A

Appendix A NOA study matrix

Assumption/Condition		Comments
Generation and Demand Scenarios	Two Degrees	Technical and economic assessment of the reinforcement options; sensitivity studies where appropriate
	Community Renewables	Economic assessment of the reinforcement options and technical assessment as required; sensitivity studies where appropriate
	Consumer Evolution	Economic assessment of the reinforcement options and technical assessment as required; sensitivity studies where appropriate
	Steady Progression	Economic assessment of the reinforcement options and technical assessment as required; sensitivity studies where appropriate
Seasonal Boundary Capability	Winter Peak	Technical and economic assessment of the reinforcement options
	Spring/Autumn	Technical and economic assessment of the reinforcement options. Technical assessment of boundary capabilities can be calculated based on agreed scaling factors from winter peak capabilities which are validated against benchmarked results. Benchmarking is subject to availability of the model and agreement on generation despatch
	Summer	Technical and economic assessment of the reinforcement options. Technical assessment of boundary capabilities can be calculated based on agreed scaling factors from winter peak capabilities which are validated against benchmarked results. Benchmarking is subject to availability of the model and agreement on generation despatch
Boundary Capability Study Type	Voltage Compliance	
	Thermal	
Contingencies	N-1-1	
	N-1	
	N-D	
Network Reinforcements	Build reinforcements	
	Reduced-build reinforcements	Assessment of reduced-build reinforcement options

Assumption/Condition		Comments
	Operational reinforcements	Assessment of operational options
Study Years	Year 1	Assessment of alternative reinforcement options subject to availability
	Year 2	Assessment of alternative reinforcement options subject to availability
	Year 3	Assessment of alternative reinforcement options subject to availability
	Year 4	Assessment of build and alternative reinforcements options excluding those are subject to Ofgem agreement
	Year 5	Assessment of build and alternative reinforcements options excluding those are subject to Ofgem agreement
	Year 7	Assessment of build and alternative reinforcements options excluding those are subject to Ofgem agreement
	Year 10	Assessment of build and alternative reinforcements options excluding those are subject to Ofgem agreement

B

Appendix B Validation checks of seasonal scaling factors

Introduction

The ESO's NOA report analysis uses a constraint cost model. In 2015/16, this was ELSI. ELSI applies scaling factors to the winter peak capabilities which are from technical studies. These give the seasonal boundary capabilities. We derived the scaling factors using a set of assumptions. The purpose of these validation checks was to verify the assumptions and if necessary recommend changes.

Background

We use a technical model to study the transmission network and find boundary limit based on winter peak loadings in the Two Degrees scenario. Boundary limits are dominated by thermal and voltage constraints that result from the loss of the worst fault on the boundary. Ambient temperature affects thermal limits so warmer seasons warm conductors more. This in turn depresses ratings and hence boundary capabilities. Voltage limits are not directly related to seasonal effects hence we considered them to stay constant across seasons. ELSI works by applying a set of scaling factors to the winter peak figure. The scaling factors change the winter values to represent warmer seasons and also for outages. Outages depend on the number of circuits on a boundary – the fewer circuits there are the greater the impact of a single outage. Once we have applied the scaling factor to get the boundary figure, the lowest of the thermal or voltage figures is the active constraint value in each season.

How we did the checks

We selected three boundaries and used the technical modelling tool to check the thermal and voltage limits for the spring/autumn and summer seasons. We also studied the effects of outages on these boundary limits. We turned the boundary limits from the technical studies into factors and compared them against the factors in ELSI. We chose boundaries B7. B7a and B8 because they had both thermal and voltage limits. They also demonstrated a variety of numbers of circuits crossing the boundaries. The table below shows the results:

Boundary Constraint	Season	Boundary	Existing ELSI Scaling	Studied Scaling	Relative Difference (ELSI vs Studied)
Thermal	**Spring/ Autumn**	Avg. B7,B7a,B8	90%	80%	**↓-10%**
	Summer	Avg. B7,B7a,B8	80%	80%	**≈0%**
	Summer Outage	B7	60%	72%	**↑+12%**
		B7a	66%	72%	**↑+6%**
		B8	71%	69%	**↓-2%**
Voltage	**Spring/ Autumn/ Summer/ Summer outage**	Avg. B7,B7a,B8	100%	90%	**↓-10%**

Conclusion

There is a spread in the differences between the existing ELSI scaling factor and the technical model studies. In the study for summer thermal intact was accurate while summer thermal outage had a 12 per cent difference. We concluded that different generation and demand patterns reduced the voltage limits. Scaling the voltage limit will give slightly pessimistic results in the studies but will help to highlight issues that we can investigate further.

Seasons and outages are just two of the factors that affect boundary capabilities. Wider system flows and how generation is located along the length of a boundary affects the distribution of loading of circuits across a boundary. This in turn affects how quickly a circuit overloads and hence when the boundary reaches its limit. The nearer a concentration of generators is to the overloaded circuit that sets the boundary limit, the sooner the boundary bites. As a result, there will always be approximations in any methodology that does not use technical study tools at every stage of the process.

Recommendations

The validation checks led to recommendations to change the scaling factors in the economic model which the table below summarises:

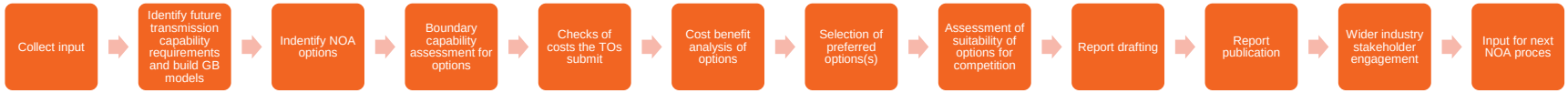
	Existing ELSI scaling factor	Recommended change
Spring autumn scaling thermal	90%	85%
Summer scaling thermal	80%	No change
Summer outage scaling thermal	80% x (n-3)/ (n-2)	70%
Voltage scaling	100%	90%

'n' is the number of circuits crossing the boundary.

The ESO implemented these revised seasonal scaling factors for the second NOA report analysis and will be prepared to amend them following future reviews. However, if the seasonal ratings are directly studied, then they may be used in place of the scaling factors

C

Appendix C NOA process flow diagram



This diagram shows the overall NOA process. The process headings can also be found in the main methodology.

D

Appendix D System requirements form templates

SRF Part	Changes	SOFI Content?	
Part A – Boundary requirement and Capability	Reduced	Yes	ESO sends out a requirement level for each boundary which triggers the TO's response in providing options to meet the capability requirement level for that boundary. The form includes the BID3 unconstrained boundary transfers. Each boundary will have its own Part A.
Part B – TO Proposed Options	Reduced	Yes	TO responds with an option that may partially or wholly meet the requirements set out by Part A. Each option will have its own Part B
Part C – Outage Requirements	Reduced	Yes	TO responds with outage requirements for that option. Each option will have its own row in Part C.
Part D – Studied Option combinations	New	Yes	TO and ESO supply how the options' capabilities have been studied to ensure that the ESO accurately and faithfully reproduces the options' order and capabilities in the economic analysis. Part D is a spreadsheet with some automation to generate flowcharts.
Part E – Options' Costs	Expanded	Yes	TOs supply asset and cost information to allow the ESO to proceed with 'cost reasonableness' (See Appendix E). Each option will have its own Part E, but only if it has featured in Part D.
Part F – Publication Information	Reduced	No	TOs supply names and descriptions of options for publication use. Each option will have its own row in Part E but only if it has featured in Part D.

SOFI stands for System Operator Functions Information.

SRF Part A: Boundary Requirement and Capability

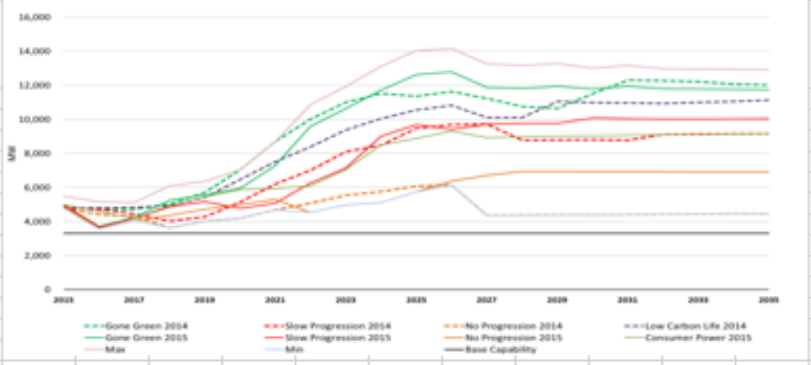
Part A: SO Requirement

For more information please see the information provided separately by the boundary studies.

Requirement preparer:	*ESO to fill in the SO/TO studying this boundary*
Planned ToI Date:	*ESO to fill in the TO engineer whom this was passed to and when*
Boundary under Analysis:	*ESO to fill in which boundary this relates to*

Winter Peak Boundary Required Transfer Summary:

Year 1 Winter Peak Base Capability (from previous year):	*Year 1 winter peak base capability for this boundary as evidenced for the TO*



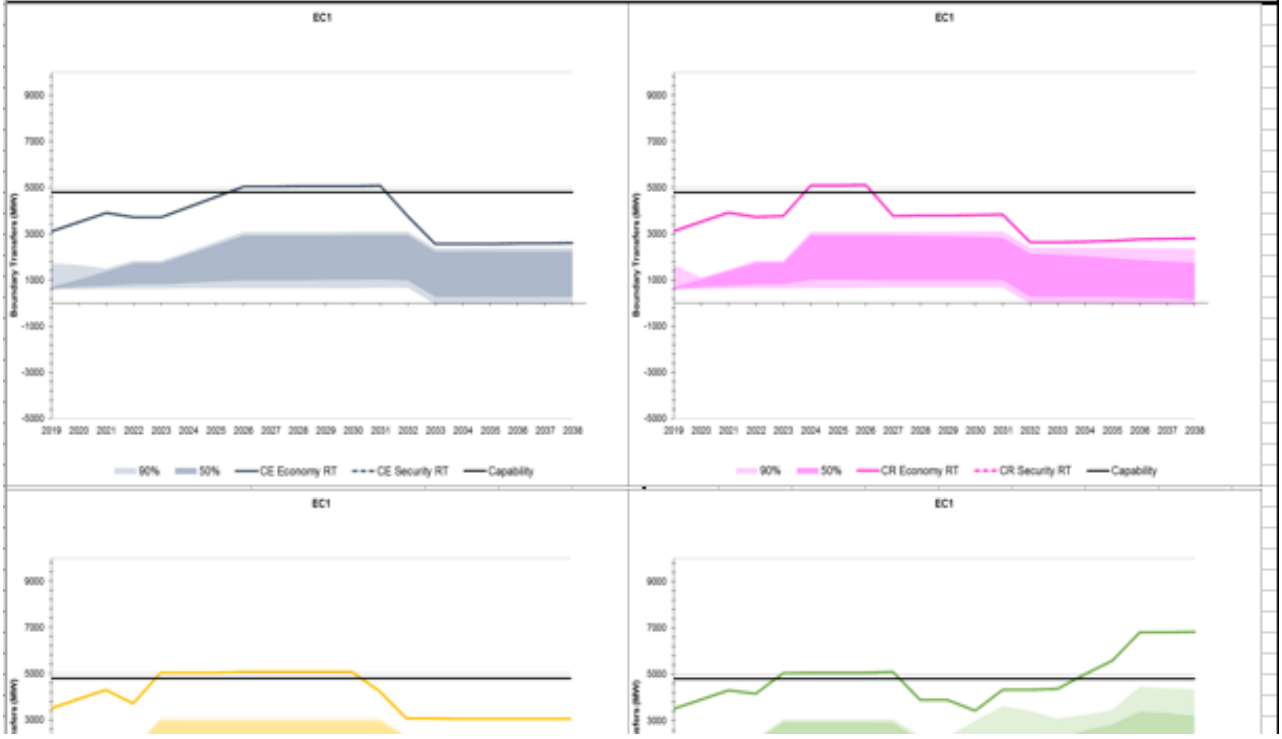
	Economy	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30
Winter Peak Required Transfers in accordance with NETS SQSS Chapter 4 Economy Background (in MW)	Two Degrees	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
	Community Renewables	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
	Consumer Evolution	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
	Steady Progression	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW

	Security	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30
Winter Peak Required Transfers in accordance with NETS SQSS Chapter 4 Security Background (in MW)	Two Degrees	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
	Community Renewables	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
	Consumer Evolution	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
	Steady Progression	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW

Unconstrained Boundary Flow

The section below details the unconstrained flow across the boundary. The 90th percentile and 50th percentile ranges have been highlighted for each scenario and this has been compared to the required transfer in accordance with the SQSS. The top four charts illustrate the FES18 unconstrained flow and the four charts below thereafter this year's FES19 unconstrained flow.

2018 Flow



SRF Part B: TO Proposed Options

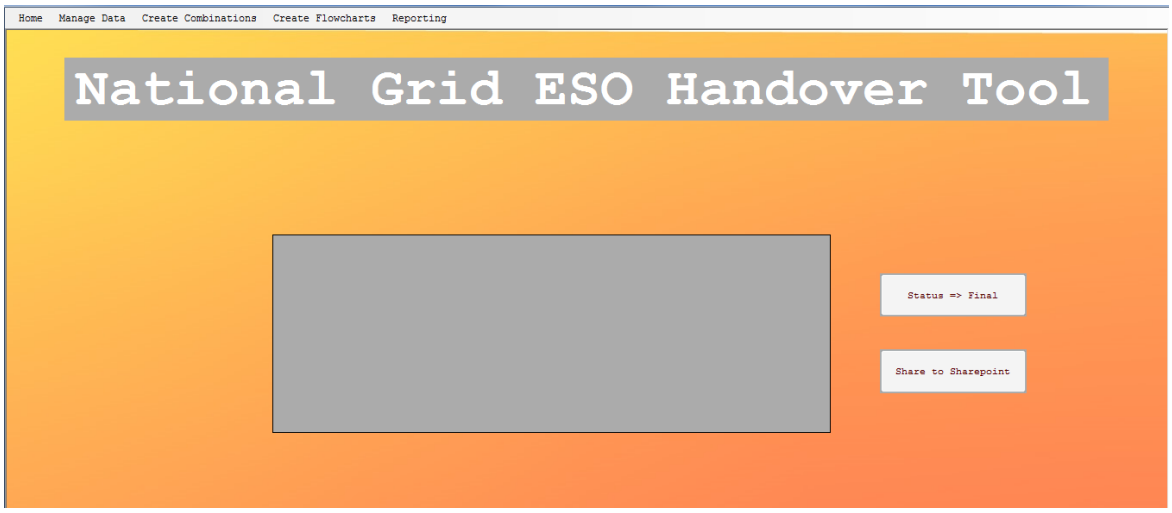
Part B: TO Proposed Options	
TO Ref number:	*Option reference number if available*
Option Name:	*Insert the name of the proposed reinforcement.*
Who initiated the option? *	*State who initiated the option, that is TO or ESO.*
Target boundary or boundaries:	*List the boundary or boundaries that the option is to reinforce*
Status: Same/Changed/New	*Select 'Same' if the option has been proposed before, or 'new' if is a new option.* ***If it has been proposed before but since modified please select 'changed' and note the modifications here along with background reasons for the change.***
Stage that option is at:	*Use the descriptions listed in the NOA methodology for the stage that the project is at. These are Project not started, Scoping, Optioneering and consenting started, Design/ development and consenting, Planning / consenting, Consents approved.*
Physical Description:	*Provide a description of the physical nature of the reinforcement sufficient to allow power system modelling. Please thoroughly list the all assets and works by type, number (for cable and OHL provide the length in km), voltage level and size. Please highlight any* ***new assets in bold.***
Diagram:	*Put a before and after diagram of how the configuration will look including circuits and substation layouts. This applies to the options which will introduce variations to the network topology and equipment layouts. For refurbishment options (e.g. Hotwiring, replacement of equipment), please put one diagram and highlight the alterations.*
What problem does the reinforcement solve?:	*Describe how the proposed solution will increase capability for each boundary in turn with reference to Part A or information supplied by boundary studier*
Lead engineer:	*TO contact name in case of queries*
Scheme or TORI number: *	*Scheme Numbers (England and Wales TO only) or TORI number (Scottish TOs).*
Environmental Impacts:	Brief overview of any environmental implications that progressing this option may
EISD:	*Year*
EISD change background if applicable:	*If the EISD has changed, please provide background reasons that have led to the change.*
Enabling works:	*State if the option also forms enabling works for a customer connection and if so which one(s).*
Enabling works' requirement nature:	*If the option* ***is*** *enabling works, please state the nature of the requirement that the works are intended to manage e.g. thermal, stability, fault level, voltage.*

SRF Part C: Outage Requirements

Part C: Outage Requirements							
TO Option Reference Number	EISD	Year of Outage	Circuits Out	Outage Duration (weeks)	Restrictions in Sequence of Works	Lead Engineer	Additional Comments
TO Reference number. Must be same as Part B.	*EISD*	*Year*	*Circuits Out*	*weeks*	*State whether the works must be done in a certain order*	*TO contact name in case of queries*	*If required, additional comments for ESO PSE*
		Year	*Circuits Out*	*weeks*			
		Year	*Circuits Out*	*weeks*			
TO Reference number. Must be same as Part B.	*EISD*	*Year*	*Circuits Out*	*weeks*	*State whether the works must be done in a certain order*	*TO contact name in case of queries*	*If required, additional comments for ESO PSE*
		Year	*Circuits Out*	*weeks*			
		Year	*Circuits Out*	*weeks*			
TO Reference number. Must be same as Part B.	*EISD*	*Year*	*Circuits Out*	*weeks*	*State whether the works must be done in a certain order*	*TO contact name in case of queries*	*If required, additional comments for ESO PSE*
		Year	*Circuits Out*	*weeks*			
		Year	*Circuits Out*	*weeks*			

SRF Part D: Studied Option Combinations

The information contained in the SRF Part D submission will be processed through the use of National Grid ESO Handover Tool. This application will be the means by which the TOs will submit their boundary capability by reinforcements and scenarios directly to National Grid ESO.



Seasonal scaling factors can be submitted using the following template. Otherwise, actual seasonal boundary capabilities can also be submitted using the ESO Handover Tool above.

Boundary Name	Seasonal Scaling Factor				Number of circuits crossing boundary	Number of outage days
	Winter	Spring/Autumn	Summer	Summer Outage		
Example	100%	85%	70%	50%	4	
B0						
B1						
B2						
B4						
B5						
B6						
B7						
B8						
B9						
B13						
EC5						
SC1						
SC1rev						
NW1						

Please enter data into column H OR column I. The number of outage days will be calculated based on the number of circuits crossing the boundary unless the number of outage days is specified.

Lock/unlock

Use this page to enter seasonal scaling factors for boundaries studied.

SRF Part E: Option Costs

Part E: Option's Costs		
TO Reference Number	TO Reference number. Must be same as Part B.	
WACC Used	% value used for Weighted Average Cost of Capital	
Option Breakdown of Costs		
Total Cost of New Assets/Works	**Cost in £m**	*The total cost of completely new transmission assets or complete replacement of transmission assets.*
Total Cost of New Assets/Works which are also separable	**Cost in £m**	*The portion of the above cost where the ownership between these assets and other (existing) assets can be clearly delineated.*
Total Cost of other Assets/Works	**Cost in £m**	*The remaining cost of any assets/works which are not completely new transmission assets or complete replacement of transmission assets.*
Total Cost of Consents	**Cost in £m**	*Total cost of consents for this option*
Total Cost of Option	**Cost in £m**	*Total cost of option (This should be the sum of 'New Assets/Works', 'other assets/works' and 'consents'*

Delay Costs *The costs table covers for when a project is delayed/cancelled now and delayed/cancelled after one year's work and resources have been put into it. The assumption is that costs after one year's progress will be the same for subsequent years apart from discounting. Use the 'reconsenting' row if the project will cost to restore consents. If there is no submisison in this table, the ESO will assume it can cancel or delay projects at nil cost.*			
	2020/21	**2021/22 (if it were to be proceeded in 2020/21)**	**Additional Comments**
Cost of Demobilisation (£m)	*cost of bringing a project in flight to a stop*	*cost of bringing a project in flight to a stop*	*If you wish, insert additional comments if you'd like to further explain the impacts of demobilising a project if it is already in flight.*
Ongoing delay costs (£m)	*cost of continuing to delay a demobilised project*	*cost of continuing to delay a demobilised project*	*If you wish, insert additional comments if you'd like to further explain the impacts of delaying a demobilised project.*
Cost of Remobilisation (£m)	*cost of proceeding a demobilised project*	*cost of proceeding a demobilised project*	*If you wish, insert additional comments if you'd like to further explain the impacts of remobilising this project if it were to be demobilised.*
Costs of Reconsenting (£m)	*cost of new consents*	*cost of new consents*	*If you wish, insert additional comments if you'd like to further explain the impacts on consents if this project were to be delayed by any number of years.*
Other Delay Costs (£m)	*additional costs to delaying the option*	*additional costs to delaying the option*	*Please state the reason for the additional delay costs. If you wish, insert additional comments if you'd like to further explain the impacts on delaying this project.*
Cancellation (£m)	*cost of permanently cancelling the project*	*cost of permanently cancelling the project*	*If you wish, insert additional comments if you'd like to further explain the impacts of cancelling an option if it is already in flight.*
Total 1 year Cost to Delay (£m)	*total cost of delaying the project for 1 year*	*total cost of delaying the project for 1 year*	*If you wish, insert additional comments if you'd like to further explain the impacts of delaying a project for 1 year*

SRF Part F: Publication Information

TO Reference Number	NOA Code	NOA Publication Name	NOA Publication Description	Additional Comments
TO Reference number. Must be same as Part B.	*Filled in by ESO*	*The name of the option to be used in the NOA publication*	*The description of this option to be used in the publication*	*If required, additional comments for ESO PSE*

E

Appendix E Process for checking NOA option cost reasonableness

This appendix describes the process that the ESO uses to assess the NOA option cost data that the TOs provide as an input to the NOA economic process.

Figure E1 shows the process map for the cost reasonableness checking process.

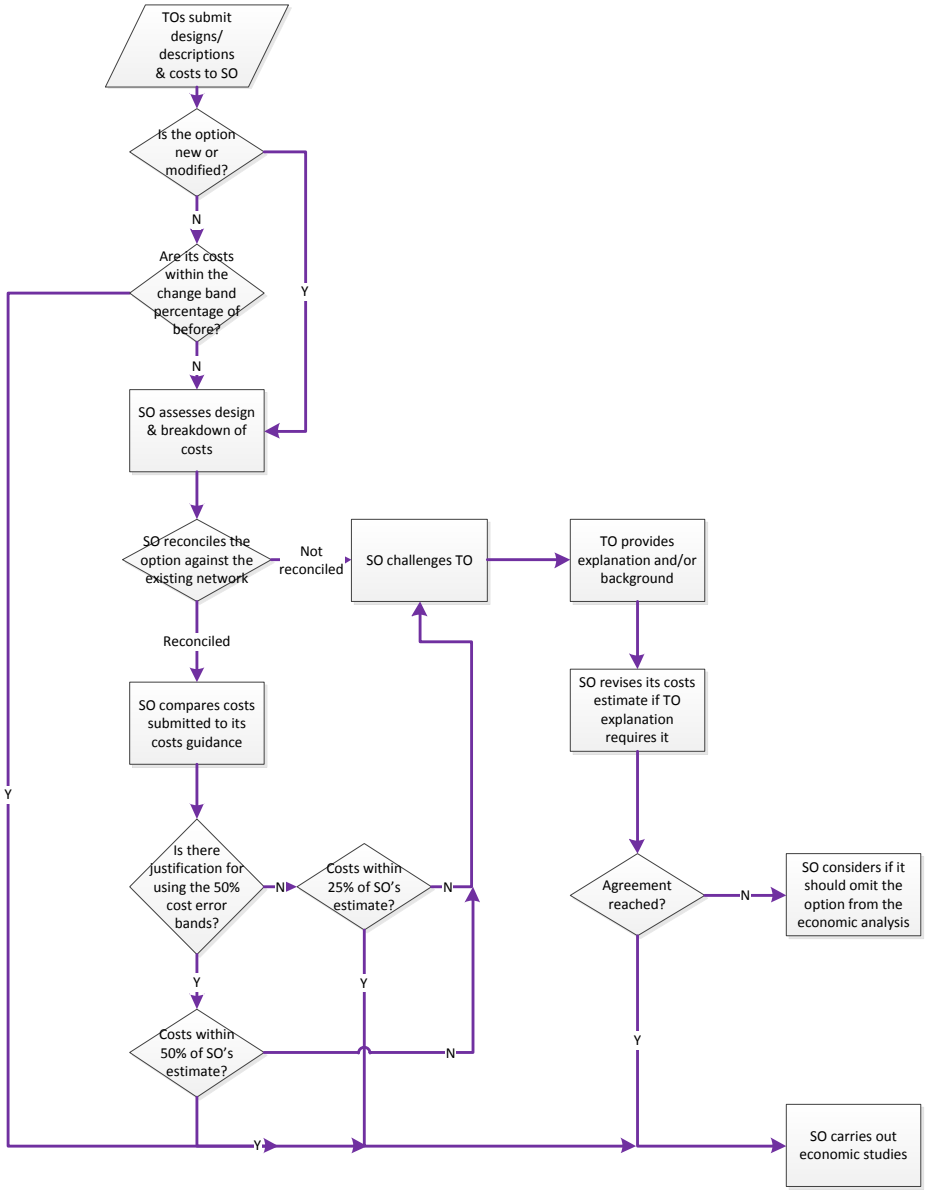


Figure E1: cost reasonableness checking process map

The input to the process is the costs that the TOs submit for their NOA options. The output of the process is the TOs' cost submissions to be deemed valid and act as an input into the NOA economic process. The TOs may modify their costs following discussions with the ESO as part of this process. If following discussions, the ESO still believes that the costs are outside of their expected range and will consequently unduly affect the economic analysis, the ESO may omit the option from the economic analysis.

The ESO maintains independent cost guidelines which are derived from RIIO unit costs and external public domain market intelligence. The ESO compares the costs of different options from a TO against previous years (allowing for inflation) and against its cost guidelines.

The headings below match the stages in the process map.

TOs submit designs/descriptions & costs to ESO

Having received the cost information from the TOs via the SRFs, the ESO gathers the information together. The ESO needs the following data, which it captures from the SRF:

- Detailed technical breakdown of the reinforcement option
- Cost data for the option.

Is the option new or modified?

Are its costs within the change band percentage of before?

The first step is for the ESO to identify which options should proceed through the cost reasonableness process. New or modified options always proceed through the cost reasonableness process. Options where the designs are unmodified from previous years' submissions may be exempt from the remainder of the cost reasonable process as they will have had their costs approved through previous years' ESO cost checks, provided any increase in costs falls within an expected range. If the costs submitted for the current year are within the change band of +/- 5% of previous submissions, then the cost checking process for such an option ends here. Options where the costs have changed outside this range, or options which have modified or new designs, proceed through the process as normal.

ESO assesses design & breakdown of costs

The aim of this step is for the ESO to understand the option, how it is intended to deliver the benefit, the component parts of the option and its benefit. The ESO takes the technical breakdown descriptions of the option and builds up its understanding of the reinforcement option:

- The ESO checks the descriptive text with any diagrams that the TO has provided Note that some options will not need diagrams, for instance if they are about thermal upgrades or other overhead line work.
- The ESO checks that equipment requirements are consistent and complete. For instance, where a new circuit is proposed, does the SRF explain how it will connect to the existing transmission system – are new bays proposed and how many, or will it reuse existing bays? Is equipment already installed mentioned separately from equipment that will be installed in the future?
- The ESO checks environmental factors. For example, whether the option needs consents and whether the option is in a mainly urban or rural setting.

It is expected that the level of disaggregation of options included in the SRF and the cost accuracy will vary with the level of maturity of the option, with those options which have been developed over a few years being broken down into more detailed aggregate components with more accurately estimated costs than those in the initial stages of conception where design and costs are more approximate.

The ESO reconciles the option against the existing network

Having built up its understanding of the option, the ESO checks the existing part of the network that the option affects. This is to identify any parts of the option that might have been omitted and which may affect the cost estimate. The ESO notes any omissions or discrepancies in the SRF and seeks clarification from the TO. An example might be that the SRF describes using a spare bay so the ESO checks the latest system diagram to check for the bay's details. For an explanation of the remainder of the process, go to the **ESO challenges TO** stage on the process map.

ESO compares costs submitted to range of costs in its guidelines

The ESO performs two tests for each option at this stage as applicable.

1) Having developed its understanding of the option, the ESO compares the option's costs against the ESO's cost guidelines.
2) The ESO identifies similar options within a TO's portfolio and checks the cost consistency between them. For instance, where two options replace the conductors of circuits of the same voltage level, the ESO calculates the unit costs based on the TO's submission and checks how similar they are.

Is there justification for using the 50% cost error bands?

Some aspects of options add a lot of uncertainty to the forecast cost of a project and so are allowed a larger cost error. For this reason, the ESO measures against a 50% cost error band for any option affected by the following:

- consents
- new technology with high uncertainty.

Costs within 25% of ESO's estimate?

This step applies to options that involve **no** added justification for the wider cost error bands.

The first stage is for the ESO to compare the TO's submission with its own estimate of costs. If the costs are within 25%, the ESO progresses to the second stage.

The second stage is to check that a TO's costs are consistent with other options' costs across its portfolio. If this is the case, then the ESO sets the option costs as 'agreed' and the costs are used in the economic process.

If the costs are outside of the 25% band and/or the costs are not consistent, the ESO asks the TO for justification. For an explanation of the remainder of the process, go to **ESO challenges TO** stage on the process map.

Costs within 50% of ESO's estimate?

This step applies **only** to options where there is justification for wider cost error bands and is a similar two stage approach.

Firstly, the ESO takes the TO's submission and compares it with its own estimate of costs. If the costs are within the 50%, the ESO progresses to the cost consistency check across a TO portfolio.

If the costs are consistent with other options' costs in the TO portfolio, then the ESO sets the option costs as 'agreed' and the costs are used in the economic process.

If the costs are outside of the 50% band and/or the costs are not consistent, the ESO asks the TO for justification. For an explanation of the remainder of the process, go to the **ESO challenges TO** stage on the process map.

ESO challenges TO

If the ESO finds that an option's costs lie outside of the range that it estimates, it approaches the TO for a more detailed understanding.

TO provides explanation and/or background

In response to the ESO's challenge, the TO provides more information to solve the query. This information might be:

- adding information, for instance including the details of cable section lengths
- correcting assumptions about assets, for instance the amount of plant involved in work on a substation bay
- amending a cost submission due to an error
- the TO challenges the ESO's understanding of costs or option scope.

This is part of an iterative stage.

If the TO provides more information to the ESO, the ESO will revise its cost estimation accordingly to check if the costs are within the 25% bracket or 50% bracket as applicable. If 'yes', then the ESO sets the option costs as 'agreed' and the TO's costs are used in the economic process.

If the TO's response means that the ESO's concerns remain, the ESO reviews its concern, clarifies it and refers it back to the TO.

If after several attempts, the ESO cannot agree to the costs and explanations that the TO is providing, the ESO engineer escalates the matter within ESO management. The ESO management decides whether to include the costs for the option in question at this stage or to omit it from the economic analysis.

ESO revises its costs estimate if TO explanation requires it

The discussion between the ESO and the TO might mean that the ESO has to recalculate its estimate of the costs. The ESO notes the revised costs.

Agreement reached?

The ESO engineer conducting the process passes the ‘agreed’ TO costs for use in the NOA economic process.

General points

The ESO keeps the cost information for all options submitted by each TO and uses them to do consistency checks of options that the same TO submits in future years.

In general, the ESO assumes that the TO cost submissions include the development costs. There might be occasions on which the submissions do not include the development costs in which case the TO and ESO will discuss this further and decide how to proceed with the option for its economic analysis.

F

Appendix F Form of report

The Electricity System Operator (ESO) will produce the main NOA report which will be public and produce appendices where there is confidential information. The confidential appendices will contain full cost details of options and will have very limited circulation that will include Ofgem. Extracts of this report will go to the relevant Transmission Owners (TO). The main NOA report will omit commercially confidential information. We will provide Ofgem with justification for the redactions. This appendix describes the contents and chapters of the report.

Foreword

Contents Page

Executive Summary

The executive summary will include headline information on options listing those that meet SWW criteria.

Chapter 1: Introduction and Aim of the Report

This chapter will describe the aim of the NOA report, provide the reader with clear guidance on its relationship with the Electricity Ten Year Statement (ETYS) and give guidance on how to navigate the NOA report.

Chapter 2: Methodology description and variations

This chapter will describe the assessment methodology used at a high level and refer the reader to the NOA report Methodology statement published on National Grid's public website.

The chapter will also include the definition of and commentary on Major National Electricity Transmission System Reinforcement options. We will include a description of how the ESO treats Strategic Wider Works (SWW).

We expect options to improve boundary capabilities will fall broadly into three categories:

- SWW that have Ofgem approval. The NOA report will refer to these options which will be included in the baseline while presenting no analysis. The Report will justify why these options are treated as such.
- Options that have SWW analysis underway. This analysis and available results will be used in the NOA report.
- Options analysed using the Single Year Regret cost-benefit analysis. This analysis will appear in the NOA report.

Should any options fall outside of these three categories, the chapter will list them with an explanation as to how and why they are treated differently.

Chapter 3: Proposed Options

This chapter is to give an overview of the options that the ESO has assessed. The overview will group options by study region and by their technical type including whether it is build or reduced build More detailed information on each option that will include status will be listed in an appendix. The chapter will include OWW options or record a nil return if there are none. It will also include a commentary on reduced-build or non-transmission ones, where applicable. The chapter will also include a short summary of the boundaries that make up the GB electricity network.

Chapter 4: Investment Recommendations

This chapter will cover the economic benefits of each option. The data will be tabulated and to support the comparison include earliest in service (EISD) and optimum delivery dates. The regret values for the options and combinations of options where the options are critical will be included as an appendix of the report, i.e. those that need a decision to proceed (or otherwise) imminently. Chapter 4 will detail the ESO recommendation whether to proceed with each option. In some instances, there might be a recommendation to proceed with more than one option. Such an instance could be at an early stage when two options are closely ranked but there is uncertainty about key factors for example deliverability.

The chapter will indicate options that are likely to meet the competition criteria. As the competition framework is uncertain due to the necessary legislation not being passed, the chapter will highlight this. The chapter will explain how options meet competition criteria.

The chapter will finish with a summary of the options for the boundary. It will provide:

- Any differences in preferred options between annual NOA reports where the ESO has carried out similar analysis in the past.
- How the scenarios have different requirements and how they affect the options.
- A comparative view of each option's deliverability and how it affects the choice of the preferred options.

The cost band will appear beside options that have a 'Proceed' recommendation.

Chapter 4 will meet the ESO obligation to produce the recommendations for the Network Development Policy for Incremental Wider Works.

Chapter 5: NOA for Interconnectors

This section of the report will introduce the method of analysing GB's potential for interconnectors to other markets and publish the analysis.

Chapter 6: Stakeholder engagement and feedback

To help our understanding of stakeholder views, through the document we will include feedback questions. We will use this feedback to refine the NOA report process and methodology for the next report.

We have used our seminars to continue to talk with stakeholders and have received some interest. Onshore TOs have engaged with us and assisted in developing this NOA report methodology. We want to extend our engagement further and will use our NOA email circulation lists.

Glossary

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Appendix G Summary of stakeholder feedback

This appendix summarises the views the ESO has on the comments we've received. We would like to thank the organisations for their feedback and contribution.

Area of feedback	Feedback	ESO response
Core NOA process: Competition	How the ESO applies the competition eligibility criteria to bundling and splitting of options. That the existing licence condition does not oblige the ESO to carry out these assessments.	Although the C27 statutory consultation had been carried out in spring 2019, we did not expect a decision until after we would submit the methodology to Ofgem. As a result, we kept the changes that we published for NOA 2018/19 but dropped those proposed for 2019/20.
Core NOA process: Early development of options	The existing licence condition does not oblige the ESO to carry out early development of options. That the TOs have responsibilities to develop the network.	Although the C27 statutory consultation had been carried out in spring 2019, we did not expect a decision until after it would submit the methodology to Ofgem. As a result, we have dropped from the methodology the proposed sections covering early development for 2019/20.
Core NOA process: Use of Earliest In Service Dates (EISD)	Delayed delivery of options is an inherent risk with large projects. The ESO should use critical sensitivities to model the cost effects of options having different delivery dates.	We needs the earliest in service date as a fundamental part of the NOA process. We can accommodate up to five different cost profiles with different EISDs. This allows us to test the effect of different EISDs with appropriate cost profiles. We believe that this is a way forward. For risks that cannot be simply included as data inputs to the CBA, we will work with relevant parties and decide whether and how sensitivity studies can be carried out on a case by case basis. The sensitivity studies will be considered and scrutinised by the NOA Committee.
Core NOA process: NOA report	Simplify the NOA report and use more visuals	We have devised a way to shorten the NOA report by stopping it duplicating the ETYS and thinning out the material in certain chapters.
Core NOA process: Non-compliant boundary reference	The respondent asked us to elaborate on two references to non-compliant in OWW Section 5 of the methodology.	The NOA is an economic assessment of wider boundaries hence the description 'non-compliant' is not relevant. We have amended these two references.
Core NOA process: NOA and Strategic Wider Works	To be more efficient, parties asked if the ESO can use the NOA cost-benefit analysis in the SWW initial needs case instead of the SWW cost-benefit process. While the NOA analysis would be more basic, it is quicker which might be more valuable.	We agree to using the NOA cost-benefit analysis outputs as a basis for SWW initial needs case where appropriate and with the TOs' agreement. This would need to be supplemented by additional analysis for any initial needs case submission. We have updated Section 1 to reflect this.
Core NOA process: Nuclear modelling	The current economic analysis tool does not realistically model the availability and operation of the GB's nuclear fleet, leading to misrepresentation of demand security in Scotland. In order to highlight any future security related reinforcement	The model we use is a deterministic model with a 20-year modelling horizon. To model GB effectively we use year-round availability factors rather than attempting to model 20 years of outages across the country. Any reinforcements that may be required to secure Scotland's demand under low-probability-high-risk network

Area of feedback	Feedback	ESO response
	requirements, a more realistic output and outage pattern for these plants must be adopted.	stress periods would be unsuitable to model in detail in NOA.
Core NOA process: Potential transmission solutions	'Storage' in table 2.2 might be better described to be used to release constraints in operational timescales. This would replace 'enhance boundary capabilities'.	We agree with this change and have amended the text in table 2.2.
Core NOA process: Probabilistic studies	The pathfinder project would benefit from a wide group of participants to contribute to the next stage of its development.	We welcome collaboration on the inputs to the tools and process in addition to the results, this will include agreeing the network data to be used in the analysis and ensuring the analysis process runs as effectively and collaboratively as possible. We plan to use the approach to analyse the whole network across the year 1 boundaries and consult on the results and next steps through our Electricity Ten Year Statement (ETYS) publication.
Core NOA process: Probabilistic studies	Supportive of the ESO work in the area of year-round thermal requirements as using a deterministic approach based on winter peak conditions to identify year-round system requirements may result in an overly optimistic or pessimistic view of system needs.	We are pleased you are supportive of our work in the area of year-round thermal requirements. We are further developing our tools and process and hope to provide more information in our ETYS publication in November. We welcome any feedback as we develop our capability in this area and recognise the need to collaborate with our stakeholders to agree the best approach for using the information in our decision-making process in the future.
Core NOA process: Probabilistic studies	Further development is needed for probabilistic approach to make sure network requirements other than DC thermal power flow are considered by the probabilistic approach.	We have plans to expand the probabilistic tools and techniques to allow more complex network modelling in the RIIO-2 period. We also intent to use the approach to model certain system operator actions and alternative reinforcement options such as commercial solutions so that the network conditions can be better represented.
High Voltage Management Process	Pathfinder projects and an ESO-led process for assessment and development of market-based solutions presents a significant opportunity to deliver better value to consumers. It is anticipated that the ESO will actively engage with the industry to further develop market-based solutions.	We're delighted to know that you appreciate our intention to facilitate consideration of a wider set of solutions to transmission system needs. We'd also like to acknowledge the importance of engagement with the industry to develop our knowledge about commercial solutions and their relevant availability. We use pathfinder projects to deliver our first attempt to a new market and will continue to engage with providers and other stakeholders through these projects.
High Voltage Management Process	The ESO is expected to undertake clear, publicised and open assessment of options with a transparent benchmark.	We support the initiative of being open and transparent in the High Voltage Management Process and hence we have included a detailed methodology in the NOA 2019/20 methodology. We anticipate to publish the relevant information

Area of feedback	Feedback	ESO response
		at each stage of the process in a timely manner. A regional report on the High Voltage Management Process will also be published after all the analysis and tender activities conclude. We will also continue to explore the ability to publish costs of all solutions considered in the High Voltage Management Process, including TO, DNO and Reactive Power Service options.
High Voltage Management Process	Combining requirements e.g. voltage support, stability, constraint management etc. can maximise the cost-effectiveness of solutions.	We intend over time to bring together our needs identification such that for a region we assess the requirements for all considered system needs. The speed at which we can achieve this will depend on the success (or otherwise) of the pathfinder projects, e.g. voltage pathfinder and stability pathfinder, looking at individual needs.
High Voltage Management Process	Information asymmetry in the process - Information and modelling capabilities available to Network Owners are superior when compared to other parties.	We have obligations to share network information and models relevant to system planning with TOs under the STC and DNOs under the Grid Code. As part of our ambitions set out in the Network Development Roadmap we are also looking to enhance the information we provide to non-network parties. We aim to ensure that all parties have the necessary information to be able to offer solutions to any identified system need. We'll continue to engage with stakeholders on the information we provide and welcome feedback on how we are doing.
High Voltage Management Process	Costs of connection need to be fairly allocated in the assessment.	A number of potential Reactive Power Service providers pointed out in the recent RFI for Reactive Power Service in Mersey that i.) any sole use connection work will be paid for in full by the User and ii.) for any socialised elements of the connection they pay a use of system charge or the equivalent. We acknowledge the design of the existing Connection Process and Charging Statement of each network owners, and that the Users pay accordingly. Hence, we've amended the draft methodology to reflect the feedback received in Table 6.2.
High Voltage Management Process	The process should be designed in a timely manner. TOs have a licence obligation to develop a compliant network efficiently and in a timely manner. There is also concern about whether the use of a screening process to select and prioritise regions in the High Voltage Management Process will	We agree that it is important any decision to network planning should be made in a timely manner that ensures an economic and efficient network. We also acknowledge the responsibility of TOs to transmission network compliance and that of DNOs to distribution network compliance. We've reflected on the design of the High Voltage Management Process and we've added further details on "programme" and made further clarifications to "roles and responsibilities" in the

Area of feedback	Feedback	ESO response
	impinge on TOs' ability to comply with licence obligations. Any proposed timeline should be reasonable considering the volume of options to be assessed and agreed by the ESO, TOs and DNOs.	methodology. We will engage with the TOs to understand the typical lead time for delivery of reactive power compensation for high voltage issues. This will help ensure recommendations of the most economic and efficient solution can be made in a timely manner but not too early to avoid unnecessary stranding risks due to future uncertainty. We anticipate analysis of the network 3-5 years ahead once the High Voltage Management Process becomes business-as-usual. This will allow sufficient time for the process to deliver recommendations in a timely manner. We will agree the timeline of regional analysis with the relevant TOs and DNOs. We've also added further details on how compliance concerns will be dealt with in 6.18 and 6.19. We'll discuss any compliance concerns raised by the TOs and agree a plan to assess these concerns in a timely manner.
High Voltage Management Process	Further development is necessary to ensure clarity of the roles and responsibilities of all parties (ESO, TOs and DNOs). This includes TOs' and DNOs' roles to: • network compliance • identifying requirements • preparing network models • coordination to develop and assess impact of whole system solutions	We've reflected on the design of the High Voltage Management Process and made further clarification to "roles and responsibilities" and the relevant paragraphs throughout Section 6. We acknowledge the responsibility of TOs to transmission network compliance and that of DNOs to distribution network compliance. We support the principle that we should work collaboratively with the TO to define any high voltage requirement in a timely manner. This will ensure the TO has sufficient confidence and time to proceed with their option to achieve network compliance if their option is the most economic and efficient, while we seek alternative options from the market. We also agree there're greater overlaps of the roles and responsibilities of the ESO, TOs and DNOs in relation to preparing network models for analysis. However, we think it is essential for the assessment of options to remain a responsibility of the ESO (for technical and cost-benefit assessment) and the relevant DSO (for technical assessment) only when a tender process may be involved in the High Voltage Management Process. This helps ensure an assessment in which all participating parties feel they are treated fairly. We will work collaboratively with the relevant DSO throughout the technical assessment to ensure any concerns caused by any of the solutions in the distribution networks are considered as part of the assessment. We acknowledge that a relevant DSO function may not exist yet now;

Area of feedback	Feedback	ESO response
		where we then expect the relevant DNO will perform the technical assessment collaboratively with us instead of the DSO. We'd also like to clarify that we expect all new options recommended by this process to eventually follow the existing Connection Process to obtain a connection to either the transmission or distribution network, where TOs and DNOs will assess the impact of these options connecting to their networks and coordinate for the whole system benefits. For the avoidance of doubt, a recommendation by this process doesn't automatically guarantee a connection to the system. We'd also work with the relevant parties to ensure we consider the costs to consumers (including any socialised network costs where applicable) appropriately throughout the assessment.
High Voltage Management Process	There is a lack of regulatory, legal and commercial framework of solution provision (except for TOs). Hence it is not clear how all solutions are to be appraised on a level playing field.	We've proposed a methodology to compare the costs and benefits of options from TOs, DNOs and Reactive Power Service Providers in the "cost-benefit analysis" section. We'd like to clarify that the "assessment period" or "service year" is not set to a standard 10-year period. Assessment period is defined as the years over which the future voltage control requirements are reasonably clear and certain (paragraph 6.69). This will be decided based on various factors, for example: • the detailed network models that are available (this is up to 10 years ahead currently in the planning process within NOA) • the degree of divergence in the future scenarios • the economic benefits expected to be achieved by recommending a solution Service years is defined as time that the option will be available and cost-effective within the assessment period (paragraph 6.79). All options will be compared on a £/MVAr basis initially. Combinations of options are then optimised to ensure the most economic and efficient solution is recommended over the course of the assessment period. We're open to ideas to improve the process currently set out in this methodology. We'd encourage discussion of these ideas through any of our stakeholder channels or bilateral meetings.

Area of feedback	Feedback	ESO response
High Voltage Management Process	Consider introducing the concept of “asset reuse factor” in the assessment to reflect typical asset life.	We’re open to ideas to improve the process currently set out in this methodology. We’d be delighted to work with the industry in the future to explore other concepts such as an “asset reuse factor” if that proves to be a practical alternative way to assess network owner options. We’d encourage discussion of these ideas through any of our stakeholder channels or bilateral meetings.
High Voltage Management Process	Need to improve and extend long-term reactive power forecast.	We’re open to ideas to improve and extend the long-term forecast of reactive power needs and we’d encourage discussion of these ideas through any of our stakeholder channels or bilateral meetings. We currently look to utilise data from FES and methodology from SOF to inform our assumptions, which are also widely consulted.
High Voltage Management Process	Consideration must be given to the cost associated with increased levels of activity by the DNOs to assess options connected to the distribution network to resolve transmission constraints. A Modification Application approach but in reverse should be considered. Further work to develop a long-term regulatory funding mechanism for Whole System planning proposals is required.	We agree that consideration needs to be made to the cost associated with the increased levels of activity by the DNOs and which there is currently no funding in RIIO-1. We are considering options, including a reverse Modification Application, and also through the ENA engaging on funding mechanisms for these types of assessments now and in RIIO-2.
High Voltage Management Process	It is incorrect to assume operational actions on the distribution network would be at zero costs. The costs of these actions should be factored into the CBA with DNOs compensated accordingly.	We’d like to clarify that where the methodology refers to “optimise existing assets” at the early stages we expect the use of TO or DNO assets within the standard practices. Any operational actions that the TOs or DNOs considered as non-standard operational actions, where there will be extra costs associated with those actions, should form part of the CBA and will only be recommended if the CBA supports such decision.
High Voltage Management Process	Any socialised costs should be incorporated as part of the assessment to reflect the true cost to consumers and enable a fair comparison.	We expect any recommended options to follow the existing Connection Process to obtain a connection to either the transmission or distribution network. We hence expect any sole use infrastructure by these options to be paid for by the providers as they currently do as part of the Connection Process. For any socialised costs, the providers pay the use of system charges according to the relevant Charging Statement of each network owners. Therefore, we do not think it is appropriate to apply a “connection-related cost” element separately to the market-based options in the CBA.

Area of feedback	Feedback	ESO response
High Voltage Management Process	How will solutions connected to the distribution networks be dispatched?	We acknowledge this is a new arrangement and we're currently considering several options. The voltage pathfinders e.g. Mersey voltage pathfinder will explore how best to dispatch these options.
High Voltage Management Process	The credibility and deliverability of options must be assured, as failure to do so may result in increased costs to consumer and potential system security and operability implications.	There are delivery risks associated with any solution, whether this is a market-based option, or one delivered by a TO or DNO. We recognise however the potential risks due to non-delivery. As such any market-based options to be delivered by commercial providers will be subject to financial penalties if they failed to deliver the service they're contracted for. The penalty terms will vary depending on the nature of system needs, for example we expect a higher penalty to be applied if the service is for compliance needs.
NOA for Interconnectors	Revise the method for setting the baseline interconnection level	We will revise the method used for setting the baseline interconnection level to ensure that the solution cannot inadvertently be seen to be favouring specific projects. The method will be transparent and shared with our stakeholders.
NOA for Interconnectors	Continue to provide a range of optimal interconnection capacities based on the Future Energy Scenarios	We agree that providing a range provides more value than a single solution, and we will continue with this approach for NOA IC 2019/20.
NOA for Interconnectors	Consider reinforcement upgrades greater than 1GW	We will investigate whether additional value may be delivered by modelling a range of sizes for potential reinforcement upgrade options.
NOA for Interconnectors	Use NOA IC as a signpost to other system operability work, with more information and transparency of the balancing services market	We agree that a more holistic assessment of all technologies and their potential impact on system operability will provide more valuable insights. These insights will be delivered via the System Operability Framework.
NOA for Interconnectors	Increase transparency of NOA IC source data, especially for European countries	We will highlight any changes made to data sources or modelling assumptions, and will improve transparency of source data, where we own the data.
NOA for Interconnectors	Focus on expanding the GB market and network information	We will refocus NOA IC on providing additional value from the main iterative analysis, by improving the GB-specific constraint and network analysis as well as drawing greater insights from the use of the European FES.
NOA for Interconnectors	Greater focus on environmental impacts	We agree, a more in-depth analysis of the impact of additional interconnection on carbon content and RES usage will be of increased benefit as GB aims to reduce emissions to net zero by 2050.