nationalgridESO

National Grid Electricity System Operator (NGESO)

Our Performance 2020 - 2021

Regulatory Report

September 2021

Foreword

Our annual Regulatory Report provides an overview of how the business has delivered on its regulatory obligations and supported the industry's consumer priorities. Here we set out a range of financial data and our cost control measures as well as performance metrics such as Reliability of Supply to demonstrate how ESO is performing.

ESO Mission

Our mission is to enable the transformation to a sustainable energy system and ensure the delivery of reliable, affordable energy for all consumers.

As the Electricity System Operator (ESO) for Great Britain, we sit at the heart of the energy system, balancing electricity supply and demand every second. We keep the lights on and the electricity flowing directly where it is needed. Millions of people rely on us every day to deliver safe, secure, and reliable electricity. As the energy landscape continues to evolve, we carry on investing and innovating with our stakeholders to tackle Great Britain's most pressing energy challenges. We remain committed to our mission to operate the electricity system of the future, and to playing our part in supporting the UK's net zero by 2050 ambition.

The Annual Performance Report is a requirement of our Regulatory Reporting Pack (RRP), in line with the Regulatory Instructions and Guidance (RIGs). The aim of this report is to highlight the work that we have carried out in 2020/21 as we have come to the end of RIIO-1 and outlines our plan moving forward into RIIO-2.

I would like to share with you in this report how we drive our performance to ensure we deliver high levels of reliability, efficiencies to further reduce our costs, and improve our customer and stakeholder satisfaction. The outputs we delivered in RIIO-1 have laid a foundation of success which our highly ambitious RIIO-2 plans build on. We look forward to working with our stakeholders to keep the electricity system secure, reliable, and cost effective for the benefit of future consumers.

I hope you find this report useful and welcome your feedback on how we can improve our reporting in the future.

Fintan Slye

Executive Director

Electricity System Operator

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Who we are and what we do

Who we are

As National Grid Electricity System Operator (NGESO), we make sure that Great Britain has the essential energy it needs by making sure supply meets demand every second of every day.

We work with industry to plan for future requirements of the electricity system. This ensures we are prepared for every eventuality and so we look up to 30 years ahead. In doing this we can provide the control room with the tools they need to balance the system.

The electricity industry is governed by a set of rules and codes which form the framework and rules for operating the transmission network. We work with industry to ensure the rules that govern the industry are fit for purpose. We also forecast charges for use of the transmission network which allows network users to plan their businesses.

The industry is changing at a rapid pace and this provides opportunities to deliver consumer benefits. To enable this to happen we need smart solutions, marketplaces and a level playing field for all. We want our stakeholders to see that we are impartial and so provide transparency on our governance and decision-making. We also want to break down barriers to realise value and work to ensure everyone benefits from the energy transformation. We play an essential role in enabling the transition to a more sustainable future.

What we do

National Grid ESO moves high voltage electricity from where it's generated, such as a wind farm, through the energy system.

Using the infrastructure owned by the 3 transmission companies - National Grid Electricity Transmission (NGET), Scottish Hydro Electric Transmission Ltd. and SP Energy Networks, this high voltage electricity is passed onto one of the fourteen Distribution Network Operators (DNOs) across the country. They own the local networks and convert electricity into a lower voltage that's suited for domestic use. Your local distribution network operator then feeds low voltage electricity through to your home or business property. We don't generate or sell electricity, but our role is to ensure homes and businesses have the power they need whenever it's needed. It might sound simple but it's a complicated job to deliver electricity every single minute of every single day, making sure that demand and supply are always balanced.

The energy system in Britain is transitioning to a low carbon future with new, smaller, and more diverse parties entering the market. Our unique position operating the National Electricity Transmission System (NETS) gives us the perspective and reach to play a pivotal role in this transformation.

The rules we are governed by

NGESO is required, as part of its licence, to plan, develop and operate the NETS in accordance with the System Security and Quality of Supply Standard (SQSS). The SQSS sets out the criteria and methodologies for planning and operation of the NETS.

NGESO is also required under its licence to comply with the Grid Code. The Grid Code is the technical code for connection and development of the NETS. It sets out the operating procedures and principles governing the relationship between NGESO and Users of the NETS, including Generators.

How we are regulated

We are regulated by Ofgem. Ofgem makes sure we're delivering value for existing and future consumers while supporting the transition to a more decentralised and decarbonised electricity system. One of the ways Ofgem does this is by setting regulatory price controls – these detail the services we'll provide and the amount we can recover from consumers for delivering them.

The services we provide and investment we need is informed by our own work and what our stakeholders think we should deliver. Our business plans are then reviewed by Ofgem to determine our allowed revenue and how our performance will be evaluated.

RIIO

Ofgem's regulatory framework is known as RIIO (Revenue = Incentives + Innovation + Outputs). The RIIO model offers energy companies incentives for securing investment and driving innovation, so they can develop sustainable energy networks and system operation services at the right cost for current and future consumers.

As of 1 April 2021, we transitioned into the second regulatory period under the new RIIO regulatory framework, known as RIIO-2, which will run up to 31 March 2026. The previous regulatory period, known as RIIO-1, ran between 1 April 2013 to 31 March 2021.

As we have moved into the RIIO-2 price control period we have started our activities set out in the RIIO-2 Business Plan to facilitate the transition to a zero-carbon power system, helping to facilitate the UK's commitment to net zero emissions by 2050. Our extensive engagement with stakeholders, customers and consumers will continue to help us develop our role during a time of significant change. Under the bespoke regulatory model, we will continue to deliver energy safely, and reliably, and play our part in driving decarbonisation – the challenge of a generation. We estimate that

delivery of the proposed new activities will generate net benefits of around £2 billion for consumers over the five-year RIIO-2 period.

We recognise that delivering the ambitious outputs that stakeholders want will require significant change within the ESO. Our capabilities and culture must evolve as we become an organisation at the cutting-edge of technology, trusted by the industry, consumers and citizens to facilitate the energy transition.

At the end of the RIIO-1 period we started dedicated activities to prepare the business for RIIO-2 and ensure we are set up to successfully deliver our business plan.

The future

As the System Operator, we produce various publications as a result of stakeholder engagement. These documents set out what we believe the future of the whole energy system will look like, and what we are proposing to deliver for consumers, across three different timeframes.

- RIIO-2 Business Plan sets out how we will enable the transformation to a zero carbon energy system and continue to ensure reliable, affordable energy for Great Britain by 2050. The plan establishes the activities we'll deliver to achieve our ambitions, the investments we'll make to meet net zero targets, how we'll innovate for the future and the performance outcomes upon which we'll be measured.
- Our Towards 2030 document builds on our Future Energy Scenarios to identify what a decarbonised 2050 energy landscape might look like, and uses this to help us understand the energy system of 2030. The next decade towards 2030 is vital and the decisions we take today will pave the way to a new energy era.
- Our Bridging the Gap to Net Zero publication takes a closer look at what needs to be done to reach the UK's 2050 net zero target. We identify and investigate the areas from our recent future energy scenarios publication that we consider to be the most important and the most uncertain and bring together a wide range of stakeholders to progress the debate and recommend actions for policymakers and industry to move towards net zero.

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Our Performance

2020 – 2021

Revenue and costs

RIIO-1 totex performance vs allowances

We have published the below tables to show our actual spend for the full RIIO-1 period. Table 1 shows our actual total expenditure (Totex), which includes both our capital expenditure (Capex) and our operational expenditure (Opex)[1]. Table 2 shows our adjusted allowances[2] for the RIIO-1 period and Table 3 shows the difference between costs and adjusted allowances with negative numbers indicating that costs exceed allowances.

Table 1: Actual Expenditure (2020/21 Prices)

2.4 (a) Actual Expenditure (£m, 2020/21 Prices)		Actual								
		2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	Total
SO	**Non-Operational capex**	43.93	46.93	45.60	61.44	66.45	80.82	88.63	88.42	522.22
	Direct costs	65.44	61.71	65.32	70.68	70.89	71.99	74.88	71.75	552.66
	Business Support	47.46	45.65	47.52	49.41	56.85	75.65	56.49	49.69	428.72
	Adjustment for IAS 19 pension accrual	-1.11	0.79	-0.44	-1.14	-0.77	-0.81	0.19	1.28	-2.01
	Controllable Opex	111.78	108.15	112.40	118.94	126.98	146.84	131.56	122.72	979.37
SO	**TOTEX**	**155.71**	**155.08**	**158.00**	**180.38**	**193.43**	**227.66**	**220.18**	**211.15**	**1,501.59**

Table 2: Total Allowances (2020/21 Prices)

2.4 (a) Total Allowances (£m, 2020/21 Prices)		RIIO-1 Allowances								
		2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	Total
SO	**Non-Operational capex**	70.90	49.76	47.11	47.57	57.91	70.59	51.60	44.55	439.99
	Direct costs	55.97	58.76	66.82	69.29	68.74	68.63	81.24	85.63	555.08
	Business Support	45.08	47.62	49.78	55.25	60.66	81.42	56.02	58.29	454.11
	Controllable Opex	101.05	106.38	116.61	124.54	129.40	150.05	137.26	143.92	1,009.19
SO	**TOTEX**	**171.95**	**156.14**	**163.72**	**172.11**	**187.30**	**220.63**	**188.86**	**188.47**	**1,449.18**

Table 3: Variance between Actual and Allowances (2020/21) Prices

2.4 (a) Variance Actual v Allowances (£m, 2020/21 Prices)		Variance to Allowance								
		2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	Total
SO	**Non-Operational capex**	26.97	2.82	1.52	-13.87	-8.55	-10.23	-37.03	-43.87	-82.23
	Direct costs	-8.83	-3.40	1.76	-0.72	-1.72	-2.97	6.26	13.12	3.49
	Business Support	-1.91	1.63	2.45	6.31	4.14	6.18	-0.55	8.08	26.33
	Controllable Opex	-10.73	-1.77	4.20	5.59	2.42	3.21	5.70	21.20	29.82
SO	**TOTEX**	**16.24**	**1.06**	**5.72**	**-8.28**	**-6.13**	**-7.02**	**-31.32**	**-22.67**	**-52.41**

[1] Capex is broadly the costs incurred in building new assets and replacing existing ones. For the ESO this is mainly IT systems. Opex is broadly the costs incurred for running day to day activities and maintaining IT systems.
Totex is the sum of Capex and Opex. It represents the total cost of expenditure.

[2] This figure is after alignment of allowance categorisation to be consistent with treatment of spend

Revenue

Total Balancing Services Use of System (BSUoS) revenue in 2020/21 was £2,027.6m. This comprised of £1,804.9m with respect to External Balancing Costs and £222.7m covering Internal System Operator costs. Total external balancing costs during the year included £43.1m of costs which in error were not billed to customers in the 2020/21 billing run. These costs are not included in our regulatory reported revenues as the costs will be billed to customers through 2021/22 tariffs.

As a result of higher balancing costs driven by unexpected demand changes due to the Covid-19 pandemic, on 23 June 2020 Ofgem approved a CUSC modification (CMP345) to cap BSUoS charges at £15MW/h over the period 25 June to 31 August. A subsequent modification was approved on 13 August 2020, lowering the cap to £10MW/h and extending the period to the 25 October 2020. The result of these modifications has been to defer £21.2m of balancing costs to be recovered though tariffs in 2021/22.

Our internal revenue of £222.7m was £80.3m lower than the prior year where we received revenue for backdated additional allowances for the 2018 Enhanced Security Re-opener and ESO legal separation.

Overview of Opex & Capex

Our overall total expenditure for the RIIO-1 period is £1,501.6m against allowances of £1,449.2m, meaning that over this price control period actual costs are £52.4m higher than allowances. This is a decrease of £10.5m from last year's forecast position.

We spent £122.7m on opex in 2020/21, which was £8.8m lower than in 2019/20. The primary driver for lower spend was a £10.0m decrease in restructuring costs now that we have largely delivered our multi-year efficiency programme. There were also lower costs due to less RIIO-2 activity and reduced travel due to Covid-19. These lower costs were partly offset by increased costs in scoping out new roles in early competition and offshore co-ordination.

2020/21 Investment Summary

During the year, the total capex expenditure was £88.4m, decreasing marginally by £0.2m from the previous year. Spend was £0.9m higher than our prior forecast.

We continued to invest in, and maintain, critical IT infrastructure for Great Britain's electricity system, and to innovate in order to anticipate and respond to new demands in technology in de-carbonisation, de-centralisation, and digitalisation to drive significant change across the energy sector. We have also invested in technology to help support the business to meet its needs during Covid-19.

CNI Data Centres spend continued through 2020/21 and all RIIO-1 deliverables were completed by the end of the year. Other key expenditure has been in European Future Energy Regulations, PAS and Shared Services Systems. Key areas of expenditure in 2020/21 were:

European Future Energy Regulations £20.2m

Spend on project TERRE and European Future Energy Regulation has been extensive in 2020/21 as we continued with the developments to implement EU Obligations in Great Britain. TERRE is a new market that has a significant impact on multiple systems and processes across the ESO landscape.

The TERRE programme deployment was paused as a result of the revised legal agreements with the EU following BREXIT. The remaining credible option, having been agreed via the industry working group including BEIS and Ofgem, was to carry out a revised cost-benefit analysis on implementing a GB only version of the replacement reserve product. The outcome of this analysis is due in Q3 FY22 and will be presented back to industry to consider next steps.

CNI Data Centres £10.9m

All Electricity enabling infrastructure has been built and tested. It is now in operational support, with National Grid's CNI support team and partners as of March 2021, following a period of stability and Early Life Support. The CNI Wide Area Network (WAN) / Dark Fibre network is fully connected and tested and handed over into operational support and maintenance as of March 2021.

The Electricity Migration strategy is complete and approved as of January 2021. All ESO RIIO-1 objectives have now been met.

Platform for Ancillary Services (PAS) £9.0m

The programme has incurred its highest level of spend in 2020/21 with delivery in three main areas; Settlements, Dispatch and Contracts.

We mobilised the replacement of our existing Settlements system, with the programme initiating in January 2021. Initial costs associated with the programme predominantly cover core infrastructure licensing costs. This major replacement will continue throughout FY22 and FY23 and will provide the ESO with a system that is capable of handling an increasing volume of market participants, as well as supporting the introduction of multiple new services.

There has also been continued spend on PAS Dispatch and Contracts which includes incremental updates to the platform in line with regulatory obligations. Improvements have also been made to the system to support the delivery of consumer benefit and control from the Electricity Control Centres.

Shared Services Systems £9.0m

Extensive work has continued on the My Finance programme, which will deliver the second phase of our transition to a new S4 Hana Enterprise Resource Planning (ERP) system. This second phase will go live in July 2021 and will deliver enhanced project functionality as well as significant reporting and governance improvements.

Infrastructure for Business Systems £5.3m

During the year, we made investments in relation to Infrastructure and Business Systems which was in response to the pandemic and to improve our technology. Costs incurred have predominately been on a Windows upgrade to ensure all staff working remotely had the latest technology to perform their duties accordingly. We also invested in Hyper Converged performance platforms to enable the transition to the cloud, and a new Data Protection suite.

Transmission Outage and Generator Availability (TOGA) £5.3m

TOGA is an ESO owned system used across the electricity industry to comply with the operational planning Grid Code obligations for transmission asset outage management and generator availability. The major replacement of TOGA was completed in September 2021.

The eGAMA (electricity Generator Availability Margin Analysis) system went live in March 2021 and eNAMS (electricity Network Access Management System) went live in September 2021. These new systems will provide improved customer satisfaction and significant functional and system performance improvements.

Electricity Market Reform (EMR) £5.0m

We implemented significant regulatory change to the EMR portal to facilitate government objectives to restore the Capacity Market following suspension. In addition to the regulatory changes for restoration, change was also implemented for regulatory easements made due to Covid-19.

There was also a significant level of customer driven improvements. To improve the customer experience and query management further, we implemented a Customer Relationship Management system (CRM). This delivered workflow management systems to enable the processing of Capacity Market assessments remotely. Finally, the first phases of strategic development were undertaken to support the ESO commitment to deliver a new EMR portal in RIIO-2.

Future Balancing £3.5m

We continued to invest in Future Balancing through foundation design work in preparation for the transformation of the balancing suite of capabilities in RIIO-2.

Security and Risk £3.5m

We continued to invest in our Security and Risk projects and remained focused on addressing advancing cyber threats. We have successfully completed and delivered all outputs set out in the May 2018 Enhanced Security Costs Re-opener in the RIIO-1 period.

RIIO-1 Investment Performance

Capex spend over the full RIIO-1 period was £522.2m, which is £82.2m higher than allowances. Annual spend has doubled over the RIIO-1 period in real terms with spend of £43.9m in 2013/14 compared to £88.4m in 2020/21. This is driven by our significant investment in implementing EU obligations, increasing levels of investment in data centre and cyber security and the development of new IT systems to support our increasingly complex energy balancing role.

Outputs

Customer and stakeholder

In 2020-21 NGESO introduced a segmented approach to insight gathering to ensure we get more meaningful feedback from all our customers. This has helped us improve the customer experience in a more targeted way and shows progress towards our ambition of being a Trusted Partner by 2025.

For this we used the existing SAT process (survey collected through an independent third party) to capture an overall view of ESO performance from our Strategic Senior customers. We also included, for the first-time, questions that captured how well we were performing on “trust”, looking at credibility (does the ESO have the right knowledge), reliability (do we deliver on time), familiarity (do we know our customers’ needs) and self-interest (do we understand how we impact customers businesses).

Alongside this, we utilised an internal survey tool (Qualtrics) to capture feedback from our operational customers throughout the year. Capturing improvements, we could make to day to day processes and projects in a more agile way.

Finally, we also increased the use of our CRM system (Salesforce) to manage our day to day queries, helping ensure more timely response and give visibility across the business of which teams were dealing with which customers to enable more joined up responses.

Like last year, we continued to engage with our customers and stakeholders through our website, our publications, consultations, newsletters, engagement forums, webinars, and bilateral meetings. And we continue to use the “you said, we did” approach to playback to our customers what we’ve heard and what we have changed following their feedback.

The key insights we gathered in 2020-21 were that our customers wanted us to be more transparent with our decision making and engage/co-create with them earlier in our projects.

For the year ahead, we have introduced and been working on a new Customer Impact Assessment tool to use at the start of all new projects. This helps identify customer impacts much earlier in our projects and has brought in a more consistent way of working on engagement plans, which consider customers much sooner in our thinking. We are also mapping our key customer journeys to ensure we have considered all customer pain points in our processes and actions we need to take to mitigate.

In 2021-22 we will have a new Roles based aspect to our SATs surveys to allow us and Ofgem to see how customers think we are performing against our Role deliverables. These will happen in September and March and the outputs will form part of the mid and final year incentives report.

Reliability and availability

Every year, we publish a Transmission System Performance Report pursuant to our Standard Licence Condition C17 (Transmission System Security Standard and Quality of Service), detailing

the availability, security, and performance of service of the NETS. Further detail on each of the transmission networks can be found in the Transmission System Performance Report. The detail in this Annual Report refers to the overall performance of the National Electricity Transmission System. The NETS in Great Britain is comprised of both onshore and offshore transmission networks. The onshore transmission networks are owned by National Grid Electricity Transmission in England and Wales, SP Transmission plc (SPT) in south and central Scotland and Scottish Hydro Electric Transmission plc (SHE Transmission) in the north of Scotland. We are the National Electricity Transmission System Operator (NETSO) for the onshore and offshore transmission networks

Availability: Annual System Availability

Annual System Availability of the NETS for 2020-21 was 94.50%.

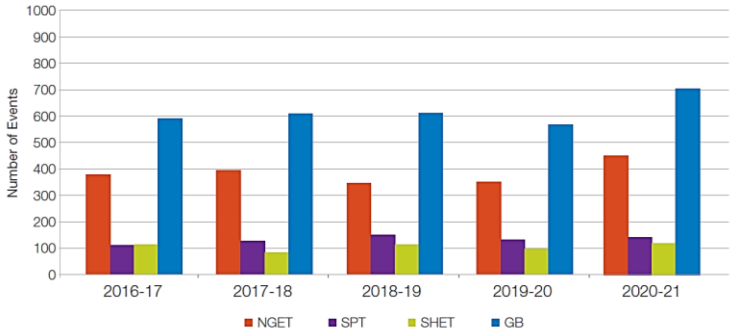
GB % Annual System Availability				
2016-17	**2017-18**	**2018-19**	**2019-20**	**2020-21**
94.31	94.44	94.55	94.69	94.50

Security

The Overall Reliability of Supply for the National Electricity Transmission System during 2020-21 was 99.999948%, compared with 99.999967% in 2019-20 and 99.999967% in 2018-19.

During 2020-21 there were 706 NETS events where transmission circuits were disconnected either automatically or by urgent manual switching. The vast majority of these events had no impact on electricity users with only 25 resulting in loss of supplies to customers.

GB System Events



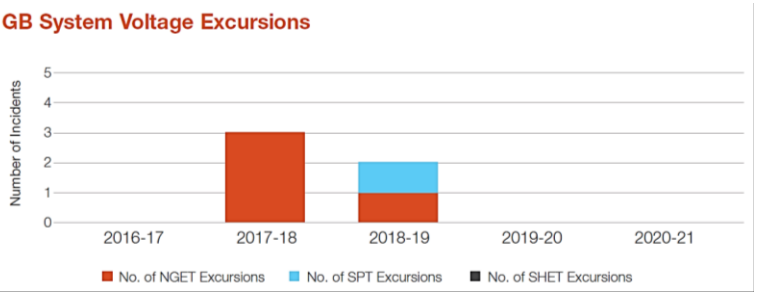
GB System Events					
	2016-17	2017-18	2018-19	2019-20	2020-21
NGET	379	398	347	355	455
SPT	108	124	157	131	138
SHET	109	85	108	100	113
GB	596	607	612	586	706

Quality of service

Quality of service is measured with reference to system Voltage and Frequency.

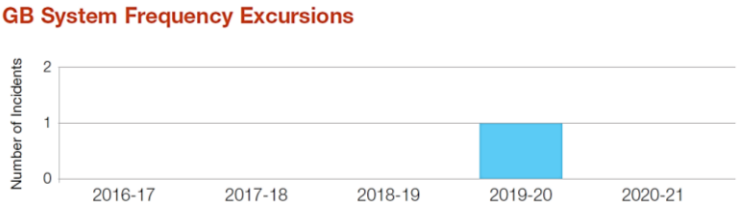
Voltage excursions: During 2020-21 there were no reportable Voltage Excursions within the National Electricity Transmission System. The chart below summarises the reportable Voltage Excursions that have occurred on the National Electricity Transmission System.

GB System – Voltage Excursions					
	2016-17	2017-18	2018-19	2019-20	2020-21
Number of NGET Excursions	0	3	1	0	0
Number of SPT Excursions	0	0	1	0	0
Number of SHET Excursions	0	0	0	0	0



Frequency excursions: During 2020-21, there were no reportable Frequency Excursion within the National Electricity Transmission System. The previous Frequency Excursions were in the 2019-20 and 2008-09 reporting period.

GB System – Frequency Excursions					
	2016-17	2017-18	2018-19	2019-20	2020-21
Number of Excursions	0	0	0	1	0



Safety

The safety of our employees is of paramount importance. Our Safety strategy has a focus on the three key components of Behavioural, Occupational and Process safety. We undertake safety surveys with our employees to provide insights to gauge attitudes to safety, to understand how effective our safety culture is and to identify where employees believe we can improve. We also measure safety using the Lost Time Injury Frequency Rate metric. This industry standard approach measures the number of lost time injuries occurring for every 100,000 hours worked.

Target: Lost Time Injury Frequency Rate 0.10
Performance: 0.00

Despite the challenging nature of the pandemic, performance was positive with no lost time injuries recorded. Key insights from the employee safety survey demonstrate positive steps towards achieving our safety ambition with a score of 6.45 (against a target of 7 by end of 2022). In comparison to the previous year, improvements were made in all survey categories. The safety

survey is used to inform and drive our safety initiatives and targets and employees stated that the person they report to truly cares about their safety. Responses also show employees felt management act fairly towards employees involved in incidents, accidents, and injuries.

Whilst improvements have been made since 2019, there are some opportunity areas around ensuring safety feedback is prioritised over budget, reliability, and schedule. It was also indicated that safety discussions are generally reactive, and a greater focus is required on promoting positive news stories

The ESO Health Safety and Wellbeing team are working with local Health, Safety and Wellbeing Champions to develop targeted plans to address the areas of concern and build on the work done to date.

Environmental Performance

As a Group (plc) we have set a voluntary target to reduce our Scope 1 and Scope 2 Greenhouse Gas (GHG) emissions across our UK and US businesses by 80% by 2030 based on 1990 levels. Our baseline emissions level was set, at group level, at 21.6m tonnes of carbon dioxide equivalent. We have achieved a group reduction of 68% against our 1990 baseline. In the longer-term we have targets to reduce our GHG emissions by 90% by 2040 and net-zero by 2050. All business units contribute to this group target and ESO form a relatively small proportion of our group emissions.

Scope 1 and 2 emissions in Electricity System Operator are from energy consumption in offices and transport use. Scope 3 emissions are from transport use.

In 2020/21 ESO scope 1, 2 and 3 emissions are 0.35 kTCO2e, 1.06kTCo2e and 0.04 kTCO2e respectively in comparison to 1.2kTCO2e, 1.1kTCo2e and 0.6kTCO2e respectively for 2019/20. These reductions have mostly been driven by the reduction in business transport and electricity usage due to Covid-19 restrictions and the smaller ‘form of control’ allocation attributed to ESO compared with other entities this year. This means that a smaller portion of the emissions have been allocated to ESO.

As a group (plc) 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 2020 (for 2019/20) we achieved an ‘A’ rating for our CDP climate change submission, putting us in the top 3% of global companies recognised for our actions to reduce emissions and mitigate climate change. This is the 5th consecutive year we have achieved this A rating. We also retained a Supplier Engagement Rating of ‘A’ recognising our supply chain leadership around climate-change.

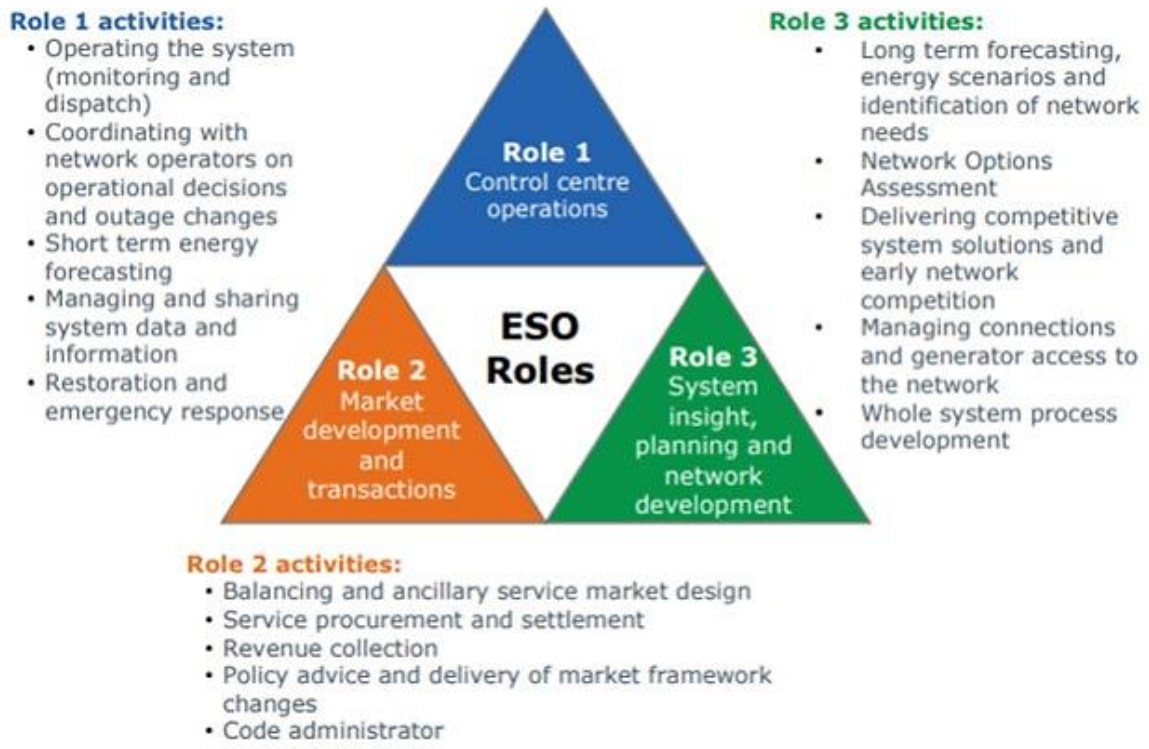
Incentives Performance

ESO Incentive Scheme

Ofgem's regulatory and incentives framework for the ESO is designed to ensure the ESO proactively identifies how it can maximise consumer benefits across the full range of its activities. These arrangements are detailed in the Electricity System Operator Reporting and Incentive Arrangements (ESORI) guidance document and in the ESO's licence (for 2020-21 this was in Special Condition 4M, although it is Special Condition 4.3 under RIIO-2), and include:

- Defining 3 roles for the ESO,
- A requirement to develop Forward Plans with industry (which will be Business Plans under RIIO-2),
- The publication of regular performance reports,
- The role of the Performance Panel, and
- The operation of the evaluative incentive scheme, including how a financial outcome is determined

The ESORI arrangements divide the ESO's activities into three roles, which are given equal weighting in the incentive scheme. The activities which fit into each role are set out below.



2020-21 represents the last year of the RIIO-1 regulatory period, and in line with the requirements of the ESORI guidance the ESO published an End of Year Report in May 2021 (consisting of an

Executive Summary and more detailed Evidence Chapters), and in June 2021 an End of Year Event took place where stakeholders and the Performance Panel had the opportunity to hear the ESO discuss its performance and ask questions.

In March 2020, the ESO set out its planned activities for the 2020-21 year in a Forward Plan, which was developed in consultation with stakeholders. However, the 2020-21 year was characterised by the Covid-19 pandemic, the incentive reports describe how the ESO acted quickly to ensure that the electricity system remained operable whilst demands were low, whilst protecting its customers from unexpected charges. These activities included developing several new products and services to ensure that the system remained operable during periods of low demand.

These additional activities led to some re-prioritisation, and the ESO produced a Forward Plan Addendum in July 2020 to provide transparency of the revised timelines. From July 2020 onwards, the ESO's incentive reports for 2020-21 measured its progress against the Forward Plan Addendum.

Despite the challenges caused by Covid-19, the ESO still delivered over three quarters of the activities set out in the Forward Plan Addendum for 2020-21. Key deliverables which were described in the incentive reports include:

- Go-live for Dynamic Containment, and subsequently making improvements (such as stacking) in response to stakeholder feedback,
- ESO reached key milestones for the Pathfinder projects: ESO invited expressions of interest for the Constraint Management and Stability Phase 2 Pathfinders and launched a tender for the Pennines voltage Pathfinder. Lessons learned are regularly captured and fed into future Pathfinders,
- Making good progress on the Loss of Mains programme, with over 16 GW of distributed generation now engaged in the programme, and ESO is now on track to deliver savings this summer - more than 12 months before the programme's compliance deadline in August 2022,
- Publishing a wide range of insights documents, including the Future Energy Scenarios (FES), Electricity Ten Year Statement (ETYS), Network Options Assessment (NOA) and Operability Strategy Report,
- ESO "joined the dots" between different market reforms in response to stakeholder feedback, publishing the ESO Markets Roadmap to 2025 and hosting a week-long stakeholder event, and
- Providing increased transparency of ESO actions, hosting a weekly ESO transparency forum, and publishing numerous data sets on the Data Portal.

The experience of operating the system during the Covid-19 lockdowns has provided valuable learning points, not just for business continuity but also for system operation. This has provided

useful insight to the ESO as it prepares to be able to operate the system with a higher proportion of renewable generation as the UK progresses towards Net Zero.

Following the publication of ESO's End of Year report for 2020-21, Ofgem published its decision on ESO's financial incentive for 2020-21 on 30 July, in line with Special Licence Condition 4M. Ofgem directed that the ESO will receive a financial incentive of £5m for 2020-21.

This is higher than the reward ESO received in previous years of this incentive scheme, and we are pleased that Ofgem and the Panel recognised our successful operation of the system during the Covid-19 pandemic, as well as our response to the feedback given by the Panel and Ofgem at the mid-year stage. We welcome Ofgem's view that the ESO's overall performance has improved each year since the introduction of the ESO's evaluative incentive scheme in 2018, and that our work during 2020-21 provides a strong foundation for our RIIO-2 plans.

Financial Incentives on EMR

During the RIIO-1 period, we have had specific incentives in our role as Electricity Market Reform (EMR) Delivery Body (Special Licence Condition 2.1). In the Capacity Market (CM), the EMR Delivery Body is incentivised to forecast peak demand which then feeds into the capacity to procure in the T-1 and T-4 auctions. Due to unforeseen impacts of the Covid-19 pandemic and associated Government interventions, the size, and patterns of demand in 2020/21 have been significantly impacted. We have been discussing with Ofgem how the impact of the pandemic has affected electricity demand and the peak demand calculations. These discussions with Ofgem are continuing.

In addition, the EMR Delivery Body has implemented improvements to the CM prequalification processes. This has driven an increase in first time prequalification for the CM which was the result of enhanced engagement, customer guidance, and improvements to query management. There was an increase in the number of disputed prequalification decisions which was partly due to the complexity of some of the rule changes during 2020/21, particularly regarding emissions limits. For the CM, we achieved a customer satisfaction score of 6.35 out of 10 and we are working with customers and delivery partners in order to significantly improve customer satisfaction going forward. In order to address the feedback and improve customer satisfaction, we have formed a Customer Focus Group within the EMR Delivery Body with champions representing all EMR teams. The group will formulate an action plan and drive through improvements. We have also created a customer group with representation from across industry to help inform our EMR portal replacement and ensure that customer needs and suggestions are at the centre of this project.

No Contracts for Difference (CfD) round was held during 2020/21, but the EMR Delivery Body has been working with BEIS and other delivery partners to prepare for CfD Allocation Round 4, which is due to open later in 2021.

Innovation

We make sure that the electricity network operates safely and efficiently around the clock, so that homes, businesses, and industry always have the power they need.

We're also helping to tackle one of the biggest challenges facing society: how to create a sustainable, low-carbon electricity system for the future, that will help the UK meet its net zero commitments. Innovation plays a vital role in this effort, which is why we're working with partners from the energy industry and beyond to harness new technologies, markets, and ways of working to support the energy transition.

Our innovation portfolio features a novel range of projects funded by Ofgem, through the Network Innovation Allowance (NIA) and Network Innovation Competition (NIC). This funding gives our business, and the people who work with us, the freedom to develop ideas in a way that wouldn't be possible in normal business operations. It allows us to test emerging technologies, or research and develop new systems and methods. We can also figure out how to deliver the biggest benefits at reduced costs, while providing reliable, low-carbon energy for the electricity system and consumers.

In preparation of our transition into the RIIO-2 framework, we carried out a fundamental innovation strategy review. Our refreshed 2021/22 Innovation Strategy sets out our innovation priorities for the first year of our RIIO-2 regulatory period.

2020/21 Performance

In 2020/21 the Electricity System Operator spent £4.671m NIC expenditure. Four eligible NIC projects were progressed in the year, two of these are ESO led, TDI 2.0 (known as Power Potential) and Black Start from DER (known as Distributed Restart). We have also provided input into and receive NIC funding for two other projects, Phoenix that is led by Scottish Power Energy Networks and Electricity Flexibility and Forecasting System (EFFS) that is led by Western Power Distribution.

The net costs at year end for these projects are reported in table 3.14. By agreement, invoicing for Phoenix and EFFS is done ex post so there is a time lag between costs incurred and costs recovered.

The impact of Covid-19 on the electricity system has been stark. Exceptionally low levels of demand (at times, 20% below expected levels) have brought on system conditions that we did not expect to see for several more years. Whilst it has been challenging, we have seen a fantastic acceleration in decarbonisation. 2020 was the greenest year on record for Britain's electricity system, with average

carbon intensity reaching a new low of 181 gCO2/kWh. May 2020 saw both the greenest month on record (average carbon intensity 143 gCO2/kWh) and the lowest carbon intensity ever seen on the system – 46 gCO2/kWh on May 24. Our recent Operability Strategy report includes a fascinating case study of a day during this period – the conditions we faced and the actions we needed to take. The resulting operability issues have given us a taste of what the future will look like, and we have had to innovate more quickly than ever before. For example, to help manage frequency during periods of extremely low demand, we rapidly created a new temporary downward flexibility service called ODFM (Optional Downward Flexibility Management).

Innovation is needed now more than ever, to make sure that we manage the safe transition to zero-carbon operation at the lowest possible cost to consumers, now and in the future.

Highlights of 2020/21

There are many highlights from this year, but to name a few:

- We embraced digital and virtual ways of working, not just to run projects, but to run workshops, engage with stakeholders, and we even held our first 100% virtual conference – the Energy Networks Innovation Conference, held in December 2020.
- We worked closely with our DNO colleagues to find market solutions to whole system operability issues: real-world trials started in both our Power Potential and Distributed Restart projects with UK Power Networks (UKPN) and SP Energy Networks (SPEN) respectively; we worked with Western Power Distribution (WPD) to explore optimal design of Active Network Management; and we trialled coordinated procurement of flexibility services with WPD in Centrica's Local Energy Market.
- We started to look more seriously at novel ways to manage rising constraint costs: in 4D Heat we explored the use of electric heat to absorb excess wind in Scotland with Scottish and Southern Electricity Networks (SSEN), and we worked with Form Energy to assess the potential of long-term energy storage solutions to solve transmission constraints. Expect much more work on this topic in the coming year.
- We took great strides in progressing our journey towards our digital transformation. Control REACT is mapping and quantifying the impacts of uncertainty as it permeates through our Control Room systems; we have worked with the University of Melbourne to develop advanced models for system planning under uncertainty. Have a look at our Digitalisation Strategy and Action Plan for more information.

The ESO Innovation Annual Summary provides more information on how we performed against our key strategy areas. The ESO Innovation Strategy sets out how we plan to innovate in 2021/22.

Case Studies

The table below contains a high level summary of the innovation projects we are currently delivering with our partners. Further information on our innovation project portfolio; including project outcomes and benefits; can be found ESO Innovation Annual Summary.

Case Study	Project Overview
Control REACT	Control REACT is a project exploring how data insights can be used by the ESO control room to identify forecast errors and uncertainties to improve operational efficiency of the electricity system.
Advanced Modelling for Network Planning under Uncertainty	This project is helping us to better advise the transmission owners on where their proposed projects and improvements to the network will have the most impact, based on the possible outcomes of different future scenarios.
Frequency Response Auction Trial	This project is trialling an innovative online auction format for the procurement of frequency balancing services, to help ESO move to real time procurement in the future.
4D Heat	The 4D Heat project was established to investigate whether off-mains gas homes in Scotland could use wind power for domestic heating to ease constraint and congestion issues on the network.
Spatial GB Clean Heat Model	This project developed an innovative spatial heat modelling tool to investigate whether local solutions could be used to deliver net zero heat to homes and commercial buildings for maximum cost efficiency and carbon savings.
Mapping the Impacts and Visualization of Risks of extreme weather on system operation (MIVOR)	This project explores the impact that climate change will have on the GB electricity system in the future, and the possible risks we need to plan for.
Phoenix project	This project is focused on the design and roll out of an innovative Hybrid Synchronous Condenser to alleviate some of the major system issues we are encountering as a result of the closure of fossil-fuelled generation.
Power Potential	This world-first project is investigating whether we can use more small-scale renewable energy generators to establish a new reactive power market to help us safely operate the GB

	electricity system, while also generating extra capacity on the network.
Solar PV Monitoring Phase 3	This project set out to discover how we could improve the way we monitor solar generation on the distribution networks, to manage the transmission system better and to save the consumer money.
Distributed ReStart	Distributed Restart is a ground-breaking project exploring whether smaller, renewable energy resources can be used to restore power to the GB electricity system following a blackout.

Uncertainties

Uncertainty mechanisms are used to allow network companies' allowed revenue to change within the price control period. This permits adjustments to allowances in line with changes from forecast. This year we have utilised the following mechanisms allowed for in our Licence.

Enhanced Securities

At the time of setting RIIO-1 allowances, there was uncertainty about the costs relating to compliance with future government recommendations and statutory requirements on the security of IT systems. Ofgem therefore included a reopener mechanism for Enhanced Security Costs in the RIIO-1 price control.

In May 2018, National Grid (NG) submitted a joint reopener application for its gas and electricity transmission licensees under Special Condition 7D of NGETs electricity transmission licence and Special Condition 6D of National Grid Gas Transmission plc's (NGGT) gas transporter licence.

In September 2018, Ofgem set out their decision to increase NG's baseline allowance by £112.9m for Enhanced Security Costs. This includes:

- £76.5m of the £84.8m requested by NG for Data Centre investments.
- £36.4m of the £40.5m requested by NG for Cyber Security (CS) enhancements.

This funding was linked to the delivery of clear outputs to deliver the enhancements as set out in NG's reopener application and to report on the progress of delivery to the Competent Authority (CA).

Following legal separation in April 2019, NGESO and NGGET report separately on the enhanced security projects, with costs allocated between the two organisations and with delivery still being undertaken jointly by shared functions.

We have successfully delivered and completed all the outputs by the end of the RIIO-1 period:

- Covid-19 delayed some interim milestones for the Data Centres projects; however, these were completed by the end of the RIIO-1 period.
- All CS projects were completed, allowing us to start to deliver our RIIO-2 investment plans.

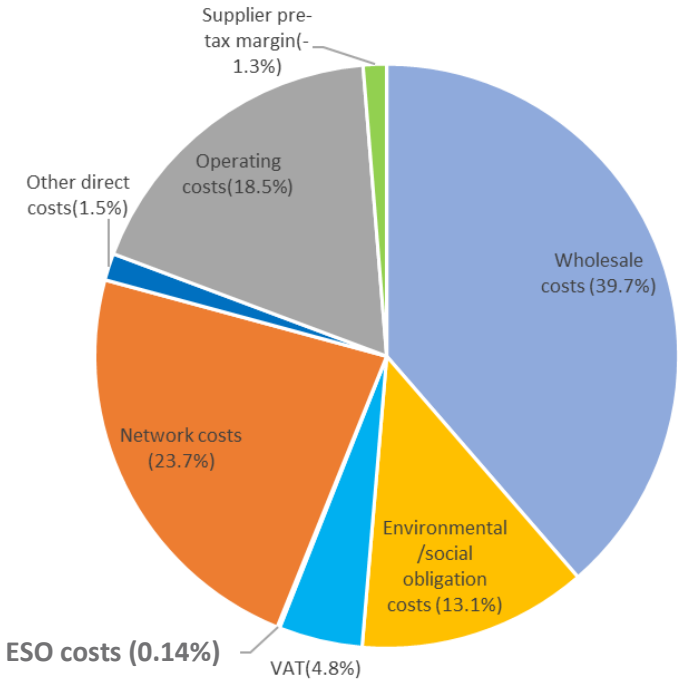
Since the reopener submission, the Network & Information Systems ('NIS') Regulation (2018) introduced obligations on the ESO business to undertake appropriate measures to manage the cyber risks of our network. Last year, we reviewed our Security Organisation and portfolio of investments to ensure we remained focused on addressing advancing cyber threats. The work undertook a deep dive of the state of cyber security controls across both our enterprise and critical infrastructure environments and resulted in a more sophisticated cyber security risk approach. This led to a re-prioritisation of the portfolio projects to address highest-risk areas first and deliver new capability to detect and respond to potential threats more readily.

Breaking Down your Bill

What are you paying for?

Energy bills can sometimes seem complex and it's not always clear what consumers are paying for. Our part of your bill, which is subject to regulatory approval, covers the cost of balancing supply and demand, making sure electricity is always there when you need it.

The below graph shows the different parts that make up the average domestic dual fuel bill[3]. The table below shows our actual contribution to the customer bill.



NGESO actual contribution to the average annual customer bill[4]								
NGESO (£)	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
	0.92	1.07	1.17	1.03	1.10	1.43	2.19	1.61

Therefore, for 2020/21, approximately £1.61 of the typical domestic household bill, or 0.14% of the consumer duel fuel bill costs were attributable to NGESO.

[3] Information sourced from Ofgem: https://www.ofgem.gov.uk/consumers/household-gas-and-electricity-guide/understand-your-gas-and-electricity-bills

[4] Figures based on Ofgem's Typical Domestic Consumption Values of 2.9 MWh/year, as published on Ofgem's website.

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Other Information

Useful information

Contact

If you would like to know more about our incentive scheme, please contact us at box.soincentives.electricity@nationalgrideso.com

If you would like to know more about our innovation projects or want to get involved, please contact us at box.SO.innovation@nationalgrid.com

Useful links

- **NGESO homepage -** https://www.nationalgrideso.com/
- **About us -** https://www.nationalgrideso.com/about-us
- **What does the ESO do -** https://www.nationalgrideso.com/about-us/what-eso-and-what-does-it-do
- **NGESO Incentives -** https://www.nationalgrideso.com/about-us/incentives
- **How we're performing (Forward Plan and performance documents) -** https://www.nationalgrideso.com/our-strategy/forward-plan/how-were-performing
- **Our Business Plan -** https://www.nationalgrideso.com/our-strategy/riio/riio-2-final-business-plan
- **Innovation website -** https://www.nationalgrideso.com/future-energy/innovation
- **Charging Overview** - https://www.nationalgrideso.com/industry-information/charging

Legal Disclaimer

This document relates to NGESO, which is a member of the National Grid group of companies and a subsidiary of National Grid plc.

This document may contain forward-looking statements concerning NGESO. Generally, use of words such as ‘anticipate’, ‘continue’, ‘estimate’, ‘expect’, ‘forecast’, ‘intend’, ‘may’, ‘plan’, ‘project’, ‘should’, ‘will’ or similar expressions is likely to identify forward-looking statements , which reflect current views about future events but are subject to risks and uncertainties that could cause actual outcomes to differ materially from those expressed in a forward-looking statement. Many such risks and uncertainties relate to factors which those making the forward-looking statement are unable to control or estimate precisely: for example, changes in general economic and business conditions, changes in currency exchange and interest rates, introduction of new or competing products or services and the behaviour of other market participants. Accordingly, forward-looking statements should be regarded with caution, and undue reliance should not be placed upon them.

Furthermore, this document, which is provided for information only, does not constitute summary financial statements and does not contain sufficient information to allow for as full an understanding of the results and state of affairs of National Grid plc and its subsidiaries, including the principal risks and uncertainties facing National Grid plc, as would be provided by the full Annual Report and Accounts (including in particular the Strategic Report section and the Risk factors). Copies of the most recent Annual Report and Accounts are available online at:

https://www.nationalgrideso.com/our-strategy/annual-report-and-accounts and https://www.nationalgrid.com/investors/resources/reports-plc.

Except as may be required by law or regulation, NGESO undertakes no obligation to update any of its forward-looking statements, which speak only as of the date of this document. The content of any website references herein does not form part of this document.

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Appendix

Innovation project costs

NIC project costs

	Status	2014	2015	2016	2017	2018	2019	2020	2021	RIIO total		
NIC funding by project	**2020/21**	actuals								(£m)	Total funding	Licensee funding
Power Potential (known as TDI 2.0)	in progress	-	-	-	0.090	1.683	2.791	2.801	2.003	9.4	10.5	2.1
EFCC	successfully completed	-	-	0.675	2.284	1.237	2.393	0.119	-	6.7	6.8	0.8
Phoenix	in progress	-	-	-	0.031	0.266	0.284	0.190	0.084	0.9	N/A	N/A
Blackstart from DER	in progress	-	-	-	-	-	-	1.675	2.585	4.3	11.7	1.2
EFFS	in progress	-	-	-	-	-	-	0.024	-	0.0	N/A	N/A

NIA project costs

NIA by Cost Project	Status	2014	2015	2016	2017	2018	2019	2020	2021	Total
	2020/21	actuals								
Eligible Bid Preparation Costs		-	0.2	-	0.2	-	-	-	-	0.4
Review of Engineering Recommendation P2/6	Successfully Completed	-	-	0.0	0.0	-	-	-	-	0.1
UK-wide wind power: Extreme and Variability	Successfully Completed	0.1	0.0	0.0	0.0	-	-	-	-	0.1
Modelling of Embedded Generation within Distribution Networks and Assessing the Impact	Successfully Completed	0.0	0.0	0.0	0.0	-	-	-	-	0.1
Quantifying benefits and risks of applying advanced network control and demand response technologies	Successfully Completed	0.2	0.0	--0.1	-	-	-	-	-	0.2
Impact of extreme events on power production at the scale of a single wind-farm	Successfully Completed	0.2	0.0	0.0	-	-	-	-	-	0.2
Optimising the operation of an integrated DC link within an AC system (ICase Award)	Successfully Completed	0.0	--0.0	-	-	-	-	-	-	0.0
A Combined Approach to Wind Profile Prediction	Successfully Completed	0.0	0.0	0.0	0.0	0.0	-	-	-	0.1
Seconomics - Digital Risk and Cyber Security	Successfully Completed	0.0	0.2	0.0	-	-	-	-	-	0.2
Mathematics of Balancing Energy Networks Under Uncertainty	Successfully Completed	0.0	0.0	0.0	0.0	0.0	-	-	-	0.1
Scalable Computational Tools and Infrastrucutre for Interoperable and Secure Control of Power System	Successfully Completed	0.0	0.0	0.1	0.0	0.0	-	-	-	0.2

NIA by Cost Project	Status	2014	2015	2016	2017	2018	2019	2020	2021	Total
	2020/21	actuals								
Protection and Fault Handling in Offshore HVDC Grids	Successfully Completed	-	0.1	0.0	0.0	0.0	-	-	-	0.2
UK Regional Wind: Extreme behaviour and predictability	Successfully Completed	0.1	0.1	0.1	0.0	-	-	-	-	0.3
Visualization of Renewable Energy Models	Successfully Completed	0.0	0.0	0.0	-	-	-	-	-	0.0
Development of Dynamic Demand Models in DIgSILENT PowerFactory	Successfully Completed	-	0.1	0.2	0.0	-	-	-	-	0.3
Reactive Power Exchange Application Capability Transfer (REACT)	Successfully Completed	0.0	0.0	0.0	-	-	-	-	-	0.1
Enhanced Weather Modeling for Dynamic Line rating (DLR)	Successfully Completed	0.0	0.1	0.0	0.0	0.0	-	-	-	0.1
Control and Protection Challenges In Future Converter Dominated Power Systems	Successfully Completed	0.0	0.1	0.1	0.1	0.0	-	-	-	0.4
Electricity Demand Archetype Model 2	Successfully Completed	0.1	0.2	0.0	0.0	0.0	-	-	-	0.3
Facilitating Enhanced Network Capacity Evaluation	Successfully Completed	0.1	0.1	-	-	-	-	-	-	0.2
Industrial and Commercial Gas & Electric Scenario Modeling	Successfully Completed	0.0	0.2	0.0	-	-	-	-	-	0.2
Project Samuel - Grid Data and Measurement Systems	Successfully Completed	0.0	0.4	0.2	0.0	-	-	-	-	0.7
Evolution of Energy Storage and Demand Management Services.	Successfully Completed	0.0	0.0	0.0	-	-	-	-	-	0.1
Avoiding voltage regulation action conflicts. (In conjunction with LCNF project CLASS)	Successfully Completed	0.1	0.1	0.0	-	-	-	-	-	0.2
EPRI Research Collaboration on Grid Operations and Control	Successfully Completed	0.1	0.4	0.0	-	-	-	-	-	0.5
EPRI Research Collaboration on Information and Communication Technology.	Successfully Completed	0.1	-	-	-	-	-	-	-	0.1
Clustering effects of major offshore wind developments	Successfully Completed	-	0.2	0.1	0.0	-	-	-	-	0.3
Investigation of sub-synchronous between wind turbine generators and series capacitors	Successfully Completed	0.0	0.2	0.1	0.0	-	-	-	-	0.3
iTesla	Successfully Completed	0.0	0.0	0.0	0.0	-	-	-	-	0.1
Granular Voltage Control (GVC)	Successfully Completed	0.0	0.2	0.0	--0.1	-	-	-	-	0.0
Frequency sensitive electric vehicle and heat pump power consumption	Successfully Completed	-	0.0	0.1	-	-	-	-	-	0.1
PV Monitoring: Phase 1	Successfully Completed	-	0.1	-	0.0	-	-	-	-	0.1
Assessment of Distributed Generation Behaviour	Successfully Completed	-	0.2	0.0	-	-	-	-	-	0.3

NIA by Cost Project	Status	2014	2015	2016	2017	2018	2019	2020	2021	Total
	2020/21	actuals								
during Frequency Disturbances										
Integrated electricity and gas transmission network operating model (ICASE Award)	Successfully Completed	0.0	0.0	0.0	0.0	0.0	-	-	-	0.1
Smart Grid Forum Work Stream 7	Successfully Completed	-	0.1	0.0	0.0	-	-	-	-	0.1
Open Source Interconnector Modelling: Phase 1	Successfully Completed	-	0.1	0.1	-	-	-	-	-	0.2
DNO Investigation into Voltage Interaction and Dependency Expectation (DIVIDE)	Successfully Completed	-	-	0.2	--0.0	0.1	-	-	-	0.2
Black Start Alternative Approaches	Successfully Completed	-	-	0.1	-	-	-	-	-	0.1
Detection and control of inter-area oscillations (DACIAO)	Successfully Completed	-	-	0.1	0.0	0.0	-	-	-	0.1
South East Smart Grids	Successfully Completed	-	-	0.1	0.2	0.0	-	-	-	0.4
Transmission Network Topology Optimisation	Successfully Completed	-	-	0.0	0.2	0.0	-	-	-	0.2
PV Monitoring Phase 2	Successfully Completed	-	-	0.2	0.2	0.3	-	-	-	0.6
Embedded cyber risks within the procurement process	Successfully Completed	-	-	0.0	0.0	0.0	0.0	-	-	0.1
Improving cyber security culture within operational areas	Successfully Completed	-	-	0.0	0.0	0.0	-	-	-	0.0
Solar PV Forecasting Phase 1	Successfully Completed	-	-	0.0	0.2	0.1	0.1	-	-	0.5
Solar PV Forecasting Phase 2	Successfully Completed	-	-	-	0.1	0.1	0.1	-	-	0.3
Transient Voltage Stability of Inverter Dominated Grids and Options to Improve Stability	Successfully Completed	-	-	-	0.2	0.2	0.1	-	-	0.5
WI-POD- Wind turbine control Interaction with Power Oscillation Damping control approaches.	Successfully Completed	-	-	-	0.0	0.2	0.2	0.0	-	0.4
SIM - Samuel Inertia Element	Successfully Completed	-	-	-	0.1	0.1	-	-	-	0.2
Project DESERT (hybrid battery and solar enhanced frequency control)	Successfully Completed	-	-	-	0.0	0.1	0.3	0.0	-	0.5
Vector Shift Initial Performance Assessment	Successfully Completed	-	-	-	-	0.0	-	-	-	0.0
Spatial district heating analysis and impact on gas and power demand	Successfully Completed	-	-	0.0	0.0	-	-	-	-	0.1
Spatial GB Clean Heat Pathway Model	In Progress	-	-	-	-	-	-	0.0	0.0	0.1
Optimisation of Energy Forecasting - analysis of datasets of metered embedded wind and PV generation	Successfully Completed	-	-	-	-	0.1	0.0	-	-	0.1
GB Non-renewable Embedded Generation Forecasting Study	Successfully Completed	-	-	-	-	0.1	0.0	-	-	0.1

NIA by Cost Project	Status	2014	2015	2016	2017	2018	2019	2020	2021	Total
	2020/21	actuals								
Assessing the stability of small-scale inverter connected PV generation	Successfully Completed	-	-	-	-	0.1	-	-	-	0.1
Virtual Synchronous Machine (VSM) Demonstrator	In Progress	-	-	-	-	0.0	0.3	0.1	0.0	0.4
Phase Lock Loop-Related Improvements to Non-Synchronous Generation Models	Successfully Completed	-	-	-	-	0.0	0.1	-	-	0.1
System Impacts of Embedded Storage (SIES)	Successfully Completed	-	-	-	-	-	0.2	-	-	0.2
Investigation & Modelling of Fast Frequency Phenomena ("F2P")	In Progress	-	-	-	-	-	0.3	0.3	0.2	0.8
Solar PV Monitoring Phase 3	In Progress	-	-	-	-	-	0.2	0.2	0.2	0.6
Situational Awareness Using Comprehensive Information	Successfully Completed	-	-	-	-	0.0	0.0	-	-	0.0
Application of New Computing Technologies and Solution Methodologies in Grid Operations	Successfully Completed	-	-	-	-	0.0	0.1	-	-	0.1
Risk-Based Analysis into Planning and Resiliency Processes	Successfully Completed	-	-	-	-	0.0	0.1	-	-	0.1
Flexibility and Resource Adequacy for System Planning	Successfully Completed	-	-	-	-	0.0	0.1	-	-	0.1
System Planning Methods, Tools, and Analytics	Successfully Completed	-	-	-	-	0.0	0.1	-	-	0.1
Optimisation of weather data to improve energy forecasting	In Progress	-	-	-	-	-	0.1	0.0	0.0	0.2
Frequency Response Auction Trial	In Progress	-	-	-	-	-	0.6	0.5	0.1	1.3
RecorDER	In Progress	-	-	-	-	-	0.0	0.4	0.0	0.5
Hybrid Grid Forming Converter	Successfully Completed	-	-	-	-	-	0.1	0.2	-	0.3
Short-term System Inertia Forecast	In Progress	-	-	-	-	-	0.1	0.2	0.1	0.3
Development of GB electric vehicle charging profiles	Successfully Completed	-	-	-	-	-	0.1	0.0	-	0.1
Black Start Capabilities from Non-Traditional Technologies	Successfully Completed	-	-	-	-	-	0.1	0.1	-	0.2
Mapping the Impacts and Visualization of Risks of extreme weather on system operation (MIVOR)	In Progress	-	-	-	-	-	-	0.1	0.2	0.2
Enhancing Energy Flexibility from Wastewater Catchments through a Whole System Approach	In Progress	-	-	-	-	-	0.0	0.1	0.1	0.2
Residential Response	In Progress	-	-	-	-	-	-	0.4	0.1	0.5
Demonstration of Virtual Synchronous Machine control of a battery system	In Progress	-	-	-	-	-	-	0.2	0.1	0.3
Testing Coordinated DSO-ESO Procurement and Dispatch	In Progress	-	-	-	-	-	-	0.1	0.0	0.1

NIA by Cost Project	Status	2014	2015	2016	2017	2018	2019	2020	2021	Total
	2020/21	actuals								
Advanced Modelling for Network Planning Under Uncertainty	In Progress	-	-	-	-	-	-	0.2	0.0	0.2
Applications of convex optimisation to enhance National Grid's NOA process	In Progress	-	-	-	-	-	-	0.0	0.3	0.3
Impact of Long-duration Energy Storage Systems on GB Transmission Planning	In Progress	-	-	-	-	-	-	0.1	0.0	0.1
DETECTS - Developing Enhanced Techniques to Evaluate Converter-dominated Transmission System Operability	In Progress	-	-	-	-	-	-	-	0.1	0.1
Control REACT	In Progress	-	-	-	-	-	-	-	0.3	0.3
4D Heat	Successfully Completed	-	-	-	-	-	-	-	0.2	0.2
SHEDD – System HILP Event Demand Disconnection	In Progress	-	-	-	-	-	-	-	0.2	0.2
Optimal Coordination of Active Network Management Schemes and Balancing Services Market	In Progress	-	-	-	-	-	-	-	0.2	0.2
Probablistic planning for stability constraints	In Progress	-	-	-	-	-	-	-	0.2	0.2
Optimal Outage Planning System	In Progress	-	-	-	-	-	-	-	0.1	0.1
TOTEM	In Progress	-	-	-	-	-	-	-	0.0	0.0
Modelling Flexible Gas Generation	In Progress	-	-	-	-	-	-	-	0.1	0.1
Total Gross Costs		1.3	3.7	2.4	1.6	1.8	3.5	3.0	2.9	20.2

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