Appendix A

A1: General roles and responsibilities of ESO and TOs

A1.1 Electricity System Operator

The ESO's roles and responsibilities are based around its overview of the network requirements. Specific role areas are as follows:

analysing UK FES data

identifying boundary transfer requirements and publishing SRFs

conducting verification studies of some boundary analysis performed by the TOs to corroborate the TOs' analysis

devising and developing options including but not limited to operational options, commercial agreements and Offshore Wider Works (OWW) as well as early development of options (see Chapter 7)

reviewing any options recommended in a previous NOA as "Proceed - Critical" but which have not been progressed by the transmission licensee to which the recommendation was given

reviewing reinforcement options and their cost estimates that the TOs propose

assessing outages and other factors affecting the availability of system access. These may affect the options' Earliest in Service Dates (EISD)

running cost-benefit analysis studies

recommending options for further development

advising on the performance of boundary reinforcement proposals in the cost-benefit analysis to facilitate further option development by the TOs

providing an explanation of the NOA Committee recommendations

recording details if a TO does not follow a NOA recommendation

assessing eligibility for competition

producing and publishing the NOA report.

A1.2 Transmission Owners

The TOs' roles and responsibilities include:

producing technical analysis of boundary capabilities of the base network and uplifts from reinforcement options

proposing and developing reinforcement and reduced-build options

providing their technical information to the ESO

providing cost information for options

producing outage and system access requirements for options

providing environmental information for options

providing consents and deliverability information for options

providing EISD of options

conducting verification studies of some boundary analysis performed by the ESO to corroborate the ESO's analysis of alternative options

undertaking stakeholder engagement (following review of draft outputs of the NOA outcome)

conducting community engagements

reviewing draft NOA reports, and appendices related to TO options.

A2: Report drafting

A2.1 Report drafting

1. The ESO drafts the NOA report but the responsibility for the content varies between the ESO and TOs. The form of the report is subject to consultation, and to Ofgem's approval. Appendix D gives more detail on the form of the NOA report.
2. The component parts of the chapters covering options and their analysis and the responsibilities for producing the material are in Table 2.8.

Table 2. 8 Areas of Responsibility

NOA report Options topic	Build options	Alternative options	Offshore	Comments
Options: Status of the option (scoping, optioneering, design, planning, construction)	TO	ESO/TO	ESO	
Options: Technical aspects – assets and equipment	TO	ESO/TO	ESO	
Options: Technical aspects – boundary capabilities	TO	ESO/TO	ESO/TO	
Options: Economic appraisal	ESO	ESO	ESO	Leads to investment recommendations for TOs
Options: Comparison of the options	ESO	ESO	ESO	
Options: Competition assessment	ESO	ESO	ESO	

A3: Roles and responsibilities for high voltage, stability and constraint management

A3.1 Electricity System Operator

The Electricity System Operator (ESO) leads the high voltage, stability and constraint management processes. The ESO shall be responsible for:

1. Planning, developing and operating the NETS in accordance with the SQSS
2. Selecting and prioritising regions by screening
3. Preparing network models for analysis
4. Collaborating with TOs and DNOs to identify requirements
5. Communicating requirements to providers
6. Collecting options from providers
7. Assessing options
8. Collaborating with DSO[23] to carry out the technical assessment of distribution-connected options
9. Recommending most economic options based on cost-benefit analysis (CBA)
10. Communicating process conclusions to providers
11. Procuring Commercial Power Services via Balancing Service Contract
12. Procuring Constraint Commercial Services via the Constraint Management process
13. Publishing the high voltage and stability management process Reports.

A3.2 Transmission Owners

Transmission Owners (TO) shall be responsible for:

1. Planning and developing their networks in accordance with the SQSS
2. Providing feedback on regions which they think should be prioritised in this process
3. Preparing network models for analysis
4. Collaborating with ESO to explore options from existing assets of their networks for analysis
5. Collaborating with ESO to identify requirements
6. Supporting the assessment of options which could have an impact on their network
7. Proposing options using the System Requirement Form – Voltage/Stability.
8. Collaborating with ESO to deliver the feasibility studies and infrastructure work required to facilitate tender options.

A3.3 Distribution Network Operators

1. Distribution Network Operator (DNO) shall be responsible for:
    a. Compliance of their networks
    b. Preparing network models for analysis
    c. Collaborating with ESO to explore options from existing assets of their networks for analysis.
2. DNOs shall also be responsible for the following, while the relevant DSO does not yet exist:
    a. Collaborating with ESO and the relevant TO to identify requirements
    b. Supporting the calculation of effectiveness factors for their networks
    c. Collaborating with ESO to carry out the technical assessment of distribution-connected options which connect to their networks.
3. DNOs will be invited to respond to any Request for Information and/or participate in any Tender Process. They can propose options which meet requirements set out by ESO via the Tender Process[24].

A3.4 Reactive Power and Stability Commercial Service Providers

1. Reactive Power and Stability Commercial Service Providers will be invited to respond to any Request for Information and/or participate in any Tender Process. They can propose options which meet requirements set out by ESO via the Tender Process.

A3.5 Constraint Commercial Service Providers

1. Constraint Commercial Service Providers will be invited to respond to any consultation and Expression of Interest and/or participate in any Tender Process of the Constraint Management Pathfinder projects. They can propose options which meet requirements set out by the ESO during the Consultation phase.

Appendix B

Potential Transmission Solutions

Table B1: Potential transmission solutions

Category		TCSNP option	Nature of constraint			
			Thermal	Voltage	Stability	Fault Levels
Alternative Options	Operational Options	Availability contract *(contract to make generation available, capped, more flexible and so on to suit constraint management)*	✓	✓	✓	
		Reactive demand reduction *(this could ease voltage constraints)*		✓		
		Enhanced generator reactive range through reactive markets *(generators contracted to provide reactive capability beyond the range obliged under the codes)*		✓	✓	
		Automatic MW redistribution *(Contracted for certain boundary transfers and faults). For example, contracted services from Demand side, generation deload/ intertrip, energy storage charge/ import and discharge/ export*	✓	✓	✓	
		Generation advanced control systems *(such as faster exciters which improves transient stability)*		✓	✓	
	Reduced-build Options	Co-ordinated Quadrature Booster (QB) Schemes *(automatic schemes to optimise existing QBs)*	✓	✓		
		Automatic switching schemes for alternative running arrangements *(automatic schemes that open or close selected circuit breakers to reconfigure substations on a planned basis for recognised faults)*	✓	✓	✓	✓
		Dynamic ratings *(circuits monitored automatically for their thermal and hence rating capability)*	✓			
		Addition to existing assets of fast switching equipment for reactive compensation *(a scheme that switches in/out compensation in response to voltage levels which are likely to change post-fault)*		✓	✓	
		Protection changes *(faster protection can help stability limits while thermal capabilities might be raised by replacing protection apparatus such as current transformers (CTs))*	✓		✓	
		HVDC de-load Scheme *(reduces the transfer of an HVDC Intralink either automatically following trips or as per control room instruction)*	✓	✓	✓	
		'Hot-wiring' overhead lines *(re-tensioning OHLs so that they sag less, insulator adjustment and ground works to allow greater loading which in effect increases their ratings)*	✓			
Build Options		Overhead line re-conductoring or cable replacement *(replacing the conductors on existing routes with ones with a higher rating)*	✓			

	Reactive compensation in shunt or series arrangements (MSC, SVC, reactors). *Shunt compensation improves voltage performance and relieves that type of constraint. Series compensation lowers series impedance which improves stability and reduces voltage drop.*		✓	✓	
	Switchgear replacement *(to improve thermal capability or fault level rating which in turn provides more flexibility in system operation and configuration. This would be used to optimise flows and hence boundary transfer capability).*	✓			✓
	OHL reconfiguration *(turn-in works at substations)*	✓	✓	✓	
	Uprating of circuits *(for higher voltage levels)*	✓	✓	✓	
	Power flow control devices *(a type of Flexible AC Transmission System device that can be used to alter power flows over a circuit)*	✓	✓	✓	
	New build (HVAC/HVDC) – *new plant on existing or new routes.*	✓	✓	✓	✓

Appendix C

System Requirement Form

2.1 Overview

1. The System Requirements Form template is in an electronic form for parts B, C, E and F using a dedicated data room. The table below gives an overview of the SRF parts and a summary of the data content.

Table C1: SRF Parts and Summary of the Data Content

SRF Part	SOFI Content ?	Description	Data content
Part A – Boundary requirement and Capability	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.	The requirements listed are the transfer capabilities for each energy scenario for each of economy and security criterion in tabulated and chart form. An example is later in this appendix.
Part B – TO Proposed Options	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	Technical description of the option including: • physical works • summary of included assets • diagram. • what requirement the option solves and how. • earliest in-service date. • any environmental impacts • other reference information including option name, status, reference number.
Part C – Outage Requirements	Yes	TO responds with outage requirements for that option. Each option will have its own row in Part C.	Outage requirements to deliver the option: • The circuit or apparatus that need to be on outage and the required duration of outage (in weeks) in each calendar year if the option is to be delivered on its EISD The number of distinct calendar years that works take place in The circuit or apparatus

			that need to be on outage and the required duration of outage (in weeks) in each calendar year if the option is to be delivered on its EISD The circuit or apparatus that need to be on outage and the required duration of outage (in weeks) in each calendar year if the option is to be delivered on its EISD The number of distinct calendar years that works take place in • The number of distinct calendar years that works take place in • The number of distinct calendar years that works take place in • The number of distinct calendar years that works take place in • Restriction on sequence of works.
Part D – Studied Option combinations	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 separate online form. Each boundary will have its own Part D.	Boundary benefit data is captured in the handover tool: • The options that provide boundary benefit on their own or together with other options and the combinations they can be used in. • The sequence of the reinforcements in each combination. This includes alternative sequences for the same combination. • The resulting absolute boundary capability in MW in each stage of each sequence. • Whether an option must follow or is an alternative to certain reinforcements
Part E – Options' Costs	Yes	TOs supply asset and cost information to allow the ESO to proceed with 'cost reasonableness' check (See Appendix C). Each option will have its own Part E.	The data recorded includes: • WACC used. • A limited break down of costs. • The cost profile for the option. • Delay, remobilisation and cancellation costs.

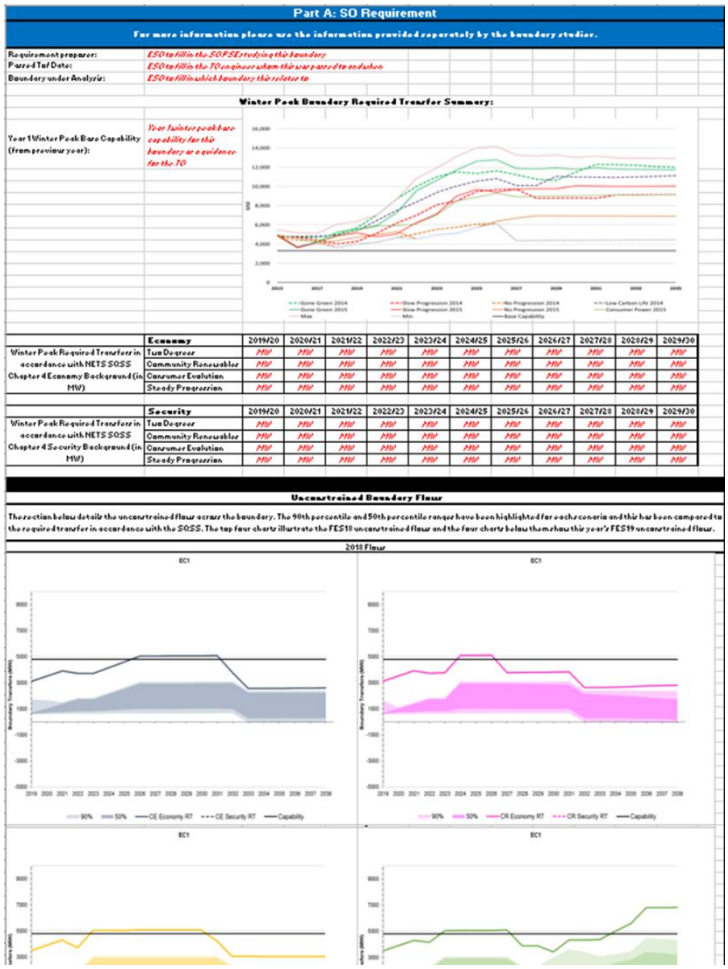
Part F – Publication Information	No	TOs supply names and descriptions of options for publication use. Each option will have its own row in Part E but only if it has featured in Part D.	The information includes: • The NOA code agreed with the ESO. • The option name to appear in the NOA report. • The description of the option to appear in the NOA report.

SOFI stands for System Operator Functions Information.

2.2 Interested Persons

1. The SRF template for Interested Persons' will be publicly available on the ESO website. The template will include sections for parts B, E and F of the SRF. Parts C and D will be determined in collaboration with the ESO and incumbent TO as required. In future cycles this may be superseded by an online portal as per the TO submission data room.

Figure C1: SRF Part A: Boundary Requirement and Capability



Seasonal scaling factors can be submitted using the following template. Otherwise, default ones mentioned in Section 2 will be used or actual seasonal boundary capabilities can also be submitted separately.

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.

Appendix D

TCSNP Key Dates for 2023

This table describes the key dates for the TCSNP in the relevant year.

Reference, number or part	Description	General timing	Specific timing for TCSNP 2023
N/A	Agree the *Basis for the cost estimate provided for each option*	Early July	07/07/2023
SRF Part A	Boundary requirement and capability	Mid-August (draft) Mid-September (final)	14/09/2023
SRF Part B	TO proposed options	Mid-August (draft) Mid-September (final)	14/09/2023
SRF Part C	Outage requirements	Mid-August (draft) Mid-September (final)	14/09/2023
SRF Part D	Studied option combinations and their impacts on the network	Mid-September	14/09/2023
SRF Part E	Options' costs	Mid-September	14/09/2023
SRF Part F	Publication information	Late October	20/10/2023

Appendix E

Process for Checking NOA Option Cost Reasonableness

This appendix describes the process that the ESO uses to check the NOA option cost data that the TOs provide. This cost data will be used as an input to the NOA economic assessment process, the costs are also used for the suitability for third party delivery and tendering assessment process.

Figure D1 shows the process map for the cost reasonableness checking process.

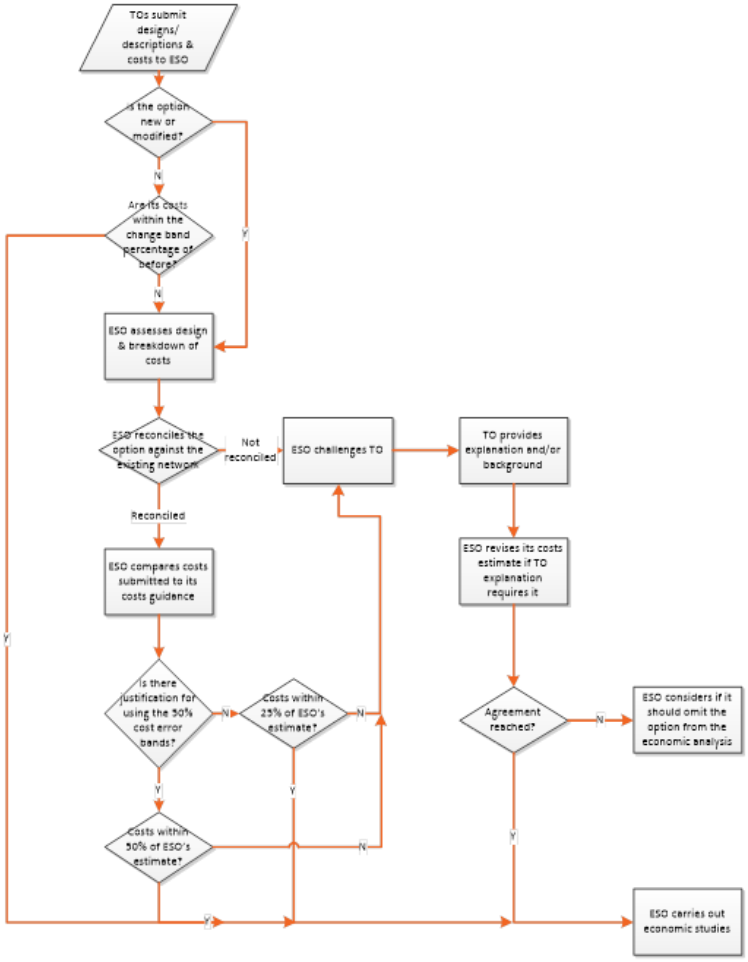


Figure D1: cost reasonableness checking process map

The input to the above 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. Depending on the type of equipment/technology, the ESO either compares the costs of each option against previous years (allowing for inflation) or against its cost guidelines.

The headings below match the stages in the process map.

TOs submit designs/descriptions & costs to ESO

Having received the SRFs that the TOs submitted, the ESO gathers the following information from Part B – work description and Part E – cost information 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 full cost reasonableness process. New or modified options always proceed through the full process. Options where the designs are unchanged from previous years' submissions, as they have already had their costs approved through previous years' cost checks, may be exempt from the rest of the checking process provided any increase in costs falls within an expected range, i.e. if the increase of the costs value is within the 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 that have been modified or evolved with new designs, should be taken 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 and the components of the option. The ESO analyses the technical breakdown from the descriptions of the option and builds up their understanding of the reinforcement option:

The ESO checks the descriptive text with or without any diagrams that the TO has provided.

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?

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 details of each option and the accuracy of its costs will vary with the maturity level of the option, i.e. Options that have been developed over several years will have more accurately estimated costs as they can usually be broken down into more detailed aggregate components , while for options that are still in their initial stages of conception, the 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 compares against the latest system diagram to confirm the availability of the bay and its details. For detailed explanation, go to the **ESO challenges TO** stage.

ESO compares costs submitted to range of costs in its guidelines

The ESO performs the checks by the following two ways 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 the option includes similar reconductoring work (e.g., same voltage level of the circuits), the ESO estimates the unit costs based on the existing TO's data and compares with the submitted data, to see if the cost is consistent.

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 it 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?

For options the wider cost error bands are not applicable, the ESO conducts the check via the following steps:

- If the TO's submitted costs, are within 25% difference when compared against the ESO's estimated costs based on its own guidelines, the ESO will then
- check that a TO's costs are consistent with other similar 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 more detailed explanation, refer to the process map from **ESO challenges TO** stage.

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 differences are within 50%, the ESO progresses to the cost consistency check against the TO's portfolio.

If the costs are consistent with other similar 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 more detailed explanation, refer to the process map from the **ESO challenges TO** stage.

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 resolve 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
- clarifying the detailed works involved, if necessary, this may require send a clear list of components being costed and the costs breakdown. This is to allow the ESO to compare with their original estimates and review the reasonableness.
- amending a cost submission due to an error

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 the cost falls within these brackets, the ESO sets the option costs as 'agreed' and the TO's costs are used in the economic process. 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 the cost falls within these brackets, the ESO sets the option costs as 'agreed' and the TO's costs are used in the economic process. If the TO's response does not resolve the ESO's concerns, the ESO will reviews its concern, clarify if necessary, and refer it back to the TO.

If ESO cannot agree to the costs and explanations that the TO provided, 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 checking 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 similar options in future years. In the consistency check, the ESO will only compare options submitted by same TO.

In general, the ESO assumes that the TO cost submissions include the project development costs. There might be occasions where this part of the cost is not included, in which case the TO and ESO will discuss further to decide how to treat this option in its economic analysis.

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 (TOs). 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. The ESO reserves the right to add or change chapters to better represent the NOA information.

Foreword

Contents Page

Executive Summary

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

Introduction

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.

Methodology

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

The chapter will also include the definition of and commentary on Major National Electricity Transmission System Reinforcement options.

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

- LOTI/SWW that have Ofgem's 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 LOTI/MSIP/SWW analysis underway. This analysis and available results will be used in the NOA report.
- Options analysed using the Single Year Least Worst 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.

Proposed options

This chapter is to give an overview of the options that the ESO has assessed. The overview will group options 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. 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.

We will cover OWW options here or in a dedicated chapter appropriate with brief descriptions of reinforcement options and our analysis.

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. An explanation of the regrets 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. The chapter will detail the ESO's 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.

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 as appropriate of each option's deliverability and how it affects the choice of the preferred options.

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

Certain details will be in the appendices and that will include the cost bands for options as appropriate.

Interconnector analysis

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

Stakeholder engagement Stakeholder engagement

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

Onshore TOs have engaged with us and assisted in developing this NOA methodology. We want to extend our engagement further and will use our NOA email circulation lists.

Glossary