SGN

Your gas. Our network.

# Gas Network Innovation Competition

Full submission pro forma October 2015

## Real-Time Networks

ofgem

RIIO NIC NETWORK INNOVATION COMPETITION

| Project Code/Version Number: |
| --- |
| SGN_GN_03/v2 |

## Section 1. Project Summary

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| --- | --- |
| 1.1. Project Title | Real-Time Networks |
| 1.2. Project Explanation | This project seeks to develop, install and demonstrate a flexible 'real-time' network that will enable the GB gas network to meet current and evolving needs. The project will install and demonstrate sensing technologies, associated hardware and software, and infrastructure in a representative section of the GB gas network. |
| 1.3. Funding licensee: | Scotland Gas Networks and Southern Gas Networks. |
| 1.4. Project description: | *1.4.1. The Problem(s) it is exploring*<br><br>The gas industry in GB is changing rapidly. A reduction in indigenous supply, the acceleration of connection of new unconventional sources, changes in consumer demand, and the advent of downstream renewables. With over 80% of peak energy demand supplied by the GB gas network, it has a very significant role to play in the journey to a lower carbon future. Key to this is a flexible distribution network that can adapt to the evolving needs of GB.<br><br>The GB gas networks methods for network modelling and management are outdated. They are based on a transmission network spine, supplying downstream distribution networks fed by a consistent source of natural gas (largely from the North Sea). Models have been developed around ensuring security of supply at peak demand conditions, thus 'snapshot' steady state modelling at worst case scenarios underpin all capital and investment within the distribution networks to meet this criteria. As the North Sea reserves have dwindled in recent years, GB is now predominantly a net importer of natural gas. The volatility of gas prices on the international market along with the emergence of unconventional sources of gas, such as biomethane require far greater network modelling capability to ensure efficient network management.<br><br>*1.4.2. The Method(s) that it will use to solve the Problem(s)*<br><br>The project will install innovative sensing technologies within a trial network. The outputs from these sensing technologies will support the development of a real-time network and revision of network modelling principles and data management methods. A novel cloud-based system alongside bespoke software will facilitate the real-time modelling, analysis and advanced forecasting. The study of downstream renewable technologies will allow analysis of their impact on network capacity and management. The potential to simulate a distributed gas source along with calorific value measurement may also be possible in |

| | |
|---|---|
| | order to demonstrate the networks' ability to effectively manage varying gas quality.<br>*1.4.3. The Solution(s) it is looking to reach by applying the Method(s)*<br>The project seeks to create a stream of real-time data and associated 'big data' analytics that will afford an understanding of network operation never before achieved. If successful, this will allow a re-write of network fundamentals and demonstrate a flexible platform for both present and future new gas sources and downstream renewables.<br>*1.4.4. The Benefit(s) of the project*<br>A reassessment of outdated steady state modelling calculations including peak 6, 1:20 and diversity in demand could reduce network investment costs.<br>The ability of the network to accept and manage distributed non-conventional gas sources could significantly reduce ongoing processing costs and capital costs for new sources.<br>The project will develop a flexible model for assessment of a range of downstream renewables. |

| | | | |
|---|---|---|---|
| 1.5. Funding | | | |
| 1.5.1 NIC Funding Request (£k) | 7,105 | 1.5.2 Network Licensee Compulsory Contribution (£k) | 798.8 |
| 1.5.3 Network Licensee Extra Contribution (£k) | 10 | 1.5.4 External Funding – excluding from NICs (£k): | 5 (also see Customer Impact for Benefits in Kind) |
| 1.5.5. Total Project Costs (£k) | 7,998 | | |
| 1.6. List of Project Partners, External Funders and Project Supporters | DNV GL – Lead project partner | | |
| 1.7 Timescale | | | |
| 1.7.1. Project Start Date | 01/04/2016 | 1.7.2. Project End Date | 31/03/2019 |

| | | | |
|---|---|---|---|
| 1.8. Project Manager Contact Details | | | |
| 1.8.1. Contact Name & Job Title | Angus McIntosh, Innovation & New Technology Manager | 1.8.2. Email & Telephone Number | Angus.mcintosh@sgn.co.uk<br>07966 195362 |
| 1.8.3. Contact Address | Axis House, 5 Lonehead Drive, Edinburgh EH28 8TG | | |
| 1.9: Cross Sector Projects (only include this section if your project is a Cross Sector Project). | | | |
| 1.9.1. Funding requested the from the [Gas/Electricity] NIC (£k, please state which other competition) | N/A | | |
| 1.9.2. Please confirm whether or not this [Gas/Electricity] NIC Project could proceed in the absence of funding being awarded for the other Project. | N/A | | |

Section 2: Project Description

## 2.1 Aims and objectives

This project aims to create a real-time gas network for the future that is flexible, secure, cost effective and safe. The objective is to optimise gas network design and operation assumptions using:

- Modern and novel flow and gas quality sensors installed in the network
- Real-time data logging and communications with a data cloud solution
- Innovative real-time demand models and network modelling

An understanding of energy (rather than volume) flow in the network in real-time and the impact of renewable and unconventional sources will enable the gas networks of the future to:

- Be more responsive to demand changes
- Facilitate connection of new supplies (including unconventional gases)
- Connect new loads with greater confidence
- Operate flexibly during maintenance, repair and upgrade operations
- Design and size future pipework more accurately
- Accommodate and understand changes in gas quality
- Respond to demand changes caused by changing weather conditions

The diagram below illustrates the complex needs of the modern energy market with gas central to the overall mix and to decarbonisation. This project aims to develop an understanding of the challenges facing the gas industry by undertaking a pilot demonstration of a real-time network.

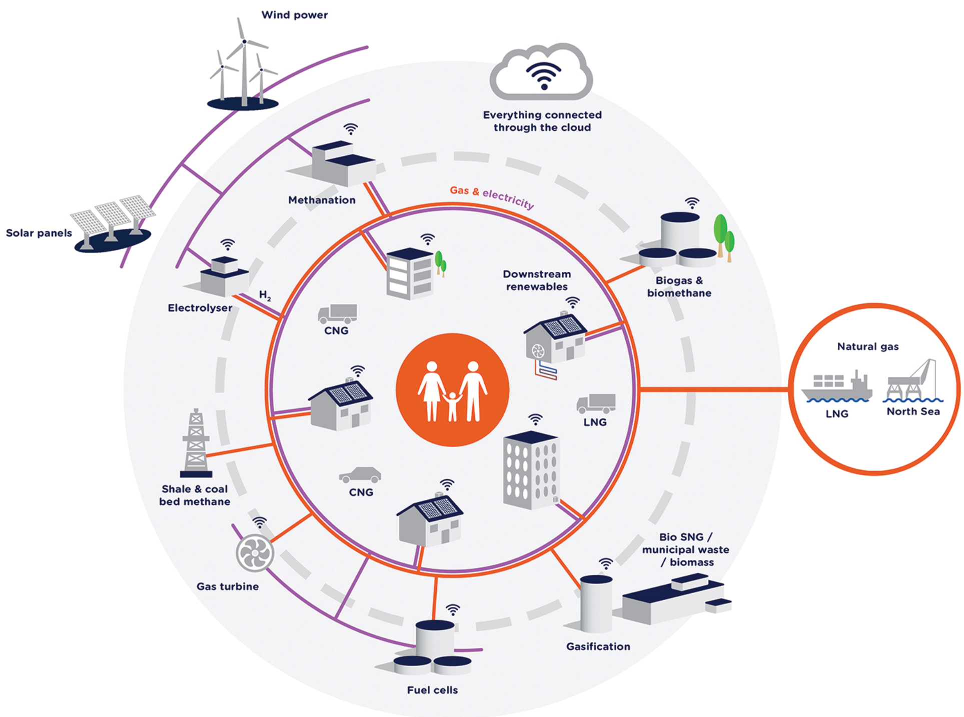



Fig 2.1 Future of gas in the energy mix

*Problem*

The GB gas industry network analysis models underpin the design of all capital and replacement projects and are a significant driver of industry and network operating costs. All network simulation models rely on a complex set of mathematics that by nature are recursive and iterative. The base assumptions for these models were taken from studies in the 1980s, and applied to the network as a whole. Whilst this method has served the industry well, it is outdated and previous restrictions on 'real' data management have now been lifted, with the advent of 'big data' and cloud storage. Developments in sensing technologies have also progressed and harvesting of data is becoming more accurate and cost effective.

The UK is unique in having the majority of its local distribution network operating at pressures not exceeding 75mbar. In order to reduce the risk of any demand spikes, causing unacceptable pressure loss, it is necessary to use a 6minute time-base to design and operate systems. The majority of other gas distribution systems around the world typically run at ranges of 2bar-4bar, leaving less exposure to transient demand variation and the associated risks on security of supply.

The modern gas network is subject to rapid and significant changes in gas quality due to increased variation in the sources of gas; these include traditional North Sea gas, nitrogen ballasted Liquefied Natural Gas (LNG), embedded unconventional gases and some more unusual sources such as LNG boil-off gas. Each of these types of gas have different gas compositions, physical properties and energy content. The potential now exists to develop real-time network modelling to account for the energy content entering the network and to understand the impact on demand at the outlets.

As a distribution network SGN has a duty to maintain security of supply and gas quality in a 1:20 condition, which is defined as (IGEM/GL/1):

> *'the maximum demand that will occur, on average, in not more than 1 winter out of 20 years. This is defined as an average in any period of 6 minutes, expressed as an hourly rate. Therefore, the mean and standard deviation are used along with standard statistical theory to calculate the point on the normal distribution that there is a 1 in 3040 probability of exceeding'*

In order to plan for the 1:20 condition, SGN needs to understand fully both current and future energy requirements. Existing network models use network pressures and an understanding of the pipeline assets (diameter, materials, pipe length etc.). For accurate real-time modelling, flows, gas qualities, pressures and temperatures are also required at strategic points of the network together with a better understanding of consumer demand.

The problems that a real-time network model could address are:

- The calculation of diversity – this is the calculation of demand taking into account the number of customers using gas downstream of any point in the network. Gas demand has changed significantly and the demand models are likely to be inaccurate due to:
  - Improvements in the efficiency and responsiveness of heating technologies at both domestic and industrial level
  - The use of integrated renewables such as gas powered fuel cells, micro CHP and gas hybrids at domestic and commercial level
  - The installation of smart meters
- Entries of embedded gas – traditionally, gas entered the distribution system only at the offtakes from the National Transmission System (NTS) and flowed, usually in one direction, to consumers. Embedded entries, such as biomethane, enter the network downstream of the offtakes and constraints are being

applied to connection of "green" sources of gas. Measurement of gas flow and quality within the network will facilitate the connection of unconventional sources of gas.

- Gas quality changes – there is a clear need for flexibility to manage different gas qualities and sources of gas and to minimise processing costs which are estimated to cost the GB gas consumer more than £300m per annum. This will support the GB rollout of SGN's Opening up the Gas Market NIC project in Oban, which seeks to widen the Wobbe Index (WI) range to support a wider range of sources, including a greater range of LNG supplies, biomethane, coal-bed methane and shale gas.
- Future business-as-usual activities such as:
  - Optimisation of network pressures, pressure control systems and methodologies improving security of supply
  - Design of increased mains insertion levels for replacement
  - Reduced general reinforcement requirements
  - Reduced carbon emissions and leakage due to lower network pressures
- The impact of renewable sources of energy on gas demand

Network analysis needs to evolve from the current steady state to transient, or 'real-time', to support entry of new and varied sources of gas, not only at peak periods, but throughout the year. Through the development of a real-time network and the provision of enhanced network performance data, SGN believe that the modelled demand could be reduced both locally and nationally.

*Method*

This project will use a pilot trial methodology with the procurement and installation of different sensor technologies across pressure tiers. These technologies, combined with novel power and communications and a cloud-based data system will be used to develop a real-time energy demand model. The project will be structured in the form of six work packages or elements. These elements will be managed through a series of go/no-go stage gates with the opportunity to review and reassess before proceeding to the next, allowing benefits to be realised at the end of each work package. The work packages are broadly as follows:

- WP 01 – Selection, development, procurement and off-site validation of sensor technologies and IT/Communications infrastructure.
- WP 02 – IP/MP/LTS – Installation of sensor technologies on area of Medway IP/MP (including Isle of Grain boil off gas MP feed). Evaluation and validation of sensor technology outputs in relation to sensor data quality, calibration and analysis against known network characteristics.
- WP 03 – LP Installation of sensor technologies on LP networks fed from Medway IP/MP (i.e. Strood LP, Cliffe Woods LP etc.). Data capture and analysis against current industry modelling assumptions. Evaluate real-time operation scenarios.
- WP 04 – Trial to include integrated renewable technologies and simulated non-conventional distributed sources.
- WP 05 – Conceptual design of systems and software
- WP 06 – NTS/LTS/IP/MP/LP cross tier assessment of real-time system. Review of data collection and processing to determine suitability of forecasting and real-time assessments

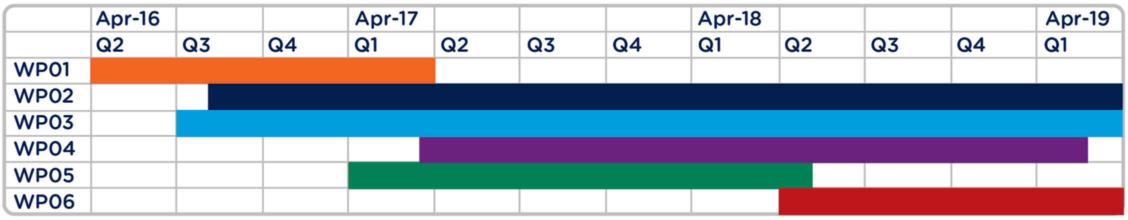



Fig 2.2 High-level project Gantt chart

*Development/Demonstration*

Real-time data is currently collected predominantly in the transmission system and at the offtakes to the distribution networks. This results in a high level, top down view of network performance and is incompatible with the rise of embedded entries into the gas distribution network.

The project seeks to demonstrate the benefits of a series of innovative technologies to support the requirements for managing variations of gas quality and flow and reacting in real-time to changing trends in the consumer market. Innovative approaches within the project will be demonstrated by installing sensors (including novel or new to gas distribution networks), power supplies, a cloud-based system for data storage and management and novel real-time network modelling.

*The Solution*

The solution is a "bottom up" understanding of network operation and energy flow across the pressure tiers in real-time. This can be achieved using:

- Gas quality, flow and pressure sensors in the network
- Local weather data
- An understanding of the impact of renewable sources of energy
- Consumer demand data
- A cloud data storage system
- A real-time network demand model regularly updated by the data cloud

## 2.2. Technical Description of Project

The development and implementation of a real-time network is a complex undertaking and is not a business-as-usual concept. There will be four types of activity none of which are currently available to SGN:

- Installation of sensors for flow, gas quality, pressure and consumer demand
- Development of a novel cloud and communications system to pass data to and from the network model
- Development of an understanding of the impact of renewable technologies
- Development of a demand and real-time network model

A well planned and controlled trial on a typical gas distribution network is required; this will incorporate existing SGN infrastructure as well as the new sensors and loggers to provide the optimum solution for testing the real-time network concept. The project will cover a number of different pressure tiers, from LP upwards, and the new demand models will be capable of returning results at an appropriate granularity for each pressure tier. The concept of a "real-time network" assumes an understanding of the network that is as close as practical to real-time. However, there will inevitably be a small delay between a measurement being made in the field, its communication to the cloud server, its adoption into the network model and then its impact on the demand calculation.

The proposed NIC trial network area is Medway in the SE LDZ of the SGN network. A network map of the SE LDZ is shown in *Appendix 2*. Existing data sources include Xoserve (annual quantity), the Safe Control of Operations (SCO) database, SGN SCADA data and network pressures. The new measurement equipment will present real-time information to data loggers and will comprise:

- Flow and gas quality sensors in the network
- Additional pressure sensors in the network
- Loggers on consumer meters
- Weather data (ambient temperature and wind speed)

Information about the impact of renewable technologies will be supplied by DNV GL who will partner with an expert contractor with extensive experience in this area. DNV GL will host a real-time cloud-based server to communicate with all the data sources. The proposed communications architecture is shown in the diagram below and a more detailed approach is demonstrated in *Appendix 3*.

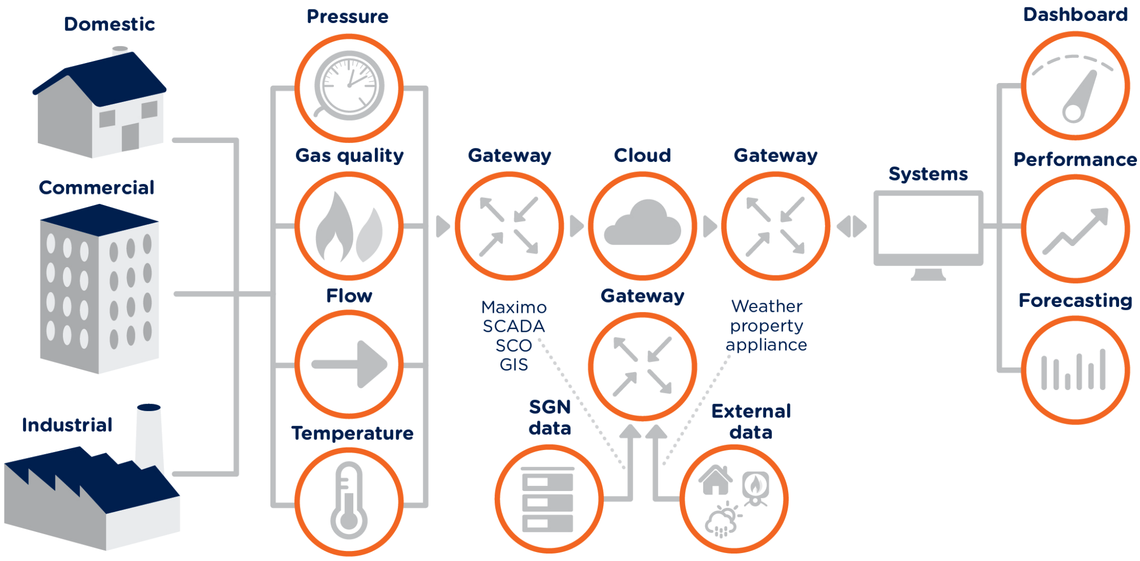



Fig 2.3 High-level data flow plan

A second data cloud will be available to provide archive, search, security, visualisation, reporting and export features. The innovative communications solution uses the technologies of the internet-of-things (the networking or physical objects embedded with sensors and connectivity) to deliver a low cost, highly scalable, feature rich environment that more than satisfies the requirements of the real-time networks project. This type of cloud-based solution is mainly used in the IT industry for analysing software networks and this is the first application of the technique for gas networks. Learning from this aspect of the project can be disseminated throughout the GB gas industry in many forms as there are alternative providers for both the cloud-based servers and the technology installed in the field.

It is proposed that the design, purchase, build and installation of the new measurement and communication equipment will take place in the first year of the project; this will be delivered as work package WP01 and the initial stages of WP02 and WP03. There will be at least a full gas year of data logged in year two as part of WP02 and WP03, which will feed and support the development and training of the concept network models in WP05. During year three, data collection and model development work will continue, but data for renewable sources of energy will be assessed; the renewable part of the project forms WP04. Throughout the measurement period, equipment in the field will be maintained and monitored to ensure data integrity. The demand models will be developed during and after the data collection phase as part of WP06. The detailed project plan is shown in *Appendix 4*. In order to model the Medway network, all the gas flow inputs and outputs were identified. The NTS supply into the Medway network is predominantly from the offtake at Shorne which supplies "traditional" natural gas from the Bacton terminal as well as nitrogen-ballasted LNG from Grain LNG. The boil-off gas from the Grain LNG import terminal is also a flow input to the network and this has a distinctive gas quality (mainly methane enriched with either propane or LNG). Examples of the network measurement points in Medway that were selected to characterise the flow and gas quality in the network are shown in *Appendix 5*.

For a number of measurement points, options have been provided to ensure that the most cost-effective site is chosen. Where there are options, they are all equally valid in terms of informing the development of the real-time network. Surveys of all the potential measurement sites have been carried out – examples of the site survey packs are shown in *Appendix 5*. Detailed plans for installing the equipment have been drawn up – examples of these are shown in *Appendix 6.*

The measurement approach is shown below. The measured calorific value and standard flow rate will be combined to determine energy flow rate.


Fig 2.4 Real-Time Networks measurement strategy

There are a number of different measurement technologies but this project seeks to embrace new and emerging technologies to develop cost effective solutions for developing real-time networks. A mixture of established, new (but tested under NIA) and novel sensor technologies is proposed; examples are listed in *Appendix 6*.

The established technology is required to provide a set of reliable flow and gas quality data for the development of the network models. The new-but-tested technology has been developed under previous NIA projects and this project allows further testing in a real-time network situation. The novel technology will not have been used on a GB network previously and it has been selected because of the particular challenges identified during the site surveys. For example, the site adjacent to the A2 near Rochester is a 36" metal pipeline operating at 2 bar and at a depth of nearly 4 m. In order to prevent a supply interruption, a meter installed through a hot-tap at the top of the pipe will be required. Due to the low pressure, and the requirement for pigging of the line, a retractable ultrasonic meter, usually used for flaring, has been selected; parallels with flaring were drawn as they too are low pressure and large diameter pipe applications.

A modular approach for sensor design and installation is proposed with each regulator or governor installation having a common format. The flow measurement equipment and gas quality tapping will be in a new pit with a kiosk mounted alongside to house the instrumentation, power supply and battery back-up, remote telemetry unit and volume conversion modules.

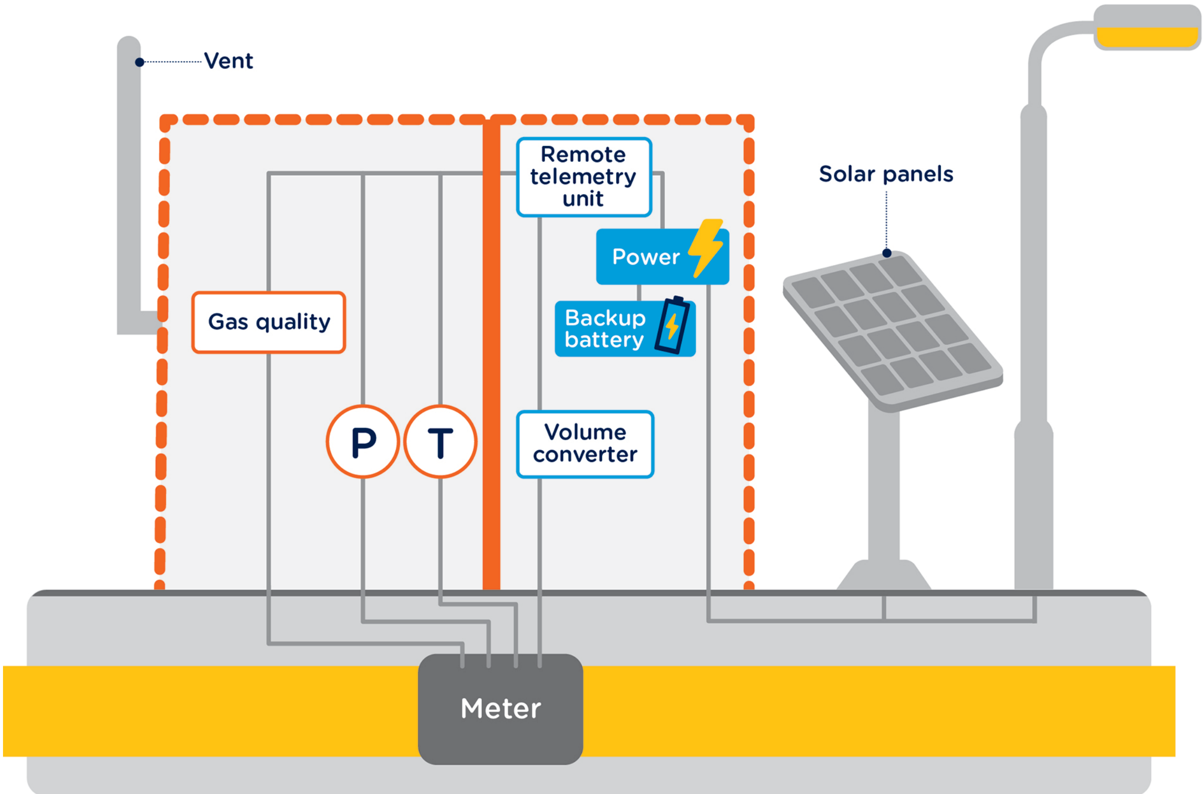



Fig 2.5 Modular design for novel sensors

For the new sites beside the A2 and the Rochester Castle Coach Park a novel ultrasonic meter application is proposed. For the Rochester PRS, the inlet pressure is 35 bar and a clamp-on ultrasonic meter is proposed – these can be unreliable for low-pressure applications, but they can operate well at higher pressures. Gas quality will be measured using a GasPT2 at the inlets and outlets of the Medway network. Within the network, it may be possible to install a number of cheaper and novel gas quality sensors. These will be laboratory tested prior to installation – the GasPT2 will be the backup solution.

The additional pressure loggers in the network will be supplied by either established technology or technology recently successfully trialled under NIA. Similarly, power supplies are likely to be a challenge as transmitting in real-time is power hungry and there is no power at any of the sites apart from Rochester PRS. The innovative solution is either to take power from existing street furniture or to use solar panel technology currently being studied under an NIA project sponsored by National Grid Gas Transmission. Any solar panels will be recessed into the top of the instrument kiosks to minimise the visual impact and potential for vandalism.

Weather data is to be obtained for the whole of the SE LDZ. This will take the form of temperature and wind speed measurements at five locations and/or the purchase of weather data from established commercial suppliers. This aspect of the project will be finalised as part of WP01 of the project.

Consumer meter data will be required to understand gas demand over the trial period. A number of options are available that may be used either alone or in combination:

- Access to live Smart Meter data in the Medway and SE LDZ area
- Another source of Smart Meter data
- Consumption data from previous network studies
- Fitting of a representative sample of consumer meter loggers

If Smart Meter data is not available during the timeframe of the project then loggers on consumer meters will be required. The technology is non-intrusive and comprises a small pulse counter (about the size of a match box) and a battery-powered data logger.

The contribution of renewable energy sources to the overall energy mix will be explored by including the impact of renewables on gas demand. The study will include low carbon heat and distributed energy including heat pumps, micro CHP, air and ground source heat pumps and solar hybrid systems.

The modelling of demand currently takes places using a 6-minute granularity. Given that one of the aims of the real-time network project is to improve the accuracy of the models the timeframe cannot be lengthened; this creates a requirement for any new real-time models to be capable of functioning at the 6-minute level. Typically, near live modelling is carried out on the higher pressure tiers only and this project will extend on-line modelling into the below 7bar system, providing the opportunity to demonstrate improved control and the ability to stretch the system. Options for the use of this understanding in the design for storage and operation of the system will be considered. The demand modelling will be novel in that it will seek to:

- Account for the energy used by consumers rather than merely the volume
- Use additional weather data from the SE LDZ area with a finer granularity than is currently used
- Establish new approaches to model validation to give proper assurance that they are appropriate for wider use
- Support alternative approaches to consumer billing

The demand models will be fully tested against the measured data for their performance at conditions across the year and across the day. This will provide assurance that processes are available for the development of robust demand models given appropriate data for any area of SGN and indeed GB.

## 2.3 Description of Design of Trials

The solution concept is illustrated in *Appendix 7*. Measurements from the gas network will be collected for a year at intervals of about six minutes and sent to a data cloud. A real-time demand model will be developed which will take data from the cloud server. The impact of gas quality, flow, weather, renewable sources of energy and consumer demand will all feed into the development of a novel demand model.

The real-time network project is designed from the outset to be statistically sound. As a general principle, the more detailed and extensive the data available, the more accurate and robust both the demand models and the real-time network live simulation will be.

### *2.3.1 Influence of Weather*

The number of consumers within a localised Composite Weather Variable (CWV) area and the number of CWV areas will be considered to ensure that the accuracy of any local adjustment can be verified by real data. The sample size thresholds apply on a network-by-network basis and the nature of the real-time adjustments applied depends on the availability of real-time data in that network. The creation of localised CWVs introduces a novel geographical breakdown – that of weather areas.

### 2.3.2 Gas Quality

The numbers of consumers within a localised calorific value (CV) area and the number of those areas where specific measurement of CV data is taken will be considered to ensure that localised CV adjustment is accurate. Previous Demand Estimation Models (DEMs) have served the industry well but they all work on the basis of volume flow. Application of a broad-brush CV that applies to whole sections of an LDZ will result in an energy model that has the same amount of scatter as existing flow models. In order to create models that estimate energy consumption, WP02 will involve the collection of 6-minute energy data (CV and flow) from strategically selected sites. The data will be used to develop models in WP05 and WP06 and to provide the actual CV at points within the LDZ.

Networks can be fed from a number of sources, each with potentially different CVs, and these sources will mix further and need to be measured within the LDZ. The penetration of specific gas qualities within a network will vary with the flow of each source and with consumer demand.

### 2.3.3 Network Flows

The flows into and out of the Medway area will be measured at key points as part of WP02. In addition, a further area of the low pressure network in Medway will be measured to understand energy flow within the network. This data will be used to test the accuracy of the demand modelling to be used generally in network analysis and for on-line modelling purposes. This testing will provide assurance that the model provides an adequate reflection of the changing demand patterns within the network, including the levels of diversity seen for different numbers of consumers.

### 2.3.4 Consumer Meters

Consumer meter data will be collected from a properly formed random sample covering the full range of consumers within the SE LDZ. The rationale for the sizes of the samples of domestic and non-domestic consumers has been derived statistically during the development of a methodology which includes a more accurate and detailed breakdown in consumer demand categories. The data collection strategy and logging will form part of WP01 and WP03; the approach is described in *Appendix 8*.

| Scenario | Number of consumer meter loggers to be installed |
|---|---|
| Use of Smart Meter data from another source but not including data from SE LDZ | 200 |
| No access to any Smart Meter data | 1200 |

In the event that smart metering data or any other relevant data source can be used, the requested funds for this aspect of the project will be returned to the GB gas customer.

### 2.3.5 Impact of Renewable Energy

Establishing robust, reliable data from desktop field trials of renewable energy technologies is difficult. The use of a laboratory-based heat system simulator is proposed as an alternative to installation of renewable technologies at customer’s properties. A simulator could cover many different house types, at different times of the year and different occupancy to generate a wide range of usage. DNV GL has identified various potential partners able to deliver this method and will select a contractor as part of a procurement process.

For domestic gas energy demand profiles, central heating and domestic hot water loads may be generated and measured by the simulator. Data should be produced with a time resolution of one minute to establish the dynamic behaviour and provide details on the interaction of the operational modes of the appliances with the heating systems. For instance, new, large combi boilers can have a very high instantaneous heat input which modulates down after a short time; this profile is very different from a traditional boiler.

The proposed work programme will include "calibration" with a traditional central heating boiler against different property types and ambient conditions. The process will be repeated with renewable technologies such as a modern condensing boiler, micro CHP (mechanical and fuel cell), solar thermal hybrid, Air Source Heat Pump hybrid and Ground Source Heat Pump hybrid.

The test simulations will give an indication of how new technologies will impact in real-time on identical properties heated to the same degree. These can be cross correlated with real annual energy consumption and correlated with the latest DECC data. Some commercial system studies will be undertaken based on existing studies and with extensions for CHP and biomass boiler systems.

This comparison of existing and new technology in a regular, reproducible manner will provide definitive and comparable data that will feed into the gas network model and assist with understanding the demand fluctuations.

## 2.4. Changes since Initial Screening Process (ISP)

Since the Initial Screening Process, further research into obtaining consumer demand data has been carried out. It is likely that appropriate Smart Metering data will not be available due to anonymisation and other uncertainties. Alternative data sources have been identified both of which include the use of consumer meter logging in the trial area; this will increase the project cost and require additional customer engagement. The cost for this aspect is approximately [redacted]. It should be noted that if Smart Metering data or any other relevant data source was to become available prior to the commencement of the consumer logging phase, these additional costs would be returned to the GB gas customer. The installation and monitoring of consumer meter logging will form part of WP03.

Following discussions with the expert panel during both bilateral sessions, amendments have been made to the cash flow of the project. The changes to the distribution of costs among the work packages does not impact on the overall project costs but allows for further de-risking of expenditure through the Project Go/No-Go Stage Gates (*Appendix 18*). Although the work package costs have altered, they remain within the +/- 20% variance as indicated in the ISP.

| | Cost | ISP% | Variance |
|---|---|---|---|
| WP01 | [redacted] | 15% | 7.5% |
| WP02 | | 30% | -12.7% |
| WP03 | | 30% | 3.3% |
| WP04 | | 15% | 4.2% |
| WP05 | | 5% | 0.2% |
| WP06 | | 5% | -2.5% |

# Section 3: Project business case

## 3.1 Introduction

This project is designed to deliver benefits that can be broadly categorised as follows:

1. *Network benefits* – to SGN, the other GB Gas Distribution Networks (GDNs) and NGGT. Any benefits realised will be passed back to customers through the IQI mechanism within the RIIO GD1 framework.
2. *Wider industry benefits* – benefits through the provision of a more flexible network that will enable network entry at a reduced cost and support downstream renewables.

GB gas network companies have a significant role to play in the future low carbon gas system. In order to do so, they must be flexible.

## 3.2 Approach

Cost and benefit predictions have been produced to support the business case for the project:

*Appendix 24* – Full Submission Spreadsheet

*Appendix 1* – Benefits Summary Table

The Full Submission Spread Sheet details the costs associated throughout the duration of the project and the benefits summary table quantifies the predicted financial and carbon benefits annually. If this project were successfully implemented across SGN, and subsequently across GB, the benefits realised will be substantial.

The breakdown of these benefits is provided in the benefit summary tables from 2020 to 2050. This business case summarises the findings of the Cost-Benefit Analysis with case studies below and in the appendix organised into key benefit areas.

*Network Benefits*

Network Benefits suggested will be achieved though:

1. the targeted 15% reduction in the redefined 1:20 peak condition and associated off peak diversification
2. the demonstration of new sensing technologies that are less expensive than existing options
3. the proposed alternative IT and data management solution versus current method

*Reduced Leakage – tangible*

By the end of the project it may be possible to contribute to a significant reduction in leakage across SGN.

This will be achieved by redefining current industry best practice demand profiles, using data obtained during the duration of the project, resulting in an overall reduction in demand and reduced Average System Pressures (ASP) hereby reducing leakage. See Case Study 1 in *Appendix 9*.

*Reduced Replacement expenditure – tangible*

All GDNs combined have been allowed £5.2bn for mains replacement (Tier 1-3), £281.6m for mains reinforcement and £135.2m for regulator replacements under RIIO GD1.

By redefining the way in which mains replacement projects are designed, a justifiable way of inserting these mains and reducing the cost of the replacement program as well as bringing significant benefit to customers through reduced disruption to traffic and the environmental effects of excavating may be achieved. See Case Study 2 in *Appendix 10*.

*Replacement of LTS and below 7bar Pressure Reduction Stations – tangible*

Pressure reduction stations are designed to supply the peak hourly flow required by the below 7 bar system. The flow required by the below 7 bar systems is identified through network analysis of those systems using the current algorithms in the Demand Derivation System (DDS) and approaches to validation of the network models.

As with Pressure Reduction Stations, the supply of gas from the LTS pressure reduction installations within the below 7 bar systems is designed to supply the peak six minute flow required by the below 7 bar system identified through network analysis.

See Case Study 3 in *Appendix 11*.

*Proof of Ultrasonic Flow metering capabilities – tangible*

As part of this project SGN aim to use new ultrasonic flow metering (USM) at key sites to measure the flow into and out of the identified trial area. As some of the innovative new sensors in the trial can be installed using hot-tapping, this will potentially reduce the cost of implementing flow measurement in real-time networks.

Additionally, following the first year of flow measurement data SGN will be able to produce a report detailing its suitability for use by DNs across GB. Under SGN's business-as-usual activity there is a program in place to replace orifice plates with USMs at NTS offtakes.

See Case Study 4 in *Appendix 12*.

*Reduced Exit Capacity – tangible*

There exists an incentive mechanism which has been put in place to encourage distribution networks to minimise their booked capacity from the NTS to protect the NTS from supply issues, free up capacity across GB and make it available in areas of higher demand.

If successful, following the rollout across SGN, it will be able to reduce the booked exit capacity, resulting in a cost saving.

See Case Study 5 in *Appendix 13*.

*Novel Gas Quality Technology vs. Danalyzer Analysis*

The chemical composition, Calorific Value (CV) or quality of the gas in the gas networks must be monitored at key sites to determine exactly how much energy is being supplied to customers connected to the network.

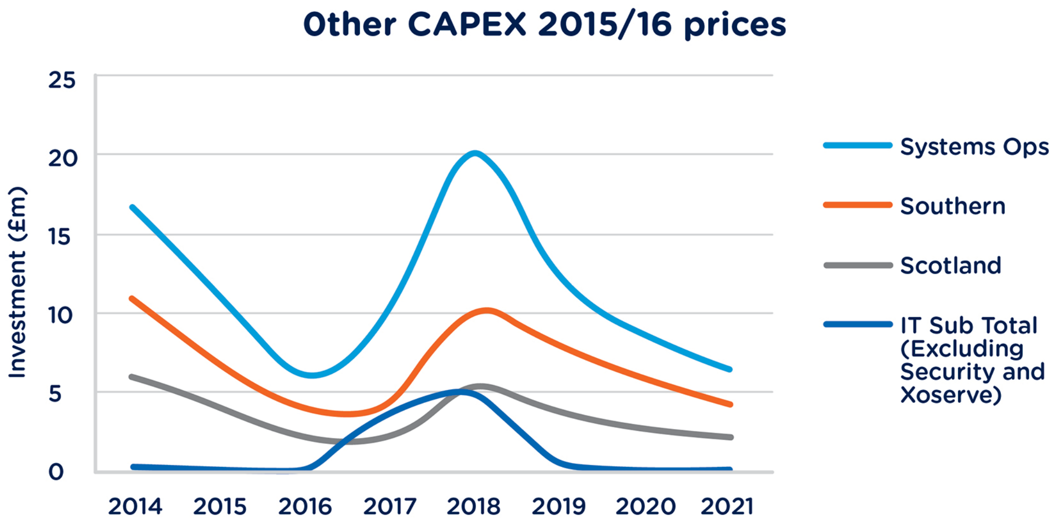
The system currently used is the Daniels Danalyzer model 500 or model 700 gas chromatograph installed at NTS offtakes. During this project SGN will implement the use of novel gas quality technology or the GasPT2 gas quality monitoring system downstream from the NTS offtakes at lower pressure tiers.

Both are cheaper systems requiring reduced maintenance and operational costs. Following a year of gas quality monitoring it will be able to assess the performance of these systems for this novel application.

SGN will also produce a report on the suitability of the novel gas quality technology for use in localised gas quality management. If we find that there is a strong business case for the wide scale use of the novel gas quality technology on the networks in GB this would provide significant savings for the GB gas customer. For example, if we could demonstrate the GasPT2 could replace current Danalyzer gas chromatographs, the saving could be over £2.148m based on a reduction of installation costs at each of the 110 sites across GB. Additionally there are significant operational and maintenance costs associated with the use of the existing Danalyzer equipment, whereas the novel gas quality technology will have fewer associated costs.

*Infrastructure Cost vs. Cloud Analysis – tangible*

GDNs invest significantly in IT infrastructure to update old systems or incorporate new ones. This is usually followed by a period of reduced expenditure as the asset is used and becomes dated until the next cycle when investments are made in renewed infrastructure.




Developments in big data cloud storage and systems afford an opportunity to change this model.

This project will be used as a test bed for a new IT strategy, utilising Software as a Service, and renting data space rather than investing in hardware cyclically.

The solution proposed is to create a cloud-based storage system. Project implementation costs will reduce as the time taken to commission hardware and software will be drastically reduced.

Additionally this project will produce a single application that manages the storage and utilisation of all of the data obtained from the infrastructure installed on the networks. Once proven, this will remove the necessity for the annual renewal of licenses currently paid to suppliers of the applications used by GDNs to fulfil the current associated operations. A breakdown of this cost benefit has been provided in *Appendix 1*.

## Wider Industry Benefits

*Removal or reduction of Nitrogen Ballasting*

In order to comply with the Wobbe Index (WI) range specified by GS(M)R, most LNG supplies delivered to GB need to be ballasted by the addition of nitrogen to reduce the WI.

Many potential streams of imported gases for the GB market may have a WI that exceeds the current upper limit in GS(M)R. Most LNG has a WI of between 51 MJ/Sm$^3$ and 54 MJ/Sm$^3$, and as such most LNG will need to be processed in order to meet the GS(M)R specification. The cost of nitrogen ballasting at LNG terminals is passed to the

GB gas consumer. The process is expensive because the nitrogen needs to be treated to remove impurities (principally oxygen) by liquefaction.

The work being done by SGN under the Opening up the Gas Market project will seek to widen the permissible WI range and substantially reduce the requirement for nitrogen ballasting.

The Real-Time Networks project will facilitate the rollout of this benefit hence the inclusion of this area in this benefit case.

Below is a breakdown of the cost of this ballasting across GB[1].

| Variable Charges | | | | | |
|---|---|---|---|---|---|
| **Utilisation** | **Terminal** | **Base** | **Power** | **Other *(water/triad/ trucks)*** | **Total** |
| 10% | Grain | £12,672,000 | £80,270,000 | £34,607,730 | £127,549,730 |
| 10% | South Hook | £12,672,000 | £80,270,000 | £34,607,730 | £127,549,730 |
| 5% | Dragon | £12,672,000 | £40,135,000 | £17,303,865 | £70,110,865 |
| | | | | **UK Total** | £325,210,325 |
| | | | **Cost per Customer** | **£16.26** | **per year** |

These calculations are based on the assumption of 20 million gas consumers in GB.

By way of applying this to the Medway area we have multiplied the cost/customer by the number of customers in the real-time network trial area. Medway has approximately 22,000 customers thus the cost of ballasted gas to supply the network area is £357,720/year.

*Reduction in Propanation – intangible*

Currently, consumers are billed on the basis of the average CV of gas delivered into the LDZ over a specified period, normally daily. This daily LDZ CV is called the Flow-Weighted Average CV (FWACV). Regulations cap the value of the FWACV to no more than 1 $MJ/m^3$ greater than the lowest FWACV of each gas supplied to the charging area.

The NTS is operated to ensure that the off-takes to the distribution networks do not encounter a range of CVs which would result in the implementation of the CV cap. This is achieved by careful control of the flows of different gas qualities within the NTS. The NTS is not required to undertake this service but it does so in its role as a prudent transporter for the gas distribution networks, shippers and consumers.

In order for biomethane supplies to gain entry to the gas network, propane needs to be added to increase the CV to close to that of the prevailing gas supply passing the injection point. Biomethane is usually GS(M)R compliant and therefore safe for consumers.  The addition of propane is to avoid the CV cap being imposed on the network. The implementation of the CV cap causes CV shrinkage in the NTS which increases transportation costs which are ultimately borne by the consumer.

If the propanation of biomethane and other low CV unconventional gas supplies is to be avoided, billing consumers closer to the point of use is likely to be a solution. The number of enquiries determining the suitability of an embedded supply of gas is increasing each year. Currently, within SGN there are 13 sites connected while another 4 are anticipated by the end of the year.  All of these sites will need to use propane to enrich the supply into the LDZs.

[1] Figures provided by National Grid LNG

The project will develop and assess the options for using a combination of additional CV measurement nearer to consumers and network analysis methods for determining the energy received by consumers.

The project will seek to develop the hardware and processes required to determine the CV received by consumers more locally, together with the likely costs. This requires the use and assessment of known and novel gas quality measuring devices and the development of novel network analysis techniques.

### 3.3 Avoidance of Capital – Intangible

By making the current gas network system more flexible and able to accept renewable/indigenous supplies, through the real-time network project, we will be able to reduce capital costs for entry into the gas network.

Most enquiries to gas distribution networks from potential biomethane producers regarding network capacity for a new embedded entry of gas do not progress beyond this initial contact stage due to the high capital costs.

By having a greater understanding of the capacity available at peak through to summer conditions the gas networks will be able to more accurately quote the cost of connection and increase access for unconventional gas sources. This will, in turn, promote the low carbon future of the gas networks by allowing more low carbon gas into the network from biomethane production or other renewables.

Following a total of 499 embedded entry enquiries to SGN only 79 were accepted and have progressed to further field survey/capacity study with a total of 13 Anaerobic Digestion plants now connected to the network.

It is estimated that up to 500 biomethane connections will be made to the gas distribution networks by 2020.

*Removal of Compression Costs*

At the Grain LNG terminal, boil-off gas is currently compressed from 15-25 mbar to 38 bar by two 3.2 MW compressors that run at 75% of full capacity for twelve hours each day for injection into the LTS and storage. Both the compression and storage of this gas have significant associated costs.

Boil-off gas is also compressed to 2 bar for injection into the Medway distribution network however, the flow into SGNs MP system is low due to uncertainties surrounding capacity of the network.

Following completion of the project, the Medway area may be able to accept a higher volume of boil-off gas. Should the flow of boil-off gas into the trial area increase it will reduce the requirement at Grain LNG for compression up to 38 bar resulting in significant cost savings. This saving will be passed directly to the customer as this is not a benefit that will be realised by either National Grid LNG or SGN. For a breakdown of this cost benefit see Section 4.

The operation of real-time networks which may result from this project may allow demands to be connected to the network which will not be physically possible to take gas at peak and would be based on a form of seasonal or interruptible contact. The understanding of demand and consequent operation of the network may allow these types of consumers to be connected and take gas over a greater period of the year than is currently allowed. SGN may consider seeking modification of the current UNC should a market emerge for these types of connections to consumers.

## Section 4: Benefits, timeliness, and partners

### (a) Accelerates the development of a low carbon energy sector and/or delivers environmental benefits whilst having the potential to deliver net financial benefits to future and/or existing Customers

The energy industry is changing. The transition to a lower carbon economy, at reduced cost, while maintaining security of supply, is a key challenge for GB. The gas network has a major role to play in the future energy mix, however, in order to do so it needs to be flexible.

This project seeks to create a flexible 'real-time' network that can demonstrate a method to manage different compositions of gas within an integrated network (see diagram in Section 2 showing the flexible network vision).

Each source of gas has different compositions that require some form of processing prior to injection into the gas distribution network.

Figure 4.1 below charts the WI range of gases that are either being injected into the gas network or being considered for injection. The ongoing Opening up the Gas Market project is developing a roadmap for GB to widen the current UK specifications within the Gas Safety Management Regulations (GSMR). If the findings to date from the initial trials in Oban can be replicated and rolled out to GB, a wider range of gases will have to be managed by the network operators. This project seeks to show how this might be managed using innovative sensing technologies and advanced network modelling. A table detailing the different gases and their potential scale is in *Appendix 14*.

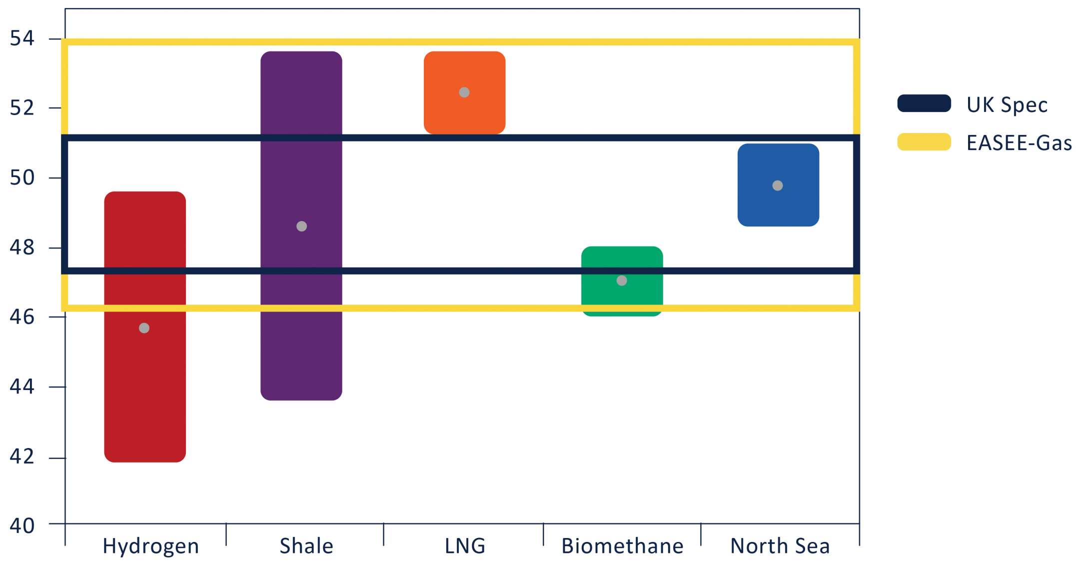



Fig 4.1 Wobbe Index of the non-conventional sources of gas against UK and EASEE-Gas specs

Each source of gas has different compositions that require some form of processing prior to injection into the gas distribution network. This processing is expensive and has an environmental impact.

For example, it is anticipated that there will at least 68 biomethane supply points added to the SGN network in the next four years.

In order for biomethane/BioSNG supplies to be injected into the gas network, propane is added to enrich the gas to meet the commercial range of the Calorific Value (CV) prevailing in the network. Whilst the biomethane otherwise already meets GS(M)R, propanation is usually necessary to increase the CV. The capital and operating costs for propanation are high, and a barrier to entry. For example, a plant with a capacity of 1000scmh would expect propanation costs of approximately £474,000 per annum. The Medway field trial location has a peak 6 demand of approximately 37,470scmh therefore, if just 10% was supplied by biomethane/BioSNG the annual propanation costs could be in the region of £1.8m.

The project will develop and assess the options for using a combination of additional CV measurement nearer to consumers and network analysis methods for determining the energy received by consumers. Flow and gas quality measurement technologies are currently high cost, however, new technologies have been developed and will be trialled as part of this project. If an alternative means of CV management can be successfully demonstrated it could reduce barriers to entry and minimise environmental impact from propane use.

A further challenge for embedded entries into the gas network is the location and suitability of the injection point. The majority of potential biomethane and BioSNG sites are likely to be closer to a <7 bar distribution gas main, rather than a high pressure gas main.

Connection to the <7 bar is very cost effective compared to the NTS or Local System (LTS). However, the distribution network must ensure that it can accommodate the gas injected at all times. Steady state modelling makes this analysis difficult. Conservative assumptions have to be made particularly in relation to low flow summer conditions to avoid venting, or worst case over-pressurisation.

If the network cannot accommodate a new connection due to current modelled flow constraints, a higher pressure solution is required. Injection into the higher pressure system is more expensive and requires significantly more capital and operating costs for compression. As an example, Grants biomethane site, which compresses to approximately 19 bar, feeds 800scmh to the network. The annual compression costs for this site are approximately £90,000. Given the identified field trial site for the real-time networks demonstration has a total peak 6 demand of approximately 37,470scmh, the equivalent value for the avoidance of compression could be in the region of £420,000.

This issue will be exacerbated as more network flow constraints are added to the network.

The number and percentage of biomethane entry enquiries that couldn’t be accommodated by the SGN network are given in the table below:

| | | Enquiries in Progress | | | |
|---|---|---|---|---|---|
| | Total Enquiries | Initial | Quoted | Accepted | Connected |
| Biomethane | 565 | 477 | 32 | 39 | 13 |

The project will improve understanding of diversity of gas supply use in real-time, allowing transient analysis of network flow constraints. This may increase the number of accepted embedded entries into the <7bar distribution network.

For LNG entry points, processing has a high capital and operating cost. There is also a significant environmental impact from the manufacture of nitrogen. National Grid LNG estimate that the annual cost of ballasting, dilution of the rich LNG with nitrogen, will be in the region of £325m per annum with current import forecasts. The Opening up the Gas Market project and the potential IRM project for GB rollout will seek to significantly reduce this for GB. The transition to a wider range of gas may require sectorisation, therefore a means of managing gas quality during this time will be required. The project will develop and assess the options for using gas quality sensing technology within the distribution network to support this.

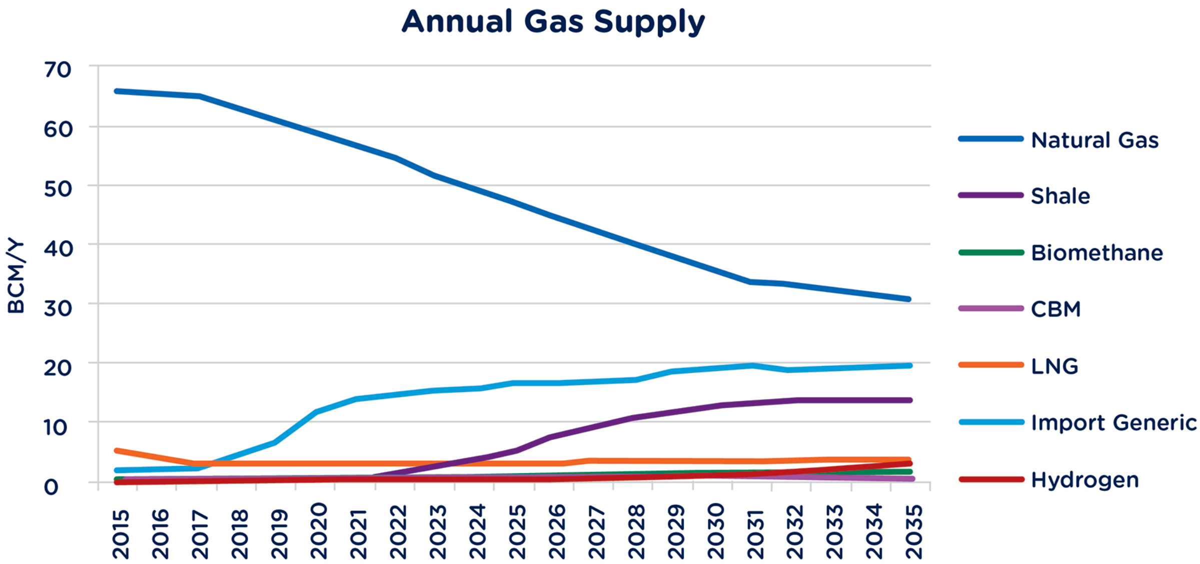



Fig 4.2 Gas futures projection[2]

Shale gas too, depending on the composition that is extracted will undoubtedly require some form of processing which will increase capital and operating costs.

*Understanding of the potential impact of downstream renewable technologies*

This project proposes dynamic property simulations of downstream integrated renewables that will provide an important insight into the fundamental appliance performance. The proposed laboratory simulation of these systems will inform both the gas and electrical industry of the potential effect on the energy network of using these new appliances. Traditionally, gas appliances have operated with no material impact on the electrical network, as the load from the boiler controls and pump is typically less than 100W, but these new devices will potentially increase this interaction. Thus gas heat pumps have a substantial electrical demand to run the fans or ground source water loop and internal refrigerant pump. Micro Combined Heat and Power (mCHP) can produce very considerable quantities of electricity, often requiring export to the electricity grid. If these products penetrate the market significantly, both will have effects on the local 440V and 11kV networks.

In future, if controls could be installed at domestic, commercial and industrial scales, then the issues around constrained energy networks could be more efficiently managed. A demand response mode could be designed and optimised to switch between gas and electricity inputs, allowing greater flexibility for managing intermittent sources into both networks. These are very important factors that must be considered when trying to model the future energy market. In this potential future, the gas and electric networks will become increasingly integrated to minimise emissions, improve the user experience and enable the networks to adapt to introduction of new technologies. The contribution of renewable energy sources to the overall energy mix will be explored by including the impact, if possible, of renewables in the Medway or surrounding network. The project aims to quantify the impact on the gas system of a number of renewable technologies i.e. Micro CHP, IE CHP (fuel cell system), hybrid heat pump systems.

The demand modelling to be developed will be based on acquiring data for a sample of statistically representative consumers. However, it is unlikely the sample would contain gas users who also have novel renewable installations. Consumers with renewable

[2] http://www2.nationalgrid.com/UK/Industry-information/Future-of-Energy/Future-Energy-Scenarios/

installations are likely to exhibit different behaviour patterns to those in the main sample of consumers. It is proposed that the impact of renewable technologies would be studied to understand how demand may change into the future.

This will allow the demand model to be adjusted and 'what-if' scenarios run to better understand the requirements for demand which will be placed on the network. The demand modelling developed through this project is intended to be more reactive to changes in consumer behaviour.

The project will also look at the efficiency of the renewable technology and its environmental impact.

*Leakage reduction*

Through improved understanding of demand diversity it is hoped that this project will demonstrate a reduction in forecast 1:20 conditions. If successful, pressures within the network will be reduced and since change in gas pressure is proportional to the square of the gas flow, the rate of leakage will also reduce. The effect leakage can have on the environment can be significant. For example, in Strood LP network, the current leakage is 212.27 tonnes of natural gas. Natural gas is at least 21 times as pernicious a greenhouse gas as carbon dioxide, therefore the CO2 equivalent of the current leakage in Strood LP is 3566.14 tCO2e.

*Reduced waste material to landfill from Streetworks*

The Strood Low Pressure Network lies within the trial area. This network includes over 100km of metallic mains, 22.5km of which are due to be replaced in the next four years. Approximately 3% of these replacements have been designed as 'open cut'. Open cut is the most disruptive method of mains replacement to customers, businesses and road users alike. It involves excavation and reinstatement for the entire length of the pipe section being replaced. It can be estimated that for every meter of pipe, 0.6 tonnes of excavated material is produced, of which 10.4% goes to landfill. Once the new main has been laid, 26% of the backfill used to reinstate the carriageway would be virgin aggregate material.

If SGN can achieve the reductions in 1:20 peak demand design conditions being targeted, following analysis and redesign of these projects, it is estimated that all of these mains could be inserted resulting in a saving of approximately 62.4 tonnes of backfill sent to landfill, and 155 tonnes of virgin aggregate material. There would also be a significant reduction in the streetworks aspects and duration.

This can be scaled by assuming a conservative 20% reduction of the open-cut length across SGNs mains replacement activities per annum. This results in a saving of 12.5 tonnes of material sent to landfill and the avoided use of 31 tonnes of virgin aggregates.

The CO2 emissions that are a resultant factor of the material haulage is normally 1.46kg CO2 per tonnes of excavated material as such a saving of 63.4kg of CO2 save per annum.

### (b) Provides value for money to gas/electricity distribution/transmission customers

In 2014 an open invite was sent out to over 1000 potential partners offering the opportunity to propose a project on how to run a flexible future gas network with a view to utilising recent advances in sensing technology and big data. From a large number of notes of interest, the parties that submitted bids were narrowed down to four. These remaining companies were invited to present their methodology to delivering this innovative project. These presentations, coupled with feedback from various stakeholder meetings helped to define the scope of the project.

Two stand-out bids were received, one from Enzen, the other from DNV GL. Although their methods differed, each had their own merits and specific strengths. In order to stimulate a competitive process and drive out the best project at best value for the GB gas customer, two discrete feasibility studies were carried out in parallel under the NIA (NIA_SGN0066).

The reports produced by the project partners set out a road map to achieving our goal of a real-time network from our current position with recommendations on sensors, communications and data solutions and technical service providers within relevant domains.

The two feasibility studies were subjected to internal (SGN) and external (IGEM) tender comparison, with both parties concluding DNV GL as the preferred partner.

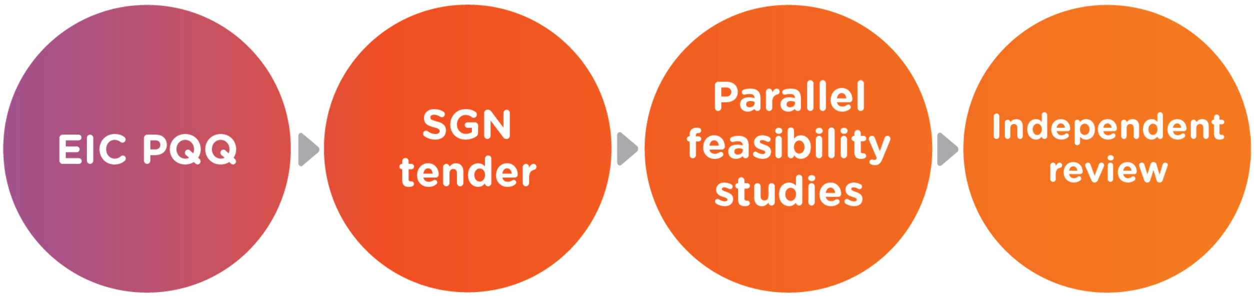



Fig 4.3 SGN's partner selection process

The location of the project has been designed to recognise the full value chain from LP distribution up to the boil-off gas network entry point at Grain LNG (see table of network features in *Appendix 15*). This connection of pressure tiers through real-time data facilitates a bottom up view of gas usage and capacity. The network section selected and the number and location of loggers being installed have been carefully selected to ensure the learning can be scaled to GB.

Purchase of hardware or utilisation of resources for any of the works required will be completed through individual procurement processes co-ordinated by DNV GL. This process will be initiated with a pre-qualification questionnaire (PQQ) followed by an invite to tender (ITT). This will ensure competitive pricing which will reflect value for the GB gas consumer. One of the requirements in this competitive process will be the inclusion of an option to have a meter logger buy-back scheme to return funds to the GB gas consumer at the end of the project.

Although the intention is that initial benefits achieved will equate directly to the gas transportation system, it is anticipated that the longer term advantages may, in the future become available to energy generators and distributors as well as customers who are driving towards demand response solutions.

A project management team will be in place to fully manage the works and costs incurred during the lifetime of the project.

The project may help facilitate the take up renewable technologies by consumers. The investigation of the impact of various technologies may help gas, and potentially electricity, infrastructure to be developed to facilitate connection of these technologies. This will support consumer choice in this area.

A detailed potential cost benefit analysis is provided in Section 3. Any outperformance achieved against SGNs RIIO GD1 allowances will be shared with the GB gas customer through the IQI mechanism.

### (d) Is innovative (i.e. not business as usual) and has an unproven business case where the innovation risk warrants a limited Development or Demonstration Project to demonstrate its effectiveness

This project will be a GB first and will provide a timely gateway into the future of gas network management.

The requirement for a flexible network capable of accommodating varied sources of gas and renewable technologies suggests that this is the right time for a change in the industry planning process and a move to real-time modelling. Recent advances in cloud storage, communications and sensor technology make this a viable proposition.

Due to the comprehensive changes to the as-is processes required to reach real-time modelling, and the uncertainty of success, this project would not be possible under business-as-usual activities. Without the NIC funding, it is very unlikely that this project would go ahead.

The complexity of bringing together innovations in sensors, communications, cloud storage and big data management, to work alongside existing developed technologies, form the key technical challenges for this project.

SGN would not fund such a project out of price control allowance because it is not part of business-as-usual, many of the benefits relate to future of gas strategy and low carbon, none of which were allowed for under RIIO GD1.

### (e) Involvement of other partners and external funding

There are two key project participants; SGN (funding licensee) and DNV GL (project partner).

DNV GL delivers world-renowned testing and advisory services to the energy value chain including renewables and energy efficiency. Their expertise spans onshore and offshore wind power, solar, conventional generation, transmission and distribution, smart grids, and sustainable energy use, as well as energy markets and regulation.

DNV GL will be responsible for the turnkey installation of sensing equipment onto the gas network, in order to carry out the breadth of works required they will subcontract certain activities on terms no less onerous that what has been proposed within this bid and agreed with SGN.

We have set out an innovation strategy to do a number of things:

- Improve the way in which we work to be more efficient, more customer focused, less disruptive whilst carrying out roadworks and reduce our carbon footprint
- Support entry into the network from renewable sources of gas and support the low carbon economy
- Open up competition in gas distribution through provision of alternative entry points

To support our innovation strategy, we adopt both a proactive and reactive approach to idea generation. We run a suggestions scheme, called Ignite, *Ignitescheme@sgn.co.uk*, for our staff, our project partners, suppliers and anyone else who wishes to make a suggestion, offer a new product or share an idea. We are also proactive in seeking new innovations and project partners, through our industry watch; our external memberships with greater access to SMEs; and most successfully through challenging our ever increasing array of project partners to come up with solutions to our industry issues via 'invitations to partner'.

SGN continually prioritise the ideas and develop projects for both the NIA and NIC based on their scale, feasibility, potential to add value to the GB gas consumer and support our outputs under RIIO GD1. The project proposals are subject to a challenge and review by SGN's Innovation Board, which reports to our Executive. Having followed this process, we believe the real-time network project to be of significant scale and potential to be considered under the NIC

## (f) Relevance and timing

Through a period of comprehensive stakeholder engagement we have engaged with a number of parties that we believe to be significantly impacted by this project.

The real-time networks project concept has been disseminated through presentations to the Smart Metering Team at DECC via the Gas Futures Group and at the Utility Week Demand Response & Future Networks conference and a CEO presentation at Utility Week Live. We have also presented to the CEN working group for gas quality hosted by Marcogaz and proposed during our presentation at the World Gas Conference in Paris.

Following discussions at the Gas Futures Group and Gas Innovation Governance Group (GIGG), support and interest has been shown by the Energy Networks Association (ENA) as well as all the participating Gas Distribution Networks.

To date, SSE Power Distribution and National Grid Gas Transmission (NGGT) have noted interest in the project and are further investigating how the development of a real-time network could offer value and benefits to their business areas. NGGT have also offered to participate in stakeholder groups for real-time networks.

"SGN's proposal to pilot a smart 'Real-Time Network' is very welcome as the industry looks to better understand the long term role for the gas network and to challenge those long held assumptions in ensuring that the future design, operation and maintenance of the network is fit for purpose to efficiently meet customers' long term needs. The focus on examining the future innovation and technology needs of the industry particularly in the area of real-time instrument and control systems is very welcome and timely."

*Quotation from Sarb Bajwa, Chief Executive, IGEM*.

Recent discussions on a European level have highlighted the challenges related to harmonising gas quality standards. The European Commission (EC) has started a project to standardise the gas quality in the EU. This work is being done in cooperation with the European Association for the Streamlining of Energy Exchange (EASEE-gas), Gas Infrastructure Europe (GIE) and other stakeholders. The EC has further issued a mandate to the European Committee for Standardisation (CEN).

Draft CEN/TC standard 234 on gas infrastructure is providing functional standards for the gas sector related to design, construction, operations and maintenance of gas infrastructure in order to ensure the technical interoperability between networks. The draft Standard defines minimum and maximum limits for WI, relative density, sulfur, oxygen, carbon dioxide and hydrocarbon and water dew temperature.

CEN/TC 234 specifies a gas WI wider than currently permitted for use in GB. Based on the work carried out in Oban as part of SGN's previous NIC Project Opening up the Gas Market, it has been demonstrated that a gas with a wider WI can be safely and efficiently conveyed and utilised in GB.

When this mandate is passed the UK will be able to accept a range of gases of varying WIs entering a network. The real-time networks project provides a timely opportunity to demonstrate why a flexible and intelligent gas network is required to manage this future scenario.

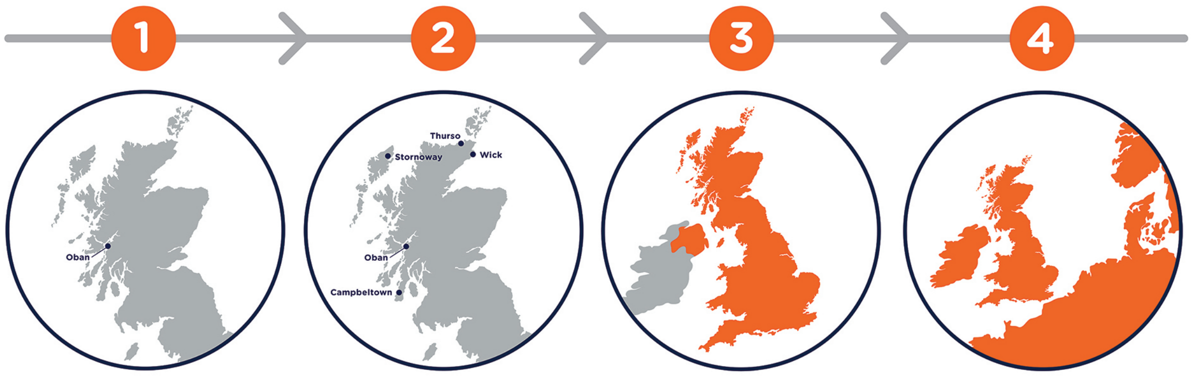



Fig 4.4 Opening up the Gas Market Rollout road map

## Section 5: Knowledge dissemination

### 5.1 Learning generated

This project seeks to develop a 'real-time' network demonstration. The project will install sensing technologies, associated hardware and software, and infrastructure in a representative section of the gas network. If successful, the project will demonstrate the gas network's potential to; accept a wider range of gas compositions and calorific values, review network design assumptions (including diversity and 1:20), optimise network investments through enhanced network management, and provide flexibility to integrate downstream renewables and respond to the emerging challenges in the industry.

Of specific interest to GB GDN and TNO stakeholders will be:

1. The enhanced understanding and management of demand diversity, both for existing and new applications and its impact on demand forecasting for peak and off-peak scenarios
2. How 'Embedded entries' of unconventional gas, boil-off gas, or LNG could be managed through sensing technologies installed on an integrated network as an alternative to gas processing
3. The technical appraisal, testing and commissioning of the innovative sensing technologies and consideration both for this application, but also as an alternative to current technology within the GB gas network
4. The innovative power and communication solutions to support the new sensing technologies proposed, using power from street furniture, for example
5. The cloud-based 'big data' data management aspects, including Software as a service (SaaS) and how pre-existing systems and software can interface with it
6. The new software developed to support network analysis and performance reporting
7. The benefits or otherwise of 'turnkey' network construction activities, incorporating electrical, instrumentation, mechanical and civil works in one package
8. The suitability of smart metering consumption data and its value to the gas networks (if available)
9. How smart metering data (if available) might be integrated into data management systems
10. The potential impact of gas or combined gas and electric downstream renewables in terms of demand and how to manage
11. The recommendations for changes to the recognised industry guidance, IGE/GL/1 Edition 2 Planning of gas distribution systems of MOP not exceeding 16 bar
12. The new management and work procedures developed as part of the real-time network

It is important that learning opportunities generated by this project are effectively disseminated to GB Gas Network Operators as well as the wider gas industry. Inclusion can also be afforded to renewable appliance manufacturers, national and international standards bodies, academia, local authorities and other key stakeholders such as the EC, ENA, DECC, IGEM and Ofgem.

### 5.2. Learning dissemination

Our knowledge dissemination plan involves both internal and external parties (this is detailed in *Appendix 16*).

*Internal Dissemination*

Knowledge dissemination within SGN is essential to the success of all innovation projects. Structured communication regarding the project will ensure the ongoing engagement of staff allowing the outcomes of the project to be adopted within the business in the future. Methods for internal dissemination will include the following:

- A dedicated intranet webpage detailing the project scope and progress.
- Project briefing presentation given to relevant employees at project start and end using SGN Team Talk as the medium
- An article outlining the project will be produced for our in-house magazine 'SGN Mail' and intranet site.
- Development of new and revision of existing management and work procedures in accordance with our Safety Management Framework (SMF).
- Inclusion of our graduate trainees in project delivery as part of their accredited training scheme
- A project steering group
- Internal reports

The change of methodology for network design and operation will require new working procedures to be developed and further training of staff to be conducted. These will be developed and published in accordance with our Safety Management Framework (SMF).

This project will have an interface with a number of business units, particularly Network Planning, Gas control, Operations, Customer Service and Network Construction. A project steering group has been established with representation from all the key business areas to ensure both support and learning dissemination.

*External Dissemination*

We believe that learning dissemination is the most powerful form of network collaboration. We chair the GIGG currently, we have established a collaborative conduit for this very purpose.

We have already carried out significant stakeholder engagement in the development of this project proposal, which has shaped its structure and intended outcomes. As a minimum we will:

- Publish a dedicated webpage within SGN.co.uk, mirroring our existing NIC projects, https://www.sgn.co.uk/Oban/
- Provide regular updates to industry collaboration groups, specifically the Gas Futures Group and the GIGG
- Deliver project presentations and articles to relevant industry bodies, such as IGEM, the Hot Water and Heating Industry Council (HHIC), the Pipeline Industries Guild
- Deliver presentations at the LCNI and other industry conferences, such as Utility week Live
- Publish 6 monthly progress reports to Ofgem
- Update the Anaerobic Digestion & Bioresources Association and European Biogas Association
- Update the European Working group for Gas Quality
- Update the Department for Energy and Climate Change
- Encourage Partner Dissemination

## 5.3. IPR

We have an agreement in principle where both parties are fully committed to the default IPR position.

At this stage, we do not know what specific forms of IPR will be created and consequently require registration, if any. The new sensing technologies that will be employed are commercial products, albeit their appraisal and approval for use will be very much relevant foreground IPR that will be shared with the other GDNs. As part of the software design and data management process, detailed prior art review is necessary and will be dependent on the solution pursued. This may employ commercial products.

It is proposed if and where IPR are to be registered, that it will be done by DNV GL, following transfer of any foreground IPR created by SGN.

Upon successful completion of the Project, royalties would be due from DNV GL (from direct utilisations, Software as a Service or software licensing), if the project is rolled out. These will be paid to SGN, subject to an evaluation of their true commercial value, on either a per unit basis (e.g. per unit manufactured and utilised), or an annual basis. The final arrangements will be determined at a later stage in the project, but will be designed so as to ensure the best value for the GB gas customer.

Income from royalties, minus any costs incurred in maintaining and managing IPR, would be returned to customers in proportion to their funding. SGN would retain the remaining portion (equivalent to our funding contribution) as profit. For this project, this would be 10%. SGN would calculate and declare this Returned NIC Royalty income in our regulatory returns on an annual basis.

Under the provisions within the contract between both parties, DNV GL will be required to comply with the NIC governance document. DNV GL will grant to the Network Licensees and the Parties: an irrevocable, perpetual, world-wide, non-exclusive royalty-free right and licence to use, access, copy, maintain, modify, enhance and create derivative works of any Relevant Foreground IPR (including any Relevant Background IPR contained therein) within their network system.

A key section of the NIC governance relates to Relevant Foreground IPR. Under the NIC document, Relevant Foreground IPRs are defined as Foreground IPRs that other Licensees will need to utilise in order to implement the Methods (the proposed way of solving a problem (the obstacle or issue that needs to be resolved in order to facilitate the low carbon future and/or provide some environmental benefit to customers)) developed in the project.

Network Licensees will only have the right to use Relevant Foreground IPRs within their network royalty free. They cannot sell or grant sub licences to Relevant Foreground IPRs.

Where access to a participant’s Background IPR is required to undertake the project, the participant shall grant a non-exclusive licence to this background IPR (Relevant Background IPR) to the other participants, solely for the purposes of the project during the term of the project. The Network Licensees will also be granted a licence for any Background IPR required to utilise any Relevant Foreground IPR for which they receive a licence.

### Commercialisation

It is anticipated that the technology could be rolled out following the completion of development and commercialisation. A commercial appraisal and recommendations will be made as part of the Project. This could take the form of the following examples:

*Example 1*

Upon completion of the project, DNV GL makes available the data and network modelling software to all distribution network operators in GB. A target price for developed software has been determined which yields positive cost benefits for gas customers. This is detailed in the CBA. This will either take the form of software licence or cloud-based software as a service option (SaaS).

This target unit pricing will be used during the development process to guide critical design features. DNVGL will act as an agent on behalf of SGN and register/protect foreground IP, which will then be assigned to SGN. SGN will issue an exclusive licence for the IP to DNVGL for the duration of the project and for five years following completion.

Royalties will be paid by DNV GL to SGN for any licences or SaaS sold to any other user or undertaker (including other DNs). The royalty should reflect the true commercial value of the IP. SGN will then return royalty to the GB gas customers, in proportion to their funding, via the Returned NIC Royalty mechanism.

*Example 2*

All sensing technologies to be employed are considered to be commercial products. The relevant foreground IP will relate to the appraisal of the equipment, method of installation and operating performance. Provision of the relevant foreground IPR will allow all Distribution Networks to determine whether they wish to deploy these technologies within their own networks.

*Example 3*

Technical assessment and evidence supporting changes to industry orthodoxy, such as the determination of a revised 1:20 design condition will be shared with relevant industry bodies, such as IGEM. These demonstrations can be updated to industry standards and specifications for the GB gas industry.

*Benefits in Kind*

To aid sharing of the benefits with the wider industry DNV GL will support SGN to showcase the Real-Time Networks solution to other network operators and explain how it could improve their operations and planning processes. DNV GL will run a free three day event inviting network operators to come together to:

- learn about the technologies and methodologies used within the project
- see demonstrations of the system
- learn how to use and have hands-on interaction with a demonstrator system
- discuss how to implement such a solution in Q&A sessions with DNV GL's experts
- better understand the benefits of the Real-Time Networks solution

This will help other network operators understand what is involved in the implementation of a Real-Time Networks solution and link and compare the benefits to their business. In addition, DNV GL will prepare a storyboard of example uses of the Real-Time Networks solution to underpin the presentation of the benefits and demonstrations that will be showcased through other joint industry events.

## Section 6: Project Readiness

The level of protection required for cost over-runs and unrealised direct benefits for the Real-time Networks project will be the default level of protection of 5% for cost overruns. No protection is required as no direct benefits are being claimed.

This section will provide evidence of why the project can start in a timely manner, how the costs and benefits have been estimated and the measures that have been put in place to minimise the cost of overruns or shortfalls in direct benefits. Furthermore, this section will explain the verification process for the information that has been provided, how the project plan would still deliver learning if take up of renewable technologies is lower than anticipated and the processes in place to suspend the project if necessary.

### Evidence of why the project can start in a timely manner

SGN is confident of the readiness of this project due to the preparation that has taken place pre-proposal and during the Initial Screening Process. Key commercial heads of terms and principles have been agreed and contracts will be in place prior to commencement of the trial.

SGN now has experience in delivering NIC projects with proven project management methods, effective planning and engagement with Project Partners and suppliers. Although the Real-time Networks project is challenging, SGN has a high degree of confidence in the delivery of a successful outcome.

In preparation for the development of a real-time network, all the current inputs and output flows to the Medway network have been identified together with key network features. The network is fed from offtakes from the NTS and with boil-off gas from Grain LNG. A map of the network is shown in *Appendix 2*.

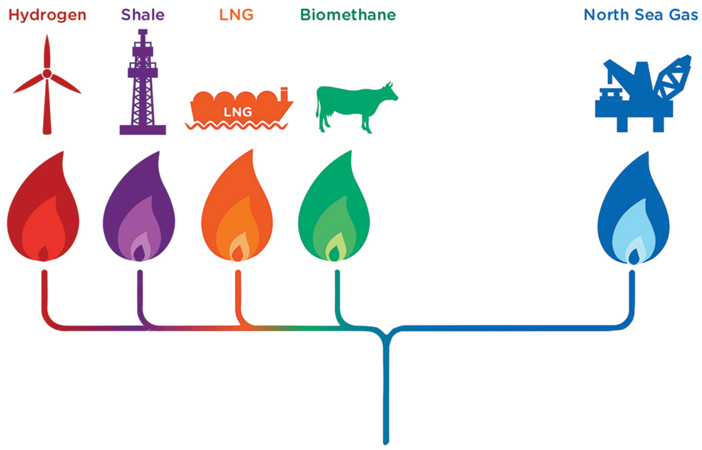



Fig 6.1 Non-conventional and conventional sources of gas

All flows into the network section and strategically selected sections within the network need to be measured. To develop the network in terms of energy flows, the gas quality needs to be well understood and measured at the inputs and exits. At mixing points or supply interfaces within the network, lower cost gas quality devices are proposed to be used downstream of more accurate devices; these measurements could be used for gas quality tracking for situations where there is more than one gas source into a network.

Site surveys have been carried out at all the input and output points and the district governor and regulator stations. The Rochester Pressure Reduction Station was also included in the survey – this included a 35 bar inlet and dual stream multi-stage pressure reduction system.

Prior to undertaking the survey, a checklist was created to ensure that all relevant information was captured. The team undertaking the survey was carefully chosen to provide a range of skills including local knowledge of the assets in the Medway area, experience in flow and gas quality measurement, experience of governor and regulator design, and expertise in identifying the geographical locations from the network maps.

Sensors installed as part of the Real-Time Networks project need to be both accurate enough for training new network models yet economical and suitable for installation in reasonable numbers. An extensive survey of gas quality and flow equipment suitable for operation on gas distribution networks has been carried out as part of the preliminary preparations for this project. Measurement on gas distribution systems is challenging because of the variation in the types of site – in Medway, the site surveys have identified pipework ranging in size from 3" to 36", pipe materials ranging from steel, PE-lined steel to PE, pressures ranging from a few mbar to 35 bar, measurement points that are 4m below ground and those that are above ground. Two of the input flow measurement sites to the Medway network will be completely new measurement points but most will be extensions to existing above and below ground installations.

A real-time network also needs to communicate regularly, frequently and reliably with the gas distribution network using GPRS or similar – this requires a power supply and a good communications signal. DNV GL has extensive gas industry expertise in integrating with all types of technology using a wide range of different communication protocols in a real-time environment. For example,

- The DNV GL Alert system is an optimisation and condition monitoring package for gas turbines. National Grid Gas Transmission can only operate their compressors with Alert running for the purpose of regulatory reporting of fuel gas emissions. The Alert system is also used for real-time energy monitoring, control, vibration analysis and alarms
- Real-time monitoring of oil and gas business critical systems in the Middle East, Russia and North Africa.

Condition-based monitoring and optimisation packages such as Alert generate hundreds of thousands of pieces of real-time data – these form "big data" systems that are stored in Industrial Historian databases. This Historian database is used for storing and retrieving critical process data for secure delivery to desktop, control rooms or business users. It is proposed that the knowledge, expertise and experience of working in these complex environments can be applied to a gas distribution business in the form of the SGN Real-Time Networks project.

Cloud-based technology is maturing to a state where it is now becoming readily applicable to real challenges in industry. Until recently it has been viewed as too new and the risks too high to be used in a gas network. The availability of some specific cloud technologies is shown below; all but one of the products was released in the last two years.

| Product | Release Date |
|---|---|
| Splunk Cloud | October 2013 |
| Iconics Hyper Historian | May 2014 |
| Wonderware Historian Online | October 2013 |
| Google Big Query | May 2010 |

One great advantage of cloud-based technology and the "internet of things" is that the software can be a service that is rented from a provider. This gives flexibility for contracting or expanding storage space as required or even cancelling a service altogether and moving the data to an alternative solution. The cloud-solution is the promise of better, more accessible insight into the data that SGN collects and stores. A rapid and real-time window into the operation of a gas network is likely to give a number of business and consumer advantages. SGN believe that it is now the correct time to investigate and develop a cloud-based solution to investigate these benefits.

*Project team*

As part of the proposal, SGN has ensured that the project team is in a position where all their members can commence project work at the identified project start date. The team are aligned to the project deliverables and are able to commit to and meet their scope of work and defined outputs. The work schedules have been developed together with DNV GL to ensure the project will start in a timely manner as detailed in the project plan. In addition, DNV GL has confirmed the project plan timescales, financial costing and the provision of services/products.

The project management structure has been assembled in accordance with Prince2 principles. Any decisions to be made regarding the project direction will be put to the project steering group and signed off by the project director.

The full project team organogram can be found in *Appendix 17*.

## Evidence of how the costs and benefits have been estimated

The project costs have been calculated using detailed knowledge of the Medway network, site surveys, software development and the installation of sensors from experienced specialist contractors and project partners. The project was broken down into three constituent parts for pricing:


Fig 6.2 Schematic of data flow for the Real-Time Networks project

Each constituent part was further broken down into Work Packages as shown in the project plan in *Appendix 4*. The table on the following page contains details of the pricing breakdown; these were obtained from specialist suppliers identified by DNV GL. The procurement of services, equipment and materials will be carried out in accordance with DNV GL's standard Procurement Procedures. Uncertainty in relation to innovative solutions and technologies has been built into the Real-Time network project plan – this relates particularly to the flow and gas quality installations.

Cost for civil engineering work for installations at locations that have yet to be excavated (such as the site next to the A2 near Rochester and the Rochester Coach Park) have been derived from previous work of a similar scale; this also includes the new pits that are planned adjacent to governor/regulator sites.

| Project Constituent | Content |
| --- | --- |
| Measurement | • Installation of flow and gas quality measurement<br>• Project Management<br>• Project Plans<br>• T/PR/G/17<br>• Documentation/manuals<br>• HAZOPs etc<br>• Civil Engineering<br>• Drawings |
| | • Installation of consumer meter loggers |
| | • Installation of pressure sensors |
| | • Installation of renewable technologies |
| Communications | • Rental of cloud server capacity<br>• Technical support and maintenance<br>• Liaising with measurement technologies, network models and SGN |
| Real-Time Models | • Real-time demand model development<br>• Real-time model development in IP/MP<br>• Purchase of socio-economic and weather data<br>• Review of data requirements<br>• Peak demand – diversity<br>• Linking below and above 7bar demand, storage and forecasting<br>• Renewables impact study |

Following the initial selection and development of sensors and loggers, DNV GL will compile supplier, material and equipment lists and a subsequent Materials Management Plan to identify long lead items / critical items and identify the proposed delivery schedule programme. This information will be documented within the Material Control Register which will be maintained throughout the duration of the project to record and track the following detail:

- Description of material and specification to be purchased against
- Identification of suppliers
- Quantities required
- Programme delivery dates, order-by date, and expected lead times
- Outstanding information e.g. sufficient information to prevent procurement

The Material Control Register will be updated on a regular basis by DNV GL. Materials and services will be procured at site level by the DNV GL Project Manager in consultation with the DNV GL Procurement Manager who will be responsible for the placement of large orders.

Regular review meetings shall be held to coordinate delivery dates and highlight any special requirements.

The overall budget will be managed by a financial controller supporting the project team. They will be responsible for managing all costs and constructing and delivering the reporting requirements as part of the project.

SGN will run a robust financial tracking and reporting system in line with current internal policies and frameworks. As per the Ofgem requirements the project finances will be held in a separate Project Bank Account which will meet the following requirements:

- Show all transactions relating to (and only to) the Project
- Be capable of supplying a real-time statement (of transactions and current balance) at any time
- Accrue expenditures when a payment is authorised (and subsequently reconciled with the actual bank account)
- Accrue payments from the moment the receipt is advised to the bank (and then subsequently reconciled with the actual bank account)
- Calculate a daily total
- Calculate interest on the daily total according to the rules applicable to the account within which the funds are actually held

SGN will engage with their financial auditors to alert them of their potential responsibilities should this project be awarded funding.

The benefits have been estimated using information available to SGN and its partner DNV GL through detailed engagement with external and internal stakeholders. The benefits are described in Section 3 and are quantified in *Appendix 1*.

## Evidence of measures used to minimise possibility of cost overruns or shortfalls in Direct Benefits

The Real-Time Networks project has been priced carefully using detailed quotations from contractors and partners.

A significant cost is for the network sensor installation that is built up from suppliers of flow, gas quality, temperature and pressure equipment. This is a turn-key solution that also includes the design of a modular solution, all engineering disciplines including civil, mechanical, control and instrumentation, electrical and software, design appraisal and approval, HAZOP, full documentation and drawings, build, factory testing and installation. All works will be carried out in accordance with SGN's processes and procedures.

Cost for the installation of consumer logging and installation of additional pressure sensors in the Medway network have been based on an average of quotations received.

A verification of all information included in the proposal (processes in place to ensure accuracy of information)

Both DNV GL and SGN have detailed and documented procedures covering technical and commercial governance.

DNV GL procedures require all documents, calculations, procedures and pricing to be verified and approved by independent experts to ensure the accuracy of information supplied. For high-value and high-profile projects such as the Real-time Networks project, the approval process is very rigorous and extends to checking by the Executive Leadership Team from DNV GL Headquarters in Hovik, Norway.

SGN has detailed major project management procedures and a project structure that ensures visibility of the project at all levels of its business, including its Executive committee.

## How the project plan will still deliver learning in the event that the take up of low carbon technologies and renewable energy in the trial area is lower than anticipated

Work Package 04 of this project includes a trial to integrate renewable technologies. This work package is a separate, but important, workstream that will commence once the sensors in the network and the loggers on the consumer meters are installed. The project structure with regard to the integration of the low carbon technologies is shown in the diagram below.

The impact of low carbon technologies and renewable energy in the trial area will be studied using a combination of laboratory simulations and data available from field trials derived from previous projects. Experience has shown that field trials with renewable technologies can be expensive and potentially unreliable; this approach to understanding the impact of renewable technologies will ensure that the project will still deliver novel and innovative learning on energy flow within a real-time gas distribution network.

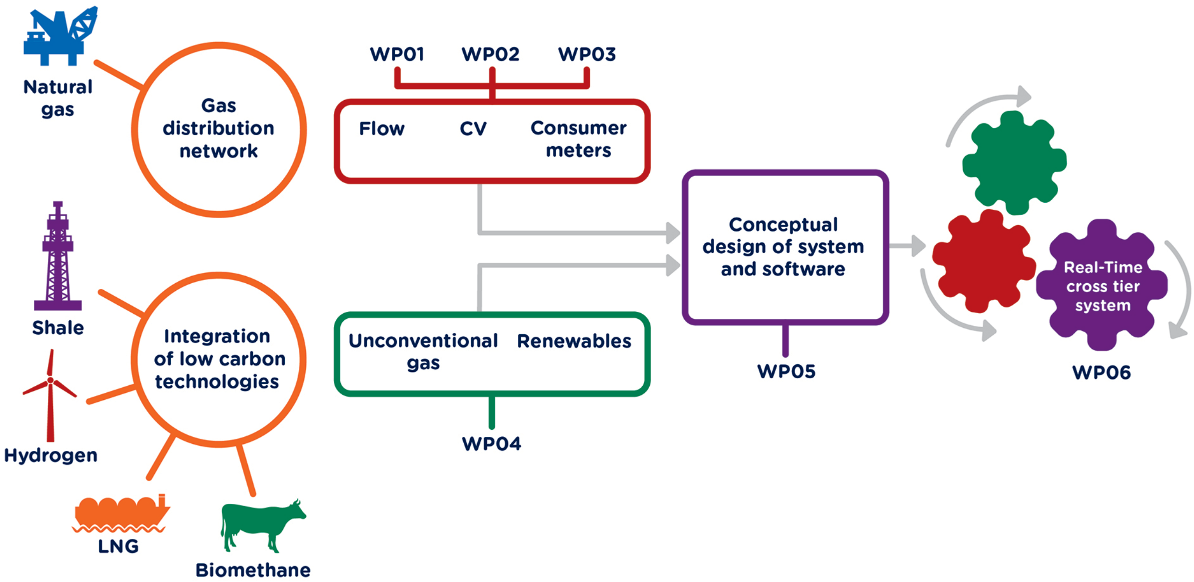



Fig 6.3 Real-Time Networks workstream flows

## The processes in place to suspend project if appropriate

The project plan contains six separate work packs denoted WP01 to WP06 (see Method pg.6).

The project is built around a series of go/no-go stage gates. The following table shows the projects proposed go/no-go stage gates for each work pack of the NIC project. Technical descriptions of what should be completed for each go/no-go stage gates are detailed in *Appendix 18*. There will also be project termination clauses within the project for any reason whatsoever, subject to 30 days’ notice.

| Stage Gate | | Go / No-Go Stage Gates | End Date |
|---|---|---|---|
| 1 | WP01 | QRA Methodology in Place | 30/06/16 |
| 2 | WP01 | Logger Customer Engagement and Data Protection Plan | 30/06/16 |
| 3 | WP01 | Detailed Design of Cloud Data Solution | 30/06/16 |
| 4 | WP01 | Detailed Consumer Meter Logger Design | 30/06/16 |
| 5 | WP01 | Data Collection Specification | 29/07/16 |
| 6 | WP01 | Communications Design and Testing | 30/06/16 |
| 7 | WP01 | Detailed Design of MP/IP Sensor Installations | 21/09/16 |
| 8 | WP01 | Laboratory Testing of Novel Sensors | 30/06/16 |
| 9 | WP01 | Renewables Data Strategy | 28/02/17 |
| 10 | WP02 | Integration and Testing of Sensors in Live Environment (IP/MP) | 31/03/17 |
| 11 | WP02 | Verification of Sensor/Communications Infrastructure | 31/03/17 |
| 12 | WP02 | Gather IP/MP Sensor Data and Review Data Requirements | 06/04/18 |
| 13 | WP03 | Proving of Consumer Loggers and Pressure Sensors in Live Environment (LP) | 31/03/17 |
| 14 | WP03 | Set Up and Gather Logger Data Requirements | 16/03/18 |
| 15 | WP03 | Logger Data Requirements Review | 16/03/18 |
| 16 | WP03 | Phase 1 – Demand Modelling Development | 06/07/17 |
| 17 | WP03 | Phase 2 – Demand Modelling Development | 18/05/18 |
| 18 | WP03 | Phase 3 – Demand Modelling Development | 29/03/19 |
| 19 | WP04 | Phase 1 – Undertake Laboratory Testing of Renewables | 04/07/17 |
| 20 | WP04 | Phase 2 – Undertake Laboratory Testing of Renewables | 07/11/17 |
| 21 | WP04 | Phase 3 – Undertake Laboratory Testing of Renewables | 13/03/18 |
| 22 | WP04 | Investigation & Analysis of Renewables Behaviour | 12/03/19 |
| 23 | WP05 | Conceptual Design of Software Solution | 18/09/17 |
| 24 | WP05 | System Testing with Psuedo-Live Data | 30/04/18 |
| 25 | WP06 | Real-Time Model Demonstration | 01/03/19 |
| 26 | WP06 | Dissemination of Project Outcomes | 21/06/19 |

## Section 7: Regulatory issues

SGN does not require any derogation, licence consent, licence exemption or any change to the current regulatory arrangements in order to carry out this project.

In the longer term concerning any outcome from the project, SGN believe there is nothing in legislation, regulation, standards or internal policies and procedures that would limit the implementation and use of a real-time network model, in that most of the requirements are to do with design rather than operation. The real-time monitoring/control system would have to ensure that the agreed minimum pressures to customers were retained as is currently required.

There might be a future change required to the SGN Safety Case if the mode of operation on distribution systems were changed.

The project will not provide a new billing system in itself, but will demonstrate how varied gas compositions, with varied calorific value, might be managed within a real-time distribution network. This will inform Ofgem and other key stakeholders about potential options for energy measurement and management in the network, which could then lead on to changes in billing. The proposed software systems would allow the operator to see the state of the network and develop both short and long term operation plans and strategies.

If successful, the developments in demand modelling and the monitoring and control of networks proposed are likely to drive changes in relevant, industry recognised best practice, design guidance IGEM/GL/1. The Institute of Gas Engineers and Managers, who are the owners of this industry document, are engaged and aware of the project potential.

## Section 8: Customer Impact

SGN prides itself on its consumer focus. Putting the customer first will be at the heart of this project. The timeline for customer engagement is discussed in Fig 19.1 in *Appendix 19* and is based on shared learning from LCNF Projects and our own previous experience, particularly through the Opening up the Gas Market project.

Our customers have told us they wish their gas supply to be safe and reliable at the lowest cost. All of the literature produced for this field trial and interactions with customers will be built around these topics and highlight the improvements the project offers.

Part of this project will involve interaction with customers and customer's premises, so the project will comply with the conditions relating to the customer engagement and data protection act as set out in NIC Governance Document.

SGN shall submit to Ofgem, at least two months prior to initiating any form of customer engagement, the following two documents:

- Customer Engagement Plan
- Data Protection Plan

The documents will detail how we and our project participants, will engage with, or impact upon, relevant customers as part of the project.

There are five primary scenarios where we may need to impact the customer in some way.

*Scenario 1 – Installing sensors at the higher pressure tiers (into and out of trial area)*

Minimum customer interaction is required during this scenario. There is no planned disruption to gas supply during the trial and mitigating measures will be in place.

*Scenario 2 – Installing sensors at street level*

The disruption that local streetworks may cause has been considered and we foresee no disruption to customers or to gas supply during this scenario. Streetworks for SGN are a daily activity and we are fully aware of the requirements.

*Scenario 3 – Collating data/installing sensors at domestic and commercial properties*

Installing sensors at properties and subsequent visits during the trial and upon completion to remove the loggers will require customer consent.

*Scenario 4 – Obtaining data from domestic and commercial properties via smart metering data*

The smart metering programme may gain momentum during the project and inclusion of this data (via DCC) may prove advantageous in reducing ongoing requirements to engage with customers directly. Nevertheless the use of smart meter consumption data itself will have an impact on customers. The data received from the DCC or shippers if available, would be held and managed by SGN as the licensee. It should be noted that there are a number of uncertainties relating to smart metering consumption data, including cost to access. For smart metering data to be used, it cannot be anonymised and a cost for accessing the data has to be established. If this was to be available then smart metering data could be employed.

*Scenario 5 – Using data obtained from previous renewable energy studies*

DNV GL have identified contractors with experience of research into the impact of renewable energy on gas demand including work carried out alongside bodies such as DECC and the Carbon Trust. Field trials have proved to be very expensive and 90% of the data generated will be specific to this project in the form of laboratory simulation trials. The remaining 10% is from field data (reference properties), which is anonymised. Fig 8.1, below, shows this diagrammatically:

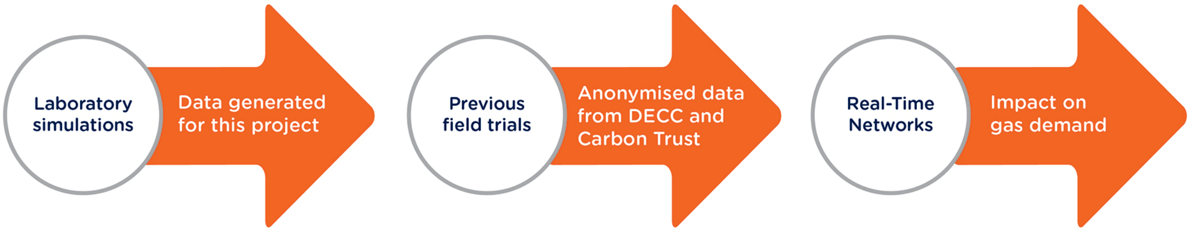



Fig 8.1 Strategy for data generation to study the impact of renewable sources of energy on gas demand

## Customer Engagement Plan

Customer and stakeholder engagement is crucial to the success of any significant project. This requires appropriate and timely engagement with both customers and the relevant authorities, especially where access to homes and business premises is required.

Stakeholder engagement is well underway and we have support from across the industry. On a local level, we have informed the Medway council of our intentions who have shown a willingness to co-operate and enthusiasm for our project.

A detailed customer engagement process will take place to ensure that the installation of the logging devices on consumer premises is undertaken with the full knowledge and consent of gas consumers taking part in the trial.

In order to make customer and stakeholder engagement as inclusive as possible, we propose to use a wide variety or information channels. Both traditional methods, such as letters/leaflets to householders, community meetings and modern social media such as Facebook, Twitter and YouTube will form part of our customer engagement strategy. A graphic showing the communication methods and timings is detailed in *Appendix 19.*

As well as using many different channels for information, the transparency of this information is also important and we will keep up-to-date progress reports, publicly available via our own internet site and on the ENA Smarter networks portal.

Our website is designed and drafted with consideration of the target audience, ensuring that the information will be easily understood by the public and easily navigated regardless of the device that the customer may use to access.

SGN and its Project Participants will not initiate any form of customer engagement until the 'customer engagement plan' has been approved by the relevant authority and will ensure the approved plan is complied with at all times.

The final Customer Engagement Plan will include:

- A communications strategy which sets out inter alia:
    - Any proposed interaction with a customer or premises of a customer
    - Ongoing communications with the customers involved in the project
    - Arrangements for responding to queries or complaints relating to the project from relevant customers

- Information on the Priority Services Customers who will be involved in the project how they will be appropriately treated (including providing information to any person acting on behalf of a Priority Services Customer in accordance with condition 37 of the Gas Supply Licence, where applicable)
- Details of any safety information that may be relevant to the Project
- Details of how any consent that may be required as part of the project will be obtained.

Data Protection Plan

Linked to the Customer Engagement Plan and covering the requirements of the Data Protection Act 1998 (DPA) this plan will ensure that data collected and used for the project is completed by adopting a 'privacy by design'[3] outlook. The DPA is the controlling legislation and is based on eight principles for dealing with personal data – these are listed below:

1. A requirement to process data fairly and lawfully
2. The data will be obtained only for specific, lawful purposes
3. The data obtained will be adequate, relevant and not excessive for the purpose it is required for
4. The information will be accurate and kept up to date
5. Data will not be held for any longer than necessary
6. Data will be processed in accordance with the rights of data subjects
7. The collected data will be protected against unauthorised or unlawful processing using appropriate technical and organisational measures and against accidental loss damage or destruction
8. The data will not be transferred outside the European Economic Area (EEA), unless that country or territory also ensures an adequate level of protection

The data protection plan will include:

- Details on data being collected
- Notification that there is no obligation on the consumers behalf to agree
- Notification that this agreement can be withdrawn at any time
- Identification of the data controller
- Timescale for reminder notifications to consumers during the life of the project
- Information on DPA
- How the data will be protected -
    - Restricted access
    - Encryption
    - Anonymisation

The table in the DPP section of Appendix 19 provides some additional detail on how this can be achieved

Both SGN and DNV GL will have access to non-anonymised data throughout the project. However, any published information from the project will have all specific consumer data redacted.

Techniques employed to anonymise the data, if required, will be based on the document "Anonymisation: managing data protection risk code of practice"[4] produced by the ICO

[3] https://ico.org.uk/for-organisations/guide-to-data-protection/privacy-by-design/

[4] https://ico.org.uk/media/1061/anonymisation-code.pdf

(Information Commissioner's Office). Reference to the additional ICO document "Determining what is personal data"[5] identifies that gas usage data that will be collected is classified as "Personal Data" as far as the Data Protection Act is concerned.

'Tokenisation' is one of the methods that will be used within the project to anonymise consumer data. The Real-Time Networks project would replace addresses with a mapped value, which refers to a table containing the range of new values and addresses. This data would be held within the real-time gateway, protected by encryption in the first instance and additionally would only be accessible in its raw state by authorised individuals. A fuller description of tokenisation can be found in the "Anonymisation" document referred to earlier.

Any subcontractors put in place by DNV GL will work under terms no less onerous than DNV GL but will have access to personal data at various stages of the project. DNV GL will apply provisions to achieve the required level of encryption.

No contact will be made with consumers by SGN or the Project Participants until the 'Data Protection Plan' has been approved by the relevant authority. The approved plan will be adhered to at all times and as stated in WP01 this will be developed from the start of the project thus ensuring the principles are embedded firmly at inception and continue through the lifetime of the work.

SGN shall publish the plans by making them readily available on our website and on the Learning Portal. An outline customer engagement and data protection plan for consumer meter logging is in Appendix 19.

*Customer incentives*

As a thank you for participating in the project, customers will be offered a free carbon monoxide detector with instructions on use and installation as well as a high street voucher to the value of £20. The carbon monoxide detector will be given to the customer at the time the logger is installed. The voucher will be delivered to the customer on removal of the logger at the end of that phase of the project.

As a further incentive, customers asked to participate will be invited to a 'cooking with gas' event wherein a professional chef will provide a cooking demonstration using natural gas. The project team will give a presentation explaining the project aims and potential benefits to the GB customer. Other local events to incentivise participation will be considered depending on success levels.

[5] https://ico.org.uk/media/1554/determining-what-is-personal-data.pdf

## Section 9: Successful Delivery Reward Criteria

This section sets out the proposed Successful Delivery Reward Criteria (SDRC), each under a subsection labelled 9.1 to 9.8. The SDRC are genuine actions linked to outputs of the project with a realistic and challenging deadline. In the following subsections we set out each criterion then clearly state the evidence we propose Ofgem should use to assess performance against criterion. Note all SDRC delivery dates refer to the end of the calendar month.

### 9.1 Procurement of Novel Sensor Technologies (WP01) by November 2016

- Research will have been conducted into technology requirements for both flow and gas quality and benchmarked against accuracy of available alternatives within the gas industry
- Key network locations will have been identified to gain required levels of detail of gas quality and flow within the identified trial area of Medway MP/IP network
- A site by site survey will have been undertaken in order to outline construction requirements including all civil and attributed costs. This process will have identified any wayleave or easement requirements for each site
- Detailed specifications outlining requirements for flow and gas quality metering will have been produced by DNV GL and delivered to SGN
- DNV GL will have drawn on their previous experience within the fields of gas quality and metering to draw up both conceptual and detailed designs for the required technologies. SGN will have confirmed the suitability of technologies for installation within their network
- An estimation of a variance against the target prices will have been identified by DNV GL
- A procurement event in compliance with industry procurement regulations will be conducted by DNV GL

#### *9.1.1 Evidence*

- All specifications, designs and supporting documents to be documented in project file
- Evidenced procurement event or a procurement exemption as per industry procurement regulations
- Acceptance, approval and sign off by project director
- Equipment purchase order produced

### 9.2 Development of Design of Cloud Based Data Solution (WP01) by June 2016

- DNV GL will have drawn on their previous experience in the fields of data and communication and carried out research into applicable cloud-based data solutions for a real-time network
- A detailed specification for the requirements of a cloud system, hosted by DNV GL will have been drawn up based on requirements data quantity, granularity and security as applicable to the project trial
- Following the identification of preferred comms systems, compatible with the loggers and sensors to be demonstrated within the real-time network, a detailed cloud system design will have been produced by DNV GL

#### *9.2.1 Evidence*

- All specifications, designs and supporting documents to be documented in project file

- Acceptance, approval and sign off by project director

## 9.3 Installation and Testing of Sensor Technologies (WP02) LTS/IP/MP by March 2017

- Following identification of preferred installation sites, any required wayleaves or easements will have been acquired and in place to meet the identified installation dates as per the project plan
- Offsite testing will have been conducted within DNV GL's lab environment with reporting produced and published for learning dissemination purposes
- A site specific risk register will have been produced for each site by DNV GL and signed off by the project director
- Relevant T/SP/G/17 will have been produced for each site for E&I, mechanical and civils
- After following all safety procedures, in accordance with SGN's Safety Management Framework and Safe Control of Operations permitry prepared, registered and authorised by SGN, the installations will have been commissioned at the approval of the project director
- On-site testing will have been conducted to the satisfaction of all relevant industry standards and that of the project director

### *9.3.1 Evidence*

- All specifications, designs and supporting documents to be documented in project file
- Reporting and findings of offsite testing of sensors to be published and made available to network licensees
- Method statements, approvals and appraisals of all installations to be held in project file
- Photographic evidence of installs to be held within project file

## 9.4 Installation and Testing of Logger Technologies (WP03) by March 2017

- A customer engagement plan will have been produced outlining all significant parties along with potential impacts and associated risks with mitigations aligned for all key risk areas
- A strategy outlining meter locations and specific targeted consumer demand type will have been produced and authorised by the project director
- An implementation of the customer engagement strategy will have been carried out with bespoke approaches to the various consumer types as identified in the data collection methodology
- Loggers will have been installed at all identified feasible locations where consent has been received without disruption to the customer or loss of supply

### *9.4.1 Evidence*

- A stakeholder engagement plan specific to the customer logging element of the project will be published
- Installation records will be received and documented within the project file

## 9.5 Conceptual Design of Systems Software (WP05) by September 2017

- DNV GL will have drawn on their previous experience in the fields of data modelling and software development to conduct research into the requirements for bringing together loggers, sensors, cloud and communications systems with novel software platform

- Detailed specifications outlining requirements for a software platform will have been produced by DNV GL and delivered to SGN. real-time data for pseudo-online system requirements will have been assessed
- A prototype demand model for real-time modelling will have been produced by DNV GL and tested in a controlled environment with legacy data
- Acceptance testing will have been conducted by DNV GL supported by relevant business users from SGN

#### *9.5.1 Evidence*

- All specifications, designs and supporting documents to be documented in project file
- Acceptance, approval and sign off by project director

### 9.6 Testing of Cross Tier Model Integration (WP06) by January 2019

- DNV GL will have finalised the prototype data modelling and software development for bringing together loggers, sensors, cloud and communications systems within the novel software platform
- Real-time data collected from the network installed loggers and sensors alongside existing SGN legacy data systems will have been modelled through SPS platform by DNV GL
- Detailed specifications outlining requirements for a software platform will have been produced by DNV GL and delivered to SGN. Real-time data for online system requirements will have been assessed
- A prototype demand model for real-time modelling will have been produced by DNV GL and tested in a controlled environment with real-time data.
- Acceptance testing will have been conducted by DNV GL supported by relevant business users from SGN

#### *9.6.1 Evidence*

- All specifications, designs and supporting documents to be documented in project file
- Acceptance, approval and sign off by project director

### 9.7 Assessment of Relevant Renewable Technologies Impact on the Network by March 2019

- A feasibility study will have been conducted identifying the significant downstream renewables based on factors such as frequency and perceived impact on demand profiles and consumption
- A partnership with local authorities or other similar bodies will have been formed to facilitate the installation of novel downstream renewables and/or access to existing installations
- Logging will have been installed at these locations where consent was available and data collected and integrated to the real-time modelling system
- An impact assessment focusing on both demand profile and power use for each type of novel downstream renewable will have been produced with findings to be made available to other network licensees as part of the project learning dissemination

#### *9.7.1 Evidence*

- Records of all available novel downstream renewables documented in project file

- A report identifying demand profile impacts of each available downstream renewable published and made available for all network licensees

## 9.8 Knowledge Dissemination of Tasks Completed by June 2019

- Comprehensive reporting assessing the technical and commercial viability for system roll out will have been compiled
- Knowledge on project outcomes will have been shared with all relevant stakeholders as per the project dissemination plan
- DNV GL will have conducted a three day learning dissemination event for network licensees and other relevant stakeholders

### *9.8.1 Evidence*

- Reports detailing all of the above criteria to be published on Ofgem portal
- GDNs invited to attend DNV GL learning dissemination event

## Action 10: List of Appendices

| | |
|---|---|
| **Appendix 1** | **Benefits Tables**<br>Financial and Carbon benefits tables |
| **Appendix 2** | **Network Diagrams**<br>Area covered by project<br>Describes each stage of the project individually |
| **Appendix 3** | **IT Cloud Solution**<br>High level solution for the cloud selection for data storage |
| **Appendix 4** | **Project Plan**<br>Illustrates timescales for project tasks and identifies key milestones |
| **Appendix 5** | **Site Survey Information**<br>Example information collected on site survey of area |
| **Appendix 6** | **Sensor Technologies**<br>Overview of established, new (but tested) and novel technologies |
| **Appendix 7** | **Network Diagrams**<br>Real-time network solution and diagram of the beach to meter process of the GB gas network |
| **Appendix 8** | **Data collection Methodology**<br>Detailing of the data to be used and how it shall be obtained |
| **Appendix 9** | **Case Study 1 – Reduced Leakage**<br>Example of how redefined peak demand definition can reduce leakage |
| **Appendix 10** | **Case Study 2 – Reduced Replacement Expenditure**<br>Example of how this project can facilitate more insertion |
| **Appendix 11** | **Case Study 3 - Replacement of LTS and below 7bar Pressure Reduction Stations**<br>Description of how we will be able to reduce the costs associated with pressure reduction station maintenance |
| **Appendix 12** | **Case Study 4** - **Proof of Ultrasonic Flow metering capabilities**<br>Detailing of what we aim to prove about USMs and where they can be used |
| **Appendix 13** | **Case study 5 - Reduced Exit Capacity**<br>Quantification of the potential benefits to be realised through a reduced exit capacity |
| **Appendix 14** | **Non-Conventional Sources of Gas**<br>Highlighting the barriers and this projects solution |

| | | |
|---|---|---|
| **Appendix 15** | **Table of Network Features**<br>A high-level list of features that indicate the trial site is statistically representative of GB |
| **Appendix 16** | **Knowledge Dissemination Plan**<br>Shows what, how, when and to whom we will disseminate the learning generated form this Project |
| **Appendix 17** | **Project Team Organogram**<br>Illustrates Project team structure |
| **Appendix 18** | **Project Go/No-Go Stage Gates**<br>Illustrates timescales and identifies key milestones |
| **Appendix 19** | **Customer Engagement and Data Protection Plan for Consumer Logging**<br>Outlines initial stakeholder engagement plan |
| **Appendix 20** | **Letter of support**<br>A letter from National Grid Transmission in support of the Real-Time Networks Project |
| **Appendix 21** | **Risk Register and Mitigations**<br>Identifies main Project risks and mitigations |
| **Appendix 22** | **Network Modelling Design Assumptions**<br>Detailing of the assumptions made in concluding the benefits of this project |
| **Appendix 23** | **Sensor Specifications**<br>Details of the performance statistics of the sensors to be used during the trial |
| **Appendix 24** | **Full Submission Spreadsheet**<br>Detailed cost and net benefit breakdown over project duration |

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## Appendix 1. Benefits Summary Tables

**KEY**

| Method | Method name |
|---|---|
| **Method 1** | Reduced Leakage |
| **Method 2** | Reduced Replacement Expenditure |
| **Method 3** | Replacement of LTS Pressure Reduction Stations |
| **Method 4** | Replacement of Below 7 bar Pressure Reduction Installations |
| **Method 5** | Holder Station Remediation |
| **Method 6** | Reduced Exit Capacity |
| **Method 7** | Infrastructure vs Cloud saving |
| **Method 8** | Software support |
| **Method 9** | Removal of N2 Ballasting |
| **Method 10** | Reduction of Compression Costs |
| **Method 11** | Increased acceptance of Embedded entry enquiries – Not Quantified |
| **Method 12** | Greater understanding of the effects of downstream renewables – Not Quantified |
| **Method 13** | Chromatograph study – Not Quantified |
| **Method 14** | Ultrasonic flow metering study – Not Quantified |

**Gas NIC – financial benefits – Cumulative**

<table>
<tr><th colspan="8">Financial benefit (£m)</th><th></th></tr>
<tr><th rowspan="2">Scale</th><th rowspan="2">Method</th><th rowspan="2">Method Cost</th><th rowspan="2">Base Case Cost</th><th colspan="3">Benefit</th><th rowspan="2">Notes</th><th rowspan="2">Cross-references</th></tr>
<tr><th>2020</th><th>2030</th><th>2050</th></tr>
<tr><td rowspan="5">Post-trial solution (individual deployment)</td><td>Method 1</td><td>0.251</td><td>0.254</td><td>0.0038</td><td>0.0356</td><td>0.081</td><td>- 0.5mbar reduction in ASP for each non-profiled network<br>- Benefit depreciation year on year obtained by following leakage forecast<br>- Leakage reduction driven by mains replacement programme</td><td>Page 14<br>Page 70</td></tr>
<tr><td>Method 2</td><td>0.079</td><td>0.132</td><td>0.053</td><td>0.494</td><td>1.128</td><td>- Benefit depreciation year on year obtained by following leakage forecast (directly linked)</td><td>Page 14<br>Page 71</td></tr>
<tr><td>Method 7</td><td>0.034</td><td>0.335</td><td>0.301</td><td>0.711</td><td>1.531</td><td>- Assumed up front cost succeeded by constant annual saving over forecast horizon</td><td>Page 16</td></tr>
<tr><td>Method 9</td><td>0</td><td>0.357</td><td>0.357</td><td>3.927</td><td>11.067</td><td>- Complete removal of the requirement for N2 ballasting<br>- Assumed constant annual saving over forecast horizon</td><td>Page 16<br>Page 17<br>Page 20</td></tr>
<tr><td>Method 10</td><td>0</td><td>0.42</td><td>0.42</td><td>4.62</td><td>13.02</td><td>- All demand in Medway trial area fed by Grain LNG (Small fraction of total Grain boil off)</td><td>Page 18<br>Page 20</td></tr>
<tr><td rowspan="6">Licensee scale<br>If applicable, indicate the number of relevant sites on the Licensees’ network.</td><td>Method 1</td><td>11.553</td><td>11.605</td><td>0.052</td><td>0.522</td><td>1.429</td><td>- 0.5mbar reduction in ASP for each non-profiled network<br>- Benefit depreciation year on year obtained by following leakage forecast<br>- Leakage reduction driven by mains replacement programme</td><td>Page 14<br>Page 70</td></tr>
<tr><td>Method 2</td><td>92.56</td><td>95.93</td><td>3.38</td><td>31.5</td><td>71.88</td><td>- Benefit depreciation year on year obtained by following leakage forecast (directly linked)</td><td>Page 14<br>Page 71</td></tr>
<tr><td>Method 3</td><td>15.407</td><td>15.5</td><td>0.093</td><td>1.023</td><td>2.883</td><td>- Average cost of affected replacements £500,000</td><td>Page 15<br>Page 72</td></tr>
<tr><td>Method 4</td><td>0.612</td><td>0.68</td><td>0.068</td><td>0.634</td><td>1.447</td><td>- Assumed constant annual saving over forecast horizon</td><td>Page 15<br>Page 72</td></tr>
<tr><td>Method 5</td><td>3.694</td><td>3.75</td><td>0.056</td><td>0.616</td><td>1.736</td><td>- Holder station decommissioning works will continue to forecast horizon</td><td>Page 15</td></tr>
<tr><td>Method 6</td><td>-8.192</td><td>-2.275</td><td>5.92</td><td>65.09</td><td>183.43</td><td>- Assumed potential 5% reduction in peak daily demand forecast<br>- Assumes continuation of incentive mechanism beyond RIIO-GD1</td><td>Page 15<br>Page 74</td></tr>
</table>

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Method 7** | 0.034 | 0.411 | 0.041 | 0.787 | 1.607 | - Assumed up front cost succeeded by constant annual saving over forecast horizon | Page 16 |
| | **Method 8** | 0.123 | 0.144 | 0.022 | 0.24 | 0.676 | - Assumed constant annual saving over forecast horizon | Page 16 |
| | **Method 9** | 0 | 88.61 | 88.61 | 974.74 | 2747 | - Complete removal of the requirement for N2 ballasting<br>- Assumed constant annual saving over forecast horizon | Page 16<br>Page 17<br>Page 20 |
| **GB rollout scale**<br>*If applicable, indicate the number of relevant sites on the GB network.* | **Note**: In order to up-scale the benefits realised in the Licensee scale to GB we have used a factor determined by the total metallic lengths of mains by GDN (3.67 of SGNs benefit).<br>We felt this to be more appropriate than using a factor of 4:2:1:1. | | | | | | **Notes** | **Cross-references** |
| | **Method 1** | 42.4 | 42.59 | 0.19 | 1.916 | 5.245 | GB values obtained by scaling SGN values by 3.67. | Page 14<br>Page 70 |
| | **Method 2** | 339.68 | 352.07 | 12.39 | 115.61 | 263.80 | | Page 14<br>Page 71 |
| | **Method 3** | 56.544 | 56.885 | 0.341 | 3.754 | 10.581 | | Page 15<br>Page 72 |
| | **Method 4** | 2.246 | 2.496 | 0.25 | 2.328 | 5.312 | | Page 15<br>Page 72 |
| | **Method 5** | 13.556 | 13.763 | 0.206 | 2.261 | 6.371 | | Page 15 |
| | **Method 6** | -21.74 | -8.94 | 12.80 | 140.79 | 396.77 | | Page 15<br>Page 74 |
| | **Method 7** | 0.124 | 1.509 | 0.150 | 3.747 | 6.756 | | Page 16 |
| | **Method 8** | 0.45 | 0.53 | 0.08 | 0.88 | 2.48 | | Page 16 |
| | **Method 9** | 0 | 325.21 | 325.21 | 3577 | 10081 | | Page 16<br>Page 17<br>Page 20 |

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Gas NIC – carbon and/ or environmental benefits - Cumulative

| Carbon and/ or environmental benefit (MtCO2e) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Scale** | **Method** | **Method Cost** | **Base Case Cost** | **2020** | **2030** | **2050** | **Notes** | **Cross-references** |
| **Post-trial solution** *(individual deployment)* | **Method 1** | 3.49 | 3.55 | 0.053 | 0.496 | 1.133 | Leakage values based on Strood LP for Post trial solution<br><br>CO2e calculated in accordance with *Network Innovation allowance Project Benefits Guide (2015)* and SGN best practice | Page 14<br>Page 70 |
| **Licensee scale** *If applicable, indicate the number of relevant sites on the Licensees' network.* | **Method 1** | 737.06 | 740.38 | 3.323 | 30.821 | 71.308 | CO2e calculated in accordance with *Network Innovation allowance Project Benefits Guide (2015)* and SGN best practice | Page 14<br>Page 70 |
| **GB rollout scale** *If applicable, indicate the number of relevant sites on the GB network.* | **Method 1** | 2705.01 | 2717.21 | 12.194 | 113.114 | 261.701 | GB values obtained by scaling SGN values by 3.67 | Page 14<br>Page 70 |
| *If applicable, indicate any environmental benefits which cannot be expressed as MtCO2e.* | **Post-trial solution, Licensee scale and GB rollout scale:**<br><br>Method 2 - Reduced Repex – Page 71<br>Method 10 - Reduction in Compression Costs – Page 20<br>Method 11 - Increased acceptance of Embedded entry enquiries – Page 18 | | | | | | | |

## Appendix 2. Network Diagrams

This appendix aims to provide a greater understanding of the geographical situation of the trial area and the networks that it will encompass.

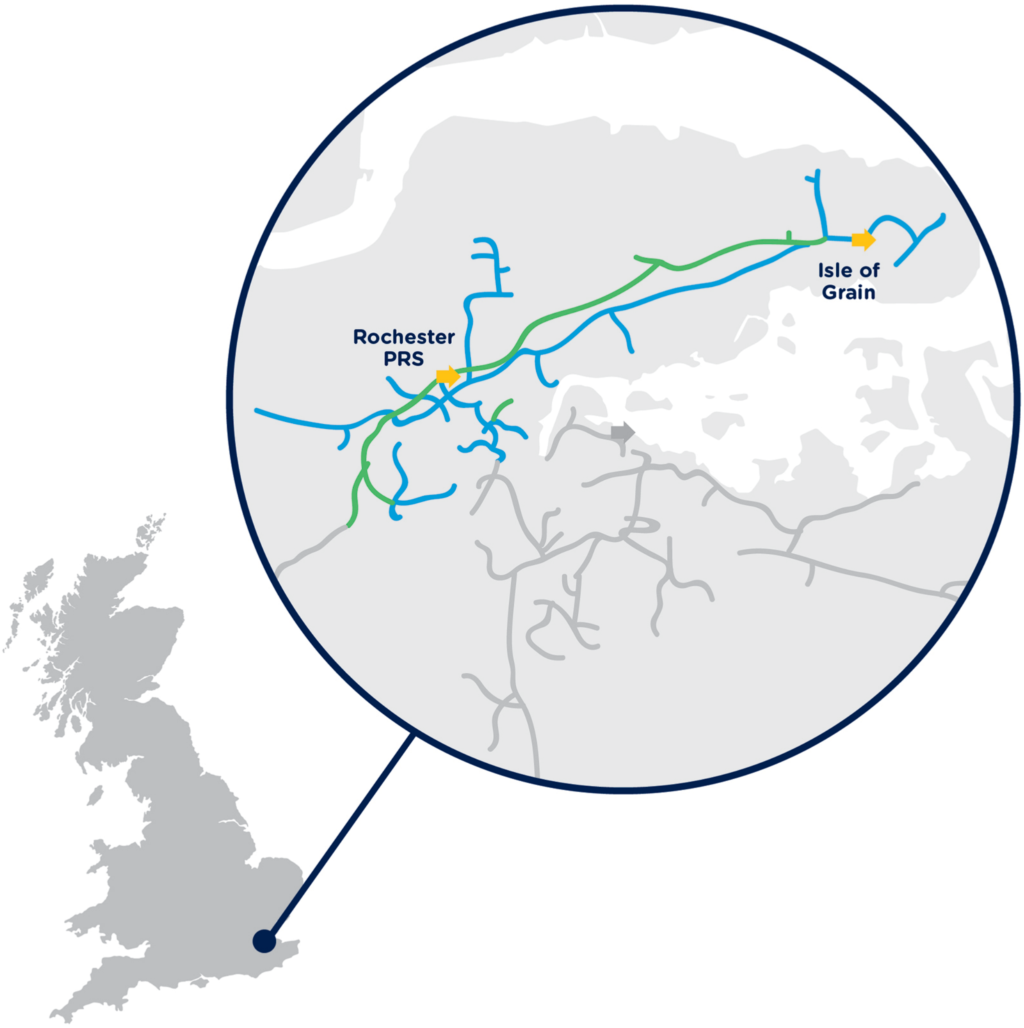



Fig 2.1: Field Trial Site Location


Fig 2.2: Medway IP-MP-LP Networks

[redacted]

Fig 2.3 NTS Schematic of Field Trial Area

## Appendix 3. IT Project Plan

It is a requirement of the Real-time Networks (RTN) project that an archive/historian be created that meets the following criteria:

1. Accept and archives data from different sources.
2. Provide a mechanism for DNV GL modellers to extract data from the archive.
3. Cloud based.
4. Demonstrate scalability.
5. Provide a secure environment.
6. Provide visualisation and reporting capabilities.

The innovative solution described in this document utilises the technologies of the internet-of-things to deliver a low cost, highly scalable, feature rich environment that more than satisfies the requirements of the RTN project. Existing products/ technologies are also utilised, minimising the need for software development.

The solution requires a virtual server in the cloud whose purpose is to receive the data from the field data logger devices and files from all of the other data sources. The data received is validated and uploaded to the data historian. Any problems are notified to a system administrator via email.

The product selected for the data historian is Splunk, primarily designed to collect, analyse and act upon the big data generated by a company's technology infrastructure, security systems and business applications. It will provide a versatile and ideal platform for archiving machine data generated by all of the Real-Time Networks devices, systems and applications. Splunk is a cloud based solution and offers the benefits of software-as-a-service; scalability, reliability of service, and simplicity of build.

### *Solution Overview*

#### Architecture

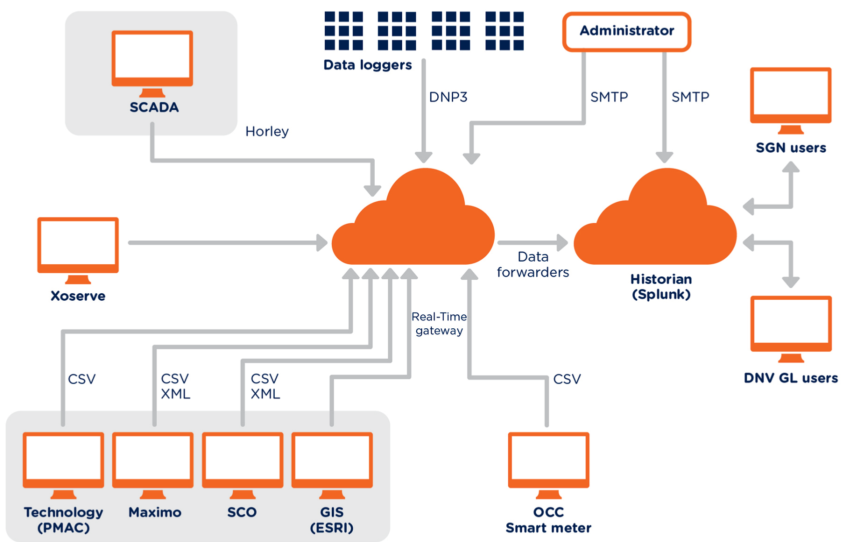



Fig 3.1:Cloud Solution IT Architecture

Fig 3.1, Left, shows the proposed architecture for the Real-time Networks project. The following sections of this chapter describe the functions of the Real-time Gateway and the Historian and their various interfaces.

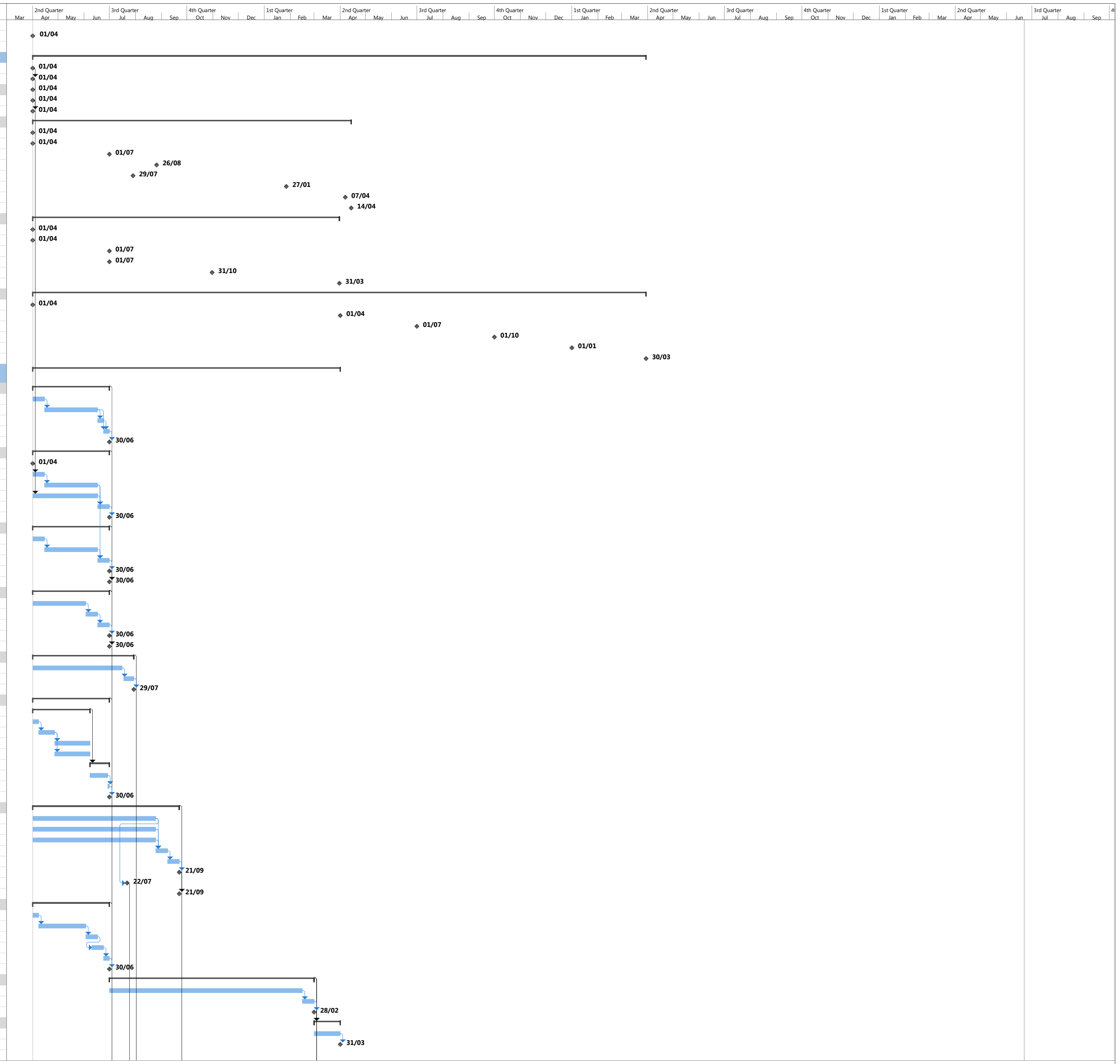
## Interface details

| Name | Description |
|---|---|
| **Real-Time Gateway** | The Real-Time Gateway is responsible for interfacing with all the disparate data sources, performing any necessary pre-processing/validation of the data and then forwarding the data to the historian. It will run on a virtual server hosted in the cloud and will have a fixed IP address. The Gateway will use Kepware KepServerEx OPC server with the necessary Distributed Network Protocol (DNP3) drivers. A file processor will run on the Real-time Gateway server to monitor the folder shares for any new CSV/XML files being uploaded. Additionally it will have the capability to interface with DCC data (if available) and can interface with many database types such as MySQL, Microsoft SQL Server, Informix, DB2, etc.<br><br>The server specification needs to be sufficient to run all of the data interfaces, and the data validation service. Storage needs to be sufficient to receive historic files from the various data sources and keep an archive for 1 month in case of failure of the archive.<br>Any missing or unexpected data will be highlighted by email to an administrator who can then correct the problem. |
| **Data Logger Interface** | The additional sensors that are being installed as part of the Real-Time Networks project will all communicate with a local Data Logger which will be configured to send data to the Real-time Gateway over GPRS at a 6 minute interval. |
| **SCADA Interface** | The interface to the SGN SCADA system at Horley will be through a daily CSV file created by the SCADA system and automatically copied to a folder share on the Real-Time Gateway. |
| **Xoserve Interface** | The Xoserve interface is unlikely to be achieved through an automatic interface. However historic data in CSV format will be available on demand and can be uploaded to the Splunk Historic Archive using the Splunk web portal. The data input will need to be correctly configured so that the historic archive file is parsed correctly. |
| **Technolog (PMAC) Interface** | The Technolog PMAC software has an export function to create CSV data files which can be scheduled through the PMAC software and copied regularly to the Real-Time Gateway. |
| **Maximo Interface** | An overnight query will be created to provide a daily update of any changes of interest to the Maximo database. The query can output either a CSV file or XML file which will be processed by the Real-Time Gateway. |
| **SCO Interface** | An overnight query will be created to provide a daily update of any changes of interest to the SCO database. The query can output either a CSV file or XML file and the files can be copied to a folder share and processed by the Real-Time Gateway. |

## Appendix 4. Project Plan

Please note the below contractor timescales, associated costings and payment milestones have been provided at a high level by relevant service providers but are still subject to negotiation and agreement through procurement events.

| ID | Task Mode | WBS | Task Name | Duration | Start | Finish |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | | 1 | **Project Start Date** | 0 days | Fri 01/04/16 | Fri 01/04/16 |
| 3 | | | | | | |
| 4 | | **2** | **Procurement** | **521 days** | **Fri 01/04/16** | **Fri 30/03/18** |
| 5 | | 2.1 | Procurement Process Approved | 0 days | Fri 01/04/16 | Fri 01/04/16 |
| 6 | | 2.2 | Data Protection Plan for Contracting | 0 days | Fri 01/04/16 | Fri 01/04/16 |
| 7 | | **2.3** | **Customer incentive costs** | **0 days** | **Fri 01/04/16** | **Fri 01/04/16** |
| 8 | | 2.3.1 | Purchase Approval | 0 days | Fri 01/04/16 | Fri 01/04/16 |
| 9 | | 2.3.2 | Procure & issue items | 0 days | Fri 01/04/16 | Fri 01/04/16 |
| 10 | | **2.4** | **Sensors (All payments TBC during procurement process)** | **271 days** | **Fri 01/04/16** | **Fri 14/04/17** |
| 11 | | 2.4.1 | Purchase Approval | 0 days | Fri 01/04/16 | Fri 01/04/16 |
| 12 | | 2.4.2 | Payment #1 - Upfront payment (7%) | 0 days | Fri 01/04/16 | Fri 01/04/16 |
| 13 | | 2.4.3 | Payment #2 - (18%) | 0 days | Fri 01/07/16 | Fri 01/07/16 |
| 14 | | 2.4.4 | Payment #3 - 20% upon order of critical parts | 0 days | Fri 26/08/16 | Fri 26/08/16 |
| 15 | | 2.4.5 | Payment #4 - 20% upon design freeze | 0 days | Fri 29/07/16 | Fri 29/07/16 |
| 16 | | 2.4.6 | Payment #5 - 20% upon FAT approval (per site) | 0 days | Fri 27/01/17 | Fri 27/01/17 |
| 17 | | 2.4.7 | Payment #6 - 10% upon completion of installation (per site) | 0 days | Fri 07/04/17 | Fri 07/04/17 |
| 18 | | 2.4.8 | Payment #7 - 5% upon submission of final documentation (per site) | 0 days | Fri 14/04/17 | Fri 14/04/17 |
| 19 | | **2.5** | **Loggers (All payments TBC during procurement process)** | **261 days** | **Fri 01/04/16** | **Fri 31/03/17** |
| 20 | | 2.5.1 | Purchase Approval | 0 days | Fri 01/04/16 | Fri 01/04/16 |
| 21 | | 2.5.2 | Payment #1 - 10% upon order | 0 days | Fri 01/04/16 | Fri 01/04/16 |
| 22 | | 2.5.3 | Payment #2 - 20% upon design completion | 0 days | Fri 01/07/16 | Fri 01/07/16 |
| 23 | | 2.5.4 | Payment #3 - 30% upon order of loggers | 0 days | Fri 01/07/16 | Fri 01/07/16 |
| 24 | | 2.5.5 | Payment #4 - 20% upon installation of 50% | 0 days | Mon 31/10/16 | Mon 31/10/16 |
| 25 | | 2.5.6 | Payment #5 - 20% upon completion | 0 days | Fri 31/03/17 | Fri 31/03/17 |
| 26 | | **2.6** | **Renewables (All payments TBC during procurement process)** | **521 days** | **Fri 01/04/16** | **Fri 30/03/18** |
| 27 | | 2.6.1 | Purchase Approval | 0 days | Fri 01/04/16 | Fri 01/04/16 |
| 28 | | 2.6.2 | Payment #1 - 15% upon order | 0 days | Sat 01/04/17 | Sat 01/04/17 |
| 29 | | 2.6.3 | Payment #2 - 25% Investigation | 0 days | Sat 01/07/17 | Sat 01/07/17 |
| 30 | | 2.6.4 | Payment #3 - 25% Analysis | 0 days | Sun 01/10/17 | Sun 01/10/17 |
| 31 | | 2.6.5 | Payment #4 - 25% Lab Testing | 0 days | Mon 01/01/18 | Mon 01/01/18 |
| 32 | | 2.6.6 | Payment #5 - 10% upon completion | 0 days | Fri 30/03/18 | Fri 30/03/18 |
| 33 | | **3** | **WP01 - Selection, development, procurement and off site validation of sensor technologies & IT/Comms infrastructure** | **262 days** | **Fri 01/04/16** | **Fri 31/03/17** |
| 34 | | **3.1** | **QRA Methodology (SG1)** | **65 days** | **Fri 01/04/16** | **Thu 30/06/16** |
| 35 | | 3.1.1 | Define QRA structure | 10 days | Fri 01/04/16 | Thu 14/04/16 |
| 36 | | 3.1.2 | Draft QRA Report & base case risk | 45 days | Fri 15/04/16 | Thu 16/06/16 |
| 37 | | 3.1.3 | SGN review & comment | 5 days | Fri 17/06/16 | Thu 23/06/16 |
| 38 | | 3.1.4 | Final Baseline QRA Report (Live document) | 5 days | Fri 24/06/16 | Thu 30/06/16 |
| 39 | | 3.1.5 | SGN Approval | 0 days | Thu 30/06/16 | Thu 30/06/16 |
| 40 | | **3.2** | **Logger Customer Engagement & Data Protection Plan (SG2)** | **65 days** | **Fri 01/04/16** | **Thu 30/06/16** |
| 41 | | 3.2.1 | Customer Engagement Preparation (Completed) | 0 days | Fri 01/04/16 | Fri 01/04/16 |
| 42 | | 3.2.2 | Identify customer engagement process/plan | 10 days | Fri 01/04/16 | Thu 14/04/16 |
| 43 | | 3.2.3 | Full engagement plan | 45 days | Fri 15/04/16 | Thu 16/06/16 |
| 44 | | 3.2.4 | Complete Data Protection Plan | 55 days | Fri 01/04/16 | Thu 16/06/16 |
| 45 | | 3.2.5 | SGN/OFGEM review & updates | 10 days | Fri 17/06/16 | Thu 30/06/16 |
| 46 | | 3.2.6 | SGN/OFGEM approval | 0 days | Thu 30/06/16 | Thu 30/06/16 |
| 47 | | **3.3** | **Detailed design of Cloud Data Solution (SG3)** | **65 days** | **Fri 01/04/16** | **Thu 30/06/16** |
| 48 | | 3.3.1 | Detailed Design | 10 days | Fri 01/04/16 | Thu 14/04/16 |
| 49 | | 3.3.2 | Specification | 45 days | Fri 15/04/16 | Thu 16/06/16 |
| 50 | | 3.3.3 | SGN review & updates | 10 days | Fri 17/06/16 | Thu 30/06/16 |
| 51 | | 3.3.4 | SGN Approval - Design, Procurement & Installation | 0 days | Thu 30/06/16 | Thu 30/06/16 |
| 52 | | 3.3.5 | Cloud Procurement | 0 days | Thu 30/06/16 | Thu 30/06/16 |
| 53 | | **3.4** | **Detailed Consumer Meter Logger Detailed Design (SG4)** | **65 days** | **Fri 01/04/16** | **Thu 30/06/16** |
| 54 | | 3.4.1 | Detailed design & locations for installations | 45 days | Fri 01/04/16 | Thu 02/06/16 |
| 55 | | 3.4.2 | Approval & Appraise Design | 10 days | Fri 03/06/16 | Thu 16/06/16 |
| 56 | | 3.4.3 | Review & agree inst. Plan | 10 days | Fri 17/06/16 | Thu 30/06/16 |
| 57 | | 3.4.4 | SGN Approval - Design, Procurement & Installation | 0 days | Thu 30/06/16 | Thu 30/06/16 |
| 58 | | 3.4.5 | Logger Procurement | 0 days | Thu 30/06/16 | Thu 30/06/16 |
| 59 | | **3.5** | **Data Collection Specification (SG5)** | **86 days** | **Fri 01/04/16** | **Fri 29/07/16** |
| 60 | | 3.5.1 | Complete Data Collection Specification | 76 days | Fri 01/04/16 | Fri 15/07/16 |
| 61 | | 3.5.2 | SGN review & updates | 10 days | Mon 18/07/16 | Fri 29/07/16 |
| 62 | | 3.5.3 | SGN Approval | 0 days | Fri 29/07/16 | Fri 29/07/16 |
| 63 | | **3.6** | **Communications Design & Testing (SG6)** | **65 days** | **Fri 01/04/16** | **Thu 30/06/16** |
| 64 | | **3.6.1** | **Design** | **48 days** | **Fri 01/04/16** | **Tue 07/06/16** |
| 65 | | 3.6.1.1 | Specification | 5 days | Fri 01/04/16 | Thu 07/04/16 |
| 66 | | 3.6.1.2 | Conceptual Design | 13 days | Fri 08/04/16 | Tue 26/04/16 |
| 67 | | 3.6.1.3 | Detailed Design | 30 days | Wed 27/04/16 | Tue 07/06/16 |
| 68 | | 3.6.1.4 | Software development | 30 days | Wed 27/04/16 | Tue 07/06/16 |
| 69 | | **3.6.2** | **Testing** | **17 days** | **Wed 08/06/16** | **Thu 30/06/16** |
| 70 | | 3.6.2.1 | Laboratory System testing (all components) | 15 days | Wed 08/06/16 | Tue 28/06/16 |
| 71 | | 3.6.2.2 | Review & acceptance testing | 2 days | Wed 29/06/16 | Thu 30/06/16 |
| 72 | | 3.6.2.3 | SGN Approval | 0 days | Thu 30/06/16 | Thu 30/06/16 |
| 73 | | **3.7** | **Detailed Sensor Equipment Design (SG7)** | **125 days** | **Fri 01/04/16** | **Wed 21/09/16** |
| 74 | | 3.7.1 | Detailed design & locations for installations | 105 days | Fri 01/04/16 | Wed 24/08/16 |
| 75 | | 3.7.2 | Develop Maintenance plan | 105 days | Fri 01/04/16 | Wed 24/08/16 |
| 76 | | 3.7.3 | Assessment of Measurement Uncertainties | 105 days | Fri 01/04/16 | Wed 24/08/16 |
| 77 | | 3.7.4 | T/SP/G/17 approval & appraisal | 10 days | Thu 25/08/16 | Wed 07/09/16 |
| 78 | | 3.7.5 | Review designs & agree inst. Plan (Inc. Updates) | 10 days | Thu 08/09/16 | Wed 21/09/16 |
| 79 | | 3.7.6 | SGN Approval - Design, Procurement & Installation | 0 days | Wed 21/09/16 | Wed 21/09/16 |
| 80 | | 3.7.7 | Sensor procurement (Long Lead items) | 0 days | Fri 22/07/16 | Fri 22/07/16 |
| 81 | | 3.7.8 | Sensor Procurement | 0 days | Wed 21/09/16 | Wed 21/09/16 |
| 82 | | **3.8** | **Lab testing - Novel Sensors (SG8)** | **65 days** | **Fri 01/04/16** | **Thu 30/06/16** |
| 83 | | 3.8.1 | Identify Novel Sensors | 5 days | Fri 01/04/16 | Thu 07/04/16 |
| 84 | | 3.8.2 | Procure Novel Sensors | 40 days | Fri 08/04/16 | Thu 02/06/16 |
| 85 | | 3.8.3 | Test Novel Sensors | 10 days | Fri 03/06/16 | Thu 16/06/16 |
| 86 | | 3.8.4 | Report on Technology Qualification Process | 10 days | Fri 10/06/16 | Thu 23/06/16 |
| 87 | | 3.8.5 | Review accuracy & suitability of sensors | 5 days | Fri 24/06/16 | Thu 30/06/16 |
| 88 | | 3.8.6 | SGN Approval | 0 days | Thu 30/06/16 | Thu 30/06/16 |
| 89 | | **3.9** | **Renewables Data Strategy (SG9)** | **174 days** | **Fri 01/07/16** | **Tue 28/02/17** |
| 90 | | 3.9.1 | Develop strategy | 164 days | Fri 01/07/16 | Tue 14/02/17 |
| 91 | | 3.9.2 | SGN review | 10 days | Wed 15/02/17 | Tue 28/02/17 |
| 92 | | 3.9.3 | SGN Approval | 0 days | Tue 28/02/17 | Tue 28/02/17 |
| 93 | | **3.10** | **Reporting** | **23 days** | **Wed 01/03/17** | **Fri 31/03/17** |
| 94 | | 3.10.1 | Draft Work Package Summary | 23 days | Wed 01/03/17 | Fri 31/03/17 |
| 95 | | 3.10.2 | Publish Work Package Summary | 0 days | Fri 31/03/17 | Fri 31/03/17 |
| 96 | | | | | | |



Project: NIC Project Plan_v1
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Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

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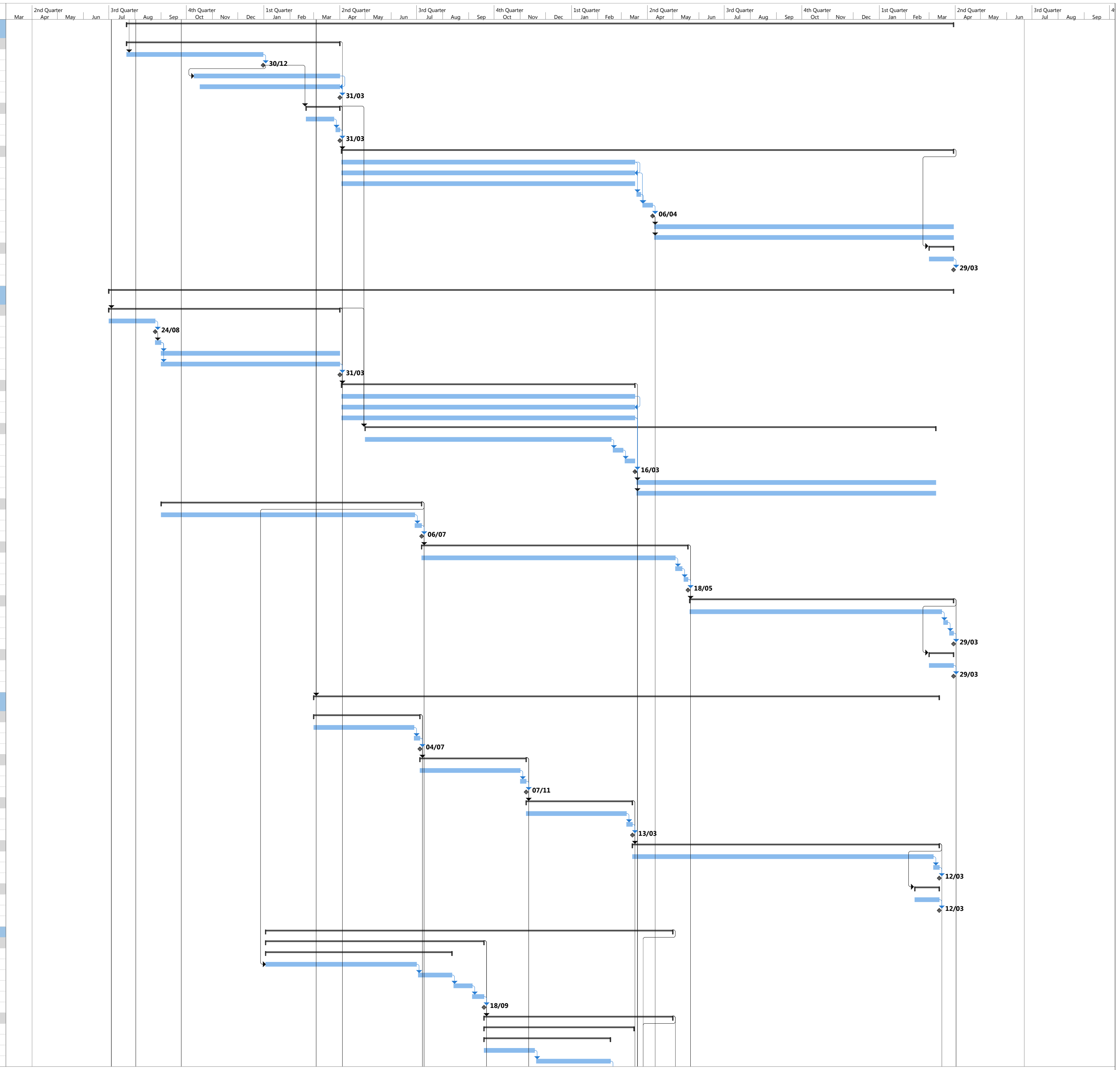
RIIO NIC NETWORK INNOVATION COMPETITION

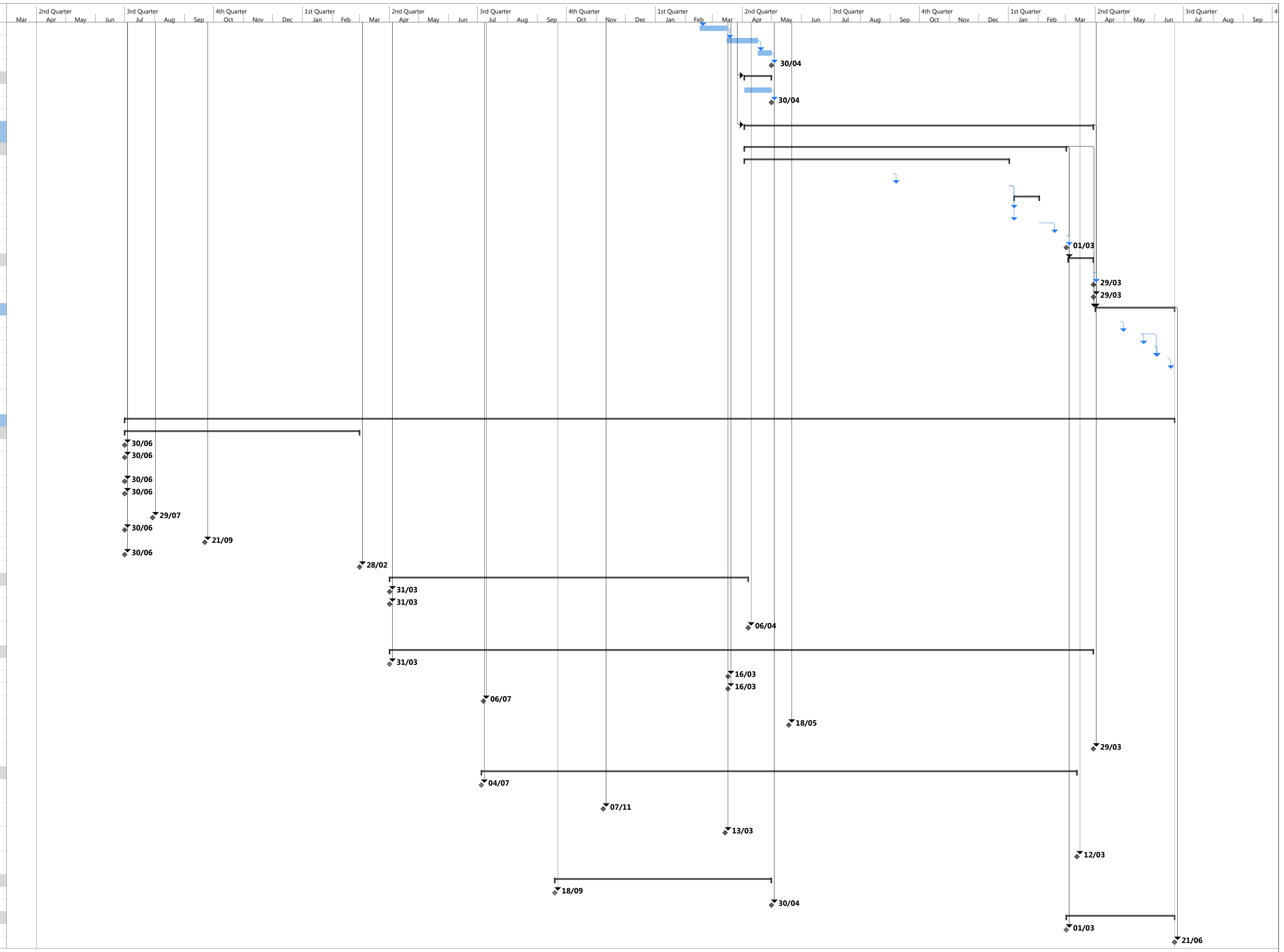
| ID | Task Mode | WBS | Task Name | Duration | Start | Finish |
|---|---|---|---|---|---|---|
| 97 | | **4** | **WP02 - Pilot 1: IP/MP - Installation of sensor technologies on area of Medway IP/MP** | **702 days** | **Fri 22/07/16** | **Fri 29/03/19** |
| 98 | | **4.1** | **Sensor Integration & testing (SG10)** | **182 days** | **Fri 22/07/16** | **Fri 31/03/17** |
| 99 | | 4.1.1 | Manufacture, Build & FAT | 117 days | Fri 22/07/16 | Fri 30/12/16 |
| 100 | | 4.1.2 | Build complete | 0 days | Fri 30/12/16 | Fri 30/12/16 |
| 101 | | 4.1.3 | Install all sensors (x 10 sites) | 125 days | Mon 10/10/16 | Fri 31/03/17 |
| 102 | | 4.1.4 | Site acceptance testing (x 10 sites) | 120 days | Mon 17/10/16 | Fri 31/03/17 |
| 103 | | 4.1.5 | SGN/DNV GL Approval | 0 days | Fri 31/03/17 | Fri 31/03/17 |
| 104 | | **4.2** | **Verification of sensor/communications structure (SG11)** | **30 days** | **Mon 20/02/17** | **Fri 31/03/17** |
| 105 | | 4.2.1 | System testing | 25 days | Mon 20/02/17 | Fri 24/03/17 |
| 106 | | 4.2.2 | Site acceptance testing | 5 days | Mon 27/03/17 | Fri 31/03/17 |
| 107 | | 4.2.3 | SGN/DNV GL Approval | 0 days | Fri 31/03/17 | Fri 31/03/17 |
| 108 | | **4.3** | **Gather Sensor Data & Review Data Requirements (SG12)** | **520 days** | **Mon 03/04/17** | **Fri 29/03/19** |
| 109 | | 4.3.1 | Setup & Receive Sensor Data (From individual sites on SAT) | 250 days | Mon 03/04/17 | Fri 16/03/18 |
| 110 | | 4.3.2 | Monitoring data gathered - On-going | 250 days | Mon 03/04/17 | Fri 16/03/18 |
| 111 | | 4.3.3 | Maintain hardware | 250 days | Mon 03/04/17 | Fri 16/03/18 |
| 112 | | 4.3.4 | Review data gathered | 5 days | Mon 19/03/18 | Fri 23/03/18 |
| 113 | | 4.3.5 | Gap Analysis & report | 10 days | Mon 26/03/18 | Fri 06/04/18 |
| 114 | | **4.3.6** | **SGN Approval - Stage gate approval** | **0 days** | **Fri 06/04/18** | **Fri 06/04/18** |
| 115 | | 4.3.7 | Year 3 - Monitoring data gathered - On-going | 255 days | Mon 09/04/18 | Fri 29/03/19 |
| 116 | | 4.3.8 | Year 3 - Maintain hardware | 255 days | Mon 09/04/18 | Fri 29/03/19 |
| 117 | | **4.4** | **Reporting** | **21 days** | **Fri 01/03/19** | **Fri 29/03/19** |
| 118 | | 4.4.1 | Draft Work Package Summary | 21 days | Fri 01/03/19 | Fri 29/03/19 |
| 119 | | 4.4.2 | Publish Work Package Summary | 0 days | Fri 29/03/19 | Fri 29/03/19 |
| 120 | | | | | | |
| 121 | | **5** | **WP03 - Pilot 2: LP Installation of sensor technologies on LP networks fed from Medway IP/MP** | **717 days** | **Fri 01/07/16** | **Fri 29/03/19** |
| 122 | | **5.1** | **Consumer Loggers & Pressure Sensors (SG13)** | **197 days** | **Fri 01/07/16** | **Fri 31/03/17** |
| 123 | | 5.1.1 | Supply Logger/Pressure Equipment | 40 days | Fri 01/07/16 | Wed 24/08/16 |
| 124 | | 5.1.2 | Manufacture complete | 0 days | Wed 24/08/16 | Wed 24/08/16 |
| 125 | | 5.1.3 | Logger FAT/Lab Testing | 5 days | Thu 25/08/16 | Wed 31/08/16 |
| 126 | | 5.1.4 | Install meter & pressure loggers | 152 days | Thu 01/09/16 | Fri 31/03/17 |
| 127 | | 5.1.5 | Equipment Test | 152 days | Thu 01/09/16 | Fri 31/03/17 |
| 128 | | 5.1.6 | SGN Approval | 0 days | Fri 31/03/17 | Fri 31/03/17 |
| 129 | | **5.2** | **Setup & Gather Logger Data (SG14)** | **250 days** | **Mon 03/04/17** | **Fri 16/03/18** |
| 130 | | 5.2.1 | Setup & Receive Logger Data | 250 days | Mon 03/04/17 | Fri 16/03/18 |
| 131 | | 5.2.2 | Monitoring data gathered - On-going | 250 days | Mon 03/04/17 | Fri 16/03/18 |
| 132 | | 5.2.3 | Maintain hardware | 250 days | Mon 03/04/17 | Fri 16/03/18 |
| 133 | | **5.3** | **Logger Data Requirements review (SG15)** | **485 days** | **Mon 01/05/17** | **Fri 08/03/19** |
| 134 | | 5.3.1 | Review data quality | 210 days | Mon 01/05/17 | Fri 16/02/18 |
| 135 | | 5.3.2 | Data quality Gap Analysis & strategy | 10 days | Mon 19/02/18 | Fri 02/03/18 |
| 136 | | 5.3.3 | Update requirements for Year 3 | 10 days | Mon 05/03/18 | Fri 16/03/18 |
| 137 | | **5.3.4** | **SGN Approval - Stage gate approval** | **0 days** | **Fri 16/03/18** | **Fri 16/03/18** |
| 138 | | 5.3.5 | Year 3 - Monitoring data gathered - On-going | 255 days | Mon 19/03/18 | Fri 08/03/19 |
| 139 | | 5.3.6 | Year 3 - Maintain hardware | 255 days | Mon 19/03/18 | Fri 08/03/19 |
| 140 | | **5.4** | **Phase 1 - Demand Modelling Development (SG16)** | **221 days** | **Thu 01/09/16** | **Thu 06/07/17** |
| 141 | | 5.4.1 | Develop prototype demand model | 215 days | Thu 01/09/16 | Wed 28/06/17 |
| 142 | | 5.4.2 | SGN review prototype demand model | 6 days | Thu 29/06/17 | Thu 06/07/17 |
| 143 | | 5.4.3 | SGN Approval | 0 days | Thu 06/07/17 | Thu 06/07/17 |
| 144 | | **5.5** | **Phase 2 - Demand modelling development (SG17)** | **226 days** | **Fri 07/07/17** | **Fri 18/05/18** |
| 145 | | 5.5.1 | Demand modelling | 215 days | Fri 07/07/17 | Thu 03/05/18 |
| 146 | | 5.5.2 | Demand modelling - Demonstrate modelling progress/findings | 6 days | Fri 04/05/18 | Fri 11/05/18 |
| 147 | | 5.5.3 | SGN review & feedback/updates | 5 days | Mon 14/05/18 | Fri 18/05/18 |
| 148 | | 5.5.4 | SGN Approval | 0 days | Fri 18/05/18 | Fri 18/05/18 |
| 149 | | **5.6** | **Phase 3 - Demand modelling development (SG18)** | **225 days** | **Mon 21/05/18** | **Fri 29/03/19** |
| 150 | | 5.6.1 | Demand modelling | 215 days | Mon 21/05/18 | Fri 15/03/19 |
| 151 | | 5.6.2 | Demand modelling - Demonstrate modelling progress/findings | 5 days | Mon 18/03/19 | Fri 22/03/19 |
| 152 | | 5.6.3 | SGN review & feedback/updates | 5 days | Mon 25/03/19 | Fri 29/03/19 |
| 153 | | 5.6.4 | SGN Approval | 0 days | Fri 29/03/19 | Fri 29/03/19 |
| 154 | | **5.7** | **Reporting** | **21 days** | **Fri 01/03/19** | **Fri 29/03/19** |
| 155 | | 5.7.1 | Draft Work Package Summary | 21 days | Fri 01/03/19 | Fri 29/03/19 |
| 156 | | 5.7.2 | Publish Work Package Summary | 0 days | Fri 29/03/19 | Fri 29/03/19 |
| 157 | | | | | | |
| 158 | | **6** | **WP04 - Trial to including integrated renewable technologies and simulated non-conventional distributed sources** | **530 days** | **Wed 01/03/17** | **Tue 12/03/19** |
| 159 | | **6.1** | **Phase 1 - Undertake Laboratory Testing of Renewables (SG19)** | **90 days** | **Wed 01/03/17** | **Tue 04/07/17** |
| 160 | | 6.1.1 | Lab based heat system simulation research | 85 days | Wed 01/03/17 | Tue 27/06/17 |
| 161 | | 6.1.2 | SGN review progress (demonstrate benefits of continued testing) | 5 days | Wed 28/06/17 | Tue 04/07/17 |
| 162 | | 6.1.3 | SGN Approval | 0 days | Tue 04/07/17 | Tue 04/07/17 |
| 163 | | **6.2** | **Phase 2 - Undertake Laboratory Testing of Renewables (SG20)** | **90 days** | **Wed 05/07/17** | **Tue 07/11/17** |
| 164 | | 6.2.1 | Lab based heat system simulation research | 85 days | Wed 05/07/17 | Tue 31/10/17 |
| 165 | | 6.2.2 | SGN review progress (demonstrate benefits of continued testing) | 5 days | Wed 01/11/17 | Tue 07/11/17 |
| 166 | | 6.2.3 | SGN Approval | 0 days | Tue 07/11/17 | Tue 07/11/17 |
| 167 | | **6.3** | **Phase 3 - Undertake Laboratory Testing of Renewables (SG21)** | **90 days** | **Wed 08/11/17** | **Tue 13/03/18** |
| 168 | | 6.3.1 | Lab based heat system simulation research | 85 days | Wed 08/11/17 | Tue 06/03/18 |
| 169 | | 6.3.2 | SGN review progress (demonstrate benefits of continued testing) | 5 days | Wed 07/03/18 | Tue 13/03/18 |
| 170 | | 6.3.3 | SGN Approval | 0 days | Tue 13/03/18 | Tue 13/03/18 |
| 171 | | **6.4** | **Investigation & Analysis of Renewables Behaviour (SG22)** | **260 days** | **Wed 14/03/18** | **Tue 12/03/19** |
| 172 | | 6.4.1 | Renewables impact assessment | 255 days | Wed 14/03/18 | Tue 05/03/19 |
| 173 | | 6.4.2 | SGN review of assessment | 5 days | Wed 06/03/19 | Tue 12/03/19 |
| 174 | | 6.4.3 | SGN Approval | 0 days | Tue 12/03/19 | Tue 12/03/19 |
| 175 | | **6.5** | **Reporting** | **21 days** | **Tue 12/02/19** | **Tue 12/03/19** |
| 176 | | 6.5.1 | Draft Work Package Summary | 21 days | Tue 12/02/19 | Tue 12/03/19 |
| 177 | | 6.5.2 | Publish Work Package Summary | 0 days | Tue 12/03/19 | Tue 12/03/19 |
| 178 | | | | | | |
| 179 | | **7** | **WP05 - Conceptual design of systems and software** | **345 days** | **Tue 03/01/17** | **Mon 30/04/18** |
| 180 | | **7.1** | **Conceptual Design of Software Solution (SG23)** | **185 days** | **Tue 03/01/17** | **Mon 18/09/17** |
| 181 | | **7.1.1** | **Real time demand model development** | **159 days** | **Tue 03/01/17** | **Fri 11/08/17** |
| 182 | | 7.1.1.1 | Prototype Demand model for Real Time modelling | 129 days | Tue 03/01/17 | Fri 30/06/17 |
| 183 | | 7.1.1.2 | Develop pseudo real time Demand data for Real Time modelling | 30 days | Mon 03/07/17 | Fri 11/08/17 |
| 184 | | 7.1.2 | Real Time Demand Model Progress Report | 16 days | Mon 14/08/17 | Mon 04/09/17 |
| 185 | | 7.1.3 | SGN Review | 10 days | Tue 05/09/17 | Mon 18/09/17 |
| 186 | | 7.1.4 | SGN Approval | 0 days | Mon 18/09/17 | Mon 18/09/17 |
| 187 | | **7.2** | **System Testing - Pseudo live data (SG24)** | **160 days** | **Tue 19/09/17** | **Mon 30/04/18** |
| 188 | | **7.2.1** | **Assessing Real Time Network Modelling - pseudo - online** | **128 days** | **Tue 19/09/17** | **Thu 15/03/18** |
| 189 | | **7.2.1.1** | **Set-up System and Model** | **108 days** | **Tue 19/09/17** | **Thu 15/02/18** |
| 190 | | 7.2.1.1.: | Linking Real time demand to online model | 44 days | Tue 19/09/17 | Fri 17/11/17 |
| 191 | | 7.2.1.1.: | Demonstrate Real time modelling principles in pseudo-online system | 64 days | Mon 20/11/17 | Thu 15/02/18 |




Project: NIC Project Plan_v1
Date: Wed 14/10/15

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

| ID | Task Mode | WBS | Task Name | Duration | Start | Finish |
|---|---|---|---|---|---|---|
| 192 | | 7.2.1.2 | Assess online data requirements for real time system | 20 days | Fri 16/02/18 | Thu 15/03/18 |
| 193 | | 7.2.2 | Report Pseudo on-line system | 22 days | Fri 16/03/18 | Mon 16/04/18 |
| 194 | | 7.2.3 | SGN Review | 10 days | Tue 17/04/18 | Mon 30/04/18 |
| 195 | | 7.2.4 | SGN Approval | 0 days | Mon 30/04/18 | Mon 30/04/18 |
| 196 | | **7.3** | **Reporting** | **20 days** | **Tue 03/04/18** | **Mon 30/04/18** |
| 197 | | 7.3.1 | Draft Work Package Summary | 20 days | Tue 03/04/18 | Mon 30/04/18 |
| 198 | | 7.3.2 | Publish Work Package Summary | 0 days | Mon 30/04/18 | Mon 30/04/18 |
| 199 | | | | | | |
| 200 | | **8** | **WP06 - Pilot 3: IP/MP/LP cross tier assessment of Real-time system** | **259 days** | **Tue 03/04/18** | **Fri 29/03/19** |
| 201 | | **8.1** | **Real Time Model Demonstration (SG25)** | **239 days** | **Tue 03/04/18** | **Fri 01/03/19** |
| 202 | | **8.1.1** | **Real time system demonstration - demand and on-line network model** | **196 days** | **Tue 03/04/18** | **Tue 01/01/19** |
| 203 | | 8.1.1.1 | Assessing Real Time Network Modelling - prototype - online: MP/IP | 110 days | Tue 03/04/18 | Mon 03/09/18 |
| 204 | | 8.1.1.2 | Assessing Real Time Network Modelling - prototype - online: LP/MP/IP | 86 days | Tue 04/09/18 | Tue 01/01/19 |
| 205 | | **8.1.2** | **Recommendations output** | **20 days** | **Mon 07/01/19** | **Fri 01/02/19** |
| 206 | | 8.1.2.1 | Recommendations for Measurement equipment | 20 days | Mon 07/01/19 | Fri 01/02/19 |
| 207 | | 8.1.2.2 | Recommendations for Comms | 20 days | Mon 07/01/19 | Fri 01/02/19 |
| 208 | | 8.1.3 | SGN Review | 10 days | Mon 18/02/19 | Fri 01/03/19 |
| 209 | | 8.1.4 | SGN Approval | 0 days | Fri 01/03/19 | Fri 01/03/19 |
| 210 | | **8.2** | **Reporting** | **20 days** | **Mon 04/03/19** | **Fri 29/03/19** |
| 211 | | 8.2.1 | Draft Work Package Summary | 20 days | Mon 04/03/19 | Fri 29/03/19 |
| 212 | | 8.2.2 | Publish Work Package Summary | 0 days | Fri 29/03/19 | Fri 29/03/19 |
| 213 | | 8.2.3 | Publish Project Findings and Recommendations | 0 days | Fri 29/03/19 | Fri 29/03/19 |
| 214 | | **9** | **Dissemination of Project Outcomes (SG26)** | **60 days** | **Mon 01/04/19** | **Fri 21/06/19** |
| 215 | | 9.1 | Dissemination plan | 20 days | Mon 01/04/19 | Fri 26/04/19 |
| 216 | | 9.2 | Complile Draft Reports & Presentations | 15 days | Mon 29/04/19 | Fri 17/05/19 |
| 217 | | 9.3 | SGN Review & comments | 10 days | Mon 20/05/19 | Fri 31/05/19 |
| 218 | | 9.4 | Final Reports & Presentations | 10 days | Mon 03/06/19 | Fri 14/06/19 |
| 219 | | 9.5 | Deliver Presentations | 5 days | Mon 17/06/19 | Fri 21/06/19 |
| 220 | | | | | | |
| 221 | | | | | | |
| 222 | | | | | | |
| 223 | | **10** | **Go/No-Go Stage Gates** | **777 days** | **Thu 30/06/16** | **Fri 21/06/19** |
| 224 | | **10.1** | **WP01** | **174 days** | **Thu 30/06/16** | **Tue 28/02/17** |
| 225 | | *10.1.1* | *Go/No-Go Stage Gate 1 - QRA Methodology* | *0 days* | *Thu 30/06/16* | *Thu 30/06/16* |
| 226 | | *10.1.2* | *Go/No-Go Stage Gate 2 - Logger Customer Engagement Plan & Data Protection Plan* | *0 days* | *Thu 30/06/16* | *Thu 30/06/16* |
| 227 | | *10.1.3* | *Go/No-Go Stage Gate 3 - Detailed Design of Cloud Data Solution* | *0 days* | *Thu 30/06/16* | *Thu 30/06/16* |
| 228 | | *10.1.4* | *Go/No-Go Stage Gate 4 - Detailed Consumer Meter Logger Detailed Design* | *0 days* | *Thu 30/06/16* | *Thu 30/06/16* |
| 229 | | *10.1.5* | *Go/No-Go Stage Gate 5 - Data Collection Specification* | *0 days* | *Fri 29/07/16* | *Fri 29/07/16* |
| 230 | | *10.1.6* | *Go/No-Go Stage Gate 6 - Communications Design & Testing* | *0 days* | *Thu 30/06/16* | *Thu 30/06/16* |
| 231 | | *10.1.7* | *Go/No-Go Stage Gate 7 - Detailed Sensor Equipment Design* | *0 days* | *Wed 21/09/16* | *Wed 21/09/16* |
| 232 | | *10.1.8* | *Go/No-Go Stage Gate 8 - Lab testing - Novel Sensors* | *0 days* | *Thu 30/06/16* | *Thu 30/06/16* |
| 233 | | *10.1.9* | *Go/No-Go Stage Gate 9 - Renewables Data Strategy* | *0 days* | *Tue 28/02/17* | *Tue 28/02/17* |
| 234 | | **10.2** | **WP02** | **265 days** | **Fri 31/03/17** | **Fri 06/04/18** |
| 235 | | *10.2.1* | *Go/No-Go Stage Gate 10 - Sensor Integration & testing* | *0 days* | *Fri 31/03/17* | *Fri 31/03/17* |
| 236 | | *10.2.2* | *Go/No-Go Stage Gate 11 - Verification of sensor/communications structure* | *0 days* | *Fri 31/03/17* | *Fri 31/03/17* |
| 237 | | *10.2.3* | *Go/No-Go Stage Gate 12 - Gather Sensor Data & Review Data Requirements* | *0 days* | *Fri 06/04/18* | *Fri 06/04/18* |
| 238 | | **10.3** | **WP03** | **520 days** | **Fri 31/03/17** | **Fri 29/03/19** |
| 239 | | *10.3.1* | *Go/No-Go Stage Gate 13 - Consumer Loggers & Pressure Sensors* | *0 days* | *Fri 31/03/17* | *Fri 31/03/17* |
| 240 | | *10.3.2* | *Go/No-Go Stage Gate 14 - Setup & Gather Logger Data* | *0 days* | *Fri 16/03/18* | *Fri 16/03/18* |
| 241 | | *10.3.3* | *Go/No-Go Stage Gate 15 - Logger Data Requirements review* | *0 days* | *Fri 16/03/18* | *Fri 16/03/18* |
| 242 | | *10.3.4* | *Go/No-Go Stage Gate 16 - Phase 1 - Demand Modelling Development* | *0 days* | *Thu 06/07/17* | *Thu 06/07/17* |
| 243 | | 10.3.5 | *Go/No-Go Stage Gate 17 - Phase 2 - Demand Modelling Development* | *0 days* | *Fri 18/05/18* | *Fri 18/05/18* |
| 244 | | 10.3.6 | *Go/No-Go Stage Gate 18 - Phase 3 - Demand Modelling Development* | *0 days* | *Fri 29/03/19* | *Fri 29/03/19* |
| 245 | | **10.4** | **WP04** | **440 days** | **Tue 04/07/17** | **Tue 12/03/19** |
| 246 | | *10.4.1* | *Go/No-Go Stage Gate 19 - Phase 1 - Undertake Laboratory Testing of Renewables* | *0 days* | *Tue 04/07/17* | *Tue 04/07/17* |
| 247 | | *10.4.2* | *Go/No-Go Stage Gate 20 - Phase 2 - Undertake Laboratory Testing of Renewables* | *0 days* | *Tue 07/11/17* | *Tue 07/11/17* |
| 248 | | *10.4.3* | *Go/No-Go Stage Gate 21 - Phase 3 - Undertake Laboratory Testing of Renewables* | *0 days* | *Tue 13/03/18* | *Tue 13/03/18* |
| 249 | | *10.4.4* | *Go/No-Go Stage Gate 22 - Investigation & Analysis of Renewables Behaviour* | *0 days* | *Tue 12/03/19* | *Tue 12/03/19* |
| 250 | | **10.5** | **WP05** | **160 days** | **Mon 18/09/17** | **Mon 30/04/18** |
| 251 | | *10.5.1* | *Go/No-Go Stage Gate 23 - Conceptual Design of Software Solution* | *0 days* | *Mon 18/09/17* | *Mon 18/09/17* |
| 252 | | *10.5.2* | *Go/No-Go Stage Gate 24 - System Testing - Pseudo live data* | *0 days* | *Mon 30/04/18* | *Mon 30/04/18* |
| 253 | | **10.6** | **WP06** | **80 days** | **Fri 01/03/19** | **Fri 21/06/19** |
| 254 | | *10.6.1* | *Go/No-Go Stage Gate 25 - Real-Time Model Demonstration* | *0 days* | *Fri 01/03/19* | *Fri 01/03/19* |
| 255 | | *10.6.2* | *Go/No-Go Stage Gate 26 - Dissemination of Project Outcomes* | *0 days* | *Fri 21/06/19* | *Fri 21/06/19* |




Project: NIC Project Plan_v1
Date: Wed 14/10/15

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

Page 3

## Appendix 5. Site Survey Information

These appendices detail an example of the surveys that were carried out at each of the key flow sites, where we will install ultrasonic flow metering to obtain accurate flow data into and out of the trial area. And an example of the surveys carried out at each key pressure reduction installation in the trial area where we will also be installing sensing and logging technologies. All other surveys are available on request.

[redacted]

Fig 5.1: A2 Rochester Golf Course Site Survey Information

[redacted]

Fig 5.2: Rochester PRS Site Survey Information

## Appendix 6. Sensor Technologies

| Measurement | Technology Status | | | Reason for Selection of Novel Technology |
|---|---|---|---|---|
| | Established | Tested under NIA or similar | Novel | |
| Flow | In-line FlowSic 500 meter | Flexim clamp-on meter | Retractable flare gas meter | Challenge of large diameter, low pressure pipe at below ground installations. Hot tap insertion required as no possibility of interrupting gas flow. |
| Gas Quality | | GasPTi (Tested by University of Milan) | MEMs and gasQS | Small and cheap but unproven in gas networks – potential for large scale roll out for monitoring live gas quality changes. |
| Power | | Solar panels (current NIA project) | Tie in to street furniture | Reliable and available power supply |
| Pressure | Technolog | Abriox Osprey | | |
| Temperature | Platinum resistance | | Retractable thermowell | Compact & network first application. Could be useful for pigged lines. |
| Communications | Existing SGN infrastructure | | Real-time data cloud approach for gas networks | Cloud technology readiness – test environment separate from SGN to protect business as usual activities |
| Volume conversion | | | Orbital Gas Systems Opto Unit | Compact & potentially more accurate than volume convertor |

## Appendix 7. Network Diagrams

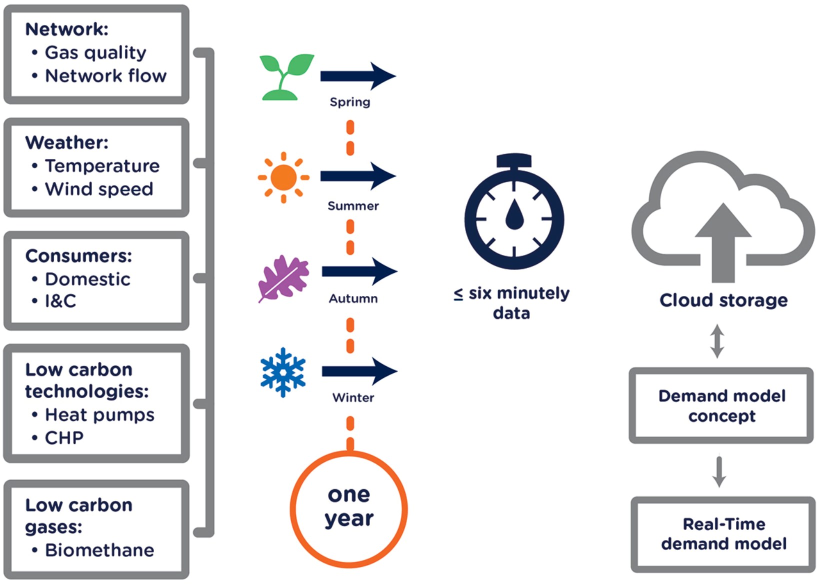



Fig 7.1: The Real-Time Network solution

The above figure explains the different Supplies of gas, demands and gas qualities that will be measured during the project and how, over the course of one year this data will enable us to redefine the peak 6 minute demand condition.

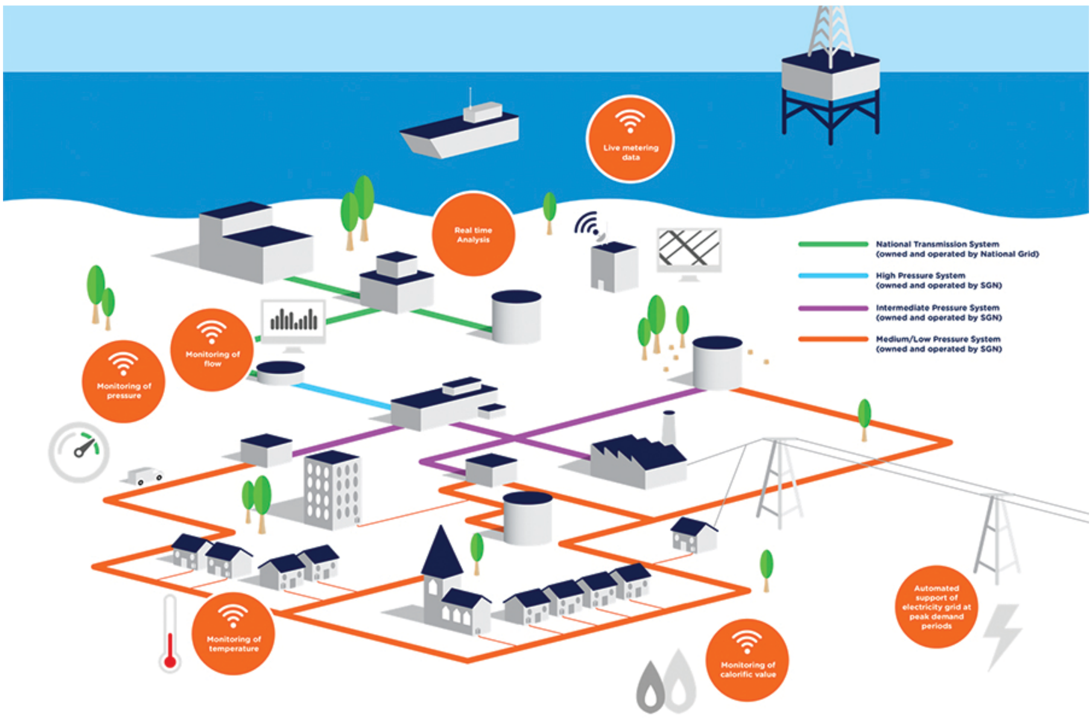



Fig 7.2 Beach to meter diagram

The Beach to Meter diagram helps to provide understanding of the pressure tiers this project will effect and in what way.

## Appendix 8. Data collection Methodology

### Introduction

This Appendix gives the background to the data to be used for training and testing the demand models that will form an integral part of the Real-Time Networks package, along with an assessment of the data required to run the developed models in a live, real-time situation.

### Demand Model Training

The Real-Time Networks project covers a number of different pressure tiers, from LP upwards, and the demand models must therefore be capable of returning results at an appropriate granularity for each one. The most detailed modelling currently takes place on LP networks and uses a 6-minute granularity. The DEC 86/600[1] equations currently used for demand estimation work on an MPRN-by-MPRN basis and this must also continue. Given that the purpose of Real-Time Networks is to improve the accuracy of the models and their applicability to the actual networks, this time frame will certainly not be lengthened, and so this creates a requirement for any new models to also be capable of functioning at the 6-minute level. For the MP and IP pressure tiers consideration will be given during the proposed project to using a design level based on an hourly granularity.

Based on these requirements, the training data for the new models must come from individual sites and be at a granularity of 6 minutes. The sources of data to be used in the project are:

- Loggers install at the required sample of sites

  Installing loggers that report on a 6-minute basis will provide exactly the data required for analysis, but is likely to be the most expensive option. Data is required for several hundred domestics and several hundred non-domestics, and installing and maintaining loggers at this many sites is likely to be costly.

  A benefit of using consumer meter logging is that the project can ensure that a representative sample of properties is selected. There is no guarantee that this sample is available from smart metering at this point in time.

- The existing Daily Metered data within SGN

  If smart meter data could be made available, it would have a positive impact on the project as the need to install data loggers would be reduced (provided that the data granularity is available at 6 minute intervals and the sample of consumers is representative of Medway and GB). There is currently uncertainty over the availability of 6 minute data from smart metering where 30 minute data is standard.

  SGN already have flow data available for the limited number of Daily Metered sites which are generally large by definition. Whilst this is hourly flow data, this could be used to supplement the data from other sources.

Other sources of data have been investigated but found to be unsuitable for the project as follows:

- Smart Meter data

  Uncertainties about the availability of and costs associated with obtaining Smart Meter data have led to alternative options being taken up. There is uncertainty about when GDNs would be able to access Smart Meter data from DCC. Whilst the

[1] DEC 86/600 is the British Gas planning standard where the demand algorithms were first published.

timetable for DCC to go live is the autumn of 2016 there appears to be uncertainty over when GDNs will be able to access data for all regions of the UK. A further blocker to the use of smart meter data concerns work to enable the secure flow of data from DCC to the DN. The cost of setting up a communication link to the secure system is estimated to be £1.5m, a figure identified by DNV-GL and based on the purchase of the proprietary software required to link with DCC data.

Furthermore there is uncertainty as to whether there would be sufficient numbers of smart meters available covering the required span of consumers needed for modelling demand. The cost of the software and systems required for access to the data is also anticipated to be extensive. It is considered inappropriate to use this project to develop the required software and systems to support access to the data.

Relevant smart meter data obtained during or only after the project could be incorporated into the Real-Time Networks solution, subject to the quality and the relevance of this data. This data can be fed into the real-time gateway and integrated into the Real-Time Networks solution[2]. The demand model would benefit from more up-to-date data that represents the most recent consumer behaviours, however smart metering is unlikely to change consumer behaviours, in terms of gas usage, significantly[3]. A step change in demand is more likely to be due to the uptake of downstream renewables and further integration or cogeneration of gas and electricity networks.

- The existing sample of sites used by Xoserve to train the allocation algorithms

  Whilst this sample of data contains a large number of both domestic and non-domestic sites the key issue is that this sample has contracts that state that their data is used to train the allocation algorithms only: this agreement would have to be changed in order for Real-Time Networks to use the data. As stated, anonymised data is not useable for the creation of demand models.

### Sample Sizes Required For Training Data

The demand model must be trained on sufficient actual load data to make the resultant statistical models both representative and robust. In practice, the choice of sample size is the result of a compromise between statistical accuracy and the cost of data collection: any statistical model will become more accurate the more data is used to train it, and therefore once the minimum requirement has been reached, the final sample sizes are defined using cost considerations. For each site, data from a minimum of one year (1/10/YY to 31/9/YY+1) is required for the development of a functional peak and off peak demand model. The project plans to collect data for 2 years to increase the likelihood of a suitable range of weather conditions being experienced.

The load data collected must provide adequate coverage of every load category that may be present in the final model. In all model descriptions so far, the DDS tags have been used as the basis for splitting loads up into groups that exhibit relatively similar behaviour. However, it is likely that more accurate modelling can be achieved using different load groups, and the definition of these groups and the creation of rule sets that assign any load to its correct (new) group can form part of the demand model creation process if required. Therefore, sample sizes must be chosen that provide sufficient data for this approach to be implemented if required. It is important to randomise the sample in order to include a wide range of locations, behaviours, social conditions, etc.

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[2] See the IT project plan included in the submission appendix (Appendix 3, Fig 3.1 "Cloud Solution IT Architecture").

[3] J. Dehaeseleer, "Gas Industry views regarding Smart Gas Grid," EGATEC, Copenhagen, 2011.

Within this context, and to provide sufficient data to create robust demand models data for sets of 50 to 60 consumers will be obtained for each of the following initial groups of domestic property types given in the table below. Note that the breakdown of domestic types given here is not meant to be a suggestion of what any final load category structure would look like, but instead have been designed to ensure that a representative sample across the whole domestic population is taken.

*Table 1: Breakdown of domestic types*

| Group | Type |
|---|---|
| **1** | **1 Bedroom Flats** |
| **2** | **2 Bedroom Flats** |
| **3** | **2 Bedroom Terraced Houses** |
| **4** | **3+ Bedroom Terraced Houses** |
| **5** | **2 Bedroom Semi-Detached Houses** |
| **6** | **3 Bedroom Semi-Detached Houses** |
| **7** | **4+ Bedroom Semi-Detached Houses** |
| **8** | **3 Bedroom Detached Houses** |
| **9** | **4+ Bedroom Detached Houses** |
| **10** | **Bungalows** |

The total number of domestics required is therefore a minimum of 500 (10 categories x 50 sites per category), with an additional 10 consumers per category to account for any losses over time; making a total of 600 domestic consumers being logged. New domestic load groupings to be created as part of the analysis will require socio-economic data for each site in the sample. This data would cover such elements as occupier lifestyle (e.g. Mosaic), age of property, occupier income, Council Tax band, etc.

Load data for non-domestic sites should be collected based on DDS tags, with a target value of either 50 or 100 sites for each category as indicated in the table below. Tags C1 and C2 have been split into their component parts to create a total of seven non-domestic sampling categories. The groups with 100 sites are those that are considered to still exhibit a range of behaviours and hence may need to be subdivided, hence the need for additional sites.

- For schools, there may be differences between large educational establishments such as universities and small establishments such as primary schools or nurseries.
- I2 (Industrials) is a category covering a very wide variety of sites, and there is a lot of variation in behaviour within this category.
- It may be beneficial to split Shops into those that are retail only (and hence use gas just for heating/cooling) and those with an additional process that uses gas (e.g. bakeries).

Bearing these points in mind, the following sample sizes are recommended as a minimum:

*Table 2: Sample Sizes*

| Load Category | Minimum total required |
|---|---|
| Schools | 100 |
| Hospitals | 100 |
| Hotels and Halls | 100 |

| | |
|---|---|
| Industrials | 100 |
| Offices | 100 |
| Pubs and Restaurants | 100 |
| Shops and Distribution Outlets | 100 |
| Minimum total Non-Domestic | 700 |

To ensure there is a good chance of continuity of data from sufficient numbers of sites, consideration should be given to the collection of data from additional numbers of sites above the minimum requirement. This will result in a total of 700 non-domestic consumers being logged including additional loggers to cater for losses over time. There will therefore be a total of 1200 loggers installed for the project.

### 'Anonymisation'

Fundamentally, to model demand on a network, the location and the type of consumer is required; without this information, demand modelling at a network level and all the benefits associated with it are not possible. Other studies looking at general area consumptions are possible with anonymised data, but for this project the location of the demand is required.

To cater for the requirement for anonymisation of the data needed SGN will produce a Data Protection Plan (in accordance with the Data Protection Act 1988). This plan shall run alongside the customer engagement plan within WP01 and be submitted more than two months before any data collection is conducted (1st July 2016).

Both SGN and DNV GL with have access to non-anonymised data throughout the project. However, any published information from the project will have all specific consumer data redacted.

Techniques employed to anonymise the data will, if required, be based on the document "Anonymisation: managing data protection risk code of practice" produced by the ICO (Information Commissioner's Office). Reference to the additional ICO document "Determining what is personal data" identifies that gas usage data that will be collected is classified as "Personal Data" as far as the Data Protection Act is concerned.

'Tokenisation' will be used within the project to anonymise consumer data. The Real-Time Networks project would replace addresses with a mapped value, which refers to a table containing the range of new values and addresses. This data would be held within the real-time gateway, protected by encryption in the first instance and additionally would only be accessible in its raw state by authorised individuals. A fuller description of tokenisation can be found in the "Anonymistation" document referred to earlier.

Should the project submission be successful this information will be fully described in the required Ofgem documentation:

- Customer Engagement Plan
- Data Protection Plan

Any subcontractors put in place by DNV GL will work under terms no less onerous than DNV GL, but will have access to personal data at various stages of the project. DNV GL will apply provisions to achieve the required level of encryption.

## Localised Composite Weather Variable (CWV)

The creation of localised CWVs introduces a different geographical breakdown within this project – that of weather areas. Local CWV will be calculated by a dedicated model that uses the known CWV formulae and the latest coefficients. It will be based on local readings for temperature and wind speed as well. Calculating local CWVs will identify if the weather at these points has the potential to differ significantly from the LDZ-wide figures used in the actual CWV calculation.

The number of weather stations will be limited, and will be evenly distributed throughout the LDZ. No more than 5 or 6 are be used for the SE LDZ.

This placement of weather stations will create a set of weather areas across the LDZ. The Rochester PRS is suitable to be used as the local site for CWV measurement within the Medway area. Other potential sites are to be identified, but these may be selected from suitable existing pressure reduction stations which are appropriately spaced geographically.

## CV Modelling

For the collection of consumer data for the wider LDZ, it would be necessary to assess the CV data for the NTS offtakes which supply the SE LDZ. The zones of influence of the Offtakes will be analysed to assess the CV of gas reaching the sample of consumers whose meters are used for the model development and specifically to assess the gas reaching to Medway area. The impact of biomethane supplies will also be assessed, where they feed into the wider network. For the Medway RTN area CV measuring would need to cover the extent to which boil-off gas would spread from Grain LNG into the wider network, which will vary with the level of boil-off gas available and the demand conditions in general. It is proposed to identify the changing CV pattern by the use alternative less costly CV measuring approaches at the DRIs downstream of the boil-off supply from Grain LNG. A number of sites have been identified for CV measuring within the Medway area. There will be a requirement to install CV monitoring within the wider LDZ to validate assumptions about the pattern of flow from the Offtakes. The need for this additional CV measurement will be verified.

## Demand Model Testing

The demand model needs to be tested under a wide range of conditions in order to assess its accuracy across all the levels at which it will be used. The demand model is intended to provide accurate results from individual loads to full LP and MP/IP networks, and therefore its performance must be tested for as wide a set of load combinations as possible.

### Demand Model Testing for RTN project

For testing the models at the aggregate level, a small sample of real networks will be used. Measurements of flow need to be captured for the overall RTN target area of Medway. There are 5 sites for flow measurement which will define the flows into and out of the Medway area. These are detailed in Appendix 5.

In addition, at least one smaller sub-network of the overall Medway area will be measured to provide an additional level of flow against which the demand model may be tested. This requires measurement at, at least, one network supply point from Christmas Lane, Grain Village or Cliffe Woods. Consideration may be given to further flow measurement points to capture data for low numbers of consumers in the order of 10 to 20 as a further proof of the accuracy of the demand model.

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## Demand Model in Real-Time

They key concept of this project is that it produces models that can be run in real-time. In order to realise the benefits this offers, however, input data must also be available in real-time from the logged sites within the Medway area. The models will be able to use whatever logged real-time data is available as they are running, and there will be considerable accuracy benefits from this. Live data and recent historic data on a site-by-site basis gives additional information over and above the best estimates provided by the model. Having such data allows the model output to be amended to fit the observed behaviour of the site, both in terms of daily load profile and load magnitude for the background conditions. These adjustments can lead to considerable improvements in model accuracy, with the model able to tailor itself to each site for which it has additional data. It is recognised, however, that such data will only be available for a subset of loads (at most, those loads with loggers). The model will be able to work with whatever data is available to it for each site,

The project will be developed to carry out the assessment of the levels of data needed for accurate modelling for operational purposes.

Appendix 9. Case Study 1 – Reduced Leakage

The following case study on the Strood Low Pressure (LP) network illustrates the potential leakage reduction if revisions to demand assumptions from a greater understanding of diversity can be achieved. Strood LP consists of approximately 193km of mixed-material distribution pipework, of which, 52% are metallic mains.

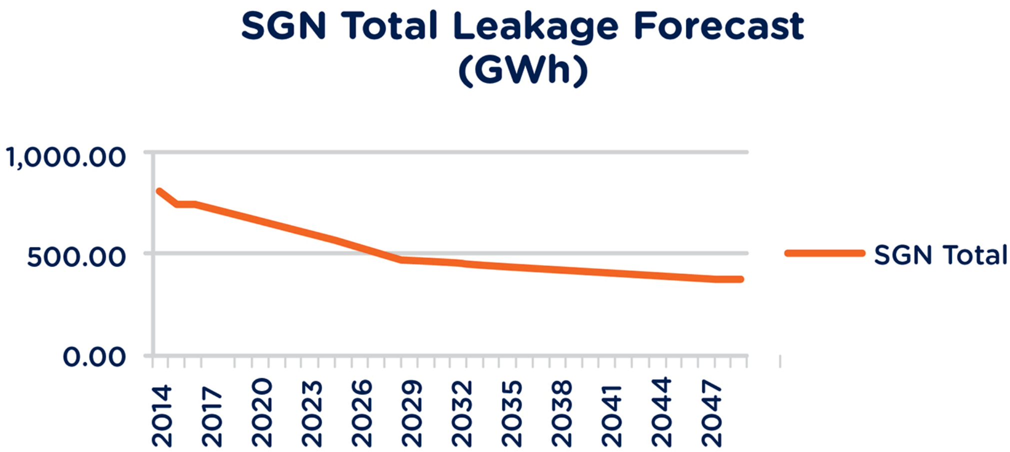
The current leakage for Strood LP can be broken down to a cost of carbon of £204,104 plus the cost of gas of £50,266.

By modelling this network on a target 15% reduction in the redefined 1:20 peak condition and associated off peak diversification, we found that the average system operating pressure (ASP) could be decreased by 0.5mbar. This reduction in pressure would result in a 1.5% leakage reduction across the network over the course of a year. This equates to a saving of £754/year (gas) and £3061/year (carbon).

In environmental terms, reducing the leakage in Strood LP by 1.5% would save over 53.2 tonnes of CO2e/year. These savings could be scaled to SGN, and GB.

The Government's Carbon plan sets the UK's progress framework for meeting carbon targets. To demonstrate how a real-time network could help meet these targets and predict the future potential benefit of this project across SGN we must first predict the future reduction in leakage due to mains replacement.

See below a graph showing the future trend of leakage to 2050.




This trend assumes a reduction in mains replacement work following the end of the 2030 Repex target and no significant changes to this policy following the end of the current price control in 2021.

Fig 9.1: Leakage forecast for SGN

Below is a table of the predicted leakage costs for SGN:

| | 2020 | 2030 | 2050 |
|---|---|---|---|
| Total Leakage (GWh) | 659 | 462 | 362 |
| Costs (£) | 11,553,400 | 9,762,795 | 10,548,548 |
| Tonnes CO2e | 740384 | 518998 | 406717 |

If we apply a similar 0.5mbar reduction in ASPs following the rollout of real-time networks in SGN we could be able to make a significant financial saving. These savings have been quantified in the benefit summary tables, *Appendix 1*.

## Appendix 10. Case Study 2 – Reduced Replacement Expenditure

For an example of how this saving will be realised we have used the Strood LP Network which lies within the project trial area. This network includes over 100km of metallic mains, 21.8km of which are due to be replaced in the next 4 years. Approximately 3% of these replacements have been designed as open cut equating to £130,920 of open-cut costs. Following analysis and redesign of these projects in a post RTN scenario, with the targeted refinement of 1:20 demand, we found that the majority of these mains could be inserted resulting in a saving of approximately £51,950.

Below is a summary of SGNs Repex costs 2013-2015. In order to find an approximate saving across SGN a percentage reduction of the cost of open-cut mains was applied.

| | LDZ | Open-Cut (m) | Total Mains Lay (m) | Costs |
|---|---|---|---|---|
| 2013-14 | SC | 88,041 | 340,781 | |
| | SE | 76,592 | 537,355 | |
| | SO | 62,705 | 292,767 | |
| Total: | | 227,338 | 1,170,903 | £95,759,812 |
| 2014-15 | SC | 80,685 | 327,546 | |
| | SE | 88,151 | 551,160 | |
| | SO | 58,557 | 249,865 | |
| Total: | | 227,393 | 1,128,571 | £96,105,754 |

Our analysis suggests that a 8.8% reduction in repex costs, due to increased insertion rates, could be applied to 60% of the total replacement length if the target reduction in the 1:20 forecast could be achieved. This would result in a saving of £3.38m/year at current replacement rates in SGN.

Fig 10.1: Open-cut mains replacement siteworks

# Appendix 11. Case Study 3 - Replacement of LTS and below 7bar Pressure Reduction Stations

PRSs are typically replaced for Asset Health or localised specific growth only, there is no general growth applied to drive replacement for capacity. Currently there are 3 PRSs across SGN which require their capacity to be increased. These projects have a total approved cost of £3,941,000.

Through the reduction in the required capacity of these stations there is an opportunity to reduce the material costs by using reduced component sizes. For example if the reduction in peak modelled demand results in a higher design pressure the size of the regulator can be reduced. Or in the case of a stream replacement the size of this replacement could be replaced with a smaller diameter.

Following the re-analysis of capacity at the three sites mentioned above there could be an opportunity to remove the requirement to reinforce these stations, removing the need for expenditure. The benefits of reduced design flow from this project would mostly impact sites where capacity is currently considered to be close to being exceeded or where complete replacement is required to ensure the integrity of the assets.

Where the replacements of components is required under health and criticality targets then there is an opportunity to save approximately 4% on the cost of each project through reduced component sizes (governors, valves, flow restrictors, streams etc).

In order to quantify this benefit the percentage of projects that are likely to be affected by a conservative 15% reduction in peak demand was applied. The same 4% saving for each of these projects was then applied to give the total benefit in this area. For a breakdown of this benefit, following the rollout of Real-Time Networks, See *Appendix 1.*

As with LTS Pressure Reduction Stations, pressure reduction installations within the below 7bar systems are designed to supply the peak six minute demand required by the below 7bar network which is identified through network analysis.

Under RIIO, SGN have a target to increase the capacity of eight governors and one DPG each year to account for the increase in demand over this period. Following the application of a refined 1:20 peak demand there could be an opportunity to remove the requirement of at least one of these capacity projects. By applying a conservative average cost for these works equates to £680,000. By reducing the required capacity of governors across SGN those governors that could then be replaced with a smaller regulator making a cost saving. We can assume a conservative 10% saving of the total approved annual cost.

# Appendix 12. Case Study 4 - Proof of Ultrasonic Flow metering capabilities

Orifice plates are used throughout GB gas networks as a method of measuring flow, usually at NTS offtakes and other sites such as pressure reduction stations. These systems are dated, require regular maintenance and are costly to install or upgrade. Many GDNs are replacing orifice plates with ultrasonic meters (USM) because these incorporate condition-based monitoring to indicate meter health and reduce the incidence of large and costly meter errors. For custody transfer applications, multi-path in-line meters are required. For other applications requiring lower accuracy measurement, clamp-on or hot-tapped meters such as those proposed for this project will be a very useful development.

The cost of installing custody transfer systems at offtakes will be approximately £1M using the more intrusive inline method which is to be used during SGNs replacement of orifice plates. The complete cost of installing a USM including pressure, temperature and communications, as in this project, is approximately £200k per site.

Following the implementation of this project we will be able to provide a study into the feasibility of the hot-tapping method as a method of installation potentially saving approximately £800,000 per replacement.

Fig 12.1 Example of a novel ultrasonic meter

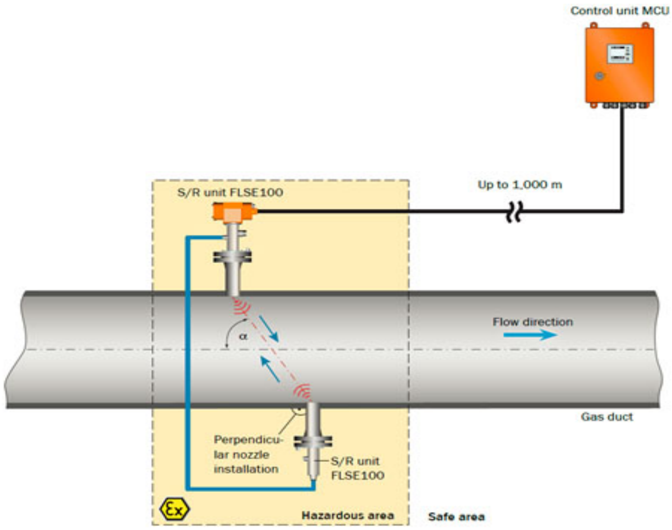




Fig 12.2 Ultrasonic meter installation

## Appendix 13. Case Study 5 - Reduced Exit Capacity

If successful, following the rollout across SGN, we will be able to reduce our booked exit capacity, resulting in a cost saving.

Below is a table of the revenue SGN earned under the Exit Capacity Incentive until now.

| | **2013/14** | **2013/14** | **2013/14** | **2014/15** | **2014/15** | **2014/15** |
|---|---|---|---|---|---|---|
| NTS Exit Capacity Incentive Performance | Southern | Scotland | SGN | Southern | Scotland | SGN |
| Pre IQI and Corporation Tax | 3.02 | 0.11 | 3.13 | 1.45 | -0.03 | 1.42 |
| Post IQI and Corporation Tax | 2.50 | 0.09 | 2.59 | 1.17 | -0.03 | 1.15 |

Here we can see the minimal revenue earned in 2013/14 in Scotland when compared to Southern and the penalty paid by Scotland in 2014/15 due to an inaccurate estimation of exit capacity.

Following the implementation of this project across SGN we will be able to accurately predict the flow into SGNs network from the NTS and increase the revenue earned. We have assumed this will be equivalent to half of the revenue earned in southern. By taking an average over the past two years this gives an approximate benefit of £1,117,500 additional revenue each year. This example only applies to SGN where capacity bookings at Scottish offtakes are based on a pressure control system.

Currently the LTS system for capacity booking uses economic, CWV and Peak day forecasts to predict the flow at the NTS offtakes. Through this project we may be able to increase the accuracy of this system by increasing the granularity of the peak demand condition. Whilst it is not possible to accurately predict what % this would be, for illustrative purposes, a reduction in prediction by 5% would result in a £4,799,633 increase in revenue earned under this incentive for SGN.

## Appendix 14. Non-Conventional Sources of Gas

| Gas Source | Definition | Potential impact/Scale |
|---|---|---|
| **LNG** | LNG is natural gas that has been compressed into liquid form. During the liquefaction, heavy hydrocarbons and inert gases are removed, resulting in gas that is generally richer than that of our indigenous reserves in the North sea. | GB is a net importer of natural gas, some 80% of gas needs will be met by Liquefied Natural Gas (LNG). |
| **Biomethane** | Biogas is a mixture of Methane and Carbon Dioxide generally produced by bacterial degradation of organic matter. Biomethane is produced by removing the majority of CO2. | The Carbon Plan identifies a need for 10-38TWh of low carbon heat delivered through energy networks by 2030 and identifies biomethane as the least disruptive technology that can support this. It is estimated that up to 500 Biomethane connections will be made to the gas distribution networks by 2020[3] |
| **BioSNG** | BioSNG is a synthetic natural gas produced by thermal gasification of waste that is unsuitable for anaerobic digestion. | According to National Grid, BioSNG has the potential to meet 40% of UK domestic gas demand. If this assertion is correct >6000 network connections would be required (based on a 22GWh BioSNG output per annum). |
| **Shale Gas** | Shale gas is natural gas usually found in compact, low-permeability rocks deep beneath the surface. | Significant Shale reserves have been discovered across GB, estimated to be 20tcf (trillion cubic feet) and there is a clear UK government intention to explore and support this opportunity. 'We need more secure, home grown energy supplies, and shale gas and oil have a vital role to play.' Energy Minister Andrea Leadsom |
| **Hydrogen** | Hydrogen is the simplest and lightest of all elements. When it burns its only by product is water vapour. It is generally produced by Steam Methane Reformation or Electrolysis. | Transporting Hydrogen in the gas grid has been widely researched in GB, Europe and the Americas. In Hamburg, Germany up to 10% Hydrogen has been injected into the gas network following a European funded research project[4]. |

[3] http://adbioresources.org/docs/July_2015_Market_Report.pdf
[4] http://www.gerg.eu/public/uploads/files/publications/GERGpapers/SD_gfe_03_13_Report_Altfeld-Pinchbeck.pdf

## Appendix 15. Table of Network Features

| Network Feature | Details |
|---|---|
| **Total Length of Mains** | Length in Medway 314.57 km<br>Length in SGN 47,947 km |
| **Length of Low Pressure Mains** | Length in Medway 230.17km<br>Length in SGN 39,464 km |
| **Proportion of Metallic Mains** | 48.8% Metallic in Medway<br>35% Metallic in SGN |
| **Proportion of LP Mains** | 73% in Medway<br>82% in SGN |
| **Approximate Number of Customers** | 22,000 |
| **Number of District Governors** | 21 |
| **Number of Distribution Pressure Governors** | One DPG at Cuxton |
| **Low Pressure Networks** | 8 |
| **Geographical Location** | Covering an area of approximately 100km² The Medway trial area is situated 50km East of London, On the north side of the River Medway |
| **Isle of Grain LNG** | The trial site incorporates the Isle of Grain LNG Terminal, The largest by capacity in Europe. This feeds the transmission at 38bar system and also feeds the 2bar MP system which flows directly into the Real-Time Networks Medway trial area |
| **Rochester Holder** | Ex-Holder station within trial area at Rochester. Since replaced by Rochester Pressure Reduction Station |
| **Diverse Demand Types** | The demand for gas in Medway consists of a significant amount of Industrial, Commercial and Domestic loads, comparable to the statistical representation of GB. There are also significant amounts of development planned, Domestic and Commercial along the River Medway |

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## Appendix 16. Knowledge Dissemination Plan

| Who | What | How | When |
|---|---|---|---|
| Ofgem | • Project data<br>• Test results<br>• Project progress | • Progress reports<br>• Publish information on Ofgem portal<br>• Update meetings<br>• LCNI Conference<br>• SGN Website | • Progress report every 6 months<br>• Comprehensive learning report after project completion<br>• Regular updates Ofgem portal<br>• LCNI Conference dates |
| HSE | • Network performance data | • Publish information on Ofgem portal<br>• LCNI Conference | • Regular updates Ofgem portal<br>• Other updates will be provided upon request<br>• LCNI Conference dates |
| DECC | | • Publish information on Ofgem portal<br>• LCNI Conference<br>• SGN Website | • Regular updates Ofgem portal<br>• Regular updates on SGN website<br>• LCNI Conference dates |
| Gas Transporters | • Network Performance data<br>• Implications local distribution networks | • LCNI Conference<br>• SGN Website | • Regular updates on SGN website<br>• LCNI Conference dates |
| Gas Shippers | • Test gas data<br>• Trial gas data<br>• Network entry implications | • LCNI Conference<br>• SGN Website | • LCNI Conference dates<br>• Regular updates on SGN website |
| ENA | • Implication of project for other gas networks | • LCNI Conference<br>• SGN Website<br>• Journal Paper | • Journal paper to be produced after completion of project<br>• LCNI Conference dates<br>• Regular updates on SGN website |
| IGEM | • Interested in all aspects of project learning | • LCNI Conference<br>• SGN Website<br>• Journal Paper<br>• Paper evening presentation<br>• IGEM Magazine article<br>• Technical site visits | • Presentation at IGEM conference in 2016/17<br>• Results of Project to be published in IGEM magazine at end of project<br>• Visit to Medway area to be offered in 2016/17 |
| Pipeline Industries Guild | • Implications for gas production<br>• Learning relating to transmission and distribution | • LCNI Conference<br>• SGN Website | • Regular updates on SGN website<br>• LCNI Conference dates |

| Who | What | How | When |
|---|---|---|---|
| Academic Institutions | • Results of appliance tests<br>• Network performance data | • Journal Paper<br>• IGEM Magazine article | • Journal paper to be produced after completion of project<br>• Results of Project to be published in IGEM magazine at end of project |
| Appliance Manufacturers | • Results of appliance tests | • Journal Paper<br>• IGEM Magazine article | • Journal paper to be produced after completion of project<br>• Results of Project to be published in IGEM magazine at end of project |
| Customers | • Project progress<br>• Outcome of Project | • Twitter<br>• Facebook<br>• Youtube<br>• Pamphlets<br>• Local and National Press | • Progress updates to be uploaded to twitter & Facebook at regular intervals<br>• Youtube video to be uploaded prior to start of Project<br>• Information pamphlets will be used before and after Project to share knowledge with customers<br>• Project updates to be publicised in local and national press at relevant stages throughout the project. |

**Internal Dissemination**

| Who | What | How | When |
|---|---|---|---|
| SGN Board of Directors | • Project outline<br>• Project results | • Presentations to the Board<br>• SGN Annual Report | • Presentations at the start and completion of the project<br>• Project outline to be submitted in 2016 Annual Report |
| SGN Executive | • Project outline<br>• Project progress<br>• Project results | • Presentation to the Executive Committee<br>• SGN Annual Report<br>• Progress reports<br>• Site visits | • Presentation at the start and completion of the project<br>• Project outline to be submitted in 2016 Annual Report<br>• Progress updates to be given monthly by Project Director<br>• Site visits to be offered throughout Project |
| SGN Operational Managers | • Project results<br>• Change to operating | • Briefing notes<br>• Presentation at Operations | • Briefing notes to be issued before start of the testing |

| Who | What | How | When |
|---|---|---|---|
| | procedures | Committee | programme<br>• Presentations at the start and completion of the project |
| SGN Medway Employees | • Project results<br>• Change to operating procedures | • Team talks<br>• Briefing notes<br>• Engineering Bulletins | • Team talks at key stages of the project<br>• Briefing notes / engineering bulletins to be issued whenever deemed necessary |
| Innovation Board | • Project updates<br>• SGN roll - Cross Project learning | • Innovation Board meetings<br>• Update reports to members | • Key stages throughout the project |
| Investment Committee | • Project spend<br>• Costs<br>• Overruns | • Innovation committee meetings<br>• Reports submitted to members | • Key stages throughout the project |
| All other SGN Employees | • Project outline<br>• Project results | • SGN Mail (internal magazine)<br>• SGNnet (intranet site) | • At the start and completion of the project |

## Appendix 17. Project Team Organogram

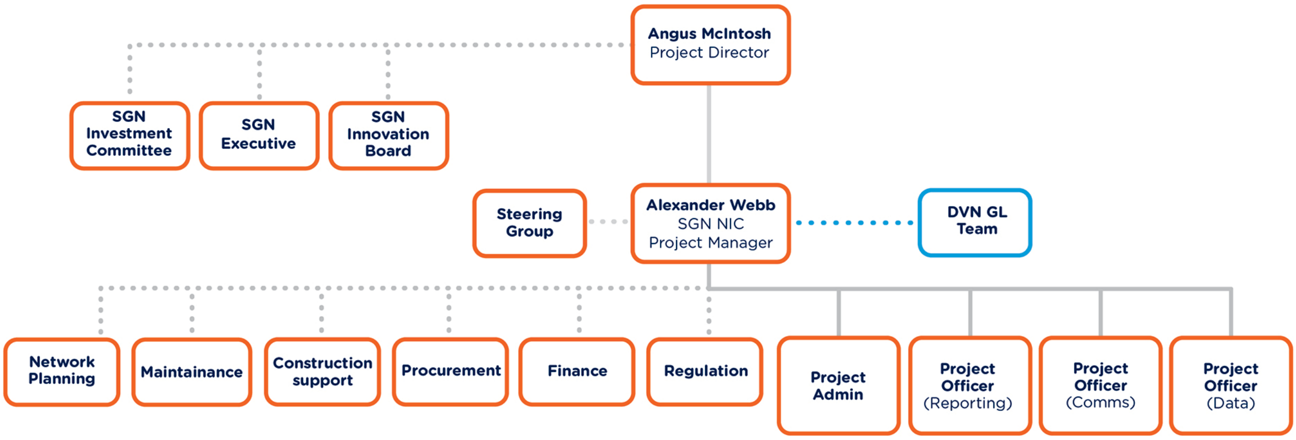


Fig. 17.1 SGN Real-Time Networks Project Team

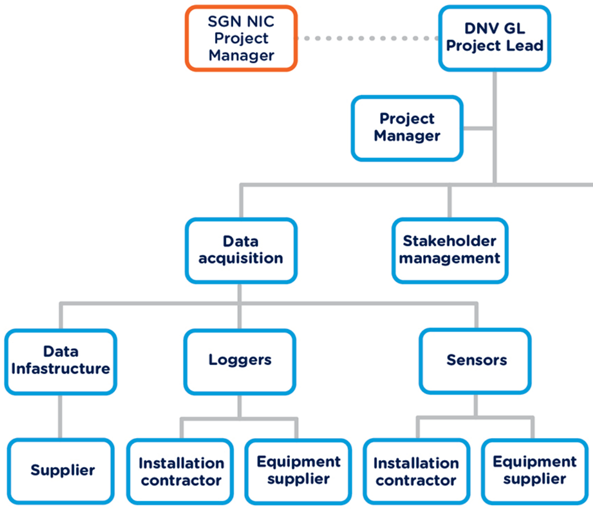


Fig. 17.2 DNV-GL Real-Time Networks Project Team

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## Appendix 18. Project Go/No-Go Stage Gates

The following table shows the projects proposed go/no-go stage gates for each element of the NIC project. Technical descriptions of what should be completed for each go / no go stage gates are detailed below:

| Stage Gate | Work Pack | Go / No-Go Stage Gates | End Date | Stage Gate Details |
|---|---|---|---|---|
| 1 | WP01 | QRA Methodology in Place | 30/06/16 | • DNV GL to define Quantitative Risk Analysis (QRA) high-level structure including all major risk categories and first estimates of individual risk values<br>• DNV GL to deliver fault tree(s), draft report and base case risk<br>• QRA principles reviewed and agreed with SGN project team<br>• Risk score against business-as-usual base case acceptable/not acceptable |
| 2 | WP01 | Logger Customer Engagement and Data Protection Plan | 30/06/16 | • Customer engagement activities will be undertaken with all stakeholders prior to project start. DNV GL to identify consumer meter logger customer process, customer engagement and data protection plan with stakeholders.<br>• Full engagement plan delivered to SGN for review<br>• SGN to agree engagement plan with Ofgem<br>• Engagement plan acceptable or not acceptable to Ofgem |
| 3 | WP01 | Detailed Design of Cloud Data Solution | 30/06/16 | • DNV GL to provide a detailed design of cloud data solution<br>• Full specification to outline data compatibility with all expected sources, mechanism for data archive and extraction from archive, cloud based, scalable, secure and with provision for visualisation and reporting<br>• Carry out challenge and review with all stakeholders<br>• Agree whether price, security, scalability and timeframes are acceptable/not acceptable to SGN project team. Procure cloud solution if agreed. |
| 4 | WP01 | Detailed Consumer Meter Logger Design | 30/06/16 | • Contractor to provide detailed design and locations of all installations<br>• DNV GL to approve and appraise design<br>• Review and agree installation plan<br>• SGN approval – design and installation. |

| Stage Gate | Work Pack | Go / No-Go Stage Gates | End Date | Stage Gate Details |
|---|---|---|---|---|
| 5 | WP01 | Data Collection Specification | 29/07/16 | • DNV GL to provide a data collection specification that facilitates the development of novel network modelling for a real-time network<br>• Specification to include consumer meter logging sites, confirmation of IP/MP sites and measurements required, identification of extra pressure logging sites and data to be collected from NTS offtake(s) and Grain LNG<br>• Challenge and review carried out with SGN Innovation and Operational teams<br>• SGN to approve/not approve data collection and confirm resources to facilitate as required |
| 6 | WP01 | Communications Design and Testing | 30/06/16 | • DNV GL to set up all communication equipment in a laboratory environment<br>• Equipment and communications functioning as per specification<br>• Demonstrate and review with SGN and sensor installation teams. Agree any remedial actions as necessary<br>• SGN and stakeholders accept/do not accept communications solution |
| 7 | WP01 | Detailed Design MP/IP Sensor Installations | 21/09/16 | • Contractor to provide detailed design and locations of all installations<br>• T/SP/G/17 approval and appraisal process for all disciplines and sites completed as appropriate.<br>• DNV GL to review designs and agree installation plan with contractors<br>• SGN to agree/not agree that procurement and installation on the network can begin |
| 8 | WP01 | Laboratory Testing of Novel Sensors | 30/06/16 | • DNV GL to identify, procure and test novel sensors<br>• Report delivered based on DNV GL Technology Qualification process<br>• Accuracy and suitability of sensors reviewed agreed with DNV GL Software team<br>• SGN to agree that sensors are or are not suitable for installation in their network |
| 9 | WP01 | Renewables Data Strategy | 28/02/17 | • DNV GL to develop a strategy to investigate the impact that renewable technologies will have been developed.<br>• The research strategy will have considered the use of data available from previous projects and set a strategy for the simulator runs required to cover the optimal types of properties.<br>• SGN will review the strategy developed to assess the value and quality of the potential outcome.<br>• The review against the performance specification will determine whether this aspect of the project can progress to the next stage. |

| Stage Gate | Work Pack | Go / No-Go Stage Gates | End Date | Stage Gate Details |
|---|---|---|---|---|
| 10 | WP02 | Integration and Testing of Sensors in Live Environment (IP/MP) | 31/03/17 | • Sensor and manufacturing complete with FAT approval. All sensors installed in IP/MP network and communications established<br>• All Site Acceptance Tests completed and provided to SGN<br>• SGN and/or DNV GL review and approve Site Acceptance Tests and any remedial actions as required<br>• Measurements sent to cloud within design specification and acceptable/not acceptable for beginning of data collection pilot scheme |
| 11 | WP02 | Verification of Sensor/Communications Infrastructure | 31/03/17 | • All equipment functioning and communications link from field to data cloud established<br>• All sensors successfully sending signals to data cloud<br>• Confirmation by SGN and DNV GL that all signals are within the specified tolerance and power consumption is as expected<br>• SGN to agree that the pilot data collection scheme can/cannot continue as planned |
| 12 | WP02 | Gather IP/MP sensor data and review data requirements | 06/04/18 | • Gather sensor data from the Medway test area and review fitness for purpose<br>• Gap analysis and fitness for purpose report.<br>• SGN will review the strategy for data collection to assess the value and quality of the data being provided, to identify any gaps in the data and implement changes for Year 3.<br>• The review against the performance specification for the data will determine whether the project should continue. |
| 13 | WP03 | Proving of Consumer Loggers and Pressure Sensors in Live Environment (LP) | 31/03/17 | • Installation of consumer meter and pressure loggers substantially completed<br>• Implementation of the cloud-based server will have been completed.<br>• Review of the final completion of the installation phase of the project to ensure all target requirements for data availability have been met.<br>• SGN to review the data collection process to assess fitness for purpose<br>• The review against the performance specification for the flow of data will determine whether the project should continue |
| 14 | WP03 | Set up and gather logger data requirements | 16/03/18 | • All equipment functioning and communications links to data cloud established<br>• All loggers successfully sending signals to data cloud<br>• Confirmation by SGN and DNV GL that all signals are within the specified tolerance and power consumption is as expected<br>• SGN to agree that the pilot data collection scheme can/cannot continue as planned |

| Stage Gate | Work Pack | Go / No-Go Stage Gates | End Date | Stage Gate Details |
|---|---|---|---|---|
| 15 | WP03 | Logger data requirements review | 16/03/18 | • Data for the logged consumers and logger network pressures will have been supplied for a year including over the peak winter period.<br>• Review of the potential on-going data requirements and the fitness for purpose of the current data and data collection process.<br>• SGN will review the strategy for data collection to assess the value and quality, to identify any gaps in the data and implement changes for Year 3.<br>• The review against the performance specification for the data will determine whether the project should continue to the next stage. |
| 16 | WP03 | Phase 1 - Demand Modelling Development | 06/07/17 | • Data for the logged consumers and for the Medway test area will have been supplied for a year including over the peak winter period.<br>• Based on first year of data a prototype demand modelling approach will have been developed along with initial views of how this may be applied.<br>• SGN will review the outcome and findings from the initial prototype demand model and consider the implications for improving the understanding of peak and off-peak demand.<br>• The review against the performance of the demand modelling and the quality of results will determine whether the project should continue. |
| 17 | WP03 | Phase 2 - Demand Modelling Development | 18/05/18 | • DNV GL to provide details of progress in development of demand modelling and related issues.<br>• DNV GL to demonstrate modelling progress, present findings to date and recommendations for further development<br>• SGN to carry out a challenge and review of progress made.<br>• SGN to approve / not approve further developments to be continued. |
| 18 | WP03 | Phase 3 - Demand Modelling Development | 29/03/19 | • DNV GL to provide details of progress in development of demand modelling and related issues.<br>• DNV GL to demonstrate modelling progress, present findings to date and recommendations for further development<br>• SGN to carry out a challenge and review of progress made.<br>• SGN to approve / not approve further developments to be continued. |

| Stage Gate | Work Pack | Go / No-Go Stage Gates | End Date | Stage Gate Details |
|---|---|---|---|---|
| 19 | WP04 | Phase 1 Undertake Laboratory Testing of Renewables | 04/07/17 | • Based on the strategy for investigating the impact of renewable technologies, the use of the Kiwa laboratory-based heat system simulator will be considered to determine behaviours of certain property types.<br>• SGN will review the outcome of the research into consumer behaviour data to assess the value and quality of the output and its ability to feed into the impact on demand modelling.<br>• The review against the performance requirements to understand the impacts on demand modelling will determine whether the project can progress to the next stage. |
| 20 | WP04 | Phase 2 Undertake Laboratory Testing of Renewables | 07/11/17 | • DNV GL to provide a progress report on laboratory testing of renewable technologies<br>• DNV GL to demonstrate benefits of continued laboratory testing for demand modelling development<br>• SGN to carry out a challenge and review of benefits and progress<br>• SGN to approve/not approve further laboratory testing of renewables technologies |
| 21 | WP04 | Phase 3 Undertake Laboratory Testing of Renewables | 13/03/18 | • DNV GL to provide a further progress report on laboratory testing of renewable technologies<br>• DNV GL to demonstrate benefits of continued laboratory testing for demand modelling development<br>• SGN to carry out a challenge and review of benefits and progress<br>• SGN to approve/not approve further laboratory testing of renewables technologies |
| 22 | WP04 | Investigation & Analysis of Renewables Behaviour | 12/03/19 | • Based on the laboratory testing the impact of renewable technologies on demand modelling will be studied.<br>• SGN will review the outcome of the research into the data for consumer behaviour to assess the value and quality and how it impacts on demand modelling SGN to approve the approach to be used in the future implementation of demand modelling |
| 23 | WP05 | Conceptual Design of Software Solution | 18/09/17 | • Based on the development of the demand modelling including the real-time demand modelling aspects, the DNV GL on-line modelling software will be set-up to model the Medway test area. The real-time demand model will be linked to be able to function with the on-line software.<br>• The developments will show that a functioning system will be available to run in real-time.<br>• SGN will review the outcome of the research to identify that the real-time prototype solution are likely to be successful when run in real-time.<br>• SGN will review against the performance required and determine whether this project can progress to the next stage. |

| Stage Gate | Work Pack | Go / No-Go Stage Gates | End Date | Stage Gate Details |
|---|---|---|---|---|
| 24 | WP05 | System Testing with Pseudo-Live Data | 30/04/18 | • The developments will provide a demonstration of a functioning system that will run in real-time using only pseudo-live data. The impact of using pseudo live data on the different pressure tiers will be assessed.<br>• SGN will review the outcome of the research to identify that the requirements for a real-time prototype solution are likely to be successful when run with real-time data.<br>• SGN will review against the performance required and determine whether this project can progress to the next stage. |
| 25 | WP06 | Real-Time Model Demonstration | 01/03/19 | • Based on the development of the Conceptual Design of Software and the demonstration using pseudo-live data, this development will provide a demonstration to show that a functioning system will run in real-time using live data from Medway. The outcome relative to the different pressure tiers will be assessed.<br>• SGN will review the outcome of the research to identify the extent to which the requirements for a real-time prototype solution have been met.<br>• SGN will review the performance of the system and determine the inputs required to the project outcomes. |
| 26 | WP06 | Dissemination of Project Outcomes | 21/06/19 | • The project dissemination plan will have been developed identifying all relevant stakeholders and the required approaches to dissemination of learning, including a learning dissemination event for network licensees and other relevant stakeholders.<br>• Comprehensive reports and presentations will have been compiled assessing the technical and commercial viability for system roll out of the different aspects of real-time networks.<br>• This stage gate is external to the project time line. |

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## Payment Milestones

| Payment Milestone | Deliverable(s) | Date | Amount | Cumulative Spend |
|---|---|---|---|---|
| 1 | Stage Gates 1 to 10 & Stage Gate 13 | April 2016 | [redacted] | |
| 2 | Stage Gate 1 to 10 & Stage Gate 13 | May 2016 | | |
| 3 | Stage Gate 1 to 10 & Stage Gate 13 | June 2016 | | |
| 4 | Stage Gates 5, 7, 8, 9 & 10 | July 2016 | | |
| 5 | Stage Gates 7, 9 & 10 | August 2016 | | |
| 6 | Stage Gates 7 & 9 | September 2016 | | |
| 7 | Stage Gates 9, 10 & 13 | October 2016 | | |
| 8 | Stage Gates 9, 10 & 13 | November 2016 | | |
| 9 | Stage Gates 9, 10 & 13 | December 2016 | | |
| 10 | Stage Gates 9, 10 & 13 | January 2017 | | |
| 11 | Stage Gates 9, 10 & 13 | February 2017 | | |
| 12 | Stage Gates 10 & 13 | March 2017 | | |
| 13 | Stage Gates 12, 14, 15 & 19 | April 2017 | | |
| 14 | Stage Gates 12, 14 & 15 | May 2017 | | |
| 15 | Stage Gates 12, 14 & 15 | June 2017 | | |
| 16 | Stage Gates 12, 14, 15, 19 & 22 | July 2017 | | |
| 17 | Stage Gates 12, 14, 15 & 22 | August 2017 | | |
| 18 | Stage Gates 12, 14, 15, 16, 22 & 23 | September 2017 | | |
| 19 | Stage Gates 12, 14, 15, 17, 20, 22 & 23 | October 2017 | | |
| 20 | Stage Gates 12, 14, 15, 17, 22 & 23 | November 2017 | | |
| 21 | Stage Gates 12, 14, 15, 17, 22 & 23 | December 2017 | | |
| 22 | Stage Gates 12, 14, 15, 17, 21, 22, 23 & 24 | January 2018 | | |
| 23 | Stage Gates 12, 14, 15, 17, 22, 23 & 24 | February 2018 | | |
| 24 | Stage Gates 12, 14, 15, 17, 21, 22, 23 & 24 | March 2018 | | |
| 25 | Stage Gates 14, 15, 17, 22, 23, 24, 25 & 26 | April 2018 | | |
| 26 | Stage Gates 18, 22, 25 & 26 | May 2018 | | |
| 27 | Stage Gates 18, 22, 25 & 26 | June 2018 | | |
| 28 | Stage Gates 18, 22, 25 & 26 | July 2018 | | |
| 29 | Stage Gates 18, 22, 25 & 26 | August 2018 | | |
| 30 | Stage Gates 18, 22, 25 & 26 | September 2018 | | |
| 31 | Stage Gates 18, 22, 25 & 26 | October 2018 | | |
| 32 | Stage Gates 18, 22, 25 & 26 | November 2018 | | |
| 33 | Stage Gates 18. 25 & 26 | December 2018 | | |
| 34 | Stage Gates 18, 22, 25 & 26 | January 2019 | | |
| 35 | Stage Gates 18, 22, 25 & 26 | February 2019 | | |
| 36 | Stage Gates 18, 22, 25 & 26 | March 2019 | | |

## Appendix 19. Customer Engagement and Data Protection Plan for Consumer Logging

An outline customer engagement plan for the fitting of consumer meter loggers is as follows:

DNV GL will identify a representative sample of meter points from a number of different consumer-type categories.

DNV GL will schedule the work to install the logging devices at the required addresses. At the start of the project a plan for the execution of the installation work and an associated schedule will be agreed. The plan should identify any risks/issues with completing the work and how these will be managed. SGN will issue the customers with a letter explaining the project purpose, with an accompanying leaflet. This correspondence will be received by the customer a minimum of 7 days prior to the intended visit. DNV GL will make arrangements to visit each site following the sending of the initial letter from SGN, to fit the equipment as required. Copies of the letter sent out will be carried by the Engineer installing the logger.


Fig 19.1: Customer logging engagement example

DNV GL will install any site equipment and infrastructure necessary to provide the required 6-minute flow data from these sites for the period of the contract. The equipment used on site will be the property of SGN. In some instances, the meter may be fed from a higher pressure tier than LP and the output from the meter fed into a flow corrector on site. In these cases, where the input to the existing logger is taken from the corrector, the logger to be fitted will also be fitted to the corrector output. In some cases this will require the reprogramming of the corrector.

Wherever possible, the product should be clipped to the gas pipe with no drilling of the property walls. Any interference with the customers' property will require customer consent prior to commencement of the work. The product should be labelled as the property of SGN and include telephone and reference numbers for meter readers who are concerned about the device.

DNV GL will report regularly regarding the sites where installation has been completed and any changes to the planned installation programme. The process for the installation work is as follows:

- DNV GL will identify the order in which the addresses will be completed and the intended week in which the work will be carried out.
- DNV GL will send a letter if required on behalf of SGN addressed to the occupier of the site in an appropriate timescale identifying the period when the work will be carried out.
- DNV GL will visit the site addresses provided and fit the equipment.
- No damage will be done to any part of the consumer's premises.
- The meter reading index will not be obscured.
- The meter remains accurate [within the Gas (Measurement of Thermal Energy) Regulations] and the access to and operation of the ECV is not affected.
- On a weekly basis DNV GL shall confirm:
  - Specific addresses where a visit has been made and the logging device was fitted.
  - Where no access was available and the logging device could not be fitted, but a card was left for the customer to contact the service provider to make an appointment.
  - An appointment was made with a customer to return at a later date (in the next week).
  - An appointment was made with a customer, but DNV GL failed to attend at the appropriate time.
- Where the equipment has been fitted DNV GL must ensure that it is fully commissioned and in good working order to send the data required before leaving site.
- DNV GL shall provide a single point of contact to SGN so that any complaints received at any point may be dealt with regarding the logger or the workmanship or conduct of DNV GL staff on site.
- Where a complaint has been received regarding the logger contact may be made with DNV GL or SGN to remove and re-site a logger at an alternative address at an additional cost to the project.
- Where a complaint has been received regarding DNV GL workmanship or conduct of staff on site, DNV GL shall make remediation of any damage at their own cost within 5 days of the complaint being received.

DNV GL or their service provider workforce who visit the properties for the purposes of this project will:

- Be competent in dealing with the public and in working within a commercial or industrial environment.
- Carry suitable ID cards and wear a suitable uniform identifying the company they work for.
- Carry copies of any letter sent to the occupier from SGN.
- Be CRB checked.

DNV GL will provide details of each employee (name, employee number etc.) to SGN prior to commencement of the work, together with the area in which they are going to work (or the site addresses to be covered).

## Communication methods and timings

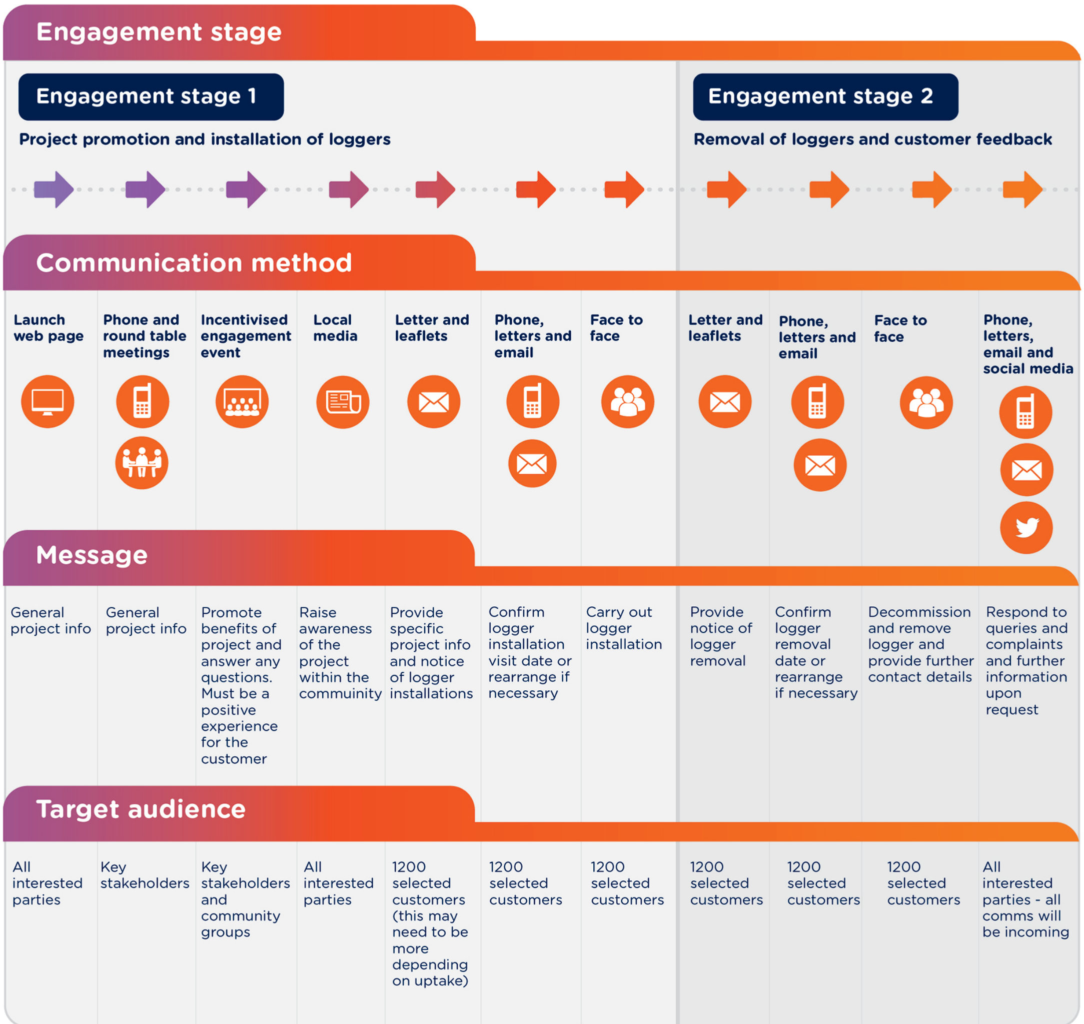


Fig 19.2: Engagement and Communication Road-Map

## Data Protection Plan

The data from the installed loggers will be subject to a Data Protection Plan for the project. The list below shows information on the contents that will be included in the plan:

- Description on use of the collected data
- Notification that there is no obligation for the customers to agree to consumption data logging
- Notification that this agreement can be withdrawn at any time
- Identification of the data controller
- Timescale for reminder notifications to consumers during the life of the project
- Information on DPA
- How the data will be protected
  - Restricted access
  - Encryption
  - Anonymisation

The table below provides additional Q&A information on how these requirements will be further developed to produce a functional Data Protection Plan:

**Key questions**

| Question | Answer |
|---|---|
| **What data is being collected?** | This will include, but is not limited to; customer names, addresses, house types, gas consumption. The data will be obtained from several sources as well as direct from customers themselves. Alternative sources under consideration include Experian, Electoral Register etc. |
| **How will your data be used?** | The data will be used to develop a modelling tool to analyse performance of the gas network. Both SGN and DNV GL will have access to non-anonymised data throughout the project. The data will also allow SGN and other authorised parties to communicate directly with the customer. |
| **How will we obtain consent?** | Issue of a letter/leaflet to identified and relevant properties advising selection for project participation. This will be followed up by a visit from one of our Engineers to finalise the agreement and undertake installation of sensor equipment. An option to opt out will be available at this early stage and will also remain throughout the project lifetime. |
| **What information will be provided?** | SGN will provide a description on the background of the project and the work that will be required to complete the installation of the logger. Notification on the supply of a free CO detector at the start of the project and a £20 high street voucher at completion will be made. Regular updates on project progress will be made to those taking part in the form of letter/leaflet. |
| **How will we deal with Priority Services Register (PSR) customers?** | In advance of issuing the letters, checks will be made to identify any customers within this category from the records maintained in the register by the shippers. This will allow SGN and the project participants to ensure all appropriate support mechanisms are in place in advance of any planned visits. |
| **Who will own the personal data?** | The data held relating to an individual will always be owned by the individual. All the rights referred to in the DPA (sixth data protection principle) will be adhered to in this project. This relates to all personal data collected in relation to the project via electronic and paper records, regardless of source. |
| **Data retention?** | There will be continual review of personal data held during and after the life of the project. This will ensure personal data is not held for any longer than it is needed. Any information no longer required will be securely deleted. Any out of date information will be also be deleted or archived if not required or amended if appropriate. Timescales will be specified in the final DPP. |
| **How will the data be stored?** | The data will be stored on an encrypted cloud service and on SGN and DNV GL infrastructure. Access will be made available to authorised personnel only with password authentication. |
| **How will the data or analysis be published** | Any data for publication will have all specific consumer data redacted or will be subject to anonymisation. |

## Appendix 20. Letter of Support

nationalgrid

National Grid House
Warwick Technology Park
Gallows Hill, Warwick
CV34 6DA

SGN
Axis House
5 Lonehead drive
Edinburgh
EH28 8TG

1st July 2015

Dear Sir/Madam

**Re: Network Innovation Competition 2015: Real-time Networks**

National Grid Gas Transmission is happy to offer support to SGN in respect of their 'Real Time Networks' NIC project.

In recent years it has become increasingly apparent that rapid changes to the gas industry from the continued reduction in indigenous supplies; acceleration in connections of unconventional sources; changes in customer demand; and the advent of downstream renewables; necessitate significant investment to ensure the gas distribution network is suitably flexible to ensure GB gas consumers continue to receive gas where and when they need it.

There are significant improvements to be made to existing best practice methods of network modelling and management due to the evolving industry needs. The development of an understanding of how energy (rather than volume) is delivered by the gas distribution network is an important step towards accommodating current and future variations in gas quality. It is also apparent that new technologies may enable the industry to monitor and measure gas supplies in ways that were not possible just a few years ago. Furthermore, they may enable us to access this data quickly and relatively cheaply through 'cloud'. We would be interested to explore how proposed changes to the way the distribution network is modelled could influence more accurate capacity booking and demand forecasting particularly.

Following engagement with SGN on this matter, we are happy to participate in technical working groups to understand the potential benefits of the project to National Grid transmission.

Yours sincerely

Tamsin Kashap
Gas Transmission Innovation Manager
National Grid

ofgem

RIIO NIC NETWORK INNOVATION COMPETITION

## Appendix 21. Risk Register and Mitigations

Scoring Key

| | | |
|---|---|---|
| 16 to 25 | 10 to 15 | 1 to 9 |

*Impact Table*

| Ref No | Risk | Business Risk | Inherent Risk Likelihood | Inherent Risk Impact | Inherent Risk Score | Controls & Mitigation | Status | Residual Risk Likelihood | Residual Risk Impact | Residual Risk Score |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Insufficient Resources** Insufficient resources assigned by the project management team leading to delays in the progress. | Time | 3 | 3 | 9 | Regular review of resource availability. Implement and maintain a project programme to monitor deliverables against the timescales and ensure that any shortage of resources impacting delivery of the overall project are clearly identified. Review programme at monthly progress meetings. | Ongoing | 2 | 3 | 6 |
| 2 | **Project Slippage** Project may slip due to unforseen circumstances | Time | 2 | 4 | 8 | Build time contingency into Project plan Hold regular team meetings to monitor progress against the programme. | Ongoing | 2 | 2 | 4 |
| 3 | **Availability of Key Equipment** Key equipment such as sensors, flow measurement, power supplies and communication equipment suitable for use with a low pressure natural gas supply may not be readily available, require further development, have long lead times or be more expensive than expected | Technical | 3 | 3 | 9 | Early contact with manufacturers, suppliers, installers, local authority and local SGN staff to ensure all issues are identified in a timely manner. Build in contingency including alternative solutions where possible. | Ongoing | 2 | 3 | 6 |
| 4 | **Site Idenfication** Identification of suitable existing measurement sites Identification of new measurement sites which may be below ground, in difficult locations or in consumer premises | Technical | 4 | 4 | 16 | Detailed site surveys at the design stage including options for alternative/additional sites if original choices prove unsuitable. | Ongoing | 3 | 3 | 9 |
| 5 | **Responsiveness** Timely responses from partners/contractors/SGN to queries and requests for information, design approvals and appraisals | Time | 4 | 4 | 16 | Provision of dedicated expert support for the project team from partners/contractors/SGN. | Ongoing | 2 | 2 | 4 |
| 6 | **Pricing Accuracy** The accuracy of the pricing depends on accurate information from SGN about existing installations, new below-ground installations, IT infrastructure and consumer premises. The assumption has been made that existing pipework, assets and infrastructure are in a sound condition. | Financial & Technical | 3 | 5 | 15 | Identify suitable target pricing through horizon scanning research activities and build in a reasonable financial contingency. | Ongoing | 2 | 4 | 8 |
| 7 | **Smart Meter Data** Lack of availability of Smart Meter data may require installation of additional loggers at customer premises | Financial & Technical | 5 | 3 | 15 | Assume that Smart Meter data will not be available and install loggers at a statistically representative sample of consumer premises / consider alternative sources of data. | Ongoing | 2 | 2 | 4 |
| 8 | **Project Start UP** Project start may slip due to contractual/financial delays between SGN and it partners and contractors. | Time | 3 | 4 | 12 | Ensure contractual and legal issues are resolved before project start date. | Ongoing | 1 | 2 | 2 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | **Consumer Flow Logging** Setting up suitable contract for installation of loggers to consumers | Financial | 2 | 3 | 6 | The accuracy of the cost for any installation work may be higher than expected. | Ongoing | | | 0 | |
| 10 | **Engagement of Renewables Stakeholders** Delay in engaging partners/users in the installation / identification of renewable technologies may cause delays in the collection of useful data for the project to assess and for developing of demand modelling. | Time | 2 | 3 | 6 | Alternative existing sources of renewables data and alternative options for deriving data will be identified and utilised within the project. Options for using test rigs as the basis for assessing the potential impact of renewables will be identified. | Ongoing | | | 0 | |
| 11 | **Additional Sources of Data** Current expected sources of data may become unavailable or not deliver the required information leading to new sources of data being implemented. This will potentially require the development of interfaces to the new data sources | Financial & Technical | 4 | 3 | 12 | Build in a reasonable financial contingency to allow for the development of new interfaces. | Ongoing | 1 | 1 | 1 | |
| 12 | **Cloud Based Historian** Selected cloud based historian may not deliver required performance / functionality. | Financial & Technical | 2 | 5 | 10 | Perform sufficient testing of the selected historian to guarantee performance / functionality is as required. Build in reasonable financial contingency and time in the project plan to switch to an alternative historian. | Ongoing | 2 | 2 | 4 | |
| 13 | **Customer Access** Refused access to customer's meters for logger installation may lead to delays in the project while scoping out alternative logger locations. Additionally, failure to gain access to the consumers meter at any agreed times. | Time | 4 | 4 | 16 | A robust process for identifying the sample of consumers required and for engaging with the consumers will ensure that suitable opportunities for fixing loggers are identified. Suitable contracts with logger installers will ensure that appropriate levels of effort in gaining access are taken before moving on to alternative sample options. | Ongoing | 2 | 2 | 4 | |
| 14 | **Data Protection** Sensitive customer demand data could be accessed inappropriately. | Financial & Technical | 2 | 5 | 10 | Ensure that all cloud servers have relevant security accreditations, dedicated environments to prevent mixing of data with other users, strong data encryption, limits on number of open ports on the gateway etc. Processes and systems will be used to ensure that only those who need access to data are granted access to it. Further, internal processes will be used such that the identity and contact details of consumers are not made available to those who see the demand data and that those who handle the contact with consumers do not have access to the demand data itself. | Ongoing | 2 | 2 | 4 | |
| 15 | **Power Failure** The loss of appropriate power to loggers and sensors would result in loss of data logging and transmission. | Financial & Technical | 3 | 5 | 15 | Use of street furniture or solar power will reduce the risks associated with battery systems. A wide range of loggers will mitigate the impacts of any individual sites which may lose power. Battery back-up to be supplied for IP/MP network measurements. | Ongoing | 1 | 2 | 2 | |
| 16 | **Communications Failure** The loss of communications between sensors/loggers and the cloud database may result in relevant data not reaching the real-time model. | Technical | 3 | 3 | 9 | Build in local storage capacity so that data can be downloaded when communications are re-established. For demonstration purposes a short term loss of communications would not be problematic. However, experience in the early part of the project when non-time critical data is being captured will provide the basis for ensuring the communications processes are robust. | Ongoing | 2 | 2 | 4 | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | **Data Extraction from Current SGN Systems** Failure to extract data from SGN's internal systems | Technical | 3 | 3 | 9 | Time critical data for real time modelling will only be needed at a late stage of the project giving opportunity for robust processes to be fully developed and tested prior to any demonstration of the real time prototype system. | Ongoing | 1 | 2 | 2 | |
| 18 | **Data Quality** Developed cloud and gateway platform may face issues when extracting data from SGN's internal systems | Technical | 3 | 3 | 9 | Time critical data for real time modelling will only be needed at a late stage of the project giving opportunity for robust processes to be fully developed and tested prior to any demonstration of the real time prototype system. | Ongoing | 2 | 2 | 4 | |
| 19 | **Weather Conditions Insufficiently Cold** Weather patterns are insufficiently varied to provide a suitable demand model | Technical | 3 | 4 | 12 | Two years of data are being collected to reduce the risk. The project in any case will produce processes for the continued update and refining of the demand model. If at worst both winters do not provide a suitable breadth of colder weather then methods would be in place for the refinement of the model in terms of changes in consumer behaviour, application to other LDZs or for extended weather data. | Ongoing | 2 | 2 | 4 | |

*Risk Status Table*

| | | | | | | |
|---|---|---|---|---|---|---|
| Likelihood | Almost Certain 5 | 5 | 10 | 15 | 20 | 25 |
| | Likely 4 | 4 | 8 | 12 | 16 | 20 |
| | Possible 3 | 3 | 6 | 9 | 12 | 15 |
| | Unlikely 2 | 2 | 4 | 6 | 8 | 10 |
| | Rare 1 | 1 | 2 | 3 | 4 | 5 |
| Score Status | | Insignificant 1 | Minor 2 | Moderate 3 | Serious 4 | Critical 5 |
| | | Impact | | | | |

# Appendix 22. Network Modelling Design Assumptions

## Current Demand Estimation: DDS Models

The current network demand calculation and validation procedures used by SGN rely heavily on the peak estimation functionality implemented within DDS. These calculations are fundamental to the current business processes for design of the below 7bar systems. Whilst these processes are functional and provide the basis for design in reinforcement and replacement activities they require intervention by analysts to allow them to be used safely, especially in the validation process.

The validation process is based around the 1:20 Pk6 estimates from DDS when modelling at peak, or based on the application of a multiplicative factor to this peak estimate when operating under validation conditions. The accuracy of the network models is therefore directly dependent on the accuracy of the DDS models. This calculation of demand has various areas where improvement may be made through the proposed project. The current basis for demand calculation and the areas for improvement involved are described below.

## DDS Peak Demand Estimation

The DDS peak estimation equations themselves are based on load research that was carried out in the early 1980s, and based on data that was collected for a number of estates for the winters 1980/81, 1981/82 and 1982/83. These models are therefore over 30 years old, and given that technology has improved and gas consumption profiles have therefore changed since this time, they are unlikely to be relevant to the population as it exists today. In addition, the statistical techniques employed in creating these models are simple, and it would be beneficial to develop a more complex system that is capable of modelling consumption profiles more closely.

The demand model currently implemented in DDS is based on simple statistical theory and the Normal distribution. Loads are split into types by DDS tag, and hence the following categories exist:

- Domestic
- Split by pre/post 1976
- Also split by presence/absence of central heating
- Shops and Offices (grouped together)
- Schools, Hospitals and Industrials (grouped together)
- Hotels
- Pubs and Restaurants (grouped together)

The areas for improvement lie in the quality of the model and the assumptions that are used to create it. Statistical probability distributions such as the Normal distribution used in the creation of these models are designed to represent purely random variation, i.e. variation in peak from one day to another is random. This is not the case because demand is heavily dependent on both weather and weekly and longer-term cycles and using a technique that relies on the variation being purely random will make the results inaccurate.

In addition to this, the 1:20 peak estimation process involves a large degree of extrapolation. The observed load values used to create the distribution are taken from a single 152-day winter, but this is then used to estimate the "1 in 3040 days" point used to signify a 1:20 demand, which is way in excess of the largest values used to create the curve in the first place.

Furthermore, the model assumes that the peaks for each load type coincide and the peak network load is the sum of the individual node peaks. In reality these peaks do not coincide due to the different load profiles of each load category and peak network demand will never approach the sum of the node peaks.

## Diversity

DDS (and, by association, the network analysis model) handles diversity to a certain extent but does not include an exhaustive approach to it. The principles behind DDS's current diversity algorithms are described below.

DDS estimates of Pk6 load are based on equations presented in DEC86/600, which includes the calculation of the 1:20 Pk6 demand for a specific load or group of domestic loads of a known annual consumption or AQ. In other words DDS includes diversity for domestic loads only. Pk6 estimates for all non-domestic loads are made on a load-by-load basis (rather than for any grouping of loads), and diversity is not applied. Hence when the group of loads being analysed contains more than one non-domestic load, Pk6 values calculated by DDS (and scaled by AQ) are simply added together.

The determination of the mean and Standard Deviations used to develop the specific domestic diversity equations contained in DEC86/600 (and used in DDS), was carried out in the early 1980s and used demand data for a number of estates with varying numbers of customers over the winters of 1980/81, 1981/2 and 1982/3.

The final form of the diversity equations covers domestic consumers as follows:

- Wet Central Heating Customers in post-76 housing
- Wet Central Heating Customers in pre-76 housing
- Non Central Heating Customers in post-76 housing
- Non Central Heating Customers in pre-76 housing

It should be noted that DEC86/600 recommends that no further diversity should be considered after certain threshold values (180, 200 or 250) are used for the numbers of consumers in each case. These form what is termed "fully" diversified flow or more accurately "assumed" fully diversified flow'

The adoption of "assumed" fully diversified flow appears to be a compromise adopted to cater for the fact that network extremities would be under-engineered if asymptotic fully diversified flow were adopted. The downside of this approach is that although assumed fully diversified flow helps compensate for underestimation of demands at extremities, it will overestimate demand near network sources, since it is around 1.25 times higher than the asymptotic value. This is one of the reasons why source flows obtained in this manner are modified by planners when determining flows for the next pressure tier.

The network analysis model is provided with only the "fully" diversified form of each of the Pk6 estimation equations. In effect, this means that an assumption is being made that there will always be more than the threshold number of domestic loads in any given group of loads being analysed. This may be true near the network source (although it isn't always for small networks), but it certainly is not true at network extremities. This known issue may be countered by adding point loads to the network model, but although this helps to minimise the problem, it does not solve it.

When this “full diversity” assumption is combined with the “no diversity” assumption for non-domestics described above, this gives the general diversity principle used in DDS and the network analysis model, which is:

*Assume full diversity for domestics and no diversity for non-domestics.*

The purpose of this assumption is to simplify calculations, as this results in peak loads from different components simply being added together to give an overall peak. However, this procedure may lead to a suboptimal estimate in the peak.

### Understanding the relationship between design criteria and network pressures experienced

UK gas systems are currently designed to meet a 1:20 peak 6 minute demand – the average demand of a six minute period which will occur, on average, once in 20 years. However, while a network may be designed to meet a 1:20 peak 6 minute demand, the safety case for a network is defined in terms of maintaining pressure in the network above a minimum design level and from an operational perspective end pressure is the key driver.

The legal minimum pressure requirement is essentially the minimum pressure which might reasonably be expected for an appliance to operate safely, this is naturally not time restricted, but nor can it be guaranteed to apply under all operating conditions. Instead, the safety criteria is considered to be met if pressures greater than the required minimum pressure are obtained under 1:20 peak demand conditions.

However, there is no understanding of how often (e.g. 1:x) the minimum pressure produced under 1:20 peak design demand conditions occurs, i.e. what is it’s likelihood. Indeed a common misconception is that the minimum pressures produced under 1:20 peak demand conditions correspond to 1:20 minimum pressures. This is not the case, not least because the methods used to model the 1:20 peak demand conditions assume some level of concurrency in the calculation of demand peaks.

The calculation of 1:20 peak 6 minute demand is currently based on the formulae developed in the early 1980s. There is a belief within the industry in general that the ‘1:20’ demand levels predicted by the current DDS process have not been widely experienced across networks, possibly because of the lack of clarity in the relationship between experienced network pressures and modelled demand.

The question remains as to what is the relationship between the real-time pressures experienced on a network both under ‘extreme’ conditions and more ‘normal’ operation and how do these relate to the network modelling undertaken. In some ways the process of network validation seeks to help explain this relationship and relate measured data to a network model, but it can only do this partially. A greater understanding of this relationship has several design implications but from a real-time perspective it would help quantify the 1:20 peak 6 demand criteria in terms of the range of pressures that are actually experienced on a network.

The methodology described above is a different demand modelling approach for determining 1:20 demands (to that currently implemented in DDS) and develops a new breakdown of demand types and approaches to understanding diversified demand. In particular, the proposed demand estimation models provide a potential means of producing data with which to gain a better understanding of the relationship between the real-time pressures experienced on a network and the network models used within planning or design.

## Understanding the relationship between below 7bar systems and high pressure distribution

There is currently a discontinuity between the design and planning of below and above 7bar systems. In other words there is no direct link in terms of the demand pattern or level between the lower pressure systems and that of the high pressure distribution systems. Whilst the lower pressure tiers are designed on the basis of the peak 6 demand and HP system is based on the daily load with assumptions for the profile of demand made to identify the hourly flows.

The DDS algorithms provide the 6 minute peak demand for design of the low pressure system. Typically the levels of demand resulting for the supplies into the low pressure system are modified through custom and practice in the validation process to 80-85% of the LP system level for use as demand on the MP or IP systems. This scaling of demand from the low pressure system is indicative of the levels of true diversity in demand in low pressure system, but is nominally treated as being scaling to reflect an hourly demand level as opposed the 6 minute granularity. In practice there is no specific data available which relates the peak 6 load to the hourly or daily demand level.

SGN currently only have the approach outlined in their internal procedure SGN/NP/28 as data to support operations and the relationship between the pressure tiers. This procedure is itself considered to be based on data which is not reflective of current behaviour.

As stated, the demand for the design of HP systems is on a daily basis with the level of flow being determined from the meter readings taken from the NTS offtakes. The published levels of daily demand for the LDZ are proportioned across the demands where there are no daily metered readings to use as a guide. Custom and practice has been across DNs to use the proportion of flows indicated by the network modelling of the lower pressure tiers to proportion the flow from the HP system.

This process has typically been used in the Scotland LDZ, but for the South LDZs the custom and practice has been to maintain the historic pattern of flow.

It is anticipated that in both cases the development of modelling in the Real-Time Network project will provide increased accuracy in the planning and operation of HP distribution networks in both Scotland and the south. The relationships between the peak 6 minute load used on low pressure and hourly and daily demands will be determined. The improved understanding of the pattern of flow across the day and across the year to the low pressure systems will impact on both the design and operation of the high pressure systems.

## Appendix 23. Sensor Specification

This specification defines the minimum technical requirements for the sensors used to collect data for the real-time distribution network model.

**Process Data**

| | |
|---|---|
| Service | > Natural gas |
| Operating temperature | > -10 to + 40°C |
| Operating pressure | > 0 bar.g – 10 bar.g |

**Hazardous Area Classification**

The sensors shall be suitable for installation within an area defined as ZONE 1 IIA T4. Certification: suitable for application a hazardous area classified as zone 1 in accordance with the ATEX Directive and The Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 1996 (SI 1996/192).

**Design Data**

| | |
|---|---|
| Ingress protection | > IP65 |

**Specification for pressure transmitters**

| | |
|---|---|
| Power supply | > 16.6Vdc to 30Vdc loop powered (for intrinsically safe applications) |
| Output | > 4-20mA (linear over the calibrated span) |
| Uncertainty of measurement | < 1% of reading |

**Specification for temperature transmitters**

| | |
|---|---|
| Power supply | > 16.6Vdc to 30Vdc loop powered (for intrinsically safe applications) |
| Output | > 4-20mA (linear over the calibrated span) |
| Uncertainty of measurement | < 1% of reading |

**Specification for the flow measurement**

The flow meter shall be of non-intrusive technology.

| | |
|---|---|
| Measured values | >Volumetric flow |
| Uncertainty of measurement | < 4% of reading |
| Nominal pipe size | > 2″ – 24″ |
| Output | > 4-20mA (linear over the calibrated span) |
| Bus protocol | > Modbus ASCII / RTU |
| Power supply | <24V DC |
| Pipe material compatibility | >HDPE , Steel |

**Specification for the gas quality measurement**

| | |
|---|---|
| Measured values | >Calorific Value (CV), Relative Density (RD) |
| Uncertainty of measurement | < 1.5% of reading |
| Output | > 4-20mA (linear over the calibrated span) |
| Power supply | <24V DC |

**Specification for remote terminal units**

| | |
|---|---|
| Analogue Inputs | >4 channels |
| Protocols | >DNP3 |
| Comms | >GPRS |
| Power supply | <24V DC |
| Memory | >81kB |
| Logging rates | >Configurable to averaging every 6 minutes |

## Appendix 24. Full Submission Spreadsheet

For further information on our submission, please contact:

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