Viking Link: UK Onshore Scheme Planning Appeal

Core Document Reference 4.1

Strategic Options Report (NGVL)

VikingLink

nationalgrid

Strategic Options Report

Date: April 2016

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1. Introduction

Viking Link is a proposed 1,400 Mega Watt (MW) high voltage Direct Current (DC) electricity interconnector between the British and Danish high voltage electricity transmission networks. Viking Link will allow electricity to be exchanged between Great Britain (GB) and Denmark.

Viking Link will enable GB to trade energy as a commodity within the European Energy Market. This will strengthen GB's economy, improve security of electricity supply and provide access to cheaper, low carbon energy to GB's consumers.

Viking Link is also needed from a European Union (EU) energy policy perspective and will significantly contribute to market integration/sustainability/security of supply and competition.

The aim of this document is to outline how Bicker Fen was selected as the connection point in GB.

2. Strategic Overview

The EU and the United Kingdom (UK) Government support the continued integration of interconnectors as a means of providing a robust and resilient energy supply. The EU faces significant energy challenges which include the present dependency on fossil fuel generation and their contribution to global warming.

Interconnectors assist in improving GB's security of supply and are one of the technologies that can assist with the integration of low carbon generation. The UK Government recognises the important role they play to support energy security, affordability and decarbonisation objectives.

To reduce dependency on fossil fuels the EU has set out renewable energy and emissions targets to decarbonise the existing energy networks. Targets include a requirement for all EU states to have at least 10% interconnector capacity by 2020[1]. In addition, the European Commission (EC) has an ambition of arriving at a 15% electricity interconnection target by 2030[2].

The UK currently has 4 GW of interconnector capacity[3] which only represents 5% of the existing electricity generated[3]. When compared with other EU countries, GB is in the lower quartile of interconnector capacity.

In December 2013 the Government published a paper titled '*More interconnection: improving energy security and lowering bills*' which outlined the commitment to increase GB's interconnection capacity[4]. The paper highlights that interconnection has the potential to contribute to ensuring energy security, affordability and decarbonisation, whilst facilitating the single European electricity market. Government

[1] http://www2.nationalgrid.com/About-us/European-business-development/Interconnectors/
[2] http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/145356.pdf
[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/510525/2904569_NIDP_2016-2021_updated.pdf
[4] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/266460/More_interconnection_-_improving_energy_security_and_lowering_bills.pdf

supports the increase of interconnection capacity through projects that efficiently deliver on these objectives and believes that further interconnection is likely to be beneficial for GB and GB consumers, as well as European partners.

The recent National Infrastructure Commission (NIC) report titled '*Smart power*'[5] highlights that interconnectors allow GB to access low cost, low carbon power as well as providing the ability to export GB renewable energy during levels of high generation. The report goes on to state that interconnectors provide flexibility allowing large volumes of electricity to be moved from where it isn't needed to where it is which provides the potential to reduce wholesale electricity costs and improve security of supply. Interconnectors can enable GB to access low carbon electricity at a low cost.

Viking Link has been accepted as a Project of Common Interest (PCI) in accordance with the European Union's Trans-European Energy Regulation (the TEN-E Regulation)[6]. This means it should deliver significant benefits for at least two European Member States, further support market integration and competition, enhance security of energy supply and contribute to reducing carbon dioxide (CO_2) emissions.

Interconnectors like Viking Link can help address the challenges faced by GB and can bring many benefits, including:

- Improving diversity and security of energy supply – by enabling the import of electricity generated from neighbouring interconnected markets.
- Helping the UK Government meet its carbon reduction commitments by providing access to a well-developed, low cost renewable energy market.
- Lowering the cost of electricity through cross border trade in electricity and shared use of the cheapest generation sources. This can help consumers in an expensive market to benefit from cheaper imports.
- Increasing market for producers, such as wind power generators – interconnectors increase opportunities to sell electricity, reducing surplus and adding value
- Facilitating competition in the European market and the optimal use of resources across EU Member States.

3. What is an interconnector?

Electricity interconnectors are connections which allow electricity to flow between countries and markets, in the case of Viking Link via subsea cables, and can be used to import or export power as required. GB already has four interconnectors, linking us to France, Ireland, The Netherlands and Northern Ireland.

Renewable sources of generation, such as wind and tidal power, provide a way to reduce our carbon footprint whilst increasing our energy supply security. These types of energy resources fluctuate and are intermittent and the ability to match supply with demand becomes increasingly problematic. Other more flexible sources of power are required to help match demand and supply. Interconnectors which

[5] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/505218/IC_Energy_Report_web.pdf

[6] EU Regulation 347/2013 on guidelines for trans-European energy infrastructure (TEN-E Regulation) came into force on 17 April 2013. The TEN-E Regulation helps build and finance the EU's priority energy infrastructure projects in order to connect EU countries currently isolated from European energy markets, strengthen existing cross border interconnections, and help integrate renewable energy supply.

can import or export power to/from neighbouring European and Scandinavian countries are ideally placed to play an important and crucial role in this challenge.

3.1. Viking Link

Viking Link is a DC electricity interconnector between the British and Danish high voltage electricity transmission networks, approximately 760 kilometres in total length it is planned to be operational by 2022. The submarine cables will cross through UK, Dutch, German and Danish territorial waters (reference Figure 1).

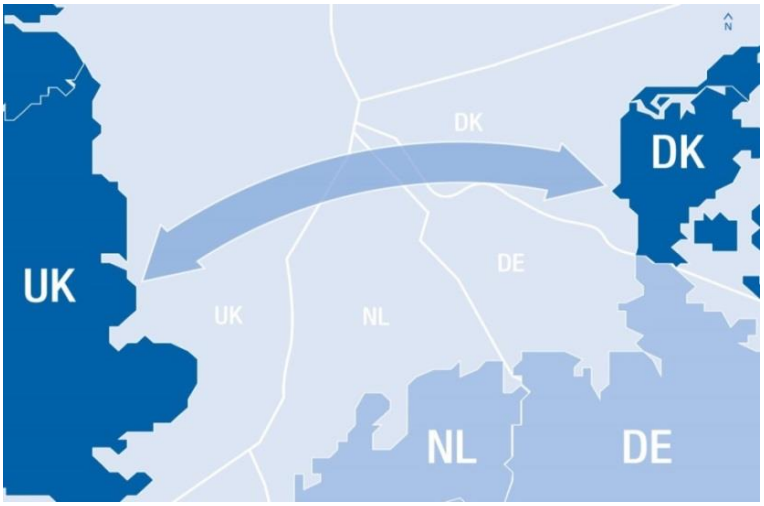

Figure 1 Map of territorial waters to be crossed

The Viking Link interconnector would be made up of a pair of submarine and underground onshore cables connected to a converter station in each country. The converter station in GB will be connected to the substation by up to six high voltage Alternating Current (AC) underground cables. Electricity would be able to flow in either direction between GB and Denmark. Figure 2 shows the main parts of the proposed interconnector project.

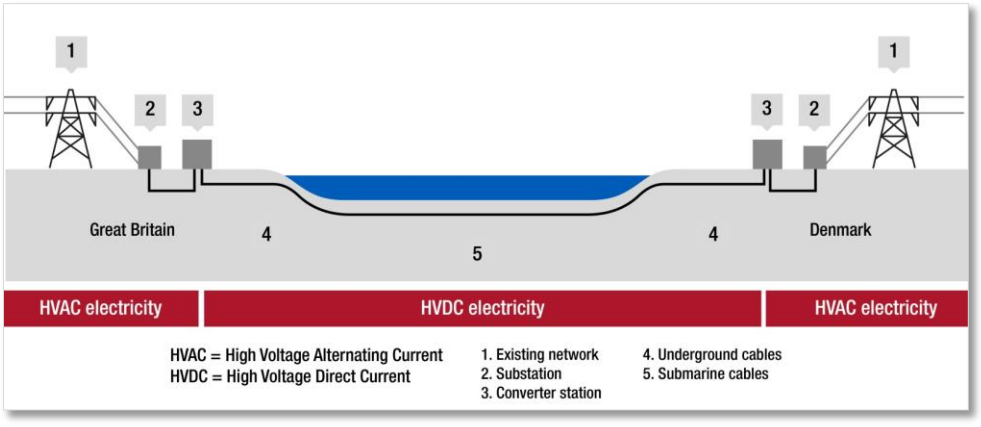

Figure 2 Schematic diagram of Viking Link project

In summary, the GB part of the project would comprise:

- Switchgear in an existing National Grid Electricity Transmission (NGET) 400 kilo Volt (kV) substation on the high voltage electricity transmission network.
- HVAC underground cables from the NGET 400kV substation to the converter station.
- An AC / DC converter station.
- DC onshore buried cables (comprising two cables and a fibre optic cable) connecting the converter station to the submarine cables.
- DC submarine cables (comprising two cables and a fibre optic cable) in the intertidal areas and offshore.

The project is being jointly developed between National Grid Viking Link Limited (NGVL) and Energinet.dk as a 50:50 partnership.

National Grid Viking Link Limited is a wholly owned subsidiary of National Grid Group and is legally separate from National Grid Electricity Transmission Plc (NGET) which has the licence to own and operate the high voltage electricity transmission system in England and Wales. In 2014, NGVL was granted an interconnector licence by the Regulator Ofgem.

Energinet.dk is an independent public enterprise owned by the Danish state as represented by the Ministry of Energy, Utilities and Climate. It owns, operates and develops the Danish electricity and gas transmission systems. Energinet.dk has extensive experience owning, building, operating and maintaining DC interconnectors reaching back to 1965.

3.2. Why connect to Denmark?

Denmark, which forms part of the Nord Pool power market, is connected to Norway, Sweden and Germany. These countries are all sources of low cost energy from hydro, nuclear and wind generation. Connecting to Denmark therefore provides access to a low cost market with prices set by a diversified energy mix from across Scandinavia and Northern Germany.

4. GB Connection Location

The connection location for any interconnector project is derived through a balance of the overall connection distance and the existing network infrastructure (i.e. ability to accommodate the connection capacity and requirement for network reinforcements) along with other factors such as environmental constraints.

4.1. Interaction with NGET

Viking Link has followed the same process that any other connectee to the GB high voltage electricity transmission network would. To secure a connection to the high voltage electricity transmission network, Viking Link applied to NGET for a connection offer in accordance with the Connection and Use of System Code (CUSC). In reaching a Connection Offer, Viking Link complied with NGET's

Construction and Infrastructure Option Note (CION) process[7] to identify the optimal connection location.

> **Note –** Viking Link initially applied for and accepted an offer for a 1,000 MW interconnector. Viking Link then applied for and accepted an offer to increase the capacity to 1,400 MW to optimise the interconnector design. NGET reassessed the work conducted as part of its initial assessments and has confirmed that it has remained valid for the increase in capacity to 1,400 MW.

NGET conducted a comparative assessment of the possible connection options on the GB high voltage electricity transmission network for Viking Link. The assessment facilitated the identification of a preferred connection point based on a range of technical, regulatory and economic factors. The NGET assessment considered a broad range of possible future energy scenarios to inform the process which included a range of possible outcomes, projected power station closures and likely network developments.

4.2. Connection point assessment

In order to identify viable connection points, Viking Link consulted NGET to assess GB's existing network capability to accept the proposed interconnector. Initially the following 19 possible connection points across the East of England were considered by NGET:

1. Existing Creyke Beck 400 kV substation.
2. Existing Saltend North 275 kV substation.
3. Existing Saltend South 275 kV substation.
4. Existing Hedon 275 kV substation.
5. Existing Killingholme 400 kV substation.
6. Existing Humber Refinery 400 kV substation.
7. Existing South Humber Bank 400 kV substation.
8. Existing Grimsby West 400 kV substation.
9. Existing Keadby 400 kV substation.
10. Existing West Burton 400 kV substation.
11. Existing Cottam 400 kV substation.
12. Existing Bicker Fen 400 kV substation.
13. Existing Spalding North 400 kV substation.
14. Existing Walpole 400 kV substation.
15. Existing Bramford 400 kV substation.
16. Existing Norwich Main 400 kV substation.
17. Existing Sizewell 400 kV substation.
18. Proposed Necton 400 kV substation.
19. Proposed Eye 400 kV substation.

Possible connection points south of the Thames Estuary were not considered due to the additional offshore route length required to access this area from Denmark.

Reference Appendix A for an overview of the connection point assessment.

[7] http://www2.nationalgrid.com/uk/services/electricity-connections/policies-and-guidance/ (**CION Process Guidance Note - Issue 002, dated 4th March 2015**).

NGET conducted a Connection Point Selection Assessment through which it was identified that all locations above what is referred to as the '*Boundary B8*' on the GB System, as indicated in Figure 3, would require extensive system reinforcement. The need for additional network reinforcements would increase cost to the GB consumer and would present a significant risk to the Viking Link project. On this basis, '*Boundary B8*' formed the northern limit of the assessment study and all connection points above this were not taken forward, reducing the list of possible connection points to the following:

1. Existing West Burton 400 kV substation.
2. Existing Cottam 400 kV substation.
3. Existing Bicker Fen 400 kV substation.
4. Existing Spalding North 400 kV substation.
5. Existing Walpole 400 kV substation.
6. Existing Bramford 400 kV substation.
7. Existing Norwich Main 400 kV substation.
8. Existing Sizewell 400 kV substation.
9. Proposed Necton 400 kV substation.
10. Proposed Eye 400 kV substation.

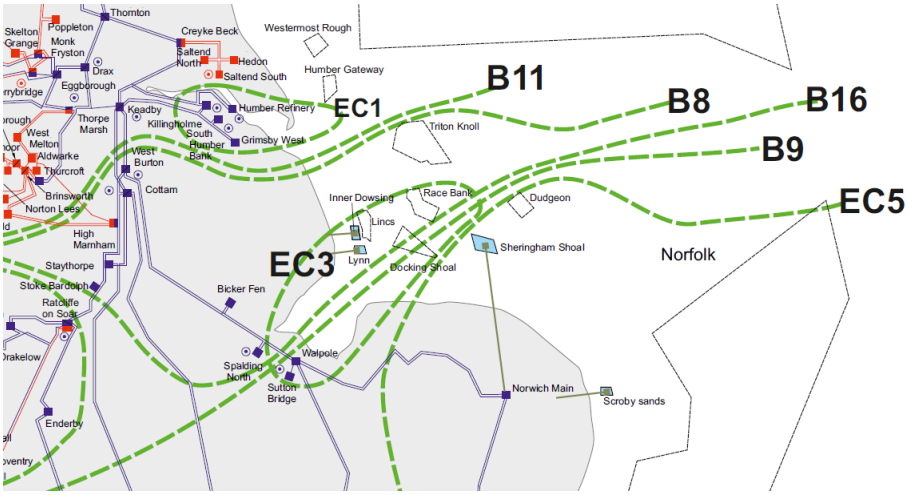

Figure 3 Schematic of the transmission high voltage network in the East of England[8]

Due to the two existing power stations connected at Spalding North 400 kV substation, NGET considered that connection of Viking Link at Spalding North would require system reinforcement such as the development of new transmission circuits.

Preliminary work undertaken by Viking Link identified that connecting into the existing Walpole 400 kV substation would require the routeing of the submarine cables through The Wash, which is acknowledged as an extremely sensitive area environmentally and ecologically of international and national importance. Viking Link would be unlikely to get consent for development within the area of The Wash whilst there were other feasible options which avoid such an important protected site.

On this basis, Spalding North and Walpole were not considered further as part of the Connection Point Selection Assessment as other feasible options were identified and the list of possible connection points was reduced to the following eight:

[8] Extract from Appendix A in the 2015 Electricity Ten Year Statement (http://www2.nationalgrid.com/UK/Industry-information/Future-of-Energy/Electricity-Ten-Year-Statement/)

1. Existing West Burton 400 kV substation.
2. Existing Cottam 400 kV substation.
3. Existing Bicker Fen 400 kV substation.
4. Existing Bramford 400 kV substation.
5. Existing Norwich Main 400 kV substation.
6. Existing Sizewell 400 kV substation.
7. Proposed Necton 400 kV substation.
8. Proposed Eye 400 kV substation.

The remaining eight possible connection points were subject to a comparative study to consider the costs of the various connection point options and to determine the optimal connection point which presents the overall best value to the GB customer.

The comparative project cost for each of the possible connection points were considered by Viking Link.

NGET conducted an economic appraisal to compare potential future cost impacts associated with each possible connection point based on a range of possible future outcomes to inform the assessment process and to identify the connection point options that performed well across a range of scenarios.

The analysis identified that there could be a significant increase in future operating costs for the high voltage electricity transmission network if the connection point was to the east of the East Anglia '*EC5 boundary*' on the GB System, as indicated in Figure 4. Connecting at substations at Necton, Norwich Main, Eye, or Sizewell, would require the development of new transmission circuits.

The proposed connection points at Necton, Norwich Main, Eye, Sizewell and Bramford were not considered further as they would not meet either NGET's or Viking Link's statutory obligations.

This reduced the viable connection point options to the following three:

1. Existing West Burton 400 kV substation.
2. Existing Cottam 400 kV substation.
3. Existing Bicker Fen 400 kV substation.

All three of the viable connection points would require a landfall being made along the Lincolnshire coastline north of The Wash.

A connection at either West Burton or Cottam would result in an underground cable route in excess of 70 kilometres from the Lincolnshire coast whilst a connection to Bicker Fen would result in a cable route of approximately 50 kilometres. The additional cable length would represent an increase in capital cost to the Viking Link project, extends the construction programme and increases disruption on the locality during construction.

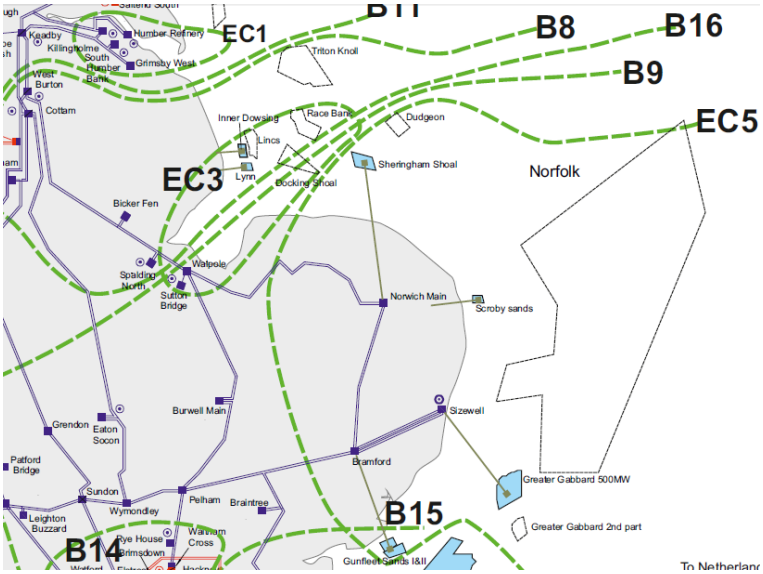

Figure 4 Schematic of the East Anglia part of the high voltage electricity network[9]

5. Conclusion

Viking Link has gone through a robust optioneering process with NGET to arrive at Bicker Fen as being the preferred connection point. There are no wider network reinforcement works such as additional transmission circuits directly attributable to Viking Link connecting at Bicker Fen.

Bicker Fen was taken forward on the basis it offered the best balance between technical, environmental and economic obligations for NGET and Viking Link and also offered the best value for GB consumers.

[9] Extract from Appendix A in the 2015 Electricity Ten Year Statement (http://www2.nationalgrid.com/UK/Industry-information/Future-of-Energy/Electricity-Ten-Year-Statement/)

6. Glossary

Definition of Terms

AC	Alternating Current
CO_2	Carbon dioxide
CION	Construction and Infrastructure Option Note
CUSC	Connection and Use of System Code
DC	Direct Current
DE	German (from Figure 1)
DK	Denmark (from Figure 1)
EC	European Commission
EU	European Union
GB	Great Britain
NGET	National Grid Electricity Transmission plc
NGVL	National Grid Viking Link Limited
NIC	National Infrastructure Commission
NL	Netherlands/Dutch (from Figure 1)
PCI	Project of Common Interest
TEN-E	European Union's Trans-European Energy Regulation
TSO	Transmission System Operator
UK	United Kingdom

Units

kV	kilo Volt (1,000 Volts = 1 x 10^3 Volts)
MW	Mega Watt (1,000,000 Watts = 1 x 10^6 Watts)

7. Appendix A: Overview of the connection point assessment