A specialist energy consultancy

Final Needs Case Assessment

Hinkley Seabank Strategic Wider Works

Ofgem

11857-001
29 August 2017

CLIENT'S DISCRETION

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Quality Assurance

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Executive Summary

Ofgem has commissioned TNEI Services Ltd ("TNEI") and its subcontractors Kuungana Advisory, Amec Foster Wheeler, and IDP Landscape ("IDPL"), to provide technical support with their assessment of the Final Needs Case (FNC) for the Hinkley Seabank (HSB) strategic wider works project. This project will facilitate the connection of the Hinkley Point C (HPC) nuclear power station. The FNC was submitted by National Grid Electricity Transmission (NGET) to Ofgem on 21st March 2017.

TNEI and its subcontractors have:

- Assessed the inputs into NGET's Cost Benefit Analysis (CBA), including whether the process options progressed are appropriate, and whether cost inputs and other assumptions are justified. This is Part A of TNEI's scope;
- Assessed NGET's delivery plan to determine whether it is efficient and whether risks have been appropriately considered. This is Part B of TNEI scope; and

The results of TNEI's assessment is summarised in the table below.

Table 1: Assessment Summary

Optioneering		
Requirements	● (green)	Key technical and environmental requirements and constraints have been identified and considered. A reasonable generation scenario has been used to assess the connection.
Technical Design	● (green)	Option has been shown to restore boundary capability. Not possible to comment in detail on robustness of T-Pylon design for the HSB route due to early stage of design. Will need to be considered at a later stage, but work to date is considered appropriate.
Consideration of Alternative Options	● (green)	NGET appear to have given fair consideration to all feasible options.
Exclusion of M5 Option	● (green)	Reasonable to rule this option out on the basis of environmental constraints.
Exclusion of HSB7	● (green)	Appropriate to rule this option out. Technically riskier than preferred option and without economic benefit.

T-Pylon		
The Necessity of T-Pylon Selection in Gaining Consent		We agree that the choice of T-Pylons provided evidence to consultees and the Secretary of State that all measures to reduce the impacts of the scheme had been considered. However, NGET has not made the case that the project categorically would not have gained consent had regular lattice rather than T-Pylons been proposed.
Process		An appropriate process has been followed.
Reduction in the Magnitude of Landscape and Visual Impacts		NGET have made a reasonable case that the deployment of T-Pylons reduces the landscape and visual effects of the project. The difference in impacts between T-Pylon and Lattice in the main is considered to be limited. There are instances where we feel that lattice pylons may have been a lower impact option. However, our review of landscape and visual impacts finds that deploying a single technology over long sections rather than having frequent switches between technologies reduces impacts. The decision overall that consistent use of T-Pylons would reduce impacts appears reasonable.
Willingness to Pay		The consideration of landscape character in the PwC T-Pylon study is subject to a high degree of uncertainty due to a lack of primary data specific to the landscape character along the connection route. Even with an upper bound figure that appears to be high, the WTP value does not meet the gap in costs between standard lattice and T-Pylons.
Cost		
Capital Costs		Justification for capital costs appears reasonable. Further evidence should be provided at Project Assessment stage. This should include more detailed breakdowns of some cost items (such as design costs and fees) and more detail on ground conditions and foundation designs. This should include information gathered through early engagement with contractors.

Cost		
Risks		Risk methodology and risk registers appear robust. More detailed consideration of risks for hypothetical lattice option HSB5L should be provided at Project Assessment stage. In particular, NGET should ensure that risks associated with ground conditions are not overly pessimistic. May be appropriate for NGET to undertake more ground investigation works ahead of Project Assessment.
Extreme Weather		More detail needed to support assumptions about extreme weather, particularly with respect to frequency, cost and duration of impact. Costs should be based on a programme which includes mitigation of risks (e.g. through relocation of plant and labour).
Cost-benefit Analyses		
Scenarios		Scenario testing uses the FES scenarios as a starting point, which seems reasonable. Assumptions over timing (the timing of HPC commissioning and the timing to which reinforcement options can be delivered) could exaggerate the benefits of the preferred option, but do not change the overall outcome.
Constraint Costs		Use of the BID3 model seems a reasonable approach for estimating constraint costs. Potential for incremental improvements in constraint cost calculating methodology, but unlikely to affect overall conclusion of FNC. Future analysis could consider other actions taken by NGET (such as energy balancing and the scheduling of reserve) that will impact on constraint costs.
NPV		Again, the timing uncertainties highlighted above have an impact on the NPV calculations, but this is unlikely to affect the overall conclusion of the FNC.

Delivery Plan		
Detail and Justification for Programme	🟢	The overall sequencing of the programme given constraints and dependencies, and individual project activity durations generally seem reasonable and achievable in our view. We would expect more justification of the build duration for the 400kV Mendips Hill underground cable and the design duration for the Bridgwater Tee. The approach to procurement [redacted] is suitable for the nature of the various works and should provide some efficiencies as [redacted]. NGET is best able to manage the interfaces and complex programme interdependencies with this approach. There is a clear strategy in place for coordinating with WPD and Surf.
Consideration of Risks within Programme	🟠	NGET appear to have applied a robust approach to delivery programme risk management, follows industry best practice for a capital project of this scale. Key risks have been assessed and mitigations are generally appropriate. We have concerns regarding the assessment of extreme weather and flooding risks. These are accounted for in risk costs but are not considered in the delivery programme. We would also expect to see further analysis in the Project Technical Assessment on overall programme and outage resiliency, particularly in relation to interaction with outages required on the WPD network.

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FIGURES

1 Introduction

In order to connect the proposed Hinkley Point C (HPC) nuclear power station, National Grid Electricity Transmission Limited (NGET) is developing the Hinkley to Seabank (HSB) transmission project. This will involve the construction of new transmission assets in the South West of England. This project is referred to in some documentation as the HPC Connection (HPCC).

On 21st March 2017, NGET submitted a Final Needs Case (FNC) for the Hinkley-Seabank project, as part of the Strategic Wider Works (SWW) process. Ofgem will assess this document to determine whether there is a justified economic need for the project to progress, what additional information should be provided at the Project Assessment stage, and whether the project could be appropriate for tendering to a Competitively Appointed Transmission Owner (CATO).

Ofgem has commissioned TNEI Services Ltd ("TNEI") and its subcontractors Kuungana Advisory, Amec Foster Wheeler, and IDP Landscape ("IDPL"), to provide technical support with their assessment of the FNC. TNEI and its subcontractors have:

- Assessed the inputs into NGET's Cost Benefit Analysis (CBA), including whether the process options progressed are appropriate, and whether cost inputs and other assumptions are justified. This is Part A of TNEI's scope;
- Assessed NGET's delivery plan to determine whether it is efficient and whether risks have been appropriately considered. This is Part B of TNEI scope; and

The rest of this report is structured as follows:

- The remainder of Section 1 describes the HSB project at a high level, introduces the scope of the FNC assessment which Ofgem will complete, and sets out the approach taken by TNEI to complete the work;
- Sections 2 through 5 set out our assessment of Part A of the scope, including an assessment of NGET's optioneering, an assessment of the benefits of T-Pylons, analysis of the cost inputs in the CBA model, and examination of assumptions in the CBA; and
- Section 3 sets our assessment of Part B of the scope, including an assessment of the efficiency of the proposed delivery plan and the consideration of risks within the plan.

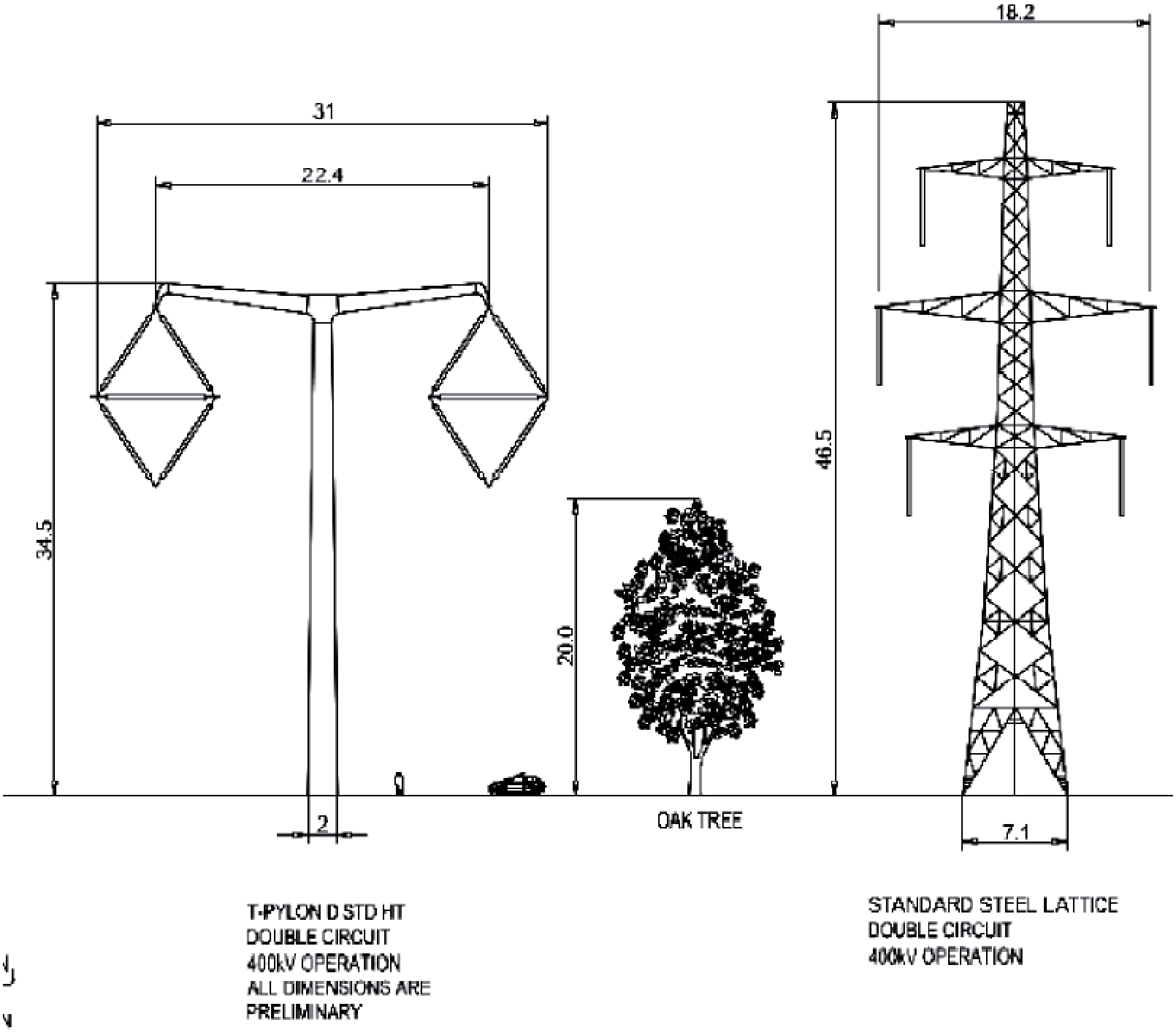
1.1 The Hinkley - Seabank Project

EDF and CGN have taken a Final Investment Decision to construct Hinkley Point C (HPC) nuclear power station, with 3.34 GW of capacity, in Somerset in the South West of England. HPC will be built with two reactors, each with a capacity of 1.67 GW. The first reactor is scheduled to be commissioned in 2024/25, and the second in 2025/26.

NGET is proposing to construct a new circuit route between the existing Hinkley Point and Seabank substations in order to accommodate the new generator. The bulk of this route will be overhead line, with the majority of the route using the new T-Pylon structure. The section of the route through the Mendip Hills Area of Outstanding Natural Beauty (AONB) will use underground cable. The HSB project received approval from the Secretary of State in January 2016.

This project represents the first use of the new "T-Pylon" for a major transmission project. This new tower design was the winner of the Pylon Design Competition, launched in 2011 by the Royal Institute of British Architects (RIBA) in partnership with the Department for Energy and Climate Change (DECC) and NGET.

Figure 1-1 T-Pylons Schematic



1.2 Strategic Wider Works and the Final Needs Case Assessment

The SWW mechanism in RIIO-T1 allows Transmission Owners (TOs) to request funding for large network upgrades that will benefit consumers on a case-by-case basis. This protects both consumers and the TOs from the uncertainty of exposure to expected large projects falling away or coming forward earlier than previously expected.

In England & Wales, a project is classified as SWW if it meets any one of the following criteria:

- Forecast costs of more than £500m;
- Forecast costs of between £100m and £500m, supported by only one customer and not required under the majority of scenarios; and
- Forecast costs of less than £100m, supported by only one customer, not required under the majority of scenarios, requires consent.

The FNC Assessment gives Ofgem an opportunity to confirm that there is an economic justification for the project (the benefits to the consumers outweigh the costs) and that the right option has been progressed. It also gives Ofgem an opportunity to highlight any additional evidence that will be required at the final Project Assessment stage, which is when efficient funding for projects is finalised.

1.3 Approach

This report is based on our comprehensive review of NGET's Hinkley-Seabank Project Strategic Wider Works Final Needs Case Submission (the FNC), delivered to Ofgem in March 2017. This includes the Main Report, as well as all the appendices and any subsequently updated information.

Where we have identified gaps in the provided information, or where we have required further clarification, we have posed Supplementary Questions (SQs) to NGET, via Ofgem. The answers to these SQs have also been considered in our assessment. We have also engaged directly with NGET through a series of three workshops.

- **Workshop 1, 29th March 2017:** NGET provided an overview of the project and the process they had followed to develop the option;
- **Workshop 2, 24th April 2017:** A detailed discussion was held on the methodology and assumptions used in the cost benefit analysis; and
- **Workshop 3, 27th April 2017:** This workshop was used to discuss the T-Pylon in detail, including costs, risks, visual benefit, and research into consumer willingness to pay.

In each part of our assessment, we have used Red-Amber-Green (RAG) ratings to qualitatively rate different aspects of NGET's FNC.

A Green rating means that we are broadly supportive of the relevant process, analysis, inputs or results and it is well evidenced and justified.

An Amber rating means that we believe NGET need to provide more justification or evidence before we can fully support what they have stated within the FNC.

A Red rating means that we disagree with the application of the relevant process or inputs or do not support the relevant analysis or results.

2 Optioneering Approach

Ofgem asked TNEI to consider whether NGET's approach to reaching a preferred strategic option for the project was appropriate, by answering four specific questions:

- Are the stated technical requirements well justified?
- Is the technical design of the preferred option technically robust and does it deliver the required capacity?
- Are there any additional feasible reinforcement options or operational measures that could connect the power station but haven't been considered by NGET?
- Is NGET's rationale for not progressing the potential 'M5 corridor option' reasonable?

Each of these questions is addressed in turn below.

2.1 Requirements

The key technical requirements which have affected the selection of NGET's preferred option are the network planning and operational requirements within the National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS), which have been assessed against a base generation scenario[1]. Environmental constraints have also shaped the development of the preferred option.

2.1.1 Electrical Requirements

In the FNC, NGET identifies that there are three aspects of non-compliance with the NETS SQSS:

- Loss of power infeed (as defined in Chapter 2 Section 2.6 of the NETS SQSS)
- Thermal compliance (as defined in Chapter 2 Section 2.10 and Chapter 4 Section 4.6 of the NETS SQSS)
- System stability (as defined in Chapter 2 Section 2.10 and Chapter 4 Section 4.6 of the NETS SQSS)

This is consistent with the approach taken in the preparation of the NWCC INC[2].

NGET has assessed the performance of the existing network with HPC connected through a series of power flow and stability studies in DigSilent Power Factory. They have robustly demonstrated that connecting the generator without enhancing the network would result in non-compliance with the SQSS. Managing this would require significant pre-fault generator constraints and would severely reduce the ability of the system to transfer power across the B13 boundary. The B13 boundary is illustrated in Figure 2-1.

The studies have been undertaken against a base generation scenario. This scenario is discussed in more detail below.

TNEI understands that the minimum required rating of the new circuit from Hinkley Point to Seabank is constrained by the underground cable section through the Mendip hills. A single core per phase

[1] This scenario was developed within the 2015 submission and represents a forecast of generation in 2020.

[2] https://www.ofgem.gov.uk/ofgem-publications/108663

would not have provided sufficient thermal capacity to maintain compliance, and therefore two cores per phase are required. The technical design is summarised in

Table 2-1.

Figure 2-1 Schematic of the network in the South West of England, showing Boundary B13

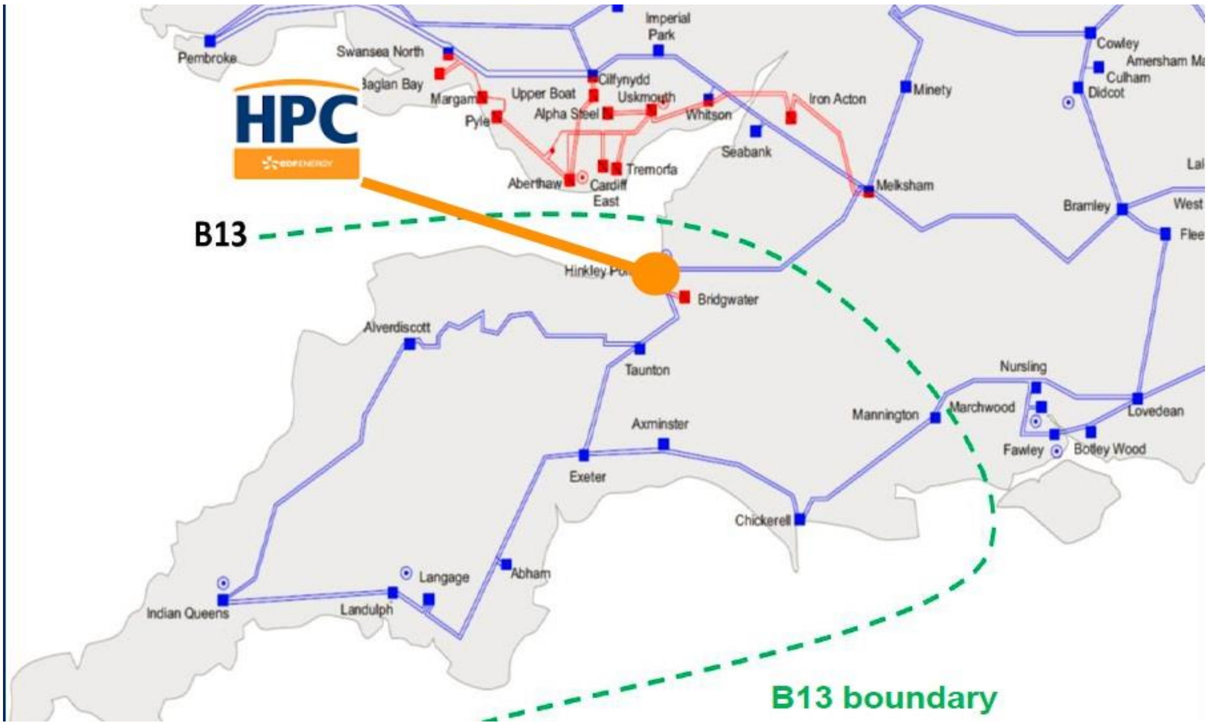


Table 2-1 Description of Technical Design

Route Section	Length	Technology	Conductor	Rating
Hinkley Point to Huntspill (existing)	14km	Lattice Tower	2x500 mm^2	1,750 MVA* (Double circuit)
Huntspill to Loxton	13km	T-Pylon	2x850 mm^2	2,820 MVA** (Double circuit)
Loxton to Sandford	8.2km	Cable	2x2500 mm^2	2,402 MVA*** (Double circuit)
Sandford to Seabank	30km	T-Pylon/ Lattice Tower	2x850 mm^2	2,820 MVA** (Double circuit)

*Post-fault summer rating, at 75°C

** Post-fault summer rating, at 90°C

*** Continuous rating

2.1.2 Base Generation Scenario

In their 2015 submission, NGET created a Base Generation Scenario, which represented a forecast of 2020, which they used to demonstrate the non-compliances in the existing network following the connection of HPC. The FNC describes in detail how this scenario has been assembled, based on assumptions about demand, embedded generation, and transmission connected generation. Table 2-2 below shows the contracted position for transmission connected generators in the region, and whether or not these have been included in the Base Generation Scenario. By including only a very limited selection of these generators, NGET is representing a "minimum credible background against which network reinforcements should be designed".

Table 2-2 South West Generators and Inclusion within Base Generation Scenario

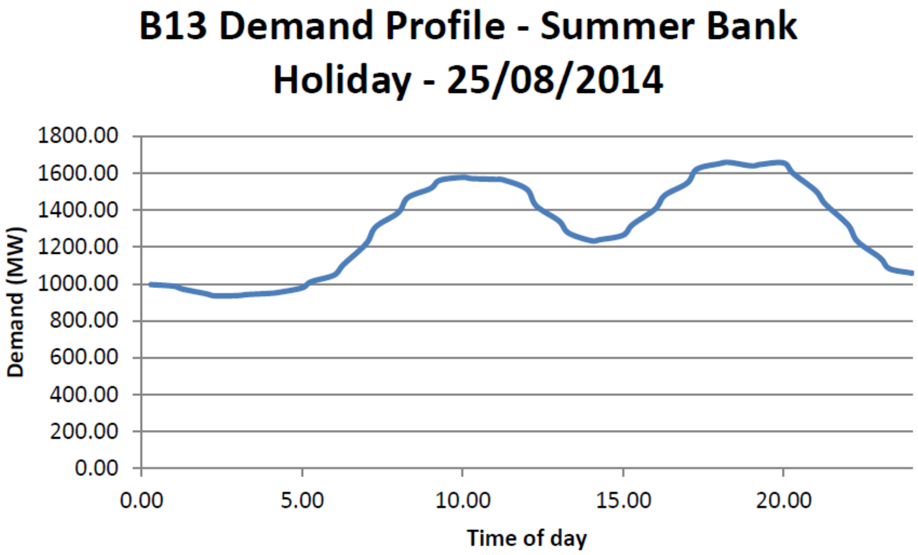
[TABLE REDACTED]

In addition, this scenario uses assumptions about peak demand in the South West, and embedded generation. The studies have been completed on the basis of there being 1,100 MW of embedded generation in the South West, based on information that was available in 2015. The majority of this is assumed to be solar PV.

System studies are generally completed for snapshots of the most onerous network conditions in a year – in practice, these are the period where demand is at its lowest (which tends to be overnight during the summer) and the period where demand is at its highest (which tends to be in the early evening in the winter).

In their **minimum demand** scenario, NGET has assumed that there could be times where there is sufficient embedded generation exporting in the region so as to reduce overnight net transmission demand in the South West to zero (900 MW). This is justified with reference to a demand profile for the B13 boundary (Figure 2-2), which shows that there are periods during daylight hours very early in the morning in summer where 1,100 MW of embedded generation would reduce demand to zero. TNEI's interpretation of this assumption is that NGET is effectively modeling the minimum demand snapshot as early morning in the summer, rather than overnight, and assuming that at this time net demand could drop to zero.

Figure 2-2 B13 Demand Profile – Summer Bank Holiday – 25/08/2014, from HSB FNC



In the **maximum demand** scenario, NGET have also included 1,100 MW of embedded generation. This is despite winter peak conditions typically occurring during periods of darkness, where solar PV output would be expected to be zero. TNEI sought clarification on the reasoning for this assumption. NGET explained that, rather than seeking to represent winter peak conditions, they were instead trying to represent a snapshot of daylight hours during a winter day. This would result in demand which is lower than the winter peak demand, but would also result in embedded generation output greater than zero. As B13 is an exporting boundary, NGET believes this to be a more onerous condition than winter peak. The inclusion of 1,100 MW embedded generation for this scenario is therefore meant to represent both a reduction in the level of peak demand, and an increase in the output of embedded generation.

For both the minimum and maximum demand scenarios, the rationale behind NGET's assumptions is reasonable although the actual assumptions seem somewhat arbitrary. In this case, this does not appear to have a material impact on the results or affect NGET's conclusions. In fact, since 2015, there has been significant growth in embedded generation which would actually exacerbate the non-compliances identified in FNC, and further support the case for reinforcing the network. For example, WDPs' Generation Capacity Register[3] from April 2017 shows that there is ~1,707 MW of generation currently connected to the network behind the B13 boundary, with another 565 MW of generation which has accepted grid connection offers and a further 594 MW to which grid connection offers have been made. The impact that this additional generation has on the needs case is considered within National Grid's CBA, which uses more recent scenarios for generation and demand. This is assessed in Section 5.

2.1.3 Environmental Constraints

The Route Corridor Study (RCS) (October 2009) followed a desk based optioneering process (as described in the December 2009 Strategic Optioneering Report) that had already established the basis of public consultation. This focussed on two potential corridors between Bridgwater and Seabank. That initial optioneering process had taken into account the environmental sensitivity of the Severn Estuary when considering options between Hinkley Point to Aberthaw via AC offshore cable) and Hinkley Point to Seabank via AC offshore cable. Initial routing studies, taking a high level

[3] https://www.westernpower.co.uk/Connections/Generation/Generation-capacity-register.aspx

account of environmental designations, showed that overhead line options between Hinkley point and Melksham and Hinkley Point and Nursling would result in greater route lengths than an overhead line connection between Hinkley Point and Seabank.

The 2009 Route Corridor Study correctly identified the environmental constraints in the area and provided a summary of the designations and receptors within those corridors. The RCS also noted that high level environmental assessment had been sought on connections between Hinkley Point and either Melksham (discussed below) or Nursling.

The preferred route corridor between Bridgwater and Seabank was assessed further in the 2011 Selection of Preferred Connection Report. This report set out a finer grain, comprehensive consideration of environmental constraints.

The Hinkley to Melksham RCS[4] study concluded that a far longer connection would be required (115km as opposed to the 47km route from Hinkley Point to Seabank) and that approximately 26km of undergrounding would be required within the western sections of the route and above that considered necessary in relation to the Cotswolds AONB. Review of that RCS has found that the conclusions on the requirement for undergrounding, at that point in the process and without extensive ornithological survey, appear reasonable.

The evaluation of environmental constraints during the optioneering process was scrutinised during the examination of the DCO application when the Examining Authority (ExA) interrogated the consideration of alternatives. It was concluded that there were no alternative options that would lead the panel to refuse the application for development consent. This provides evidence that the consideration of environmental impacts during the optioneering process was robust.

2.2 Technical Design

2.2.1 Boundary Capability

NGET has assessed how effective their selected option is at restoring the boundary capability following the connection of HPC. The boundary capability has been assessed in terms of thermal limits and stability limits for three scenarios: winter peak, summer max, and summer min. Table 2-3 presents the boundary capabilities which are determined for the existing network, showing that these are insufficient for the required transfer[5] across this boundary. Then, the table shows the resultant boundary capability when the selected option is in place[6].

This shows that the selected option restores the capability of the B13 boundary to a level that enables the required transfer.

Table 2-3 Boundary Capability

	Winter Peak	Summer Max	Summer Min
Required Transfer	2,877 MW	3,883 MW	4,180 MW

[4] This was a separate study to the others mentioned in this report, and was carried out in 2015.

[5] We understand that this is based on the 2014 Future Energy Scenarios.

[6] This is calculated based on a more onerous generation background, with 7,805 MW of generation initially operating behind the boundary.

Without Reinforcement			
B13 Stability Limit	1,586 MW	1,884 MW	1,990 MW
B13 Thermal Limit	3,622 MW	3,510 MW	3,599 MW
With Selected Option			
Post-Fault System Stability	Stable	Stable	Stable
B13 Stability Limit	N/A - Stable	N/A - Stable	N/A - Stable
Post Fault System Overloads	Within Limits	Overload	Overload
B13 Thermal Limit	6,283 MW	6,178 MW	4,840 MW

Once the selected option is in place, there will be three double circuits crossing the B13 boundary. Therefore, there is a possibility that changes in the future distribution of generation and demand in the South West could change the distribution in flows across these circuits, resulting in different boundary capabilities.

We have explored this further with NGET through SQs and discussions, with the following observations:

- We understand that the circuit which tends to limit the boundary capability is the southern circuit from Exeter to Nursling;
- There is growth anticipated in embedded generation throughout the South West. However, this generation is expected to be distributed relatively evenly throughout the region, and is therefore considered unlikely to result in a redistribution of power flows across the B13 circuits;
- Large generators connecting to the network in the South West could potentially cause redistribution of the power flows on the B13 circuits. This would require significantly large volumes of generation to connect such that the ‘limiting circuit’ changes from the Southern circuit to either the Hinkley – Seabank or Hinkley – Melksham circuit;
- However, we understand that the most significant uncertainty around generation in the South West is related to future interconnector connections, which are expected to connect to the network along the south coast. If exporting, these circuits would therefore primarily contribute to power flows on the southern circuit from Exeter to Nursling, and would not result in the ‘limiting circuit’ changing; and
- There is some risk that very large generators or interconnectors connecting into the North of this region could potentially cause power flows to redistribute so that the boundary capability changes. We expect this would be accounted for as part of the annual NOA process.

2.2.2 T-Pylon Designs

This project will include the first use of the new T-Pylon structure as part of transmission reinforcement. TNEI would not typically comment on detailed civil engineering design of transmission works as part of a needs case assessment. However, given the T-Pylon is a new structure a technical review of the T-Pylon design and associated foundation has been carried out by TNEI, specifically addressing civil, structural and geotechnical aspects.

2.2.2.1 Pylon Layout

The pylon comprises a steel circular hollow section main mast approximately 34m high. The mast's cross section tapers from approximately 2m diameter at the base to 1.19m at the top. The main mast is delivered to site in 3 separate sections which are bolted together in-situ. A central node is bolted to the top of the mast which supports two cross arms projecting approximately 11.25m from the central node. At the end of each cross arm is a 'horn' which supports the insulators and conductors. It is understood that NGET have refined the design such that the cross arms and 'horn' comprise a single fabricated section. All other sections are erected on site and bolted together via a flanged connection.

It is understood that NGET considered reducing the mast to two sections, to save on materials. The conclusion was that this wasn't economic, as deliveries would then fall under The Road Vehicles (Authorisation of Special Types) (General) Order (commonly known as STGO) due to the overall length of vehicles. Although not prohibitive, STGO would require additional administration and notification to Highways and Police authorities prior to vehicle movements. TNEI agree that the minor saving in material costs (one flanged connection) is outweighed by the overhead costs associated with STGO. Therefore, TNEI would not expect this element of the design to be refined any further.

TNEI did not reviewstructural calculations, therefore it is not possible to assess the design in depth. However, the overall shape and size of the pylon is comparable with wind turbine towers and it can be concluded that the design appears reasonable based on TNEI's extensive experience of wind turbine structural design. Recent experience of wind impacts on tubular structures[7] highlighted significant impacts on the towers through dynamic loadings, leading to some increased early deterioration of the masts and potential fatigue failures. This has resulted in modifications of the design to account for these load effects. Until the T-pylon calculations are reviewed it cannot be confirmed that all impacts from dynamic loading, or indeed other loading effects have been accounted for.

The intended design life of the pylons is understood to be in the region of 80 years. Whilst this design life is easily achievable with current design standards and a robust design solution, it is considered that periodic maintenance would need to be undertaken to ensure this is not compromised. Specifically, periodic inspection to identify defective, loose and/or corroded bolts is considered fundamental to such a design. Failure of one or more bolts could overload adjacent bolts and ultimately lead to connection failure(s).

An access hatch is located at the bottom of the tower, but it is understood that the intention is only to use this access during construction, after which it will be sealed. It is advised that this access hatch is securely sealed but able to be used throughout the design life of the pylon such that internal bolted connections can be inspected as part of a planned maintenance and inspection regime. To facilitate this, the localised stiffeners around the opening would need to be modified to support a door. The internal ladder will require regular inspections or it may contribute to a hazard at a later date.

Details supplied show an earth bond across the bottom joint. In previous examples of tubular supports earth continuity has been provided across each bolted connection rather than relying on

[7] Giosan, I. (2000) "Vortex Shedding Induced Loads on Free Standing Structures"

current to flow through the joint. This may require additional earth bonds to be added, which will raise the cost of the T-pylon, but should not significantly affect the overall cost at the scheme level.

2.2.2.2 Surface Finish

The external finish of the pylon is a painted off-white matte colour. All steel structures depend on their surface treatment to guard against corrosion. With a suitable surface preparation (e.g. shotblasting) and factory application, a high specification paint system can achieve a coating life of 25-40 years. Therefore, it is anticipated that over the intended design life of the pylon (80 years), re-painting may be required at least once. It is likely that further re-painting may be required at a reduced number of towers.

There are several additional factors that may impact the T-pylon and will affect the durability of the finish. These include:

- **REDACTED:** [redacted]
- **Agricultural Operations:** Spraying of chemicals and manure on fields could land on the pylon structures. If left, some of these chemicals can be corrosive and increase the breakdown of the protective coatings

Due to the design of the pylon, re-painting would have to be conducted from Mobile Elevated Working Platforms (MEWPs). 'Rough Terrain' and high reach MEWPs are widely available, therefore re-painting activities, if required, are not considered to be overly difficult.

Even with modern advanced mixing processes, no two paint batches are ever identical in colour, often displaying subtle differences in shade. Therefore, if pylons do require re-painting, it should be ensured that they are re-coated in their entirely, rather than on a piecemeal basis. This approach should reduce any aesthetic / visual amenity issues.

2.2.2.3 Unauthorised Access

Unlike the lattice pylon design, the T-Pylon restricts the ability of unauthorised personnel to climb the external surfaces and therefore presents a reduced public liability risk. It should be ensured that the hatch at the base of the tower is adequately secured such that unauthorised access into the mast is prohibited and the risk of vandalism is limited.

2.2.2.4 Accidental Damage

Additional Protection in some Tower locations may be necessary to protect against damage to the pole structures. These would also be a consideration for Lattice structures and would be considered during detailed design of the route. This might include damage due to vehicle impact (in both Rural and Urban settings) or fire.

2.2.2.5 Foundation

Pylon foundations should be a bespoke design suitable for an individual project's ground conditions. This process should reduce construction costs and ensure optimal value for the Consumer.

Indicative foundation design drawings for Hinkley have been presented for review along with a drawing for Eakring test line as a comparator. TNEI has not completed a detailed design review of structural calculations. However, an assessment on the reasonableness of the designs can be formed and compared with foundations for similar structure types.

The foundations comprise of steel reinforced concrete slab foundations of various sizes, dependent upon pylon type (i.e. tension, suspension etc.). The Eakring foundations incorporate 48 No. 25mm diameter holding down bolts embedded in the foundation. The bolts are tied to the bottom reinforcement mat with stirrups ensuring the tension forces in the bolts are transferred to the base of the foundation. A short section of pylon mast ("transition piece") is attached to the top of the foundation via the holding down bolts and subsequently encased with a reinforced concrete plinth 3.3m in diameter x 0.4m high. This process requires a two stage concrete pour which can potentially lead to workmanship issues, if the joint is not prepared and finished correctly. It is advised that close attention is given to this element during the construction phase in order that an inherent weakness is not presented in the foundations.

The Hinkley indicative drawings present broadly the same foundation arrangement as used at Eakring although the level of detail presented is not as advanced. NGET has stressed that comparisons between the foundation designs for both projects should be 'made with caution' due to number of differences in the project. [redacted].

[redacted].

It appears likely that the foundation designs will change as the project is developed further. This could lead to either increasing or decreasing costs, but the overall impact of this is considered to be relatively small.

The transition piece could be replaced by a solution which uses longer holding down bolts i.e. the mast is bolted directly to the foundation. Each option has its advantage and disadvantages, for example the transition piece will be easier to install but the foundation may have more workmanship issues as it will require a two stage concrete pour, whereas a bolted design can utilise a single stage concrete pour (reducing workmanship issues) but installation of bolts will be longer and require more accurate setting out. The difference in cost between the two options is likely to be negligible. However, it would be advantageous to understand whether NGET and their designers have considered such an alternative and whether it would present a more efficient structural design and realise any significant cost savings.

The level of detail presented on the indicative Hinkley drawings would suggest a hybrid of the two options discussed above (i.e. a transition piece bolted directly to the foundation which in turn is bolted to the mast, no concrete plinth around the transition piece). If correctly interpreted, this solution would result in a buried bolted connection that would be susceptible to corrosion brought on by groundwater / moisture. Clarification should be sought on the exact detail to be adopted at Hinkley to ensure corrosion risks are minimised. It is likely this level of detail will not be available until the detailed design stage.

Similar structures have suffered early fatigue failures at the interface between the structure and the foundation. It is not evident from the information supplied whether dynamic loadings and fatigue effects have been addressed in the design, however this can be suitably considered in the final detailed design of the pylon and foundation interface joint. As noted above these conditions can be critical for the performance of the pylon.

The bolted connection between the transition section and the mast is external and is thus vulnerable to corrosion. Such connections on similar structures have plastic/rubber caps fitted to the bolts (See Figure 2-3 below) to limit corrosion and are regularly inspected for corrosion etc. It is recommended that the external bolts are fitted with similar caps and a maintenance regime which incorporates regular inspections is implemented.

Figure 2-3 Example of Rubber Caps on External Bolted Connection

The Eakring foundations are supported off vertical and raked piles. The raked piles allow the efficient transfer of lateral forces from the pylons into the ground, whilst the vertical piles transfer forces to suitable underlying geology. The arrangement and number of piles is reasonable for structures of this nature. It should be noted that the number, length and arrangement of piles will change from project to project due to the encountered ground conditions. It is noted that the Hinkley indicative drawings do not specify raked piles, instead opting for larger diameter vertical piles. The larger diameter may be necessary to accommodate the lateral loads. Due to the anticipated ground conditions it may not be possible or efficient to drive raked piles. It is recommended that clarification is sought from NGET on why raked piles are not proposed and whether their use is possible and whether in turn this will reduce the diameter and ultimately cost.

The arrangement of reinforcement steel in the foundations appears suitable and does not present any obvious constructability issues. Lapping and continuity of reinforcement bars would appear to be suitable and temporary support steel requirements have been considered. Concrete cover to reinforcement would also appear to be in line with design requirements and best practice.

As previously stated, the pylon mast designs are similar and comparable to wind turbine foundations. On wind turbine foundations, the transition piece is fitted with a neoprene strip (see Figure 2-4 below) to allow for movement between the concrete foundation and steel tower (caused by load deflection and thermal actions). The top of the strip is then sealed with a polyurethane sealant to prevent water ingress. This feature limits the risk of concrete cracking and potential future water ingress which could lead to degradation of the reinforcing steel. The pylon and foundations designers should consider whether adding a similar strip of material would be beneficial and help ensure the intended design life is not compromised.

Figure 2-4 Wind Turbine Transition Piece (waiting to be installed), Showing Black Neoprene Strip

2.2.3 Environmental Mitigations

Key mitigation measures employed, to minimise the effects on the environment and therefore reduce consenting risk, consisted of:

- Undergrounding of the line within the Mendip Hills AONB;
- Route selection;
- Reconfiguration of the Local Distribution Network;
- Specification of T-Pylons for the majority of the overhead line sections; and
- The Offsite Planting and Enhancement Strategy (OSPES).

Consent has been gained and therefore these measures were sufficient to minimise environmental effects to the point that they were considered to be acceptable by the Secretary of State balanced against the benefits of the project. They were therefore effective in minimising environmental effects and reducing consenting risk.

Specific questions over the decision not to adopt a route within the M5 corridor and the use of T-Pylons are dealt with in Section 2.4 and Section 3 below.

2.3 Additional Feasible Options

As part of the assessment of the North West Coast Connection (NWCC) project, TNEI assessed the overall optioneering approach used by NGET and found this to be an appropriate approach for developing transmission assets. We considered in detail the options that NGET had considered and ruled out at each stage, from strategic options to routing options.

TNEI have not repeated this assessment for HSB, as the approach used by NGET for HSB is identical to NWCC. Whether there were any feasible options which NGET did not consider has been assessed. Based on the review of the FNC and subsequent SQs, it appears that NGET has assessed all viable options:

- NGET has considered options for enhancing the existing network without constructing new circuits;

- Connections to the closet transmission substations which provide boundary capability have been considered at the strategic options stage; and
- For the preferred Hinkley to Seabank circuit, a range of onshore and offshore technologies have been considered with a variety of routes.

Having already reviewed the different connection options considered by NGET, Ofgem has not asked TNEI to comment on the validity of eliminating each of these options during the optioneering process. However, two eliminated options are discussed in further detail below:

- The M5 Corridor Option – this was eliminated from the optioneering process due to environmental constraints; and
- A network enhancement option (referred to as HSB7) – this was ruled out due to poor performance in the cost benefit analysis.

2.4 M5 Corridor Option

Alignment within the M5 corridor was considered at several points during development of the scheme. Since commencement of the project in 2009, NGET has undertaken a number of optioneering studies including:

- HPCC Project: Route Corridor Study (October 2009);
- HPCC Project: Strategic Optioneering Report (December 2009);
- HPCC Project: Selection of Preferred Connection Report (August 2011);
- HPCC Project: Strategic Optioneering Report (August 2011);
- HPCC Project: Connection Options Report (2012); and
- HPCC Project: M5 Routeing Study (February 2012).

The key studies examining this option were as follows:

2.4.1 The 2009 Route Corridor Study (RCS).

In response to comments received in the pre—study information exchange from the RSPB and Environment Agency (para 2.27) this study considered options along the route of the existing 132kV overhead line. The RCS states (para 1.12) that NGET had already confirmed through high level consideration of constraints and technical requirements that Bridgwater to Seabank was the option to progress. It focussed on Hinkley to Seabank but also considered environmental constraints on the less preferred options.

Chapter 8.0, Broad Route Corridors, assesses options of corridors close to the M5 in the process of considering routes in parallel to the existing 132kV cable. It details various constraints at specific points along the M5 corridor. The RCS does not specifically assess route options within the M5 route corridor but it provides justification for the alignment of corridor options 1 and 2 which takes into account the possibility of following the M5.

Identified environmental constraints along the M5 corridor included:

- The creation of a 'wirescape' consisting of the new overhead line alongside the existing 132kV line;
- Proximity to large settlements at Burnham-on-Sea, Weston-super-Mare and Clevedon which restricted routing options;
- Proximity to and need to cross a number of residential properties;
- Areas of woodland close to the M5; and

- The setting of heritage assets including the Brent Knoll Scheduled Monument.

2.4.2 Selection of Preferred Connection Report 2011

This report considered two broad route corridor options that had been identified in the Route Corridor Study. Corridor 1 followed the line of the existing 132kV line (with option 1A involving removal of the existing 132kV line and option 1B running the new and existing overhead lines together). Corridor 2 was a new route with an option for a section, between Compton Bishop and west of Yatton, which would closely follow the M5.

The report notes that some consultees had requested consideration of an M5 corridor option and that it had been previously discounted due to environmental constraints including ancient woodland and residential properties (para 3.13). It did not consider an M5 corridor option or the use of T-Pylons.

2.4.3 M5 Routeing Study (MRS) 2012

This study was undertaken ahead of the Scoping and statutory consultation processes. It states (para 1.1.2) that it was in direct response to a representation from Tessa Munt MP advocating an M5 corridor route.

Options are described within a study area extending out to 1km either side of the M5. It correctly identifies all of the environmental and land use constraints that must be considered. Two routes were discussed in detail; one running close and parallel to the M5 east of the road and another which has been optimised to minimise the instances of oversailing properties and impacts on other constraints such as areas of woodland. The close and parallel option was discounted as it could not demonstrate sufficient quality of design to avoid oversailing properties and the removal of vegetation that acts as mitigation for the motorway.

The optimised M5 route was found to be technically achievable. The study provided a comparison of this and NGET's preferred option (subsequently consented under the DCO) considering the key constraints. It found that, for all constraints, the preferred option performed better than an optimised M5 corridor route with the key benefits relating to effects on landscape, the AONB (as a high value landscape receptor) and on settlements and residential properties. The study noted that the optimised M5 corridor would require larger pylons to accommodate numerous changes of direction and to achieve clearance from motorway infrastructure.

This study assumed the use of lattice pylons and did not consider T-Pylons.

2.4.4 Findings of the Examining Authority (ExA)

The ExA Report to the Secretary of State briefly summarises the optioneering process and reporting that informed it. The Panel was satisfied with that process.

The report also discusses the consideration of alternatives that took place during the DCO process. This included consideration of a suggested Gas Insulated Line (GIL) connection running alongside the M5 in a formed tunnel. NGET pointed out that the same constraints to overhead line development identified in the MRS would apply to a GIL solution as well as the increased costs. The ExA concluded that the additional capital costs outweighed the benefits of utilising GIL.

Section 5.14 of the ExA's report states that the ExA was of the view that it was satisfied that the approach adopted by NGET to consideration of alternatives was *'…reasonable, robust and* *proportionate.'* (para 5.14.31). The Panel concluded that consent could be granted. Subsequently Bircham Dyson Bell, in its note on NGET's aspects of design, concluded that promotion of an M5 corridor route would have introduced greater project risk.

2.4.5 Review in the Field

Field work undertaken by IDP Landscape (IDPL) included consideration of the perceived aesthetic benefits arising from seeking to achieve a connection route that followed the alignment of the M5. Site work suggested that such an approach would serve to reinforce the 'severing effect' of the M5 route upon the landscape. By combining the highway route and the overhead line route into one linear feature the combined impact upon landscape character and visual amenity would potentially be greater than for each individually. By adopting an alternative route detached from the immediate M5 corridor the pylons, whether lattice or T-Pylons, will be placed within a receiving landscape that helps to diffuse their impact rather than the alternative of drawing attention to their divisive linear attributes which would be more legible were the pylons to be routed close to the M5.

IDPL considers that such an approach would mean that the pylon route would constantly be within the main field of vision for the many receptors using the motorway. Unlike when set within a landscape where intermittent and scattered mature vegetation and built form can fragment continuity of views, there would be no relief from the pylons which would then become an over-riding defining characteristic of the linear route which is the situation that presently exists just to the north of the River Avon M5 bridge crossing.

2.4.6 Conclusions on Consideration of an M5 Corridor Option

The option to utilise the M5 corridor was considered throughout the optioneering process with the level of detail of assessment increasing as the project progressed and consultees continued to advocate this option. The MRS provides a comprehensive assessment of a workable route option within the corridor, comparing the performance of this against NGETs established preferred option. Both TNEI and IDPL consider that, from review of the information available, exclusion of the M5 corridor route option at the optioneering stage was reasonable. This was then borne out by the ExA examination and reporting.

2.5 HSB7 Option

NGET included an option in the CBA which involved enhancement of the existing network rather than construction of a new overhead line. Specifically, this option includes:

- Installation of series compensation of up to 35% at four substations in the South West;
- Installation of seven 225 MVAr STATCOMs at Hinkley Point substation; and
- Reconductoring of the existing overhead line route between Hinkley Point and Melksham.

HSB7 performs relatively poorly in the cost benefit analysis, with regrets of between £117m to £608m across the four core FES scenarios when all options are assumed to be deliverable in the same year. This is because it leads to a lower B13 boundary capability than the preferred option. If considering NGET's Earliest In Service Date (EISD) of 2028/29, as NGET do in the FNC document, the option performs much more poorly, with regrets of several billion pounds in all scenarios.

Although this result suggests that HSB7 should be ruled out, it is worth noting that this option has been less thoroughly developed as compared with NGET's preferred option. Therefore, it is possible that incremental changes could be made to the design that might increase the boundary capability of this option, for example through installation of additional STATCOMs and series compensation equipment. It is unknown what impact this might have on the CBA, but the effects are likely to be relatively small, as any decrease in constraint cost would be associated with an increase in capital cost[8].

However, this would depend on the technical design of this option being feasible and robust. TNEI has explored this with NGET, with a number of technical issues identified which make this option less attractive:

- Use of such a large number of STATCOMs to manage stability is not common practice, and could introduce the risk of onerous control system interactions between STATCOMs and nearby generators;
- Series compensation introduces a risk of sub-synchronous resonance, which could damage the shaft of nearby generators;
- The proposed HSB7 design would be 'bespoke' to the HPC connections. Further connections could render the design invalid, and ultimately trigger further reinforcement by changing the dynamic performance of the local system following a fault;
- These issues could be addressed at the design stage of the project, but they are likely to carry more risk to system operation than HSB5.

It is possible that incremental improvements to the design of HSB7, in addition to small changes in the methodology, could result in this option performing slightly better in the CBA. This could even lead to the decision between HSB5 and HSB7 becoming more marginal e.g. if HSB7 has lower regret in one scenario. However, this option does introduce technical challenges that would need to be addressed and would represent a significant technical risk for system operation. These challenges and risks could be mitigated, but it is clear that this is not justifiable when an alternative option, HSB5, exists, which performs better in the CBA and carries much less technical risk.

In addition, this option performing better would depend on it being deliverable in 2024/25 rather than 2028/29, or on the HPC commissioning date being postponed. We have not assessed the expected EISD of this option in detail, but the underlying reason for the longer programme – outage requirements mean that the series compensation work and reconductoring work cannot be undertaken in parallel – is reasonable.

[8] Although further possible changes to aspects of the CBA methodology as discussed in Section 5, such as the inclusion of pre-construction costs for HSB5, could also potentially change the relative performance of this option.

2.6 Summary of Assessment

Our assessment is summarised in Table 2-4.

Table 2-4 Summary of Assessment of Optioneering

Optioneering		
Requirements	●	Key technical and environmental requirements and constraints have been identified and considered. A reasonable generation scenario has been used to assess the connection.
Technical Design	●	Option has been shown to restore boundary capability. Not possible to comment in detail on robustness of T-Pylon design for the HSB route due to early stage of design. Will need to be considered at a later stage, but work to date is considered appropriate.
Consideration of Alternative Options	●	NGET appear to have given fair consideration to all feasible options.
Exclusion of M5 Option	●	Reasonable to rule this option out on the basis of environmental constraints.
Exclusion of HSB7	●	Appropriate to rule this option out. Technically riskier than preferred option but without economic benefit.

3 Justification for T-Pylons

Ofgem asked TNEI to consider whether NGET has justified the use of T-Pylons on the project. This involved consideration of two specific questions:

- Is NGET correct to conclude that the proposed connection option would not have received planning consent if it used traditional lattice pylons in place of T-Pylons, and has it followed an appropriate process to reach this conclusion?
- Has NGET demonstrated the visual benefit of T-Pylons as opposed to traditional lattice pylons and has it provided robust evidence to show that consumers are willing to pay for this benefit?

Each of these questions is addressed in turn below.

3.1 The Necessity of T-Pylon Selection in Gaining Consent

NGET obtained a legal opinion from Bircham Dyson Bell (BDB) in February 2017 to inform the Finals Needs Case submission that considered the key design aspects of the project including the use of T-Pylons along with undergrounding, route selection, reconfiguration of the local distribution network and off site planting. The legal note, while concluding that their promotion reduced consenting risk, provides no clear opinion on the necessity of the use of T-Pylons to obtain consent. It consistently finds that choice of lattice pylons *may* have resulted in increased consenting risk and a need for further mitigation.

The legal note is supported by the opinion of Michael Humphries QC which endorses NGET's judgements in seeking to mitigate consenting risk. The Final Needs Case notes his conclusion that decisions made to mitigate impacts, including the use of T-Pylons, *'appropriately mitigated a significant risk of development consent not being granted for the project'*. The statement referred to all five issues that had been covered by the legal note. Counsel considers that each issue individually, as well as cumulatively, represented a significant consenting risk.

It cannot be concluded from these opinions that consent would not have been granted if lattice towers were proposed in place of T-Pylons and it must be noted that the counterfactual outcome cannot be known as it is impossible to know the determination of the Examining Authority and SoS should an alternative scheme have been proposed. All recent new high voltage overhead line builds in the UK have utilised lattice towers. The Beauly – Denny line is such a lattice tower and the towers being installed on the new Nemo connection between Richborough and Canterbury is also a lattice steel tower. Therefore, whilst National Grid provided information detailing how the T-Pylon is preferred in this location following consultation with affected stakeholders and legal opinions concluded that consenting risk was reduced, it can not be confirmed that a line using lattice towers could not have been consented.

3.2 Process

The process of gathering evidence to support the promotion of the T-Pylon appears to have included the following key elements:

- Assessment within the Pylon Design Options Report (PDOR);
- Stakeholder consultation and analysis of responses to assess the impacts of T-Pylons on consenting risk;

- Analysis of environmental impact assessments and route corridor studies to understand the level of mitigation provided by T-Pylons;
- Post consent legal opinions from BDB and Michael Humphries QC summarising the legal views expressed during the process and prepared to support the Final Needs Case;
- Post consent production of a Stakeholder Feedback Report (December 2016) to support the Final Needs Case; and
- Post consent commissioning of a Willingness to Pay (WTP) study specific to the deployment of T-Pylons in areas outwith the Mendip Hills AONB.

The PDOR (August 2013) set out a detailed appraisal of pylon options within each section of the preferred route considering landscape, visual amenity, historic environment and ecological effects. It compares standard lattice pylons, low height lattice pylons and T-Pylons and provides reasoned justification for the technology choices for each section and it is considered that this is an appropriate and reasonable approach to design. For example, the report specifies the use of low height steel lattice pylons on top of Puriton Ridge where this technology would minimise landscape effects due to its shorter height compared to standard lattice pylons and its lower prominence against the background within views than the T-Pylon.

The PDOR usefully summarises the main dimensional and visual characteristics of the lattice and T-Pylon options for the connection route and references design principles in the context of the Holford Rules. Those principles identify the importance of height in determining the potential extent of visibility of pylons but acknowledge that the visual mass of a pylon is also a factor. However, IDPL's wider document review, focussing on landscape and visual impacts, has indicated that height is more frequently referenced when explaining design decisions whilst there is more limited reference to the visual mass of the T-Pylon design. This could suggest a possible weighting in favour of the T-Pylon. In addition, there appears to be little reference to the simple and crisp design of the T-Pylon and its effect upon the way in which the scale of the landscape is interpreted as a consequence. Site work has suggested that the simpler design of the T-Pylon could result in the scale of the landscape being perceived as being reduced i.e. the perception that existing landscape features and the spatial attributes of the landscape seem smaller when T-Pylons are added. This could, in turn, influence how the character of the receiving landscape is perceived.

Appendix B of the PDOR identifies the principles for considering the potential effects upon landscape character and visual amenity as:

- Landscape type;
- Filtering and screening of views;
- Backgrounding;
- Visibility of other overhead lines;
- Distance from visual receptor; and
- Angle of view and elevation.

IDPL's review has found that the influence of all six criteria upon the potential landscape and visual impacts associated with both the lattice and T-Pylon are all reasonably explored and used as the basis for informing judgements as to which type of pylon would be more appropriate in differing locations along the preferred route.

The reduced extent of visibility of the T-Pylon is often referenced and presented as an argument against use of the taller lattice pylon option but this appears not to acknowledge that the greater extent of visibility of the lattice option would only be experienced at greater distances at which the lattice pylon will already be a small distant element within the wider landscape. Moreover, at these greater distances the visual permeability of the lattice structure will also further reduce its potential visibility suggesting that too much emphasis might have been placed upon the perceived benefits of the shorter T-Pylon.

Overall, however, the review finds that the PDOR is a considered report that has reasonably explored the design options.

The statutory stakeholder consultation (Section 42) process began in September 2013 and included consultation on the utilisation of T-Pylons as identified in the PDOR. The differences in the levels of effect between lattice towers and T-Pylons were demonstrated using comparative photomontages and animations[9]. From the overview of the visualisation material utilised within the consultation process it would appear that these have been prepared consistent with current guidance and that the appropriate process for the presentation of verified images was adhered to.

The legal opinions have been discussed in the previous Section. It is understood that legal opinion was obtained leading up to the final decision to utilise T-Pylons. However, as there is no precedent indicating the impact on consenting risk, this would have needed to rely on the justification within the various optioneering reports and drawing parallels from similar locations where the impacts of traditional lattice pylons had been determined.

The December 2016 Stakeholder Feedback Report followed the extensive pre-consent consultation process. It was limited in the range of stakeholder opinions that were received following consent which may be due to stakeholders not being willing/able to engage once statutory requirements ended. The list of all stakeholders that were invited to provide feedback is not provided in the report. Of those asked, only the Joint Councils, one of the Sedgemoor DC ward councillors, the Campaign to Protect Rural England and the National Trust provided responses. It would have been beneficial to see responses from Natural England, Historic England and the AONB Board. NGET concluded from analysis of these responses that they demonstrated that there was stakeholder support for the use of T-Pylons. However, the responses do not demonstrate an overriding need to utilise T-Pylons in order to gain consent.

The WTP study is discussed in detail in Section 3.3.2 below.

The Development Consent Order (DCO) application process places emphasis upon the importance and role of consultation and demands a substantive evidence base to demonstrate that 'good design' has been achieved, is embedded within the project and has developed through an iterative process. The Planning Inspectorate will have had to satisfy itself that the DCO application was complete and met all requirements. The examination process for National Significant Infrastructure Projects (NSIPs) is rigorous and review of the Planning Inspectorate's (PIN's) website evidences the degree of scrutiny that the application was subjected to during examination. Therefore, the ExA was satisfied that the process followed was appropriate.

Overall this review finds that NGET followed an appropriate process.

3.3 T-Pylon Benefits

3.3.1 Reduction in the Magnitude of Landscape and Visual Impacts

During the site visit undertaken by IDPL as part of this review, a selection of 12 viewpoints included within the submitted Environmental Statement were visited and consideration was given as to

[9] Available at http://www.hinkleyconnection.co.uk/video.aspx

whether there would be a demonstrably different magnitude of impact upon both landscape character and visual amenity were lattice pylons to be proposed rather than T-Pylons. IDPL made the following observations:

- Lattice pylons will more readily merge/disappear into the landscape for distant views, particularly where they sit beneath ridgeline height i.e. where there is no 'skylining'. This might reduce the strength of argument against their use on account of their greater height.
- T-Pylons will clearly be a new, unfamiliar element set within the various landscapes and, as such, will more readily draw the eye although this will ameliorate over time as visual receptors become more familiar with them.
- The T-Pylons have a 'fresh' and more contemporary appearance that arguably 'updates' the landscape. The matter of images and perception would be an interesting one to explore – consider the contrast between 'industrial' lattice pylons set within established landscapes against new, contemporary T-Pylons that convey a more progressive message of inward investment into a region/landscape.
- The T-Pylons, by their relatively simple form, may have the perceived effect of 'down-sizing' a receptor's interpretation of the scale of the landscape. Visual receptors know how large lattice pylons are, not so T-Pylons, and thus their simple form may result in receptors perceiving the scale of a receiving landscape to actually be smaller than it actually is. This may be horizontal scale when set within the Somerset Levels or vertical scale when seen against the backcloth of the Mendips AONB or when traversing the Tickenham Ridge.
- Similarly T-Pylons appear to more easily 'dwarf' buildings when sited within relatively close proximity to them. A different visual relationship is established between pylon and building and the visual weight of the T-Pylon structure can appear to be more over-bearing resulting in a perceived increase in adverse visual effects.
- The removed lattice pylons would often already be quite recessive visually within the landscape except when the receptor is within close proximity to them.
- Lattice pylons generally more readily fade into the landscape except where they are 'skylined'.

In the main any differences were thought to be limited.

The site review suggested that the margins are sometimes tight as to which of the two alternatives would be the better option visually from a specific location. From a design perspective, there should be continuity along lengths of the connection route. Therefore, it is recognised that there may be locations along the route where a lattice pylon might be argued to be a more appropriate option but would not be appropriate if adjacent to T-pylons. However, NGET has made a case for the visual benefits associated with use of the T-pylon and has communicated this through the assessment process and illustrated the benefits via visualisation material.

IDPL's review finds that, while some were included within the Preliminary Environmental Information Report (PEIR), effective and greater use might have been made of utilising zone of theoretical visibility (ZTV) mapping associated with the two options to demonstrate geographic coverage and visibility. NGET may wish to make use of comparative ZTVs at Project Assessment to justify the benefits of T-pylons. The screening effects associated with existing vegetation and settlements could have been mapped into such ZTVs which would then have been available to present a more calculated method of presenting the benefits and merits of the two pylon options and these could have, for example, factored in the greater visibility associated with angle pylons etc. This would also have helped counter-balance the evidence produced by visualisations and photomontages which, if not viewed on site as they should be (which they are usually not), can have the effect of down-playing potential visual impacts.

In conclusion, review of the materials suggests that NGET has made a reasonable case that the deployment of T-pylons reduces the landscape and visual effects of the project. There are instances along the route where it could be argued that the use of lattice towers might be beneficial. However IDPL's review concurs with the landscape and visual assessment that has informed the design process in that multiple switches between the two pylon types would result in greater effects.

3.3.2 Willingness to Pay

NGET commissioned PwC to undertake two willingness to pay (WTP) studies to inform the Final Needs Case; one considering WTP relating to undergrounding of the route as it passes through the Mendip Hills AONB and a second specifically looking at WTP for the use of T-Pylons on sections of the route outwith the AONB. TNEI's review has focused on analysis specific to T-Pylons. A discussion was included within the T-Pylon workshop of 27th April with the authors of the WTP analysis providing clarification on methodology and findings. Treatment of landscape character has been reviewed by IDPL based on its experience of the landscape and visual impacts of transmission infrastructure.

The WTP analysis set out to provide a non-market valuation of WTP; i.e. analysing the value attributed to landscape and visual amenity that is not traded in conventional markets. The methodology selected was to utilise relevant previous WTP studies to provide data that could be adjusted to reflect the specifics of the HSB project. This approach of 'benefits transfer' relied heavily on the previously undertaken PwC and Accent research outlined in Table 3-1 Willingness to Pay Reference Studies:

Table 3-1 Willingness to Pay Reference Studies

Previous Study	Description
PwC and SHET Transmission (SHE-T), 2014, Sustainability: Measuring the impact of the Beauly Denny transmission project: Visual amenity non market impacts.	Commissioned by SHE-T and undertaken by PwC, this involved primary quantitative research to estimate WTP values that could be applied to the upgrade of the Beauly Denny transmission line. The study sampled respondents throughout the UK, as well as international visitors, and was designed specifically to arrive at a WTP for various landscape character types within and around the Cairngorms National Park without explicitly setting this out to respondents as the area in question. The study surveyed participants asking them how much they would be willing to pay to avoid the impacts described through extra taxes rather than energy bills.
Accent, 2012, Consumers willingness to pay research.	This study gathered qualitative data through extended focus groups and quantitative data through consumer surveys. Notably it considered consumer's WTP through their electricity bills over an eight year period and so has a fundamentally different basis of calculating values to the SHE-T and HPCC studies.
Gibbons et al., 2011, The amenity value of English nature, a hedonic price approach.	While this study considered the value associated with proximity to various amenities such as designated areas, habitats or gardens, it did so in relation to property prices. As such it is of limited value in thinking about WTP to avoid the impacts of infrastructure.

The HSB WTP study combined WTP values attributable to UK residents over the age of 16 with values for international visitors.

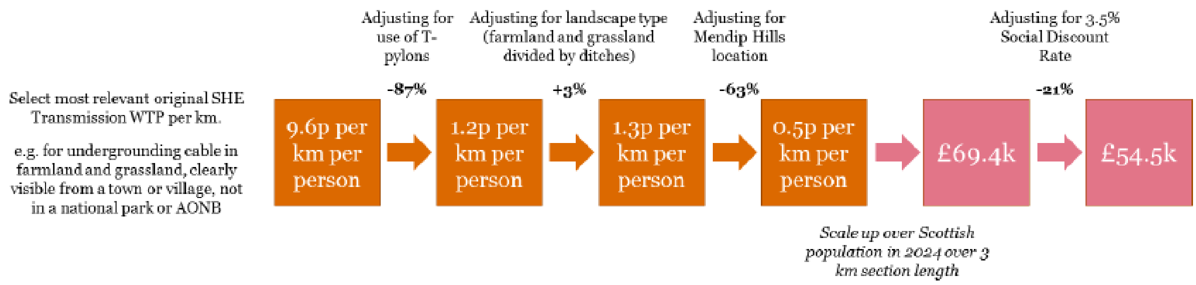
PwC, both within its report and during the T-Pylon workshop, recognised the main limitations of its HSB study as being:

- Lack of primary research specific to the landscape character along the connection route and therefore the need to employ a benefits transfer methodology; and
- Uncertainties around quantifying adjustments made to the values taken from the SHE Transmission study.

The approach taken has resulted in a broad range of WTP values (between £12.0m and £39.4m in total for all sections) between upper and lower bound scenarios that were designed by PwC to account for those uncertainties. The route (excluding the section within the AONB) was broken down into five sections and WTP ranges for each section were calculated taking into account the characteristics of each section.

An example of the adjustments made to the SHE Transmission WTP study values, as provided in the PwC study and applicable to a single section, is shown in Figure 3-1.

Figure 3-1 Example of Variables/Adjustments made from Most Relevant SHE-T WTP Study Value



Detailed review of the HPCC WTP study and discussion with PwC has highlighted the following points:

Table 3-2 WTP Study Observations

Aspect	Observation	Recommendation
Landscape Character	Areas along the HPCC route were characterised using National Character Area profiles. For each section of the route, the analysis used WTP estimates for the most similar landscape type from the SHE-T study as the starting point. PwC considered that this was a more transparent approach that avoided inaccuracies that would have resulted from considering landscape character at a finer grain. IDPL's review of landscape character has identified that the landscapes within each study are very different in character, scale and context. To compare the landscapes of the HPCC with those at Beauly Denny is not considered to be a robust approach. A more robust methodology would have referenced regional and local landscape character areas	A more robust approach would include more detailed consideration of the landscape character types in question and ideally collect primary data specific to the landscape character types along the HSB route to avoid the need for a unit transfer approach.
Landscape Character	The study used two comparisons to provide upper and lower bound figures relating to landscape character. For the upper bound figure, ranking data from the survey was indexed against similar landscapes in the SHET study for each set of characteristics (inside/outside AONB; visible/not visible from a town/village etc.) to derive equations to calculate WTP.. To provide a lower bound figure, values from the SHE-T study were taken, unadjusted, based on what was considered to be the 'most similar' landscape.	A study collecting primary data and designed to assess more scheme specific / finer grain landscape character types would enable more accurate forecasting of WTP.
Inclusion of international visitors	The responses of international visitors were included within the analysis to account for the welfare benefit to them. International visitors are assumed to have WTP to avoid visual impacts both inside and outside of the AONB in PwC's upper bound estimate, but only within the AONB in the lower bound estimate. The actual additional costs of T-Pylons would be borne by UK bill payers and the elements of those bill payers' WTP relating to the benefit of attracting overseas revenue, or to an altruistic value, are likely to differ from the hypothetical response of visitors.	Exclude any WTP attributed to international visitors should not be included when considering the WTP of energy bill-payers.

Aspect	Observation	Recommendation
Location Adjustment	This is the largest percentage change in the sensitivity analysis. Initially the HPCC WTP study suggests making a location adjustment based on preferences about location. A survey of 1,000 people to inform the WTP study provided ranking data that was used to adjust WTP values between the Cairngorms and Mendip Hills. This resulted in a 97% downward adjustment for Scottish respondents and a 95% downward adjustment for respondents from elsewhere in the UK, when compared to the Cairngorms. PwC judged this to be an overestimate of how much WTP would vary, and so the HPCC study instead makes an adjustment based on direct visitor expenditure, leading to a 63% downward adjustment. An alternative would have been to compare spend per visitor to account for differences between the visitor profiles of the Cairngorms and Mendip Hills. PwC confirmed that data to allow this was not identified. However this would still not allow for the various factors (of which landscape is one) which draw visitors to each of the areas.	Primary data specific to the Mendip Hills would allow a more robust assessment. In the absence of such primary data, the survey-based adjustment (~95-97%) should be considered as a valid lower bound assumption.
Timeframes	All values have been calculated on an 80 year basis (reflecting the expected operation life of the upgrade) while the CBA is based on 40 years (reflecting the economic life of the upgrade).	Where WTP is considered in determining a preferred option, WTP should be assessed over the same timescale as other CBA inputs.
WTP through energy bills	The SHE-T study, on which the WTP values are based, presented the concept of WTP in the context of an increase in taxation, rather than as an increase in energy bills. It is possible that presenting the question to respondents in this manner could lead to inconsistencies in how the impact of additional costs are interpreted by respondents.	Future studies could reference an increase in energy bills when measuring WTP.
Overall WTP	None of the WTP studies consider electricity consumers' total WTP for visual amenity (i.e. across the whole of the UK). It is unclear whether consumers would be willing to fund similar schemes on all similar landscapes UK-wide.	This consideration is likely to become increasingly important as more SWW projects are evaluated in future. It is recommended that a WTP study is performed to evaluate the total budget that consumers are willing to commit to pay for visual amenity.

Overall, the magnitude of the range between the upper and lower bound figures (£12.0m to £39.4m for all sections) is understandable given the approach and assumptions made but that level of uncertainty limits the use of the study in informing a decision on the installation of T-Pylons. Based on the observations made in the table above regarding the assumptions, the upper bound figure appears to be high. . Notably this upper figure is less than the cost differential between standard lattice and T-Pylons.

In order to provide more robust evidence of WTP for the use of T-Pylons, and a narrower range of values, a study would need to be undertaken where:

- Primary data specific to the HPCC scheme is collected and analysed to allow greater certainty and a narrower range of values to be defined;
- Further consideration is given to the treatment of landscape character and to how a methodology might be developed that more accurately takes into account the specific character, scale and contexts of the HPCC route and differences between its landscapes and those at Beauly – Denny;
- Further consideration is given to the appropriateness of including international visitor values within the overall WTP figures where these are being used to consider the WTP of energy bill-payers; and
- To accurately understand bill payer's WTP specific to the HSB project, overall WTP for similar forms of mitigation throughout the UK needs to be understood as the cumulative cost to bill payers of several such schemes could foreseeably exceed their WTP budget.

3.4 Summary of Assessment

Our assessment is summarised in Table 3-3.

Table 3-3 Summary of Assessment of T-Pylon Benefits

T-Pylon		
The Necessity of T-Pylon Selection in Gaining Consent	🟠	We agree that the choice of T-Pylons provided evidence to consultees and the Secretary of State that all measures to reduce the impacts of the scheme had been considered. However, NGET has not made the case that the project categorically would not have gained consent had regular lattice rather than T-Pylons been proposed.
Process	🟢	An appropriate process has been followed.
Reduction in the Magnitude of Landscape and Visual Impacts	🟢	NGET have made a reasonable case for deployment of T-Pylons in order to reduce landscape and visual effects. The difference in impacts between T-Pylon and Lattice in the main is considered to be limited. There are instances where we feel that lattice pylons may have been a lower impact option. However, practically a single technology needs to be deployed over long sections and the decision overall that T-Pylons would reduce impacts appears reasonable.
Willingness to Pay	🟠	The consideration of landscape character in the PwC T-Pylon study is subject to a high degree of uncertainty due to a lack of primary data concerning the specific landscapes along the HPCC route. Even with an upper bound figure that appears to be high, the WTP value does not meet the gap in costs between standard lattice and T-Pylons.

4 Costs

Ofgem has asked TNEI to assess whether the cost estimates for the HSB project appear reasonable. In particular, Ofgem has asked us to assess the costs of both the T-Pylon option as well as a counterfactual option where the route is instead constructed using lattice towers. The key elements of the cost that we have assessed are the capital costs, the risk costs, and the costs associated with extreme weather events. Each of these is discussed in turn below.

4.1 Capital Costs

TNEI has reviewed the capital costs of each option at a high level, with a more detailed assessment undertaken for the preferred option, HSB5, and for a hypothetical alternative option which utilises lattice towers along the whole route instead of T-Pylons, HSB5L. For all the other options, we are comfortable with the estimated capital costs presented, bearing in mind that these costs have by necessity been determined in less detail than those of the preferred option.

The capital costs of HSB5 and HSB5L are presented in

Table 4-1 and Figure 4-1[10]. The only difference between these two costs is for the overhead line section, where the lattice is estimated to be around £48m cheaper. It is reasonable that most other cost items do not change, although in practice different costs would be expected for the contingency and programme risk, and possibly for the extreme weather cost. These costs are discussed in Section 4.3.

Ofgem should consider whether or not it is appropriate for the HSB5L option to include T-Pylon development costs. Finally, NGET should ensure that assumptions about inflation are consistent. Across all the CBA options, inflation varies from 1.4% to 1.9%. We understand that this is to account for changes in the initial price level. However, the same inflationary adder of £14.4 m has been used for both HSB5 options, which implies inflation of 1.75% for HSB5 and 1.85% for HSB5L.

Table 4-1 [TABLE REDACTED]

Figure 4-1 [FIGURE REDACTED]

4.1.1 T-Pylon and Lattice Tower Costs

Figure 4-2 translates the overhead line costs for these two options into a £/km cost for the entire HSB route. This is compared with NGET's estimate of £/km costs for a 'typical' T-Pylon route and a typical lattice tower route. These 'typical' costs are calculated for a generic route, which is understood to be based on an assumption of good ground conditions.

[10] This is not the final version of the costs provided for HSB5. NGET subsequently revised these costs to update the calculation of risks and inflation. These revised costs were not reviewed in detail by TNEI although at a high-level they were considered to be comparable.

In addition, Figure 4-3 shows these costs again with land costs removed so that these can be compared to the benchmark costs calculated by the IET[11] which exclude land costs. This shows that both the HSB lattice and HSB T-Pylon are more expensive than a 'typical' alternative, but also provides justification that NGET's typical route cost aligns with a common industry benchmark.

In general, TNEI and AMEC FW believe these costs appear to be high, but that this is not unrealistic given challenges with respect to ground conditions along the route.

Figure 4-2 [REDACTED]

Figure 4-3 [REDACTED]

As these figures show, the main costs which are driving the higher cost for the HSB route (compared to the generic alternatives) are:

- Design costs (including fees);
- Enabling works costs;
- Abnormal costs; and
- Foundation costs.

Each of these cost elements is discussed in turn below.

In general, we believe that the cost estimates provided for both the HSB T-Pylon and HSB lattice appear to be reasonable, given the nature of the project (particularly the ground conditions and accessibility). We also understand that further value engineering by NGET should help to reduce the cost of the T-Pylon. However, as the headline costs are much higher than the generic or benchmark costs, we would expect to see further justification provided at the Project Assessment stage for both the T-Pylon and lattice alternative.

4.1.1.1 Design Costs

There is a significant increase in preliminary costs, design costs and fees associated with moving from the generic to the HSB lattice – per km, [redacted]. This is much more significant than the increase in cost associated with the move from the generic to the HSB T-Pylon.

Table 4-2 [REDACTED]

NGET has stated that this is largely due to the complexity of the scheme and the fee percentage applied.

A breakdown of the contract prelims and design costs has not been supplied although some discrepancy in the level of uplift could be accepted. For the contract prelims, which would be driven

[11] http://www.theiet.org/factfiles/transmission.cfm

by the increased complexity and novelty of the T-pylon, the data supplied does not account for the cost difference between the HSB solutions and the generic models.

Both the L12 and the T-pylon towers have been fully designed prior to this project and whilst the location will impact the site specific loadings on the structures, these are unlikely to impact the L12 design greater than the T-pylon. Due to the form of the towers the type of foundations will be different and this will impact the design. The T-Pylon foundation will have a significant moment at the base to be resisted but the four separate footings on the L12 tower will resolve this into vertical loads at each leg. The impact from the site locations will be on the pile numbers and length, which affects both the L12 tower and the T-Pylon. Therefore, some difference in the cost difference is expected, but more evidence is required to justify the very large difference stated by NGET in their submission.

With regards to the fee, a fee increase would be expected to be consistent across both the T-Pylon and Lattice options. [redacted]. This may help to explain the large increases observed for the HSB Lattice compared to the HSB T-Pylon. These costs should be broken down in further detail and justified at the Project Assessment stage.

4.1.1.2 Enabling Works

The conditions of the HSB5 route introduce significant challenges for enabling works. This can be seen in

Figure 4-4 – almost all of the increase in enabling works is due to the specific nature of the HSB route, rather than the move to T-Pylons from lattice towers. Cost increases arise due to, for example:

- The need for extensive number of access crossings, temporary bridges, and large culverts in the area;
- The length, depth and width of access tracks (required due to the poor ground conditions and poor accessibility along the entire route);
- High costs for traffic management;
- High costs for vegetation management.

Given our understanding of the route, these are considered to be appropriate drivers for the difference in enabling works costs.

Figure 4-4 [REDACTED]

4.1.1.3 Abnormal Costs

There are some 'abnormal costs' associated with the HSB route, beyond those considered as part of the enabling works. This includes costs associated with additional connections, associated with crossing the Avon River, and associated with installing an overhead line in an industrial area. Further information on these costs has been sought from NGET, although at the time of writing this report, this has not been made available. However, the total abnormal cost has a relatively minor impact on the total cost of the route [redacted].

In addition, these costs are assumed to be the same for both the lattice and T-Pylon option, which, given the nature of these costs, appears to be reasonable. More information on these costs should be provided in the future, but they are relatively small and unlikely to have affected the decision on which option is preferred.

4.1.1.4 Foundations

Foundation costs are [redacted] more expensive for both HSB options (T-Pylon and lattice), particularly with respect to the generic lattice option. This is due to the poor ground conditions along the route and the need for piled foundations along much of the route. The cost estimates have been informed by initial ground condition surveys (including boreholes and cone penetration test studies).

Table 4-3 [REDACTED]

TNEI and AMEC FW have reviewed the geotechnical surveys as well as illustrative foundation designs for T-Pylons on the HSB route and compared these to the foundation designs for the existing Eakring T-Pylons. It is expected that the cost of the foundations would be significantly higher for the HSB route compared to a Generic route, but marginally higher for the T-pylon than the lattice tower.

[redacted]

Foundation costs should be developed in more detail prior to the Project Assessment stage. Further ground condition investigation work will help to ensure that costs estimates are robust. NGET should ensure that the baseline cost estimate for foundations does not include any contingency element (see Section 4.2.1).

4.1.2 Cable Costs

The overall cable cost [redacted] has been compared to the benchmark costs produced by the IET for 400 kV AC buried cable, of medium capacity (6,380 MVA).

With land and project management costs excluded from the NGET estimate, the cost of the cable (in 2015/16 prices) is [redacted], which amounts to a per km cost of approximately [redacted]. The figures provided by the IET imply a cost per km of £14.5m /km. Therefore, the underground cable cost is considered to be reasonable. The increase in the IET's benchmark costs compared to NGET's may be due to the large rating of the cable assumed by the IET compared to that which will be installed for HSB.

4.1.3 Additional Capability

Ofgem has asked TNEI to consider whether any expenditure on additional capability above the minimum requirement is well justified.

The only additional capability that has been identified is the overrating of the conductor on the overhead line section of the route. This has been done so as to more closely match the rating of the overhead line with the rating of the underground cable. The capital cost difference between different conductor sizes is marginal and is therefore considered appropriate as a lower rating would result in a much higher constraint cost.

4.2 Risk Methodology and Allocations

For estimating contingency costs, NGET has utilised the same risk methodology as for their North West Coast Connections Initial Needs Case. TNEI reviewed that methodology in collaboration with Pöyry as part of our 2016 report on the INC. As part of that review, TNEI and Pöyry provided general commentary on the methodology, which was considered to be robust. The methodology involves production of risk registers for each scheme within the HPCC programme.

Each risk is categorised in terms of its expected likelihood and anticipated impact. A quantified cost risk analysis is run on these risk registers using the @RISK Monte Carlo simulation software. This produces P50 and P80 risk costs. NGET have clarified in an SQ that these costs should only be applied to forecast future costs. This reduces the contingency amounts which are shown in

Table 4-1.

Risk uplifts for all schemes within the preferred option, as well as for schemes for other CBA options, are shown in Table 4-4.

Table 4-4 [REDACTED]

Based on TNEI experience, these risk amounts are considered to be reasonable for the current stage of the project development. A high level review of the risk registers has been undertaken, and we consider that the major risk items have been accounted for. We note that the risk allowances are lower for HSB than for NWCC. This is to be expected, as the HSB scheme is more advanced and there is therefore more certainty on costs and scope.

4.2.1 Overhead Line Risk Registers

Two separate risk registers have been produced for the overhead line route: one scheme for the southern element of the route and one for the northern. The two risk registers are similar and result in similar risk uplifts, but it is encouraging to see risks being considered at this level of detail at this stage of the project.

For both overhead line risk registers, the most significant risks are associated with T-Pylon Foundations (medium probability, very high impact) and Haul Road Construction (high probability, high impact). Given the challenging ground conditions on the route, it is reasonable to have significant uncertainty associated with this. However, given the base cost has been derived from a probabilistic assessment of ground conditions, there is a chance that this already includes an element of risk, such that the total project cost represents a relatively pessimistic view of ground conditions. For example, as the base cost is based on an average expected ground condition cost, it might be appropriate to consider opportunities for cost reduction associated with ground conditions being less onerous than expected. The level of ground condition survey work which has been done to support this assessment is sufficient considering the stage of the project. All reasonable risks seem to have been considered, with notes on quantification used to support qualitative scores.

A separate risk register has not been prepared for the lattice overhead line elements of the hypothetical HSB5L option. Instead, the same absolute contingency cost has been applied to this option as for HSB5. However, these risk costs are based on % uplifts. As HSB5L is cheaper than HSB5, the same total P50 amount [redacted] implies that HSB5L is proportionally riskier than HSB5 by roughly 0.7%[12]. We agree that both the HSB5 and HSB5L routes will face similar risks. However, in practice it seems likely that the T-Pylon option would be relatively riskier than the lattice option as it is a new design. Therefore, it is expected that the risk associated with HSB5L has been overestimated as compared with HSB5.

The underlying risk registers should be different for T-Pylons and lattice towers. For example, supply chain risks included in the risk register as "T Pylon Delivery" would be expected to be higher for T-Pylons (a new technology) than for conventional lattice towers[13] (a separate risk register for lattice towers might be expected to include a "Lattice Tower Delivery" risk). Similarly, the risk associated with changing exchange rates or raw material prices would be expected to be different for lattice towers and T-Pylons, particularly as the T-Pylons have a much higher volume of steel. Costs associated with poor ground conditions may also be different.

It is unlikely that this will have a significant impact on the overall cost differential between the T-Pylon and the hypothetical lattice alternative, but it may be appropriate for NGET to consider this in more detail as part of any future cost submission.

Due to the magnitude of the ground condition risk, it may be appropriate for NGET to undertake further intrusive ground condition surveys in advance of the Project Assessment. This would help to reduce the uncertainty about how costs might be affected. This could even involve early involvement with contractors for example by scoping and/or reviewing borehole surveys. Ultimately, this should help to reduce the risk premiums from NGET's contractors. NGET should consider whether this would be beneficial and whether it is possible within the delivery plan.

4.3 Extreme Weather

In their cost estimate, NGET has included an allowance for the impact that extreme weather events might have on construction. This is because they believe that, due to the location of the project, there is a heightened risk that construction will need to be halted due to flooding and heavy rainfall. This is based on historical experience of flooding and heavy rainfall in the region.

Risks like these are usually considered to be high impact low probability events and therefore NGET has considered them outside of the risk register. Costs incurred due to extreme weather and flooding would potentially be covered under the SWW regime by a Cost and Output Adjusting Event.

4.3.1 NGET Methodology

For flooding, for each element of the work programme, a cost per day associated with works being halted has been derived. This cost accounts for the costs of both idle labour and machinery, estimated based on the number of teams that would be working that particular element.

Then, the number of lost days associated with a flooding event has been calculated for each element of the programme. This has been done for both high workload and low workload events. Based on this number of days and the cost per day, the total cost per event has been calculated. A cost for an average workload event has been assumed based on the average cost of the high and low workload events.

[redacted]. It is understood

[12] Extreme weather costs have been excluded from this calculation.

[13] It is noted that NGET is seeking to mitigate this risk through supply chain engagement and by giving its contractors access to the Eakring facility.

that information about the frequency of flood events and the number of days lost due to flooding is derived based on a desktop study of historical flooding in the region.

For rainfall, a very similar approach has been used. The costs per day associated with lost work are the same, but the number of days lost is now derived from daily average rainfall data from the past ten years, with an assumption made about the number of heavy rainfall days during which work could not continue. For rainfall, there are assumed to be two high workload events, two low workload events and two average workload events.

4.3.2 TNEI and AMEC FW Commentary

It is positive to see these high impact and low probability risks being considered in this level of detail. However, further detail will need to be provided to support any proposed extreme weather risk cost at the project assessment stage or to justify any changes to the COAE mechanism.

Justification of the costs associated with the extreme weather and programme risks has been submitted. Further evidence is required as the [redacted] costs attributed to the North and South OHL new line construction appear high. Also comparing this against the route risk registers figures of [redacted], North, and [redacted], South have been utilised. This results in per day figures significantly below the [redacted] used in the extreme weather calculation.

Some aspects of the methodology that is being applied could be clearer. The distinction between "High Workload", "Low Workload" "Average Workload" events is not intuitive. A summary of flooding in Somerset, based on NGET research, has been provided. It is understood that this has been used to determine the number of days lost due to flooding, but the way in which this has been done is not clear.

More justification is needed to support the assumption that, during the construction period, there will be [redacted] flooding events and [redacted] heavy rainfall events. For example, for flooding events, NGET's assumptions are based on the fact that heavy flooding occurred in both 2012 and 2014 – twice in the last five years. The extent to which these floods would have theoretically affected the construction of HSB is not clear. Therefore, without further evidence, the assumption that the HSB project would be affected by [redacted] flood events during the construction period, with earliest construction activities commencing in 2019 and finishing in 2025 (seven years) is not robustly justified. For example, the proposed construction period for the Mendips 400 kV cable lasts from 2019 to 2023 (five years) – the cost calculation implies that this element of the work will be subject to [redacted].

It is notable that no allowance has been made within the delivery programme for extreme weather events (see Section 6.2.1), especially considering the assumptions about the number of events that have been used to calculate the cost. Given the potential magnitude of costs associated with extreme weather, it would be appropriate to ensure this is robustly considered in the project programme. This should include consideration of mitigations for reducing the overall cost (E.g. relocating plant and labour during flooding periods) which should help to reduce the overall cost, particularly in cases where the alternative is 100 days of lost productivity at [redacted].

The source of the rainfall data has not been provided. This should also be clarified.

4.4 Assessment Summary

Our assessment is summarised in Table 4-5.

Table 4-5 Summary of Assessment of Optioneering

Costs		
Capital Costs		Justification for capital costs appears reasonable. Further evidence should be provided at Project Assessment stage. This should include more detailed breakdowns of some cost items (such as design costs and fees) and more detail on ground conditions and foundation designs. This should include information gathered through early engagement with contractors.
Risks		Risk methodology and risk registers appear robust. More detailed consideration of risks for hypothetical lattice option HSB5L should be provided at Project Assessment stage. In particular, NGET should ensure that risks associated with ground conditions are not overly pessimistic. May be appropriate for NGET to undertake more ground investigation works ahead of Project Assessment.
Extreme Weather		More detail needed to support assumptions about extreme weather, particularly with respect to frequency, cost and duration of impact. Costs should be based on a programme which includes mitigation of risks (e.g. through relocation of plant and labour).

5 Cost-Benefit Analyses

Ofgem asked TNEI to consider whether the inputs and assumptions used by NGET in its quantitative CBA are valid. Ofgem asked that this include (but not be limited to) consideration of:

- Demand and generation scenarios, with a comparison of the latter to the contractual background and historical rates of consent approval, slippage in connection dates or TEC (Transmission Entry Capacity) reduction requests.
- Are the sensitivities included in the CBA by NGET (including consideration of the potential impacts of generation connected at distribution level) reasonable and have any alternatives not been considered?
- Does BID3, the network constraint modelling tool NGET is using for its Cost-Benefit Analysis, provide a representation of power flows that appear reasonable and are calculated in line with energy modelling best practice?
- Load factors for new generation.

The CBA in NGET's Final Needs Case follows three main steps:

1. NGET presents a range of scenarios, designed to explore alternative demand and supply backgrounds, and for which the starting point is the 2016 Future Energy Scenarios ("FES2016"). The intent of the scenarios is to then test the robustness of the reinforcement options to these different market outcomes. NGET has focused on the key uncertainties in the generation mix behind the B13 boundary, and has defined sensitivities to the FES2016 scenarios that explore a range of local generation backgrounds.
2. NGET then uses its BID3 electricity market model to estimate constraint costs. This analysis is used to estimate the constraint costs associated with each of the proposed reinforcement options, under each of the scenarios and sensitivities defined in the first step.
3. The estimated constraint costs are then combined with NGET's estimates of capex and opex for each reinforcement option to perform a Net Present Value ("NPV") analysis. The NPV analysis is again performed for each reinforcement option and for each of the scenarios. This analysis is then used as the basis for a "least worst regrets" analysis that is used as the basis for selection of the economically most favourable reinforcement option.

The three sections of this report that follow cover these three steps, summarising the findings from our review of NGET's CBA.

5.1 Development of Scenarios and Local Generation Sensitivities

NGET's scenario analysis has used the four FES2016 scenarios as a starting point. A further five local generation sensitivities have then been defined, as variants of the Slow Progression scenario from FES2016. These sensitivities are therefore labelled as SPA to SPE and they vary in the assumptions made for some of the more significant supply-side options in the region. The scenarios used in NGET's analysis are summarised in Table 5-1.

Table 5-1 [REDACTED]

NGET has assumed that 1,670 MW of HPC is commissioned in 2024, with the full 3,340 MW of capacity online by 2025 in all scenarios and sensitivities. We understand from NGET that this timing is in line with the modified planning application timescales for HPC, [redacted]. This is discussed further in sections 5.1.1 and 5.1.2.

We agree that using the FES2016 scenarios as a starting point for this analysis is reasonable. The FES scenarios are developed through consultation with a wide range of industry stakeholders and so they consider different views from across the sector. The scenarios are also used more broadly as a basis for NGET's network planning, and so their use here is consistent with NGET's overall approach to planning.

We also agree that the input assumptions that have been varied across the different scenarios and sensitivities are generally reasonable and identify the key uncertainties in the evolution of the generation background behind the B13 boundary over the period analysed.

We have identified some areas where the choice and design of scenarios and sensitivities could be open to challenge. These observations are noted in Table 5-2 and discussed in more detail in the sections that follow. As noted in the table, some of these choices could impact on the CBA results, although they are unlikely to impact on the conclusion and recommendation on which reinforcement option to pursue.

Table 5-2 TNEI's Observations Regarding NGET's Scenario and Sensitivity Selection

Observation	Materiality of Impact on CBA Quantified Outputs	Materiality of Impact on Selection of Reinforcement Option
Timing uncertainties over the commissioning of HPC and the date by which reinforcement options will be ready	HIGH	MEDIUM Increases the sensitivity of option selection to any other changes to CBA inputs
Some scenario assumptions are not consistent with FES scenarios	LOW	LOW
The SPA scenario is materially different from the other scenarios modelled (e.g. in terms of assumptions about embedded generation) and may distort the results	MEDIUM	MEDIUM Increases the sensitivity of option selection to any other changes to CBA inputs

5.1.1 Timing Uncertainties

There is significant uncertainty over both (a) the date by which each of the reinforcement options could be completed, and [redacted]. Uncertainty over the delivery dates for the different reinforcement options has been discussed in Section 2.5 in the context of HSB7.

NGET has assumed that the first reactor of HPC is commissioned in 2024/25 in all scenarios and sensitivities modelled. We understand from NGET that this date is consistent with EDF's current plans. [redacted].

Because of this uncertainty, the analysis presented here compares the reinforcement options assuming that they can all be completed by 2024/25 (see Table 5-4). Even where the same delivery dates are assumed for competing reinforcement options, or where a later commissioning date for HPC is assumed, HSB5 would remain the preferred reinforcement option in both NGET's analysis and our own analysis. However, the worst regret between the preferred option and the next best option is reduced when compared against NGET's original analysis with a different delivery date for each option.

To the extent that a 2024/25 commissioning date for HPC is met, and to the extent that other reinforcement options cannot be delivered more quickly, it remains valid to consider such a scenario. This would lead to the current outcome from the least worst regret analysis being unchanged (see Section 5.3 for an explanation and assessment of the least words regrets analysis). We have not carried out a detailed evaluation of the likelihood of the assumed 2024/25 commissioning date.

5.1.2 Consistency with FES Scenarios

[redacted]. No further changes have been made to the FES2016 scenarios, for example to delay other new capacity.

It could be argued that this makes these scenarios less consistent. For example, less capacity might be brought online by the Capacity Market during these years.

However, in the medium-term it is unlikely that the timing of HPC's commissioning would have a significant impact on the assumptions adopted in the FES2016 scenarios. We also note that it seems unlikely that any changes would have a material impact on the conclusions drawn from the CBA.

5.1.3 Appropriateness of the SPA Scenario

[redacted], leading to a few years where both this unit and HPC are generating. Further, the SPA sensitivity adopts other assumptions that appear to be outliers when compared against other scenarios. In SPA, it is assumed that [redacted] GW of solar PV is online in the region by 2036. The scenario with the next highest solar PV total is the FES Consumer Power scenario with [redacted] GW.

The high volume of generation connected under this sensitivity has not been considered in NGET's technical analysis and it is possible that, if assessed against the requirements of the NETS SQSS, the generation included in this scenario could trigger further reinforcements.

The SPA sensitivity has a significant impact on the least worst regrets analysis. In NGET's analysis (which assumes different delivery dates for each reinforcement option) there is a [redacted] difference between the worst regret on options HSB5 and HSB6.

5.2 Modelling of Constraint Costs in BID 3

NGET has modelled the GB and European electricity markets (a) with each of the reinforcements in place, and (b) under each of the scenarios and sensitivities identified above. NGET has used BID3 to estimate that constraint costs that would result from each combination. BID3 is a tool designed and developed by Pöyry Management Consulting, which NGET has procured for modelling the electricity market. BID3 is not a power-flow model; rather it is a market modelling tool that simulates the most economic dispatch options across GB and Europe. Power flow constraints are represented in terms of boundary capabilities, which are determined in DigSilent's Power Factory model (see Section 2.2.1).

For the CBA analysis performed for the Hinkley-Seabank Needs Case, NGET has run the model twice:

- The first model run is unconstrained, and is used to model the dispatch of energy resources as would be nominated ahead of gate closure.
- The second model run considers boundary constraints (including the B13 boundary capabilities mentioned earlier) in order to evaluate a modified dispatch, thereby representing the actions taken by the SO because of physical constraints on the transmission network.

The first model run is optimised using the underlying Short-Run Marginal Cost ("SRMC") of the available supply options. The constrained model run is instead optimised based on the underlying SRMC multiplied by bid/offer multipliers. Renewables and low carbon plants are assumed to submit negative bids, accounting for the subsidy-related opportunity cost of curtailment. The bid-offer multipliers used for conventional plant are informed by NGET's analysis of historical bid/offer data from the Balancing Mechanism ("BM"). The constraint costs that are fed into NGET's CBA are then calculated by multiplying the bid and offer prices used in the constrained model run by the change in volume for each supply option.

NGET's modelling in BID3 extends to 2035/36, whereas the CBA extends for 40 years. For subsequent years, NGET takes an average of the constraint costs incurred in the final three years of the BID3 analysis (2032/33 to 2035/36) and extrapolates this average over the remainder of the period considered by the CBA.

We note that BID3 is a recognised tool for market modelling that is used by electricity market participants worldwide, as well as by Pöyry Management Consulting in its own analysis. The tool has been audited[14] for NGET by Professor Keith Bell (University of Strathclyde) and Dr Iain Staffell (Imperial College). The audit found that the new model addresses many of the concerns that have previously been raised regarding the ELSI model, which has been used for performing this type of analysis in the past.

We have identified some improvements that could be made to the modelling of constraint costs in BID3, and these are summarised in Table 5-3 and discussed in the sections that follow. However, we do not expect that any of these changes would impact materially on the conclusions drawn from NGET's analysis, or the selection of the preferred reinforcement option.

Table 5-3 TNEI's Observations Regarding the Modelling of Constraint Costs in BID3

Observation	Materiality of Impact on CBA Quantified Outputs	Materiality of Impact on Selection of Reinforcement Option
Energy balancing, and the scheduling of reserve, are not included in the BID 3 model	**UNKNOWN**, but potentially **HIGH**	**LOW**

[14] See http://www2.nationalgrid.com/WorkArea/DownloadAsset.aspx?id=8589938716

Observation	Materiality of Impact on CBA Quantified Outputs	Materiality of Impact on Selection of Reinforcement Option
BID 3 model is set up to use a Linear Programming (LP) approach rather than a Mixed-Integer Linear Programming (MILP) approach	UNKNOWN	UNKNOWN, but likely to be LOW
Modelling of BM bid and offer prices does not consider future diversity in BM participation (e.g. on the demand-side)	UNKNOWN	LOW
Bids submitted by plants benefitting from a CfD are not accurately represented	UNKNOWN	UNKNOWN, but likely to be LOW
Variations in boundary capability across scenarios or over time are not considered in the modelling	UNKNOWN, but likely to be LOW	UNKNOWN, but likely to be LOW

5.2.1 Energy Balancing and the Scheduling of Reserve

The second, constrained model run executed in BID3 only considers the impact of transmission constraints at the boundaries defined by NGET in the model. The modelling does not consider energy balancing (e.g. resulting from errors in forecasting demand or intermittent renewables) or the scheduling of reserve.

This is likely to have an impact on the constraint costs incurred. Constraint costs might be expected to be higher if these additional requirements were modelled, especially in scenarios with more intermittent generation (with greater potential for forecasting errors).

NGET have provided us with analysis of the % of periods during which key generators behind boundary B13 (Langage, HPC) have bids or offers accepted. This analysis provides reassurance that this simplification is unlikely to materially affect the selection of a preferred reinforcement option. The analysis has been provided for options HSB5 and HSB7, and there is very little difference in the behaviour of the key generators behind B13 between these two options.

5.2.2 Linear Programming Approach

NGET has run BID3 in Linear Programming (LP) rather than Mixed-Integer Linear Programming (MILP) mode when evaluating constraint costs for this CBA. This means that BID3 solutions include unfeasible outcomes, where constraints such as generator minimum stable levels are not observed. We understand that NGET has performed some checks to compare outputs including constraint costs under the two modes, and has found LP to provide a good approximation of the MILP solution. Therefore, the LP mode has been used, as this is faster and less computationally intense.

5.2.3 Modelling of BM Bid and Offer Prices

NGET's analysis in BID3 has assumed that market participants only submit single bids and offers, rather than multiple P-Q pairs. The analysis also only considers bids and offers submitted by supply-side units, and does not consider the potential for bidding behaviour to change over time – the bid and offer multipliers used are informed by historical data.

Increased demand-side participation, and increased diversity in BM participation more generally, may lead to changes in bidding behaviour that lead to deviations from the modelled behaviour. Clearly these changes are very difficult to predict.

For NGET's analysis of this reinforcement, the assumptions made seem reasonable, and we would not expect the uncertainties highlighted above to systematically favour one option over another.

5.2.4 Bids Submitted by Plants Benefiting from a CfD

NGET has assumed that renewables and low carbon generation benefitting from a subsidy submit a fixed negative bid to the BM. For plant receiving support under the Renewables Obligation, this seems reasonable and is a fair representation of the lost support that generators would seek to recover through their bid. For plant receiving support through a Contract for Difference ("CfD") we note that this is likely to deviate materially from the actual bidding behaviour of generators. Intermittent CfD plant are likely, for example, to submit bids that vary hourly to reflect the change in lost support as the day-ahead hourly price moves.

Without re-running the modelling with this change, it is difficult to be sure of is the materiality of this assumption. However, under most scenarios, in most hours, the impact of bids from low carbon plants is likely to be low. However, the presence of HPC – a large low carbon plant benefiting from a CfD – close to boundary B13 means that there is perhaps an increased risk that this assumption has some unforeseen impact on the analysis.

5.2.5 Variations in Boundary Capability Over Time

For each reinforcement option, the resultant boundary capability has been assessed for a single generation and demand scenario. As discussed in Section 2.2.1, the boundary capability could change in practice due to changes in local generation or demand backgrounds.

However, it is expected that most anticipated future changes (e.g. growth in embedded generation or connection of interconnectors) are unlikely to affect the capability of the boundary.

5.3 Least Worst Regrets Analysis

NGET has modelled the constraint costs for each of the proposed reinforcement options, for each scenario and sensitivity presented in Section 5.1. Together with the capital and operating cost estimates for each option, the change in modelled constraint costs that results from each reinforcement option are input to a Net Present Value ("NPV") analysis. As mentioned previously in Section 5.2, NGET has only modelled constraint costs to 2035/36, but has taken an average of costs incurred during the last three modelled years, and assumed that these costs remain at the same level for the remainder of the 40 year NPV analysis period.

The NPV analysis is carried out in accordance with HM Treasury's "Green Book". Costs and benefits are discounted using a discount rate of 3.5%, falling to 3.0% after 30 years. Capital costs are converted to an annuity (calculated using a post-tax real weighted average cost of capital (WACC)) and spread over the 40-year modelled economic life of the reinforcement.

Through calculating the NPV of each reinforcement option across all the scenarios and sensitivities, a preferred reinforcement option can be inferred for each of the scenarios. The difference between the NPV of each option and NPV of the preferred option under a given scenario is the 'regret' suffered for choosing that option under a given scenario. Thus, the 'worst regret' can be calculated for each reinforcement option. The preferred reinforcement option is then selected as the option that, across the modelled scenarios, suffers the 'least worst regret'.

NGET performed the regret analysis using both different delivery dates for each reinforcement option, and assuming all options can be delivered by 2024/25. The results of NGET's regret analysis assuming all options can be delivered by 2024/25 are summarised in Table 5-4. The table shows the results for the four core FES scenarios, and then for the NGET-defined sensitivities. As noted previously it can be seen that the SPA sensitivity significantly increases the worst regret for many of the reinforcement options. The key observations made during our analysis of the NPV and least worst regret analysis are presented in Table 5-5.

Table 5-4 [REDACTED]

Table 5-5 TNEI's Observations Regarding NGET's NPV and Least-Worst Regret Analysis

Observation	Materiality of Impact on CBA Quantified Outputs	Materiality of Impact on Selection of Reinforcement Option
NPV analysis period is not consistent across all the scenarios	**HIGH**, when different delivery timescales are assumed for each reinforcement option, **LOW** where delivery timescales are aligned	**MEDIUM**/**LOW**
Timing uncertainties may distort outputs from the CBA	**HIGH**	**MEDIUM**
Not all relevant HSB5 costs have been included in CBA	**LOW**	**LOW**

5.3.1 NPV Analysis Period

Where NGET has assumed different delivery timescales for the various reinforcement options in its analysis, the NPV analysis considers the net benefit realised for each reinforcement option over the 40-year period starting from the year in which the reinforcement is completed. Thus, for option HSB5, which is assumed to be complete by 2024/25, the NPV analysis considers benefits estimated up to and including 2063/64, whereas for option HSB4, with a completion date of 2030/31, the NPV analysis extends to 2069/70. Note that this is not relevant for the results shown in Table 5-4 where the delivery timescales are aligned across all reinforcement options.

In reality, option HSB5 would continue to yield benefits during the period 2063/64-2069/70 because the assets at the end of their economic life would be renewed. Similarly, the capex inputs to the CBA are calculated to include annuitised costs over the full 40-year assumed asset life.

For large infrastructure CBAs, evaluating the economic merits of each option over the same period, i.e. with the same end date to the NPV analysis, provides a more robust like for like comparison of benefits and disbenefits. While the analysis would then not be over the exact economic life of the asset for each reinforcement option, this can be taken into account through accounting for annuitised capex only over the years included in the CBA.

5.3.2 Timing uncertainties

As noted previously in Table 5-2, NGET's analysis is based on assumptions about the different delivery timescales for each of the reinforcement options, and the [redacted], and different assumptions could lead to a much closer comparison between the different reinforcement options, as indicated by Table 5-4.

5.3.3 Pre-construction costs

The CBA for option HSB5 includes a significantly lower cost than the £839m shown in NGET's Needs Case. NGET has excluded certain costs from its CBA on the grounds that these costs are already sunk. When considering whether the reinforcement should be funded by consumers[15], all amounts relating to efficient construction spend (i.e. the amounts to be funded by consumers) should be included.

The inclusion of these costs would not in isolation change the preferred option. However, it would reduce the gap between the preferred option and other options, increasing the sensitivity of the CBA results to other changes.

[15] NGET's treatment of these costs is geared towards evaluating which option should be taken forward, given commitments made to date, whereas the analysis should instead evaluate which option represents best value for consumers.

5.4 Assessment Summary

Our assessment is summarised in Table 5-6.

Table 5-6 Summary of Assessment of Optioneering

Cost-benefit Analyses		
Scenarios	Green	Scenario testing uses the FES scenarios as a starting point, which seems reasonable. Assumptions over timing (the timing of HPC commissioning and the timing to which reinforcement options can be delivered) could exaggerate the benefits of the preferred option, but do not change the overall outcome.
Constraint Costs	Green	Use of the BID3 model seems a reasonable approach for estimating constraint costs. Potential for incremental improvements in constraint cost calculating methodology, but unlikely to affect overall conclusion of FNC. Future analysis could consider other actions taken by NGET (such as energy balancing and the scheduling of reserve) that will impact on constraint costs.
NPV	Green	Again, the timing uncertainties highlighted above have an impact on the NPV calculations, but this is unlikely to affect the overall conclusion of the FNC.

6 Delivery Plan

NGET has prepared a project programme (provided version dated 27th January 2017) to deliver the Hinkley Seabank works and is developing and maintaining this as progress is made from pre-construction works through to tendering and construction. A procurement strategy has also been developed. The most economical optimal delivery date for option HSB5, which is the preferred option, is given as 2024 by the CBA and this is reflected in the project programme.

A review has been undertaken as part of the final needs case assessment to determine the efficiency and justification of the construction programme and programme risks, considering various constraints and dependencies.

Table 6-1 provides a summary of key dates including customer connection dates. It is understood that EDF has requested HPC backfeed [redacted] to support the construction and commissioning of their new generation plant.

Table 6-1 Summary of Project Key Dates (Customer Connection Dates)

Milestone	Owner	Date
Final Investment Decision	EDF	October 2016
Development Consent for Hinkley Seabank Connection	Secretary of State	January 2016
HPC backfeed for EDF	NGET	[redacted]
Economical optimal delivery date HSB5	NGET	2024
HPC connection for EDF Stage 1 (Reactor Unit 1)	NGET	December 2024
HPC connection for EDF Stage 2 (Reactor Unit 2)	NGET	December 2025
Commitment to be operational	EDF	2025

NGET has reported on the progress of pre-construction works and has indicated that following FID and award of development consent, the following activities have been ongoing:

- Stakeholder engagement on key DCO requirements and with communities affected by works,
- Aligning construction programme with EDF's,
- Contract strategy and preparation for tendering the works,
- Engagement with WPD and Surf to align construction programme to National Grid's, development works, secure consents and land rights (for work outside the DCO),
- [redacted]
- Continuation of the DCO implementation process, including continuation of land negotiation, purchase and easement rights,

- Undertaking the T-Pylon supplier framework setup in readiness for future OHL works,
- Development and procurement works for the132kV Cable Undergrounding (W and AT route), Sandford 400/132kV Substation, 400kV Mendips Cable and the new 400kV Overhead Line including additional site investigations and surveys.

NGET commissioned Arcadis to independently review the construction programme (excluding tendering timescales), and this was completed in February 2017. Arcadis is an international consultancy with strong credentials in design, engineering and management consultancy. The findings of the review are summarised as follows:

- **Outage Schedule:** Proposed outage stages seem comprehensive and logical; outage schedule appears reasonable and achievable over 7 successive outage seasons,
- **Portfolio Programme:** Portfolio Programme time to construct critical path packages appears reasonable and credible given the stage of development and risks; please note that this is the same version provided to TNEI,
- **Work Packages:** All stand-alone work package programmes require updates to reflect the 2-year variation to the Hinkley Point construction programme which was required to move to current contracted dates. There are some inconsistencies apparent between construction timescales contained in the detailed work packages and Portfolio programmes,
- **Recommendations:** Review time allocations for successive short-duration outages to ensure all work can be delivered, e.g. terminations, commissioning & protection, and update all work packages to ensure timescales and outage seasons are aligned with the latest Portfolio Programme and Outage Schedule.

Arcadis also provided detailed recommendations on each work package/project including WPD works. It is understood that Arcadis' recommendations will be adopted within a future iteration of the plan.

6.1 Programme Review

Ofgem has asked TNEI to consider whether the delivery plan provides sufficient detail and justification on assumptions relating to project lead times and key milestones.

This is a complex project and NGET has divided it into 15 projects by asset type/works to help with programme management. [redacted].

6.1.1 Activity Duration

The duration for each project activity has been reviewed and compared to industry benchmarks based on our extensive experience of similar works. This is evaluated using a RAG rating where green indicates a duration which is, based on TNEI's experience, consistent with similar industry projects, amber indicates a duration that seems somewhat longer than typical and red indicates a duration that is significantly longer than expected. We have considered the specific description of works to identify any outliers and possible underlying causes are detailed below Table 6-2. Any outliers have been queried with NGET and RAG ratings reflect any additional justification provided.

Table 6-2 Assessment of Activity Durations

Project	Description of Works	Overall	Tender	Design	Build
Shurton Substation	New 400kV substation	🟢	🟢	🟢	🟢
Shurton Line Entries	New Shurton 400kV OHL (13 pylons)	🟢	🟢	🟢	🟢
Bridgwater Substation	Uprate Bridgwater substation	🟢	🟢	🟢	🟢
Taunton Substation	Additional Super Grid Transformer (SGT) at Taunton Substation	🟢	🟢	🟢	🟢
Seabank Substation	Extend Seabank 400kV Substation	🟢	🟢	🟢	🟢
Sandford Substation	New 400kV/132kV Sandford Substation	🟢	🟢	🟢	🟢
400kV OHL North	New 57km 400kV route between Bridgwater and Avonmouth using the existing 132kV corridor	🟢	🟢	🟢	🟢
400kV OHL South	48.5km Overhead Line (OHL) (116 T Pylon, 27 Lattice)	🟢	🟢	🟢	🟢
Hinkley-Bridgwater OHL Uprating	Uprating 15 km OHL from 275kV to 400kV	🟢	🟢	🟢	🟢
Melksham Reconfiguration	Reconfigure Melksham Substation	🟢	🟢	🟢	🟢
400kV Cable (Mendips)	8.5km Underground cables through Mendips AONB	🟢	🟢	🟢	🟠
132kV Cables	Underground 15 km 132kV Cable double circuit	🟢	🟢	🟢	🟢
Bridgwater Tee (Shurton 400kV Cable)	300 m of 400kV Cable (single circuit)	🟢	🟢	🟠	🟢
275kV Cable Removal	Remove 0.5km 275kV Cable double circuit	🟢	🟢	🟢	🟢
WPD Managed Works	Substation works at Churchill, Seabank, Portishead, Weston, Radstock, Taunton and Bridgwater Surf Telecoms (fibre) 77km diversion 132kV interactions with 33kV network and lower voltages OHL removal: 67km / 249 pylons	🟢	🟢	🟢	🟢

6.1.1.1 Substations

[redacted]. The procurement process is over 18 months for Shurton substation which is significantly higher than expected. However, NGET has stated that this is due to this activity starting and then pausing in response to changes in EDF's programme.

NGET commenced Shurton procurement events in 2015 to meet the previous contracted date of October 2019 for station supplies (backfeed). In mid-2016, this was put on hold pending clarity on the EDF programme. [redacted]. As local enabling works (Shurton and OHL connections) are being funded through RIIO-T1 Special Condition 6F: Baseline Generation Connections Outputs and Generation, NGET can progress these works before Ofgem approval on the final needs case.

The Sandford procurement period is around 18 months. When queried, NGET indicated that the reason for this duration is that procurement activities are aligned with a notional SWW Project Assessment. This would allow tendered costs to be provided as part of that project assessment step, however contracts may not be signed until later in NGET's delivery process.

Design timescales for substations are broadly consistent with the scope and scale of the works from our experience.

Substation build is between 13 months for installing a new supergrid transformer at Taunton substation to 46 months for the new build 400kV GIS substation at Shurton. The Shurton substation build is longer than typical based on our experience; however, the majority of the substation infrastructure will be completed for commissioning of the first circuit in 2022. Mobilising for build in April 2019 to achieve the backfeed milestone gives an initial build time of around 36 months which is reasonable. Due to the phasing of the project, there are subsequent visits by the contractors and commissioning teams for each outage to connect the remaining circuits to Shurton and commission the generator onto the system.

NGET has indicated that the period for the development of the Shurton line entries project is longer than typical as it contains periods of downtime associated with updated timescales for HPC'. Early development was necessary to support the DCO application. Detailed development commenced in 2016. However, this was suspended to align with, and coordinate development of, these works with the detailed designs for Shurton substation.

6.1.1.2 Overhead Lines

NGET has confirmed that they intend to tender the OHL packages of work including T Pylon and F route removal together to allow efficiencies in scale by appointing one contractor. Procurement takes approximately 24 months with [redacted] and NGET preparing the fully scoped design. NGET also indicated that the tender period starts earlier to obtain tendered costs that inform SWW Project Assessment. However, contracts may not be signed until later in the programme. This should support completion of regulatory assessments in a timely manner as per the delivery plan, allowing construction work to progress and requested customer connection dates to be met.

The duration of design activities for the north and south routes (20-24 months) appears to be appropriate, given that foundation design, interface design and temporary works design will be relatively new and less "off-the-shelf" than existing lattice tower design. The 12-month design period for the Hinkley Bridgwater uprating is also appropriate. Within the project delivery plan, more details on the interaction between outstanding geotechnical surveys, the foundation design and foundation construction should be sought. However, a high level review indicates this can be suitably and safely delivered in the proposed timescales.

Overhead line build rates for the T-Pylons are around [redacted] both the north and south route. This is at the higher end of OHL build rates from our experience; however, given the challenging ground conditions in some areas and the use of the T-Pylon design, this is broadly reasonable. Due to the construction sequence of the 400kV OHL, the south part commences prior to the North. Overhead line delivery rates for the Hinkley Bridgwater uprating are also 1.5 months/km.

6.1.1.3 Underground Cables

The duration of the tendering process for the 400kV Mendips cable is 24 months to date; however, procurement has been on hold for approximately 18 months pending updated timescales for the project. NGET has indicated that tenders were received and evaluated prior to the pause (to meet the previous connection date of June 2022) and a [redacted]. The contractors will be required to revalidate their tenders based on the latest detail from the DCO and revised overall programme. This project is on the critical path to completing the south route so it is positive that NGET has been engaging closely with the market to progress procurement as far as possible.

NGET has stated that the 18-month design phase for the Mendip Hills cable section includes the following activities:

- discharging DCO requirements; preparation of traffic management, drainage and other plans for local authority approval; applications for secondary licences from local authorities and other stakeholders; detailed planning approval from local authorities;
- pre-construction environmental and ecological surveys; detailed ground investigations; interfaces with stakeholders and other contractors; pre-construction environmental mitigation (note that ecological surveys must be carried out at particular times of the year depending on the species);
- detailed design of the cable system, Sealing End Compounds and all associated construction works;
- resource and construction planning;
- procurement and manufacturing for construction;
- vegetation clearance Winter 2018/19.

From our experience, this timeframe seems reasonable given the activities involved and the scale of the project.

The build rate for the Mendip Hills cable section [redacted] is much slower than expected. However, our understanding (based on supplemental questions answered by NGET) is that this also allows for clearance and re-instatement / landscaping after September 2022 during the closeout period. Taking this into consideration gives a faster build rate of [redacted]. Arcadis has assessed this duration as reasonable. This includes 6 months for haul road installation – without, the build rate is approximately [redacted]. This appears to be high based on TNEI experience and NGET should provide further justification to support this build rate.

The development and sanction duration for the WPD W and AT 132kV cable routes is 33 months which is much longer than expected. However, there have been delays of approximately 18 months due to EDF's updated timescales on the project project.

The design duration for the Bridgwater Tee, 300m of 400kV underground cable (single circuit), is [redacted] quite long given the scope of the project. NGET has confirmed that the main construction works for the Bridgwater Tee are scheduled from June 2023 to August 2024 to commission the new asset. However, this also allows for clearance and re-instatement / landscaping after August 2024 during the closeout period which is why the build activity completes in August 2025 in parallel with close out. Arcadis also notes that construction occurs over two outage seasons and appears not to be continuous alongside VQ Route; we have reviewed the outage programme and this is also our understanding. Based on this, the build duration seems reasonable.

For the 275kV cable removal project, the scope of works is to decommission the circa 0.5km 275kV redundant oil impregnated cables adjacent to Hinkley Point 275kV substation. NGET has indicated that this is not a critical path aspect of the programme in terms of value and duration. As such the strategy for procurement is at an early stage and the programme duration allows for flexibility in approach (hence the Tender, Design and Build activities presented in parallel in the project programme). The 'build' task (which is the execution of the removal of the decommissioned cable) has been brought forward to 2023 to give the contractor flexibility to decommission the redundant Hinkley-Bridgwater 1 cables when they are removed from service in 2023 in parallel. NGET has stated that this may allow economies of scale with the Hinkley-Bridgwater uprating and the strategy will be reviewed moving into the delivery phase.

6.1.1.4 WPD Managed Works

Our high level review of the WPD managed works indicates that these are reasonable and consistent with the work scope and with NGET timelines with this aligning with conclusions from Arcadis's detailed independent review. Arcadis note some inconsistencies between the NGET programme and the individual WPD projects, although not material. However, we would recommend that these are reviewed for efficiencies and further detail of the WPD managed works are provided in the overall programme to support coordination i.e. sequencing and interaction with outages and critical milestones.

6.1.1.5 Review and Closeout

The duration of review and closeout for each project is approximately 12 months. NGET has stated that this includes final reinstatement of sites, snagging and defect correction, review of costs, compilation of asset data books, drawings, Project Managers Report and Health and Safety File, final contract negotiation and agreement, handover of completed assets for operational use and lesson learnt meeting. Whilst some of these tasks will be of a relatively fixed length regardless of project size e.g. review of costs, final contract negotiation and agreement, we would expect that activities such as final reinstatement of sites, snagging and defect correction etc would be dependent on the scale of each project. NGET should aim to achieve efficiencies for the smaller projects within the overall programme.

This phase does not include longer enduring tasks such as aftercare for assets and for mitigation such as landscaping.

6.1.2 Constraints and Dependencies

NGET has identified the programme critical path and a number of milestones along it that need to be achieved in order to deliver the project in time.

We have reviewed the various constraints and interdependencies on the programme that include:

- Ensuring that WPD supplies are secured before beginning removal of WPD 132kV lines,
- The new 400kV OHL is to be connected from Sandford to Seabank before reconfiguration works on the existing Hinkley Point Melksham circuit can be completed,
- System access availability (on both National Grid and WPD's network) for a large number of circuits,
- Non-working periods due to geography / location of the construction works.

Removal of F Route South and F Route North, WPD's existing 132kV double circuit, is required for safe construction and connection of the proposed new 400kV circuit between Bridgwater and Seabank. This is phased to allow the south route to be released for removal first, enabling the 400kV line south to be built to Sandford and the HPC backfeed energised in 2022. The north route is then released in 2023 to allow completion of the 400kV circuit north. The 132kV F Route is dismantled in parallel with 400kV route build which provides some efficiency.

NGET has indicated that less critical works will be delivered in parallel.

Table 6-3 Critical Construction Milestones

Construction Works	Date
F Route South released	Aug 2021
New Substation at Sandford 400/132 kV energised	Oct 2022
New Line (South) completed	Oct 2022
F Route North Released	May 2023
New Line (North) completed / Seabank completed	Sep 2024*
Reconfiguration and uprating works completed (Melksham)	Oct 2024

*consistent with Final Needs Case

We note that the Seabank substation, Shurton line entries and some Bridgwater uprating activities are completing in 2025 i.e. Hinkley - Bridgwater OHL and Uprating Shurton 400kV Cable (Bridgewater Tee). For example, NGET has confirmed that the build element of the Bridgwater uprating includes for re-instatement and clearance of site works, in parallel with project closure. However, the system related works are completed in August 2024 which ensures that additional boundary capability is delivered in line with the recommendation of the CBA. This is also consistent with Seabank substation and Shurton line entries projects where review and closeout commence in August and September 2024 respectively.

From our review of the programme, projects, milestones and outage plan, NGET's management of interdependencies and constraints appears to be reasonable and takes advantage of efficiencies where possible.

6.1.3 Procurement Strategy

[redacted]

[redacted]

[redacted]

We consider that it is reasonable to tender works as an individual contract if the works are stand-alone and interfaces with other works are limited, for example in terms of asset type and timing of build. It should be noted that this results in additional delivery risk and project management costs for NGET due to the coordination required across projects.

Table 6-4 [REDACTED]

The procurement strategy, tender process and market tested information will be assessed in greater detail in the SWW Project Assessment submission.

6.1.3.1 T-Pylons

The procurement strategy for T-Pylons is somewhat different to the other HSB projects [redacted]

[redacted]:

- [redacted]
- [redacted]

In our view, both these approaches may be efficient, and NGET could ask tenderers to bid on both.

[redacted]

6.1.4 Management of Third Parties

The main interface is between NGET and WPD in order to remove the F Route South and North. NGET and WPD have had some discussions on opportunities for efficiencies in delivery of both the 400kV and 132kV works and the proposed split is summarised in Table 6-5. In our view, this appropriately reflects opportunities for procurement efficiency, construction efficiency (location, duration, use of services) and minimising interfaces (e.g. landowners, contractors). The RIIO framework states that risk should be allocated to the party best able to control or influence it so we have considered this principle throughout our review.

Surf runs its fibre communications along the existing 132kV F Route infrastructure so NGET is obliged to provide a new fibre network to ensure its services are maintained. However, the delivery of these works will be undertaken by Surf in two phases aligning with the programming of Hinkley-Seabank works. In our view, this is a reasonable approach and Surf are best placed to install their new fibre communications network.

[redacted]

National Grid's approach is to adopt the same Project Control methodologies (this includes cost controls, project governance, and dispute resolutions) as it does when managing other projects.

National Grid and Surf are currently finalising the [redacted]

NGET has provided a proposed third party governance structure for WPD and Surf. Surf is a sister company of WPD and owned by the WPD Group.

Table 6-5 Split of Works by Responsible Party

Works	Description	Party Responsible for Delivery	Consultant Comments
WPD Substation Works	Sandford Substation 132kV Works	NGET	We agree that it is more efficient to use one contractor to design and construct Sandford 400kV and 132kV SS through NGET. More integrated and costs, interfaces and risks should be reduced.
WPD Substation Works	Churchill SS, Avonmouth SS, Portishead SS, Seabank SS, Bridgwater SS	WPD	132kV substation modifications, agree most efficient for WPD to deliver.
WPD OHL Works	132kV OHL Route Removal	NGET	132kV W route shares a haul road with the new 400kV route. We agree that it is more efficient to have the single interface with land owners and the civil contractor.
WPD OHL Works	W, AT, N and BW Route	WPD	New assets to replace assets removed. Works do not overlap with 400kV route, appropriate that this is delivered by WPD.
WPD Cable Works	W (8.6km) and AT (km) Route	NGET	Efficiencies due to proximity of 132kV routes to 400kV route and substations. Efficiencies for resourcing and managing scale of work.
WPD Cable Works	G Route (2km), DA, BW & G routes (Seabank SS entries), Y Route, Misc 33kV, 11kv & LV undergroundings	WPD	Short routes for 132kV, 33kV, 11kV and low undergrounding diversions and crossings are routine works for WPD.
SURF Works	Installation of new fibre optic link to replace F Route link	WPD-SURF	Reasonable to remain within WPD-SURF remit.
WPD Works	NGET Programme & Project risks associated with WPD delivery of works	NGET	It is appropriate that all works are coordinated by NGET to ensure integration with the overall Hinkley-Seabank delivery timeline.

This split of work should provide NGET with direct contractual control for the critical elements of the programme and also reduce overall interface risks. Upon assessment, this should provide some efficiencies in procurement, site costs and coordination in our view.

This also results in a scope of works which WPD would be able to manage in a phased manner, and could be considered as part of their routine work.

6.1.4.1 [REDACTED]

[redacted]

6.1.5 DCO Requirements and Constraints

DCO requirements (set out in Schedule 3 of the DCO) include the need for a number of management plans to be prepared for approval by relevant authorities by contractors and implemented before construction can commence. These include a Construction and Environmental Management Plan (CEMP) setting out management and mitigation measures for the construction of the proposed development. Additional construction mitigation plans and other management plans must also be approved and implemented before commencement of any stage of the Authorised Development. DCO and HSE (CDM Regulations) requirements will be discharged during the design phase.

NGET note that the DCO contains onerous requirements on contractors to submit multiple planning documents to relevant authorities prior to construction. However, we would expect that contractors on the frameworks should generally be used to this for large capital projects and sufficient time appears to have been allocated in the design phase of the programme.

There are likely to be a number of DCO interfaces on requirements and access across contractors. NGET appear to be managing this by phasing of the programme e.g. Project packages B, C & D are considered as one project in the programme to ensure key interface issues on DCO requirements and access are addressed with all contractors on board. Arcadis note that timescales for contractors to concurrently address multiple DCO planning requirements 'appear compressed, e.g. 400kV cable'. NGET should highlight this in the tendering process to enable tenderers to respond on how they will manage this.

Scheme wide DCO requirements are expected to be discharged by Local Planning Authorities in 2017. The management and mitigation plans required to do so are not yet available.

6.1.6 Outage Planning

Outage planning is complex due to the large number of activities and interfaces; NGET has identified this as a key risk. NGET has indicated that the necessary outages and available outage periods have been identified in collaboration with WPD to deliver new or reconfigure existing infrastructure to meet customer connection dates. There are 40 separate outages on the 132kV / 400kV networks over seven outage periods with the outage season running from April to October (non-winter periods). These are consistent with the critical construction milestones shown in Table 6-3.

Arcadis carried out a comprehensive review of all outages between April 2018 and October 2024 in Outage Schedule Revision C, their findings indicate that they regard this as logical and credible. Arcadis also provided some minor comments to be addressed by NGET in Revision D on opportunities for efficiencies and clarifications.

NGET note that further work is required to document requirements for WPD outages at 33kV and that this is part of ongoing discussions with WPD through monthly coordination meetings. This will help to mitigate outage coordination risk.

6.2 Consideration of Risks

Ofgem has also asked us to consider the treatment of risks within the delivery plan.

NGET appear to have applied a robust approach to delivery programme risk management which follows industry best practice for a capital project of this scale and includes the following features:

- Development of a detailed programme risk register and individual project risk registers including delivery risk,
- Risk review sessions involving an assessment of the probability and impact of the risk as well as monitoring the progress and effectiveness of the mitigating actions,
- Regular Programme and Review meetings to discuss development and construction of the project. NGET indicate that at this stage, critical early year works that are required to achieve the connection milestones are monitored. Over the course of delivery, these will include:
    - Overall delivery of proposed development works including third party works
    - Review of construction plan
    - Identification of any issues that may impact delivery programme
    - Agreement of actions to mitigate any resulting consequences
- Preparation of a PMO Manual utilising the principle of having a Programme Management Office (PMO) to support the delivery of large programmes of work within Electricity Transmission.

This is aligned with best practice for management of a project of this nature and scale.

Arcadis's independent review of the delivery programme also found that time allocations for the construction of critical path work packages appear reasonable and credible and that NGET's programme has an appropriate balance between deliverability and risk.

NGET has outlined a number of key risks and mitigations for the delivery programme and these are reviewed below. Key risks (and associated consequences) for the project programme, risk sharing arrangements and detailed cost information for the preferred option will be assessed in detail as part of the SWW Project Assessment submission.

6.2.1 Extreme Weather and Flooding

NGET highlight that in the area of much of the proposed development, flooding has been a relatively regular occurrence in recent years and has been highlighted as a substantive risk for this project. Flooding could have a substantial impact on project delays and additional costs. NGET has indicated that extreme weather / rainfall events have not been included in the programme as they are of low risk but could have very high impact. However, a significant contingency for extreme weather and flood risk has been included in the total project cost and this is based on an assumption that these events will occur multiple times during construction. NGET should ensure that their programme and their cost assessments are consistent in their treatment of extreme weather and flooding.

6.2.2 Third Party Risk

The management of third parties has been identified by NGET as a key risk because specifically the removal of the F route 132kV corridor to allow construction of the 400kV circuit is critical to delivery. It is our view that NGET has taken a reasonable approach to managing this through coordination with WPD and Surf to develop the project programme and division of responsibility for works and activities. Monthly review/coordination meetings as enshrined in the framework agreement will support early identification of the realisation of risks and appropriate remedial action to be taken.

There is also a risk that any delays or constraints to any of the embedded WPD projects could impact the overall project delivery timeline (or require additional costs to stay on track). This will need to be managed carefully throughout project delivery using the coordination mechanisms described.

6.2.3 Outage Planning Risk

Due to the criticality of the outages to enable programme delivery, outage planning is a key risk. NGET indicate that it is being mitigated by a joint review of sequencing to minimise the risk of system outage impact and this will be reviewed at regular coordination meetings prior to, and during, the delivery of the project.

There will be substantial outages required on WPD's network both at 132kV and lower voltage levels. WPD have formally noted that whilst the outages fit within the sequence of work and the outage programme is deliverable, there is little opportunity during 2018-2024 for other works or incidents on the WPD system. NGET indicates that it continues to work with WPD to mitigate this risk and has confirmed that the programme has been developed in conjunction with WPD to ensure that all known constraints on the WPD network have been accounted for.

Both NGET and WPD have carried out analysis to ensure their respective networks remain compliant during the construction work. This will ensure that transmission and distribution supplies remain secure for consumers and customers during the delivery of the project.

When queried on the resilience of the programme, NGET indicated that they are confident that the programme is resilient against known constraints and should unforeseen events occur, they would be assessed and managed, with the programme updated accordingly. Any financial/contract changes would be agreed and implemented in accordance with contract terms and conditions.

Arcadis noted that the outage schedule for network reconfiguration and new build assets appears reasonable and achievable over 7 successive outage seasons (2018 -2024). However, there is some risk that any overruns during successive short-duration outages could impact subsequent work packages and the overall programme. They have provided some specific recommendations for further optimisation of the outage schedule including

We would expect to see further analysis in the Project Technical Assessment on programme and outage resiliency as procurement progresses and with corresponding development of the project risk register.

6.2.4 Customer Connection Delays

The primary driver for the need to reinforce the transmission network is HPC and the timing of the reinforcement should align with the connection of these generators to avoid significant constraint costs and non-compliance with NETS SQSS.

NGET has indicated that a delay to HPC connection dates, when reflected in the FES, would use CBA analysis carried out through the NOA process to identify any new decision to take in the best interest of consumers (i.e. delay or progress) given project maturity, scale of delay and any other load-related drivers updated as part of that process.

6.2.5 Procurement Risks

[redacted]

[redacted]

[redacted]

[redacted].

The training facility at the Eakring Training Centre will serve as a training centre for NGET engineers and contractors to accelerate familiarity with installation and maintenance of the T-Pylons.

[redacted]

6.2.6 Development Consent Order (DCO) Risks

The Secretary of State granted development consent for the Hinkley-Seabank project in January 2016. NGET has identified a number of outstanding DCO risks including:

- [redacted]
- **Adherence to conditions:** Challenges in complying with the numerous conditions, requirements, obligations etc. within the DCO facing National Grid, WPD and appointed Contractors.
- **Interactions between stages of work:** Interactions between stages of work which either occur simultaneously or sequentially result in similar locations have potential to result in contractual gaps or inadequate information for the relevant authority.

NGET has outlined a number of mitigation strategies for the above risks including engagement with key Local Authority stakeholders for each activity, providing advanced notice and updates to the works and early engagement to agree timings, format and content for conditions discharge. Also, NGET has provided evidence of carrying out market engagement to support securing the major contracts (on the critical path) early in the programme so that interfaces between work stages are agreed from the outset. We agree with the risks and mitigations identified and are encouraged by the NGET market engagement strategy to reduce this risk.

In its independent review, Arcadis notes that the timescales for contractors to concurrently address multiple DCO planning requirements 'appear compressed, e.g. 400kV cable'. We would expect this to be addressed in more detail by NGET in the Project Technical Assessment following procurement progress.

6.3 Assessment Summary

Our assessment is summarised in Table 6-6.

Table 6-6 Summary of Assessment of Delivery Plan

Delivery Plan		
Detail and Justification for Programme		The overall sequencing of the programme given constraints and dependencies, and individual project activity durations generally seem reasonable and achievable in our view. We would expect more justification of the build duration for the 400kV Mendips Hill underground cable and the design duration for the Bridgwater Tee. [redacted]. There is a clear strategy in place for coordinating with WPD and Surf.
Consideration of Risks within Programme		NGET appear to have applied a robust approach to delivery programme risk management, follows industry best practice for a capital project of this scale. Key risks have been assessed and mitigations are generally appropriate. We have concerns regarding the assessment of extreme weather and flooding risks. These are accounted for in risk costs but are not considered in the delivery programme. We would also expect to see further analysis in the Project Technical Assessment on overall programme and outage resiliency, particularly in relation to interaction with outages required on the WPD network.

7 Conclusions

TNEI and its subcontractors have:

- Assessed the inputs into NGET's Cost Benefit Analysis (CBA) for the HSB project, including whether the process options progressed are appropriate, and whether cost inputs and other assumptions are justified. This is Part A of TNEI's scope;
- Assessed NGET's delivery plan for the HSB project to determine whether it is efficient and whether risks have been appropriately considered. This is Part B of TNEI scope; and

In general, we believe that National Grid has made a robust case for the need for this project, but further evidence could be provided in some areas at the project assessment stage.

- All reasonable options appear to have been considered. The technical requirements that have been considered when developing the project are appropriate, and the technical designs are reasonable, although many aspects of the design are still at a relatively early stage.
- The requirement for T-Pylons instead of Lattice Towers is less certain. NGET has made a reasonable case that deployment of T-Pylons reduces the landscape and visual effects of the project, and an appropriate process was followed to reach this decision.

  NGET has not made the case that the project categorically would not have gained consent had regular lattice rather than T-Pylons been proposed.
- The T-Pylon option is more expensive than a lattice alternative. This appears reasonable (see below). However, **the value of Willingness to Pay (WTP) does not meet the gap in costs between standard lattice and T-Pylons. The provided estimate of consumer willingness to pay for the T-Pylon is subject to uncertainty due to the lack of primary data specific to the landscape character along the connection route.**
- Capital costs are relatively high, although this appears reasonable given the challenging ground conditions. Further evidence to support these costs should be provided at a later stage (e.g. through engagement with contractors). In particular, it may be appropriate for further ground investigation works to be done ahead of the Project Assessment in order to reduce the uncertainty associated with costs and risks.

  The calculation of risks costs associated with extreme weather events should be revisited and developed in more detail, particularly with respect to the frequency of events, duration of impacts, and assumed cost due to stranded plant and labour. Potential mitigations (such as reallocation of plant and labour) should also be considered in the cost.
- The cost-benefit methodology is reasonable, and while there are potential modifications which could be made, these appear unlikely to affect the over conclusions of the FNC. NGET may consider some of these points in future analyses.
- The delivery plan, including the approach to procurement, coordination with third parties, and the programme/sequencing, appear reasonable, although further justification of build durations should be provided for some elements of the programme. Risk management appears, in general, to be robust. Further information overall programme and outage resiliency, particularly in relation to interactions with distribution network outages, would be expected in the final project assessment.

Treatment of extreme weather should be consistent in the delivery plan/programme and the cost estimates.