RIIO GD2 Business Plan Appendix

Innovation

December 2019

SGN
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Contents

1 Overview

Innovation projects enable network operators to improve their understanding of new technologies and how they integrate into the networks. They also identify new opportunities and speed up their wider adoption. In SGN, we use innovation to develop new solutions to problems which exist now, or which we anticipate we will face in the future.

This appendix reviews our approach to innovation, from project identification, through various stages of development, to implementation, the resultant customer benefits delivered within GD1, and our approach to GD2.

We have already saved customers £125m in GD1 (Network Innovation Allowance (NIA) and Network Innovation Competition (NIC)), and our use of innovation is recognised for challenging convention and pioneering new approaches in all areas of our network. It is important that we continue to invest in Research and Development (R&D) to explore new ideas in GD2, including innovation for vulnerable customers, and not rely purely on existing or new-to-market technology to maximise benefits to consumers.

We use the experience gained during GD1 to highlight why we believe that new and innovative techniques for carrying out work faster, with less disruption and lower cost, should continue through GD2. As described in section 3 our performance over GD1 has been very successful, we have registered 137 NIA projects (August 2019) with some 40% delivering quantifiable financial benefits and many of the remaining projects delivering other noticeable benefits such as minimising disruption, minimising safety risk and minimising environmental impact.

To support our approach to innovation and to find out what innovation our stakeholders and customers want to see from us, we have carried out a wide-range of stakeholder engagement with the explicit objective to inform our decision-making processes. We have also consulted with specialist panels on how we can minimise the impact of our works through innovation on vulnerable customers. The lessons that we have learnt from both these exercises are explained in this document.

We support the principle of funding more innovation through business as usual (BAU) using our totex allowance. Our proposals for GD2 show the level of expenditure required, to comply with a BAU requirement implemented to maximise customer benefit under the totex incentive mechanism.

We propose to build on the BAU option with additional “development” and “disruptive” funding proposals based on utilising separate NIA funding, these additional funds would be linked to our high-level areas of focus. This will ensure that there is a steady stream of value adding projects, including innovation projects for vulnerable customers, supported through the Technology Readiness Levels (TRLs) that will provide similar benefits for customers to those delivered within GD1. This “development” and “disruptive” funding will allow our networks to continue with a strong innovation stimulus, covering both large-scale transformational R&D projects as well as smaller scale process or technological innovations, that would not necessarily be funded under the BAU option or deliver benefits within the same price control period in which the projects were started.

The principles to the “development” and “disruptive” funding would be similar to that of the current NIA mechanism by promoting a collaborative approach between the networks and stakeholders. This would also prevent network companies duplicating projects and commercialising ideas with no incentive to share the findings, clear disadvantages of having a BAU only mechanism.

Our proposal for funding the development and disruptive innovation in GD2 would be based on a multiplier of two times that of our own committed spend on BAU innovation i.e. if we commit to spend £1.5m on BAU innovation then we would propose that we would be able to fund £3.0m of development and disruptive innovation projects per annum. Stakeholder evidence suggests there is support for SGN providing a contribution towards early TRL innovation, we are therefore proposing a voluntary contribution of 10% towards the costs of these early stage projects (with a TRL <7).

Table 1: Funding proposal in GD2

Options	TRL Levels	Costs (£m p.a.)	Cumulative Total (£m p.a.)	Themes / Areas of Focus
BAU	TRL 8	1.50	1.50	Themes and areas of focus are described in Section 6
Development	TRL 4 to 7	1.45	2.95	
Disruptive	TRL < 4	1.45	4.40	

While benefits from innovations are difficult to predict at the outset we would anticipate, based on our GD1 experience, performance projections could be between £10 - £15m a year should our development and disruptive proposals for the NIA mechanism be accepted. The potential for all mechanisms within GD2 is represented in the graph below which plots investment levels and the potential return of investment (ROI) for GD2. Figure 1 represents only the projections for innovation developed and implemented within the GD2 price control period, excludes GD1 transition benefits.

Figure 1: GD2 Potential return on investment

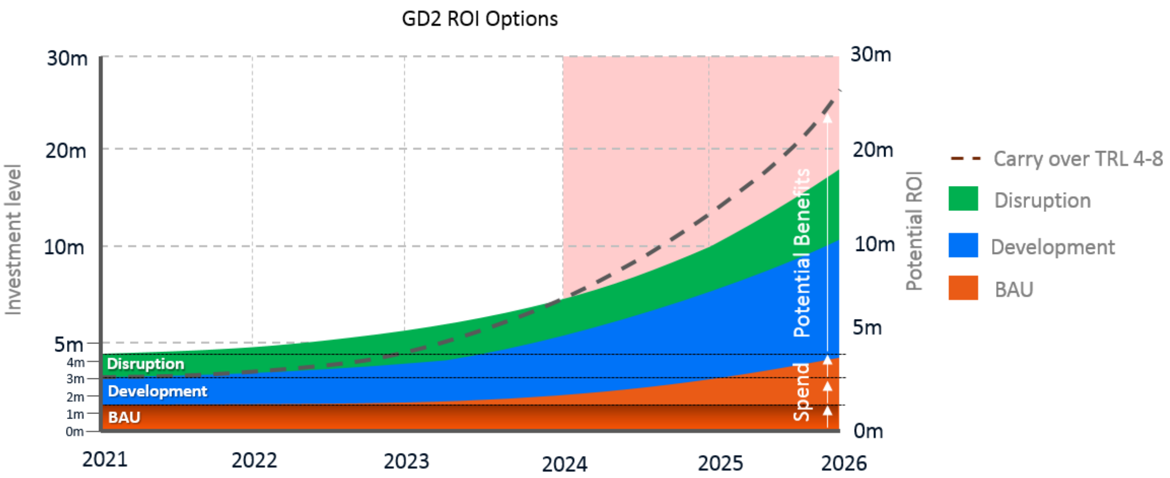


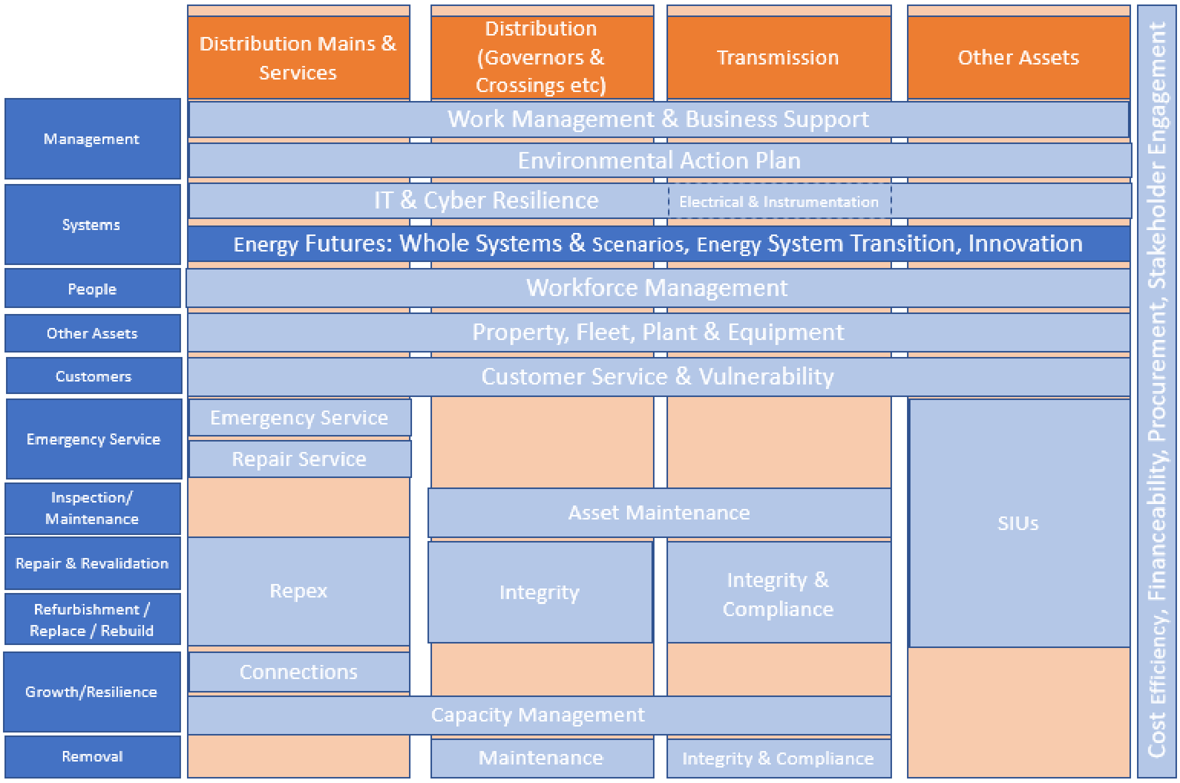
Table 2: Allocated development and disruptive funding requests: Scotland and Southern (per annum)

Scotland (£m)	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26
Cost of innovation (Development)	Funded through NIA								0.48	0.48	0.48	0.48	0.48
Cost of innovation (Disruptive)	Funded through NIA								0.48	0.48	0.48	0.48	0.48

Southern (£m)	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26
Cost of innovation (Development)	Funded through NIA								0.97	0.97	0.97	0.97	0.97
Cost of innovation (Disruptive)	Funded through NIA								0.97	0.97	0.97	0.97	0.97

2 Innovation within the business plan

Figure 2: Appendix structure



We embrace the concepts of innovation and creativity at all levels to help us solve the most challenging issues we face, both as a company and as part of the gas industry. Innovation permeates across all of our investment requirements and to reinforce this we have included a specific innovation section within each of the business plan appendices. Successful innovation can be rolled out in the business to help reduce costs, improve efficiency and, ultimately, reduced customer bills.

Over the years we have identified many challenges facing our industry, but with them come opportunities and to take advantage of these we have applied a highly innovative approach to solving “friction points”. In doing so, we have seen enhanced efficiency within our business, outwardly we have been able to share the benefits with customers, while also offering great support to the UKs commitment to decarbonise the energy system and meet climate change targets. Specific examples of the innovations we have developed are provided in the annexes to this appendix, sections 9 and 10.

Innovation falls into many categories, for SGN we split into two. Firstly, operational innovation, where we innovate our processes, methods of working, support functions, tools and equipment, IT systems and approach to digitisation, all with the express objective to improve our operational effectiveness, improve our environmental performance, increase safety, consider vulnerable customer issues and improve our efficiency. Ultimately this also leads to reducing our costs and thereby our cost to serve each and every customer.

Secondly, we are using innovation to help us, and our industry, address the pressing issue on Energy System Transition (EST) and how we are collaborating with others to help change the face of the industry as it is today. This is through a flexible approach to decarbonisation, the growth of green gases such as hydrogen and the revision of gas quality specifications, all to help the UK meet its climate change targets. We explain our approach to this in greater detail within the two Energy Futures appendices (006 and 007).

3 GD1 performance and learnings

Our GD1 innovation projects have generated savings over £125m, this will be fully passed onto customers in GD2. Innovation is embedded within our culture and is contained within our operational excellence strategic roadmap which was developed to ensure this culture continues. Our people are encouraged to put ideas and solutions forward and we instinctively collaborate with industry peers.

During GD1, the opportunities for doing this are encouraged through two incentive schemes.

- the Network Innovation Allowance (NIA) - 0.5% to 1% of total revenue across an 8-year period. This is available for projects which conform to a specific set of criteria, on a 'use it or lose it' basis; and
- the Network Innovation Competition (NIC) - An annual competition with up to £20m of funding for gas network companies.

Ofgem have now confirmed through their Sector Specific Final Determination document that they will replace both of the above mechanisms with new equivalent mechanisms within GD2. The NIA mechanism within GD2 will require network companies to set out the level of funding against high level areas of focus, together with the value/benefits this may generate.

Collaboration is encouraged and enhanced through our participation within a number of key industry bodies and initiatives such as Energy Networks Association (ENA), Gas Innovation Governance Group (GIGG), Institution of Gas Engineers and Managers (IGEM), Pipeline Industries Guild (PIG) and the Energy Innovation Centre (EIC) (Further details are provided within the following sections).

We maximise opportunities through our relationship with Small and Medium Enterprises (SMEs) that has been built up during GD1 as well as using our internal 'IGNITE' scheme. We will continue to utilise the allowances available for the remainder of GD1 to develop ideas for entry into the network innovation competition.

A significant operational innovation portfolio has been established under GD1 with innovation ranging from operational and process changes through to future networks, industry standards and decarbonisation.

Using the allowance mechanisms available to us we drive operational excellence through innovation and technology to deliver benefits to customers which can be demonstrated by the following examples of our commitment during GD1:

- minimising disruption: 7 operational core and vac machines in operation,
- minimising disruption: CISBOT robots have travelled over 39.0 km,
- keeping the gas flowing safely: Self-amalgamating tape has transformed our approach to riser pipe risk management significantly reducing the number of disconnections, and
- improving our service: Live main insertion techniques are reducing the number of customer interruptions[1].

3.1 Collaboration and information sharing

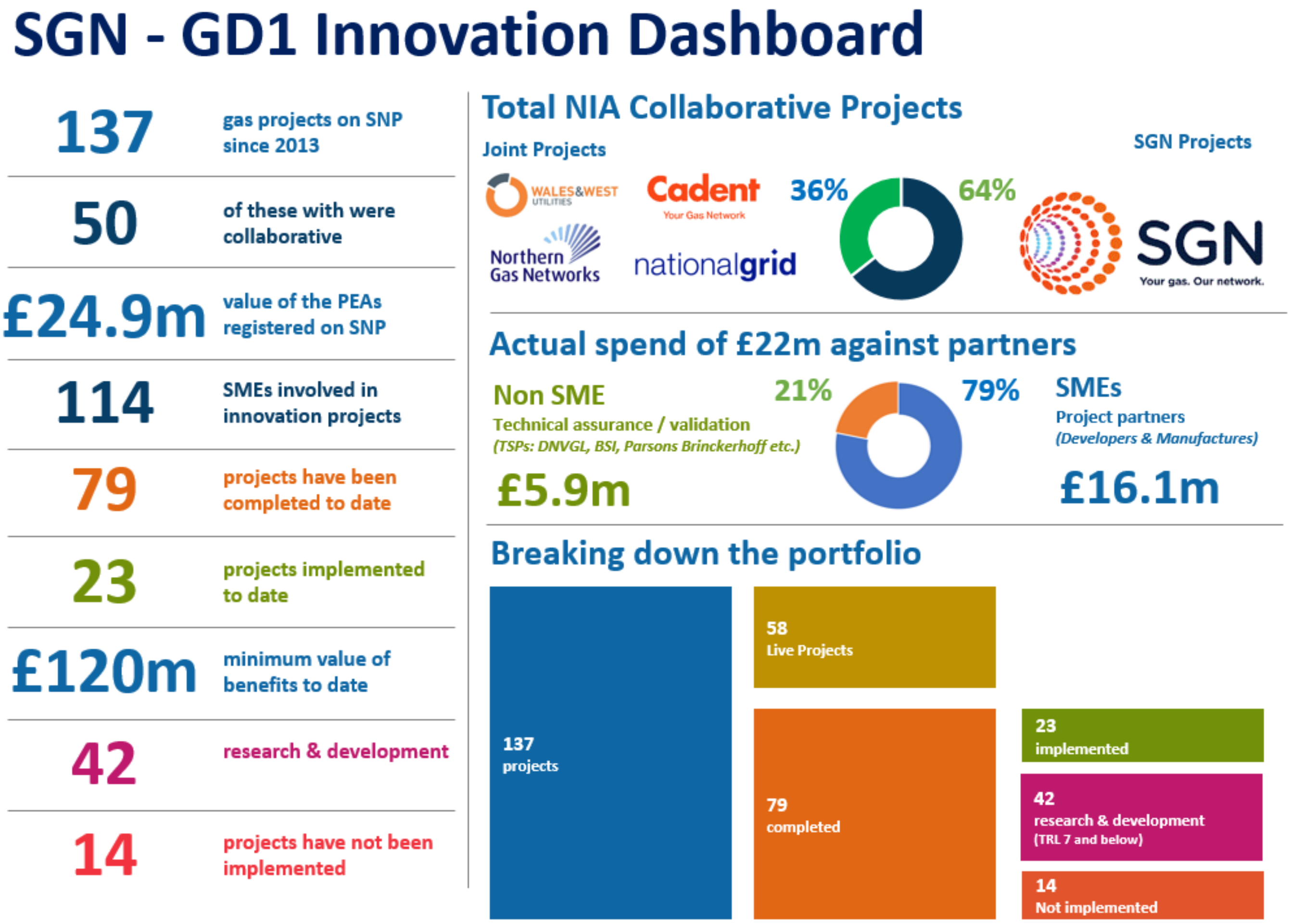
Recognised as an industry leader in the scope of innovation, we have been collaborating with other external partners to develop new and innovative techniques for managing risks on the gas distribution network, specifically CISBOT (cast iron joint sealing robot) which was developed in conjunction with ULC Robotics and is now being deployed by both ourselves and Cadent.

The innovation dashboard below highlights some of the key benefits from innovation that have been delivered in GD1. This shows that in total, as at August 2019, we have a portfolio of 137 NIA projects registered and 50 of

[1] http://www.energynetworks.org/gas/futures/gas-innovation.html

these projects, some 36%, are collaboration projects we are developing within one or more of the other gas network companies. In addition of the 79 projects completed to dates some 23 (approximately 30%) have been implemented with the remainder being either lower TRL projects that require further development or projects that we do not intend progressing. The figures have been extracted from the ENAs Smarter Networks portal[2] and only relate to the projects developed within the NIA mechanism, to August 2019.

Figure 3: Innovation dashboard (NIA projects only)



Note: All figures correct to end of August 2019

It is unlikely that these projects would have progressed without the NIA framework or the ecosystem of SMEs we have developed to support us in bringing forward new ideas. These companies have also been prepared to take some financial risks themselves to support project development within the framework. The transparent environment of the NIA has fostered further innovative thinking and shared application across all Gas Distribution Networks (GDNs).

The risk and associated cost of being able to successfully implement a project will largely depend on the technology readiness level (TRL) of a concept. As the TRL increases it is imperative that we can demonstrate that it can be safely, efficiently, and economically implemented within the bounds of gas network policy and procedures and it is scalable to deploy network wide.

We believe that continuing the NIA framework ensures benefits will continue to be realised with the appropriate allocation of risk between third parties, consumers and networks.

[2] http://www.smarternetworks.org/

Some innovation benefits have already been realised and are now reflected in our current costs (2018/19); some current innovation is likely to roll out as we move into GD2 and a level of efficiency has been built in to our GD2 investment proposals to reflect this. This is covered in more detail within section 6.1

It is important that we continue to maintain good relationships with the recently developed ecosystem of SMEs as these companies have demonstrated that they are prepared to continue working with us and put monies at risk to pursue further innovation ideas. Irrespective of the funding mechanism, they will be critical to deliver new innovations and energy solutions for further cost savings in GD2 and beyond.

3.2 Developing ideas in GD1

Innovation is embedded within our culture, one of our goals is to continue to reinforce this culture of innovation and development in our business. 'IGNITE', our internal ideas management scheme, has been central to our development of this innovative culture. Our focus on the encouragement, progression and implementation of ideas from everyone (internal and external) to improve our thinking, products and processes has been critical to our success. 'IGNITE' is now an ingrained business function which has been fine-tuned in GD1 to deliver benefits where possible. The idea submissions have ultimately been aligned to SGNs strategic goals and industry innovation strategy's and this is now a far more refined process today than ever before, but this has not always been the case.

Throughout GD1 we have continually sought out new ways of working, new products and services that could add value to our business and customers not just generate an NIA funded innovation project. The success of 'IGNITE' is not only about promoting valuable ideas it has also been a learning curve in preventing less beneficial ones from progressing, ensuring we apply a 'fast-to-fail' approach.

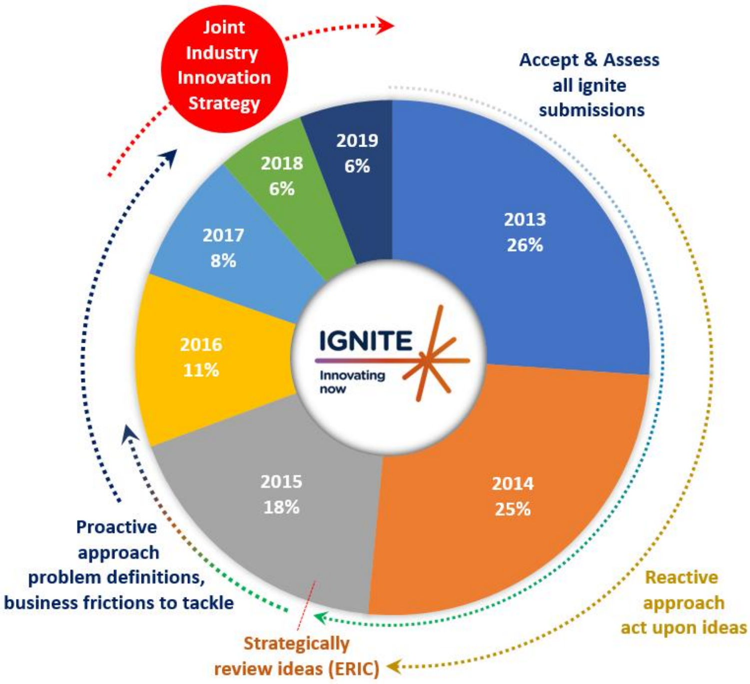
The initial scope of the 'IGNITE' in 2013 was wide, accepting and reviewing any type of idea with no prequalifying criteria. This attracted large volumes in the first instance with only a very small proportion being capable of being deployed. The initial submissions covered everything from changing to cheaper printer paper to installing energy efficient lightbulbs in our offices and depots; collectively generating small opex and environmental savings. We also ran field trials for a number of 'BAU off the shelf products' predicted to have been of value, but when put into practice were shown not deliver as expected. This prevented us from adopting such items while running up costs on ideas that did not deliver benefits.

Our total number of ideas submitted in GD1 is currently sitting at almost six thousand (5,872). Our suppliers also participate within our 'IGNITE' scheme and are actively encouraged to bring us the latest market thinking. Today's submissions are debated openly and a case for progression built. The chosen ideas can be championed by anyone as a BAU project. Ideas are now assessed with support from multi-functional teams and acted upon based on the proposed value. As a standard way of working, good ideas are now assessed, validated and deployed into the business. This assessment process over time has reduced the volume of ideas but increased the quality.

Our innovation team pick up the ideas of value which require more development work, following our innovation development process to ensure a fundamental level of compliance and best value are assessed and can be achieved. We believe that this approach enables us to open our innovation ideas to third parties (SME tenders), ensuring that we maximise development knowledge and leverage technical and financial risk, where appropriate.

In 2015, strategic priorities were added to the submission criteria for 'IGNITE' utilising the 'ERIC' principles *(Eliminate, Reduce, Innovate & Control).* The process matured at this time, ideas evaluated by a business area that had limited scope beyond that area could be implemented as BAU without being registered; providing general business efficiencies for that particular workstream.

Figure 4: IGNITE scheme process



In conjunction with the BAU 'IGNITE' process we were also developing our NIA portfolio. This was initially based on ideas received, reacting to the submissions accordingly and trying to develop solutions which BAU innovation could not overcome. Overtime key themes started to emerge which could be linked to specific business processes. Through engagement and collaboration with all gas network operators these common themes became the joint gas innovation strategy we have today.

Acting upon our drive to embrace change and continually evolve through innovation, 'IGNITE' has been an essential ingredient in the delivery of our performance in GD1 and we are currently looking at ways of digitising the process to bring additional efficiencies.

3.3 Deployment of BAU in GD1

We are a forward-thinking network operator developing internal business ideas and initiatives in conjunction with the NIA and NIC funding mechanisms to actively pursue new and exciting opportunities to significantly reduce the impact our activities have on our resources and customers. Whilst it is difficult to assign financial savings to such BAU initiatives, the combined impact has driven efficiency, improved unit rates from pre-GD1 benchmark levels, by reducing the duration, size and general impact of our works, making us more productive overall.

Smarter working using better methods of plant detection, has reduced the time it takes to identify our underground assets. Initial on-site detection is critical in providing a quicker delivery of overall street works. We have reviewed the market place in this area to provide front end improvements and efficiencies to street works processes. We aim to pin point the correct location, first time where possible, whilst avoiding any potential third party plant in an often-congested road or footpath.

Examples of the varying BAU technological advances deployed in SGN have been listed below.

Magnetometers - Enable joint location

The M10d magnetometer can detect the magnetic fields of all ferromagnetic objects including manholes, valve boxes, cast iron pipes, "bell" joints and service connections.

The magnetometer helps pinpoint the exact location of where to dig. This technology has now been deployed within SGN improving delivery of works in carriageway resulting in quicker plant detection and reducing the number of excavations by only digging were we need to dig.

CAT 4 – Plant location

The CAT4 plant location system lets the operator check an intended excavation area for power, radio and generated ‘genny’ signals, and pinpoint located utilities, in a single scan. The bar graph ‘tidemark’ enables the user to quickly spot and zero-in on a buried conductor.

Minimising impact damage to other utilityies such as electrical cables is achieved using this technology. The use of the CAT 4 avoids third party damages which have the potential to have a significant impact in delaying street works delivery.

Gas tracker - PE service locator

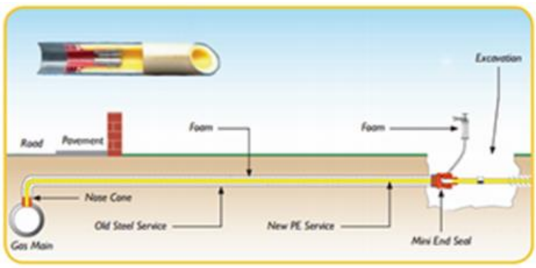
Gas Tracker is a system for identifying and tracking gas pipes made of polyethylene (PE) or other plastics. Using this equipment we can now follow the route of a pipe up to 300 meters from the transmitter and this allows pipes to be accurately located.

The system will also identify a gas pipe of any material if the detector can be placed directly in contact with the pipe. This technology removes the requirement for any additional excavation (e.g. slip trenches) when trying to locate gas pipes, as well as any associated disruption.

Mains bursting (dead insertion upsizing)

Pipe bursting or splitting is the replacement of an existing, metallic, underground pipe with a new PE pipe of the same size, or larger, without the need for a continuous trench to excavated. This technique can be used when downsizing dead or live pipe insertion is not possible due to capacity constraints. This tends to be utilised as a specialist technique under specific scenarios rather than a standard pipe replacement method.

Live service insertion



This technique has allowed SGN to replace a service without isolating the flow to the main, reducing disruption to neighbouring properties.

After fitting an insertion head to the existing metallic service, the new PE service pipe, with a nose cone fitted to the end, is inserted using a pushing machine. This annular space between the new PE service and the existing service is then filled with expanding foam, before the remainder of the supply pipe is re-laid to the meter.

This process significantly reduced the duration of the works and the need to excavate an entirely new pipe track.

3.4 Working with third parties

Through collaboration and shared learning, we are driving innovation forward in our industry. We could not achieve what we do without the support and expertise of all our project partners, colleagues and the other network licensees that support our diverse portfolio.

We are proactive in our approach, maintaining our reputation as key innovators through accessible and credible speaking opportunities, workshops, and our own inclusive field trials and demonstrations. Given the scale of potential benefits from our project portfolio, especially our pioneering and ambitious NIC projects, means that we take our obligations to share our progress seriously, through full project reports, workshops, conferences and engagement with industrial bodies. We will also engage with stakeholders, third parties and SMEs to explore how we can create and deliver exciting new innovation projects.

The structure of the existing funding mechanisms gives us extraordinary scope to broaden our horizons and really push technological boundaries. We thrive on 'what-ifs' and know that the best way to make things happen is to work with like-minded partners who want to share and develop great ideas. We may actively look for expertise in a specific field, or a company may approach us in need of help with their own project. Either way, we have extraordinary working relationships with over 114 SMEs that account for almost 80% of the partners that we work with, as well as many multinational organisations based in Europe and North America, built over many years and multiple projects. Whether they are long-standing or new, project partners give us flexibility and diversity.

Our total spend with project partners is provided in the innovation dashboard shown in Figure 3 above and the following table details some of the companies within each classification:

Table 3: Third party project partners for NIA

SME Companies	Non-SME Companies
TRACTO-TECHNIK UK LTD	GL INDUSTRIAL SERVICES LTD
STEER ENERGY SOLUTIONS LTD	ENERGY INNOVATION CENTRE LTD
PROHEAT SYSTEMS LTD	ROSEN UK
ULC PIPELINE ROBOTICS	WRc PLC
GAS MEASUREMENT INSTRUMENTS	HEALTH & SAFETY LABORATORY
PIPELINE TECHNOLOGY LIMITED	CRANE FLUID SYSTEMS
KIWA GASTEC	JAMES FISHER IMS TRADING
UTONOMY LTD	NPL MANAGEMENT LTD
OXFORD FLOW LTD	
SYNTHOTECH SPECIAL PRODUCTS	
LONG O DONNELL ASSOCIATES LTD	
ALH SYSTEMS LTD	

3.5 Innovation projects delivered

The innovation projects that we have delivered in GD1 have been categorised according to 'lead innovations' and 'significant innovations' as follows.

- Lead innovations.
  Innovation projects are rarely developed in isolation, more regularly they depend upon a family of supporting innovations, where each innovation in isolation delivers limited value but as a strategic whole they complement each other to deliver a better consumer outcome. These lead innovations have enabled a significant change in a process or a change to the way that we deliver our projects.
- Other significant innovations.
  In addition to the lead innovations, there are other significant innovations that are more stand-alone in nature, or provide more bespoke solutions. They have had a direct impact on the way that we delivered our projects in GD1 which may also feed through into GD2.

An example of one of our lead innovations projects delivered in GD1 is shown below.

Large CISBOT (cast iron joint sealing robot)

From the inception of the gas industry cast iron mains were laid as the most appropriate carrier pipe for distributing gas. At the joints of these mains yarn was packed into the cup before a lead seal was applied. This sealing method was effective at sealing these joints as the moisture content within towns gas swelled the yarn. Natural Gas from the North Sea is dryer and does not provide the moisture necessary to swell the yarn in the joints of these mains, other methods are therefore required.

ULC Robotics developed a cast iron joint sealing robot known as Large CISBOT. This advanced robotic technology can remediate cast iron pipe by internally injecting all the joints in a given area with an anaerobic sealant. This project carried out a detailed technical assessment and field trial of the joint sealing robot CISBOT, which has proven to repair or rehabilitate cast iron joints under live conditions.

This project ultimately delivered an innovative solution for the repair of leaking lead yarn joints within our cast iron mains population and is now a critical part of our mains risk management strategy. The project evaluated the effectiveness of the remediation technique and associated inspection method. The project was deemed to be very successful and will provide benefits across the gas industry. This would not have been possible without the technical and practical assessment of CISBOTs performance when repairing large diameters mains using this live mains inspection/remediation technique.

CISBOTs pioneering technology minimises disruption to the general public as there is no need for multiple excavations in the road. The system is being used on larger mains in inner city locations and it also dramatically reduces our carbon footprint.

- By the end of GD1, CISBOT robots will have travelled over 60km.
- We aim to continue to use the CISBOT robot as part of our embedded innovation (i.e. business as usual) to remediate tier 3 pipes as this has proved to be successful in reducing the risk in these mains in GD1.

We have used this innovation on most of our high failure tier 3 mains through the course of GD1, reducing the amount of gas in buildings and leakage across the network. Going forward into GD2, there will be limited opportunity to continue remediating at the same rate on this category of mains as we targeted a significant portion through GD1. Given that the population of un-remediated mains is not vast there will only be the need for retaining the use of one robot to achieve a safe and reliable network, within GD2.

It is not just SGN embracing CISBOTs potential, our project partners ULC Robotics are now working with Cadent Gas to roll out this award-winning technology in their areas. Thanks to the NIA, we have been able to share the success of our pioneering technology with other gas network companies to provide benefits to consumers and less disruption to UK motorists.

In section 9 we have set out in much greater detail how these lead innovations address a specific problem that is related to either opex or repex activities. We also define the problem that the innovation family is looking to address, the realisable benefits that we are looking to achieve (reducing cost, minimising disruption, improving safety, improving resilience and reducing environmental impact) and how they have been supported by a series of innovation mechanisms (NIA, NIC and innovation funding incentive(IFI)) that have supported the delivery and contributed to the economic, environmental or social benefit.

A fuller description of lead and other innovations is given in section 9, the lead innovation summaries annex.

3.6 GD1 benefits realised

The GD1 innovation funding mechanisms (NIA & NIC) have helped develop specific technologies, commercial arrangements and operating practices which are now being deployed on the networks, delivering savings for consumers and more reliable and safer energy supplies. The table below show how we categories the benefits of innovation between those are financial and those that are non-financial.

Table 4: Classification of benefits

Benefit	Category
Financial	Efficiency / economic savings Cost avoidance
Non - financial	Health and safety Environmental benefit Customer improvement Resilience TRL change

The innovation dashboard shown in section 3.1 highlights how successful we have been at identifying and implementing innovation projects that have and will continue to change the way we operate.

The range of estimated benefits we present in this section are not formal projections, as they are made at a point in time and may change as projects are rolled out into business as usual. Many of the innovative initiatives have the potential for multiple benefits, only some of which will be financial. This is further highlighted within section 9 where we describe how innovations have impacted core reporting processes and detail under which categories the 'Realisable Benefits' are being achieved.

With the above in mind, our current forecast of the benefits that will be delivered during GD1 is as shown in the table below.

Table 5: GD1 benefits by funding mechanism (March 2019)

Funding Area	Number of Projects	Forecast Total GD1 (£m)
NIA	117[3]	£117.49
NIC	5	£8.16
Total	**122**	**£125.65**

[3] The number of NIA projects under development continues to increase and the figures for August 2019 are quoted elsewhere in the document.

Innovation strategy values

As identified within the gas network innovation strategy, published on the ENA website, we identify projects against a number of key themes.

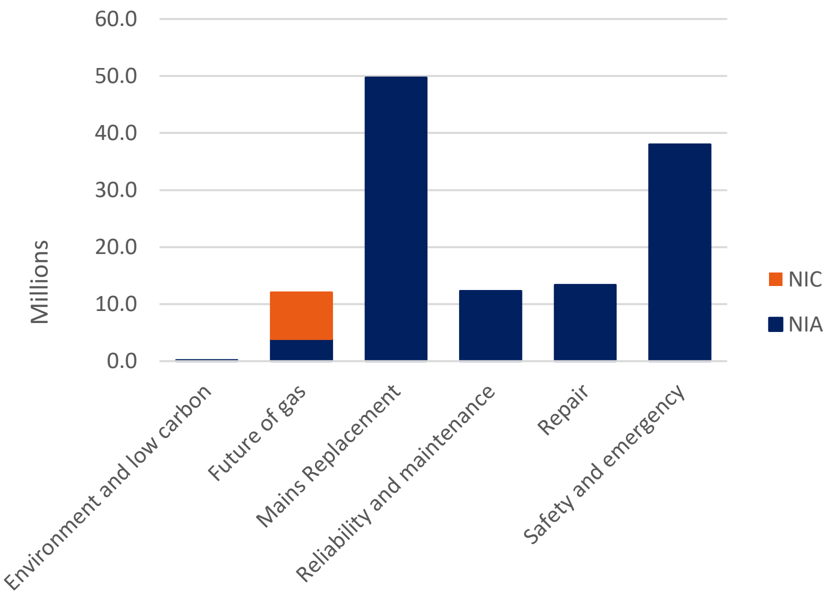
The following is a summary of the work we have done so far across all the themes of the strategy since the start of GD1. The chart and the table below show where we have focused our innovation efforts under the NIC and NIA schemes.

Table 6: NIA projects by theme (March 2019)

Strategy Theme	NIA		NIC		Total	
	No.	Benefit (£m)	No.	Benefit (£m)	No.	Benefit (£m)
Environment and low carbon	7	0.19		-	7	0.19
Future of gas	14	3.89	3	8.16	17	12.05
Mains Replacement	23	49.74		-	23	49.74
Reliability and maintenance	30	12.29		-	30	12.29
Repair	27	13.37	2	-	29	13.37
Safety and emergency	16	38.01		-	16	38.01
Grand Total	117	117.49	5	8.16	122	125.65

By focussing our projects on these strategic themes, we have delivered benefits for the customer over the GD1 period. The following chart forecasts the expected benefits from all NIA and NIC projects that we have been involved in over GD1. The difference in project spend between NIA and NIC projects can be significant and while NIC projects have to date incurred a greater project spend they are yet to deliver significant benefits during this price control and are only likely to be fully implemented within GD2 or beyond. In comparison with a total project spend of slightly less than £8m, the mains replacement NIA projects undertaken are expected to deliver a significant benefit of almost £50m over GD1.

Figure 5: Delivered benefits over GD1 by theme (March 2019)



3.7 Project summary (NIA and NIC)

The table below provides details of the top 11 NIA and NIC innovation projects that we have or will implement within GD1 and also provides a forecast for the average annual anticipated efficiency benefit and the benefit is anticipated from the year of implementation. The figures are provided based on the combined benefit for both Scotland and Southern networks. It should also be highlighted that the benefit information is still being validated and the values quoted may change within our final business plan submission.

Detailed descriptions of the individual projects for all NIA and NIC projects can be obtained from the ENA Innovation portal[4], using the reference number provided within the table.

Table 7: Top NIA and NIC project over GD1

Reference	Name	Funding	Area	Period	Financial year	Annual benefit
NIA_SGN0019a	Large CISBOT (T2/T3 REPEX)	NIA	Repex	GD1	2015/16	£5,518,968
NIA_SGN0017	Portable 'Gas In Ducts'	NIA	Opex	GD1	2015/16	£2,685,750
NIA_SGN0018	Microstop	NIA	Opex	GD1	2017/18	£2,790,000
NIA_SGN0019	Large CISBOT (Joint Sealing Robot)	NIA	Opex	GD1	2014/15	£2,709,000
NIA_SGN0022	Anaerobic Pressure Guns	NIA	Opex	GD1	2014/15	£675,000
NIA_SGN0024	RCA GPS Survey	NIA	Opex	GD1	2016/17	£1,520,000
NIA_SGN0030	Self-Amalgamating Tape (Stage2)	NIA	Opex	GD1	2014/15	£1,900,000
NIA_SGN0052	Core Drilling and Flow Stop, WASK	NIA	Opex	GD1	2018/19	£560,000
NIA_SGN0067	Smart Paints and Coating Systems	NIA	Opex	GD1	2018/19	£559,000
NIA_SGN0068	PE Bodied Valves	NIA	Opex	GD1	2016/17	£700,000
SGNGN02	Opening up the Gas Market	NIC	Opex	GD1	2015/16	£1,360,000

For the remaining NIA and NIC projects the average annual anticipated benefits is forecast to be £50,428. Over 60% of projects are expected to deliver benefits other than efficiency benefits, such as raising the TRL of the project, safety, customer or environmental benefits.

3.8 Innovation funding prior to GD1

Not all projects that have delivered a benefit within GD1 were developed during this period. A number of the projects were developed during the previous price control under the IFI stimulus. These projects were implemented just prior to the start of the current price control and it is only within this period that benefits could be realised.

Our forecast for the average annual anticipated efficiency benefit for the top six IFI innovation projects implemented within GD1 is given in the table below, anticipated from the year of implementation. The figures are provided based on the combined benefit for both our Scotland and Southern networks.

[4] http://www.smarternetworks.org/

Table 8: Benefits from IFI projects

Reference	Name	Funding	Area	Period	Financial year	Annual benefit
IFI	Live Mains Insertion	IFI	Repex	GD1	2013/14	£4,820,000
IFI	20mm ServiFlex	IFI	Repex	GD1	2013/14	£3,120,000
IFI	29mm Mains Inspection Camera	IFI	Repex	GD1	2013/14	£2,380,000
IFI	Core and Vac	IFI	Opex	GD1	2013/14	£2,122,670
IFI	Wask PE Riser System III	IFI	Repex	GD1	2013/14	£978,000
IFI	26 Tonne Vac Ex	IFI	Repex	GD1	2013/14	£957,835

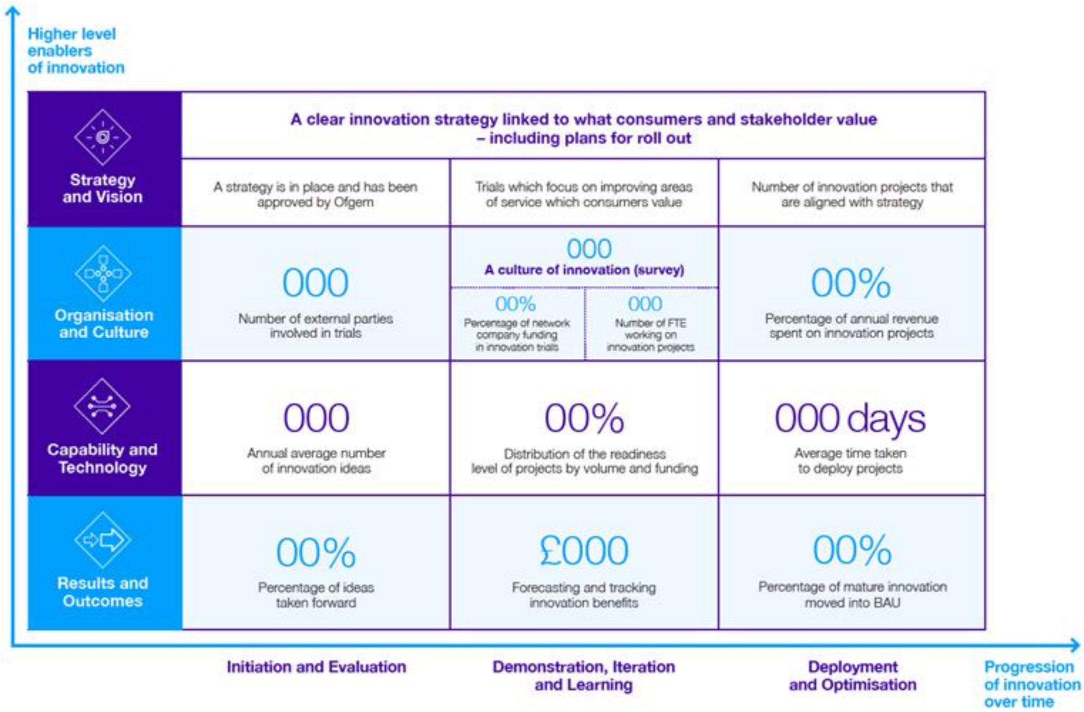
For the remaining 21 IFI projects the average annual anticipated benefits is forecast to be £87,790.

3.9 Benefits reporting in GD1 and GD2

As of August 2019, all of the gas and electricity networks collectively reviewed the innovation benefits measurement and reporting going forward. We provisionally agreed a strategy with respect to benefits reporting and have detailed a common methodology with respect to benefits reporting. SGN are now reviewing the framework developed by Baringa as a starting point, but this will require further refinement and detail is required before it can be included to review innovation benefits in RIIO-2.

The Baringa model was developed through the Energy Innovation Centre (EIC) with valued input from all networks and key stakeholders, a high level overview of the outputs of the model is shown below:

Figure 6: Innovation measurement framework



The model was developed in collaboration with the networks to provide a format for innovation reporting, enabling comparison between network companies on innovation.

3.10 Awards and recognition in GD1

Since the start of GD1, many projects in our portfolio have been recognised in a variety of forms. The efforts of the innovation team and project partners were recognised by The Innovation Institute and National Joint Utilities Group (NJUG). Furthermore, the team successfully won at the Utility Week Stars Awards and the UK Energy Innovation Awards. Along with our project partners, we have won several industry awards for our innovation projects:

- UK Energy Innovation Awards 2014 - Best Innovation Contributing to Customer Quality and Reliability of Supply – CISBOT
- NJUG Awards 2014 (Vision for Streetworks) - Special Award for Outstanding Innovation – CISBOT and Robotics
- Innovation Awards 2014 (NEF – The Innovation Institute) – Innovator of the Year – Sam Wilson Utility Week Stars Awards 2014 – Innovator Award – CISBOT
- IGEM Gas Industry Awards 2014 – Customer Service Award – Opening Up the Gas Market
- AGSM Gas Safety Awards 2015 – Gas Innovation Award – Opening Up the Gas Market
- UK Energy Innovation Awards 2015 –Contribution to Quality and Reliability of Gas Supply – Optomole
- London Construction Awards 2015 – London Innovation of the Year – CISBOT™ and Robotics
- IGU Global Gas Awards 2015 – Opening Up the Gas Market
- The Energy Awards 2015 – Innovation of the Year – CISBOT & Robotics
- International Society for Trenchless Technology - 2019 No Dig Awards - Trenchless Project Completed – CISBOT George St, Edinburgh
- Utility Week Achievement Awards 2019 - Capital Project Management Award – CIRRIS Team of the Year

Over the past two years we have been presented with a variety of prestigious awards, some related to our approach to innovation schemes, methods and processes. Those particularly relevant are listed below (with links given to relevant websites), while our whole list of awards can be found on our website: www.sgn.co.uk.

- **AD & Biogas Industry Awards (ADBA)**: Best Innovation in Biomethane
- **AGSM Gas Safety Awards:** Gas Safety Initiative of the Year (**locking cooker valve** initiative)
- Sustainability First awards: Gold Award for Safety and Peace of Mind category (**locking cooker valve** initiative)
- **CIPR (Chartered Institute of Public Relations) InsideStory Awards:** Best Employee App
- EIC (Energy Innovation Centre) National Awards: Best gas network improvement – Proheat
- **EIC National Awards:** Best innovation contributing to quality and reliability of gas or electricity supply - Robotics
- **Gas Industry Awards**: IGEM Innovation Project Award - SGN 'Opening Up the Gas Market' Project
- R&D 100 Awards (Special Recognition): Gold Award for Market Disruptor for CIRRIS XI and CIRRIS XR with ULC Robotics
- **UK Business Awards**: Utilities award for our **robotics project**
- **UK Business Awards**: Innovation (B2C) award for our **robotics project**
- **UK IT Industry Awards:** Highly Commended for Best Use of Cloud Services
- **UK Business Awards:** Gold Award for the Utilities category
- **Utility Pipeline Technology Award**
- **Utility Week Stars Awards**: Data Demon Award, The Asset Capture project team

4 GD2 Stakeholder insight

We have undertaken a programme of engagement and research with customers and stakeholders throughout the development of our business plan. Further information is detailed in chapter 4 of our business plan and the Enhanced Engagement appendix (022). Overall our engagement on innovation has been extensive; we have and continue to actively seek the views of a wide-range of stakeholders, listening to what is important to them and looking to understand their expectations for us.

Collaborating by sharing ideas, knowledge and learning is key to maximise the potential use of NIA and NIC funding. By working with other gas networks and project partners, we can tackle common ongoing issues we all face and as a result improve efficiencies.

We engage directly with stakeholders, third parties and SMEs to explore how we can create and deliver exciting new innovation projects.

Our innovation showcase events are arranged at our regional depots to both demonstrate our innovative projects and directly engage our project partners. Attendees and exhibitors include a range of our SME partners, internal colleagues, our Board of Directors, Executive team and Operational groups. These events generated positive feedback from all in attendance further promoting our culture of innovation.

"This was a unique opportunity for us to engage with a quality cross section of audience rarely assembled by any network in one place at the same time."

Mike Deane, Business Development Manager, Crane Building Services & Utilities.

As detailed in the Enhanced Engagement appendix (022) throughout GD1 and in the development of our GD2 business plan we have used a number of mechanisms to maximise our reach to engage our stakeholders on innovation. Examples include stakeholder satisfaction surveys, roundtable events, stakeholder and customer workshops, specialist panels, and formal customer research including willingness to pay and acceptability testing. We have also engaged with our own employees, for example asking them to submit their innovative ideas through our 'IGNITE' scheme, and encourage digital engagement with employees through internal Yammer groups which encourage innovation ideas to be put forward.

Our engagement process has been far-reaching, and when we engage with stakeholders and customers more generally we very commonly find innovation is raised as an area our they think is important[5,6]. With that comes a strong message, that they want to see us continue with the pace of our innovation[7,8,9].

We have taken a proactive approach to thoroughly test our plans with our stakeholders. To establish what stakeholders think should be our top priorities and where we should concentrate our efforts, we held a number of stakeholder workshops the results from which were consistent with 'keeping the gas flowing safely', was a key priority for stakeholders. Our research with customers has shown they also see this as very important, but feel our top priority is to 'keep costs down' [10].

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[5] MFT Workshop March 2016 London & Edinburgh (Ref 006,007)

[6] Safe & Efficient round table event – London (Ref 089)

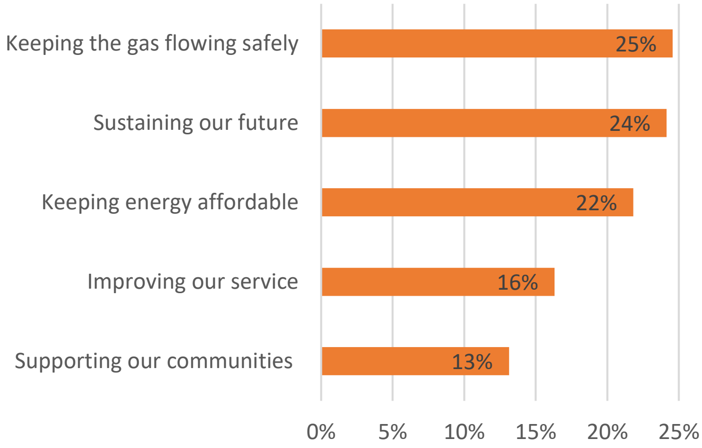
[7] MFT Workshop March 2017 London, Portsmouth, Edinburgh (Ref 008,009,010)

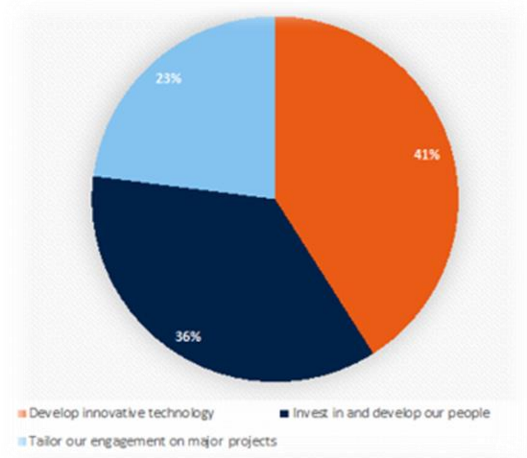
[8] Shaping the Business Plan Qualitative workshops - Sharing Financial Risk. Innovation investment (Ref 083)

[9] Safe & Efficient round table event London (Ref 089)

[10] Stage 1: Explorative Qualitative Workshops and interviews (Ref 002)

Figure 7: Stakeholder feedback





At our Moving Forward Together workshops (MFT) 2016 we asked our stakeholders what they thought we should focus on as a company. We asked stakeholder to rate the importance of objectives we had created to support priority areas important to stakeholders. The majority (41%) wanted us to focus on developing innovative technologies. At our MFT workshops in October 2018, we asked our stakeholders where we could be doing more in the remaining years of GD1[11]. The main points that emerged from the stakeholders when specifically engaged about Innovation and research were:

- They want more scaling up innovation i.e. more innovation in general.
- Link-in more to innovative university research work.
- Increase funding for R&D work.
- Promote our innovation successes more.

At our qualitative customer research workshops held in August 2019, customers generally saw the benefits of innovation, saying it is ‘how companies move forward’, and they thought we should be at the forefront of this. Customers felt we are of a scale and success level to be able to invest and should be seen to lead innovation. Future customers especially had the mindset that someone must do it, and there was no reason why it should not be SGN. SMEs business customers were also very supportive of innovation and were keen for funding of projects at every stage of the innovation cycle. There was some support for early innovation projects, but these should be carefully assessed, for example, the innovation should benefit customers long term, and be in areas which are important (such as decarbonisation, sustainability, environment and safety).[12].

11 MFT Workshop November 2018 London & Edinburgh (Ref 013,014)

12 Shaping the Business Plan Qualitative workshops - Sharing Financial Risk. Innovation investment (Ref 083)

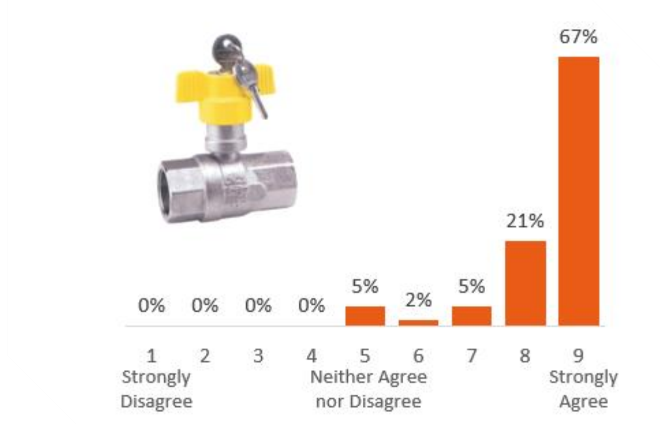
4.1 Positive impact

The enthusiasm for innovation and for our stakeholders to see us lead on innovation was just as apparent at our MFT 2017 workshops in London. Here we saw 48% strongly agree that our investment in innovation is an effective way for us to minimise disruption. Stakeholders have consistently told us that minimising disruption is an area they want us to invest in[13].

One example of an innovation that has received almost universal praise from our stakeholders, as well as being an multi award-winning innovation, has our locking cooker valve. This device can be easily fitted to any gas cooker, allowing families and carers of people suffering the effects of diseases such as dementia, to allow their family

member to stay in their home safely and without danger of harming themselves on their gas cooker.

Figure 8: Stakholder feedback to the statement "The locking cooker vlave is a tool which can make a posistive diffrence" (Source MFT workshop 2017)



4.2 Shared future

Innovation will play a key role in decarbonising our energy supplies. The work we are undertaking in this area is described in greater detail in our Energy Futures appendices (006,007). At our 2017 Moving Forward Together workshops stakeholders showed strong support for us to investigate innovative and alternative uses for our gas networks and suggested that priority should be given to research into looking at the use of alternative gases in our networks [14]. This was reinforced by our specialist Future of Heat stakeholder panels [15] and our Shared Future workshop in August 2019 [16].

We held Sustainability round table events in early 2019, attended by a range of expert stakeholders17. The feedback and recommendations from stakeholders was very positive and constructive. Recommendations specific to innovation included:

- Develop a strategic approach to innovation including innovation portals/channels for new ideas
- Consider partnerships with universities
- Embed innovation into the culture of the organisation
- Differentiate between short-term and long-term innovation
- Focus on how funding through the regulator is spent – NIC and NIA funding
- Engage with suppliers on innovation and best practice early

[13] Moving Forward Together workshops London & Edinburgh Nov 2018 (Ref 013,014)

14 MFT Workshop March 2017 London, Portsmouth, Edinburgh (Ref 008,009,010)

15 Specialist panel: Future of heat, Edinburgh 1 and 2 (Ref 023,024)

16 Share Net Zero Future round table event – Scotland (Ref 090)

17 SGN Sustainability Roundtable – London & Glasgow (Ref 065, 066)

- Consider partnering with academic institutions
- Engage with stakeholders and citizens affected by our activities to develop innovations that will benefit them
- Frame the business as a high-tech innovative company – need to appeal to attract talented people to the industry in the future.

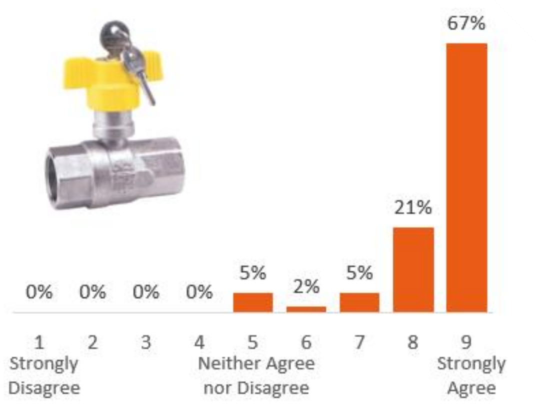
Customers consistently rate future energy solutions as a high priority for further investment.[18,19] Customers were asked a question in relation to investing in innovation, in particular to develop alternative energy sources, such as hydrogen, which produce zero or very low emissions in our quantitative acceptability testing research. Southern customers gave this element an acceptability score of 69% in total; Scottish customers gave a score of 73%. Acceptability was lower amongst domestic customers in both networks when compared to SME business customers[20].

4.3 Safe and efficient

We have invested significantly in robotics to reduce disruption, keep the gas flowing during our works, operate in a more environmentally friendly manner and in doing so, generally providing a better service to our customers. Our stakeholders have told us that they recognise we have worked hard to improve our service and they support for our work on innovation to minimise disruption, believing this should be an area we should continue to invest in[14] .

At the 2017 MFT workshops, our stakeholders were asked if introducing innovation to the issue of disruption was something we should concentrate on. 77% of stakeholders asked, gave strong agreement (score of 8 or 9) that investing in innovation is an effective way of minimising disruption, adding to this they saw our iCore and robotics technology as an avenue that should be pursued. This gives us a very positive steer that we have good stakeholders support to target innovation investment to reduce disruption

Figure 9: Stakholder feedback to the statement "Investing in innovation is an effective way of minimising the diruption we cause" (Source MFT workshop 2017)



Stakeholders at our workshops also told us they want to see us share information, collaborate more and learn best practice from other organisations. This was specifically mentioned for innovation, where they wanted us to share ideas not with other gas networks but also other organisations on innovation, for example participating in London's Utility Sector Panel day has been taken on board as well as the suggestion we should promote the use of trenchless technology such as iCore and robotics across more stakeholder groups.

[18] Explorative Qualitative Workshops and interviews (Exploratory Phase) (Ref: 002)
[19] Conjoint & WtP Summary report (Valuation Phase) (Ref: 005)
[20] Business Plan Acceptability Testing Phase 2 (Ref 079)

4.4 Innovation supporting vulnerable customers

Through specific workshops in August 2019, held in both our network areas, our stakeholders supported our proposals for vulnerable customers; in that we should specifically look for innovation projects that would address information and process weaknesses in the following areas:

1. Mitigating the risk of the energy transition,
2. Joining up information flows to provide better service,
3. Minimising the impact of supply disruptions, and
4. Adoption of new solutions through inclusive design to improve.
    - Identification of customers with additional needs
    - Access to services
    - Security and peace of mind
    - Affordability

During GD1 we have been engaging with research panels via SCOPE, pan disability charity, who over many years have been working with disabled people, building up a diverse network of supporters, advocates and representatives. The large group panels are made up of individuals with direct experience of being disabled or as parents of disabled children who are able to articulate their experiences and provide their opinions on how products, services and policies impact on their lives. We will continue with this engagement in GD2 to inform and support our innovation for vulnerable customers.

5 Relevance to GD2 cross sector issues

Given the success of innovation in GD1, we believe that the GD2 price control should encourage ambitious behaviour aligned to innovation helping to secure long-term consumer benefit. However, the proposals for GD2 under Ofgem's sector specific final determination are weaker than the current price control arrangements: the potential gains appear to have been lowered and the risks are considerably higher, with additional uncertainty from subjective elements within the proposals, such as the totex incentive mechanism. Changing the balance between risk and reward could impact the level of uncertainty and commitment to innovation shown by network companies.

5.1 Decarbonisation and whole systems

We have worked together with Cadent, National Grid, Northern Gas Networks and Wales & West Utilities as part of the Energy Networks Association (ENA) Gas Innovation and Governance Group (GIGG) to develop the Gas Network Innovation Strategy.

The strategy agreed sets out the key focus areas where we will look to add value to customers from innovation projects; and how we will share the lessons learnt through the process with other GDNs. The strategy is structured around seven innovation themes:

- Future of Gas
- Safety and Emergency
- Reliability and Maintenance
- Repair
- Distribution and Mains Replacement
- Environment and low carbon
- Security

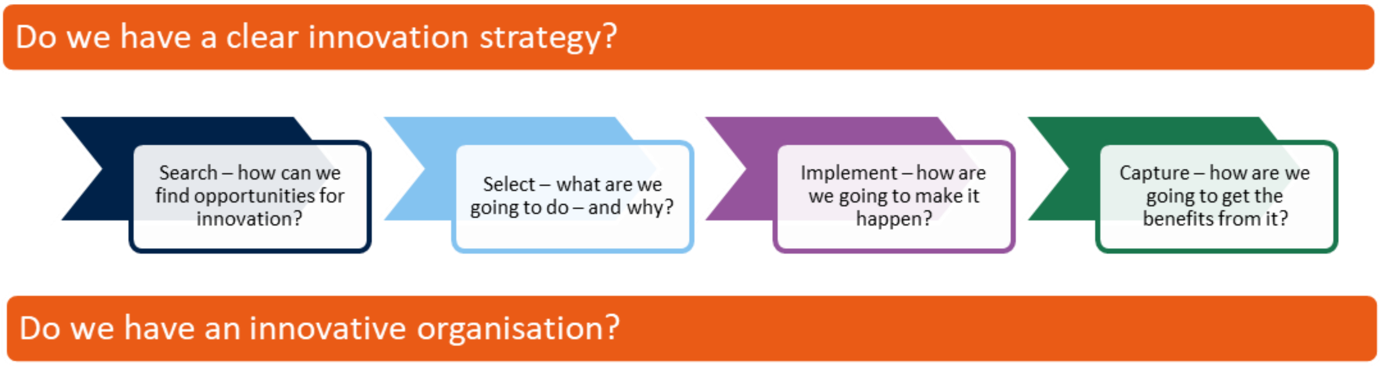
A description of each of the themes, as developed by the networks, in conjunction with the ENA is provided within the strategy paper on the ENA website[21]. In addition, our proposals for innovation focused on the energy transition for GD2 is covered within two separate Energy Futures appendices (006 and 007).

5.2 Innovation process

The process model for innovation we have adopted is simple and is not dependent on the type of innovation technology or technique. We are confident that we can align this to the appropriate innovation funding mechanism proposed for GD2.

[21] http://www.smarternetworks.org/

Figure 10: Innovation process model (adapted from Bessant and Tidd, 2013)



The model[22] shown above is an illustration of the process, from:

- Searching for and finding new opportunities for innovation
- Selecting the right innovations (what are we going to do and why)
- Implementing the innovation (how are we going to make it happen) and
- Capturing the value from the innovation (how are we going to get the benefit).

The innovation process is clear and very similar to that adopted by other successful innovation teams. What sets us apart from the rest is the clear alignment to our overall strategy and the culture of innovation that has been embraced by all within our organisation.

5.3 Resilience

Our innovation strategy is based on providing solutions to key network process friction points. These have a strong relationship with issues of network resilience. As an example, the application of innovation to risers through self-amalgamating tape, and the deployment of live insertion techniques has significantly increased the immediate resilience of the customer that we are serving by reducing their exposure to interruptions or extended outages.

The move to longer term resilience is demonstrated through development of innovations surrounding smart paints, and remote monitoring of assets. This will extend the life of the asset and give us greater insight into the operating profiles of the asset so that we are able to provide more timely and appropriate intervention strategies, in advance of asset failure.

22 Bessant and Tidd, 2013

6 Innovation in GD2

We strongly advocate the continued use of innovation incentives in GD2, through the NIA and replacement NIC schemes. We believe they are the most effective mechanisms for meeting customer outcomes and delivering benefits to consumers beyond the confines of the five year price control period. Furthermore, the networks working in conjunction with the EIC and Baringa have developed a framework for performance monitoring, benefits tracking and reporting. This will provide greater clarity around how innovation outcomes will be measured and the process by which networks will be held accountable for the delivery of 'outcomes', as opposed to 'outputs'.

The priorities chosen from our stakeholder engagement with our customers have shown we should also focus our innovation efforts now on the key areas below:

1. Keeping costs down
2. Providing excellent service
3. Keeping the flow of gas and acting safely
4. Supporting communities
5. Future energy solutions and minimising our environmental impact

Ofgem have now confirmed through their Sector Specific Final Determination document that they will replace both GD1 innovation incentives with new equivalent mechanisms for GD2. We have delivered innovation projects under BAU and will continue to progress this in GD2. We believe that it is also important to provide an opportunity to deliver lower TRL level technologies and secure future consumer benefits (through efficiency and quality) and to support the SME supply chain. There is an added risk that discouraging or excluding certain levels of technology readiness projects will hamper the innovative culture that we have created over GD1 at a time when consumers and key stakeholders are requesting that this should be enhanced.

It is important to understand the part that innovation plays in developing the processes and a safety case through which new techniques and technologies are deployed, challenging legislation and industry orthodoxy (British, European and industry Standards). Examples of such projects include:

- Implementation of solutions developed such as iCore – a key customer focused solution to reduce disruption from roadworks, while has payback it will exceed price control.
- Technical and commercial reports and assessments of third-party products and techniques.
- Technical and commercial field trials and assessment of third-party projects.

Delivering workloads in each of these highlighted areas has clear potential to deliver real quantitative and qualitive benefits as network efficiency-based projects, but many of these may not have progressed to a readiness level that would allow implementation as BAU innovation.

We propose to build on the BAU option with additional 'development' and 'disruptive' funding proposals based on utilising NIA funding separate from our BAU totex allowance, these additional funds would be linked to our high-level areas of focus. This will ensure that there is a steady stream of value added projects supported through the TRL levels that will provide similar benefits for customers to those delivered within GD1. This will be key to prepare the networks for the challenges ahead and to smooth the transition to the energy system of the future whilst also addressing consumer vulnerability issues. It is important to note that in planning for the energy system transition innovation R&D should not only address future and alternative energy sources such as hydrogen, ground source heat pumps, etc, but also the need to prepare and develop our network to cope with a more diverse and flexible energy mix. The 'development' and 'disruptive' funding will mitigate any potential risk associated with this issue and allow our networks to continue with a strong innovation stimulus covering both large-scale transformational R&D projects, as well as smaller scale process or technological innovations that would not necessarily be funded under the BAU option. These smaller scale projects with lower TRLs do not tend to be projects that are quick to implement and as such are unlikely to deliver benefits within the limited horizon of a five year price control.

The ’development’ and ’disruptive’ funding would use the NIA mechanism to promote a collaborative approach between the networks and stakeholders, this would also prevent network companies commercialising ideas with no incentive to share their findings.

The table below highlights the options and the level of funding that we believe will be required for GD2 and further details are provided within the following sections.

Table 9: Proposals for GD2

Options	TRL Levels	Costs (£m p.a.)	Cumulative Total (£m p.a.)	Themes and Areas of Focus
BAU (Totex)	TRL 8	1.50	1.5	See below
Development (NIA)	TRL 4 to 7	1.45	2.95	
Disruptive (NIA)	TRL < 4	1.45	4.40	

An appropriate balance needs to be found between avoiding extra costs for customers and promoting the kinds of behaviour amongst companies that will result in the outcomes Ofgem desires. We will align to key stakeholder priorities and focus our strategy on the following key areas of innovation:

- Accelerating competitive energy opportunities
- Creating a low maintenance, smart, cost-efficient network
- Driving operational excellence through technology and innovation
- Transforming support processes and enabling functions
- Supporting Vulnerable Customers and keeping pace with customer and stakeholder expectations

These areas of focus will then transform into evaluation and development of work streams such as robotics, control systems, automation, Asset Digitalisation (Artificial Intelligence (AI) and Machine Learning (ML)), augmented reality and additive manufacturing.

Engagement levels with internal and external stakeholders will be enhanced to ensure that we are all aligned in the strategy, particularly with the drive toward embracing digitalisation and realising the benefits available for asset management as a result of emerging sensor technology, real-time data and analytical capability. This was addressed with the Energy Data Taskforce and we will work closely with our IT, Operations and Asset functions when developing new technologies.

Innovation net benefit analysis

Table 10 below provides the innovation project costs as at February 2019 together with the expected present value of benefits over the first five years of GD1, and the associated net benefit of that category of project.

This shows that for NIC projects the net benefit is significantly less than the costs incurred, which given the scale of the project and the longer-term transformation focus is expected. For NIA the net benefit is slightly positive for the opex project and negative for the repex benefits over the five years of the price control to date.

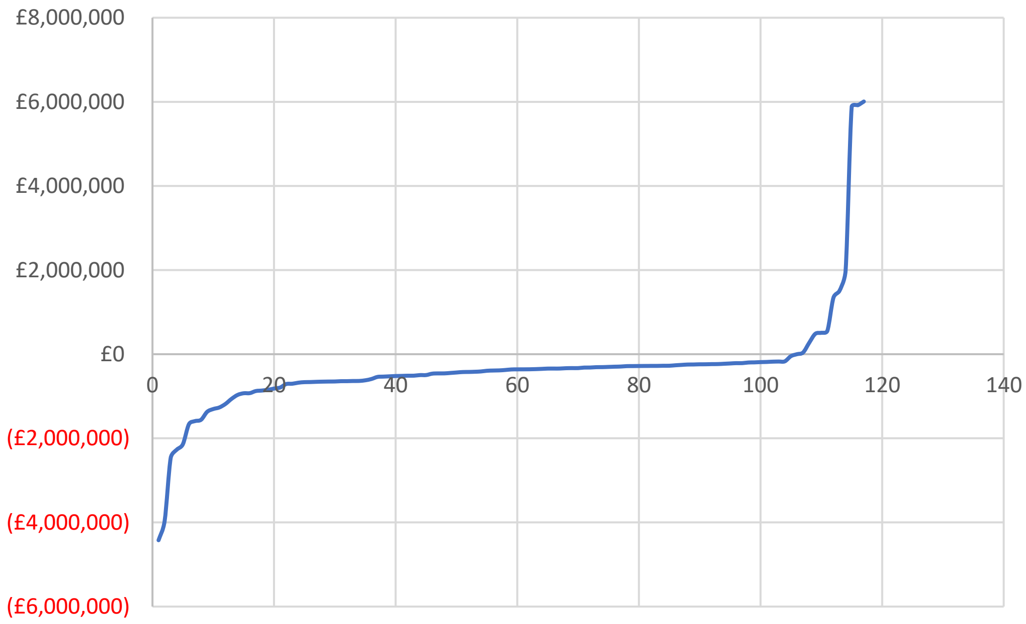
Table 10: Net benefits over 5 years of GD1

Funding	SGN Costs (£m)	5 year present value Benefits	Net Benefit (£m)
NIA	£ 39.1m	£ 33.0m	(£ 6.2m)
Opex	£ 31.1m	£ 32.9m	£ 1.9m
Repex	£ 8.1m	£ 0.0m	(£ 8.1m)
NIC	£ 39.7m	£ 3.2m	(£ 36.5m)
Opex	£ 32.3m	£ 3.2m	(£ 29.1m)
Repex	£ 7.4m	-	(£ 7.4m)
Grand Total	£ 78.8m	£ 36.1m	(£ 42.7m)

This gives a simple payback for NIA projects of five and a half years for opex projects and 12 years for repex projects. We have not been able to provide an equivalent assessment for the IFI projects as our records do not have the cost data captured appropriately for innovation project prior to the start of RIIO-GD1.

Figure 7 below presents the distribution of net benefits delivered by NIA innovation projects. This demonstrates that there is a very broad distribution of projects where the returns are determined by a couple of 'star' projects rather than projects as a whole showing a positive return.

Figure 11: Net benefits from innovation



The second observation is that this is post event analysis, it does not capture the perspective of the benefits envisioned when the original investment decision was made. As an example, the extent of the increase in lane rental charges were not fully forecast when the CISBOT project was initiated, similarly the social and planning benefits and broader process changes brought about by new techniques such as self-amalgamating tape would not have been fully recognised.

The final observation is that this benefit curve is a perspective at a point in time on the basis of a five year regulatory window, the innovation process and the adoption of innovation itself creates opportunities which may not be fully recognised in these figures.

6.1 Carrying forward benefits from GD1

Innovations that were originally developed under the IFI structure in GDPCR1 (the price control prior to GD1) have led to some of the benefits that have been delivered in GD1. In the same way, we anticipate that benefits associated with the innovation funding in GD1 will also lead through to realising benefits in GD2.

For the first year of GD1 we achieved a benefit of innovation of approximately £16.4m, which increased to nearly £35.6m by the end of GD1. Our analysis shows a spike in 2018/19 due to the timing of Tier 2 and 3 repex projects and the deployment of CISBOT during that period. As we move into GD2, the majority of the savings achieved during GD1 have been incorporated into the baseline at 2018/19 prices and as such are reset. The incremental savings are then run forward at approximately £1.5m per year. for GD2. This figure reflects the known projects that are expected to be implemented in the last few years of GD1 and our current forecast for both the expected benefit and date of implementation.

We have demonstrated that innovation stimulated through NIA and NIC has provided significant customer benefits through the course of GD1. These benefits would not have been realised in the absence of such funding support mechanisms. We believe that for GD2 it will be essential to have a discretionary mechanism similar to the NIA to support the development of projects linked to our themes and key areas of focus; but we need to recognise the impact that changes to the innovation stimulus could have on the type of project undertaken.

Within GD2 Ofgem have stated that they expect companies to transition more innovation to BAU and that this will be supported by additional incentive mechanisms to reflect risk/reward. The details for incentive mechanisms are still to be determined it is therefore not possible to fully calibrate their impact within our overall assessment.

6.2 Innovation for vulnerable customers in GD2

Our plans to support vulnerable customers within GD2 are set out in greater detail in the Customer and Vulnerability Plan appendix (023). This confirms that we welcome Ofgem’s additional focus on vulnerable customers in RIIO-GD2 and that our ambition, by the end of GD2, is to have helped 250,000 vulnerable customers to use energy safely, efficiently and affordably.

To ensure that we achieve this we are proposing to use the NIA mechanism to continue innovation for lower TRL projects, through our development and disruptive proposals (see below), to provide a conveyor belt of emerging ideas, concepts and innovations addressing our key themes. This will also allow us to fully embed bespoke solutions for vulnerable customers, obtained from our stakeholder panel consultations, through the development phases of innovation projects. Our innovations projects will require to demonstrate that consideration has been taken of the impact they may have on vulnerable customer and that any negative impacts have been mitigated through design development.

We will also continue engaging with research panels, such as SCOPE, the pan disability charity, within GD2 to help influence and tailor our innovations for vulnerable customers. Developing our learning from GD1 to ensure that when considering vulnerability, we consider the ‘barriers’ and ‘impact on wellbeing’ rather than the disability when developing innovation projects.

6.3 Business as usual innovation in GD2

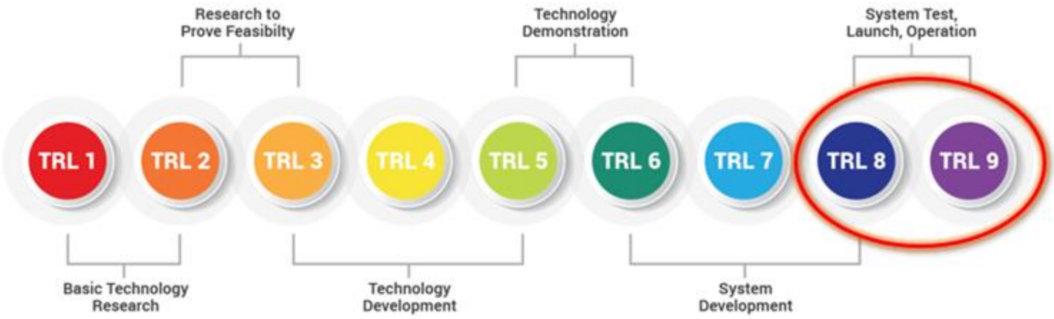
BAU innovation refers to projects that are at a late stage of commercial development, which could be successfully rolled out through the price control mechanism. We actively encourage adoption of new technology as an internal BAU process, and we are continually reviewing the market place for new products we think will deliver value to our current business processes.

The BAU model of innovation within a regulated company can only deliver incremental marginal improvements. It does not deliver the stated aim of ‘innovation’ as per the current NIA framework which supports development and disruptive innovation. Current NIA projects focus on a key business friction points whereby a solution is developed from initial R&D feasibility, through to an implemented commercial product. We already self-fund implementation of BAU projects through capex investment. However, these are direct outputs from off the shelf products or products developed from our internal suggestion scheme 'IGNITE'; they often don't solve the key friction points and are only a modification of existing tooling or equipment, all be it slightly enhanced. Benefits from this type of innovation tend, in the main, to be non-financial in nature, as they minimise safety or environmental risks.

In general, a price control does not allow for any risk recovery to support significant speculative investment. This is because the financial benefits of any innovation that is implemented within a price control period will be fully recovered by consumers during the next price control. As such any innovation that is going to be deployed under the BAU business model has to be fully assessed and deployed within that period. It must be able to realise sufficient commercial benefits during one price control period to make a return on the investment made during the assessment and the deployment stages.

As such, a BAU innovation model will effectively eliminate funding of lower TRL R&D type projects, focusing only on what is deliverable in the short term with rapid payback and even this will become more challenging as the price control period progresses. The move to a BAU innovation model will also impact on partnership arrangements and risk.

Figure 12: TRL 8 and 9 - ready for deployment



Under BAU innovation there is a potential for high TRL innovation (TRL level 8 and 9), that are specifically targeting operational efficiency, becoming BAU. This is based on our experience from GD1, where we implemented 17 NIA projects that had been bought up to TRL 8 ready for implementation. After this we then followed the BAU Implementation process, funded by us.

We will embrace a BAU model primarily focusing on directly implementing new products, processes and services from industry suppliers at the least cost. This introduces a commercial competitive edge to our innovation deliverables; which could lower the collaboration with other networks as a direct result. Our application of innovation in BAU will primarily be focused on network performance in comparison to the other networks to ensure our overall delivery performance remains high. Moreover, if the performance measure on innovation is aligned to this BAU framework, network collaboration will naturally be stifled as GDNs seek to ensure they retain a competitive commercial advantage, ensuring they meet defined targets. This approach is likely to be perceived as contrary to the top priorities from our stakeholders, whereby they expect that we will continue to innovate to drive efficiency and value across all networks for the consumer.

The selection process for BAU innovation projects will be directly aligned to what the market place has to offer, in comparison to NIA where we define the problem and then develop solutions to solve it. BAU innovation will restrict our ability to deliver direct innovative solutions. This change in focus in terms of BAU funding will also mean a new product is deployed only when it is commercially viable and has potential to deliver benefits which are achievable within a short price control period.

Demonstrable examples for this can be seen from our current NIA portfolio which shows the levels of indicative funding required to deliver a project under a BAU from a TRL 7 to TRL 8 and drive the subsequent efficiency savings in our opex and repex processes.

Table 11: GD1 innovation TRL 7 start

GD1 BAU Innovation				
Project Name	**NIA Budget**	**TRL Start**	**TRL Fin**	**Benefit (p.a.)**
Microstop (Implementation Ongoing)	£370,000	TRL 7	TRL 8	£2,790,000
Osprey Pressure Validator	£51,568	TRL 7	TRL 8	£171,976
Immersion Tube Preheating	£882,359	TRL 7	TRL 8	£47,567
Tornado Max	£21,798	TRL 7	TRL 8	£8,000
Total	**£1,325,725**			**£3,017,543**

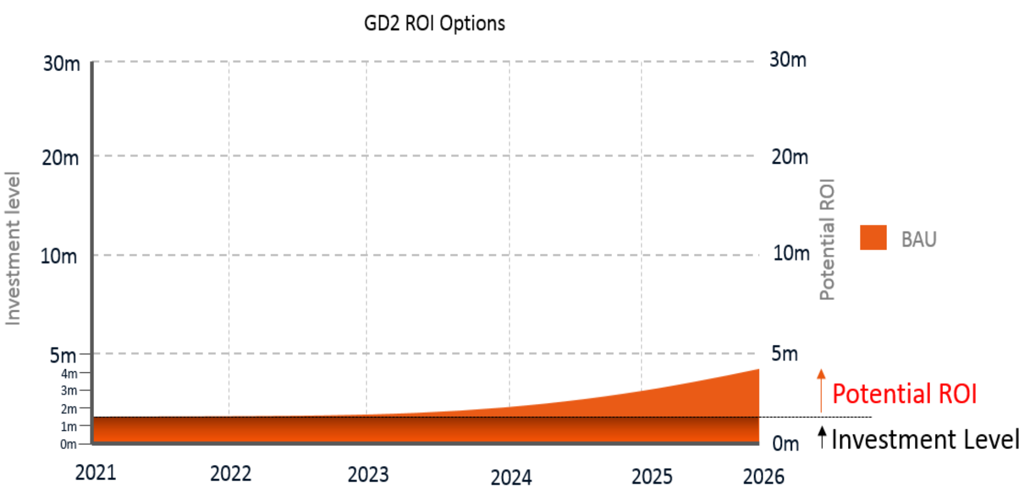
It is worth noting the variation in returns compared to original NIA budget. Some projects, such as Mircostop, are a close to commercially available product that addresses a key business problem e.g. when renewing gas pipes within multi-occupancy, high-rise buildings which can be an expensive safety reactive process and has a clear financial benefit associated with it.

When this is removed from the high TRL projects listed, the return on investment is significantly lower; and two of the three remaining projects were delivered at a net loss. Some of the projects noted above, such as Immersion tube preheating required a number of phases of NIA development in order to climb the TRL scale to 7, as such would not be considered as suitable for BAU implementation.

The projects above still required NIA funding to commercially develop a solution, but under a 'BAU model' the technical and financial burdens will sit with the suppliers to finalise any market solution. Upon completion of TRL 8 NIA projects, we fund an implementation phased rollout for each project when fully viable.

Under BAU innovation funding, where we are able to identify innovations that provide a clear solution to a defined business problem, then they will be funded by us according to the level of confidence in the ability to derive a financial payback during the GD2 period. Adopting this approach and focusing all efforts to roll-out BAU aligned projects would likely require total indicative funding levels of £1.5m per annum. For this level of expenditure we would envisage a limited potential financial benefit through the price control period.

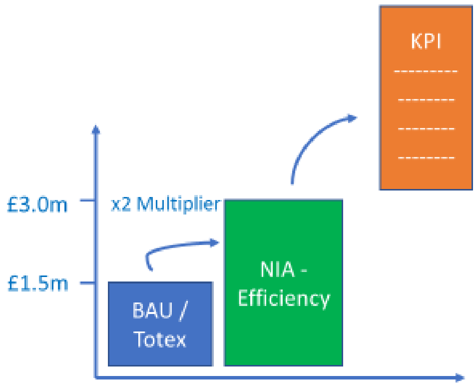
Figure 13: Potential for BAU innovation



The ability of most projects to progress within a BAU mechanism will be determined according to the confidence in whether they can be deployed into daily activities, the amount of training and monitoring required to support that deployment and the changes required to established practices in order to secure a payback in the remaining period of the price control. If an innovation requires a more complex change in process, then it will be less likely to be deployed.

Our proposal for funding the development and disruptive innovation in GD2 (see below) would be based on a multiplier of two times that of our own committed spend on BAU innovation i.e. if we commit to spend £1.5m on BAU innovation then we would propose that we would be able to fund £3.0m of development and disruptive innovation projects per annum. Stakeholder evidence suggests there is support for SGN providing a contribution towards early TRL innovation, we are therefore proposing a voluntary contribution of 10% towards the costs of these early stage projects (with a TRL <7).

Figure 14: Innovation multiplier



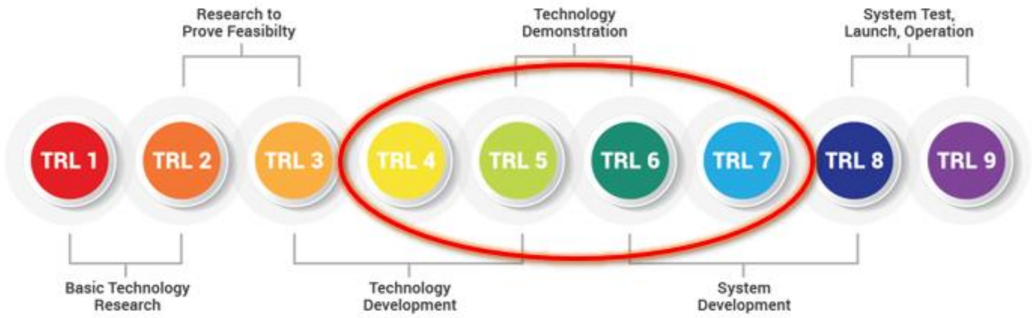
This approach would enhance the BAU innovation process as well as reward innovative behaviours and culture. This would ensure that we would continue to innovate to drive efficiency and value within the network for all consumers, especially vulnerable customers, which is a top priority from our stakeholders, as well as continue to collaborate with other networks and our strong ecosystem of SMEs.

6.4 Medium TRL / development innovation in GD2

We recognise the benefit that appropriate innovation can bring to all consumers, especially vulnerable consumers, by reducing costs, minimising environmental impact and creating a steady stream of emerging ideas, concepts and innovations both internally and from the SME market. To do this we would need a funding mechanism that supports those projects that are currently between TRL 4 and TRL 7 to feed the BAU innovation model.

We propose to seek additional funding through the GD2 NIA mechanism to be included in our allowance base that would be used to continue innovation of lower TRL projects and the engagement with SMEs to enhance the number of products that have the potential to be developed.

Figure 15: TRL 4 to 7 – development innovation



As demonstrated below, developing projects from a lower TRL level up to TRL 8 has had real benefits in terms of providing a tailored solution to a friction point within GD1. This development process adds value for our customers if targeted across the correct areas and linked to the key themes of our Network strategy.

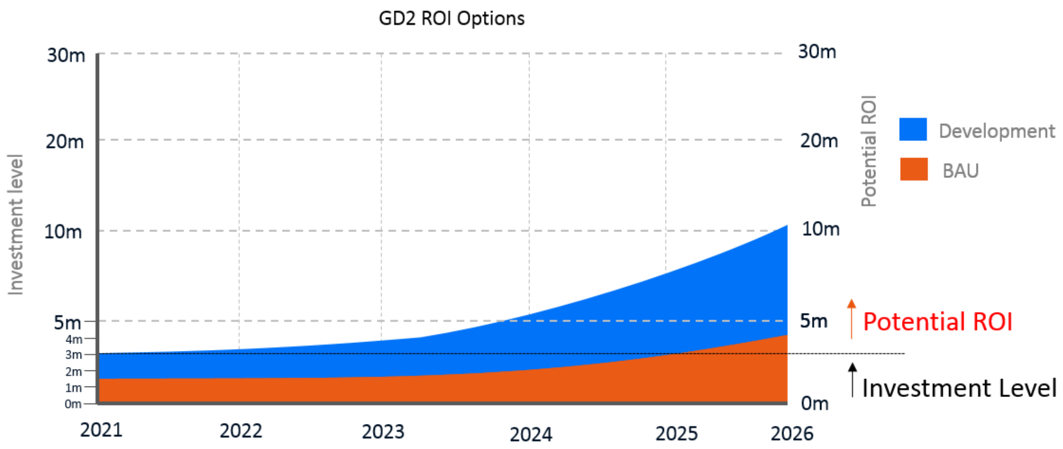
Table 12: GD1 projects (development)

GD1 BAU Innovation				
Project Name	**NIA Budget**	**TRL Start**	**TRL Fin**	**Benefit (p.a.)**
Water Extraction Reel & Y Branch	£ 100,480	TRL 3	TRL 8	£ 38,000
Small Pressure Pot / Anaerobic Pressure Guns	£ 6,986	TRL 4	TRL 8	£ 675,000
Advanced Mini Bag Kit	£ 90,250	TRL 4	TRL 8	£ 486,000
Long handled PE Top Tee Cutter	£ 19,547	TRL 4	TRL 8	£ 105,000
Magnetic Filtration in Medium to LP Networks	£ 80,433	TRL 4	TRL 8	£ 23,938
Self-Amalgamating Tape (Stage 2)	£ 27,990	TRL 4	TRL 8	£ 1,900,000
40mm Serviflex	£ 30,254	TRL 4	TRL 8	£ 7,500
RCA GPS Survey (MGDC - GeoField)	£ 477,240	TRL 3	TRL 8	£ 1,520,000
Total	**£ 833,180**			**£ 4,755,8438**

Adopting this approach and focusing all efforts on developing innovations to BAU aligned projects, the total indicative funding levels for these types of projects would likely be £1.45m per annum. With such a mechanism, we would envisage a potential financial benefit to cost ratio of 3:1 once the innovation is implemented and if it is successful. This funding would also support innovation projects for vulnerable customers and our ambition to target support for over 250,000 such customers over GD2.

This would ensure a steady stream of emerging ideas, concepts and innovations addressing our key themes are developed that would normally be discounted from the BAU innovation approach. For vulnerable customers we would specifically look for projects that would address information and process weaknesses as details in section 4.4 above.

Figure 16: Potential for development innovation



We would also expect that the engagement with SMEs would be maintained at current levels whereby 79% of all current NIA spend goes directly to SMEs with the remainder allocated to safety and engineering technical assurance, testing and validation services. Adopting this development to BAU approach, would supply the proposed BAU framework with a steady stream of ideas and innovations. Without this, there is a potential that the commercially available products and services are depleted quickly.

6.5 Low TRL / disruptive innovation in GD2

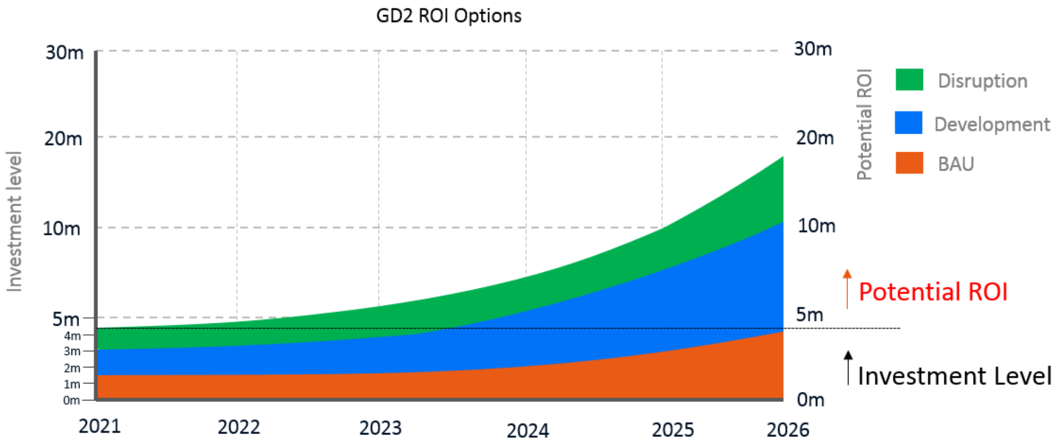
As can be seen from the table below, one of our most successful innovation projects has been the introduction of CISBOT into the gas networks. This project was developed initially from TRL 4 and supported by NIA funding up until TRL 8 was achieved. This introduction was verging on disruptive as can be seen by the investment required and the actual benefits realised to date. CISBOT has also now been introduced by Cadent Gas, which should in turn bring more significant savings to its network and consumers. This also highlights the benefits of retaining the funding allowance, as any outputs from one GDNs project are shared with all other networks. The new reporting framework developed by the EIC and Baringa, for all networks, will provide a transparent mechanism to demonstrate the value gained through sharing and collaborating.

Table 13: GD1 disruptive innovation

GD1 BAU Innovation				
Project Name	NIA Budget	TRL Start	TRL Fin	Benefit (p.a.)
Large CISBOT (Cast Iron Joint Sealing Robot)	£ 834,600	TRL 4	TRL 8	£ 2,709,000
Total	**£ 834,600**			**£ 2,709,000**

The total indicative funding levels for these types of projects would be in the region of £1.45m per annum and we would envisage significant financial benefits to the consumer through the price control.

Figure 17: Potential for disruptive innovation



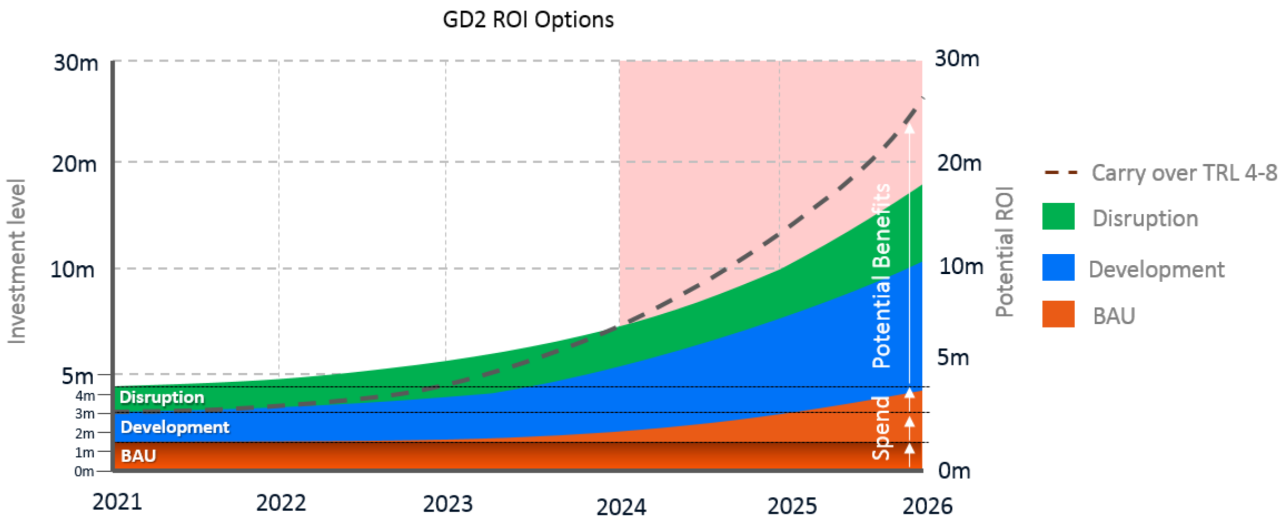
We have been a leader during GD1 period for disruptive innovation and have continued to challenge convention, from Gas Safety (Management) Regulations (GS(M)R) specified gas through to robotics. Without research and development (low TRL) projects, our ability to deliver projects specifically tailored to meet the needs of vulnerable customers and for BAU implementation will be significant hindered. Projects that start with a low TRL can through development deliver benefits for consumers, but these will only be realised when they are commercially ready to deploy. Due to the short duration of the 5 year price control period this is more likely to be within GD3 or later.

6.6 Transitioning to GD2

In comparison to the current NIA framework the benefits delivered by realigning to the BAU innovation model will restrict our ability to deliver on our ambition. We do recognise that the payback five year period for a return on investment will be a key indicator of success, which will introduce an additional element of risk which GDNs need to manage for BAU implemented projects. As such, this will likely restrict the scope of any BAU projects to a minimum of TRL 8 only, potentially limiting the value of any new products or service introduced.

During GD1, no projects with a status level of TRL 8 were initiated as this was disallowed under the NIA governance requirements. However, our investment in developing projects was £ 3.80m, which is anticipated to deliver a financial value (return) of some £25m. Carry over four to eight TRL projects from GD1 in to GD2 have the potential to deliver benefits to a similar level, but this will not be realised if funding to support full commercial development is not available.

Figure 18: Potential for GD2 with transition projects



As shown in previous sections, focusing on TRL 8 projects will significantly reduce the financial return available and have a direct impact on savings ultimately delivered to consumers. There will also be other disadvantages through less engagement with SMEs and less collaboration with the other GDNs.

We believe a BAU only innovation model will not address vulnerable consumer issues, support the energy transition, or tackle the general industry inefficiency and process friction points, as these need a tailored approach which BAU will not deliver. We understand innovation in BAU may offer an efficiency 'quick fix' by introducing new products, processes and services quicker in to the business as no development work will be required. However, this 'off the shelf innovation' offers limited scope for improvement as the benefits are potentially marginal. Assessing innovation in BAU becomes an assessment of the cost of implementation (including purchase, training, roll-out & maintenance) against return on investment. As BAU products are generally product version changes its unlikely to provide any real value in terms of opex or repex savings, limiting any potentially benefits to the customer in monetary terms.

The funding mechanisms available in GD1 have provided SMEs, who play a vital role, with a clear route to market in order to develop and roll-out new technologies. However, under a BAU only model these opportunities for development and deployment are likely to be lessened, with only suppliers and manufactures providing the networks with 'enhanced' versions of standard products.

7 Assurance

Our business plan, including appendices, has been subject to a rigorous assurance process which is detailed in Chapter 3 of the Plan and the Board Assurance Statement.

Our Director of IT was appointed as the Sponsor for the Innovation appendix and associated Business Plan Data Templates (BPDTs); which have been through the following levels of review and assurance:

First Line

This was undertaken at project level by the team producing the document, as a regular self-check or peer review.

Second Line

This was undertaken independently within the organisation to review and feedback on product development, including a workshop on innovation. Both Senior Manager and Director sign-off was obtained.

Our RIIO-GD2 Executive Committee: (1) considered the appropriateness of assurance activity for the appendix and (2) provided assurance to SGN's Board that the Business Plan meets Ofgem's assurance requirements.

Third Line

This was undertaken by external advisors and groups providing critical challenge during the development of products within the Business Plan. Feedback and challenge were provided by the Customer Engagement Group (CEG) and Customer Challenge Group (CCG).

Fourth Line

This was undertaken by independent and impartial external providers, who provided a detailed and comprehensive report to both the Executive Committee and Board of Directors:

Advisor / Group	Contribution
Ove Arup and Partners	Review of Innovation appendix against Ofgem's assurance requirements.
PwC	Business Plan Data Template review for Opex Cost Matrix: Non-Controllable Activity Costs

8 Glossary

All acronyms and associated descriptions can be found within the Glossary appendix (000).

9 Lead innovation annex

a. SynthoScope camera (live mains insertion)

IFI Funded Project

The SynthoScope camera system is a pipeline inspection solution that minimises excavation by maximising survey distance. The system is designed to UK gas industry standards for use up to 2 barg operating pressure, and up to 4 barg for international applications. Modular components enable a range of applications and entry/exit from the main is achieved using under pressure equipment that enables the camera to be launched and retrieved under controlled 'live' gas conditions, without the need to isolate or interrupt the gas supply.

Key benefits include:

- An upfront decision making 'no dig' tool.
- Significant improvement in the rate of pipe replacement.
- Faster diagnosis of in-pipe obstructions, water ingress, poor pressure conditions and gas leakage to assist in repair and emergency.
- Precise location of joints, defects and interference.
- No interruption of supply for increased customer satisfaction.

Development of the SynthoScope camera and its application to the live mains insertion process has allowed better planning and increased the effectiveness of the 'live' gas mains replacement technique. Better pre-operation planning ensures that obstacles and fittings in the carrier pipe are avoided or removed and do not disrupt operations. Maximising the use of this innovation allowed us to minimise the number of excavations required and reduce the overall disruption to both customers and road users whilst delivering efficient mains replacement projects.

b. Large CISBOT (cast iron joint sealing robot)

NIA_SGN0019 http://www.smarternetworks.org/project/nia_sgn0019

From the inception of the gas industry cast iron mains were laid as the most appropriate carrier pipe for distributing gas. At the joints of these mains yarn was packed into the cup before a lead seal was applied. This sealing method was effective at sealing these joints as the moisture content within towns gas swelled the yarn. Natural Gas from the North Sea is dryer and does not provide the moisture necessary to swell the yarn in the joints of these mains, other methods are therefore required. ULC Robotics developed a cast iron joint sealing robot known as Large CISBOT. This advanced robotic technology can remediate cast iron pipe by internally injecting all the joints in a given area with an anaerobic sealant. This project carried out a detailed technical assessment and field trial of the joint sealing robot CISBOT, which has proven to repair or rehabilitate cast iron joints under live conditions.

This project ultimately delivered an innovative solution for the remediate of leaking lead yarn joints within our cast iron mains population and is now a critical part of our mains risk management strategy. The project evaluated the effectiveness of the remediation technique and associated inspection method. The project was deemed to be very successful and will provide benefits across the gas industry. This would not have been possible without the technical and practical assessment of CISBOTs performance when repairing large diameters mains using the trenchless technique.

CISBOTs pioneering technology minimises disruption to the general public as there is no need for multiple excavations in the road. The system is being used on larger mains in inner city locations and it also dramatically reduces the distribution company's carbon footprint.

- By the end of GD1, CISBOT robots will have travelled over 60km.
- We aim to continue to use the CISBOT robot as part of our embedded innovation (i.e. business as usual) to remediate Tier 3 pipes as this proved to be a successful technique in reducing the risk of our Tier 3 Iron pipes in GD1.

We have used this innovation on most of our high failure Tier 3 mains through the course of GD1, reducing the amount of gas in buildings and leakage across the network. Going forward into GD2, therefore, there will only be the need for 1 robot to achieve a safe and reliable network. There will always be a Tier 3 main deteriorating to the point of needing the use CISBOT. However, as we targeted this through GD1 the population of un-remediated mains is not as vast as when CISBOT was first introduced.

c. ServiFlex service relay initiative

IFI Funded Project

We have carried out repex operations throughout GD1 to replace the ageing metallic low-pressure gas network and the associated service pipes. The relaying of a domestic service can be carried out using a number of methods, the first part of this project (started under IFI) focuses on extending the use of 20mm ServiFlex for the replacement of ¾" steel service pipes.

A programme of development was put in place to investigate the capabilities of the ServiFlex pipe. The programme trialled the product but also provided field knowledge that led to modifications that allowed more effective installation. The scope of this project to allow for service insertions with 20mm ServiFlex from the customers meter position back towards the main.

The objectives of the project were to:

- Reduce the interruption time for customers requiring a service relay.
- Reduce the cost of relaying a service ultimately providing better value to the customer.
- Reduce and where possible eliminate the amount of excavation and reinstatement.
- The successful development of the ServiFlex system provides positive environmental benefits with a reduction in the number of excavations required, the time taken and the impact on the customer.

d. Customer self-isolation and restoration

NIA_SGN0026 http://www.smarternetworks.org/project/nia_sgn0026

When a gas supply failure occurs, it is necessary to isolate every customer at the meter before the network can be recommissioned. This project developed a process whereby rather than engineers visiting each property then customers were empowered to carry out the isolation and restoration of their own supply. The principal reason for supporting this project was to reduce the duration of a gas outage / incident. This would reduce the cost of the incident and minimise its impact on consumers. It is estimated that adopting this approach could reduce the duration of an incident by approximately 70%.

e. 40mm Serviflex

NIA_SGN0061	http://www.smarternetworks.org/project/nia_sgn0061

Similar to the ServiFlex system discussed above, this type of polyethylene pipe is large and was specifically developed for use in replacing 11/4" steel services with a corrugated dual wall liner that when used with specialist installation equipment can negotiate tight radius bends without compromise to the design life of the material. Development of the 40mm ServiFlex polyethylene pipe system allows the below ground section of a large 50mm steel (ST) service / service riser to be replaced. Maximising the use of this technique has allowed us to minimise the number of excavations required and reduce the disruption to customers and road users.

When combined with the Microstop fitting (discussed below) this also allows the live supply to be maintained to the above ground section of a service riser while the below ground section is replaced.

f. Self-amalgamating tape (stage 2)

NIA_SGN0030	http://www.smarternetworks.org/project/nia_sgn0030

A simple innovation project that allows a repair on small joint leaks on our riser network. It provides a quick and simpler method than current repair equipment that tends to be rather bulky. Time is reduced compared to conventual repair techniques and reduces the requirement for cutting off / disconnecting risers that leads to customer disruption and loss of supply.



The tape also provided a more complete solution that allowed greater time between temporary and permanent repair activities. This provided the business with greater opportunities to more efficiently manage resources for the permanent repair, essentially allowing unplanned escape work to be proactively planned and managed.

g. Advanced minibag

NIA_SGN0088	http://www.smarternetworks.org/project/nia_sgn0088

This project enhanced a previous project to use the Mini-Bag Tool as a method to exchange meter service Emergency Control Valves (ECV). The additional development of the Advanced Mini Bag Kit facilitates the exchange of ECVs, located in semi concealed meter boxes where the ECV is a 90° type.

This equipment enables the replacement of the faulty ECV under live gas conditions, eliminating the need for any excavation to be carried out. As this tool can be used by a trained First Call Operative (FCO) (one person operation) it eliminates the need for sending two people.. The replacement process fully eliminates the need to excavate and physically isolate the gas service.

The Advanced Mini Bag kit is 'user friendly', lightweight and a 'no blow' solution for semi-concealed and historic ECVs.

h. Microstop

NIA_SGN0018	http://www.smarternetworks.org/project/nia_sgn0018

Pipe Tech Ltd provided the Microstop system that facilitates flow stopping operations to be undertaken on small diameter network risers and laterals in multiple occupancy dwellings. This had not been possible before and flow stopping operations were limited to larger diameter mains or polyethylene pipe using a squeeze-off technique.

The key advantages of the Microstop system are:

- Reduction in customer interruption
- Improved speed of operation
- Resolves aesthetic issues with other live transfer techniques
- Full bore bypass system, supporting replacement of the below ground riser section through insertion of carrier pipe
- Supports development of new PE materials, such as 40mm PE Serviflex (see above)

The Microstop system has proven itself to be an ideal tool that supports the partial replacement of network risers (below ground) where the above ground section of pipework is found to be in satisfactory condition. Through its use we have been able to significantly improve the customer experience by reducing disruption and the time customers are without a gas supply.

i. Predictive analytics

IFI Funded Project

We were faced with a challenge from Ofgem regarding Gas in Buildings (GIBs) and failures; to find trends in weather-based impact. We delivered an outcome that no other networks have achieved, to establish the link between cold weather events and what happens on the network between GIBs and failures.

We have commissioned a new piece of work that will refresh those rates in history. We used hypercube (an innovative solution) which validated how we manage risk. Hypercube was able to highlight the mains we should be working on and this confirmed the strategy to which we already work.

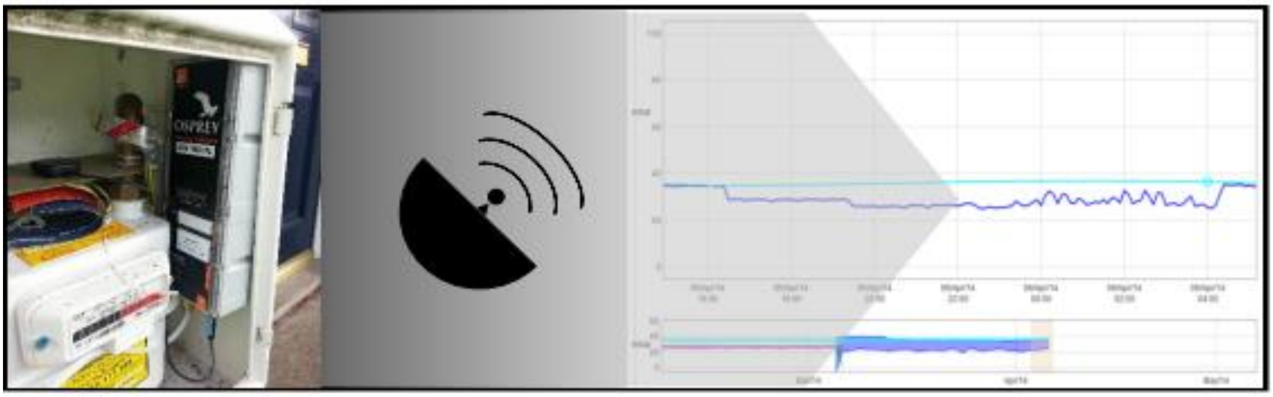
j. Osprey pressure validator

NIA_SGN0021 http://www.smarternetworks.org/project/nia_sgn0021

Network validation based on a comprehensive knowledge of pressures across our networks is fundamental to all our reinforcement, replacement and pressure management design and asset investment. Historically, accurate validation has been recorded through data loggers, located at key locations across our distribution networks with our engineers visiting these sites regularly to download pressure data.

The Abriox Osprey Pressure Validator is an intrinsically safe, battery powered remote monitoring unit that can be installed in bollards, posts and meter boxes to monitor gas pressures up to 100mbarg. It transmits data automatically or on-demand to a pressure management website for displaying, interpreting and archiving the results and for export into network validation software and other business systems. The equipment sends location information via Global Positioning System (GPS) and pressure data via General Packet Radio Services (GPRS) to the PressureTrac™ web database.

Field trials of the Abriox Osprey Pressure Validator were carried out across Southern and Scotland local distribution zones (LDZs) low pressure (LP) networks during the winter period of 2013/14 to evaluate the overall suitability of the unit for our data logging needs. The key driver for this project was to exploit new technology being made available at a juncture where current stocks of loggers are requiring either expensive battery replacement or full unit replacement.



During the course of the trial, a key benefit which came to light was in the investigation of any poor system pressures and the immediacy with which results were made available to our Network Planning teams. These loggers avoid the need for repeat site visits to download results and the ability to remotely monitor system pressures within a few minutes of fitting. This ultimately resulted in benefits to the consumer in being able to establish the root cause of any issue at an early stage and thereafter identification of any enduring solution in a timely manner.

k. Smart paint

NIA_SGN0067	http://www.smarternetworks.org/project/nia_sgn0067

We have many above ground assets that require on-going surface maintenance with paint or other coating systems to protect them from the elements and prevent corrosion. New coating systems come onto the market all the time and we need to assess their suitability for use on our network. No two paint/coating manufacturers work to the same performance standards and this create a problem, we therefore needed to initially set up our own.

We started a 12-month test programme in 2016, trialling selected coatings on a variety of pipe surfaces above and below ground before carrying out accelerated corrosion and abrasion testing in a laboratory. The final report in will enable us to select the most suitable products for our network.

l. Opening up the gas market

NIC_SGNGN02	https://www.sgn.co.uk/Oban/Innovation-Oban-Project-Documents/

In GB, over 80% of peak energy demand is supplied by the gas network It therefore has a very significant role to play in meeting energy needs and the journey to a lower carbon future. Key to this is a flexible distribution network that can adapt to the evolving needs of the GB energy system. The 'Opening up the Gas Market' project was designed to test system flexibility, by challenging the legislative requirements for gas quality.

Fig. 5 Oban

GB is now a net importer of gas, with prices and access to supply increasingly depending on international markets. Hence, GB gas prices exhibit volatility, given the short-term and/or spot market conditions.

Whilst there are many compositional factors that influence combustion, the Wobbe Index (WI) is arguably the most important parameter in regard to natural gas. The WI is a measure of the amount of energy delivered to a burner. All gas-fired equipment is designed to operate within a particular range of WI. If gases outside this range are combusted, this can lead to a range of problems from poor quality combustion through to equipment damage and ultimately dangerous situations. Too high or too low a WI can cause greater emissions of carbon monoxide through incomplete combustion, as well many other undesirable flame effects.

The Gas Safety (Management) Regulation 1996 (GS(M)R) established an acceptable WI range following test work on appliances carried out in the 1980s. Appliance technology has however developed significantly since then. This coupled with rising import demand and declining indigenous supply led to the inception of this project with the aim of redefining safe WI limits for GB that accommodates the more abundant gas sources.

The ‘Opening up the Gas Market’ project therefore sought to demonstrate that gas, which meets the European Association for the Streamlining of Energy Exchange (EASEE) Gas specification but sits outside of the characteristics specified within GS(M)R can be distributed and utilised safely and efficiently in GB.

Throughout the one-year trial, the Oban network operated safely without incident, demonstrating that a higher WI gas can be injected, distributed and utilised safely. Based on the project findings, it was confirmed that a change to the WI limits with GS(M)R is achievable for GB with considerable cost benefit. The learning from this project should be disseminated through the IGEM Gas Quality Standard Working group in support of the changes to GS(M)R.

m. Core & vacuum excavator (‘Core and Vac’)

IFI Funded Project

The aim of this projects aim was to develop new techniques, products and methods that reduce or eliminate the requirement for: excavation; significant operational foot print; multi-stage reinstatement; complex traffic management; and disruption to our customers, while maintaining safety and efficiency.

In 2012 we pioneered the first combined core and vacuum excavation (core & vac) vehicle and end to end process for repairing our assets. We also gained the first agreements with local authorities for the use of keyhole reinstatement methods in Glasgow and London.

Excavating and reinstatement is an inconvenience to our customers and is also a high cost to our business.

Traditional methods typically consist of hand or mechanical, full size or mini excavators used to carry out excavation (shown below). Most commonly, the team will complete the repair work and leave the excavation guarded for the contractor to undertake the whole backfill and reinstatement process and remove the barriers.

The core & vac technique (shown below) involves two main operations: the coring operation to cut and open the top surface of the carriageway; and the vacuum operation to remove the sub base and expose the gas main. This is followed by reinstatement using the core & vac equipment.

With this system, an operation that would normally take 3-5 days can be carried out in a matter of hours. Apart from the obvious time and cost savings, additional benefits include reduced width of road closure, less delay to road users, the road can be reopened in a shorter time if circumstances change, reduced material costs and a higher quality of reinstatement.

We are widening the capability of core and vac through several projects and investing in ambitious new technology including robotics to aid in minimising the size of streetworks activities. Some of the follow-on projects include:

- Core Drill Flow Stop – this project looks to develop equipment to allow both core drilling and flow stop operations to be carried out without the need for large excavation. This project aims to reduce the impact on our customers, the environmental issues and the associated costs.
- Olympic Rings – There are occasions, however, when a single (600mm diameter) core hole may be insufficient to access a pipe failure and/ or carry out the repair and requires a 'multiple overlapping core' approach (multiple hole).
- iCore – With iCore, we have developed in partnership with TRACTO-TECHNIK tools and equipment to significantly extend the range of distribution network operations that can be undertaken in keyhole excavations. This project concentrated on network improvements including insertion of PE in iron mains, trenchless insertion of PE services, and making service connections to facilitate our significant mains replacement programme.

n. RCA GPS survey (Geofield)

NIC_SGN0024	http://www.smarternetworks.org/project/nia_sgn0024

A large part of our business is based on replacing or laying new mains and associated infrastructure. As such, there is a constant stream of asset and project related data going out and coming back from field locations where this work is taking place. At present we rely on paper-based processes for communicating this information and updating our asset register. The project brings together new mobile devices, GPS data capture hardware and new software (Sigma 7's Geo-Field) which together will resolve issues in the way we capture and process mains and asset information (particularly Geographic Information System (GIS) orientated information) from the field.

Benefits include:

- Reliable and consistent communication from a live working environment
- Ease and speed of use in the field
- Time-stamped, location specific data using GPS
- Reduced timescales for projects
- Improved asset data handling through automation

o. Advanced gas detection

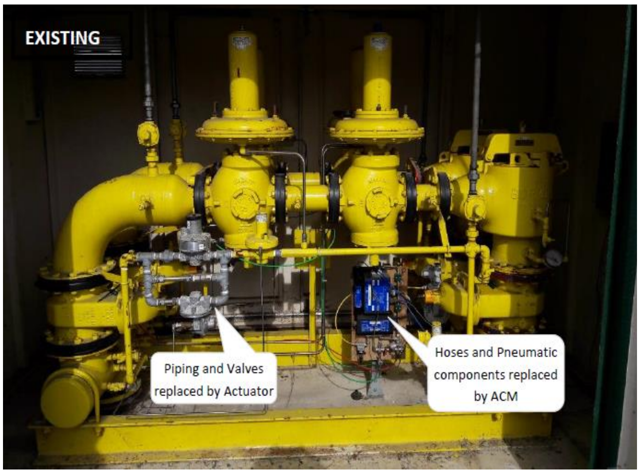
NIA_SGN0064	http://www.smarternetworks.org/project/nia_sgn0064

This project seeks to revolutionise the way we capture and record gas escape readings and eliminate paperwork and electronic forms. The objectives of the project are to produce a portable gas detection device to detect methane and carbon monoxide gases and determine if readings detected on site are from a natural gas leak. These readings are then automatically linking to geospatial positions as a digital record of work.

This aims to advance our gas detection equipment and escape management through an automated approach. This project builds and extends the work of a previous NIA project for remote gas leak detection. (NIA_SGN0017 – Portable 'Gas in Ducts')

p. Remote pressure control and management

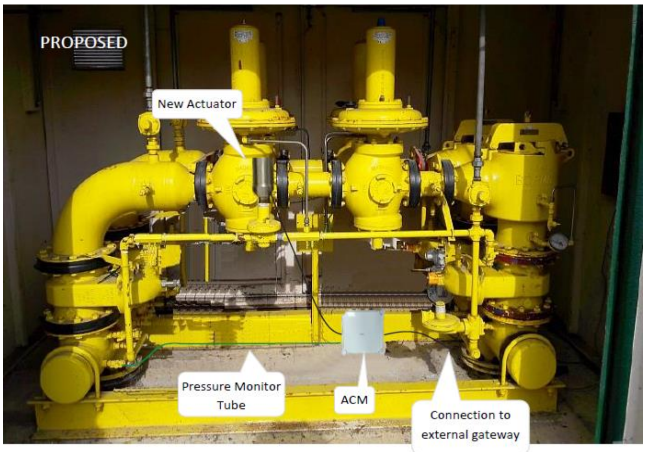
NIA_SGN0122 **http://www.smarternetworks.org/project/nia_sgn0122**



The project is delivering the ability to remotely adjust gas pressures via connected pressure management devices. We currently rely on several pressure control systems to manage our distribution networks; however, some of this existing technology is becoming outdated and while considering a solution to this problem we became aware of a new engineering design company called Utonomy. The concept involves the fitting of an 'Electronic Actuator' to the regulator pilot which will ultimately be able to remotely control/adjust the governor setting in 'real time', thus dispensing with the need to attend site to manually adjust settings.

The Utonomy concept involves the fitting of an 'Electronic Actuator' to the regulator pilot which will ultimately be able to remotely control/adjust the governor setting in 'real time', thus dispensing with the need to attend site to manually adjust settings.

The implications for implementing this technology could be far reaching in terms of benefits. When we prove compliance via this NIA project for using the 'remote control' actuator, not only will we be able to demonstrate foregoing the need to be concerned with physically attending site to adjust pressures, thus freeing up significant manpower, but we will also be afforded with the means to adjust pressures at any given time, thereby enabling our Network Managers to readily manipulate Network pressures as necessary, in order to achieve network optimisation.



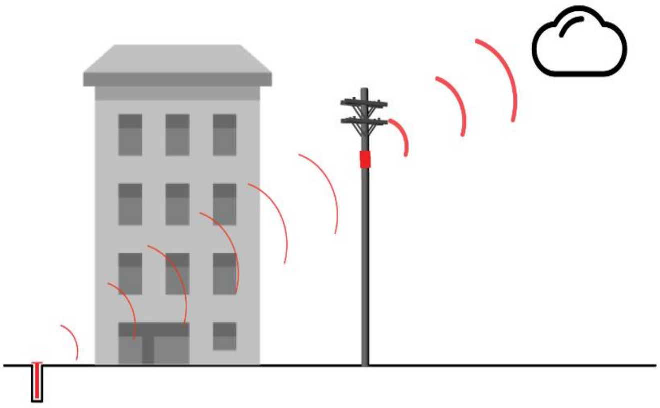
q. Serviforge

IFI Funded Project

Serviforge is a system whereby leaking threaded joints in a gas network riser may be repaired through "fogging" with anaerobic sealants. This enables multiple leaks to be sealed simultaneously without the need to tap into any joints.

r. Remote site monitoring

NIA_SGN0110 **http://www.smarternetworks.org/project/nia_sgn0110**



GDNs have 'at risk' mains that are not leaking but require frequent monitoring as a risk management measure prior to direct replacement being carried out. We also have sites where work is being carried out but remain live and require periodic checking.

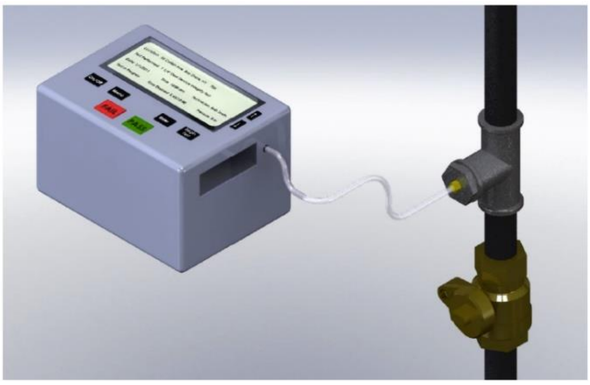
Monitoring of these scenarios require personnel to be on site, as frequently as necessary, to take the gas measurements and subsequently report findings. On occasion, this demands resource to travel to known locations to perform a very quick survey. However, depending on location (e.g. London) the entire operation can take several hours.

This project will look at alternatives to human resources, and will develop a battery powered remote monitor that, when installed, will allow gas readings from an existing job to be automatically transmitted direct to the Cloud. This will allow readings to be monitored remotely, more frequently and automatically escalate activities as necessary.

s. Automated pressure tester

NIA_SGN0079 **http://www.smarternetworks.org/project/nia_sgn0079**

This device aims to help ensure the accuracy and consistency of the testing of gas pressures and data recording process while removing the potential for human error and providing the opportunity to automatically update our asset records via a suitable cloud-based service.



The successful development of this device has the potential to reduce costs and improve accuracy, efficiency and compliance in relation to the pressure testing of mains, services and risers.

t. Real time networks

NIC_ SGNGN03 **http://www.smarternetworks.org/project/sgngn03**

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.

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. For this, we are gathering real-time data which feeds into our newly developed Cloud Data-Solution to facilitate real-time modelling, analysis and advanced forecasting.

10 Innovation within reporting categories annex

Implemented innovation projects

This section allocates the lead innovations identified within section 9 above to a number of business plan cost categories. As each innovation has several business benefits which can be classified as financial, (direct savings and/or costs avoided) and non-financial (health, safety, customer and environmental) this section highlights our view of the benefits delivered. We also highlight the supporting innovations that are contributing to each category. It should be highlighted that there is significant cross over between costs categories for these supporting innovations.

a. Repex – replacement of mains (tier 1, <= 8" diameter)

Category	Repex – Replacement of Mains – Trenchless Technology
Task:	Replacement of Mains / Streetworks
Task definition:	To remove the risk of deteriorating small diameter Tier 1 (≤8" cast iron) mains requires replacement of these pipes, as mandated by the HSE. There are various methods available to enable this replacement, the operation selected will depend on the design diameter of the new main. For mains where the replacement diameter is smaller than the original main then mains insertion techniques can be used. All replacement methods involve highway excavation and reinstatement work which is a major cost driver within the repex programme.
Problem:	Pipe Risk Management / reducing the Scale of Excavations
Problem Definition:	Tier 1 mains are predominantly found in residential locations. Any work carried out on such pipes results in considerable disruption to our customers and road users, as multiple excavations are often needed to complete a replacement project. Where it is possible to reduce the size of the replacement main by insertion techniques. The most efficient technique is live insertion as this minimises both excavation sizes and customer disruption. However, unidentified features, fittings or blockages within mains can stop or limit the effectiveness of insertion projects. Designers use ideal insertion mains diameter size which could be achieved without any real-world information to validate this decision. This assumption can lead to reactive solutions being used as the unknown internal pipe features can create operational difficulties resulting in more time, disruption and potentially larger excavations on site.
Solution:	Minimising Excavation Frequency and Size
Solution Description:	Development of the Synthotech camera and its application to the live mains insertion process has allowed better planning and increased the effectiveness of this replacement technique. Better pre-operation planning ensures that obstacles and fittings in the carrier pipe are avoided or removed and do not disrupt operations. Maximising the use of this innovation allowed us to minimise the number of excavations required and reduce the overall disruption to both customers and road users whilst delivering efficient mains replacement projects.
Realisable Benefits:	**Economic Benefit**: Med; **Minimise Disruption**: High; **Improve Safety**: High; **Improve Resilience**: Low; **Reduce Environmental Impact**: High
Lead Innovation:	SynthoScope
Innovation Description:	NIA_SGN0072
Deployment Challenge:	Operationally live insertion is a much more technical challenging method of replacing mains than either open cut or dead insertion. This innovation has allowed us to change our processes, whereby obtaining more accurate information in advance of the operation allows for better planning and design considerations. Deployment of the live camera increases project preparatory works, but on balance this does not increase overall time on site. The use of the camera maximises mains insertion, supports more efficient on-site works, while minimising customer disruption and significantly reducing the time any customer is off gas.

	This innovation and the change in process to deploy it has increased the success rate from 10% (pre-GD1) to 50% and allowed live insertion to become the predominant mains replacement technique used within SGN.
Supporting Innovations:	
NIA_SGN0001	**Survey Replacement Matrix** To investigate and develop the capabilities of the Serviflex product range to allow for service insertions with 20mm Serviflex; live service insertion from the customers meter position to the main.
NIA_SGN0081	**Interruption Solutions – Live ECV, Meter, and Service Replacement (Stage 1)** Network licensees endeavour to minimise interruption to customer supplies during engineering works wherever possible. This project aimed to investigate the potential reduction in interruptions by reviewing the feasibility of live service and live ECV renewal. The objective was to identify any existing gas industry technologies that could reduce the number of unplanned customer interruptions.
NIA_WWU_033 (Collaborative Project)	**Development of a Risk Based Approach for Safe Control of Operations** Development of an innovative risk based approach to the selection of suitable methods of control such as permits to work, non-routine operations, routine operations and method statements. A supporting innovation that improves the timing of work by integrating SCO procedures into a competency management matrix. Develop a new risk based methodology to improve how complex tasks are planned, executed, and managed to enhance operational control whilst potentially streamlining the administrative process for all GDNs.
NIA_SGN0028	**Gas Eco (GECO) Gas Pump** SGN identified an issue when decommissioning and abandoning gas pipes and gas holders as the gas contained within them is currently vented to atmosphere. This has an environmental impact which we looked to resolve. Pipetech Pipeline Technology Ltd helped SGN develop a prototype gas pump, powered by compressed air. Pipetech manufacture prototype pumps which are single stage air powered gas pumps capable of pressurising gas that would normally be released into the atmosphere after abandoning pipes. This enables the previously vented gas to be injected back into the network.
NIA_SGN0001	**Synthotech Service Relay Initiative** Repex operations throughout GD1 to replace ageing metallic low pressure gas network and the associated service pipes. The relaying of a domestic service can be carried out using a number of methods, the first part of this project (started under IFI) focuses on extending the use of 20mm Serviflex for replacement of ¾” service pipes. The objectives of the project were to: • Reduce the interruption time for customers requiring a service relay • Reduce the cost of relaying a service to provide better value to the customer • Reduce and where possible eliminate the amount of excavation and reinstatement. The successful development of the Serviflex system provides positive environmental benefits with a reduction in the number of excavations required, the time taken and the impact on the customer.
NIA_SGN0015	**Pneumatic PE Pushing Machine** Traditional service replacement has involved open cutting i.e. significant open trench

	excavations to relay the service and to cut off the old metallic service at the mains. This project looked at the potential for technical alternatives to service replacement techniques currently used within the gas industry. Throughout GD1 there was a greater focus towards service insertion and this project looked to improve and extend the design of the PE Pipe Insertion Machine to enable PE pipe to be inserted back to the original meter position. The aim was to reduce the number of services re-laid to meter boxes and to reduce the number of open cut service renewals. The project developed a machine that will impart enough force to insert PE around 3 easy bends without damaging the PE and with no safety risk to the user. This process removes the risk of any physical injury to the operative relaying the service.
NIA_SGN0019	**CISBOT (Cast Iron Joint Sealing Robot)** A significant proportion of the gas distribution network comprises cast iron pipelines which all operators have a commitment to replace. ULC Robotics developed a cast iron joint sealing robot known as Large CISBOT. This advanced robotic technology can remediate cast iron pipe by internally injecting all the joints in a given area with an anaerobic sealant. This project carried out a detailed technical assessment and field trial of the joint sealing robot CISBOT, which has proven to remediate or rehabilitate cast iron joints under live conditions. This project ultimately delivered an innovative solution for the remediation of leaking lead yarn joints within SGN cast iron mains population and is now a critical part of SGNs mains risk management strategy. The project evaluated the effectiveness of the remediation technique and associated inspection method. The project was deemed to be successful across the gas industry. This would not have been possible without the technical and practical assessment of CISBOTs performance when remediatiing large diameters mains using the trenchless technique.
NIA_SGN0023 (Collaborative Project)	**Cured In-Place Pipe (CIPP) (Stage 2)** The gas distribution networks (GDN) jointly initiated a project to explore the potential use of cured-in-place (CIP) liners and polyurethane spray linings as a method of permanent rehabilitation of ageing iron distribution mains. The initial engagement with suppliers who could deliver a CIPP solution for natural gas pipelines was key challenge. Historical attempts at deploying this technology were not successful but further technological development prompted further testing. Gap analysis and a technology review was then undertaken to demonstrate fitness for purpose of CIPP lining technologies, focusing on iron mains of 8” diameter and above operating up to 2 barg pressures. The project is still ongoing however if successful the output may demonstrate that CIPP technology could potentially provide reliable method of long term risk managing larger diameter mains up to and including 2barg.
NIA_SGN0051	**Olympic Rings for RIIO** The development and testing of a multiple coring system, to maximise the use of our core and vac machines, for use within public highways. Successful development will reduce the requirement for conventional excavation, allowing existing equipment to be used within core and vac excavations.
NIA_SGN0056	**Mains and Service Replacement through a keyhole** SGNs iCore project aims to design, develop and manufacture a mains replacement insertion system for live or dead insertion of pipes (63mm through to 180mm diameter) inside existing metallic pipes from a 600mm diameter cored keyhole excavation.

NIA_SGN0121	**Hypercube** This was a project to develop a Network Analytic Platform (NAP) model which will integrate within existing replacement processes, as well as developing a GIB (Gas in Building) event algorithm.
NIA_SGN0046	**Cotter Plate Identification and Remediation (Stage 1)** We have seen many changes in the types of materials used in the construction of our distribution system. This project addresses problems associated with a specific gas fitting called a 'Cotter Plate' which are known weak parts of the network but cannot be easily identified. These fittings are primarily associated to the Greater London area as this was the main repair technique used during the blitz of World War Two. This project looked to develop a method of locating and remediating Cotter Plates. SGN developed and refined a method to identify likely Cotter Plate locations using historical records of bomb damage. This information was translated in to a map (GIS) output. Trial holes in the identified areas were undertaken to validate the analysis, the repair process was then incorporated in to SGN CISBOT programme.
NIA_SGN0061	**40mm Serviflex** Network risers within multiple occupancy buildings have an inherent level of risk influenced by the number of occupants and the likelihood of a gas leak incident. Most network risers are constructed in steel which, depending on the environment its located, can be susceptible to corrosion. 40mm serviflex offers the same solution and benefits to network risers as 20mm serviflex provides to domestic services. This project carried out in conjunction with Radius Systems Ltd developed an initial prototype system for the renewal of below ground network riser entry's by inserting 40mm serviflex. The entry pipe into a multi-occupancy building is often built into the structure minimising access to the pipe. The objective of this project is to prove the suitability of 40mm Serviflex pipe to insert in to the existing steel pipe thus renewing it. The application of this new approach to replace the below ground building entry provides benefits to customers by minimising disruption.
NIA_SGN0077	**Solutions to Pipeline Graphitisation and Corrosion – Stage 1** A significant proportion of the Gas distribution network comprises cast iron pipelines which all DNOs have a commitment to replace. Methodologies used to management this activity from high level perspective are based on the potential impact and resultant incident based on a fractured main not the long-term degradation based on graphitisation and/or corrosion. This project developed the learning from a previous NIA project (NIA_NGGD0014 CIFFP). This study reviewed the causes of pipeline corrosion with particular emphasis on the unique challenges of graphitisation. This project looked to prove the concept of dealing with the issue of pipeline corrosion and more specifically to: • develop systems to prevent the onset of pipeline corrosion • develop systems to arrest existing corrosion processes Upon completion this feasibility study generated further assessment work and future project concepts, such as IronClad (NIA_SGN0111).
Follow-on Innovations:	

NIC_ SGNGN04	**Robotic Roadworks and Excavation System (RRES)** The next transformational phase in the performance of network excavations and operations will require the integration of Artificial Intelligence (AI) with advanced digital tooling to automate routine works, making them quicker, safer, more cost effective and consistent. The system will use advanced robotic arm technology fused with a mobile platform and AI working with a suite of sensors and controls to enable autonomous, safe and efficient mains excavation. Once exposed, the RRES will attach a newly developed universal access fitting to the main to enable a set of inspection and maintenance operations to be performed.
Delivery: **Deployment Time:** **Deployment Challenge:**	Comments A new technology that took 1-2 years to deploy Process challenges that need to be overcome: - Staff / training issues - Contract issues.
Deployment potential:	Full roll-out will be achieved when all mains capable of being inserted are replacement using this technique.
Deployment Saving:	The NIA was successful. This technology when coupled with live mains insertion allows cost savings by reducing the expenditure necessary for open cut streetworks through minimising multiple excavations, reducing required restoration times and perimetry.

Roll out	Start GD1	GD1/GD2	End GD2
% of mains where technology is applicable	60%	60%	60%
% of mains where innovation is deployed	10%	50%	55%

b. Repex – replacement of mains (tier 2 and 3, >8" diameter)

Category	Repex – Replacement / Repriorisation of Mains – Robotics
Task:	Replacement of Mains / Streetworks
Task definition:	To reduce the risk of a deteriorating large diameter Tier 2 and Tier 3 mains traditionally requires the replacement of these pipes. Historically this has involved laying pipes in parallel where an open track is excavated, trench support provided with sufficient space for individual(s) to access the work area in order to lay the replacement pipe prior to the abandonment of the existing pipe. The preparation of deep excavations and volume of associated works is a major cost driver in the repex programme.
Problem:	Pipe Risk Management / reducing the Scale of Excavations
Problem Definition:	By targeting mains with identified joint leaks or those that have a high risk of joint leakage without extensive excavations improves overall safety, reduces the level of disruption associated with excavation. This is particularly important given that Tier 2 and Tier 3 mains are predominantly found in city locations and any work carried out on them results in a considerable disruption to our customers and road users. In addition to reducing risk and improving customer experience there will also be an associated reduction in excavation costs.
Solution:	Managing Risk / Minimising Excavation via. Robotics
Solution Description:	Where a large diameter main has to be replaced the process will be similar to 7.1 (Replacement of Tier 1) and live insertion will be used if the design confirms a smaller diameter can be used. Where there is an identified high level of repairs on a Tier 2/3 asset (Tier 3 leakage hotspots) then the pipe will have a high risk score driving the requirement for replacement. The major source of leaks on Tier 2/3 pipes is deteriorating lead-yarn joints. By using robotics to seal these joints from inside we are able to reduce the rates of leakage and manage the risk. This postpones the need to replace these pipes. This minimises the number of excavations required as several joints can be repaired from the one initial excavation (upstream and downstream).
Realisable Benefits:	**Economic Benefit**: Med; **Minimise Disruption**: High; **Improve Safety**: High; **Improve Resilience**: Med; **Reduce Environmental Impact**: High
Lead Innovation:	Large CISBOT (Cast Iron Joint Sealing Robot)
Innovation Description:	NIA_SGN0019
Deployment Challenge:	CISBOT is robotic technique that travels 50m either side from the point of insertion along a live gas main to identify and then re-seal lead-yarn joints. To implement this technology, we had to undertake a substantial volume of technical assurance and obtain national/international certification to introduce a non-intrinsically safe robot into a live gas main. This involved substantial mitigation work, front end engineering design changes and process changes. This has now created a technology capable of being carried out through one excavation, from the rear of a single box truck. Deployment is

	currently operated through single source contract with specialist provider.
Supporting Innovations:	
IFI	**Launch Technologies** Whilst the robotic system was a standalone product significant development work was undertaken in terms of the launch mechanisms to allow it to be introduced into a live gas main. A key challenge to overcome was the managing of the gas-air mix as it crosses the explosive limits in an environment with a non-intrinsically safe robot.
IFI	**Crawler Cameras** Live camera operation to inspect the internal pipework before using the CISBOT robot reduces the risk of deployment failures and improves project planning.
NIA_NGGD0014 (Collaborative Project)	**Cast Iron Fitness for Purpose (CIFFP)** The Gas Distribution Networks (GDNs) are investigating various techniques to assess the condition of Cast Iron (CI) pipes including, coupon removal for localised metallurgy, internal pipe inspections (inner/outer wall corrosion). This project took an in-depth review and assessment of technologies and methodologies that provide intelligence on the fitness for purpose of CI pipe. This project developed a methodology that satisfies obligations under the Pipeline Safety Regulations to enable Tier 2/3 pipes to be safely maintained for continued use, or be categorised in such a way to prioritise for remediation or decommissioning.
NIA_SGN0003	**SynthoTrax I-Seal Robot (Technical Feasibility Study)** The scope of this project is to investigate the technical potential to develop a robotic system that can remotely travel to, locate, and seal leaking joints from a single live access point.
NIA_SGN0078	**Utilisation of the Modular NIC Robotics Platform** A feasibility study to review existing methods/products/technologies that could be deployed from the robotic platform. The outputs from this project have informed Cirrus and a future robotics programme.
The following supporting techniques were detailed within section 9a - Tier 1 - Trenchless Technologies and a full description is also given in Section 10 – Summary List	
NIA_SGN0002 **NIA_SGN00??** **NIA_WWU_033** **NIA_SGN0028**	Survey Replacement Matrix Desktop Survey (Risk Trading) Risk Based Approach for Safe Control of Operations Gas Eco (GECO) Gas Pump
The following supporting techniques have limited uses for deployment on larger diameter Tier 2/3 mains. Primary deployment is demonstrated under 9a - Tier 1 - Trenchless Technologies and a full description is also given in Section 10 – Summary List.	
NIA_SGN0051 **NIA_SGN0056** **NIA_SGN0121**	Olympic Rings for RIIO Mains and Service Replacement through a keyhole Hypercube
Follow-on Innovations:	
NIC_SGNGN01	**CIRRUS** Development of a more versatile robot that if successful could seal other joint types (i.e. non-lead yarn joints). These currently make up <10% of the existing

	joints on our Tier 2/3 network. We are currently looking to establish the appropriate implementation processes.
NIA_SGN0086	**Cured In-Place Pipe (CIPP) (Stage 3)** The eventual development of fully structural CIP liners to enable the rehabilitation of existing large diameter metallic mains. The projects will also develop a delivery mechanism to allow rapid implementation of CIP liners. There are challenges in deployment in areas with service connections that need to be overcome before we prove the technology.
Delivery:	
Deployment Time:	A new technology that took three to four years to deploy into commercial operation.
Deployment Challenge:	Process challenges that needed to be overcome: - Technical, design and certification - Staff / training issues - Capacity issues from the single source contract provider. - Lead times for support innovation (i.e. launch innovation) - Maintenance of robot during deployment.
Deployment potential: **Deployment Saving:**	Approximately 40 km of tier 2/3 out of a total length of 425km to the end of the GD1. In GD2 we expect to repair 10% of the km to the end of GD2. The NIA was successful. This robotic trenchless technology provides significant cost savings by reducing the expenditure necessary by minimising the requirement for multiple excavations and associated road permits. In central London we estimate the savings could be up to £300 per km section of tier 2/ 3 main compared to the cost of an equivalent open cut operation replacement. In rural areas the savings will be significantly.

Roll out	Start GD1	GD1/GD2	End GD2
% of mains where technology is applicable	5 – 10%	5 – 10%	5 – 10%
% of mains where innovation is deployed	0%	8%	10%

c. Repex – replacement of services

<table>
<tr><th>Category</th><th>Repex – Replacement of Services – Trenchless Technology</th></tr>
<tr><td>Task:</td><td>Service Replacement / Streetworks</td></tr>
<tr><td>Task definition:</td><td>Service replacement associated with mains replacement projects. Current policy states that when undertaking any work on a non-polyethylene services these should be replaced. Dependent on the replacement method selected multiple excavations could be required causing disruption to the customer. The amount of road openings associated with this replacement work is a major cost driver and will impact project costs. Customers will also be disconnected, potentially for the duration of the operation.</td></tr>
<tr><td>Problem:</td><td>Service Replacement / Reducing the Scale of Excavations</td></tr>
<tr><td>Problem Definition:</td><td>Existing meters are often located internally within the property. Historically services were replaced using a variety of techniques, open cut, thrust-bore and partial insertion, to a revised meter position in a meter box to the front of the property, as dictated by policy. Insertion involves the minimum excavation and reinstatement works of all available replacement methods. The time necessary to complete the operation also varies with the replacement method selected, which in turn dictates the duration of interruption to the customers supply.</td></tr>
<tr><td>Solution:</td><td>Minimising Interruption and Excavation Frequency and Size</td></tr>
<tr><td>Solution Description:</td><td>Development of the 20mm Serviflex polyethylene pipe system allowed services to be replaced back to the existing meter position. Maximising the use of this technique allowed us to minimise the number of excavations required and reduce the disruption to both customers and road users. In addition, this minimised the requirement for relocating the meter to an outside meter box and laying long lengths of outlet pipework to reconnect the customers supply.</td></tr>
<tr><td>Realisable Benefits:</td><td><table>
<tr><th>Economic Benefit</th><th>Minimise Disruption</th><th>Improve Safety</th><th>Improve Resilience</th><th>Reduce Environmental Impact</th></tr>
<tr><td>Med</td><td>High</td><td>High</td><td>Low</td><td>High</td></tr>
</table></td></tr>
<tr><td>Lead Innovation:</td><td>Servi-Flex Service Relay Initiative</td></tr>
<tr><td>Innovation Description:

Deployment Challenge:</td><td>IFI
The project is to investigate and develop the capabilities of the Serviflex product to allow for ¾” diameter service insertions with 20mm Serviflex, and 1” diameter live service insertion from the customer’s meter position.
Adapting policies and procedures. Changing processes associated with the deployment of 20mm Serviflex and associated project preparatory works, including maximising insertion and replacement back to the original meter position.</td></tr>
<tr><td>Supporting Innovations:</td><td></td></tr>
<tr><td>NIA_SGN0079</td><td><u>Automated Pressure Tester</u>
This project proposes to develop an automated pressure tester. This proposed device aims to help ensure the accuracy and consistency of the testing and</td></tr>
</table>

	data recording process while removing the potential for human error and providing the opportunity to automatically update our asset records via a suitable cloud based service.
NIA_SGN0033	**Long handled PE Top Tee Cutter** The project scope was to investigate and develop a tool to provide a safer, more user friendly and efficient method of commissioning a polyethylene top tee without having a detrimental effect on its integrity.
The following supporting techniques were detailed within the preceding sections and a full description is also given in Section 10 – Summary List.	
NIA_SGN0028 **NIA_SGN0056**	Gas Eco (GECO) Gas Pump Mains and Service Replacement through a keyhole
Follow-on Innovations:	
NIC_ SGNGN04	**Robotic Roadworks and Excavation System (RRES)** Details of this technology are confirmed in 3.1 above and in section 11 – Summary List
Delivery:	Comments
Deployment Time:	A new technology that took 1-2 years to deploy
Deployment Challenge:	Process challenges that need to be overcome: - Staff / training issues - Revisions to policies and procedures - Contract payment issues.
Deployment potential:	Full role out will be achieved when all services capable of being inserted are replacement using this technique.
Deployment Saving:	The NIA was successful. This technology allows significant cost savings by reducing the expenditure necessary for open cut streetworks. Time to reconnect customers is also minimised together with the need to provide both an outside meter box and long lengths of outlet pipework.

Roll out	Start GD1	GD1/GD2	End GD2
% of services where technology is applicable	70%	70%	70%
% of services where innovation is deployed	50%	55%	60%

d. Repex – large service / riser replacement

Category	Repex – Large Service Replacement – Trenchless Technology
Task:	Large Service Replacement / Streetworks
Task definition:	Current policy states that when undertaking any work on a non-polyethylene services these should be replaced. This also applies to large services to commercial premises. Dependent on the replacement method selected multiple excavations could be required causing significant disruption for the customer. The amount of road openings associated with this replacement work is a major cost driver and will impact project costs. Customers will also be disconnected, potentially for the duration of the operation.
Problem:	Large Service Replacement / Reducing the Scale of Excavations
Problem Definition:	Dependent of the method selected to replace these large services, open cut, thrust-bore or insertion, multiple excavations could be required. Insertion involves the minimum excavation and reinstatement works of all available replacement methods. For riser replacement multiple customers would also be disconnected for the duration of the operation.
Solution:	Minimising Interruption and Excavation Frequency and Size
Solution Description:	Development of the 40mm Serviflex polyethylene pipe system allows the below ground section of a large 50mm steel service / service riser to be replaced. Maximising the use of this technique allowed us to minimise the number of excavations required and reduce the disruption to customers and road users. When combined with the NIA_SGN0018 (Microstop) this also allows the live supply to be maintained to the above ground section of a service riser while the below ground section is replaced.
Realisable Benefits:	<table><tr><th>Economic Benefit</th><th>Minimise Disruption</th><th>Improve Safety</th><th>Improve Resilience</th><th>Reduce Environmental Impact</th></tr><tr><td>Low</td><td>High</td><td>High</td><td>Low</td><td>Med</td></tr></table>
Lead Innovation:	40mm Serviflex
Innovation Description: **Deployment Challenge:**	NIA_SGN0061 Adapting policies and procedures. Changing processes associated with the deployment of 40mm Serviflex and associated project preparatory works, including maximising insertion and allowing replacement back to the original meter position.
Supporting Innovations:	
NIA_NGGD0055 (Collaborative Project)	**Development of Gas Industry Specification for Polymeric Pipe Lining Systems for Multi-Occupancy Buildings** There are many multi-occupancy buildings across the country with internal gas risers. These risers, usually constructed of steel or copper, are approaching the end of their expected operational life. This project developed for publication of a new Gas Industry Standard that defines what a suitable and sufficient design and performance specification should be in order to demonstrate compliance with relevant legislation. This

	project developed a robust performance specification for the use of polymeric pipe lining technology for use within multi-occupancy buildings. The development of the specification and test procedure was to standardise a coating/lining system as a validated technology for lining risers that could demonstrate its fitness for purpose. The output was specifically documented in a Gas Industry Standard that was agreed unanimously by all participating networks, providing a comprehensive objective technical specification to facilitate the evaluation, verification and certification of any new innovative polymer lining technology.
NIA_SGN0018	**Microstop** When working on an above ground steel riser Microstop allows a bypass to be installed thereby maintaining gas supply integrity whilst replacing pipework and fittings that are in poor condition. The project was to develop the tool and methodology so that it was able to be integrated into our processes and confirm that performance of the tool conformed with UK standards and specifications.
The following supporting techniques were detailed within the preceding sections and a full description is also given in Section 10 – Summary List.	
NIA_SGN0028 **NIA_SGN0033** **NIA_SGN0056** **NIA_SGN0072**	**Gas Eco (GECO) Gas Pump** **Long handled PE Top Tee Cutter** **Mains and Service Replacement through a keyhole** **SynthoScope**
Follow-on Innovations:	
NIC_ SGNGN04	Robotic Roadworks and Excavation System (RRES) Details of this technology are confirmed in section 11 – Summary List.
Delivery:	Comments
Deployment Time: **Deployment Challenge:**	A new technology that took 1-2 years to deploy Process challenges that need to be overcome: - Staff / training issues - Revisions to policies and procedures - Contract payment issues.
Deployment potential:	Full role out will be achieved when all services capable of being inserted are replacement using this technique.
Deployment Saving:	The NIA was successful. This technology allows significant cost savings by reducing the expenditure necessary for open cut street works. Time to reconnect customers is also minimised. Furthermore, for service risers supply is maintained so there is no need to disconnect customers, throughout the replacement operation.

Roll out	Start GD1	GD1/GD2	End GD2
% of risers where technology is applicable	10%	10%	10%
% of risers where innovation is deployed	0%	50%	60%

e. Opex – mains and service escapes

<table>
<tr><th>Category</th><th>Opex –Gas Supply Emergency’s and Escapes (Mains and Services) – Minimising Supply Isolations</th></tr>
<tr><td>Task:</td><td>Supply emergency’s and Mains and Service Escapes</td></tr>
<tr><td>Task definition:</td><td>Responding to public reported gas escapes and supply interruption incidents received through the national gas emergency number. Actions include attending site within one hour, establishing source of reported gas escape or incident and taking any actions necessary to safeguard life and property.</td></tr>
<tr><td>Problem:</td><td>Supply Interruption / Disruption</td></tr>
<tr><td>Problem Definition:</td><td>Gas escapes from mains and services are treated as immediately priority. During such events we respond accordingly dealing with the localised gas escape by locating it ensuring all life and property are safe and applying the necessary repair. During a gas supply outage/incident, where a large number of customers are affected, it is necessary to locate the problem before attempting a repair. Once the source of the supply interruption is established then the system needs to be stabilised by stopping the flow of gas on the affected section of the network. This is accomplished by visiting each affected premise and isolating their supply at the meter control valve. Where access to the property is not available then the services need to be isolated in the street. On completion of the repair works on the network outage/incident then gas supplies can be re-established again through visiting each property.</td></tr>
<tr><td>Solution:</td><td>Customer Self Isolation and Restoration</td></tr>
<tr><td>Solution Description:</td><td>This project developed a process whereby rather than engineers visiting each property then customers were empowered to carry out the isolation and restoration of their own supply. The principal reason for supporting this project was to reduce the duration of a gas outage / incident. This would reduce the cost of the incident and minimise its impact on consumers. It is estimated that adopting this approach could reduce the duration of an incident by approximately 70%.</td></tr>
<tr><td>Realisable Benefits:</td><td><table><tr><th>Economic Benefit</th><th>Minimise Disruption</th><th>Improve Safety</th><th>Improve Resilience</th><th>Reduce Environmental Impact</th></tr><tr><td>Med</td><td>Med</td><td>Med</td><td>Low</td><td>Low</td></tr></table></td></tr>
<tr><td>Lead Innovation:</td><td>Customer Self Isolation and Restoration</td></tr>
<tr><td>Innovation Description:
Deployment Challenge:</td><td>NIA_SGN0026

In order for the maximum benefits to be realised changes to the National Emergency Management procedures required to be agreed before the documents could be updated.</td></tr>
<tr><td>Supporting Innovations:</td><td></td></tr>
<tr><td>NIA_SGN0014</td><td><u>Tornado Max</u>
The scope of this project is to offer a new and improved piece of equipment that improves and extends the design and functionality of the Tornado air powered vacuum device for the removal of small quantities of water from pits and valve chambers, for purging redundant gas pipes, and the removal of</td></tr>
</table>

	residual gas trapped in building voids to aid re-occupation.
NIA_SGN0064	**Advanced Gas Detection** SGN working with GMI to develop gas detection equipment which will build on instruments that are already being used by GDNs throughout GB. The project will develop a new method of managing site investigation data. Currently hardcopies of Leakage Investigation Survey (LIS) worksheet are collected from the operatives once completed and stored for three years in each depot. The GS700 unit will have the ability to record the data electronically, using a web based application. This has the potential to allow full site work history to be available anywhere across the business, providing a rigid audit trail, whilst removing the need for a resource to manually manage the hardcopies of these records.
NIA_SGN0118	**High Volume Gas Escapes (Stage 1)** This project aims to provide a solution which can quickly and effectively repair a leaking pipe at the leak source. This project will therefore seek to identify and develop a number of prototyped options for responding to high volume gas escapes from low pressure pipelines. The work outlined in this proposal is focused on Low Pressure Pipes (up to 2 barg), but will ideally also be appropriate for Medium Pressure Pipes (up to 7 barg). This encompasses both metallic and PE pipes, and diameters of 63mm to 1200mm.
The following supporting techniques were detailed within the preceding sections and a full description is also given in Section 10 – Summary List.	
NIA_SGN0072	SynthoScope
Delivery:	Comments
Deployment Time:	A new technology that took 1-2 years to deploy
Deployment Challenge:	Process challenges that need to be overcome: - Staff / training issues - Revisions to policies and procedures
Deployment potential:	While this innovation has now been implemented within the national emergency procedures we have not had occasion to invoke these procedures. Where appropriate it will be used in all large scale supply interruptions.
Deployment Saving:	The NIA was successful. This technology allows significant cost savings by reducing time to reconnect customers in the event of a large supply disruption.

Roll out	Start GD1	GD1/GD2	End GD2
% of escapes where technology is applicable	<5%	<5%	<5%
% of escapes where innovation is deployed	0%	100%	100%

f. Opex – risers and lateral service escapes

Category	Opex – Escapes (Risers and Laterals) – Minimising Supply Isolations
Task:	Mains Risers and Lateral Service Escapes
Task definition:	Responding to public reported escapes received through the national gas emergency line. Actions include establishing the source of reported gas escape and any actions necessary to safeguard life and property.
Problem:	Re-active Escape Management
Problem Definition:	When dealing with escapes on multi-storey rising mains and service laterals it is important to establish the source of the escape. The actions of our engineers will be largely dependent on where the leak is located and the scale of readings obtained. In these types of situation time is limited and decision taken will have implications for how and when we undertake the eventual repair. The best outcome is that a temporary repair is undertaken allowing us time to review and programme future permanent repair work or planned replacement. Temporary repairs currently involve our First Call Operative (FCO) calling an engineering team to site. When managing gas escapes on network risers it is often the case that the situation requires the network riser to be isolated and a full replacement programmed, in the days following the escape. This situation causes mass disruption and inconvenience to our affected customers who could be without a supply for a number of days or in some cases weeks.
Solution:	Minimising Interruption and Disruption
Solution Description:	The development of Self Amalgamating tape allowed a suitably trained individual (FCO) to carry out the immediate repair, allowing for a one-man operation i.e. no Engineering Team required. The tape also provided a more complete solution that allowed greater time between temporary and permanent repair activities. This provided the business with greater opportunities to more efficiently manage resources for the permanent repair, essentially allowing unplanned escape work to be proactively planned. A number of other innovations have been developed that look to minimise customer disruption through limiting or removing the requirement for supply isolation.
Realisable Benefits:	**Economic Benefit**: Med; **Minimise Disruption**: High; **Improve Safety**: High; **Improve Resilience**: Low; **Reduce Environmental Impact**: Low
Lead Innovation:	Self-Amalgamating Tape (Stage 2)
Innovation Description:	**NIA_SGN0030** Initial developed through the Innovation Funding Incentive (IFI) mechanism self-amalgamating tape (SAT) was developed as a repair technique for leaks on screwed joints on both risers and lateral pipework. The original project also set out to identify the technical and training requirements to support its introduction into the business.
Deployment Challenge:	The challenge is to ensure the use of this innovation is supported by the appropriate changes in policy and procedures. It was also necessary to support the roll-out with updated training to ensure full deployment and use by First

	Call Operatives rather than Distribution Teams. The initial roll out of SAT was targeted in areas where there is higher density of network risers in multi occupancy buildings. However, when deploying new repair techniques in this area the technical assurance and confidence in the new process must be demonstrated to our operatives. Operative confidence in any new gas repair technique is critical because safety is our key concern. This being the case we had to ensure we that our operatives never just isolated the riser without first attempting the initial SAT repair. When our operatives are faced with such scenarios there is a time pressure to deal with the leak and make it safe as soon as possible. The immediate isolation of the entire riser is a quick and effective way of isolating the located gas escape but causes mass disruption to all building residents.
Supporting Innovations:	
The following supporting techniques were detailed within the preceding sections and a full description is also given in Section 10 – Summary List.	
NIA_SGN0014 **NIA_SGN0024** **NIA_SGN0064** **NIA_SGN0003** **NIA_SGN0072**	Tornado Max RCA GPS Survey Advanced Gas Detection SynthoTrax I-Seal Robot (Technical Feasibility Study) SynthoScope
Follow-on Innovations:	
NIA_SGN0112	**Forged Carbon Fibre Products (FCFP) - Stage 1 and 2** Project to develop a carbon fibre shell to encase a SAT wrapped repair. This evaluation will facilitate product design and integration into the distribution network following successful completion of the Stage 2 field trials.
Delivery:	Comments
Deployment Time: **Deployment Challenge:**	A new technology that took 1-2 years to deploy Process challenges that need to be overcome: - Staff / training issues - Revisions to policies and procedures
Deployment potential:	This technology has been implemented within the business and is being used as a business as usual technique.
Deployment Saving:	The NIA was successful. This technology allows significant cost savings by promoting one man operation and avoiding the immediate isolation of a customer's supply. The temporary repaired above ground pipe can then be managed more effectively for the permanent repair.

Roll out	Start GD1	GD1/GD2	End GD2
% of escapes where technology is applicable	10%	10%	10%
% of escapes where innovation is deployed	0%	50%	50%

g. Opex – mains and service repairs

Category	Opex – Mains and Service (Repairs) – Minimising Impact
Task:	Mains and Service Repairs (All Materials)
Task definition:	Once the initial escape has been secured, then the business must develop a permanent repair solution. Often this may involve the replacement of the affected pipework. The repair should be designed to minimise the potential for future disruption to the customer and provide a method of repair that will be permanent in nature.
Problem:	Supply Interruptions During Repair Work
Problem Definition:	The location of the escape and/or the temporary repair will ultimately determine the type of permanent repair that is required. The permanent repair of a service often results in the service being fully replaced. An escape at a mains joint will require the leak to be sealed, either by injecting anaerobic sealant into joint or by fitting an encapsulation case around the joint before filling with sealant. When undertaking any permanent repair work it is often necessary not only to excavate in order to undertake the work but to isolate a customer's supply.
Solution:	Minimising Interruption and Excavation Frequency and Size
Solution Description:	Where a service does not require to be replaced to affect the repair this is generally due to the leak being associated with the Emergency Control Valve (ECV). Replacing an ECV on a live service can be a difficult operation without creating the scenario were the operative inadvertently creates more escaping gas. Historically, this operation often had to be aborted as a suitable seal could not be obtained, leading ultimately to the replacement of the full service. The development of the Advanced Minibag is a more effective tool that allows for the exchange of an ECV in a gas free atmosphere. A customer's supply still requires to be temporarily interrupted however the duration is significantly shorter than either the exchange using the old technique, or the time taken to replace the service. The mini bag and advanced mini bag was created to also be used on semi concealed meter installations where the ECV is directly connected to a 90° elbow bend where this operation was impossible in the past.
Realisable Benefits:	**Economic Benefit**: Low **Minimise Disruption**: Med **Improve Safety**: High **Improve Resilience**: Low **Reduce Environmental Impact**: Med
Lead Innovation:	Advanced Minibag
Innovation Description:	NIA_SGN0088 To develop an Advanced Mini Bag Kit to facilitate the exchange of ECVs, whilst removing the need to excavate and physically isolate a gas service.
Deployment Challenge:	Challenge is to ensure the use of this equipment is supported by the appropriate changes in policy and procedures. It was also necessary to support the roll-out with updated training to ensure full deployment. Operative confidence in any new gas repair technique is critical because safety is our key concern. This being the case we had to ensure that our operatives never just isolated the service to work on it 'dead'. When working on a live service there is an added element of operational pressure placed on our operatives this being the case they must trust the new equipment and process they have been

	trained to use. The immediate isolation of the service is a quick and effective way of ensuring safe working environment but can result in further disruption and delays in reconnecting the customer.
Supporting Innovations:	
NIA_SGN0022	**Small Pressure Pot** The scope of this project is to evaluate the small pressure pot to provide a more effective technique by which to seal joints, it will reduce the number of joints requiring encapsulation and as a result the size of excavation and use of expensive external contractor resources.
NIA_SGN0027	**Water Extraction Reel & Y Branch** New equipment to be used in conjunction with current mains camera equipment to detect and remove the water inside of the low pressure network.
The following supporting techniques will be used to varying degrees dependent on the nature and the location of the permanent repair. Primary deployment is demonstrated under the previous sections and full details are given in Section 10 – Summary List.	
NIA_SGN00xx [IFI] **NIA_SGN0001** **NIA_SGN0003** **NIA_SGN0024** **NIA_SGN0028** **NIA_SGN0033** **NIA_SGN0052** **NIA_SGN0056** **NIA_SGN0072**	Infinity Rider/ Bypass Hoses Synthotech Service Relay Initiative SynthoTrax I-Seal Robot (Technical Feasibility Study) RCA GPS Survey Gas Eco (GECO) Gas Pump Long handled PE Top Tee Cutter Core Drilling and Flow Stop, WASK Mains and Service Replacement through a keyhole SynthoScope
Follow-on Innovations:	
NIA_SGN0112	**Forged Carbon Fibre Products (FCFP) - Stage 1 and 2** Details of this technology are confirmed in 3.6 above and in section 11– Summary List
Delivery:	Comments
Deployment Time:	A new technology that took 1-2 years to deploy
Deployment Challenge:	Process challenges that need to be overcome: - Staff / training issues - Revisions to policies and procedures
Deployment potential:	This technology has been implemented within the business and is being used as a business as usual technique.
Deployment Saving:	The NIA was successful. This technology allows more efficient working by promoting one man operation and avoiding the immediate isolation of a customer's supply. The temporary repaired above ground pipe can then be managed more effectively for the permanent repair.

Roll out	Start GD1	GD1/GD2	End GD2
% of ECV where technology is applicable	100%	100%	100%
% of ECV where innovation is deployed	0%	90%	90%

h. Opex – riser repairs

Category	Opex – Riser (Repairs) – Minimising Impact
Task:	Riser Repairs (All Materials)
Task definition:	Once the initial escape has been secured (opex - mains and services escapes), then the business must develop a permanent solution. This should be designed to minimise the potential for future disruption to the customer and provide a method of repair that will be permanent in nature.
Problem:	Supply Interruptions During Riser Repair Work
Problem Definition:	When undertaking any permanent repair work on a riser it is often necessary to isolate a customer's supply. In doing so this can create a decommissioned asset that cannot be easily recommissioned (due to safety considerations) and can lead to significant delays in recommissioning or delivering the full replacement.
Solution:	Minimising Interruption and Excavation Frequency and Size
Solution Description:	Where the escape is located on the below ground section of the riser, then this previously required the replacement of the full riser, both above and below ground sections. Developed through the innovation the use of the Microstop equipment allows the gas supply to be maintained to the customers supplied from the above ground steel riser while the below ground section is replaced. This is one of a number of innovations that have been developed to maintain gas supplies during a repair/replacement operation to minimise customer disruption. This also allows supply isolation and the number / size of excavations to be minimised.
Realisable Benefits:	<table><tr><th>Economic Benefit</th><th>Minimise Disruption</th><th>Improve Safety</th><th>Improve Resilience</th><th>Reduce Environmental Impact</th></tr><tr><td>Med</td><td>High</td><td>High</td><td>Low</td><td>Med</td></tr></table>
Lead Innovation:	Microstop
Innovation Description:	NIA_SGN0018 Microstop is a bypass methodology to maintain gas supply integrity whilst replacing pipework and fittings that are in poor condition. Development work included creating the tool and defining the methodology to be used as this would allow it to be integrated into our processes. Further development work also confirmed that the tool conformed with UK standards and specifications.
Deployment Challenge:	Challenge is to ensure the equipment complies with appropriate standards, is suitable for use in a multi-occupancy building, and that the equipment can be deployed with appropriate changes in policy and procedures. It was also necessary to support the roll-out with updated training to ensure full deployment.
Supporting Innovations:	
The following supporting techniques were detailed within the preceding sections and a full description is also given in Section 10 – Summary List.	
NIA_SGN0061	40mm Serviflex
NIA_SGN0088	Advanced Minibag
NIA_SGN0033	Long handled PE Top Tee Cutter
NIA_SGN0056	Mains and Service Replacement through a keyhole

NIA_SGN0072	SynthoScope
Follow-on Innovations:	
New	Possible developments in camera technology to improve integrity assessment and additional fire protection technologies at the ECV.
Delivery:	Comments
Deployment Time:	Microstop was originally identified as a potential technology in 2015. This is now in the implementation phase and going through phased deployment across the depot structures. Deployment phasing started in depots with the highest density of risers.
Deployment Challenge:	- Equipment modification based on learnings from trials. - Staff training - Contracts and contractor engagement - Revisions to policies and procedures - Stock scheduling and spares provision
Deployment potential:	This innovation can only be applied to repairs in network risers in multi-occupancy buildings. The ability to use these innovations will be dependent upon access (i.e. pipework in the stairwell or customer properties) and where overall riser deterioration is not at a level to justify full replacement, at this time. From experience to date, we have found the technology more deployable in mid-band (<6 storeys) multi-occupancy buildings. Use of this technology postpones eventual replacement and introduces the riser into an asset condition monitoring programme. Successful deployment in GD2 depends on appropriate contract structuring and a broader consideration of building fabric safety, that may arise out of the Hackett Review.
Deployment Saving:	The NIA was successful. The temporarily repaired above ground pipe can now be proactively managed. • Cost of part or full replacement for a generic mid-rise tenement is approximately £20-30k and disruption of approximately one week. • Cost of repair using new approaches is generally less than £10k, with ongoing survey costs, and there is no customer interruption.

Roll out	Start GD1	GD1/GD2	End GD2
% of risers where technology is applicable	50%	50%	50%
% of risers where innovation is deployed	0%	50%	50%

i. Opex – inspection and maintenance (<7 barg)

<table>
<tr><th>Category</th><th>Opex – Inspection and Maintenance - Fault Finding</th></tr>
<tr><td>Task:</td><td>Inspection and Maintenance (<7 barg)</td></tr>
<tr><td>Task definition:</td><td>Maintenance resources are often tasked to visit a site on multiple occasions or for extended periods. This can result in periods where there is time spend monitoring rather than producing. All maintenance processes require review to introduce improvements, where possible, through amending tooling, procedures or information accuracy.</td></tr>
<tr><td>Problem:</td><td>Lack of Operational Process Efficiency</td></tr>
<tr><td>Problem Definition:</td><td>Inspection processes such as monitoring network pressures are resource intensive with delays experienced between when information is recorded, to when it can be used to support decision processes. In the past recording equipment installed at points within the network often failed, due to battery or installation issues. Notifications of these failures were only highlighted when the engineers returned to remove or service the equipment. The result of these failures was an incomplete record of network performance.

Maintenance processes often involve governor stream isolation before work can be undertaken.</td></tr>
<tr><td>Solution:</td><td>Streamline Processes to Improve Information Accuracy</td></tr>
<tr><td>Solution Description:</td><td>Development of improved digital logging equipment changed how network condition information is recorded and retrieved, automatically uploading pressure information to the cloud enabling planners to immediately be able to use this data to determine/amend system operating parameters. Other Maintenance options involve improved tooling and/or amended processes.</td></tr>
<tr><td>Realisable Benefits:</td><td><table><tr><th>Economic Benefit</th><th>Minimise Disruption</th><th>Improve Safety</th><th>Improve Resilience</th><th>Reduce Environmental Impact</th></tr><tr><td>Low</td><td>Med</td><td>Med</td><td>Low</td><td>Med</td></tr></table></td></tr>
<tr><td>Lead Innovation:</td><td>Osprey Pressure Validators</td></tr>
<tr><td>Innovation Description:</td><td>NIA_SGN0021

Through a partnership with Abriox (original equipment manufacturer) we trialled the use of a new type of digital logger. This is a wireless, intrinsically safe, battery-powered remote monitoring unit, that fits inside bollards, posts and meter boxes and monitors gas pressure up to 100mbarg. A secondary objective of this work was to introduce competition to the supply market for this type of recording equipment.</td></tr>
<tr><td>Deployment Challenge:</td><td>Challenge is to ensure the use of this equipment is supported by the appropriate changes in policy and procedures. It was also necessary to support the roll-out with updated training to ensure full deployment.

Adoption of this new equipment was quickly integrated in to SGN. The new logger system was an adaptation of an existing process which operatives were robustly trained in. The output from the pressure logging process also helped identify areas of the network where potential issues could be more accurately identified. Using this information and feeding it back in to operational processes reinforced the confidence SGN had in the system further supporting</td></tr>
</table>

	the investment and further phased roll out of the new logger system.
Supporting Innovations:	
The following supporting techniques will be used to varying degrees dependent on the Maintenance operations being undertaken.	
NIA_SGN0016	**Starline/Marwin Valve Bolt Replacement** Develop operational practices and tooling to support the replacement of corroded bolts on Starline/Marwin valves whilst pressurised.
NIA_SGN0070	**Magnetic Filtration in Medium to Low Pressure Networks** This project is to investigate the latest developments in magnetic filtration technology for use on SGN plant. This would allow the potential for utilising more cost-effective methods of gas filtration on the network pressure regulating stations, with the potential to remove the restriction on Low Pressure networks, returning the systems to their full operating parameters.
NIA_SGN0073	Corrosion Mapping for Buried Orpheus Regulator Modules Project to enable the internal long range non destructive testing (NDT) inspection of buried Orpheus regulator modules without having to excavate or grit-blast the pipework. Eliminating environmental concerns arising from waste disposal issues caused by grit blasting and associated excavation materials.
NIA_SGN0082	Automated Regulator Maintenance (ARM) (Phase 1) This system is an electronic regulator diagnostics system that can be operated both remotely and manually to further improve the operational safety and efficiency, as well as modernise the capabilities of maintenance activities. The aim of the Project is to trial the Plexor inspection system on a regulator stream ranging in pressures from 0.4 to 75 barg, semi-automatically onsite and remotely using Global Positioning System (GPS) as a location mark.
NIA_SGN0092	Pit Protect (Unsuccessful) This project is to evaluate and report on the nature and extent of the pit wall water ingress within the SGN network.
NIA_SGN0128	BVR (Furmanite Ball Valve Replacement) External corrosion has been identified on auxiliary valves on the impulse rails to the governors. The external corrosion is due to condensation from pressure reduction, and galvanic corrosion due to dissimilar metals. There are a significant number of governors within SGN network operating at 2 to 7 barg consisting of approximately 1600 streams. Currently the governors must be bypassed or isolated at the fire valve to enable the valves on the impulse rails to be removed and replaced. This can often lead to a stream replacement or a full governor replacement.
The following supporting techniques were detailed within the preceding sections and a full description is also given in Section 10 – Summary List.	
IFI **NIA_SGN0072** **NIA_SGN0079**	Crawler Cameras SynthoScope Automated Pressure Tester
Follow-on Innovations:	
NIC_ SGNGN03	**Real Time Networks** This project seeks to demonstrate a 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.

Delivery:	Comments
Deployment Time:	A new technology that took 1-2 years to deploy
Deployment Challenge:	Process challenges that need to be overcome: • Staff / training issues • Revisions to policies and procedures
Deployment potential:	This technology has been implemented within the business and is being used as a business as usual technique.
Deployment Saving:	The NIA was successful. The time taken to deploy the new loggers is similar to the older Technolog equipment, however once fitted less maintenance is required and more accurate information on pressures is available. The use of these loggers also means that pressure information is immediately available to system designers and managers reviewing the performance of the network.

Roll out	Start GD1	GD1/GD2	End GD2
% of jobs where technology is applicable	80%	80%	80%
% of jobs where innovation is deployed	0%	75%	80%

j. Opex – inspection and maintenance (>7 barg)

Category	Opex – Inspection and Maintenance (>7 barg) - Protection
Task:	Inspection and Maintenance (>7 barg)
Task definition:	All maintenance processes required review to introduce improvements, where possible, through amending tooling, procedures or information accuracy.
Problem:	Inefficient Operational Processes
Problem Definition:	Process reviews undertaken to ensure most efficient process is utilised and offers the most appropriate protection for both above and below ground steel local transmission system (LTS) assets.
Solution:	LTS Pipeline Efficiency
Solution Description:	Developments in paint and coating technology for use on SGNs plant were investigated to improve to improve and prolong the protection of our assets. Other innovations were developed that will impact on how network condition information is recorded and utilised to assist in increasing asset life. Other options involve improving tooling or amended protection processes.
Realisable Benefits:	**Economic Benefit**: Low; **Minimise Disruption**: Low; **Improve Safety**: Low; **Improve Resilience**: Low; **Reduce Environmental Impact**: Low
Lead Innovation:	Smart Paint
Innovation Description:	NIA_SGN0067 The scope of this project is to investigate the latest developments in paint and coating technology and products for use on SGNs plant. This would allow the potential for utilising more cost-effective solutions for the protection of both above and below ground assets.
Deployment Challenge:	Ensure considerations for Control of Substances Hazardous to Health (COSHH) and risk assessments for all new products added to the paint register. Produce a maintenance work instruction, in SGNs Safety Management Framework (SMF) format, that enables the operative to select a suitable paint system for the equipment and the applications techniques required.
Supporting Innovations:	
The following supporting techniques will be used to varying degrees dependent on the Maintenance operations being undertaken.	
NIA_SGN0002	**Immersion Tube Preheating** To design, construct and install two innovative pre-heaters with heat output capacities of circa 100kW and 326kW, compliant with UK legislation and standards. They will employ novel burner design which offers the same efficiency as modular boilers with a simplified industrial design for long life and ease of service. This type of burner technology has not previously been utilised for gas-preheating.
NIA_SGN0035	**Beyond Visual Line of Sight (BVLOS) Aerial Inspection Vehicle (Drone)** The scope of this programme of work by VTOL Technologies is to develop an Remotely Piloted Aircraft Systems (RPAS) BVLOS specification that is endorsed by the Civil Aviation Authority (CAA) which can then be used to develop an RPAS

NIA_SGN0106	**Strategic Pipeline Heat Study** The strategic heat study will aim to evidence how to optimise our alarm, control and operating philosophies to increase energy efficiency, reduce unnecessary call outs and potentially eliminate the requirement for lagging. Many of our sites have preheating systems installed to manage the Joule-Thomson effect from pressure reduction. There are a significant number of alarms and faults associated with preheating control systems. If we can optimise our control systems we hope to be able to eliminate unnecessary callouts.
NIA_SGN0117	**Bolt Integrity** This project sets out to develop a reinforcement clamp for use on live site and prove the procedures for its use within SGN
The following supporting techniques were detailed within the preceding sections and a full description is also given in Section 10 – Summary List.	
NIA_SGN0070 **NIA_SGN0082** **NIA_SGN0128** **NIA_SGN0126**	Magnetic Filtration in Medium to Low Pressure Networks Automated Regulator Maintenance (ARM) (Phase 1) BVR (Furmanite Ball Valve Replacement) LTS Demand Forecasting Tool Scoping Study (Phase 1)
Follow-on Innovations:	
	In development
Delivery:	Comments
Deployment Time: **Deployment Challenge:** **Deployment potential:** **Deployment Saving:**	A new technology that took 1-2 years to deploy Process challenges that need to be overcome: - Staff / training issues - Revisions to policies and procedures This technology has been implemented within the business and is being used as a business as usual technique. The NIA was successful. Application of this innovation is currently being deployed within the business.

Roll out	Start GD1	GD1/GD2	End GD2
% of jobs where technology is applicable	20%	20%	20%
% of jobs where innovation is deployed	0%	50%	50%

k. Opex – gas market development

Category	Opex – Gas Market Development – Customer
Task:	Market Development
Task definition:	To examine the extent to which gas composition characteristics can be amended to open the natural gas market to greater supply options.
Problem:	Prescriptive Composition Characteristics
Problem Definition:	As a country we are now a net importer of natural gas, with prices and access to supply increasingly depending on international markets. Gas prices exhibit volatility, dependent on the short-term and/or spot market conditions. Whilst the sources of new natural gas are numerous, gases have different compositions and the GB specification for gas composition is very prescriptive, therefore limiting the market and exacerbating the problem. Current arrangements dictate that for gases with compositions that sit outside of the GB specification to be conveyed and used, expensive gas processing is required to bring them within permitted ranges. This limits the type and source of gases which can be used in GB and, in turn, ultimately leads to increased costs for consumers.
Solution:	Testing different gas compositions
Solution Description:	To undertake a trial using different compositions of natural gas within the network to understand their effect on both the network and customer appliances.
Realisable Benefits:	<table><tr><th>Economic Benefit</th><th>Minimise Disruption</th><th>Improve Safety</th><th>Improve Resilience</th><th>Reduce Environmental Impact</th></tr><tr><td>High</td><td>Low</td><td>Low</td><td>Low</td><td>High</td></tr></table>
Lead Innovation:	Opening Up the Gas Market
Innovation Description: **Deployment Challenge:**	**NIC_SGNGN02** Ensure that all results are documented and a full review in undertaken with the HSE. Work with the Gas Industry and the HSE to amend the gas composition requirements within the Gas Safety (Management) Regulations 1996
Supporting Innovations:	
NIA_SGN0107	**<u>IGEM Gas Quality Standard Working Group</u>** The principle objective of the working group is the production of an IGEM standard covering UK gas quality specification in order to facilitate a change from GS(M)R that reflects the decline in UK continental shelf (UKCS), the available alternative sources of gas and aligns with the European standard. The standard will set the Wobbe Index (WI) range appropriate for the UK initially examining an extension of the upper range. The specification will also examine the further widening in the lower range and changes to other quality parameters at an appropriate stage as and when the evidence emerges. Alongside this technical review there is a parallel process reviewing the legislative and regulatory case for change.
NIA_SGN0113	**<u>Gas Quality Impacts on Industrial and Commercial applications</u>** The project aims to explore the effects of a wider gas Wobbe Index range

	including blended hydrogen mixtures (up to 20% H_2) by researching the measures in place around the world to ensure safe and efficient combustion of wider specification gas. The research will review the effects of rate of change of Wobbe Index and the frequency/magnitude of these gas quality changes and how this will impact network modelling. The industrial and commercial equipment examined will be greater than 1 MW in size and the research will also consider any instrumentation used in the burner/process that controls, measures or may be affected by gas quality. The range of Wobbe Index for this study is 45.67 MJ/m^3 to 53.25 MJ/m^3. This range is not exclusive and any appropriate information outside of this range will be considered.
The following supporting techniques were detailed within the preceding sections and a full description is also given in Section 10 – Summary List.	
NIA_SGN0126	LTS Demand Forecasting Tool Scoping Study (Phase 1)
Follow-on Innovations:	
NIA_SGN0105	**100% Hydrogen** A feasibility project to establish the technical and commercial viability of a 100% hydrogen network. The subsequent demonstration project will be to show that hydrogen can be distributed safely and reliably.
Delivery:	Comments
Deployment Time:	A new technology that took 2-3 years to deploy
Deployment Challenge:	Process challenges that need to be overcome: - Staff / training issues - Revisions to policies and procedures
Deployment potential:	This technology has been implemented within the business and is being used as a business as usual technique.
Deployment Saving:	The NIC was successful. We have successfully obtained a derogation from the Gas Safety (Management) Regulations for the Statutory Independent Undertakings (SIUs) and are working with industry bodies to introduce change to this legislation.

Roll out	Start GD1	GD1/GD2	End GD2
% of projects where technology is applicable	100%	100%	100%
% of projects where innovation is deployed	0%	100%	100%

11 Summary list of innovations annex

NIC / NIA Reference	Description
IFI	Launch Technologies
	Whilst the robotic system was a standalone product significant development work was undertaken in terms of the launch mechanisms to allow it to be introduced into live gas mains. A key challenge to overcome was the managing of the gas-air mix as it crosses the flammability limits in an environment with a non-intrinsically safe robot.
IFI	Core & Vac (also 26 Tonne Vac Excavator)
	The aim of this projects aim was to develop new techniques, products and methods that reduce or eliminate the requirement for; excavation; significant operational foot print; multi-stage reinstatement; complex traffic management; and disruption to our customers, while maintaining safety and efficiency. The ‘Core & Vac’ technique involves two main operations; the coring operation to cut and open the top surface of the carriageway; and the vacuum operation to remove the sub base and expose the gas main. This is followed by reinstatement using the Core & Vac equipment.
IFI	Crawler Cameras
	Live camera operation to inspect the internal pipework before using the CISBOT robot reduces the risk of deployment failures and improves project planning.
IFI	Serviforge
	This is a system whereby leaking threaded joints in a gas network riser may be repaired through "fogging" with anaerobic sealants. This enables multiple leaks to be sealed simultaneously without the need to tap into any joints.
IFI	Survey Replacement Matrix
	The scope of this project is to investigate and develop the capabilities of the Serviflex product range to allow for service insertions with 20mm Serviflex; live service insertion from the customer meter position to the main.
IFI	SynthoScope Camera (Live Mains Insertion)
	Development of the SynthoScope camera and its application to the live mains insertion process has allowed better planning and increased the effectiveness of the ‘live’ gas mains replacement technique. Better pre-operation planning ensures that obstacles and fittings in the carrier pipe are avoided or removed and do not disrupt operations. Maximising the use of this innovation allowed us to minimise the number of excavations required and reduce the overall disruption to both customers and road users whilst delivering efficient mains replacement projects
IFI	Synthotech Service Relay Initiative
	Repex operations throughout GD1 to replace the ageing metallic low pressure gas network and the associated service pipes. The relaying of a domestic service can be carried out using a number of methods, the first part of this project focuses on extending the use of Serviflex for replacement of ¾” service pipes using the existing Serviflex pipe. A programme of development was put in place including, modification of installation. The scope of this

NIC / NIA Reference	Description
	project is to investigate and develop the capabilities of the Serviflex product range to allow for service insertions with 20mm Serviflex, from the customer meter position. The objectives of the project were to: • Reduce the interruption time for customers requiring a service relay. • Reduce the cost of relaying a service to provide better value to the customer. • Reduce and where possible eliminate the amount of excavation and reinstatement. The successful development of the Serviflex system provides positive environmental benefits with a reduction in the number of excavations required, the time taken and the impact on the customer.
IFI	Wask PE Riser System III
	Corrosion can occur on metallic risers which require regular inspection, maintenance, protection and in some cases replacement. The WASK Riser system looks to eliminate these factors by using a range of dedicated corrosion resistant metal fittings. Standard PE pipe connects to these fitting using the WASK site-assembled crimp joint. The gas supply enters each dwelling through an outside wall by means of a WASK house entry tee or entry elbow. The system is lightweight and does not require skilled welders or pipe-fitters to install. Costs of installing the WASK riser and lateral system show significant savings compared to an all steel system. Utilising this PE Riser system can, in certain circumstances, also avoid the need to use scaffolding.
NIA_SGN0002	Immersion Tube Preheating
	To design, construct and install two innovative pre-heaters with heat output capacities of circa 100kW and 326kW, compliant with UK legislation and standards. They will employ novel burner design which offers the same efficiency as modular boilers with a simplified industrial design for long life and ease of service. This type of burner technology has not previously been utilised for gas-preheating.
NIA_SGN0003	SynthoTrax I-Seal Robot (Technical Feasibility Study)
	The scope of this project is to investigate the technical potential to develop a robotic system that can remotely travel to, locate, and seal leaking joints from a single live access point.
NIA_SGN0014	Tornado Max
	The scope of this project is to offer a new and improved piece of equipment that improves and extends the design and functionality of the Tornado air powered vacuum device for the removal of small quantities of water from pits and valve chambers, for purging redundant gas pipes, and the removal of residual gas trapped in building voids to aid the re-occupation of the occupants.
NIA_SGN0015	Pneumatic PE Pushing Machine
	Traditional service replacement has involved open cutting i.e. excavation to cut off the old metallic service at the mains. This project is looked at the potential for technical alternatives to service replacement techniques currently used within the gas industry. Throughout GD1 there was a greater focus towards service insertion and this project will looked to improve and

NIC / NIA Reference	Description
	extend the design of the PE pipe insertion machine to enable PE pipe to be inserted back to the original meter position. The aim was to reduce the number of services re-laid to meter boxes and to reduce the number of open cut service renewals. We produced a machine that will impart enough force to insert PE around three easy bends without damaging the PE and with no safety risk to the user. This process removes the risk to the operative relaying the service of any physical injury.
NIA_SGN0016	Starline/Marwin Valve Bolt Replacement
	Develop operational practices and tooling to support the replacement of corroded bolts on Starline/Marwin valves whilst pressurised.
NIA_SGN0018	Microstop
	Microstop is a bypass methodology to maintain gas supply integrity whilst replacing pipework and fittings that are in poor condition. The project was to develop the tool and methodology so that it was able to be integrated into our processes and confirm that performance of the tool conformed with UK standards and specifications.
NIA_SGN0019	Large CISBOT (Cast Iron Joint Sealing Robot)
	CISBOT is robotic technique that travels 50m either side from the point of insert along the pipe to identify and then remediate lead-yarn joints. Our development work has now created a technology capable of being carried through one excavation, carried out from the rear of a single box truck.
NIA_SGN0021	Osprey Pressure Validators
	The scope of this project is to work in partnership with Abriox (manufacturer) to support the field trial of a wireless, intrinsically safe, battery-powered remote monitoring unit that fits inside bollards, posts and meter boxes and monitors gas pressure up to 100mbarg. The aim is also to introduce competition to the supply market for this type of equipment.
NIA_SGN0022	Small Pressure Pot
	The scope of this project is to evaluate the small pressure pot to provide a more effective technique by which to seal joints, it will reduce the number of joints requiring encapsulation and as a result the size of excavation and use of expensive external contractor resources.
NIA_SGN0023	Cured In-Place Pipe (CIPP) (Stage 2)
(Collaborative Project)	The gas distribution networks (GDN) jointly initiated a project to explore the potential use of cured-in-place (CIP) liners and polyurethane spray linings as a method of permanent rehabilitation of ageing iron distribution mains. The initially finding and engagement with suppliers who could deliver a CIPP solution for gas was key challenge. Historical attempts at deploying this technology have failed but they were exhumed for testing. Gap analysis and technology review was then done to demonstrate; fitness for purpose of CIPP lining technologies, focusing on iron mains of 8" diameter and above operating up to 2 barg pressures. The project is still ongoing however if successful the output may demonstrate

NIC / NIA Reference	Description
	that CIPP technology could potentially provide reliable method of long term risk managing larger diameter mains up to and including 2 barg.
NIA_SGN0024	RCA GPS Survey (Geofield)
	By implementing an electronic data exchange and capture process to greatly reduce the possibility for error while at the same time increasing efficiency and reducing the timeline of the process. The envisaged solution will use a GPS enabled device for use in the field coupled to a data exchange server running geospatially orientated data capture software.
NIA_SGN0026	Customer Self Isolation and Restoration
	The principal reasons for supporting this project are through reducing the duration of a gas outage / incident. This would reduce the cost of the incident and minimise its impact on consumers. It is estimated that this approach could reduce the duration of an incident by approximately 70%. This, in turn would reduce the cost of the consumer isolation and restoration element and the consumer compensation element of the incident by a similar amount.
NIA_SGN0027	Water Extraction Reel & Y Branch
	New equipment to be used in conjunction with current mains camera equipment to detect and remove the water inside of the low pressure network.
NIA_SGN0028	Gas Eco (GECO) Gas Pump
	SGN identified an issue when decommissioning and abandoning gas pipes and gas holders as the gas contained within them is currently vented to atmosphere. This has an environmental impact which we looked to resolve. Pipetech Pipeline Technology Ltd helped SGN develop a prototype gas pump, powered by compressed air. Pipetech manufacture Prototypes pumps which are single stage air powered gas pumps capable of pressurising gas that would normally be released in to the atmosphere after abandoning pipes. This enables the previously vented Gas to be injected back into the Gas network.
NIA_SGN0030	Self-Amalgamating Tape (Stage 2)
	A number of innovations have been developed that look to minimise customer disruption through limiting or removing the requirement for supply isolation. Additional benefits are achieved by promoting temporary repair by the First Call Operative and affording a proactive/managed approach to the permanent repair.
NIA_SGN0031	Stent Bag
	The scope of this project is to design, develop and test an innovative stent bag system that can maintain gas supplies during high volume gas escapes and reduce the potential loss of supply to customers.
NIA_SGN0033	Long handled PE Top Tee Cutter
	The scope of this project is to investigate and develop a tool to provide a safer, more user friendly and efficient method of commissioning a polyethylene top tee without having a detrimental effect on the integrity of the top tee.

NIC / NIA Reference	Description
NIA_SGN0035	Beyond Visual Line of Sight Aerial Inspection Vehicle (Drone)
	The scope of this programme of work by VTOL Technologies is to develop an RPAS BVLOS specification that is endorsed by the CAA which can then be used to develop a RPAS
NIA_SGN0046	Cotter Plate Identification and Remediation (Stage 1)
	SGN has seen many changes in the types of materials used in the construction of its distribution. This project addresses problems associated with a specific gas fitting called a 'Cotter Plate' which are known weak parts of the network, but cannot be easily identified. These fittings are primarily associated to the Greater London area as this was the main repair technique used during the blitz after successful bombing campaign. This project looked to develop a method of locating and remediating Cotter Plates. SGN developed and refined a method to identify likely Cotter Plate locations using historical records of bomb damage. This information was translated in to a Map (GIS) output. Trials in the identified area areas were done to validate this, the repair process was incorporated in to SGN CISBOT programme.
NIA_SGN0051	Olympic Rings for RIIO
	The development and testing of a multiple coring system within highways to reduce the requirement for conventional excavation, allowing existing equipment to be used within core and vac excavations.
NIA_SGN0052	Core Drilling and Flow Stop, WASK
	This project is to develop equipment to undertake under pressure drilling, tapping and sealing, including installing a bypass facility, through a 600mm diameter core excavation on 4-12" diameter mains operating up to 2 barg.
NIA_SGN0056	Mains and Service Replacement through a keyhole
	Design, develop and manufacture a mains replacement insertion system for live or dead insertion of pipes (63mm through to 180mm diameter) inside existing metallic pipes from a 600mm diameter cored keyhole excavation.
NIA_SGN0061	40mm Serviflex
	Network risers within multiple occupancy have an inherent level of risk if there were ever a gas leak incident. Most network risers are constructed in steel which depending on the environment its located can be susceptible to corrosion. 40mm Serviflex offers the same solution and benefits to network risers as 20mm Serviflex provides to domestic services. This project developed an initial prototype system by Radius Systems Ltd for the renewal of below ground network riser entry's by inserting 40mm serviflex. The entry pipe in to a multi-occupancy building is often built into the structure minimising any access to the pipe. The objective of this project is to prove the suitability of 40mm Serviflex pipe to insert in to the existing steel pipe thus renewing it. The application of this new approach now provides benefits to is customer by minimising disruption but also replacing below ground building entry.

NIC / NIA Reference	Description
NIA_SGN0064	Advanced Gas Detection
	SGN working with GMI to develop gas detection equipment which will build on instruments that are already being used by GDNs throughout GB. The project will develop a new method of managing site investigation data. Currently hardcopies of LIS worksheet pads are collected from the operatives once completed and stored for three years in each depot. The GS700 unit will have the ability to record the data electronically, using a web based application. This has the potential to allow full site work history to be available anywhere across the business, providing a rigid audit trail, whilst removing the need for a resource to manually manage the hardcopies of LIS.
NIA_SGN0067	Smart Paint
	The scope of this project is to investigate the latest developments in paint and coating technology and products for use on SGNs plant. This would allow the potential for utilising more cost effective solutions for the protection of both above and below ground assets.
NIA_SGN0070	Magnetic Filtration in Medium to Low Pressure Networks
	This project is to investigate the latest developments in magnetic filtration technology for use on SGN plant. This would allow the potential for utilising more cost effective methods of gas filtration on the network pressure regulating stations, with the potential to remove the restriction on Low Pressure networks, returning the systems to their full operating parameters.
NIA_SGN0072	SynthoScope
	Live insertion is a more challenging operational process whereby the more accurate information you have the better planning and design considerations you can make in advance of the operation. Operationally live insertion is a much more technical way of inserting mains than open cut or dead insertion. However, this innovation has allowed us to change our processes. Associated with the deployment of the live camera and increases the associated project preparatory works, but including overall delivers maximised mains insertion design, quicker and efficient on-site gas works site, minimising customer disruption and significantly reducing the time any customer is off gas. This innovation and change in process to deploy it this has allowed live insertion to become the predominant replacement technique used in SGN.
NIA_SGN0073	Corrosion Mapping for Buried Orpheus Regulator Modules
	Project to enable the internal long-range NDT inspection of buried Orpheus regulator modules without having to excavate or grit-blast the pipework. Eliminating environmental concerns arising from waste disposal issues caused by grit blasting and associated excavation materials.
NIA_SGN0077	Solutions to Pipeline Graphitisation and Corrosion – Stage 1
	A significant proportion of the gas distribution network comprises cast iron pipelines which all GDNs have a commitment to replace. Methodologies used to management this activity from high level perspective are based on the potential impact and resultant incident based on a fractured main not the long-term degradation based on graphitisation and/or corrosion.

NIC / NIA Reference	Description
	This project developed the learning from previous NIA projects (NIA_NGGD0014 CIFFP) and looked at the prevention of the onset of degradation occurring and ways of arresting further degradation preventing the situation worsening. This study reviewed the causes of pipeline corrosion with particular emphasis on the unique challenges of graphitisation. This project looked to prove the concept of dealing with the issue of pipeline corrosion and more specifically to: • develop systems to prevent the onset of pipeline corrosion • develop systems to arrest existing corrosion processes This completed feasibility study generated further assessment work and future project concepts such as IronClad (NIA_SGN0111).
NIA_SGN0078	Utilisation of the Modular NIC Robotics Platform
	A feasibility study to review existing methods/products/technologies that could be deployed from the robotic platform. The outputs from this project have informed Cirrus and a future robotics programme.
NIA_SGN0079	Automated Pressure Tester
	This project proposes to develop an automated pressure tester. This proposed device aims to help ensure the accuracy and consistency of the testing and data recording process while removing the potential for human error and providing the opportunity to automatically update our asset records via a suitable cloud based service.
NIA_SGN0081	Interruption Solutions – Live Meter, and Service Replacement (Stage 1)
	Network licensees endeavour to minimise interruption to customer supplies during engineering works wherever possible. This project aimed to investigate the potential reduction in interruptions by reviewing the feasibility of live service and live ECV renewal. The objective was to identify any existing gas industry technologies that could reduce the number of unplanned customer interruptions.
NIA_SGN0082	Automated Regulator Maintenance (ARM) (Phase 1)
	This system is an electronic regulator diagnostics system that can be operated both remotely and manually to further improve the operational safety and efficiency measures, as well as modernise the capabilities of maintenance activities. The aim of the Project is to trial the Plexor inspection system on a regulator stream ranging in pressures from 0.4 to 75 bagr, semi-automatically onsite and remotely using Global Positioning System (GPS) as a location mark.
NIA_SGN0086	Cured In-Place Pipe (CIPP) (Stage 3)
	The gas distribution networks jointly initiated this project to explore the potential use of cured-in-place (CIP) liners and polyurethane spray linings as a method of permanent rehabilitation of ageing iron distribution mains. The initially finding and engagement with supplier’s who could deliver a CIPP solution for use in the gas industry was key challenge. Gap analysis and technology review was done to demonstrate; fitness for purpose of CIPP lining technologies, focusing on iron mains of 8” diameter and above operating up to 2 barg pressures. The project is still ongoing however if successful and

NIC / NIA Reference	Description
	implemented prior to the end of GD1, the output may demonstrate that CIPP technology could potentially provide a reliable method of managing long-term risk in larger diameter mains.
NIA_SGN0088	Advanced Minibag
	This project is to produce an Advanced Minibag Kit to facilitate the exchange of ECVs, whilst removing the need to excavate and physically isolate the gas service.
NIA_SGN0092	Pit Protect (Unsuccessful)
	This project is to evaluate and report on the nature and extent of the pit wall water ingress within the SGN network.
NIA_SGN0105	100% Hydrogen
	The scope of this feasibility project is to establish the technical and commercial viability of a 100% hydrogen network demonstration. The subsequent demonstration project will be to demonstrate that hydrogen can be distributed safely and reliably.
NIA_SGN0106	Strategic Pipeline Heat Study
	The strategic heat study will aim to evidence how to optimise our alarm, control and operating philosophies to increase energy efficiency, reduce unnecessary call outs and potentially eliminate the requirement for lagging. Many of our sites have preheating systems installed to manage the Joule-Thomson effect from pressure reduction. There are a significant number of alarms and faults associated with preheating control systems. If we can optimise our control systems we hope to be able to eliminate unnecessary callouts.
NIA_SGN0107	IGEM Gas Quality Standard Working Group
	The principle objective of the working group is the production of an IGEM standard covering UK gas quality specification in order to facilitate a change from GS(M)R that reflects the decline in UKCS, the available alternative sources of gas and aligns with the European standard. The standard will set the Wobbe Index (WI) range appropriate for the UK initially examining the extension of the upper range. The specification will also examine the further widening in the lower range and changes to other quality parameters at an appropriate stage as and when the evidence emerges. Alongside this technical review there is a parallel process reviewing the legislative and regulatory case for change.
NIA_SGN0110	Remote Site Monitoring
	GDNs have 'at risk' mains that are not leaking but require frequent monitoring as a risk management measure prior to direct replacement being carried out. SGN also have sites where work is being carried out but remain live and require periodic checking. This project will look at alternatives to human resources, and will develop a battery powered remote monitor that, when installed, will allow gas readings from an existing job to be automatically transmitted direct to the Cloud. This will allow readings to be monitored remotely, more frequently and automatically escalate activities as necessary.
NIA_SGN0112	Forged Carbon Fibre Products (FCFP) - Stage 1

NIC / NIA Reference	Description
	The project will facilitate the development of the basic products and includes additional conceptual design to refine the FCF products given the unique material properties. Further evaluation of the preliminary tools and moulds will enable final selection of products/product components.
NIA_SGN0113	Gas Quality Impacts on Industrial and Commercial applications
	The project aims to explore the effects of a wider gas Wobbe Index range including blended hydrogen mixtures (up to 20% H_2) by researching the measures in place around the world to ensure safe and efficient combustion of wider specification gas. The research will review the effects of rate of change of Wobbe Index and the frequency/magnitude of these gas quality changes and how this will impact network modelling. The industrial and commercial equipment examined will be greater than 1 MW in size and the research will also consider any instrumentation used in the burner/process that controls, measures or may be affected by gas quality. The range of Wobbe Index for this study is 45.67 MJ/m^3 to 53.25 MJ/m^3. This range is not exclusive and any appropriate information outside of this range will be considered.
NIA_SGN0117	Bolt Integrity
	This project sets out to develop a reinforcement clamp for use on live site and prove the procedures for its use within SGN
NIA_SGN0118	High Volume Gas Escapes (Stage 1)
	This project aims to provide a solution which can quickly and effectively repair a leaking pipe at the leak source. This project will therefore seek to identify and develop a number of prototyped options for responding to high volume gas escapes from low pressure pipelines. The work outlined in this proposal is focused on low pressure pipes, but will ideally also be appropriate for medium pressure pipes. This encompasses both metallic and PE pipes, and diameters of 63mm to 1200mm.
NIA_SGN0121	Hypercube
	This was a project to develop a Network Analytic Platform (NAP) model which will integrate within existing replacement processes, as well as developing a GIB (Gas in Building) event algorithm.
NIA_SGN0122	Remote pressure control and management
	The project is delivering the ability to remotely adjust gas pressures via connected pressure management devices. SGN currently rely on several pressure control systems to manage their distribution networks; however, some of this existing technology is becoming outdated and while considering a solution to this problem SGN became aware of a new engineering design company called Utonomy.
NIA_SGN0126	LTS Demand Forecasting Tool Scoping Study (Phase 1)

NIC / NIA Reference	Description
	Produce a comparative assessment of potential for a bottom up demand forecasting system against current industry top-down processes outline benefits to GDNs. Identify further project phases that will look to develop and implement a novel demand forecasting tool with consideration to ongoing operation and maintenance.
NIA_SGN0128	BVR (Furmanite Ball Valve Replacement)
	External corrosion has been identified on auxiliary valves on the impulse rails to the governors. The external corrosion is due to condensation from pressure reduction, and galvanic corrosion due to dissimilar metals. There are a significant number of governors within SGN network operating at 2 to 7 barg consisting of approximately 1600 Streams. Currently the governors must be bypassed or isolated at the fire valve to enable the valves on the impulse rails to be removed and replaced. This can often lead to a stream replacement or a full governor replacement.
NIC_SGNGN01	CIRRUS
	Development of a more versatile robot that if successful could seal other joint types (i.e. non- lead iron joints). These currently make up <20% of the existing joints on our Tier 2/3 network. We are currently looking to establish the appropriate implementation processes.
NIC_SGNGN02	Opening Up the Gas Market
	Great Britain (GB) is now a net importer of gas, with prices and access to supply increasingly depending on international markets. Hence, GB gas prices exhibit volatility, given the short-term and/or spot market conditions. Whilst the sources of new natural gas are numerous, gases have different compositions and GBs specification for gas composition is very prescriptive, therefore limiting the gas market and exacerbating the problem. Current arrangements dictate that in order for gases with compositions that sit outside of GBs specification to be conveyed and used within GB, expensive gas processing is required to bring them within these specifications. This limits the type and source of gases which can be used in GB and, in turn, ultimately leads to increased costs for the consumer.
NIC_ SGNGN03	Real Time Networks
	This project seeks to demonstrate a 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.
NIC_ SGNGN04	Robotic Roadworks and Excavation System (RRES)
	The next transformational phase in the performance of network excavations and operations will require the integration of Artificial Intelligence (AI) with advanced digital tooling to automate routine works, making them quicker, safer, more cost effective and consistent. The system will use advanced robotic arm technology fused with a mobile platform and AI working with a suite of sensors and controls to enable autonomous, safe and efficient mains excavation. Once exposed, the RRES will attach a newly developed universal access fitting to the main to enable a set of inspection and maintenance operations to be performed.

NIC / NIA Reference	Description
NIA_NGGD0014	Cast Iron Fitness for Purpose (CIFFP)
(Collaborative Project)	The Gas Distribution Networks (GDNs) are investigating various techniques to assess the condition of Cast Iron (CI) pipes including, coupon removal for localised metallurgy, internal pipe inspections (inner/outer wall corrosion. This project took an in-depth review and assessment of technologies and methodologies that provide intelligence on the fitness for purpose of CI pipe. This project developed a methodology that satisfies obligations under the Pipeline Safety Regulations (PSR) to enable Tier 2/3 pipes to be safely maintained for continued use, or be categorised in such a way to prioritise for remediation or decommissioning.
NIA_NGGD0055	Development of Gas Industry Specification for Polymeric Pipe Lining Systems for Multi-Occupancy Buildings
(Collaborative Project)	There are a large number of multi-occupancy buildings across the country with internal gas risers. These risers, usually constructed of steel or copper, are approaching the end of their expected operational life. This project developed a new publication of a new Gas Industry Standard (GIS) that defines what a suitable and sufficient design and performance specification should be in order to demonstrate compliance with relevant legislation. This project developed a robust performance specification for the use of polymeric pipe lining technology for use within multi-occupancy buildings. The development of the specification and test procedure was to standardise a coating/lining system as a validated technology for lining risers that could demonstrate its fitness for purpose. The output was specifically documented in a Gas Industry Standard that was agreed unanimously by all participating networks, providing a comprehensive objective technical specification to facilitate the evaluation, verification and certification of any new innovative polymer lining technology.
NIA_WWU_033	Development of a Risk Based Approach for Safe Control of Operations (SCO)
(Collaborative Project)	Development of an innovative risk based approach to the selection of suitable methods of control such as permits to work, non-routine operations, routine operations and method statements. A supporting innovation that improves the timing of work by integrating SCO procedures into a competency management matrix. Develop a new risk based methodology to improve how complex tasks are planned, executed, and managed to enhance operational control whilst potentially streamlining the administrative process for all GDNs.