SO Process for Input into TO Led SWW Needs Case Submissions

System Operator

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About this document

This document contains National Grid System Operator's proposed methodology for inputs into TO led Strategic Wider Works submissions. The methodology responds to the new requirements for the SO as part of the NOA process, as outlined in Licence Condition C27 in respect of the financial year 2015/16.

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Contents

Strategic Wider Works Overview

1 RIIO-T1 identified large transmission projects, which strengthen or extend the electricity transmission system, as wider works outputs. These are triggered by a need to increase the capacity of the network or to extend the network to accommodate new generation and lead to economically efficient transmission of electricity in the GB, as well as comply with network security standards.

2 Ofgem's Guidance on the Strategic Wider Works (SWW Guidance)[1], which was published in October 2013, states that there was uncertainty around the timing and cost of some large transmission projects at the time of finalising RIIO-T1. The document suggests this was predominantly due to extent of these projects' dependency on the level of future generation. Considering the scale of the investments involved the SWW Guidance states that the potential impacts of this uncertainty on GB consumers could be significant.

3 The SWW Guidance states that to help manage this uncertainty, flexible Strategic Wider Works arrangements were included in RIIO-T1 to consider large transmission projects when more information was available to inform decisions on whether the investment is in the interests of existing and future consumers.

4 The detailed process regarding the Strategic Wider Works (SWW) arrangements for the Transmission Owner (TO) is presented in the SWW Guidance. However, it is worth noting that the process involves approvals from Ofgem at three distinct stages:

a. Eligibility: To be eligible, the proposal must meet pre-defined criteria including the level of the expected cost and outputs it is expected to deliver. Further details on the criteria and the information required for eligibility assessment is presented in the SWW Guidance. If the project is eligible for assessment, Ofgem will initiate the review of the Needs Case submission, as set out below.

b. Needs Case[2]: The purpose of the Needs Case document is to present technical and economic rationale and necessary evidence to underpin the choice of the preferred option compared to a credible range of alternative solutions. Hence, as part of the review of the Needs Case, Ofgem seek to review the TO's appraisal of technical need and cost benefit assessment across a range of solutions and credible scenarios, which may be based on different factors in relation to generation, demand, fuel price forecasts, renewable subsides, etc. Furthermore, Ofgem seek for evidence on the optimal delivery date of the preferred option. Through this review, Ofgem seek to ensure that, given the range of uncertainties, the preferred solution

[1] Source: www.ofgem.gov.uk

[2] Projects which are already in the Transmission Owner's RIIO-T1 Business Plan are envisaged to have their eligibility outlined. Hence, such projects are likely to progress straight to the Needs Case stage.

offers the best long-term value for money for existing and future GB consumers. In most cases, ahead of making any decisions, Ofgem seek to consult stakeholders on their initial views on the Needs Case.

c. Project Assessment: The purpose of the Project Assessment is to present more in-depth evidence on the preferred option and demonstrate the TO's readiness to proceed with the project. There may be some overlap between Ofgem's reviews of the Needs Case and the Project Assessment. In particular, as part of the review of the Project Assessment Ofgem assess whether the TO has developed a robust development plan and risk management arrangements to deliver the project efficiently. Ofgem also review whether the technical plans of the preferred solution are sufficiently advanced to assess the efficient costs and specify a new SWW output. To inform their final decision on the proposal Ofgem will consult stakeholders on the detailed Project Assessment and their views on the SWW output and costs.

5 In addition to the three formal stages, there are ongoing discussions between the TO and Ofgem. Historically, the System Operator (SO) has not been involved in such discussions. Furthermore, in the past the SO has predominantly submitted responses to Ofgem's consultation on specific projects seeking SWW approvals. Although the SWW arrangements continue to be a TO led process, the Network Options Assessment (NOA) process introduced through ITPR seeks to increase the SO's role. Within this context, the purpose of this document is to outline the process and arrangements that will exist between the SO, TOs and Ofgem where the SO will provide input into TO led Strategic Wider Works Needs Case submissions.

6 This document has two distinct components:

a. To provide a high level overview of the general process from initiation to conclusion of Strategic Wider Works arrangements and the SO's role in this wider process; and

b. To provide a detailed Cost Benefit Analysis (CBA) Methodology, which is the SO's principle contribution to TO led Needs Case submissions[3].

7 It is important to note that whilst the CBA undertaken by the SO will lead to recommendation of a preferred, most economically efficient, option to meet the system needs, any investment decision will remain with the TOs. Also note that the process summarised in this document, particularly regarding the SO's role in the CBA and the wider SWW process, reflects the default position for a typical network reinforcement project seeking approval through the SWW route.

8 Projects with more bespoke requirements may require a different approach, which would be developed and agreed though joint working between the respective TO and the SO, and subsequently presented to Ofgem for approval prior to commencing the

[3] Please note that this is the default SO role for typical new projects. Details regarding SO's activities for existing projects at different levels of development are also outlined later in this document.

preparation of the SWW Needs Case. This may include analysis other than CBA, for example, system operability.

9 Furthermore, the content of this document is based on the current process outlined in the SWW Guidance. We understand that the existing SWW process is currently being reviewed. As this process changes, the contents of this document may need to be refreshed.

Strategic Wider Works Process and the SO's Role

10 The process for SWW Needs Case and Project Assessment development from start to submission consists of various sequential activities. The text below outlines these activities and the SO's role across them for typical new projects seeking necessary SWW approvals for investment on the transmission network. By the nature of the activities outlined, the SO's role in the SWW process will be to provide the necessary support to the TOs and Ofgem in their respective decision making processes.

11 There are considerable linkages between the annual NOA Report process and the SO's role in the wider SWW process. These are also captured in the relevant steps outlined below.

12 **Step 1: Identification of the system need**. This could be achieved through the following channels.

a. SO assesses the system need through an annual Electricity Ten Year Statement (ETYS) process, which subsequently informs the NOA Report. The analysis may result in the SO requesting the TO to consider initiating the preparation of a SWW Needs Case.

b. SO and TOs regularly discuss and review network capacity issues and the need for SWWs in a particular TO's area at Joint Planning Committee (JPC) meetings. The SO may request the TO to consider initiating the preparation of a SWW Needs Case.

c. SO may request the TO to consider initiating the preparation of a SWW Needs Case, based on any new information which SO and / or TO may have obtained (e.g. updated information regarding certain customer connections).

13 Following the trigger, the SO will engage with the TO to understand the context of the project, particularly if such discussions haven't already been undertaken as part of the NOA Report process or the JPC. In addition to understanding the project's background, the discussions will seek to establish whether the project demands a different approach on SO's wider role and the CBA, to those identified in this document, due to any non-typical requirements. If yes, the SO and TO will work together to develop the bespoke approaches, as necessary.

14 Another key outcome of this meeting will be development of an issues log, which will be jointly maintained by the TO and SO throughout the project. This may be required to be shared with Ofgem at any stage of the SWW process.

15 **Step 2: Evidence for Eligibility Assessment**[4]. The TO prepares the evidence for eligibility assessment to provide confirmation to the SO that the works required are Strategic Wider Works. The TO engages with Ofgem to share the evidence prepared for the eligibility assessment for initial feedback. The TO may seek the SO's support to prepare the required evidence, as necessary.

16 **Step 3: Ofgem's Eligibility Assessment**. Upon receipt of the Eligibility Assessment, Ofgem will review whether the project is eligible and meets the qualification criteria. Ofgem may wish to consult the SO at this stage. If the project is eligible for SWW, Ofgem will confirm this to the TO.

17 **Step 4: SO's initial recommendations for a range of scenarios**. The SO makes initial recommendations to the TO regarding the range of scenarios which should be studied for the Needs Case submission.

18 **Step 5: Agree the range of scenarios (SO and TO)**. Through discussion, the SO and TO agree a range of scenarios required to be assessed as part of the Needs Case submission[5]. The TO may wish to study additional scenarios, beyond those agreed with the SO[6]. The TO engages with Ofgem to share the evidence prepared for the choice of scenarios for the Needs Case submission and seek initial feedback.

19 **Step 6: Agree the counterfactual (SO and TO)**. The TO and the SO discuss and agree the definition of the counterfactual state for the network boundaries under consideration as part of the Needs Case. The counterfactual for typical projects is 'do nothing'. If, due to the bespoke nature of the project considered, the definition of the counterfactual requires further considerations, the SO and the TO will engage with Ofgem with appropriate evidence for feedback on this issue, early in the assessment process.

20 **Step 7: Options Development (refresh / update)**. Based on the identified system need, the TO develops options to meet this requirement. This includes an assessment of the:

i. boundary capability increase associated with each solution;

[4] Projects which are already in the TO's RIIO-T1 Business Plan, will progress directly to Step 4.

[5] For projects, where the TO has already initiated the development of the SWW Needs Case, the project historic background may influence the discussions between the SO and the TO, and subsequently the choice of scenarios and requirements for any further analysis (as necessary).

[6] If there is disagreement between the SO and the TO on choice of scenarios, the issue will be recorded with appropriate evidence within the issues log. The TO may wish to look at additional scenarios outside of this process. In the near future, as the SO continues to use an open source model, the SO will share the model with the TO to undertake any simulations for additional scenarios. Once the SO has procured a new model, the SO may need to simulate the additional scenarios on TO's request. However, depending on the SO's rationale on non-inclusion of these additional scenarios, the relevant scenarios may not feature in the CBA report prepared by the SO.

ii. earliest in deliver dates of the solutions developed;

iii. forecast capital expenditure of the solutions with relevant spend profiles, estimates of any significant asset refurbishment works (cost and timing);

iv. asset life span in the developed solutions; and

v. deliverability considerations as identified in the NOA Report methodology.

21 Please note that the TO would have already developed a range of options ahead of initiating the preparation of the Needs Case. They may also feature the respective year's NOA Report. At this stage the TO may need to refresh the network analysis based on the scenarios agreed as part of Step 5.

22 **Step 8: The SO reviews the options**. Consistent with the NOA Report process, the SO's review process will ensure that the TO has considered a credible range of options to meet the system need. This will also include testing system operability of the options, particularly for options (or scenarios) which have not featured in the respective NOA Report.

23 This review process will also involve discussions with the TO to review the technical need and options development process adopted. In addition, to ensure that a credible range of options are included in the Needs Case, the SO may develop any non TO led options at this stage (e.g. non-build options, offshore integration options). Depending on the nature of the project, the TO may request the SO to undertake some additional technical analysis. The type and extent of this analysis will be agreed on a project by project basis.

24 **Step 9: Cost Benefit Analysis (CBA)**. SO requests the TO to provide a range of information to perform the CBA. The SO performs a CBA on the agreed options. (Full details on CBA methodology are presented in Appendix C, while an overview of the CBA process is presented in the Appendix B). Upon completion of the analysis, the SO will provide the TO with an independent CBA report, which will include a recommendation for the least-worst regret preferred option for the project.

25 Along with the report, the SO will also provide a copy of the CBA model to both the TO and Ofgem, including all results of constraint cost simulations for scenarios and options appraised. Depending on the type of model used[7] to forecast the constraint costs, the SO may also be able to provide the model used for constraint simulations (on a confidential basis).

26 **Step 10: TO prepares and submits the SWW Needs Case to Ofgem**. The results obtained from the CBA, are incorporated into the Needs Case submission. The TO

[7] The SO currently uses an in-house developed open source model for constraint cost forecasts. The SO is able to share this model, along with all input assumptions, with the TOs. This model will be replaced in the future by a third-party package. The SO will not be able to share this model with the TOs or Ofgem. However, the SO will be able to share all input assumptions adopted for the simulations performed in this model.

may wish to present additional evidence in relation to the CBA, as necessary. The SO provides additional support as required by the TO.

27 **Step 11: Ofgem's assessment of the Needs Case**. During the Ofgem assessment the SO and TO will jointly respond to any queries from Ofgem. Based on the Ofgem feedback, reconsideration of particular elements of the Needs Case may be required. The SO will provide support to the TO as necessary at this stage (particularly in terms of the choice of scenarios, review of the options and the CBA). Upon receiving all clarifications from the TO and the SO, Ofgem may seek to consult stakeholders regarding the Needs Case. The SO will continue to provide comments through such consultation process.

28 **Step 12: Ofgem's decision on the Needs Case**. Ofgem make a decision on the Needs Case and progress the project to the next stage, as appropriate.

29 **Step 13: The TO prepares SWW Project Assessment**. The SO is unlikely to be able to provide much support at this stage. However, if the costs for the preferred option have changed considerably or there are notable changes in the scenarios, the SO may need to refresh the CBA analysis.

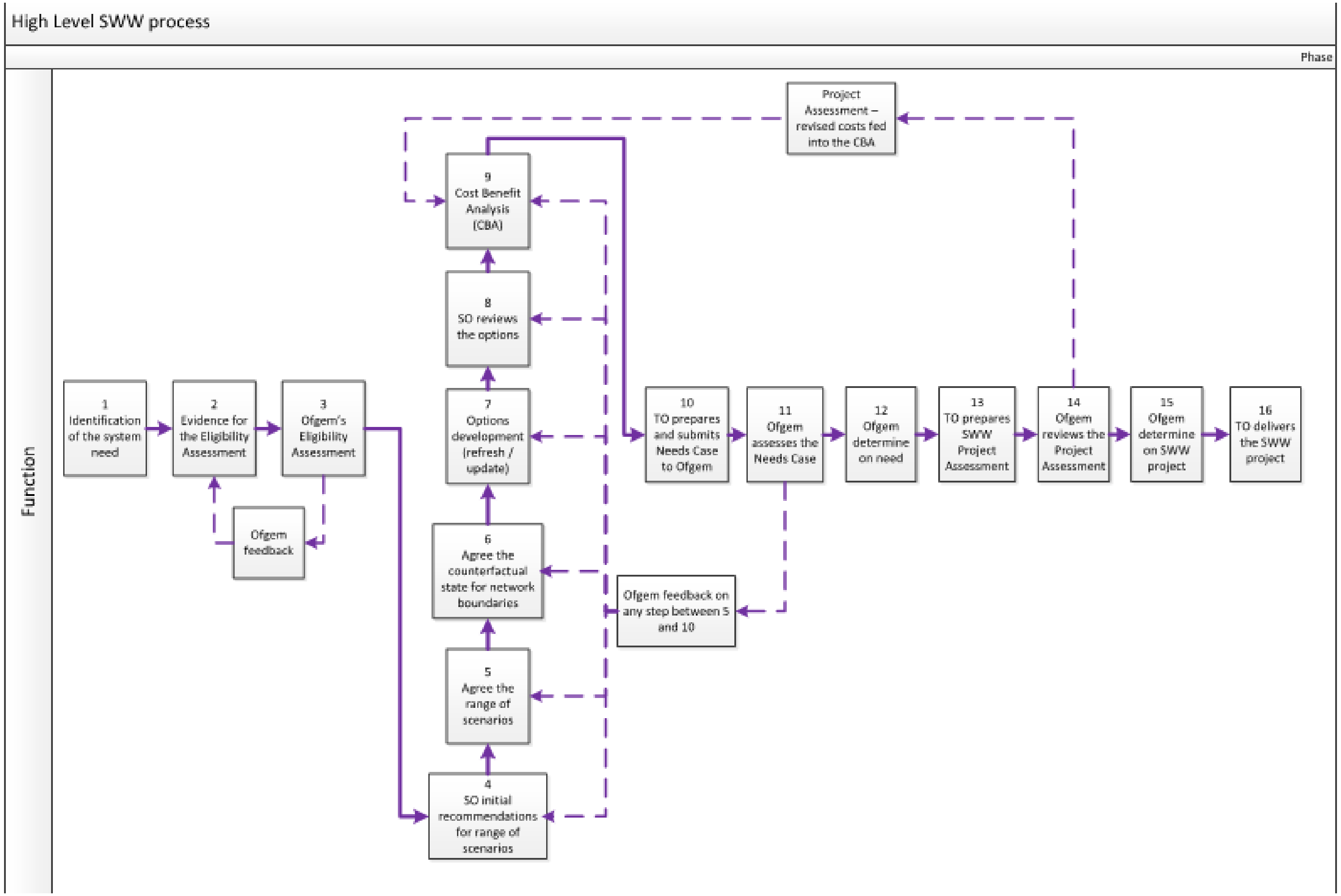
30 **Step 14: Ofgem's review of Project Assessment**. Ofgem will assess the Project Assessment, and the SO and the TO will respond to any queries, as necessary. Ofgem will consult the stakeholders as part of this review. The SO will continue to provide responses through the consultation process. Equally, the SO will provide any further evidence as necessary to support the TO. This may include further analysis on operability and optimal timing.

31 **Step 15: Ofgem determines on the SWW project**, including efficient costs and SWW outputs, and instigates a licence change, as necessary.

32 **Step 16: The TO delivers SWW project**.

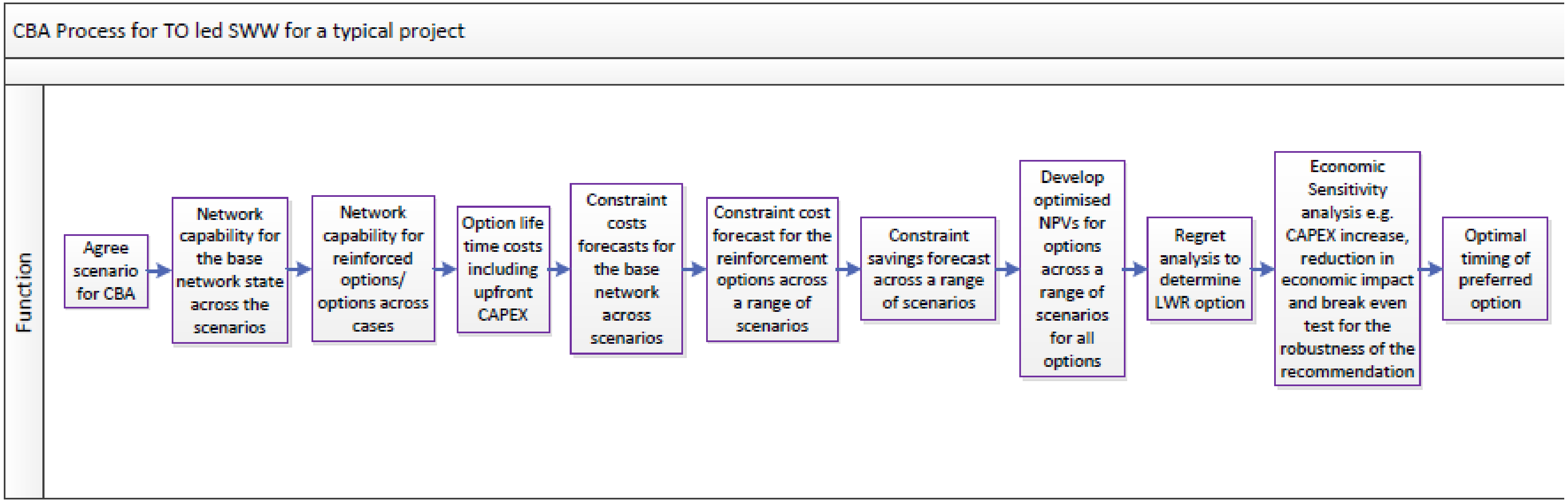
33 The SWW process flow diagram is presented in the Appendix A. The CBA process is presented in Appendix B, while full details of the CBA process are presented in Appendix C.

Appendix A: Strategic Wider Works (SWW) Process Flow Diagram



This diagram shows the overall SWW process. The text in each box corresponds to the descriptions of the stages explained in general methodology above. The numbers correspond to the step numbering in the text.

Appendix B: Cost Benefit Analysis Flow Diagram



This diagram shows the overall Cost Benefit Analysis process performed for a typical new project seeking approval from Ofgem through SWW submission. Detail of the Cost Benefit Analysis methodology is explained in the Appendix C.

Appendix C: Cost Benefit Analysis for TO led Needs Cases

Introduction and Context

C1 On-going changes to industry frameworks such as Integrated Transmission Planning and Regulation (ITPR) and NOA coupled with the forthcoming enhanced SO role of National Grid, place greater emphasis on integrated GB network investment planning and optimisation. These industry changes will raise stakeholder expectations on National Grid activities, and demand high quality Cost Benefit Assessments to support Needs Case documents for network developments.

C2 The Economics Team within Electricity Network Development has been established to appraise the value associated with specific network developments. These developments tend to either follow the prescribed Strategic Wider Works (SWW) process, or stem from a connection application for a new generator / interconnector connecting to the GB electricity system.

C3 National Grid's ETYS process performs a related annual network assessment to help plan future developments on major network boundaries, but does not consider discrete project developments separately or map them across all Future Energy Scenarios (FES) generation backgrounds. The Economics Team provides a detailed appraisal of specific projects to determine the economic merit of different solutions based on prevailing FES backgrounds and pertinent local factors, whilst respecting requirements of the Security and Quality of Supply Standards (SQSS) and the expectations of our NETS stakeholders.

C4 Each network development proposal is managed as a new project entity in which a range of solutions are studied and contrasted. The comparison accounts for forecast lifetime investment costs, lifetime operational savings and the corresponding network value that each solution offers. Assessments are conducted on a GB-wide basis since all projects within the GB market place have implications for the wider GB customer base in terms of capital and operational expenditure (Capex and Opex).

CBA Objectives

C5 The CBA objective is to produce and contrast key economic measures for various network solutions from a GB-wide customer perspective, leading to solution preference based on strict economic criteria. Solution preference is considered across a range of scenarios and accounts for all pertinent cost streams and factors. The CBA relies upon of a series of detailed and structured projections including: -

- FES backgrounds (generation and demand)
- Any local generation (or other) sensitivity with significant influence
- The future network state based on ETYS
- The boundary capability changes associated with each solution (and background)
- Forecast Capital Expenditure by solution (P50, P80[8] values)

[8] Probability (P) is the chance of an investment cost being exceeded. P50 refers to 50% chance and is therefore the mean expectation, whilst P80 implies a 20% chance of being exceeded.

- Any significant asset refurbishment cost and its timing
- The life span of the assets
- Future cost of capital (Weighted Average Cost of Capital or WACC) by investor share
- Social Time Preference Rate (STPR) of 3.5% pa[9].
- Future fuel prices and carbon prices
- Future renewable subsidy projections
- The operating regime of interconnectors

C6 At a high level, these forecasts serve to simulate future market conditions and identify how balancing actions will be utilised by the System Operator (SO). More discussion on how these assumptions contribute to the analysis can be found in Appendix 1 in the form of an illustrative CBA example.

CBA Preference Selection Philosophy

C7 The CBA analysis delivers a series of economic performance matrices reporting the Net Present Value (NPV) and corresponding Regret metrics for each potential solution, under each background. Whilst both the NPVs and Regret measures are reviewed, any emerging solution preference or recommendation is based on a Least Worst Regret (LWR) approach, provided solution stability and robustness can be demonstrated.

C8 Least Worst Regret analysis is designed to identify solutions from the range of possibilities which are least likely to be wrong across the range of uncertainties. It is not designed to pick options that offer the largest benefit (highest NPV), although this often occurs coincidentally. This approach provides a more stable and robust decision against the range of uncertainties, and minimises the chance of a particularly adverse outcome impacting consumers.

C9 The underlying economic philosophy is that it is advantageous to pick the solution that has the lowest adverse consequence across the range of studies, given the uncertainties in forecasts and other assumptions. It requires that all studies are seen as credible at the investment decision stage. Importantly, they need not be equally likely, and are unlikely to be so given the nature of uncertainty within future market place and wider industry.

C10 A regret measure is defined as the difference in the NPV between 'the option being considered' and 'the best possible option under that scenario', i.e. for each scenario, all options are considered against the option that offers the maximum NPV (taking into account both investment and operational costs). It follows that the best alternative has zero regret against which all other options in the scenario are compared. The mechanics of this can be seen in the Appendix D, which presents a worked example.

[9] Although the HM Treasury's Green Book recommends reducing the STPR after first 30 years of the appraisals, the SO proposes to adopt the 3.5% p.a. STPR (discount rate) over the entire appraisal period. This is not least because the Treasury's recommended reduction is unlikely to make any material change to the outcome of the analysis.

Best Practice in CBA

C11 There are usually a plethora of potential solutions to any specific network requirement. In order to focus CBA effort on a summary selection, a multi-criteria 'optioneering' process is required to filter the number of solutions down to a manageable number. Care must be taken to ensure that the set of solutions progressing to CBA retains the wider range and scope. This is because Best Practice in CBA work requires that a sufficiently wide and diverse set of options is progressed to adequately map the full solution space with reasonable resolution. Factors that should be evident in the range of solutions considered include: -

- The most minimal SQSS compliant solution (lowest possible investment cost solution meeting SQSS requirements)
- A range of topographical configurations where credible alternatives exist.
- A range of technologies (where practical)
- A range of capabilities (differing levels of boundary capability)
- A range of investment costs levels

CBA Methodology for TO led Needs Cases

C12 As identified in the core Network Options Assessment Report Methodology document, the NOA will provide investment signals for potential projects seeking to tackle congestion on the GB network. If the investment signal triggers the TO's Needs Case, the SO will assist the TO in undertaking a more detailed CBA. This Appendix provides an overview of the methodology which the SO will adopt for undertaking a detailed CBA as part of the TO's SWW Needs Case submission.

C13 Depending on the nature of the project, the SO may also provide further support on developing and reviewing the technical need of the project. The processes regarding such support are currently being will being developed and will shared with the TOs, Ofgem and the wider industry at a later date.

C14 Driven by the objectives of the CBA and the context outlined above, the overview of the methodology is summarised below:

- Establish the reference case position in terms of constraint costs forecasts associated with the counterfactual network state, across a range of generation scenarios and sensitivities. In order to undertake this assessment, the TO will need to analyse and provide data on counterfactual network capabilities for the boundaries affected for all agreed scenarios and sensitivities.
- Model constraint forecasts for the deliverable options short-listed by the TO across a range of generation scenarios and sensitivities. Again, in order to undertake this assessment, the TO will need to analyse and provide data on network capabilities by boundaries affected for all agreed scenarios and sensitivities for each short-listed investment option.
- Establish the forecasts of economic impact, measured as constraint cost savings, of the short-listed options, across the studied generation scenarios and sensitivities, over the options' assumed asset life.

- Undertake Cost Benefit Assessment, by:
  - Appraising the economic case of the options by adopting the Spackman[10] approach and determining respective NPVs across the studied generation scenarios and generation sensitivities. In order to undertake this analysis, the TO will need to provide life time costs information for all short-listed options, including capital, maintenance and / or refurbishment costs (with annual expenditure profiles) as well as evidence on losses.
  - Establish life-time worst regrets associated with each option appraised
- Make recommendations for the preferred option i.e. the least-worst regret solution, taking into consideration the impact of sensitivities and breakeven analysis.
- Determine optimal timing of the preferred solution by assessing regrets across each scenario and sensitivity and different years of delivery.
- Assess the robustness of the recommendation by assessing the impact of key economic sensitivities e.g. increase in capital expenditure, reduction in forecast of economic impacts, performing breakeven analysis to establish the level of change required in forecast of economic impacts or capital expenditure to result in zero net present value of options across all scenarios and sensitivities.

C15 This process is summarised in the figure presented in Appendix B.

C16 The remainder of this document presents details of various critical elements pertinent to the CBA.

Study Backgrounds

C17 All prospective CBA solutions must be considered against all credible backgrounds such that their performance against each is mapped and understood. This means that all FES backgrounds are studied against all solutions, and any other specific dependencies based on local conditions are also explored across the same range. This provides a matrix of NPV outcomes allowing comparison by solution and by background.

C18 The SO will work together with the relevant TOs to develop and agree a suitable range of credible scenarios for the CBA.

[10] The Joint Regulators Group on behalf of UK's economic and competition regulators recommend a discounting approach that discounts all costs (including financing costs as calculated based on a Weighted Average Cost of Capital or WACC) and benefits at the Social Time Preference Rate (STPR). This is known as the Spackman approach. Further details of our assumptions regarding WACC and STPR are presented later in this document.

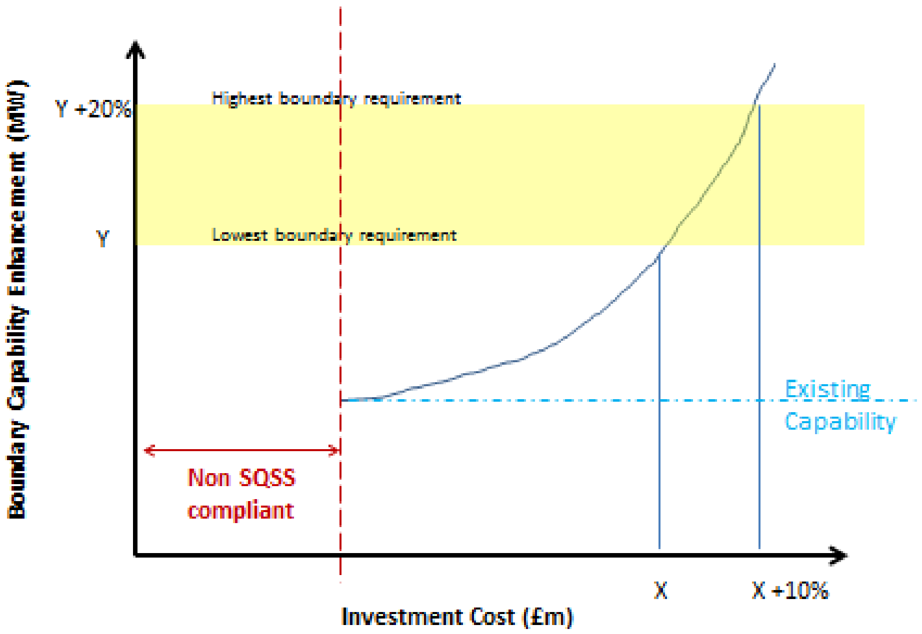
Forecasts and Projections

C19 Future forecasts within the CBA process follow one of two opposing value streams, namely, constraint savings (a consumer benefit) and investment costs (a consumer dis-benefit). These two streams must cover the same time period, but come from different sources. The constraint cost savings are determined by a modelling process called ELSI. The investment forecasts are produced by Transmission Owner (TO) costing teams or National Grid's E-Hub team. Their yearly projections are developed into present value (PV) equivalents using agreed cost of capital and discounting methods within the CBA.

C20 Constraint cost savings are derived by comparing ELSI's annual constraint costs for a particular solution with the corresponding base/counterfactual condition. Where reinforcement improves network efficiency, a constraint saving will occur. Future constraint savings have the same discount rate (STPR, see below) applied to future year values to account for the time-value of money. This provides a PV of constraint cost savings for each solution, for each background.

C21 All future investment costs must account for the investors Weighted Average Cost of Capital (WACC) and future payments discounted (by STPR) to produce a PV of the anticipated investment expenditure. These calculations follow the recognised 'Spackman' accountancy methodology designed to account for the time-value of money.

C22 In some circumstances, such as where the base reference point is the least cost SQSS compliant solution, the corresponding investment cost should be derived from the incremental cost of the solution (the additional expenditure relative to the reference solution). In this way, a presumption that as an absolute minimum the least cost SQSS compliant solution already exists, but that enhanced consumer value in additional incremental reinforcement may be achieved. In simple terms this could be likened to exploring economies of scale as illustrated below:



Constraint Cost Savings forecasting

C23 National Grid's preferred in-house modelling tool for medium to long range network constraint cost forecasts is called 'ELSI'. This tool is capable of producing medium / long term forecasts of network constraint costs for different network states and for various FES backgrounds. FES forecasts provide suitable data for modelling a 20 year period which may, occasionally, be sufficient to reflect the life expectancy of an asset. More typically, asset life is expected to exceed a 20 year period, hence an extrapolation technique is used to populate latter years. Typically, the final (20th) year values are adopted for each and every additional year to match the asset life horizon; although other alternatives may be considered if final year results appear particularly volatile. Most generation and transmission assets are assumed to have a 40 year life span, hence constraint cost savings must span this duration too.

Investment Cost Projections

C24 Each possible design solution is examined and costs are estimated by a specialist team. National Grid's dedicated National Grid team is E-Hub, other TOs have their own teams. Their investment cost projections should detail the total cost (including P50 and P80 contingency provisions), the spread of costs across development years and any significant refurbishment cost anticipated during the assets' life. The yearly investments are mortgaged over the asset life using the WACC assumption, and corresponding future payments discounted by STPR to derive Present Values (PVs) of each solution.

C25 Generally, P50 investment cost values are used in the CBA, however, the analysis is repeated with P80 values providing insight into the way in which delivery risk can influence preferences. This ensures that if a cheap but more risky solution emerges as a preference based on the P50 (ie. mean) values, then the P80 study will reveal this exposure.

Counterfactual / Base References

C26 The Counterfactual or Base network condition is the reference point to which other solutions are compared to identify the scale of benefit offered by the solution.

C27 There are several approaches to establishing a suitable counterfactual reference. Where practical, the base or counterfactual condition is either the 'do nothing' or 'do minimum' condition.

- The 'do nothing' is based on the existing network state without the introduction of this particular project. The 'do nothing' condition lends itself to conditions where the prevailing network state is SQSS compliant but significant network congestion is likely.

- The 'do minimum' refers to that level of investment required for this project in order to meet SQSS requirements. This is helpful where new connection assets are required to meet SQSS.

C28 Occasionally, it may be impractical to derive a counterfactual state. This could be because several low cost compliant solutions co-exist or where SQSS requirements are open to interpretation. Under these circumstances it is reasonable to regard the 'best solution within each background' as the reference point from which others solutions in the same background are measured.

C29 If, due to the bespoke nature of the project appraised, the definition of the counterfactual cannot be defined as the 'do nothing' and requires further considerations, the SO and the TO will engage with Ofgem with appropriate evidence for feedback on this issue, early in the assessment process.

NPVs and Regret Metrics

C30 The economic measures of NPV and corresponding regret matrices are developed to allow cross comparison of the solutions across scenarios and backgrounds. NPVs are generally the difference between PV investment costs and PV of constraint savings. Where constraint savings exceed investment costs then the solution has economic merit relative to the counterfactual state. Where NPVs are negative, then the converse is true.

C31 If the solution delivery timeframes are flexible i.e. not driven by a fixed contracted date, then solution NPVs may flex across different years. This occurs where the constraint savings in early years are lower than the corresponding finance costs or the converse. To explore optimal timing, the NPVs for each study are calculated across the first 10 years from the EISD (Earliest In Service Date) and the largest NPV (and corresponding year) is then determined. This ensures optimal timing for each solution by background is captured in the CBA for the purposes of cross comparison.

C32 Where several solutions show economic merit (positive NPV) then comparison can be made through Regrets analysis. Regret is defined as the difference between the NPV for a particular solution and the best solution across all backgrounds. Preference is then given to solutions that offer the lowest level of regret across all backgrounds and is called the Least Worst Regret (LWR). This LWR mechanism is demonstrated in the Appendix D.

Optimal Timing across all Backgrounds

C33 If divergence of the project's optimal timing (highest NPVs by year) occurs across different backgrounds (as is often the case), a second regret table is developed for any preferred solution(s). This reports the competing pressures across all backgrounds for a specific solution and helps identify the minimum timing regret across early years. This is illustrated in the Appendix.

Results

C34 The CBA methodology is designed to identify a preferred solution that maximises value, minimises risk and identifies optimal timing. Generally, the LWR solution offers the most economic course of action. However, this should be reviewed to establish that the solution is genuinely independent of the others and that it demonstrates a satisfactory level of robustness against unforeseen exogenous variables. This is tested through generic robustness tests in which either: -

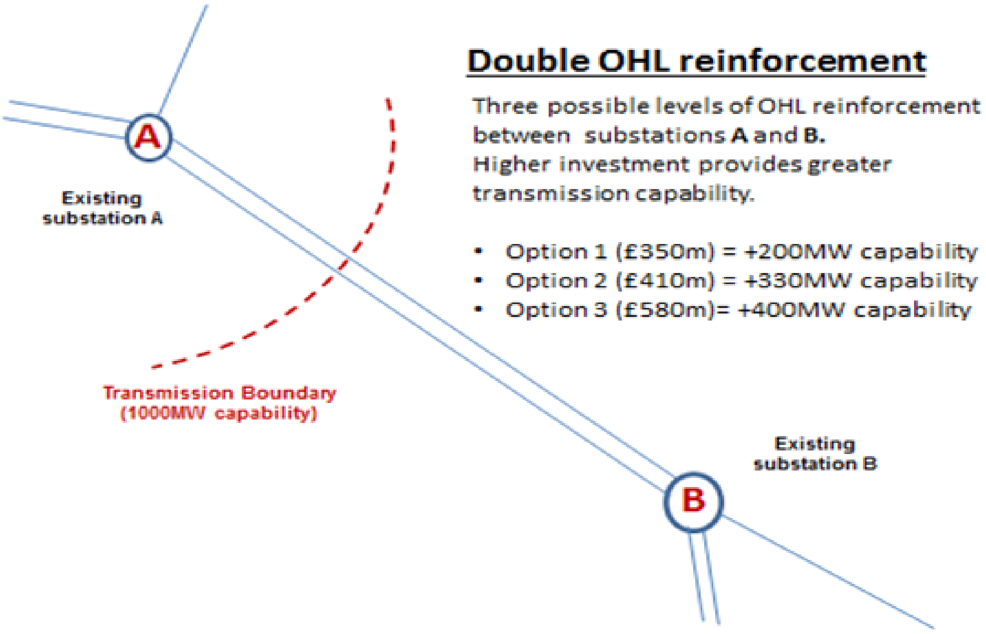
- Constraint cost savings are reduced by fixed percentages without impacting the outcome,
- Investment costs are increased by fixed percentages without impacting the outcome.

C35 Furthermore, the scale of the regrets that drives the LWR selection should be considered in relation to the scale of the investment cost. If a disproportionate increase in capital cost yields only a marginal improvement in regret values (which drives the LWR), then a simple review should also be undertaken. Where investment costs are in the billions and the regrets measures are in the few millions, then preference should be given to cheaper solutions since investment costs are less likely to undershoot than constraint savings overshoot. Investment costs are certainly more tangible and stable than constraint savings across the asset lifetime.

Appendix D: An Illustrative new connection / reinforcement CBA example

D1 Consider an example case where a length of transmission circuit is regularly the critical pinch point resulting in network constraint actions, and that this condition is forecast to increase in future.

D2 The multi criteria optioneering filter has already ruled out any new circuit route as there are much cheaper reconductoring options available which do not present significant planning delays. The counterfactual state is the existing network state with a 1000MW capability without any upgrades. This represents the reference condition from which other solutions are measured. There are four counterfactual models, one for each FES background scenario.



D3 In this example, we have a transmission boundary that requires reinforcement due to changing generation background patterns. The existing network has a 1000MW capability and there are three possible reconductoring options that could be implemented. The options would provide various levels of enhancement and investment cost, as illustrated in the table below.

Option	Capability Enhancement (MW)	Resulting Capability (MW)	*Investment Cost (£m)*
Option 1	200	1200	***350***
Option 2	330	1330	***410***
Option 3	400	1400	***580***

D4 Investment Costs range from £350m to £580, and as investment costs increase, transmission capability increases, but the relationship is not linear, and typically has step increases due to the standard unit sizes of transmission assets.

D5 Each of the three reinforcement solutions represents an increasingly expensive network investment with enhanced boundary capabilities compared to the existing state. The CBA will be able to identify the economic trade-off between investment costs and lifetime constraint savings. All of the options can be delivered within the current year hence no future year discounting is required, and the PV of investment cost is as shown in the table above.

D6 ELSI models are constructed to reflect the corresponding boundary capabilities, and run to determine the yearly constraint costs for each solution against each background. Results are consolidated into Present Values using the STPR assumption discussed previously.

D7 These constraint values are deducted from corresponding counterfactual case values to isolate the savings associated with the solution for each year. These forecasts are repeated across all backgrounds including any relevant local scenario designed to explore the wider solution space.

D8 The PV of constraint savings for each solution, by background is produced and is shown in blue below. The corresponding NPVs are produced by deducting the investment PV from the savings PV. This is shown in the second table below where GG – Gone Green, LCL – Low Carbon Life, SP – Slow Progression and NP – No Progression.

PV of Constraint Savings (£m)	FES Scenario				PV of Investment Cost (£m)
Option	GG	LCL	SP	NP	
Option 1	£423m	£413m	£378m	£324m	£350m
Option 2	£800m	£720m	£600m	£430m	£410m
Option 3	£979m	£800m	£630m	£460m	£580m

NPVs by Solution, by FES Scenario	FES Scenario			
	GG	LCL	SP	NP
Option	NPV	NPV	NPV	NPV
Option 1	£73m	£63m	£28m	-£26m
Option 2	£390m	£310m	£190m	£20m
Option 3	£399m	£220m	£50m	-£120m
column NPV max	£399m	£310m	£190m	£20m

D9 The NPV values shown are the maximum (or optimised) values achieved across credible delivery timeframes. The highest value for each background is identified and use as a reference to calculate the regret associated with other solutions. The completed regrets table is shown below.

Regrets £m					
Options	**GG**	**LCL**	**SP**	**NP**	**Worst Regret**
Option 1	*326*	*247*	*162*	*46*	***£326m***
Option 2	*9*	*0*	*0*	*0*	***£9m***
Option 3	*0*	*90*	*140*	*140*	***£140m***
		Least Worst Regret: Option 2			***£9m***

D10 The Worst Regret for each solution (across the rows) is logged, and then the Least Worst Regret identified. In this example the LWR is Option 2 with £9m regret and is the best option across three of the backgrounds. This solution has a £410m investment cost.

D11 If repeating this assessment for credible reductions in constraint savings or increases in investment costs gives the same patterns, then we can conclude that we have found a stable preference that offers protection from adverse outcomes and the best investment value for money.

Optimising Delivery Timescales

D12 Having determined a robust LWR solution, consideration of its delivery date is required. This entails repeating the Regret analysis but with a fixed solution (the LWR) and flexing the delivery year. This means that the NPV values are mapped across each delivery year and compared against the best, by background. This gives a timing regret table as shown below.

LWR Solution	
Commissioning Year	Timing Regret (£m)
Year 1	100
Year 2	69
Year 3	48
Year 4	47
Year 5	97
Year 6	160
Year 7	225

D13 Plotting this relationship reveals the opposing risks of early investment versus late investment. It can be seen that: -

- Commissioning to meet year 4 is the optimal time frame, although year 3 is almost the same.
- The exposure for late delivery exceeds that of early delivery