ESO RIIO-2 Business Plan Cost-Benefit Analysis Report

1 July 2019

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1. Delivering Consumer Benefit

1 Approach to cost-benefit analysis (CBA)

To create a robust well justified business plan, it is essential that the ESO's decision making process considers our commercial judgement, stakeholder views and economic assessments.

For the initial economic assessment in our July submission we have undertaken two cost-benefit analysis[1] (CBA) methods. Firstly, we used a simplified and transparent approach developed by us, and secondly we used the Ofgem model for the ESO that is based on the approach used for the other RIIO regulated companies. As we have been working with Ofgem to develop this model for the ESO, we needed to use a simplified initial approach as a placeholder until this was finalised. The main document refers to the first approach and for our October submission we will move to the Ofgem model, though we do not expect the results to be materially different overall. More detail is in section 1.3. We have been guided by best practice from HM Treasury's Green Book using an established set of practical procedures, recommended by Ofgem, for guiding expenditure related decisions.

The principle of CBA is the determination of financial and economic cash flow of the projects. This value, whether positive or negative, is used to support the appraisal of the investment options and the final decisions. The table below outlines how we have interpreted the guidance we have received:

Ofgem Guidance	ESO understanding
Be consistent with published guidance and recognised best practice, for example HM Treasury Green book and Spackman discounting approach.	Build this best practice into our thinking, work with HM Treasury Green book and use the Spackman discounting appropriate in the CBA templates.
The ESO should undertake its CBA at an activity level, consistent with its business plan reporting.	We will align our CBA with the activities in our ambition document, where appropriate we will combine activities e.g. shared data platform.
A CBA is an essential part of the investment decision pack and will be prepared for any new or transformational investments or additional roles or responsibilities that the ESO undertakes.	We will apply a CBA to all our transformation activities, combined with the above point this should look to avoid CBAs which are not proportionate.
Existing or ongoing activities should be justified through appropriate benchmarking.	For non-transformational activities, we do not intend to perform a CBA. Instead we will use historical costs as our benchmark, supported by stakeholder feedback.

[1] Please note these figures represent our proposed spending. The cost that is borne by consumers in any year will depend on the funding model chosen for the ESO.

Consistent with the HM Treasury Green Book, the ESO must clearly identify the range of options that were considered to meet the stated aim. This list should, where feasible, include an option that requires a minimal initial investment (the “do minimum option”) against which other options can be compared.	The number of options naturally vary for each activity, with some being binary i.e. do the activity or not. As we are considering transformational activities there will always be a “do minimum option” to consider.
Benefits should be categorised as per the ESO 2019-21 Forward Plan and Ofgem Forward Work Programme: • Lower bills for consumers • Ensuring system security and reliability • Reduced environmental damage • Better quality of service • Benefits for society as a whole.	As per the Forward Plan 2019-21 we will use the five areas to categorise RIIO consumer benefits.
Costs and benefits should cover the period to 2030, which represents the useful economic life of the investments made by the ESO and is consistent with asset life assumptions used in the ESO RIIO-2 finance model. Where possible the ESO should look to identify when investments will be recovered in shorter timeframes.	For each activity, will we undertake a CBA to the end of the RIIO-2 period in 2026 and highlight when the CBA becomes positive.
We do not expect the ESO to use CBAs mechanistically (i.e. including all schemes with positive NPV and excluding all those with negative NPV). Where a scheme has a marginally positive or negative NPV, the ESO should consider the inclusion or exclusion of such a scheme, drawing on sensitivity analysis and the identification of any non-monetised benefits or costs.	When an assessment is close to zero we will undertake further scenario or sensitivity analysis to add to our understanding of the activity. In addition, we will consider stakeholder feedback and our commercial and technical judgment (see next item).
It is the overall position, determined across the following three distinct elements, which will determine and substantiate the most appropriate solution: Commercial and Technical Justification paper; Stakeholder Engagement & Support; and the quantitative analysis (i.e. CBA).	We will balance the CBA with our stakeholder feedback and own commercial and technical judgment.
We expect the ESO to undertake sensitivity analysis consistent with the HM Treasury Green Book guidance and consistent with their stakeholder approved process based	Where appropriate we will use the *FES* scenarios, for example where an activity’s benefits are dependent on the future energy landscape. Some activities will naturally be less sensitive under the *FES* scenarios, so their benefits will vary less.

on the 2018 *Future Energy Scenarios* (*FES*).	Here we may look to consider additional scenarios if required.
The ESO must clearly show the links between its CBA, business plan and associated data tables.	Consistent follow of activities from the business plan to CBA for example, naming convention. Business plan to pull out and use the CBA as part of the narrative supporting the activity.

1.1 What we are appraising using CBA

Our business plan contains both our ongoing and transformational activities. In line with guidance, we are performing a CBA on our transformational activities rather than our ongoing activities. Our ongoing activities will have their costs benchmarked.

In our Ambition document, we proposed 51 new activities. Many of these work together to deliver a common benefit or share a common cost base. To ensure our CBA is proportionate and meaningful we have combined the 51 activities into 20 larger activity groups for our CBA analysis. This is described below.

1.2 How we are analysing consumer benefit

For each of the activities detailed above, there are multiple options which have been considered to deliver it. As these are transformational activities, in all cases there is a natural “do minimum” or “status quo” option which becomes the counterfactual on which the other option(s) are compared against. There may also be further options for how the activity is delivered. As the future energy landscape is uncertain the benefits which each activity delivers may be different. Therefore, where appropriate we have used additional scenarios or sensitivities to fully understand the benefits that the activity delivers.

For our CBA, we have considered the costs and benefits over the RIIO-2 period. To add further transparency, we will also highlight where activities become net positive i.e. when benefits cover costs.

For our simplified and transparent CBA, we have taken the following approach:

1. For each activity identify the opex and capex required to deliver it
2. Calculate the benefits associated to the activity
3. For each year take the cost from the benefits to arrive at the net benefits
4. Sum the net benefits for each year of the RIIO-2 period to arrive at the total net benefits for that activity.

As noted above we have also completed the Ofgem CBA model. This was finalised too late to be fully integrated into this submission but will be used for the October submission. This undertakes the CBA in a more robust way making a number of additional assumptions around financing and discounting. We show the differences and similarities in the table below:

Assumption	ESO approach	Ofgem model
Capex deprecation period	No deprecation assumption	Seven years
Cost of carbon	BEIS Traded value	Societal cost of carbon[2]
Cost of Capital (CoC)	No CoC assumption	2.64% (placeholder)
Discount rate	0%	3.5%
Price base	2018/19	2018/19

The Ofgem model calculates a Net Present Value (NPV), rather than a net benefit, which is similar but accounts for financing, depreciation and discounting. For the October and December submissions we will use the Ofgem model. The table as the end of this section compares the calculated values.

1.3 Benefits calculations

In the following section we note how we have calculated our benefits. As each activity and the benefits it delivers are distinct, there is no set method we have used to calculate them. The detail of these are shown in the subsequent sections reflecting the broad nature of activities which the ESO undertakes. To structure our thinking, we here have used a high-level framework when considering benefits:

We will use the five categories of consumer benefit (as referenced above), this is also consistent with the ESO Forward Plan 2019-21:

Improved safety and reliability

The on-demand provision of electricity is a fundamental part of our modern life which must be continuously attended to with the utmost importance by the Electricity National Control Centre (ENCC) and supporting functions. We will continue our focus on system balancing and security at optimum cost in line with the expectations that government, the regulator and the consumer have of us. We look further ahead, to ensure we can operate the system in the future, as it rapidly transforms with low-carbon, intermittent, non-synchronous and distributed generation sources.

Improved quality of service

Over recent years we have transformed our approach to engage deeply with all our stakeholders, listening to what they want from us and delivering on that where we can, and where we cannot, explaining why. This rich stakeholder input has shaped how we do things and put much more of a focus for us on why and how we can improve our quality of service. Improved service quality ultimately benefits the consumer due to interactions in the value chains across the industry being more seamless, efficient and effective.

[2] All calculations in this submission use the BEIS traded value.

Lower bills than otherwise the case

We lower consumer bills by working to control, reduce, and optimise elements of the system charges which we can impact and influence. Theses charges are the Balancing Services Use of System and Transmission Network Use of System charges (BSUoS and TNUoS). These charges are levied on suppliers and transmission-connected generators, and passed through to end-consumers. We optimise across BSUoS and TNUoS by linking our balancing decisions with our *Network Options Assessments (NOA)* so that in the long-term the economic and efficient outcomes are being driven when planning, developing and investing in the network. Nearer to real time we manage BSUoS by focusing on controlling, reducing, and optimising our spend on balancing and operating the system. These charges flow through to the consumer bill from suppliers, therefore any reduction of this cost (approximately £1 billion of BSUoS and £3 billion of TNUoS per annum) will benefit the consumer.

Reduced environmental damage

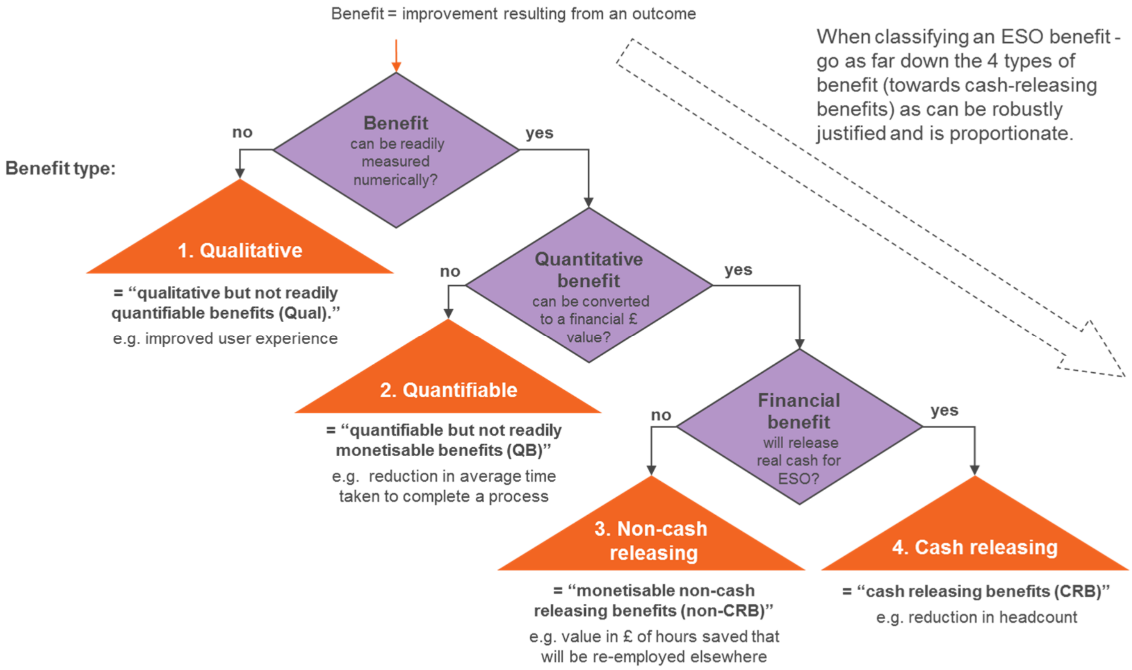
Great Britain has committed to reducing its CO2 emissions year on year, and as the ESO we are at the centre of the transition to a low-carbon electricity system. We therefore support new providers and technologies to enter and compete in the existing and new markets basing our decisions on the technical capabilities of providers. We also work innovatively to design novel solutions which ensure the system can operate safely and securely both now and in the future with large levels of intermittent and non-synchronous generation running. We are committed to being ‘technology neutral’, as market participants already have environmental costs priced into their products and services, for example through carbon price levies. We will not choose to procure from providers based on the fuel they use to generate power.

Benefits for society as a whole

By 2050, energy system decarbonisation efforts could add 19 million jobs and $52 trillion of gross domestic product (GDP) to the global economy, increasing the GDP of Northern and Western Europe by 1.25% and 2.5%, respectively. It could also generate a 15% increase in global welfare and reduce negative health effects caused by local air pollution by 60%.

When we calculate benefits, we will assign them to one of these categories. We will also provide qualitative descriptions aligned to these categories.

Where we can we look to monetise benefits but this is not always possible. If not, we use the following logic to decide which type of benefit the activity will deliver:



To keep the analysis proportionate we focus on the benefits that are easiest to define, quantify and attribute. This means that the harder to analyse benefits are not quantified so our CBA is likely to be a conservative estimation of the benefit the ESO would deliver.

If multiple activities are all necessary to unlock some of the benefits, to avoid double counting, we only attribute the benefit to one of the activities.

Where we are currently unable to monetise benefits we will undertake a breakeven analysis, taking the costs of the activity and determining what level of benefits would be required to allow that activity to cover its costs. We also note that the majority of our benefits will be realised outside of the ESO. Here we have assumed that when a benefit is not directly delivered by the ESO, that third parties will fully pass on that saving to consumers:

Theme	Activity Group	Benefit type
Theme 1	Control centre architecture and systems	CBA
	Enhance our people and data capability	CBA
	Restoration	CBA
Theme 2	Transforming participation in balancing and capacity markets	CBA
	Designing the markets of the future	Break-even
	Transform access to the capacity market	CBA
	Transform the process to amend our codes	Break-even
	A fully digitalised whole system Grid Code by 2025	CBA
	Fully or partially fixing BSUoS	CBA
	Open data unlocking zero-carbon system operation and markets	Break-even

Theme 3	Transforming network planning through competition	CBA
	Extending NOA to end of life asset replacement decisions	CBA
	Extend the NOA approach to connections wider works	CBA
	Support decision-making for investment at the distribution level	CBA
	Support competition through helping establish the Competitively Appointed Transmission Owner (CATO) regime.	Break-even
	Review of the Security and Quality of Supply Standard (SQSS)	Break-even
	Implement and enhance improved analytical capabilities	Break-even
Theme 4	Closer ways of working with other network organisations to streamline the connection process for smaller players	CBA
	A pathway for zero-carbon whole system operability and beyond	CBA
	A whole system approach to accessing networks	CBA

Our net benefit assumptions, data (including costs) and calculations can be found in the following section. A summary is shown below, with a comparison between the two approaches:

ESO activities (£million)	ESO Net Benefits	Ofgem 5 year NPV	Difference (£million)	Difference (%)
Control centre architecture and systems	124	140	16	13
Enhance our people and data capability	22	23	1	5
Restoration	-36	-8	£8	-78
Theme 1 total	110	155	5	41
Transforming participation in balancing and capacity markets	41	49	8	20
Transform access to the capacity market	46	54	8	17
A fully digitalised whole system Grid Code by 2025	1	2	1	153
Fully or partially fixing BSUoS	291	267	-24	-8
Theme 2 total	379	371	-7	-2
Transforming network planning through competition	593	559	-34	-6
Extending NOA to end of life asset replacement decisions	142	132	-10	-7

Extend the NOA approach to connections wider works	143	134	-9	-6
Support decision-making for investment at the distribution level	35	35	0	0
Theme 3 total	912	860	-52	-6
Closer ways of working with other network organisations to streamline the connection process for smaller players	3	4	1	23
A pathway for zero-carbon whole system operability and beyond	842	794	-48	-6
A whole system approach to accessing networks	161	154	-7	-4
Theme 4 total	1,006	951	-55	-5
ESO Total	2,407	2,338	-69	-3

The £2.4 billion total above only includes activities with a full cost-benefit analysis. The £2.3 billion benefit figure quoted in the main business plan document also includes the cost of new activities that have not been subject to a CBA.

1.4 Next steps

We will continue to refine our CBA numbers adding further detail around options, scenarios and sensitivities. To support the overall narrative, we will create an overarching CBA narrative for the ESO, including more detail on benefits enabled by one activity but realised elsewhere, or where third parties realise costs to fully deliver a benefit – the whole system approach. Finally, we will fully integrate the Ofgem CBA templates into our submission.

2 Cost-benefit analysis: Theme 1

This section provides further context on the costs and quantifiable benefits of our proposed theme 1 transformational activities.

Net benefit of our proposal against the status quo is between minus £93 million and plus £219 million, with a central estimate of £110 million over the RIIO period.

In this section, all costs, benefits and net benefits are shown in 2018/19 prices.

2.1 Control centre architecture and systems

Net benefit of all our proposal against the status quo is between minus £62 million and plus £214 million, with a central estimate of £124 million over the RIIO period.

The quantitative benefits have been reached based on analysis to date and informed technical judgement. Several the benefits have not been monetised and this is based on a small subset of benefits, so the actual benefits are likely to be significantly higher. We are therefore confident that this transformational activity will deliver significant value for end consumers.

Incremental Costs

Table 1: Incremental costs for the preferred option

Costs £m	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Capex Spend	26	39	46	38	26	174
Opex spend	0	1	2	4	5	11

The total costs for this transformational activity are £185 million over five years.

Incremental Benefits

Several quantitative incremental benefit areas have been identified in transforming our balancing and control capability.

Benefit Area one – reduced CO2 emissions

Our proposals help unlock the benefits of the lower carbon intensity energy market of the future. Without investment in new balancing and control capability, the control room will not be able to maximise the use of low-carbon technologies which may be available in the market, whilst still balancing in a technology-neutral manner. Under the reasonable assumption that the control room has leverage over the carbon emissions associated from its residual balancing role, typically five percent of all market activity, we can calculate the carbon savings by comparing the carbon intensities of high and low decarbonisation intensities. We assume our proposals unlock the lower carbon intensities of our Two Degrees scenario against a counterfactual of Consumer Evolution. We have tapered these benefits as new systems and tools come online and reduce in the final year to avoid double counting restoration benefits. This generates £48 million of consumer benefit over RIIO-2.

Table 2: carbon prices 2021-26

Calendar year:	2021	2022	2023	2024	2025	2026
Carbon value (£/tCO2e, BEIS central estimate, 2018 real prices)	14.56	15.11	15.68	16.28	17.70	23.95

Table 3: benefits calculation for reduced CO2 emissions

Financial year:	2021/22	2022/23	2023/24	2024/25	2025/26	RIIO-2 Total	Calculation
Carbon intensity Consumer Evolution (gCO2/kWh)	146.72	143.63	148.28	137.06	130.75		A
Carbon intensity Two Degrees gCO2/kWh	112.94	100.61	100.52	92.73	75.28		B
Reduction gCO2/kWh	33.78	43.03	47.76	44.32	55.48		C = A - B
Expected demand TWh (Two Degrees)	288.18	286.36	285.24	284.50	284.82		D
Carbon price t/CO2e (calendar year adjusted to FY)	14.74	15.30	15.88	16.75	19.78		E
Saving (£m)	144	189	216	211	313		F = C x D x E
Attributable saving (£m)	7	9	11	11	16		G = 5% x F
Taper	60%	80%	100%	100%	94%		H
Adjusted saving (£m)	4	8	11	11	15	**48**	= G x H

Benefit Area two – greater interconnection

Analysis[3] indicates interconnection benefits of £11 billion over the next 25 years which averages at £440 million per year. The value of the benefit is the predicted reduction in the total spend on electricity in GB because of interconnector imports. This is due to imported electricity being cheaper than electricity generated by carbon-intensive GB generators, especially fossil fuels such as gas.

[3] "Connecting for a Smarter Future", p.16, National Grid Ventures, 2018. https://www.nationalgrid.com/document/118641/download

A modest assumption is that our investments contribute to unlocking around two percent of these benefits through modelling and managing these in our balancing and situational awareness tools. This gives an estimated consumer benefit of £35 million. A sensitivity analysis of a one to three percent reduction gives a benefit range of £18 million to £53 million.

Benefit Area three – flexible technology

There is up to £4.7 billion consumer savings per year to 2030 from new flexibility sources, according to a report to the Committee on Climate Change[4]. The benefits are estimated between £3.2 billion and £4.7 billion per year in a system meeting a carbon emissions target of 100gCO2/kWh in 2030. The value of the benefits includes:

- Reduced investment in low-carbon generation as the available renewable resource and nuclear generation can be utilised more efficiently enabling the system to reach the carbon target with less low carbon generation capacity. (Between 25 percent and 60 percent of total savings depending on scenario).
- Reduced system operation cost as various reserve services are provided by new and cheaper flexibility sources rather than by conventional generation. (Between 25 percent and 40 percent of total savings depending on scenario).
- Reduced requirement for distribution network reinforcement and backup capacity. (Between 10 percent and 20 percent of total savings depending on scenario).

Based on our technical judgement, we assume our investments contribute to ultimately unlocking one percent of these benefits, leading to £124 million of consumer benefits over RIIO-2. As new systems come online over the RIIO-2 period, we have tapered these benefits so they increase over the period. A sensitivity analysis of unlocking 0.5 percent and 1.5 percent of the benefits gives a range of £62 million to £185 million.

Central estimated benefit in 2025/26 = 1 percent x £4.7 billion per annum = £47 million

Low estimate in 2025/26 = 0.5 percent x £4.7 billion per annum = £23.5 million

High estimate in 2025/26 = 1.5 percent x £4.7 billion per annum = £70.5 million

Table 4: benefit calculation for flexible technology

Financial year:	2021/22	2022/23	2023/24	2024/25	2025/26	RIIO-2 Total
Tapered proportion of full annual benefit	1/8	1/4	1/2	3/4	100%	

[4] "Roadmap for Flexibility Services To 2030, A report to the Committee on Climate Change", p.1, Poyry and Imperial College London, 2017https://www.theccc.org.uk/wp-content/uploads/2017/06/Roadmap-for-flexibility-services-to-2030-Poyry-and-Imperial-College-London.pdf

Central estimate of benefit (£m)	5.9	11.8	23.5	35.3	47.0	**124**
Low estimate of benefit (£m)	2.9	5.9	11.8	17.6	23.5	**62**
High estimate of benefit (£m)	11.8	23.5	47	70.5	94	**247**

Benefit Area four – inertia forecasting and needs management

Inertia forecasting and needs management improvements will allow us to understand system inertia to a higher degree of accuracy. This in turn will enable us to manage our risk closer to the edge of the envelope. This issue will be resolved in May 2022, so we assume benefits until then (i.e. 13 months). Our current spend on Rate of Change of Frequency (RoCoF) is £144 million per year. Assuming a 10 percent improvement in accuracy, which is consistent with our demand forecasting improvement in 2018/19, delivers £14.4 millon per year of benefit.

The RoCoF spend for the 12 months of 2018/19 was a total of £144 million.

Central estimate of benefit = 10 percent x £144 million x 13/12 = £16 million

Low estimate of benefit in = 5 percent x £144 million x 13/12 = £23 million

High estimate of benefit = 15 percent x £144 million x 13/12 = £7.8 million

Benefit Area five – improved situational awareness

Improved situation awareness allows us to manage transmission constraints to a greater degree. We assume a 2.5 percent accuracy improvement on forecast constraints. This is based on modest technical judgment, with savings halved in the first two years as systems are implemented. This delivers benefits of £82 million over RIIO-2. A sensitivity analysis of unlocking between one percent and four percent of these benefits gives a benefit range of £33 million to £131 million.

Table 5: benefit calculation for improved situational awareness

Financial year:	2021/22	2022/23	2023/24	2024/25	2025/26	RIIO-2 Total
Tapered % of full annual benefit	50%	50%	100%	100%	100%	
Constraint costs (£m)	600	689	809	931	909	
Central benefit estimate (£m)	8	9	20	23	23	**82**
Low estimate benefit (£m)	3	3.4	8.1	9.3	9.1	**33**
High estimate benefit (£m)	12	13.8	32	37	36	**132**

Benefit Area six – Balancing Mechanism outage downtime

From recent events, we have calculated the cost of an unplanned outage as approximately £700,000 per hour. Since 2016 there has been on average 2 hours 23 minutes of unplanned outage per year, costing £1.67 million per year.

We assume our proposals will lead reduce this to one hour per year of unplanned outage. This will deliver savings of just under £5 million over RIIO-2. A sensitivity analysis of reducing unplanned outages per year to between 1.5 hours and 0.5 hours gives a range of £3.1 million to £6.6 million in consumer benefit.

Estimated benefit = £700,000/hour x (2.5 – 1) hours/year x 5 years = £5 million

Low estimate benefit = £700,000/hour x (2.5-1.5) hours/year x 5 years = £3.1 million

High estimate benefit = £700,000/hour x (2.5-0.5) hours/year x 5 years = £6.6 million

A summary of the central estimate of benefits is in the table below:

Table 6: benefits from reduced balancing mechanism outage downtime

Benefits £m	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Reduced CO2 emissions	1	2	4	6	10	48
Greater interconnection	5	6	7	8	9	35
Flexible technology	6	12	24	35	47	123
Inertia forecasting and needs management	14	1				16
Improved situational awareness	8	9	20	23	23	82
Balancing Mechanism (BM) outage downtime	1	1	1	1	1	5

Uncertainties and risks

The key uncertainties and risks are outlined in the table below:

Risk	Mitigations
Unable to source vendors to deliver requirements. Unable to source skilled resource within ESO and market participants to deliver in required timescales.	Starting our work as soon as possible, in particularly creating the cross-sector design authority, and ensuring we work with them to ensure we are agile and flexible.
Unforeseen market changes mean requirements change.	Developing capability in an agile, modular fashion to ensure flexibility.
Market landscape does not evolve as expected.	

2.2 Enhance our people and data capability

Net benefit of all our proposal against the status quo is between £5 million and £41 million, with a central estimate of £22 million over the RIIO period.

The actual net benefits will be much higher than this because in this analysis we have considered only monetised a small subset of the benefits. We are therefore confident that this transformational activity will deliver significant value for end consumers.

Incremental Costs

Table 7: Incremental costs for preferred option

Costs £m	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Capex Spend	3	3	4	5	4	18
Opex spend	0	0.1	0.2	0.3	0.5	1

The total costs for this transformational activity are £19 million over 5 years.

Incremental Benefits

Several quantitative incremental benefit areas have been identified in transforming our balancing and control capability.

Benefit Area one – resource costs

Updated shift patterns, working arrangements and increased staff retention will enable a reduction in resource costs. We estimate £5 million savings over RIIO-2.

Benefit Area two – training costs

The increased knowledge of new starters will reduce training time. Our internal analysis estimate that these will be £3 million over the RIIO-2 period.

This assumes we can reduce the training time by three months due to the increased knowledge the new starter already has. This would save approximately £32,000 per candidate. We train on average more than 30 people per year. We taper these as new systems are introduced and reflected in simulators.

Annual benefit by 2025/26 = £32,000 per staff x 30 staff per year = £960,000 per year

Benefit Area three – improved decision making

Control room engineers will be able to improve decision-making through new and improved training simulators, whilst producing a consistent approach from all control room staff and increasing confidence in model delivery and our ability to simulate future scenarios. This will allow us to reduce the money spent on operational uncertainties. We assume a modest two percent reduction in response, reserve and inertia balancing spend, which we estimate will continue to be approximately £400 million per year, from increased confidence in managing the unknowns. We assume the new simulation capability is added as we develop new balancing tools and taper the benefits as new systems are introduced.

This delivers an expected benefit of £33 million over RIIO-2. A sensitivity analysis of a 1percent to 3percent reduction in spend gives a benefit of between £17 million and £50 million

Estimated annual benefit by 2025/26 = 2percent x £400 million per year = £8 million per annum

Table 8: Incremental benefits for preferred option

Benefits £m	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Resource costs	1	1	1	1	1	5
Training costs	0.2	0.4	0.6	0.8	1	3
Improved decision making	3	6	8	8	8	33

Uncertainties and risks

The key uncertainties and risks are outlined in the table below:

Risk	Mitigations
Reluctant engagement from external stakeholders to develop a holistic resourcing approach.	Early engagement to understand individual business needs.
Reluctant buy-in from academia to create a bespoke course meaning subsequent recognised qualifications are not created.	Approach existing universities where relationships have already been established.
Existing simulator is not fit for future development or use.	Explore alternative supplier options.
Unable to acquire the necessary skill to produce the simulator of the future.	Early engagement with specialist recruitment agencies.

2.3 Restoration

The net benefit of this activity is -£36 million over the RIIO-2 period.

Our restoration policies are the ultimate insurance policy. Allowing new technologies to provide restoration services and implementing our restoration decision making tool, will ensure that should a system restoration ever be required, it will minimise the disruption to the UK's £5.7 billion[5] per day Gross Domestic Product (GDP). Given the £115 million net benefit from 2025 to 2050 of the Distributed Resource innovation project[6], we anticipate our proposals being net benefit positive to 2050.

Incremental Costs

Table 9: Incremental costs for preferred option

Costs £m	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Capex Spend	0	4	11	12	7	34
Opex spend	0	0	1	2	3	7

The total costs for this transformational activity are £41 million over five years.

Incremental Benefits

We have been able to monetise the benefits in two areas.

Benefit Area one – Black Start from Distributed Energy Resources (DER)

The net-present value of implementing the Black Start from DER project is £115 million to 2050, due to increased competition and reduced costs associated with large generator readiness. This would be passed on to GB consumers through reduced BSUoS. We assume this is allocated evenly from 2025 onwards, which is when the project will start delivering benefits. This delivers £4.6 million of benefit during RIIO-2 and £23 million to 2030.

Benefit in 2025/26 = £115 million / (2050-2025) = £4.6 million.

This delivers £4.6 million of benefit during RIIO-2 and £23 million to 2030.

5
Office for National Statistics: Gross Domestic Product: https://www.ons.gov.uk/economy/grossdomesticproductgdp/timeseries/abmi/pn2 2019 Q1 values pro-rated to a daily value

6 National Grid Electricity System Operator: Black Start from Distributed Energy Resources https://www.ofgem.gov.uk/system/files/docs/2018/11/redacted_electricity_nic_submission_2018_esoen01_v03.pdf

Benefit Area two – carbon savings

We estimate that the Black Start from DER project will lead to a reduction of 810,000 tonnes of carbon dioxide by 2050. We assume this is allocated evenly from 2025 onwards which is when the project will start delivering benefits. With an average carbon price of £19.78 per t/CO2e in 2025/26:

Benefit in 2025/26 = £19.78 x 810,000 / (2050-2025) = £0.6 million

This delivers benefits of £0.6 million over RIIO-2 and £4.6 million to 2030. These are purely savings from restoration.

Table 10: incremental benefits for preferred option

Benefits £m	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30
Black Start from DER					4.6	4.6	4.6	4.6	4.6
Carbon savings					0.6	0.8	0.9	1.1	1.3

Uncertainties and risks

The key uncertainties and risks are outlined in the table below:

Risk	Mitigations
A Restoration Standard is not established and implementation frameworks are not utilised.	ESO can set target restoration timeframes through our current structure and justify our Restoration Strategy against this.
A sub-standard or inappropriate restoration tool is identified and implemented.	Project scoping and resource to support are included in funding plans.
New roles and responsibilities between industry parties are currently unknown and may influence restoration options.	Ongoing engagement with Distribution System Operator (DSO) model development and impact on restoration to ensure that associated roles and responsibilities iterate and adapt as required.
Various stakeholders challenge proposed Grid Code changes.	Mitigated in part through maintaining a dialogue with other parties involved in restoration, and facilitating and championing relevant regulatory, legal or code changes to enable full participation. Proactively sharing code changes and timetables for implementation and maintaining industry awareness.

Roles and skillset required for DER are challenging to resource.	This will be mitigated through the resourcing and simulation part of our business plan.
Cost of providing sufficient resilience in telecommunications means focussing on a small number of large resources, limiting the involvement of smaller DERs.	The Network Innovation competition (NIC) DER project will provide a working (albeit small-scale) solution for resilient telecommunications which can be suitably scaled for GB wide use.
Unknown level of technical changes and how to implement these that are required on distribution networks. Risks around failure to change restoration speeds, lack of investment in DER technology.	Risk likelihood will be identified through the NIC DER project as it is currently of unknown likelihood.
Despite new technologies and techniques, the restoration speed does not reduce.	Annual evaluation of restoration time against expectations and inclusion of new technologies and products will feed into this evaluation.
Market mechanisms across multiple different parties (ESO/DSO/DERs) too complex and may be susceptible to distortion.	Market mechanisms are still being trialled for Balancing Services and will be iterated with this risk in mind.
The high cost of retrofitting existing DER and distribution networks (including systems and telecommunications) and funding arrangements unclear.	Working to identify the specific requirement and associated costs through the NIC project.

2.4 Summary of costs to support the CBA analysis for theme 1

This table shows the cost of transformational activities within this theme:

CBA reference	Expenditure area (£ million)	21/22	22/23	23/24	24/25	25/26	Total
2.1	Opex	0	1	2	4	5	11
	Capex	26	39	46	38	26	**174**
	Total	**26**	**39**	**47**	**42**	**31**	**185**
2.2	Opex	0	0	0	0	0	1
	Capex	3	3	4	5	4	**18**
	Total	**3**	**3**	**4**	**5**	**4**	**19**
2.3	Opex	0	0	1	2	3	7
	Capex	0	4	11	12	7	**34**

Total	**0**	**5**	**12**	**14**	**10**	**41**
CBA opex subtotal	0	1	3	6	9	19
CBA capex Subtotal	29	46	60	56	36	226
CBA subtotal	**29**	**47**	**63**	**61**	**45**	**245**
Allocated ongoing & cross cutting costs	73	75	70	66	67	**351**
Subtotal	**102**	**123**	**133**	**128**	**112**	**596**
Theme 1 opex	0	0	0	10	10	20
Theme 1 capex	30	50	60	60	40	240
Theme 1 ongoing & cross cutting totex	70	70	70	70	70	350
Theme 1 total	**100**	**120**	**130**	**140**	**120**	**610**

3 Cost-Benefit Analysis: Theme 2

3.1 Build the future balancing service and wholesale markets

This section provides further context on the costs and quantifiable benefits of our proposed theme 2 transformational activities

Net benefit of all our proposal against the status quo is between £309 million and £930 million, with a central estimate of £370 million over the RIIO period.

In this section, all costs, benefits and net benefits are shown in 2018/19 prices.

3.1.1 Transforming participation in balancing markets

Using a conservative estimate of benefits, the net benefit of this activity is between £14 million and £67 million, we have shown the detail around the central estimate of £41 million over the five year RIIO-2 period.

This net benefit has been calculated considering costs and benefits over the five-year period up to 2025/26. There will be benefits beyond this period and so this analysis will underestimate the net benefit. The ratio of estimated benefits to costs over the period is 2.3.

Deliverables

The key deliverables above the status quo are:

- A single day-ahead response and reserve market
- Established markets for voltage and thermal constraints close to real time

- A single, integrated portal for ESO markets
- A sandbox experimental market environment.

Incremental Costs

Delivery of these will require additional capex and opex spend over the status quo. The increased capex spend is focused on the delivery of the portal. In this CBA we will only consider the benefits of improving participation in balancing service markets and so we have only included the portal costs associated with these markets. The costs of the capacity elements of the system are considered in a separate CBA. The capex spend in the first two years is focused on development of the portal for the response and reserve markets and it is expected that prior to 2022/23 we will have a single day-ahead market in operation for these products. In later years, the spend will be more targeted to operability markets such as voltage, thermal constraints and inertia. In addition, we anticipate that we will need to evolve the portal as markets in the distribution networks develop so that we make efficient, whole system decisions in our markets.

The capex costs shown in Table 11 have been estimated by benchmarking against the costs associated with the development of our Platform for Ancillary Services (PAS) which we have developed successfully internally using the Agile methodology. It is anticipated that the portal will be delivered in a phased manner using an agile approach either internally as for PAS or using a third party as is the case for the auction platform trial we are currently undertaking with EPEX Spot, the European Power Exchange.

The increased opex spend is equivalent to an extra five FTEs over the business as usual level who will be working closely with stakeholders such as service providers and DNOs to ensure that we deliver efficient markets that consider whole system costs. There is significant work required to take our current thinking on operability challenges together with the output of our operability pilot projects and convert these into transparent, efficient markets which are open to a wide range of technologies. This includes running our sandbox market environment to develop learning and the development of the enduring solution. In addition, there will be increased and deeper interactions between the ESO and the DNOs with the growing number of small distributed market participants and the development of markets in the distribution network. This will be delivered through an increase in scope and scale of the Power Responsive campaign.

Table 11: Incremental costs for preferred option

Costs £m	2021/22	2022/23	2023/24	2024/25	2025/26
Capex Spend	6.2	6.2	4.6	3.1	3.2
Opex spend	0.4	1.1	1.7	2.3	2.6

The total costs for this transformational activity are £31.5 million.

Incremental Benefits

The benefits of the preferred option are outlined in a qualitative way in the table below:

Benefit	Description
Improved safety and reliability.	Proposal ensures that there is sufficient flexible energy to maintain security of supply in a low-carbon world. Proposal ensures that operability can be maintained by delivering market solutions to manage voltage, constraints and system stability in a low carbon world.
Improved quality of service.	The single platform is designed to remove the current pain points identified by stakeholders and facilitate easier participation in a range of markets.
Lower bills than would otherwise be the case.	The primary focus of this work is to contribute to delivering the savings forecast in the Committee on Climate Change report through attracting sufficient flexibility onto the system. The work here on markets is necessary but not sufficient to deliver these savings. Some savings that can be directly attributable to this work are: • Reduced price of balancing services compared to the status quo due to increased competition in markets. • Reduced volume of services purchased due to move to day-ahead. • Improved efficiency in capacity mechanism due to increased market liquidity. • Reduced costs for market participants due to more efficient systems and processes are passed on to consumers.
Reduced environmental damage.	Increased flexible generation on the system will result in less curtailment of low carbon generation and there will be less part-load running of thermal plant for response and reserve. This will allow our carbon targets to be reached more rapidly and cost efficiently.

It is difficult to put a monetary value on all these benefits, as it is uncertain exactly how future markets will respond especially given the unknown political, regulatory and economics landscape. Therefore, the numerical calculation for the CBA is focused on lower bills. We will further narrow our analysis to consider only the response and reserve markets and exclude the benefits of efficiencies in operability markets or whole system thinking. This will significantly underestimate the benefits of the proposal but if it is still looks to deliver net positive in these circumstances the analysis demonstrates that the proposal is beneficial to consumers.

Two broad incremental benefit areas have been identified in the response and reserve markets.

Benefit Area one – more liquid response and reserve markets

The value of the response and reserve markets today is estimated at around £350 million per annum. By moving closer to real-time we increase the number of potential participants, further increasing the liquidity above today's levels. Some early trials have shown that market prices could be reduced by around five percent through this increased competition[7]. Our experience of prices in the response market in the last two years suggests that this is extremely conservative as prices have dropped by more than 60 percent in this time, as has been seen in work done under Power Responsive to open up balancing service markets to additional players, for example, price data can be found in page 28 onwards of the Power Responsive Annual Report[8]. If we assume that we realise five percent savings in 2023/24 (allowing two years for implementation), and in each of the following two years of RIIO-2 this would result in a benefit of £52.5 million from increased liquidity:

5 percent x £350 million per year = £17.5 million per annum over the final three years of RIIO-2

This five percent estimate is being conservative, as we recognise we have already unlocked significant potential via Power Responsive, but there are still many smaller players that are not yet captured. To cover the uncertainty here, we have considered market price reductions of 2.5 percent and 7.5 percent, given annual savings of £8.75 million and £26.25 million respectively.

Benefit Area two - buying the optimal volume of response

The volume of response we require varies considerably from day to day. At the month ahead stage we tender for the minimum volume and manage the daily variation using mandatory response on thermal plant. Having markets which are able to operate in real term unlocks addition liquidity in three ways. Firstly, parties can choose between a longer term and short-term product allow us to achieve a better price for products by offering greater choice to market parties. Secondly, by operating a market closer to real-time means the more specific volume can be targeted. Volume set in advance will necessarily carry “headroom” to account for forecasting inaccuracies. Thirdly, allowing market parties to bid in, allows them to be more confident of their position, and will potentially unlock services from parties who otherwise were restricted due to intermittent generation.

The annual cost of response is around £130 million, see for example, the monthly report and forecast on BSUOS costs for May 2019[9]. From consideration of the daily variation and the decline in mandatory services we can purchase considerably less volume than in the status quo. In this analysis, based on our previous experience, we estimate a five percent reduction on purchased volume compared to the status quo from 2023/24 resulting in a benefit of £19.5 million from buying a more optimised volume.

5 percent x £130 million per year = £6.5 million per annum over the final three years of RIIO-2

Table 12: Incremental benefits for preferred option

Benefits £m	2021/22	2022/23	2023/24	2024/25	2025/26	Total
More liquid markets	0	0	17.5	17.5	17.5	52.5

[7] *ESO 2019/21 Forward Plan*”, p.111, National Grid ESO, 28 March 2019. https://www.nationalgrideso.com/document/140736/download

[8] http://powerresponsive.com/wp-content/uploads/2019/04/Power-Responsive-Annual-Report-2018_19-FINAL.pdf

[9] https://www.nationalgrideso.com/document/143561/download

Closer to real-time markets	0	0	6.5	6.5	6.5	19.5

The total incremental benefits from consideration of the response and reserve markets is between £46 million and £98 million, with a central estimate of £72 million.

Net benefit of preferred option

The net benefit of the preferred option using the identified costs and benefits above is between £14 million and £67 million, with a central estimate of £41 million over the RIIO-2 period which is highly positive. The actual net benefit will be much higher than this because in this analysis we have considered only a small subset of the benefits. We are therefore confident that this transformational activity will deliver significant value for end consumers.

Uncertainties and risks

The key uncertainties and risks are outlined in the table below.

Risk	Mitigations
Arrangements for procurement of balancing services at the distribution level are not yet defined. This may lead to market portal design not being aligned to future arrangements.	Active participant in Energy Networks Association (ENA) Open Networks Programme and platform design is aligned with current preferred option. Platform will be designed to be extremely flexible to work with emerging market designs.
IT delivery risk for platform.	Focus is on delivering a flexible platform which can be adapted easily in a changing world. Build on lessons learnt from development of PAS; deliver in an agile manner beginning with a minimum viable product then delivering progressively greater complexity and functionality through a series of targeted rollouts. Work closely with our stakeholders.
System change happens quicker than expected before new markets are in place. This results in higher costs to consumers.	Work continuing through this regulatory period on market change. Focus on learning by doing and use of innovation projects or sandbox to accelerate learning.
Not all trials will be successful resulting in some regret spend for consumers.	Accept that not all trial markets will be successful and that some regret spend is inevitable given the uncertainty faced by the ESO. Focus on taking well-understood and justified risks.

3.1.2 Designing the Markets of the Future

It is difficult to perform a meaningful CBA for designing the markets of the future. It is clear that benefits will be delivered through this work but it is difficult to identify precisely in advance what these benefits will be. We have therefore instead performed a form of break-even analysis by considering the magnitude of benefits that need to be delivered and assessing whether this is reasonable given our understanding of benefits delivered in the past and how this might change in the future.

The cost of this proposal over the RIIO-2 period is £3.2 million.

Incremental Costs

The spend required occurs of the final three years of the RIIO-2 period and is associated with the detailed design of the future markets. Work will be undertaken in partnership with stakeholders; ensuring views of all industry parties and captured and reflects, and that longer term sustainable future markets are put at the heart of the outcome. The output will be designs for the balancing mechanism suitable for a future with a high volume of low carbon plant together with a large number of small, distributed flexible assets.

Table 13: Incremental costs for preferred option

Costs £m	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Capex Spend	0	0	0	0	0	0
Opex spend	0	0	0.2	1.5	1.5	3.2

To implement changes to the markets arising from the design, further work and systems would need to be implemented incurring additional costs. The cost of this work can therefore be considered an option fee to access the possibility of implementing a new market design in future.

Table 14: Incremental FTE requirements

	2021/22	2022/23	2023/24	2024/25	2025/26
Extra FTE (from opex)	0	0	3	6	6

The total costs for this transformational activity are £3.2 million.

Incremental Benefits

The benefits of the preferred option are outlined in a qualitative way in the table below:

Benefit	Description
Improved safety and reliability.	Proposal ensures that there is sufficient flexible energy to maintain security of supply in a low-carbon world.

Improved quality of service.	The markets will be designed with the future needs of market participants in mind and not their past needs as is presently the case.
Lower bills than would otherwise be the case.	The focus of this work is to contribute to delivering the savings forecast in the CCC report through attracting sufficient flexibility onto the system. This work on markets is necessary but not sufficient to deliver these savings. Some savings that can be attributed to this work include improved efficiently in both wholesale and balancing markets which in theory should result in reduced costs and prices in those markets.
Reduced environmental damage.	Markets designed with the future in mind will be more conducive to decarbonisation and so reduced carbon will therefore result in reduced environmental damage.

The monetary value of this work is difficult to quantify but it is anticipated that this work will result in improved efficiency in wholesale and balancing markets. Given the annual spend in these markets is around £35 billion, even a small improvement in efficiency would result in a large consumer benefit. It should be noted that a study into future market design would not, itself, deliver quantifiable benefits. Instead the costs can be viewed as an option fee to allow a change to be made in the future if the costs of implementation across the entire industry were outweighed by the benefits of more efficient markets. However, we are confident that this transformational activity will deliver significant benefits for consumers.

Uncertainties and risks

The key uncertainties and risks are outlined in the table below.

Risk	Mitigations
There is a risk that industry do not engage with the process and this results in a sub-optimal market design; there will also be overlap potential which will need to be co-ordinated such as in relation to Clean Energy package, European Network Codes or BSC developments.	Utilise best practice engagement approaches e.g. Power Responsive and Charging Futures – Learn / Ask / Contribute. Ensure ESO is appropriately resourced with access to consultant funds so ESO can undertake 'heavy lifting' on behalf of industry with consultancy support.
As with any project there will be risks to time, quality and cost in relation to delivery of the project and management of the project scope, etc.	Manage as a project with good project management and appropriate project controls. Creation of some form of industry oversight for input, challenge and review e.g. as with Power Responsive.
The scale of the project is ambitious so there is a risk that the market design does not fully meet (yet to be defined) requirements or that	Ensure appropriate cost stage gates throughout design project to monitor spend against project delivery.

the benefits are not as expected i.e. there is a small risk benefits do not outweigh costs.	In-built project controls as only undertaking first-stage design activities with any detailed design activities and subsequent implementation activities to then follow.

3.1.3 Transform Access the Capacity Market

The CBA for this activity has been calculated with reference to the status quo which maintains the current approach to incremental change to future market arrangements. This proposal seeks to deliver a fundamental transformation of the access to the capacity market.

Using a conservative estimate of benefits, the net benefit of this activity is between £12 million and £80 million, we have shown the detail around the central estimate of £46 million over the five year RIIO-2 period.

This net benefit has been calculated considering costs and benefits over the five-year period up to 2025/26. There will be benefits beyond this period and so this analysis will underestimate the net benefit. The ratio of estimated benefits to costs over the period is 2.5.

Incremental Costs

The additional spend under this proposal, is front-loaded to support the development of the new Electricity Market Reform (EMR) functionality as part of the ESO market portfolio, to support the new market parties. There is budget allocated in subsequent years to ensure continued development of the processes and platforms to meet regulatory changes and evolve markets.

The additional spend is £25 million to fund the develop of new system through capex, together with £3.5 million of opex cost for running the new systems and processes to deliver the capacity market, and the FTE provide support to enhance our modelling capability, and administer the rules.

Table 15: Incremental costs for preferred option

Costs £m	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Capex Spend	8.3	8.3	3.1	2.6	2.6	25
Opex spend	0.8	0.9	0.8	0.6	0.4	3.5

To cover these additional costs a net benefit of at least £28.4 million needs to be demonstrated.

Incremental Benefits

The benefits of the preferred option are outlined in a qualitative way in the table below:

Benefit	Description

Improved safety and reliability.	Proposal facilitates a Capacity Market that is open to a broader mix of participants, including generators, storage and demand-side resources. This ensures there is sufficient capacity to maintain security of supply in a low-carbon world.
Improved quality of service.	Clearer, better coordinated rule change process reduces complexity and administrative burden for market participants. Enhanced modelling ensures participants are rewarded fairly for their contribution to security of supply.
Lower bills than would otherwise be the case.	The primary focus of this work is to contribute to delivering the savings forecast in the CCC report through attracting sufficient capacity and flexibility onto the system. Savings that can be directly attributable to this work are: Enabling greater access to the Capacity Market will facilitate competition and maximise liquidity in the auctions. Enhanced modelling will ensure the right amount of capacity is secured, minimising the risk of procuring more capacity than is needed. All of this means security of supply will be provided at the lowest possible cost to consumers.
Reduced environmental damage.	An open and accessible Capacity Market, with a diverse mix of participants, supports meeting the UK's 2050 carbon reduction target.
Benefits for society as a whole.	A level playing field for markets with reduced barriers to entry enables new and small parties to participate, supporting the wider economy.

For the CBA we have focused on benefits that could be achieved by enhancing data and modelling and by ensuring the auction is as liquid as possible with flexible generation and demand side players of all types entering the market. Economic theory suggests that greater liquidity in the auction will drive lower clearing prices.

Two broad incremental benefit areas have been identified in the capacity market:

Benefit Area one – enhanced modelling capability

Better industry data and enhanced modelling and analysis capability will allow for better forecasting capability. Much of the theory on which capacity calculations are derived is based on systems with conventional generation. A new understanding of security of supply is required for a system with large volumes of renewable generation and distributed flexible assets.

There is a fine balance for consumers between overpaying for security for supply and ensuring that the security of supply standard is met. Improved modelling of security of supply in a low-carbon, high-flexibility world underpinned by improved information on the assets will enable us to more accurately find the balance and ensure security of supply at the most efficient cost.

This enhanced data and modelling capability will reduce sensitivities in the forecasting process and allow us to refine recommended capacity to secure in each auction. Any reduction in the amount of capacity to be procured through the auction, as a result of this enhanced capability, will benefit the consumer as less capacity is required at the auction clearing price, ensuring security of supply at the best possible cost.

In our modelling, we have assumed that we save consumers the equivalent of 1 GW of capacity being purchased due to the enhanced capability – any capacity saving is hard to be certain on, given the complexity of how the final auction price is arrived at. This is equivalent to approximately two percent of the volume purchased in the T-4 auction. To cover the uncertainty here, we have considered capacity savings of 0.5 GW and 1.5 GW, given annual savings of £8.5 million and £25.5 million respectively. The prices are derived based on the average cost of GW of capacity in the four T-4 auctions held to date.

Table 16: Historic auction summary data for T-4 capacity market auctions

T-4 Auction (delivery year)	Clearing Price (£/kW/year)	Capacity secured (GW)	Cost of 1GW	
2021/22	8.4	50415	£	8,400,000
2020/21	22.5	52425	£	22,500,000
2019/20	18	46353	£	18,000,000
2018/19	19.4	49258	£	19,400,000
Average	**17.075**	**49613**	**£**	**17,075,000**

Furthermore, this enhanced modelling capability will allow for derating factors for current and future technologies to be further refined. This will ensure that technologies are appropriately rewarded for their contribution to security of supply.

Benefit Area two – reduced barriers to entry and cost of participation

We will work to remove barriers to market entry for the capacity market, simplifying requirements and making the process as efficient as possible for applicants. This should reduce the cost of market participation for applicants and saving could be passed to the consumer.

If each applicant company, we have conservatively assumed 400 such companies as seen in the CM register[10] were to save two FTE weeks of time (total cost of FTE £100,000 per year), we assume a total annual saving of £1.5 million (400 companies x £100,000 / 52 x 2) to be passed to the consumer through lower overall cost in the industry. This saving is assumed to be equivalent to a senior analyst within ESO and mirrors their time on this activity.

Benefit Area three – Increased market liquidity

Whilst difficult to monetize the benefits due to numerous external market factors, economic theory suggests that greater liquidity would drive a lower clearing price driving long term reduction to consumer cost. The actions taken to the reduce barriers to entry will create a more liquid market. Introducing further volumes of additional flexible generation and demand side to the market should result in the capacity market clearing

[10] https://www.emrdeliverybody.com/CM/Registers.aspx

lower than it otherwise would have done so. If the price were to clearer lower, this would provide further benefit to consumers. For illustration, a £1 per kW per year reduction in capacity market clearing price would save consumers around £50 million per year.

We have assumed that the benefits are realised from 2022/23 onward and are consistent across the period:

Table 17: Incremental benefits for preferred option

Benefits £m	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Benefit 1: more efficient capacity purchased reducing cost of consumer	-	17.0	17.0	17.0	17.0	68
Benefit 2: reduced barriers to entry reducing industry costs of participation	-	1.5	1.5	1.5	1.5	6
Benefit 3: increased market liquidity			*Not monetised*			

The total incremental benefits for this proposal are between £40 million and £108 million, with a central estimate of £74 million, plus any benefits gained in auction clearing prices through increasing liquidity.

Net benefit of preferred option

The net benefit of the preferred option using the identified costs and benefits above is between £12 million and £80 million, with a central estimate of £46 million over the RIIO-2 period which is highly positive, before the additions of benefit of increasing market liquidity. The actual net benefit will be much higher than this because in this analysis we have considered only a small subset of the benefits. We are therefore confident that this transformational activity will deliver significant value to consumers.

Uncertainties and risks

Since the suspension of the Capacity Market, the ESO has been working with BEIS and the industry towards its restoration. We still believe that the Capacity Market is the right answer for affordable security of supply. Subject to the outcome of this process, the key uncertainties and risks in this work area are outlined in the table below:

Risk	Mitigations
Ofgem / BEIS may wish to retain all responsibility for Capacity Market rule development.	Engage with Ofgem, BEIS and industry to explain the benefits of ESO being able to apply its expertise and drive the development of rules across markets. Work with BEIS to ensure rule development and administration is aligned with their responsibility for Capacity Market Regulations. Use current and forthcoming rule change consultations to demonstrate the value we can add in this area and that we take account of the needs of all market participants.

The current ringfence around the EMR function limits the scope for efficiencies from increased coordination of rule development and data sharing across the ESO.	Ofgem are already consulting on whether the EMR ringfence remains necessary in light of the recent legal separation of the ESO. We can use the example of legal separation to demonstrate that we manage sensitive information and potential conflicts of interest successfully. Engage with BEIS, Ofgem and industry to explain the protections provided by the new ESO ringfence and that removing the additional EMR ringfence will increase efficiencies and reduce the number of separate interactions for our customers.
We may not get access to all of the industry data that would be required to undertake enhanced modelling and analysis.	Work with stakeholders, including the Government's Data Task Force, to ensure the ESO has access to relevant data. Engage with other European System Operators to ensure consistent operating regimes and reliability standards implementation across Europe as well as availability of consistent data sources or modelling.

3.2 Develop Code and Charging Arrangements that are Fit for the Future

3.2.1 Transform the code processes

It is difficult to perform a meaningful CBA for transforming the codes process. While it is self-evident that that benefits will be delivered through this work, it is difficult to identify precisely in advance what these benefits will be, with a number of codes modification being cost neutral and all having to demonstrate they meet the code modification requirements defined by Ofgem[11]. We have therefore instead performed a form of break-even analysis by considering the magnitude of benefits that need to be delivered and assessing whether this is reasonable given our understanding of benefits delivered in the past and how this might change in the future.

The cost of this proposal over the RIIO-2 period is £5.9 million.

Incremental Costs

Delivery will require additional opex spend over the status quo. The transformational opex spend will increase over the RIIO-2 period driven by extra headcount. This will increase from an extra 5 FTEs in 2021/22 to an extra 22 FTEs over the business as usual level who will in coordination with industry transform the code process and deliver substantial volumes of market change through this new process. This is an increase compared to the ongoing headcount in RIIO-T1 of 35 FTEs. The increase has been developed by considering: benchmarking against other code administrators such as for the Smart Energy Code; the volume of potential code change driven by the low carbon transformation; the volume of resource committed by Ofgem during the Significant Code Reviews. There is substantial work in rationalising, simplifying and harmonising content

[11] https://www.nationalgrideso.com/document/140341/download

within the Connection and Use of System Code (CUSC) and SO-TO Code (STC). We also recognise that the ability to launch and support Significant Code Reviews and control strategic code change is a large undertaking requiring significant knowledge and expertise. We believe an incremental approach, rather than a one-step implementation, will best deliver this process transformation allow the gradual build-up of skills and capabilities alongside the corresponding legislative changes required to fully fulfil our ambition. An incremental transformational programme will also allow the current status quo FTE to continue to focus on implementing important industry change.

Table 18: Incremental costs for preferred option

Costs £m / FTE	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Opex spend	0.6	0.9	1.2	1.5	1.7	5.9
Total additional FTE above ongoing FTE	5	10	14	18	22	

The total costs for this transformational activity are £5.9 million over five years.

Incremental Benefits

The benefits of the preferred option are outlined in a qualitative way in the table below:

Benefit	Description
Improved safety and reliability.	Ensures codes remain appropriate for emerging markets and business models to contribute to safe and reliable operation of the system at all times in future.
Improved quality of service.	The modification process is more efficient and reduces the time which customers are involved in it and codes more generally with change with the most expected benefits being easily prioritised. Newer and smaller providers are now better served by more tailored and suitable arrangements allowing for more players to enter a more competitive market.
Lower bills than would otherwise be the case.	The primary focus of this work is to drive efficiency into the codes and code change process by reducing barriers to entry and increasing information provision. The result is to contribute to the creation of more efficient and competitive markets, reducing wholesale market costs, as well as BSUoS and TNUoS costs, depending on the code in question and against a counterfactual of no change to the process.

	There are also internal efficiency savings for industry participants as there is a quicker and less resource intensive change process and a better critical friend, etc.
Reduced environmental damage.	There will be minor consequential benefits to the environment as a result of these changes e.g. more efficient codes contribute to more efficient decarbonisation.

We see two significant ways in which these benefits will be delivered:

- Overall process efficiency for ESO and Industry e.g. fewer meetings, more focused discussions etc., these efficiencies are likely to be realised year-on-year, by the average number of codes modifications which the ESO facilities a year[12]. We have assumed these benefits are delivered over four years, given a one year start up for the process.
- Realising the benefits of code modifications to the market quicker, in particular prioritising high value code modifications. This is likely to be realised over a single year from a high value modification being deliver one year earlier.

Quantifying the benefits of the improving the code frameworks is not straightforward. However, more efficient change will allow benefits from modifications to be realised sooner releasing value to consumers earlier. A more open efficient code process will also reduce barriers to entry in the market, creating the opportunity for more diverse parties to participate in the process. It is useful to consider historical code changes when considering what benefits might be delivered in the future. The Ofgem cost-benefit analysis for CMP264 and CMP265 on embedded benefits indicated that a one year delay in implementation cost consumers £300 million. Given the volume of transformational change required over the RIIO-2 period it is not unreasonable to assume that a similar size benefit can be delivered in the period. Indeed, we only need benefits of two percent of this to break even over the period. This could be delivered by one high-value modification such as embedded benefits or a number of smaller value modifications. We can therefore be confident that this activity will deliver benefits which far exceed the costs of implementation.

Uncertainties and risks

We are conscious that Ofgem and BEIS are undertaking a joint Energy Codes Review and the scope of the conclusions and timescales are currently unclear. Subject to this review we outline uncertainties and risks detailed in the table below:

Risk	Mitigations
BEIS / Ofgem Joint Energy Codes Review does not align with our RIIO-2 ambition and / or complete during the ESO Forward Plan 2019-21 period.	Continue to undertake a leadership role in the Energy Codes Review. Subject to the conclusion of our review. Our business plans would require revision and so should be subject to future amendment.

[12] For the CUSC there are on average 15 modifications a year.

Based on stakeholder feedback and Ofgem's proposals in the RIIO-2 sector specific methodology publication we have assumed that the ESO will remain the code administrator for CUSC, STC and Grid Code, as well as being the de factor code administrator for the SQSS.	Continue to engage with industry to demonstrate that we are best based placed to maximise consumer benefit in the codes that we administer.
We have assumed that necessary primary legislation changes will be made in at the start of the RIIO-2 period to provide the necessary powers to fundamentally transform code processes. This is a key dependency which then unlocks further transformative change over the remainder of the RIIO-2 period.	Continue to undertake a leadership role in the Energy Codes Review. Engage Ofgem and BEIS to highlight the legislative changes required to enable our future role.

3.2.2 Work with all stakeholders to create a fully digitalised whole system Grid Code by 2025

The CBA for this activity has been calculated with reference to the status quo which maintains the current manual interaction with the Grid Code. The status quo was chosen as the counterfactual as it is the minimum activity that we believe is required to deliver balancing service markets over the RIIO-2 period.

Using a conservative estimate of benefits, the net benefit of this activity is £0.7 million, with a cost to benefit ratio of 1.1. This work only begins to deliver benefits in 2024/25 and through to 2029/30 it will realise net benefits of £16.5 million. Further benefits through more liquid markets, which have not been monetized, mean that this analysis likely underestimate the net benefit.

Incremental Costs

Delivery will require additional capex and opex spend over the status quo. The increased capex spend is focused on delivering the digitised platform on which the grid code will sit. This has been benchmarked with our IT providers. The increased opex spend contains three elements:

- Consultancy costs to support the project life cycle – we have factored in consultancy costs over years two to four of the RIIO-2 period consistent with the expected project lifetime. Using an external consultant provides the ability to flex skill and capability support through the project life cycle. These costs have been estimated via our internal Group Procurement with the assumption of a mid-tier consultant to support the project.
- Increased internal FTE over the business as usual level – our estimates of is equivalent to an extra five FTEs over the business as usual level who will be working closely with our external consultants and industry to deliver the whole system Grid Code by 2025.
- Run the business costs for ongoing support of the digitalised code – some enduring additional costs of operating the new digited platform.

Incremental costs are set out in table 19.

Table 19: Incremental costs / FTEs for preferred option

Costs £m / FTE	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Opex spend		1.1	1.1	1.2	0.1	3.5
Capex spend		0.5	0.5	0.5	0.5	2.1
Total additional FTE above ongoing FTE		5	5	5		

The incremental costs for this transformational activity are £5.6 million over the RIIO-2 period.

Incremental Benefits

The benefits of the preferred option are outlined in a qualitative way in the table below:

Benefit	Description
Improved safety and reliability.	A digitised code will improve the understanding of requirements for market participants and enhance compliance.
Improved quality of service.	A simplified code will enable enhanced visibility of requirements for their connection project, driving earlier and more efficient decision making. Customers will have an additional source of information which will provide critical information as and when they need it. There will be an efficiency saving for customers in the time and effort required to engage with ESO and DNOs in the future. Future amendments to the code will be automatically updated, improving visibility of updates and impacts for customers.
Lower bills than would otherwise be the case.	Future connection application decisions will be facilitated in a more timely and efficient manner which will decrease the manpower and effort required by industry. A clearer understanding of the rules will determine more financially appropriate procurement decisions by all industry stakeholders.
Reduced environmental damage	There will be minor consequential benefits to the environment as a result of these changes e.g. more efficient codes contribute to more efficient decarbonisation.

The benefits of a digitised whole system grid code are a more user friendly, inclusive and tailored experience which will work efficiently for the diverse needs of our customers. A Grid Code that is easier to understand will provide efficiencies in the pace of how important decisions are taken throughout the connection journey, and will crucially provide more targeted and customised information as and when customers need it. Removing this barrier in the market will also aid the support for new smaller entrants and innovation in the market. New parties in a more liquid market, will deliver efficiencies and benefits and lower cost for consumers in the long run.

To put a conservative estimate on the benefit of a digitised grid code, we have looked at the scale of the use of the grid code by parties connecting to transmission and distribution. We have assumed that the improved digital service which remove one person month of effort from each application process (approximately total cost of FTE £0.1 million per year); and have conservatively assumed there are 500 potential projects which require to interact with the grid code. For comparison in 2018, there were 393 applications for connection to the transmission network alone. Annual benefit from 2025/26 will be £4.2 million per year (500 projects x £100,000 / 12). This saving is assumed to be equivalent to a senior analyst within ESO and mirrors their time on this activity.

We have assumed that half the benefits are realised from 2024/25, and then the full benefit realised from 2025/26 onwards once the platform is developed and implemented.

Table 20: Incremental benefits for preferred option

Benefits £m	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Improved processes	0	0	0	2.1	4.2	6.3

The incremental benefits from digitising the Grid Code are £23 million out to 2030, and £6 million in the RIIO-2 period.

Net benefit of our preferred option

The net benefit of the preferred option using the identified costs and benefits above is at least £17 million to 2030, which is positive and the benefits considered at three times the costs. The actual net benefit will be much higher than this because in this analysis we have considered only a small subset of the benefits. We are therefore confident that this transformational activity will deliver significant value to consumers.

Uncertainties and risks

Our proposals to develop a whole system grid code are also dependent on the conclusions of the Ofgem & BEIS joint Energy Codes Review. Subject to this review please find the uncertainties and risks detailed in the below table.

Risk	Mitigations
Business capabilities and resource.	Targeted use of consultants.
Lack of industry engagement impacting quality and delivering to timescales.	Engage with Ofgem, BEIS and industry to explain the benefits of ESO being able to apply its expertise and drive benefits across markets.

We have assumed that necessary primary legislation changes will be made in at the start of the RIIO-2 period to provide the necessary powers to fundamentally transform code processes. This is a key dependency which then unlocks further transformative change over the remainder of the RIIO-2 period.	Continue to undertake a leadership role in the Energy Codes Review. Engage Ofgem and BEIS to highlight the legislative changes required to enable our future role.
As with any project there will be risks to time, quality and cost in relation to delivery of the project and management of the project scope, etc.	Manage as a project with good project management and appropriate project controls.
Based on stakeholder feedback and Ofgem's proposals in the RIIO-2 sector specific methodology publication we have assumed that the ESO will remain the code administrator for CUSC, STC and Grid Code, as well as being the de factor code administrator for the SQSS.	Continue to engage with industry to demonstrate that we are best based placed to maximise consumer benefit in the codes that we administer.

3.2.3 Look at fully or partially fixing one or more components BSUoS

Under the status quo, the BSUoS price is set ex-post, and stakeholders tells us that they do not like the volatility and unpredictability of the product. This variability leads to them adding risk premia to their prices, pushing up the overall cost to the consumers. Fixing the BSUoS price will likely reduce the risk premia added by market parties, but instead replaces it with a cost of managing the forecasting and cashflow risk borne by the ESO. These lower overall costs, will result in savings to consumers.

The CBA for this activity has been calculated with reference to the status quo which maintains ex-post charging arrangements for BSUoS. The status quo was chosen as it is the default position which will remain without a proactive change to the structure of BSUoS.

This activity has an estimated net benefit of £291 million and up to £791 million. This assumes the necessary facilitative changes are made prior to the start of the RIIO-2 period for implementation from 1st April 2022. Given the uncertainty here and the highly positive benefits, we have assumed the lower estimate for our central estimate.

Incremental Costs

Delivery of our preferred option will not require incremental capex or opex over the status quo, nor any additional FTEs. It may require opex and capex associated with implementation but these costs are expected be accounted for through ongoing arrangements for the RIIO-2 period (i.e. relating to periodic changes to the charging arrangements).

Based upon previous internal analysis undertaken prior to legal separation, the costs used for the CBA are estimates of the additional cash flow costs which would be associated with a move from ex-post to ex-ante charging arrangements for BSUoS. It has been assumed that there will be an additional £150 million per annum of under recovery risk for ESO in each financial year if we were to fix BSUoS on an annual basis; this change would result in an additional cash flow risk for ESO until those under recovered costs can be recovered in future. It should be noted that this analysis was carried out prior to legal separation and will be updated by September 2019.

These additional costs relate to new funding facility costs (such as a revolving credit facility with a commercial bank) and some form of Parent Company Guarantee, which will ensure that the ESO has access to the funds required to maintain the business in the event of under recovery of BSUoS. These costs do not include any costs associated with wider arrangements for the ESO (e.g. in relation to the weight average cost of capital) but we do not expect these to materially affect the CBA.

Therefore, based upon previous internal analysis undertaken by ESO the costs of new funding arrangements could be in the region of £2.2 million to £7.4 million per annum from implementation of the change, assumed to be from 1st April 2022.

Table 21: Incremental costs for preferred option

Costs £m / FTE	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Other costs: NGESO funding arrangements estimates		2.2 - 7.4	2.2 - 7.4	2.2 - 7.4	2.2 - 7.4	8.8 – 29.6

The total costs for this transformational activity are therefore currently estimated at £8.8 million - £29.6 million over the five years. For our CBA we have used the higher estimate to take a conservative approach to potential costs.

Incremental Benefits

The benefits of the preferred option are outlined in a qualitative way in the table below:

Benefit	Description
Lower bills than would otherwise be the case.	Additional costs to consumers incurred through the RIIO-2 arrangements with ESO (and added to BSUoS) are expected to be lower than the current costs to consumers incurred due to risk premia being added by chargeable parties in respect of forecasting uncertainty and an inability to hedge BSUoS.

Based upon previous industry analysis undertaken by a CUSC Work Group exploring fixing BSUoS with a notice period as demonstrated in the Final Modification Report for CMP250, stabilising BSUoS with at least a twelve-month notification period, Section 2.163[13] an illustrative annual saving to consumers in an order of magnitude of £80 million to £200 million per annum was recorded for one of the scenarios considered. We will

[13] https://www.nationalgrideso.com/document/106876/download

work with Ofgem and industry to further refine the benefits associated with this transformational actively over the coming months.

Table 22: Incremental benefits for preferred option

Benefits £m	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Risk Premia Reduction		80-200	80-200	80-200	80-200	320-800

The incremental benefits of our preferred option could therefore potentially be in the region of £80-200 million per annum from implementation of the change assumed to be from 1st April 2022. For our CBA we have used the lower estimate to take a conservative approach to potential benefits.

Net benefit of our preferred option

The net benefit of the preferred option using the pessimistic forecast of the identified costs and benefits above is £291 million over the RIIO-2 period which is highly positive and before the additional benefit of increasing market liquidity, and could be up to £791 million. We are therefore confident that this transformational activity will deliver significant value to consumers.

Uncertainties and risks

The key uncertainties and risks relating to this transformational activity are outlined in the table below:

Risk	Mitigations
If CBA assumptions are not robust or circumstances change then there is a risk that the costs associated with the new arrangements outweigh the savings associated with the new arrangements. An added uncertainty it that it is challenging to understand risk premia values due to commercial confidentiality concerns amongst chargeable parties.	Review costs/benefits being utilised to ensure robust estimates. Engage with industry in relation to potential benefits to sense check assumptions.
The funding and regulatory arrangements and their associated costs for ESO to facilitate such a transition remain uncertain and this is exacerbated by the recent separation of ESO within the National Grid Group.	As above, update the costs which are to be associated with the new arrangements to ensure robust estimates.
The changes to BSUoS would need to occur via a Code Modification process which would provide uncertainty in relation to the specifics of any change to be presented to the Authority for approval in due course.	Engage with Ofgem in advance to ensure the scope of the defect and the proposal align with expectations.

There are uncertainties in relation to the future direction of Balancing Services Charges more widely which could in theory interact with the options within this paper prior to RIIO-2.	Keep proposals under review to ensure that the costs and benefits are reflective of the most recent position for BSUoS.

3.3 Summary of costs to support the CBA analysis for theme 2

This table shows the cost of transformational activities within this theme:

CBA reference	Expenditure area (£ million)	21/22	22/23	23/24	24/25	25/26	Total
3.1.1	Opex	0	1	2	2	3	8
	Capex	6	6	5	3	3	**24**
	Total	**7**	**7**	**6**	**5**	**6**	**32**
3.1.2	Opex	0	0	0	1	1	3
	Capex	0	0	0	0	0	**0**
	Total	**0**	**0**	**0**	**1**	**1**	**3**
3.1.3	Opex	1	1	1	1	0	4
	Capex	8	8	3	3	3	**25**
	Total	**9**	**9**	**4**	**3**	**3**	**28**
3.2.1	Opex	1	1	1	1	2	6
	Capex	0	0	0	0	0	**0**
	Total	**1**	**1**	**1**	**1**	**2**	**6**
3.2.2	Opex	0	1	1	1	0	4
	Capex	1	1	1	1	1	**3**
	Total	**1**	**2**	**2**	**2**	**1**	**6**
	CBA opex subtotal	2	4	5	7	6	24
	CBA capex subtotal	15	15	8	6	6	51
	CBA subtotal	**17**	**19**	**13**	**13**	**13**	**75**
	Allocated ongoing & cross cutting costs	57	56	53	55	55	**277**
	Subtotal	**74**	**75**	**66**	**68**	**68**	**352**
	Theme 2 opex	0	0	0	10	10	20
	Theme 2 capex	10	10	10	10	10	50

	Theme 2 ongoing & cross cutting totex	60	60	50	50	50	270
	Theme 2 total	**70**	**70**	**60**	**70**	**70**	**340**

4 Cost-benefit analysis: Theme 3

This section provides further context on the costs and quantifiable benefits of our proposed Theme 3 transformational activities

Net benefit of all our proposals against the status quo is estimated at £907 million and up to £972 million over the RIIO period.

All costs, benefits and Net benefits are shown in 2018/19 prices.

4.1 Network Options Assessment (NOA)

4.1.1 Facilitate Competition by embedding pathfinding projects into the NOA process

Net benefit of our proposal against the status quo is estimated at £593 million. This has a benefit to cost ratio of 120, with net benefits positive from 2021/22.

Incremental Costs

Delivery of our transformational activities will require additional capex and opex spend. These are summarized below in table 19. These costs are associated with the additional operation of the NOA process, this does not include the overall costs to produce the NOA.

Table 23: Incremental costs for Facilitate Competition by embedding pathfinding projects into the NOA process

Costs £m	2021/22	2022/23	2023/24	2024/25	2025/26
Opex spend	0.1	0.1	0.1	0.2	0.2
Capex spend	0.8	0.8	0.8	0.8	0.8

The total costs for this transformational activity are £4.5 million.

Incremental Benefits

This activity is to take the learnings and processes from the ESO 2019-2021 forward plan and embed this learning into network investments. The pathfinding projects cover a wide range of network challenges, such as regional voltage challenges, constraint management, network stability and the implementation of commercial solutions competing with traditional transmission assets. As the pathfinding projects adopt a learn by doing approach it's hard to accurately forecast the savings as a result of this activity. However, from our forward plan we have seen that this benefit will be realised throughout the RIIO period. Benefit calculation for implementing commercial solutions is calculated by:

1. Complete the standard NOA process
2. Add in a commercial solution that is assumed to provide additional boundary capacity
3. Use historic costs of other commercial solutions as a benchmark for analysis
4. Repeat the NOA process with this extra commercial option
5. Calculate the difference between (1) and (4).

Table 24: incremental benefits for Facilitate Competition by embedding pathfinding projects into the NOA process

Benefits £m	2021/22	2022/23	2023/24	2024/25	2025/26
Consumer benefit of implementing commercial solutions.	157	80	134	123	104
Implementing voltage pathfinders.	This value is forecast in theme 4.				
Network Stability pathfinder.	This value is forecast in theme 4.				
Constraint management pathfinder.	It is not yet known the value of the constraint management pathfinder as it is in very early scoping phase and very dependent on the solutions. More detail will be available for the December submission.				

The net benefit of the preferred option using the identified costs and benefits above is £593 million over the RIIO period, which is highly positive. We are therefore confident that this transformational activity will deliver significant value to consumers.

The table above only shows value out until 25/26 however there is further value out until 27/28. This value is mainly attributed to a more flexible commercial solution being available before an asset build.

Uncertainties and Risks

Risk	Mitigations
Delays to network investment due to running competitive processes.	We will develop streamlined and timely processes that minimise delays. The cost

	of any unavoidable delays will be factored in to our final CBA.
Increased participation of services in network development adds another layer of complexity to balancing services market.	The role of longer term tenders will be considered alongside our developments of other balancing services.
Increased use of commercial services could increase operational complexity.	Our planning and control room processes will ensure we can manage this risk.
Increased risk of non-delivery of solutions from using new providers and technologies.	We will manage the risk of non-delivery through our tender processes.
Risk that frameworks and funding arrangements hamper the roll out of competition.	We will work closely with Ofgem and other relevant stakeholders such as ENA to develop appropriate frameworks.

4.1.2 Extending NOA to other areas of network development

Extending the NOA to end of life asset life asset replacement decisions

Net benefits of our proposal against the status quo: £142 million. This has a benefit to cost ratio of 26, with positive net benefits after 2022/23.

We propose to expand our network planning processes to look at TO end of life asset replacement decisions. Currently, TOs consider the best way to replace assets that are reaching the end of their life. However, TOs do not have access to the same level of operational data as the ESO. We believe that by reviewing decisions, the ESO would be able to recommend a different approach.

The principle behind this CBA is when assets replacement is not considered as part of the NOA and the existing non-interactive processes continue. It's worth noting that initially we will only consider assets that may have an impact on major network boundaries.

Incremental Costs

Delivery of our transformational activities will require additional capex and opex spend. These are summarized below in table 20. These costs are associated with the additional processing required to include the asset life information in the NOA process, this does not include the overall costs to produce the NOA.

Table 25: Incremental costs for End of Asset Replacements

Costs £m	2021/22	2022/23	2023/24	2024/25	2025/26
Opex spend	0.2	0.3	0.3	0.3	0.3
Capex spend	0.8	0.8	0.8	0.8	0.8

The total costs for this transformational activity are £5.2 million.

It is very difficult to forecast the exact benefit for this activity as the ESO does not hold asset price data or long term asset replacement information. Part of this activity will require the TOs to submit this extra data with their NOA submissions. Below we present a conceptual yet highly plausible scenario where this activity will generate consumer value.

Incremental Benefit

Suppose an asset is due to be replaced like-for-like, due to life expiry, in 2025 at a cost of £50 million. If NOA recommends that the asset is upgraded in 2030 at a cost of £60 million, then the current process would result in a cost of £50 million to replace the asset in 2025 and the another £60 million to upgrade it in 2030 for a total spend of £110 million. There is a clear benefit in bringing the asset upgrade forwards to negate the need to replace the existing asset like-for-like. Bringing forwards the upgrade to 2025 may increase the capital cost of the upgrade from £60 million to £71 million in present value terms but the need to replace the asset is negated. This results in a capital cost saving of £39 million. It is acknowledged that asset life will be reduced to 2065 from 2070 but most of this value will erode with discounting and become immaterial with the overall saving.

Calculation of the forecast saving during the RIIO-2 period

Of schemes submitted to NOA 4 there were 25 percent which were overhead line (OHL) related. Assets are only considered for replacement when their life expires in the next 5 years, this is based on set TO risk factors. Therefore only 12.5% (being 5 years of out of 40 – the assessment period of NOA) of reinforcements will be considered as value created in RIIO-2. Thus, of the 36 options in NOA 4 submitted to upgrade existing assets approximately five schemes can provide benefit of the RIIO-2 period. We have profiled these to the back end of the RIIO-2 period. The average cost of these 36 schemes is £29.5 million. If this activity can save five schemes over the RIIO-2 period the savings would be as per below:

Table 26: Incremental benefits for End of Asset Replacements

Benefits £m	2021/22	2022/23	2023/24	2024/25	2025/26
Number of asset replacement schemes.	0 as this is the year of implementation.	1	1	1	2
Consumer Benefit.	0	29.5	29.5	29.5	59

The net benefit of the preferred option using the identified costs and benefits above is £142 million over the RIIO period, which is highly positive. We are therefore confident that this transformational activity will deliver significant value to consumers.

Uncertainties and Risks

Risk	Mitigations
Duplication of efforts between ESO and TOs and/or increased bureaucracy.	We will work closely with TOs to ensure any activity undertaken by the ESO adds value.

ESO assessment could delay investment decisions.	We will work closely with TOs to understand their processes and time criticalities to ensure the ESO assessment complement this.
Levels of planned TO end of life asset replacement investment is currently not known to the ESO.	These should be available once TO business plans are published.

4.1.3 Extend NOA approach to all connections wider works

We propose to expand our network planning processes to look at Connections Wider Works, these are more local issues that don't necessarily pertain to a bulk transfer requirements. The principle behind this CBA is that the NOA currently looks at ~30 boundaries and this provides a certain value to the consumer. Our counterfactual is to maintain this approach and only look at the major boundaries versus investing in this activity to cover more of the network.

Net benefit of our proposal against the status quo is between £143 million and £208 million. This has a benefit to cost ratio of between 26 and 38, with net benefits being delivered after 2022/23.

Incremental Costs

Delivery of our transformational activities will require additional capex and opex spend. These are summarised below in table two. These costs are associated with the additional processing required to include Connections Wider Works in the NOA process, this does not include the overall costs to produce the NOA.

Table 27: Incremental costs for Connections Wider Works

Costs £m	2021/22	2022/23	2023/24	2024/25	2025/26
Opex spend	0.1	0.1	0.1	0.1	0.1
Capex spend	0.8	0.8	0.8	0.8	0.8

The total costs for this transformational activity are £4.3 million.

Benefit

As we do not know what extra wider works will be required throughout the RIIO-2 period, we've taken a backward-looking approach based on the output of NOA 4 coupled with the materiality of existing wider works that aren't currently considered within the NOA document.

NOA 4 looked at 34 boundaries across GB, which presented 139 different reinforcement options. An initial search found 15 options that were in customer offers that were not considered in the NOA. This suggested that to expand the NOA to consider these extra options would lead to around a 10 percent increase in boundaries and options to analyse. Again, NOA 4 showed the value created by presenting a recommended investment plan for the next 12 months was between £1.85 billion and £2.67 billion.

If the NOA was expanded to look at 10 percent more boundaries and hence cover more of the smaller wider work schemes, then it is reasonable to expect these savings to increase. However, the relationship between looking at more boundaries and saving more money will not be linear and given the uncertain nature of options it is very challenging to determine the extra value this would generate, however even a pessimistic saving of just two percent more would provide the consumer between £37 million and £53.4 million.

Table 28: Incremental costs for Connections Wider Works

Benefits £m	2021/22	2022/23	2023/24	2024/25	2025/26
High estimate	0	53.4	53.4	53.4	53.4
Low estimate	0	37	37	37	37

The net benefit of the preferred option using the identified costs and benefits above is between £143 million and £208 million over the RIIO-2 period, which is highly positive. We are therefore confident that this transformational activity will deliver significant value to consumers.

Uncertainties and Risks

Risk	Mitigations
This could delay decisions on whether these additional elements of wider works go ahead.	This proposal means all connections wider works will now follow the same process providing greater clarity.
The ESO may need to develop additional modelling capabilities to assess each wider works.	Ensure efficient processes are in place to assess new areas.

4.1.4 Support decision making for investment at the distribution level

The ESO currently assesses investment decisions for transmission networks (which includes the 132kV networks in Scotland). We considered whether there would be value in expanding the ESO's role further to also under take a NOA type process at the 132kV networks in England and Wales. Do demonstrate the potential value in this activity our CBA counterfactual is that we do not expand the NOA into the 132kV domain and we do not provide any support for DNOs.

We also consider it a viable option for the ESO to perform a NOA type assessment on the 132kV network, this is discussed below, however the incremental costs assume a consultancy role for the ESO.

Net benefit of our proposal against the status quo: is £35 million. This has a benefit to cost ratio of 8, with net benefits delivered after 2022/23.

Incremental Costs

Delivery of our transformational activities will require additional capex and opex spend. These are summarized below in table 27. These costs are associated with the additional resource to require to support DNO activities.

Table 29: Incremental costs for all 132kV assets

Costs £m	2021/22	2022/23	2023/24	2024/25	2025/26
Opex spend	0.1	0.2	0.2	0.2	0.3
Capex	0.8	0.8	0.8	0.8	0.8

The total costs for this transformational activity are £4.8 million.

Benefit

The level of expected investment at this level is expected to be around £40 million per year, as noted in our 18/19 Forward Plan. Therefore, we believe there is value to be gained through the ESO focusing on supporting the DNOs rather than expanding into the 132kv networks now.

The NOA balances operational costs vs investment costs and historically the NOA determines that ~60 percent of all options submitted make it onto the optimal path and hence may be proceeded for the next 12 months. (This 60% of options being included on the optimal path does not mean options are necessarily inefficient, the process is designed to intentionally challenging of options submitted). If we assume the same proportion when extending the NOA to lower voltage levels, it is reasonable to say that the NOA could deliver value for the consumers via the DNO. It should be noted that the NOA takes a national approach and therefore may recommend more than 60 percent in any given area. Applying the 60 percent to the £40 million investment implies around £16 million could be recommended not to proceed for that 12-month period. Given the uncertainty here, as have assumed that not all the £16 million savings would be realised, but a more conservative £10 million.

It is not reasonable to say definitively this is a direct reduction in investment costs however this figure highlights that a NOA type process may save overall investment costs.

We believe that by sharing our expertise we could help the DNOs to optimise their investment plans and generate savings of around £10 million a year for consumers over the RIIO-2 period.

Table 30: Incremental benefits for all 132kV assets

Benefits £m	2021/22	2022/23	2023/24	2024/25	2025/26
Estimate of supporting DNO optimisation.	0	10	10	10	10

The net benefit of the preferred option using the identified costs and benefits above is £35 million over the RIIO period, which is highly positive. We are therefore confident that this transformational activity will deliver significant value to consumers.

Uncertainties and Risks

Risk	Mitigations
The absence of one overall co-ordinating party could lead to differing approaches across the country, potentially causing confusion for solution providers.	The ESO support role will include a role to support consistency across networks

4.1.5 Support actions across all our transformational activity

Implement and enhance improved analytical capabilities

Our modelling capabilities underpin all of our deliverables in theme 3 and many in theme 4. With increasingly complex, and interacting, needs on the network the right modelling and analytical capabilities can bring about significant benefits.

As this is a facilitating activity, we have not undertaken a CBA as these benefits are captured in the subsequently enabled activities.

Table 31: Incremental costs for Implement and enhance improved analytical capabilities

Costs £m	2021/22	2022/23	2023/24	2024/25	2025/26
Opex spend	0.1	0.1	0.1	0.1	0

Uncertainties and Risks

Risk	Mitigations
Difficult to predict how tools will need to evolve in future due to changing needs and increased understanding of issues.	Proposals based on best assumptions at present.

4.1.6 Undertake with industry a review of the SQSS

As these standards underpin all our planning work, ensuring that they support the most efficient decision making helps the ESO and TOs to deliver efficient investment. We expect the review could be completed within four years and the ESO would require £1 million to deliver this. It is assumed TOs would also require resource as a joint team would need to deliver the review.

Table 32: Incremental costs for review of the SQSS

Costs £m	2021/22	2022/23	2023/24	2024/25	2025/26
Opex spend	0.3	0.3	0.3	0.1	0

Uncertainties and Risks

Risk	Mitigations
The review could deliver limited actual change.	Focusing on specific areas rather than a generic review should help ensure practical action is achieved.
Review could delay changes.	As above.
The changes the review delivers could have limited tangible benefits.	Focus on the biggest areas of concern should ensure some tangible benefits can be achieved.

4.2 Competitively Appointed Transmission Owner (CATO) Regime

Ongoing activities

Provision of ongoing support to Ofgem in the development of their preferred model for onshore competition in transmission.

Adapting the level of support required, based on the evolution of Ofgem's plans for their preferred model.

Transformational activities

To undertake specific development work for competition in onshore transmission, we will work on the basis of establishing an Early tender model. We will develop our ability to identify and articulate network needs, establish new capabilities to identify strategic options for potential providers to tender against; and leverage our current experience to support the design of the tender process.

To establish the capability to support Ofgem's tender process, we will enhance our ability to provide support to a much larger number of potential tenderers through developing and resourcing Customer Relationship Management tools, establish additional power system engineering capability to perform technical assessment of tendered options, and establish additional commercial analysis capability to perform commercial assessment of tendered options.

Cost of transformational activities

To support the development of Ofgem's preferred approach, we would establish a business lead to take the overarching role of driving forward the shape of the solutions and work closely with Ofgem to provide the support in defining the early tender model. The business lead would also require the support of two SMEs as help design the solution and specify the additional capabilities required by the ESO.

It is anticipated these roles would be required for the first three years of the five-year period (2021/22 to 2023/24).

To support operation of the tender process, we would require additional customer relationship management (CRM) and analytical capability to manage the interface with tenderers and assess the options submitted in tenders. We anticipate that:

1. the time taken to provide appropriate support to tenderers would require one additional FTE to manage;
2. the increased volume of technical assessment work required to analyse tender submissions would require two additional FTE power system engineer resources and;
3. to manage the increased number of tender submissions to assess in the NOA, we would require two additional FTE commercial resources to deal with the assessment of those options, as well as additional IT infrastructure to enable the analysis.

It is anticipated these roles would be required for the last three years of the five-year period (2021/22 to 2023/24).

Delivery of our transformational activities will require additional capex and opex spend. Except for the cost of additional IT infrastructure to enable the tender analysis (which is captured in the NOA section), additional spend is summarised below:

Table 33: Incremental costs for transformational activities

Costs £m	2021/22	2022/23	2023/24	2024/25	2025/26
Opex spend	0.5	0.5	0.6	0.3	0.3
Capex	0.3	0.2	0	0	0

Uncertainties and Risks

The key uncertainties and risks are outlined in the table below.

Risk	Mitigations
Delays to network investment due to running competitive processes.	We will develop streamlined and timely processes to minimise this risk.
Duplication of efforts between ESO and TOs and/or increased bureaucracy.	We will work closely with TOs to ensure any activity undertaken by the ESO adds value.
Investing resource in developing CATO regime without certainty that it will proceed.	We will work closely with Ofgem to focus resource on activity that best supports their needs.
Changes to the current criteria (new, separable and high value) for competitive treatment of onshore transmission, for example a reduction in the high value	We will agree with Ofgem a mechanism that allows us to scale the resources deployed to support the CATO regime if its criteria for applicability change from current levels.

threshold) may significantly increase the number of projects subject to competition.	
Resourcing and funding development of an early model could leave NGESO without key capabilities required to deliver support for a late model.	Through our work with Ofgem we will seek to understand the need for NGESO to secure funding for, and develop, further capabilities as required.
Uncertainty over the role Ofgem want ESO to play in the regime.	Through our work with Ofgem we will seek to understand the need for NGESO to secure funding for, and develop, the required capabilities.

4.3 Summary of costs to support the CBA analysis for theme 3

This table shows the cost of transformational activities within this theme:

CBA reference	Expenditure area (£ million)	21/22	22/23	23/24	24/25	25/26	Total
4.1.1	Opex	0	0	0	0	0	1
	Capex	1	1	1	1	1	**4**
	Total	**1**	**1**	**1**	**1**	**1**	**4**
4.1.2	Opex	0	0	0	0	0	1
	Capex	1	1	1	1	1	**4**
	Total	**1**	**1**	**1**	**1**	**1**	**5**
4.1.3	Opex	0	0	0	0	0	1
	Capex	1	1	1	1	1	**4**
	Total	**1**	**1**	**1**	**1**	**1**	**4**
4.1.4	Opex	0	0	0	0	0	1
	Capex	1	1	1	1	1	**4**
	Total	**1**	**1**	**1**	**1**	**1**	**5**
4.1.5	Opex	0	0	0	0	0	0
	Capex	0	0	0	0	0	**0**
	Total	**0**	**0**	**0**	**0**	**0**	**0**
4.1.6	Opex	0	0	0	0	0	1
	Capex	0	0	0	0	0	**0**
	Total	**0**	**0**	**0**	**0**	**0**	**1**
4.2	Opex	0	0	1	0	0	2
	Capex	0	0	0	0	0	**1**
	Total	**1**	**1**	**1**	**0**	**0**	**3**
	CBA opex subtotal	1	1	2	2	2	7
	CBA capex subtotal	3	3	3	3	3	15
	CBA subtotal	**4**	**4**	**5**	**5**	**5**	**23**
	Allocated ongoing & cross cutting costs	8	8	7	7	7	**37**

Subtotal	**12**	**12**	**12**	**12**	**12**	**60**
Theme 3 opex	1	1	2	2	2	7
Theme 3 capex	3	3	3	3	3	15
Theme 3 ongoing & cross cutting totex	8	8	7	7	7	37
Theme 3 total	**12**	**12**	**12**	**12**	**12**	**60**

5 Cost-benefit analysis: Theme 4

This section provides further context on the costs and quantifiable benefits of our proposed theme 4 transformational activities.

Net benefit of all our proposal against the status quo is estimated at £1,006 million and up to £1,166 million over the RIIO period.

In this section, all costs, benefits and net benefits are shown in 2018/19 prices.

5.1 Closer ways of working with network organisations to streamline the connection process for smaller players

Net benefit of our proposal against the status quo: £3.2 million. This has a benefit to cost ratio of 1.7, which is net benefit positive after 2023/24.

Cost of transformational activities

Delivery of our transformational activities will require additional capex and opex spend. These are summarized below:

Table 34: Incremental costs for connection process

Costs £m	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Capex	0.8	0.8	0.2	0.1	0.1	2.1
Opex	0.2	0.3	0.3	1.0	1.0	3.0

The capex spend is focused on the delivery of a connections hub which will facilitate our proposed transformational activities in this area. This hub will provide open and consistent information on both the connection process across the whole electricity system as well as information relating to available capacity across the transmission – distribution interface serving potential applications to electricity networks across the whole of GB. We are expected this project to be delivered in two phases. The first phase will see development of the basic hub supporting the needs of new parties connecting to the system. Following the planned delivery of this work in 2022/23, phase two will commence to develop the enhanced features of both available capacity across the transmission and distribution interface and also a secure on-line area for customers to view their accounts and check the progression of their applications.

Increased opex spend is equivalent to between 13 and 17 FTEs across the period. These are split between project resource to deliver the connections portal and resource required for the ongoing use and maintenance of the portal and associated customer service activities. This operational resource will increase gradually across the RIIO-2 period reflecting the phase roll out of the connections portal.

The total costs for this transformational activity are £4.7 million.

Benefits

The chart below shows the number of connection applications the ESO has received in each of the last three financial years. Additionally, in the last twelve months we have seen a 60 percent increase in applications from new market participants (see chart below). This growth is driven primarily by new smaller generation units for battery storage and solar connections, new interconnectors and new demand points for data centres and independent DNO's.

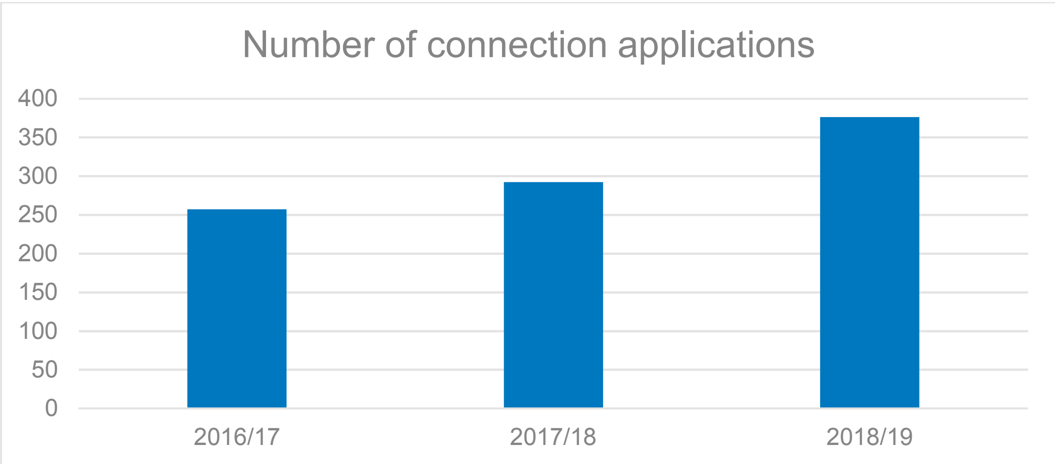


Chart: number of connection applications

Both these drivers will result in a need for additional ESO resource in the RIIO-2 period to provide appropriate support for customers through the connections process. We believe, in addition to the qualitative benefits described in the main report, it will be more efficient for us to provide initial support through our proposed connections hub. Our forward-looking analysis (summarised below) takes a conservative view of the future rate of increase in applications will slow from around 20 percent today to around 8 percent per year. We have also assumed we will provide support at a similar rate to today, which is also likely to be an underestimate.

We have estimated that the information presented on the central connections hub will reduce our direct resource requirements by five percent. This will be delivered from April 2022. A further five percent will be delivered in April 2024 with capacity information across the transmission-distribution interface. Roll-out of our secure on-line account management facility in April 2025 will deliver an additional 30 percent saving. We also believe there will be efficiencies directly for customers in managing the connections process. This includes our proposed activities to enhance the customer experience through extension of customer seminars and dedicated support staff. These efficiencies are also estimated below.

Table 35: Incremental benefits for connection process

Benefits £m	2021/22	2022/23	2023/24	2024/25	2025/26
Applications	393	424	458	494	533
ESO efficiency saving	0.21	0.23	0.25	0.55	2.3
Customer efficiency savings	0.21	0.46	0.77	0.81	2.1

The net benefits of the preferred option using the identified costs and benefits above is at least £3.2 million over the RIIO-2 period. The actual net benefits will be much higher than this because in this analysis we have considered only a small subset of the benefits. We are therefore confident that this transformational activity will deliver benefit to consumers.

Uncertainties and Risks

The key uncertainties and risks are outlined in the table below.

Risk	Mitigations
There are many major industry initiatives which will influence the scope of our planned activities over the next two years (e.g. BEIS data task force, governance reform review, BEIS / Ofgem work on smart systems and flexibility).	We have developed our approach based on the natural evolution of our current ways of working we which believe provides a least regrets pathway for the ESO. We are actively involved in many of these activities and will refine our business plan as required in a timely manner.
IT experience of new technology.	Learning from previous lessons learnt on similar IT projects (for example, Transmission Outage and Generator Availability (TOGA) replacement). Close coordination with our IT developers to understand stakeholder needs and build project in an agile manner. Working closely with stakeholders.
System need changes happen quicker than pace of industry change.	Ensure that agile arrangements are developed with codified changes following as soon as practicable. Facilitate the transitions in RIIO-ED2 such that this price control is not seen to be a blocker to the energy transition.

	More detailed scenario planning of future energy landscape.

5.2 A pathway for zero carbon whole system operability and beyond

Net benefit of our proposal against the status quo are estimated at £842 million. This has a benefit to cost ratio of 11, with net benefits positive from the start of the RIIO-2 period.

Cost of transformational activities

Delivery of our transformational activities will require additional capex and opex spend. These are summarised below:

Table 36: Incremental costs for zero carbon whole system

Costs £m	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Capex	9.5	11.4	17.1	14.3	9.2	62
Opex	2.1	3.1	4.1	5.7	6.2	21

The total costs for this transformational activity are £83 million.

The capex spend is focused across four areas;

- Provision for additional Regional Development Programmes (RDP) across GB. Each of these programmes has a potential for a bespoke IT spend and we used our initial RDPs to inform the costs of this work in RIIO-2. We have assumed a minimum of three RDPs in progress per annum increasing to five towards the end of the RIIO-2 period reflecting the increasing driver to optimize the whole electricity system.
- Increased offline modelling and data management. Developing our existing package to incorporate increased visibility of distribution networks and their operational characteristics. Whilst initial works would be undertaken in the period 2021-23 we would see most of this development from the start of RIIO-ED2 in April 2023 reflecting the additional drive to distribution system operation expected in this price control period.
- Embedding of our Enhanced Frequency Control Capability (EFCC) and Power Potential innovation projects to ensure whole system operability. These new systems will support our plan to facilitate zero carbon operation of the system by 2025.
- Identifying future operability needs beyond 2025. Whilst we envisage much of this work to be completed within innovation projects, the articulation of our long term needs and product strategy will be done within the business.

Increased opex spend is up to around 30 FTEs in 2022/23. This peak period reflects the need for us to complete detailed operability assessments ahead of 2025 and ensuring that the appropriate frameworks and data exchange mechanisms are in place. This number will then diminish by around 50 percent through the period to 2025/26 as increased maturity and automation of our systems facilitates reduced FTE equivalents

Benefits

We have quantified benefits in two areas; whole system operability and RDPs.

Whole system operability

There is significant value that will be released through identifying new needs for operability and opening up potential new market opportunities. Currently the national control room take numerous actions each day to ensure an operable network. The network is becoming inherently more difficult to operate due to reducing system inertia and increased MVAr demand amongst numerous other challenges. We have assessed the potential value through two methodologies which are described further below. In both cases, they estimate an increasing value opportunity of up to around £400 million per annum by 2025/26.

NOA-type assessment

We have conducted a NOA-type assessment of a series of operability constraints and calculated the cost to re-dispatch the network to address the system needs. This has forecast operability costs of £596 million per year in the period 2021-2026 with a long-term upwards trend which is made up of stability at £234 million, voltage at £130 million and RoCoF at £323 million. There is also a natural synergy because an action to fix a voltage problem may also fix a stability problem, so we take 75 percent of each of these to reflect that giving:

(£234 million x 75 percent) + (£134 million x 75 percent) + £323 million = £596 million.

Power system analysis suggests that 10 GVA of fault infeed is needed to address system operability challenges. One asset based solution provides 200 MVA at a cost of ~£25 million therefore ~£1.25 billion would address system operability challenges. Using the scaling from an innovation project for implementation it was assumed a 70 percent reduction in costs throughout the RIIO-2 period, dependent on implementation of assets or commercial solutions. It should be noted this value can only be delivered through third parties. We have used the 70 percent benefit to provide a conservative assessment as summarized in the table below and assumed it will gradually increase in value across the RIIO-2 period from 2022/23:

Estimated annual benefit by 2025/26 = 70 percent x £596 million = £417 million with a phased introduction of this benefit in preceding years:

- 2/8 of £417 million benefit = £104 million in 2022/23,
- 3/8 of £417 million benefit = £156 million in 2023/24
- 7/8 of £417 million benefit = £365 million in 2024/25.

We recognize that the whole system operability activity will only be the start of releasing these benefits, and that many other of the ESO roles and transformational activities will support their realization. As the £596 million above is based on the size of the problem and does not consider the cost of mitigations, these could be build or non-build. The cost of any commercial solutions is either based on market or historic information and both will be compared on a level playing field. We used commercial solutions in NOA 4 and in other pathfinding projects, so we are confident that by RIIO-2 we will have improved this process. To reflect these third-party costs, we have further assumed that there will be an additional cost of £200 million over the four years to realize this benefit, either an investment in an asset or a market solution.

Table 37: Incremental benefits for zero carbon whole system

Benefits £m	2021/22	2022/23	2023/24	2024/25	2025/26
Operability savings 70%.	0	104	156	365	417
Additional costs.	0	-50	-50	-50	-50

We have compared this analysis with the recent CBA undertaken by our EFFC innovation project[14] as illustrated in the chart below. This shows a similar level of potential benefit to the NOA analysis conducted.

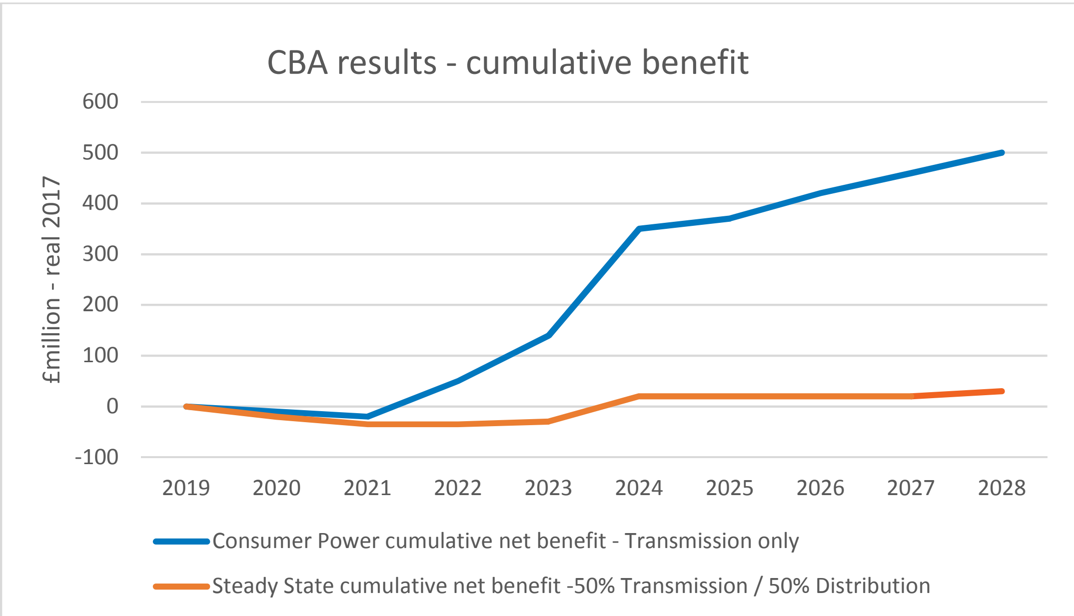


Chart: EFFC innovation project example

Benefits of RDPs

Our RDPs already delivering significant value for the end consumer with the first RDP delivering a net saving of £13 million through avoided asset build. We have used this value along with the value of our second completed RDP to forecast future RDP benefits based on this historic performance.

The two RDPs to date have provided different benefits:

[14] https://www.nationalgrideso.com/document/142876/download

- RDP 1 produced a saving in required asset build. We have used the quoted saving of £13 million in this calculation.
- RDP 2 provided network access for renewable power ahead of the traditional connection process. This second RDP allowed an extra 278 MW of renewable generation across four grid supply points (GSPs). In our assessment, we have assumed this generation would connect in 2020 ahead of planned asset build in 2026. We have also assumed a carbon offset of ~1 TWh[15] of carbon free generation per year. We have assumed a similar carbon saving profile for future RDPs Below is the carbon saving calculation, we have assumed one year to realise the benefits.

Table 38: carbon savings from RDP

	2021/22	2022/23	2023/24	2024/25	2025/26
Carbon intensity Two Degrees gCO2/kWh	146.72	143.63	148.28	137.06	130.75
Carbon generation reduction TWh	1	1	1	1	1
Thousand Tonnes of carbon saved	147	144	148	137	131
Carbon price £/tCO2e	4.76	4.94	6.44	10.18	13.21
Saving £ million	-	0.71	0.95	1.40	1.73

To avoid double counting of asset savings and carbon saving we have assumed that each RDP will save either carbon or asset build in equal proportions.

We have committed to a minimum of three inflight RDPs per annum during the RIIO-2 period depending on system needs. Based on historic experience these will take approximately two years to complete. We have therefore trended RDP completions across the RIIO-2 period to match this rate. The results of this assessment are shown in the table below. We recognize that the benefits may diminish over time as the most beneficial regions are investigated first and have used a scaling factor in our calculation below to reflect this.

Table 39: Incremental benefits for RDPs

Benefits £m	2021/22	2022/23	2023/24	2024/25	2025/26
RDPs completed	1	2	2	2	3

[15] 278MW of carbon free generation with an estimated load factor of 40%

Asset Saving	12.9	12.9	12.9	12.9	25.8
Carbon Saving	0	0.71	0.95	1.40	1.73

The net benefit of the preferred option using the identified costs and benefits above is estimated to be £842 million over the RIIO-2 period.

5.3 A whole system approach to accessing networks

Net benefit of our proposal against the status quo is between £161 million and £321 million. This has a benefit to cost ratio of between 18 and 34, with net benefit positive from the start of the RIIO-2 period.

Cost of transformational activities

Delivery of our transformational activities will require additional capex and opex spend. These are summarized in the table below:

Table 40: Incremental costs for whole system approach

Costs £m	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Capex	1.0	1.0	1.0	1.0	1.0	5.2
Opex	0.6	0.8	1.2	1.0	1.0	4.5

The capex spend is focused on the IT equipment needed to facilitate greater levels of data and information relating to outages to both transmission connected parties and also those connected to distribution networks. This includes enhancing our currently inflight replacement for the existing outage notification tool to better notify distribution connected parties as well as providing remote accessibility reflecting their needs. It also covers the greater extent to which we will need to model the impact of distribution networks on the transmission system during outage periods.

In the period 2021-23 we are proposing an opex spend increase of the equivalent of 6 FTEs to cover the GB wide roll-out of the Network Access Planning (NAP) process and SO-TO code procedure (STCP) cost recovery mechanism. These FTEs will also support our initial work to develop our deeper access liaison with DNOs including increased procurement and co-ordination of flexibility services from DER. The development of this activity will increase from the start of RIIO-ED2 in April 2023 reflecting the delivery of enhancements to our outage planning tool and the roll out of developed deeper access planning arrangements across the transmission and distribution system interface. A drop of FTEs equivalent from a peak of 17 to 13 is expected towards the end of RIIO-2 as the outage planning tool enhancements are completed.

The total costs for this transformational activity are £9.7 million.

Benefits

It is difficult to put a monetary value on all these benefits, particularly as our deeper access planning thinking is still at an early stage, and so the numerical calculation for the CBA is focused on lower bills. This will significantly underestimate the benefits of the proposal but if it is still net benefit positive in these circumstances the analysis demonstrates that the proposal is beneficial to consumers.

As a result, our quantified assessment relates to the benefits that will be delivered through rolling out the NAP process STCP cost recovery mechanism across GB. Consumer value for this approach has already yielded results in Scotland which in 2018/19 were forecast to be between £16 million and £36.7 million, equivalent to between a 7 percent and 16 percent reduction in costs[16]. If the same proportion of benefits could be realised in England Wales we would expect to see savings of between £17 million and £41 million. Power system knowledge infers a 50:50 split in complexity for outage planning between England & Wales (E&W) and Scotland.

Cost increases are based on forecast NOA percentage year-on-year increases of constraint costs, this percentage increase is then mapped from 18/19 outturn of constraint costs. The NOA uses a complicated constraint forecasting mechanism, which is beyond the scope of this submission.

Further we have used the NOA process to forecast constraints costs based on the 18/19 outturn numbers. This has provided the following forecast benefit over the RIIO-2 period of this transformational activity.

Table 41: Incremental costs for whole system approach

Benefits £m	2021/22	2022/23	2023/24	2024/25	2025/26
Estimated E&W constraint costs based on NOA forecast.	351	316	363	428	493
Forecast saving based expanding the process into E&W with a 7% reduction.	24.6	56.3	25.4	29.9	34.4
Forecast saving based expanding the process into E&W with a 16% reduction.	56.3	50.6	68.3	78.7	76.8

Net benefit of preferred option

The net benefit of the preferred option using the identified costs and benefits above is at least £161 million over the RIIO-2 period which positive. The actual net benefit will be higher, up to £321 million than this because of the uncertainty of the benefits which could be realised in England and Wales. We are therefore confident that this transformational activity will deliver benefit to consumers.

[16] In 18/19 transmission system constraint costs were £222.6m in Scotland and £248.8m in England and Wales (E&W)

5.4 Summary costs to support the CBA analysis for theme 4

This table shows the cost of transformational activities within this theme:

CBA reference	Expenditure area (£ million)	21/22	22/23	23/24	24/25	25/26	Total
5.1	Opex	0	0	0	0	0	2
	Capex	1	1	0	0	0	**2**
	Total	**1**	**1**	**1**	**1**	**0.6**	**4**
5.2	Opex	3	4	5	6	7	24
	Capex	9	11	17	14	9	**62**
	Total	**12**	**15**	**22**	**21**	**16**	**86**
5.3	Opex	1	1	1	1	1	5
	Capex	1	1	1	1	1	**5**
	Total	**2**	**2**	**2**	**2**	**2**	**10**
	CBA opex subtotal	3	5	6	8	9	31
	CBA capex subtotal	11	13	18	15	10	69
	CBA subtotal	**15**	**18**	**25**	**24**	**19**	**100**
	Allocated ongoing & cross cutting costs	42	42	39	38	39	**199**
	Subtotal	**57**	**60**	**63**	**61**	**57**	**299**
	Theme 1 opex	0	0	10	10	10	30
	Theme 1 capex	10	10	20	10	10	60
	Theme 1 ongoing & cross cutting totex	40	40	40	40	40	200
	Theme 1 total	**50**	**50**	**70**	**60**	**60**	**290**

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