

**Gas
Transmission**

nationalgrid

GT Information Technology Investment Plan

IT Annex A20.03

December 2019



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1 EXECUTIVE SUMMARY

This annex provides an overview of our proposed Information Technology (IT) Direct investments for RIIO-2 and how they support National Grid Gas (NGG) in meeting the expectations and priorities set out by our stakeholders. It provides details on the requirement for each investment, how it aligns to our stakeholder priorities and the broader needs of the business.

We began the journey to modernise our IT in RIIO-1 by refreshing major systems and putting in place foundations we can build upon to meet future needs. In RIIO-2 we will invest **£180.1m** to consolidate and modernise our IT systems and capabilities. This will enable us to continue to maintain and operate a safe, efficient and reliable network and provide capability to meet the needs of our customers and stakeholders.

Below is a summary of what we plan to deliver against our stakeholder priorities:

 <p>I want the gas system to be safe</p> <p>£4.5m</p> <p>We will ensure the safety of the public and employees by using geospatial systems to visualise our pipelines and understand their environment.</p> <p>We will enable investigation of potential pipeline infringements identified by helicopter surveys.</p>	 <p>I want to take gas on and off the transmission system where and when I want</p> <p>£111.7m</p> <p>We will maintain and refresh the IT systems that give us oversight and control of the physical and commercial operation of the NTS and allow us to manage our assets.</p> <p>We will invest in new modelling capability to allow us to improve the way we manage risk.</p>	 <p>I want all the information I need</p> <p>£10.5m</p> <p>We will continue to work with the industry to agree and prioritise the information it needs.</p> <p>We will maintain and refresh our IT systems accordingly.</p>
 <p>I want you to facilitate the whole energy system of the future – innovating to meet the challenges ahead</p> <p>£49.9m</p> <p>We will support transition to a low carbon energy future by enhancing our IT systems to support industry changes through the RIIO-2 period.</p> <p>We will deliver a balancing and capacity system built around customer needs. We will also innovate and grow our technology capability.</p>	 <p>I want to connect to the transmission system</p> <p>£3.6m</p> <p>We will further digitise our processes and interactions with our customers.</p> <p>We will invest in our customer tools to improve the connection process and support our changing customer base, by becoming quicker, more responsive and transparent throughout the customer journey.</p>	

We have estimated our IT investments based on previous experience of delivering similar projects, engagement with our delivery partners and ongoing discussions with industry analysts. Our cost estimates are benchmarked by independent IT analysts, Gartner, against a range of similar investments across multiple industries, and have confirmed them to be broadly within their overall benchmark ranges.

1.1 Scope of the IT Annex

Our IT investments are split into two categories: those specifically for the benefit of a business entity (IT Direct) and those that are shared IT investments made centrally within National Grid Group IT to benefit the group (NG IT Direct). There are three IT Direct investments across NGG, NGET and ESO. This IT Annex focuses on the NGG IT Direct investments, as shown below.

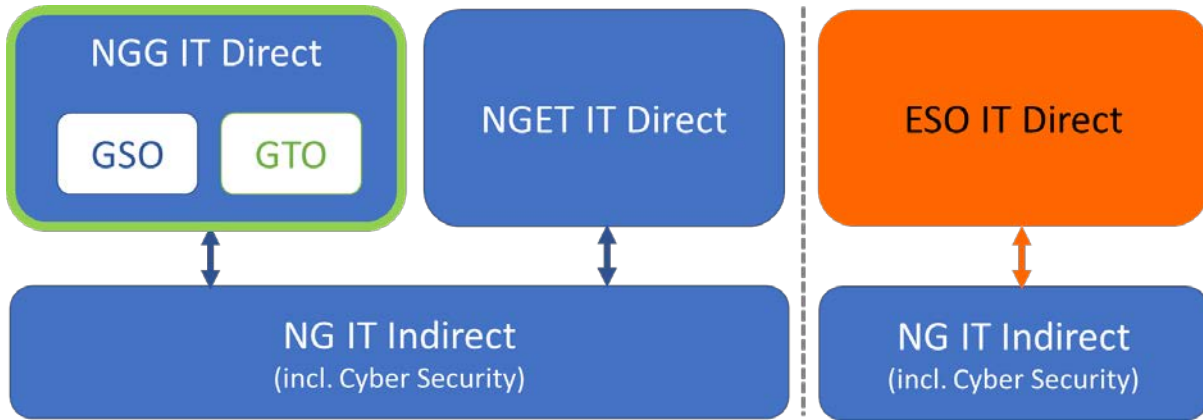


Figure 1: Scope of the IT Annex

1.1.1 NGGT IT Direct Investments

The NGG IT Direct investments cover our Gas Transmission Owner (GTO) and Gas System Operator (GSO) businesses. These investments are highly interdependent with and reliant upon our NG IT Indirect investments. There is also close alignment between GTO and NGET investments due to the nature of these businesses. These interdependencies are covered in outline in section 2.3.4 and in detail in section 3. The proposed NGGT IT Direct investment is **£180.1m**.

1.1.2 NG IT Indirect Investments

The NG IT Indirect investments are shared investments leveraging group IT to deliver the IT environment that provides NGG with efficient, scalable, reliable IT services. This enables the economies of scale for procurement and unlocks access to global support providers.

Our Indirect IT investments fall into five categories: Hosting, Enterprise Networks, Businesses Services, End User Compute, and IT and Digital Operations. The regulated businesses fund a proportional or allocated cost of these systems for their needs. These investments are outlined in detail under the following Indirect Annexes:

Annex	Title
A20.06	Infrastructure Hosting Services
A20.11	Enterprise Networks
A20.09	Business Services
A20.13	End User Compute
A20.20	IT Operations and Tooling
A15.07	Cyber Security

Whilst the delivery, management and maintenance of these infrastructure services are considered separate to the IT Direct business drivers, they are an integral part of our IT and underpin our RIIO-2 plan.

1.2 How you should read this IT Annex

Our IT annex consists of the following three core sections:

Chapter 2: Introduction to our RIIO-2 Plan

- A summary of our IT investment story so far within RIIO-1
- An outline of our RIIO-2 Investment plan, including how we have structured the plan to align with stakeholder priorities, the IT capabilities that are need to deliver them and our categorization of consumer benefits
- The key interdependencies with our investments between entities and Indirect investments
- How we costed and benchmarked our investments
- Key risks to delivering our plan

Chapter 3: NGG IT Investments

- A detailed description of our NGG IT Direct investments by stakeholder priorities and the IT capabilities they delivery
- The needs case for each investment, our cost estimates and how their rank against Gartner's benchmark, the options we have considered and our recommendations for proposed solutions
- How our investments support NGG in delivering consumer benefits

Chapter 4: How we deliver the plan

- Our IT delivery model and how we have organised to deliver the RIIO-2 plan
- The best practice processes, methods and tools that underpin how IT capabilities
- Our approach to programme delivery to cater for agility and operating using a bimodal approach
- The change delivery framework that we use to manage change in our organisation

2 OUR RIIO-2 PLAN

Our RIIO-2 plan will deliver an efficient, flexible and reliable network, with the right capabilities to meet the needs of current and future customers, enabling Great Britain’s energy transformation. To achieve these goals, we must invest in our IT to continue to drive efficiency, enable innovation and deliver the levels of reliability and safety that our customers and consumers have told us they expect.

Throughout RIIO-1, we have continued to invest in the underlying health of our IT systems. IT is increasingly a core enabler to how we operate. It supports what and how we will deliver against our stakeholder priorities. For the purposes of this document we have linked all NGG IT investments to the stakeholder priority where most benefit is realized. However, most investments support multiple priorities.

2.1 Our RIIO-1 Story

Although we are only part way through the RIIO-1 period we have largely delivered, or are on track to deliver, what we said we would in our submission. Through the current period, we have invested in:



Figure 2: RIIO-1 Investment Summary

2.2 Our Proposed Investments Areas for RIIO-2

Our RIIO-2 plan will:

- Sustain our core IT systems:** we will maintain the technology health of our core IT systems that manage our asset health, data, work, and operation of the network. Many of these systems will be reach end of life during the RIIO-2 period, and in line with our IT Asset Health policy (see Appendix 1), we will invest to ensure we maintain our safety and reliability performance for our stakeholders whilst extracting the most value for money from our systems.

- **Support market and regulatory change**, unlocking consumer and customer value through, developing ensuring our IT systems to support the delivering the future energy system and transition to a low-carbon future.
- **Delivering new capability** in areas such as data management, analytics, AI and machine learning to deliver our stakeholders' needs.

Through RIIO-2, the areas we intend to invest in are:



Figure 3: Our RIIO-2 Investment Areas

2.3 How we have built our RIIO-2 Plan

We have built our investment plan by reviewing the stakeholder priorities and the key technology capabilities that are required to deliver these. We grouped investments into common IT capability areas, such as for instance digital experience or insights and innovation. These are illustrated by our IT capability model (see Figure 4). Each stakeholder priority may be mapped to multiple IT capabilities.

Each of our IT investments contain: a needs case, the technical options we considered to deliver the solution, our cost estimates for the recommended option, Gartner's benchmark of the investment and a summary of how this investment delivers consumer benefits.

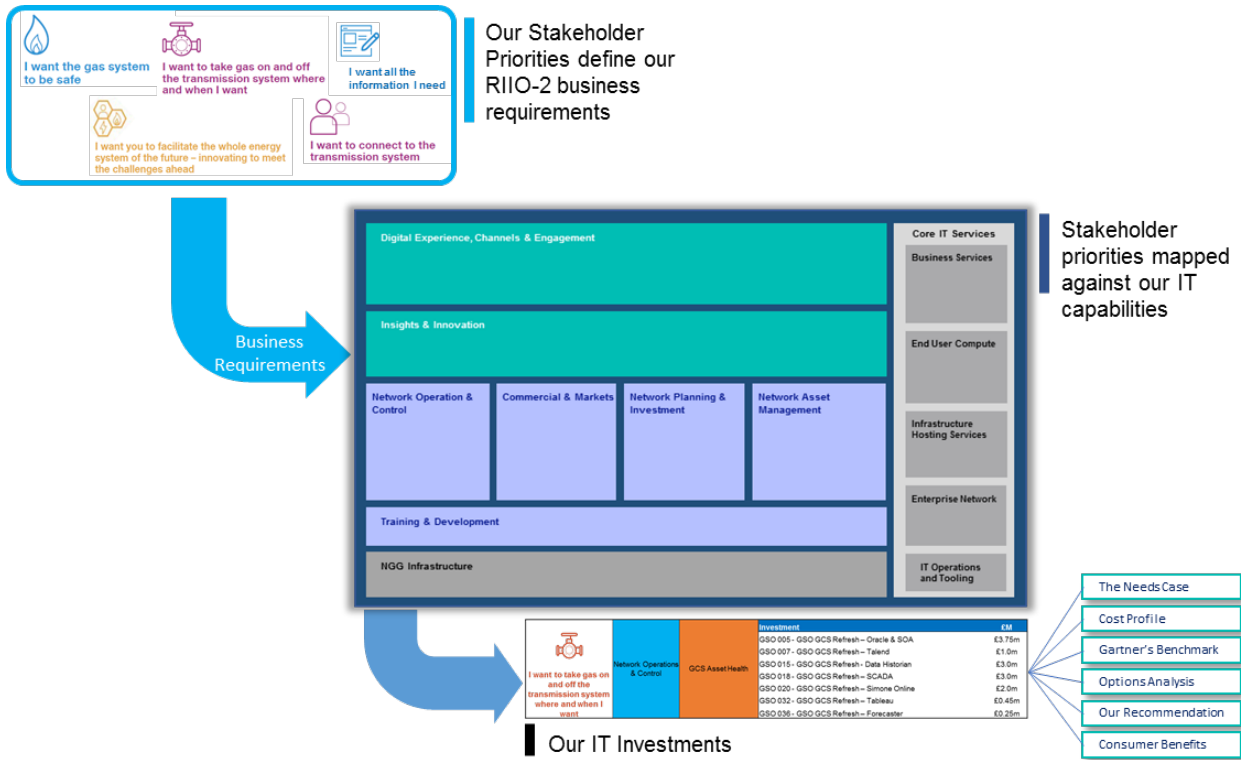


Figure 4: Our IT Investments are built from IT capabilities required to deliver our stakeholder priorities

2.3.1 Our IT Capability Model

Our IT Capability Model describes the key technical capabilities that we require to deliver the RIIO-2 plan. Each of these capabilities are underpinned by IT platforms or services that work together to deliver business solutions (see Figure 5). These business solutions are dependent upon core IT services provided by group IT (covered by our IT Indirect investments) such as back office business services, desktop and server infrastructure, cloud hosting and network services.

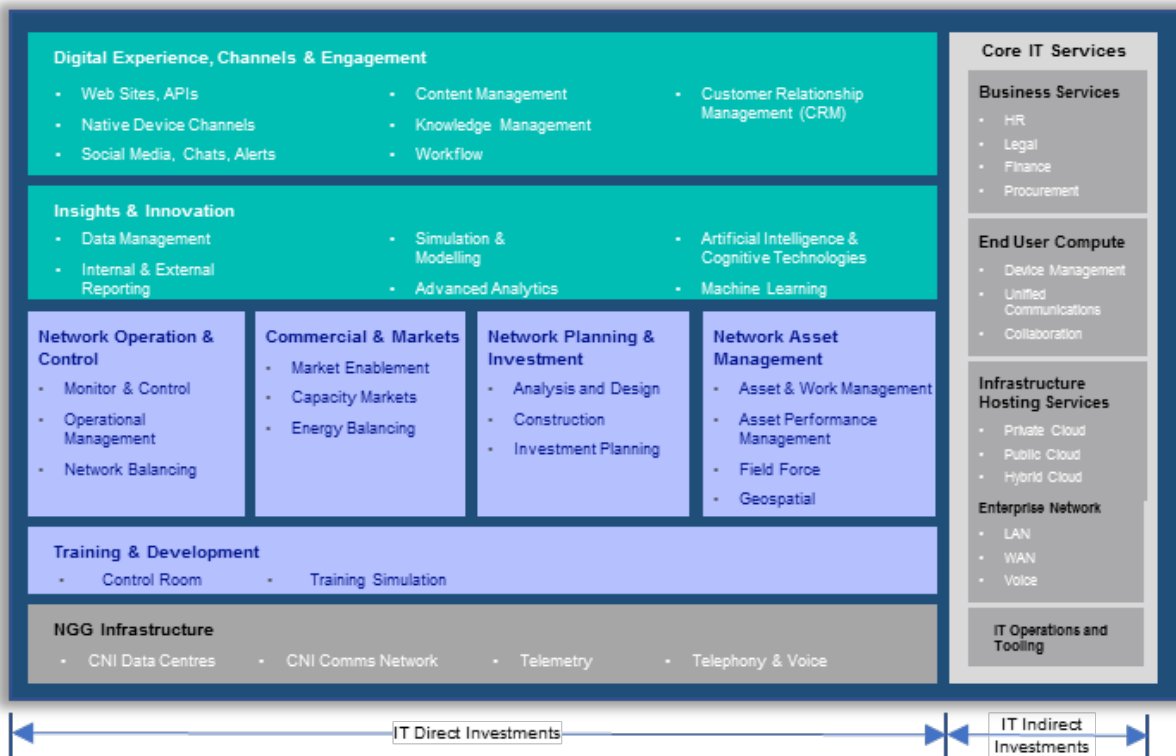


Figure 5: Our IT Capability Model

The IT Capability Model allows us to drive synergies by investing in common platforms and services, where that is beneficial, to ensure efficient and consistent delivery of business capability. Examples of efficiencies we can deliver through this approach include for instance:

- Cost efficiencies in software licencing, skills for implementation, infrastructure & support
- Consistency in the quality of our technology development and delivery activities
- Alignment and reuse of technology across National Grid, for instance in areas such as sharing cloud platforms, enterprise customer platforms and business support services.

We build complex engineering solutions using these platforms and services and supplement them with bespoke components, where there are unique requirements. We have summarised each of the IT capabilities below:

- **Digital Experience, Channels & Engagement** - This capability provides us with technology to share data with the market and support customers in accessing our services. This includes providing portals for our customers to communicate with us and the ability for us to share raw data with stakeholders for them to incorporate into their own systems and processes.
- **Insights and Innovation** - The Insights and Innovation capability provides a consistent repository for our data, supporting our understanding of how the network and our assets are performing. It enables us to take advantage of advanced analytics and data analysis using modelling, simulation and machine learning to optimise our operation of the network and support efficient asset management. A consolidated platform of data supports the removal of siloed data and enables us to monitor and improve data quality.
- **Network Operation and Control** - Our Gas Control and Management systems are designed, developed and operate across this capability to support the operation of the network. This capability incorporates requirements to meet Critical National Infrastructure (CNI) standards ensuring service and security of its operation.
- **Commercials and Markets** - This includes the systems and services which support NGG's commercial and market processes, such as our balancing & capacity system, Gemini.
- **Network Planning and Investment** - Solutions to enable network analysis and design and support the assessment, planning and management of interventions on our assets are provided by this capability.
- **Network Asset Management** - This capability supports the efficient asset management of our assets by holding our asset data and its condition and providing tools to plan and execute work. It enables us to understand where our pipeline assets are in the country and track and manage our field force work delivery.
- **Training and Development** – this includes capabilities to support the training of our key operational staff the network control rooms
- **NGG Infrastructure** – These capabilities are enablers to the above. We need the right level of infrastructure to meet the acceptable level of speed, capacity and security with our systems so that both our staff and our customers receive the right level of service. Our infrastructure allows for our communication network to work, ensuring messages are passed through safely and securely.

2.3.2 How we have structured our IT Investments

Our IT Direct investments are categorised by stakeholder priorities and mapped to IT capabilities and summarised in Figure 6 below.

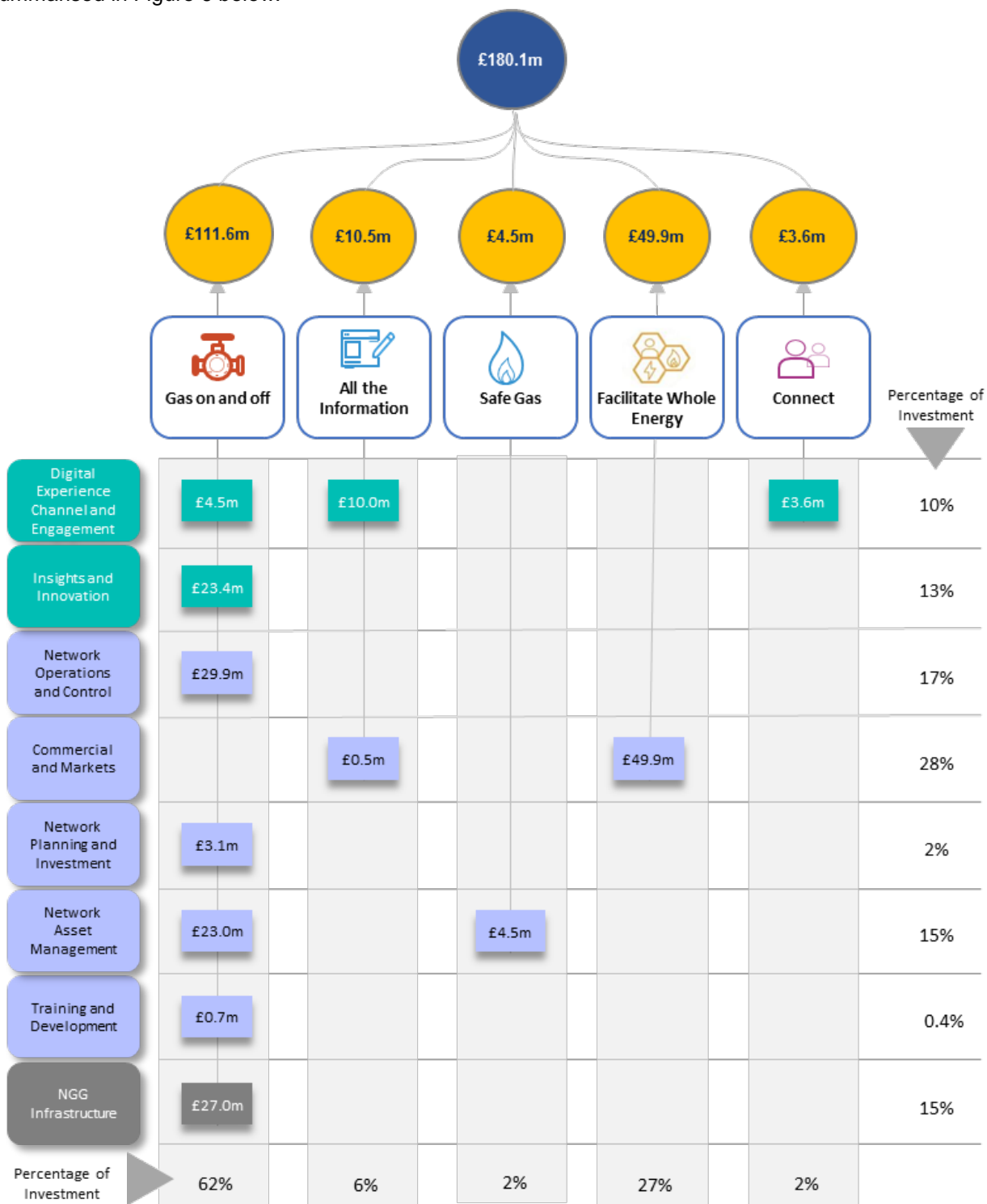


Figure 6: A summary of our IT investments by stakeholder priority mapped to IT capability

Throughout our RIIO-2 submission build process we've continued to ensure all our investment proposals are aligned to our key stakeholder priorities ("KSPs"). Our IT Direct investments uniquely align to multiple KSP's and as part of our drive to ensure explicit linkage and driving greater investment efficiency, investment alignment has developed as our submission has advanced. To ensure high level integrity, our total costs are consistent throughout our submission, however, IT Direct investments are approximately aligned to KSPs via a percentage apportionment in the wider submission. This results in KSP value misalignment in a handful of direct investments to the wider submission, however there is complete overall cost alignment.

2.3.3 How We Categorised Consumer Benefits

In all that we do, our aim is to deliver the highest possible benefit for consumers; while we do not have direct contact with consumers, they benefit from our activities in the following five ways against which we have assessed each of the investments described in Section 3:



Improved safety and reliability

Today, gas delivers three times as much energy as electricity; it keeps 80% of the UK's 28 million homes¹ warm and comfortable. We will continue to focus on system balancing and security at optimum cost in line with expectations that Government, the regulators and the consumer have of us.



Improved quality of services

We have been working hard to transform how we engage with stakeholders by listening to what stakeholders want from us and delivering what we can, explaining why we can't in certain situations. This more collaborative approach is enabling us to shape how we do things, enables us to prioritise our work and improve our quality of service. This in turn improves the end-to-end value chain across the industry making it more seamless, efficient and effective which ultimately benefits the end consumer.



Lower bills than otherwise the case

We take a strategic approach to our investments across the gas network, working with the other half of our business, the Gas Transmission Owner and customers so that long-term economic and efficient outcomes are being selected and driven when planning, developing and investing in the network. Nearer real-time, we manage balancing costs by focusing on controlling, reducing and optimising our spend on balancing and operating the system for which we are also incentivised. We are therefore lowering consumer bills by working to control, reduce and optimise elements of the system charges which we may impact and influence.



Reduced environmental damage

National Grid is committed to doing the right thing every day, which includes supporting the nation reduce its greenhouse gas emissions and journey towards Net Zero 2050. We will look for new and innovative ways to run our network safely and securely while reducing our overall emissions and impact on the environment and communities.



Benefits for society as a whole

Creating a cleaner, more efficient energy system (a decarbonised energy system), could add 19 million jobs and \$52 trillion of gross domestic product (GDP) to the global economy². Proportionate economic benefits would be experienced across Great Britain as well as general environmental and health benefits such as physical health benefits from reduced air pollution, and mental health benefits from greener living and more liveable cities (co-benefits of GHG emission reduction).

¹ Department for Business, Energy & Industrial Strategy, Energy Consumption in the UK (ECUK) 1970 to 2018 July 2019. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/820843/Energy_Consumption_in_the_UK_ECUK_MASTER_COPY.pdf

² Towards 2030 – A System Operator for Great Britain's Energy Future April 2019 <https://www.nationalgridgas.com/news/towards-2030-system-operator-gbs-energy-future>

2.3.4 Investment Interdependencies and Synergies

Our NGG IT Direct investments have interdependencies with IT investments in other business entities in National Grid as well as with our IT Indirect investments. This includes for instance shared systems and functionality between GTO and GSO in network analysis, where both businesses work together to operate and maintain our Gas network and also in managing customer interactions in the connections processes.

GTO also shares many of its systems with National Grid Electricity Transmission (NGET), due to inherent similarities in operational structures and business processes in the two transmission businesses, for example in asset maintenance, asset performance management and field operations.

These shared systems and capabilities deliver synergies and economies of scale within our entities and across our National Grid businesses. This allows us to deliver more efficient implementations and running costs for our IT systems. Our investments reflect this alignment and we have outlined where we have shared investments in section 3. Any change in the IT Direct investment plans for GTO, GSO and NGET will therefore have a commensurate impact on shared investments across these entities.

As discussed earlier, NGG along with other National Grid entities leverage group IT services covered by our IT Indirect investments. These include for instance: core back office business services, desktop and server infrastructure, cloud hosting services and network services as well digital services. Our NGG IT Direct investment plan is critically dependent upon these core IT services and as such any changes in the IT Indirect investment portfolio will have a consequential impact in our ability to deliver the RII0-2 plan.

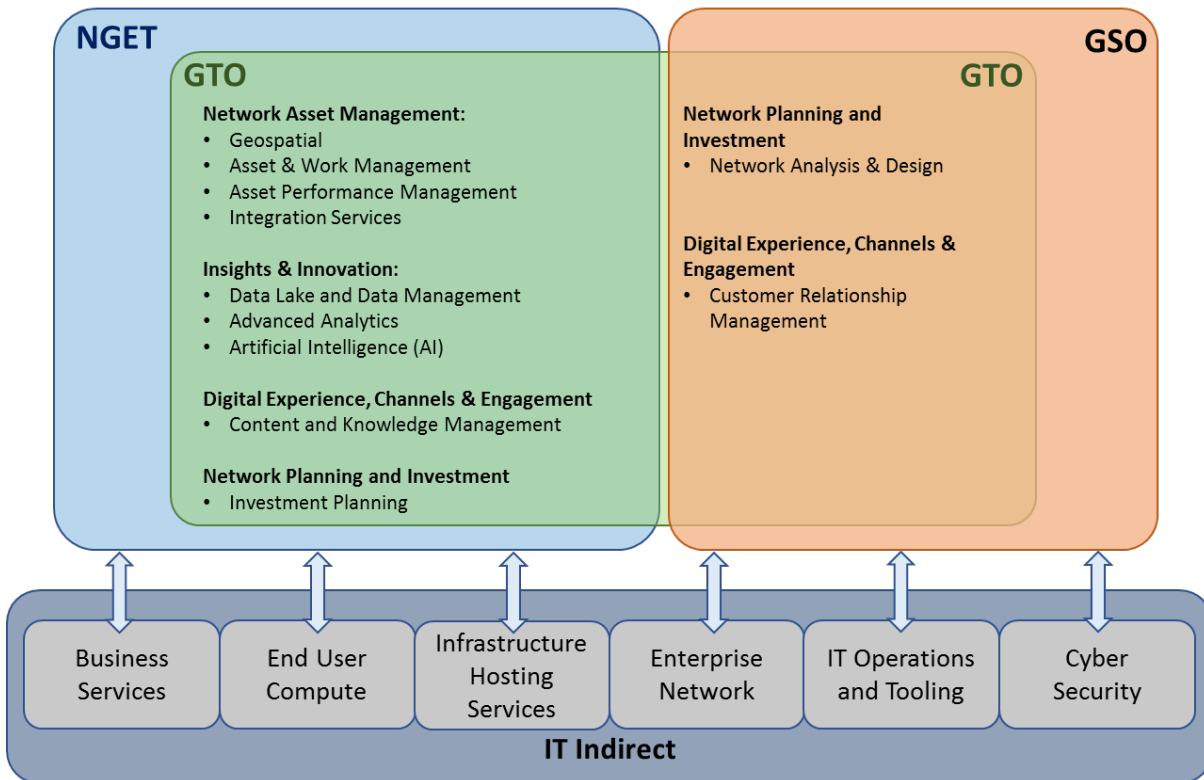


Figure 7 illustrates the interdependencies between GTO, GSO and NGET investment areas as well as the IT Indirect supporting investments.

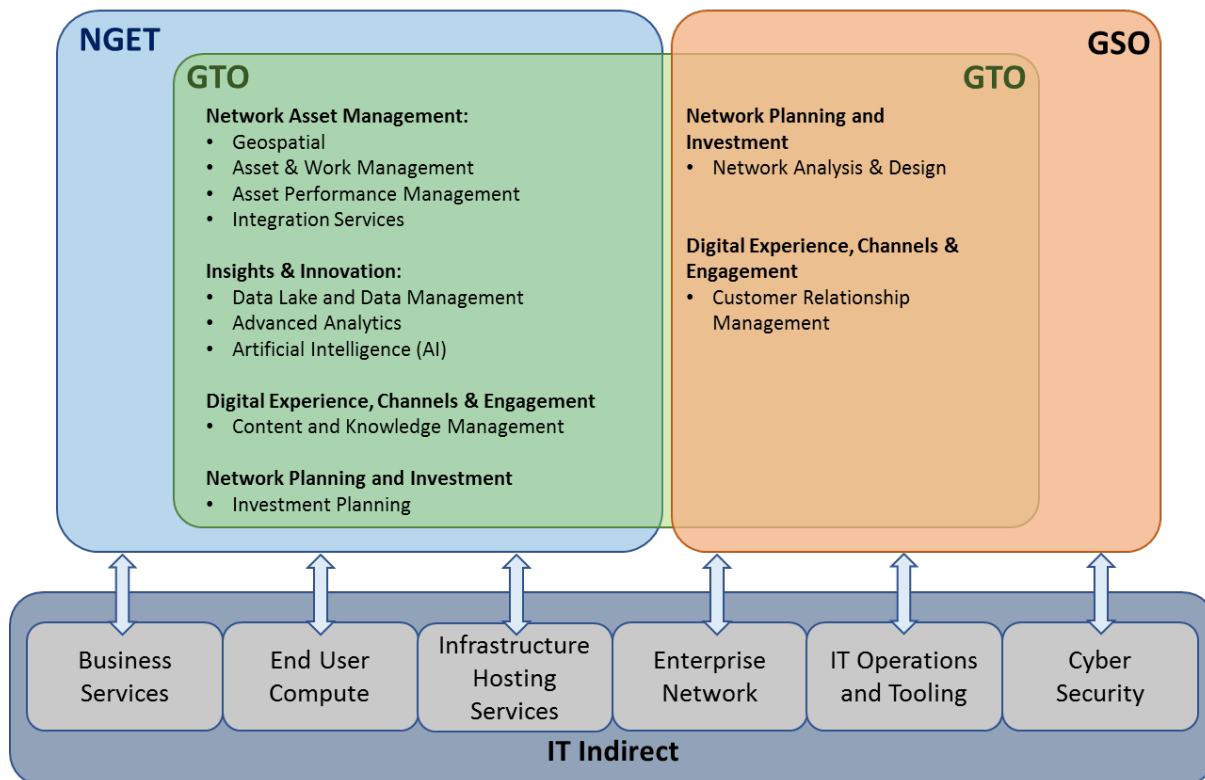


Figure 7: Interdependency between NGG, entities and IT Indirect investments

2.3.5 Our Costs and Benchmarking Approach

Our investments, and their associated benefits, are summarised by IT capability within our stakeholder priorities described in section 3. To ensure that the costs associated with these investments are realistic, efficient, and comparable to our peers, we engaged Gartner, an independent benchmarking organisation, to review our investment plan. This, combined with our own intellectual property from comparable projects and cross-functional technology teams, has led us to the proposed investment profile.

Across the investment portfolio, several approaches were taken to benchmarking each of the individual investment proposals. Gartner took comparative data and conducted a verification of what is planned in the future, based on what we know today.

For example, where we have planned an asset refresh, Gartner had a clear and tangible starting point. They knew the technology to be refreshed, the scale and scope was usually clear, and it had accurate data on the component costs of an upgrade (hardware, software, people costs) based on today's prices. Similarly, for a new application, Gartner estimated the size of this based on a large database of project implementations. It benchmarked against known comparable projects, normalised for the actual estimated size of our requirement. In both instances, known costs to deliver were used and normalised for scope. Using a combination of historical trend data and research analysts predicting future trends, Gartner could model a future cost and provide the benchmark. While this is an estimate, the materiality of this part is typically very small.

Gartner benchmarked £141.2m of our total £180.07m investments.

[REDACTED]

[REDACTED]³. Of the £141.2m benchmarked, Gartner were not able to benchmark 8 per cent of the investments. This was invariably due to the complexity or niche nature of systems to our industry, such as scope of our CNI gateway or asset protection services. Gartner were not able to initiate a benchmark without a more in-depth analysis of our systems which was not possible in the time available. That notwithstanding, industry benchmarking was performed against 92 per cent of the investment value, where Gartner were able to benchmark our costs

[REDACTED]

against industry comparators or assess our costs by function point analysis. They found that overall our costs were within their benchmark range or all in line with their expectations, formed from their knowledge of IT investments made by other utility companies.

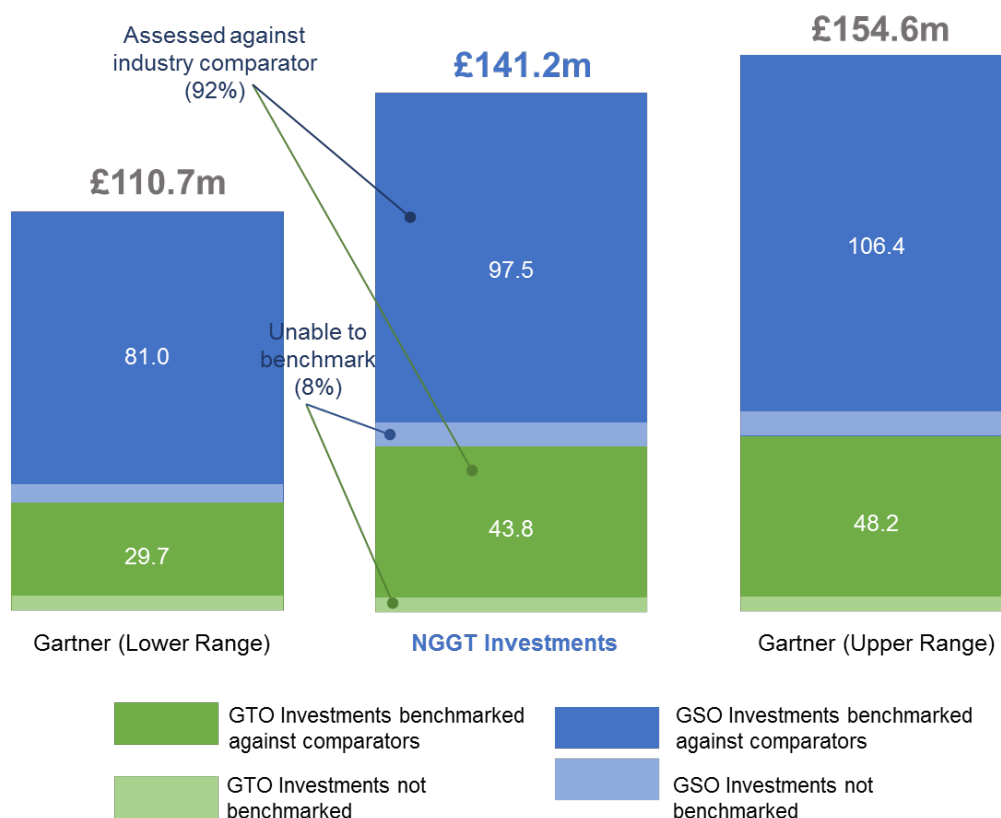


Figure 8: A summary of Gartner's benchmark of our IT Direct investments

A detailed assessment of Gartner's benchmark for each of our investments is described in section 3. The full Gartner report can be found in Appendix 2.

2.3.6 Risks to our RIIO-2 Plan

We have identified several key risks that could impact the delivery of our RIIO-2 plan. Principle among these are:

- Technology Changes:** During RIIO-2 we expect technology change to continue at an ever-increasing pace, which will create new opportunities and challenges for IT and NGG. We conduct market assessments to understand industry trends and potential changes in technology and have taken account of these where applicable to future proof our investments in RIIO-2. However, the pace of technology change and innovation in the IT industry will inevitably have a disrupting effect on our planned IT investments. We will therefore continue to re-assess and respond appropriately during RIIO-2, to ensure suitable adjustments are made to our IT investments where required to maintain our commitments to stakeholders.
- Regulatory Changes:** Our investment plan is built on current legislation and obligations upon National Grid and its entities. This includes for instance data and security compliance as well as current European legislation. We have assumed a similar level of regulatory-driven change on IT systems during RIIO-2 as we have seen across RIIO-1. A significant increase in the scale of change will require us to review our overall IT plan. We will therefore continue to monitor and assess our forecast of regulatory-driven change on IT systems during RIIO-2 to assess this risk.
- Investment Plan and Delivery:** As outlined in section 2.4.1, our investment plan assumes some shared systems and platforms across entities (e.g. NGG and NGET) as well as delivery of core IT

services via the IT Indirect investments. This approach reduces overall costs. Any reduction in investment / funding in these portfolios will impact our ability to share these platforms, resulting in increased costs.

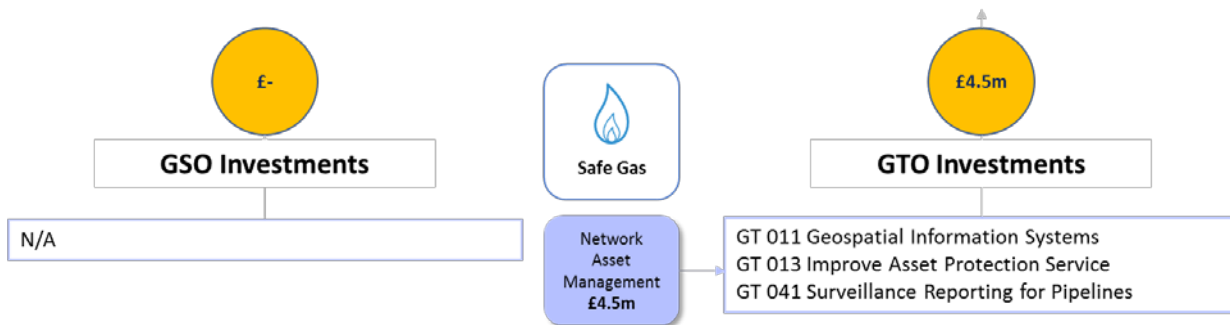
3 NGG IT Investments

3.1 I Want the Gas System to be Safe (£4.5m)

Stakeholders have consistently told us that safety is a top priority, and therefore, we will continue to invest in the technology health of core systems that support us in maintaining our safety standards. This will enable NGG to continue to protect the public, our employees and the environment from safety risks associated in maintaining and operating our assets.

Our IT systems support the asset management processes which ensure we maintain a safe and reliable network. We need to maintain and enhance these systems through RIIO-2 to ensure we maintain our safety standards and further reduce risk.

This involves investment in the areas shown below:




3.1.1 Network Asset Management

3.1.1.1 GTO Geospatial Information Systems (GIS)

We run and maintain an underground pipeline network. It is therefore essential that we can visualise where our assets are and the environment around them. This ensures we keep members of the public and our employees safe by understanding where our assets are and identifying the risks that they pose.

Geospatial Information System (GIS) provides a map-based view of our assets, allowing us to understand proximity to other features such as housing, river crossings, motorways and the topography of the land and enabling us to record issues with our assets along the length of the pipeline.

Our investments in the GIS capability are covered by the three investments below:

 I want the gas system to be safe	Network Asset Management	GTO Geospatial Information Systems	Investment	
			GT 011 Geospatial Information Systems Tech Health	
			GT 013 Improve Asset Protection Service	
			GT 041 Surveillance Reporting for Pipelines Tech Health	

- GT 011 - Geospatial Information Systems Tech Health (██████)** - Our investments during RIIO-1 consolidated our GIS systems to simplify our systems landscape. From 2022, we will need to invest in our GIS systems to ensure that it remains supportable in line with our IT Asset Health policy (see Appendix 1). We will also improve the capability to understand and visualise risk, hazard and asset health to drive business efficiency and safety.

Our strategy for the RIIO-2 period is centred around sustaining performance of our current GIS solution whilst broadening the range of applications exploiting the existing functionality. We plan to increase data collection and improve data accuracy, integrity and quality associated with our asset information. We will continue to use GIS to support the understanding of our pipeline asset health through the management and analysis of cathodic protection and in-line inspection data. We will also develop further geospatial reporting and layers and deliver an improved capability to manage modern data types, such as LIDAR and 3D

Options Analysis

Option Description	Pros	Cons
<p>Do not invest during RIIO-2 and run unsupported systems</p> <p>(Rejected as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)</p>	<ul style="list-style-type: none"> No investment 	<ul style="list-style-type: none"> Increased risk to reliability and safety, creating unacceptable safety risk to employees and public. NGG will be breaching safety compliance and legislation. Exposed to risks including: cyber threat, business disruption, poor productivity, poor user experience and increased Opex, as outlined in our IT Asset Health policy (see Appendix 1). Increased asset health cost due to an increase in reactive asset health maintenance.
<p>Invest to ensure systems supportability and delivery of required enhancements during RIIO-2.</p> <p>(Recommended)</p>	<ul style="list-style-type: none"> Systems and capabilities to remain safe, efficient, operational and supportable in line with our IT Asset Health policy. Enables NGG to meet safety requirements and remain compliant with IGE/TD/1. Enable opportunities for better safety and risk management, as we leverage improvements and enhancements in the GIS capability. 	<ul style="list-style-type: none"> Increased capex investment

Recommendation

Our recommended option will support our safety commitments in RIIO-2. National Grid is currently participating in the Government’s Geospatial Commission pilot on a National Underground Asset Register. Improvements in our Geospatial systems will support our steps to publish our pipeline locations more widely and the Energy Data Taskforce (EDTF) recommendations on digital mapping.

Consumer Benefit



Improved safety and reliability

Our recommendation will support the delivery of an efficient, reliable and safe network by: complete maintenance and inspection to policy; ensuring mitigation of risk of pipeline infringements; IGE/TD/1 compliance; reduced risk of pipeline degradation and prevention of higher failure risk.

3.2 I Want to Take Gas On and Off the Transmission System Where and When I want (£111.7m)

You have told us you value being able to flow gas without restriction. As a joint transmission owner (TO) and system operator (SO), our activities under this priority include maintaining and operating our physical network, and the day-to-day processes that support the market.

Our IT systems are core to how we optimise operation of our network to ensure customers' requirements are met. During RIIO-2 our IT systems will be key enablers to how we plan and deliver the network capability that meet our stakeholder needs. They will also allow us to plan and deliver our network asset health programme, to maintain our current level of reliability and availability, whilst minimising the risk of impacts to consumers.

To meet these needs, we plan to invest in the following capabilities:

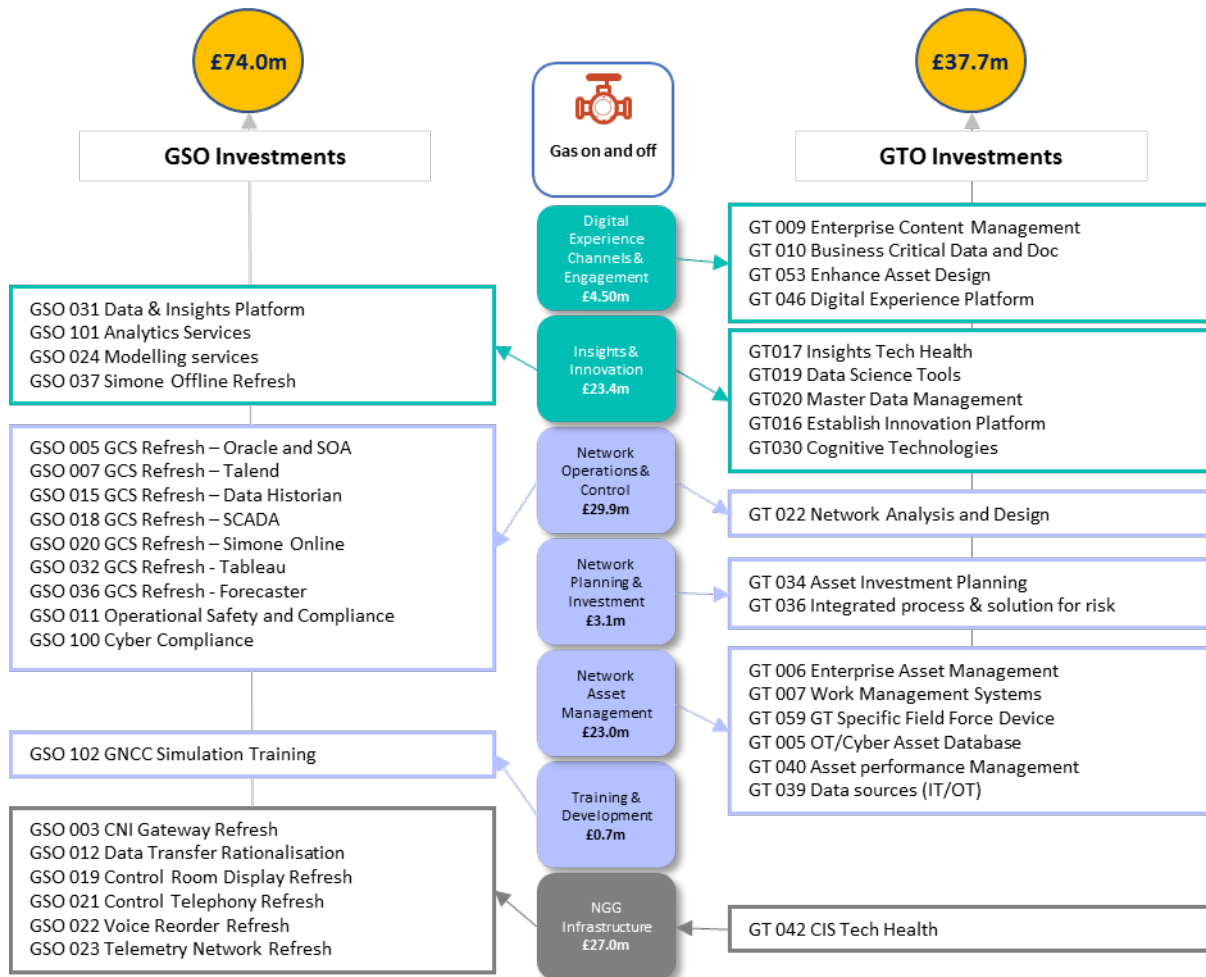


Figure 9: A summary of Gas on and off IT capabilities and investments

3.2.1 Network Operation & Control

3.2.1.1 GCS Asset Health

The Gas Control Suite (GCS) is a suite of systems used for operational planning, real-time monitoring and control of the Gas Network Transmission System (NTS) within the Gas National Control Centre (GNCC). The system also provides business intelligence, data analytics and decision support. Figure 9 provides an overview of the GCS and associated systems landscape.



Figure 10: Overview of the GCS and associated systems landscape.

GCS was implemented during RIIO-1, as part of the iGMS Evolution Programme (IEP) and consists of three main components – Clea SCADA, Data Historian and Fusion. Clear SCADA, associated telemetry systems and supporting networks are designated as Critical National Infrastructure (CNI) by the Centre for Protection of National Infrastructure (CPNI) and as such are subject to specific regulations on their resilience and levels of security. The remaining elements of the GCS (namely [REDACTED]) applications are also critical to the operational processes within the GNCC. As such they also have similar levels of resilience and security requirement.

Other supporting applications include: [REDACTED], [REDACTED]. The critical nature of GCS demands appropriate levels of resilience and reliability, achieved through robust design and support arrangements underpinned by current vendor support for all components of the system.


During RIIO-1 we will migrate these CNI systems to the Ark hosted data centres as part of the CNI Data Centre migration programme, which is due to be completed by March 2020.

As part of our “evergreen” maintenance strategy for IT Asset Health, we ensure that software and infrastructure components are kept in step with the supplier’s maintenance release, stay secure whilst delivering the level of performance required by our operators and other parties with whom we need to share data.


The timing and costs for refreshes are influenced significantly by vendors’ support policies, which are subject to change. We maintain an ongoing technical roadmap for our systems to ensure that our systems are kept in support in line with our IT Asset Refresh Policy (see Appendix 1)

Assessment of the risk vs cost trade-off is carried out to determine whether the life of major systems can be extended beyond the standard refresh period. However, the overriding priority is to maintain reliability and supportability, as well as enabling business change for these critical systems.

In RIIO-2 we will make the following technology health investments to maintain the GCS estate:

 <p>I want to take gas on and off the transmission system where and when I want</p>	Network Operations & Control	GCS Asset Health	Investment		£M
			GSO 005 - GSO GCS Refresh – Oracle & SOA		[Redacted]
			GSO 007 - GSO GCS Refresh – Talend		
			GSO 015 - GSO GCS Refresh - Data Historian		
			GSO 018 - GSO GCS Refresh – SCADA		
			GSO 020 - GSO GCS Refresh – Simone Online		
			GSO 032 - GSO GCS Refresh – Tableau		
			GSO 036 - GSO GCS Refresh – Forecaster		

GCS is also dependent upon other IT systems and infrastructure capabilities, these include:

 <p>I want to take gas on and off the transmission system where and when I want</p>	NGG Infrastructure	GSO Core Infrastructure Asset Health	Investment		£M
			GSO 003 - GSO CNI Gateway refresh		[Redacted]
			GSO 012 - GSO Data Transfer Rationalisation and Refresh		
			GSO 019 - GSO Control Room Display Refresh		
			GSO 021 - GSO Telephony Systems refresh		
			GSO 022 - GSO Voice Recorder refresh		
			GSO 023 - GSO Telemetry refresh		

We cover the core GCS investments below and the GCS dependent investments in section 3.2.6.

Needs Case and Scope of Investment

- GSO 005 - GCS Refresh – Oracle & SOA ([Redacted])** - The technology stack for the Gas Control Suite (GCS) forms a critical part of the decision support suite of applications and was implemented in 2016 as part of the original IEP programme. It manages a range of gas operational processes including:
 - Commercial Operations – Shipper Notifications, NTS Supply and Demand, Line Pack, Transportation Flow Advice
 - Demand Forecasting – D-1, D-2 to D-5, Shrinkage Requirements, Site Forecasts
 - Energy Allocation – for NTS sites such as Compressors, Interconnectors, Storage, Terminals, Unique Sites, as well as managing Flow Weighted Average Calculations Values (FWACV)
 - NTS Configuration – including Site and Point configuration
 - Monitoring and Alerts – within defined tolerances
 - Commercial Contracts

The technology stack comprises a custom application called [Redacted] layer to manage all workflows.

As part of our IT Asset Health policy, we plan to undertake ongoing interim and major upgrades to the Oracle suite to align with vendor supported roadmaps. Whilst some components of the [Redacted] are being upgraded as part of the CNI data centre migration programme (to be completed by March 2020), minor software upgrades will be required in RIIO-2 on an annual basis, and a full upgrade of the entire technical stack will be required by FY25/26.

- GSO 007 - GCS Refresh – [Redacted]** manages the Extract, Transform and Load (ETL) of data from both internal and external sources to and from our CNI landscape. It is used primarily to pull data from multiple data sources and populate it into an Operational Data Store (ODS). This is used to support operational and management reporting requirements. The system is currently upgraded every two years and we anticipate this to continue into RIIO-2.

However, during RIIO-2 we will review the use of the Talend ETL, as part of a wider architectural review, to see how it should be used (or replaced) to meet future ETL requirements, particularly those associated with the new data and insights platform.

- GSO 015 - GCS Refresh – Data Historian ([Redacted])** - Data Historian is a time-series database which is used to collect, store, display, analyse and report on telemetry information from our SCADA systems. The SCADA system is separated from the rest of the Gas Control Suite to provide an additional layer of security. The Data Historian provides way to route near real time, historical and real-time data streams from the

SCADA system to the Gas Control Suite to support business processes such as line pack amendment amongst others. We have custom functionality within the system to manage several business processes. Like the other elements of the GCS in CNI support, Data Historian is maintained by minor patches and upgrades using the evergreen asset health approach.

We are currently reviewing the services provided to Distribution Network Operators (DNOs), including the Flow Weighted Average Calorific Value (FWACV) calculations which are managed within Data Historian. There is an assumption that this functionality may be migrated to the DNOs. We will therefore review the way in which Data Historian will be used in conjunction with our data platform and new analytical and modelling capabilities in RIIO-2. In the absence of certainty, we plan to invest in a full upgrade or replacement of Data Historian to maintain vendor support or to replace it with a comparable alternative, subject to the outcome of the review.

- **GSO 018 - GCS Refresh – SCADA (████████)** - Our Supervisory Control and Data Acquisition (SCADA) system is an off-the-shelf product from ██████████ called ██████████. It is used to monitor and control the NTS. Instrumentation is connected to Remote Terminal Units (RTUs) which relay data to the SCADA system via the Gas Remote Sites Communications (GRSC) network. It was implemented in 2016 and is upgraded on an annual basis. The hardware for this system will be refreshed as part of the CNI Data Centre migration (due to complete by March 2020). A major software upgrade is planned in mid-2020.

In RIIO-2, we plan to maintain this critical system with annual software version upgrades (which are covered through BAU support) and a major software and hardware upgrade towards the end of the RIIO-2 period, in line with our asset health refresh policy. Each annual upgrade will regression test the integration with other CNI systems and ensure vendor support and cyber security compliance.

- **GSO 020 - GCS Refresh – Simone Online (████████)** - Simone Online is our real-time network analysis tool used in the control room. It allows us to undertake current state and predicted future operational risk assessments which include current and predicted status of assets, flows, pressures, linepack, gas quality parameters. It uses telemetered data from the SCADA system as well as flow notifications from Fusion. During RIIO-1 we have integrated Simone Online with GCS to better support these data flows and allow us to present the information it provides on SCADA displays. Whilst we look to develop more dynamic network modelling capabilities in RIIO-2 (see GSO Enhanced Analytics section 4.2.2.1), we continue to see an ongoing requirement for Simone Online in RIIO-2 to provide within-day operational support to the control room.

Investment is therefore required to upgrade Simone Online during the RIIO-2 period to maintain currency and vendor support for this critical control room application.

- **GSO 032 - GCS Refresh – Tableau (████████)** - Tableau is a data visualisation and reporting tool used to create dashboards for a range of different use cases from real-time on-demand operational data through to forecasting and trend analysis. It takes feeds primarily from Fusion and Data Historian to build data insights and visualisations. During RIIO-2 we see the need for greater complexity in the type of analysis and insights required as well as significant increases in data volumes that will need to be handled. As such, we plan to maintain the asset health of this system through RIIO-2.


As part of our review of the data and insights architecture to support our RIIO-2 ambitions, we will review the use of our visualisation tools more widely. Whilst Tableau has suited our requirements for building dashboards and analytical reporting in RIIO-1, we anticipate the need for much larger volumes of data ingestion and more complex analytical algorithms to support our analytical and modelling scenarios. We will therefore review the suitability of Tableau through RIIO-2, with a potential to replace this, if required, in RIIO-2 with suitable alternatives.


- **GSO 036 - GCS Refresh – Forecaster (████████)** – We publish our demand forecasts over a range of timescales to assist the industry to make efficient decisions in balancing their supply and demand positions. Effective and accurate forecasting of gas supply and demand is critical to our GSO decision-making


processes, particularly with increasingly uncertain future supply and demand patterns. Forecasts feed into Planning Network Access (one to ten years ahead), Planning and Procuring activities (one month to one week ahead), and real time Operational Control and Situational Awareness of the NTS (day ahead to within-day).


In RIIO-1 we implemented the Forecaster application which provides models used to generate forecasts required for the current incentives regime in RIIO-1. We plan to review our future demand forecasting capability in RIIO-2, with a view to potentially replacing this application. However, until the scope and complexity of the new solution is confirmed, we will need investment to sustain the current application in order to maintain currency and vendor support.


Investment Cost, Benchmarks and Cost Profile


GCS Refresh – Oracle & SOA							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									


GCS Refresh – Talend							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

GCS Refresh – Data Historian							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

GCS Refresh – SCADA							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

GCS Refresh – Simone Online							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

GCS Refresh – Tableau							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

GCS Refresh – Forecaster							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

Our cost estimates are based on previous experience of similar projects in RIIO-1. Gartner has benchmarked our estimates as being broadly within their range of estimates except for GCS Oracle & SOA and Tableau, where our estimates are slightly higher than their upper range. This is due to bespoke nature of our Oracle and SOA implementation. Our estimates include an upgrade of the portal applications within GCS which may need to be replaced. We have therefore included the cost of a possible replacement of the portal, which has not been considered in the Gartner assessment. For Tableau, Gartner has assumed we had 200 dashboards and around 20 data tables, whereas we currently have over 400 views referencing around 170 tables. On this basis, we are comfortable that our estimates are reasonable.

GCS Asset Health - Options Analysis

Option	Pros	Cons
<p>Do not invest during RIIO-2 and run unsupported systems</p> <p>(Rejected as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)</p>	<ul style="list-style-type: none"> We do not believe this is a viable for the reason outlined in the cons section of this table due to the issues and risks this option introduces to managing NTS 	<ul style="list-style-type: none"> Failure to comply with license and safety case: software and infrastructure components will exceed end of life. Vendors will withdraw support with risk that system issues may increase and could become a serious risk to our operational processes. Increases cyber security risk for these CNI systems Likely increase in ongoing opex costs for support. Inability to access data needed for network modelling and analysis, which is tightly managed within our CNI environment. Inability to combine this with other non-CNI sources.
<p>Technology Health upgrade only</p>	<ul style="list-style-type: none"> Standard migration approach based on historical experience of similar asset health upgrades Processes remain largely unchanged and users require familiarisation training only. Reduced cyber risk as standard upgrades are incorporated 	<ul style="list-style-type: none"> Sub-optimal service not taking opportunity to refresh or replace with more efficient service. Increased cost of maintenance in the long-term as systems are enhanced during RIIO-2. May increase risk of vendor lock in and a "lopsided dependency" risk for our CNI systems. May not meet future business requirements.
<p>Technology Health upgrade / refresh and/or rationalise (Recommended)</p>	<p>In addition to the above:</p> <ul style="list-style-type: none"> Take the opportunity to refresh and/or rationalise technology stacks as required to improve efficiency and systems management 	<ul style="list-style-type: none"> Potentially more complex than mere upgrades as we look for opportunities to upgrade / refresh to support ongoing enhancement and maintenance of these services.

GCS Suite – Recommended Option

We are recommending the third option to upgrade or refresh as the overarching strategy for delivering these investments, to maintain the currency and vendor supportability of these services. As part of the overall refresh programme, we will review the ongoing suitability and status of the following applications:

- Data Historian** – This time series database was implemented as part of the IEP programme. As we start to build more capability in our data & insights platform using modern AI and machine learning algorithms, we see a greater use of the data lake as the home for staging, manipulation and onward consumption of data. This may mean that the size of the Data Historian may diminish to primarily provide a time-series view of the SCADA data in the future. We will assess how the use of the Data Historian may change in RIIO-2 and have therefore provisioned for a full replacement in case that the current solution becomes unfit for purpose.
- Tableau** – This is currently restricted to be used with the CNI space and is constrained in its ability to handle analysis of very large data sets. We are also exploring its ability to model data in near real-time which appears to be limited. We will explore the use of other dashboard and visualisation tools (e.g. PowerBI) to deliver these capabilities in RIIO-2
- Talend** – we will review the use of ETL tools as part of our future data and insights architecture, as we start to ingest greater volumes of data more frequently from our CNI systems. This may mean that we upgrade or replace Talend as appropriate during RIIO-2.

Consumer Benefit



Improved safety and reliability



Lower bills than otherwise the case

The recommended option allows us to ensure we maintain the IT system capability we need to ensure safe and reliable operation of the NTS.

The recommended option also enables us to explore where IT systems capabilities can help us introduce efficiencies and innovation internally as well as our customers, helping reduce operational costs and supporting more informed decision making.

GCS Asset Health Roadmap

Following the migration of the GCS suite to the new CNI data centres, we have developed a roadmap for the proposed maintenance of the suite as shown below:



3.2.1.2 GSO 0011 - GSO Operational Safety & Compliance - Continual Improvements - £12.5m

Needs Case and Scope of Investment

When GCS was implemented it replaced many off-line tools, which had been developed outside of the previous system, iGMS, because of the complexity of changing it. All our critical activities are now managed in a single suite of systems.

In addition to managing the GCS infrastructure, described in section 3.2.1.1 above, we will need to update and enhance the core applications and underlying processes to address ongoing operational and safety compliance requirements. These requirements are typically driven by the evolving configuration and behaviour of the National Transmission System, operational learning and industry best-practice.

This will also include changes to address:

- Alarm Management: changes to ensure we continue to manage alarms in line with industry best practice (EEMUA 191⁴)
- Human-machine interface: This will support delivery of ongoing changes needed to ensure system adheres to HMI best practice (EEMUA 201⁵)
- Decision support tools: amendments to reflect changes to operational processes e.g. linepack and balance and capacity management
- Continuous improvements, for instance in automation to remove risk of human error

Investment Costs, Benchmarks and Cost Profile

Investment Name	GSO Operational Safety & Compliance - Continual Improvements						Gartner Benchmark Range		Gartner Rating	
	Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low		High
CAPEX	2.50	2.50	2.50	2.50	2.50	2.50	12.50	12.51	13.48	

Our costs are based on similar outturns in RIIO-1 and reflect the cost of the team currently delivering GCS

⁴ EEMUA 191 Alarm systems - a guide to design, management and procurement

⁵ EEMUA 201 Control rooms: a guide to their specification, design, commissioning and operation

changes to address operational compliance and safety. It is assumed that the demand in RIIO-2 will be of a similar scale experienced since the implementation of GCS. Our cost estimates are at the lower end of the Gartner benchmark range and they consider our approach to be reasonable.

Options Analysis

Options	Pros	Cons
<p>Do not invest in GCS during RIIO-2 to address ongoing operational and safety compliance requirements.</p> <p>(Rejected as this is not a viable option, due to the reasons outlined in the cons section and the risks this option introduces in managing the NTS)</p>	<ul style="list-style-type: none"> No Investment 	<ul style="list-style-type: none"> Failure to mitigate operational safety and compliance risks ultimately leading to a detrimental impact to consumers' supply of gas. Risk of not being able to meet our licence and regulatory obligations.
<p>Manage Operational & Safety compliance changes outside by developing off-line tools outside of GCS.</p>	<ul style="list-style-type: none"> Operational and safety compliance changes are address Lower capex investment required compared to option 3. 	<ul style="list-style-type: none"> Requires additional manpower / opex to develop and maintain off-line tools. Increases risks of errors and ultimately operational & safety compliance breaches through data duplication. Inability to address operational learning, automation and to Continual Improvements within GCS.
<p>Maintain GCS by address ongoing operational and safety compliance requirements (Recommended)</p>	<ul style="list-style-type: none"> Meets ongoing operational and safety compliance requirements. Ensures all critical activities are managed in a single suite of systems which meet CNI standards. Supports evergreen approach to maintain GCS, avoiding need to large-scale system upgrades or replacement. Removes need for off-line tools needed to support GCS. Reduces changes of error associated with manual process activities. 	<ul style="list-style-type: none"> Requires ongoing capex investment.

Recommended Option

Our recommended option ensures we maintain operational and safety compliance within our GCS suite of systems, negating the need for end-user computing tools to complement operational processes.

Consumer Benefit



Improved safety and reliability

The recommended option provides ongoing and operational compliance ensuring we mitigate the risks associated with safe operation of the NTS.

5.1.1.1 GSO 0100 – GSO Cyber Compliance (£3.2m)

UK infrastructure is subject to many security threats, that are increasing in sophistication and persistence. These threats include terrorism, criminality and general vulnerability in information technology (IT) and operational technology (OT) systems. Our network is part of Great Britain's Critical National Infrastructure (CNI) and appropriate protection from threats is therefore essential to underpin the safety, security and reliability of the nation's energy supply. The UK Government sets the requirements for the appropriate levels of physical and cyber resilience that are to be achieved in the national interest.

Needs Case and Scope of Investment

GSO 0100 – GSO Cyber Compliance - £3.2m – During RIIO-2, we will continue to align with cyber security best practice and standards, as defined in the National Institute of Standards and Framework's Cybersecurity Framework (CSF), published in February 2014. This allows us to identify and manage risk through a comprehensive range of security controls and measures. Ongoing engagement with UK National Cyber Security Centre (NCSC), Centre for the Protection of National Infrastructure (CPNI) and the Department for Business, Energy and Industrial Strategy (BEIS) will be central to the protection of our systems.

We will continue to work with the NIS competent authority (comprising Ofgem and BEIS) to help shape our cyber investment plans, identifying the most effective and efficient way to meet them.

We will apply these standards as we invest in asset health refreshes and as well as our proposed investments in new data & insights platforms, enhanced analytics and modelling services.

This investment is to provide cyber uplift to cover cyber security advisory and consulting services (via our in-house cyber security team and external security expertise) across all our GSO investment projects in RIIO-2.

Options Analysis

Option	Pros	Cons
Do not invest during RIIO-2 (Rejected as this is not a viable option, due to the reasons outlined in the cons section and the risks this option introduces in managing the NTS)	<ul style="list-style-type: none"> We do not believe this is a viable for the reason outlined in the cons section of this table due to the issues and risks this option introduces. 	<ul style="list-style-type: none"> Increased risk exposure from cyber threats to CNI systems potentially resulting in significant impacts to the availability and reliability of gas Non-compliance to NIS-D regulations leading to potential fines of several millions of pounds
Provide cyber security support for all GSO investment to ensure compliance (Recommended)	<ul style="list-style-type: none"> Reduced cyber risk exposure Increased NIS-D compliance by ensuring security team involvement throughout the project lifecycle 	<ul style="list-style-type: none"> Increased project cost overhead

Recommended Option

Our recommendation is to provide this cyber security expertise to all GSO projects to ensure security standards and regulations compliance

Consumer Benefit



Improved safety and reliability

The recommended option addresses ongoing cyber security requirements and ensures we mitigate the risks associated with safe operation of the NTS.

Investment Cost, Benchmarks and Cost Profile

GSO Cyber Compliance							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX	0.51	0.78	0.83	0.64	0.46	3.21	3.2	3.2	

Our cost estimates assume the following:

- We have reviewed each of the RIIO-2 investments and identified the scale of effort required for those impacted by cyber compliance. We have applied a range of 5-10% uplift on relevant GSO investments to cover security architecture delivery support, dependent upon the level of cyber security involvement. For instance, exposure of CNI related data to external stakeholders may attract the upper end of the range, whereas internal integration flows may attract the lower end
- Penetration testing on infrastructure and services resulting from technical upgrade or commissioning of new services – this varies from £50k to £200k dependent upon the scope and scale of the project

Our estimates for this investment are within Gartner's broad benchmark range for these services.

5.1.2 Insights and Innovation

5.1.2.1 GSO Enhanced Analytics

To plan and operate the NTS efficiently we need to be able to forecast the requirements to flow gas on and off the system (supply and demand) and assess the network and commercial options to meet them (see Figure 11).

This applies to our processes across all energy timescales:

- Long term planning and investment decisions (e.g. replacement or decommission of a compressor or placing a contract)
- Short term planning (e.g. deciding on how to schedule system access to minimise risk to consumers)

Decisions on the day (e.g. whether to run a compressor or to undertake an energy trade)

- Our Gas Planning and Operational Standards ensure we have consistent assumptions across the range of these planning timescales

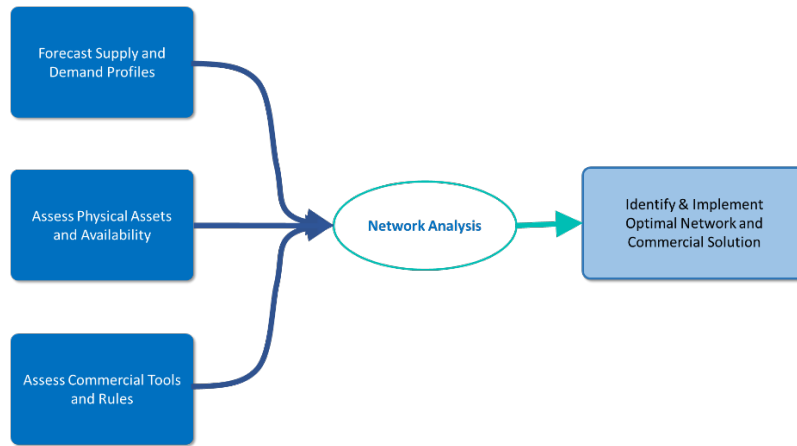


Figure 11: Steps to assess network and commercial solutions

We develop our insights using a suite of inter-linked tools which support these processes, including:

- **Data Stores** – which hold both raw time-series data (Data Historian) as well as a structured data in an Operational Data Store (ODS) to allow us to develop various analyses
- **Analysis Tools** – we use a range of analytical tools, such as Python and “R” along with offline and end-user developed tools and spreadsheets. We also use a tool called Forecaster to forecast gas supply and demands, annually, monthly, weekly and daily, depending on the activity being undertaken, as described in section 3.2.1.1
- **Modelling Tools** – we use network analysis and modelling tools, such as Simone Online, to model the physical assets, simulating the flow of gas in the pipeline network as well as forecasting gas supply and demand. It is integrated with our Supervisory Control and Data Acquisition (SCADA) system and uses telemetered data as well as flow notifications to predict the future within day flows, pressures, linepack on the network. An offline version, Simone offline is used to support long term planning and investment decisions as well as short term planning, such as assessing the schedule of maintenance activities on the network.

In RIIO-2, we anticipate a much more challenging environment in optimising asset investment decisions and market solutions to meet the agreed level of network capability. These include: increased complexity resulting from our ageing assets; increased number of fuel interactions and their interdependencies, new fuel sources and the need to model them and UK’s net zero carbon emissions ambition and the modelling of the new energy scenarios required to support this. This will drive the need to substantially improve our ability to analyse and model the network against multiple supply and demand scenarios and network configurations, as illustrated in Figure 12.

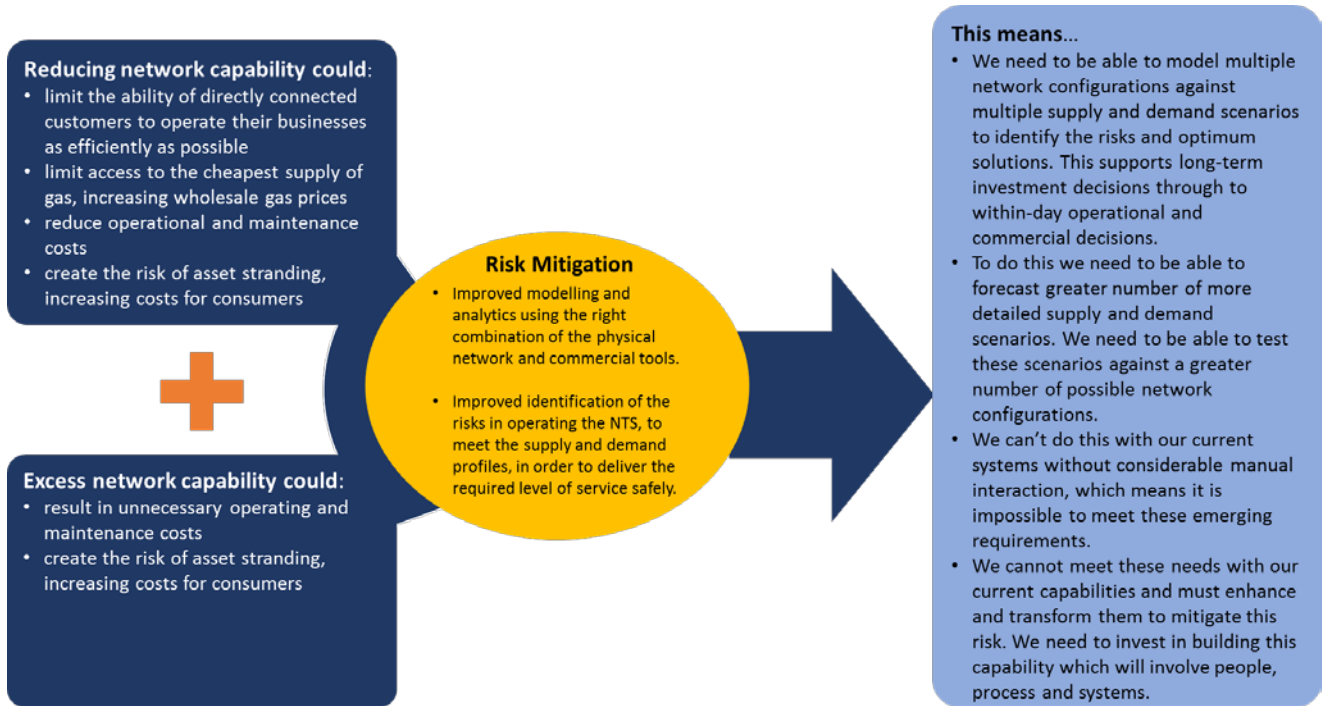


Figure 12: Challenges in optimising asset decisions and market solutions

We currently build siloed solutions for different analytics and modelling scenarios. Whilst these have met our needs through RIIO-1 they are constrained in requiring skilled, manual intervention which prevent us being able to scale them to meet the increased volume and complexity of multi-scenario and modelling we will need in RIIO-2. We propose to establish a platform-based architecture that enables us to use best-in-class capabilities which will allow much greater repeatability and re-usability in building our future and modelling solutions. These platforms align to our IT capabilities discussed above.

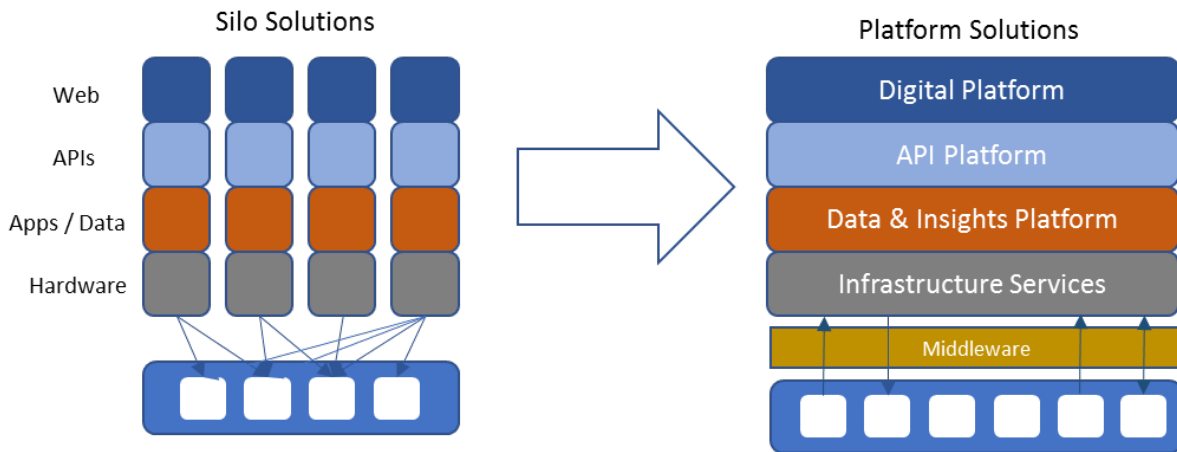


Figure 13: Our proposed approach to a platform-based architecture

Our data and insights platform will form the foundation of our future insights capability and will be integrated with our digital information platform using standardised APIs, enabling us to publish existing and future information to our stakeholders. Figure 14 illustrates the core capabilities that comprise the data and insights platform:

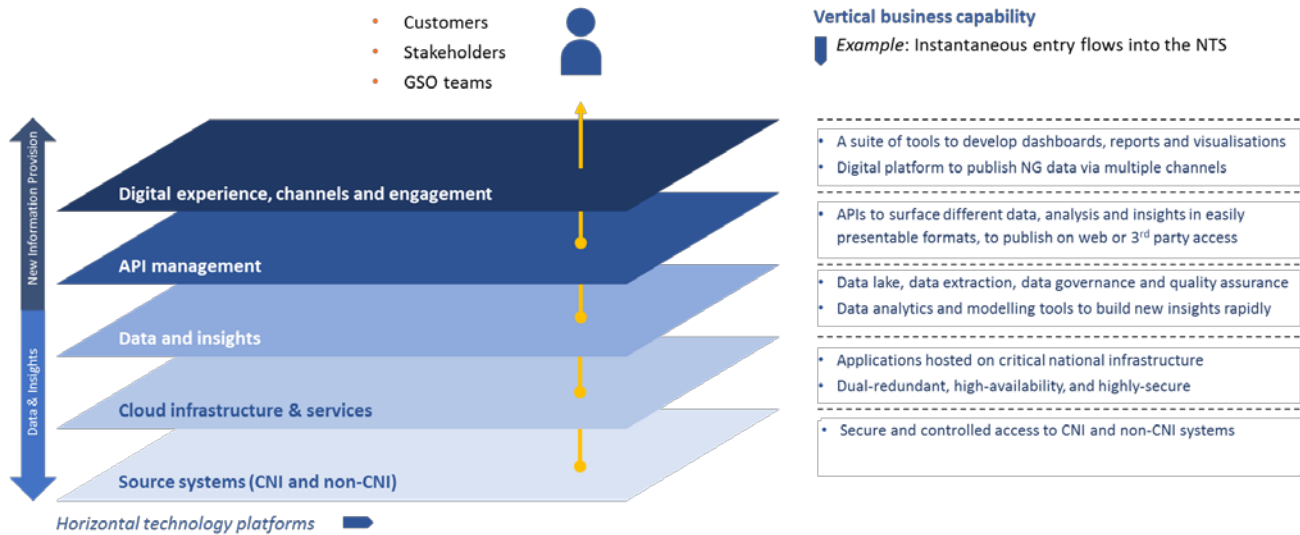


Figure 14: Data & Insights Platform Capabilities

We have planned for three areas of investment in this area:

<p>I want to take gas on and off the transmission system where and when I want</p>	Insights & Innovation	GSO Enhanced Analytics	Investment		£M
			GSO Data & Insights Platform		[Redacted]
			GSO Analytics Services		
			GSO 024 - Modelling Services		

These investments are linked to our information provision investments:

<p>I want all the information I need</p>	Digital Experience, Channels and Engagement	GSO RIIO-2 Information Provision	Investment		£M
			GSO 0001 - GSO New Information Provision		[Redacted]
			GSO 0025 - GSO MIPI Refresh		

Taken together these investments will substantially enhance our ability to support the following KSPs:

- “I want all the information I need”
- “I want to take gas on and off the transmission system where and when I want”

Needs Case and Scope of Investment

Our data and innovation investments are described in the following sections.

- **GSO 031 - GSO Data & Insights Platform** ([Redacted]) - This investment provides the foundations we need to enable the various internal teams and external users to unlock the value of the data we hold in a secure and reliable manner. It will become the key technology underpinning all our internal and external data management functionalities, pulling together data from a variety of sources. This includes CNI and non-CNI data as well as integration platforms.

Core elements of this platform will include:

- Data lake(s) to enable staging of raw data from CNI and non-CNI data sources
- An extract, transform and load (ETL) solution to ingest and egress data to/from data sources
- Data management capability to include data governance, metadata and master data management
- A data quality management capability to ensure we maintain the hygiene of our source and staged data
- Data pipelines to manage both ad-hoc (batch) as well as near real-time data feeds
- An API management capability which will enable us to publish data insights for use by both internal and external stakeholders

We intend to deploy the above capabilities using a cloud-based architecture for machine learning and AI, leveraging the benefits of flexibility, elasticity and extendibility that are inherent with cloud services.

This will address the following constraints within our current capability:

- The size of data sets that we need for our analysis are too large and cumbersome to be handled on our current analytics infrastructure and laptops
 - Data needed for network analysis is sourced from GCS, which is tightly managed within our CNI environment, and therefore not readily available. Data is also required from other non-CNI sources (some outside of GSO) and combining these data sets is a time consuming and cumbersome process.
 - Data cleansing prior to analysis is manually intensive and a time-consuming process, and constrains our ability to use this data in an efficient manner within the control room environment
- **GSO 101 - GSO Analytics Services (██████████)**- This investment will allow us to extract data from the new platform in an auditable and repeatable way, and analyse it using standard programming languages and tools. It will provide enhanced data science tools and capability, allowing us to exploit advances in machine learning, artificial intelligence (AI) and predictive analytics. We plan to build new insights for a range of different use cases, for example:
 - Rapid and predictive insights required on network and market participant behaviours.
 - Statistical analysis to support supply and demand patterns for any given year.

These analytical insights will be developed using modern analytical tools, such as Python, “R”, SAS, scala, matlab, and others. Whilst many of these tools are opensource, fundamental to using these tools is high-levels of localised and server-side computing power to process these large data volumes in short timescales. We will therefore invest in cluster computing frameworks (e.g. Apache Spark) as required, as well as local machines to deliver this.

These capabilities are dependent upon the data and insight platform, described above, to:

- store and manage data sets – where users can register and load data sets on the platform
 - process and analyse datasets
 - manage the access rights of each data set
 - publish insights via APIs for internal and external use
- **GSO 024 - Modelling Services (██████████)** – This investment will allow us to build and run models, providing flexibility to adapt them readily to address the changing environment in RIIO-2. Specifically, this will deliver the following enhancements:
 - **Intelligent network modelling** – Simone models the flows and pressures on a network identifying any low or high pressure breaches. However, it is not able to automatically simulate how we will control the network or provide network solutions to meet the supply and demand requirements. These require manual input and assessment for each supply or demand scenario or network configuration. We need new capability to model the volume of supply and demand patterns and network options we need going forward. We will use machine learning and AI technology to develop an intelligent, automated network modelling solution.
 - **Supply and demand analysis** – provide an automated solution to derive hourly supply and demand profiles from Future Energy Scenarios (FES) data to support network analysis across all timescales.
 - **Supply & demand forecasting enhancements** – develop solutions to better predict behaviour of the network based on a range of changing factors that impact the operation and commercial running of the network. This will typically cover D-1, D-5 forecasts etc.
 - **Analytics and modelling DevOps capability** – provide a DevOps capability to support the end-to-end development of the operations lifecycle for analytics and modelling. This includes the use of mainly open source tools to automate the build to deployment process as well as test automation and code and version management.

We will look to use open source machine learning tools (e.g. ████████████████████) as well as other tooling to build these new models and integrating them into our data platform.

Investment Costs, Benchmarks and Cost Profile

GSO Data & Insights Platform							Gartner Benchmark Range		Gartner Rating	
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High		
CAPEX	[REDACTED]							[REDACTED]		

GSO Analytics Services							Gartner Benchmark Range		Gartner Rating	
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High		
CAPEX	[REDACTED]							[REDACTED]		

GSO Modelling Services							Gartner Benchmark Range		Gartner Rating	
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High		
CAPEX	[REDACTED]							[REDACTED]		

A summary of our cost estimates is shown below:

GSO Data & Insights Platform – Our costs estimates are based on data platforms delivered across National Grid Group (e.g. ET/GT) as well as our experience of building similar foundational capabilities for the Market Information Provision Initiative (MIPI) service. They include the provision of a data lake, data quality analysis, data governance, analytical modelling software, dashboard and visualization tooling, an API management capability. Gartner has benchmarked our cost estimates to be slightly higher than their upper range.

Analytics Services – Our cost estimates are based on a small team of technical resources and IT infrastructure to develop, test and deploy the range of analytics use cases identified to be delivered in GSO. The Gartner benchmark of our estimate is around 10% higher than their range, because we have factored the cost of backend system environments to support development during project releases.

Modelling Services - Our cost estimates are based on in-house development of:

- a custom intelligent network modelling solution, for both online ([REDACTED]) and offline ([REDACTED]) modelling. This includes the one-time build for both solutions. We have also assumed twice yearly releases for the online solution and an annual release for the offline solution
- a supply and demand analysis solution to support deriving profiles from future energy scenarios (FES) ([REDACTED]). This includes a one-time build, followed by annual releases during the RIIO-2 period
- supply and demand forecasting – [REDACTED]. This includes a one-time build, followed by annual releases.
- a DevOps capability to support the design, build to deployment lifecycle - [REDACTED]. This includes a one-time build, followed by annual enhancements / updates to maintain the currency of the estate.

Gartner's benchmark of our modelling service estimates is in the middle of their range and reflect a reasonable approach to developing these advanced modelling solutions.

Options Analysis - GSO Data & Insights Platform ([REDACTED])

Option	Pros	Cons
<p>Do not invest during RIIO-2</p> <p>(Rejected as this is not a viable option, due to the reasons outlined in the cons section and the risks this option introduces in managing the NTS)</p>	<ul style="list-style-type: none"> • No Investment 	<ul style="list-style-type: none"> • Hinders our ability to make the optimal decision over investing in assets or commercial solutions due to lack of data availability ultimately impact the efficiency of our decisions and long-term investment decisions • Inability to enhance the information we publish impacting our ability to support the Energy Data Task Force recommendations.

Option	Pros	Cons
<p>Enhance and extend the shared analytics, data and insights platform with ETO, GTO to incorporate GSO requirements</p>	<ul style="list-style-type: none"> • Extends and enhances existing platform, build separate GSO data pipelines and integrated to CNI systems. This would also build capabilities to handle large volumes of data, extending current capabilities • The shared ETO/GTO platform has a roadmap to migrate to a cloud hosted service in RIIO-2, though that is covered in the in-directs investment (see section 3.2.2.4) 	<ul style="list-style-type: none"> • Does not leverage our investment in MIPI and would not provide a common integrated platform for data and insights • Inflexible and would not be suitable for rapid industry change we are witnessing today (on premise infrastructure model) • Will still need to move to cloud at a later point in time • Challenges in extracting CNI datasets in will need to be overcome
<p>Build new cloud-based data and insights platform in the cloud for GSO (Recommended)</p>	<ul style="list-style-type: none"> • Scalable, elastic architecture to support large data volumes for ingestion, manipulation and consumption • Builds on our investment in migrating MIPI platform to the cloud and extending it to support all data pipelines • Flexibility for rapid enhancements • Delivers new API management solution which provides a way of delivering our insights in a consistent way for both internal and external customers • Leverage cloud best-practice and standard product solutions 	<ul style="list-style-type: none"> • Higher investment cost than using shared ETO/GTO platform • Challenges in extracting CNI datasets will need to be overcome

Options Analysis - GSO Analytics Services ()

Option	Pros	Cons
<p>Do not invest during RIIO-2</p> <p>(Rejected as this is not a viable option, due to the reasons outlined in the cons section and the risks this option introduces in managing the NTS)</p>	<ul style="list-style-type: none"> • No Investment 	<ul style="list-style-type: none"> • Will not be able to scale up to deliver the analytical solutions we need to deliver in RIIO-2 on existing laptop devices
<p>Deliver analytical solutions using enhanced software and hardware capability to meet the RIIO-2 (Recommended)</p>	<ul style="list-style-type: none"> • Will enable us to scale up the capability, as required, to meet the enhanced data volumes and rapidity with which we will need to develop different analyses in RIIO-2 to meet internal and external stakeholder needs • Will enable GSO to build greater insights and analysis to identify the risks in operating the NTS • By enhancing our capabilities in this area, it allows us to maximise our existing and new data to provide raw data, information and insights both internally and externally to support the efficient functioning of the gas markets by allowing us and market participants to make informed decisions. 	<ul style="list-style-type: none"> • Additional investment required

Options Analysis – GSO Modelling Services ()

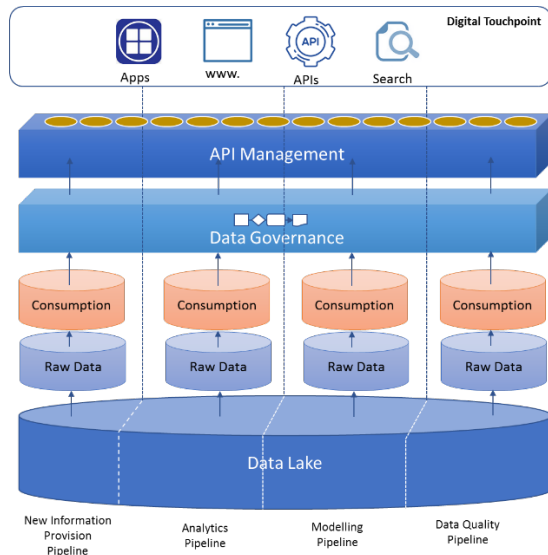
Option	Pros	Cons
<p>Do not invest during RIIO-2</p> <p>(Rejected as this is not a viable option, due to the reasons outlined in the cons section and the risks this option introduces in managing the NTS)</p>	<ul style="list-style-type: none"> • No Investment 	<ul style="list-style-type: none"> • Increased risk of failure to make the optimal decision over investing in assets and market solutions to meet the agreed level of network capability. • Failure to provide required level of transparency granularity in our investment decisions. • Inability to assess the risks in accepting customers' requests to flow gas on and off the system resulting in constraints and / or increased balancing actions.
<p>Implement an off-the-shelf package for enhanced modelling</p>	<ul style="list-style-type: none"> • Potentially simpler solution if all requirements are met using an off-the-shelf package, but likely to require significant customisation 	<ul style="list-style-type: none"> • Uncertainty over whether a flexible off-the-shelf solution exists to support the unique requirements of network modelling of the NTS • Likely to require significant customization to support the volume of scenarios and supply and demand patterns

Option	Pros	Cons
Build a custom intelligent network modelling solution integrated with SIMONE (Recommended)	<ul style="list-style-type: none"> Meets the future network modelling requirements for GSO to support the operation of the network both long and near term Aligns with our information and insights platform solution Leverages cloud services to optimize efficient delivery Automates many of the current manual network analysis activities 	<ul style="list-style-type: none"> Potentially highest cost to maintain with additional customisations Potentially higher cost than an off-the-shelf product, but uncertainty as to whether one exists

Recommended Option – Data and Insights Platform

Our recommendation is to deliver a new cloud-based data and insights platform for GSO, as it provides the most efficient solution in the long-term for the following reasons:

- It enables us to extend our investments in MIPI, to manage multiple data pipelines that can handle different use cases e.g. publishing market data and insights, building new analytical reports and dashboards as well as developing complex models and data visualisations using AI and Machine Learning tools.
- It provides the scalability and elasticity that we require to build insights in a rapid and repeatable way, using cloud capabilities
- It allows ET/GT data and insights solutions to be delivered unconstrained by GSO priorities



Recommended Option – Analytical and Modelling Services

Our recommendation is to establish the advanced analytics and modelling capability required to enable us to build the critical analyses to support market efficiency and prevent market failure scenarios. We anticipate that bespoke deep learning models will be required to enable us to more accurately predict and respond to network conditions and market behaviour patterns, improve the way we model supply and demand forecasting from within-day (near real-time) to after-the-day and future energy scenarios.

As part of the Analytical and Modelling services capability build, we will also need to train our people. There is increasing demand for this capability across both the breadth of our business and the depth of capability required to support key Gas System Operator processes. For example, to forecast significant peaks and swings in demand, managing constraint volatility and modelling the impact of hydrogen on the NTS.

Consumer Benefit



Improved safety and reliability

Enhanced situational awareness through greater forecasting and modelling capability will improve our understanding of the system and enable more informed operational, ultimately resulting in a safer network.



Improved quality of services

It will help us provide greater justification support for our investment decisions reducing the scope and length of challenge and review by Ofgem and other stakeholders creating efficiency for all parties involved in the end to end process.



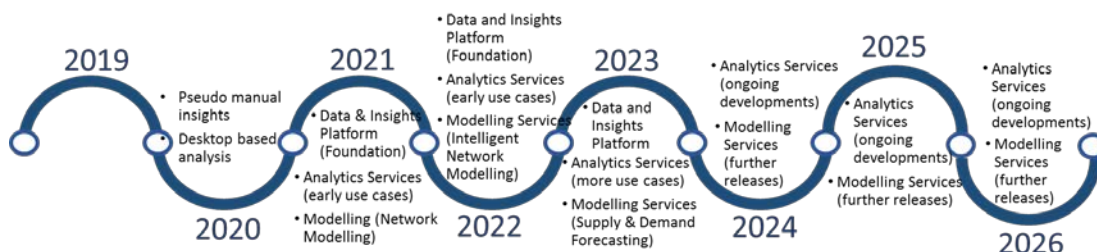
Lower bills than otherwise the case

Our recommended option provides us the enhanced capability we need to ensure we make the optimal decision over investing in assets and market solutions to meet the agreed level of network capability, which provides the most efficient solution for consumers.

It will allow us to better assess the risks in accepting customers' requests to flow gas on and off the system (which reduces the risk of constraints and / or increased balancing actions increasing consumer costs).

Enhanced Analytics Roadmap

We have developed a proposed roadmap for these investments in RIIO-2 as shown below:



5.1.2.2 GSO 037 - Simone Offline refresh

Needs Case and Scope of Investment

Simone offline is used to support a range of planning activities from NTS investment planning to day-ahead operational planning. It fulfils NGG's obligation under its Gas Transporter Licence to maintain a Network Model and is audited by Ofgem. The system is shared between GTO and GSO, ensuring we use the same network models and approach for modelling the NTS. The system hardware and software were refreshed in 2015. This investment provides a further refresh to ensure ongoing vendor support for the application and hardware.

Options Analysis

Option	Pros	Cons
Do not invest during RIIO-2 (Rejected as this is not a viable option, due to the reasons outlined in the cons section and the risks this option introduces in managing the NTS)	<ul style="list-style-type: none"> No Investment 	<ul style="list-style-type: none"> Risk of failure of application resulting in inability to make the optimal decision over investing in assets potentially resulting in suboptimal investment decisions.
Upgrade Simone offline in line with IT Asset Health Policy (Recommended)	<ul style="list-style-type: none"> Provides vendor support for hardware and software to ensure ongoing reliability and supportability. Enables us to continue to run balance the network's supply and demand requirements 	<ul style="list-style-type: none"> None

Recommended Option

The recommended option ensures we maintain our capability to support long-term planning decision on the NTS.

Consumer Benefit



Lower bills than otherwise the case

Our recommended option ensures we retain our current capability to make the right network investment decisions, ultimately leading to lower consumer costs.

Investment Costs, Benchmarks and Cost Profile

GSO Simone Offline Refresh							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

Our cost estimate are based on a similar upgrade project undertaken in 2015/16 which cost £400k. Gartner was not able to estimate the functional size but accept the estimate reflects costs based on previous project delivery experience.

5.1.2.3 Network Analysis & Design (GTO)

- **GT 022 - Network Analysis and Design (NAD)** (████) – GTO’s NAD capability uses Simone Offline to understand any network impact in the long term, by assessing various scenarios that will better inform any investment decisions and changes to our assets and network. This provides the capability to allow us to demonstrate how we manage statutory and legal requirements for network configuration and investment planning to meet customer needs.

In RIIO-2, with our increased levels of maintenance to address our aged network asset infrastructure, we will need to model the network at a greater level of granularity, typically site level, than is currently necessary. This is currently not possible with Simone Offline. Additionally, we will look to expand our capability to have improved visualisation and simulation by leveraging our Insights, GIS, AIP and APM capabilities, whilst exploring opportunities for automation of the end-to-end process to define boundary condition and investment planning.

Investment Costs, Benchmarks and Cost Profile

Network Analysis and Design							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

Our costs are based on experience of similar IT investment delivery in RIIO-1 and Gartner has benchmarked our estimates to be at the lower end of their range.

Options Analysis

Option	Pros	Cons
<p>Do not invest during RIIO-2</p> <p>(Rejected as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)</p>	<ul style="list-style-type: none"> • No Investment 	<ul style="list-style-type: none"> • GT unable to carry out modelling at a site level, rather than a holistic network level. • Impact to customer connections process • Exposed to risks including; cyber threat, business disruption, poor productivity, poor user experience and increased Opex, as outlined in our IT Asset Health policy (see Appendix 1).
<p>Invest to ensure systems supportability and delivery of required enhancements during RIIO-2.</p> <p>(Recommended)</p>	<ul style="list-style-type: none"> • Systems and capabilities to remain safe, efficient, operational and supportable in line with our IT Asset Health policy. • Enables more informed decision making for future requirements, that will better support the safe and efficient operation of the NTS • Integrated process and visualisation for network analysis and investment planning resulting in effective management of upstream network management process. 	<ul style="list-style-type: none"> • Increased capex investment

Recommended Option

Our recommendation is to invest in sustaining our core NAD capability whilst delivering enhancements in integration and automation, to support more effective and efficient investments and decision making on our ageing asset infrastructure.

Consumer Benefits



Improved safety and reliability

More informed decision making to deliver the safe and reliable management of NTS



Lower bills than otherwise the case


Our recommended option ensures we retain our current capability to analyse and plan network investments which allow us to assess the most efficient solutions to meet the agreed level of network capability

5.1.2.4 GTO Insights Platform, Data Lake and Analytics

Our insights platform and data lake implemented during RIIO-1 gave GTO the foundation capability to consolidate data from multiple systems in one location to perform analytics. It offers a platform to perform information management, advanced modelling and analysis of our asset data. As GTO looks to move to more mature asset management models (time, condition, risk, predictive and financially optimised), the increased use of data and analytics to enable informed decision making will be essential.

Our Insights platform also provides our core reporting to support asset management decision making as well as the efficient and safe operation of our network. We use the platform to ensure the governance of our data and create quality rules and metrics to enable us to improve our datasets.

Our investments in this area include:

			Investment	£M
 <p>I want to take gas on and off the transmission system where and when I want</p>	<p>Insights & Innovation</p>	<p>GTO Insights Platform, Data Lake and Analytics</p>	GT 017 Insights and Data Lake Tech	
			GT 019 Data Science and Analytics Tools Tech Health	
			GT 020 Establish Master Data Management	

Needs Case and Scope of Investment

In RIIO-2, we will need to continue to invest in the technology health of this platform and further improve the critical data used across our core systems.

- GT 017 – Insights and Data Lake Tech Health (████)** - Understanding the condition of our assets is key to ensuring they are safe and reliable and that we are managing interventions on them in the most efficient way. In RIIO-1, we developed multiple, targeted condition-monitoring techniques that capture data about our assets and introduced an Insights platform to analyse and make sense of this data. We currently share our Insights Platform and Data Lake with NGET and expect this to continue in RIIO-2.

In RIIO2, we see an increase in the amount and diversity of data we will capture as we on-board new sources of data and make use of unstructured data to better understand our ageing asset infrastructure. We will invest in the technology health of this platform, whilst exploring opportunities to transition to a cloud model and extended functionality in RIIO-2.

This will be achieved by integrating our insights platform with our Asset Performance Management (APM) systems to provide a consolidated view of asset performance (section 3.2.3.2 for details of our APM capability).

- GT 019 - Data Science and Analytics Tools Tech Health (████)** - Our Data Science tools enable us to take advantage of advanced analytics and data analysis. In RIIO-1, we started to use basic capabilities for analytics using data science tools. In RIIO-2, we will invest to maintain the health of these tools and develop more sophisticated analytics using artificial intelligence and machine learning techniques to enable us to make asset management decisions, understanding different operational scenarios and the impacts of

changes to our assets. We will also gather and analyse more data from our assets, integrating existing sources and new ones such as remote sensors (Internet of Things) to inform our analytics and provide early insight into asset performance. (see section 3.2.3.2 for details of IoT)

- **GT 020 - Establish Master Data Management (████)** – In RIIO-2, we will increase the number of data sources with consequential increases in data volumes and transaction frequencies. This could lead to significant data management issues resulting from inconsistency and data quality issues of our critical data sets (such as asset, location, condition etc). Master data management (MDM) is a comprehensive method of enabling us to link all our critical data to a common point of reference. We plan to implement new MDM capabilities to manage multiple data sets and to reduce the risk of siloed data as we seek to develop common insights.

Investment Costs, Benchmarks and Cost Profile

Insights and Data Lake Tech Health							Gartner Benchmark Range		Gartner Rating	
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High		
CAPEX										

Data Science and Analytics Tools Tech Health							Gartner Benchmark Range		Gartner Rating	
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High		
CAPEX										

Establish Master Data Management							Gartner Benchmark Range		Gartner Rating	
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High		
CAPEX										

We anticipate continued investment to enhance and develop our data solutions, as we ingest and manage more data from a greater number of sources over the regulatory period. Our estimates are based on shared capabilities with NGET and experience of similar solutions in RIIO-1. Gartner has benchmarked our estimates to be within their expected range.

Options Analysis

Option	Pros	Cons
Do not invest during RIIO-2, and run on unsupported systems (Rejected) as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)	<ul style="list-style-type: none"> • No Investment 	<ul style="list-style-type: none"> • Risk to following consumer benefits: Improved reliability and safety; Lower bills than would otherwise have been the case; Reduced environmental damage both now and in the future. • Exposed to risks including: cyber threat, business disruption, poor productivity, poor user experience and increased Opex, as outlined in our IT Asset Health policy (see Appendix 1).
Invest to maintain and extend data management capabilities in RIIO-2. (Recommended)	<ul style="list-style-type: none"> • Maintains supportability for critical data management services in line with our IT Asset Health policy • Enables our ability to take on more data from disparate data sources in a consistent way, ensuring quality of data is maintained • Removes requirements of additional resources otherwise required and investment on assets to maintain network availability and safety. • A key enabler for our ability to deliver on the recommendations from the Energy Data Taskforce 	<ul style="list-style-type: none"> • Increased investment required

Recommended Option

Our recommendation is to make investments in all the three investments described above. This will not only enable us to maintain the health of our systems, in line with our IT Asset Health policy, but also to enhance and develop our key capabilities in managing the consistency and accuracy of our data. Investments in data science and analytics tools will enable us to extend on the work we are doing in RIIO-1 to build much deeper and richer insights from different data sources with greater volumes.

Consumer Benefit



Improved safety and reliability

Our investment ensures we have accurate and consistent data, which can be analysed and interpreted to make safe, efficient and reliable decisions on our network.

5.1.2.5 Innovation Technologies - Artificial Intelligence & Cognitive (GTO)

In RIIO-1 we started our digital journey by exploring new and emerging technologies to reduce costs for consumers and deliver a safe and reliable network. However, NGG, like the Utility industry, is at an early stage of digital adoption (see Figure 15) maturity. We anticipate further changes in technology over the next regulatory period offering greater benefits with associated challenges for adoption.

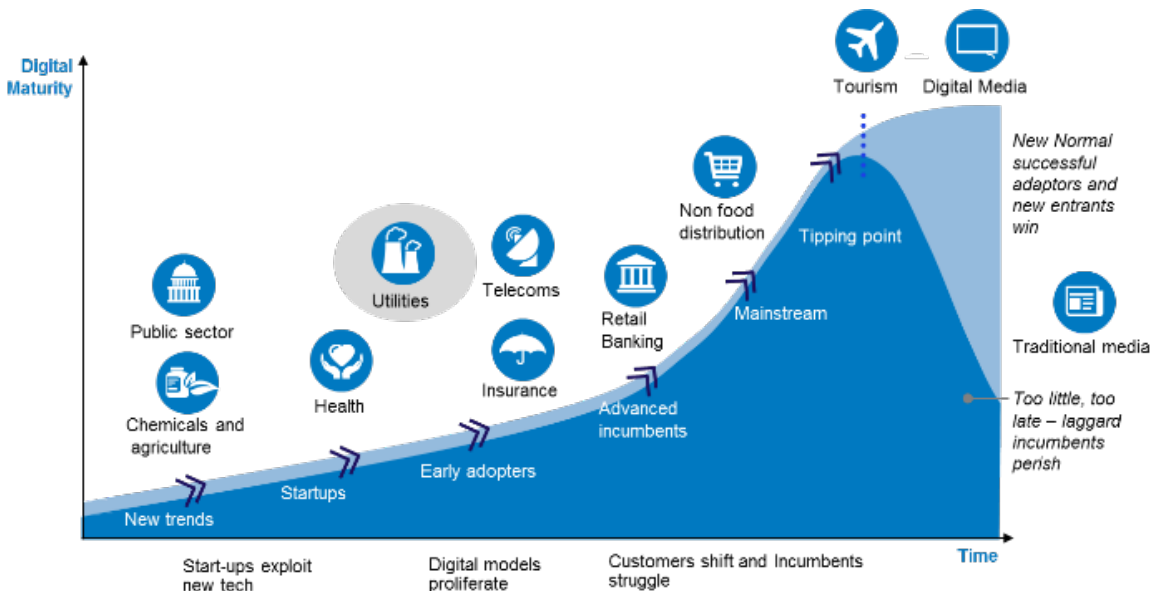


Figure 15: Industry Digital Maturity (McKinsey)

In RIIO-2, we expect further advances in Artificial Intelligence (AI) and Machine Learning (ML) which we plan to utilise to support how we operate, monitor, analyse, plan and take appropriate action on the transmission network, to allow us to meet our customer and stakeholder priorities more effectively.

We plan investments in the following areas to develop our capability in this area:

			Investment	£M
<p>I want to take gas on and off the transmission system where and when I want</p>	Insights & Innovation	GTO Innovation Technologies - Artificial Intelligence & Cognitive	GT 016 Establish Innovation Platform & Capability	[Redacted]
			GT 030 - Cognitive Technologies to support Business Processes, Work, Asset and Corrosion Management	

Needs Case and Scope of Investment

- GT 016 - Establish Innovation Platform & Capability** – We need a way to safely and efficiently explore and develop capabilities using AI and ML technologies. To achieve this, we propose to set up a development environment (“sandbox capability”) with a number of test tools and services to experiment with emerging technologies to support solution delivery in RIIO-2. This will enable us to experiment with new data types, formats and methods in building the new capabilities we discuss elsewhere in this document.

This will be a shared investment between NGG and NGET to gain synergies in delivering new capabilities for both organisations.

- GT 030 - Cognitive Technologies to support Business Processes, Work, Asset and Corrosion Management (████)** – As part of our digital strategy we plan to exploit new technologies to automate and enhance how we carry out maintenance and inspections of our assets to reduce the risks to our employees or members of the public in carrying out these tasks.

During RIIO-2 we will invest in AI services (i.e. Natural Language Processing, Learning and Reasoning, Digital Knowledge Virtualisation, Visual Recognition) to address areas such as:

- Reduction of manual processing of unstructured content (Videos, images, design, drawings) through auto recognition, analysis and processing, creating improved accuracy and reduced likelihood of human error
- Analyse and interpret policy and maintenance documentation to ensure processes are understood and followed, allowing for improved asset management and safety
- Using analytical techniques to interpret our pipeline inspection data or analyse gas quality data to understand the impact of gas blending on our assets.

Investment Costs, Benchmark & Cost Profile

GTO - Establish Innovation Platform & Capability							Gartner Benchmark Range		Gartner Rating	
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High		
CAPEX										

GTO - Implement Cognitive Technologies to support Business Processes, Work, Asset and Corrosion Management							Gartner Benchmark Range		Gartner Rating	
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High		
CAPEX										

Our estimates are based upon similar technology investments and development environments in RIIO-1, and they have been assessed by Gartner based on typical and comparable AI spend. Our costs are within the recommended range.

Option Analysis

Option Description	Pros	Cons
No investment in RIIO-2 period	<ul style="list-style-type: none"> No investment 	<ul style="list-style-type: none"> Likely to result in increased spend outside of IT to meet business requirements via other manual means Hinders NGG's ability to innovate and digitise our processes NGG IT infrastructure will fall behind industry standard and be put at risk of significantly increased spend in RIIO-3 period No additional levers for improvement in network availability or safety in RIIO-2 period and RIIO-3 benefits expected to be significantly delayed Significant misalignment between NGG and energy industry
Invest in new Cognitive Technologies to support Business Processes in RIIO-2 (Recommended)	<ul style="list-style-type: none"> Enable NGG to innovate and digitise to meet, and create opportunities to further exceed, stakeholder priorities and consumer benefits Likely to offer value throughout the asset management lifecycle, for improved reliability, efficiency and safety 	<ul style="list-style-type: none"> Increased spend but provides an opportunity to digitise and innovate to offset costs where successful.

Option Description	Pros	Cons
	Opportunity to consolidate, drive efficiencies, productivity and a better experience for our customers and stakeholders	

Recommended Option

Stakeholders expect us to innovate and use new technology where it offers a clear benefit. As we gather increasing volumes of data we need to find new ways to manage and exploit it. AI and ML offer the potential to do this, but we need to be able to experiment and explore how and where to use it.

Our recommended solution supports this by providing an environment to manage this technology and for targeted investments to be made in AI and ML where there are benefits for stakeholders. The increase in digital enabling technologies also means this investment will reduce the risk of inefficiencies and disruption from emerging technologies in future.

Consumer Benefit



Improved safety and reliability

Exploring and exploiting new technologies to improve how we maintain our assets to reduce risk to employees and the public


5.1.3 Network Asset Management

5.1.3.1 Asset and Work Management

Our RIIO-2 business plan will provide the reliable and flexible network that our stakeholders have told us they value. Understanding asset condition is key to ensuring safe and efficient asset management. We plan to build on asset management tools and techniques we have developed in RIIO-1 to enhance our capability.

We have an ageing gas network infrastructure and will continue to spend to keep the level of risk at the same level, on the physical assets that are required to meet the needs of our stakeholders. This will include investing in the technology health and capability of our systems that support us in planning, maintaining and operating our network in the most cost-efficient way.

This is made up of the following investments:

	Network Asset Management	GTO Asset and Work Management	Investment	£M
 <p>I want to take gas on and off the transmission system where and when I want</p>			GT 006 - Enterprise Asset Management Tech Health	[REDACTED]
			GT 007 – Work Management System Tech Health	
			GT 059 - GT Specific Field Force Device Tech Health	
			GT 005 - OT/Cyber Asset Database	

Needs Case and Scope of Investment

In RIIO-2, these core systems will be reaching end of life and require technology health investments to ensure we can continue to manage our assets, data, work and field force. We will reassess our systems and replace or upgrade appropriately to ensure we maintain our safety and reliability performance whilst extracting the most value for money from our systems.

- GT 006 - Enterprise Asset Management Tech Health (REDACTED)** - Our core asset register and work management system is fundamental to the safe and efficient delivery of our maintenance programme and understanding the condition of our assets. It holds our technical asset register and we schedule and execute work and inspections to maintain the levels of service expected by our stakeholders. During RIIO-2, this system will become end of life and due for upgrade or replacement.

We cover this investment as part of a separate justification report with an associated cost benefit analysis (CBA) and sets out our strategy and approach in RIIO-2. See Annex A28.04 - Ellipse Justification Paper for more details.

Our cost estimates are based on conducting similar scale technology refreshes within RIIO-1, along with iterative enhancements. Gartner has placed our estimates for Work Management and OT/Cyber Asset Database investments to be within their benchmark range. They have however placed the GT Specific Field Force Devices cost estimates to be above their benchmark range. We are comfortable with our estimates because of the additional cost associated with intrinsically safe devices which are covered in this investment, based on our experience in RIIO-1.

Options Analysis

Option	Pros	Cons
<p>Do not invest and run unsupported systems during RIIO-2</p> <p>(Rejected as this is not a viable option, due to the reasons outlined in the cons section and the risks this option introduces in managing the NTS)</p>	<ul style="list-style-type: none"> No Investment 	<ul style="list-style-type: none"> Exposed to risks including; cyber threat, business disruption, poor productivity, poor user experience and increased Opex, as outlined in our IT Asset Health policy (see Appendix 1).
<p>Invest to maintain systems to supported levels, in line IT Asset Health policy and delivery of required enhancements.</p> <p>(Recommended)</p>	<ul style="list-style-type: none"> Systems and capabilities to remain safe, efficient, operational and supportable in line with our IT Asset Health policy. Removes requirements of additional resources and investment on assets to maintain network availability and safety, in the absence of appropriate technology. Improved safety, efficiency and performance of field operations and management of network assets. Removing risks associated with impact to asset reliability and a reduction in network capability. 	<ul style="list-style-type: none"> Increased investment required.

Recommended Option

Our recommendation is to invest in all four investments in this area as they will:

- Maintain the health of our IT systems and field force devices in line with our IT Asset Health policy
- Move to a fully supported integrated market leading asset management solution to replace our ageing EAM system (see separate Justification Report)
- Enable us to integrate our OT asset information with EAM enabling us to better plan and manage the health of those assets

Consumer Benefits



Improved safety and reliability

Our recommendation will enable us to maintain the health of our assets and enable our employees to work safely, whilst also reducing the risk to the public from asset failure

5.1.3.2 GTO Asset Performance Management (APM)

In RIIO-1, we developed multiple, targeted condition-monitoring techniques that capture data about our assets and introduced an insights platform to analyse and make sense of this data. These systems manage critical data such as:


- cathodic protection information and in line inspection details
- asset performance and emissions data
- gas measurement information to comply with thermal energy and gas safety regulations

Asset Performance Management (APM) allows us to develop consolidated view of the asset performance. It enables us to move to a reliability-centred maintenance, that allows proactive maintenance of assets before faults

develop. In RIIO-1, we started on this journey and plan to exploit this capability further in RIIO-2, capturing more data from more assets. This includes more structured as well unstructured data.

We also see much greater use of sensors on our assets to capture real-time performance and condition data. This is currently done on small scale using isolated solutions with varying levels of manual effort and process. We will invest in new Internet of Things (IoT) technologies to implement this in a consistent way across our assets.

Our investments in this capability for RIIO-2 consists of:

 <p>I want to take gas on and off the transmission system where and when I want</p>	Network Asset Management	GTO Asset Performance Management	Investment		£M
			GT 040 – Asset Performance Management Tech Health		[Redacted]
			GT 039 - Data Sources (IT/OT) to Support Insights and Asset Performance Management		

Needs Case and Scope of Investment


- GT 040 – Asset Performance Management Tech Health ([Redacted])** – Our objectives for asset performance driven are driven by a need to achieve higher network safety and reliability at lower maintenance & capital cost. These include:
 - a move away from time-based maintenance within our Enterprise Asset Management systems to one which integrates this with our Asset Performance Management capability
 - a consolidation of siloed asset performance solutions
 - alignment of our strategic roadmaps for these services


We started to invest in APM during RIIO-1 and will need to maintain this capability in line with our IT Asset Health policy. We will also extend this capability in RIIO-2 to capture more data on more assets with a view to transition to an integrated industry standard APM solution by the end of the RIIO-2 period.

- GT 039 - Data Sources (IT/OT) to Support Insights and Asset Performance Management ([Redacted])** – To enable more ingestion of IoT data we will invest in industrial scale event processing capabilities to capture sensor data from our assets. We will integrate this data with our insights platform using new data transfer capabilities. We recognise the cyber risks associated with data transfer from our Operational Technology (OT) services and will invest to ensure we implement secure systems without impacting our network.

This investment will significantly enhance the breadth and depth of data we capture on our assets, enabling us to build much better insights on the performance of our assets and ultimately improved decision making on maintaining our ageing infrastructure.

Investment Costs, Benchmark & Cost Profile

Asset Performance Management Tech Health							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX	[Redacted]								

Data Sources (IT/OT) to Support Insights and Asset Performance Management							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX	[Redacted]								

Our estimates are based on similar delivery in RIIO-1 and advisory from our deliver partners. Gartner has benchmarked our estimate to be at the upper end of their range, which reflect the relative maturity of these capabilities and the nascent cyber risks associated with delivering them.

Options Analysis

Option Description	Pros	Cons
<p>Do not invest and run unsupported systems during RIIO-2</p> <p>(Rejected as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)</p>	<ul style="list-style-type: none"> No Investment 	<ul style="list-style-type: none"> Would not deliver requirements for an increase in condition monitoring activities and would drive data analytic activities outside of core systems resulting in reduced productivity and increased costs. Risk to network reliability, non-compliance with legislation, safety impacts, environmental damage and consumer bills, due to unavailable or inaccurate data. Exposed to risks including: cyber threat, business disruption, poor productivity, poor user experience and increased costs, as outlined in our IT Asset Health policy (see Appendix 1).
<p>Invest to ensure systems supportability and delivery of required enhancements during RIIO-2.</p> <p>(Recommended)</p>	<ul style="list-style-type: none"> Systems and capabilities to remain safe, efficient, operational and supportable in line with our IT Asset Health policy. Removes requirements of additional resources and investment on assets to capture operational data, in the absence of appropriate technology. National Grid compliant with legislation (Calculation of Thermal Energy) Regulations 1997 and Uniform Network Code to publish Calorific Value (CV) data Improved safety, efficiency and performance of assets through better understanding of network. Removing risks associated with impact to asset reliability, consumer benefits and a reduction in network capability. 	<ul style="list-style-type: none"> Increased capex investment required.

Recommended Option

Our recommendation is to maintain the Asset Performance Management (APM) systems in line with our IT Asset Health policy and transition to an integrated APM tool. We will also gather more data from our assets, integrating existing sources and new ones such as remote sensors (Internet of Things) to inform our analytics and provide early insights into asset performance. This will help to drive down risk of asset failure and support our approach to monetised risk.

Consumer Benefits



Improved safety and reliability

Our ability to better capture and analyse the asset condition will enable us to mitigate the risk of supply of gas.



Reduced environmental damage


Able to provide key compressor environmental data in compliance with emissions regulations, leading to the efficient and reliable running of compressors.

5.1.4 Network Planning and Investment

5.1.4.1 GTO Asset Investment Planning (AIP)

Our Asset Investment Platform (AIP) helps us to invest appropriately based on risk driven by data to compare different investment options. Our RIIO-2 plans are developed using the monetised risk model, which considers TOTEX cost and the resultant service level risk, in terms of safety, reliability, environmental, societal and financial risk. We are using the monetised risk model to determine priority for asset investment, which is vital to ensuring that the right asset health investments are made at the right time and at the right scale to achieve best possible results at optimised costs.

Our investments in this capability consist of:

 I want to take gas on and off the transmission system where and when I want	Network Asset Management	GTO Asset Investment Planning	Investment		£M
			GT 034 - Asset Investment Planning Tech Health		
			GT 036 - Integrated process / solution for risk & reliability centred asset management (EAM, AIP, APM)		

Needs Case and Scope of Investment

- GT 034 - Asset Investment Planning Tech Health (████)** - In RIIO-1 we invested in Copperleaf C55, our AIP platform. In RIIO-2, we will maintain this system in line with our IT Asset Health policy. As we capture more asset condition data in RIIO-2, we will continue to enhance this system and use this to improve the accuracy of risk profiles that we use for investment decision making. This will in turn enable us to develop plans based on service, risk and cost.
- GT 036 - Integrated process / solution for risk & reliability centred asset management (EAM, AIP, APM) (████)** – As we develop and mature the individual capabilities across our EAM, AIP and APM eco-system, we will need to optimise the way in which these systems interact. We anticipate much greater reliance and enhancements in our decision-making capabilities such as AIP, APM and Advanced Analytics as we move towards a more intelligence-led asset management future. In contrast we see a gradual reduction in some traditional capabilities in our EAM systems, such as planning and performance functionality. Whilst individual investments in this eco-system allow us to build capabilities for specific use cases, this investment in RIIO-2, will ensure we better integrate these systems so that we can move to the next generation of intelligent asset management (see Figure 16).

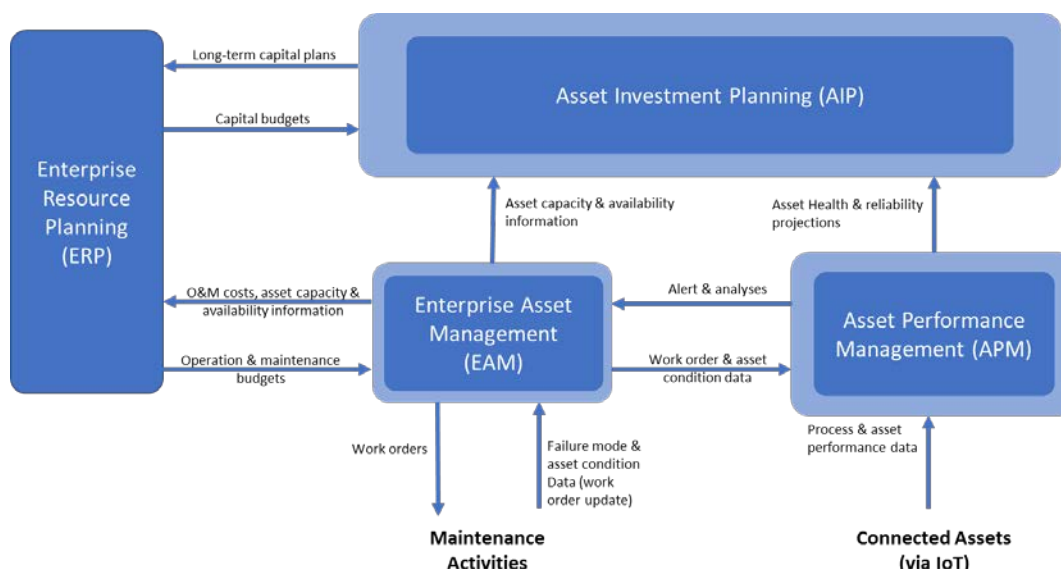



Figure 16: EAM Eco-System Landscape

Continual investment during RIIO-2 in these areas will enable us to evolve our systems so that we can optimise our capital spend and asset risk management whilst improving network safety by using sophisticated asset risk modelling and condition assessment.

Investment Costs, Benchmark & Cost Profile

Asset Investment Planning Tech Health							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

Integrated process / solution (EAM, AIP, APM)							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	



Our estimates are based on our experience of implementing and integrating AIP solutions in RIIO-1. Gartner has benchmarked these to be within their range and assume a single team and set of processes across NGET and NGG.

Options Analysis

Option Description	Pros	Cons
<p>Do not invest and run unsupported systems during RIIO-2</p> <p>(Rejected as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)</p>	<ul style="list-style-type: none"> No Investment 	<ul style="list-style-type: none"> Network reliability and performance put at risk Increased investment resulting from an absence of technology in this area Unable to provide rigorous governance and assurance of capital spend. Exposed to risks including: cyber threat, business disruption, poor productivity, poor user experience and increased Opex, as outlined in our IT Asset Health policy (see Appendix 1).
<p>Invest to ensure systems supportability and delivery of required enhancements during RIIO-2.</p> <p>(Recommended)</p>	<ul style="list-style-type: none"> Systems and capabilities to remain safe, efficient, operational and supportable in line with our IT Asset Health policy Removes requirements of addition resources and investment on assets to maintain network availability and safety. Enables more efficient management of network. Enables the continued use of the monetised risk model, removing impact to network availability and performance. 	<ul style="list-style-type: none"> Higher Capex investment required.

Recommended Option

Our recommendation is to continue to maintain our Asset Investment Planning (AIP) systems in line with our IT Asset Health policy whilst maintaining our integration with our core EAM, AIP and APM systems as they evolve during RIIO-2. This investment will enhance our reactive maintenance and investment planning capability by bringing AIP together with our other core capabilities, which will have developed and further matured in RIIO-2.

Consumer Benefits



Improved safety and reliability

Our recommendation will enable us to build integrated investment plans using asset condition, maintenance plans to determine long-term capital plans which can be delivered in a safe and reliable manner.

5.1.5 Digital Experience, Channels and Engagement

5.1.5.1 GTO Enterprise Content Management and Digital Engineering

Our Enterprise Content Management (ECM) system holds critical documents such as drawings and technical documentation, to support the maintenance of our assets across Great Britain. It supports the Asset Performance and Information Management capability and allows NGG to design assets and network connections according to required engineering and safety standards.

Our RIIO-2 investments consist of:

	Digital Experience, Channels and Engagement	GTO Enterprise Content Management and Digital Engineering	Investment	£M
			GT 009 - Enterprise Content Management Tech Health GT 010 - Business Critical Data and Document Tech Health GT 053 - Enhance Asset Design to improve management process for operation & control	

Needs Case and Scope of Investment

- **GT 009 – Enterprise Content Management (ECM) Tech Health (█████)** - During RIIO-1, we migrated our ECM solution to a standard cloud-based content management system. We will continue to maintain this system through RIIO-2 to ensure supportability in line with our IT Asset Health policy.


GT 010 – Business Critical Data and Document Tech Health (█████) – During RIIO-2, we see the need to manage more structured and unstructured content. This includes management of LIDAR data, 3D models as well as video content and business critical documentation which is used to maintain our assets in an efficient and safe way. This capability will not only allow us to store these different content types in a common environment, but also support collaboration with third parties when handling new digital information. We anticipate much greater volumes of data ingestion of these new data types in RIIO-2 and have costed for this in our estimates.


- **GT 053 - Enhance Asset Design to improve management process for operation & control (█████)** – Our experience of working with our construction partners in RIIO-1 demonstrated considerable benefits in using Digital Engineering, often referred to as Building Information Modelling (BIM), in 3D model projects. BIM provides a 3D view of assets and allows you to test how asset interventions might be constructed before reaching site and is currently being use by our top tier delivery partners for major capital investments to assess, design and construct assets. BIM also incorporates the collection, manipulation, storage and sharing of information on sites and assets between functions, partners, stakeholders and customers which will lead to the reduction in effort associated with creating handover documentation. Currently we do not have automated technical capabilities to handle these models and to ingest relevant meta data associated with these model into our core systems.


In RIIO-2, we plan to invest in:

- Improving our capability for using BIM to help in optioneering and delivery of capital projects
- Creating a digital representations of our assets
- Integrate with broader systems (AIP, APM, EAM) bringing Digital Engineering data to and from the common data environment from other key platforms
- Develop digital simulations from the integrated data sources to replace manual processes
- Develop a common data environment for collaborative working with our partners, bringing together other key elements such as our Digital Platform and our ECM systems.

Investment Costs, Benchmark & Cost Profile

Enterprise Content Management Tech Health							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

Business Critical Data and Document Tech Health							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

Enhance Asset Design to improve management process for operation & control							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX							Benchmarks not available		

Our cost estimates for ECM tech healthcare based on a shared capability with NGET and were derived from similar technology health investments made in RIIO-1. Gartner has benchmarked these to be within their range, based on equivalent projects in the Gartner database.

Our cost estimates for the enhancements to support new content data types and collaboration with our stakeholders include provision for much greater volumetric in RIIO-2 and year on year enhancements to our ECM systems to support this requirement. Gartner has benchmarked our estimates to be above the higher range, but we are comfortable with our estimates as they include provision for additional enhancements and data volumes for NGG.

Our estimate for the enhanced asset design capability are based on new technologies that would be required to handle BIM 3D models as part of a common data environment. These capabilities are limited in NGG today and we plan to develop our technical solutions in RIIO-2. We will conduct a detailed review of the capabilities we need early in RIIO-2. Gartner were not able to benchmark this investment given the bespoke nature of the potential solutions that may arise.

Options Analysis

Option	Pros	Cons
<p>Do not invest during RIIO-2 and run unsupported systems</p> <p>(Rejected as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)</p>	<ul style="list-style-type: none"> No Investment 	<ul style="list-style-type: none"> Risk of impact to reliability, safety and overall network capability in the absence of a secure and reliable solution to store and access business critical documentation used to manage the gas network in line with policy and regulatory compliance Exposed to risks including: cyber threat, business disruption, poor productivity, poor user experience and increased Opex, as outlined in our IT Asset Health policy (see Appendix 1).
<p>Invest to ensure systems supportability and delivery of required enhancements during RIIO-2.</p> <p>(Recommended)</p>	<ul style="list-style-type: none"> Systems and capabilities to remain safe, efficient, operational and supportable in line with our IT Asset Health policy. Able to retain and access knowledge to manage network in a safe and efficient manner, removing risk to network capability and consumer benefits. Enable our content and information management capability to support common data structures and be able to better share data with our partners. Allow NGG to handle new types of digital information being provided by third parties 	<ul style="list-style-type: none"> Increased Capex investment

Recommendation

Our recommendation will enable us not only to maintain our ECM system in line with our IT Asset Health policy but also to enhance our systems to support new content data types and common data structures, as well as better collaboration with our partners. We recommend investment in enhancing our digital engineering capability which will improve our asset design processes. This will also allow us to develop a centralised capability to manage collaboration, knowledge and search.

Consumer Benefits



Improved safety and reliability

- Our recommendations will allow us to store and access mission critical digital content in a secure manner to inform asset decision-making in line with policy
- Establish a consistent method of collaboration with our partners to manage our network in a safe and efficient manner


5.1.5.2 GTO Digital Experience Platform

Needs Case and Scope of Investment

GT 046 – Digital Experience Platform (DEP) – In RIIO-1, we implemented a foundational capability for a Digital Experience Platform (DEP) to allow us to develop and publish workflows, across our internal front and back-office processes, as well external customer and stakeholder interactions. This provides our customers and stakeholders with a consistent, secure and personalised view of and access to information across multiple systems in our landscape.

In RIIO-2, we plan to maintain this platform in line with our IT Asset Health policy and enhance the number of different systems that we will integrate with DEP. These will include for instance: content management, IoT, mobile, web portals and search, through integrations across the various digital touchpoints. We will continue to review the suitability of this platform in line with our evolving requirements to access and publish more data in RIIO-2.

Investment Costs, Benchmark & Cost Profile

Digital Experience Platform						Gartner Benchmark Range		Gartner Rating	
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low		High
CAPEX									

Our cost estimates are based on our experience of similar delivery in RIIO-1 and the investment is shared platform with NGET. Gartner has benchmarked our estimate to be within their range.

Options Analysis

Option	Pros	Cons
Do not invest during RIIO-2 (Rejected as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)	<ul style="list-style-type: none"> No Investment 	<ul style="list-style-type: none"> Will constrain ability to deliver GT's work efficiently, impacting network reliability and performance as well as a detrimental impact to customer experience Exposed to risks including: cyber threat, business disruption, poor productivity, poor user experience and increased Opex, as outlined in our IT Asset Health policy (see Appendix 1).
Invest to ensure systems supportability and delivery of required enhancements during RIIO-2. (Recommended)	<ul style="list-style-type: none"> Systems and capabilities to remain safe, efficient, operational and supportable in line with our IT Asset Health policy. Supporting the digitalisation of various IT capabilities, business processes and digital touchpoints will be essential in RIIO-2 to efficiently manage the Gas network and enhance customer experience 	<ul style="list-style-type: none"> Increased Capex investment required

Recommended Option

Our recommendation is to continue to build on the investment we made in the Digital Experience Platform (DEP) in RIIO-1 by extending this to integrate with much greater digital touchpoints and backend systems. This will support multiple user audiences, including internal employees, customers and other external stakeholders, allowing seamless interactions between them.

This will enhance our overall technology capability as we move further into the digital era, where digitalising our business processes (as outlined within each technology capability) will be essential to delivering a safe, efficient and reliable gas network and customer & stakeholder interactions.

Consumer Benefit



Improved safety and reliability

Our recommendation will provide a consistency in the way we access data from multiple sources to support decision making in maintaining a safe and reliable network



Improved quality of services

Our recommendation will enable us to provide an improved user experience, providing access to our relevant information to customers and stakeholders in a consistent and secure manner


5.1.6 NGG Infrastructure

5.1.6.1 GSO Core Infrastructure Asset Health

In section 3.2.1, we described how we intend to maintain our core Gas Control Suite (GCS). These systems are dependent upon several supporting infrastructure services which will need to be refreshed as part of the normal asset health maintenance cycles, during RIIO-2.

We plan to invest to maintain these systems to ensure they are supported by our suppliers, in line with our IT Asset Health Policy (see Appendix 1). This ensures that they stay reliable, secure and up to date, while delivering the level of performance required by our operators and other parties with whom we need to share data.

These investments consist of:

 <p>I want to take gas on and off the transmission system where and when I want</p>	NGG Infrastructure	GSO Core Infrastructure Asset Health	Investment	£M
			GSO 003 - GSO CNI Gateway refresh	
			GSO 012 - GSO Data Transfer Rationalisation and Refresh	
			GSO 019 - GSO Control Room Display Refresh	
			GSO 021 - GSO Telephony Systems refresh	
			GSO 022 - GSO Voice Recorder refresh	
			GSO 023 - GSO Telemetry refresh	
			GT 042 - Comprehensive Integration Services	


Needs Case and Scope of Investment

- GSO 003 - GSO CNI Gateway Refresh** () - A security perimeter (the CNI Gateway) provides security for the control systems, separating them from the National Grid non-CNI business network. It handles the majority of end-user access and data transfers, including to and from the telemetry network, Independent Gas Distribution Networks (IDNs), Shippers, Xoserve and third-party service providers. Its function is to inspect traffic for malicious content, provide defence in depth and routing of data traffic for the CNI applications. The critical nature of the gateway demands high levels of resilience and reliability. Failure of the gateway would compromise the security and safe operation of the control centre, SCADA and telemetry services. This investment will refresh the hardware and software of all components related to the CNI gateway, including: Citrix Access Gateways (CAG), Enterprise File Transfer (EFT) services, Inner and Lower firewalls, proxy services, AV patching, Windows licenses etc.

The CNI Gateway was refreshed as part of the migration to the new CNI Data Centres (due to be completed by March 2020). There is a need to refresh the Gateway during RIIO-2 in line with the IT Asset Health Policy (see Appendix 1).

Investment Costs, Benchmarks and Cost Profile

The cost estimate profile for this investment is shown below.

GSO CNI Gateway Refresh							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX							Benchmarks not available		

Cost estimate is extrapolated from a similar project undertaken in 2013 (GSV £552k - INVP2995 and INVP1050). The CNI DC programme (2019) rationalised some of the legacy services into a new security perimeter which now forms the backbone for the CNI gateway. The previous upgrade of the CNI Gateway only accounted for 60-70% of the components in the new service and have uplifted the investment to reflect this. Gartner were not able to complete a benchmark for this refresh within the timescales.

Options Analysis

Option	Pros	Cons
Do not invest during RIIO-2 (Rejected as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)	<ul style="list-style-type: none"> No Investment 	<ul style="list-style-type: none"> Would not comply with NIS-D guidance for asset health maintenance of these critical parts of the CNI landscape Lack of vendor support for key systems and services leading to possible performance and reliability issues including potential safety and operational issues on the NTS with failure to meet safety and license obligations.
Invest to ensure systems supportability and delivery of required enhancements during RIIO-2. (Recommended)	<ul style="list-style-type: none"> Maintain operational safety for these services Reduced risk of operational failure Maintains current operational level of these services Maintains cyber security compliance in line with NIS-D guidance Continued vendor support for these services into RIIO-2 	<ul style="list-style-type: none"> Additional cost and effort to implement.

Recommended Option

Maintaining the asset health of these critical components of the CNI landscape are essential to providing a secure and safe gas control systems operation environment and to ensure compliance with cyber security regulations and guidance for CNI landscapes.

Consumer Benefit



Improved safety and reliability

Maintaining these critical systems and infrastructure provides ongoing and operational compliance ensures we mitigate the risks associated with safe operation of the NTS.

- GSO 012 - GSO Data Transfer Rationalisation and Refresh (████)** - Several systems which transfer data from both internal and external data sources to/from the GCS suite will require rationalisation and consolidation. This is as a result of technical debt accrued from: the separation of the Gas Distribution business (Cadent), Xoserve's migration to cloud platform, market and regulatory driven changes and ongoing refresh of legacy services to address cyber security threats during RIIO-1. We have already begun this rationalisation during RIIO-1, with the replacement of legacy JCAPS data flows (e.g. shipper notifications) to our strategic Common Integration Services (CIS) platform - Oracle Fusion, and migration from legacy security gateway services to our supported security gateway from Verizon. Refer to the diagram showing the legacy managed file transfer components described in section 3.2.1.1 for reference.

We plan to continue to migrate all our data transfer services to the CIS platform, through RIIO-1 and into RIIO-2. Work will be required to rationalise and consolidate our data flows, as well as enhancing the CIS platform to improve scalability and resilience to meet future data transfer needs with market participants as well as third-party service providers.

Investment Costs, Benchmarks and Cost Profile

GSO Data Transfer Rationalisation and Refresh							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

These costs are based on similar projects which have sought to rationalize legacy managed file transfer, aggregation and middleware services onto common platform. Our cost estimate is at the top of the Gartner benchmark range but reflects the level of complexity and third-party engagement required to deliver this kind of project.

Options Analysis

Options Analysis

Option Description	Pros	Cons
<p>Do not invest during RIIO-2</p> <p>(Rejected as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)</p>	<ul style="list-style-type: none"> No Investment 	<ul style="list-style-type: none"> Increased likelihood of display board failure resulting in impact on situational awareness within the control room due to lack of network visibility Ultimately this could lead to safety and operational risks due challenges seeing the network in real-time
<p>Replace wall boards and integrate existing and new systems into the control room (Recommended)</p>	<ul style="list-style-type: none"> Maintain the operational capability of the GNCC by refurbishing and enhancing them to support staff needed to address increasing workload through RIIO-2 Contribute to safety of operation of the NTS by enhancing the GNCC facilities to address guidelines on human factors and ergonomic design (such as EEMUA 201 and BS EN ISO 1104). Maintain GNCC fire safety and security by complying with latest Fire Regulations and CPNI security guidelines. 	

Recommended Option

Our recommendation is to complete the control display refresh within the RIIO-2 period to maintain vendor support and security compliance into RIIO-2

Consumer Benefit



Improved safety and reliability

Maintaining these critical systems and infrastructure ensures ongoing operational compliance enabling us to mitigate the risks associated with safe operation of the NTS.



Lower bills than otherwise the case

Providing clear control room displays enable our teams to make the optimal network and commercial decisions in the best interest for the network and the end consumers.

- GSO 021 - GSO Control Telephony Refresh (████)** - The GNCC Telephony system connects duty managers with sites and stations, allows one touch call transfers and swift connections to any party using an easy to access phone directory. The system has a touch screen interface with specific layouts for ease/safety of operation and in case of an emergency allows swift access to all the numbers needed to manage the Gas Network. Having upgrade the current telephony systems in FY20, as part of the natural asset health maintenance of this service, the following investments will be required in RIIO-2:
 - Upgrade the GNCC phone system – █████ in FY23
 - A full replacement of the GNCC phone system – █████ in FY24

Investment in this area maintains our capability to manage operational telephone communications in the GNCC through maintaining and refreshing the GNCC Control Telephony and Voice Recorder systems.

In addition, BT has announced end of support for PSTN lines by 2025. We are already reviewing options for replacement with market solutions and will need to replace our existing PSTN lines in RIIO-2. Investment for this replacement will be covered in the Indirect IT investments documented separately.


Investment Costs, Benchmarks and Cost Profile

GSO Control Telephony Refresh							Gartner Benchmark Range		Gartner Rating	
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High		
CAPEX										

Our costs estimates are based on a software upgrade – [REDACTED] in FY23 and full technology refresh/replacement – [REDACTED] in FY26. They are based on similar scoped projects undertaken in 2018/19. Our estimates are below the Gartner benchmark range and demonstrate our efficiency in delivering these upgrades through experience of doing this on multiple occasions in previous years.

- GSO 022 - GSO Voice Recorder Refresh ([REDACTED])** - Investment is required to cover GSO’s portion of the Voice Recording (VR) system which records all applicable calls from analogue, IP and mobile telephones across GSO, ESO, Arc and Corporate business areas for legal and regulatory requirements via a single system. This can cover incidents from the GNCC which may need to be retrieved for further investigation should the need arise both internally and by the Regulators. It also provides call recordings for internal investigations and lesson learnt from customers queries and complaints. This investment covers the upgrade of the Cisco IP phones and voice recording (Witness) system in FY24/25.

Investment Costs, Benchmarks and Cost Profile

GSO Voice Recorder Systems Refresh							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	

The cost estimates for the refresh of the voice recorder system (Witness) is based on similar upgrade undertaken between 2018-19. Our costs estimate is in the mid-point of the Gartner benchmark range.

Options Analysis – Telephony and Voice Recorder

We have considered the options analysis for Telephony and Voice Recorder together as they are typically closely aligned implementations.

Option Description	Pros	Cons
Do not invest during RIIO-2 (Rejected) as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)	<ul style="list-style-type: none"> Unable to maintain current levels of safety and operational compliance. 	<ul style="list-style-type: none"> Lack of vendor support for key systems and services leading to possible performance and reliability issues including potential safety and operational issues on the NTS with failure to meet safety and license obligations.
Implement upgrades / refresh to maintain asset health in RIIO-2 (Recommended)	<ul style="list-style-type: none"> Continued vendor support for these services into RIIO-2 Maintain operational safety for these services Reduced risk of operational failure Maintains current operational level of these services 	<ul style="list-style-type: none"> Does not necessarily benefit from newer technologies that may be available for these services during the RIIO-2 period
Replacement of systems in RIIO-2	<ul style="list-style-type: none"> Vendor support for these services through RIIO-2 Potentially enhanced functionality and performance. Maintain operational safety for these services Reduced risk of operational failure Replace systems to ensure operational level of these services 	<ul style="list-style-type: none"> Additional cost and effort to implement. Value of investment at this stage not demonstrated given the pace of changing technology in this area

Recommended Option

The recommended option maintains the safety and reliability of our systems through refreshing them rather than replacement, as there are no major new requirements for new capabilities which necessitate a replacement.

Consumer Benefit




Improved safety and reliability

Maintaining these critical systems and infrastructure provides ongoing and operational compliance ensures we mitigate the risks associated with safe operation of the NTS.

- GSO 023 - GSO Telemetry Refresh ([REDACTED])** - In RIIO-1, we replaced the legacy Ulysses Telemetry Network (UTN) and refreshed it with the Gas Remote Sites Communications (GRSC) solution, which is part of the Critical National Infrastructure (CNI) managed by Vodafone. It links the IT systems used by the gas

control rooms with the outstation equipment installed at remote sites to monitor and regulate the flow of gas. The contract for the support service from Vodafone was put in place in May 2014 and had a life of 7-years with an option to extend for another 3 years. PSTN / DSL lines used as part of the GRSC network will also need to be replaced before the end of BT support in 2025. There is therefore a need to refresh the current service in line with the end of the contractual period, taking the opportunity to deliver the updated security features to comply with cyber security / NIS-D guidelines.

Investment Costs, Benchmarks and Cost Profile

GSO Telemetry Refresh							Gartner Benchmark Range		Gartner Rating	
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High		
CAPEX										

The previous GRSC project replaced the hub and remote site (Gas Distribution and Transmission sites) as well as all the switchgear, software etc. The project complicated by the fact that remote equipment had to be replaced from 180 sites, with involvement from NROs, the need to follow strict access procedures and safety compliance. The outturn for the UK Transmission part of the project was [REDACTED] (as per SOIC briefing paper). We have estimated a GSO investment of [REDACTED] over 3-years (from FY24 to FY26), to allow for the replacement of PSTN/DSL links (which become end of life in 2025), the possible need for a new RFP process and that this would need to be a GSO specific project. As part of the Cadent separation, new satellite dish and software were installed (operational from Oct 2019). The need for an upgrade of the head-end software as well as replacement of the remote equipment for 180 sites will be assessed as part of this investment.

Our cost estimates are in line with Gartner’s benchmark range.

Options Analysis

Option	Pros	Cons
Do not invest during RIIO-2 (Rejected as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)		<ul style="list-style-type: none"> Unable to maintain current levels of safety and operational compliance The current contractual support arrangement with Vodafone for the GRSC service ends in 2025 (incl. 3-year extension) and cannot be extended further Reliance on PSTN/DSL, which is no longer supported beyond 2025, so do nothing is not an option
Upgrade existing equipment in 180 remote sites only (Rejected as not viable given the PSTN/DSL issue)	<ul style="list-style-type: none"> Potentially lower cost of £5-6m to maintain the existing equipment (subject to more detailed review) Continued vendor support for these services Reduced risk of operational failure 	<ul style="list-style-type: none"> The security framework for this service will be over 10 years old and not compliant with the latest cyber security standards Risk that the remote sites equipment may not be upgradable and would need to be replaced
Replacement of systems hub and remote sites equipment before end of RIIO-2 (Recommended)	<ul style="list-style-type: none"> Take opportunity to take advantage of potential 5G communications equipment Take opportunity to review and update the security posture of remote sites and their communications Take advantage of latest remote sites equipment, which may be cheaper and future proofed Reduced risk of operational failure Will address replacement of the end of life ISDN service by 2025 	<ul style="list-style-type: none"> Additional cost and effort to implement. Significant effort to replace 180 x remote sites equipment

Recommended Option

Our recommendation is to replace or refresh the current hub and remote sites equipment, as part of our IT Asset Health Policy. However, we will undertake a detailed assessment of the vendor supportability for hardware and software during FY23.

Consumer Benefit

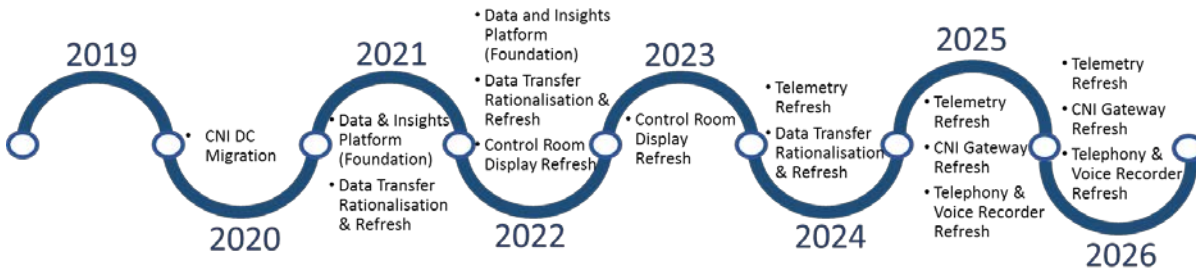


Improved safety and reliability

Maintaining these critical systems and infrastructure provides ongoing and operational compliance ensures we mitigate the risks associated with safe operation of the NTS.

GSO Core Infrastructure Asset Health Roadmap

We have developed a proposed roadmap for these changes during the RIIO-2 period:



5.1.6.2 Comprehensive Integration Services (CIS) - Tech Health (GTO)

Comprehensive Integration Services (CIS) is an integration platform that allows us to create consistent, efficient and centrally operated exchange of data between systems and services (both Internal and external to NG). Continued investment in this capability ensures that data flows between systems are maintained to meet service levels and security requirements. It also enables ongoing reuse of designs and helps to minimise the impact of large changes across the systems landscape.

- GT 042 - Comprehensive Integration Services (CIS)** – In RIIO-1, we invested in a strategic platform, and through the re-platforming of a significant percentage of interfaces we removed the technology risk of our CIS platform. The current integration platform has separate components for data integration, application integration and limited capability to integrate time series data or videos/images captured from different locations.

As we continue to assess our asset condition during RIIO-2, we will look to leverage data across multiple systems to enable informed tactical and strategic decisions. We will invest to maintain our CIS platform with a supportable and scalable solution, whilst extending its capabilities to meet current and the future business needs. With a view to deliver an integration Platform as a Service (iPaaS) over Cloud, which can allow us to consolidate application and data integration on a hybrid platform. This will further rationalise the landscape and address different data sources across the field, remote sites, and core systems.

Investment Costs, Benchmark & Cost Profile

CIS Tech Health							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

We have used experience of similar delivery in RIIO-1 and consultation with our partners to assess our costs. Our investment is based on a shared platform with NGET and we are within Gartner’s recommend range.

Options Analysis

Option	Pros	Cons
Do not invest during RIIO-2 (Rejected as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)	<ul style="list-style-type: none"> No Investment 	<ul style="list-style-type: none"> Exposed to risks including; cyber threat, business disruption, poor productivity, poor user experience and increased Opex, as outlined in our IT Asset Health policy (see Appendix 1). Our integration services are fundamental to all of our platforms and support key business processes.

Option	Pros	Cons
<p>Update systems to supported levels in line with manufacturer support roadmaps and continue to develop core systems on a value case driven approach</p> <p>(Recommended)</p>	<ul style="list-style-type: none"> • Systems and capabilities to remain safe, efficient, operational and supportable in line with our IT Asset Health policy. • Ensure business and operational critical data flows between systems are maintained to meet service levels and security requirements. • Removed risk of impact from changes expected to the GT technology landscape during RIIO-2, allowing for efficient design, delivery and running of systems to support business capability. 	<ul style="list-style-type: none"> • Increased Capex investment

Recommended Option

Our recommended solution is to invest to maintain a supportable integration platform, in line with our IT Asset Health policy. We will carry out continuous assessment of the market and review option of transitioning to an iPaaS solution, which can support our RIIO-2 capabilities and drive further consolidation.

Consumer Benefit



Improved safety and reliability

- Our solution enables us to efficiently connect our systems and transfer business critical information that is required to maintain our network in a safe and reliable way

5.1.7 Training & Development

5.1.7.1 GSO 102 - GSO GNCC Simulation Training (████)

Needs Case and Scope of Investment

During RIIO-1 we have enhanced our training processes and timescales to address the age profile of our control staff. We have shortened the time to fully train a control engineer from 24 months to 12 months, which has allowed us to recruit and replace 75% of the control engineers. In parallel we have trained the teams to use the new IT systems, such as GCS and online Simone, which we've implemented in the GNCC.

Our training has focused on the individual, through a combination of targeted academic training with external providers, in house training, and on the job shadowing of experienced staff (predominantly control engineers) to gain operational competence of managing real life situations on the NTS. A consequence of this "renewal" process is that we have less experienced control staff.


In RIIO-2, we anticipate a much more challenging environment in optimising how we use our assets and market solutions to allow customers to flow gas on and off the system in the unconstrained way they do today. We also anticipate more extreme conditions, like those we experienced on 1st March 2019, and need to ensure that we train our control teams to deal with these conditions.

We recognise the need for a step change in our engineering capability to support this, as outlined in the GSO Annex As part of this, we intend to increase our focus on training of GNCC teams, as a whole rather than individuals, to utilise the new capabilities we plan to deliver during RIIO-2 (as outlined in section 3.2.2.1) To do this we need a training environment, or offline copy of our IT system, which will support this team-based approach to training.

Failure to develop our engineering capabilities as outlined will leave us unable to adequately prepare our control teams to meet the increasingly complex challenge of real-time operation of the NTS and market facilitation, driven by changing network dynamics, ageing infrastructure and technological advancements.

Investment Costs, Benchmarks and Cost Profile

GSO 102 - GNCC Training & Simulation						Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	

CAPEX		No benchmarks available	
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Our cost estimates are based on provisioning training environments for core GCS, Portal, SCADA, Data Historian, Simone Online, Forecaster and associated infrastructure and integration service. These costs are based on current cost models for similar test environments. Gartner were not able to benchmark this investment as they were not able to find sufficient comparative data to initiate a benchmark comparison.

Options Analysis

Option	Pros	Cons
Do not invest during RIIO-2 (Rejected as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)		<ul style="list-style-type: none"> Control teams not adequately prepared to routinely and proactively manage operational conditions they have not previously experienced. Increased risk to our safety and reliability performance
Provision simulation environments to be used on demand for training GNCC control teams (Recommended)	<ul style="list-style-type: none"> Ability to train our control teams to prepare for increasingly complex real-time operation of the NTS and market facilitation, Supports our step change in engineering capability to make better decisions. 	<ul style="list-style-type: none"> Opex cost of maintaining training environments, though they can potentially be shared

Recommended Option

Our recommendation is to proceed with delivering dedicated simulation environments as it is the most efficient way in which training can be delivered to GNCC operatives without disruption to existing inflight programmes of work.

Consumer Benefit



Improved safety and reliability

Enhancing the training of our operational teams ensures we mitigate the risks associated with safe operation of the NTS.



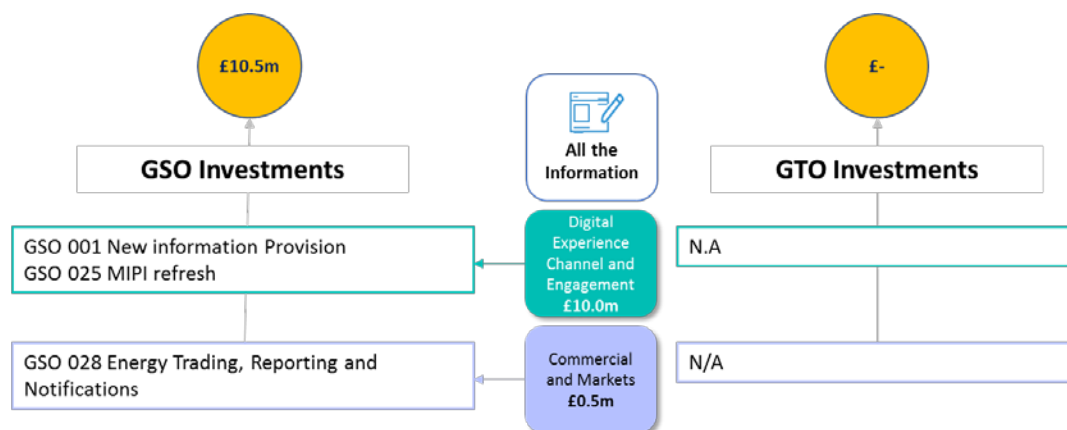
Lower bills than otherwise the case

Train our control teams optimise how we balance use of our assets and market solutions in the challenging environment we anticipate, optimising our costs (such as constraint or contract costs), reducing costs for customers and consumers.

5.2 I Want All the Information I Need to Run My Business, and to Understand What You Do and Why (£10.5m)

Stakeholders have told us that transparency and information are fundamental how they operate their businesses efficiently and effectively. Our data and insights provide value for consumers by ensuring that the gas market runs smoothly. We recognise that our stakeholders need us to provide good quality information and data to inform their business decisions

Our IT systems underpin the information we provide and how we share it with stakeholders. During RIIO-2 we will invest to maintain our systems to ensure they're reliable and enhance our capabilities to provide more information and different ways to access and use it. To meet these needs, we plan to invest in the following capabilities:



These investments are also dependent upon our proposed investments in Enhanced Analytics, which provide foundations for how we manage data and provide further insights and analysis as described in section 3.2.2.1.

5.2.1 Digital Experience, Channels and Engagement

5.2.1.1 GSO RIIO-2 Information Provision

Our main system for publishing data is called the Market Information Provision Initiative (MIPI), which provides a range of within day, operational and after the day information, via web pages and automated, programmable / machine-readable interfaces.


Stakeholder demand for operational information has increased dramatically through RIIO-1. We've maintained and enhanced this system through this period to meet the increased load that this has placed upon it. We've also enhanced it to meet ongoing regulatory and market requirements.

In 2018 we engaged with the industry to explore ways to improve our operational data provision and better understand how they use this information. We have launched the Gas Operational Data Community and implemented an online industry engagement platform to discuss and prioritise future enhancements. This has allowed us to provide additional information where demand from stakeholders is clear and true value to consumers is evident.

Our plans for RIIO-2 build upon this work and we will continue to support and maintain an industry engagement platform to understand what customers want, ensuring we have open conversations about how to prioritise their needs.

We believe that our proposals align with the Energy Data Task Force's (EDTF) objectives in supporting open data sharing to support innovation and a move to a decarbonised future.

These investments consist of:

 I want all the information I need	Digital Experience, Channels and Engagement	GSO RIIO-2 Information Provision	Investment	£M
			GSO 0001 - GSO New Information Provision GSO 0025 - GSO MIPI Refresh	

Needs Case and Scope of Investment

- GSO 001 - GSO New Information Provision (████)** - Customers continue to tell us of the importance of the information we provide, along with an ever-growing list of improvements they would like to see. These range from improvements in the data they get, to the way in which they get access to this data. As the market continues to evolve, customers are asking for more and more information to help inform their businesses.

This investment provides a fixed annual budget to deliver these enhancements. We will continue to support the Gas Operational Data Community and maintain an industry engagement platform to understand what customers want, and to ensure we have open conversations about how to prioritise their needs. Any enhancements will continue to be prioritised through industry engagement aligning with the Data Openness Triage process recommended by the EDTF. We recognise the risks associated with developing our information services in this way and we will be transparent with our Customers that these resources are finite. The scope and therefore cost of each IT enhancement will vary dependant on whether the information already exists within our systems or has to be derived, the complexity of transferring and publishing the information via MIPI. We will work with the customer community when it’s necessary to set priorities. We will continue to collaborate with partners and stakeholders as the industry drives ahead with the EDTF’s recommendations of digitalisation and data transparency.

We believe that our proposals align with the EDTF’s objectives in supporting open data sharing to support innovation and a move to a decarbonised future.

Note: The obligations for DNOs and Xoserve to publish data are not covered by this investment

- GSO 025 - GSO MIPI Refresh (████)** - The MIPI system was implemented in 2006 to publish near-real time gas flows into the NTS at each eligible sub-terminal. We have continuously evolved and expanded the system since then. The system consists of two major components: the data tier which stores the data we publish and the web-tier which supports web-pages, user interface and API functionality. The system is currently being migrated to cloud infrastructure. During 2018/19 the MIPI data tier (previously hosted in DXC data centres) was migrated to a new NG partner hosted Azure cloud instance. The web tier (hosted on an Accenture hosted Azure instance) along with minor enhancements will be migrated to the new Azure service and be completed in 2020. During RIIO-2, we will continue to maintain the system to ensure vendor support.

How users interact with websites and extract data has improved as technology has progressed since MIPI was implemented. We will also investment in MIPI to “modernise” the user interface and deliver enhancements including:

- Self-service and user configuration capability** – users have told us that the MIPI interface is cumbersome to use and that the reports available are static in nature and not easy to adapt. We plan to refresh the user interface and build capability that will allow users to configure and personalise their view of the data, enabling them to make market decisions more efficiently.
- Delivering modern APIs** – APIs account for around 80% of the way in which MIPI data is accessed by customers. Our stakeholder feedback suggests that we need to improve the efficiency and accessibility of these APIs for non-technical users. We plan to refresh our current APIs using modern technologies, which will enable customers and non-technical users to embed these APIs more easily into their processes in an efficient manner.

- **New instant messaging capability** – stakeholders have told us that we need to be more transparent with our data. We plan to implement a live chat feature that will allow customers to interact with us to discuss specific data queries much more quickly than previously

Investment Costs, Benchmarks and Cost Profiles

GSO 001 - GSO New Information Provision (£7.5m)							Gartner Benchmark Range		Gartner Rating	
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High		
CAPEX										

GSO 025 - GSO MIPI Refresh (£2.5m)							Gartner Benchmark Range		Gartner Rating	
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High		
CAPEX										

A summary of our cost estimates for these investments are:

- **New Information Provision** - We assume we will continue to deliver enhancement through periodic releases. These cost estimates are based on two annual releases by a development team. We have estimated that each 6-monthly release will cost [REDACTED]. We have also included [REDACTED] for backend systems changes for provision of new data during the RIIO-2 period. Gartner have assessed our costs to be in the middle of their benchmark range.
- **GSO MIPI Refresh** - This investment covers the delivery of new capabilities in the web tier. The cost estimates are based on work undertaken in RIIO-1, extending the existing capability and taking into consideration current pain points taken from third-party engagement. Gartner has benchmarked our estimates to be in the middle of their range.

Options Analysis – GSO MIPI Refresh

Option	Pros	Cons
Do not invest during RIIO-2 (Rejected as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)	<ul style="list-style-type: none"> • No Investment 	<ul style="list-style-type: none"> • Failure to enhance the information customers want will impact the efficiency of the gas market, which in turn impacts most of components of the consumer bill. • Failure to address the EDTF's objectives to support innovation and a move to a decarbonised future.
Build new data engagement platform	<ul style="list-style-type: none"> • Delivers consistent user experience and data availability, using a common platform, for all data sets and user communities 	<ul style="list-style-type: none"> • MIPI provides this capability today and so the need for a separate DXP is questionable
Re-use and extend the MIPI web tier for information provision (Recommended)	<ul style="list-style-type: none"> • Leverages the existing investment in the MIPI platform and the cloud capabilities that underpin it 	<ul style="list-style-type: none"> • May not meet all future demand requirements

Options Analysis - GSO New Information Provision

Option	Pros	Con
Do Nothing in RIIO-2 Do not support Gas Operational Data Community and delivery industry enhancements	<ul style="list-style-type: none"> • Reduced capex 	<ul style="list-style-type: none"> • Failure to enhance the information customers want will impact the efficiency of the gas market, which in turn impacts most of components of the consumer bill. • Failure to address the EDTF's objectives to support innovation and a move to a decarbonised future.
Plan upon forecast of future changes Agree pipeline of changes through RIIO-2 with Gas Operational Data Community	<ul style="list-style-type: none"> • Funding based upon baselined plan of changes. 	<ul style="list-style-type: none"> • Lack of certainty over changes and therefore ability to agree a plan. • Plan may constrain ability to meet emerging industry / EDTF. This could require the industry community to prioritise changes within budget

Option	Pros	Con
Agree an annual budget and prioritise changes within budget (Recommended)	<ul style="list-style-type: none"> Continues process and approach established in RIIO-1. Provides a mechanism to address emerging requirements. Aligns with EDTF principles 	<ul style="list-style-type: none"> Fixed annual budget may constrain scope of changes that can be delivered. This could require the industry community to prioritise changes within budget.

Recommended Option

Our recommendations for these investments are:

- Make annual investments for new information provision changes, as it builds upon the approach we have already implemented. It will provide additional information where demand from stakeholders is clear and true value to consumers is evident. We believe that our proposals align with the Energy Data Task Force’ objectives in supporting open data sharing to support innovation and a move to a decarbonised future.
- Investment in the MIPI changes to deliver new capabilities, that will significantly improve the user experience for self-service, user engagement with National Grid, data download and improve the efficiency of our APIs. Our cost estimates are based on work undertaken in RIIO-1, extending the existing capability and taking into consideration current pain points taken from third-party engagement. Gartner has benchmarked our estimates to be in the middle of their range.

Consumer Benefit



Providing the information customers want will impact the efficiency of the gas market, which in turn impacts most of components of the consumer bill.



Supporting the Energy Data Task Force’ objectives support innovation and a move to a decarbonised future it benefits society as a whole and reduces environmental damage in the future.

5.2.2 Commercial & Markets

5.2.2.1 GSO 0028 - GSO Energy Trading, Reporting and Notifications Refresh - £[REDACTED]

Needs Case and Scope of Investment

The system is used to log and settle trades for gas and electricity shrinkage trades by GSO to support operation of the gas and electric compressors. It supports UNC obligation to publish Shrinkage trading data to the market daily.

During RIIO-1 we replaced our obsolescent bespoke system with a third-party cloud-based trading application, enTrader which is provided by Contigo. The solution is shared with ESO. This solution addressed a number of internal SOX audit findings.

Through RIIO-2 we need to maintain our capability to log, settle and report upon our shrinkage trading activities.

Investment Costs, Benchmarks and Cost Profile

GSO Energy Trading, Reporting and Notifications Refresh						Gartner Benchmark Range		Gartner Rating	
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low		High
CAPEX	[REDACTED]						[REDACTED]		

Our costs reflect annual vendor upgrades to the solution and below Gartner’s benchmark lower range. We consider this to be a reasonable assessment given our experience of these upgrades.

Options Analysis

Option Description	Pros	Cons
<p>Do not invest during RIIO-2</p> <p>(Rejected as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)</p>	<ul style="list-style-type: none"> No Investment 	<ul style="list-style-type: none"> Increased risk of failure of service. Risk of failure to meet UNC obligations, and inability to provide shrinkage information to the market.
<p>Annual upgrade of existing solution (Recommended)</p>	<ul style="list-style-type: none"> Leverages the existing investment in enTrader and maintains the reliability of the application and vendor support. 	

Recommended Option

Our recommended option is to maintain the supportability of this service through annual upgrades.

Consumer Benefit



Lower bills than otherwise the case

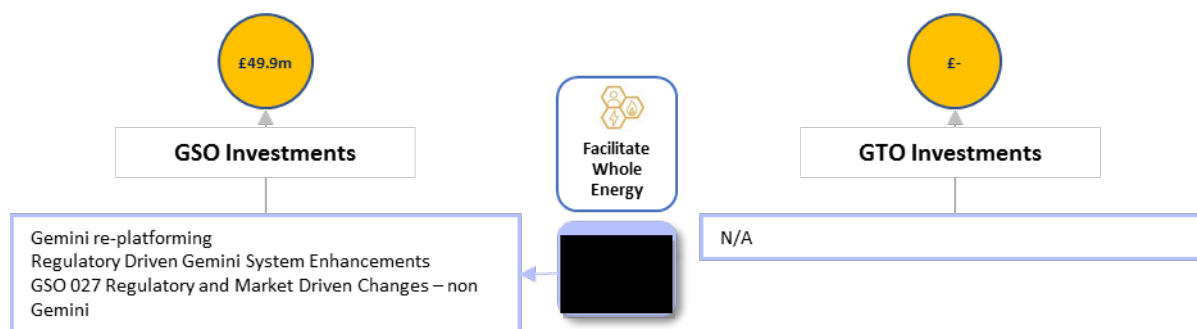
Efficient shrinkage trading will minimise industry costs which reflect in consumer costs.

3.4 I Want You to Facilitate the Whole Energy System of the Future – Innovating to Meet the Challenges Ahead (£49.9m)

Stakeholders want us to take a leading role in driving and enabling the energy transition. Where we can, leading on delivering the future energy system and, where we need to, collaborating with others. This means enabling and supporting market and regulatory change, whilst unlocking consumer and customer value through developing the right systems to deliver a digital future

Our IT systems play a central role in the gas market operates. Through RIIO-2 we need to ensure they can facilitate the industry change which will be at heart of the energy transition.

This means investing in the Commercial & Markets IT capability:



We will also recognise the importance of the Energy Data Taskforce’s recommendations on data transparency and the role that open data sharing has in promoting competition, innovation. This is supported by our investments described in section 3.3.1.1

3.4.1 Commercial & Markets

3.4.1.1 Gemini Re-platforming (GSO)

The Gemini system is at the core of how the gas market operates. It is the main interface between shippers and National Grid Gas System Operator. It is used by shippers to balance their portfolios and to book capacity on the network. National Grid own the current Gemini system but Xoserve (the Central Data Services Provider (CDSP)) manage it on our behalf.

The current Gemini system will become unsupported in 2025. Coupled with this is we need a system which is agile to industry change whilst also responding to feedback received from stakeholders throughout this RIIO-2 business planning process.

We propose to sustain the current system by re-platforming it onto cloud-based infrastructure as well delivering enhancements to rectify the external user’ requirements to improve performance and stability of the application. More information on our plans and the options we have considered can be found in Annex A25.04 Gemini Justification Report

3.4.1.2 GSO RIIO-2 Commercial Markets - Regulatory Change

This focus area is about leading and driving the industry along the pathways to decarbonisation, whilst enabling whole system solutions through cross-sector collaboration. From an IT perspective, this means ensuring our IT systems which support commercial and market processes facilitate gas regulatory change.

During RIIO-1 we have focused on GB market compliance with EU legislation driven principally by the Third Energy Package. We’ve delivered significant changes to both NG IT systems and Gemini, to meet our customers’ requirements and those mandated by Great Britain and EU regulation. The work we’ve done ensured that the changes benefit GB PLC and are completed in the least disruptive and most efficient way possible

We anticipate significant amount of industry change as we move into and through the RIIO-2 period. We anticipate increased focus on decarbonisation of the energy sectors in which natural gas has traditionally met the energy demand, through EU or UK policy drivers or changing industry trends. However, the direction and

speed of change affecting gas markets and, importantly, efficient operation for end consumers, are all uncertain and this lack of certainty requires us to be flexible. We need to ensure that we have the appropriate funding and processes to deliver the regulatory and market change to support this through the RIIO-2 period. This cover the following investments:

- **Regulatory Driven Gemini System Enhancements (GB&EU) (£22.5m)** - The balancing and capacity processes and services which the Gemini system supports are at the centre of the GB gas market. This investment covers delivery of changes to the system to reflect industry change to these areas.
- **GSO 027 - GSO Regulatory and Market Driven Changes - Non-Gemini (£11.0m)** - Industry changes also typically impact non-Gemini systems, supported by National Grid IT. These include changes to support information provision and operational processes which are supported by MIPI and GCS respectively. This investment covers delivery of changes to these systems to support industry change

Investment Costs, Benchmarks and Cost Profile

Regulatory Driven Gemini System Enhancements (GB&EU) (£22.5m)							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

GSO 027 - GSO Regulatory and Market Driven Changes - Non-Gemini (£11.0m)							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

During RIIO-1, we have implemented regulatory drive change on Gemini through annual releases, and for planning purposes we assume the same through RIIO-2. Our costs assume year on year Gemini investment through RIIO-2 in line with the average investment across RIIO-1 with a 10% increase to reflect the anticipated increase we foresee in RIIO-2.

During RIIO-1, investment in regulatory driven change on NG IT systems has been approximately 75% of the equivalent investment on Gemini. We have assumed this will continue in RIIO-2 and have reflected this in our costs above.

Options Analysis

Option	Pro	Con
Do not invest during RIIO-2 (Rejected as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)	<ul style="list-style-type: none"> • No Investment 	<ul style="list-style-type: none"> • Failure to deliver changes to the market that unlock value for industry participants, resulting in higher costs for participant and ultimately consumers. • Failure to meet GB and EU regulatory requirements.
Plan investment in line with “worst case” Use the current Gas Markets Plan (GMaP) to forecast the most significant system changes that could be envisage changes during RIIO-2	<ul style="list-style-type: none"> • Covers the most significant changes that could occur during RIIO-2 and therefore provides a “worst case” scenario to plan for. 	<ul style="list-style-type: none"> • Insufficient certainty over the likelihood and timing of some of the more significant to be credible. • May not be deliverable
Plan investment based upon average RIIO-1 expenditure (Recommended)	<ul style="list-style-type: none"> • Represent a realistic deliverable level of change that the industry can support. 	<ul style="list-style-type: none"> • May not meet all future demand requirements. Risk of underfunding.

Recommended Option

Our recommended option ensures we plan for a volume of change which both the industry and National Grid can deliver.

Consumer Benefit



Improved quality
of services

Ensures compliance with GB and EU regulatory requirements



Lower bills than
otherwise the
case

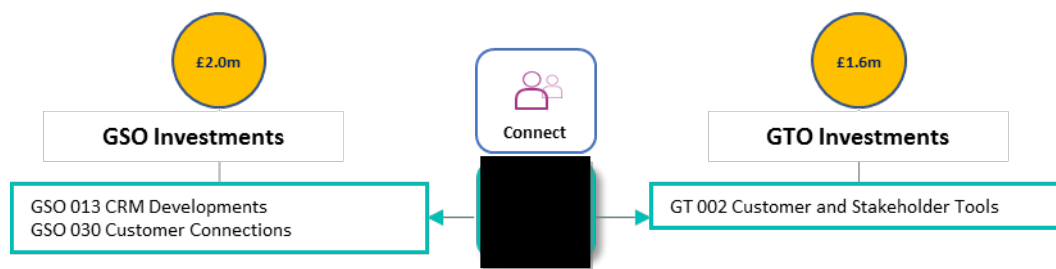
This will deliver changes to the market that unlock value for industry participants, resulting in lower costs for participants and ultimately consumers

3.5 I Want to Connect to the Transmission System (£3.6m)

Our network connects supplies from nine gas importation facilities to nearly 100 offtakes for distribution networks, power stations and interconnectors, as well as eight storage sites. We connect, modify or disconnect new and existing sources of gas supply and demand as customers' requirements change. We also manage the processes customers use to reserve capacity to flow gas on the network.

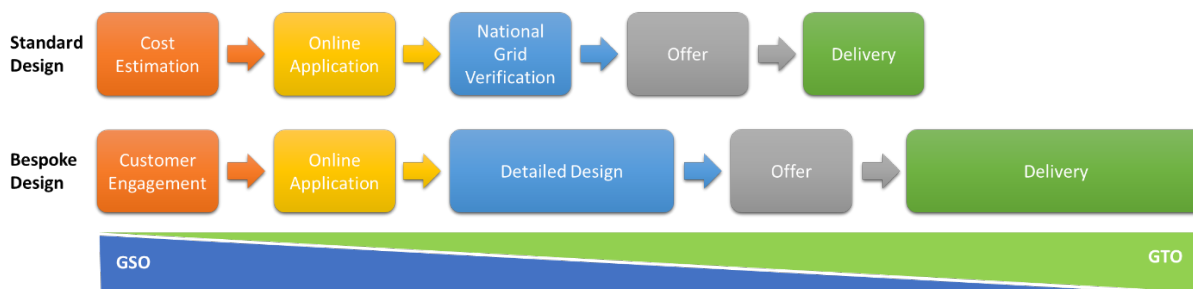
During RIIO-2 we will ensure our IT platforms continue to support our interactions with customers and improve the overall customer experience, as well as providing a quicker, more responsive and transparent service. We will also explore new ways IT can support how we meet the requirements of our changing customer base.

This means investing in the Digital Experience, Channels and Engagement IT capability:



3.5.1 Digital Experience, Channels and Engagement

Our connections service is essential to the effective working of the competitive wholesale energy market. The Customer Connections process spans both GSO and GTO businesses. Our teams work collaboratively from the initial engagement process through to final commissioning of the network connection. GSO lead and support the commercial engagement whilst GTO support the design and technical delivery processes.



Customers have told us that they want quicker and cheaper connections and for us to be more transparent in our processes. During RIIO-1, we have started on a journey to enhance the customer experience with the implementation of the Gas Connections Application Portal, which benefits all customers regardless of size and type. We have also started to automate our connections processes in a new Customer Relationship Management (CRM) system based on Salesforce. This has primarily focused on supporting the later stages of the connections process.

In RIIO-2, our investments are focused on ongoing enhancements and development of the portal solution, rationalisation and automation of GTO managed processes into CRM, and further enhancements and automation of workflows in GSO.

Taken together, our investments to enhance the customer digital experience consist of:

I want to connect to the transmission system	Digital Experience, Channels and Engagement	GSO Customer Relationship Management	Investment	£M
			GSO 0030 - GSO Customer Connections GSO 0013 - GSO CRM Developments GT 002 - Customer and Stakeholder Tools Tech Health	

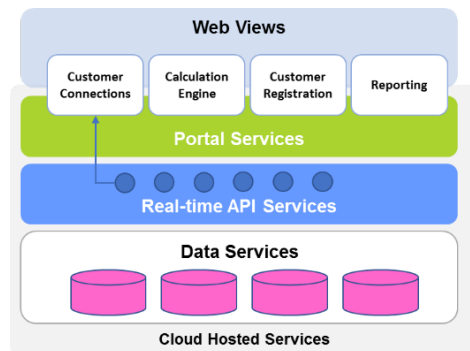
3.5.1.1 Customer Connections and Customer Relationship Management (CRM)

- **GSO 030 - Customer Connections - £1.5m** - Historically connections to the NTS were required to support typically large-scale entry/exit connections, or to facilitate storage. Each connection request would be

handled on a case by case bespoke basis with a Minimum Offtake Connection (MOC) at a greenfield site typically costing up to £2M and taking up to 2 years to deliver.

In response to this, we initiated a National Innovation Competition (NIC) project, in RIIO-1, collaborating with three small and medium-sized enterprises (SMEs). Following a successful trial as part of the Customer Low Cost Connections (CLoCC) project, a new Gas Connections Applications Portal was delivered in 2018. This demonstrated that the cost of a new standard design connection to an existing Above Ground Installation (AGI) could be reduced to less than £1m and that the time to “gas on” from initial enquiry could be reduced to 1 year. We will embed the improvements resulting from this project into business as usual.

In RIIO-2 we will continue to invest in the portal, related internal systems and other aspects of our website to improve our customer self-service capability and provide customers with unified, timely and continuous access to relevant information.



Our proposed investment for RIIO-2, include two key areas:

- **Extend functionality** - The portal functionality will be enhanced to support non-standard connections as well as the current standard design connections. We will integrate our connections portal to Salesforce CRM, in which we plan to build end-to-end workflows for the different connection processes. We plan to deliver the management of the end-to-end process for Gas Connections, Diversions and Shipper lifecycle processes (when customers enter and leave the market). We will also develop the processes to support formal interactions with the Distribution Network Organisations (DNO's) under the Offtake Arrangements Document (OAD). These enhancements support the delivery of our Licence obligations and generate efficiencies enabling resources to focus on higher value-add activities with our customers.
- **Refresh the portal** – We will enhance and extend the infrastructure to support the larger anticipated data volumes and maintain the hardware and software as part of our IT Asset Health refresh policy.
- **GSO 013 – GSO CRM Developments (██████)** - This investment extends the CRM capability we deployed in RIIO-1, using Salesforce, by automating more of our customer interactions and workflows as well as some of our supporting processes such as query management and data management. We will also integrate CRM with our Gas Connections Applications Portal to provide a more seamless end to end connections customer experience.
- **GT 002 - Customer and Stakeholder Tools Tech Health (██████)** – In GTO, we have thus far not implemented our CRM system and currently manage our processes using several customer and stakeholder tools that were developed over RIIO-1. These systems have limited self-service and automation for the end to end customer journey and provide poor stakeholder interaction capability. This investment will allow us to rationalise our various tools into our common CRM system. We intend to automate the various workflows and customer interactions that underpin the downstream customer connections process and continue to enhance these throughout the RIIO-2 period. This will provide a more transparent and seamless

process for users, as well as enhancing the overall digital experience for both our customers and wider stakeholders.

Investment Costs, Benchmarks and Cost Profile

GSO Customer Connections							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

GSO CRM Developments							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

Customer & Stakeholder Tool Tech Health							Gartner Benchmark Range		Gartner Rating
Investment (£m)	FY21/22	FY22/23	FY23/24	FY24/25	FY25/26	Totals	Low	High	
CAPEX									

Our cost estimates for the portal infrastructure and functional changes are based on our experience of delivering the Gas Connections Applications Portal. We intend to enhance functionality to support the complex and bespoke (non-standard) connections processes, scaling the infrastructure meet future data volumes and to provide ongoing support for this service. Gartner has benchmarked our estimate to be at the higher end of their range and this reflects the complexity and hand-offs associated with the bespoke connections processes

Our cost estimates for our two CRM investments reflect the enhancements we intend to make in GSO and the significant effort associated with automating our downstream connections process in GT. They are based on our experience of deploying CRM functionality in RIIO-1. Gartner has benchmarked our estimate to be within their range, having compared them with similar CRM enhancement projects.

Options Analysis

Option	Pros	Cons
<p>Do not invest during RIIO-2</p> <p>(Rejected as this is not a viable option, due to the reasons outlined in the cons, issues and risks this option introduces in managing the NTS)</p>	<ul style="list-style-type: none"> No Investment 	<ul style="list-style-type: none"> Inability to meet our customers' expectations in relation to the efficiency, flexibility and digitisation of our customer and connection processes. Continuing to operate manual processes, resulting in increased cost, to track gas transmission connections impacts the efficiency of the service that NGG provides to its customers and potentially increases the end to end cost to the consumer. Although we will continue to meet our license requirements in this area we are starting to see new customers that have not worked with National Grid apply and providing additional support to these customers will not be possible should the system/process efficiency not be realised.
<p>Extend and enhance Connections Portal and CRM system enhancements in both GSO and GTO</p> <p>(Recommended)</p>	<ul style="list-style-type: none"> Improved customer digital experience and process transparency for all our connections processes Delivers much greater efficiency in the way we manage our customer interaction as well as greater visibility of our processes for the end to end user journey More effective decision making by having all relevant information available for a customer or connection interaction. Meeting our Customers' expectations Greater process efficiency through having all relevant information in one place. 	<ul style="list-style-type: none"> Requires Capex investment

Option	Pros	Cons
<p>Deliver Portal upgrade only with limited improvements in functionality</p> <p>(Rejected as it does not allow us to support the end to end customer connections process)</p>	<ul style="list-style-type: none"> • Maintains the health of our CRM system in line with our IT Asset Health Policy (see Appendix 1) • Improved interface with our Customers • Broader range of connection scenarios covered 	<ul style="list-style-type: none"> • Full benefit of integrated external portal and internal CRM system will not be realised. • Will not be able to support the scale and volume of transactions that we will need to cope with for bespoke connections and the downstream process in GT • Large volume of internal manual hand offs will remain. This could result in process inefficiencies and errors. • Main efficiency saving will be through the internal CRM investment so internal resource allocation will not be improved by this investment

Recommended Option

Our recommendation is that we deliver both the CRM development and Connections Portal investments. Delivering both investments will provide our customers and stakeholders with an enhanced interface, becoming a one stop shop for connections and diversions. The internal CRM delivery will provide automation and internal efficiency, across GSO and GTO, which will ultimately be reflected in reduced application fees and project outturn costs. The Connections investment will provide a scalable portal to handle both standard and non-standard connections. The deliverables will build on investments already made in RIIO-1 and continue the drive for incremental improvements of the connections process and associated systems.

Consumer Benefit



Improved safety and reliability

Our recommendation will provide a single source of the truth for all customer and stakeholder data, allowing NGG to make informed and timely decisions to manage the network safely and reliably



Improved quality of services

Our recommendations will enable us to promote new connections at over 200 additional network locations and facilitate an increase in connection applications



Lower bills than otherwise the case

Improving the customer connections process will reduce the time and cost of connecting to the NTS and potentially increase the number of connections, which will reduce customer costs which impacts consumer costs.

4 HOW WE DELIVER OUR RIIO-2 PLAN

4.1 Our IT Delivery Model

Our RIIO-2 plan delivers more change than we did during RIIO-1. We have therefore reviewed how our people, processes and technologies will need to change, building on what we have established during RIIO-1, to support this increased demand in an efficient way to deliver value for our customers and stakeholders.

4.1.1 Our IT Organisation

An organisation that has a dedicated business aligned project team supported by global cross-functional capabilities will be key to successfully delivering the RIIO-2 plan. To support this we have introduced a dedicated NGG team structure, focused on NGG specific requirements and including specific capabilities for strategy and planning, change and programme delivery as well as service delivery (see Figure 17).

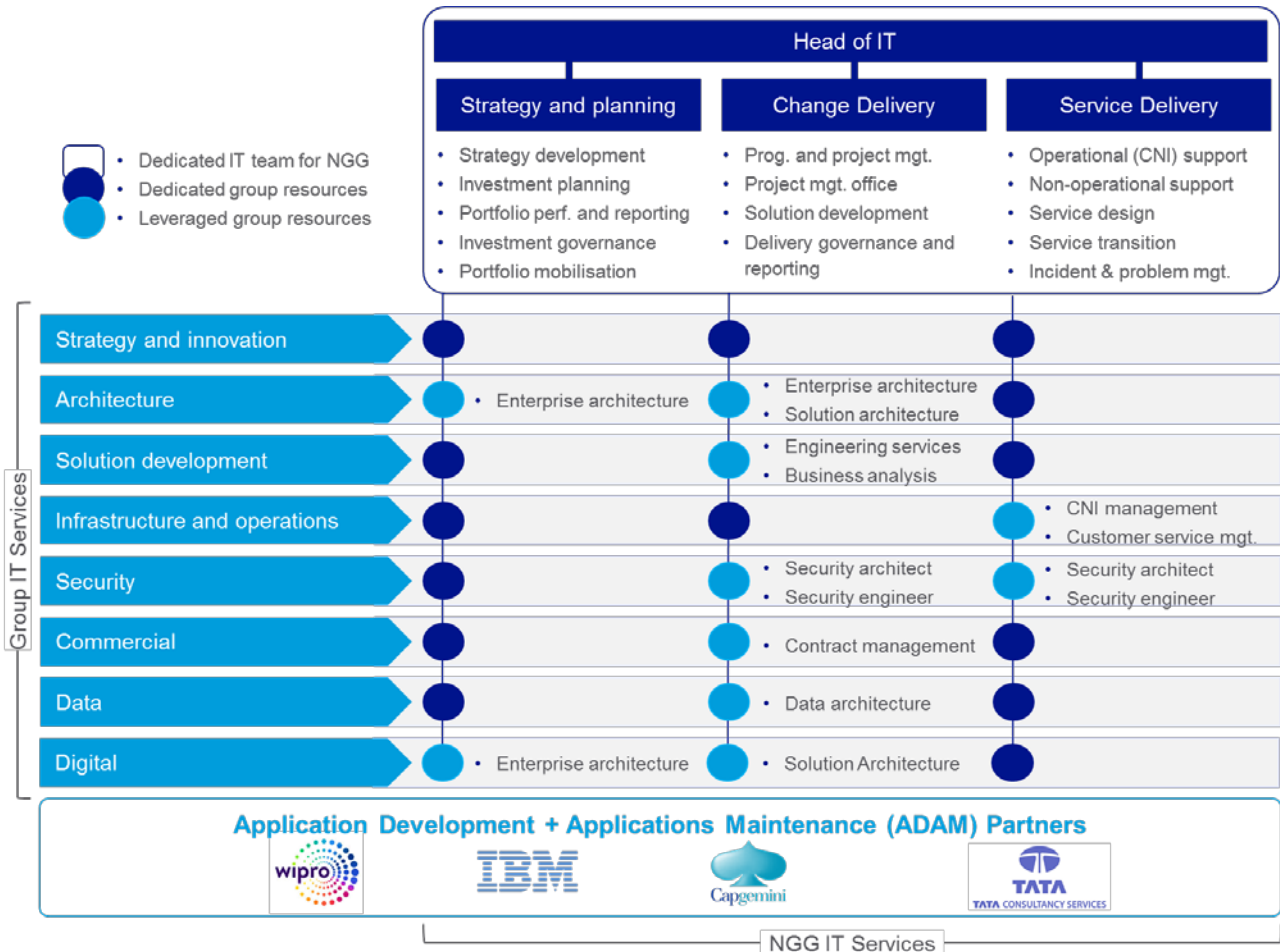


Figure 17: IT resources dedicated to NGG and where services are drawn from the wider group IT

The NGG IT team will leverage the wider group IT organisation to deliver core products and services. This provides a greater level of focus on the requirements of NGG, while balancing risk, responsibilities and obligations to our customers and stakeholders. By centralising common services we benefit from the economies of scale that the group offers and avoid duplication of resource and solutions. This model will also allow the team to scale quickly and efficiently by drawing on dedicated resources (where specialism is required, e.g.. CNI) or leveraged from wider group IT functions where the requirement is generic (such as infrastructure services).

Group IT provides a range of in-house services, including:

- **Strategy and innovation** – lead the development of strategic IT roadmaps with the inclusion of emerging technology
- **Architecture** – translate the strategy into IT roadmaps that govern solution development to achieve our business goals – this includes enterprise and solution architecture support to our delivery teams
- **Solution Development** – define and deliver IT solutions, partnering with stakeholders, development and infrastructure teams and external vendors
- **Infrastructure and operations** – build and maintain infrastructure and production applications, manages services desk, acts as a single point of contact for IT support of NG employees
- **Security** – understand threats to better assess risk, balance benefit and cost of security controls against risks and aids the organisation to better prioritise measures against increasing cost challenges. They work to reduce risk via transparency, policy, implementation support and the provision of operational services
- **Commercial** – coordinate all aspects of external spend, including monitoring SLAs, providing reporting on vendors, aid in maintaining an overall beneficial vendor relationship and to drive value for money for all our technology spend with third-party providers
- **Data Management** – responsible for the governance and utilisation of information as an asset to generate business value and deliver actionable insights
- **Digital** – ideate, validate and build concepts to enable the digital transformation across National Grid

These internal capabilities are supported by broader skills and delivery experience from our Applications Development and Applications Maintenance (ADAM) partners. These partners are selected via a competitive tendering process to ensure that we get value for money by driving cost reduction and improving quality in our delivery. Our ADAM partners consist of some of the largest and most experienced consultancy organisations, such as Wipro, TATA, IBM and Capgemini, and complement our internal teams across a number of capabilities, as shown in Figure 18. They bring industry best-practice capabilities including for instance deep agile delivery experience, user centric design thinking approaches as well as supporting tools and methods to enable a fast paced, efficient delivery approach.

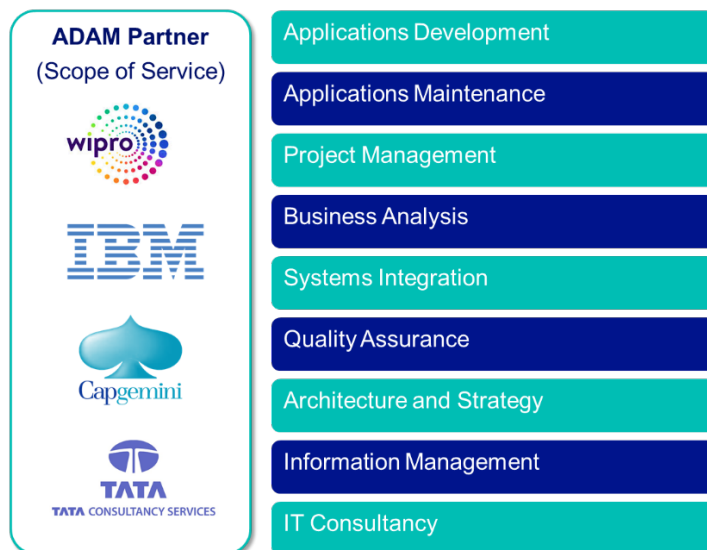


Figure 18: Our ADAM Partner Services

4.1.2 Our Best Practice Processes, Tools and Methods

Embedding best-practice delivery processes, tools and methods are key building blocks for consistent and successful programme delivery. In RIIO-1, we implemented a number of these building blocks to enable us to manage the portfolio of projects across GSO and GTO. Principle among these were:

- **Portfolio Management using Microsoft Project Online (POL)** – We have now deployed this across all our IT project portfolios in National Grid. This allows us to monitor and track the progress of all projects by providing an overview of all running projects, deadlines, states and responsibilities. We are also able to optimise our resource utilisation and deployment across projects, allowing us to flex resources and to take early interventions on critical projects as necessary.
- **Project Management tooling** – we operate a mixed delivery model utilising both onshore and offshore resources to maximise efficiency. To enable virtual team working we have deployed Microsoft Azure DevOps, which provides an Integrated Development Environment (IDE), allowing us to manage multiple delivery teams across geographies. We plan to extend this capability by using Azure Boards which will enable our virtual teams to track their work with kanban boards, backlogs, team dashboards and custom reporting.
- **Scaled Agile Framework (SAFe)⁶** – we started to use the Scaled Agile Framework (SAFe) for some of our projects and seen the benefits in faster delivery times, focus on building the right products, early return on investment and early risk reduction. We have also seen higher quality and predictability resulting from adopting SAFe principles. We are now upskilling our teams in the use of SAFe in order to further leverage benefits from this model. We have started to use JIRA, a project delivery tool, to enable our development teams to collaborate more effectively by providing greater visibility, prioritisation and scheduling of tasks throughout the development lifecycle.
- **DevOps** – during RIIO-1 we implemented capabilities to better integrate our development teams with operations teams. We have seen the benefits of deploying DevOps capability in GSO particularly in managing changes to our Gas Control Suite. These include effective code management, better quality control code deployments and managing multiple development environments.

We plan to exploit and extend these building blocks to deliver our ambitions for RIIO-2. Three core building blocks will be essential for us to deliver our plan for RIIO-2.

These are: Agile Delivery, Continuous Integration / Continuous Delivery (CI/CD) and DevOps:

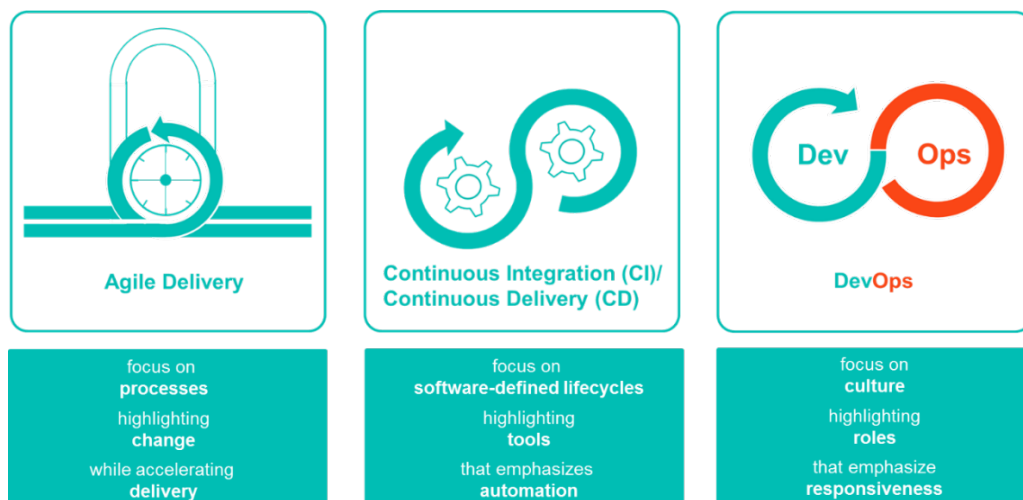


Figure 19: Core building blocks for our RIIO-2 programme delivery

We plan to build capability in these areas in the following ways:

- **Agile Delivery Framework Deployment** – we will continue to upskill our organisation in the use of agile, and where appropriate the Scaled Agile Framework (SAFe), for projects where there is a need to dynamically adapt to changing customer requirements or where creativity and innovation in finding the best solution are more important such as analytics and modelling. We will continue to use traditional approaches for projects where predictability, planning and control are more important, such as a

⁶ <https://www.scaledagile.com/enterprise-solutions/what-is-safe/>

software or hardware upgrades. In all cases, we will build on our experience of using a user-centric delivery approach where they can deliver value very quickly. In practice a blended approach using both agile and traditional methods (often referred to as a bimodal approach – see section **Error! Reference source not found.**) will be required to deliver our portfolio in RIIO-2.

- **Continuous Integration / Continuous Delivery (CI/CD)** – this is a natural progression of agility and we will automate to smooth out bottlenecks in order to release value more efficiently into the business and for our customers. We plan to introduce the following:
 - **source code control** – use opensource tools to support multiple developers, in disparate locations across a large code base, increasing our ability to deliver successful high-quality solutions
 - **test automation** – to drive consistency and quality of our code whilst reducing cycle times. We will automate, where possible, the different testing cycles in our software development lifecycles
 - **build CI tool chains** – using build automation tools we will look to bring consistency in the way we build and deploy our application to the cloud, reducing errors and detecting defects early in the process
 - **embed continuous delivery (CD)** – as we mature our CI tool chains, we will move to automated and controlled deployments across our key platforms
- **DevOps** – we will build on our experience in RIIO-1 to focus on collaboration and communication between our development, operations and other IT teams, such as IT security. We will exploit the use of collaboration tools such as for instance JIRA, Git/Jenkins or Gradle that can accelerate developer productivity as well as operational efficiency.

4.2 Our Approach to Programme Delivery

4.2.1 Portfolio Planning

We recognise that we have a diverse portfolio of projects to deliver in RIIO-2 that will require us to better coordinate our existing processes such as strategic planning, investment appraisal, and project and programme delivery. During RIIO-1, we implemented a National Grid wide process to allow us to prioritise portfolio investments to deliver most benefits to our customers, stakeholders and consumers. This provides a more proactive approach to investment planning, ensuring that we put in place the right capabilities and resources required to deliver our plan (see Figure 20). The process starts with categorisation of strategic initiatives aligned to business goals into those that will be taken forward for evaluation and selection. Projects are selected based on cost, deliverability, benefits and alignment to the strategy and then ranked in order of organisational priority. The portfolio is then balanced to ensure that we have the right mix of projects to maximise consumer value, factoring in risks and resource availability. Continuous project reviews are then carried out to monitor the progress of initiatives and remediations put in place in case of deviation from the plan.

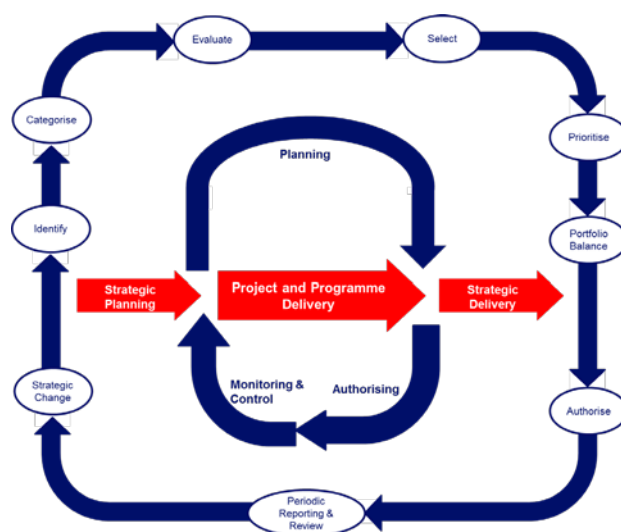


Figure 20: Our Portfolio Planning Process

4.2.2 Our Bimodal Delivery Approach

In RIIO-2, we will have competing challenges in managing a large programme of work to maintain our IT assets (applications and infrastructure), upgrading our core infrastructure whilst building new capabilities particularly in the enhanced analytics, information provision and customer interaction areas and delivering regulatory changes. Delivering this diverse portfolio will necessitate using a combination of traditional delivery methods for changes where there is predictability in outcomes and planning and control are critical to success, and agile methods where there are high levels of uncertainty or where creativity and innovation in finding the best solution is important. IT asset health upgrades, statutory changes and some small releases typically fall into the former category whereas for instance analytics, modelling and some functional change releases may fall into the latter category. We believe a blended approach, often referred to as a bimodal approach, will be required to deliver our RIIO-2 portfolio (see Figure 21)

Our platform-based architectural approach in RIIO-2, along with our best-practice processes, methods and tools will enable us to deliver solutions in a common way, sequenced to ensure the enabling infrastructure supports our functional changes. We will also put in place strong technical and service transition governance with a focus on designing solutions to operate with minimal defects. We will achieve this through closer collaboration with our delivery and operation teams, something that is already in place, but will mature during RIIO-2 using devops tools and processes.

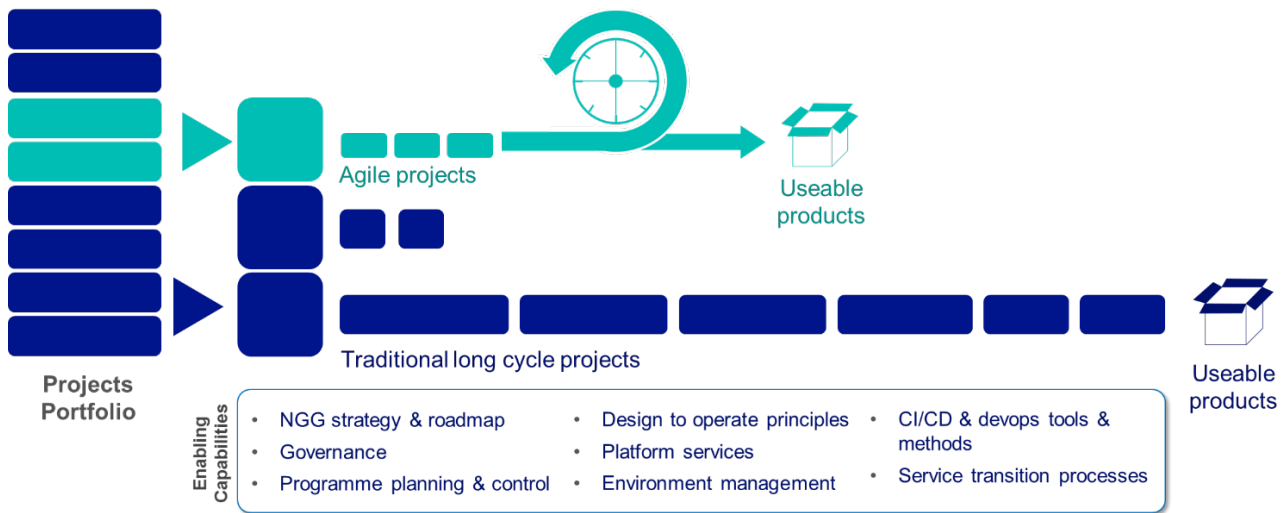


Figure 21: Bimodal Delivery Approach

4.2.2.1 Our Agile Delivery Approach

We have built up considerable experience of using agile and more recently SAFe principles in our programme deliveries in RIIO-1. The ethos of these projects is to deliver value quickly, by developing a continuous cycle of epics (a block of work that has a common objective). These epics are typically refined and prioritised into work packages for delivery by our agile teams. Work packages may be delivered as releases (a collection of work packages) or individual packages of work. In RIIO-2, we will look to industrialise this approach to ensure efficient delivery across our portfolio of agile projects (see Figure 22)

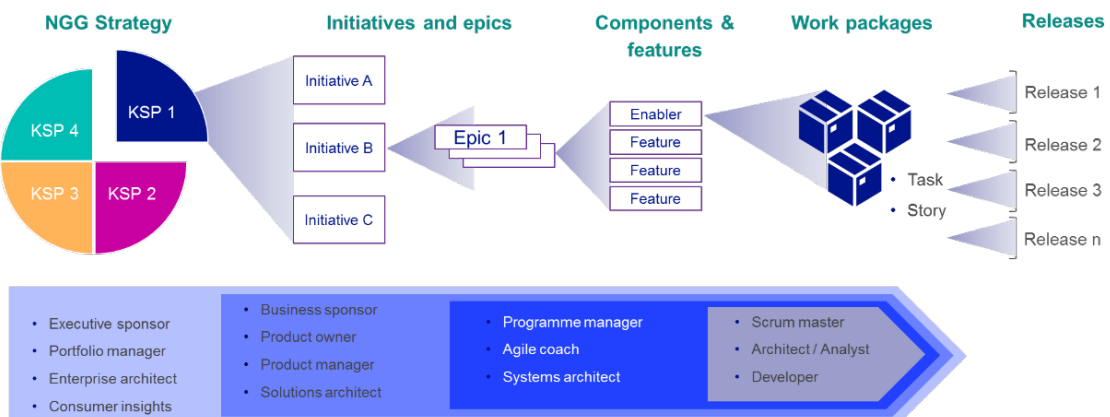


Figure 22: Agile work packages

We will embed non-technical agile roles within the business, such as product owners and data scientists to provide greater focus and ownership of the delivery and implementation of capabilities. We will continue to upskill our technical teams to adopt agile ways of working across the new innovations whilst also specialising in our chosen solution development areas.

We will build on the capabilities we have delivered in RIIO-1 by continuing to review and enhance our operating model, covering people, process and technology enablers (see Figure 23).

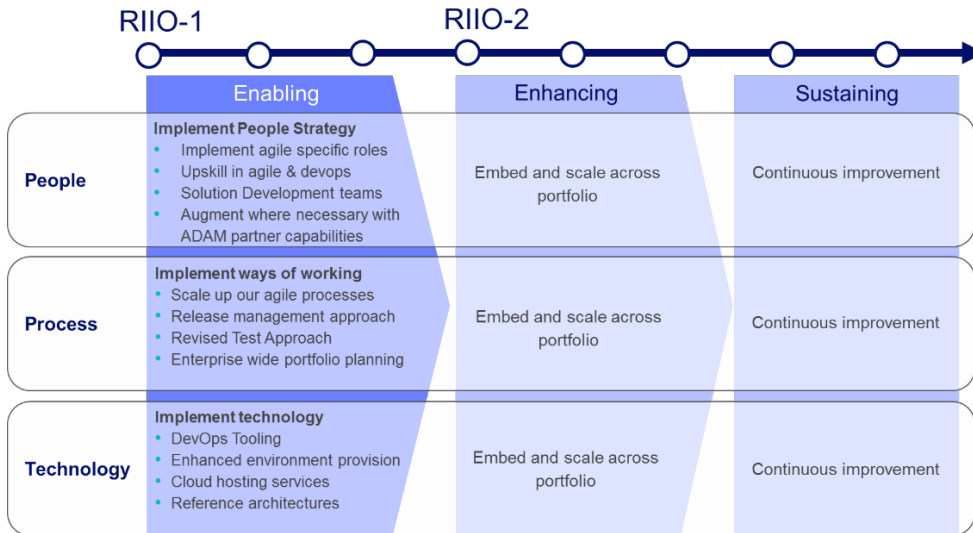


Figure 23: Our People, Process and Technology focus for RIIO-2

4.2.3 Our Change Delivery Framework

In order manage change we have implemented a change delivery framework which is used across all major UK change programmes (see Figure 24). This framework provides consistency and predictability in the way in which we implement changes into the business. We use stage gates to provide controlled separation between different programme phases, review completion status of preceding phases and the readiness for the next one as well as delivery against the business case. The use of the Framework is adapted for our smaller, more incremental agile deliveries with an inspect and adapt approach based on working solutions.

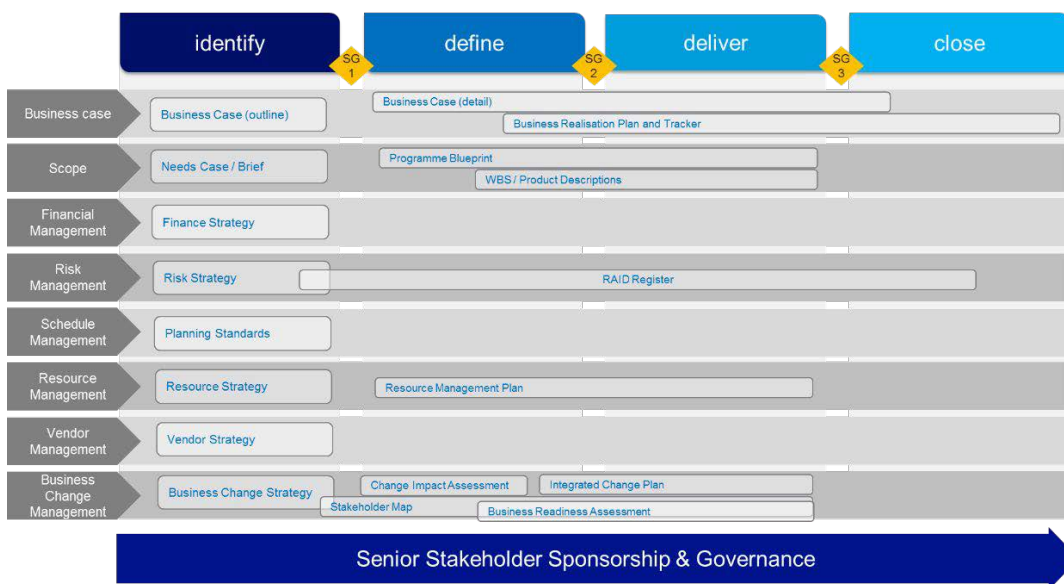


Figure 24: Our Change Delivery Framework

4.3 Overall NGG Delivery Portfolio

The diagram below shows the outline NGG portfolio delivery plan for RIIO-2.

Key Stakeholder Priority	IT Capability	Business Unit	Investment name	FY22	FY23	FY24	FY25	FY26
Safe Gas	Network Asset Management	GTO	GT 011 - Geospatial Information Systems Tech Health	[Green bar]				
			GT 013 - Improve Asset Protection Service	[Green bar]				
			GT 041 - Surveillance Reporting for Pipelines Tech Health	[Green bar]				
Gas On / Off	Network Operation & Control	GSO	GSO 005 - GSO GCS Refresh - Oracle & SOA	[Blue bar]				
			GSO 007 - GSO GCS Refresh - Talend	[Blue bar]				
			GSO 015 - GSO GCS Refresh - Data Historian	[Blue bar]				
			GSO 018 - GSO GCS Refresh - SCADA	[Blue bar]				
			GSO 020 - GSO GCS Refresh - Simone Online	[Blue bar]				
			GSO 032 - GSO GCS Refresh - Tableau	[Blue bar]				
			GSO 036 - GSO GCS Refresh - Forecaster	[Blue bar]				
			GSO 011 - GSO Operational Safety & Compliance - Continual Improvements	[Blue bar]				
			GSO 100 - GSO Cyber Compliance	[Blue bar]				
			GTO	GT 022 - Network Analysis and Design Tech Health	[Green bar]			
	Insights & Innovation	GSO	GSO 031 - GSO Data & Insights Platform	[Blue bar]				
			GSO 101 - GSO Analytics Services	[Blue bar]				
			GSO 024 - GSO Modelling Services	[Blue bar]				
			GSO 037 - GSO Simone Offline Refresh	[Blue bar]				
		GTO	GT 017 - Insights Tech Health	[Green bar]				
			GT 019 - Data Science Tools Tech Health	[Green bar]				
			GT 020 - Establish Master Data Management	[Green bar]				
			GT 016 - Establish Innovation Platform & Capability	[Green bar]				
	Network Asset Management	GTO	GT 006 - Enterprise Asset Management Tech Health	[Green bar]				
			GT 007 - Work Management Systems Tech Health	[Green bar]				
GT 059 - GT Specific Field Force Device Tech Health			[Green bar]					
GT 005 - OT/Cyber Asset Database			[Green bar]					
GT 040 - Asset Performance Management Tech Health			[Green bar]					
GT 039 - Data Sources (IT/OT) to Support Insights and Asset Performance Management			[Green bar]					
GTO		GT 034 - Asset Investment Planning Tech Health	[Green bar]					
		GT 036 - Integrated process / solution for risk & reliability centred asset management (EAM, AIP, APM) [Capex]	[Green bar]					
		GT 009 - Enterprise Content Management Tech Health	[Green bar]					
		GT 010 - Business Critical Data and Document Tech Health	[Green bar]					
		GT 053 - Enhance Asset Design to improve management process for operation & control	[Green bar]					
		GT 046 - Implement a Digital Experience Platform	[Green bar]					
NGG Infrastructure	GSO	GSO 003 - GSO CNI Gateway refresh	[Blue bar]					
		GSO 012 - GSO Data Transfer Rationalisation and Refresh	[Blue bar]					
		GSO 019 - GSO Control Room Display Refresh	[Blue bar]					
		GSO 021 - GSO Control Telephony Refresh	[Blue bar]					
		GSO 022 - GSO Voice Recorder Refresh	[Blue bar]					
	GSO 023 - GSO Telemetry Network Refresh	[Blue bar]						
	GTO	GT 042 - CIS Tech Health	[Green bar]					
Training & Development	GSO	GSO 102 - GSO GNCC Simulation Training	[Blue bar]					
	GSO	GSO 001 - GSO New Information Provision	[Blue bar]					
Commercial & Markets		GSO 025 - GSO MIPI Refresh	[Blue bar]					
	GSO 028 - GSO Energy Trading, Reporting and Notifications Refresh	[Blue bar]						
Whole Energy	GSO	Gemini Replatforming	[Blue bar]					
		Regulatory Driven Gemini System Enhancements (GB&EU)	[Blue bar]					
		GSO 027 - GSO Regulatory and Market Driven Changes - Non-Gemini	[Blue bar]					
Connect	GSO	GSO 013 - GSO CRM Developments	[Blue bar]					
		GSO 030 - GSO Customer Connections	[Blue bar]					
	GT	GT 002 - Customer & Stakeholder Tools Tech Health	[Green bar]					

5 APPENICES

5.1 Appendix 1 - IT Asset Health Policy

The age of a system and its constituent and interacting parts is an indicator of potential risk to system reliability and supportability. Our asset refresh policy acts as a trigger for us to review the future of a system. Other triggers are external drivers (such as market changes and/or changes to the operational environment) and system performance.

5.1.1 Asset Refresh

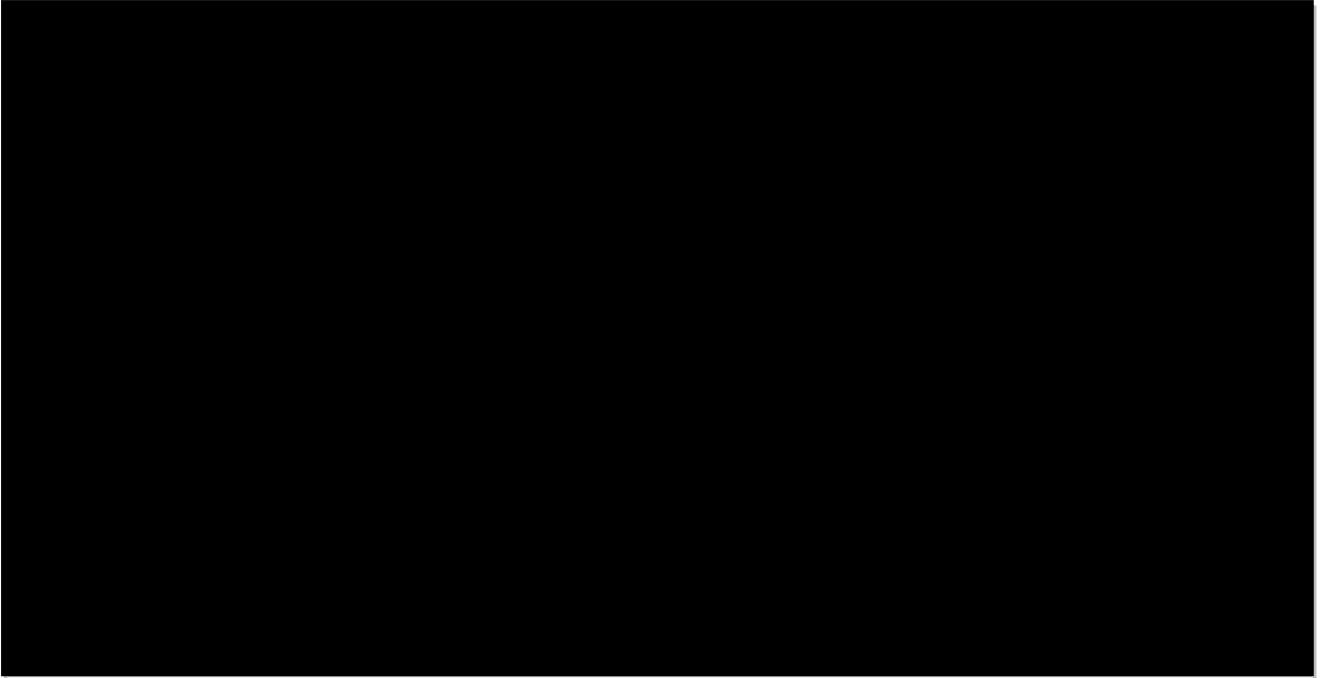
We define a refresh as the replacement of hardware with comparable, supportable hardware and / or an upgrade to a current (supported) version of system software and application software. Upgrading to a current version of software ensures the availability of maintenance and security patches, it may also bring increased system capability, but that will be a by-product of the upgrade and not its primary purpose.

5.1.2 Asset Replacement

A full replacement differs from a refresh, in that the usual trigger for a full replacement of an IT system with a new system will be to develop new or changed business capabilities. The business requirements will have changed to an extent that it is not considered possible or cost effective to accommodate the new and changed requirements through changes to the existing system and the procurement of an entirely new system is considered the best option in terms of the business benefits delivered versus the cost. The business requirements that drive such a replacement may be functional (e.g. a new process must be supported) or non-functional (e.g. a substantial increase in user numbers, resilience required or transaction throughput).

The IT Asset Health policy ensures we refresh or replace these IT systems when further life extension is not achievable without an unacceptable reduction in service levels. This will maintain vendor support for our systems, with ongoing maintenance and security patches. This is essential to ensure the ongoing reliability and security of our IT systems which are essential to underpin the safety, security and reliability of the nation's energy supply.

As technology evolves, we will also review opportunities to consolidate and simplify our current IT systems and infrastructure as part of a refresh or replacement decisions, to help drive efficiencies, productivity and improve the overall experience for our customers



5.3 Appendix 3 – NGGT IT Direct Investments

Key Stakeholder Priority	IT Capability	Business Unit	Investment name	Total FY22 to FY26 (£m)
Safe Gas	Network Asset Management	GTO	GT 011 - Geospatial Information Systems Tech Health	
			GT 013 - Improve Asset Protection Service	
			GT 041 - Surveillance Reporting for Pipelines Tech Health	
Gas On / Off	Network Operation & Control	GSO	GSO 005 - GSO GCS Refresh - Oracle & SOA	
			GSO 007 - GSO GCS Refresh - Talend	
			GSO 015 - GSO GCS Refresh - Data Historian	
			GSO 018 - GSO GCS Refresh - SCADA	
			GSO 020 - GSO GCS Refresh - Simone Online	
			GSO 032 - GSO GCS Refresh - Tableau	
			GSO 036 - GSO GCS Refresh - Forecaster	
			GSO 011 - GSO Operational Safety & Compliance - Continual Improvements	
		GSO 100 - GSO Cyber Compliance		
		GTO	GT 022 - Network Analysis and Design Tech Health	
	Insights & Innovation	GSO	GSO 031 - GSO Data & Insights Platform	
			GSO 101 - GSO Analytics Services	
			GSO 024 - GSO Modelling Services	
			GSO 037 - GSO Simone Offline Refresh	
		GTO	GT 017 - Insights Tech Health	
			GT 019 - Data Science Tools Tech Health	
			GT 020 - Establish Master Data Management	
			GT 016 - Establish Innovation Platform & Capability	
	Network Asset Management	GTO	GT 006 - Enterprise Asset Management Tech Health	
			GT 007 - Work Management Systems Tech Health	
			GT 059 - GT Specific Field Force Device Tech Health	
			GT 005 - OT/Cyber Asset Database	
			GT 040 - Asset Performance Management Tech Health	
			GT 039 - Data Sources (IT/OT) to Support Insights and Asset Performance Management	
	Network Planning and Investment	GTO	GT 034 - Asset Investment Planning Tech Health	
	Digital Experience, Channels & Engagement	GTO	GT 036 - Integrated process / solution for risk & reliability centred asset management (EAM, AIP, APM) [Capex]	
			GT 009 - Enterprise Content Management Tech Health	
			GT 010 - Business Critical Data and Document Tech Health	
			GT 053 - Enhance Asset Design to improve management process for operation & control	
	NGG Infrastructure	GSO	GT 046 - Implement a Digital Experience Platform	
GSO 003 - GSO CNI Gateway refresh				
GSO 012 - GSO Data Transfer Rationalisation and Refresh				
		GSO	GSO 019 - GSO Control Room Display Refresh	

Key Stakeholder Priority	IT Capability	Business Unit	Investment name	Total FY22 to FY26 (£m)
			GSO 021 - GSO Control Telephony Refresh	
			GSO 022 - GSO Voice Recorder Refresh	
			GSO 023 - GSO Telemetry Network Refresh	
		GTO	GT 042 - CIS Tech Health	
	Training & Development	GSO	GSO 102 - GSO GNCC Simulation Training	
Information Provision	Digital Experience, Channels & Engagement	GSO	GSO 001 - GSO New Information Provision	
			GSO 025 - GSO MIPI Refresh	
	Commercial & Markets	GSO	GSO 028 - GSO Energy Trading, Reporting and Notifications Refresh	
Whole Energy	Commercial & Markets	GSO	Gemini Replatforming	
			Regulatory Driven Gemini System Enhancements (GB&EU)	
			GSO 027 - GSO Regulatory and Market Driven Changes - Non-Gemini	
Connect	Digital Experience, Channels & Engagement	GSO	GSO 013 - GSO CRM Developments	
			GSO 030 - GSO Customer Connections	
		GTO	GT 002 - Customer & Stakeholder Tools Tech Health	
			Totals	

5.4 Appendix 4 – Glossary

Acronym	Description
ADEPT	Asset Data Enrichment Programme Transmission
AI	Artificial Intelligence
AIP	Asset Investment Planning
API	Application Programming Interface
APM	Asset Performance Management
BIM	Building Information Modelling
BI	Business Intelligence
CARD	Cyber Asset Records Database
CNI	Critical National Infrastructure
CPNI	Centre for Protection of National Infrastructure
CRM	Customer Relationship Management
CSF	Cyber Security Framework
CSOC	Cybersecurity Operations Centre
DNO	Distribution Network Operators
DR&S	Digital Risk & Security
DXP	Digital Experience Platform
EAM	Enterprise Asset Management
ECM	Enterprise Content Management
ERP	Enterprise Resource Planning
ET	Electricity Transmission
EUC	End User Compute
GAInS	Gas Asset Information Systems
GCS	Gas Control Suite
GDPR	General Data Protection Regulation
GIS	Geographic Information System
GNCC	Gas Network Control Centre
GRC	Governance, Risk & Compliance
GRSC	Gas Remote Sites Communication
GSO	Gas System Operator
GT	Gas Transmission
GTO	Gas Transmission Owner
HR	Human Resources
IoT	Internet of Things
iEP	iGMS Evolution Programme
iGMS	Integrated Gas Management System
IT	Information Technology
LAN	Local Area Network
MIPI	Market Information Provision Initiative
NGET	National Grid Electricity Transmission
NGG	National Grid Gas
NIST	National Institute of Standards and Technology
NTS	National Transmission System
OT	Operational Technology
PaaS	Platform as a Service
PARCA	Planning and Advanced Reservation of Capacity Agreement
SaaS	Software as a Service
SO	System Operator
SOX	Sarbanes Oxley
SRP	Surveillance Reporting for Pipelines
TCR	Technology Change Roadmap
TFO	Transmission Front Office
TO	Transmission Owner
TSO	Transmission System Operator
WAN	Wide Area Network