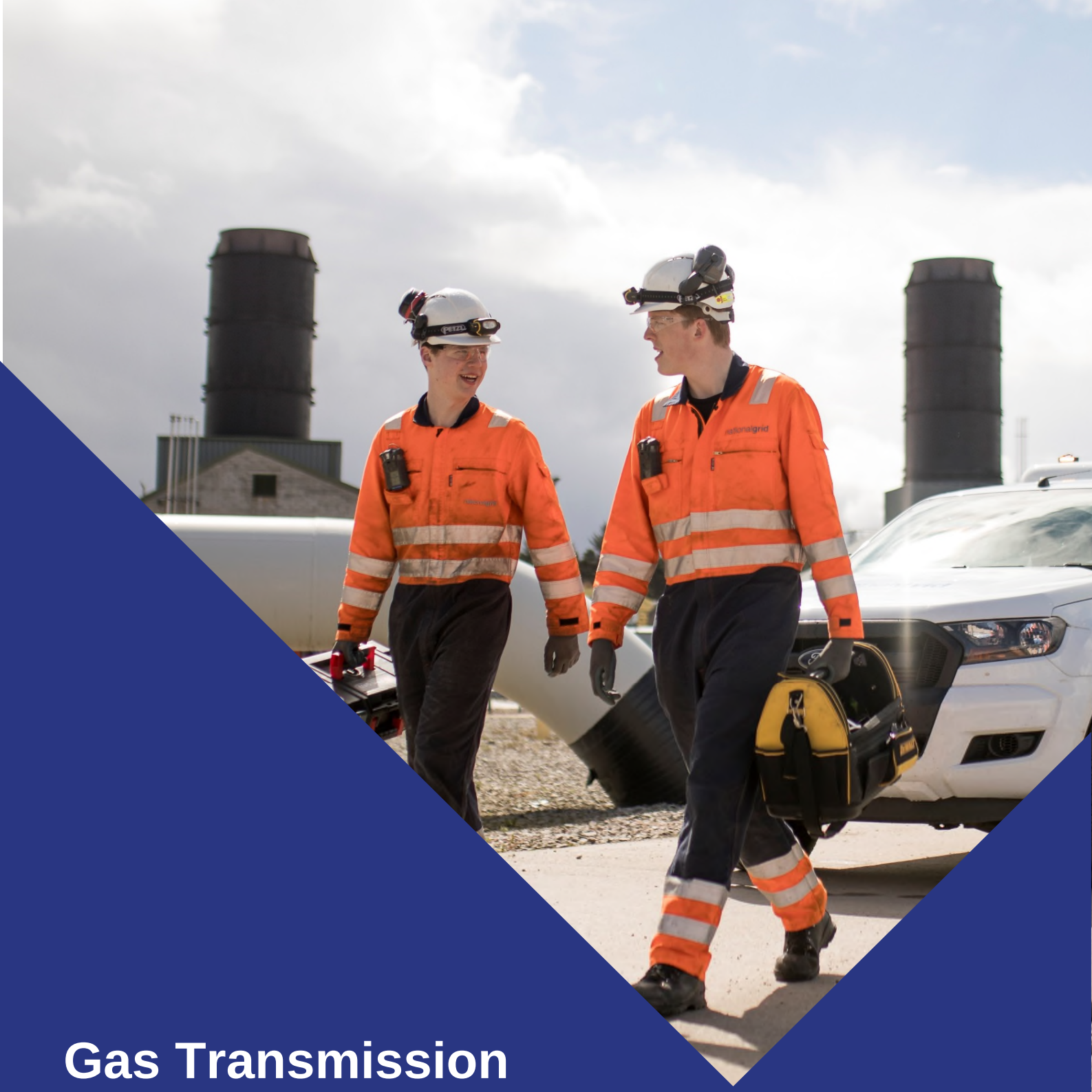

Gas Transmission

Our Performance: 2018/2019

nationalgrid

National Grid Gas Transmission

Our Performance for 2018/19

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I. Executive Summary for 2018/19

1. This report describes the financial and operational performance of National Grid Gas Transmission (hereafter abbreviated to National Grid) against the stakeholder outputs we have committed to deliver.

Director update on Business Plan, risks and future strategy

Performance Overview

2. I am proud to report that we have delivered strong output performance, which is consistent with last year in most areas. We have benefitted this year from favourable supply patterns which has allowed us to optimise compressor operation, leading to improved performance against environmental targets. We have worked hard this year focussing on enhancing the customer and stakeholder experience and this has led to further improvements in satisfaction.

3. Financially our performance has been adversely impacted by the May 2018 Reopener outcomes with allowances reduced by £208m. We disagreed and were disappointed with Ofgem's decisions, in particular with our Industrial Emissions Directive (IED) and River Humber Gas Pipeline Replacement Project (Feeder 9) submissions. Both play key roles in delivering the network our customers and consumers expect, to deliver lower cost energy supplies. To partially mitigate the impacts of these decisions, we have reviewed our spend across these specific and other wider activities, and have driven through scope and efficiency changes which have resulted in a Totex reduction of £74m. Overall our Totex performance has reduced by £134m compared to last year.

4. During 2018/19, we commenced a multi-year restructuring programme called 'Performance Excellence (PEx) Value' which covers a range of initiatives, including developing flatter, leaner organisational structures, simplifying our processes and ways of working. This ambitious programme is re-shaping our UK business in response to the changing needs of our customers and driving efficiencies to help ease cost pressures on our customers, and ultimately, end consumers. Within the RIIO-T1 period we forecast that the cost to achieve will be roughly equivalent to the savings generated, with £30m Opex benefit per annum embedded going forwards.

5. This year we continued to focus on and refine our asset health investment plans for the remainder of the RIIO-T1 period. We are balancing our position between managing network risk, delivering Network Output Measures (NOMs) and delivering against our allowances. Our ability to make these difficult trade-offs will be facilitated by improved asset management capability delivered through the Richmond Project and our Data Enhancement Programme. As we move towards the end of the period, we now have a clear understanding of the works that we need to undertake to maintain the health of our network and continue to identify lower cost options to mitigate network risk, for example the use of high efficiency gearboxes instead of a local gas actuator resulting in a saving of circa £50k per

installation. Overall through RIIO-T1, we will have invested £275m over allowances to ensure the safety and reliability of the network for customers and consumers.

6. In June 2019, we will make a Needs Case submission to Ofgem for the IED investments at St Fergus and Hatton. This process was agreed as part of the Ofgem decision on the IED Reopener. The aim of the submission is to gain regulatory certainty on the need and outputs at both of these sites. Currently we are forecasting to spend £51m within the RIIO-T1 period on these investments, which could be subject to change depending on Ofgem's assessment of the Needs Case.

7. During 2018/19 we have been developing our RIIO-T2 business plan. We have carried out our most extensive listening exercise to create our stakeholder-led business plan. In that time, we have engaged more than 100 times, covering over 500 individuals including domestic and major energy consumers. We were the first network company to meet the requirement for setting up our independent user group. As part of the business plan development, we have engaged with Ofgem both on a bi-lateral and stakeholder basis to design key aspects of the new framework. In February 2019, we published our playback document sharing and consulting on our emerging ideas for our business plan. We are on course to submit our RIIO-T2 business plan to Ofgem's RIIO-T2 Challenge Group on the 1 July 2019.

Output Delivery

8. We have continued to deliver strong performance for our customers against our five output categories, with performance broadly consistent to 2017/18. Table 3 summarises our performance against each individual output and provides a comparison to our 2017/18 performance.

9. We have delivered strong **safety** performance with no injuries to the public and no Gas Transmission employee Lost Time Injuries (LTI) in 2018/19. Two serious process safety events occurred in 2018/19 both of which involved the release of gas from the National Transmission System (NTS). One release was attributed to a flange on a stopple tee on Feeder 14 near Avonmouth, whilst the other was as a result of a failure on a pressure regulator stream at Didcot Power Station Above Ground Installation (AGI). Both incidents have been fully investigated in conjunction with the Health and Safety Executive (HSE) who are satisfied with the outcome of the investigations. These events reiterate the importance of the focus we are giving to managing the health of our ageing assets. We also remain on track to meet the Department for Business, Energy and Industrial Strategy (BEIS) requirements by introducing enhanced physical site security at our key sites.

10. In 2018/19 we have continued to provide high levels of **reliability and availability** ensuring the efficient delivery of 99.99% of our customers' gas requirements. This year we have maintained a strong level of communication with our stakeholders, presenting material at Operational Forums such as 'interesting days' presentations and creating educational material to support the Industry. Our customers have also benefitted through a reduction of £3.6m in our Operating Margin (OM) costs and

improved performance in the Price Performance Measure (PPM) of our Residual Balancing incentive.

11. In 2018/19 we have delivered £236m of investment to deliver a safe and reliable gas transmission network for our customers. We are forecasting to meet our target for the number of Replacement Priority 1 (RP1) assets reported through the current NOM regime and remain on target to deliver all NOMs in aggregate by the end of RIIO-T1, thus maintaining the health of the network for the benefit of current and future consumers.

12. In 2018/19 we made good progress with our key investment projects such as our River Humber Gas Pipeline Replacement Project which will replace a 3 km underwater section of the Feeder 9 pipeline with a tunnelled solution. This pipeline section is one of the most critical to UK gas supplies on the NTS and removing the risk associated with both tidal estuary erosion and third party interference is essential in continuing to provide a reliable and secure gas supply to our customers. In 2018/19 the Tunnel Boring Machine (TBM) made significant progress completing 3,402m of the 4,862m total tunnel length. In addition, the final weld on the eight, 650m long pipeline sections was completed in September 2018.

13. Changing supply patterns have the potential to have a significant impact on our **environmental** outputs. In 2018/19, the network experienced a much more diverse supply of gas into the NTS that was closer to the centres of demand than in 2017/18. Liquefied National Gas (LNG) terminal flows increased, with the number of LNG cargoes received increasing from 49 in 2017/18 to 109 in 2018/19. This demonstrates the highly variable nature of gas flows on to the NTS, which are dependent on prevailing supply and demand conditions both in the UK and the global market.

14. As a result of this supply pattern, usage of our compressor fleet reduced allowing the network to be operated in a more economic manner. The reduction in compressor running hours has resulted in a subsequent reduction of CO_2 emissions from compressors by 53% compared to 2017/18 levels. This reduction in compressor running hours, coupled with our initiatives collectively known as the '1000 tonne reduction challenge', has had a positive impact on our Greenhouse Gas (GHG) emissions incentive and for the first time we have outperformed the associated target.

15. We provide our annual emissions performance as part of our Carbon Disclosure Project (CDP) submission. This enables us to benchmark our performance against other organisations. In 2018 we achieved an 'A' rating for our CDP submission, putting us in the top 2% of global companies recognised for our actions to reduce emissions and mitigate climate change.

16. For **customer satisfaction,** we are proud that our improvements in customer service have been reflected in an increased customer satisfaction rating from 7.60 last year to 7.79 in 2018/19. This improvement reflects the focus and hard work across our whole business to improve the way we provide the experience our customers need. Our focus is to continue this journey, always aiming to exceed the

expectations of our customers. Our stakeholder satisfaction score also increased from 8.00 to 8.08 and we have done this whilst expanding our reach across more customer and stakeholder contacts than ever before.

17. In terms of **customer connections**, we continue to work with customers and stakeholders to improve the service we offer both in terms of the products and charging structure. The trial self-lay connection with one customer is now in the detailed design and construction phase and our Network Innovation Competition (NIC) funded Customer Low Cost Connections (CLoCC) project has embedded the identified process and design changes into Business As Usual (BAU). Our new online gas connections portal is now live via the National Grid Connections website, with 20 customers registered to use the portal, and a total of 47 cost estimates generated. In addition, we have met all requirements associated with connection and capacity requests submitted by our customers.

18. **Innovation** enables us to seek opportunities to deliver the greatest value for consumers. In 2018/19 we undertook 36 Network Innovation Allowance (NIA) projects, which focused on delivering value to the consumer and driving step changes in our key strategic innovation areas. Throughout 2018/19, both of our live NIC projects concluded: Project GRAID and Project CLoCC. Both projects have successfully delivered against the aims and objectives that they set out to achieve. A significant NIA project this year is 'Hydrogen in the NTS (HyNTS)' which is assessing the impact hydrogen could have on our gas transmission assets. The project is exploring whether our equipment becomes more brittle, whether cracks and faults grow faster, and whether welding requirements differ when hydrogen flows through it.

Financial Performance

19. Across RIIO-T1 our Totex is planned to be £3,212m against an allowance of £2,922m. This results in a forecasted spend above allowances of £290m which is an increase of £134m compared to 2017/18. Over the RIIO-T1 period we plan to invest circa £1.8bn of Capex across our overall business.

20. The change in performance is due to a decrease in forecast allowances of £208m, offset by a decrease in Totex of £74m. The allowances have decreased as a result of the outcome of the May 2018 Reopeners. To partially mitigate the impacts of these decisions we have reviewed our spend across these specific and other wider activities and have driven through scope and efficiency changes.

21. We are forecasting to spend above our allowances in the areas of Transmission Owner (TO) Non Load Related Capex, TO Non Operational Capex and TO Opex. Details on performance against allowances for each area and changes in performance compared to 2017/18 are detailed in the Performance Summary section.

Consumer Bill Benefit

22. In RIIO-T1 less than £10 (2018/19 prices) of the average domestic consumer gas bill of £540[1] will relate to the gas network services we provide. In 2018/19 the proportion of the bill attributable to National Grid services was approximately £7.26[2] which equates to 1.3% of the typical gas bill. This is a reduction compared to 2017/18 where the National Grid portion of the domestic consumer gas bill was £9.02. The decrease in 2018/19 is largely driven by a reduction in allowed revenue from 2017/18 to 2018/19 of circa. £130m.

Key Risks and Looking Ahead

23. Our key areas of focus remain on managing our ageing asset base, facilitating changing customer **requirements**, responding to the dynamic cyber threat landscape and the efficient delivery of high value projects, e.g. the River Humber Gas Pipeline Replacement Project. Following the outcome of the May 2018 Reopener on Enhanced Security, we have progressed the defined programme of cyber security works and continue to work with the Competent Authority (a joint role between Ofgem and BEIS) on further compliance with the NIS (Network and Information Systems) Directive. At present, we have not included in our forecast any additional NIS compliance costs.

24. We will submit our Needs Case for the IED investments at St Fergus and Hatton in June 2019. In order for us to progress these projects we will need Ofgem to provide timely approval of the needs cases. This will enable us to place machinery train orders with confidence in the regulatory funding being provided. To avoid unnecessary additional costs to consumers we currently plan to place these orders in early August 2019. In addition to these regulatory submissions, we also plan to agree the RIIO-T1 regulatory issues requiring 'close-out' during this financial year. The intent is to keep close-out issues to pre-defined items as outlined within the RIIO-T1 Final Proposals.

25. The development of monetised risk to inform asset health plans has progressed significantly during this last year and is a key building block of our RIIO-T2 asset investment plan. We are in the process of rebasing the RIIO-T1 NOMs target which involves conversion of an asset count to a monetised risk value. We anticipate this work concluding during Summer 2019 and will report our asset health performance on a monetised risk basis going forward. The use of monetised risk provides new insights into the prioritisation of asset health investments which we will use both for the remainder of RIIO-T1 and the RIIO-T2 plan.

26. We will continue to drive efficiencies and innovation in both our Capital Programmes and Operating Costs. The asset health campaigns are delivering

[1] Figure taken from the Ofgem publication 'Bills, Prices and Profits' and based on realised costs, as reported by the six larger energy companies in their annual consolidated segmental statements 2017

[2] In 2016/17 following the previous calculation method the value calculated was £16.29 (in 2016/17 prices)

efficiency savings and maximising the outage opportunities available to us. They are also deploying a number of our successful innovations, for example, Composite Pipe Supports, High Efficiency Valve Actuator Gear Boxes and Business Information Modelling (BIM). In terms of Operating Costs, our focus is on realising the benefits of our PEx Value initiative. We expect the exact realisation of savings to be subject to change as we further develop and refine our plans through to the end of the RIIO-T1 period

27. During 2018/19 the issue of decarbonisation has risen up the political agenda. It's important that National Grid plays a leading role in this debate and is proactive in reducing our own impact on the environment. Customers and stakeholders continue to tell us that gas has an integral role to play in delivering the most cost-effective decarbonised future across power, heat, transport and industry. We have initiated a number of hydrogen innovation projects under the banner of 'HyNTS' which look at the challenges of moving to a hydrogen economy and the implications on the NTS. In addition, we are seeking ways to reduce the impact of our most polluting plant on the environment through a Carbon Capture and Usage project called 'Captivate'. These are over and above the BAU activities associated with emission compliance and continual improvement.

28. The implications of Brexit remain a significant concern and we have continued to assess and prepare for the UK withdrawal from the European Union (EU), focusing on a potential no-deal scenario. We have carried out a significant piece of unfunded work to assess the Statutory Instruments, relevant in a no-deal scenario, and their impact on industry codes and commercial arrangements. During 2019/20 we will respond to emerging political developments, maintaining our close working relationships at all levels with BEIS and Ofgem, plus other key stakeholders.

29. A price control review is the most significant event for a network company and the outcome materially impacts our ability to provide the essential services our customers and ultimately consumers expect, as well as our ability to fulfil the decarbonisation agenda. We will submit our draft RIIO-T2 business plan to the Ofgem Challenge and Review group on 1 July 2019. A further submission to the same group will be made on the 1 October 2019 before submission of our full business plan to Ofgem on the 9 December 2019. This will begin an assessment process that will conclude with the setting of our allowances and outputs for the period 2021-2026. The feedback and assessments undertaken throughout this process are likely to impact our activities for the remainder of the RIIO-T1 period both in terms of resources and the works we undertake to prepare for RIIO-T2.

30. A key aspect underpinning our December RIIO-T2 submission is network capability. This is the ability to accommodate levels of gas flow onto and off the network. We are bringing together a number of our analysis tools to produce a view of this capability. We will continue to work with our stakeholders to ensure that our proposals can meet their needs in the most efficient way possible

31. I trust you find this Regulatory Performance Pack informative and we would welcome any feedback on how we can improve our reporting.

Phil Sheppard (Director, National Grid Gas Transmission Owner)

Performance Summary

Financial performance

32. Across RIIO-T1 our Totex is planned to be £3,212m against an allowance of £2,922m. This results in a forecasted spend above allowances of £290m which is an increase of £134m compared to 2017/18.

33. Overall, we are forecasting to spend above our allowances in RIIO-T1. The change in performance from 2017/18 is primarily due to a reduction in funding following the 2018 Reopener decisions.

34. With reference to the restated[3] table compared to last year our forecast spend has decreased by £74m on a constant 2018/19 price base and the adjusted allowances have decreased by £208m.

Table 1: Eight-Year Forecasted Spend and Allowances Overview (restated table)

Activity	**Spend (8 Year forecast) (£m)**	**Allowance (inc. uncertainty mechanism) 8 year forecast (£m)**	**Cost vs Allowance (£m)**
TO Load Related Capex	45	46	1
TO Non Load related Capex	1,369	1,189	(180)
TO Non Operational Capex	145	72	(73)
TO Opex	879	758	(120)
SO Capex	276	332	56
SO Opex	498	525	27
Total	**3,212**	**2,922**	**(290)**

35. Based on the table above, the main areas of differences between cost and allowances relate to:

[3] In order to better understand the underlying position of spend versus allowances, Table 2.4 is restated to better align allowance with spend categories.

- TO Load Related Capex – we are forecasting to spend up to our overall allowance. We are currently forecasting to underspend our allowances for Network Flexibility, but overspend against Environmental Aftercare due to ongoing works at Felindre.

- TO Non Load Related Capex – we are forecasting to spend above allowances for Asset Health. This is a result of us continuing to observe that the actual network condition is at a lower level (i.e. more observed condition issues) than the modelled view within our NOMs methodology, but we are continuously looking for efficiency in delivering the work required. We are forecasting to spend below allowances on the Aylesbury IED-Large Combustion Plant (LCP) works delivering an innovative catalyst solution, this is partly offset by additional spend on Integrated Pollutions Prevention and Control (IPPC) phase 1 and 2 works from the last price control period.

- TO Non Operational Capex – we are forecasting to spend above allowances driven by the need to invest in data and systems to improve the management of asset health of our network. We are also delivering additional projects on general cyber security and Project One, which is an update to our Enterprise Resource Planning software.

- TO Opex – we are forecasting to spend above allowances on Business Support costs and Closely Associated Indirect costs. Costs in this area are to deliver the increase in asset health spend, which also has an impact on Business Support costs, in support of the larger business.

- SO Capex – we are forecasting to spend below allowances as a result of lower forecasted spend on Xoserve and Telemetry separation. The level of Xoserve spend is predominantly driven by the change in our Gemini strategy and a lower level of expected EU related Gemini change work than anticipated at the beginning of RIIO-T1.

- SO Opex – we are forecasting to spend below allowances due to a higher proportion of Xoserve allowances allocated to Direct Opex, following the outcome of the review of agency costs.

36. Compared to the performance of cost against allowances reported in 2017/18 the main reasons for change are:

- TO Load Related Capex – our performance compared to allowances has decreased by £10m as a result of forecast increases of £5m for Felindre Variable Speed Drive (VSD) and £7m for modifications at Carnforth Nether Kellet to enhance network flexibility (Scotland 1 in 20) and entry capacity.

- TO Non Load Related Capex – the year-on-year change has been predominantly due to the May 2018 Reopener outcomes, specifically we did not receive £76m of additional allowances for the IPPC 4 works at Peterborough and Huntingdon; for ISS, funding was not provided for additional shared sites and site extensions, and we have deferred the majority of these

works into RIIO-T2; and for Feeder 9, Ofgem's view of efficient costs was £38m below our forecast. For asset health spend our performance is unchanged.

- TO Non Operational Capex – Our forecast spend has increased by £10m against fixed allowances of £72m. The increase is due to investment in our IT infrastructure, which will deliver cost savings in the longer term.
- TO Opex – compared to last year we show a £5m performance decrease. Overall spend has increased by £2m and allowances have reduced by £3m following the funding decision for the Quarry and Loss Reopener.
- SO Capex – our SO Capex costs have remained broadly stable at £276m
- SO Opex – our SO Opex costs have remained stable at £498m

Return on Regulated Equity (RoRE)

37. The Return on Regulatory Equity (RoRE) figure is a key measure by which Ofgem compare operational and financing performance across Network Operators. The methodology of calculating the figure has altered from prior years with the introduction of the Regulatory Financial Performance Reporting pack, part of the suite of regulatory reporting required by Ofgem. The new methodology is more comprehensive than previously, encompassing a fuller range of the costs and allowances associated with a RIIO regulated business, including totex, financing, tax and incentive performance, and company funded innovation costs. As such, the comparison here is to the RoRE submitted in accordance with the Request for Information issued by Ofgem in October 2018 and published as part of the 2017/18 Ofgem Annual Report. A supporting annex has been provided to explain the differences to the prior year reported RoRE.

38. The 2018/19 RoRE is 6.07%, a decrease of 0.37% from 2017/18. The primary reason for this decrease is that the current year operational RoRE reflects the outcome of the September 2018 Reopener Decisions, whereas the prior year RoRE assumed allowances equal to the spend forecasts within our reopener submissions. The Reopener decisions provided lower levels of allowances than we had requested, offset in part by a consequential reduction in Totex.

Table 2: RoRE comparison

	2018/19	**2017/18**
Operational RoRE	6.07	6.44
Financing and tax		0.32
Total RoRE		6.76

Primary outputs

39. Our primary outputs (as driven by incentives) are detailed in Table 3.

Maximum Allowed Revenue TO

40. The Gas Transmission TO Maximum Allowed Revenue for 2018/19 is £708.0m.

Licence Term	2017/18 (17/18 price base £m)	2018/19 (18/19 price base £m)	Commentary for year-on-year variance
Base Revenue (BR)	828.8	688.6	• -£40.4m (2017/18 price base) decrease in opening base revenue (PU) allowances. • -£134.9m (2017/18 price base) decrease in MOD. Detailed MOD commentary included in Appendix I. • +£12.4m relating to TRU (2017/18 price base) in 2018/19 as a result of the movement between forecast and actual RPI in 2018/19 compared to the movement in 2017/18. • +£22.5m due to further year's RPI uplift.
Pass Through (PT)	6.9	4.7	• Business rates, licence fees and policing costs are trued up against the ex-ante allowances with a two-year lag. The value from 2017/18 to 2018/19 has decreased by £2.2m (nominal price base). • Independent systems costs are trued up within year. The true up value was stable between 2017/18 and 2018/19
Incentives (OIP)	3.5	6.2	• The 2018/19 incentive includes the Customer and Stakeholder Satisfaction Incentive and Stakeholder Engagement Reward for 2016/17 performance. The incentive revenue has increased since 2017/18 by £2.7m (nominal prices)
Network Innovation Allowance (NIA)	3.8	4.2	NIA costs have increased slightly on a year-on-year basis, due to the value of sanctioned innovation projects increasing through 2018/19.
Network Innovation Competition	11.6	15.4	As per the Ofgem direction, the NICF revenue term has increased in 2018/19 compared to 2017/18. This year, two projects were awarded funding;

Licence Term	2017/18 (17/18 price base £m)	2018/19 (18/19 price base £m)	Commentary for year-on-year variance
Funding (NICF)			Robotic Roadworks and Excavation System and H21.
PARCA (PTV)	0.0	-	The PTV term has been removed from the Revenue Regulatory Report Pack (RRP) and PARCA costs will be retrieved as part of the Base Revenue calculations in the PCFM.
Correction Term (-K)	-6.9	-11	The correction term in 2018/19 is based on the £11m over-collection of revenue in 2016/17 (as reported in the 2016/17 submission) uplifted as per the licence algebra requirements.
Maximum Allowed Revenue	**847.6**	**708.0**	

Maximum Allowed Revenues SO

41. The Gas Transmission SO Maximum Allowed Revenue for 2018/19 out-turned at £198.4m.

Licence Term	2017/18 (17/18 price base £m)	2018/19 (18/19 price base £m)	Commentary for year-on-year variance
Base Revenue (SOBR)	93.2	94.6	• -£1.2m (2017/18 price base) decrease in opening base revenue allowances. • -£3.9m (2017/18 price base) decrease in MOD. Detailed MOD commentary included in Appendix I. • +£3.4m relating to TRU (2017/18 price base) in 2017/18 as a result of the movement between forecast and actual RPI in 2018/19 compared to the movement in 2017/18. • +£3.1m due to a further year's RPI uplift.

Licence Term	2017/18 (17/18 price base £m)	2018/19 (18/19 price base £m)	Commentary for year-on-year variance
Constraint Management (CM)	11.7	13.3	The 2018/19 revenue includes the 2018/19 ex-ante allowance of £34.2m plus the cost adjustment of -£36.3m plus incentive revenue of £15.4m for 2016/17 performance. All values are quoted after the WACC and RPIF uplifts have been applied. The cost adjustment and incentive revenues are subject to a two-year lag from the year of performance.
Transportation Support Services (TSS)	3.6	-1.0	The 2018/19 revenue includes the 2018/19 ex-ante allowance of £4.8m plus the cost adjustment of -£-10.30m plus incentive revenue of £4.6m for 2016/17 performance. All values are quoted after the WACC and RPIF uplifts have been applied. The cost adjustment and incentive revenues are subject to a two-year lag from the year of performance.
Incentives (SOOIRC)	91.7	108.1	Further detail on incentive costs and performance is included below.
Correction Term (-SOK)	-9.4	-16.6	The correction terms in 2017/18 is based on the £16.6m over-collection of revenue in 2016/17 (as reported in the 2016/17 submission) uplifted as per the licence algebra requirements.
Maximum Allowed Revenue	**190.8**	**198.4**	

Innovation

42. Throughout the last year, we have focused on innovation that delivers a step change for customers, providing a safe, reliable and efficient energy system for the future. We have developed an innovation strategy with a clearer focus on the future of the network. In the last 12 months, we have delivered against our ambition for 2018/19; building on our capacity to measure the business value delivered from

innovation and developing new ways to share this with our stakeholders and customers.

43. In 2018/19 we undertook 36 NIA projects across our key themes (safety, reliability, environment, strategic, system operability and customer and connections) at a cost of £4.67m. Particular successes this year have been projects such as 'Valve Pits Insulation' which reduces noise emissions from our sites, replacing traditional methods of fibreglass lagging with acoustic panels on top of the valve pit, rather than directly attached to the pipework. The trial was at our Wormington site, with sound levels significantly reduced from 66.78 dB to 54.28 dB, directly delivering benefit to the local community living around the site. In addition, the surface of the panels is resistant to moisture, which gives them a longer lifespan than fibreglass lagging. Also, as they are not placed around pipework, they reduce the risk and costs associated with water damage and corrosion.

44. Throughout 2018/19 both our live NIC projects concluded, Project GRAID and Project CLoCC. Both projects have successfully delivered against the aims and objectives that they set out to achieve.

45. Our ambition for 2019/20 is to drive innovation projects that meet the needs of our stakeholders to deliver value and help to create the decarbonised gas network of the future. We will continue our focus on assessing the value of innovation through our value tracking process and complete the development of the Benefits Measurement Framework with the Energy Innovation Centre (EIC) and other networks. As we move towards RIIO-T2 we remain committed to increasing our levels of innovation, utilising a wide range of funding routes to drive real change in our business that delivers value to our customers and a decarbonised network of the future.

Table 3: Outputs and Incentives Performance (primary & secondary)

	Safety			
	Our output	**2018/19 Target**	**2017/18 Performance[4]**	**2018/19 Performance**
1	Comply with HSE legislation	100%	**Complied**	**Complied**
2	Meet requirements for enhanced physical site security	Meet BEIS requirement by 2021	**On track**	**On track**
3	Meet requirements for enhanced data security	Submit six-monthly report on delivery of data centre investments and cyber security enhancement initiatives	**N/A – New output for 2018/19**	**On track / subject to review with the NIS Competent Authority**
	Reliability and availability			
	Our Output	**2018/19 Target**	**2017/18 Performance**	**2018/19 Performance**
4	Maintain our security of supply obligations in Scotland (Network Flexibility)	Ensure compliance with 1 in 20 obligations by 2020	**Strategy in place to ensure compliance**	**Strategy in place to ensure compliance**
5	Meet our targets for investing in our assets to maintain their health (NOMs targets)	Deliver network replacement outputs in accordance with the licence	**In aggregate, on track to deliver eight-year target**	**In aggregate, on track to deliver eight-year target**
6	Replace Feeder 9 (pipeline that runs across the Humber Estuary)	Commission new Feeder 9 pipeline by 2020	**On target –Construction underway, commissioning planned for September 2020**	**On target - Construction underway, commissioning planned for September 2020**
7	Deliver benchmark performance for maintenance outage days	11 days (for Remote Valve Operations)	**1 maintenance day called**	**0 maintenance day called**
8	Minimise National Grid driven changes to maintenance planning	13 days (<7.25% of workload 13.34 of 184 days)	**No changes**	**No changes**
9	Meet constraint management target	£22m + RPI for entry/exit capacity £28.93m target	**£0.43m costs**	**£0m cost**
10	Meet target for Transmission Support Services and for Constrained LNG & Long Run contracting	£3.62 + RPI allowance – This incentive ended 1 October 2018 and therefore the incentive profit for 2018 is based on a 6-month scheme.	**£0m cost**	**£0m cost**

[4] As reported in the 2017/18 RRP. Please note that all previous year figures are in 2017/18 price base unless otherwise stated.

	Reliability and availability			
	Our Output	**2018/19 Target**	**2017/18 Performance**	**2018/19 Performance**
11	Deliver existing capacity obligations in accordance with Unified Network Code (UNC), Licence and Gas Act	All UNC, Licence and Gas Act capacity obligations to be met in full	**System issues, including planned outages, impacted a minority of auctions**	**System issues, including planned outages, impacted a minority of auctions**
12	Deliver accurate 13:00 day ahead demand forecasting	8.41 mcm average forecast error	**8.24 mcm average**	**8.90 mcm average**
13	Deliver accurate demand forecasting at the two to five days ahead stage	13.70 mcm average forecast error	**12.06 mcm average**	**12.44 mcm average**
14	Meet target for residual balancing linepack performance measure	<2.80 mcm average daily change	**1.99 mcm average daily change**	**1.90 mcm average daily change**
15	Meet target for residual balancing price performance measure	Average daily difference between max and min price paid, to be within 1.5% of System Average Price (SAP)	**Difference 1.77% of SAP**	**Difference 0.73% of SAP**
16	Procure Operating Margins (OM) in an economic and efficient manner	Incur OM costs efficiently and publish report on the steps taken to promote competition	**Report published on time, £1.9m decrease in cost in 2017/18**	**Report published on time, £3.6m decrease in cost in 2018/19**
	Environment outputs			
	Our output	**2018/19 Target**	**2017/18 Performance**	**2018/19 Performance**
17	Develop an integrated and cost-effective plan to ensure the remainder of our compressor units are compliant with the Integrated Pollutions Prevention and Control (IPPC) and IED legislation	Delivery date 2018	**Integrated plan submitted as part of the May 2018 Industrial Emissions RIIO-T1 Reopener submission**	**Integrated plan submitted in May 2018. In process of agreeing needs case for St Fergus and Hatton**
18	Undertake works at Peterborough and Huntingdon Compressor Stations as part of IPPC legislation	Delivery date 2020	**On track to deliver one new unit at each site as part of IPPC 3**	**On track to deliver works at each site as part of IPPC 3**
19	Undertake works at Aylesbury Compressor Station to ensure compliance with IED	Delivery date 2020	**Successfully commissioned at the beginning of 2018**	**Successfully commissioned 2018**
20	Report on our business carbon footprint	Publish in annual report	**Published in our annual report**	**Published in our annual report**
	Environment outputs			
	Our output	**2018/19 Target**	**2017/18 Performance**	**2018/19 Performance**
21	Meet greenhouse gas emissions targets	<2,897 tonnes for 2018/19	**3,928 tonnes**	**2,871 tonnes**

22	Meet our targets for the amount and the cost of the energy we use to run the network	<2,676 GWh (Gigawatt hours) gas equivalent usage target in 2018/19[5] <£94.8m cost target for 2018/19	**3,816 GWh** **£71.2m**	**3,223 GWh** **£77.5m**
	Customer Satisfaction outputs			
	Our output	**2018/19 Target**	**2017/18 Performance**	**2018/19 Performance**
23	Undertake annual satisfaction survey with our customers and stakeholders.	Customer 6.9/10 Stakeholder 7.4/10	**7.6 for customer** **8.0 for stakeholder**	**7.79 for customer** **8.08 for stakeholder**
24	Submit annual stakeholder engagement report	Cap of 9 and collar of 4	**Achieved a score of 4.3**	**Achieved a score of 4.85**
	Customer Connections outputs			
	Our output	**2018/19 Target**	**2017/18 Performance**	**2018/19 Performance**
25	Achieve our obligated times for delivering extra capacity on the system	Target of 24 months from the point of formal commitment	**Compliant - No incremental capacity due for delivery this year**	**Compliant - No incremental capacity due for delivery this year**
26	Meet timescales for connection applications as specified in UNC Modification 373 and comply with reasonable requests for a customer connection to the NTS	2 business days for application acknowledgment 5 business days to confirm competent connection application 2 months for initial connection offer 9 months for full connection offer 3 months for a Feasibility Study Report	**8 of 9 offers timescales met** **1 offer two days outside of the specified timescales (timescales agreed with customer)**	**6 offers progressed in 2018/19** **1 offer is due in 2019/20** **1 offer has had the FCO timescales extended as per the customer request**

Key

Red – Missed an annual output and forecast to miss the remainder of our eight-year output commitment

Amber – Missed annual output but on target to progress towards the remainder of our eight-year output/successful achievement of annual output and risk of failure of the remainder of our eight-year output

Green – Successful achievement of an annual output and on target to meet the remainder of progress towards our eight-year output commitment

[5] In accordance with the NTS Shrinkage Incentive Ex Ante Baseline Value Statement usage target and actuals are quoted in GWh gas equivalent, using a factor of three to convert from electricity to gas equivalent.

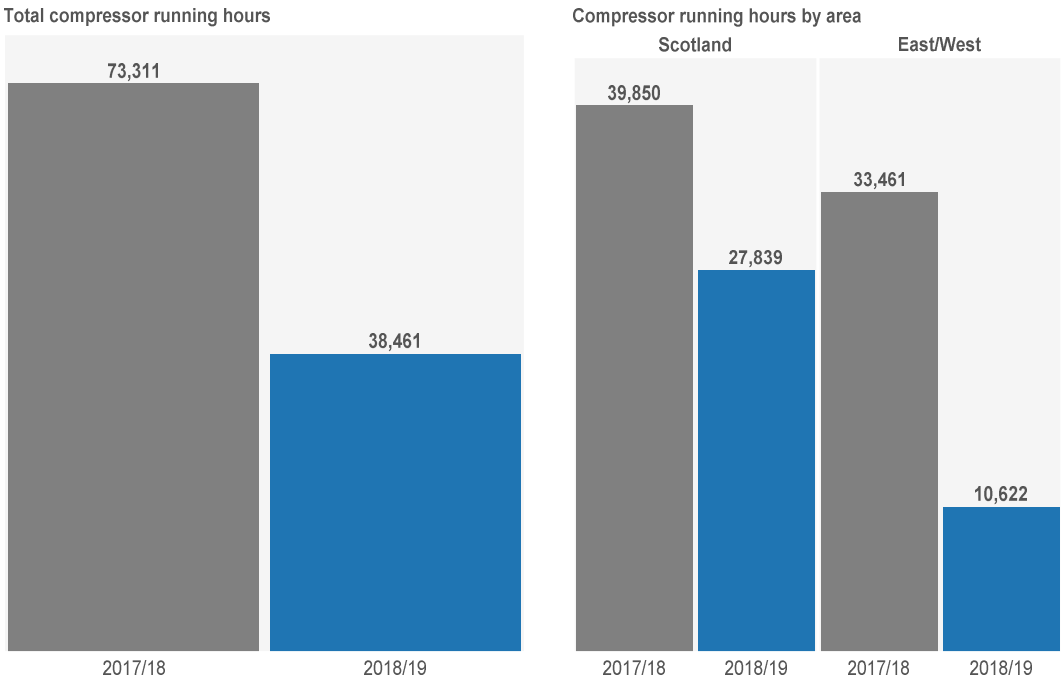
II. Operational Context

46. Our performance in 2018/19 is contextualised by the continued evolution of the operational challenges the business has faced during the financial year. As the sole owner and operator of the Gas Transmission network in Great Britain, National Grid manages the day-to-day operation of the NTS including the residual balancing of the network, maintaining system pressures and assuring gas quality. During 2018/19 we have effectively facilitated the delivery of 99.99% of gas requirements for customers.

47. Achieving this level of performance requires us to continually adapt to the changing use of the network by our customers. These requirements are becoming increasingly influenced by global markets and the continued trend towards decarbonising the economy, manifesting itself as interactions between the gas and electricity systems.

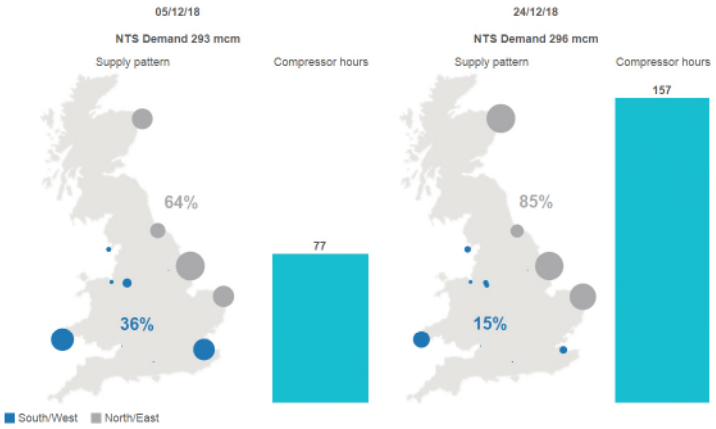
48. The global market effects have resulted in higher than expected LNG flows on to the network with an 81% increase in volume from 2017/18 to 2018/19. The supply point impact of this is increasing inputs in the south of the network, which in turn requires changes to the ways in which the network is configured and how the compressor fleet is utilised. Figure 1 below highlights the reduction in compressor running hours in 2018/19 compared to the previous year as we have adapted to changing market conditions.

Figure 1: Compressor utilisation in 2018/19 compared to 2017/18.



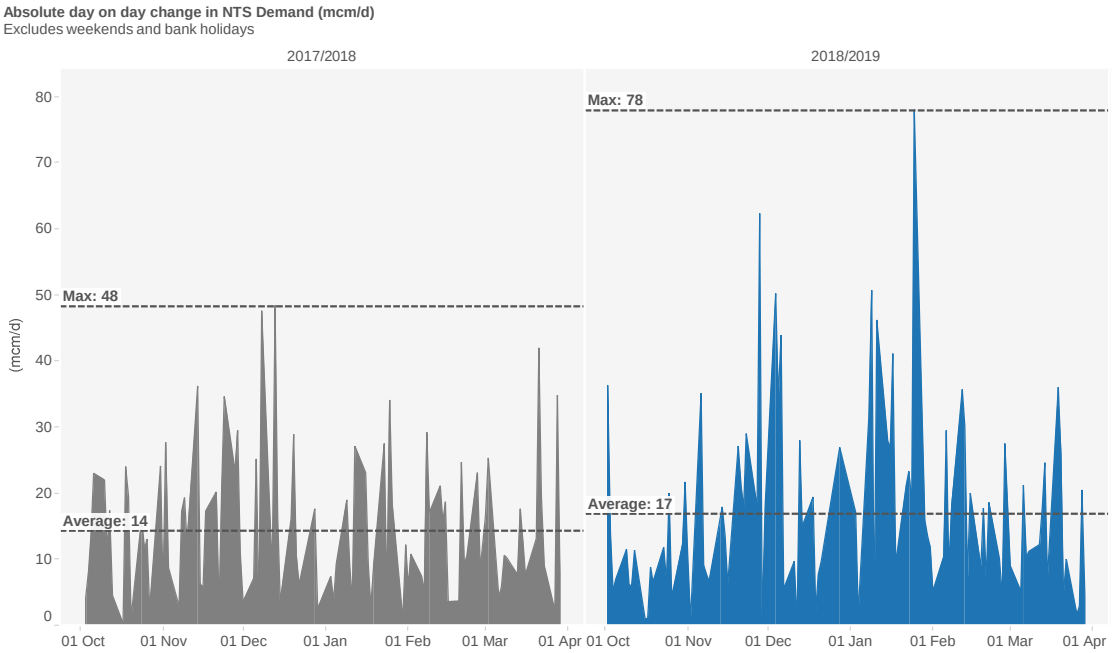
49. To demonstrate the impact that different supply patterns can have on compressor utilisation, the chart below shows two days, one with low LNG flows and the other with high LNG flows. The level of variation is very material, and the impact on compressor utilisation is significant.

Figure 2 – Compressor running hours and NTS demand on two separate days in the 2018 winter period



50. During the year, the interactions with the electricity network have seen a notable change which we believe is set to continue. The reduction in gas prices has meant that during the winter, gas has been the fuel of choice for fossil fuel generation. This has resulted in higher day-to-day variances due to volatility of renewable generation. The day-to-day demand changes during the winter of 2018/19 compared to 2017/18 can be seen in figure 3 below.

Figure 3: Day to day demand change in 2018/19 compared to 2017/18



51. With these scenarios becoming more common, it is imperative that we continue to enhance our forecasting capability, looking across the sector to understand how we need to adapt in order to continue to provide the service our customers require.

52. The consequence of changing flow patterns, and sometimes notable shifts day-to-day, is that during the summer months in particular, the planning of access to the assets for maintenance purposes is becoming more challenging with customer requirements becoming harder to forecast.

III. Outputs

53. Under the RIIO-T1 framework, National Grid's performance as owner and operator of the gas NTS is assessed against five key outputs:

- Safety
- Reliability and Availability
- Environment
- Customer Satisfaction
- Customer Connections

54. These outputs focus on delivery of outcomes that our customers and stakeholders have told us they value most. There are also a series of more specific outputs that sit within each of these five key output areas. These are detailed within Table 3 and have been used in our assessment of our 2018/19 performance.

55. We have continued to implement a number of strategies and applied these through a range of initiatives to deliver our outputs as efficiently as possible and to provide the greatest benefit to customers. Our 2018/19 performance against these key outputs is outlined further in the Output sections below.

IV. Outputs – Safety

56. The safety of our workforce, the public and our assets, remains a top priority at National Grid. We aim to deliver world class safety performance which is crucial to our customers, employees and contractors, the communities we serve and to the reputation of our business. Specific outputs under this theme relate to compliance with safety legislation and meeting the requirements for enhanced physical site security. In 2018/19 we were compliant with all of our safety related outputs. Two serious process safety events occurred in 2018/19 and these have been fully investigated in conjunction with the HSE who are satisfied with the outcome of the investigations and the measures that are being implemented to minimise the likelihood of similar issues occurring in the future.

57. We are also on track to meet the Department for Business, Energy and Industrial Strategy (BEIS) requirements for enhanced physical site security.

Gas Transmission Safety Performance

58. Within the Gas Transmission business, there were no injuries to members of the public as a result of our activities and zero employee and contractor Lost Time Injuries (LTI) in 2018/19. The combined employee and contractor lost time Injury Frequency Rate (IFR) was therefore zero. The combined employee and contractor Total Recordable Injury Frequency Rate (TRIFR) for Gas Transmission closed the year on 0.31, based on seven injuries.

59. There were two serious process safety events during 2018/19, both which involved the release of gas from the NTS. The first incident occurred in December 2018 when a gas release was identified on Feeder 14 close to Avonmouth. The source of the leak was identified as a flange on a stopple tee originally installed over 20 years previously. The second event occurred in January 2019 when there was a significant gas release as a result of a failure on a pressure regulator stream at Didcot Power Station Above Ground Installation (AGI). Both incidents were reported to the HSE under RIDDOR. Both events have been fully investigated using root cause analysis techniques and corrective actions are being implemented according to the agreed plan to minimise the likelihood of future occurrences. These actions focus primarily on our strategies for managing and maintaining assets of this type and ensuring the learning from these incidents is captured and used to avoid other similar issues. These events support the focus we are giving to the health of our assets with further detail on asset health strategy and delivery provided in Section XI.

60. Throughout 2018/19 we have focused on a number of initiatives to promote and encourage safety and wellbeing at National Grid. These include:

- Competency Management – The management of competence of our operational staff is being improved through the roll out of a new competence management system. This includes the implementation of a set of ‘Core’ standardised competence requirements for each operational role and

establishing a new Competence Governance Group to govern all competence related activities.

- Operational Risk Management – An improved process for operational risk management on our Compressor Stations and Terminals has been developed and implemented across these sites to identify and manage any issues which could impact the safety and reliability of the operational assets.

- Health and Wellbeing - Mental and physical health continues to be a focus for National Grid and developments in 2018/19 have included the appointment of trained wellbeing champions, providing information/guidance relating to supporting people through change and helping to prevent stress. There has also been a 'Switch Off' campaign as part of our 'preventative' strategy to encourage healthy behaviours that positively impact physical and mental health.

61. Innovation has continued to play a key role in driving improvement in safety, with a number of projects contributing to our continued emphasis on improving safety. The Mobile Condensate Tank project has begun this year, which is a novel solution to replace our fleet of condensate storage tanks (example shown in Figure 4) with safe, easy to use mobile condensate drain tanks rated for the full NTS line pressure. These tanks will eliminate any risks associated with managing the pressure boundary that otherwise exists when connecting high pressure systems to the existing low pressure storage tanks. These new mobile condensate tanks will have the additional benefit of significantly reducing maintenance and inspection costs.

62. The biggest risk to the network remains third party interference and to minimise this risk we have been exploring, through our Overmesh Pipeline Protection project, whether modern protective mesh systems can help alert excavator drivers to the presence of our pipelines and prevent accidental damage. Initial trials have been very positive with the mesh installed under half a metre of soil and tested with excavators weighing 15 and 22 tonnes. The hi-visibility mesh not only provided an early warning to the driver, it survived attempts to lift and tear it.

63. Safety remains a key driver of innovation. To find out more about our projects and how they help to support and improve the management of the National Transmission System (NTS) please visit:

www.nationalgrid.com/gasinnovation

Figure 4: Condensate storage tank at Peterborough Compressor Station

Enhanced Physical Site Security

64. In May 2018 as part of the Reopener, we put forward our plans to comply with the BEIS requirements for enhanced physical site security. Funding was not provided for additional shared sites and site extensions, as following Ofgem's efficiency review, we did not meet the materiality threshold for the Reopener. Since this decision, we have deferred the shared sites that we were due to deliver into RIIO-T2 and are investigating and developing ways to reduce the cost of these works. Details of progress of our enhancements can be found within the Section XI. Non Load Related Capital Expenditure. In summary, we remain on track to meet BEIS's requirements.

V. Outputs – Reliability and Availability

65. The reliability and availability of our transmission network and the service it provides is vital to our customers. In 2018/19 we continued to provide high levels of reliability and availability for our customers to input and offtake gas from our system. The section below details how we have performed against our Reliability and Availability outputs outlined in Table 3. In summary, most of our outputs in this area have been met, and all are on target to be met within the remainder of the RIIO-T1 period. The only areas where an issue has been experienced is with regards to 'Capacity Obligations' (Output 11 in Table 3) and 'Deliver accurate 13.00 day ahead demand forecasting' (Output 12 in Table 3). This is discussed further in the 'Constraint Management Incentive Scheme' and 'Demand Forecasting Incentive Scheme' sections below. Reliability and Availability outputs not discussed in the below section, are covered in X. Load Related Capital Expenditure and XI. Non Load Related Capital Expenditure.

Network Output Measures (NOMs)

66. The reliability and availability of the NTS to our customers depends predominantly on the health of our assets, both today and into the future. NOMs are currently being used as a proxy for network risk to measure the risk across the RIIO-T1 period. As per previous submissions we have identified that the current NOMs approach for predicting asset condition over-predicts for some asset groups, and under-predicts for others. This is still the case and it is therefore important to note that our asset health investment planning is not based on the modelled view but targeted to address actual network condition/issues and minimise disruption to customers.

67. We have spent £113.1m on asset heath works in 2018/19, compared to £130.4m in 2017/18. We had also forecast to undertake asset health investment as part of the IED Reopener. Ofgem decided not to fund this work, therefore all costs have been reallocated to asset health and works have been prioritised with the existing portfolio. This led to an increase in the asset health spend of £3.2m more than forecast in 2017/18 RRP but an equivalent reduction within the IED asset health category. Our overall forecast for RIIO-T1 asset health remains at £693m (including Feeder 9 design costs), the same forecast as reported in 2017/18. This is £100m above our RIIO-T1 allowance of £593m.

68. We have restated our Table 6.6 Condition & Risk tables following identification of a logic issue within our asset ageing process. The restatement process has reduced the numbers of Replacement Priority 1 (RP1) assets in all Primary Asset Classes, except Pipelines. The overall impact is a net increase of 40 RP1 assets for 2017/18 compared to previously stated numbers using the old ageing process.

69. Based on the restated numbers and comparing the end of 2018/19 with the end of 2017/18, the number of Replacement Priority 1 (RP1) assets across the NTS has increased from 2,013 to 2,153.

70. We continue to prioritise asset improvement works that deliver maximum benefits for customers. We are favouring refurbishment interventions over full asset replacements, which reduce network risk and extend the life of the asset, but with the consequence that the refurbishment intervention may not be sufficient to claim a network output. The implication is that a significant proportion of Asset Heath spend does not apparently reduce NTS risk as the SAC unit of measure is too large to record an intervention benefit and reduce the numbers of reported RP1s.

71. We are still forecasting to meet the NOMs targets outlined in our current Licence (Special Condition 7D.8) by the end of the RIIO-T1 period. We further discuss our new NOMs Methodology in Section XI, through which our current volume-based License targets will be changed to a monetised risk metric.

Maintenance Days Used Incentive Scheme

72. The Maintenance Days Used incentive is designed to reduce the impact we have on our customers when we undertake our routine maintenance activities. For 2018/19 the incentive only included maintenance days for Remote Valve Operations (RVO); the In-Line Inspections (ILIs) element of the scheme ceased in 2015/16.

73. We have sought to align all of our routine valve maintenance work with customer outages where possible, and only one Maintenance Day for RVOs was requested ahead of the summer maintenance period (April to October) (as in 2017/18). However, this was reduced to zero days after realigning the work with the customer. This ensured that zero Maintenance Days were called in 2018/19.

74. We have continued to build upon the improvements made in previous years to help us to improve the service we provide to customers.

Maintenance Day Changes Incentive Scheme

75. The aim of the Maintenance Day Changes incentive is to reduce the impact our maintenance activities have on customers should we make changes to our planned maintenance after 1 April for the forthcoming summer maintenance period. The incentive scope does not include changes which were initiated by customers, only those initiated by us.

76. The Maintenance Day Changes incentive includes any maintenance days called; it is not limited to RVOs. In total, there were 184 days of planned maintenance in 2018/19 compared to 281 days in 2017/18. This decrease, driven in part by a higher volume of internally impacting works, led to an updated benchmark for changes of 13.34 days in 2018/19, which is 7.25% of all Maintenance Days and Advice Notice Days[6] called. This compares to a benchmark of 20.37 days in 2017/18.

[6] Where a single maintenance activity affects multiple NTS Exit Points on a day, this is construed as a single day for the purposes of the Maintenance Incentives.

77. In 2018/19, there were no changes initiated by us during the maintenance period. This is the same level of performance as 2017/18. The incentive was more challenging this year because we received and acted on 47 days of customer change requests during the summer maintenance period, compared to 41 in 2017/18, demonstrating our continued commitment to be flexible to customers' requirements.

78. This performance was primarily delivered by several improvements that we made in 2018/19 including improving our planning processes. This included an increase in face-to-face meetings with customers and telephoning/emailing customers eight weeks prior to the planned maintenance affecting them, allowing us to capture any changes to customer outages earlier.

79. The reduced use of Maintenance Days throughout 2018/19 has ensured minimal impact to our customers' operations. This provides a better value service for our customers and the wider energy industry. This does however create additional risk for National Grid as aligning more of our maintenance activities to our customers' outages means that should a customer change or cancel their planned outage dates, we risk our own work being disrupted or cancelled.

80. Our annual maintenance programme review for 2018/19 can be found on our website at:

https://www.nationalgridgas.com/data-and-operations/maintenance

Constraint Management Incentive Scheme

81. The Constraint Management incentive is designed to incentivise National Grid to maximise available capacity on the network and minimise constraint management costs through the efficient and economic planning and operation of the NTS. We therefore release as much capacity as possible, develop effective constraint management strategies and make economic and efficient NTS investment and planning decisions. This benefits our customers, and ultimately end consumers, as the costs of commercial constraint management actions to the Industry are mitigated or minimised, and balanced against NTS investment whilst maximising access to the NTS. Running a constraint-free network provides choice for our customers to land and utilise the cheapest gas and has a positive impact on the market. A robust Constraint Management incentive drives an effective strategy which delivers value to Industry and end consumers who share in the benefit of strong performance. The National Grid overall 2018/19 Constraint Management incentive scheme performance was £31.1m which resulted in £17.3m being returned to customers.

82. In 2018/19 (pre-sharing factor), overall revenue from Entry Capacity products, including Entry Capacity Overruns, decreased to £1.3m from £3.4m in 2017/18. In 2017/18, higher than anticipated Entry Overrun revenue was generated following a Shipper capacity trade error which resulted in an additional £1.2m (pre-sharing factor) of Entry Overrun charges. This has not been seen in the 2018/19 financial year.

83. We have seen less revenue across all Entry Capacity products; owing to a milder winter and lower overall demand on the gas network, compared to that experienced in 2017/18; especially December 2017 and at the end of February 2018/beginning of March 2018. The price differential between the European and UK markets drove higher demand for Entry capacity at the Bacton Interconnector in December 2017 which has not been replicated in 2018/19. Following the Gas Deficit Warning issued on 1 March 2018, gas prices spiked and this resulted in an increase in capacity product revenues in that month, that has not been repeated in March 2019.

84. Revenue from Exit Capacity products decreased to £0.9m in 2018/19 from £1.1m in 2017/18. The Gas Deficit Warning on 1 March 2018 also led to higher revenue from Exit Capacity products which, similarly to Entry, was the outcome of a specific scenario that has not been replicated in 2018/19. In addition, much lower revenue was generated from Exit Interconnector locations throughout 2018/19 than seen in 2017/18. The lower revenue generated across many of the capacity products could be attributed to milder weather experienced in 2018/19.

85. In 2018/19 we proactively managed a number of potential constraints. Three examples are provided below:

- During August and September 2018, following a diversion request from Highways England, we established a detailed daily procedure with one of our Shippers and direct customers to switch gas capacity and gas flows from one offtake to another to allow the diversion works to progress. If the diversion works had gone ahead without this agreement in place, flows at the affected offtake would have been discontinued, which would have impacted customer operations and required costly commercial actions to buy back firm capacity entitlements. Through our strong customer relationships, we were able to establish this agreement at a zero-cost to both Highways England and National Grid.

- In Summer 2018, we carried out essential maintenance at Bacton Interconnector which limited gas flows. We managed the commercial risk of this maintenance work by working closely with our Operational colleagues at Interconnector UK to ensure that work could be carried out safely and efficiently whilst not hindering customer operations. Planning for maintenance, especially on a unique part of the network like Bacton, where there are entry and exit gas flows, requires ongoing network modelling and risk analysis.

- Following an alert to a potential planned strike at Milford Haven, network analysis was carried out to ensure that we had good asset availability to meet any South-West demand should the strike go ahead and continue on an ongoing basis.

86. We need to undertake both planned and ad hoc maintenance activity on the network. The risks associated with planned maintenance work are reviewed to determine whether the work will impact the local and wider network. If there is an unacceptable amount of risk, other options will be considered. If maintenance work is more ad hoc then there may have to be a different way of managing such work,

for example, developing an approach in conjunction with stakeholders and customers, to manage the risk effectively such that the work can go ahead.

87. Although the network issues seen in 2017/18 have not been replicated in 2018/19, National Grid has continuously utilised both physical and commercial tools to ensure that potential constraints have not manifested themselves. National Grid has maintained a strong level of communication with customers and stakeholders; through our standard communication methods and via agenda items at the Operational Forum.

88. We have continued our plans for ongoing improvement and maintenance of our customer relationship. We continually aim to educate the Shipper community to allow us to be able to manage the network in a more efficient way with the end consumer in mind. The following points are examples of the activities undertaken in 2018/19:

- In April 2018, at the Operational Forum we carried out a Capacity Constraint and Energy Balancing scenario game to aid understanding of Constraint Management and Energy Balancing interactions and the actions and tools available to potentially manage such a scenario.

- We have also spoken to the Operational Forum about Offtake Rules, in a bid to explain what it means when there is a constraint and what our expectations are for Shippers. All of this goes some way in ensuring that Industry are better educated and they therefore understand the regime and their role and actions within it whilst working alongside National Grid.

- Discussions and presentations relating to specific “interesting days,” giving Industry the opportunity to ask for more information and enhanced understanding on how and why we use our commercial and operational tools.

- Frequently Asked Question (FAQ) document. We have compiled an initial list of frequently asked capacity-related questions based on past interactions with our customers and have published this on the National Grid website. We have done this so that customers have a go-to document which should hopefully provide answers to the capacity-auction-related questions. This a dynamic document that will continue to evolve as we receive further feedback from our customers.

89. Where it was identified that there could be a system issue with Gemini and/or Gemini Exit, we ensured that we mitigated any automation issues and took steps to process auctions manually.

90. In instances where, due to a third party system, the Day-Ahead auction has failed, our obligations were not impacted as there were subsequent Within-Day obligations available to Shippers. Where a particular Within-Day auction(s) had failed, Shippers would have the remaining hours within the Gas Day to participate so our obligations were not impacted.

Transportation Support Services Incentive Scheme – scheme ceased Oct 2018

91. The Transportation Support Services (TSS) scheme incentivised National Grid to minimise the cost of procuring specific tools to support gas demand in the South West as an alternative to network investment. This incentive ceased in October 2018 with no spend incurred during 2018/19.

Demand Forecasting Incentive Schemes

92. The national demand forecasts published by National Grid for day ahead (D-1) and for two to five days ahead (D-2 to D-5) are a key tool for the UK gas industry in ensuring the economic balancing of gas supply and demand. The provision of timely and accurate forecasts aid in ensuring efficient operation from both a physical and commercial perspective, ultimately reducing operating costs which directly impact on end consumers gas bills. National Grid strives to continually optimise its forecasting processes, to deliver greater accuracy and increased consumer benefit.

93. From a demand forecasting perspective, 2018/19 has proved to be a challenging year as the ways in which gas is used, both domestically and industrially, continued to evolve. New sources of electricity generation from the greater availability of renewables, to the increasing capacity of our electricity interconnectors, has had a significant impact on typical gas for power requirements. Continued uptake of smart heating systems, and increasingly efficient insulation has continued the divergence in domestic demand from our traditional temperature based models.

94. All of these factors have resulted in an increase in the variability of demand, impacting on the accuracy of our forecasts. Average day to day change in national demand has increased from 12.18 mcm to 13.77 mcm in 2018/19, with 18 days this year showing a greater than 40 mcm change from the previous day. The most extreme of these daily demand changes was 86.67 mcm. Consequently, average forecasting error has increased.

95. In 2018/19 the average error on the D-1 incentive was 8.90 mcm against a target of 8.41 mcm (Fixed target of 8.5 mcm + storage adjuster of -0.09 mcm)[7]. The average error has increased this year from 8.24 mcm in 2017/18. The D-2 to D-5 incentive average error was 12.44 mcm in 2018/19 against a target of 13.70 mcm. The average error has increased from 12.06 mcm in 2017/18.

96. Throughout 2018/19 we have embarked on several activities to drive improvements in the accuracy of our demand forecasts, including:

[7] National Grid are currently reviewing a potential difference between Demand forecasting short-cycle storage adjuster License calculation methodology and storage adjuster principles, Ofgem to be advised on conclusion.

- Ongoing process improvements to improve both demand and supply forecasting.
- Increased LNG ship monitoring as the LNG markets become more prevalent
- Ongoing education within the team to understand changes in fuel distribution for Power Stations

97. We plan to make a fundamental step change in the way we utilise and analyse data used for our forecasting processes in 2019/20 to drive increased accuracy and benefit.

Residual Balancing Incentive Scheme

98. The aim of the Residual Balancing incentive scheme is to incentivise National Grid's residual balancing activities in two ways:

- The Linepack Performance Measure (LPM) incentivises National Grid to minimise differences in linepack volumes between the start and end of each gas day. This is to ensure that any system imbalances within the day are resolved, and that any associated costs are levied across those system users responsible for that day's imbalance.
- The Price Performance Measure (PPM) evaluates the impact National Grid has on the market in its Residual Balancing role by measuring the price range of its trading actions compared to the System Average Price (SAP). This incentivises the System Operator to minimise the impact it has on market prices.

99. The LPM element for 2018/19 achieved a daily average linepack performance of 1.9 mcm over the year, compared to the 2.8 mcm incentive target. This was slightly better than the level for 2017/18 (which was 2.0 mcm). LPM was better than the target of 2.8 mcm on 292 days during the year (80% of days), a slight increase compared to 2017/18 (282 days, 77% of days).

100. The PPM element achieved an average price spread of 0.73% of SAP, compared to the 1.5% incentive target. This represented an increase in performance on the 2017/18 value of 1.77%. We took residual balancing actions that enabled the system to balance on 158 days (43%) compared to 148 days (41%) in 2017/18. Representing an increase in the number of days National Grid were required to enter the market to encourage balancing.

101. On the days when we took actions, the average price spread was 2.0%, compared with 5.0% in 2017/18 and 4.3% in 2016/17. Demonstrating increased value to the customer despite a more challenging environment. Multiple factors have been identified which when combined created the more challenging backdrop for balancing, namely Linepack swing and Shipper behaviour. Linepack swing has increased despite gas demand decreasing. The NTS now accommodates much wider imbalances in supply and demand during a gas day, presenting a more challenging environment for Residual Balancing to operate

efficiently in. As a result, we have entered the market earlier and more frequently particularly during challenging periods.

102. Shipper behaviour continues to have a substantial impact on balancing the NTS especially on weekends and holidays. The Top 10 over and under delivered Shippers alone contributed to approximately 50% of the imbalance volume over the year. There were eight Shippers with an imbalance of greater than 1 GWh on more than 200 days throughout the year. We continue to engage with these shippers to understand the changing drivers behind habitually leaving an imbalanced position.

103. On 21 October 2018, a particularly challenging day for balancing on the NTS, the top five Shippers contributed to 12.5 mcm of the 15.2 mcm gain in Linepack. Despite National Grid setting SMP Sell at 4.7 pence per therm (p/th) below SAP showing limited reaction from the market.

104. Following the implementation of Operational Balancing Accounts (OBAs) in October 2015, we have continued to work with adjacent Transmission System Operators (TSOs) to ensure OBA operations do not materially impact residual balancing.

105. In 2018/19 we continued to manage the risks posed to the system both within the day, whilst also adopting a proactive approach by using trend analysis and forecasting to assess the future risk to the NTS.

Operating Margins (OM)

106. We are required to procure our Operating Margin (OM) requirements on an annual basis in accordance with, TPD Section K of the Network Code, the obligations set out in National Grid's gas transporter licence, and the obligations detailed in the National Grid's Safety case.

107. OM may be used in the intermediate period following operational stresses to allow market actions to take effect and during the potential run-down of the system in the event of a Network Gas Supply Emergency. There were no OM service utilisations in the 2018/19 incentive year.

108. All costs incurred for the procurement and utilisation of OM are cost pass through within the Licence. Under the RIIO-T1 regime, we have a reputational incentive to promote competition in the procurement of OM services for our customers. We aim to meet the OM requirement in the most economic and efficient manner.

109. OM procurement costs have decreased from £11.1m for the 2017/18 incentive year to £7.5m for the 2018/19 incentive year with a lower OM volume requirement (~0.9 Terawatt hours to ~0.7 Terawatt hours).

110. The lower cost base achieved for our customers reflects a continued focus on stimulating a more competitive market response, through industry engagement to identify and secure new service providers.

111. We have continued to review the OM contract templates based on feedback which has resulted in an improved contractual framework and alignment across the suite of contracts. These have been well received by service providers.

112. Although increasingly challenging, we continue to see potential for further competition, particularly from gas fired power stations for OM service provision. We will continue to explore the potential for further competition as we move forward.

VI. Outputs – Environment

113. As one of our key outputs under RIIO-T1, minimising the impact our business has on the environment is important both to us, and our customers.

114. In 2018/19 we have made good progress against our environmental outputs outlined in Table 3. As a result of reduced compressor running hours, coupled with our initiatives collectively known as the '1000 tonne reduction challenge', we have outperformed against our GHG gas emissions target and reduced CO_2 emissions from compressors by 53%. We have reported appropriately on our Business Carbon Footprint and we are on track to meet our IED legislative obligations with delivery of works at Peterborough and Huntington compressor stations. Further information about IED and works at our compressor stations can be found in Section XI. Non Load Related Capital Expenditure.

Emissions

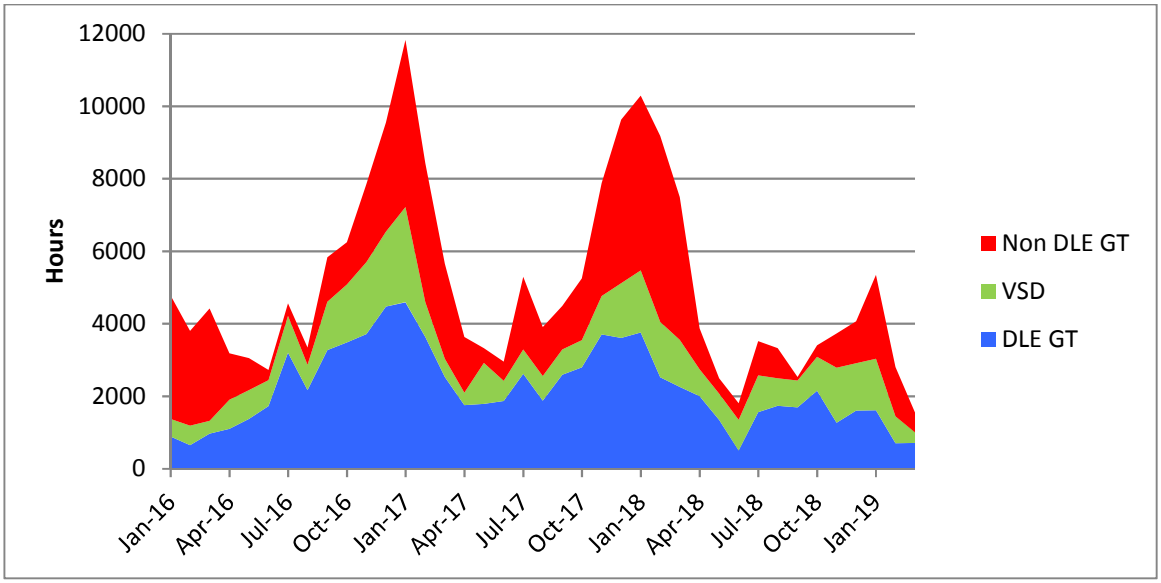
115. IED has been in force since January and February 2013, in Scotland and England/Wales respectively. We updated our plan to comply with this legislation as part of the May 2018 Reopener. We report on progress within Section XI. In summary, work at Peterborough and Huntingdon is continuing to progress well. We are also progressing initial work for Hatton and St. Fergus. We are therefore on track to meet our outputs in this area.

116. In addition to IED, the Medium Combustion Plant Directive (MCP) was transposed into UK legislation in December 2017 and January 2018 in Scotland and England/Wales respectively. As part of these changes in UK legislation, the time derogation for gas driven compressors has been confirmed as 2030 from the original 2025, in part influenced by National Grid lobbying EU stakeholders.

117. The MCP Directive applies to the smaller gas compressors and affects 27 of the NTS compressor units, with a compliance date of 2030. Other combustion plants, such as pre-heat systems, are also captured as part of this Directive with a compliance date of 2025. The investment strategy plan is being drawn up for RIIO-T2 and will be submitted as per required timelines.

118. In 2018/19, compressor utilisation has reduced by 47.5% compared to 2017/18 (Further detail can be found in Section II– Operational Context). Subsequently, we have seen a reduction in CO_2 emissions from compressors of 53%, and also a decrease in NOx emissions by 62% from 2017/18 levels. The improved NOx performance is also due to the increased proportional use of Dry Low Emission (DLE) gas turbines and electric drives. (see figure 5 – This shows the hours utilisation in 2015 to 2018 by unit type)

Figure 5 – 2015 to 2019 Utilisation by Unit Type



Business Carbon Footprint

119. As a Group, we have set a voluntary target to reduce our Scope 1 and Scope 2 GHG emissions across our UK and US businesses by 45% by 2020 based on 1990 levels. Our baseline emissions level was set, at group level, at 21.6m tonnes of carbon dioxide equivalent. Our current forecast is that we will better the 2020 target. In the longer-term we have targets to reduce our GHG emissions by 70% by 2030 and 80% by 2050.

120. Scope 1 and 2 emissions in Gas Transmission can be broken down into sources including compression, venting, leakage, buildings and transport. Scope 3 emissions are from business transport only

121. The majority of the emissions in Gas Transmission are from fuel use in gas and variable speed driven electric compressors. Emissions from compressor stations are largely dependent on the locational balance between supply and demand conditions, driven by market forces.

122. Scope 1 emissions have fallen significantly in 2018/19 when compared with the 2017/18 emissions, from 585 KTCO2e to 295 KTCO2e. Most of the reduction is due to changing supply and demand conditions which have contributed to a 47.5% reduction in operational running hours for our compressor fleet. The volume of methane vented from the compressor fleet has also reduced by 27%. This is mainly due to two factors: a continued high focus on reducing venting within operational and maintenance outage periods, and the reduction in compressor running hours. More detail on our venting performance and the actions and initiatives undertaken to reduce vented gas can be found in the narrative on our GHG incentive.

123. Scope 2 emissions have also fallen significantly, from 101 KTCO2e to 50.6 KTCO2e with running hours of our electric drive compressor fleet also falling.

124. Scope 3 emissions have fallen from 2.4 KTCO2e to 1.9 KTCO2e.

125. We provide our annual emissions performance as part of our Carbon Disclosure Project (CDP) submission. This enables us to benchmark our performance against other organisations. In 2018 (for 2017/18) we achieved an 'A' rating for our CDP submission, putting us in the top 2% of global companies recognised for our actions to reduce emissions and mitigate climate change.

126. Our GHG inventory, measurement, data collection, aggregation and reporting processes are verified by an independent third party providing assurance of relevance, accuracy, consistency, transparency and completeness.

Shrinkage Incentive Scheme

127. The aim of the Shrinkage incentive scheme is to minimise the costs we incur in our role as NTS Shrinkage Provider. These costs are recharged back to users as part of NTS commodity charges.

128. The overall volume of shrinkage gas and electricity procured for the combined elements of Shrinkage (Compressor Fuel Usage (CFU), Unaccounted for Gas (UAG) and Calorific Value (CV) shrinkage) was 3,223 GWh gas equivalent in 2018/19. This represents a decrease in overall volume of 593 GWh gas equivalent from 2017/18. This is largely due to a decrease of 1331 GWh gas equivalent in the volume of CFU, outweighing an increase of 746 GWh in the volume of UAG. (This is pre-reconciliation UAG, which includes some energy that is reconciled to particular users after close-out - refer to the UAG Incentive section for further detail).

129. The volume of CFU was 44% lower than in 2017/18, driven by a reduction in the supplies at the St Fergus terminal, as LNG supplies stepped up over winter, with the gas component of CFU being specifically lower. Compressor use is primarily driven by the supply/demand patterns presented by the market, which vary year-to-year, and different compressor units at different sites have different efficiencies in relation to CFU. We continued to manage the operation of electric units over periods of peak electricity demand to reduce Transmission Network Use of System charges (often referred to as triad charges).

130. In forward trading for 2018/19 we enhanced our trading platform, by aggregating prices for greater efficiency, and adapted our strategies to manage market changes. We achieved EU Emissions Trading Scheme (ETS) compliance for gas compressor emissions, including additional purchases following the suspension of free allowances for the UK due to Brexit.

131. In managing the NTS Shrinkage incentive scheme we incurred gross costs of £77.5m, including £55.3m for gas (net of meter reconciliations) and £20.6m for electricity. This is higher than costs for 2017/18 (£71.2m), as higher market prices outweighed lower volumes. Against the total incentive target of £94.8m, this represents a £17.3m outperformance that is shared with customers.

Unaccounted for Gas (UAG)

132. UAG is a reputational incentive with a requirement to undertake projects and initiatives to investigate the causes and reduce sources of UAG.

133. For the first time, UAG is being reported as post-reconciliation UAG enabling a more accurate representation of UAG performance from the start of the RIIO-T1 period. This is calculated using closed-out corrected measurements after meter or data error has been detected and reconciled. Please note; due to this change the UAG values stated in the Shrinkage narrative will differ because they have used the pre-reconciliation UAG values.

134. UAG has increased compared to 2017/18. The annual UAG energy for 2018/19 was 1,517 GWh, which is 117% more than last year. This is mainly due to increases in the magnitude of positive UAG days over this current period. Despite this, the observed levels of annual UAG have been in decline since April 2013 except for 2015/16 where there was an increase.

135. We review and investigate UAG values daily, paying particular attention to any days where UAG exceeds +/-20 GWh. During 2018/19 there were 53 days that exceeded the +/-20 GWh limit, which is 21 days more than 2017/18. The causes of UAG have been identified on 25% of these days. All identified meter or data errors will be reconciled.

136. Reconciliations carried out over the past year (54 in total) have equated to a net energy value of -67 GWh. This has exceeded the amount reconciled in 2017/18 by 47 GWh. Most of these reconciliations are for days in 2018/19, however, reconciliations have also been processed for 2016/17 and 2017/18.

137. In 2018/19 we have continued to look for ways to improve our UAG performance. The following remain key focus areas for UAG management are:

- Improving data handling between sites and billing systems, through the implementation of data visualisation, enhancing the D+5 close out data quality and reducing billing uncertainty; and

- Maintaining a close relationship with all meter asset owners and validation agencies, providing a consistent and effective platform to receive metering system validations and to solve measurement issues.

138. In 2018/19 we received meter validation reports for 99% of all the NTS entry and exit facilities, which is an improvement to the 98% we received in 2017/18. These validation reports have been reviewed and, where necessary, queries raised with the asset owners. For the few sites where validation reports were not provided, or the equipment had failed, we have scheduled to witness the meter validations as part of our 2019/20 witness programme.

139. National Grid is continuing to improve its validation of end of day measurements, through the development of new data visualisation tools, to help address data

quality challenges experienced throughout the pre-close out period. A repository for reconciliation data has been developed that assists with calculating post-close out UAG and the production of future UAG reports.

140. National Grid is also continuing to investigate other variables that may impact UAG including NTS linepack changes and increased LNG inputs.

141. Manchester University's mathematics department continue to carry out an independent assessment of a dynamic baseline UAG. It is expected to provide a range of improved analytical methods for identifying potential causes of UAG. A prototype application that undertakes change point analysis on assessed UAG values has been developed and is currently being trialled for identifying occurrences of meter error. The application is intended to be used for investigating periods when high levels of positive or negative UAG are observed.

Greenhouse Gas Emissions Incentive (GHG)

142. The aim of the GHG incentive scheme is to incentivise National Grid to reduce the amount of natural gas vented from our compressors (primarily methane), and to reduce the effect of our operational activities on the environment. This is important both to us, our customers and stakeholders.

143. The emissions allowance is set each year by Ofgem, the allowance for 2018/19 is 2,897 tonnes, for each tonne of natural gas vented over the allowance we are subject to a price and cost payment, which is based on our NTS GT Licence formula using the latest non-traded carbon reference venting price published by BEIS. For 2018/19 this price was £1,447 per tonne of natural gas vented.

144. Compressors are used to increase pressure in parts of the NTS and to move gas from the sources of supply to areas of demand. To undertake this activity to deliver customer requirements, we will select the Best Available Technique (BAT) in accordance with IED.

145. The need to operate an individual compressor on any given day is dependent upon several variables, including the sources of demand and supply, the prevailing network conditions and the need to accommodate maintenance and construction plans.

146. The total amount of natural gas vented from compressors in 2018/19 was 2,871 tonnes, which is 99% of the target allowance. This is a reduction of 27% compared to the total amount of natural gas vented from compressors in 2017/18.

147. The volume vented decrease is primary due to two factors; continued high focus across our business to reduce compressor pressurisation and venting within operational and maintenance outage periods and a reduction of compressor running hours.

148. The focus for 2018/19 was to improve venting performance from previous years, to identify initiatives and where possible reduce controllable emissions. These

initiatives formed an action plan known as the ‘1000 Tonne Reduction Challenge’ with the aim to reduce 1000 tonnes of venting performance of 2017/18 during 2018/19 to bring the emissions volume back to allowance and to embed the efficient use of our processes throughout the remainder of the RIIO-T1 period.

149. The initiatives have been successful, and coupled with a reduction in compressor running hours, have saved over 1000 tonnes of GHG emissions in 2018/19 compared to 2017/18.

150. The improvements can be summarised as; improved communication between compressor sites and Gas National Control Centre (GNCC), new decision support tools, improved screens available to GNCC showing pressurised compressors, bundling of ad hoc outage requests and testing activities, incentive cost consideration alongside operational requirements, and venting initiatives undertaken at specific sites.

151. The GHG emissions calculation methodology for calculating the mass of Natural Gas vented will be verified by an Independent Examiner and submitted to the authority by 31 July 2019.

152. We successfully complied with Special Conditions 8J and 3D.47, Greenhouse Gas Investigative Mechanism (GHGIM). In response to stakeholder views we undertook an investigation to improve our understanding of fugitive venting. As part of this we identified ways to increase transparency through accurate measurement of venting and developed methods to deliver long-term carbon benefits through cost effective mitigation of venting.

153. The GHGIM research and development project improved our understanding of fugitive venting. We continue to enhance our measurement capability with an innovation project called Monitoring of Real-time Fugitive Emissions (MORFE). This project will provide a full solution for improved imagery and quantification of fugitive leak detection to support cost based decisions on asset repair and replacement programmes.

VII. Outputs – Customer Satisfaction

154. The RIIO-T1 price control recognised the need to encourage network companies to respond to the changing requirements of an evolving customer base and develop strategies to drive improvements in customer and stakeholder satisfaction.

155. Our customer satisfaction output is supported by two separate financial incentives:

- customer and stakeholder satisfaction survey; and
- stakeholder engagement incentive scheme.

156. This year we applied the successful actions from our 2017/18 customer satisfaction survey to help increase responses to our 2018/19 stakeholder satisfaction survey. As a result, our combined response volume improved by 79% year-on-year, representing an increase of 126 responses compared to the previous year.

157. In 2018/19, we achieved a customer satisfaction score of 7.79 against a baseline of 6.90. The stakeholder satisfaction score was 8.08 against a baseline of 7.40.

158. The customer satisfaction score has increased by 0.19 since last year's score of 7.60. The stakeholder satisfaction score has increased by 0.08 from the 2017/18 score of 8.00. We have achieved an increase in scores overall across a broader range of customer and stakeholder contacts than in previous years and continue to strive to contact all customers and stakeholders who respond to our survey, where they have stated they are happy to be contacted.

159. We received increasing scores for nine customer and stakeholder service areas from 2017/18 and we received scores for the first time in a further nine service areas this year as a result of our continued focus on increasing responses and acting on previous feedback. The areas that received increasing satisfaction scores included Future Energy Scenarios for the second year in a row and Gas Capacity which moved from 5.50 last year to 8.60 this year, by acting on customer feedback. Connections declined from 8.13 to 7.78 this year and in January, a customer who had highlighted some specific challenges was invited into our Customer Experience Governance Board so that the group could listen first hand to the pain points. Agreed actions included a more collaborative approach going forward and a reduction of handovers.

160. In 2018/19, our customers and stakeholders remained a key priority as we continued our focus on putting them at the heart of everything we do. From our operations and activities - as part of RIIO-T1, to engagement and co-creation in building our RIIO-T2 plans. Through the customer feedback received in 2017/18 our Customer Experience Governance Board aligned behind four strategic focus areas that were created from the drivers of satisfaction:

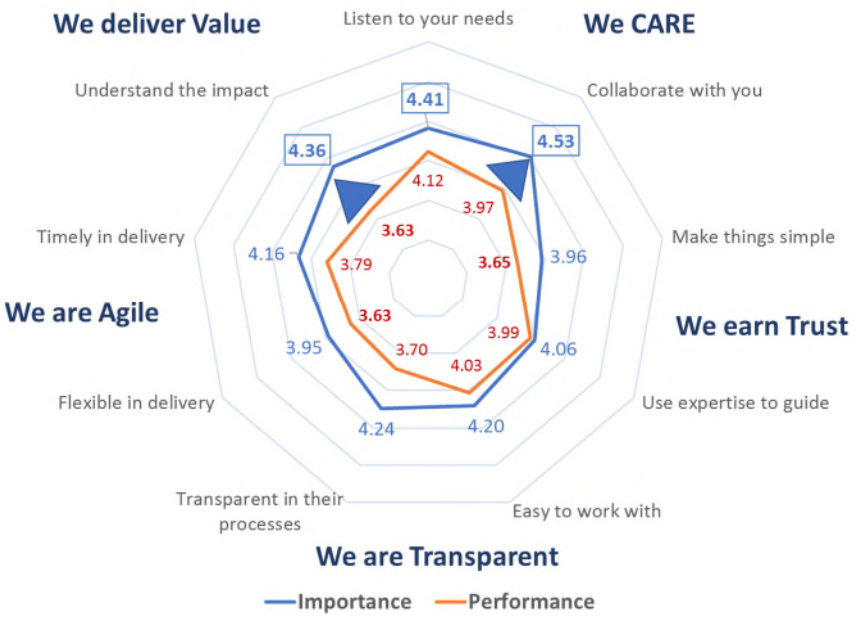
- Customer Ownership - from aligning objectives, to customer service training.

- Customer Relationship Development – developing Account Management capability and customer experience tools and systems.
- Customer Journey Development – redesigning processes through the customer experience lens.
- No Surprises – Measuring the important things for customers, as they happen – turning insight into action.

161. As part of our customer transformation programme, we made in-roads to improving our performance on these, and we have done this whilst expanding our reach across more customer and stakeholder contacts than ever before.

162. We also began monitoring our performance against the five Customer Principles (Care, Agile, Transparency, Value and Trust) identified in 2017/18, through all the feedback received. This was to understand the level of importance to the variety of customers and stakeholders we engage and interact with across our business. We learnt that collaboration, listening and understanding the impact our actions have, hold the greatest overall importance. Whilst our poorest performance is currently seen in making things simple, flexibility and understanding the impact of our actions. Overlaying the importance of a behaviour versus our performance has highlighted that collaborating and understanding our impact as two key focus areas for improvement for the year ahead.

Figure 6 - Source: CSAT/SSAT survey responses 2018/19 – n23



163. During 2018/19 we increased the scope of our monthly Customer Experience Governance Board to cover the stakeholder experience and have launched a program to assess what we need to create and develop across all aspects of stakeholder management, so that it is fit for future. We also launched our full customer experience strategy that takes us through RIIO-T2, so that we can

sustainably build on the more tactical improvements we have made to date. This has been fully endorsed by our Group Executive Board.

164. Our Net Promotor Score (NPS) programme is now in its second year and covers Voice of the Consumer (VOC) at Executive peer to peer level and Voice of the Employee (VOE) at National Grid UK management level. The latter was launched to complement our Employee Engagement Survey to understand how enabled our teams are through their internal support (IT, Procurement etc.) to deliver the service that our customers need. Our Executive VOC reaches out to all our customers through an NPS survey and 52 customer organisations have engaged with us through this channel (45 named, seven anonymously). Our internal VOE yielded a 72% response rate through its NPS survey in December.

RIIO-T2 Stakeholder Engagement

165. As we develop our RIIO-T2 business plan we have continuously looked for opportunities to improve our awareness and understanding of how our activities benefit and affect our stakeholders. As part of realising this intention, we introduced an industry first in February 2019 by publishing our Playback consultation for Gas Transmission. Taking a phased approach, we used the Playback to summarise what stakeholders have told us so far, suggesting how we might address their feedback and asking what they want in the RIIO-T2 business plans.

166. The Gas Transmission consultation saw over 3,300 page views on our website. Most of the 47 gas and electricity transmission respondents found our consultation to be relevant to them and nearly all respondents found the consultation to be clearly written. There was strong support for our approach to customer engagement, alongside a prevailing view that we should improve our customer service further.

167. Throughout the reporting year, we have continued to find new ways of engaging our stakeholders through digital channels, the “Your Energy Future” website, audio webinars and face-to-face engagement across the UK. Most importantly in terms of our improvement agenda, we have checked back on each engagement activity to clarify and confirm what we have heard.

VIII. Outputs – Customer Connections

168. Delivering timely capacity and connections to our customers is a Licence obligation and key output under RIIO-T1. In 2018/19[8] we received five new NTS connection applications. There were a further three customer applications that were received in 2017/18 that were carried over and due to have an offer made in 2018/19.

169. Under this output our performance can be split into two main areas:

- the Connection Application to Offer (A2O) process; and
- the Planning and Advanced Reservation of Capacity Agreement (PARCA) process and the delivery of incremental capacity.

The NTS Connection Application to Offer (A2O) Process

170. In total, there were eight live NTS connection applications within the A2O process during 2018/19.

171. In 2018/19 we issued six Full Connection Offers (FCO) within the timescales set out in the UNC.

172. Of the eight applications made, seven were for exit connections, one an entry connection of which six applications progressed to detailed design and construction.

173. Table 4: Summary of the NTS Connection Applications and Offers

Connection Applications		**Offers made in 2018/19**	
Received in 2017/18 and carried over to 2018/19	3	FCO extension requested	1
Received in 2018/19	5	Offer accepted	6
		Carried over to 2019/20	1
Total	**8**	**Total**	**8**

174. The trial self-lay connection offer made in 2016/17 is still being progressed and is now in the detailed design and construction phase. Processes have been developed for the customer to complete the detailed design and construction activities, whilst we have an auditing and asset acceptance role. The project has experienced some delays as we work through some of these issues with the trial customer. The trial will better establish the necessary process and standards that

[8] Details of the NTS Connection Application to Offer (A2O) process can be found at the following link.

will allow customers to efficiently adopt this self-lay approach if they choose to do so.

175. In 2018/19, as part of the CLoCC project, we undertook a review to identify improvements in how we charge for connections that would benefit our customers. As a result, we introduced a new, lower cost charging statement. This was amended to reduce application fees for Simple and Medium FCO, apply simple application fees to Entry to allow a greenfield fee option and quantify specific charges for pre-connection study categories to allow transparency of these fees with a pre-defined scope.

Disconnections

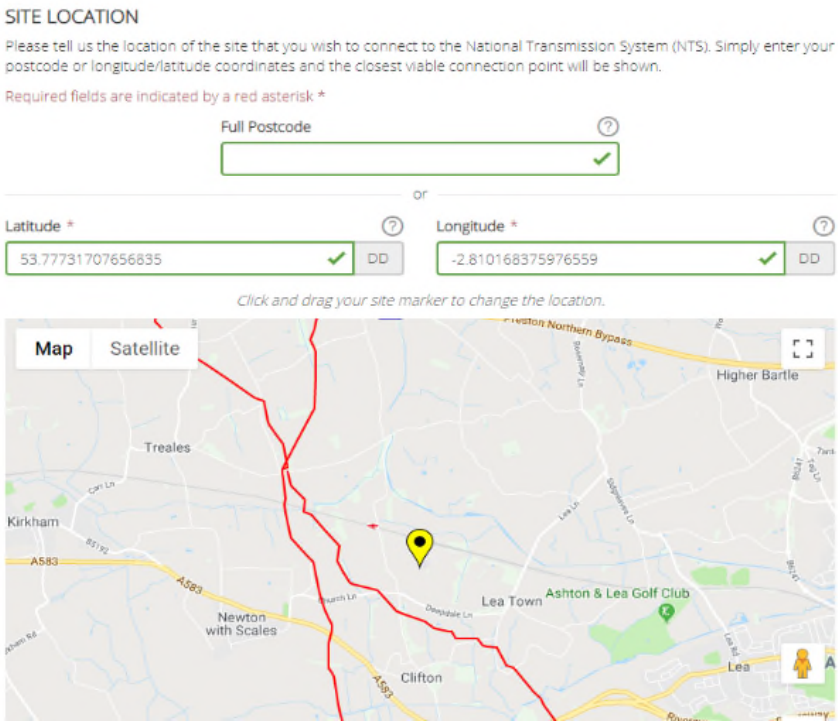
176. In 2018/19 we have received and progressed one disconnection application.

Future Connection Requirements

177. We have continued to work with our customers and stakeholders to understand their future connection requirements both directly and through the CLoCC project, following our successful NIC submission and the launch of Project CLoCC in February 2016.

178. During 2018 we have closed out the Project CLoCC and embedded the identified process and design changes into BAU. Our new online gas connections portal is now live via the National Grid Connections website. We have had 20 customers register to use the portal, generating a total of 47 cost estimates to date.

Figure 7: Customer Connections Portal Cost Estimate – Site Location Screen



Incremental Capacity and PARCAs

179. Ten applications for PARCA Phase 1 Works were completed in the 2018/19 formula year. The applications were Keadby Power Station (PS), Thornton Curtis DN, Silk Willoughby, Bacton, Peterborough Eye (Tee), Tilbury Marshes PS, Kings Lynn B (withdrawn), Drax and Hirwaun. The required Phase 1 outputs for these applications were completed successfully within the timescales set out in the UNC. NTS Exit Capacity was reserved and the PARCAs proceeded to Phase 2. Only one application, Drax PS, reserved capacity through the proposed release of funded incremental obligated exit capacity, although this was with a zero Revenue Driver.

180. Nine new PARCA applications were received in the 2018/19 formula year.

181. The nine applications received were as follows:

Proposed new NTS connections

- Entry - none.
- Exit - Kings Lynn B PS, Tilbury Marshes PS, Saltholme PS

Existing NTS points

- Entry - Milford Haven
- Exit - Staythorpe PS, Balgray, Ipsden, Ipsden 2, Mappowder

182. All PARCA applications except one, Tilbury Marshes PS (which had not reached Competency under the UNC in 2018/19), have been delivered within UNC timescales with offers made.

183. Two of the three PARCA applications for new NTS Exit connections, Kings Lynn B PS and Saltholme PS can be satisfied through the reservation of capacity provided for by exit capacity substitution. PARCA offers are being made and are waiting to be accepted by the customer. These projects are yet to be included in the Licence.

184. One PARCA application, Staythorpe, was submitted to restore the baseline in response to previous PARCA applications substituting unsold (and therefore substitutable) capacity at Staythorpe. This application could be met for short periods of time through the reservation of unsold exit capacity within the existing baseline and then, subsequently, through exit capacity substitution. A PARCA offer was issued, accepted and capacity reserved.

185. Three PARCA applications, Ipsden, Ipsden 2 and Mappowder, were submitted due to errors made by the applicant during the Annual Application Window in July 2018. All three PARCAs could be satisfied through the reservation/substitution of unsold exit capacity within the existing baseline. PARCA offers were made, exit capacity reserved and allocated for the applicant.

186. One PARCA application, Balgray, was received from an applicant embedded within Scotia Gas Networks (SGN). An offer has been made, and will be accepted with capacity being reserved via substitution and unsold capacity.

187. One PARCA application, Milford Haven, has seen an offer made and accepted, with entry capacity reserved via a proposal to release via funded incremental obligated entry capacity.

188. There were no PARCA terminations during the 2018/19 formula year.

Table 5: Summary of the PARCA Applications and Offers

PARCA Applications			
Received in 2017/18	10	Offer made - Customer accepted	9
		Withdrawn	1
Received in 2018/19	9	Application not reached Competency	1
		Offers made and accepted	6
		Offers made and to be accepted	2
Total	**19**		**19**

IX. Totex (TO and SO)[9]

189. In 2018/19 our Totex spend was £478m compared to £489m last year. The year-on-year change is predominantly associated with the TO:

- Baseline Capex decreased by £10m, primarily due to a reduction in asset health spend (£17m), offset by increases in emissions reduction (£4m) and Non Operational capex (£3m).
- Uncertainty Capex has decreased by £11m, primarily due to decreased spend on Feeder 9 (£15m) and Pipeline Diversions (£5m), offset by an increase in Enhanced Physical Site Security spend (£9m)
- Controllable Opex has increased by £4m, primarily due to an increase in Closely Associated Indirect spend (£13m), Business Support costs (£2m) and Faults (£3m), offset by a reduction in planned inspections and maintenance (£1m) and a pensions adjustment (£11m).

190. Our updated forecast for the eight years is £3,212m compared to allowances of £2,922m. We have restated RRP Table 2.4 to align allowance with spend categorisations. This impacts TO Non Load Related Capex and TO Opex, SO Capex and SO Opex. The adjustments are a recategorisation only and do not alter Totex spend or total allowances.

Overview Transmission Owner (TO)

191. The TO Totex forecast for the eight years is £2,438m compared to an allowance of £2,065m.

192. In comparison to the 2017/18 restated Table 2.4, our forecast spend has decreased by £74m overall and our adjusted allowances have decreased by £201m following the September 2018 Reopener decisions. The key changes to our allowances and the spend changes are listed below:

Allowances:

- Feeder 9 allowance has reduced by £38m, reflecting the difference between our Reopener submission for Feeder 9 and the Ofgem directed funding.
- Our IED allowance was reduced by £170m based on the outcome of the May 2018 Reopener.
- Our forecast allowance for Enhanced Physical Site Security in 2017/18 was £242m which consisted of £210m baseline and additional funding request of £32m. The Reopener decision provided no additional funding. Our forecast for

[9] All numbers in this section are in 2018/19 price base

2018/19 includes a return of £24m but a request for an additional £5m which is a net decrease of £18m

- A reduction of £2m in quarry and loss capex following the decision of the May 2018 Reopener

- TO Opex allowances have reduced by £3m following the decision on the "Quarry & Loss RIIO-T1 Reopener Submission".

193. These reductions are offset in part by additional funding we will request for St Fergus and Hatton of £51m and legacy diversions of £11m.

Spend:

- Baseline TO Capex spend over the eight year RIIO-T1 period has reduced by £21m, due to reductions in emissions reduction (£27m), IED decommissioning (£8m) and Other Capex spend (£8m), offset by increases in load related capex (£10m), decommissioning (£2m) and Non Operational capex (£10m).

- Uncertainty Capex spend has reduced by £55m, reflecting the reduction in anticipated funding, primarily related to the Enhanced Physical Site Security (£50m). The remainder relates to Feeder 9 and Quarry and Loss.

- Baseline Total Controllable Opex spend has increased by £3m which is primarily due to increases in Faults (£7m), and Closely Associated Indirects (£21m), offset by reductions in Planned Inspections and Maintenance (£14m), Business Support costs (£1m) and an IAS 19 Pensions Adjustment (£10m).

- Uncertain Opex has decreased by £1m, a reduction of £4m related to Quarry and Loss claims, offset by an increase in Physical Security Opex of £2m.

194. The above items are covered in further detail within the relevant table narrative and in Section X. Load Related Capital Expenditure, XI. Non Load Related Capital Expenditure, Section XII. Non Operational Capital Expenditure (TO) and Section XIV. Operating Costs (TO and SO).

Overview System Operator (SO)

195. The overall GSO forecast Totex costs for the period are £774m against allowances of £857m. The main areas of difference on a restated basis are:

- SO Capex – we are forecasting to spend £56m less than allowances as a result of lower forecast spend on Xoserve and Telemetry separation. The lower Xoserve spend is driven by a change in strategy for Gemini investment and a lower level of EU driven Gemini change work.

- SO Opex – the underspend to allowances for Opex is largely driven by a higher proportion of Xoserve allowances being allocated to direct Opex following the outcome of the review of agency costs.

196. Compared to the performance of cost against allowance reported in 2017/18:

- SO Capex – our performance compared to last year is £8m lower which is predominantly due to a reduction in forecast allowances of £7m where lower allowances were awarded following the conclusion of the May 2018 Reopener for enhanced security costs.

- SO Opex – performance is broadly in line with that reported in the prior year, though savings resulting from restructuring in 2018/19 are being offset by increasing IS costs in the final two years of the RIIO-T1 period. The above items are covered in further detail within the relevant table narrative and in Section XIII. Capital Expenditure (SO) and Section XIV. Operating Costs (TO and SO).

Summary of Spend and Allowances

197. The non-restated table below shows forecast spend and allowances against the six main activity areas as per RRP Table 2.4.

Table 6: Overview Eight-Year Forecasted Spend and Allowances (as per Table 2.4)

Activity	Spend (£m)	Allowance (incl. uncertainty mechanism) (£m)	Cost vs Allowance (£m)
TO Load Related Capex	45	46	1
TO Non Load related Capex	1,369	1,094	(275)
TO Non Operational Capex	145	72	(73)
TO Opex	879	854	(25)
Total TO	**2,438**	**2,065**	**(372)**
SO Capex	276	341	65
SO Opex	498	516	18
Total SO	**774**	**857**	**83**
		-	-
Total	**3,212**	**2,922**	**(290)**

198. In order to better understand the underlying position of spend versus allowances, Table 2.4 is restated to better align allowance with spend categories. The adjustment made to the baseline position in Table 6 are detailed below:

- IED allowances of £95.2m are currently included within baseline Opex in Table 2.4. All IED spend is captured within the Non Load Related Capex category. Therefore, the IED allowances within Opex are reallocated to Non Load Related Capex to be consistent with the treatment of spend.

- SO allowances of £9.5m for the data and cyber security Reopener are recategorised between Capex and Opex to better align with the actual

categorisation of spend. The allowance split is based on generic allocations set at the beginning of RIIO-T1 with all allowance deemed as Capex.

199. See the restated Table 2.4 and main reasons for differences between costs and allowances in the Performance Summary.

Consumer Bill Impact

200. In RIIO-T1 less than £10 (2018/19 prices) of the average domestic consumer gas bill of £540[10] will relate to the gas network services we provide. In 2018/19 the proportion of the bill attributable to National Grid services was approximately £7.26[11] which equates to 1.3% of the typical gas bill. This is a reduction compared to 2017/18 where the National Grid portion of the domestic consumer gas bill was £9.02. The decrease in 2018/19 is largely driven by a reduction in allowed revenue from 2017/18 to 2018/19 by circa. £130m.

201. We have applied Ofgem's methodology for calculating the components of a domestic consumer's bill. Approximately 50% of gas transmission charges are recovered via entry charges and classified by Ofgem as costs entering the wholesale market prices. The exit costs, which include the 'direct' domestic sector consumption, are allocated to Gas Transmission network costs.

202. Our calculation of the customer bill impact is aligned to the above approach (allocating entry charges to the wholesale sector).

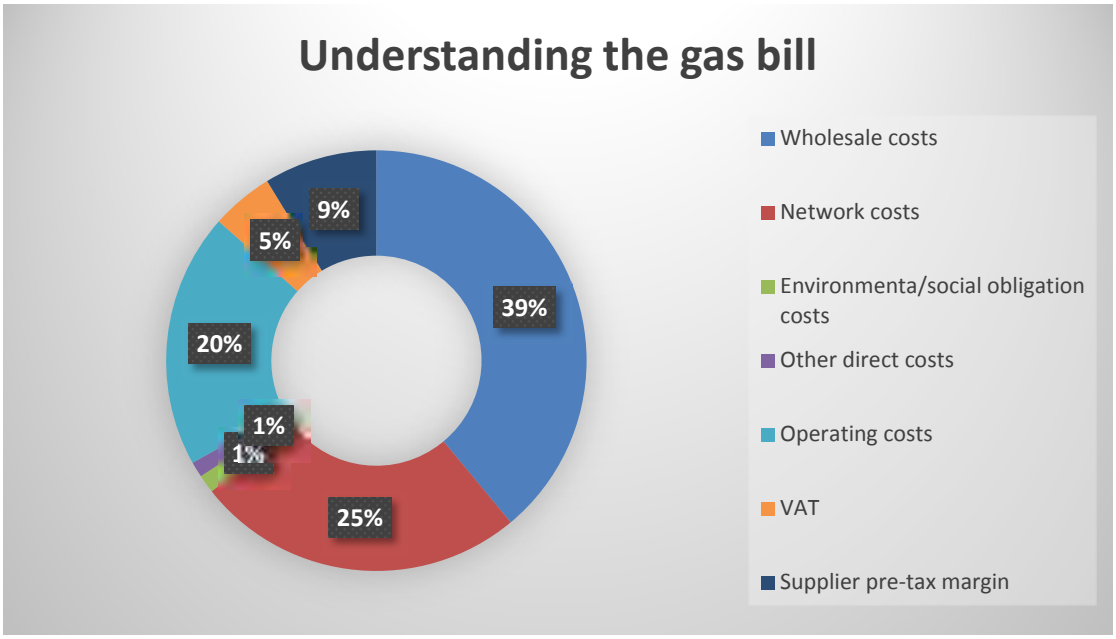
203. Our current estimate is that the Gas Transmission element of an average domestic customer bill will rise by £1.28 from the start of the RIIO-T1 period.

Figure 8: Breakdown of the Customer Gas Bill[12]

[10] Figure taken from the Ofgem publication 'Bills, Prices and Profits' and based on realised costs, as reported by the six larger energy companies in their annual consolidated segmental statements 2017

[11] In 2016/17 following the previous calculation method the value calculated was £16.29 (in 2016/17 prices)

[12] Gas bill breakdown available from Ofgem: https://www.ofgem.gov.uk/publications-and-updates/infographic-bills-prices-and-profits


Understanding the gas bill
39%
25%
1%
1%
20%
5%
9%
Wholesale costs
Network costs
Environmenta/social obligation costs
Other direct costs
Operating costs
VAT
Supplier pre-tax margin

X. Load Related Capital Expenditure (TO)

Introduction

204. This section covers our load related capital expenditure. In 2018/19 our expenditure was £2.5m and our updated forecast for the eight years is £44.9m[13] compared to an allowance of £45.7m. Compared to last year, forecast spend has increased by £9.9m on a constant 2018/19 price base, due to increases of £4.7m in the Baseline Entry category and £5.2m in the Network Flexibility category.

205. The reasons for the increases in forecast compared to 2017/18 are explained in more detail in the narrative below, but in summary are due largely to movements in:

- Baseline Entry – increase in Felindre VSD (+£5.3m), offset predominantly by a reduction in Tirley Pressure Reduction (-£0.8m)
- Network Flexibility – increased cost for Scotland 1 in 20 projects, specifically Carnforth/Nether Kellet Reverse Flow (+£7.4m), offset by reductions in Bishop Auckland Re-wheel (-£1.7m) and Bishop Auckland Reverse Flow (-£0.6m)

System Flexibility

206. In 2018/19 we continued with our system flexibility project which was initiated to re-assess the needs case utilising the 'seedcorn' funding received under RIIO-T1. Although the baseline allowances for this activity are included within Load Related Capital Expenditure, the spend incurred during 2018/19 falls within SO Opex, further detail can be found in Section XIV. Operating Costs.

Scotland 1 in 20

207. Under our 1 in 20 demand obligation we have continued to assess the need case for the Scotland 1 in 20 suite of projects.

208. During 2018 the flows through the St Fergus terminal peaked at 92 mcm/d; 14 mcm/d less than the previous period.

209. The average flow through St Fergus reduced to 68 mcm/d, from 89 mcm/d in 2017/18.

210. The high level of uncertainty of flows from the terminal remains. If the current levels of supply remain or decline further, this could lead to a situation where it is no

[13] The £2.3m expenditure and £44.8m forecast exclude Offtakes

longer possible to maintain the current Assured Operating Pressures[14] (AOPs) obligation in Scotland.

211. The worst case credible supply level (40 mcm) at a peak demand (437 mcm) has been assumed based on the 2018 FES. This scenario indicates that it is not possible to achieve the AOP in 2022/23.

212. Additionally, we are at risk of not meeting AOPs in 2019/20 and 2020/21 if we were to lose the largest sub-terminal for more than one day, however we believe this risk is not credible under peak conditions.

213. An additional supply sensitivity was identified and assessed. This was based on public reports of the Heimdal platform closing in 2021[15] and the announcement of a new pipeline linking Norway to Denmark and Poland[16] that will be operational in 2022[17]. This scenario indicates that there will be additional risk of supplies into the St Fergus terminal and therefore adds to the risk of not meeting AOPs in Scotland in 2021/22.

214. Updated analysis to assess the capability against the 2018 Future Energy Scenarios (FES) has been carried out in 2018/19.

215. A Cost Benefit Analysis (CBA) was completed on a full range of options, including options to invest on the DN network and/or use commercial contracts. The most economical solution is to invest on the NTS and enable the reversal of compression at both Carnforth/Nether Kellet and Bishop Auckland; these are now being progressed through the network development process. In terms of timing, we are currently forecasting to begin works in 2019/20, although this is subject to the next stage sanction.

Environmental Aftercare

216. The planning consent conditions for two pipeline projects completed during the Transmission Price Control Review 4 (TPCR4) (Wormington to Sapperton and Milford Haven to Tirley) included undertaking monitoring and aftercare regimes for a period of 10 years after project completion. This was to ensure that there were no enduring negative environmental impacts from the pipeline projects. Both of

[14] A minimum pressure at an offtake from the NTS to a DN that is required to support the downstream network. AOPs are agreed and revised through the annual Offtake Capacity Statement process.

[15] Potential closure of Heimdal platform: *https://www.offshoreenergytoday.com/gassco-to-use-vesterled-pipeline-beyond-design-life/*

[16] Norway to Denmark and Poland pipeline: *https://ec.europa.eu/info/news/energy-union-commission-endorse-baltic-pipe-project-pipeline-unites-creating-new-gas-supply-corridor-european-market-2019-apr-15_en*

[17] Completion 2022: *https://www.reuters.com/article/us-poland-denmark/poland-confident-of-meeting-2022-deadline-for-completing-gas-link-to-norway-idUSKCN1J0130*

these projects are now closed following confirmation from BEIS that the consent conditions have been discharged. The environmental aftercare category also included funding to complete the Tirley pressure reduction station and associated works (which included activity at Felindre compressor station) delayed into RIIO-T1 due to difficulties obtaining planning consent at Tirley.

Felindre

217. Felindre Compressor Station was built as part of the South Wales Expansion Project (SWEP), triggered by the requirement to connect the Milford Haven LNG terminal to the NTS.

218. The compressor station was designed as one electric VSD with two gas turbine units as back-up. Construction of the compressor station was completed in 2010 but final commissioning could not commence until completion of the Tirley Pressure Reduction Installation (PRI), which had been delayed by planning issues. Tirley was completed and commissioned in September 2012, however the expected volumes of gas at Milford Haven did not materialise and flows were not high enough to commission the VSD compressor although progress was made in commissioning the smaller gas turbine units.

219. Since Tirley PRI was completed, work has been ongoing to complete associated works. Most work specific to the Felindre gas turbine units has now been completed, allowing unrestricted use of the units. Full commissioning of the control system will be completed with the VSD commissioning. Total outturn cost in the RIIO-T1 period is expected to be £4.8m.

220. The Felindre VSD unit was put into preservation from 2014 to 2016, due to the continuing low flows through Milford Haven. In January 2016, the decision was made to progress with commissioning the VSD due to higher flow forecasts at Milford Haven. The decision was also made at this time to proceed with creating a loop within the network for recycling gas to the compressor. The loop will reduce dependence on the unpredictable Milford Haven flows for commissioning the VSD and enable operational and environmental testing of any of the Felindre units.

221. Construction of the cross connection that will create the loop commenced in March 2019. The new Alltwern NTS site is due for completion in autumn 2019. Full project closure is expected in 2020.

222. Work to prepare the VSD for commissioning has progressed in parallel with works at Alltwern. This has identified the full scope of works required to fully commission the unit, which requires additional investment to that previously forecast. Final commissioning is expected in 2020, following completion of the Alltwern cross-connection, and full project closure is expected in 2021 with an outturn cost of £16.6m.

XI. Non Load Related Capital Expenditure (TO)

Introduction

223. This section covers our Non Load Related Capex. In 2018/19 our expenditure was £233.1m[18] and our updated forecast for the eight-year RIIO-T1 period is £1,369m[19] compared to an allowance of £1,189m[20]. Compared to last year our forecast spend has decreased by £96m on a constant 2018/19 price base. The key variances in forecast are due to:

- A reduction of £50.2m in enhanced physical site security costs which is largely due to the deferral of Shared Sites to the RIIO-T2 period, accounting for £47.1m
- A reduction of £43.5m in the IED related cost forecast. The main variances are:
    a. As part of the May 2018 Reopener, Ofgem decided not to fund Asset Health and Decommissioning costs. This has resulted in a reduction in the IED forecast of £27.1m
    b. We have further developed the solutions at St Fergus and Hatton which has reduced the RIIO-T1 forecast by £6.1m with part of this due to re-phasing into RIIO-T2
    c. The forecast delivery costs for Peterborough IPPC compliance has reduced by £4.3m
    d. The forecast for Emissions Abatement optioneering has reduced by £6.0m, as the output of an integrated plan was delivered as part of the May 2018 IED Reopener
- Feeder 9 uncertainty mechanism costs have reduced by £2.7m based on the latest project forecast
- Quarry and Loss costs have reduced by £2.2m as the forecast spend at one site has been delayed until RIIO-T2
- Decommissioning costs have increased by £2.0m

Asset Health

224. We have delivered £113.1m of investment in 2018/19 to manage network risk and continue to deliver a safe and reliable gas transmission network for our customers.

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[18] Excluding customer contributed Diversions of -£14.7m. This is the in-year reversal of customer contributed Diversion costs within RIIO-T1 due to the implementation of IFRS15 “Revenue from Contracts with Customers”. There is a corresponding debit of £14.7m within the Capital Contributions section of Table 4.2

[19] Excluding customer contributed Diversions of £9.1m. There is a corresponding credit of £9.1m within the Capital Contributions section of Table 4.2

[20] As per restated table 2.4

Our Asset Health campaigns are maturing and we are delivering them efficiently whilst also moving focus onto preparation for RIIO-T2.

225. There are 11 Asset Health campaigns which are being delivered in RIIO-T1 of which the key themes of work in delivery (and spend in 2018/19) were:

- National AGI Renovation Campaign (NARC) (£19.8m)
- St Fergus Campaign (£15.6m)
- Bacton Campaign (£14.5m)
- Peterborough and Huntingdon (£13.3m)

226. As reported in previous RRP submissions, we continue to observe that the actual network condition is at a lower level (i.e. more observed condition issues) than the modelled view within our current NOMs methodology. We continue to forecast a higher overall workload over the period and therefore cost for asset health baseline investments of £685.1m (excluding Feeder 9) over the RIIO-T1 period which is circa £100m over allowances.

Smart Delivery

227. During 2018/19 we continued to focus on and refine our asset health investment plans for the remainder of the RIIO-T1 period. We continue to balance our position between managing network risk, delivering Network Outputs Measures (NOMS) and delivering against our allowances. As we move towards the end of the period we have a clear understanding of the works that we need to undertake to maintain the health of our network and continue to identify lower cost options to mitigate network risk.

228. In 2017/18 we developed more refurbishment and repair options that were used to minimise cost. One of these solutions was the shallow dig technique for repairing vent and sealant lines on buried valves. In 2018/19 we have continued to adopt new techniques such as:

- A 3D Laser scanner has been utilised at St Fergus to measure pipework corrosion. This approach has reduced time taken to complete the measurement to 5 minutes (83% reduction in time). This has provided a quicker and more accurate measurement of corrosion defects allowing for the most appropriate intervention to be undertaken.
- A new Valve Healthcare toolkit has been developed as part of an innovation project for addressing valve stem-seal issues. The toolbox provides solutions to assess condition, clean and protect the valve stem seal. This provides a more cost-effective intervention for ageing valves than traditional repair or replacement techniques.
- A pilot programme has been developed for utilising our Pipelines Maintenance Centre (PMC) for survey works of our AGI's. In addition, issues found that can

be fixed on the day are resolved which reduces costs of having to re-visit the site. Larger asset issues are prioritised and resolved at a later date.

Managing Risk

229. The risks associated with our ageing asset base continue to pose a significant challenge. Balancing the risk of failure with the need to manage costs requires careful management. To support this, in 2017/18 we implemented an Operational Risk Assessment and Mitigations (ORAM) approach to manage the risks at site level. This approach continues to be refined and is helping us to manage the upward cost pressure on our asset health programme and maximise value for our customers and stakeholders.

230. Our belief is that there is a clear need for gas and the network until at least 2045 and we need to invest appropriately now to maintain this key infrastructure and keep future energy options open. We have been able to reduce our forecast and contain our expenditure in the latter years of RIIO-T1 through efficient delivery, innovative solutions and focussing on immediate safety and reliability issues. However, it remains our firm belief that we need to increase investment in our network in the future.

231. We are currently developing our future business plans for RIIO-T2 and beyond and we are committed to involving our customers and stakeholders in this process. As part of this approach, we have listened carefully to what our customers and stakeholders want from the gas network. They have told us that reliable gas supplies are essential whether it's for heating, power generation or for continued operation of industrial processes. Based on this feedback, our aim is to maintain current levels of network risk and provide customers with similar levels of reliability and availability.

232. Our monetised risk models are supporting the development of our RIIO-T2 asset health plans and we are using this approach to demonstrate the benefits of future investment plans. Based on this, and what are customers and stakeholders are telling us, we forecast a significant ramp up in asset health investment in RIIO-T2 and beyond to manage risk on our ageing network and deliver the level of reliability and availability that customers currently experience.

233. We plan to consult with customers and stakeholders throughout 2019 on the content of our RIIO-T2 business plans and the level of investment required to maintain network risk. Our final year forecast is subject to some uncertainty and dependent of the outcome this consultation.

Campaign Approach

234. We continue to deliver the majority of our programme through our campaigns. This is a successful approach providing more focussed scopes of work for our contractors, utilising standard designs, streamlining project documentation and making better use of available system outages. Without this approach, our work delivery would be constrained by our ability to take outages on the network.

Developing our Asset Management Capability

235. We have developed an asset optimisation Decision Support Tool (DST) which has supported development of our new NOMs Methodology, the monetised risk rebasing process (see below) and ongoing RIIO-T2 asset health investment planning. The DST allows us to quantify the risks associated with all assets in financial terms, which can be used to identify, justify and prioritise our future asset health investments and ensure future customer service expectations are met. This DST solution is being further developed to support our end-to-end investment management processes, including strategy development, investment scoping and optioneering, portfolio planning and project governance.

NOMs Methodology Development

236. Following the submission of our NOMs Methodology documents to Ofgem in May 2018, we started a major validation exercise to ensure that the results produced by the Methodology are suitable for further use. In parallel with this validation work, we have used our provisional NOMs monetised risk models to rebase our current, volume-based RIIO-T1 Licence target into an equivalent target based on monetised risk.

237. A draft validation report document was submitted to Ofgem in December 2018, which included a detailed review by industry asset experts. We are undertaking additional testing using a variety of alternative supply and demand scenarios, to assess the sensitivity of the Methodology to the applied scenario and to identify the appropriate scenario to be used for RIIO-T1 rebasing and RIIO-T2 planning. This additional testing also addresses a query raised during public consultation concerning the robustness of the approach to current and future NTS supply and demand conditions.

238. We also submitted our draft rebased target to Ofgem in December 2018. This proposed target has been subjected to initial testing by Ofgem ensuring that the new monetised risk target is at least as challenging as the current, volume-based NOMs target.

239. The provisional rebased target satisfied Ofgem's equally challenging tests and the final rebased target will be submitted to Ofgem following agreement of the final NOMs Methodology and supply/demand scenario to be applied for rebasing. Following successful completion of testing, a change to Licence condition 7D.8 will be progressed.

240. After completion of the Licence change we will submit our current and forecast performance against the new monetised risk target. We anticipate that reporting against the new monetised risk target will commence formally from the 2019/20 RRP.

241. In addition to progressing work associated with the new NOMs Methodology, we continue to support Ofgem through a cross-sector group to develop an evolved RIIO-T2 reporting approach, called Network Asset Resilience Metrics (NARMs).

This is expected to fully incorporate the principle of managing long-term risk, through targeted asset health investments.

Data

242. The improvements to our approach of asset management, together with the anticipated demands of the new NOMs methodology, require a significant enhancement of our asset data and investment in our asset management technology systems and data analysis capability. To achieve this, we are progressing two major improvements, these projects are detailed in Section XII. Non Operational Capital Expenditure.

Key Project Delivery for 2018/19

243. This section of the narrative details key project deliveries in 2018/19. It should be noted that although the projects may largely have completed within the reporting year, the actual NOM count may be reported in next year's RRP submission.

National AGI Renovation Campaign (NARC)

244. Since commencing in 2017 NARC has accelerated asset health works across the NTS. The approach aims to change and revolutionise the way National Grid asset health works are delivered by batching work into asset classes for survey and delivery. This helps to increase delivery volumes and improve efficiency and delivery which in turn maximises value from complex, time limited and expensive feeder outages. NARC is now in its second batch of works (NARC 2) and to date has isolated over 500 km of NTS and recompressed gas back into the system for re-use, saving around 17 mcm of natural gas being emitted to atmosphere.

245. NARC renovates AGIs and sections of compressor stations to resolve Plant Status Issues. The campaign covers invasive work requiring gas outages such as valve replacement, pipe-throughs and replacement block valve assemblies. It also undertakes actuator replacements, valve enhancements, such as new vent and sealant lines, various integrity based work and an element of civils that is associated with the mechanical work. In the last two years NARC, has contributed over a third of all NOMs delivered.

246. In 2017/18 we successfully implemented the Campaign Decision Panels (CDPs), which have the responsibility to agree the scope and approve construction works outside of usual governance cycles, increasing efficiency and pace of delivery. In 2018/19, the CDPs were streamlined into two meetings with two proven Design Houses, fully supported by Main Works Contractors (MWCs) from the asset health framework. The decision panels were further supported by Pipeline Maintenance Centres (PMC) advance site visits to verify the maintenance and operability of the site and conduct enhanced maintenance techniques (where possible), which were fed into the NARC design process. The CDPs approved NARC works on 27 sites.

247. An overview of the sites completed in 2018/19 is shown in Figure 9.

Figure 9: NARC 2018/19 Progress Map

248. In 2018/19 NARC 2 successfully delivered the following examples of work:

- The use of Building Information Modelling (BIM) from design phase 3D images towards video rehearsal of activities. High quality virtual rehearsals were used to aid stakeholder engagement, assess process safety, verify constructability, particularly temporary works, and reduce cost and programme uncertainty.

  An example of this is Brisley Offtake where BIM was ,used to support a coordinated approach to stakeholder management. Using BIM, concise, accurate articulation of the works was communicated with the customer which enabled project critical outages, isolations, final design of supply pipework, commissioning activities and the return to service date to be agreed and planned. This allowed works to be delivered within three months and under a single Feeder 2 outage which provided a saving of circa £2m which is largely due to negating the need for a stopple and bypass.

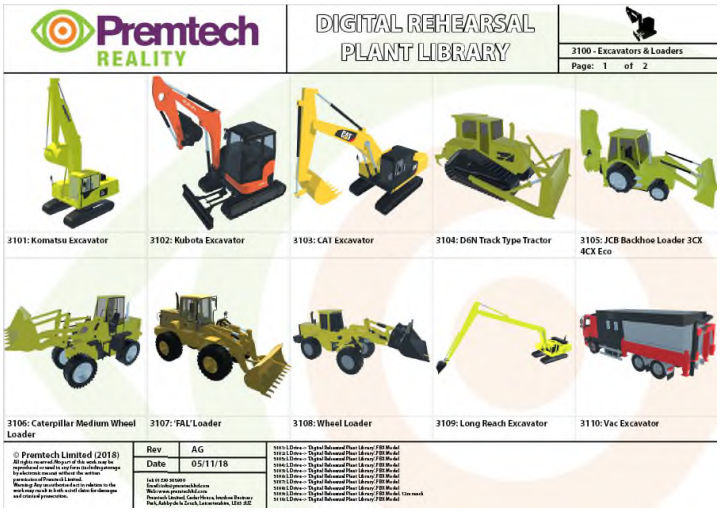
Figure 10 : 3D Rehearsal of Brisley crane and installation (left), Brisley photo(right)

Figure 11: Design Image (utilising BIM) of Brisley Site Works

- During NARC 2 drones have been used to undertake point cloud surveys to efficiently collect images and data points prior to and during the works. This data has been used for communicating project development, assessing how successful delivery has been compared to the planning, and to form a digital rehearsal plant library.

Figure 12: Point cloud Image of Yarcombe Block Valve site during the pipe through works.

Figure 13: The Digital Rehearsal Plant Library was developed to improve efficiency and accuracy by the designer when developing the 3D rehearsal images and videos for buildability and safety assessments



- The 'pipe-through' solution created in the first phase of NARC was further expanded to reduce whole life cost, compared with replacing the block valve, particularly valve maintenance and coating inspection. During 2018/19 five sites were piped through; Yarcombe, Cotleigh, Orton on the Hill, Higham on the Hill and Wibtoft. The latter three sites were redundant block valve sites which were all removed under a single outage of Feeder 14. This has reduced future risk, maintenance and operational costs.

Figure 14: Photo during the pipe through of Orton on the Hill Block Valve

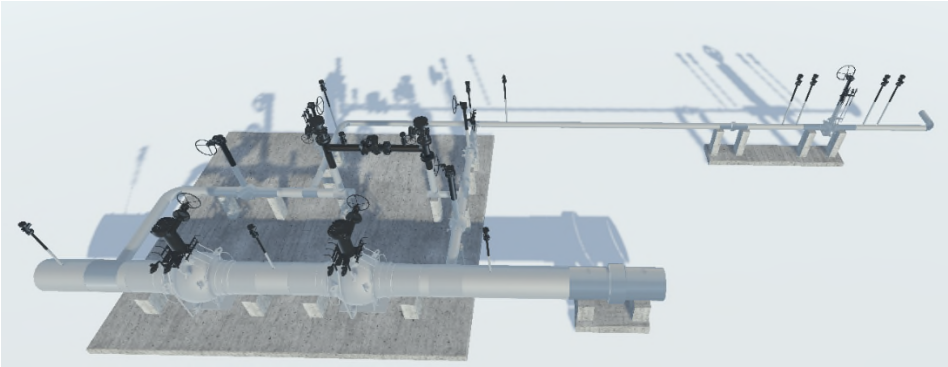
- NARC 2 implemented the modular block valve design developed in 2017 for the block valve replacements at Abernyte, Erpingham and Guestwick. Through this standard design solution the team ensured efficient, high quality offsite fabrication, safe offsite hydrostatic testing and minimal network outage period for installation.

Figure 15: Hydrotest of Guestwick Block Valve off site

Figure 16 and 17: Overnight Installation of new Abernyte block valve (left), new Erpingham block valve installation (right)

- During the NARC 2 design phase a modular offtake solution was developed. The solution has met high safety, design and constructability criteria. In addition, by closely working with the designer, the pipework layout now provides additional functionality to allow gas supply to the offtake during an upstream or downstream pipeline section outage. This means future maintenance activities and planned works further down Feeder 2 will have no impact on our customers supply, resulting in significant savings related to access and maintenance costs.

Figure 18: The modular offtake arrangement



- As part of the NARC 2 campaign five high performance gearboxes have been installed on new non-critical locally operated valves, and another seven were installed to replace existing actuator problems, overall saving a further £330k.

- In addition to the application on non-critical locally operated valves, NARC 2 succeeded in gaining internal approval through the Basis of Design Document Query (BODDQ) process to install high efficiency gearboxes on non-critical remote valve actuator replacements. This will potentially save £50k per site and

provide benefits such as reducing Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) risk, reducing maintenance costs and improving reliability. It will also contribute significantly to increasing NTS Cyber security.

Figure 19: High Efficiency Gear Box installed

- In 2017 pipe support work was incorporated into NARC for delivery. The contact points between pipe supports and pipelines is an area where corrosion can occur and must be inspected as the existing paint systems reach the end of their life. The work on these assets typically involves inspection and repair or replacement of the concrete and steelwork as required. To check for corrosion of the pipeline, the works include removal of the support around the pipeline, often requiring complete removal and replacement of the concrete plinth. In 2018/19 we have inspected beneath over 110 supports classified with highly significant suspect corrosion.

Figure 20: Inspected and painted Scotland block valve site

- Following the NARC innovation project for Glass Reinforced Plastic (GRP) pipe supports the NARC campaign installed the first ever of these supports onto the NTS, at Bishop Auckland AGI. The supports are cheaper to purchase than the steel supports and the lightweight, non-corroding split body design will enable easier and cheaper withdrawal for pipeline inspection.

Figure 21: GRP pipe support installed at Bishop Auckland

- The CDP approved NARC to rectify a number of non-invasive plant status issues at Bishop Auckland AGI. Throughout NARC 2 the site has been inspected for corrosion and re-painted, over 20 P/11 damage assessments have taken place, 18 pipe supports have been replaced, 30 wind and water lines re-coated, two regulator streams have had new cladding and a vent valve has been replaced.

  Often what is categorised as non-invasive work requires contingency plans that are highly invasive, should integrity issues be found. To achieve these works

13 outage sections were negotiated and nine Non Routine Operations (NRO's) were put in place (including contingency plans for de-pressurising pipework requiring their own G35 modification). Successful collaboration between contactors and National Grid enabled the majority of these works to be completed and circa £400k savings from the Bishop Auckland project.

Figure 22: New acoustic cladding on Bishop Auckland regulator streams

- The NARC team continued to inspect and resolve numerous NTS integrity issues, including severe corrosion at Bishop Auckland Compressor and a suspected severe crack at Kirriemuir. The severe corrosion at Bishop Auckland was repaired using the latest composite carbon fibre wrap techniques. The suspected 1m crack indication found at Kirriemuir, which was identified as a manufacturing defect, was fully assessed by NARC and repaired.

- A multi-year conceptual design and plan was generated for Kings Lynn compressor station bi-directional area. As part of this, an assessment of the existing assets was undertaken including monitoring of pipe movement via laser scans and stress analysis. Detailed site surveys were undertaken, including boreholes to 50m, to determine ground conditions and requirements for the detailed design. A conceptual design was generated meeting existing and future functionality, and this was agreed with multiple stakeholders. A multi-year delivery plan was developed meeting outage and construction constraints.

  A well-structured technically and commercially based competitive tender was undertaken, that allowed contractors to apply economies of scale savings to the project and in particular ensure that access risk is allocated most effectively between client and contractor. One innovative way NARC did this, was by splitting the Kings Lynn tendered works into two separate clear phases, one for works which had no/little access constraints, the other which had many and varied access constraints. Although this took considerable planning and stakeholder engagement, the initial tender responses fully evidenced the approach with a wealth of technical innovation detailed (driven by competition) and offering significant savings against the baseline estimate.

249. In 2018/19 as well as the NARC 2 works delivered above, surveys and conceptual design reports were completed for 2 feeder sections and two compressor stations to inform the NARC 3 scope of works.

St Fergus Campaign

250. St Fergus terminal is a key gas entry point into the UK which was built in 1975 in a coastal environment which accelerates corrosion degradation. Across the site, investment is being made on various work streams, prioritised through the ORAM process which began in late 2016. The investment being made on site focuses on management of existing asset issues that pose a potential safety risk, whilst in parallel retaining appropriate levels of compression capability and meeting our environmental targets. The ORAM has prioritised corrosion remediation and restoring the compressor cabs to full operational capacity. These themes have formed the primary areas of investment at St Fergus during 2018/19, whilst in parallel preparing for future construction works on the theme of electrohydraulic actuation and the next key areas for corrosion remediation.

251. Corrosion remediation has continued to be a critical investment theme through 2018/19. The significant defect population observed at St Fergus, obtained through the corrosion management (CM/4) visual inspections of all assets on site, indicates the driver for continued investment in the corrosion theme. In addition, the site is managing an action plan for remediation of corrosion defects in response to the HSE Action Legal which requires the remediation of all Grade 6 defects at St Fergus by December 2020.

Figure 23 - Revalidation of ‘Fin Fan’ tubes and corrosion remedial works at St Fergus Plant 1 Aftercoolers

252. In terms of corrosion investment, over 400 physical interventions have been undertaken during the Plant 1 outage which commenced in May 2018. Substantial

work has been undertaken to remediate the associated defects, including a number of pipe cut outs, in addition to fitting clamps and wraps. The Plant 1 actuating gas ring main has also been extensively remediated to enable continued operation and extensive flange inspection (543 inspections) and remediation (243 replacements) has been undertaken on all flanges located within the Plant 1 isolation.

253. Corrosion Under Pipe Supports (CUPS) was also identified as an emerging issue during the Plant 1 outage. Deemed a high-risk issue, inspections were undertaken on all CUPS locations (2174 inspections) across Plant 1. During the outage, four pipework cut outs were undertaken to remediate significant wall loss, two of which were as the result of these inspections. Innovative repair solutions have also been implemented such as flange compression clamps and grouted wraps that are efficient to implement and require less intrusive activities.

254. Throughout 2018/19 we continued with our programme of works to improve the existing compressor cab infrastructure. Units 1A, 1B, 1C, 1D, 2A and 2D all received minor upgrades associated with existing ventilation and insulation systems to lower cab operating temperatures. Major work was completed on Units 1A, 1B and 1D which has seen the exhaust stack replaced, the volute refurbished and new ventilation system installed.

Figure 24 – Installation of replacement exhaust (bottom section) Cab 1D St Fergus

255. There are 236 constant spring hangers installed at St Fergus which support the main process pipework on all compressor units and both Plant 1 and 2 aftercooler inlet manifolds. Investment was made to replace all spring hangers on the site, and during 2018/19 the investment was completed with the replacement of those spring hangers associated with the Plant 2 aftercoolers.

256. The gas ring main that serves as the operational gas supply for actuators on the Emergency Shutdown (ESD) Valves is heavily corroded. The optioneering report and associated Formal Process Safety Assessment (FPSA) identified that actuation for the ESD valves would be better provided by an electrical/electrohydraulic solution rather than gas actuation. The completion of the detailed design and commencement of planning for implementation was undertaken in the second half of 2018/19.

257. A number of innovation activities are being undertaken at St Fergus to support greater efficiencies in the delivery of corrosion remediation. Significant savings in time and cost have been obtained through the use of a laser scanning tool. Work undertaken on a defect located on the underside of the pipe adjacent to the pipe support was substantially reduced after the use of the laser scanning tool and a finite element analysis undertaken by DNVGL determined that the mechanical integrity of the pipe was within the acceptable range, removing the need for a costly cut out and delay to the delivery programme.

258. A key area of focus for 2018/19 has been the preparation for future outages to be undertaken during 2019/20. Our increased knowledge of the asset condition, and more robust site-wide risk assessment process has enabled us to better scope works for prioritised and efficient delivery. Significant effort has been spent undertaking surveys, reviewing isolation boundaries, scoping for future years work and developing detailed designs.

Bacton Campaign

259. The Bacton terminal is a key gas entry point into the UK, both currently and into the future. The site commenced operation in 1968 in a coastal environment which accelerates degradation. Bacton as a site had 237 Plant Status issues as a starting baseline. These are being progressed through our investment process. By examination of the risks and consideration of the needs case work at Bacton, we have identified issues that should be prioritised and are considering options to retain safe operation of the site while we complete the final stages of the need case review. At Bacton there is a strong interaction between asset health and the needs associated with the Future Operating Strategy (FOS). The works undertaken at Bacton in 2018/19 were:

Bacton AH-1A: Installation of 17 new valves

260. During the period from Spring 2018 through to Winter 2018, a total of 17 new main line valves were installed. These valves had previously been planned and represent some of the most critical interfaces to our customers and connection to the wider network.

261. Numerous smaller valves were installed around these mainline valves to facilitate safe operational use of the larger valves. This work necessitated considerable interaction with our close neighbours and customers, such that we could share outage periods on our respective plants and minimise disruption to both parties.

262. The highly invasive nature of the replacement of many of these valves necessitated plant shut downs that are unlikely to have been undertaken since the early days of this plant being built nearly 50 years hence. Outages of this nature can only be commenced when gas demand is sufficiently low as significant areas of the plant were out of commission.

263. A number of valves on Feeders 2 and 4 were replaced during 2018, along with replacement of one ring main isolation valve. Given the significant outage in place during summer 2018, opportunities were taken to add new valves that reduce future operational impact to both the National Grid terminal and associated suppliers. This permits scheduling of highly invasive Asset Health works behind the newly installed isolation valves.

264. Due to the extensive isolations required around Feeder 2, the opportunity was also taken to reconfigure pipework into Interconnector UK (IUK), providing the ability to feed this customer from either Feeders 2 or 4. Previously IUK had only a single feed from Feeder 2. This had traditionally created constraint issues for the project team and phasing of subsequent works. This constraint was readily rectified by re-designing the pipework in the Feeder 2 and 4 area. Extensive engagement with IUK representatives was required throughout the planning and delivery co-ordination of these alterations and associated valve replacements. IUK were back on line on the 28 June as originally planned with full flow capacity available and utilised.

265. In a similar manner to the initial stages of this Asset Health campaign, the design and delivery phases were developed using an ‘agile’ methodology. Design is a number of phases ahead of the installation phase. As of Spring 2019, the approval and sign-off of the finalised design is approaching completion with final delivery phase currently scheduled for June 2020.

266. Some re-phasing of delivery phases has required re-planning, these primarily being undertaken to share outages with other projects or customers to reduce the risk of constraint costs, drive efficiency, and meet customer commitments.

Figure 25: Installation of new isolation valve (Phase 3a)

267. The use of BIM – 3D modelling is part of business as usual within the Bacton projects. BIM has considerably reduced the likelihood of fabrication issues and on-site 'clashes' with other pipework or assets. It is used during design review meetings to aid the discussion on plant layout. BIM is also key in associated review processes required as part of the FPSA. In addition, completed works are laser scanned upon completion with the final as-built records being referenced from the laser scan 'point cloud survey'.

Bacton AH-1A: Painting

268. In addition to the valve replacements, the corrosion protection painting works, commenced in 2017, were further progressed during summer 2018. These works generally utilise the depressurised condition of plant that has been shut down to facilitate other works.

269. Work has also continued dealing with the repair of wind/water-line corrosion features. An earlier survey of the site had shown evidence of early coating failure on all of the surveyed sections. Whilst these had not escalated to severe corrosion defects, it is imperative that repairs are affected early, thereby minimising costs and removing potential for future asset health integrity issues.

Bacton AH-1A: Pipe supports and bolt replacement

270. Because of the coastal environment and its ability to accelerate corrosion issues, the AH-1A scheme is required to replace bolts on the flange faces on-site. This

phase of works is currently suspended following discovery of an issue affecting coating resilience.

271. Along with the painting requirements associated with the above ground pipework, the AH-1A scheme is required to investigate and remediate the pipe support arrangements on-site. This work commenced during summer 2018. The approach used was to review scope of this project following completion of the initial phases. With these early phases now complete, a number of findings including the discovery of some insufficient base foundations have necessitated further pipe support replacements to continue.

272. Where possible, the concrete pipe supports have been removed to permit inspection of both the pipe support and pipe. Where accessible these surfaces have been repaired and new pipe supports installed to the latest standard.

273. The removed pipe supports have been re-purposed as shore line defence blocks through an opportunistic discussion with the local Council. Removed material has been examined such that it presents no contamination risk and then dropped off at a pre-designated collection point for Council operatives to collect and install at the bottom of the cliff face on the shore line.

Figure 26: Diamond cut removal of old pipe support using *'cheese cutter'*

Gas Robotic Agile Inspection Device (GRAID)

274. Separate to the asset health works on-site, is the installation of the GRAID connection launch facility. During Summer 2018 the mechanical connection was

completed for the GRAID robot, fitted to the end of the far Eastern Manifold header adjacent to the Shell 4 area of plant. The robot was successfully launched from this facility immediately after fitment.

Figure 27: Installation of GRAID launch connection point

Preheat 3

275. The site Preheat system provides heat to the incoming gas supplies, prior to entering flow control equipment, to prevent the formation of liquids in the pipework and ice build-up on the external surfaces. There remain a number of Asset Health Plant Status Issues associated with the Preheat systems. Preheat 3 was sanctioned in winter 2018 and is currently in its design phase. This project will address the prioritised Asset Health pre-heat works ensuring continued safe operation of the Preheat system and associated plant.

Human Machine Interface (HMI) replacement

276. The Human Machine Interface provides the control room operator with the means to control the site via visual displays and associated keyboard and mouse. The system installed at Bacton is 17 years old, and is therefore past its useful life with a depleting set of spares available and lack of technical support available from the Original Equipment Manufacturers (OEM). It has required some stabilisation works during recent years in order to be able to effectively recover from any loss of hardware however, the HMI platform and hardware remain in a ‘fragile’ state. A project is currently in design phase to replace this aged system and also to improve its resilience in such a manner that single point failures are eliminated as far as practicable.

277. In the years since the existing HMI and control system was designed and installed, there have been a number of developments to the requirements associated with design of such systems. The HMI replacement scope has been designed for compliance with both Human Factors and Cyber Compliance requirements. Given the critical delivery timescales involved the scope is centred around those key deliverables, whilst ensuring systems have sufficient baseline architecture to accommodate follow up requirements for delivery at a subsequent stage.

Asset Health 2 – Electrical Assets

278. This project was commenced to collate a composite scope to inform future decisions on the integrity matters associated with power supplies on-site. A number of the assets are now aged and are no longer directly supportable. Limited works were progressed during 2018 as there is a significant impact from the FOS that has been proposed for site. This project was therefore de-prioritised for immediate development pending development of the FOS approach.

Ongoing ORAM review for Bacton

279. ORAM assessments are conducted for Bacton on a 3-monthly basis. The output of these Risk Assessments aid the prioritisation and scoping of future work requirements and also feature in the day-to-day priorities for the on-site Operations Team. The ORAM output and associated reviews of Plant Status Indictors are currently being reviewed to inform future Asset Health planning requirements and to ensure the plant remains safe and effective in its operation.

Compressor Programme

280. The compressor machinery used on the gas turbine driven compressor units is made up of three component parts: gas generator, power turbine and centrifugal gas compressor. The investments on these parts carried out in 2018/19 are detailed below.

Gas Generator

281. We have five different asset types of gas generator making up the national fleet of 61 gas generators currently in operation across the NTS. In addition, we have a number of spare gas generators to provide resilience to the operational units. The gas generators (commonly referred to as the prime mover) are a combination of light industrial and aero-derivative turbines and are monitored and maintained routinely through a series of work and management procedures carried out by our operational field force.

282. Gas generator ‘major maintenance interventions’ including overhaul, are typically carried out every 24,000 consumed hours or based on condition. Indicators of our machinery data highlighted the need for a number of major interventions. During 2018/19, we undertook five overhaul activities and rotated positions of a number of gas generators. These included four Rolls Royce Avon overhauls and a ‘service exchange’ of one General Electric LM2500+ gas generator.

283. The ‘service exchange’ option continues our strategic approach for managing the General Electric LM2500+ fleet, and has been shown, to provide greater certainty to manage a project efficiently providing an ‘as’ new engine regardless of the condition of the engine we commit to overhaul.

284. The most recent winter ‘running season’ has generally seen lower utilisation of the engine fleet. There remains an aged population of engines within the fleet and overhaul work of these remains planned, but with necessary re-phasing in order to meet the most probable utilisation requirements. The future year’s gas generator overhaul and maintenance programme reflects this likely demand to guarantee availability and reliability of Plant. Pre-works arrangements are in hand for an additional three gas generator overhauls in the next delivery year.

Power Turbine

285. Power turbines receive the exhaust gases produced by the gas generator. The power turbine harnesses these exhaust gases and they provide the motive energy to turn the compressor. Power turbine maintenance and overhaul requirements, as with the other machine train components, are heavily influenced by both run hours and elapsed time.

286. During 2018/19, we undertook overhaul activities on three power turbines. One power turbine was required to have overhaul works scheduled earlier than originally planned in order to assist other asset health works being undertaken at St Fergus.

287. Works associated with the power turbine overhaul at Wooler were planned and combined with the works on the Dry Gas Seal fitted to the gas compressor. This permitted usage of the available outage window to reduce the effective downtime of the complete compressor unit.

Centrifugal Gas Compressors

288. Gas compressors provide the actual compression of the natural gas within the NTS. All of the NTS compressors are centrifugal compressors. They are driven, either by a power turbine or an electric motor. In the case of the power turbine driven units, the prime mover is a gas generator, referred to above.

289. During 2018/19, we completed the overhaul of one gas compressor at Kirriemuir. This overhaul utilised parts previously salvaged from a soon to be disconnected unit (Kings Lynn Unit A). A second compressor overhaul at Kirriemuir is planned for 2019/20. This will build off the experiences and lessons learned from the first unit.

290. In addition, pre-works were started to overhaul the gas compressor at Bishop Auckland. In a similar manner to the re-phasing of works on power turbines and gas generators, the Bishop Auckland gas compressor overhaul has now been substituted for alternative gas compressor overhaul works on Unit C at Carnforth. This is an emerging issue that was not foreseen – the re-phasing of works to

Carnforth is necessary as this is impacting delivery of the control system refurbishment of the same unit.

Pipelines Campaign

291. In total 379 km of pipeline was in-line inspected in 2018/19 and 10 significant pipeline excavations and repairs were completed from previous inspections in 2017/18. The selection of the pipelines requiring inspection is driven by a condition and risk based approach, considering pipeline condition, criticality and performance of corrosion prevention.

292. A two-year approach to completing excavations has been undertaken in an attempt to allow sufficient time for planning the excavation works. As a result of this there are a further 23 excavations to be undertaken in 2019/20 which were found as part of the 2017/18 in-line inspections.

293. In 2018/19, remedial work was completed on a number of nitrogen sleeves which provide additional protection for our pipelines as they cross under roads, railways and rivers. Following the initial works in 2016 using the methodology developed by United Kingdom Onshore Operators Association (UKOPA), a new simplified methodology has been developed to prioritise the most critical sleeves for intervention.

294. In 2018/19 multiple locations over 20 pipelines were surveyed for possible reduced depth of cover risks caused by changing environmental factors over the course of the NTS lifespan. The areas surveyed included rural areas and river crossings. The results of the surveys were assessed by National Grid pipeline experts to develop a selection of cost effective risk mitigation measures. The mitigation measures will be implemented during 2019/20 and are due to include innovative low cost options such as installing polyethylene (PE) protection slabs over pipelines in ditches, fencing off areas of low cover by agreement with the landowner, and in rivers installing concrete frond mattresses to protect the pipeline.

Huntingdon/Peterborough Asset Health Investment Campaign

295. At the start of the RIIO-T1 period, both Peterborough and Huntingdon consisted of three Avon machines each. We continue to advance the programme of works to deliver new gas turbine compressor units at each site, as required to maintain efficient transmission capability across the centre of the network and to meet south west exit capacity obligations (see the Emissions chapter of this section for progress on these projects).

296. The programme of asset health works was sanctioned for £31.7m outturn in 2016, this is financially separate from the emissions scope, but bundling presented a significant opportunity to leverage outage and project management efficiencies.

297. We also started the delivery of similar asset health works at Peterborough to replace existing obsolete and unsupported Fire and Gas Detection systems, which were operationally accepted in October 2018.

298. We started work to replace the unit control system on compressor Unit C at Huntingdon, which is also obsolete and no longer supported. Operational Acceptance was achieved in December 2018. Additionally, pipe supports on various above ground pipe have been replaced and various vibration issues have been addressed.

299. The MWC is continuing to progress the detailed design for the asset health work at Huntingdon. To ensure timely delivery critical items such as the station control systems, valve and actuators have been procured.

300. At Peterborough, we have continued to advance the detailed design for the asset health works with the MWCs. To support the asset health delivery for future years we have also started the procurement of critical items of process plant, such as station control systems, valves, actuators and scrubbers (including condensate tank).

Preheaters

301. National Grid require pre-heat in a number of situations:

- where we have pressure reduction either on installations where exit pressures are lower than inlet pressures,
- where we require lower pressure gas for local operations such as boiler gas supply; and
- where we have Offtakes with Legacy Network Exit Agreements (NExA) which require that we supply gas to a contractually agreed temperature typically at power stations.

302. Where pre-heat is required due to pressure reduction this is to counteract the Joules Thomson Effect which occurs as gas expands. Low temperature gas can cause damage to National Grid assets and prevent correct functionality.

303. To provide pre-heat National Grid has historically installed water bath heaters which are now considered an inefficient method of heating, more recent installations employ modular boilers and heat exchangers. Monitoring of temperatures back to control systems is typically in place to ensure that required temperatures are maintained with low temp alarms set to inform GNCC.

304. During 2018 National Grid, have completed the replacement of existing modular boilers at Kings Lynn PS, Little Barford PS and Cilfrew pressure reduction station.

Kings Lynn

305. The Kings Lynn PS offtake had been decommissioned and rebuilt by the customer. As part of this, the existing modular boiler was identified for replacement along with other asset health works and a change in outlet pressure. Works were completed and commissioned during summer 2018.

Figure 28 – The replacement boiler house being delivered onto the existing base at Kings Lynn

Little Barford

306. The little Barford PS Pre-Heat was successfully replaced in summer 2018 during a two-week outage by the Power Station. Initially without an outage, replacement would have required a new concrete base, new flow and return pipework plus associated telemetry, power and ducting. However, discussions with the modular boiler supplier and the power station operator enabled a plan to be developed to decommission and remove the existing and install the new boiler in the two-week period.

307. A review of the risks associated with lifting on the site was held and agreement with the customer on the use of their car park for the crane to complete the lift(s) made. This collaborative working ensured the project was delivered as efficiently as possible.

Figure 29 – The redundant boiler house being lifted out at Little Barford

Cilfrew

308. The pre-heat requirement at Cilfrew is significantly greater than that required for the two power stations mentioned above. Initial proposals suggested that two new boiler houses would be required to replace the existing boiler houses. Further analysis of the actual pre-heat load and historical pressures/flows enabled a reduction in the pre-heat load to be agreed. This reduction meant that a single bespoke boiler house, manufactured in two sections could be installed at a saving of approximately £1m. One of the redundant boiler houses was able to remain connected to facilitate the works outside of the period when a full gas outage was agreed.

309. The replacement of the pre-heat at Cilfrew was successfully completed during Summer 2018.

Figure 30 - Setting up of the Crane at Cilfrew

DSEAR Compliance Campaign

310. The DSEAR 2002 is the United Kingdom's implementation of the European Union ATEX directives. The intention of the Regulation is to reduce the risk of a fatality or serious injury resulting from a dangerous substance igniting and potentially exploding. The Regulation requires operators to create an Explosion Protection Document (EPD) for any work activity involving flammable or explosive atmospheres. Through this process the operator must prove compliance of equipment for continued use otherwise it must be replaced with correctly certified equipment.

311. The DSEAR compliance campaign was sanctioned by National Grid in April 2017 to ensure that our assets fully comply with the Regulation. The campaign aims to produce an EPD to demonstrate compliance at each of our 542 gas transmission sites. The EPD's consist of the following documentation:

- A validated hazardous area drawing
- Hazardous area inspection records in compliance with BS EN60079-17
- ATEX certificates
- Hazardous area asset register
- Site specific DSEAR risk assessment
- Schedule of responsibilities document for shared sites

312. Our initial approach to completing the EPD's required detailed physical inspection of all hazardous area assets to assess their compliance. This initial approach allowed sufficient defect data to be gathered to adopt a risk based inspection programme from September 2018 onwards. The type of inspection required is determined by the hazardous area zone and ignition potential of the asset. Under the new approach, assets that are classified as high/medium risk receive a 'detailed' inspection i.e. electrically intrusive and low risk assets receive a 'close' inspection i.e. external inspection only. Adopting this approach has considerably increased the inspection rate and reduced outage requirements which has helped us to achieve circa 350 complete inspections in 2018/19.

313. Key sites which were inspected in 2018/19 include Bacton, Felindre, Nether Kellet, Carnforth, Warrington, Churchover and Wisbech. In addition, as of March 2019, St Fergus inspections were 70% complete and AGI's were 75% complete.

314. In order to deliver this campaign, we are utilising a combination of agency personnel and specialist ATEX inspection contractors to undertake the inspections and identify non-compliances. The non-compliances are then risk assessed and prioritised for rectification. For a typical compressor station inspection, it will require 4-5 personnel working for 6-8 weeks. Using contractors from the new ATEX inspection framework has realised significant savings over other contracting strategies (circa £1.2m).

315. Throughout the remainder of RIIO-T1 we will continue to inspect our sites and rectify non-compliances in line with DSEAR requirements. The estimated project completion date for inspections is March 2020. Upon project completion, the EPD will be managed as part of BAU processes.

Unit Control Systems

316. Microprocessor based control systems are fundamental to the operation of the compression plant at entry points and compressor stations. The majority of our control systems are modular and we are able to optimise our investment through replacement of component parts as they reach the end of their operational life. Throughout 2018/19 we have made significant investment in the replacement of unit control system modules with major spend at Peterborough (Fire and Gas control system), Huntingdon (Unit C control system) and Carnforth (Unit C control system) compressor stations.

The River Humber Gas Pipeline Project (Feeder 9)

317. In 2018/19 we have continued to progress the replacement of the Feeder 9 pipeline where it crosses the Humber estuary. This is driven by our continuing concerns over the integrity of Feeder 9 due to rapid and unpredictable estuary movements that are reducing the depth of cover over the pipeline.

318. As the sole transportation route across the river Humber, Feeder 9 is one of the most critical pipelines on the NTS. It plays a pivotal role in the provision of entry gas from the Easington area to demand centres in the South and East and to the UK gas market as a whole. Network analysis using FES demonstrates that there is a long-term requirement for the Feeder 9 pipeline to perform this function.

319. If Feeder 9 was to become unavailable, UK Security of Supply would be significantly impacted and there could be substantial entry capacity buy back costs. Capacity buy back costs and the increase in wholesale gas prices associated with a long term unplanned supply loss would result in increased costs for the industry and the end consumer.

320. Through our strategic optioneering process and extensive stakeholder engagement including a national Development Consent Order (DCO) planning process, we have determined that a replacement pipeline in a tunnel is the most economic and least environmentally harmful long term solution. We are therefore progressing with a replacement pipeline solution as well as continuing to monitor and, where appropriate, conduct remediation activities on the current pipeline crossing.

Existing Feeder 9

321. Throughout 2018/19 we have continued with the two-monthly survey regime to continue close monitoring of the crossing. Latest survey results show that the frond mattresses remain in place but that the level of silt build up is not as envisaged. Some areas of the mattresses appear to be more exposed than other areas. We will therefore continue to monitor every two months and take further remediation action if required.

322. The lease from the Association of British Ports (ABP) to operate the existing Feeder 9 pipeline in the Humber expired in September 2016. National Grid lease continues as a secure tenancy under the Landlord Tenant Act. Lease renewal negotiations have continued through 2018/19 and remain ongoing.

Feeder 9 Replacement Project

323. The TBM, christened ‘Mary’, was launched on 6 April 2018. The TBM has progressed in accordance with the planned tunnelling route, passing the halfway point (2431m) on 8 January 2019. By the end of the reporting period the TBM had progressed to a distance of 3,402m of the 4,862m total tunnel length. At this point, it was 30.2 metres below the river bed, having excavated 111,354 tonnes of material, with 1,366,941 hours of expended effort, and 16,932 of tunnel segments

installed. Of the 111,354 tonnes of material excavated, 100,808 tonnes were classified as ‘inert’ and have been reused for landfill restoration works.

324. Since its launch in April 2018, the TBM has progressed forward with an average tunnelling rate of 9.44 metres/day. As the TBM progresses further away from the Goxhill launch site, various tunnelling operation interventions have to be performed to service the TBM and extend its operational effectiveness further from the launch site. For example, addition of booster pumps to grout supply pipe and extension of all supply ancillaries fed from Goxhill.

325. The nature of tunnelling, and conveyance of its abrasive arisings, also impart wear on the TBM, associated service vehicles and ancillary plant, necessitating TBM and plant outage interventions to affect repairs and replacement of components.

326. The pipeline (line-pipe and concrete coated) sections completed delivery at Goxhill during 2018/19. These pipeline sections were welded together and overcoated with concrete coating. The stringing yard now has the full completed inventory of eight coated pipe sections, each measuring approximately 650m long. The final weld was completed on these pipe strings on 20 September 2018.

327. The completed pipe strings sit on a bespoke pipe handling system consisting of a network of rails and associated bogies ready to be hydraulically ‘jacked’ into the tunnel.

Figure 31 Coated line pipe sections (8 August 2018)

Figure 32: TBM in launch shaft at commencement of tunnel drive (April 2018)

Construction of reception shaft at Paull

328. Upon completion of tunnelling operations, the TBM will arrive on the North Bank of the Humber and break-through into a pre-constructed reception shaft. This reception shaft is located to the North of the Paull AGI site. Here the TBM will be dismantled in sections within the shaft and removed from site for re-use. During 2018/19 the design of the reception shaft has been finalised and constructed.

329. The pipeline route from the reception shaft to the Paull AGI has been designed and associated activities for the construction of this short pipeline section, and associated tie-in to the Paull AGI are currently ongoing. To date, the cross connection in Paull, including hot tap (under pressure) connection, has been completed and commissioned allowing back feed in the network to facilitate the final connection. Works associated with the road crossing between Paull AGI and the tunnel reception shaft were well advanced at the end of the reporting period.

Figure 33: Drone image of TBM reception shaft on Paull side of Humber (Spring 2019)

330. Following on from the decision to install a concrete coated pipeline with an aqueous filled tunnel, chemical testing had shown Humber sea water to contain extremely aggressive bacterial/electrolytic properties, potentially leading to excessive degradation of the concrete tunnel lining. During 2018/19, a Cathodic Protection (CP) system design suitable for the identified conditions was progressed. By 31 March 2019 re-design of the CP design was completed by the Joint Venture (JV) partners and the National Grid G/35 modification procedure for the CP was 50% complete.

331. During 2018/19 the National Grid project team and the JV partners sought to address revised commercial arrangements for the project. Successful negotiations were concluded and the project has now changed from an NEC Option C contract (Target contract with activity schedule) to an Option A contract (Priced contract with activity schedule). This will provide better cost certainty, whereby the JV now own all of the ground risk.

332. During 2019/20, tunnelling operations will continue. The TBM is expected to enter the reception shaft at Paull in late summer 2019. Upon arrival, the complex matter of TBM dis-assembly commences, with the TBM being lifted out of the shaft in sections for transportation offsite. During winter 2019/20, installation of the CP system will be undertaken in preparation for the installation of the 42” pipeline which is currently scheduled for late winter (February). The pipeline is not due for commissioning until late summer 2020.

Feeder 9 Innovation

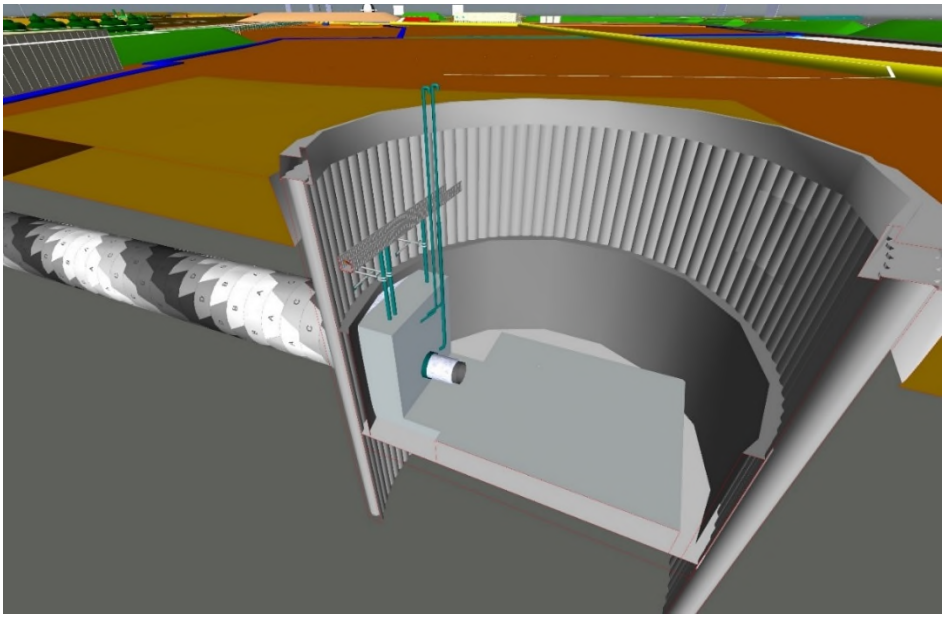
333. The River Humber Gas Pipeline, once constructed will be the longest pipeline in a tunnel in Europe. This unique combination of civil and mechanical construction requires the highest standard of planning. Throughout the project development we continue to look for opportunities to explore innovative ways of working and delivering efficiencies.

334. BIM 360 is the chosen software platform to perform the field BIM solution. This application, which is installed on the project iPads, enables the project team to view all the models, drawings, specification sheets, certificates, and mark-up on site 'in the field' off line when not connected to the Wi-Fi. The iPads are synced when back in the office after use to ensure the information is up-to-date. This technology will continue to be used where appropriate to drive efficiencies throughout the duration of the project.

335. During 2018/19 further developments of the BIM model have enabled the TBM operators to immerse themselves into the project and walk around as if they are on site, including walking around the whole TBM. Most importantly the Virtual Reality (VR) model has been incorporated into Health and Safety inductions. We have trialled it with numerous new operatives on site who found it to be very useful, enabling them to become more familiar with the site and the surroundings before they go out on to site the first time, which ultimately improves safety and their awareness.

336. In order to provide the correct Asset Management data for handover, Skanska have developed a tool that can collect welding and tunnel data in the field and link-back to the BIM model via the production of data sheets. With the aid of a data validation and collection tool, and via the help of the tunnelling telemetry consultants, data is collected and linked this back to the model. This will form part of the handover data pack upon project completion. As the process was trialled on this project, further work is required to make the pipeline data more effective.

Figure 34: BIM image of TBM reception shaft



Paull AGI – preparation for revised Feeder 9 connection

337. Paull AGI is a shared offtake site between National Grid and Northern Gas Networks (NGN). The configuration of the site meant that at the point of sale to NGN in 2005 the transfer of assets ('Project Blackwater') was different to that on more common offtakes, resulting in National Grid having ownership for additional assets. Some parts of Paull AGI date from the early days of the NTS, with the site being part of Feeder 1.

338. The existing assets required significant asset health investment as a result of their age and condition. We reviewed the requirements for the site with NGN and developed an optimum solution to rationalise the site into a standard minimum connection, thereby removing many aged assets and reducing the ongoing upkeep of the simplified site. This approach resulted in a transfer of assets to NGN on 18th February 2019.

The rationalisation of the site:

- improves the reliability of the network and removes the safety risks associated with poor condition assets.
- enables the proposed new Feeder 9 pipeline to enter Paull AGI in a more cost efficient location achieving an estimated saving of £0.9m on the Feeder 9 project.
- achieves full telemetry and electrical separation from NGN, in line with our current policy.

339. Whilst a considerable amount of required works was completed in 2015/16 and 2016/17, we have continued working with NGN and a number of contractors to progress finalisation of design and delivery requirements. The phased manner of

project delivery, and associated Network access, necessitated the interaction with four MWCs.

340. As part of the rationalisation works being undertaken, and in preparation for the connection of the new Feeder 9, the disconnection of the ex-Feeder 1, 600mmm diameter Easington-Paull pipeline, was completed.

341. Work associated with the close out of this project remain ongoing, with the completion of project data books complicated by the need to split the asset data and history between two owners. The current programme advises that final closure of this rationalisation and asset transfer project should be completed by early summer 2020.

Figure 35: Paull site equipment pre-rationalisation (2016)

Figure 36: Paull site equipment post rationalisation (2018)

Decommissioning (formerly Quasi-Capex)

342. As our network changes, some assets are no longer required for operation whilst others can be rationalised reducing the asset health investment on these sites.

Churchover Compressor A and B units

343. At Churchover Compressor Station, Orenda (A and B) units were previously replaced by one gas turbine and one electrically driven unit. Physical isolation of the A and B units, in accordance with our policies and procedures has been completed. Work to ensure safety and compliance of the disconnected assets left on site has also been completed. The remaining disconnected assets will be removed at a later date.

344. Project closure is expected later this year, following completion of drawing updates.

Feeder 1: Easington to Paull pipeline

345. As part of the rationalisation works being undertaken at Paull Above Ground Installation and in preparation for the connection of the new Feeder 9, Humber Crossing, an efficient bundling opportunity was identified. This involved the disconnection of the ex-Feeder 1, 600mmm diameter Easington-Paull pipeline, measuring some 23.28 km in distance.

346. The pipeline was previously disconnected at the Easington Terminal but remained connected to the NTS at Paull. The pipeline had been used for some years to stabilise pressure fluctuations on the former regulator stream feeding the NGN offtake at Paull. Since the Paull site has been rationalised there was no longer a

requirement to stabilise pressure fluctuations on the regulator streams. The Feeder was therefore suitable for disconnection.

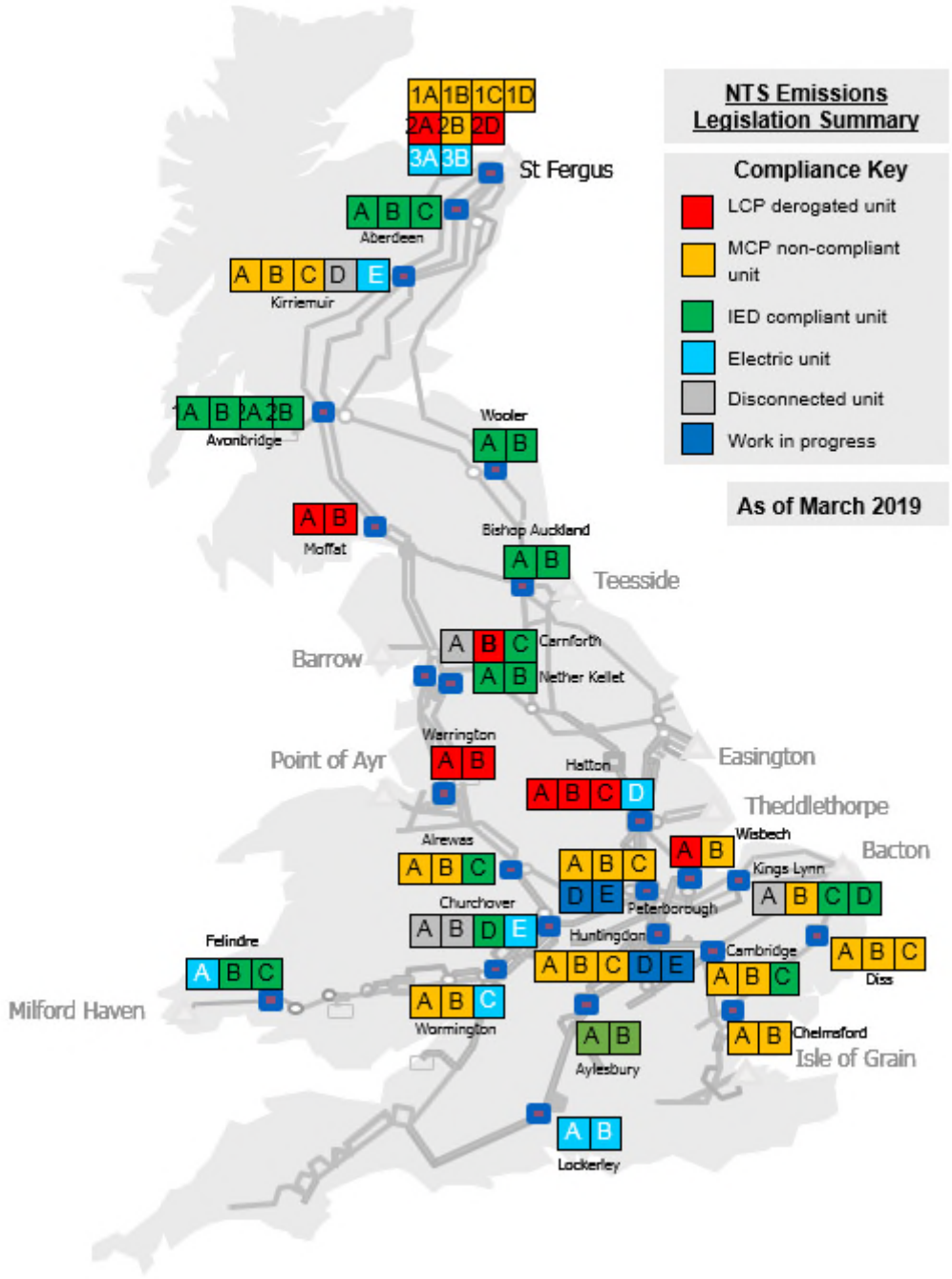
347. The outage requirements associated with Paull rationalisation project, and the rationalisation itself offered the opportunity to disconnect the Feeder 1 live connection at Paull. The pipeline was disconnected from the NTS, capped and filled with Nitrogen during summer 2018.

Emissions

348. This section covers all emissions related work that we have progressed throughout 2018/19.

349. Plans to ensure our assets are compliant with the MCP are progressing, and will be submitted to Ofgem for review as part of the RIIO-T2 business plan submission.

Figure 37: Compressor unit type and compliance with environmental legislation



350. National Grid engaged with stakeholders through 2014 to 2018 to develop an integrated plan for compliance with the IED legislation, this culminated in a regulatory submission to Ofgem in May 2018. This confirmed the outputs for the works at Peterborough and Huntingdon and provided a mechanism to agree the investment requirements at Hatton and St Fergus in 2019. Ofgem decided not to fund other works as they considered they were not driven by IED compliance. These works have therefore been descoped and reprioritised with existing investment plans.

IED - IPPC Peterborough and Huntingdon

351. At the start of the RIIO-T1 period, Peterborough and Huntingdon consisted of three Avon machines each. Both sites are critical to efficient transmission across the centre of the network. They also ensure we meet south east and south west exit capacity obligations. We continue to advance the programme of works to deliver two new gas turbine compressor units at each site under IPPC.

352. At Huntingdon, the programme of works was sanctioned internally in late 2016 and the MWC mobilised to site at Huntingdon in 2017. This included core and extraordinary work scopes such as new station control buildings and new electrical supplies.

Huntingdon

353. During 2018/19 the key activities completed at Huntingdon consisted of:

- Detailed design completion to >90% and procurement of the main contractor's long lead materials, including design and factory manufacture of the new station and unit control and protection system.
- Preparation and completion of piling to enable install of new compressor bases.
- Mobilisation of the primary civils and mechanical sub-contractors, undertaking on-site civils activities and commencing off-site mechanical fabrication works respectively.
- Installation of rotating machinery train packages and noise enclosures onto their completed bases.
- Progression of civil works for installation of suction gas separators, station flow meters (both bundled Asset Health funded scope) and new suction / discharge header pipework into the two new compressors.
- Installation of electrical ducting, drainage and new control building groundworks have commenced.

354. Delays to the procurement of long lead materials, notably pipeline, and technical difficulties experienced during the compressor base piling activities combined to delay the commissioning from October 2019 to February 2020. The impact of this is that intrusive commissioning activities would need to be undertaken during the winter. However, as the existing compressors at Huntingdon are heavily relied upon for operating the NTS, this would not be acceptable from a security of supply perspective.

355. Considering this delay, a joint schedule review was undertaken in Q1 2019 between National Grid and the main contractor, and a re-sequenced programme has been agreed that moves intrusive activities that would prevent the site from operating to outside of the winter running season. The impact of the re-sequenced programme is the 2 x new Solar Titan compressor machinery trains, Units D & E, will now be fully commissioned in October 2020.

356. A cost reduction / risk mitigation plan has been implemented to mitigate the impact of the additional costs associated with the programme delay from 2019 to 2020.

Figure 38: New Compressor Machinery Trains on bases at Huntingdon

Figure 39: Ongoing Site Works at Huntingdon

Peterborough

357. The MWC mobilised to site at Peterborough early in 2018, in preparation for taking delivery of the compressor machinery train packages from Solar Turbines in Q4 2018.

358. During 2018/19, the key activities completed at Peterborough consisted of:

- Detailed design completion to >90% and procurement of the main contractor's long lead materials, including design and factory manufacture of the new station and unit control and protection system.
- Delivery and offloading of all equipment associated with the new compressor units, including the compressor machinery trains, low noise enclosures and ancillary equipment provided by the OEM.
- Installation and commissioning of new station vent stack in eastern field, including connections to new vent pipework laid from the existing compressors and station equipment, and vent pipework for new compressors in advance of their installation.
- Relocation of the 42" discharge pipe that traversed the centre of the compressor station, taking gas from the existing discharge header to the AGI to flow back onto the NTS.
- The relocation of the discharge pipe and commissioning of the new vent stack (allowing the existing vent stack to be decommissioned & removed) has created a sterile area in the centre of the compressor station for the two new compressors, Units D and E. Piling for the new compressor bases started in this sterile area in Q1 2019.

359. The programme remains on track for the two new Solar Titan compressor machinery trains, Units D and E, to be fully commissioned in October 2020.

Figure 40: Ongoing Site Works at Peterborough

IED - IPPC Phase 4 and IED – LCP Phase 2 St Fergus

360. As one of the highest utilisation compressor sites on the NTS, St Fergus enables UK Continental Shelf (UKCS) and Norwegian gas supplies entry onto the NTS. Compression is required to raise the pressure of the gas supplied via the North Sea Mid-stream Partners (NSMP) sub-terminal to NTS pressure. St Fergus comprises of three plants; Plant 1 has four Avon units, Plant 2 has one Avon and two RB211s and Plant 3 has two electric VSDs.

361. The gas driven compressors at St Fergus are required both to supplement the operation of electric drives and to provide backup capability. Unlike our other compressor stations, the St Fergus location means that it is not possible for other sites in the network to provide backup. If compression is not available on site, gas cannot enter the network from one sub-terminal.

362. Our strategy for St Fergus proposes a programme of work, which addresses:

- the LCP requirement associated with the two RB211 units,

- The requirement to reduce our fleet emissions in accordance with our IPPC obligations.

363. Our plans to achieve compliance with the requirements of the IED legislation have evolved since the submission of our business plan in the May 2018 Reopener. To meet our IPPC obligations, we are proposing to replace one of the Avon machines.

364. In terms of LCP, we gained approval from the Scottish Environment Protection Agency (SEPA) to enter the RB211 units, 2A and 2D, into the Limited Life Derogation (LLD) from 1 January 2016. Our latest options assessment indicates that an enduring solution to LCP would be the replacement of one of the RB211s with both of the existing units disconnected once the limits of the LLD have been reached. However, this decision is subject to a CBA.

365. We are reviewing the overall compression requirements at St Fergus with moderations and preliminary shortlisting of OEM supplier based on completed BAT assessments. Further details of our updated plans are provided in our submission for needs case confirmation in June 2019.

IED – LCP Phase 1 Aylesbury

366. We operate two Rolls-Royce Avon 1535-190G Dry Low Emissions (DLE) gas turbine driven compressor machinery trains at this site (Units A and B). The two units are unique prototype DLE engine units that were installed in 1999. They are compliant with the 'existing plant' Emission Limit Values (ELVs) contained in the IED for NOx. The station is required for moving gas towards the South West and to provide backup capability to electric drives at Lockerley (gas turbine driven compression plant cannot be installed at Lockerley due to local planning constraints on noise and partial gas powered back-up is provided by Aylesbury compressor station).

367. In 2016 we completed the construction phase of a catalyst installation to reduce Carbon Monoxide (CO) emissions to achieve the new CO ELVs. Unit B was successfully commissioned to Operational Acceptance stage in 2017 and Unit A followed in 2018. Asset acceptance and project closure is expected to conclude in 2019/20.

IED – LCP Phase 2

368. The following sections give a brief overview of the work and proposals at each LCP Phase 2 site, based on the proposals from May 2015 and updated to our Integrated Emissions Plan submitted in May 2018.

IED – LCP Phase 2 Wisbech

369. Wisbech compressor station, constructed in 1980, has two gas turbine driven compressor units designed to operate independently of each other. The station was primarily designed to provide network compression to move gas from the entry terminals at Easington, Theddlethorpe and Bacton into the south and west of the

country. The use of compression at Wisbech has become increasingly variable over the last ten years. The site is now predominantly used to provide back up to other East area compressors, particularly Peterborough and Huntingdon, during outage periods.

370. At Wisbech, we previously reported how we have retained the RB211 unit A on a 500 hour/year derogation and exchanged the gas generator in unit B from a Maxi Avon to a compliant Avon. We have continued to review the longer term need of this station, balancing asset health costs against the resilience provided by the station. The network resilience provided by the station while IED emissions related works are ongoing at Peterborough and Huntingdon confirms the need for the station to at least 2023. With further IED works required at Hatton and potential MCP compliance works at other East area compressors in RIIO-T2, Wisbech will continue to provide valuable network resilience.

IED – LCP Phase 2 Carnforth and Nether Kellet

371. Carnforth and Nether Kellet compressor stations are located in the north west of the England. The two stations adjoin each other but are physically separate, each with their own independent control systems and different maximum allowable discharge pressures. Carnforth and Nether Kellet are used for bulk gas transmission, predominantly moving gas from the northern terminals of St Fergus and Barrow, down the west coast and towards the Midlands.

372. Carnforth consists of three units. Units A and B are both RB211s which are not compliant with IED-LCP emissions limits. Unit C is a compliant DLE machine. The adjacent Nether Kellet site consists of two smaller compliant DLE machines.

373. Our strategy for Carnforth is to decommission units A and B and for unit C to provide the operational capability required with the Nether Kellet site providing the required backup.

374. Carnforth unit A is physically disconnected from the compressor station pipework and is not available for use within the NTS.

IED – LCP Phase 2 Hatton

375. Hatton compressor station is located in the east of the UK. It has a pivotal role in the operation of the NTS and is required for compliance with the 1-in-20 obligation, which forms part of our Gas Transporter's Licence. With nine connecting pipelines, Hatton is used across a wide range of scenarios. The station is used to facilitate gas flows from terminals to the north, to support the operation of storage sites in the North West, to provide demand support in the south east and to support the interconnector flows at Bacton.

376. In addition to the electric VSD, the site consists of three RB211 machines which supplement the VSD and provide backup capability. The RB211s are not IED-LCP compliant.

377. In December 2017, the VSD unit was found to have suffered damage to the compressor rotor assembly and the unit was taken out of service. Strip inspection identified a portion of one of the 17 impeller vanes missing from the impeller assembly. An official Root Cause Analysis (RCA) was launched between National Grid and the OEM. The RCA identified significant cracks, a weld manufacturing deficiency to the impeller and operation of the compressor unit outside the prescribed operation envelope, as the main contributory factors.

378. The OEM recommended a new impeller be manufactured using a process which would avoid the manufacturing defect. The programme remains on track for the new impeller to be fully commissioned in June 2019.

379. One RB211 was placed on the 500-hour Emergency Use Derogation and the remaining two units on the Limited Life Derogation. Entering one unit into the 500 hours' derogation provides flexibility in terms of the future solution for the site and extends the potential construction window for any new units. Our current investment plan is based on installation of new compliant gas powered compression and the decommissioning of the two life limited machines after 2023.

380. We are reviewing the specific compression requirements at Hatton with moderations and preliminary shortlisting of OEM suppliers based on completed BAT assessments. Further details of our updated plans are provided in our submission for needs case confirmation in June 2019.

Kirriemuir

381. Kirriemuir compressor station is located in Scotland on the same site as the Kirriemuir multi-junction that conveys the majority of gas from Scotland towards the south. The station comprises three Avon gas turbine driven compressor units (Units A, B and C), an RB211 gas turbine driven compressor unit (Unit D) which was recently disconnected from the NTS and a 35 MW electric driven VSD compressor (Unit E).

382. The RB211 Unit D is impacted by IED-LCP legislation and is on a Limited Life Derogation. A decision to disconnect unit D was previously made ahead of significant expenditure on a major overhaul, with no replacement capability to be installed. Three Avon gas turbines and the VSD will remain on the site.

383. Plans to ensure the site is compliant with the MCP is progressing, and will be submitted to Ofgem for review as part of the RIIO-T2 business plan submission.

Moffat

384. Moffat compressor station, constructed in 1980, has two identical gas turbine driven compressor units designed to operate independently of each other. The station was primarily designed to provide network compression to move gas from Scotland to the south. The units are now primarily being used:

- to provide occasional resilience to Aberdeen, Kirriemuir and Avonbridge;

- to provide occasional resilience to Carnforth and Nether Kellet;
- to support entry flows from St Fergus; and
- to move linepack out of Scotland.

385. Moffat consists of two RB211 units (A and B) which are not compliant with IED-LCP. The units have been placed on the 500-hour Emergency Use Derogation (EUD). Against the background of increased St Fergus flows, the continued availability of Moffat provides valuable resilience and facilitates network access to support outages for maintenance and construction on other compression sites.

Warrington

386. Warrington compressor station, constructed in 1984, consists of two RB211 units (A and B) which are not compliant with IED-LCP. Both compressor units are currently on 500-hour EUD in order to comply with the LCP element of IED. The station was primarily designed to facilitate Barrow and St Fergus entry by moving large volumes of gas into the south. Since the commissioning of the trans-Pennine pipeline between Pannal and Nether Kellet in 2007, Warrington's use has reduced significantly with the station being run for on average 34 hours per year over the last five years.

387. Based on the current FES, Warrington is no longer required to support the entry flows it was designed for. Although there is the potential for future user signals to require additional West coast compression, there is no certainty over when these signals will be received, if at all. It is also not certain that the current capability at Warrington would be the best fit for this need. We are proposing to disconnect the compressor station at Warrington from the NTS and will be submitting our decommissioning plan to Ofgem for review as part of the RIIO-T2 business plan submission.

Diversions (non-customer funded)

388. National Grid has various agreements for the location of our pipelines (e.g. Deed of Easement or Deed of Grant) so that we can undertake maintenance and gain access to the asset. A number of these easements contain existing liabilities or other obligations to divert pipelines, for example “lift and shift clauses”. In some instances, we are required to pay the costs associated with the pipeline diversion.

Willington Down Feeder 7 Diversion

389. The Willington Down Diversion is a 2 km section of the Feeder 7 pipeline between the Chalgrove multi-junction and Didcot Power station which was successfully completed during 2017. The works were funded by National Grid due to the terms of a historical Deed of Grant, allowing the customer to request diversion at the pipeline operator’s cost. Minimal costs were incurred during 2018/19 for the finalisation of records and land agreements. The project team successfully negotiated the removal of a claim for £150k from the land owner submitted for the relocation of a site access following completion of the diversion. Although the terms of the Deed of Grant covered the diversion, associated works such as this were not covered.

Diversions (customer funded)

390. Some of these types of deeds described above do not have extra liabilities and thus the developer pays for the diversion on a cost pass-through basis. At all times, we endeavour to work with developers to ensure costs are kept to a minimum.

Highways England M49 Pipeline Diversion

391. Highways England approached National Grid due to the proximity of a proposed upgraded motorway junction on the M49 to the Feeder 14 pipeline. The detailed design for the diversion and Materials Procurement were completed during 2017 followed by successful completion of the diversion during 2018.

392. Following collaboration with two customers downstream of the diversion works, Seabank Power and Wales & West Utilities, a six-week full pipeline outage was agreed, avoiding the need for an expensive stopple operation. The cost saving is estimated to be £1m and safety improvements will also be achieved by avoiding the need for hot works. It was originally expected that the gas would need to be recompressed into the downstream network but working with Wales & West and the GNCC, pressures were reduced to a level where recompression was not required saving a further £150k.

393. Although not directly related to the diversion, the full outage arranged was also used to facilitate the removal of redundant plant from the Avonmouth LNG facility. Works on both schemes were competitively tendered together, awarded to the same contractor and managed by a single project management team. The outage costs, project management and MWC overheads were shared across the two schemes.

394. Diversion works were completed as per programme during 2018.

High Speed 2 (HS2)

395. We have been working with HS2 since 2012. In total, five Feeders are affected by the HS2 route from London to Birmingham and all require diversion. Close working relationships have been established with the HS2 team to ensure that diversion designs are developed with a view to minimising overall cost and align with stakeholder requirements. Examples of areas that have been taken forward with the HS2 designs are:

- Alignment with HS2 site accommodation/access routes to minimise cost and impact on the local community.
- Working with HS2 designers to request modification of the HS2 civils design such as the location of balancing ponds, drainage that would be lower cost than to extend diversion routes.
- Alignment of diversions with other utility providers ensuring coordinated approach to land requirements.
- Re-route to avoid removal of mature trees.

396. The five diversions are scheduled to take place during 2018, 2019 and 2020.

397. The first diversion TX05, was completed during summer 2018. The diversion was the first HS2 gas diversion to be successfully completed and the work has been praised by the customer.

398. The design for the diversion and especially the pipeline route across the new HS2 track was designed working with HS2. Specific requirements in relation to the depth of cover and backfill above the pipe to ensure the HS2 track foundations met their required standards was necessary. At this location, the HS2 route is in a cutting. As can be seen the pipeline was installed into a cutting rather than by non-open cut crossing techniques such as a micro tunnel. This technique was selected as it allows for the installation of a concrete slab which in turn allows the depth of cover from the pipeline to the HS2 track to be reduced. The cost benefit analysis of this technique and overall land take impact is preferable

Figure 41 – Pipeline being installed into a cutting as part of the TX05 diversion

Figure 42 and 43 - Pipeline being installed into a cutting as part of the TX05 Diversion

399. The TX05 diversion was completed under a full outage without the need for recompression by working with the local distribution network. This arrangement generates a £150k saving based on recompression costs or significantly more if a diversion via stopples is required.

400. Work is also underway developing diversion feasibility/conceptual designs for HS2 Phase 2a and 2b. At present seven diversions have been identified as being required for Phase 2a and provisionally scheduled for delivery from 2021 – 2023. An additional 16 diversions have been identified as required for HS2 Phase 2b with delivery expected 2024 – 2026.

A13 Thurrock

401. Works have recently commenced on the diversion of Feeder 5 funded by Thurrock Country Council due to the widening of the A13. Due to the location on the network the diversion is due to be undertaken via a bifurcated stopple and bypass technique.

402. Ongoing liaison with the customers representative over the last 12 months has enabled finalisation of the detailed design and agreement of the programme to ensure both the highways contractor's work and the work on the National Grid diversion can be completed successfully, concurrently. The diversion will be completed via a two stage micro-tunnel without disrupting traffic on the road. The micro-tunnel has been extended to under the areas where the road is currently being widened allowing these works to continue throughout.

A1 Morpeth

403. Work with Highways England is ongoing in relation to the proposals to divert the A1 at Morpeth which will require a diversion of Feeder 13, a key Feeder for flows from St Fergus. The detailed design for the diversion, agreement on the location of site accommodation and access together with purchase of long lead materials have all been agreed. The customer confirmed late in 2018 that due to their consenting process the diversion would be required in 2020 rather than 2019. Currently works are largely on hold, materials have been placed in storage and correspondence is focusing on alignment of the programme for delivery during 2020.

404. Initial network analysis results for the diversion suggested that the works could only be completed via stopples due to the requirement for the ability to flow gas from St Fergus at all times. The increase in cost of a stopple vs. full outage diversion on Feeder 13 was estimated at > £2M, however, although diversion via stopples allows for the flow of gas to continue, the implications of restrictions in flow during the process could put the network ability to flow gas away from St Fergus at risk. The stopple and bypass operation also poses a greater risk to the network than a full outage which can be completed in a much shorter timescale. Discussions with the customer and National Grid have been ongoing throughout 2018 to develop a legal framework allowing the diversion to progress. Although not yet finalised, the diversion contract would place the liability for any directly associated constraint costs with Highways England.

Initial Works

405. We are currently working with the Lower Thames Development scheme and road schemes proposed for the A428, A500 plus a number of housing developments and early phase highways schemes. We are keen to emphasise to customers that early engagement and development of diversion options is key to ensuring successful completion of the customers scheme and can lead to significant overall cost savings.

Enhanced Physical Site Security

406. Our network is subject to a multitude of security threats, which are continually evolving and often increasing in sophistication and persistence. These threats include terrorism, criminality, espionage, activists/extremists, vulnerabilities within systems and vulnerability from insider action.

407. The Physical Security Upgrade Programme (PSUP) is a government mandated initiative to enhance physical site security. All works are closely evaluated by BEIS.

408. In 2014 BEIS completed a review of National Grid sites in which a number of our Gas Transmission sites were identified as requiring a PSUP solution.

409. Of these Gas Transmission sites, those identified by BEIS prior to the site review in 2014 formed Phase I of our programme of works. As reported last year, solutions at all these sites were completed as of 31 March 2018, with all sites now being monitored by the Alarm Receiving Centre (ARC). The remaining sites included by BEIS constituted our Phase II programme of works.

Phase II

410. Subsequent to the agreement of the site list by BEIS in February 2015 we identified that, for seven Phase II sites, the rationale for inclusion in the PSUP was no longer valid. Following discussion with BEIS it was confirmed that no physical security enhancements were required at these sites and it was proposed to return the associated allowances through our May 2018 Reopener.

411. The remaining Phase II sites have had detailed designs developed. These have been placed under contract with our MWC consortium partners and are in full construction, with the first site now being monitored by the ARC. All solutions will be delivered by 31 March 2021.

412. In our RRP in 2017/18, we reported costs for our Phase II programme of £83.5m (2018/19 prices). Our latest cost forecast for these sites is £81.4m, which is broadly in line with our view from last year.

Shared Sites

413. As part of the BEIS review of sites in 2014/15, a number of Shared Sites were classified as requiring PSUP solutions. In this case Shared Sites are sites owned by Gas Distribution Networks (GDNs) but contain assets owned by National Grid.

414. For a subset of these sites we are the sole driver and therefore responsible for funding and delivering PSUP solutions. The remaining sites have a joint driver, for which all but one site the GDN is responsible for funding and delivering the solution. At this one site, National Grid are liable for a share of the capital costs, in line with BEIS guidelines.

415. In our May 2018 Reopener we requested allowances for funding the PSUP solutions of these Shared Sites. Ofgem’s determination did not meet the materiality

threshold for the submission and therefore made no adjustment for National Grid as part of this Reopener.

416. Ofgem will assess the efficient costs for National Grid as part of the RIIO-T1 close-out process, and provide funding for efficient costs incurred during the RIIO-T1 price control.

417. Following the May 2018 Reopener determination, we are reviewing our delivery approach to the PSUP. The purpose of this review is to understand the efficiencies we could implement on our existing delivery model and review alternative approaches that could be utilised to deliver our solutions closer to the unit cost deemed efficient by Ofgem.

418. This review process will take time and therefore we have taken the decision to defer delivery of these Shared Sites until RIIO-T2.

Site Extensions

419. There are occasions when our sites need to be extended, for example to accommodate additional assets. If this is required at a site at which physical security has already been upgraded through the PSUP then the existing solution must then be modified and extended to ensure the revised perimeter meets the PSUP specification.

420. Allowances for PSUP solutions at two site extensions were requested in our May 2018 Reopener. Due to the interactions with other onsite activities the work will be undertaken during the RIIO-T1 price control.

421. The site solutions are nearing completion of the detailed design stage with on-site activities planned to commence in FY20/21. A number of design options have been considered to establish the most effective, innovative and efficient solution to provide savings to the PSUP works.

422. All PSUP site extensions are currently forecast to be completed by March 2021. Our latest cost forecast for these sites is £6.55m.

Phase III

423. In 2017 we worked with BEIS to update the collective understanding of threat to our assets and the impact of this on the NTS. Through further analysis a number of additional sites were identified for inclusion in the PSUP. These will form Phase III of the programme.

424. Last year we reported that we were to undertake early scoping works for these sites in RIIO-T1. We are now proposing to undertake this activity in RIIO-T2.

XII. Non Operational Capital Expenditure (TO)

Introduction

425. In 2018/19, our Non Operational Capex was £21.9m and our updated forecast for the eight-year RIIO-T1 period is £144.9m, compared to an allowance of £71.9m. Compared to the prior year the forecast spend has increased by £10.4m in real terms.

426. The overall forecast increase relates mainly to increases in IT of £7.0m and Plant and Machinery of £4.6m.

427. The movement in IT is due largely to a £5.4m increase in the forecast for Project One. This programme has been initiated to drive improved efficiencies in relation to data management and reporting and involves investing in a new SAP system which will transform finance processes.

428. Other IT expenditure forecast increased by £5.8m resulting mainly from new projects in 2018/19 such as Legacy Device Replacement, Geogrid and Network Modernisation Programme.

429. These increases were offset by reductions in Data and Technology (£2.0m) and Technology Change Roadmap (£1.2m). These are described in more detail in Appendix II – Costs and Outputs RRP Table Narratives.

430. The forecast increase in Plant and Machinery spend of £4.6m reflects the actual growth in costs during 2018/19 and continuation at this level for the final two years of RIIO-T1 on items such as gas test equipment, portable vent stacks, calibration equipment and site tooling.

Transmission Foundation System (TFS)

431. In 2018/19, data structures for pipeline assets have been improved to support critical asset management processes. Improvements to non-pipeline assets will continue to be completed through the Richmond programme.

432. In 2019/20, the reporting data structures will be updated to enhance data governance and provide flexibility in reporting to support new ways of working delivered under Richmond.

Transformation Programme

Richmond

433. In last year's RRP we described the scope and purpose of the Richmond programme in relation to our objective of improved asset management capability. The programme continues the delivery of enhanced asset management, investment management and data analytics capabilities whilst assuring verified

data from the asset data enhancement activity is successfully uploaded into core asset management systems.

434. We have completed the high-level design phase and are engaged in detailed design and implementation of improvements confirmed during that phase. An agile programme method has been adopted which drives prioritised value delivery and we have teams focusing on asset condition management, cost-value decision support, coordinated investment planning and field operations resource management.

435. These cross functional teams are supported by data and systems teams that provide technology enablers through updates to our asset management systems, analytics systems and enterprise content management system, plus the introduction of a new investment management system. Technology changes include both new functionality and extended data scope.

436. Richmond teams are working within an established systems architecture and are building a data architecture to better coordinate information design, a business architecture to coordinate integrated process design and information flows across the business, and a policy architecture to reduce management overhead and secure compliance. These architectures underpin the revised operating model through end-to-end design simplification and alignment with ISO 55000 best practice and ensure we provide value to customers and stakeholders. We are testing our design and approach with an external challenge panel on a quarterly basis.

437. These developments are partially system related Non Operational Capex and partially Opex business change activities. The benefits of these projects have begun to be realised in 2018/19 with further value flowing from more substantial changes in the latter half of 2019. This will include further development of our monetised risk (NOMs) methodology which supports our future business plans and provides insight into the management of network risk at least cost.

Asset Data Enhancement

438. The Asset Data Enhancement programme completed in September 2018. It delivered enhanced asset data to support ongoing improvements in our asset management approach and NOMs methodology based on monetised risk.

439. The programme has enhanced our asset data providing the required level of granularity in our core asset management system. All asset data collected across 535 locations was verified and quality assured to confirm adherence to our internal data quality standards with appropriate controls in place. This more granular asset data will enable the systematic collection and storage of additional condition and defect information, that will feed enhanced asset management activities supporting our new NOMs methodology.

440. Work is continuing to optimise the structure and quality of data in our core asset management system; this will be achieved through the application of business rules and increased capability in our data management function.

XIII. Capital Expenditure (SO)

Introduction

441. This section covers our SO Capex investment. In 2018/19, total SO Capex was £32.7m which was £5.4m higher than in 2017/18. The increase is mainly driven by spend on Data Centres due to delivery of the wide area network infrastructure (+£4.0m) and spend on the Gemini system for regulatory change and replatforming (+£2.7m).

442. The SO Capex forecast for the full RIIO-T1 period is £276.2m which is broadly in line with last year (£1.6m increase overall) driven predominantly by increases in Gemini replatforming (+£2.4m), Gas Control Suite (GCS) enhancement and infrastructure projects (+£3.4m). These increases are mainly offset by lower spend on Security and Risk management (-£1.1m) and decreases in Telemetry projects (-£3.5m).

Enhanced Security

443. Cyber security is viewed as a critical issue by the Government and this is evidenced by the development of the National Cyber Security Centre (NCSC). This has been formally recognised by EU Government through the introduction of EU Legislation to enhance the security and resilience of networks and information systems. The Networks and Information Systems (NIS) Directive places requirements on providers of essential services, including National Grid, to ensure their networks and IT systems are effectively protected from cyber-attack. This new legislation was transposed into UK law in May 2018. As part of the May 2018 Reopener, funding was provided to progress National Grid's compliance with the NIS Directive. Below we discuss two of these aspects; Data Centres and Operational Technology.

Data Centres

444. During 2018/19, we concluded our commercial and contractual activity with Crown Hosting (joint venture between UK Government and Ark Data Centres) to fully procure two highly secure Data Centre facilities. Extensive work has been undertaken to prepare the two new Data Centres, including the delivery of a highly secure Critical National Infrastructure (CNI) network that connects the new Data Centres to existing operational control rooms and other CNI sites and services. Additionally, works to build up the application network, infrastructure and software were completed to advanced stages in preparation for the migration of the Gas Control Suite CNI services in November 2019.

445. Throughout 2019/20 it is expected that the new data centre facilities will become fully operational as CNI services within National Grid.

Operational Technology (OT)

446. We are nearing the successful completion of the pilot phase to develop an Intrusion Detection System (IDS) solution for a range of OT equipment. A combination of upstream IDS and on-site IDS will provide a proportional level of detection capabilities with a reduction in sites requiring an on-site solution.

447. The project is currently tracking 3-4 months behind schedule due to site access (permits and operations resources) and telemetry issues around the upstream IDS solution. These are being mitigated for the rollout through planning and increasing the notice period for competent review/sign off.

448. Specific project costs at Huntingdon and Peterborough are forecast to increase by circa £200k. The original quote from the System Integrator has increased to cover additional cost uncertainty around the level of firewalls required between trusted and untrusted zones, switch specification and the addition of penetration testing to the scope.

Telemetry

449. Telemetry systems allow us to monitor and control the flow of gas through the NTS; they consist of telemetry outstations and the communications network which connects the outstations to the Gas Control Suite (GCS). This facilitates safe operations and ensures the quality and quantity of gas meets consumer requirements.

450. We continue to invest during RIIO-T1 in the refurbishment and replacement of telemetry outstations in order to manage the risk of asset ageing and obsolescence. With total spend of £2.3m in 2018/19, Phase 4 of the telemetry replacement programme is nearing completion and phase 5 initiated which is expected to complete in 2020/21. We continue to review the drivers for Distribution Network separation at telemetry sites focussing on a risk based approach which will provide efficient investment for customers.

Market Facilitation – Xoserve

451. In 2018/19, Xoserve Gemini regulatory driven change focussed on implementation of the EU phase 4 regulatory changes. This investment will ensure we are compliant with EU Gas Regulations embedding EU Tariff Network Code obligations.

452. In addition, spend started to be incurred on Gemini Re-platforming which will extend the life of the Gemini platform into RIIO-T2 and ensures security, availability and resilience of the system. The sustain strategy of re-platforming Gemini was agreed in 2017/18 after customer engagement and completion is expected in 2020/21.

Gas Control Suite

453. Spend on GCS in 2018/19 was focussed around risk and compliance. The integration of the forecast and future simulated data (Simone) with current operational data was delivered successfully into GCS. This has provided the capability to further improve the assessment and management of operational risks. The storage monitoring solution was also successfully delivered which has mitigated some significant risks to our regulatory and legislative reporting obligations. The operational logging solution was the final focus where development and testing activities have continued. However, the work has been re-prioritised and will be postponed until the latter stages of 2019/20.

XIV. Operating Costs (TO and SO)

Introduction

454. This section covers our TO and SO operating costs. The costs and allowances outlined within this section are based on our restated Table 2.4, as referenced in the Executive Summary. In 2018/19 our expenditure was £188m and our updated forecast for the eight years is £1,377m compared to an allowance of £1,284m. Compared to last year our eight-year forecast spend has increased in real terms by £0.4m.

455. Within the TO there has been an increase of £1.8m in the forecast year-on-year, with increases in Closely Associated Indirect costs and Faults offset by reductions in Planned Inspections and Maintenance.

456. Within the SO there has been a reduction of £1.4m in the forecast year-on-year, with a decrease in Direct Costs (including Xoserve) of £4m offset by an increase in Business Support costs of £3m which is described in more detail in the SO Overview below.

TO Overview

457. TO Controllable Opex spend in 2018/19 was £126m, representing a real term increase versus prior year of £4m. Our updated TO Opex (including uncertainty mechanism spend) forecast for the eight years is £879m which is £121m above our allowances of £758m. Compared to last year our forecast spend has increased in real terms by £1.8m. The main movements within year and for the eight-year forecast are:

- Closely Associated Indirect costs have increased year-on-year in real terms by £13.3m. The increase has been largely driven by GMP (Guaranteed Minimum Pensions) equalisation pension costs following a high court ruling.
- There is an increase reported in Direct Costs (£2.6m) as a result of delivering the PEx value cost efficiency programme. The £6.7m decrease in the eight-year forecast in real terms reflects the cost efficiency and restructuring programme.
- Planned Inspections and Maintenance have reduced by £1.1m year-on-year. The eight-year forecast of £215m is below the allowances of £249m (2018/19 prices) and £14m lower in real terms than the previous year forecast following a further review of the maintenance strategy.
- This year we have adopted IFRS15 accounting treatment in the UK, which means contributions for capital works relating to diversions are now recognised as the works are completed. This is a change for the UK regulated businesses where revenues were previously deferred over the life of the asset which is shown in the costs of Excluded, Consented and De-minimis Services, the value of this in FY19 is £23.6m

- Business Support costs have increased year-on-year in real terms by £1.6m. The main increases in costs related to consultancy and staff costs relating to ongoing controls work, PEx value consultation and additional resources required for RIIO-T2 preparation.

- The eight-year forecast of £269m for Business Support costs is now £110m above allowances of £159m and is in line with previous year forecast.

- Uncertainty Opex costs have reduced year-on-year in real terms by £2.2m. The eight-year forecast is £29m above the allowances of £31.5m.

SO Overview

458. Total SO Opex costs for 2018/19 were £61.6m which was £6.1m lower than forecast.

459. Direct costs (excluding IAS 19 adjustment) were £2.1m lower than forecast. The main driver was a reduction of £1.7m in Xoserve costs due to a lower level of Opex project work and a change to assumptions on asset lives which determines the level of amortisation of capital contributions. Forecast costs associated with cash cost of restructuring were £3.5m higher, but these costs were largely offset by efficiency savings resulting in lower employee costs.

460. Business Support Costs were £4.2m lower than forecast. This was due to favourable changes in allocation metrics and negotiated savings for IT contracts and insurance costs.

461. Annual costs have reduced by £0.2m compared to prior year. Operating costs in 2018/19 included £5.8m associated with restructuring which delivered £4.1m of efficiency savings. Further year on year reductions in cost were due to lower Xoserve costs and support function contract savings as mentioned above.

462. Our eight-year forecast for Controllable Opex of £498m is in line with our prior forecast. The £6.1m savings against forecast in 2018/19 will be offset by increasing Opex costs from ongoing investment in IT systems.

System Flexibility

463. In 2018/19 we continued with our system flexibility work. There were two specific areas of system flexibility studied in greater detail, which enabled a more specific collaboration with our stakeholders.

464. The first Gas Future Operability Planning (GFOP) publication of 2018/19 centred around a study of future gas supply pattern variability.

465. The second area of study was within-day flexibility, and during early 2019 a suite of publications were released, including:

- Understanding customer within-day behaviour

- Forecasting customer future within-day behaviour
- South East focus study

466. We have hosted a number of webinars, attended forums such as the Gas Operations Forum, and held circa 40 bilateral meetings to capture the views of our stakeholders to help develop our understanding and feed into our analysis and publications.

467. The Gas Flex Tool, developed in 2017/18 in partnership with Baringa (using Seedcorn funding), was utilised to generate within day forecasts that fed into our GFOP analysis.

468. There have been over 1000 views of our GFOP publications since January 2019. All of our GFOP publications can be found on the National Grid website here: www.nationalgrid.com/gfop

469. Our analysis and stakeholder feedback have highlighted a number of potential areas of focus for 2019/20. These will be prioritised in conjunction with our Stakeholders.

470. Through the RIIO-T2 review of Network Capability, further analysis across the whole network is underway. Network Capability is a range of measures that quantifies customer needs, and our ability to meet them. This enables us to identify areas where there is a potential mismatch between our capability and customers' future requirements.

Econometric Benchmarking - E2Gas

471. In mid-January 2017, the Council of European Energy Regulators (CEER) with its contractor Sumicsid initiated a 14-month project to benchmark European electricity and gas transmission operators. We agreed to participate in the study which includes approximately 20 electricity TSOs and a similar number of gas TSOs. The study aims to provide information on the relative efficiency of TSO asset development and maintenance activities for a 2017 snapshot, and by repeating the analysis biannually in the future, identify how efficiency improvement initiatives progress over time. Unlike the activity-based benchmarks in which we participate (ITOMS and GTBI) this study offers the potential to provide information about the mix of activities (e.g. concerning replacement and renewal strategies). The study aims to improve on methodological and transparency aspects of earlier electricity and gas high-level benchmarking studies, which require a complex set of cost and output adjustments to account for various country specific factors, so that the results can benefit both regulators and companies.

XV. Innovation

472. Throughout 2018/19 we have remained focused on innovation that delivers a step change for customers, focusing on projects that provide a safe, reliant and efficient decarbonised energy system for the future. We have embedded the Gas Network Innovation Strategy published in March 2018, realigning our portfolio and assessing our performance against the five key themes: Future of Gas, Safety and Emergency, Reliability and Maintenance, Environment and Low Carbon, and Security. This has helped drive a focused portfolio of innovation that delivers the greatest value to our customers and stakeholders.

473. In 2018/19 we spent £4.67m of the £4.82m allowance. Of this spend, £594k (12.7%) was internal expenditure. Our total NIC expenditure incurred in 2018/19 for Project GRAID (Gas Robotic Agile Inspection Device) and CLoCC totalled £2.9m.

474. We undertook 36 NIA projects across our five key innovation themes. Particular successes this year have been projects such as 'Valve Pits Insulation' which reduces noise emissions from our sites, replacing traditional methods of fibreglass lagging with acoustic panels on top of the valve pit, rather than directly attached to the pipework as shown in Figure 44. The trial was at our Wormington site, with sound levels significantly reduced from 66.78 dB to 54.28 dB, directly delivering benefit to the local community living around the site. In addition, the surface of the panels is resistant to moisture, which gives them a longer lifespan than fibreglass lagging. Also, as they are not placed around pipework, they reduce the risk and costs associated with water damage and corrosion.

Figure 44: Acoustic Panels installed at the Wormington Site

475. Another significant NIA project is ‘Hydrogen in the NTS’ which falls under our HyNTS programme of hydrogen work. This project is assessing the impact hydrogen could have on the NTS, considering the pipeline, associated equipment including compressors, valves, pressure reduction and pre-heating equipment, and our directly connected customers. The project is exploring whether our equipment becomes more brittle, whether cracks and faults grow faster, and whether welding requirements differ when hydrogen flows through it. We are also reviewing all UK and European standards relating to hydrogen, noting which standards are best suited for transportation on the NTS and where any gaps lie.

476. ‘Valve Care Toolbox’ is another example of an NIA project, which is seeking to reduce the need for expensive excavations with a range of new tools that allow technicians to assess, clean and protect buried valves from the surface. In the past, our only option for inspecting buried valves was to dig down, lift out the valve actuator with heavy lifting equipment, and then check the condition of the valve. It is an expensive and time-consuming process. The project is in two phases. Phase one has successfully designed and tested prototypes of a range of tools for use. Phase two is completing this testing and identifying other potential valve remediation tools, whilst also developing an operational database, which will guide our technicians through the best course of action to take to maintain a valve and the right tools to use under various scenarios.

477. Through our ‘Open Source SCADA’ project, we are aiming to eliminate the complexity and cost that is inherent in SCADA systems, whilst improving our cyber security. During phase one of the project, we successfully designed, installed and tested an open source SCADA system on one of our compressors. Open source software uses coding that is open to a community of users, leaving us independent of OEMs and vendors. It is cheaper and simpler to secure and upgrade, and highly flexible and customisable. The trial was a great success, and phase two has been progressing this year, improving the platform and developing a method to roll out across an entire compressor site. The platform has been future-proofed, so that as new security features are developed, we can incorporate them without having to change the system’s architecture. Software updates, which are an essential element of keeping systems secure, can also be introduced and controlled remotely, removing the risk of human error at individual sites. Therefore, instead of having to do multiple upgrades across multiple sites, we can do things once, without costly duplication – and every site will be consistently protected.

478. We participated in the ENA joint gas and electricity call for ideas for the 2019 Network Innovation Competition (NIC), whilst also launching our own call. Response across both calls was positive, with a number of new and existing partners responding with potential ideas. The ENA joint submissions underwent rigorous cross-network review process alongside an internal review process for our own NIC call for ideas. A number of ideas were deemed more suitable for consideration under NIA due to the nature and scale of these projects, whilst some were deemed ineligible for either NIC or NIA funding.

479. Following a review of the ideas submitted for the 2019 NIC process, the Captivate Large Scale Demonstrator Project was identified as the most suitable candidate for the process. Captivate is an ambitious programme of work to capture emissions from our assets to 'lock' them in solid rock form. An NIA project is underway within the Captivate programme to build a fully containerised carbon capture demonstrator to prove the carbon capture process can capture emissions from a boiler house's emissions at a National Grid site. The NIC project would have provided a large scale demonstration of the carbon capture process on a National Grid compressor to tackle all technical challenges and develop a standardised end-to-end process to capture carbon. Following submission of the Initial Screening Proposal (ISP) in March 2019, we were informed on 29 April 2019 that the NIC project would not be able to proceed to Full Submission.

480. Throughout 2018/19 both our live NIC projects concluded, Project GRAID and Project CLoCC. Both projects have successfully delivered against the aims and objectives that they set out to achieve.

481. Project GRAID has spent a total of £6.5m to design and develop a remotely operable robot that can be inserted into live, high pressure 100 bar(g), mild steel pipework systems to undertake both visual and physical inspection of the otherwise inaccessible buried sections of the system. The project has successfully delivered against its four main objectives:

I. To accurately and reliably determine the condition of high-pressure below ground pipework at AGI's using an internal inspection robot.

II. To generate a proactive, rather than reactive, risk based approach to the management and maintenance of ageing assets, based on the knowledge of the actual condition of pipework.

III. Minimise the occurrence of unnecessary excavations and eradicate premature replacement of assets, reducing significant carbon emissions and generating cost savings of circa £58m over 20 years.

IV. Minimise the likelihood of asset failure through proactive asset management, thereby significantly reducing the risk of a high-pressure gas release into the atmosphere and the consequential financial, environmental and reputational impact.

482. Following completion of the NIC project, we have begun an NIA project to assess the suitability of using Acoustic Resonance Technology (ART) sensors on the GRAID robotic platform, which would significantly improve the quality, quantity and speed of an inspection. This in turn will save money on site during the inspection and provide additional data which will strengthen the confidence in the assessment of the condition of the unpiggable pipeline.

483. Project CLoCC (Customer Low Cost Connections) has spent a total of £4.5m to simplify the process of connecting to the National Transmission System (NTS) for

a new generation of gas customers, opening up the NTS to a wider range of gas sources. The project has successfully delivered against its three objectives:

I. Creating an online connections platform to facilitate the customer experience. The goal of this workstream was to consider what elements of the current Application to Offer (A2O) process (a National Grid procedure specified within the Uniform Network Code) could be supported by development of an online gas customer connections portal and what functionality would be most beneficial to potential future customers.

II. Innovative physical connection solutions tailored to the needs of non-traditional NTS gas connections at high pressure. This workstream was tasked with completing a global technology watch, developing conceptual designs and conducting field trials of the proposed engineering connection solution(s).

III. Optimising commercial processes to meet the requirements of non-traditional NTS gas customers. Considering areas such as payment terms, fees and contract optimisation.

484. As a result of the project, we have demonstrated time and cost savings by considering the new standard design connection journey a customer follows and a number of customers have indicated they will be applying to National Grid for a Standard Design connection as the project is implemented. Project CLoCC has engaged a pilot customer, BioCow Ltd, whose Somerset Farm project in Cambridgeshire is expected to be the first direct biomethane gas connection to the NTS.

485. Throughout 2018/19 we have attended several industry conferences as exhibitors and a number of others as delegates. Exhibitor highlights include the Utility Week Live Conference 2018, where National Grid showcased a number of our key innovation projects and reached out to new third parties to share the challenges facing our business and identify opportunities to work together. In addition, the Low Carbon Networks and Innovation (LCNI) conference held in Telford in October 2018 was a success. Through several presentations and our innovation exhibition, we featured a broad range of NIA and NIC projects. We had demonstrations of projects in third party interference, cyber security, welding and noise mitigation, and showcased the GRAID robot. The presentations included the launch of our Project GRAID and Project CLoCC videos and summarised the key project learnings as both projects were coming to a close.

Figure 45: National Grid Showcase at the LCNI 2018 Conference

Figure 46: The Gas Robotic Agile Inspection Device on display at LCNI 2018

486. We have continued to work closely with the Gas and Electricity Networks to share our learning and work collaboratively across a number of areas. Highlights have included the development of the Gas Innovation Governance Group's (GIGG) Implementation Log which tracks all completed NIA projects that are being rolled out across the networks. Additionally, the launch of the ENA Joint Gas and Electricity call for ideas was a notable success. With preparations for RIIO-T2, we have worked closely with our stakeholders to present the story of innovation and how our portfolio has developed over RIIO-T1.

487. With our value tracking process embedded across the business we have been working to identify further projects that are ready for implementation. With several projects currently planned to be implemented within ongoing capital projects, we expect to see an increase from our current £8.6m in value delivered to date across the portfolio. We have engaged with the Energy Innovation Centre (EIC) and a number of the gas and electricity networks to develop a 'Benefit Measurement Framework' which provides a scorecard based approach to allow an assessment of network companies' performance across a full spectrum of innovation activities, irrespective of funding source. Currently in draft, the measurement framework is based around outcome measures which are focused on outputs and secondary indicators. We have participated in a wide range of stakeholder engagement as this framework has been developed, to ensure the framework meets our stakeholder's needs.

488. Our ambition for 2019/20 is to drive innovation projects that meet the needs of our stakeholders to deliver value and help to create the decarbonised gas network of the future. We will continue our focus on assessing the value of innovation through our value tracking process and complete the development of the Benefits Measurement Framework with the EIC and other networks. As we move towards RIIO-T2 we remain committed to increasing our levels of innovation, utilising a wide range of funding routes to drive real change in our business that delivers value to our customers and a decarbonised network of the future.

XVI. Market Facilitation

489. National Grid has a number of roles in facilitating the Great Britian (GB) and EU gas markets. This section discusses the areas we have focussed on in 2018/19 including the Future of Gas (FoG) project, Brexit, and the Gas Transmission Charging Review. Our customers and stakeholders have told us that one of their priorities is that we "facilitate and lead the debate" and this section will highlight examples of how we are listening to them and are acting on their feedback.

Background

490. Over the coming years there is set to be significant changes in the UK energy industry and it will be important to ensure the GB gas regime remains flexible and adaptable to this change. Within RIIO-T1 our focus has been to manage market change effectively. However, due to the expected increased volume and scale of developments within RIIO-T2 we envisage our role will evolve to drive this change.

491. Financial year 2018/19 has been a significant year for us as we have worked with our customers and stakeholders to ensure our business strategy fully prepares us for the future. Most notable of these activities include;

- the development of the Gas Markets Plan (GMaP) as part of the Future of Gas (FoG) project which sets out our view of the key role Gas Transmission can and will play throughout the 2020s to 2050
- the implications of the Brexit vote through the EU referendum, the impacts on the EU and GB gas regime and preparation for the UK's exit from the EU
- Gas Transmission Charging Review (GTCR) to deliver significant improvements to the GB charging regime.

492. We continue to play an active role in the GB and EU gas market activities by influencing the development of EU change, both in terms of the continued development of EU Network Codes and other legislative developments. Within the GB market we are developing the Capacity Release Methodology, continuing work on gas quality developments and proactively reviewing our Gemini strategy and Xoserve arrangements to ensure that they are fit for purpose and have the ability to operate and manage future industry change.

Future of Gas Project (FoG)/ Gas Markets Plan

493. In March 2018 we published the conclusions of our Future of Gas stakeholder engagement programme in the Future of Gas: How gas can support a low carbon future. Throughout the programme, we tested our thinking in the Future Energy Scenarios 2017 and worked with over 150 stakeholders to understand the potential role of gas until 2050, as we progress towards achieving our national carbon targets.

494. We set out five key themes; decarbonisation of heat, decarbonisation of industry, decarbonisation of transport, whole energy system and future networks and markets. For each theme we explored the problem, the potential solutions, the actions National Grid will take, triggers for potential further work and policy recommendations. One of the actions we committed to was to work with stakeholders to establish a long-term change plan for gas market frameworks.

495. In 2018, we tested the concept of the Gas Markets Plan with a wide range of stakeholders. There was strong support for National Grid to initiate the GMaP, and to develop it collaboratively with stakeholders. Stakeholders told us that a long-term plan for gas market frameworks would advance the energy transition, given the uncertainty about the future role of gas as the UK progresses towards meeting 2050 carbon targets.

496. All stakeholders agreed that consumer benefit needs to be at the heart of GMaP. Its aim should be to deliver efficient, cost-optimal gas market solutions for consumers. This will be achieved by stakeholders collectively putting consumers at the heart of decisions about facilitating what the future of gas looks like. We also heard that stakeholders wanted a clear route for a broad group of current and future industry participants to be engaged in developing the GMaP. As we develop the detailed GMaP, we will be considering the best tools to enable us to create a tangible plan that articulates the consumer benefits of each change project. A Steering Group of senior-level experts will begin to meet this year, to advise on priorities.

497. We held an interactive workshop with 19 stakeholders in March 2019 to start to develop the detail of the plan. The slides from that workshop can be found here. We heard valuable insights about the major developments likely to impact gas markets and the signs that those developments are beginning to happen, which we will use to trigger the development of specific work packages that form the GMaP.

498. At the stakeholder workshop in March 2019, we asked what topics we could provide more information on to help stakeholders to engage in future discussions. This is particularly important to enable smaller or non-traditional stakeholders to provide inputs to the GMaP. We are planning education materials for stakeholders on subjects such as gas blending, hydrogen and CCUS.

499. To facilitate the future gas market frameworks appropriately, we need to understand a broad range of perspectives, so at the workshop we tested our thinking on how to engage stakeholders going forwards. Stakeholders want a forum structure that keeps people engaged, that is held in different locations, that disseminates related intelligence, but that does not duplicate existing engagement groups.

500. We will be holding the first Future of Gas Forum in May 2019. It will bring together traditional and non-traditional market participants, potential new entrants, consumer representatives, BEIS, regulators and National Grid, to shape the GMaP and monitor our progress in delivery.

Brexit

501. Following the UK's decision to leave the EU in the referendum held on 23 June 2016, the two-year withdrawal process was triggered in a letter to the EU Council President on 29 March 2017. Under the terms of Article 50 of the Treaty of Lisbon, the UK was scheduled to leave the EU on 29 March 2019. This has been delayed by extending the Article 50 process until 31 October 2019. Under the terms of this Withdrawal Agreement, there is provision for a transition period until the end of 2020 during which (a) the UK and EU are expected to agree a Future Economic Partnership and (b) existing regulatory arrangements for cross-border UK/EU energy flows would remain unchanged. Future UK/EU energy arrangements are expected to form part of the Future Economic Partnership.

502. During 2018/19 we have continued our work to assess and prepare for the UK withdrawal from the EU, focusing on a potential no-deal scenario and collaborating closely and regularly with BEIS, Ofgem and wider stakeholders, including interconnectors and other gas TSOs in Northern Ireland, Ireland, Belgium and the Netherlands. We have carried out a significant piece of unfunded work to assess the Statutory Instruments, relevant in a no-deal scenario, and their impact on industry codes and commercial arrangements. These changes required to industry codes and related agreements to maintain the legal basis for industry processes and commercial arrangements are progressing through normal industry open governance in readiness for a no-deal scenario and have been drafted in a way that allows for change in response to political developments. This is specifically in relation to system operation, balancing and interconnection points to EU Member States.

503. Additionally, we have actively participated in the BEIS chaired Markets Operability and Trading Board (MOT) which focuses on making sure there is a clear joined up plan between BEIS, Ofgem and National Grid on managing key Brexit energy related risks. We have seconded an experienced manager to the BEIS Gas Brexit team to provide knowledge and expertise to enable the Brexit transition process. We have been working with Prisma to ensure UK shippers continue to have access to interconnection point capacity after Brexit. Furthermore, we have participated in workshops, bilateral meetings and responded to industry consultations as appropriate.

504. We will continue our work during 2019/20 to respond to emerging political developments, maintaining our close working relationships at all levels with BEIS, Ofgem and other key stakeholders. We will also continue working with ENTSOG (European Network of Transmission System Operators for Gas) to understand the implications of Brexit on our future membership status. Additionally, we aim to continue our working membership with Gas Infrastructure Europe (GIE).

Gas Transmission Charging Review (GTCR)

505. The Gas Charging Review continued its development through industry workgroups (NTS Charging Methodology Forum and Modification specific workgroups) in 2018/19. In December 2018, Ofgem decided on UNC Modification 0621 and its alternatives, with the decision to reject (i.e. not implement) any of the 0621 proposals identifying EU Tariff Code (TAR) compliance concerns. Post the UNC process to consult on the 0621 proposals, National Grid supported Ofgem in preparations regarding compliance considerations and impact assessment analysis.

506. National Grid raised UNC Modification 0678 in January 2019 to cover all the aspects of the charging review that included delivering compliance with EU Commission Regulation 2017/460 (the EU Tariff Code) incorporating changes that address Ofgem's reasons for non-implementation of 0621.

507. Meetings with industry were frequent. National Grid undertook substantial engagement with stakeholders, customers and interested parties. A total of ten alternatives have been raised to UNC Modification 0678 which have also been managed through the workgroups. All UNC material on the workgroups and modifications can be found on the Joint Office of Gas Transporters website https://www.gasgovernance.co.uk/0678.

508. The range of proposals under 0678 propose either a Capacity Weighted Distance (CWD) Reference Price Methodology (RPM) or a Postage Stamp (PS) RPM. The workgroups concluded on 10 April 2019 with the consultation on the 11 proposals closing on 8 May 2019.

509. Subsequent versions of the modification incorporated the outputs from these discussions to inform the proposals. Discussions have been broad in terms of the proposals and the specifics of compliance with TAR. This also helped manage the alternative modifications so that awareness of the areas where potential alternatives might be raised were more visible. A number of alternatives have been raised to UNC Modification 0621 which are also being managed through the workgroups.

510. In April 2019, National Grid received a Licence direction (https://www.ofgem.gov.uk/system/files/docs/2019/04/decision_letter_unc678.pdf) to conduct a preliminary EU consultation in line with Article 26 of EU TAR NC. This consultation was issued on 23 April 2019 (https://www.nationalgridgas.com/about-us/eu-network-codes-implementation) with receipt of representations to National Grid closing on 8 May 2019.

511. UNC Modification 0678 and all alternatives raised will go to UNC Panel on 23 May 2019 after which a Final Modification Report (FMR) will be submitted to Ofgem on 29 May 2019. An impact assessment along with the required EU Consultations (required under the EU Tariff Code) are expected to follow in the proceeding months after submission of the FMR to Ofgem.

European Market Activities

EU Tariff (TAR) Network Code

512. The TAR code establishes a network code on harmonised transmission tariff structures for gas. It sets out the EU-wide rules which aim to enable market integration, enhance security of supply and to promote the interconnection between gas networks.

513. We have provided regular updates and held discussions with stakeholders and customers at industry forums including UNC Transmission Workgroup, the NTS Charging Methodology Forum and the Gas Storage Operators Group as well as in a number of bilateral meetings and communications with individual stakeholders. Industry discussions on the TAR code have been incorporated into the Charging Review to ensure a holistic approach is taken in the development of a GB charging framework that is both fit for purpose and compliant with the EU tariff code. The TAR Code drives a number of changes to the GB charging regime such as the removal of fixed price capacity tariffs at interconnection points, a drive that most of the allowed revenue should be recovered via capacity tariffs and increased obligations in transparency and consultation.

514. We were proactive in the development of the TAR code both at a European level and by working closely with BEIS and Ofgem seeking to influence the codes and to ensure they are implemented effectively. The implementation solutions developed for 0678 (Charging Review) have been in consultation with customers and stakeholders as part of the Charging Review. Due to our influencing, the final TAR code enables National Grid to largely preserve our current TO/SO model and ensures that there is sufficient flexibility in the code that many of the changes considered in the Charging Review were largely driven by GB requirements rather than simply EU compliance. We have ensured, through the proposals for 0678 (and alternatives) that the regulatory reporting under National Grid's Licence is not affected with the introduction of Transmission Services and Non-Transmission Services being implemented through the UNC changes.

515. The TAR code entered into force on 6 April 2017, however elements of the TAR code will be applied to GB for the first tariff year after 31 May 2019 which for GB starts 1 October 2019. Modification 0678 (and the range of alternatives) propose changes, that could be implemented for 1 October 2019 or as soon as possible after this, in line with an Ofgem decision.

516. We continue to be active at the European level to facilitate a coherent implementation of the TAR code between Member States and to influence the development of the process by which ENTSOG shall monitor implementation of the TAR code in its role to assist ACER's monitoring duties. We are also working with our EU counterparts to develop a formal ENTSOG position on the harmonisation of tariffs and revenue methodologies in preparation for the upcoming reopening of gas legislation in 2020 as part of the European Commission's Gas Package 2020.

EU Interoperability (INT) Code

517. The most notable development in terms of EU Interoperability code this year was an issue raised on ENTSOG's Functionality Platform, that storage operators and Market Area Managers are not obliged under the Interoperability Code to offer the Edigas-XML schema with an AS4 protocol. A number of EU Shippers had invested in AS4 while some operators continued to use the AS2 protocol which caused the Shippers to incur extra costs when upgrades were required. ACER and ENTSOG conducted a joint consultation which resulted in a clear preference for the EU data exchange obligations to be extended to virtual trading points, such as GB's NBP. We expect legislative changes to be brought forward to amend this EU Code, and to mandate the AS4 protocol, later in 2019.

PRISMA

518. The CAM Code introduced market based capacity auctions and the adoption of a Joint Capacity Booking Platform (PRISMA) for the sale and purchase of capacity at Interconnection Points. In 2018/19 we have worked with Prisma to improve system usability and change its helpdesk/back end support activities. We have also supported Prisma's efforts to increase its customer base which will result in lower unit costs for all users. We have also been working with Prisma to change the Articles of Association to mean that they are still applicable post Brexit.

Gas EU Security of Supply Regulation

519. The revised Gas Security of Supply Regulation (amended to Regulation (EU) No 994/2010) came into effect in November 2017 and contains a phased implementation of obligations until 1 March 2019. Some of the new obligations contained within the revised Regulation are direct on TSOs. Other obligations sit with Member States but have an indirect obligation on TSOs to contribute towards their fulfilment.

520. During 2018/19 we have been working closely with BEIS and Ofgem to implement obligations as per the phased implementation timescales contained within the regulation. The most notable of these obligations was the introduction of the "Solidarity" principle which was effective from 1 December 2018. This obliges BEIS to implement measures which trigger action in a Solidarity event. We have been working with BEIS and Ofgem to draft the Solidarity bilateral agreements to be implemented with connected Member States and assisted BEIS in fulfilling their obligation. It has been important that we have played a key role to ensure that the implementation approach is compatible with current emergency procedures and minimal change is required.

GB Market Activities

Capacity Release Methodology

521. National Grid produces a methodology describing the processes for release of NTS capacity. Included in this is an economic test which is used to help justify the release of incremental capacity at an Aggregated System Entry Point (ASEP). In 2018 we identified a need to review the rules for the economic test to make sure it remains operable following the outcome of the GTCR. At the same time, we also received customer feedback regarding the current test, based on their recent experience.

522. Amending the economic test has therefore been the main focus for the most recent review of the Capacity Release Methodology statements. A new economic test has been proposed that takes account of customer feedback, and that is designed to work with all possible outcomes of the GTCR.

523. Industry engagement has taken place throughout the second half of 2018/19, and revised Capacity Release Methodology statements are anticipated to be effective, subject to Ofgem approval, before the end of July 2019.

Gas Quality Developments

524. An industry working group led by the Institute of Gas Engineers and Managers (IGEM) has continued its work exploring changes to the GB gas quality specification in the Gas Safety Management Regulations (GS(M)R). The aim is to review interchangeability parameters and establish a new specification in a new IGEM standard. Separately, an ENA group is working to revise and update the remainder of GS(M)R.

525. The IGEM working group was instigated by SGN following the conclusion of SGN's Opening up the Gas Market (OGM), which concluded that domestic appliances could be safely operated with higher Wobbe index gases than currently permitted under normal conditions under GS(M)R. In 2018/19, further studies were completed:

- A review of the Dutton work that led to the current limits;
- A study of the impact of a wider range of gas quality on industrial and commercial applications;
- A study to investigate the impacts of wider Wobbe gas on NTS assets.

526. The current proposals for the new standard are to increase the upper Wobbe Index limit from 51.41 MJ/m3 to 52.85 MJ/m3, remove the limits of Soot Index and Incomplete Combustion Factor, introduce a Relative Density limit of 0.7 and increase the oxygen limit from 0.2mol% to 1.0 mol%. We expect IGEM to submit an evidence case to HSE and BEIS in Q2 2019 to start a formal process of impact assessment and consultation.

527. Following our industry consultation on a number of topics in relation to gas quality that concluded in February 2018, http://www.talkingnetworkstx.com/gas-quality-consultation.aspx we have been exploring the feasibility of gas quality blending

services. At present, we require all parties delivering gas to the NTS to comply with GS(M)R parameters. At St Fergus and Bacton there are multiple pipelines that deliver gas into our terminal infrastructure prior to the gas leaving the terminal on NTS pipelines and we are currently exploring the feasibility of relaxing requirements for some parties at these locations if we can assure that the blend will be compliant at entry to the NTS pipelines.

Xoserve and Gemini

528. Xoserve provide a number of services to National Grid and to our customers, which in the main are associated with Gemini operation and change management, shipper invoicing, energy balancing processes and shipper lifecycle activities. Under the current regulatory arrangements, National Grid receives a funding allowance for the provision of these services from Xoserve.

Xoserve Relationship/Performance

529. The customer experience when interfacing with our back-office systems has continued to be a key area of focus for us this year, this has led us to continue to work closely with Xoserve to review and seek improvements in the delivery of data services across a range of operational areas in partnership with Xoserve. The results of this work have led to:

- Increased Xoserve support and attendance at our Gas Operational forum, allowing Xoserve to provide updates to our customers on issues and market changes which may affect them. This also provided the opportunity to answer any specific questions on the services Xoserve provide on our behalf or the issues accounted in the delivery of services where the impact has been felt by the customer. A key area of focus at these sessions has been to provide the industry with updates on issues such as Unidentified Gas and the allocations process.

- Improved service desk provision. Following customer feedback, we have worked closely with Xoserve to improve the service desk provision, this has included reprioritisation of calls related to Nominations and Re-nominations to ensure they are actioned within day, a ‘mystery shopper’ process to check call quality on an ad hoc basis, and the development of a new ‘Chat Bot’ feature which will allow users of Gemini to receive instant answers to queries via an automated instant messaging tool. These provisions were developed through engagement at the Gas Operational Forum.

- Greater encouragement for Xoserve to improve its service to customers using the Gas Operational Forum as a key interaction to proactively seek more detailed feedback on the areas where customers have indicated improvements are required. This could be initiated from general feedback, NPS or comments via the Customer Satisfaction/Stakeholder Satisfaction survey programme.

530. In order to proactively drive performance and reputation of National Grid and Xoserve in our interactions with Shippers we are seeking to understand a customer

journey mapping exercise specifically around 'Shipper lifecycle' to aid understanding across National Grid/Xoserve, identify any gaps in service and map customer pain points/opportunities. This will be a key focus over the next year.

531. Our current interface with Xoserve continues through monthly meetings. We have embedded a scorecard report to drive collaborative focus on key issues. We are developing this further by incorporating a horizon scan which enables us to understand and plan more effectively any future changes taking place. Next steps are to embed a strategic account plan to better understand both key drivers and strategies for the future, to help leverage opportunities and to ensure both our business objectives and requirements for RIIO-T2 are aligned.

Gemini Strategy within RIIO-T1

532. Gemini is currently operating on ageing hardware and infrastructure software which brings increasing risks to its security, availability and resilience. Xoserve therefore identified an investment requirement to sustain Gemini's infrastructure and we have been continuing to work with Xoserve to re-platform Gemini (to maintain vendor support for the hardware and infrastructure software layers of the Gemini application) as an economic alternative to prolong the life of this system ahead of a full replacement.

533. This year, we have worked closely with Xoserve to understand the best re-platforming solution. This has included an assessment of the non-functional requirements (e.g. the expected load placed on the system, access to it and its control), data archiving and platform solutions to be delivered as part of the re-platform solution. A platform solution whereby assets are taken as a service rather than National Grid owning the assets has been defined as the best solution and a hosting partner selected. Mobilisation for delivery commenced in January 2019, a key component being to take into consideration the wider change programme both within Xoserve and National Grid. High level design commenced in March 2019. The re-platforming project is expected to be completed by 2020.

534. In parallel with the re-platforming activity, we also wanted to explore how the user experience for Gemini could be improved and we engaged with customers and stakeholders in 2018 to capture the 'pain points' that are currently experienced with the system. We plan to deliver a new within day capacity and nominations report in October 2019 as part of the GB Charging release as a result of this engagement and are currently working through what other functionality improvements we may be able to deliver.

Gemini / Xoserve Strategy within RIIO-2

535. RIIO-T2 provides us with the opportunity to explore other options for the provision of the system and services which Shippers use to book capacity and balance their portfolios (currently Xoserve and Gemini) to provide value in the future. This shall ensure not only that the right system and services are delivered, but also that they are efficient, fit for purpose in the future and are agile to adapt to future change as identified in the Gas Markets Plan referred to in the FOG section of this narrative.

536. In 2018/19, we have been working with stakeholders to understand their requirements for the capacity and balancing services and system within RIIO-T2. Following this, we have been building our plans and justification for a replacement system to be delivered in 2025. At this stage, it will also be appropriate to explore other options for system and service provision.

XVII. Operational Review

537. In 2018/19 we have seen a relatively warm winter which is classed as the 5th warmest winter in the past 59 years. The highest daily demand seen this year was 402.6 mcm on the 23rd January 2019. This was lower than the highest demand experienced in 2017/18 of 417.6 mcm.

538. In winter of 2018/19 the System Average Price (SAP) was 56.6 p/th and ranged from 34 p/th to 73 p/th. The 2017/18 SAP was 56 p/th ranging from 41 p/th to 373 p/th (high price due to 1 March 2018 'Beast from the East' cold weather conditions). The reduced price range was due to a decrease in demand and healthy supply position over winter 2018/19.

539. The total consumption for the year was 81.7 bcm compared to 89.7 bcm in 2017/18. This decrease was largely driven by reduced demand from LDZ Offtakes and IUK export.

540. The coldest day in 2018/19 was recorded on the 1 February 2019. The lowest demand seen was 129.6 mcm on 2 September 2018. This was 2 mcm lower than last year's minimum.

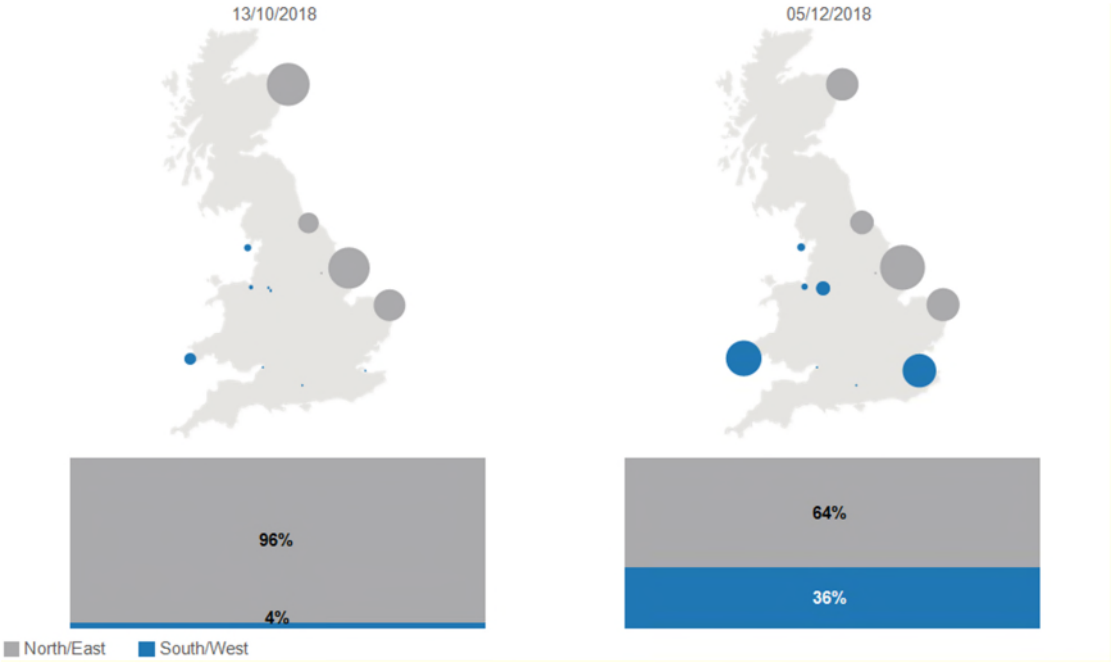
541. In 2018/19, the network experienced a number of supply changes resulting in a much more diverse supply of gas into the NTS, closer to the centres of demand than in recent years. Consequently, usage of key assets reduced allowing the network to be operated in a more economic fashion. LNG terminal flows increased, with the number of LNG cargoes received increasing from 49 in 2017/18 to 109 in 2018/19.

542. In 2018/19 all significant offtake pressure customer obligations were delivered. The development and execution of our operational plans ensured 100% of firm capacity purchased by customers was made available for use and 395 maintenance operations were completed successfully during the year.

Operational challenges

543. Non-diversified supplies as observed during October 2018 (see figure below) require a larger transit distance for gas from point of supply to point of demand and need more network intervention e.g. compression. With LNG supplies particularly close to high demand centres these challenges are eased.

Figure 47 - The diagram below shows the differing supply profile of two days last Winter.



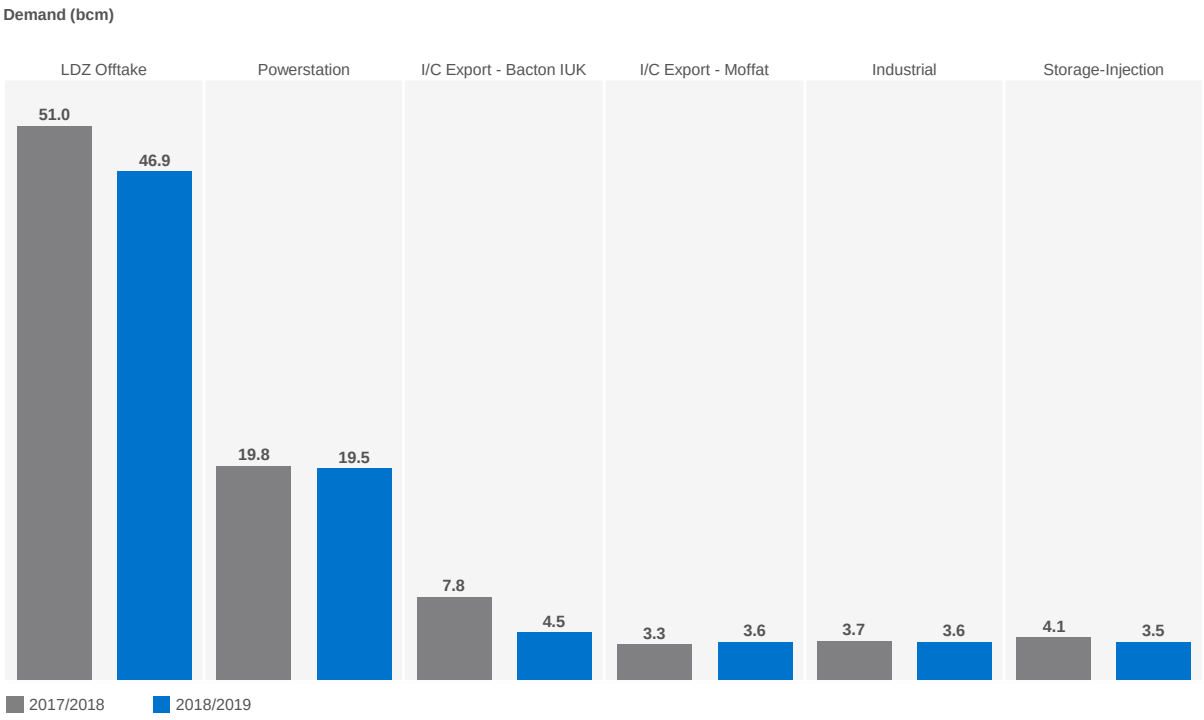
544. During the winter, there were 426 GS(M)R supplier gas quality excursions, which were resolved using the relevant processes.

545. There were unplanned system events at one NTS offtake resulting in a loss of flow to the offtake. All efforts were made to return the flow in a timely manner, whilst ensuring the safe operation of the NTS.

Gas Demand and Supply

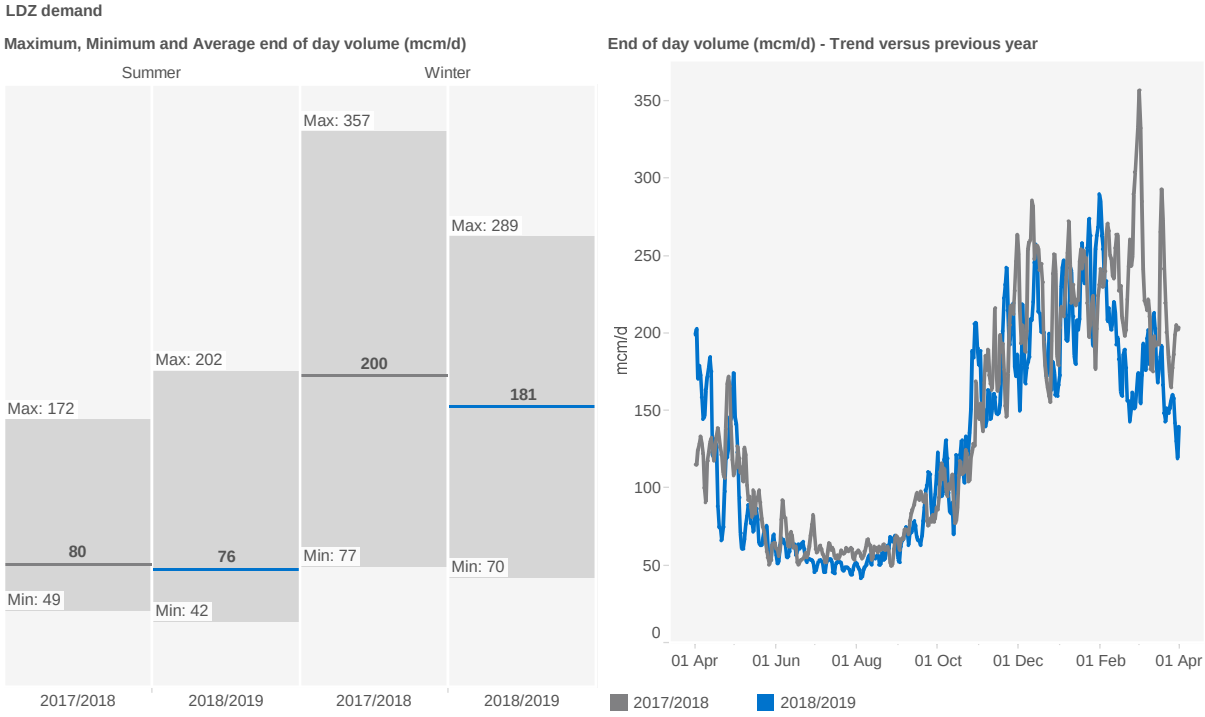
546. The chart below displays the gas demand for the past 12 months by the individual demand components.

Figure 48: Gas demand in 2018/19 vs 2017/18 by demand components



547. LDZ demand was lower in 2018/19 at 46.9 bcm compared to 51.0 bcm in 2017/18; averaging 181 mcm/d in winter 2018/19 compared to 200 mcm/d in 2017/18.

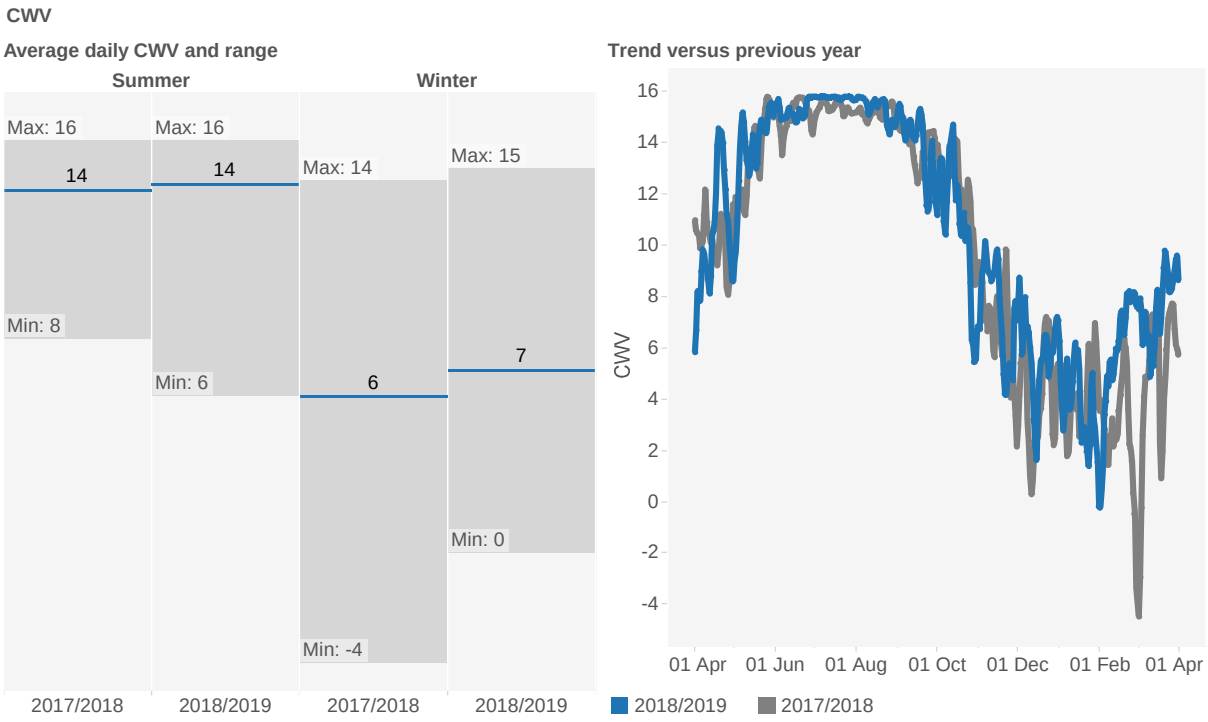
Figure 49: LDZ demand average daily volume and range and trend previous years



Weather

548. The Composite Weather Variable (CWV) is a single measure of daily weather and is a function of actual temperature, wind speed, effective temperature and seasonal normal effective temperature. The CWV highlights a slightly warmer winter than last year which correlates with LDZ demand levels seen. There is a narrower range of CWV in Winter, when compared to the previous year, this is in line with the narrower range of LDZ demand.

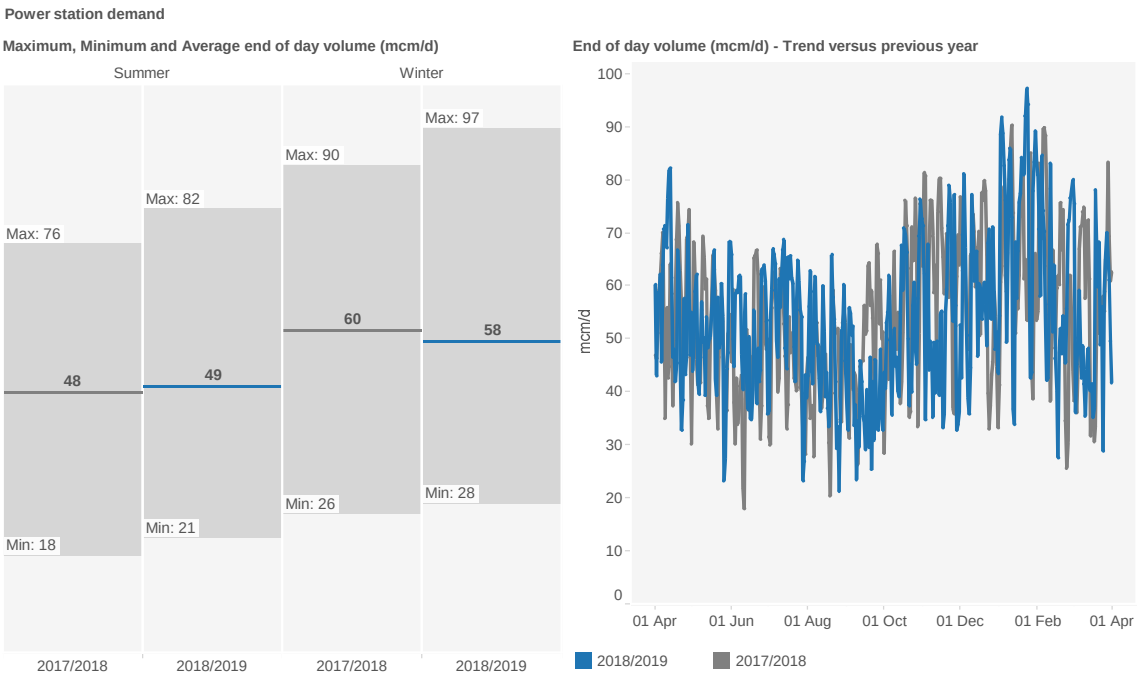
Figure 50: National Composite Weather variable data



Demand for Power Generation

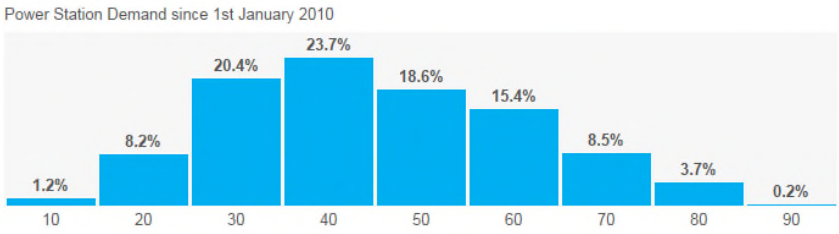
549. The chart below shows the gas demand for power generation this year, compared to the previous year. In the Summer, although the average demand was lower, the range of demand was slightly wider when compared to the previous year, with little change in Winter.

Figure 51: Demand for power generation



550. The demand for power generation on 23/01/19 was the highest end of day value recorded in recent years at 97mcm.

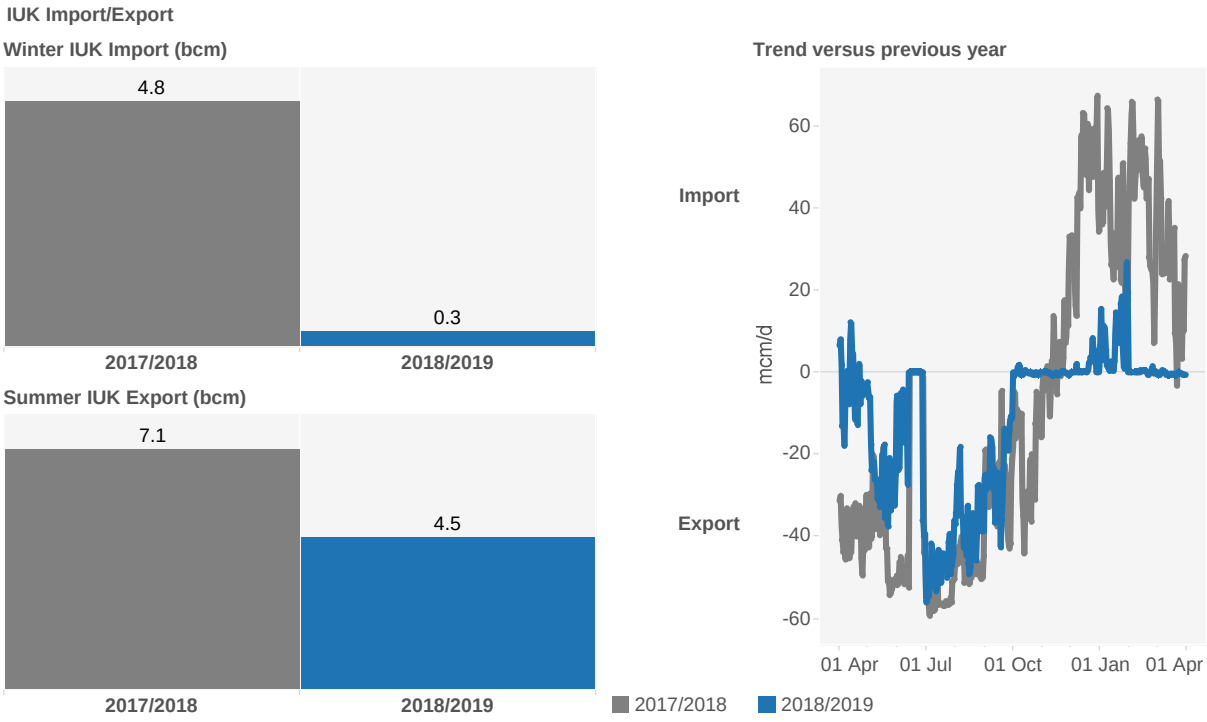
551. Since 2010, demand of 90 mcm/d or more for power generation has occurred on only 0.2% of days.



Import/Export Flows at IUK

552. Figure 52 shows the import/export flows at IUK for this year in comparison to last year showing a greater than 90% reduction in imports and a 36% reduction in exports.

Figure 52: IUK import/export volumes for 2018/19 vs 2017/18

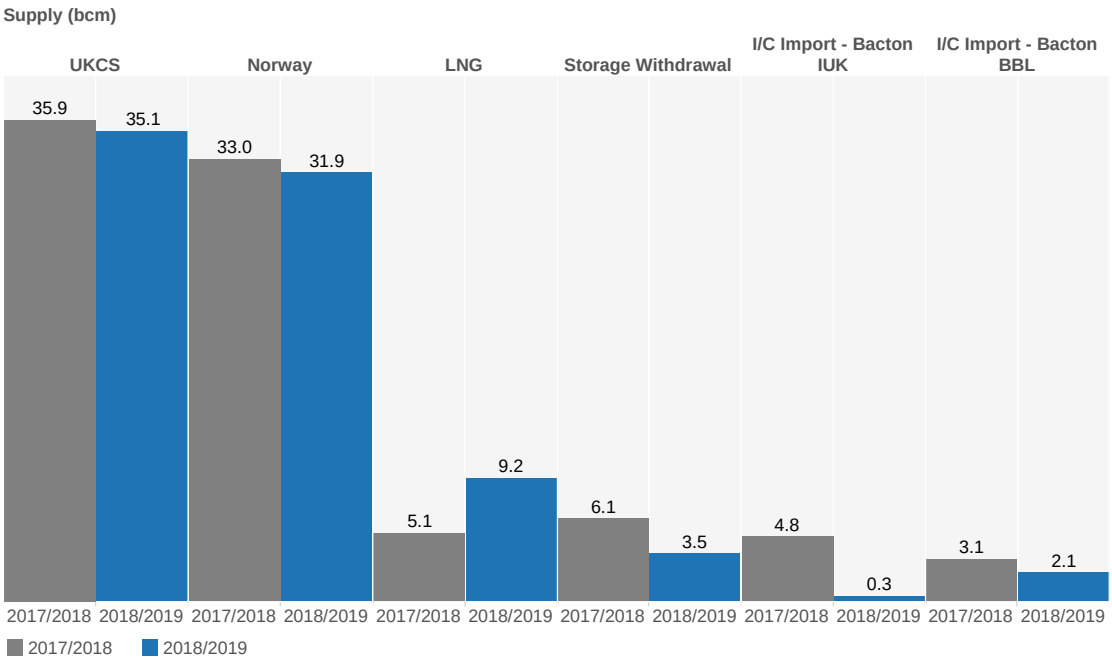


Supply Breakdown

553. Figure 53 shows the volume of supply by source type. Compared to the previous year, the largest elements of the supply profile; UKCS and Norway have remained at similar levels.

554. There has been an increase in supply from LNG, which has been offset by significant decreases in storage withdrawal and import via IUK and BBL.

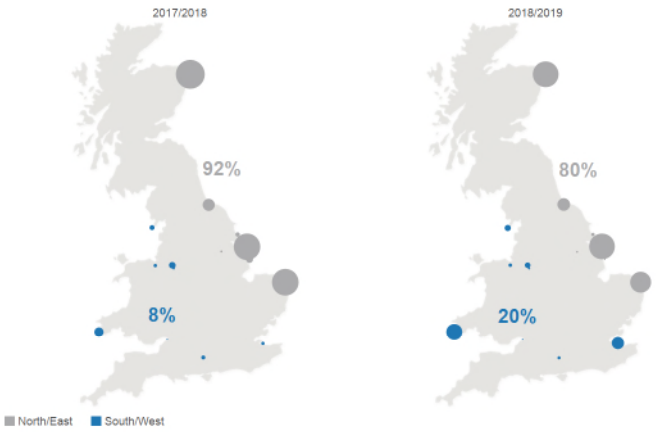
Figure 53: Gas supply breakdown 2017/18 vs 2018/19



Supply Profile by Location – Winter 2017/18 vs Winter 2018/19

555. The below chart shows the gas supplied to GB by geographic location, and shows that most gas continues to be supplied through Easington, St Fergus and Bacton, however the locational profile has changed to some extent. When compared to the previous year, there has been an increase in the volume of supply entering the NTS in the South and West.

Figure 54: Supply profile by location for winter 2017/18 and winter 2018/19

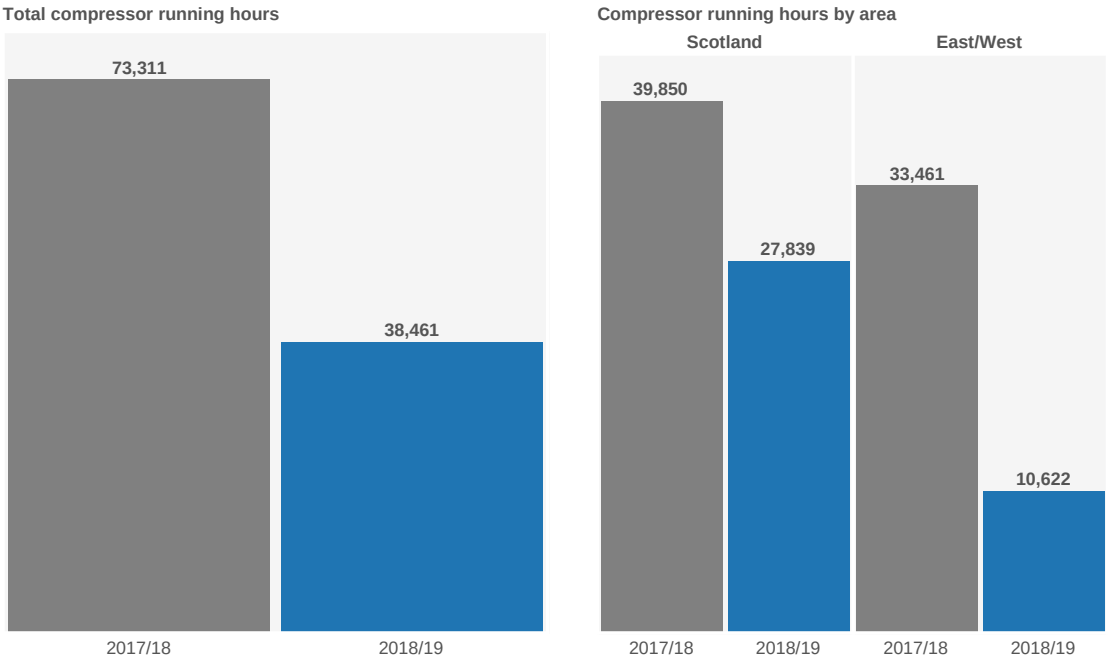


Compressor Utilisation

556. Overall compressor running hours have decreased significantly from 73,311 hours in 2017/18 to 38,461 hours in 2018/19.

557. As a result of the changes in volume of supply by location, the regional profile of compressor running hours has changed, with a decrease in East/West and Scotland

Figure 55: Compressor running hours from 2017/18 to 2018/19

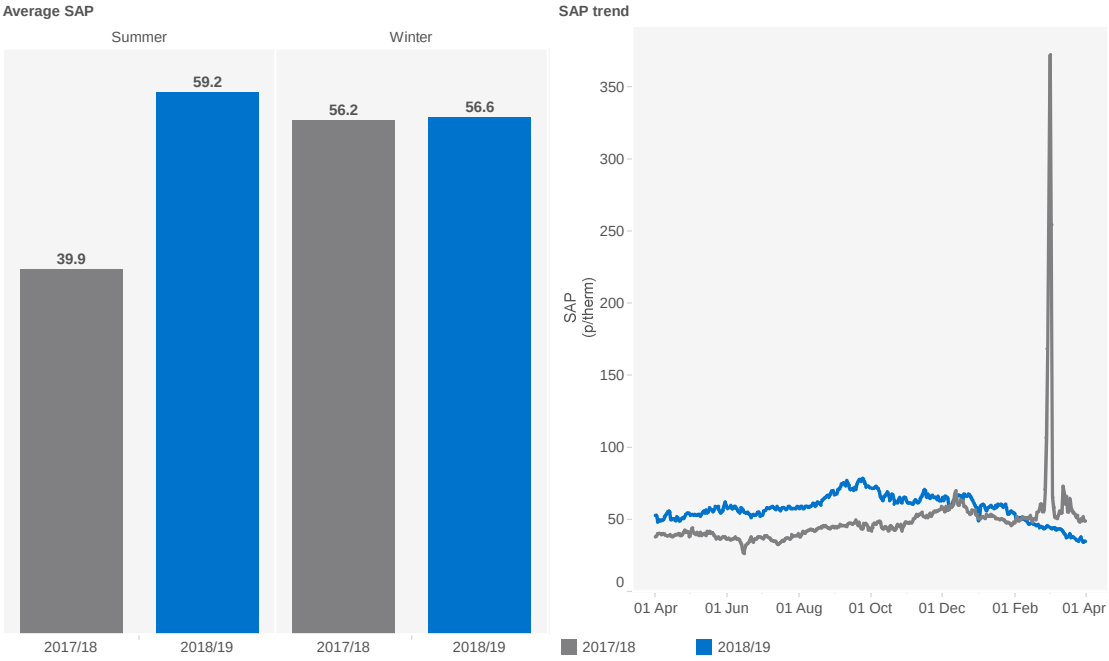


Commercial Prices

558. Commercially, average gas prices were similar this winter, however last Winter included a large spike in prices around 01/03/18 due to the 'Beast from the East' cold snap.

559. Summer gas prices were significantly higher in 2018/19.

Figure 56: Daily SAP from 2017/18 to 2018/19

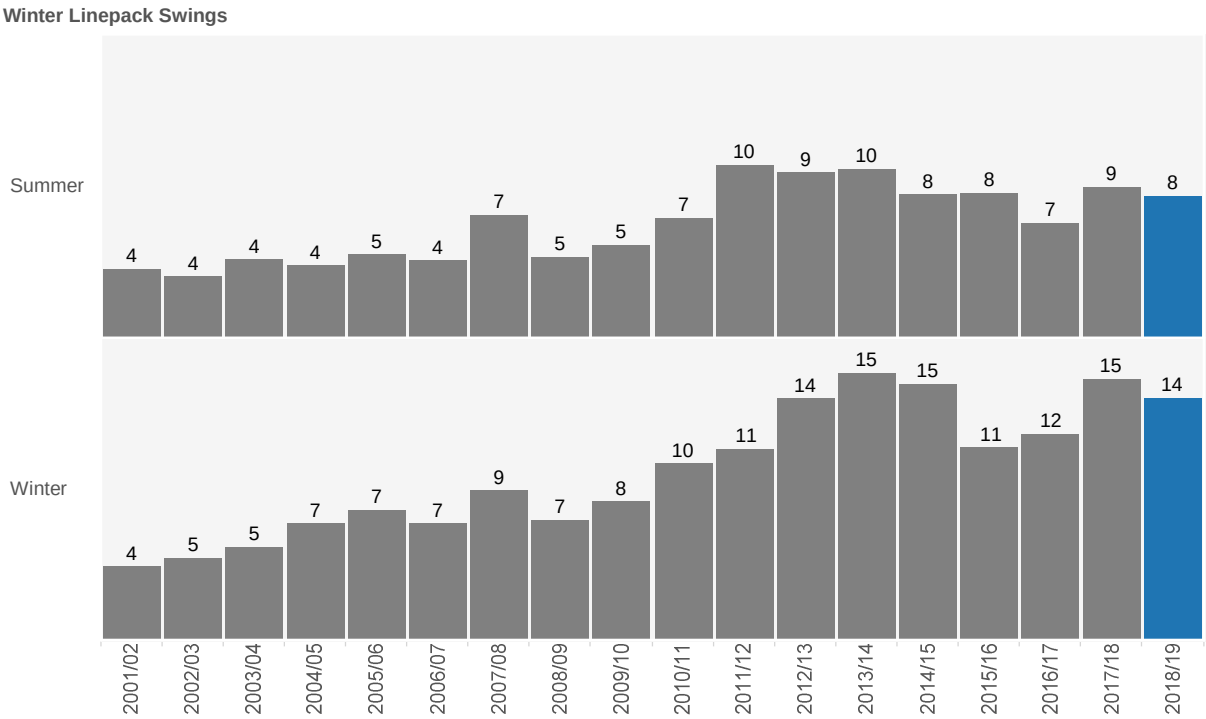


Comparison of NTS linepack swing

560. Within day profiling remains an ongoing issue for system operability, due to the NTS and associated contractual rules, which have been designed for flat supply and demand profiles. It can therefore be challenging to meet customer requirements, in particular maintaining required pressures on days of significant linepack swing.

561. When comparing the daily linepack swings recorded in 2018/19 versus 2017/18, the average linepack swings have decreased slightly, however they remain relatively high compared to historic levels.

Figure 57: Chart showing average daily linepack swing since 2001/02



Appendix I – Totex Tables

Totex
National Grid Gas Transmission
2018/19

Actual/Forecast Expenditure (£m, 2018/19 Prices)

		Actual	Actual	Actual	Actual	RIIO-T1 Forecast				
		2014	2015	2016	2017	2018	2019	2020	2021	Total
	Load Related Capex	3.9	1.6	1.5	1.8	2.7	2.5	15.4	15.5	44.9
TO	Asset Replacement Capex	63.3	60.4	81.5	103.2	130.4	113.1	71.4	69.7	693.0
	Other Capex	33.7	37.3	30.8	16.0	46.3	51.0	78.8	25.9	319.9
	Non Operational capex	13.8	13.1	14.6	23.6	18.8	21.9	24.4	14.6	144.9
	Total Capex	**114.7**	**112.5**	**128.4**	**144.6**	**198.2**	**188.5**	**190.0**	**125.7**	**1,202.7**
	Opex									
	Faults	9.6	6.7	3.4	4.6	5.1	7.8	6.4	6.3	49.9
	Planned Inspections and Maintenance	27.0	29.0	26.1	29.2	27.4	26.3	25.4	24.8	215.3
	Other direct costs	1.2	7.1	5.5	5.3	5.9	6.9	5.2	5.3	42.3
	Closely Associated Indirect Costs	23.9	21.0	26.0	31.9	33.3	46.6	37.0	32.7	252.6
	Business Support	25.3	27.2	30.9	33.2	38.3	39.9	37.0	36.8	268.6
	Adjustment for IAS 19 pension accrual	- 0.7	0.3	- 0.2	- 0.8	1.0	- 10.1	-	-	- 10.5
	Total Controllable Opex	**86.4**	**91.3**	**91.7**	**103.5**	**111.0**	**117.3**	**111.0**	**105.8**	**818.1**
	UNCERTAIN EXPENDITURE									
	Load Related Capex	-	-	-	-	-	-	-	-	-
	Asset Replacement Capex	-	5.0	3.2	32.9	56.3	41.7	28.3	13.5	180.8
	Other Capex	40.2	26.1	15.9	4.3	23.4	27.3	28.1	10.0	175.3
	Total Uncertain Capex	**40.2**	**31.2**	**19.1**	**37.1**	**79.6**	**69.0**	**56.5**	**23.5**	**356.1**
	Controllable Opex	6.7	4.8	6.7	8.5	10.9	8.7	7.5	6.9	60.7
TO	**TOTEX**	**248.0**	**239.7**	**245.9**	**293.7**	**399.8**	**383.6**	**365.0**	**262.0**	**2,437.6**
SO	**Non Operational capex**	23.3	35.8	47.0	35.2	27.3	32.7	43.8	31.1	276.2
	Direct costs	30.8	35.7	37.2	35.6	36.2	35.9	37.7	31.2	280.3
	Closely Associated Indirect Costs	9.1	11.1	9.7	11.1	9.2	5.6	6.2	7.9	70.1
	Business Support	15.2	14.0	15.8	16.9	15.8	19.8	25.3	24.6	147.5
	Adjustment for IAS 19 pension accrual	- 0.4	0.2	- 0.2	- 0.6	0.6	0.3	-	-	- 0.1
	Controllable Opex	**54.8**	**61.1**	**62.6**	**63.0**	**61.8**	**61.6**	**69.3**	**63.7**	**497.8**
SO	**TOTEX**	**78.0**	**96.9**	**109.5**	**98.2**	**89.1**	**94.3**	**113.1**	**94.8**	**774.0**

Total Allowances (£m, 2018/19 Prices)

		RIIO-T1 Allowances								
		2014	2015	2016	2017	2018	2019	2020	2021	Total
	Load Related Capex	19.8	8.1	1.6	1.4	7.8	6.6	0.3	-	45.7
TO	Asset Replacement Capex	114.1	133.9	127.9	134.2	160.1	132.8	84.6	78.6	966.2
	Other Capex	35.3	23.9	14.1	16.6	42.0	42.9	26.9	8.4	210.1
	Non Operational capex	13.5	12.7	8.7	8.1	7.3	5.5	8.4	7.7	71.9
	Total Capex	**182.8**	**178.5**	**152.3**	**160.2**	**217.2**	**187.9**	**120.2**	**94.8**	**1,293.9**
	Faults	8.5	8.6	8.7	8.7	8.8	8.8	8.9	9.0	69.8
	Planned Inspections and Maintenance	29.8	30.1	31.0	30.9	31.4	31.5	32.7	32.2	249.5
	Other direct costs	11.5	9.3	9.3	10.3	11.5	9.9	8.5	7.7	78.1
	Closely Associated Indirect Costs	20.0	20.8	21.6	21.5	21.7	21.7	21.7	22.0	171.0
	Business Support	19.5	19.0	19.5	19.8	19.7	20.0	20.4	20.6	158.6
	Adjustment for IAS 19 pension accrual	-	-	-	-	-	-	-	-	-
	Total Controllable Opex	**89.2**	**87.7**	**90.1**	**91.2**	**93.1**	**92.0**	**92.2**	**91.6**	**727.0**
	UNCERTAIN EXPENDITURE									
	Load Related Capex	-	-	-	-	-	-	-	-	-
	Asset Replacement Capex	-	-	-	-	-	-	-	-	-
	Other Capex	- 5.0	- 1.7	1.3	- 3.4	- 6.0	- 14.6	22.5	19.8	12.9
	Total Uncertain Capex	**- 5.0**	**- 1.7**	**1.3**	**- 3.4**	**- 6.0**	**- 14.6**	**22.5**	**19.8**	**12.9**
	Controllable Opex	**5.3**	**3.6**	**2.1**	**2.5**	**6.3**	**6.4**	**4.0**	**1.3**	**31.5**
TO	**TOTEX**	**272.3**	**268.1**	**245.9**	**250.5**	**310.6**	**271.7**	**238.9**	**207.4**	**2,065.3**
SO	**Non Operational capex**	**70.2**	**42.5**	**36.1**	**36.5**	**35.8**	**40.4**	**39.4**	**30.7**	**331.7**
	Direct costs	57.9	60.8	66.6	68.4	62.5	66.1	67.3	66.4	515.9
	Business Support	-	-	-	0.1	0.4	1.7	2.8	4.5	9.5
	Adjustment for IAS 19 pension accrual									-
	Controllable Opex	**57.9**	**60.8**	**66.6**	**68.5**	**62.9**	**67.8**	**70.1**	**70.9**	**525.4**
SO	**TOTEX**	**128.1**	**103.2**	**102.6**	**105.0**	**98.7**	**108.2**	**109.5**	**101.6**	**857.0**

Variance Actual/Forecast v Allowances

		Variance to Allowance								
		2014	2015	2016	2017	2018	2019	2020	2021	Total
	Load Related Capex	16.0	6.5	0.1	- 0.4	5.1	4.2	- 15.1	- 15.5	0.8
TO	Asset Replacement Capex	50.8	73.4	46.5	31.0	29.8	19.7	13.1	9.0	273.2
	Other Capex	1.6	- 13.5	- 16.7	0.6	- 4.3	- 8.1	- 51.8	- 17.5	- 109.8
	Non Operational capex	- 0.3	- 0.4	- 5.9	- 15.5	- 11.5	- 16.4	- 16.0	- 6.9	- 73.0
	Total Capex	**68.0**	**66.1**	**23.9**	**15.6**	**19.0**	**- 0.6**	**- 69.9**	**- 31.0**	**91.2**
	Faults	- 1.1	1.8	5.3	4.1	3.7	1.0	2.5	2.8	19.9
	Planned Inspections and Maintenance	2.7	1.0	4.8	1.7	4.0	5.3	7.3	7.4	34.2
	Other direct costs	10.3	2.3	3.9	5.0	5.6	3.1	3.3	2.4	35.8
	Closely Associated Indirect Costs	- 3.9	- 0.2	- 4.4	- 10.5	- 11.6	- 24.9	- 15.3	- 10.7	- 81.6
	Business Support	- 5.7	- 8.3	- 11.4	- 13.4	- 18.6	- 19.9	- 16.6	- 16.2	- 110.0
	Adjustment for IAS 19 pension accrual	0.7	- 0.3	0.2	0.8	- 1.0	10.1	-	-	10.5
	Total Controllable Opex	**2.9**	**- 3.6**	**- 1.6**	**- 12.3**	**- 18.0**	**- 25.4**	**- 18.9**	**- 14.2**	**- 91.1**
	UNCERTAIN EXPENDITURE									
	Load Related Capex	-	-	-	-	-	-	-	-	-
	Asset Replacement Capex	-	- 5.0	- 3.2	- 32.9	- 56.3	- 41.7	- 28.3	- 13.5	- 180.8
	Other Capex	- 45.2	- 27.8	- 14.6	- 7.7	- 29.4	- 41.9	- 5.6	9.8	- 162.4
	Total Uncertain Capex	**- 45.2**	**- 32.9**	**- 17.7**	**- 40.5**	**- 85.6**	**- 83.6**	**- 33.9**	**- 3.7**	**- 343.2**
	Controllable Opex	- 1.5	- 1.2	- 4.6	- 6.0	- 4.6	- 2.3	- 3.4	- 5.7	- 29.2
TO	**TOTEX**	**24.3**	**28.4**	**- 0.0**	**- 43.2**	**- 89.2**	**- 111.9**	**- 126.1**	**- 54.6**	**- 372.3**
SO	**Non Operational capex**	47.0	6.6	- 10.9	1.3	8.5	7.7	- 4.4	- 0.4	55.5
	Direct costs	27.1	25.0	29.4	32.8	26.4	30.2	29.6	35.2	235.6
	Business Support	- 15.2	- 14.0	- 15.8	- 16.8	- 15.4	- 18.1	- 22.6	- 20.1	- 138.1
	Adjustment for IAS 19 pension accrual	0.4	- 0.2	0.2	0.6	- 0.6	- 0.3	-	-	0.1
	Controllable Opex	3.1	- 0.3	4.0	5.5	1.1	6.2	0.8	7.2	97.6
SO	**TOTEX**	**50.1**	**6.3**	**- 6.9**	**6.8**	**9.6**	**13.9**	**- 3.7**	**6.8**	**153.2**

Appendix II – Published Outputs

Totex
National Grid Gas Transmission
2018/19

2.5 Published Outputs

1. Stakeholder Satisfaction

	2014	2015	2016	2017	2018	2019	2020	2021
NGGT Customer survey - baseline	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
NGGT Customer survey - score	7.2	7.6	7.6	8.0	7.6	7.8	-	-
Stakeholder survey - baseline	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
Stakeholder survey - score	7.8	7.9	8.0	8.0	8.0	8.1	-	-

2. Incremental Capacity

	2014	2015	2016	2017	2018	2019	2020	2021
Signals for incremental capacity (GWh/day)								
Entry								
Exit								
PARCA Termination Value (£m)	0.0	0.0	0.0	(0.0)	(0.1)	0.0	0.0	0.0

3. Gas Constraints

	2019
Constraint management revenues - Entry	1.3
Constraint management revenues - Exit	0.9
Constraint management costs - Entry	0.0
Constraint management costs - Exit	0.0

Legal disclaimer

This document contains certain statements that are neither reported financial results nor other historical information. These statements are forward-looking statements within the meaning of Section 27A of the Securities Act of 1933, as amended, and Section 21E of the Securities Exchange Act of 1934, as amended.

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