Norfolk Boreas Offshore Wind Farm

Design and Access Statement

(Version 5) (Tracked Changes)

DCO Document 8.3

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Glossary of Acronyms

AIS	Air Insulated Switchgear
CABE	The Commission for Architecture and the Built Environment
CRS	Cable Relay Station
DAS	Design Access Statement
DCO	Development Consent Order
EIA	Environmental Impact Assessment
ES	Environmental Statement
HDD	Horizontal Directional Drilling
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
kV	Kilovolts
MW	Megawatts
NPSs	National Policy Statements
NSIP	Nationally Significant Infrastructure Project
OLEMS	Outline Landscape and Ecological Management Strategy
PEIR	Preliminary Environmental Information Report
SCADA	Supervisory Control and Data Acquisition
SuDS	Sustainable Urban Drainage
VWPL	Vattenfall Wind Power Limited

Glossary of Terminology

Array cables	Cables which link wind turbine to wind turbine, and wind turbine to offshore electrical platforms.
Cable logistics area	Existing hardstanding area to allow the storage of cable drums and associated materials and to accommodate a site office, welfare facilities and associated temporary infrastructure to support the cable pulling works.
Cable pulling	Installation of cables within pre-installed ducts from jointing pits located along the onshore cable route.
Ducts	A duct is a length of underground piping, which is used to house electrical and communications cables.
Interconnector cables	Offshore cables which link offshore electrical platforms within the Norfolk Boreas site
Jointing pit	Underground structures constructed at regular intervals along the onshore cable route to join sections of cable and facilitate installation of the cables into the buried ducts
Landfall	Where the offshore cables come ashore at Happisburgh South
Landfall compound	Compound at landfall within which HDD drilling would take place
Link boxes	Underground chambers or above ground cabinets next to the cable trench housing low voltage electrical earthing links.
Mobilisation area	Areas approx. 100 x 100m used as access points to the running track for duct installation. Required to store equipment and provide welfare facilities. Located adjacent to the onshore cable route, accessible from local highways network suitable for the delivery of heavy and oversized materials and equipment.
National Grid new / replacement overhead line tower	New overhead line towers to be installed at the National Grid substation.
National Grid overhead line modifications	The works to be undertaken to complete the necessary modification to the existing 400kV overhead lines.
National Grid overhead line temporary works	Area within which the work will be undertaken to complete the necessary modification to the existing 400kV overhead lines.
National Grid substation extension	The permanent footprint of the National Grid substation extension.
National Grid temporary works area	Land adjacent to the Necton National Grid substation which would be temporarily required during construction of the National Grid substation extension.
Necton National Grid substation	The grid connection location for Norfolk Boreas and Norfolk Vanguard
Norfolk Boreas site	The Norfolk Boreas wind farm boundary. Located offshore, this will contain all the wind farm array.
Norfolk Vanguard	Norfolk Vanguard offshore wind farm, sister project of Norfolk Boreas.
Offshore cable corridor	The corridor of seabed from the Norfolk Boreas site to the landfall site within which the offshore export cables will be located.
Offshore electrical platform	A fixed structure located within the Norfolk Boreas site, containing electrical equipment to aggregate the power from the wind turbines and convert it into a suitable form for export to shore.
Offshore export cables	The cables which transmit power from the offshore electrical platform to the landfall.

Offshore service platform	A platform to house workers offshore and/or provide helicopter refuelling facilities. An accommodation vessel may be used as an alternative for housing workers.
Onshore 400kV cable route	Buried high-voltage cables linking the onshore project substation to the Necton National Grid substation.
Onshore cable route	The up to 35m working width within a 45m wide corridor which will contain the buried export cables as well as the temporary running track, topsoil storage and excavated material during construction.
Onshore cables	The cables which take power and communications from landfall to the onshore project substation.
Onshore infrastructure	The combined name for all onshore infrastructure associated with the project from landfall to grid connection.
Onshore project area	The area of the onshore infrastructure (landfall, onshore cable route, accesses, trenchless crossing zones and mobilisation areas; onshore project substation and extension to the Necton National Grid substation and overhead line modifications).
Onshore project substation	A compound containing electrical equipment to enable connection to the National Grid. The substation will convert the exported power from HVDC to HVAC, to 400kV (grid voltage). This also contains equipment to help maintain stable grid voltage.
Overhead Line	An existing 400kV power line suspended by towers.
Project interconnector cable	Offshore cables which would link either turbines or an offshore electrical platform in the Norfolk Boreas site with an offshore electrical platform in one of the Norfolk Vanguard offshore wind farm sites.
Running track	The track along the onshore cable route which the construction traffic would use to access workfronts.
The Applicant	Norfolk Boreas Limited
The project	Norfolk Boreas Wind Farm including the onshore and offshore infrastructure.
Transition pit	Underground structures that house the joints between the offshore export cables and the onshore cables
Trenchless crossing compound	Pairs of compounds at each trenchless crossing zone to allow boring to take place from either side of the crossing.
Trenchless crossing zone	Areas within the onshore cable route which will house trenchless crossing entry and exit points.
Workfront	A length of onshore cable route within which duct installation works will occur, approximately 150m.

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1 INTRODUCTION

1.1 Purpose of the Design and Access Statement

1. The purpose of this Design and Access Statement (DAS) is to provide details of the use, layout, scale and appearance of the Norfolk Boreas Offshore Wind Farm (the 'project'). The DAS supports the application for a Development Consent Order (DCO) for the project and should be read in conjunction with the DCO and supporting documentation.

2. This document contains details of above ground permanent infrastructure which will be installed in each area, which in North Norfolk and Broadland administrative areas will be limited to link boxes (see Section 5.2). In Breckland above ground permanent infrastructure will also include the onshore project substation and National Grid substation extension.

3. The application is based on realistic worst-case parameters for the project. The design of the onshore project substation will continue to be developed post-consent and a detailed design will be submitted for approval in accordance with DCO Requirement 16 and any principles included within this DAS.

4. The project is described in more detail in section 3 of this DAS and in Chapter 5 Project Description of the Environmental Statement (ES) (document reference 6.1.5). The onshore project area is shown in Figure 1 to 3 and the offshore project area in Figure 4.

5. Given that offshore above-ground infrastructure will be a minimum of 73km offshore, they will not be visible from the coast. Therefore, the DAS focuses on demonstrating the design and development of the Norfolk Boreas permanent onshore above-ground infrastructure such as the onshore project substation and National Grid substation extension including overhead line modifications.

6. The DAS explains the principles and concepts that have influenced the form and appearance of the elements of the onshore project area and provides a tool to communicate how the requirements for good design and access provision have been considered, and will be considered for the detailed design of the onshore project substation in due course.

7. Information contained in the ES has been used to inform the preparation of this DAS, and reference should be made to the ES for full details of both the offshore and onshore project components and their relationship to the receiving environment, particularly:

    - Chapter 2 Need for the Project (document reference 6.1.2);

- Chapter 3 Policy and Legislative Context (document reference 6.1.3);
- Chapter 4 Site Selection and Assessment of Alternatives (document reference 6.1.4); and
- Chapter 5 Project Description (document reference 6.1.5).

2 PLANNING CONTEXT AND GUIDANCE

2.1 National Policy Statements

8. National Policy Statements (NPSs) form primary planning policy documents that are specifically provided for by the Planning Act 2008 to guide decision making on Nationally Significant Infrastructure Project (NSIP) applications. The application for the project will be determined in accordance with relevant NPSs.

9. Further detail on the planning policies associated with the project is found in ES Chapter 3 Policy and Legislative Context (document reference 6.1.3).

10. The three NPSs that hold particular relevance for offshore wind and its associated onshore development are:

- Overarching NPS for Energy (EN-1, July 2011) (Department of Energy and Climate Change (DECC) 2011a);
- NPS for Renewable Energy Infrastructure (EN-3, July 2011) (DECC 2011b); and
- NPS for Electricity Networks Infrastructure (EN-5, July 2011) (DECC 2011c).

2.1.1 Overarching NPS for Energy (EN-1)

11. Existing policies set out within EN-1 make clear the requirements for good design in energy projects. Paragraph 3.7.1 of EN-1 explains that much of the new electricity infrastructure that is needed will be located in places where there is no existing network infrastructure. It acknowledges that this is likely to be the case for many wind farms, or where there may be technical reasons why existing network infrastructure is not suitable for connecting the new generation infrastructure.

2.2 Guidance

12. There is no specific guidance provided for the preparation of a DAS in relation to NSIPs.

13. This DAS has been prepared in line with The Commission for Architecture and the Built Environment guidelines (CABE, 2007). The bullet points below outline the key parameters set out in the CABE guidelines:

- Use – the purpose of the onshore project substation and how it will fit within the surrounding environment;
- Amount – size and volume of the onshore project substation and its constituent elements;
- Layout – the relationship between the onshore project substation and the surrounding buildings;

- Scale – the physical size and shape of the onshore project substation development;
- Appearance – the physical look of the onshore project substation specifically the design and materials;
- Landscaping – how mitigation proposals will be applied to screen the development from wider views; and
- Access – including how access will be achieved during construction and operation and how roads and watercourses will be crossed.

14. These parameters are discussed in section 5 of this DAS.

15. The project design will take into account the National Infrastructure Commissions' Design Principles for National Infrastructure (National Infrastructure Commission, 2020[1]). The Design Principles for National Infrastructure provide design guidance for all Nationally Significant Infrastructure Projects (NSIP) within the UK to ensure good, unified and environmentally sound design. The numbered points below outline the Design Principles set out by the National Infrastructure Commission:

    1. Climate - Mitigate greenhouse gas emissions and adapt to climate change
    2. People - Reflect what society wants and share benefits widely
    3. Places - Provide a sense of identity and improve our environment
    4. Value - Achieve multiple benefits and solve problems well

[1] National Infrastructure Commission; Design Group, Climate People Places Value, Design Principles for National Infrastructure, February 2020.

3 DESCRIPTION OF THE DEVELOPMENT

3.1 The Project

16. The Norfolk Boreas Offshore Wind Farm comprises an area of 725km^2 located approximately 73km from the Norfolk coastline within which wind turbines would be located. The offshore wind farm would be connected to the shore by offshore export cables installed within the offshore cable corridor from the wind farm to a landfall point at Happisburgh South, Norfolk. From there, onshore cables would transport power over approximately 60km to the onshore project substation near Necton, Norfolk.

17. Once built, Norfolk Boreas would have an export capacity of up to 1,800 megawatts (MW), with the offshore components comprising:

- Wind turbines;
- Offshore electrical platforms;
- Offshore service platform;
- Met masts;
- Measuring equipment (LiDAR and wave buoys);
- Array cables;
- Interconnector cables or project interconnector cables; and
- Export cables.

18. The key onshore components of the project are as following:

- Landfall;
- Onshore cable route, accesses, trenchless crossing technique (e.g. Horizontal Directional Drilling (HDD)) zones and mobilisation areas;
- Onshore project substation; and
- Extension to the Necton National Grid substation and overhead line modifications.

19. The onshore and offshore project areas are shown on Figure 1 to 4. A full description of the project for offshore and onshore elements can be found in Chapter 5 Project Description of the ES (document reference 6.1.5).

3.1.1 Development Scenarios

20. Vattenfall Wind Power Limited (VWPL), the parent company of Norfolk Boreas Limited, is also developing Norfolk Vanguard, a ‘sister project’ to Norfolk Boreas. The Norfolk Vanguard project is approximately one year ahead of Norfolk Boreas in its development programme having submitted its DCO in June 2018. In order to minimise impacts associated with onshore construction works for the two projects, Norfolk Vanguard are seeking consent to undertake duct installation and some

enabling works for both projects at the same time. This is the preferred option and considered to be the most likely however, Norfolk Boreas needs to consider the possibility that Norfolk Vanguard may not proceed to construction.

21. In line with the Norfolk Boreas ES (document reference 6.1) this DAS considers the following two alternative scenarios:

- **Scenario 1** – Norfolk Vanguard proceeds to construction, and installs ducts and other shared enabling works for Norfolk Boreas.
- **Scenario 2** – Norfolk Vanguard does not proceed to construction and Norfolk Boreas proceeds alone. Norfolk Boreas undertakes all works required as an independent project.

22. Table 3.1 outlines the key elements of onshore construction works to be carried out by Norfolk Boreas under each scenario. Full details of the scenarios are presented on Chapter 5 of the ES (document reference 6.1.5) including a further detailed comparison provided in Appendix 5.1 (document reference 6.3.5.1).

Table 3.1 Overview of key onshore construction elements for Scenario 1 and Scenario 2 to be undertaken by Norfolk Boreas

Onshore elements	Scenario 1	Scenario 2
Landfall		
Landfall compounds	✓	✓
Cable duct installation via HDD	✓	✓
Transition pits and link boxes	✓	✓
Cable pulling	✓	✓
Onshore Cable Route		
Pre-construction works	✓ (limited as majority completed by Norfolk Vanguard)	✓
Cable duct installation via open cut trenching	✗ (installed by Norfolk Vanguard)	✓
Cable duct crossings (e.g. hedgerows, underground services, roads or tracks, watercourses)	✗ (installed by Norfolk Vanguard)	✓
Trenchless crossings (e.g. HDD) and associated trenchless compounds	✗ (installed by Norfolk Vanguard)	✓
Mobilisation areas	✗ (not required)	✓
Running track	✓ (approx. 12km)	✓ (approx. 60km)
Accesses	✓	✓
Cable pulling	✓	✓

Onshore elements	Scenario 1	Scenario 2
Cable logistics area	✓	✓
Jointing pits and link boxes	✓	✓
Onshore Project Substation		
Pre-construction works	✓	✓
A47 junction improvement	× (installed by Norfolk Vanguard)	✓
Access road to onshore project substation	✓ (extension of road installed by Norfolk Vanguard by approx. 300m)	✓ (approx. 1.8km)
Construction of onshore project substation	✓	✓
Temporary construction compound and mobilisation area MA1a	✓	✓
Screening	✓	✓
National Grid Substation Extension and Overhead Modifications		
Pre-construction works	✓	✓
Extension to existing Necton National Grid Substation	✓ (easterly direction)	✓ (westerly direction)
National Grid Overhead line modifications	× (installed by Norfolk Vanguard)	✓
Screening	✓	✓

23. Table 3.2 provides a list of key onshore parameters and their associated characteristics for the project.

Table 3.2 Indicative onshore project characteristics

Parameter	Characteristic
Landfall	
Landfall	Happisburgh South
Onshore Cable Route	
Export cable route length (km)	60 (approximate)
Number of onshore cable trenches	Up to two *(scenario 2 only)*
Number of ducts	Up to two *(scenario 2 only)*
Jointing Pits	Up to 150
Onshore Project Substation	
Onshore project substation area (m x m)	Up to 250 x 300
Number of substations within compound	One substation (comprised of two converter halls)
Onshore project substation tallest building (m)	Up to 19 (HVDC converter hall)

Parameter	Characteristic
Onshore project substation tallest structure (m)	Up to 25 (Lightning protection mast)
Onshore project substation fence height (m)	Up to 3.5
National Grid substation extension	
Grid connection location	Necton National Grid substation
National Grid substation extension area (m x m)	Up to 135 x 150 (*Scenario 1)* Up to 200 x 150 *(Scenario 2)*
National Grid substation extension tallest structure (m)	Up to 15 (Outdoor AIS busbar and landing gantries)
Overhead Line Modifications (Scenario 2 only)	
Net number of permanent new towers	1
Tallest new tower (m)	Up to 55m

24. Under Scenario 1 some of the power generated by the wind turbines may be transmitted via subsea project interconnector cables to an offshore electrical platform located within either of the Norfolk Vanguard offshore wind farm sites. This energy would then be transmitted to shore via Norfolk Vanguards export cable.

25. Given that offshore infrastructure such as wind turbines, offshore electrical and service platforms will be a minimum of 73km offshore, they will not be visible from the coast. Therefore, any requirement for a landscape and visual impact assessment in relation to offshore infrastructure has been scoped out of the Environmental Impact Assessment (EIA). As such, this DAS considers the onshore infrastructure only.

4 SITE SELECTION PROCESS

4.1 Introduction

26. The siting, design and refinement of the project has followed a site selection process, taking account of environmental, physical, technical, commercial and social considerations and opportunities, as well as engineering requirements. This has been undertaken with the aim of identifying sites that will be environmentally acceptable whilst also enabling, in the long-term, benefits of the lowest energy cost to be passed onto the consumer. A multi-disciplinary design team was formed to undertake the site selection process which included a team of specialists comprising engineers and EIA consultants whose expertise were drawn upon throughout the site selection process (see Statement of Competence, document reference 6.3.6.1).

27. The site selection process is shown in Plate 1, and outlined in more detail in Chapter 4 Site Selection and Assessment of Alternatives (document reference 6.1.4). Each stage of site selection forms part of an iterative design process undertaken to identify the most suitable locations and configuration for project infrastructure. The framework for the site selection process is based upon a set of robust design principles and engineering requirements.

28. The details of how sensitive site selection has shaped the final project design are also discussed in section 5 of this DAS.

4.2 Consultation

29. VWPL, on behalf of both Norfolk Boreas and Norfolk Vanguard has undertaken pre-application engagement with stakeholders, communities and landowners to inform the submitted project design and communicate decisions on refinements (for further information see the Consultation Report (document reference 5.1)). The Norfolk Vanguard and Norfolk Boreas Scoping reports (Royal HaskoningDHV, 2016 and 2017) and Norfolk Vanguard and Norfolk Boreas Preliminary Environmental Information Reports (PEIRs) (Norfolk Vanguard Limited, 2017 and Norfolk Boreas Limited, 2018) set out the process for the development of the onshore and offshore elements of the project showing a series of search areas for the landfall, onshore cable corridor, cable relay station (CRS) locations (no longer required) and onshore project substation locations.

30. The refinements in the project layout and configurations have been communicated to relevant audiences through the informal and formal pre-application stages between Norfolk Vanguard scoping in October 2016 and the Norfolk Boreas DCO application (June 2019), and feedback received has been taken into consideration where possible.

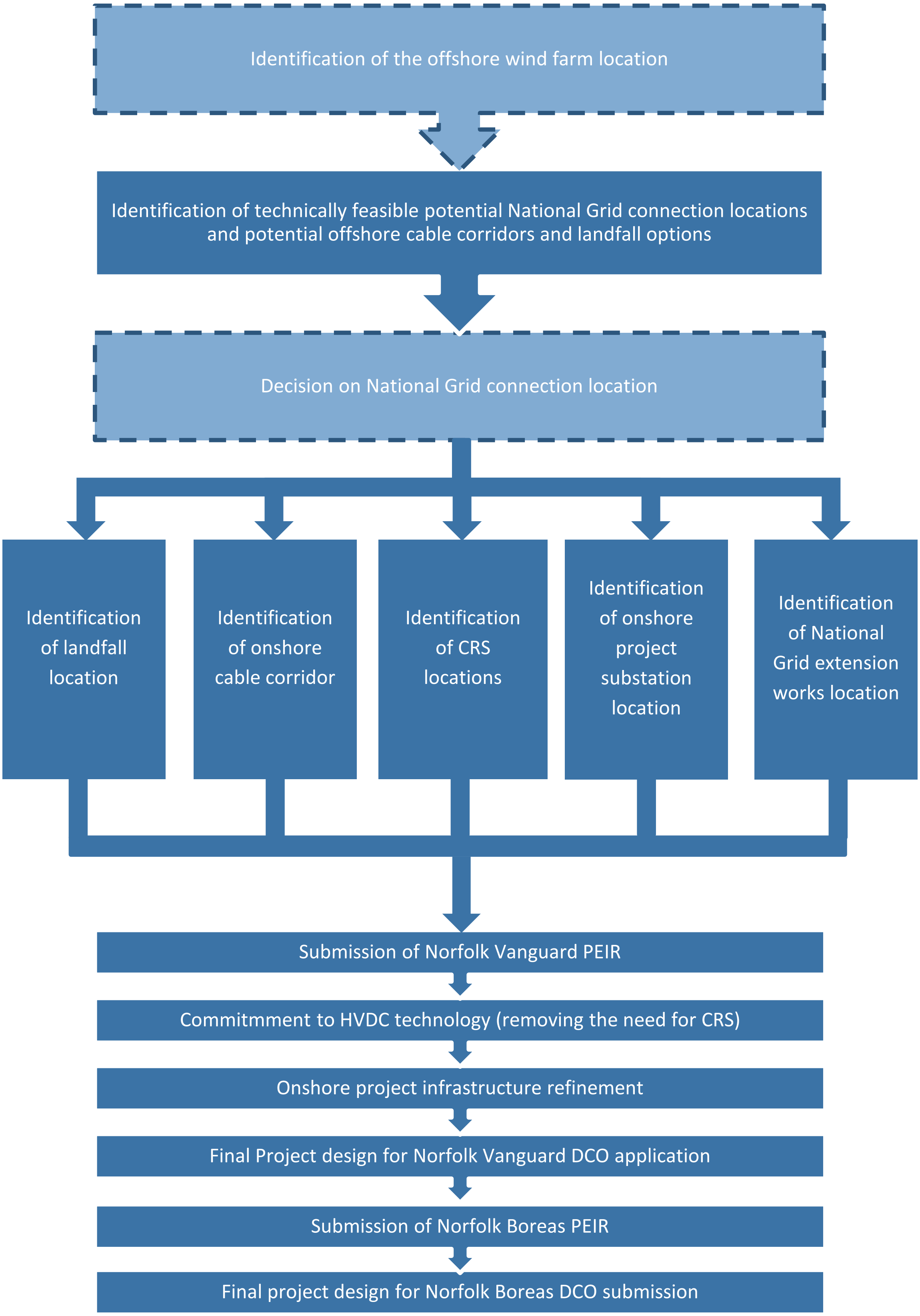

Plate 1 Site selection process Norfolk Boreas and Norfolk Vanguard[2]

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1 Strategic decisions regarding fundamental project locations, denoted by hatched lines, such as the offshore wind farm location and grid connection point have been made in conjunction with the Crown Estate and National Grid respectively.

4.3 Design Considerations

4.3.1 Consideration of Alternatives Influencing the Project Design

31. A number of alternatives have been considered as part of the design decision-making process to date. Assessment of alternatives has been considered from the outset of the project, and were reported within the Norfolk Vanguard and Norfolk Boreas Scoping reports (Royal HaskoningDHV, 2016 and 2017) and Norfolk Vanguard and Norfolk Boreas PEIRs (Norfolk Vanguard Limited 2017 and Norfolk Boreas Limited, 2018), and alternatives have been considered throughout the refinement of the project.

32. As project design is an iterative process, and a multidisciplinary approach, alternatives have been considered incorporating engineering, buildability, cost, environmental, landowner, community, and stakeholder considerations to inform the final design.

33. The early strategic project consideration of alternatives which fed directly into the site selection process are detailed in Table 4.1.

Table 4.1 Strategic project alternatives considered

Alternatives considered	Decision	Benefit
• Strategic approach to concurrently delivering Norfolk Boreas and Norfolk Vanguard; or • No elements of Norfolk Boreas considered within the design envelope for Norfolk Vanguard	**To take a strategic approach to delivering Norfolk Boreas and Norfolk Vanguard.**	The decision to install cable ducts for Norfolk Boreas during the construction of Norfolk Vanguard, would allow the main civil works for the onshore cable route to be completed in one construction period and in advance of the delivery of cables for the pulling phase. This removes the requirement to reopen the land at a later date for the Norfolk Boreas construction, which minimises the construction periods thus reducing impacts on sensitive receptors, and minimising disruption. Co-location of onshore project substations will keep these developments contained within a localised area and, in so doing, will contain the extent of potential impacts.
• Overhead lines along the ~60km route from landfall to grid connection location • Buried onshore cables within ducts along the ~60km route from landfall to grid connection location	**Buried onshore cables within ducts**	The environmental benefit of burying cables as opposed to overhead lines and pylons is a significant reduction of permanent visual impacts.

Alternatives considered	Decision	Benefit
• Ducts laid in a sectionalised approach to enable cable pull through at a later stage • Open cut and direct lay of onshore cables along the full length of the cable route	**Under Norfolk Boreas Scenario 2 ducts laid in a sectionalised approach to enable cables to be pulled through the ducts at a later stage. Under Scenario 1 ducts will be laid by Norfolk Vanguard (see above)**	The environmental benefit of installing ducts and backfilling the trenches in discreet sections, rather than installing ducts along the entirety of the route before backfilling would minimise the amount of land being worked on at any one time and would also minimise the duration of works on any given section of the route.
• Deploy High Voltage Alternating Current (HVAC) transmission technology • Deploy High Voltage Direct Current (HVDC) transmission technology	**HVDC technology**	The environmental benefits of selecting HVDC technology include the removal of the need for CRS infrastructure near the coast, a reduction in the overall area of land impacted (for example reduction in working width along the onshore cable route from 50m to 35m (for Scenario 2) and a reduction in the overall construction time.
• Undertake a short HDD at landfall exiting in the intertidal area • Undertake a long HDD at landfall exiting in the subtidal area	**Undertake a long HDD at landfall**	The environmental benefits include not having to access or disturb the beach and therefore minimising impacts on tourism, potential archaeology and intertidal ecology.

4.4 Identification of Onshore Project Substation Location

34. In order to identify the most appropriate location to site the onshore project substation, National Grid’s Guidelines on Substation Siting and Design (The Horlock Rules (National Grid, undated)) have been taken into consideration. These guidelines document National Grid’s best practice for the consideration of relevant constraints associated with the siting of substations. The Horlock Rules have been considered as part of the development of the onshore project substation location and those relevant to design are outlined within Table 4.2.

Table 4.2 Application of Horlock Rules (relevant to design) to onshore project substation

National Grid’s Approach to Design of Substations	Norfolk Boreas onshore project substation considerations
Design	
In the design of new substations or line entries, early consideration should be given to the options available for terminal towers, equipment, buildings and ancillary development appropriate to individual locations, seeking to keep effects to a reasonably practicable minimum.	HVDC technology has been committed to which removes the requirement for a Cable Relay Station. In addition, onshore cable will be buried to avoid introducing new overhead power lines. Overhead line modification is unavoidable as part of the National Grid extension works, however the number of new towers has been minimised by replacing an existing tower. The net increase in new towers will be one, which will be located in proximity to existing towers to reduce the potential

National Grid's Approach to Design of Substations	Norfolk Boreas onshore project substation considerations
	proliferation of energy infrastructure (This work would only be undertaken by Norfolk Boreas Limited under Scenario 2 as under Scenario 1 the work would have been completed by Norfolk Vanguard Limited). Realistic worst case dimensions have been proposed for the substation infrastructure, taking into account the largest structure (the converter hall at up to 19m tall) as well as the tallest (Lightning protection mast at 25m).
Space should be used effectively to limit the area required for development consistent with appropriate mitigation measures and to minimise the adverse effects on existing land use and rights of way, whilst also having regard to future extension of the substation.	Permanent footprints for the onshore project substation are based on realistic preliminary layouts. During detailed design undertaken post consent, consideration will be given to space-efficient solutions where appropriate. The location of the onshore project substation has avoided direct impacts to Public Rights of Way.
The design of access roads, perimeter fencing, earth shaping, planting and ancillary development should form an integral part of the site layout and design to fit in with the surroundings.	A detailed landscape and visual impact assessment has been undertaken to support the application. This process has informed the approach to landscape planting to minimise potential visual impacts. The choice of substation site was driven by the existence of existing woodland, and the proposed landscape planting will reinforce these areas. The presence of access roads, perimeter fencing and ancillary development were taken into account as part of this assessment.
Line Entry	
In open landscape especially, high voltage line entries should be kept, as far as possible, visually separate from low voltage lines and other overhead lines so as to avoid a confusing appearance.	All new cabling between the landfall and the onshore project substation (approximately 60km) will be buried underground to avoid the introduction of new overhead lines in an open landscape. Modifications to the existing overhead line structures are required near Necton to accommodate the newly installed infrastructure. The net new number of towers required to accommodate the works is one, and will be in proximity to the existing corner tower (to the north east of the existing Necton National Grid substation) to minimise proliferation of energy infrastructure and additional clutter (This work would only be undertaken by Norfolk Boreas Limited under Scenario 2 as under Scenario 1 the work would have been completed by Norfolk Vanguard Limited).
The inter-relationship between towers and substation structures and background and foreground features should be studied to reduce the prominence of structures from main viewpoints. Where practicable the exposure of terminal towers on prominent ridges should be minimised by siting towers against a background of trees rather than	Overhead line modification is unavoidable as part of the National Grid extension works however, the number of new towers has been minimised by upgrading an existing tower. The net increase in new towers will be one, which will be located in proximity to existing towers to reduce the potential proliferation of energy infrastructure (This work

National Grid's Approach to Design of Substations	Norfolk Boreas onshore project substation considerations
open skylines.	would only be undertaken by Norfolk Boreas Limited under Scenario 2 as under Scenario 1 the work would have been completed by Norfolk Vanguard).

35. Following this process under Scenario 1 the onshore project substation would be co-located alongside the Norfolk Vanguard onshore project substation.

36. Under Scenario 2, where Norfolk Vanguard does not proceed, the location that has been identified for the Norfolk Vanguard substation area would be a suitable location for the Norfolk Boreas onshore project substation.

37. However, if only one substation was to be built (as would be the case under Scenario 2) a small area of land to the east of the Norfolk Vanguard onshore project substation footprint would become of limited use for farming. Therefore, a wider area was considered for the location of the onshore project substation under Scenario 2 and it determined that a location approximately 150m further east than the footprint for the Norfolk Vanguard was preferable. Chapter 4 Site Selection and Assessment of Alternatives provides more information on the Scenario 2 onshore project substation location (document reference 6.1.4).

4.5 Design Principles and Recommendations

38. The final design of the onshore project substation and National Grid substation extension will be subject to detailed design phase which will happen post-consent. In order to minimise visual impacts as far as possible, the appropriate building design and materials will be considered, to ensure blending with the local environment and minimisation of impacts as far as possible (as outlined in Table 4.3).

Table 4.3 Design Principles for the onshore project substation and National Grid substation extension

Principle	Description
1	Continue to engage relevant authorities on detailed design and landscaping proposals as detailed design progresses.
2	Actively seek appropriate building design and materials (e.g. building materials, shape, layout, coloration and finishes).
3	The design of the onshore project substation will be within the parameters set out in Requirement 16 of the DCO, namely: • The total number of buildings housing principal electrical equipment must not exceed two; • Buildings must not exceed a height of 19m; • External electrical equipment must not exceed 25m; • The total footprint of each building housing the principal electrical equipment must not exceed 110m by 70m; and • The fenced compound area must not exceed 250m by 300m.
4	The design of the National Grid substation extension will be within the parameters set out in Requirement 16 of the DCO, namely: • The total net number of new overhead line towers must not exceed one, and must not exceed a height of 55m; • Buildings and external electrical equipment must not exceed a height of 15m; and • The fenced compound area (excluding accesses) must not exceed 135 metres by 150 metres in the event of scenario 1, or exceed 200 metres by 150 metres in the event of scenario 2.
5	Landscaping to minimise the visual impacts, and respond to local landscape character and biodiversity will be undertaken and considered with building design and layout of ancillary structures. Delivery of this principle will be guided by implementation of the Outline Landscape and Ecological Management Strategy (OLEMS) (document reference 8.7).
6	A detailed Sustainable Urban Drainage (SuDS) drainage strategy will be developed, in accordance with the Outline Operational Drainage Plan (Document reference 8.21).

5 ONSHORE PROJECT DESIGN

5.1 Introduction

39. The onshore cables will be buried underground in ducts. The only potential above ground infrastructure associated with the onshore cable route is the inclusion of link boxes, which are considered within this DAS. Other than link box design, the DAS focuses on the design and development of the Norfolk Boreas onshore project substation and National Grid substation extension (including overhead line modifications).

40. There will be no permanent above ground infrastructure associated with the landfall, therefore this aspect of the project is not considered further within this DAS.

41. As set out in section 2.2, the approach within any DAS is to consider the use, amount, layout, scale, appearance, landscaping (where relevant) and access of the permanent above ground infrastructure.

42. Where aspects related to the onshore project design would differ under Scenario 1 or Scenario 2, this is explicitly stated and design elements under both scenarios provided. This includes;

- Access to the onshore project substation (section 5.3.4);
- Overhead line modifications at the Necton National Grid substation and the scale, location and layout of the National Grid substation extension (section 5.4.2); and
- Strategic landscaping and planting schemes at the onshore project substation and Necton National Grid substation (section 5.5).

43. Under Scenario 1 the design and development of the onshore infrastructure will also be considered cumulatively with Norfolk Vanguard and consideration will be given to a design approach which can be applied across both projects.

5.2 Link Boxes Design

5.2.1 Use, Amount, Scale, Layout and Appearance

44. The onshore cable route will be approximately 60km in length, from the landfall to the onshore project substation near Necton. Sections of cabling would be connected together in jointing pits along the route and link boxes would be required in proximity (within 10m) to a subset of jointing pit locations. Link boxes would be the only potential permanent above ground feature associated with the onshore cable route.

45. Link boxes would not be required at all jointing pit locations and can typically be placed at 5km intervals. Separate link boxes are required for each cable circuit, with the maximum number of cable circuits required for the project being two. The precise number and placement of the link boxes would be determined as part of the detailed design post-consent.

46. The link boxes, with maximum dimensions of 1.5m x 1.5m, would either be buried to ground level within an excavated pit, with access provided via a secured access panel (refer to Plate 2) or alternatively, above ground link box cabinets (1.2m x 0.8m x 1.8m) may be utilised which are typically sited on a 0.15m deep concrete slab.

47. There is no requirement for permanent lighting at link boxes.

Plate 2 Example below ground link box following reinstatement (Source: Rey Wind Farm, VWPL.)

48. Prior to the installation of any link box, the Applicant shall consult with the landowner (and if reasonably requested by the landowner, the relevant tenant) as to the location and level of any relevant link box. Where reasonably practicable (and subject to reasonable engineering requirements or construction requirements) the Applicant shall comply with the landowner/tenant's requests as to location and level of the relevant link box. Unless there are reasonable engineering requirements, construction requirements or specific requirements by the landowner/tenant the link box shall be located in or within 2 metres from a field boundary hedge (measured from the centre of the hedge nearest to the link box) or other boundary structure and shall be laid level with or below the surface of the Easement Strip.

5.2.2 Access

49. Access to link boxes is only required for periodic testing purposes. Where possible, the link boxes would be located close to field boundaries and in already accessible locations. No additional formal access is proposed to each link box.

5.3 Onshore Project Substation Design

5.3.1 Use

50. The onshore project substation converts the High Voltage Direct Current (HVDC) electrical power from the Norfolk Boreas export cables to High Voltage Alternating Current (HVAC) which is the appropriate voltage system required for connection to the National Grid. Filtering, switchgear and associated protection and control equipment is also located at the onshore project substation to comply with the technical requirements of the National Grid and allow safe operation of the Norfolk Boreas connection.

5.3.2 Amount, Scale

51. The onshore project substation will consist of up to two converter stations, each having a power transfer capability of between 800MW and 1,000MW. The two converter stations will be located within the single onshore project substation footprint.

52. As such, the onshore project substation will consist of:

- 2x converter buildings - housing DC filter equipment and power electronics to convert HVDC to HVAC power for connection to National Grid;
- 2x outdoor HVAC compounds – each compound will contain one or more 400kV transformers, plus HVAC filters, busbars and cable sealing ends;
- Control building – housing SCADA and protection equipment;
- Access roads – for operation and maintenance access to equipment; and
- Associated connections between equipment via overhead busbar and cabling, including buried earthing system.

53. The largest equipment within the onshore project substation will be the converter buildings which will not exceed a height of 19m. The tallest structure within the onshore project substation would be the lightning protection masts at a height of 25m. All other equipment will not exceed a height of 13m. The total land requirement for the onshore project substation to the perimeter fence is 250m x 300m. Permanent palisade fencing will be installed around the onshore project substation compound up to a height of 2.4m with an additional 1m of electrical pulse fencing. Table 5.1 details how each of these design parameters are secured.

54. The final appearance of the onshore project substation is subject to detailed design post consent. For the purposes of the DAS, indicative maximum parameters (as set in DCO Requirement 16) have been provided with reference to a Rochdale Envelope approach in terms of realistic worst case design parameters.

Table 5.1 Onshore Project Substation Design Parameters

Commitment	Secured in
The total number of convertor buildings housing the principal electrical equipment must not exceed two	dDCO requirement 16. (1)
Buildings must not exceed 19 metres above existing ground level	dDCO requirement 16. (5)
Total footprint of the buildings housing the principal electrical equipment must not exceed 110 metres by 70 metres	dDCO requirement 16. (6)
External electrical equipment must not exceed a height of 25m above existing ground level	dDCO requirement 16. (5)
The fenced compound area for the onshore project substation must not exceed 250 metres by 300 metres	dDCO requirement 16. (7)
That outside electrical equipment, other than lightning protection masts, will not exceed 13m	Design and Access Statement
The permanent fencing around the onshore project substation will be up to height of 2.4m with an additional 1m of electrical fence	Design and Access Statement

5.3.3 Layout and Appearance

55. In addition to the main converter buildings, the onshore project substation compound would contain electrical equipment including power transformers, switchgear, harmonic filters, cables, lightning protection masts, control buildings, communications masts, backup generators, access, fencing and other associated equipment, structures or buildings. The onshore project substation would have a compact layout, with the majority of equipment contained in agricultural style buildings. Examples of typical agricultural style buildings are presented in Appendix 2.

56. The onshore project substation would be enclosed by a fence surrounding the compound, the fence will be galvanised steel finish or material of similar or reduced light reflectivity. Other infrastructure and equipment would be included within the compound such as interconnecting cables, access tracks, hard standing, car parking, water tanks, communications mast, diesel generators and welfare facilities.

57. The onshore project substation would be connected to the existing Necton National Grid substation by means of HVAC underground cables.

58. An indication of the typical appearance and layout of a HVDC substation is shown on Plate 3 along with the maximum height controls as detailed in Table 5.1.

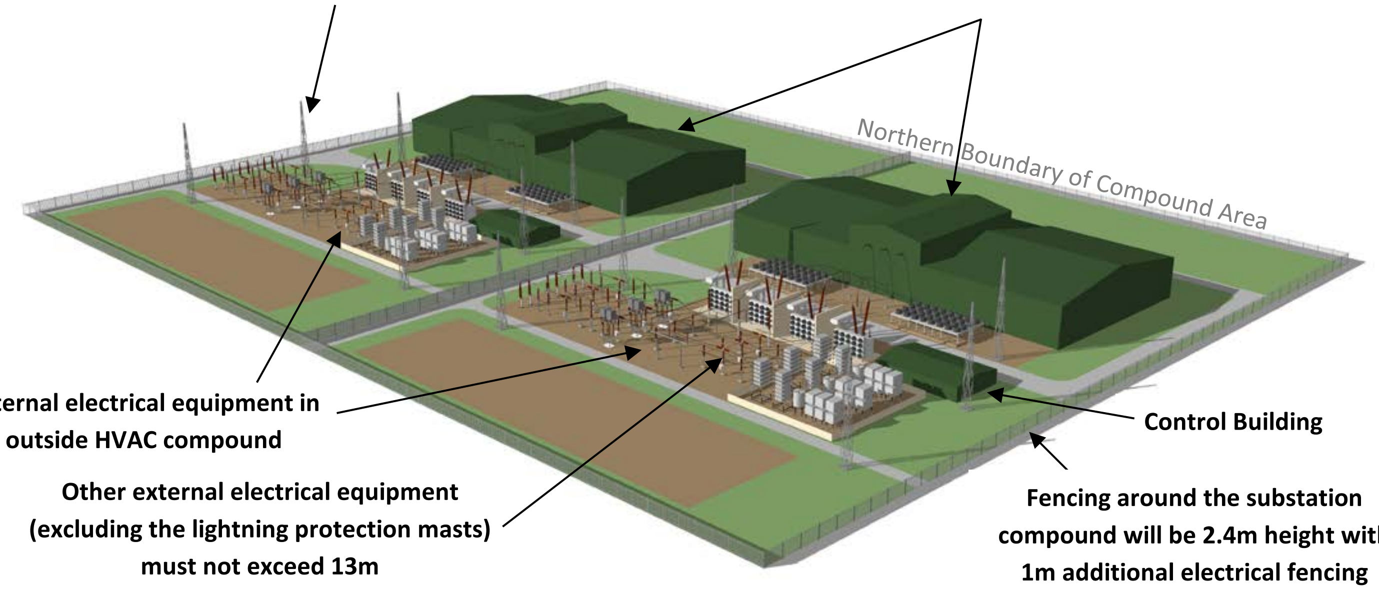

Plate 3 Indicative onshore project substation layout – HVDC

59. The layout of the onshore project substation will be finalised once specialist contractors are appointed and based on the most appropriate and best available technology. There are differences in layouts offered by different contractors however the potential options being considered show the convertor buildings located to the northern end of the site and the outdoor electrical equipment being located to the south. This has facilitated the development of an illustrative zoning plan, shown in Figure 9 Scenario 1 and Figure 10 Scenario 2, which identifies the following zones within the onshore project substation for each scenario:

- 'Northern Zone' containing the convertor buildings, control buildings, lightning protection masts and some outside electrical equipment; and
- 'Southern Zone' containing outside electrical equipment.

60. Both zones may also contain fencing, access roads, hardstanding and below ground systems such as drainage and earth systems.

5.3.4 Access

61. The onshore project substation will be accessed from the A47. This will require carriageway works at Spicers Corner junction of the A47 to install a right turn filter and new exit from the A47, and installation of an access road to the onshore project substation as shown in Figure 3. Under Scenario 2 these works would be undertaken by Norfolk Boreas.

62. Under Scenario 1 the junction works and access road from the A47 (up to the Norfolk Vanguard substation) would have been installed by Norfolk Vanguard. Therefore, the access works required under Scenario 1 will be limited to the extension of this access road by approximately 300m to the Norfolk Boreas onshore project substation (Figure 2).

63. Consultation with highway stakeholders, including Highways England and Norfolk County Council, will continue to be undertaken post-consent to finalise the onshore project substation access strategy.

64. During operation, the onshore project substation would not be manned, however access would be required periodically for routine maintenance activities, estimated at an average of one visit per week.

5.3.5 Lighting

65. Normal operating conditions would not require lighting at the onshore project substation, although low level movement detecting security lighting may be utilised for health and safety purposes. Temporary lighting during working hours will be provided during maintenance activities only.

5.3.6 Design Process and Design Guide

66. To fulfil DCO Requirement 16(2) and assist in discharging Requirement 18 (2)(j) the Applicant proposes to follow the design process outlined below to provide Breckland Council further information to enable them to approve the layout, scale and external appearance of the onshore project substation once the details are available.

67. The Applicant will engage with Breckland Council to review the mitigation and landscape proposals and the architecture of the convertor building of the onshore project substation, at an early stage ~~the time~~ when further detailed design information is available based on the most appropriate and best available technology. This will be undertaken through the production of a Design Guide.

68. The Design Guide will set out the design approach and mitigation measures to be applied in respect of the onshore project substation. The detailed design of the onshore project substation will integrate embedded mitigation in order to reduce potential effects on landscape character and visual amenity, on ecology and archaeology and on the communities in the local area. The Design Guide is primarily focussed on landscape design, rather than architectural design but will set out the design of the built features, including the structural components which are functionally non-negotiable, as well as the landscape features. The relationship between the architecture and the landscape is a fundamental consideration, and while the Design Guide does not aim to redesign the structural components of the

onshore project substation, it does nonetheless review the potential to further integrate the onshore project substation within the landscape. In particular, it considers how mitigation planting helps to integrate the onshore project substation into the landscape and explores the importance of colour in further enhancing this idea of integration.

69. The construction material for the proposed converter building serves a functional purpose in providing a managed environment for the sensitive converter equipment and will include structural requirements to support features such as internal overhead gantries. Consideration also needs to be given to the construction material functionality with respect to aspects such as fire safety, weatherproofing and maintainability. ~~The Applicant would identify any optionality of construction material, if available, which satisfies the functional requirements and this could be considered within the design process.~~

~~69.~~70. The Applicant has produced a Preliminary Design Report, presented in Appendix 3, to provide further information which will guide and inform the Design Guide and the detailed design of the onshore project substation. The report considered the consultation responses from local stakeholders, which requested the onshore project substation be made as discreet as physically possible. The report presents appropriate design options for the external architectural treatment of the convertor buildings and includes a review of the materials options for the convertor halls, colour analysis and review of potential façade colours. It also includes information on the design principles outlining the approach on form, massing and style and isometric visualisations of the indicative design layout of the onshore project substation.

71. The comparative study within the Preliminary Design Report was used to explore the scope for alternative materials to potentially be used in construction of the convertor buildings, the outcome has been dictated by the very specific and stringent technical requirements associated with housing electrical infrastructure. Sheet metal is the most appropriate material for the construction of the convertor buildings, in light of the high performance and safety standards, existing use in surrounding agricultural building and range of colours which will enable consideration and selection of colour which will minimise visual impacts and facilitate the onshore substation being as discreet as possible within the local landscape. The report identified that the colour and finishes for the materials presents the most extensive scope in terms of design options, with colour presenting the greatest scope for altering the appearance of the convertor halls. Also, a modern-style shed structure for the convertor building is considered to present~~s~~ the most suitable option owing to the simplicity of its form and its association with the

other similar modern-style shed structures, which are dispersed across the Norfolk landscape.

~~70.~~72. The Preliminary Design Report has set out the initial parameters regarding the design options for the convertor buildings at the onshore project substation and the information in the report will be developed further through the Design Guide as the project progresses and the iterative design evolves.

~~71.~~73. ~~It will enable some involvement in terms of~~ The development of the Design Guide will enable local stakeholders to provide feedback on local preferences in relation to colour and material finish ~~(if possible) options~~ for the convertor buildings, with the purpose of ensuring ~~ensure~~ the substation developments are sensitive to place, with visual impacts minimised as far as practicable. It is also recognised that the local community have experience of growing trees and other plants in this local area. Through consultation on the Design Guide, the Applicant would welcome the opportunity to share local knowledge on native species that are suited to local conditions. This would ensure that the 'palette' of species selected would present the best opportunity for successful establishment and growth.

~~72.~~74. During the Design Process, plans could be used to show the view cones from the key views to the most prominent aspects and parts of the onshore project substation to share with stakeholders and detailed plans of these areas to show the special treatment in the landform modelling and planting that would enhance the mitigation potential.

~~73.~~75. An outline detailing the proposed content and structure of the Design Guide is presented in Appendix 1.

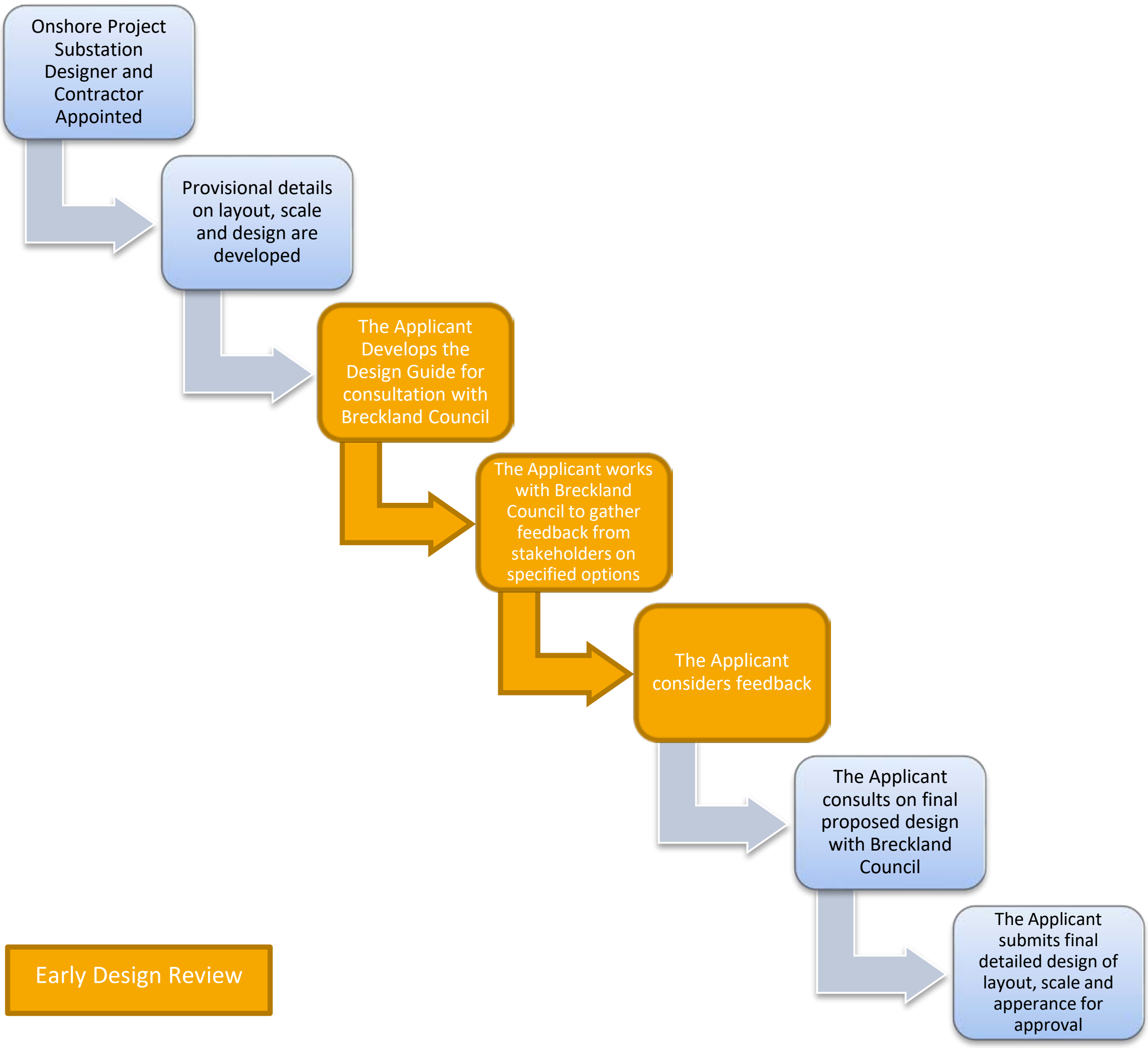

Plate 4 Onshore Project Substation Design Process

~~74.~~76. The Applicant will follow the design process as set out in Plate 4. The Applicant is committed to undertaking a design review at an early stage to inform the final detailed design, as highlighted in Plate 4. Once the onshore project substation designer and contractor have been appointed the provisional details on the layout, scale and design can be developed. This will facilitate the production of the Design Guide, as detailed in Appendix 1, which will further develop the initial parameters set out in the Preliminary Design Report (Appendix 3) and guide the detailed design of the onshore project substation ~~and~~, as well as set out the proposals for embedded mitigation, highlighting how potential effects will be reduced.

~~75.~~77. This Design Guide will be shared with Breckland Council at an early stage. The Applicant will work with Breckland Council to agree what aspects highlighted in the Design Guide are open to influence by local ~~parties~~ stakeholders (which will include Necton Parish Council, Holme Hale Parish Council, relevant landowners and closest located residents), such as the different colour options for the convertor buildings, for example – thereby determining the purpose and parameters of any potential consultation process.

~~76.~~78. The proposed onshore project substation design, and the contextual information provided by landscape architects as described in the Design Guide, will also inform a refreshed stakeholder analysis focussing on who to involve in any consideration of options highlighted in the Design Guide, e.g. how might the detailed design affect different stakeholder groups and should there be engagement with those groups as part of any focussed dialogue process?

~~77.~~79. Engagement could take place, with a range of stakeholders who are likely to have an interest in determination of aspects that can help mitigate visual impacts as far as possible but will include Necton Parish Council, Holme Hale Parish Council, relevant landowners and closest located residents to the Onshore Project Substation. The range of stakeholders to be consulted and that can input into the process would be determined in light of the information provided by the Design Guide, and in collaboration with Breckland Council.

~~78.~~80. Following this, Breckland Council and the Applicant would determine what type of process would best enable the desired engagement – and deliver enhanced local understanding of the constraints and opportunities associated with different mitigation approaches, to help ensure the most locally appropriate and sustainable decisions are made with respect to any options highlighted in the Design Guide.

~~79.~~81. The Applicant and Breckland Council would work together to deliver the process, and review its effectiveness – ensuring learning from previous engagement is taken on board.

~~80.~~82. The feedback on the Design Guide would then be considered and the Applicant will consult with Breckland Council on the final design proposals before the final details of the design, layout, scale and approaches are produced and submitted to Breckland Council for approval.

5.4 National Grid Substation Extension and Overhead Line Modifications

5.4.1 Use

~~81.~~83. The existing Necton National Grid substation would require an extension to accommodate the Norfolk Boreas connection points. The National Grid substation extension would need to accommodate circuit breakers and associated busbar structures which allow connection onto the existing 400kV overhead line for generation to be transmitted onto the wider National Grid system.

5.4.2 Amount, Layout, Scale and Appearance

~~82.~~84. The existing Necton National Grid substation would require an extension to accommodate the Norfolk Boreas connection points. The National Grid substation extension would need to accommodate circuit breakers and associated busbar structures which allow connection onto the existing 400kV overhead line for generation to be transmitted onto the wider National Grid system.

~~83.~~85. The Necton National Grid substation will be extended in an easterly (Scenario 1, Figure 2) or westerly (Scenario 2, Figure 3) direction to accommodate new Air Insulated Switchgear (AIS) bays installed along the busbar extension for Norfolk Boreas. The substation extension will be similar in appearance to the existing National Grid substation near Necton as it is in simply an extension to the existing busbar and AIS bays. The maximum height of the outdoor busbar bays at the substation is estimated to be 15m.

~~84.~~86. Under Scenario 1, extension works to the west of the Necton National Grid substation would have been undertaken to accommodate the Norfolk Vanguard connection points, and a further extension to the east would be required to accommodate Norfolk Boreas. The extension would be 135m to accommodate five new AIS bays for Norfolk Boreas.

~~85.~~87. Under Scenario 2, the Necton National Grid substation outdoor busbar will be extended in a westerly direction to a total length of 200m with seven new AIS bays installed along the busbar extension.

~~86.~~88. In addition to the existing Necton National Grid substation itself, modifications to the existing overhead line structures adjacent to the substation would be required to provide a double turn-in arrangement[3]. Under Scenario 1 these works would have been completed by Norfolk Vanguard to accommodate both projects.

~~87.~~89. Under Scenario 2 two new overhead line towers will be required in proximity to the existing corner tower (to the north east of the existing Necton National Grid substation) with a maximum height of 55m. The existing corner tower will be demolished such that the net new number of towers will be one.

5.4.3 Access

~~88.~~90. The existing Necton National Grid substation has an existing access from the A47. This would continue to be used during operation.

[3] Each overhead line tower carries two 400kV circuits. In this arrangement, both circuits are turned into the substation busbar structure.

89. The operational Necton National Grid substation will be owned and operation by National Grid and would be unmanned. Maintenance of the substation would be undertaken approximately every three years. Visual checks would be undertaken on a monthly inspection visit to the site.

5.4.4 Lighting

~~91.~~92. During operation, the Necton National Grid substation would not be illuminated under normal operating conditions. Temporary site lighting would be provided during working hours when conducting maintenance activities only.

5.5 Onshore project substation and National Grid Substation Extension Landscaping

~~92.~~93. The onshore project substation site benefits from some substantial existing hedgerows and woodland blocks within the local area, which was a key consideration for the site selection of the onshore project substation. These would provide mitigation of landscape and visual effects from the outset and can be strengthened during the early phases of the project to ensure robust screening. However, Norfolk Boreas Limited has committed to planting to further screen the onshore project substation and National Grid substation extension.

~~93.~~94. The extent and location of mitigation planting incorporated into the design reflects the location of the infrastructure under each scenario:

- Scenario 1: onshore project substation to the east of the Norfolk Vanguard substation (Figure 5) and the extension of the National Grid substation in an easterly direction (Figure 7).
- Scenario 2 the onshore project substation further west (Figure 6) and the extension of the National Grid substation in a westerly direction (Figure 8).

~~94.~~95. Under both scenarios, planting would mostly comprise of indigenous woodland species and would be located around the onshore project substation and along the southern edge of the National Grid substation extension. Owing to the dimensions of the onshore project substation site, the National Grid substation extension, and the temporary works areas, construction activities would be required to level existing contours. The earthworks required for the cut and fill to create the level platform may produce surplus soil which could be used to form subtle earthwork bunds of up to 2m along the western side of the onshore project substation. This would help to give an incremental increase to the overall height of screening along this sensitive boundary which is not constrained by planting restrictions associated with underground cables.

~~95.~~96. Under both scenarios, the mitigation planting would be designed to comprise a mix of faster growing 'nurse' species and slower growing 'core' species. Nurse species, such as alder, birch, and pine would grow quicker, so that after 20 years they would be 8m in height. They would provide shelter to bring on core species, such as oak, beech and horse chestnut, so that after 20 years they would be up to 6m in height. The nurse species would be sufficiently fast growing to provide substantial screening of the onshore project substation after 20 years. The core species would outlive the nurse species and characterise the woodland structure over the longer term.

~~96.~~97. The proposed landscaping is described in more detail in the OLEMS (document 8.7), with regard to the re-establishment of hedgerows and tree planting. The landscaping works will be designed in detail post-consent in accordance with DCO Requirement 18.

6 SUMMARY

~~97.~~98. This DAS forms part of the suite of documents submitted as part of the DCO application for the project, and sets out the various principles, concepts and considerations incorporated into the design of the onshore electrical transmission works.

~~98.~~99. The design of the project is part of an ongoing process in which Norfolk Boreas Limited is committed to optimising the quality of the design. The design-development process has been informed by consultation particularly in relation to site selection, design evolution and accessibility considerations.

~~99.~~100. Although indicative at this stage, the design for the onshore project substation and National Grid substation extension will set out to achieve a high standard of design whilst at the same time balancing the operational requirements of the facility with the character and appearance of the existing environment.

~~100.~~101. There will be no requirement for public access to the onshore project substation or National Grid substation extension, and appropriate security measures will be installed to prevent unauthorised access to the onshore electrical transmission works once operational.

~~101.~~102. Integration of the building into the local landscape will be further assisted by detailed landscape design including planting using a selection of appropriate indigenous species to increase site biodiversity.

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8 APPENDIX 1 OUTLINE FOR THE NORFOLK BOREAS DESIGN GUIDE

Outline for the Norfolk Boreas Design Guide

Team

The Design Guide will be prepared by Norfolk Boreas Limited (the Applicant) and will combine input from specialist consultants. The Design Guide will further develop the initial parameters as detailed in the Preliminary Design Report (Appendix 3). This part of the Norfolk Boreas project will enable the team to undertake the detailed design of the onshore project substation and ensure that embedded mitigation is integral in this process. The Design Guide will be presented as an A3 document, and will combine text and figures to explain the proposals

Overview

The Design Guide will set out the design approach and mitigation measures to be applied in respect of the onshore project substation for Norfolk Boreas offshore wind farm. The detailed design of the onshore project substation will integrate embedded mitigation in order to reduce potential effects on landscape character and visual amenity, on ecology and archaeology and on the communities in the local area.

Structure

The Design Guide will be structured into three parts:

- the first will outline the aims, the approach, and the scope of the design guide, outlining how it will guide the detailed design of the onshore project substation;
- the second will focus on the existing conditions, demonstrating how a responsive and holistic approach to the existing environment and the communities within it will help with successful integration; and
- the third section will present proposals for landscape mitigation in respect of the onshore project substation, highlighting how potential effects will be reduced.

Aim, Approach and Scope

The aims of the Design Guide will be as follows;

- To present a document that provides clarity and certainty regarding the development of the detailed design of the proposals;
- To provide a means by which the local authority and stakeholders can provide feedback;
- To draw on the depth and breadth of knowledge collected by the team through the ES process and to use this understanding as the basis for the development of the detailed design;
- To enable collaborative working between the design team members to develop proposals following an integrated and holistic approach; and

- To assist in seeking approvals under DCO Requirement 18 (2) (j) on the use of materials and colours for the design of the onshore project substation, in accordance with the Outline Landscape Ecological Management Plan.

The approach will be to develop locally specific mitigation measures based on a review of existing good practice precedents, detailed analysis of local landscape conditions and consideration of how the onshore project substation infrastructure can be best integrated into the existing rural landscape.

The Design Guide will be primarily focussed on landscape design, rather than the substation architecture due to the technical and functional requirements but will set out the design of the built features, including the structural components which are functionally non-negotiable, as well as the landscape features. The relationship between the architecture and the landscape is a fundamental consideration, and while the Design Guide does not aim to redesign the structural components of the onshore project substation, it does nonetheless review the potential to further integrate the onshore project substation within the landscape. In particular, it considers how mitigation planting helps to integrate the onshore project substation into the landscape and explores the importance of colour in further enhancing this idea of integration and explores the importance of colour in further enhancing this idea of integration. The options proposed will ensure that the onshore project substation is sensitive to place, with visual impacts minimised as far as practical by the use of appropriate design, planting and modifications to landscape topography and hydrology. The Design Guide will be developed in parallel with the operational drainage strategy, which will be in accordance with the principles of the Sustainable Drainage Systems (SuDS), as detailed in the Outline Operational Drainage Plan (Document reference 8.21). A holistic approach will look to identify the best options which would integrate the drainage systems with the indigenous and proposed landscaping.

Existing Conditions

As its starting point, the Design Guide will use the findings from the ES, in order to highlight sensitive receptors with potential to be affected by the project. The approach will then be to develop the design, taking into account how the detail of the design can best mitigate potential effects.

The landscapes of the site and surroundings work as a system comprised of different interrelated layers: from the underlying geology which influences local soil types and land uses, to the habitat networks which support local flora and fauna, and to the functional uses of areas around the onshore project substation. Designing with an understanding of these layered landscapes will help ensure that the final design will integrate well with each of these layers and ensure mitigation measures are specific and relevant to the local landscape context.

Embedded Mitigation

The Design Guide will set out the design principles which will guide the detailed design of the onshore project substation and demonstrate how these principles are to be implemented. It will present the various mitigation measures in respect of ecology and hydrology and landscape, and the visual amenity of the local communities.

Embedded mitigation will include the detailed design of the built features, considering the layout of the site and the colour and texture of the materials to be used. It will also include the detailed design of the landscape features, including tree, hedgerow and grassland planting, earthworks, water attenuation ponds and drainage, and how these are integrated to form a robust landscape framework.

The technical and functional requirements of the substation preclude alterations to the substation architecture. However, it does allow an opportunity to consider the colour of the cladding of the convertor buildings in order to establish an appropriate colour which integrates the convertor buildings within the existing landscape most effectively through different seasons.

The construction material for the proposed converter buildings serves a functional purpose in providing a managed environment for the sensitive converter equipment and will include structural requirements to support features such as internal overhead gantries. The Preliminary Design Report explored potential materials and identified that sheet metal is the most appropriate material for the convertor buildings but that colour and finishes of materials present the most extensive scope in terms of design options. ~~Consideration also needs to be given to the construction material functionality with respect to aspects such as fire safety, weatherproofing and maintainability. The Design Guide will identify any optionality of construction material, if available, which satisfies the functional requirements and this could be considered within the design process.~~

The Design Guide will include a colour and material finishes comparative study for the convertor buildings, ~~as the selection of the materials to be used will be dictated by the functional requirements of the onshore project substation~~, the comparative study would focus principally on the choice of colour but will present material finish options ~~if possible~~. The choice of colour would offer the greatest scope in terms of changing the appearance of the proposed development. The colour comparison study involves a range of existing colours in the landscape at the site being sampled and compared as potential colour options, which can be used to colour cladding material for the convertor buildings. It will also explore the potential for the use of two or more colours options together.

Indicative photomontage images of the onshore project substation will be presented using a computer model to compare each colour option. The photomontages be used to illustrate the colour options by applying a range of colours to the model of the converter halls. Furthermore, baseline photography would be taken at different times of the year to represent the seasonal changes in the colours of the local landscape and the models presented in the context of these changes. In order to best understand and appreciate the colour options, it is advised that site visits be carried out by the local authority and stakeholders, where the photomontages can be considered, along with test panels of the different colour options. The finish of the paint will also be important to ensure that the reflectiveness of surfaces is reduced as much as possible. Feedback can then be gathered from the local authority and stakeholders on the different colour options, which can be considered as part of the final design.

9 APPENDIX 2 PHOTOGRAPHS OF AGRICULTURAL STYLE BUILDINGS

Photographs of Agricultural Style Buildings

Figure 1 Contemporary barn building with clad in metal sheet

Figure 2 Barn vernacular with dark weatherboard cladding

Figure 3 Large scale farm building with solar roof

Figure 4 Biomass centre with wooden cladding

Figure 5 Gas insulated Substation building clad in metal sheet

10 APPENDIX 3 PRELIMINARY DESIGN REPORT

Royal HaskoningDHV
Enhancing Society Together

VATTENFALL

Norfolk Boreas Offshore Wind Farm

Preliminary Design Report

Applicant: Norfolk Boreas Limited
Document Reference: ExA.AS-2.D14.V1
Deadline 14

Date: August 2020
Revision: Version 1
Author: Optimised Environments

Photo: Ormonde Offshore Wind Farm

Date	Issue No.	Remarks / Reason for Issue	Author	Checked	Approved
23/08/20	01	Response to Action 12 / Issue Specific Hearing 5	JP / LA	CD / AH	JL

Glossary of Acronyms

DAS	Design and Access Statement
DCO	Development Consent Order
EIA	Environmental Impact Assessment
HVDC	High Voltage Direct Current
LVIA	Landscpae and Visual Impact Assessment

Glossary of Terminology

Indicative mitigation planting	Areas identified for mitigation planting at the onshore project substation, Necton National Grid substation extension and the A47 junction.
National Grid substation extension	The permanent footprint of the National Grid substation extension.
Norfolk Boreas	Norfolk Boreas Wind Farm including the onshore and offshore infrastructure.
Norfolk Vanguard	Norfolk Vanguard Offshore Wind Farm, sister project of Norfolk Boreas.
Onshore project substation	A compound containing electrical equipment to enable connection to the National Grid. The substation will convert the exported power from HVDC to HVAC, to 400kV (grid voltage). This also contains equipment to help maintain stable grid voltage.
The Applicant	Norfolk Boreas Limited.

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1 Introduction

At the Issue Specific Hearing 5 for the Norfolk Boreas Offshore Wind Farm, held on 24th July 2020, a request was made by the Examining Authority, for the Applicant to provide further information regarding the design of the onshore project substation, in accordance with Action Point 12 as follows;

Action 12: Provide materials options for the converter halls and sketch design options for layout, massing and "agricultural style" for the proposed onshore project substation in light of more certainty regarding Norfolk Vanguard, for inclusion in the DAS.

In respect of Action 12 and in order to meet Deadline 14, this Preliminary Design Report has been prepared by OPEN with input from technical specialists at Vattenfall and Royal Haskoning DHV. It has been prepared as further information, which will guide and inform the Design Guide and the detailed design of the Norfolk Boreas onshore project substation. This document presents appropriate design options for the external architectural treatment of the convertor halls which form part of the onshore project substation, taking a responsive approach in respect of the characteristics of the local landscape.

It also considers consultation responses from local stakeholders, which overwhelmingly request that the onshore project substation be made as discreet as is physically possible. The preferred options presented will ensure that the onshore project substation is sensitive to the attributes of the local landscape, with visual impacts minimised as far as is practically possible through the use of appropriate design, building materials, layout, coloration and finishes, albeit whilst also complying with the exact functional requirements which must be adhered to, in order to fulfil performance, quality and safety standards associated with design and build of electrical infrastructure.

This Preliminary Design Report includes an overview of the approach taken based on the established design parameters and principles in existing documentation (Section 2); a review of the materials options for the convertor halls (Section 3); a colour analysis and review of potential façade colours for the external treatment of the convertor halls (Section 4); an overview of the zoning plan (Section 5) and how that could be reflected in an indicative onshore project substation site layout (Section 6) and conclusions relating to the proposed solution for the external appearance of the onshore project substation in terms of materials, colours and layout.

Figure 1: Photo of the Local Landscape 1

2 Approach

In terms of the detailed design of the onshore project substation, the initial stage of the approach needs to identify those aspects which present scope to explore alternative design options. The onshore project substation is a component of the electrical infrastructure. As such it has a specific set of functions, forming the terminal equipment to the high voltage direct current cables, and converting the direct current to alternating current for input into the National Grid.

The principal concern in the design of the onshore project substation, therefore, is that it meets its functional requirements and adheres to the safety, performance and efficiency standards that are set out in all relevant policy and guidance. Aspects typically considered in architectural design are set out below along with commentary regarding the potential scope for these aspects to undergo an exploration of design alternatives in respect of the onshore project substation.

2.1 Form and Mass

The form of the converter halls is determined by the space required to house the indoor components of the electrical infrastructure. The converter halls will, therefore, be no bigger than they are technically required to be to serve this function and within the maximum parameters defined by dDCO Requirement 16 (5); must not exceed a height of 19m above existing ground level and Requirement 16 (6); the total footprint of each convertor hall must not exceed 110m by 70m. The form of the converter halls will be determined by the rectangular footprint within which the electrical components are arranged. This layout determines a large rectangular building and while the shape of the roof presents various design options, the preferred option would be to use a traditional pitched roof as this would be most in-keeping with rural Norfolk. It would also reduce the perceived scale of the converter halls by drawing down the height of the wall heads, rather than building them up as would be required if a flat roof structure were to be used. While the scope for design options in terms of shape and mass are limited, Section 5 presents the Zoning Plan for the site, while Section 6 presents Isometric Visuals illustrating how the form and mass of the converter halls sit in the landscape.

2.2 Style

Large scale agricultural sheds are a common feature in the Norfolk landscape. The relatively flat and low-lying nature of the landscape means that these large structures can often appear exposed, apart from where woodland offers some form of screening. In order that the converter halls appear as discreet within their landscape setting, as is practically possible, it is proposed that this familiar style of functional shed is used. This will ensure that the converter halls do not appear as an unfamiliar style of building by paying reference to the many other modern-style sheds with a similar appearance. It would not be appropriate to mimic the more traditional style of agricultural sheds as they are of a much smaller scale and made of materials inappropriate for housing electrical infrastructure. The functional requirements of the converter halls limit the design options for the style of the architecture.

2.3 Materials

While the choice of materials for the construction of the converter halls will be largely influenced by their functional requirements, there is scope to explore a small range of options, which could potentially be appropriate. Section 3 sets out a comparative analysis of material options based on a set of criteria specific to the requirements of the converter halls, as well as other criteria including appearance, sustainability and cost.

2.4 Colours and Finishes

The choice of colours and finishes for the external surfaces of the converter halls presents the greatest scope in terms of alternative design options. These are explored in Section 4, where different colour options are applied to visualisations of the converter halls, in order to identify the most subtle appearance.

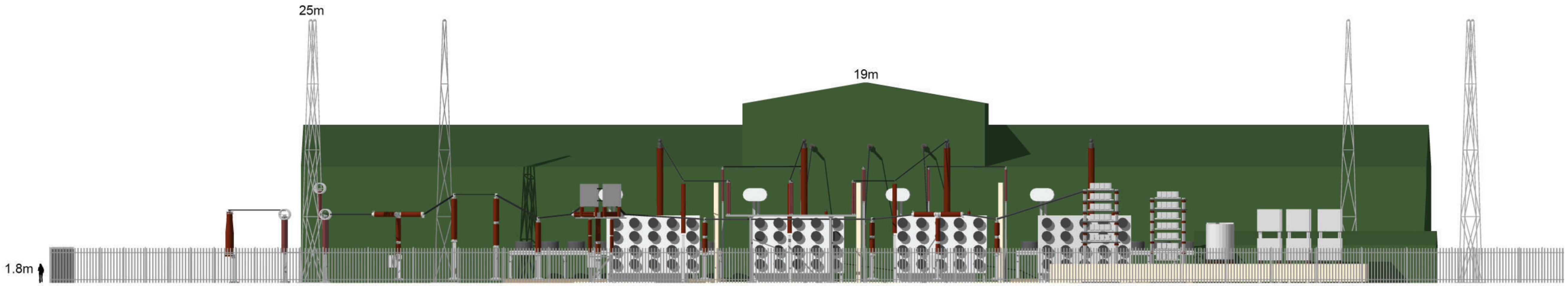

Figure 2: Elevational Visualisation of Model

3 Materials

Consideration of Material Options

In this section, a comparative analysis of potentially suitable materials is presented, based on the technical requirements of the converter halls, as well as other important considerations.

The key technical requirements of the materials to be used in the construction of the converter halls are set out below;

- Strong enough to form robust and secure large-scale structures;
- Fire resistant and able to withstand high temperatures without the structural integrity of the material being compromised;
- Resistant to severe weather conditions, including high winds, water ingress and heat waves;
- Forming surfaces and joints that are completely impermeable to water;
- Suitable to form the large spans and surfaces required to construct large structures;
- Sufficiently durable to withstand the impacts of a 30 year lifecycle; and
- Low maintenance.

In addition to these key requirements there are other criteria that need to be considered in the selection of materials, which include;

- Volumes required and associated costs;
- Extent of prefabrication or in-situ construction of materials and associated requirement for specialist skills on site;
- Sustainability in terms of extraction and manufacture, transportation, construction processes and end of lifecycle re-use or recycling; and
- Appearance of materials, in terms of colour, texture and reflectiveness.

The four different materials considered in this comparative assessment include masonry, timber, fibre cement and sheet steel. In this section of the report, each of these four materials is assessed against the key technical requirements and other criteria, set out above.

Figure 3: Materials **Source:** Dezeen, Switchgear Station, C.-F.-Moller

Figure 4: Materials **Source:** Virkkunen & Co Architects, Lauttasaari electrical substation

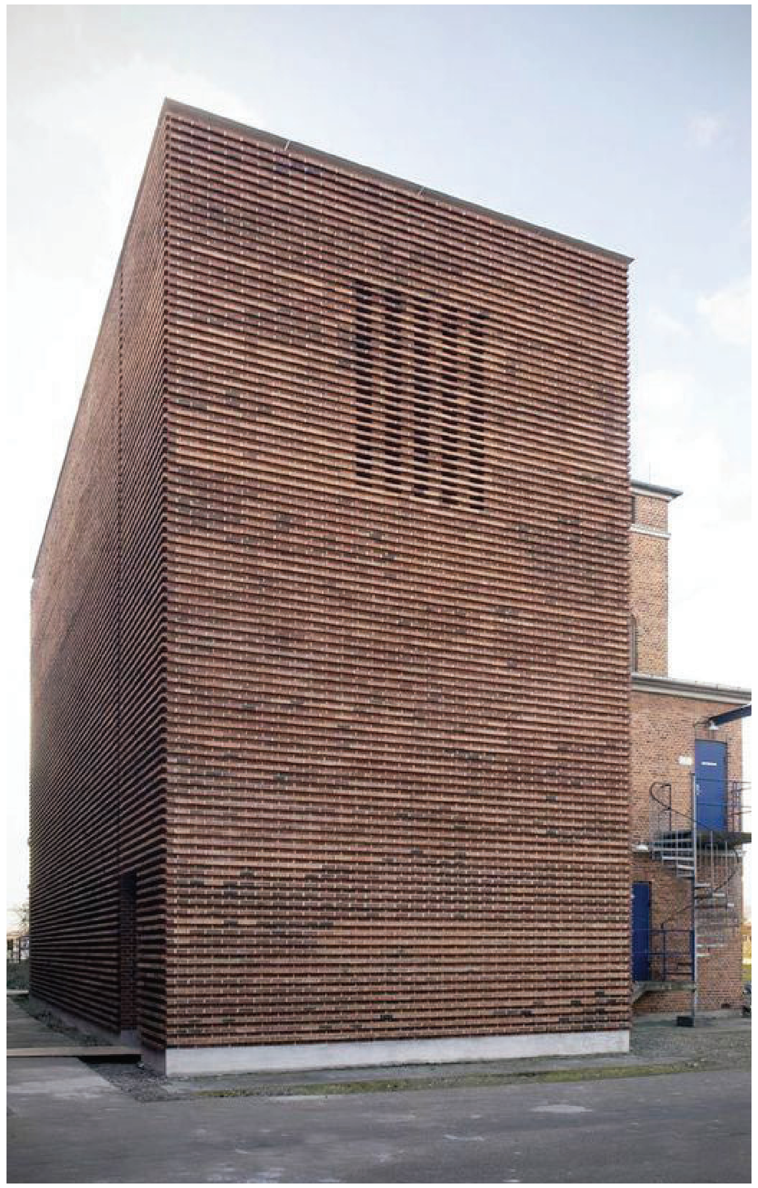

Figure 5: Materials **Source:** Gottlieb Paludan Architects, H.C.Ørsted Power Plant

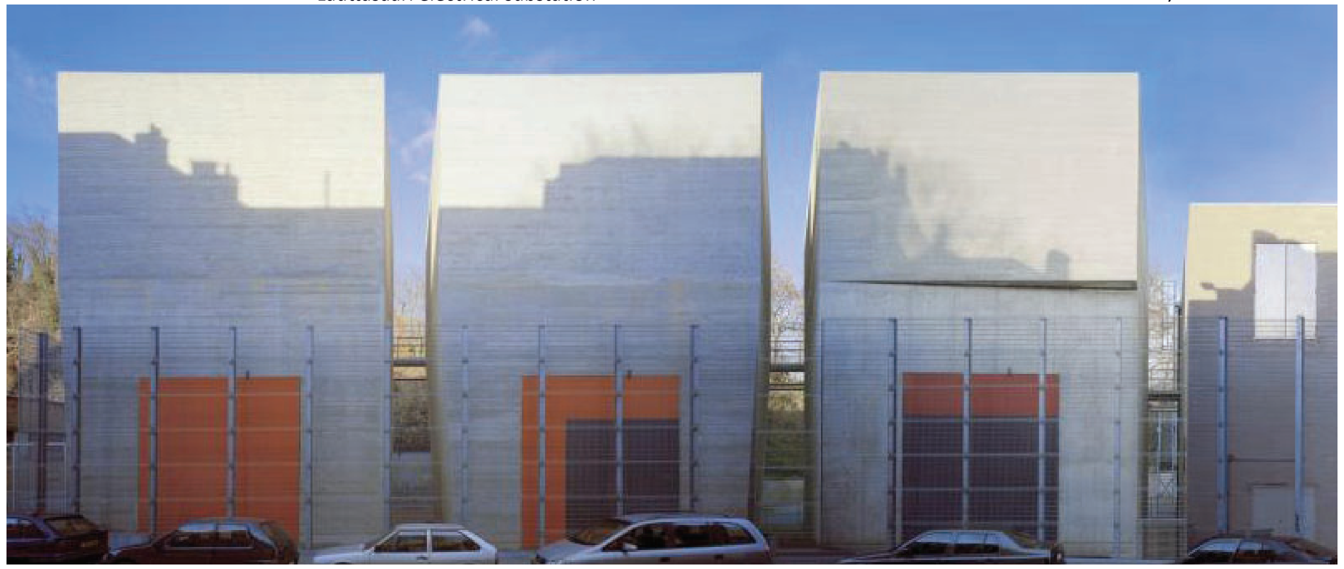

Figure 6: Materials **Source:** Substation Rou Pouplin (Dethier Architecture)

3.1 Masonry

Advantages

- Masonry can be used to build a strong and robust structure.
- Masonry is inherently fire resistant and can help keep the interior cool despite hot external conditions.
- Masonry provides good protection against severe weather conditions such as storms and heat waves.
- Masonry should provide a water-tight and impermeable structure, providing cavity walls and damp-proof courses are well-designed and carefully constructed.
- Masonry buildings are durable and low maintenance.
- It is possible to source most types of masonry relatively locally within the UK, thus reducing travel time, and masonry can be salvaged for re-use on other projects at the end of the lifecycle of the structures.

Disadvantages

- Masonry is not commonly used for such large-scale buildings in rural locations or to house electrical infrastructure.
- The colour range available is restricted to the natural colours of the materials or the colouring of the bricks.
- On site fabrication of large-scale buildings is time consuming and will increase the length of time for construction.
- Construction requires skilled tradespeople.
- All forms of masonry are comparatively more expensive, especially natural stone.
- The masonry just provides the external skin and an internal structure for support will still be required.

Figure 7: Masonry Example 1 **Source:** London Olympics Substation (NORD)

Figure 8: Masonry Example 2 **Source:** Marbjerg Waterworks, Roskilde_Gottlieb Paludan Architects

3.2 Timber

Advantages

- Timber is a renewable and recyclable material that can be sustainably sourced in the UK.
- Timber is a relatively low cost material that is readily available from local sources in the UK.
- If specified and detailed correctly, timber can provide a durable and relatively low maintenance material.
- Timber structures can be readily and quickly assembled on site from prefabricated sections and panels.
- The natural appearance of timber can fit well in a rural context where woodland and hedgerows provide enclosure.

Disadvantages

- Timber poses a serious fire risk in respect of the construction of the converter halls and would require special fire protection systems.
- Timber can be a high maintenance material which requires ongoing treatment to avoid deterioration in its appearance and structure.
- Timber can be susceptible to water leaks through joints, especially if flooding or storms occur.
- On site fabrication of large-scale buildings is time consuming and will increase the length of time for construction.
- The small scale of the wooden cladding can emphasis the large scale of the structure.
- An internal skin to the timber exterior is still required.
- Timber is susceptible to impact damage and insect attack if not properly treated.

Figure 9: Timber Example 1 **Source:** Sick & Fischbach Architects, warehouse in Ochsenhausen

Figure 10: Timber Example 2

3.3 Fibre Cement

Advantages

- Fibre cement provides a robust material that is fire resistant, relatively low maintenance and relatively durable.
- Fibre cement is a relatively low-cost material that is readily available from local manufacturers in the UK.
- Fibre cement structures can be readily and quickly assembled on site from prefabricated panels.
- Large scale sheds made from fibre cement are a common feature in rural landscapes.
- Fibre cement can be recycled at the end of the lifecycle of the structure.
- Fibre cement presents a subtle matt finish in relatively subdued shades of grey that can appear fairly discreet in landscape settings.

Disadvantages

- Fibre cement sheets are smaller than metal sheets and therefore require more time for construction.
- Fibre cement panels can be heavy which means a more robust structural support system is required and larger foundations.
- An internal skin to the fibre cement is still required.
- The high cement content reduces the sustainability of this material as cement requires the extraction and treatment of raw minerals.
- The colour range available is restricted to shades of grey unless colour specified for bespoke panels.
- Fibre cement is susceptible to impact damage.

Figure 11: Fibre Cement Example 1 Source: Marley Eternit

Figure 12: Fibre Cement Example 2 Source: Coverworld UKI

3.4 Sheet Metal

Advantages

- Sheet metal provides a robust material that is fire resistant, very low maintenance and durable.
- Sheet metal is a relatively low-cost material that is available from local manufacturers in the UK.
- Prefabricated sheet metal panels are large and lightweight and can be readily and quickly assembled on site.
- Large scale agricultural and industrial sheds made from sheet metal are a common feature in rural landscapes.
- Sheet metal can contain recycled steel and also be recycled at the end of the lifecycle of the structure for reuse on other structures.
- Sheet metal provides a complete cladding system with no additional layers required.
- Insulated sheet metal panels will last beyond the 30 year lifecycle of the converter halls.
- The colour range available is extensive with also different types of finish available, making colour matching to local contexts possible.

Disadvantages

- Sheet metal can present a reflective surface if the appropriate finishes and coatings are not applied.
- Corrugated sheet metal can present a utilitarian appearance that looks unfinished.
- The smooth appearance of sheet metal can lack the texture and interest of other materials such as timber or masonry.
- The extraction of raw materials and production of sheet metal reduces the sustainability of this material, especially if also imported from overseas.
- Sheet metal is susceptible to impact damage.

Figure 13: Sheet Metal Example 1 **Source:** Kingspan Corrugated Sheet, Asda Didcot Distribution Centre

Figure 14: Sheet Metal Example 2 **Source:** Unstudio Architects, Electricity substation (50/10 kV)

3.5 Materials Conclusions

The comparative analysis of materials demonstrates that sheet metal is the most appropriate material for the construction of the converter halls. This is largely owing to its high performance and safety standards, as well as the ease with which it can be constructed, its robustness, durability and low maintenance requirements, its existing use in surrounding agricultural buildings and the range of colours which enable a colour match with the local landscape, as presented in Section 4: Colours, below.

The visualisations presented below presents a comparison between the use of smooth sheet metal panels (Figure 15) and corrugated metal sheets (Figure 16). This shows that from the distances at which the converter halls are likely to be viewed, the differences will be largely indiscernible. The options regarding finishes, such as smooth or corrugated will be considered further in the Design Guide. These visualisations demonstrate the 'Dark Green' colour used in the EIA visualisations.

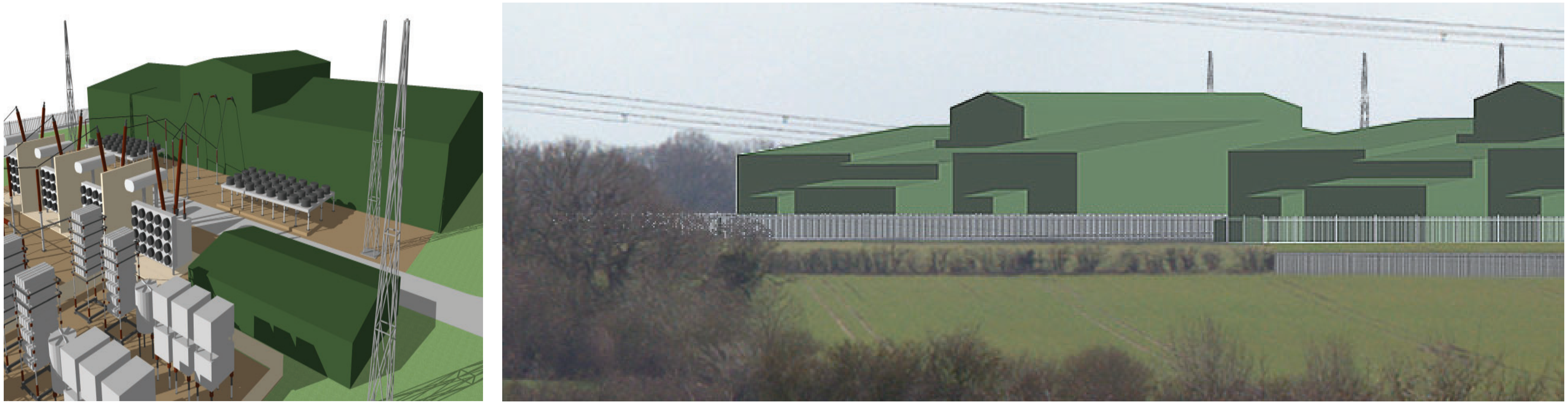

Figure 15: Smooth Finish Visualisation

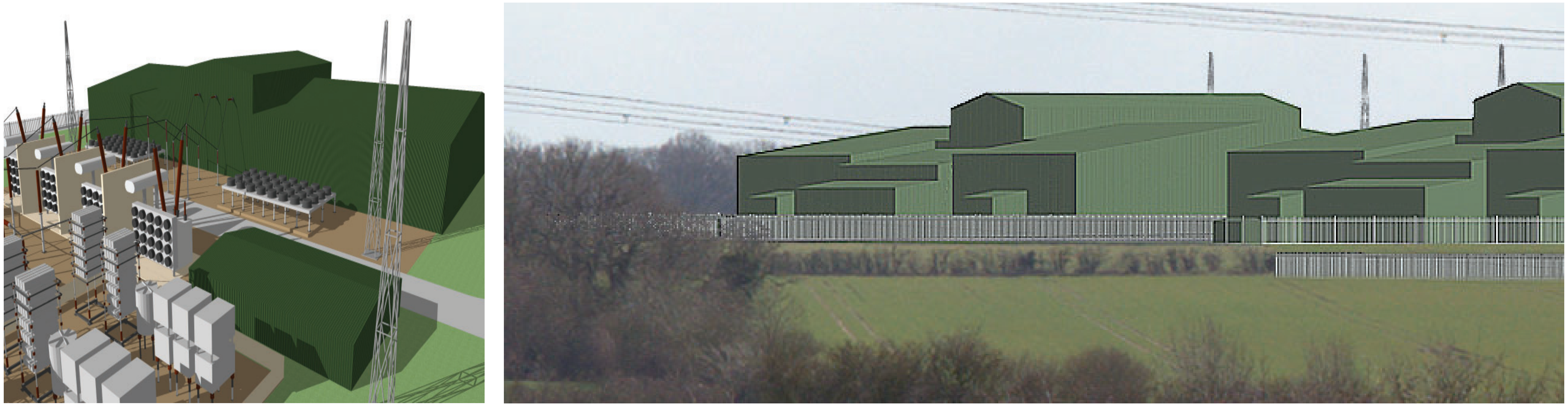

Figure 16: Corrugated Finish Visualisation

4 Colours

While the choice of materials to be used in the construction of the converter halls will be largely influenced by their functional requirements, the principal purpose in the selection of the colours and finishes is to ensure the converter halls are as discreet within their landscape setting, as is practically possible. The approach taken to test out various colour options, makes reference to the visual impact assessment carried out as part of the Norfolk Boreas EIA.

Those aspects of the assessment that are relevant to this report include an understanding of the extent to which the converter halls will be visible across the local landscapes and where this visibility coincides with roads, paths and settlements, thus highlighting those people whose views will be affected by the converter halls. These views are represented by the viewpoints used in the assessment. An understanding of how the converter halls are seen to sit within the landscape from these viewpoints is then important, in terms of whether they sit against an open skyline or enclosed woodland, as this will make a difference in terms of what colourings and finishes will work best to keep them as discreet as is practically possible.

Other important considerations include whether the converter halls are being viewed from the south or the north, as in views from the south they will be front-lit which means not only will colour choices appear brighter than in views from the north, but that finishes have a notable effect on the potential glare that can occur in views from the south. It is also important to remember how the colours in the landscape change, especially in a farmed landscape where rotational systems of crop growing can alter the colouration of the patchwork field pattern both seasonally and annually.

The process to explore the potential colour options combines an understanding of the colours present in the local landscape and the colours available in respect of the materials to be used. The comparative analysis of materials in Section 3 concluded that sheet metal clearly presented the most appropriate option in respect of the technical requirements of the converter halls. Sheet metal also presents a wide choice of colour options and finishes, which in terms of the design of the converter halls provides the scope to ensure a subtle and recessive appearance.

Figure 17: Photo of the Local Landscape 2

4.1 Colour Palette

Site work and photography have helped identify those colours that make up the farmed and wooded patchwork of the local landscape. These colours have been used as the basis for a colour match with the range of colours available as coatings for Kingspan metal sheeting. Rather than explore a broad range of colours, this analysis has looked to define a narrower range of more subtle and recessive colours that best match those colours in the local landscape, and in so doing will help to reduce the visual impact of the converter halls.

The colour palette presents the original dark green used in the EIA visualisations, along with eight alternative options. These are based on a natural, and relatively neutral palette of greens, greys and browns, all of which are suitably muted in tone. The visualisations on the following pages test out the colour options by applying these eight colours to the external surfaces of the converter halls. The viewpoint from the A47, opposite Spicer's Corner has been used, as, of all the EIA viewpoints, this shows the fullest extent of the converter halls. The Scenario 1 visualisation, used in the EIA, has been used to illustrate the different colour options. This is in order to ensure the visualisations illustrate the worst case scenario with the Norfolk Boreas and Norfolk Vanguard onshore project substations visible together.

While the visualisations show a single colour applied for each option, there is potentially scope to apply two or more colour options together. For example, a darker shade could be used around the lower level and a lighter colour around the upper level of the converter halls to enable the colours to better match the darker shades of the surrounding woodland and farmland and the lighter shades of the sky. Similarly, different colours could be used on the different aspects, for example, to enable the brighter front-lit sides to be toned down appropriately. This broader scope of colour selection will be explored further at the detailed design stage.

Figure 18: Colour Palette

4.2 Colour Options

Dark Green (shown in EIA visualisations)

Figure 19: Dark Green Visualisation

Figure 20: Camouflage Visualisation

Figure 21: Goosewing Grey Visualisation

Figure 22: Hollybush Visualisation

Figure 23: Khaki Green Visualisation

Figure 24: Merlin Grey Visualisation

Figure 25: Mushroom Visualisation

Colour Options

Figure 26: Olive Green Visualisation

Figure 27: Quartz Grey Visualisation

5 Zoning Plan

The Zoning Plans (as presented in Figures 9 and 10 of the Design and Access Statement) illustrate the basic principle underpinning the indicative layout of the site for each scenario; whereby the converter halls will be located in the northern part of the site and the outdoor electrical infrastructure will be located in the southern part of the site.

Figure 28 shows Scenario 1, in which the Norfolk Boreas and Norfolk Vanguard projects would be implemented (although only Norfolk Boreas is shown on the Zoning Plan), and Figure 29 shows Scenario 2 in which only the Norfolk Boreas project would be implemented.

In both scenarios the converter halls would be located in the northern part of the site. This arrangement is guided by the functional requirement for the converter hall to connect the incoming HVDC cables to the north and for the outdoor electrical equipment to connect the outgoing 400 kV cables to the south.

This arrangement also has the advantage of keeping the larger structures grouped together and furthest away from settlement to the south. Furthermore, this configuration has been designed to optimise the enclosure afforded by Necton Wood, which sits to the north of the site and which provides a natural backdrop in views from the south, as well as screen in views from the north.

The Zoning Plans will form the basis of the detailed design that will be implemented post-consent.

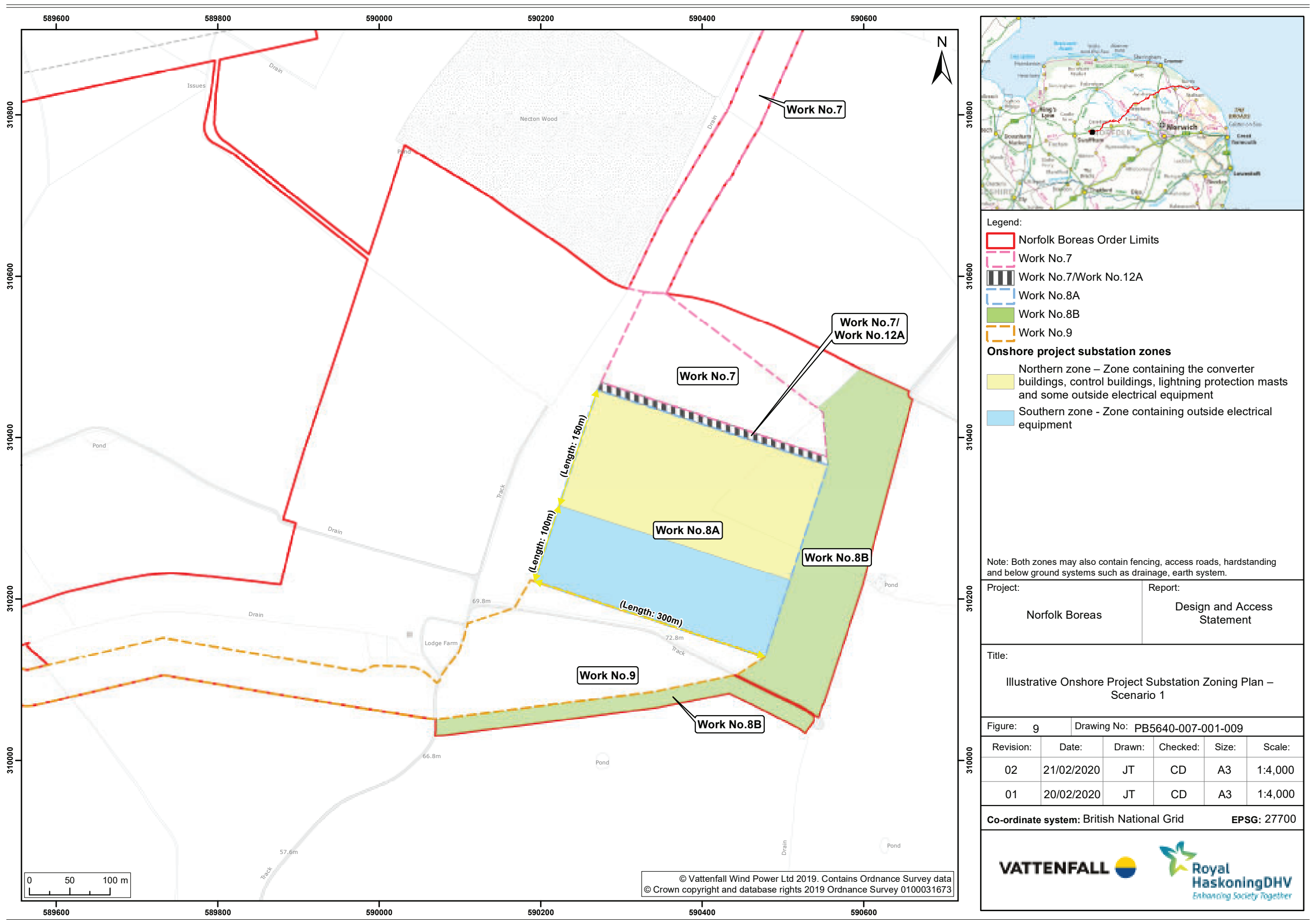

Figure 28: Scenario 1 Zoning Plan

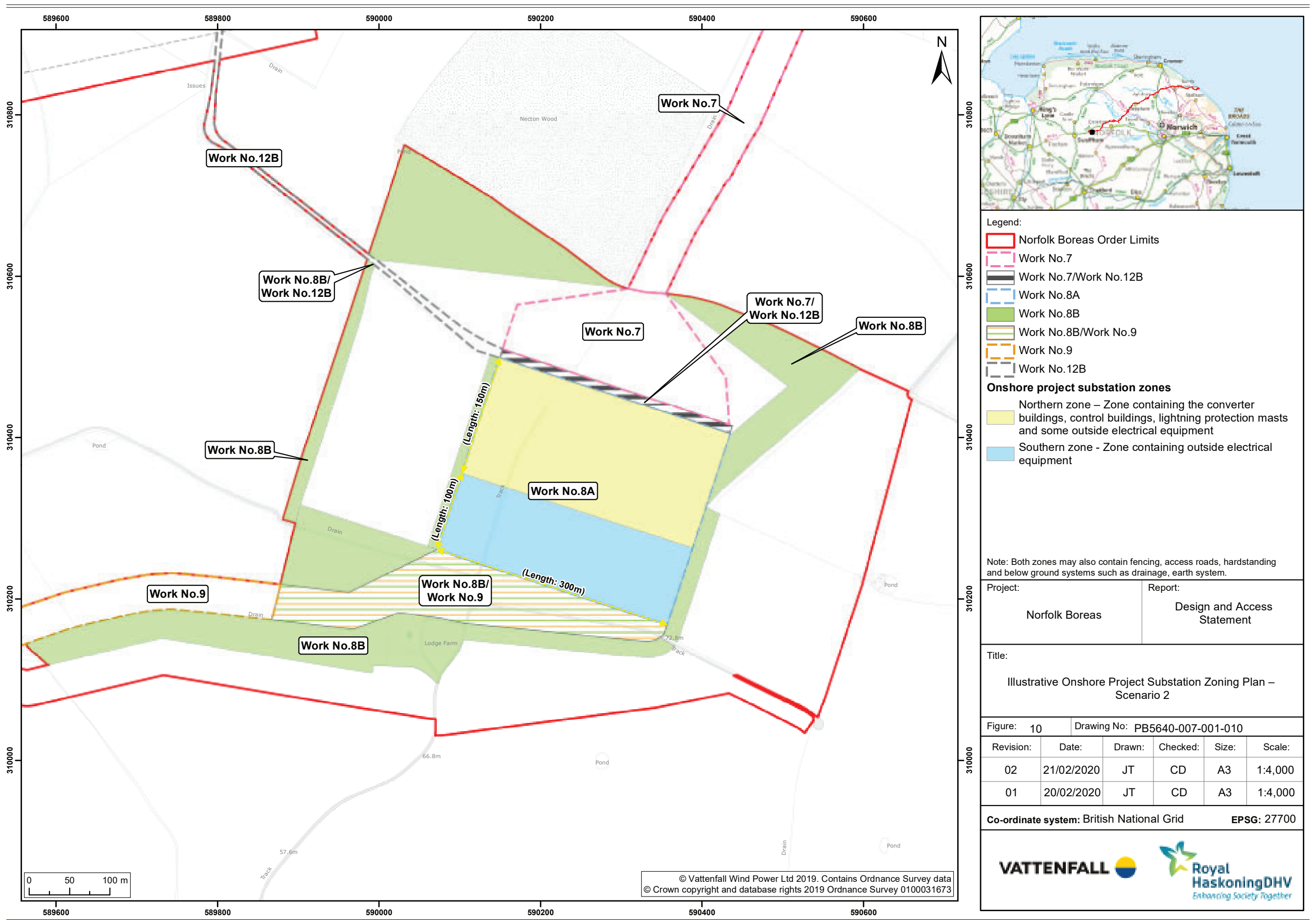

Figure 29: Scenario 2 Zoning Plan

6 Site Layout

Isometric visualisations have been prepared to illustrate how the Scenario 1 and Scenario 2 onshore project substations would sit in the landscape, as seen from a 'bird's eye view'. Figure 30 shows Scenario 1, in which the Norfolk Boreas and Norfolk Vanguard projects would be implemented, and Figure 31 shows Scenario 2 in which only the Norfolk Boreas project would be implemented.

The elevated viewpoint is positioned to the south-east of the site. The visualisations show the indicative model that was used in the EIA visualisations. While this presents an indicative interpretation of the onshore project substation, it does represent the key functional requirement underpinning the Zoning Plan, in which the converter halls are to be located in the northern part of the site, and the outdoor electrical infrastructure in the southern part.

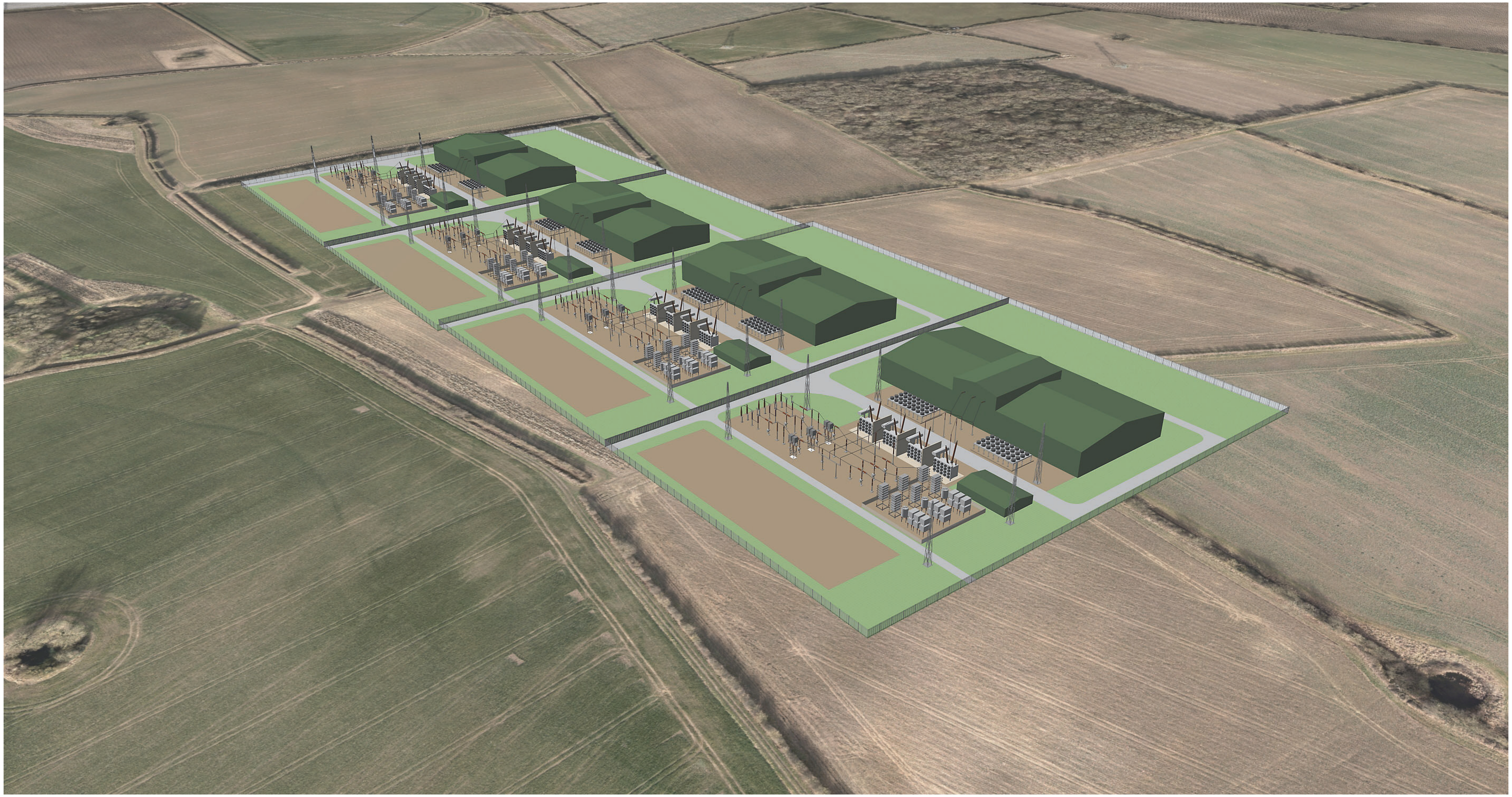

Figure 30: Scenario 1 Isometric Visualisation

Figure 31: Scenario 2 Isometric Visualisation

7 Summary

This Preliminary Design Report has been prepared in response to a request from the Examining Authority made as part of Norfolk Boreas Offshore Wind Farm Issue Specific Hearing 5. The request sought further information regarding the design of the converter halls, which form part of the onshore project substation. The detailed design of the converter halls will not be progressed until post consent, as new advancements in technology are likely to take place between application and post-consent stage, which could potentially make contemporary designs for the converter halls obsolete. Furthermore, detailed design requires the input of specialist contractors who are yet to be appointed.

The most important consideration in the design of the converter halls is that they meet the exact functional requirements as set out by Health and Safety obligations, Electrical Safety Regulations and electrical design specifications. These requirements inevitably impose restrictions in terms of the scope within which alternative design options can be explored. The size, form and mass of the converter halls will be determined by the size, form and mass of the electrical infrastructure they are required to house. In order to make these large buildings as discreet as is practically possible, the design must be simple and honest.

A modern-style shed structure presents the most suitable option as it will not draw undue attention, owing to the simplicity of its form and its association with the other similar modern-style shed structures, which are dispersed across the Norfolk landscape. It would also be somewhat dishonest to dress the converter halls up as a traditional farm sheds, when they are substantially larger and performing a completely different function. In respect of the suitability of traditional materials, such as timber, Section 3: Materials sets out the comparative disadvantages of using these materials in the construction of the converter halls.

While a comparative study has been used to explore the scope for alternative materials to be used in the construction of the converter halls, the outcome has been dictated by the very specific and stringent technical requirements associated with housing electrical infrastructure. Sheet metal is by far the most appropriate material, especially in light of the high performance and safety standards required when dealing with high voltage electrical infrastructure.

The colour and finishes for the materials, presents the most extensive scope, in terms of design options, with colour presenting the greatest scope for altering the appearance of the converter halls, as demonstrated by the colour test visualisations. This is why the focus of this report has been on the selection of colours and finishes that will help blend the converter halls in with the local landscape. To this end, the exploration of the colour options has highlighted the most subtle tones as being most appropriate.

This Preliminary Design Report sets out the initial parameters regarding the design options for the converter halls at the onshore project substation. Information in this report, as well as in the DAS, will be developed further as the project progresses and the iterative design evolves. This process and its outcomes will be documented in a Design Guide to accompany the final detailed design.