Consultancy support for the NEMO Interconnector

Cost assessment report

Project No. 378029

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Glossary of terms and abbreviations

Abbreviation	Meaning
AC	Alternating Current
AIS	Air Insulated Switchgear
CACM	Capacity Allocation and Congestion Management
CREG	La Commission de Régulation de l'Electricité et du Gaz Commissie voor de Regulering van de Elektriciteit en het Gas Commission for the Regulation of Electricity and Gas
CSC	Current Source Converters
CT	Current Transformer
CUSC	Connection and Use of System Code
DC	Direct Current
DTS	Distributed Temperature Sensing
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
Elia	Electricity Transmission Operator (Belgium)
EPC	Engineering Procurement and Construction
EU	European Union
FCA	Forward Capacity Allocation
FEU	Forced Energy Unavailability
FIDIC	International Federation of Consulting Engineers
FTE	Full Time Equivalent
GIS	Gas Insulated Switchgear
HVDC	High Voltage Direct Current
IGBT	Insulated Gate Bipolar Transistor
ITT	Invitation to Tender
JDA	Joint Development Agreement
kV	Volts x 10^3
LCC	Line Commutated Converters
MCAA	Marine and Coastal Access Act
MI	Mass Impregnated (Paper cable insulation)
MLWM	Mean Low Water Mark
MSC	Mechanical Switched Capacitors
MUMM	Management Unit of the North Sea Mathematical Models

MW	Watts x 10^6
NGET	National Grid Electricity Transmission (Great Britain)
NGIL	National Grid International Ltd
NGNLL	National Grid Nemo Link Ltd
NRA	National Regulatory Authority
NSCOGI	North Sea Countries Offshore Grid Initiative
O & M	Operating and Maintenance
Ofgem	Office of Gas and Electricity Markets
PQQ	Prequalification Questionnaire
SCADA	System Control and Data Acquisition
SEU	Scheduled Energy Unavailability
SHE	Safety, Health and Environment
SVC	Static VAR Compensation
SWA	Service and Warranty Agreement
TJP	Transition Joint Pit
TSO	Transmission System Operator
UK	United Kingdom
VSC	Voltage Source Converter
VT	Voltage Transformer
w/c	Week commencing
XLPE	Cross-linked Polyethylene (Cable insulation)

Executive summary

National Grid Nemo Link Ltd (NGNLL) and the Belgian Electricity Transmission Operator (Elia) are proposing an electrical interconnector (to be known as the Nemo Interconnector) between Britain and Belgium in order to provide a connection between the respective transmission networks. The interconnector will consist of subsea and underground HVDC cables, connected to a converter station and electricity substation in each country.

Unlike existing interconnectors from the UK where investment was realised via the merchant approach, it is proposed that the Nemo Interconnector will come under the regulatory regime with revenues effectively underwritten by customers. Consequently, and to fulfil its statutory obligations, Ofgem, working with the Belgian Regulator CREG (Commission for the Regulation of Electricity and Gas), has engaged British Power International to carry out a review of the Project costs and assess whether or not they can be deemed economic and reasonable. The report draws upon a number of sources including a Cost Template and more than 50 responses to requests for information from the developers. However, the level of detail, explanation and substantiation, for the most part, has been both limited and cursory.

The developers have carried out a thorough feasibility process with respect to the selection of the converter station sites and cable landfalls in each country together with the marine cable route. After selection of the preferred route and converter sites the developers subsequently carried out a number of detailed surveys and studies both to prove the route and to provide sufficient information to proceed to the tender stage. Generally we believe the development work carried out to date to be appropriate for this scale of project. However, we also consider that some of the initial 'optioneering' feasibility studies and employee costs are not directly associated with the Nemo project and should therefore be removed from the allowable costs.

The developers have followed an established procurement process, including a pre-qualification process, in order to ensure quality and value for money to the extent possible. Appropriate suppliers have been invited to tender for the supply and installation of either the converters or the cable, or both items. Functional specifications have been issued and we believe this should enable suppliers to utilise their standard designs which will result in competitive prices. The major contracts are based on the FIDIC Silver model which is used extensively in offshore industries for large EPC projects. [redacted] The balance of risk between the EPC contractor and the developers, and hence contract price, will not be known until the contract negotiations are complete.

There are two converter technologies currently available to meet the requirements of the Nemo interconnector, namely Line Commutated (LCC) or the newer Voltage Source (VSC). The developers have selected VSC for a number of technical reasons and also to minimise the grid infrastructure reinforcement that would be required for an LCC arrangement. Nonetheless, on a like-for-like basis, LCC is the cheaper option and it is our recommendation, therefore, that this should be used for setting the capital cost allowance. Tenders for capital works are based on a 40 year asset life but the proposed regulatory regime is for 20 to 25 years. We do not believe that there would be a significant cost premium, if any arising from the difference between a 40 year tender requirement and the shorter regulatory life.

From a review of the developer's project costs it is apparent that, as a general theme, the forecasts provided are very conservative and include a generous element of contingency to allow for unforeseen circumstances. In our view, they represent a significant over-estimation. The developer's staff numbers provided to us for the construction and operational phases appear to be on the high side as do the individual employee costs. Additionally we believe there are a number of items, including the on-going maintenance, insurance, rents and rates etc that have been overestimated. We also have reservations about making an allowance for the decommissioning and removal of the sub-sea cable which, in all likelihood, will not be required.

Generally there is little supporting information for the costs that have been presented so we have reduced the costs in order to reflect the above comments. These are shown in tabulated form later in this Report. We believe that the revised costs more accurately reflect the likely outturn on the information available and would recommend their use until such time that the developers are able to provide further justification.

Our assessment of reasonable costs over the regulatory lifetime of the project is significantly lower than the forecasts provided by the developers. Our overall assessment (which includes development costs, construction costs, decommissioning and operating costs) is in the order of 35% lower than those provided by the developers on a like for like basis. Details are set out in Section 15 of this report.

End of section

1. Introduction

Note: For the purposes of this report the developers NGNLL together with Elia are referred to collectively as 'Nemo' and the Nemo Interconnector Project itself as 'the Project'.

1.1 Background

National Grid Nemo Link Ltd (NGNLL)[1] and the Belgium Electricity Transmission Operator (Elia) are proposing an electrical interconnector (to be known as the Nemo Interconnector) between Britain and Belgium in order to provide a connection between the respective transmission networks.

The interconnector will consist of subsea and underground HVDC cables, connected to a converter station and electricity substation in each country, to facilitate the transfer of power in either direction between the two countries. The capacity will be in the order of 1,000MW. Within the UK it is proposed that the converter station and substation will be constructed on part of the site formerly occupied by the Richborough Power Station in Kent, and a similar arrangement will be constructed in Belgium at Zeebrugge.

Unlike existing interconnectors from the UK where investment was realised via the merchant approach, it is proposed that the Nemo Interconnector will come under the regulatory regime with revenues effectively underwritten by customers. For this purpose a new 'Cap and Floor Regime' has been developed and this is outlined briefly in section 1.2. It is therefore necessary for Ofgem and CREG to ensure that the interconnector costs represent value for money. Consequently and to fulfil statutory obligations, Ofgem, working together with CREG, engaged British Power International to carry out a review of the Project costs and assess whether or not they can be deemed economic and reasonable. In respect of the Cap and Floor Regime, BPI was asked to give an opinion as to which costs might be considered to be allowable. The costs to be evaluated include the capital costs for the development and construction phases, the on-going operating costs for the life of the interconnector and decommissioning costs.

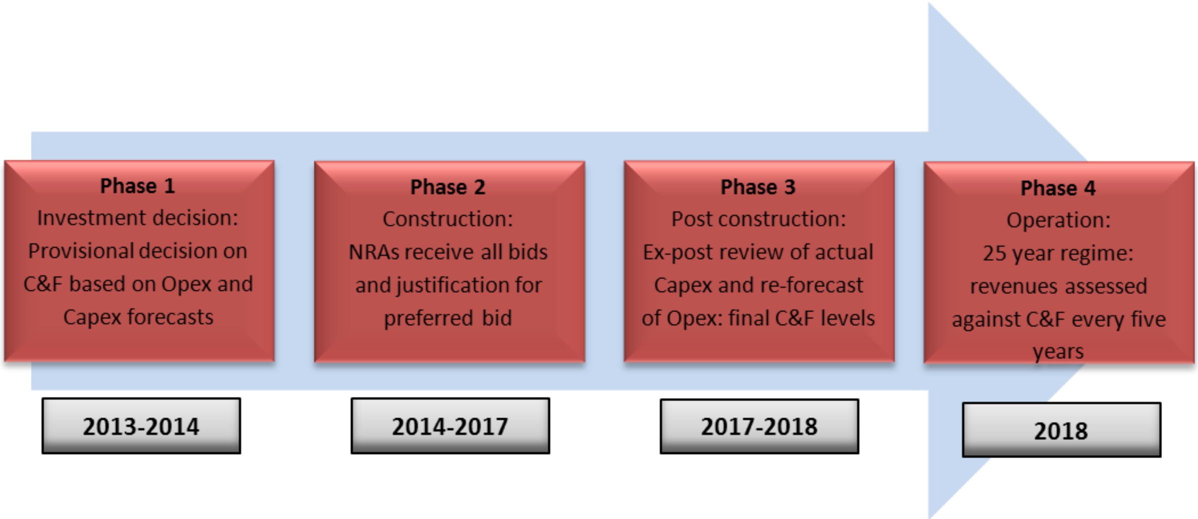
1.2 The Cap and Floor Regime

Ofgem and CREG have developed a new regulatory regime for interconnector investment. The intention is that it will be applied for the first time to this Project. The proposed approach for a cap and floor mechanism, intended to offer a predictable and stable framework within which investment can be made, is set out in Ofgem's consultation paper[2], published in March 2013. The mechanism effectively guarantees income for the asset owners between the cap and floor levels. Revenues earned above the cap will be returned to consumers and revenues below the floor level will require an additional payment from consumers via Transmission Use of System Charges.

The proposed regime is to be of a 20 or 25 year duration. The levels of the cap and floor will be flat in real terms, being set ex-ante and remaining fixed for the regime duration. The levels will be set through a cost based approach, using a regulatory asset value model as in onshore price controls in GB and Europe. The costs which are used to compute the cap and floor will be based upon an ex-post review of capital costs and an ex-ante review of operating costs (ie before the event). Figure 1 shows the proposed timing of regulatory decisions set out in the consultation paper.

[1] National Grid Nemo Link Ltd is a subsidiary company of National Grid plc for the development of the Nemo link.
[2] Cap and Floor Regime for Regulated Electricity Interconnector Investment for application to project NEMO, Consultation, March 2013, Ofgem.

Figure 1: Timing of regulatory decisions based on NEMO project time plan



Source: Ofgem Consultation Paper 'Cap and Floor Regime for Regulated Electricity Interconnector Investment for application to project NEMO', March 2013

1.3 About the cost review process

The process for this cost review required us to gather information from a variety of sources and then to review, compare, conclude and recommend. Information sources included the Cost Template spreadsheet completed by Nemo, more than 50 responses to requests for information provided by Nemo (some of which are mentioned or referenced specifically in this Report[3]), meetings with Nemo representatives at Ofgem's offices, information provided by Ofgem, information in the public domain and, finally, our own information, knowledge and experience.

We understand that whether or not the Project goes ahead depends crucially upon the eventual outturn of the Cap and Floor Regime. We therefore expected detailed information, cost breakdowns, risk registers, Board Papers and so on (which naturally would have been treated in total confidence by us). After all, the purpose of this Report is to help Ofgem and CREG determine appropriate levels for the Cap and Floor Regime (underwritten by customers) which, in turn, will help Nemo and the Project.

Although Nemo has provided responses to our various requests for information, the level of detail (such as the lack of disaggregated capex forecast), explanation and substantiation, for the most part, has been both limited and cursory. This was very disappointing and, in our experience of delivering similar projects, not at all what we expected from the Nemo partners who are both leading international companies and major transmission operators. The interconnector is a project of stature requiring a significant investment of money and resources.

As a consequence of the lack of detailed information and justification for decisions, numbers, costs etc, we have had to make assumptions on cost and other issues which might have been avoided had more detailed information been available to us. It must be remembered that this cost assessment process (or any other in similar circumstances) is necessary because the Project will be underwritten by electricity customers via the Cap and Floor Regime. Therefore NRAs must be involved as they have a duty to customers to ensure that the costs that they are being asked to underwrite are fair and appropriate. If any developer of a project is expecting it to be underwritten in this way, the developer must expect 'public' scrutiny and challenge in just the same way that private investors would scrutinise costs and challenge assumptions and plans if funding were sought from commercial

[3] Each information request carried a reference number in the form PH1_0xx where 'xx' represents the sequentially numbered document.

lenders. This process is essentially a public Due Diligence instead of a private one and electricity customers are entitled to the same level of investigation and protection.

For the process to work to the optimum it requires the full co-operation and participation of the developer. When reviewing this process for application to future projects we believe that NRAs should consider how to ensure that developers engage in it fully. Doubtless there are various methods that might be considered across a spectrum depending upon the degree of authority and compulsion that NRAs might wish to exert, although an atmosphere of full and willing participation would be preferable.

1.4 About this Report

This Report is intended to support Phase 1 of the process to provide an indication of the level of reasonable and economic costs that may be used to determine preliminary cap and floor levels. The costs will be subject to refinement as outcomes become clearer, particularly following the conclusion of the tender process for the capital works and after the construction stage.

Although this Report has been commissioned by Ofgem and CREG to address specific Terms of Reference, our view was that it should be capable of being read as a 'stand-alone' document, so it was important to describe the background to the Project and the work that has taken place in order to bring it to its current situation in October 2013 where tenders have been received only recently from a number of competing prospective contractors. Having set out the background we provide assessments of the technical issues, the procurement process and the treatment of risk. We conclude with a review of Nemo's forecast of costs and our own assessment and estimate of costs for the project including some recommendations as to those cost items that we believe may (or may not) be allowable under the Cap and Floor Regime.

1.5 Introduction to BPI

British Power International (BPI) has over 30 years' experience in the planning, development, operation and management of electric power systems.

Originally known as British Electricity International (BEI), a subsidiary of the UK Electricity Council, BPI was originally established to provide consultancy services to UK and overseas electricity suppliers and network operators using existing resources and staff from within the UK's Electricity Supply Industry. Following the privatisation of the UK's Electricity Supply Industry the ownership of BEI was transferred to National Power, the largest of the newly created generating companies and later to Eastern Group that later became TXU Europe. In 1999 BPI became independent from TXU following a management buy-out by the existing successful management team and the business was re-named British Power International.

BPI is now the consultancy and design arm of the Freedom Group, part of the EnServe Group, a leading provider of infrastructure support services to the Utility and Energy sectors with an annual turnover of £300 million. Consultancy work is undertaken in isolation from the rest of the group and physical and procedural controls are in place to preserve confidentiality of information.

As well as offering proven technical and economics consultancy expertise, we bring a practical understanding of how power systems work in a broad spectrum of operational environments, market conditions and patterns of ownership. We provide advice to governments, regulatory authorities and agencies as well as to private sector companies, banks, donors and funding agencies.

Our expertise extends from strategic advice on all aspects of power generation, transmission and distribution, through to power markets and regulation and the impact of energy production and utilisation on the environment. BPI's services range from policy, technical, and commercial issues through to management development and training.

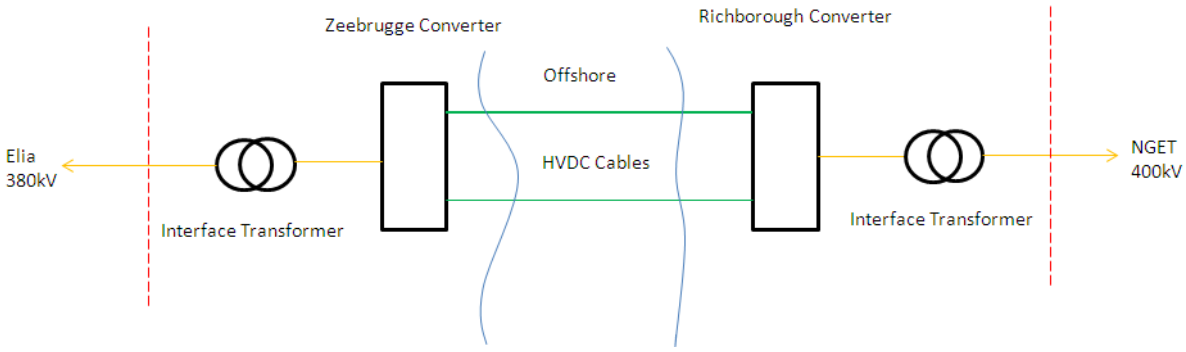
End of section

2. Project description

2.1 Scope

A 1,000MW subsea electricity interconnector is being jointly developed by NGNLL and the Belgian transmission company Elia. The project, known as the Nemo Link, will connect the UK and Belgian electricity transmission systems by means of subsea cables between Richborough, Kent and West Zeebrugge in Belgium. It is proposed that the Nemo Link will become operational in 2018. The interconnector is shown diagrammatically in Figure 2.

Figure 2: Diagrammatic representation of the Nemo interconnector



It is proposed that the interconnector will utilise HVDC technology and consist of the following main components:

- HVDC subsea cables laid between the landfall points at Richborough and Zeebrugge (Figure 3);
- HVDC cables laid between landfall at Richborough and the UK converter station (Figure 3);
- HVDC cables laid between landfall at Zeebrugge and the Belgian converter station (Figure 5);
- Identical converter stations at Richborough and Zeebrugge comprising a symmetrical monopole arrangement and utilising Voltage Source Converters;
- Interface transformers to facilitate a connection to the UK Grid and to that in Belgium;
- Associated switchgear and ancillary equipment.

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Figure 3: Proposed offshore cable route

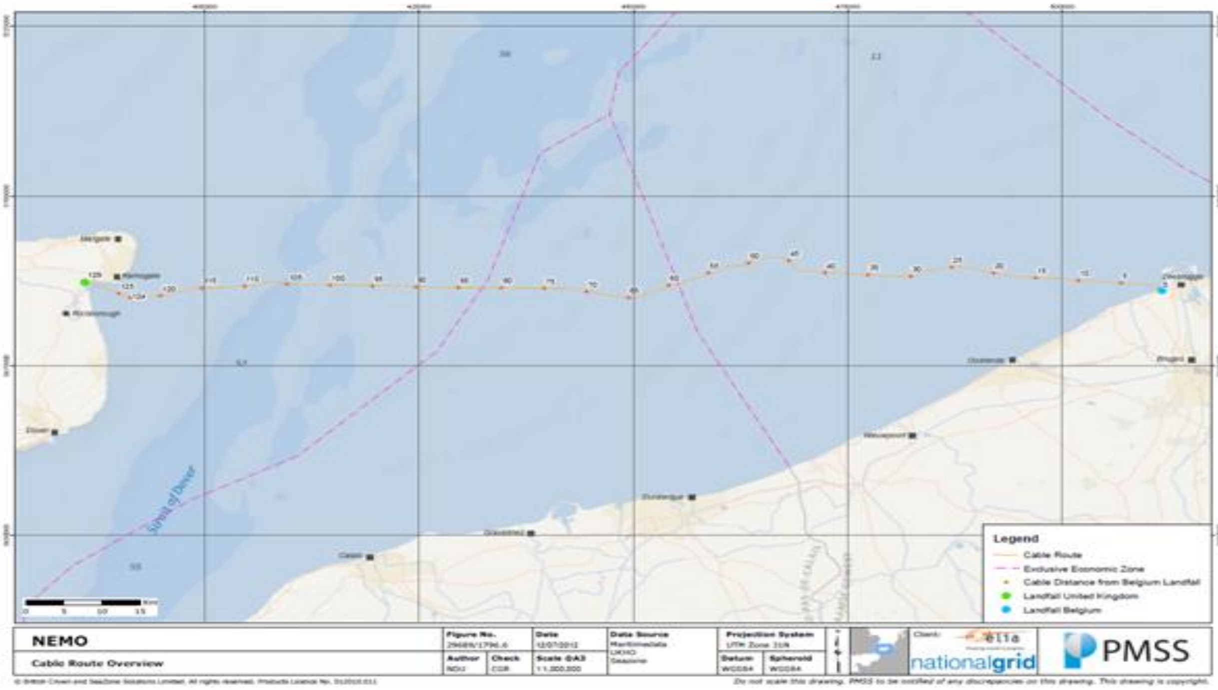


Figure 4: Proposed onshore cable route Richborough

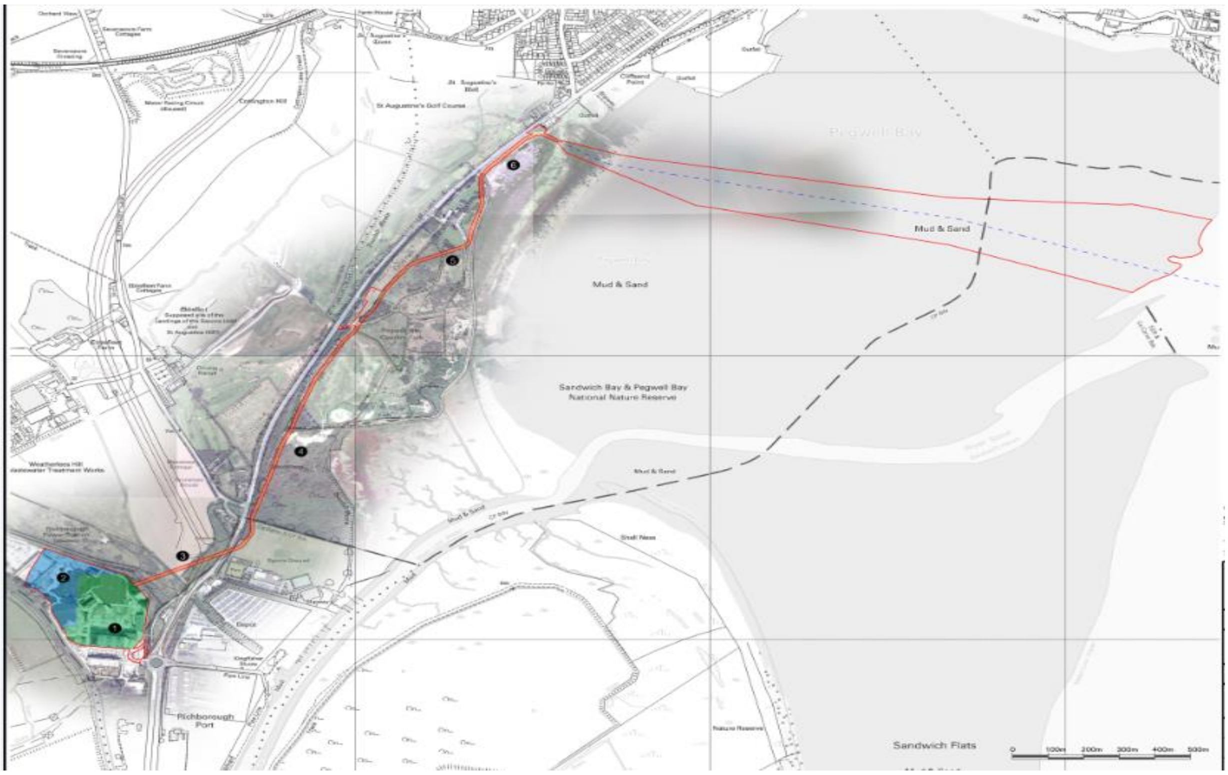
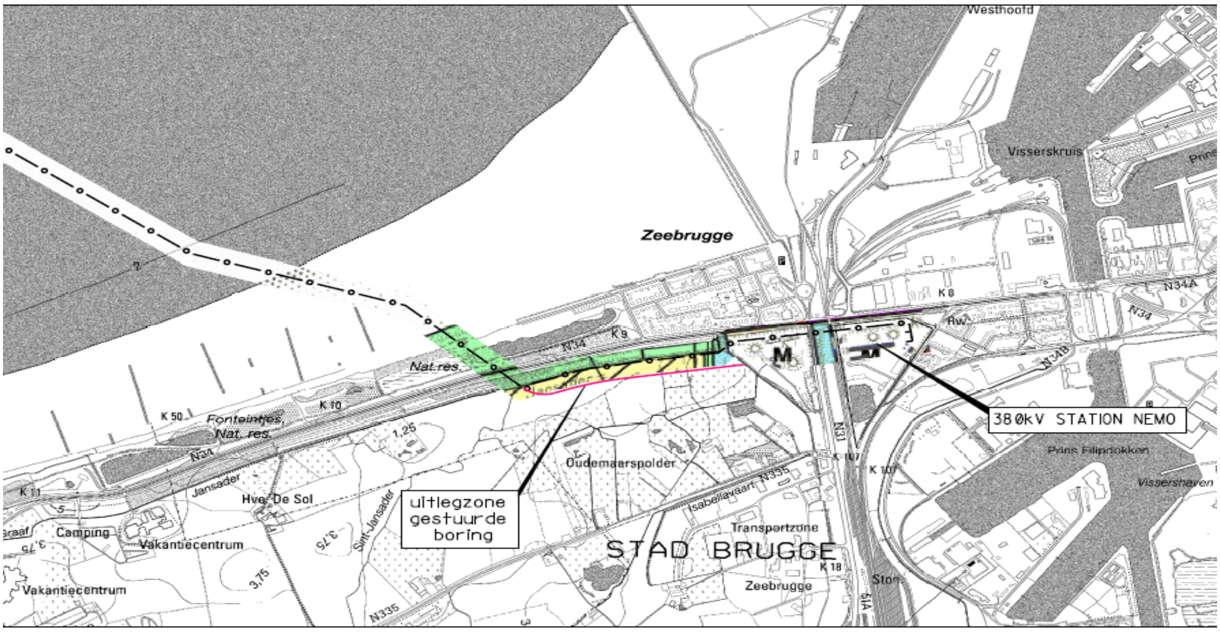


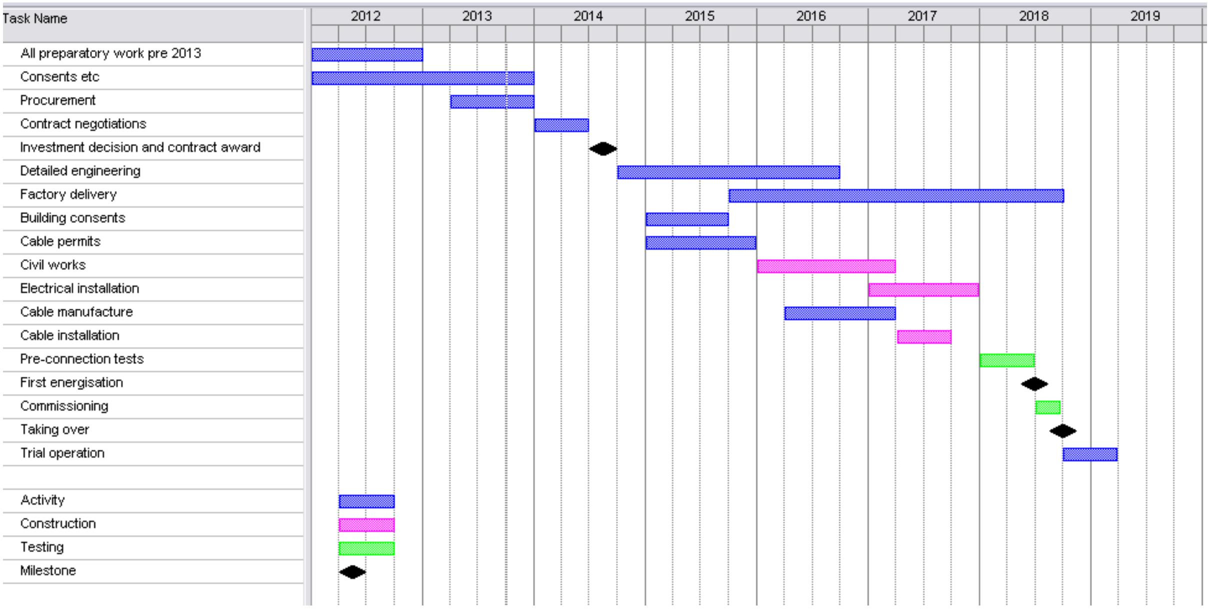
Figure 5: Proposed onshore cable route Zeebrugge



2.2 Programme

The Nemo project is expected to generally follow the development and construction timetable as shown in Figure 6 (a simplified version of a more detailed timetable supplied by Nemo under Request for Information PH1_014).

Figure 6: Nemo project timetable (simplified)



Some of the main tasks worth mentioning:

1. The construction tenders were issued to short listed suppliers for submission by 31 July 2013 and there was an extension of the submission date to 23 September;

2. Contract negotiations are expected to be complete by the end of the second quarter of 2014;
3. Contract award will immediately follow on – mid 2014;
4. Detailed engineering is scheduled for 2015 and 2016;
5. Construction will commence first quarter of 2016;
6. Cable installation will take place during the [redacted];
7. Commissioning will be carried out in the third quarter of 2018;
8. The NGET grid connection is planned for 2018
9. Operations scheduled for final quarter of 2018.

From the information supplied by Nemo, the timing of the project is driven both by the energy market and partly by factors which are specific to the project. Accordingly Nemo considers that the benefits of the interconnector[4] can only be realised if it is commissioned by 2018. An earlier date is not possible due to the earliest date by which NGET can offer a connection to the UK Grid.

End of section

[4] The benefits of the Nemo Project are further discussed in Section 4.

3. The developers

In October 2007 Elia System Operator SA, the Belgian transmission operator company, and National Grid International Ltd (a subsidiary of National Grid plc, the group responsible for the delivery of both gas and electricity across Great Britain) signed a Joint Development Agreement (JDA) to investigate the feasibility of developing an electrical interconnector between Britain and Belgium. Under the terms set out in the JDA, a common Steering Committee was appointed in order to steer the project from a pre-development stage into signing the main investment contracts. If the project goes ahead to construction and implementation the JDA will be replaced by a contract.

Under the British electricity regulatory system development of an interconnector is a licensable activity. The Electricity Act does not allow the holder of a Transmission Licence to hold additionally an Interconnector Licence. National Grid Electricity Transmission plc (a subsidiary of National Grid plc) holds a Transmission Licence in respect of its ownership and operation of the transmission system in Great Britain. Consequently, National Grid plc has established a company to hold the Interconnector Licence and to be a partner in the consortium[5]. The new company is called National Grid Nemo Link Limited (NGNLL). NGNLL was granted an Interconnector Licence for the Nemo Link by Ofgem in March 2013.

End of section

[5] National Grid has two other subsidiaries participating in Joint Ventures to operate interconnectors:

- National Grid Interconnectors Limited which, with Reseau de Transport d'Electricite, jointly owns and operates an interconnector between the UK and France known as IFA (Interconnexion France Angleterre); and
- National Grid Holdings One plc which, with the Dutch Transmission System Operator TenneT, owns and operates BritNed Development Limited which is a interconnector between the UK and the Netherlands known as BritNed.

4. Background and need case

The electricity industry in Great Britain will undergo much change over the next few years as several coal fired power stations are retired and significant nuclear capacity comes to the end of its operating life. The UK Government's plan to provide secure and affordable electricity supplies into the future involve the construction of nuclear generation and the expansion of renewable energy, mainly offshore wind. It is likely the UK will require its generating mix to incorporate 34% of wind generating capacity by 2020.

However, in isolation wind generation is, by its very nature, intermittent and it is therefore necessary to develop an electricity system that can respond to changes in generating output. Interconnectors between states can provide an effective way to manage these fluctuations in supply and demand.

European strategy recognises the need to upgrade Europe's energy infrastructure and in particular to interconnect across borders in order to meet the EU's core energy policy objectives of competitiveness, sustainability and security of supply. Specifically it is recognised that interconnectors are a prime mechanism for the transport and balancing of electricity generated by renewable sources. Additionally the EU recognises that interconnectors are able to help facilitate a competitive and well-functioning integrated market for energy. Consequently the EU back in 2002 set a target for all Member States to have interconnections equivalent to at least 10% of their installed generation capacity by 2005. Currently UK interconnection capacity amounts to about 4% of installed capacity.

In December 2009, the UK and Belgium both became signatories to the North Sea Countries Offshore Grid Initiative (NSCOGI) with the objective to coordinate offshore wind and infrastructure developments in the North Sea. Interconnection between countries is a prerequisite to achieving this.

A number of interconnector projects are underway in the UK including connections to Norway and the Republic of Ireland. These will supplement the three existing UK interconnectors to France, the Netherlands, and Northern Ireland. However, Nemo believes, for the reasons stated above, there is a requirement for additional interconnector capacity and that a UK–Belgium interconnector has many advantages, viz.

- To reduce the risks associated with a single point connection it is considered prudent to interconnect the UK to different parts of Europe;
- The geographical proximity of Belgium to the UK; after France it provides the shortest subsea cable route;
- The Belgium electricity transmission is highly connected to Central Europe;

Nemo has produced a forceful and persuasive argument to support the case for an interconnector between the UK and Belgium. However, the Nemo interconnector remains a commercial venture which, under the cap and floor regime, will be underwritten by the electricity consumer. No matter how compelling the technical justification for interconnectors generally and Nemo in particular, the project will no doubt only proceed if the project remains commercially viable for Nemo on the one side, whilst on the other the regulators are satisfied of a satisfactory outcome for consumers. An extract from Nemo's Needs Case is set out as Appendix 1 to this Report.

End of section

5. Feasibility studies

5.1 Overall

From the information provided by Nemo we believe that it has carried out a thorough feasibility process with respect to the selection of the converter station sites and cable landfalls in each country together with the marine cable route. This has enabled Nemo to make an objective and informed decision taking account of all the information available from the various surveys and studies. These are described below.

However, although these studies are comprehensive in nature, we believe that the early feasibilities studies would be part of assessing project options and future business strategic choices and so would be part of a corporate planning process rather than for the Nemo project specifically.

5.2 UK landfall and converter station site

Nemo identified the following criteria for the siting of a converter station, so it was important that sites selected for investigation fulfilled them as far as possible. The criteria were:

- A site of approximately 4 hectares;
- The potential for securing the necessary consents and licences;
- The scale of anticipated environmental effects and the sensitivity of the environment;
- Whether appropriate interest in land may be available for each potential converter station site (purchase or long lease);
- The feasibility of an appropriate high voltage alternating current (HVAC) connection to the grid system from the converter station; and
- The feasibility of an appropriate high voltage direct current (HVDC) connection between the converter station and a suitable subsea cables landfall.

Prior to 2006 ten potential sites (from an initial group of 28) were under consideration in Suffolk, Essex and Kent together with the potential landfall sites along those county coastlines. The eventual choice, Richborough, did not appear on the original list but was added subsequently as an eleventh option. The eleven sites under consideration are shown in Table 1.

Table 1: Potential grid connections and landfalls considered in 2006-2007

Ref	Grid connection point	Landfall
1	Sizewell NGET 400kV substation	Sizewell
2	Bramford NGET 400kV substation	Vicinity of Felixstowe
3	Bradwell NGET 275kV substation	Bradwell
4	Rayleigh NGET 400kV substation	Shellhaven
5	Shellhaven (Thames Gateway)	Shellhaven
6	Grain NGET 400kV substation	Grain
7	Kemsley NGET 400kV substation	Swale estuary or north of the Isle of Sheppey
8	Cleve Hill NGET 400kV substation	Cleve Hill
9	Canterbury North 400kV NGET	Richborough
10	Sellindge NGET 400kV substation	Folkestone area
11	Richborough	Richborough

The sites under consideration as potential landfalls were in locations where there appeared to be a sufficient absence of built development to allow cables to be brought ashore and to be routed to the potential connection point.

Initial investigations were carried out primarily by desktop analysis and site visits to areas that showed potential on paper. Later, during 2007, the land ownership of some sites was investigated. Stakeholder opinion was sought from local planning authorities, Natural England and the Environment Agency. Using all of this information and the stakeholder feedback an interim report on the feasibility of all options was prepared and a shortlist drawn up comprising Kemsley, Shellhaven and Richborough.

Having shortlisted these three, there followed further consultation during 2007 with the relevant local planning authorities (Canterbury City Council, Dover District Council, Swale Borough Council and Thanet District Council), Natural England, the Environment Agency and Kent Wildlife Trust. The announcement of the Thames Gateway development in 2007 ruled out Shellhaven as an option leaving only two potential sites.

In 2006 Kemsley seemed preferable for a variety of reasons; useable land close to the NGET 400kV substation, good highway access and nearby large industrial buildings. However, Kemsley was eventually rejected because for three main reasons:

- The anticipated detrimental effects upon areas designated for nature conservation and employment coupled with a consequent lack of local planning authority support;
- Difficulties with the cable landing and onshore routeing due to wetlands designated for nature conservation value; and
- Land ownership investigations in 2007 leading to a conclusion that there was no suitable parcel of land.

In late 2007 Richborough appeared most favourable from a planning perspective being a brown field site allocated for re-use. Additionally, the landowner was willing to sell and the nearby landfall site at Pegwell Bay supported the most direct marine cable connection to West Zeebrugge. Nevertheless, there were two potential issues. First, the landfall site presented nature conservation difficulties, but as the cables from the Thanet Offshore Wind Farm had been successfully installed nearby this issues was considered to be low risk. The second issue concerned the route of the connection from the converter at Richborough to the NGET 400kV substation at Canterbury for access to the national grid. There were a number of ecological constraints in the area together with residential and business developments but Nemo considered that a connection would be possible nonetheless. Taking account of all relevant issues Nemo selected Richborough as the preferred site.

There were six landfall options under consideration. Following a review of the alternatives taking consideration of the technical and environmental assessments, the cable landfall selected was near to Pegwell Bay Service Station South, an area to the south of the petrol station located at the west of Pegwell Bay on the A256. The subsea cables would be installed beneath the inter-tidal mudflats from low water to a Transition Joint Pit (TJP) south of the Service Station in an area of degraded saltmarsh. The subsea cables would be connected by joints to the onshore underground cables.

The optimum onshore underground cables route from the landfall to the Richborough site was identified from an initial feasibility study. Specific factors taken into account included:

- Designated sites of nature conservation;
- Presence of protected species;
- Proximity to residential areas;
- Archaeology;
- Highways;

- Planning proposals;
- Watercourses;
- Risk of encountering contamination;
- Utilities and services; and
- Land use.

It was decided that the preferred route of the onshore underground cables will run from the TJP on the coastal side of the existing cycle track which runs parallel to the A256 Sandwich Road, through Pegwell Bay Country Park, then into Stonelees Nature Reserve and BayPoint sports complex. From the sports complex, the cables will be routed by horizontal directional drilling (HDD) beneath the A256, Minster Stream, and a compartment of Sandwich Bay to Hacklinge Marshes SSSI terminating in the converter station. The overall length of the onshore cable route from the TJP to converter station site is approximately 2.3km. This route offers a short, technically and environmentally acceptable route which minimises disturbance to local residents, landowners and environmental features.

5.3 Marine cable route

In 2006 consultancy firm Metoc[6] completed a desktop study of marine routes on behalf of Nemo. Metoc concluded that there were feasible marine routes to support the short-listed sites. Any risks to consent being granted were thought to be manageable within project timescales. Metoc confirmed that the shortest marine route for the project was between Richborough and West Zeebrugge and noted that the costs of addressing marine risks were likely to be insignificant in relation to the capital expenditure of the project.

5.4 Belgian landfall and converter station site

Several onshore connection location options in Belgium were considered including Zeebrugge, Oostende and Koksijde. A connection point and landfall in Zeebrugge was selected for technical, economic and environmental reasons. A key reason for the selection of this landfall and connection point was that the Project would be able to make use of the increased grid capacity that will be offered by the Stevin project which will upgrade Elia's 380kV electrical grid between Zomergem and Zeebrugge.

The Stevin project, which is required to allow the planned offshore wind farms in Belgian waters to connect to the Belgian transmission system, facilitates the connection of this project and accommodate the increasing power requirements of the Port of Zeebrugge. The specific environmental reasons for selection of Zeebrugge for the onshore connection to the grid and the associated landfall are:

- Project in Zeebrugge would require the least amount of overhead line in coastal areas in comparison to the other potential landfall locations; and
- The selection of Zeebrugge as the connection point for the Project minimises negative environmental effects on features such as visual amenity and ornithology.

End of section

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[6] In 2006 Metoc was privately owned but since late 2010 has been part of the Intertek Group of Companies and provides specialist technical services in the marine, coastal and river environments.

6. Studies and assessments

6.1 Studies and assessments carried out for the Project

Nemo has provided a list of the studies and surveys undertaken to date. These are set out in Table 2. Future surveys will be undertaken for ecological purposes at the pre-construction stage. Further geophysical surveys may be undertaken by the contracted cable installer.

Further economic feasibility studies will be undertaken this year prior to the final investment decision. The listing does not make reference to time series data on market conditions which are continuously collected.

Studies and assessments such as these are a form of Due Diligence. In addition to providing the specific information they demonstrate that Nemo has taken all reasonable steps to identify, so far as possible, the relevant issues and risks associated with the project. This should give confidence to regulators, stakeholders and all those with a commercial interest in the project.

The results of the studies and surveys will help to develop the procurement strategy and approach to overall risk. In particular we recognise that construction risks taken by suppliers will be reduced dependent upon the quality of upfront survey data provided during the tender process and this greater confidence should result in lower prices being offered. Additionally, we recognise there are many statutory obligations, particularly in relation to the environment, that must be met and so we believe the number and type of studies carried out to date are as would be expected for a project of this magnitude and complexity.

Table 2: Studies and assessments carried out for the Project

1.	**Offshore studies:**		
1.1.	Feasibility route study		
1.2.	Desktop route study		
1.3.	Unexploded ordinance (UXO) study		
1.4.	Seabed survey		
	1.4.1.	Bathymetry	
	1.4.2.	Geophysical survey (Multi-beam echo, Side-scan sonar, Sub-bottom profile, photos,…)	
	1.4.3.	Geotechnical survey [Vibrocores and cone penetration test – (CPT)]	
	1.4.4.	Lab tests on vibrocores	
		1.4.4.1.	Visual description
		1.4.4.2.	Natural moisture content
		1.4.4.3.	Bulk density of intact core
		1.4.4.4.	Particle size distribution testing by sieve and hydrometer
		1.4.4.5.	Particle density
		1.4.4.6.	Specific gravity
		1.4.4.7.	Atterberg limits
		1.4.4.8.	Determination of total sulphate content on soil or water sample
		1.4.4.9.	Determination of ph value
		1.4.4.10.	Determination of total carbon including carbonates
		1.4.4.11.	Determination of organic matter
		1.4.4.12.	Dry density – moisture content relationship
		1.4.4.13.	Thermal conductivity test (original sample and mixed sample)
1.5.	Tidal flow modelling		
1.6.	Sandwave and sediment transport modelling		
1.7.	Sediment plume dispersal modelling		

1.8.	Modelling on trench infill rates	
1.9.	Pre-estimate on pre-sweep dredging of sandwaves	
1.10.	Marine archaeology study	
1.11.	Maintenance strategy	
1.12.	Environmental studies (UK, FR and BE)	
1.13.	Crossings study	
1.14.	Burial risk assessment	
2.	**UK onshore studies:**	
2.1.	Landfall and converter station location assessment including consideration for grid connection opportunities.	
	2.1.1.	Desk based assessment
	2.1.2.	Field based assessments
2.2.	Feasibility route study	
2.3.	Desktop route study	
2.4.	Soil sampling and lab tests	
2.5.	Topography	
2.6.	Acoustic simulations (preparatory)	
2.7.	Wintering bird survey;	
2.8.	Intertidal invertebrate surveys;	
2.9.	Breeding bird survey;	
2.10.	Redshank nest survey	
2.11.	Hydrology and flood risk	
2.12.	Ecological assessments including:	
	2.12.1.	Extended phase 1 habitat surveys (including assessment of trees for potential bat roosts);
	2.12.2.	NVC survey of saltmarsh vegetation;
	2.12.3.	Reptile survey;
	2.12.4.	Watervole surveys
2.13.	Archaeological study	
2.14.	Landscape and visual including photomontages	
2.15.	Traffic and transport	
2.16.	Noise and vibration	
2.17.	BREEAM assessment	
2.18.	Sustainability assessment	
2.19.	Arboricultural impact assessment	
2.20.	Air quality	
2.21.	Coastal tourism, recreation and socio-economics	
2.22.	Richborough site: ground penetration investigation	
2.23.	Richborough site: factual site investigation report	
3.	**Belgium onshore studies**	
3.1.	Landfall and converter station location assessment including consideration for grid connection opportunities.	
3.2.	Haalbaarheidstudie Zeebrugge converter station	
3.3.	Desktop route study	
3.4.	Soil sampling and laboratory tests	
3.5.	Topography	

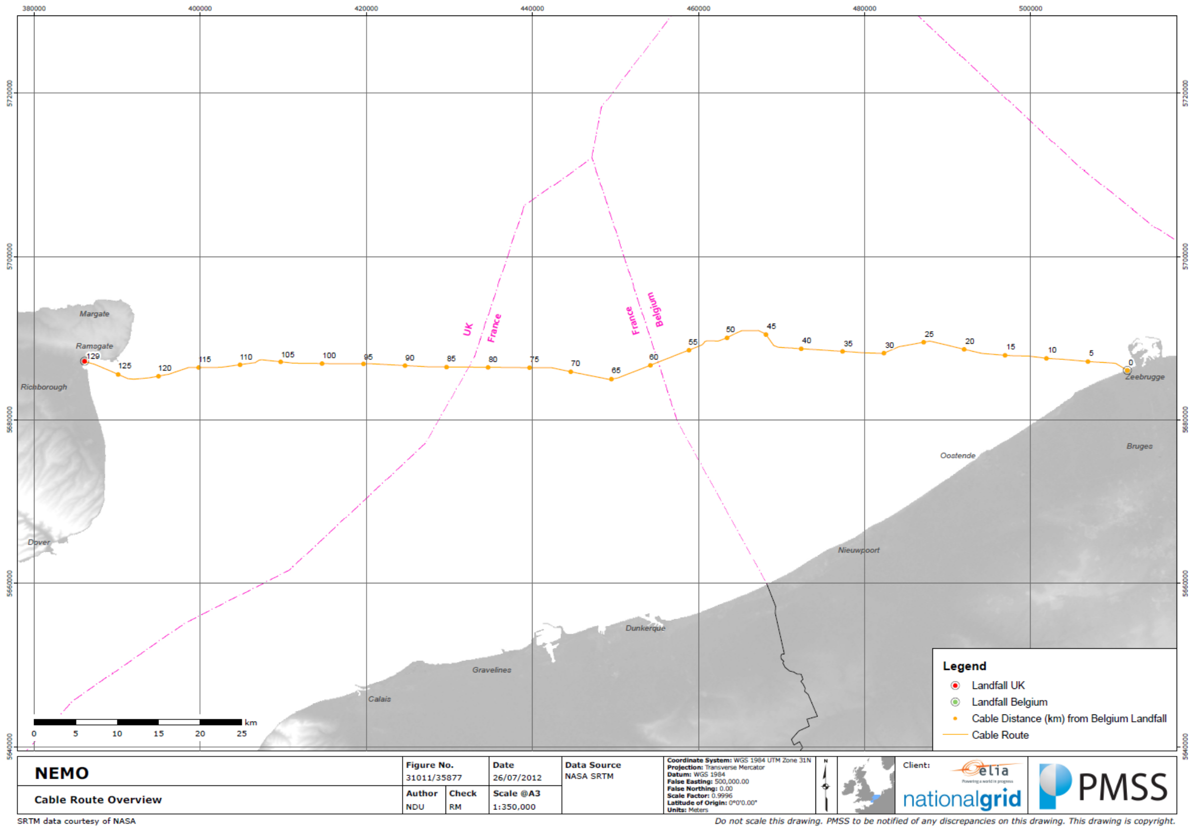
3.6.	Acoustic simulations (preparatory)
3.7.	Zeebrugge site architectural concept
3.8.	Technical report (environmental investigation) on BE onshore cable route
3.9.	Ground water monitoring
3.10.	Milieutoets
3.11.	Archaeological study
4.	**Economic Feasibility Studies**
4.1.	Revenues, welfare and competition studies
5.	**Technical specification**
5.1.	Converters
5.2.	Cable
6.	**Physical security requirements**
6.1.	Physical security requirements

End of section

7. Consents and wayleaves

Given the nature of this project Nemo must seek both terrestrial and marine consents and wayleaves from the responsible authorities in the UK and Belgium together with France for part of the marine route (see Figure 7). Some consents are necessary in order for the project to begin whilst others are not needed for the time being and will be applied for later or once the construction work begins. An 'overview of permits' list was provided in the form of a spreadsheet attached to a briefing note but was not referred to in it. We understand that there are some consenting issues yet to be resolved so some costs will not be finalised until later in the Development phase.

Figure 7: Map showing the route of the Nemo Link



7.1 Terrestrial

Belgium: The most challenging consent in Belgium is expected to be the building and environmental consent for the Zeebrugge converter station. Mitigation strategies include frequent contacts, the use of an architectural contest for the design of the converter building and environmental studies to transparently explain the impacts of the converter station to stakeholder.

UK: The site of the proposed converter station at Richborough falls within the administrative boundaries of both Thanet District Council and Dover District Council. Consequently planning applications, each accompanied by a voluntary Environmental Statement, were submitted to both Thanet and Dover District Councils. The applications cover the converter station and HVDC onshore cables down to the Mean Low Water Mark.

We understand that negotiations are on-going with relevant landowners in respect of cable easements between the cable landing point and the converter station. NGNLL has said that it will, if necessary, use the Compulsory Purchase powers granted by its Interconnector Licence to secure any easements which cannot be agreed by negotiation. This could have an effect on the proposed programme although we believe that any impact on the overall cost would be minimal.

Similarly, in the event that one or both of the Local Planning Authorities does not determine the application, Nemo will launch an appeal.

7.2 Marine

As noted above, the cable route passes through UK, French and Belgian waters. Simultaneous applications have been submitted the UK, French and Belgian Authorities.

UK: The relevant legislation is the Marine and Coastal Access Act 2009 (MCAA 2009) and the determining authority is the Marine Management Organisation (MMO). The jurisdiction of the MCAA 2009 extends from Mean High Water Mark to the UK Median Line.

France: The French Ministry of Ecology has already determined the application and given confirmation that no Appropriate Assessment relative to Conservation area is needed and that there are no regulations for submarine cables crossing its EEZ[7]. Apart from giving notice to the Maritime Prefecture of Cherbourg ten days' prior to installation of the cable, the French authorities may be considered to have given approval.

Belgium: Every project must pass through an environmental permit procedure, pursuant to the law on the protection of the marine environment (20 January 1999) and two Royal Decrees, all three having been modified in 2003. The legislation requires an environmental impact assessment (EIA) by the Management Unit of the North Sea Mathematical Models (MUMM).

The public must also be consulted during a 45 day period including neighbouring countries if the impact could cross international borders. Based on the EIA and on the results of the public consultation, the MUMM advises the federal Minister responsible for the marine environment. In this advice the MUMM gives an opinion on the acceptability of the project with regard to the marine environment and on the conditions which the project must fulfil to be acceptable. The Minister decides whether the environmental permit should be granted.

There is also a permit procedure for the installation of the cables. Requests are submitted to the Federal Public Service for Economic Affairs, which advises the Minister of Energy.

At the time of writing we understand that there are some consents in both countries yet to be obtained. Until they are agreed they represent a risk to the project both in terms of cost and programme and, in the final analysis, could dictate whether or not the project proceeds.

End of section

[7] 'Exclusive Economic Zone'; normally 200 nautical miles (370km) out from a country's coast unless there is an overlap with a neighbouring state in which case the neighbours agree on the delineation of the boundary.

8. Grid connections

8.1 UK – National Grid Electricity Transmission

Within the UK, National Grid Electricity Transmission (NGET) is responsible for the provision of grid connections to the high voltage transmission system for, amongst others, interconnectors. The Connection and Use of System Code (CUSC) constitutes the contractual framework for connection to, and use of, the high voltage system.

As a result of its pre project feasibility and development studies National Grid International Ltd[8] (NGIL) decided on the Richborough site as its preferred location for the UK end converter station of the proposed Nemo interconnector. Consequently, in September 2008, it applied to National Grid Electricity Transmission (NGET) for a 400kV connection at Richborough, a process governed by the Connection and Use of System Code. This connection was for an interconnector with converters utilising LCC technology.

As part of the CUSC, in March 2009 NGIL entered into the Construction Agreement in respect of a "1,000MW HVDC Interconnector at Richborough 400kV Substation" and the Bilateral Connection Agreement for an "Interconnector Owner at Richborough 400kV Substation". The connection date offered by NGET, and accepted by NGIL, was March 2019.

As discussed more fully in Section 9, Voltage Source Converter (VSC) technology has been developing over the last few years to incorporate larger power flows and NGIL made an application to modify its connection request based on the use of VSC in December 2010. Consequently an "Agreement to Vary the Construction Agreement and Bilateral Connection Agreement" was entered into on 1 July 2011.

This agreement, amongst other things, prescribes the direct works to be installed by NGET in order to accommodate the Nemo Interconnector, viz;

1. At Richborough, a new 400kV GIS double busbar substation to provide one HVDC connection and two circuit connection from Richborough to Canterbury North, and also possible 400/132kV SGTs that may be required from Third Party Works. In addition, two bays may be required for MSCs or SVCs if they cannot be installed at the new Canterbury North GIS substation due to space limitations at that site;
2. At Canterbury North 400kV substation, a new 400kV GIS double busbar substation linked to mesh corners 3 and 4 of the existing substation, consisting of 6 feeder bays, one bus-coupler bay, and one bus-section. In addition, two bays for MSCs or SVCs will be required if there is sufficient space;
3. A new 400kV OHL double circuit from Richbourough 400kV GIS substation to the new 400kV double busbar GIS substation at Canterbury North, strung with 2 x 500mm^2 AAAC conductor operating at 65°C;
4. Divert the Canterbury North – Sellindge 2 and Canterbury – Kemsley 2 circuits into the new 400kV GIS double busbar substation at Canterbury North.

It is also noted that there are some third party works (UK Power Networks) which involve the removal and/or diversion of some 132kV lines. It is likely that these works together with the consents required for the new 400kV overhead line will be principal risks to successful completion in 2018 given that they are effectively outside of Nemo's control. We have been provided with a programme for the grid connection works.

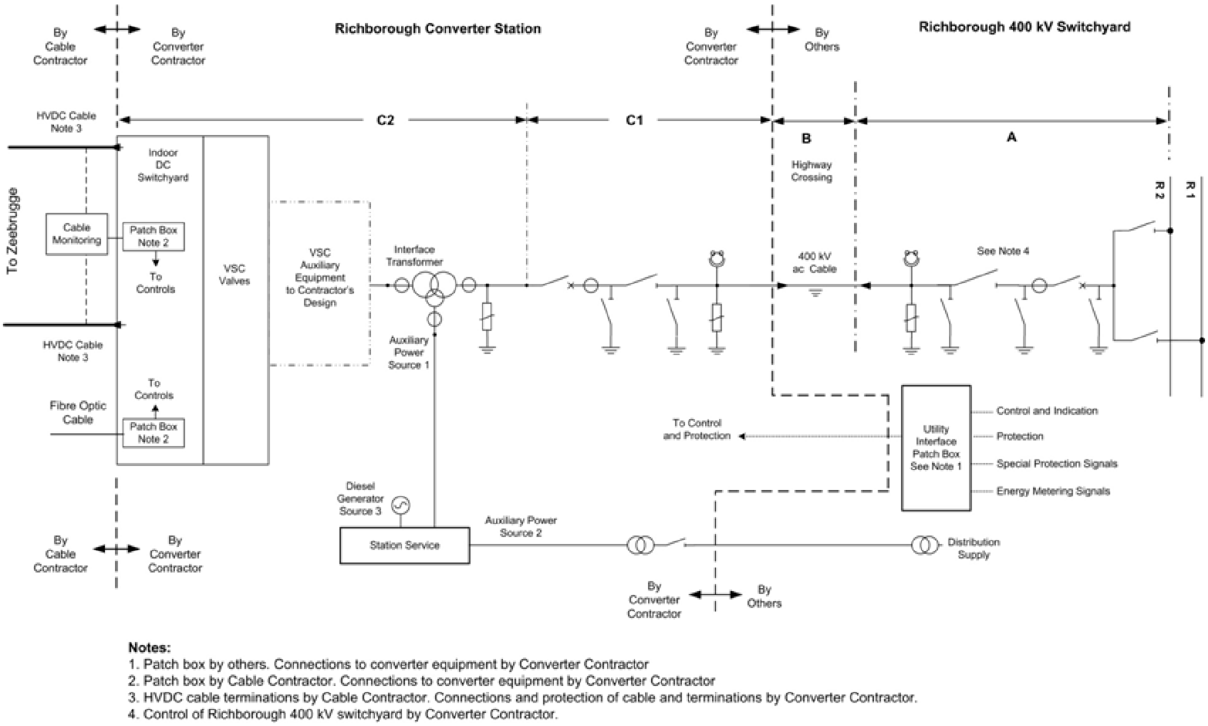
The works to be carried out by the developer are similarly described:

[8] National Grid International Limited is the vehicle through which early development contracts were entered into prior to the establishment of National Grid Nemo Link Limited.

1. The User is to construct a 1,000MW HVDC converter station based on Voltage Source Converter design;
2. Connection of the HVDC link to the interconnector bay in the 400kV Richborough GIS substation.

A single line diagram indicating the boundary between the grid connection and the converter station is shown in Figure 8. This diagram was issued as part of the tender documentation in order to identify the scope of works to the potential suppliers of the Richborough converter station.

Figure 8: Conceptual Single Line Diagram Richborough Converter Station



In Great Britain the Connection Use of System Code (CUSC) requires ownership and operational responsibility of the connection bay by the connecting party. For Richborough, NGET will install a new 400kV GIS substation but Nemo will be responsible for the installation of the circuit between the extent of the works carried out by the converter supplier (most likely a set of sealing ends) and the new GIS board. Currently, it is not clear which party will physically carry out the work.

Due to the expansion in the use of GIS substations, changes have recently been made to the CUSC which allow for an alternative ownership arrangement. Nemo is considering these options. In any case, Nemo will have to make provision in its costings for the connection into the GIS bay – it is assumed this is included within the allowed costs for third party works.

8.2 Belgium - Elia

Elia, The Belgian Transmission System Operator (TSO), in close collaboration with the federal energy administration, establishes and publishes a 10-year Grid Development Plan every 4 years. This document highlights all the grid capacity needs and describes the TSO's investment program to meet these needs. The Federal Regulator (CREG) and the public are consulted in the process and the grid development plan is approved by the energy Minister.

A third party, wanting to access the grid, can apply for a connection agreement (through a detailed study), and reserve capacity on the grid. Within Belgium, interconnectors, including HVDC over sea interconnectors, form part of the responsibility of the Belgian TSO and therefore no specific grid connection agreement is required in order to reserve capacity on the grid. Essentially the Belgian TSO approves its investments through the Grid Development Plan once approved by the energy Minister.

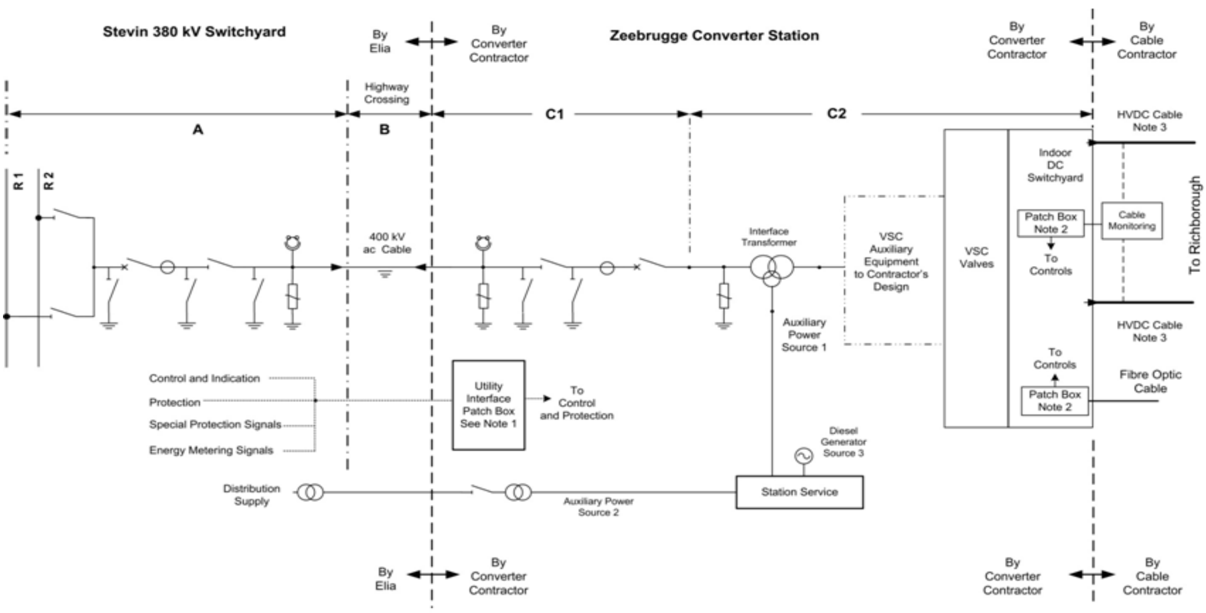
To facilitate a UK interconnector, a project was commenced in 2007 to extend the existing Belgium 380kV grid to Zeebrugge. The project, known as Stevin, includes for a new substation as part of the existing grid at Zomergem and circuits to Zeebrugge at a new substation, Stevin.

The Stevin project addresses four major needs.

1. It enables offshore wind power to be brought on land and transmitted to the domestic market.
2. It is necessary in order to create a further interconnection with the Belgian grid via a subsea connection to the United Kingdom (Nemo)
3. This expansion of the 380kV grid will significantly improve the electricity supply for the West Flanders region and make further economic development possible in the strategically important growth area in and around the port of Zeebrugge.
4. It enables the connection of additional decentralised electricity generation (wind, solar and other forms of sustainable energy) in the coastal region.

A single line diagram indicating the boundary between the grid connection and the converter station is shown in Figure 9. This diagram was issued as part of the tender documentation in order to identify the scope of works to the potential suppliers of the Zeebrugge converter station.

Figure 9: Conceptual Single Line Diagram of the Zeebrugge Converter Station



Notes:
1. Patch box by Elia in converter control and protection room. Connections to converter equipment by Converter Contractor
2. Patch box by Cable Contractor. Connections to converter equipment by Converter Contractor
3. Cable terminations by Cable Contractor. Connections and protection by Converter Contractor.

For reasons of operational safety, maintenance and security Elia in its role as Belgian System Operator owns and operates all user connection bays within Elia substations. The boundary indicating the extent of the work to be carried out by the converter supplier will likely coincide with the final operation and ownership boundary for the Zeebrugge site which will physically be located at a set of sealing ends. Elia will be responsible for the provision of a new GIS board at Stevin and then the connection from the Zeebrugge HVDC bay up to the boundary at the sealing ends.

End of section

9. Technical considerations

9.1 Introduction

BPI has carefully reviewed the project scope and tender documentation in order both to assess the likely capital cost of the interconnector and to provide Ofgem and CREG with a view on whether the interconnector specification is reasonable and economic. The project scope includes the converter stations, including all switchgear and the grid interface transformers, the land cable to the landing points and subsea cable between the UK and Belgium.

9.2 Converter technology

The two basic converter technologies used for high voltage direct current transmission are conventional line commutated (LCC), or current source converters, and self-commutated or voltage sourced converter (VSC) devices.

LCC or current source converters have been in commercial use since the 1950s. Indeed most HVDC systems currently in service are of the LCC type and the technology is well established. Line commutated converters use line-commutated thyristor valves. This system requires 50% reactive power compensation and specialised HVDC converter transformers, and necessitates a relatively large compound to accommodate the outdoor switchgear and equipment. This technology, used for example at Sellindge for the 2,000MW French interconnector, is well suited to a long distance, high power interconnector using oil impregnated submarine cables.

The development in power electronics which led to the introduction of insulated gate bipolar transistor (IGBT) based switching valves in the 1980s made a new HVDC technology feasible. Voltage sourced converters (VSC) are also referred to as self-commutated converters. The fundamental difference between the voltage sourced converter technology and conventional line commutated technology is that VSC HVDC uses IGBTs, which are able to switch off current - hence there is no demand for a synchronous voltage for the commutation process. An additional advantage of VSC HVDC technology is its ability to control the reactive power at both converter stations independent of active power flow and with the only constraint being the maximum apparent power and output voltage, which is limited by the rating of the VSC valves. Thus VSC HVDC can be placed anywhere in the ac network without concerns about the available short circuit ratio. The performance and characteristics of self-commutated converters depends strongly on the arrangement of the converter valves and switching devices.

Until recently, VSC technology was not suitable for the transmission of loads in excess of 500MW, but recent developments have increased its load capacity to above 1,000MW. Although LCC or current source converters have been used successfully in many countries over a number of years, the following factors make VSC based technology attractive:

- Independent control of reactive and active power
- Reactive control independent of other terminals
- Simpler interface with AC system
- Compact filters
- Provides continuous AC voltage regulation
- No minimum power restriction
- Operation in extremely weak systems
- No commutation failures
- No restriction of multiple infeeds
- No polarity reversal needed to reverse power

- Black start capability
- Variable frequency

A comparison between current source and voltage source converter technology is shown in Table 3.

Table 3: Comparison of converter technologies[9]

	Current source converter	Voltage source converter
Maturity of technology	Mature	Developing
Valves	Thyristor, dependent on AC system voltage for commutation	IGBT, self-commutating
Commutation failure	Can occur	No
Minimum DC power	Typically 5-10% of rated power	No minimum value
Reactive power exchange with AC system	50% of active power transmitted	Independent control of active and reactive power
Reactive compensation	Required	Not required
AC harmonic filters	Switchable filters required	Less filtering required, filters need not be switchable
Converter transformers	Special design required	Conventional transformers can be used
Reversal of power flow	DC voltage polarity reversal required	Controllable in both directions, no reversal of DC voltage polarity required
Converter station footprint (relative size)	200m x 120m x 22m (100%)	120m x 60m x 22m (~40%)
Conversion losses (per converter end)	0.5% to 1% of transmitted power	1% to 2% of transmitted power
DC cables	MI insulation only	MI insulation or XLPE

VSC is still a developing technology for HVDC interconnectors, particularly in relation to the rated power. Table 4 on the next page provides examples of projects with different DC technologies in order to derive the actual state of the art in terms of rating. Certainly, until fairly recently, VSC converters were used almost exclusively for sub 500MW ratings, for example the BritNed interconnector rated at a 1,000MW utilised LCC technology and was commissioned as recently as 2011.

In terms of reliability HVDC System Energy Unavailability is the key factor for analysing HVDC performance. Energy Unavailability is the sum of Forced Energy Unavailability (FEU) and Scheduled Energy Unavailability (SEU). FEU is the amount of energy that could not have been transmitted over the DC system due to forced outages. FEU together with the number and duration of outage events by category are considered to be the most useful measurements of system performance for operation evaluation and planning of future systems.

LCC Thyristor based converters is a proven technology that has been in use worldwide for over 30 years. Reliability for LCC interconnectors has a median for Forced Energy Unavailability (FEU) of less than 1%. For VSC technology the suggested FEU is between 1% and 2% for projects of less than

[9] NGET

400MW capacity. Currently, reliability figures in the form of FEU for VSC based projects above 400MW are difficult to come by and even scarcer for those in the region of 1,000MW.

VSC technology, although still in its infancy for interconnectors of 1,000MW or above, is likely to become the industry norm within a reasonably short period of time because of its inherent technical advantages. At the time of writing this report (2013) the capital cost of VSC projects are generally higher than equivalent LLC but this disadvantage is likely to decrease as VSC technology develops and manufacturing costs reduce.

VSC technology has now developed to a point where it is being utilised for HVDC interconnector projects up to about 1,000MW. Nemo is likely to be one of a number of interconnectors, to be commissioned over the next few years, of 1,000MW and upwards, which will make use of VSC converters.

Table 4: Examples of projects with differing DC technologies[10]

Name	Type	DC voltage	Rated power	DC circuit	Commissioning date
Murraylink	VSC	± 150kV	220 MW	Land cable	2002
Caprivi Link	VSC	350kV	300 MW	OHL	2009
Estlink	VSC	± 150kV	350 MW	Sub-sea cable	2006
BorWin 1	VSC	± 150kV	400 MW	Sub-sea cable	2009
Transbay	VSC	± 200kV	400 MW	Sub-sea cable	2010
Inelfe	VSC	± 320kV	2 x 1,000 MW	Land cable	Est 2014
NorNed	LCC	± 450kV	700 MW	Sub-sea cable	2007
BritNed	LCC	± 450kV	1,000 MW	Sub-sea cable	2011
Ballia-Bhiwadi	LCC	± 500kV	2,500 MW	OHL	2010
Hukunbeir-Liaonin	LCC	± 500kV	3,000 MW	OHL	2009
Yunnan-Guangdong	LCC	± 800kV	5,000 MW	OHL	2010
Xiangjiaba-Shanghai	LCC	± 800kV	6,400 MW	OHL	2010

9.3 Nemo

Nemo has issued a tender package, the Nemo Interconnector Main Works. In essence the package includes a 1,000MW symmetrical monopole VSC HVDC interconnector between the UK and Belgium with converter stations located at Richborough and Zeebrugge respectively. The final design and layout will be dependent on the specific design of the different converter suppliers. Generally the Contractor is to provide a complete and functional system, fully equipped and integrated to the adjacent installations and systems, whilst meeting site constraints and with an environmentally friendly design concept.

[10] CIGRE – Voltage Source Converter HVDC for Power Transmission – Economic Aspects and Comparison with other AC and DC Technologies.

9.4 Converter stations

The tender documentation provides a functional specification together with an order of precedence for a list of technical standards, codes and regulations to be followed by the Contractor, namely:

1. Standards as specifically notes within the tender
2. Grid codes and technical specifications and connection agreements
3. Standards and technical specifications as listed
4. EN standards
5. BS standards
6. IEC standards
7. ISO standards
8. CIGRE technical brochures
9. CIGRE recommendations

A functional specification is provided for the following equipment:

- VSC Valves and associated equipment
- Valve cooling systems
- Interface Transformers
- Smoothing, Phase/Valve Reactors
- AC control and Protection
- DC control and protection
- Operator controls
- HVDC Telecontrol system
- Communications Equipment
- DC Measuring Devices
- Surge Arresters
- Capacitors and shunt reactors
- Resistors
- Insulators
- Bushings
- Control and power Cabling
- Air Insulated AC and DC Disconnect Switches
- Interlocking for Disconnects and Earth Switches
- Voltage Transformers
- Current Transformers
- Power Quality measurement
- Station earthing
- Station service

In addition we also note the stipulation with regards to the site design and the use of either gas insulated or air insulated switchgear because of pollution associated with coastal locations, namely:

- The EHV AC switchgear to be gas insulated and located in a dedicated building
- The DC switchyard equipment to be air insulated and located in an enclosed (indoor) switchyard.
- Because the design of the VSC auxiliary equipment depends on the manufacturer, it may be GIS, AIS or a combination of GIS and AIS.
- The interface transformer shall be located outdoor (interface transformers with noise enclosures are not considered as indoor transformers.

The availability and reliability levels of the supplied equipment are stated in the form of required minimum performance levels and are linked to the provision of spares, namely:

	Guaranteed values HVDC % per year (1)
Forced Energy Unavailability (FEU):	0.5
Scheduled Energy Unavailability (SEU):	1.0
Forced Outage Rate:	2.0 (2)

Notes:

(1) For the HVDC system both converter stations excluding HVDC cables and terminations
(2) Target level

9.5 Symmetrical Monopole

There is little information on the options that were considered for the configuration or indeed for the choice of a symmetrical monopole arrangement although in all probability it followed the selection of Voltage Sourced Converters.

Although the bipole system has some advantages, not least two poles that can operate independently, nonetheless the symmetrical monopole is generally the lower cost option.

9.6 HVDC cable systems

The tender documentation provides a functional specification for two land and submarine pole cables and optionally one optical fibre telecommunication cable. The system transmission capacity is quoted as 1050MW and the operating voltage between ± 350kV and ± 400kV. The cables are to be designed to provide the required rated power transmission capacity under prescribed system, environmental and operating conditions. Further, they are to be designed to operate continuously at full rated voltage and power levels for a minimum of 40 years life. The cables, terminations and joints to be supplied can either be of the mass impregnated paper type or XLPE.

There is also a requirement for optical fibres to be integrated into the cable construction in order to provide distributed temperature sensing (DTS - temperature profiling) and strain measurements, together with back-up data transmission between converters. Nemo has requested the system is able to detect hazardous changes to the cables thermal environment such as exposure due to sediment migration and, in addition, the provision of near real-time fault location capabilities in the event that anchor damage for example also affects the optical fibres. Generally the main purpose of the DTS system is to optimise utilisation of the HVDC cable system by providing real time ratings based on conductor temperatures rather than assumed values.

Albeit, the cable tender provides essentially a functional specification, nonetheless the tender does prescribe the make-up of the sheath, armour and serving. The thermal design is to be based on calculation methods described in appropriate IEC Standards and is to include allowances for actual site conditions.

Minimum performance levels are quoted as:

	Guaranteed values % per year
Forced Energy Unavailability (FEU):	0
Scheduled Energy Unavailability (SEU):	0.25

The prescribed installation is reasonably standard with the subsea cables to be installed in a common trench with burial beneath the seabed and with onshore transition joints positioned above the inter-tidal zone near Zeebrugge and Richborough converter stations. As a minimum the contractor is to meet the relevant requirements identified in DNV-OS-H101 Marine Operations, General.

9.7 Spares requirements

Converter sites: The Contractor is to provide equipment spares to meet the guaranteed availability. Mandatory spares are identified within the specification and additional spares are to be identified by the contractor in order to meet the performance requirements. Additionally, the contractor is to provide a list of spares which, although not necessary to meet the availability criteria, are those that it recommends for five years and ten years of operation. The recommended spares to be considered by the Contractor are set out in Table 5.

Table 5: Recommended spares are to be considered by the Contractor

Major spare equipment	Required to meet specified lifetime availability
Strategic major items	To be held by the Nemo and available to the Contractor to use for repair with replacement within 16 weeks.
Non-strategic items	To be held by the Contractor on 2 week availability.
Maintenance spares	To be held at site.
Spares policy	To be developed with the Contractor. This will include: • cost of spare • lead time for delivery • likelihood of failure • impact on availability • shelf life of spares
Consumables (non-maintenance)	Stocks for 18 months operation to be provided at start up. Replacements to be ordered by the Nemo.

The mandatory spares include an interface transformer and reactor coils at each site. Suggested optional spare parts include a GIS bay, control and protection equipment, AC filter and shunt capacitors, current transformers, voltage transformers, disconnectors, IGBT modules, auxiliary equipment etc.

Cables: The Contractor is to supply mandatory spares including:

- 2km of HVDC land cable
- HVDC terminations for each site
- Submarine cable repair joints x4 (double for XLPE cable)
- 6km of HVDC submarine cable to be stored in an enclosed building accessible by a cable laying vessel. The cable storage facility is to be located within a 1,000km of the site and provided on an annual rental basis after expiry of the warrant period.

The Contractor is also asked to provide a list of recommended spares in order to meet the guaranteed availability including any additional spares to meet the performance guarantees. The Contractor is also to provide at each HVDC converter station a complete set of equipment for accurately locating submarine cable faults.

BPI believes the spare parts, either mandatory or optional, to be a very comprehensive in terms of maintaining the interconnector's performance and availability over the designed operational life of 40 years. It is worth mentioning, however, that the storage for the submarine cable will in all probability to be part of a shared facility and, although perhaps of relatively low cost, the need for site located cable fault location equipment may be questionable.

9.8 Conclusions

As a general comment we note Nemo commissioned an external consultant, Teshmont Consultants from Manitoba, Canada, a respected company and with much experience of HVDC projects, to draft the technical specification. We believe Teshmont's knowledge of the market place should help in the provision of competitive prices from suppliers.

BPI has carefully reviewed the technical specifications and makes the following comments.

Individual items of equipment are generally specified to national and international standards as a minimum with no apparent over-specification. The use of functional specifications will allow suppliers to utilise their standard designs, which together with identical requirements for Richborough and Zeebrugge, should result in competitive tendered prices.

The overall switchgear requirements are reasonable including the use of gas insulated switchgear where specified.

The plant and circuit protection requirements including individual zones of protection, speed of operation, redundancy, security, sensitivity and maintainability are stated by way of a set of minimum requirements. Protection arrangements such as that for the interface transformers are suggested together with inter-tripping schemes with the external network. Additionally there are some special schemes to cover contingencies for either the automatic reduction or increase in power transfer dependent upon AC network conditions. Generally we find the overall protection requirements to be reasonable. Two independent protection systems operating in parallel would be expected for systems of this complexity, costs and importance.

The three levels of independent AC auxiliary power viz, tertiary off the interface transformer, a high voltage local street supply and a diesel generator, we view as reasonable for the converter sites. Likewise for the redundant battery systems for the protection and control systems and uninterruptible power supplies (UPS) for computer based control systems.

The use of VSC technology allows for the use of either impregnated paper or cross-linked polyethylene (XLPE) insulated cables and potential contractors are able to choose which they believe to be the most appropriate and/or cost effective. We do not believe the tender specification either for the cable or the installation to be overly specified.

The strategic spares requirement will be decided during the tender evaluation exercise and consequent negotiations. It is reasonable to expect that the cost of the strategic spares will be included in Capex. However, BPI does have some reservations because it is likely that much of the equipment will not be used until after the initial regulatory regime. We suggest that the NRAs consider how the cost of such spares should be treated to ensure that they are appropriate for the life of the regulatory regime only. The likely cost of spares has been included within the overall costs for the converter stations and cable provided to us and so it is not possible at this time to comment on any specific reduction that should perhaps be made.

Generally the equipment as described and specified is that which would be expected for an interconnector of this capacity in terms of the general arrangement and layout, and for a design operational life of 40 years. The symmetrical monopole option is likely to be a lower cost option when compared to an equivalent bipole. We also accept that VSC technology, with its inherent technical advantages and need for a smaller footprint, is an attractive and perfectly reasonable solution for the needs of the project.

However, VSC technology is still relatively immature, certainly for interconnectors of 1,000MW and above and, although it is reasonable to believe that manufacturing costs will probably reduce over time as demand increases (and conversely LCC costs increase as demand falls for technical reasons), nonetheless at this moment in time the choice of VSC is far from clear-cut. For a project of this size and with a choice of two converter arrangements, either of which, technically, could be utilised for the project, we would have expected to see far more analysis of the costs associated with each. Indeed, we believe it almost inconceivable that for a project of this size and complexity that a detailed cost benefit analysis has not been carried out in order to support the decision making process. Certainly If this project was to follow a merchant approach with shareholders exposed to any possible higher costs then this analysis would have been an essential part of the funding process. We believe it reasonable to expect that projects such as this that are to be underwritten by electricity customers, should be subject to no lesser levels of scrutiny to ensure that best value for money is obtained. When considering the alternative technologies we consider that the overall least cost option should be used to set the capital value and we have therefore used LCC as the basis for our cost assessment.

It is worth noting that Nemo made its first application to NGET for a grid connection in 2008 stating that LCC technology would be utilised - at that time VSC was not generally being considered for interconnectors of 1,000MW, or thereabouts, in size. Due to rapid advances in technology VSC became an option soon after and Nemo amended its application. With the information currently available it appears that the main reason for this subsequent change to a VSC arrangement was based around the additional network reinforcement that would otherwise be required by NGET to its infrastructure, and the consequential delay this would add to the grid connection and hence earliest operational date of the interconnector.

BPI's cost assessment is included in Section 14.4.2 of this report.

End of section

10. Telecommunications, SCADA and Information Technology (office systems)

10.1 Telecommunications

The project has laid out requirements for a Telecommunications system to control the operations of the Interconnector. The requirements are for a fully redundant system consisting of a main system and a completely separate and independent back up system to connect the converter stations at Zeebrugge and Richborough. The telecommunication requirements also include local telephony and internet connections for the two converter stations as well as interfaces with the Elia and National Grid corporate local area networks.

The Nemo requirements specify that the Contractor should consider the option of a separate submarine telecommunication cable to run next to the main electricity cable and not be an integral part of the submarine cable. Nemo have categorically stated that the telecoms systems is solely for use within the scope of the Nemo organisation and is not intended for any form of commercial use. Utilising the fibres exclusively for the operation of the interconnector will enable Nemo to make a comparison of cost, reliability, degradation and overall performance between the submarine cable option and the alternative of leased lines from third parties. BPI believes this to be the correct approach.

The interface and design requirements specified appear reasonable and in line with what would be expected.

10.2 SCADA

Nemo has specified the requirements for the SCADA system for controlling and monitoring the interconnector and associated equipment, protection and controls. The design requirements and scope of this element of the project are comprehensive and reasonable and include sufficient redundancy for reliability. The SCADA system envisaged is a relatively standard system and all costs have been included in the Contractor overall sum so it is not possible to assess the reasonableness of the costs at this juncture.

10.3 Information Technology (office systems)

There are no specified requirements at this stage for either standard or bespoke software development for office and administration activities. It is assumed that the standard applications such as e-mail and office packages will be required as well as internet access for use of web-based programs.

This item does not include the trading and accounting platforms, which are identified separately but will no doubt include standard office equipment such as PCs and printers but not specialised equipment for Trading systems and SCADA.

10.4 Trading platform

Nemo was asked in the questionnaire to elaborate on their trading strategy and the IT platform and systems required to support the business. NEMO are not yet at the stage of selecting and defining the business systems required. NEMO confirmed that they intend to maximise revenue through explicit capacity auction products and implicit Within Day trading as participants in the GB and Belgian energy markets. NEMO are also aware of the changes taking place in respect of the European Third Package in particular the Capacity Allocation and Congestion Management (CACM) and Forward Capacity Allocation (FCA).

It is expected that the trading platform could be similar to that used by other existing Interconnectors. A typical proprietary trading platform could include the following capabilities:

- Interconnector Customer Management
- Long-term, Medium-term, Daily and Intraday Capacity Auctions
- Secondary Trading: Capacity Transfers at all timescales, Capacity Resales
- Capacity Entitlement Management
- Nomination Management
- Use It or Lose It / Use It or Sell It Application
- Capacity and Nomination Curtailment Tool
- Deemed Metered Volumes Calculation
- Settlement and Invoicing Source Data Generation
- Credit Limit Management
- Interfaces with internal and external IT Systems

These types of systems are available either as proprietary or as a bespoke development. We expect that Nemo will specify and source an appropriate system in good time for the system to be in place for operation in 2019.

End of section

11. Procurement process

11.1 Scope

The major procurement exercise of the project relates to that for the main plant and equipment. Nemo has followed an established process in order to secure an optimum solution to the requirement, particularly to ensure quality and value for money.

In view of the specialist nature of the work required and the limited number of companies that would have the capability to deliver the work, three separate lots have been defined for the main construction contracts

- Lot 1: Engineering, manufacturing and construction of 2 HVDC converter stations
- Lot 2: Engineering, manufacture and installation of a HVDC cable system (2 x 2km onshore cable route and 130 km offshore cable route
- Lot 3: Lot 1 and 2 combined.

Under each lot, delivery and installation have been kept together deliberately in order to limit risk for Nemo and place responsibility and risk with the contractor as far as possible.

The bidders were provided with a high level design and functional specification based on the full delivery of a 1,000 MW symmetrical monopole VSC HVDC system. Bidders were given the flexibility to develop detailed technical solutions within prescribed parameters.

11.2 Pre-qualification

In view of the size, complexity and technical requirements a robust prequalification process was required to ensure that only firms with the required capability, experience and resources were invited to bid.

Nemo ran a thorough prequalification process to narrow down potential bidders to a shortlist of those that were eventually invited to bid. The process was conducted in accordance with the European Utilities Procurement Regulations, beginning with a publication in the Official Journal of the European Union in June 2012. The prequalification process was discussed with potential suppliers at a supplier event in September 2012. The Prequalification Questionnaire (PQQ) consisted of sections focussing on company information, product information (for both converters and submarine cable) and safety and environmental aspects. Suppliers failing to meet the pre-set minimum scores for individual sections or failing to meet the minimum required overall score were excluded from the process[11].

In total 15 suppliers responded to the PQQ and following evaluation, 11 were selected to remain in the procurement process, 6 for converter supply and 5 for cable supply. We consider that this is an appropriate and manageable number of potential suppliers to provide sufficient competition to secure both an optimal technical solution and value for money.

11.3 Tender process

Companies invited to tender were provided with a pack of tender information that included the following:

- Instructions to Tenderers;
- Contract Award Criteria;
- Commercial Information and Terms and Conditions;

[11] Applicants were required to achieve a total score of at least 60% which comprised a score for each of the three sections weighted 40% for product information and 30% each for company information and safety. Additionally, the individual score for each of the three sections had to reach at least 50%.

- Employer's requirements – Project Description, SHE, QA and Project Management;
- Employer's Requirements – Technical Specification;
- Employer's Requirements – Standard Specifications;
- Employer's Requirements – Site Information;
- Employer's Requirements – Site Information Belgium;
- Employers Requirements- Site Information Marine Cable;
- Tender Return Documentation; and
- Draft Contracts

Tenderers were only permitted to submit a Lot 3 tender if all parties forming the Contracting entity submitted a tender for Lot 1 and/or Lot 2. The closing date for the receipt of tenders was 31 July 2013. The indicative timetable published in the ITT is set out in Table 6.

Table 6: Indicative tendering timetable published in the ITT

Activity	Indicative date
Project launch date	11 April 2013
Site visits	w/c 22 April 2013
Tender meeting 1	w/c 29 April 2013
Tender meeting 2	w/c 3 June 2023
Tender return date	31 July 2013
Tender evaluation	August to December 2013
Tender presentations	w/c 14 October 2013
Tender negotiations	w/c 27 January 2014
Factory visit (if required)	TBD
Notice of intent to award (standstill period)	June 2014
Contract award	June/July 2014

The tender close was extended to 23 September and we assume that some of the subsequent dates shown in this indicative timetable will change as a consequence.

For all offers the tender price was to be a fully inclusive price with option prices to be provided where requested and pricing principles set out where requested to describe how amendments and variations should be priced. The contract award criteria were specified in the information provided to tenderers. There were three assessment areas which are shown in Table 7.

Table 7: Tender assessment criteria and weightings

Criteria	Weighting %
Mandatory criteria	Pass/Fail
Technical criteria	40%
Commercial criteria	60%
Total	**100%**

Tenderers were required to pass all mandatory criteria to proceed to have their technical and commercial sections evaluated. The mandatory sections were principally concerned with safety, health and environmental issues.

The structured scoring mechanism was set out for the technical assessments, covering the following main areas:

- Project Management
- Design;
- Installation;
- Operation and Maintenance; and
- Interfaces

Tenderers were required to meet a minimum score for each question in order for their tender to be considered further.

95% of the commercial award criteria were to be awarded on the whole life cost model, taking into account capital expenditure, operation costs and technical performance. The remaining 5% was to be based on the amendments to the drafting of the terms and conditions. [redacted]

11.4 Draft contracts

The following draft contracts were issued to potential tenderers:

- Engineering, Procurement and Construction (EPC) for Lots 1, 2, and 3
- Service and Warranty Agreement (SWA) for Lots 1, 2, and 3
- Interface Agreement – applicable to Lot 1 and Lot 2 only

The major contracts were based on the FIDIC silver model which is extensively used in offshore industries for large complex projects. Although other forms of contract were considered, including the LOGIK standard form or the development of a bespoke contract, the FIDIC silver model was considered fit for purpose and in view of the partners' detailed knowledge through previous projects it was the preferred model.

Nemo is keen to utilise turnkey type contracts and reduce exposure to interface risk and has structured the contracts accordingly. Whilst this is an understandable approach there is a cost involved. It is not known what premium the suppliers will add to their prices to accept the risks.

The FIDIC Silver contract is designed for onshore construction and acts as a generic base for the procurement of plant and equipment. Nemo has amended the FIDIC Silver contract to cater for the factual circumstances of the Interconnector and the offshore works required during construction. Amendments have also been made to reflect Nemo's business requirements. The amendments made include the following:

- **Administrative changes:** Changes to the notice and confidentiality provisions, and to the scope of the Employer's Representatives powers.

[redacted]

- **Fitness for purpose:** On the basis that the EPC Contractor is an expert in the Works it is undertaking, the FIDIC Contract has been amended to provide greater clarity as to the standard to which the works must be performed, include a warranty as to the suitability of the

Interconnector once constructed and require the EPC Contractor to confirm the suitability of the Employer's Requirements.

- **Performance security:** Downgrade triggers have been inserted, and a provision to convert bonds to cash security if the bonds cease to comply with the requirements of the contract and are not replaced. Further, a requirement for a snagging bond has been included and also provided requirements for the percentage levels of the bonds referenced in the EPC Contract.

[redacted]

- **Certainty of timetable:** The delay provisions have been amended to:
  - Allow the Employer to take the benefit of the float in the programme;
  - Not grant an extension of time where there are concurrent delays caused by an event which would not entitle the EPC Contractor an extension of time;
  - Allow a revisiting of previous determinations in light of new information;
  - Allow the Employer the right to request, at its cost, acceleration of the works in circumstances where the EPC Contractor is entitled to an extension of time.
- **Suspension provisions:** Amended to increase the period before which the EPC Contractor can request the contract continues or the suspended works are omitted from the contract.
- **Force Majeure provisions:** Amended to clarify that certain events which are considered by Nemo normal operational risks which the EPC Contractor should be responsible for managing will not be considered force majeure.
- **Latent defect regime:** Included.

[redacted]

- **Liability caps:** Amended.
- **A contractual right of set-off:** Has been provided for the Employer.

[redacted]

End of section

12. Risk

12.1 Introduction

We have reviewed the available information about project risk. This was in the form of:

- A table of Top 10 Risks made available to us in response to Request for Information reference PH1_024;
- An outline of the anticipated insurance programme, including limits, deductibles and principal exclusions attached as an Appendix to PH1_024 which, we were informed, will be subject to negotiation with cable and converter suppliers; and
- The draft contracts sent to bidders as part of the tendering package.

12.2 Top 10 risks

We asked for details of the principal project risks and assumptions and for an explanation as to how the principal risks would be mitigated and to what extent identified risks would be mitigated by the use of insurance. A table of the 'Nemo Project Top 10 Risks' was provided numbered from one to ten. It was prefaced with the comment "The numbering of the risks doesn't necessarily reflect the ranking of the risks". The use of the word 'necessarily' is intriguing since it implies that some of the risks may be ranked (in the list) and some may not; if so they were not identified. If some or all of the listed risks have been ranked it would have been helpful to know. Moreover, we expected to see a risk register with rankings covering the whole project, as far as possible, but no such register was provided. The identification of these ten risks suggests that Nemo has given some consideration to the matter. Have other risks have been identified and recorded somewhere?

The table was accompanied by a separate list of mitigation measures. We have combined them with the Top 10 Risks table for easier reference and this is shown on the next page as Table 8.

[redacted]

[redacted]

Table 8: Nemo project top 10 risks and mitigation

(Compiled from Request for Information reference PH1_024)

<table>
<tr><th>No</th><th>Risk</th><th>Mitigation</th></tr>
<tr><td>1</td><td>Risk associated with obtaining permits and consents across multinational and multijurisdictional boundaries incl. refusal due to public acceptance in either country, delay and/or legal challenge.</td><td>To mitigate the permit/consent risk the Nemo project has submitted simultaneous applications accompanied by a voluntary Environmental Statement to ensure that a full assessment has been undertaken and is considered in the determination.</td></tr>
<tr><td>2</td><td>Risk that Nemo may be delayed due to an unclear regulatory framework (e.g. revenue sharing, legal form).</td><td>The Nemo project are working with the regulators in both Belgium and Great Britain to ensure that the proposed regulatory framework is delivered in timescales to enable an investment decision can be taken in 2014</td></tr>
<tr><td>3</td><td>Risk that the profitability during Nemo’s lifetime may be affected due to the increase of the number of interconnections, i.e. the added value of a single interconnection decreases as the number of interconnections increases.</td><td rowspan="2">Prior to an investment decision being taken, a further economic study will be undertaken to assess the likely impact of further interconnection and changes to both the European and UK market models will have on the project. The project will only proceed if the Boards of Elia and National Grid are satisfied that the investment will produce an appropriate risk related return.</td></tr>
<tr><td>4</td><td>Project economics are not viable for one or both parties e.g. potentially adverse impact of items such as flow based market coupling of CWE/NEW area or impact of UK EMR Capacity Payments.</td></tr>
<tr><td>5</td><td>Risk of delay in the necessary grid reinforcements at the Belgium and UK side</td><td>In the UK the Nemo project are working closely with the NGET team to support the public consultation process regarding any grid reinforcements required in the UK, being available to answer project related questions including the reason for the project and the location chosen for the converter station and the subsea cable landing point.
The Stevin project is considered as critical for Elia, both for Nemo and the offshore project. Especially for the Offshore project there is a large political acceptance to realise the project in time. Elia did set up a dedicated team for the Stevin project and is in close contact with all stakeholders.</td></tr>
<tr><td>6</td><td>The floor and cap proposals may not be suitable; which may cause the project to be less profitable or even unprofitable (regulatory risk with financial implication)</td><td>Please see the answer to Risks 3 & 4</td></tr>
<tr><td>7</td><td>Risk of delays due to key suppliers being overbooked (e.g. due to a saturated cable market) or themselves having poor supply chain management</td><td>A comprehensive EU procurement exercise is being undertaken which will consider amongst many aspects the ability of each supplier to deliver to programme.</td></tr>
<tr><td>8</td><td>Risk of legal challenge by non-winning party of the tendering process</td><td>A full procurement exercise is being undertaken strictly in accordance with EU regulations – significant legal support is also being provided to this aspect of the project.</td></tr>
<tr><td>9</td><td>Quality problem discovered during test at manufacturer's causes liabilities and/or delays in project Nemo</td><td rowspan="2">Nemo is currently undertaking an exercise to identify the insurable and uninsurable risks anticipated. Thereafter, an appropriate insurance solution will be tailored for both the construction and post-construction (“operational”) insurable risks.</td></tr>
<tr><td>10</td><td>Damage of cable by ships in distress: emergency anchors, dropping objects, sinking vessels</td></tr>
</table>

[redacted]

12.3 Insurance

Risks 9 and 10 and other issues are expected to be mitigated through appropriate insurances. We have seen a tabulated outline of the anticipated insurance programme[12] covering both the construction phase and the operational phase. It includes limits, deductibles and principal exclusions. The insurances described are those that we would expect. Most are allocated to Nemo, some to the contractor(s) and some will be applicable to both parties such as Employer's Liability. We understand that the insurances will be subject to negotiation with the successful contractor(s) as part of the overall contract negotiation process. This seems reasonable. Nevertheless, there is a balance to be struck between an evaluated risk, that which will be allowed (or not) under the Cap and Floor Regime and over-insuring. The contractor's costs will feed directly to the price of the project and it will be important to ensure that they are comprehensive but not excessive due to demands for unreasonable levels of cover.

[redacted]

12.4 Allocation of risk during construction in the draft contract

The draft contract is based on the FIDIC Silver contract, [redacted]. The underlying philosophy in the draft contract as notified in Request for Information reference PH1_054 is that it "…places risk and liabilities where they can best be managed…". This manifests itself in various clauses such as 4.10A, 4.11, 4.12 and 5.1 where responsibilities are passed to the contractor. [redacted]

12.5 Risk management during construction in the draft contract

Clauses 8.3 and 8.3A provide for a risk management process. The contractor must give notice to the employer as early as possible of any potential delays, matters that could cause the Contract Price to increase, impair performance, and affect safety, quality and so on. Such matters are to be entered into a Risk Register. Either party may then require the other to attend a Risk Reduction Meeting with the aim of reducing or avoiding the risk(s), seeking solutions and deciding upon the necessary action. We would expect Nemo's Joint Venture Supervisory Board to be made aware of major risks at the very least.

[redacted]

[12] 'Appendix A – Insurance' which was an embedded attachment to Request for Information PH1_015.

12.6 Risk management during operation

Risk management during operation of the interconnector will be provided by a combination of insurances, service and warranty agreements, the availability of spares and mitigation of third party sub-sea cable damage so far as possible.

[redacted]

Two five year service and warranty agreements (SWA) will be put in place, one with the cable supplier and the other with the converter station supplier. These will provide for servicing and maintaining the assets and include maintenance of an electronic asset management system. Under the convertor station agreement there will be a requirement for a 24/7 helpline with graded response times for attending to problems. There does not appear to be a cost estimate or separate provision for these agreements. We assume that proposals will form part of the tenders submitted by bidders and will doubtless be the subject of negotiation. The approach to be taken after the first five years will be decided based upon experience of the process.

The cable supplier will also be required by the SWA to provide lengths of submarine cable to be held at an agreed store for necessary repairs. Diagnosing and repairing faults will also include a requirement to source the necessary vessels. The SWA will include an incentive to complete repairs quickly.

Third-party damage to the cable is expected to be the prime cause of service interruption. A cable burial protection study has been undertaken to determine the required burial depth to militate against such damage as far as possible. In the event of a cable strike, if it is possible that the perpetrator can be identified, we would assume its insurers would cover the cost of the repair. Issues in respect of service interruption and the Cap and Floor Regime are addressed in section 14.4.3.

Converter station failure could be due to the failure of any one of a number of integrated sub-systems. To mitigate against this bidders have been asked to provide a guarantee level of annual trips by robust design and this will be assessed in the whole life cost assessment.

Looking at the proposed organisational structure during operation it would appear that responsibility for risk management would lie primarily with the Operations and Asset Manager although it is not at all clear. We would expect the Supervisory Board to receive regular reports on these matters and to give them due consideration.

End of section

13. Forecast costs provided in the Cost Template

13.1 Introduction

In order to undertake the cost assessment exercise, Nemo was asked to populate a cost template for project costs. The template comprised annual costs for the development, construction and operational phases.

All costs were expressed in Euros at 2011 price levels. Specific price movements were only applied to staff costs which were subject to an additional 1% per annum increase over general inflation, for which the assumption is 3% per annum. Development costs incurred in Pounds sterling were converted to Euros using an exchange rate of €1.15 to £1.

The forecasts provided were initial estimates prepared approximately a year ago. It is the intention of Nemo that the values undergo a major update upon conclusion of the procurement process to select the major contractor(s) when the full extent of the services provided are known and costs are firmer. On this basis many of the forecast costs are very broad estimates at this stage which will be subject to refinement as the project progresses. Nevertheless, we used the cost template provided as the basis for our cost assessment. We challenged the estimates and the assumptions upon which they were based, reviewed information provided by Nemo, and used data for comparable projects to produce our own assessment of costs which are discussed in section 15.

13.2 Development costs

The total amount forecast by Nemo for development was approximately €38.3m, this included a contingency of €10m to cover operating costs during construction and €9.6m to cover interest on costs during the development period.

The forecast for development costs (before interest) of €28.7m covered actual expenditure up to and including 2012 and forecast expenditure thereafter. Table 9 shows the development cost forecast pre-interest provided by Nemo. The actual expenditure incurred was €8.7m and forecast future development expenditure of €20m (including €10m contingency).

Table 9: Development cost forecast provided by Nemo (2011 prices, €000s) pre-interest charges

	Actual costs to 2012	Estimate of future costs	Total estimated development costs
Employee costs	1,018	2,791	3,809
Marine surveys	3,484	362	3,845
Consents and permissions	358	741	1,099
Wayleaves and easements	20	[redacted]	[redacted]
Land costs	974	1,065	2,039
Environmental studies	1,613	404	2,017
Legal	595	2,161	2,756
Other costs	692	12,001	12,693
Total	**8,754**	[redacted]	[redacted]

Source: Request for Information PH1_003a.

The Employee costs, which are forecast by Nemo to exceed €3.8m during the development period relate to contributions from staff from both parties and their parent companies towards the project. Nemo has explained that it is a licence condition that no cross subsidy or abuse of competitive position occurs and all work undertaken by NGET and Elia for project Nemo is negotiated on an arm's length basis. Parent company staff costs chargeable to the project have been and will be apportioned to the job via time sheeting. The hourly charge out rates used is the same as for external clients in the case of National Grid or other investment projects in the case of Elia. Within National Grid, European Business Development (EBD) staff costs will be charged using timesheets. The hourly rates for EBD staff differ to those used by NGET. EBD staff costs were not charged to the project up to the end of 2012 but will be charged on a timesheet basis through the remainder of the development period. The Nemo estimate of their resource requirements during the development phase is summarised in Table 10.

Table 10: Estimated resource requirements (in FTE)

	2007	2008	2009	2010	2011	2012	2013	2014
Elia	0.2	0.3	0.6	0.9	1.2	3.6	4.2	5.6
National Grid						4.9	7.0	5.5
Total	0.2	0.3	0.6	0.9	1.2	8.5	11.2	11.1

Source: Request for Information PH1_009.

13.3 Capital expenditure

The total amount forecast by Nemo for capital expenditure, before any capitalisation of development costs, was [redacted] over the lifetime of the project. This is broken down in Table 11 on the next page before the addition of interest charges [redacted], the total thus reducing to [redacted]. Nemo has used an indicative budget cost of [redacted] (see section 14.4.2) but that covers only items 1, 2 and 7 in Table 11. Adding items 3 to 6 gives the full capital budget of [redacted].

The estimates provided by Nemo for the major works were of a high level and not broken down into the various components. The estimates were based on budgetary prices provided by converter and cable suppliers in 2007 in response to a 'mini specification' and high level description of the requirements. The estimate provided was supported by on-going benchmarking of new supplier estimates and public domain information.

The actual cost will not be known until the procurement process has been completed and a preferred bidder selected. The prices tendered will depend on a number of factors that may mean that the final price may differ significantly from the budget prices obtained earlier. The bid prices will no doubt be affected by the strength of the order books of the prospective contractors, their current and future commitments and their appetite for risk and acceptance of the proposed contractual terms.

The bulk of the forecast capital expenditure is expected to be incurred during the initial construction period but during the lifetime of the project some asset replacement will be necessary and this has been estimated by Nemo at approximately [redacted].

The decommissioning value is the discounted present day value of the amount estimated for decommissioning in 2035. The cost in 2035 is estimated at [redacted] of which is for offshore decommissioning and [redacted] is for on shore decommissioning.

Nemo is of the opinion that the removal of the asset after lifetime is not mandatory, but, at least for the permit application of the offshore cable part in Belgium, it is mandatory to set up a provision for cable removal. At the end of the lifetime of the asset, the competent authorities will determine whether or not Nemo is required to remove its asset.

Nemo expects that after termination of the lease agreement at the converter sites in UK and Belgium, to remove the asset and hand it back over to the landowner in its initial state.

Table 11: Capital Expenditure forecast provided by Nemo (2011 prices, €000s, pre interest charges)

[REDACTED]

Source: Request for Information PH1_003a.

The offshore decommissioning value was based on estimations from specialised consultants, taking into account the mobilisation and demobilisation of the offshore equipment and an average price per length to take specific soil conditions into account.

The decommissioning cost for the works in France and UK are estimated at a higher rate, compared to the works in Belgium, due to existing soil conditions (mobile sand waves and hard soil conditions)

For the removal of the converter stations, only rough estimations based on onshore experiences were made with more detailed estimations to be investigated in the future.

Nemo estimates included a sum of €70m for 'Other costs' which includes project management, insurance, third party works, contingency and trading systems.

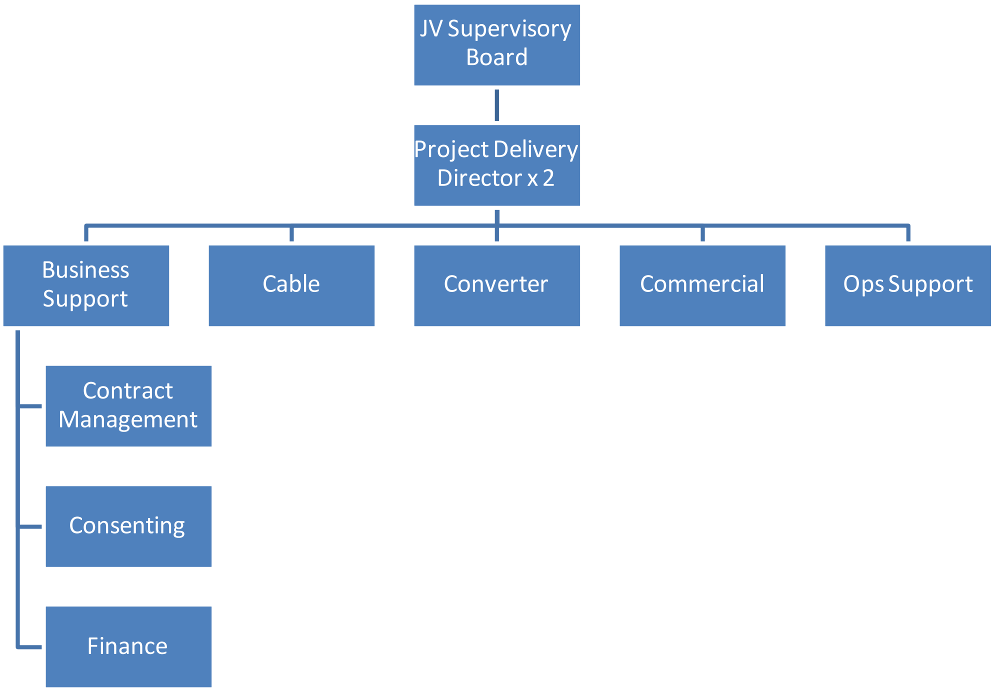
Based on experience obtained during the BritNed experience Nemo has estimated that the total staff requirements during construction will be in the order of 20 to 35. The split between JV staff and contractors will be decided based on resources and expertise required at the time.

The indicative organisation proposed by Nemo for the JV staff during construction is shown in Figure 10 on the next page.

The estimated resource requirements, expressed as full time equivalents (FTE), during this period are expected to be:

- Business Support 10 FTE
- Cable 6 FTE
- Converter 6 FTE
- Commercial 6 FTE (note commercial is anticipated to have a more pronounced profile, building up to a peak and then declining to a steady state)
- Ops support 6 FTE (this is the average over the last three quarters).

Figure 10: Proposed organisation chart during construction



Source: Request for Information PHI_009.

In addition to the above core staff for managing the construction phase and supporting the business, commercial and operational aspects there will be a significant number of EPC contractors employed to deliver the converter station build and install the cable.

The estimates provided also include €45m to cover interest during construction

13.4 Operating Costs

Table 12 summarises the operating cost forecasts provided by Nemo.

Table 12: Operating cost forecast provided by Nemo (2011 prices, €000s)

	Total over assumed operational lifetime (25 years)	**Annual cost** (typical – slight variations for some items each year)
O&M		
Employee Costs	17,763	629
Contractors	92,000	3,680
Materials	0	0
Other	0	0
Total maintenance costs	109,763	4,309

Table 12 continues on the next page…/

Table 12 continued…

Trading		
Employee Costs	35,232	1,247
Contractors	0	
Grid Costs	0	
Exchange Fees	10,000	400
Market related costs	142,500	5,700
Materials	0	0
Other	12,500	500
Total trading costs	200,232	7,847
Administration and General		
Employee costs	34,645	1,227
Contractors	0	
Legal, Professional, Consultancy	10,000	400
Materials	0	
Information Technology	15,000	600
Customer Relations/Communications	10,000	400
Training	3,750	150
Insurance	116,294	4,652
Leases	22,500	900
Rent	7,500	300
Rates	32,500	1,300
Utilities	5,000	200
License fees	3,750	150
Other	4,800*	180
Total Administration and general	261,244	10,579
Depreciation - Assets	560,086	22,219
Depreciation - Decommissioning	16,716	669
Depreciation - Development Costs	38,319	1,533
Financing	0	
Decommissioning Interest Charge	18,284	501
Total Opex section	**1,209,139**	**47,537**

Note*: Includes an additional cost of €300,000 in the first year (2019) for a launch event.

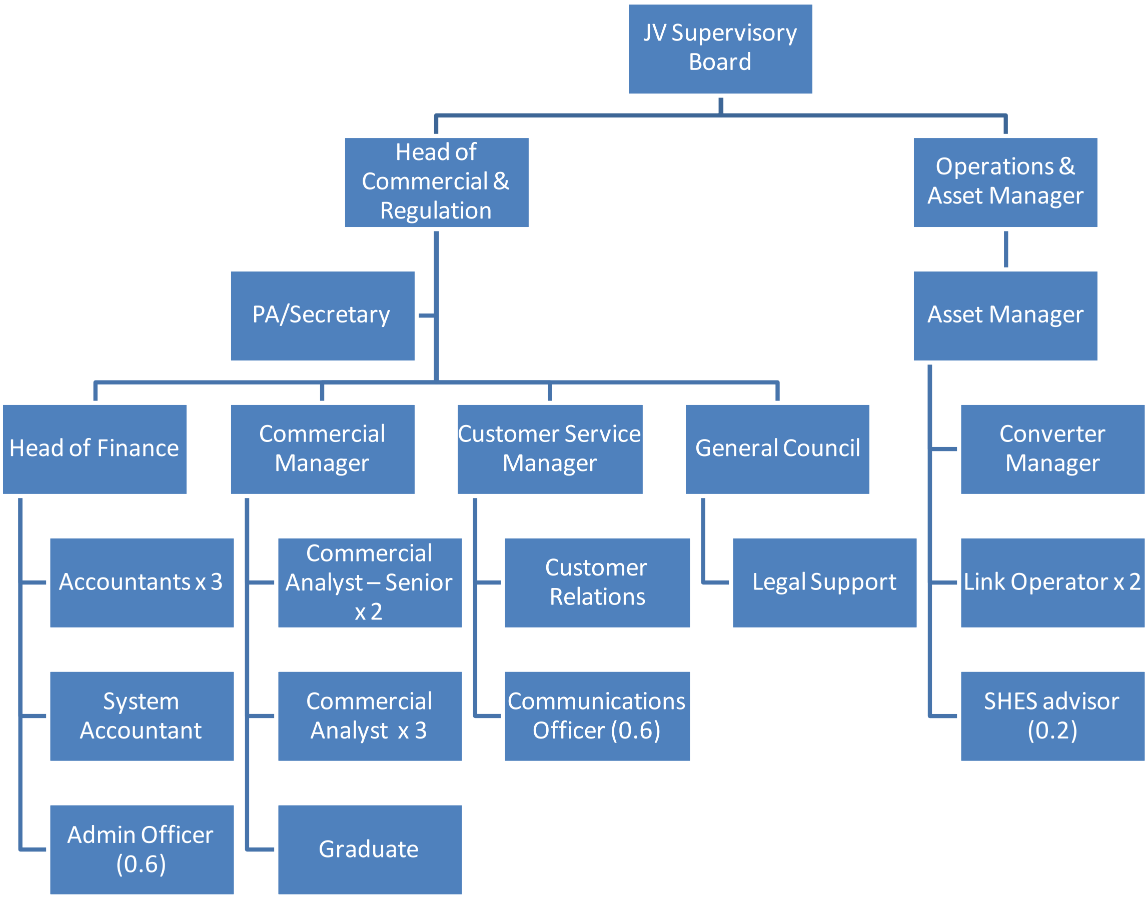
Source: Request for Information PH1_003a.

Employee costs

The forecast employee cost, which cover operating and maintenance, trading and administration and general costs amount to €88m over the operational phase of the project.

The indicative organisation proposed by Nemo for the JV staff during the operational stage is shown in Figure 11 on the next page.

Figure 11: Proposed organisation during the operational stage



Source: Request for Information PHI_009.

The estimated resource requirements, expressed as full time equivalents (FTE), during this period are set out in Table 13.

Table 13: Estimated resource requirements during operation

Commercial	**FTE**
Head of Commercial and Regulation	1.0
Customer Service Manager	1.0
Commercial Manager	1.0
Customer Relations	1.0
Commercial Analyst - Senior	2.0
Commercial Analyst	3.0
Graduate	1.0
Total	**10.0**

Table 13 continues on the next page…/

Table 13 continued….

O&M	
Operations and Asset Manager	1.0
Converter Manager	1.0
Asset Manager	1.0
Link Operator	2.0
SHES Advisor	0.2
Total	**5.2**
Business Support	
Head of Finance	1.0
Management Accountant	1.0
General Counsel	1.0
Accountant	2.0
Legal Support	1.0
Administration Officer	0.6
System Accountant	1.0
PA/Secretary	1.0
Communications Officer	0.6
Total	**9.2**
Overall total	**24.4**

Source: Request for Information PH1_009.

Operation and maintenance

Forecast operating and maintenance costs are in excess of €4.3m per annum, €0.63m of which relates to employee costs and €3.7m relates to external contractors.

In the case of cables, it is intended that a five year service and warranty agreement will be put in place with the cable supplier. This will address the onshore cable and subsea cable maintenance requirements. This will include servicing of link boxes, sea cable to land cable transition pits and the cable sealing end terminations. In addition the supplier will be required to maintain records on an electronic asset management system recording details of all delivered maintenance and operational performance of the cable.

Nemo will also put in place arrangements for monitoring of the cable. This will consist of regular surveys to review compliance against consents obligations, to ensure that the level of cable burial is being maintained and that cable protection measures, e.g. rock mattressing, are still in place and performing as planned.

Based on the analysis undertaken to date Nemo has developed a cable burial protection study. This will be used as the starting point for the operational phase cable risk management system. As part of this assessment the cable route will be sectionalised according to seabed conditions and a prioritised approach to cable surveying will be developed based on the results of the cable installation.

For the convertor stations, it is intended that a five year service and warranty agreement will be put in place with the convertor station supplier. This service and warranty agreement will encompass all planned and reactive maintenance on both convertor stations (Richborough and Zeebrugge). As part of the agreement the contractor will provide schedules for planned maintenance to manufacturer recommendations.

The service and warranty agreement will incentivise the convertor supplier to work towards achieving high levels of reliability (minimising the number of unplanned interruptions to service) and availability (the duration that the interconnector is not capable of full operation).

The service and warranty agreement envisages 24/7 helpline facilities and graded response times in line the categorisation of the defect to be addressed.

During these five years, Nemo personnel will supervise the maintenance works. After the five year maintenance contract, Nemo will take a position on the further maintenance approach, based on the experience and lessons learned of the Nemo personnel mentioned above. Either a new maintenance contract with the supplier will be put in place, or Nemo will perform the maintenance in-house, or there will be a combination of both.

The draft Service and Warranty Agreement (SWA) requires the supplier to diagnose and propose repair plans for all faults associated with the cable. This will include where necessary the sourcing of appropriate vessels for the diagnosis and repair of cable faults. Minimum response times are specified in the draft SWA for responding to prioritised fault events according to their severity.

The cable supplier will deliver several lengths of spare submarine cable, stored at a location to be agreed, for the undertaking of offshore cable repairs. The supplier will have access to all the spares procured by NEMO and will be responsible for obtaining additional spares to replace those used.

The supplier is incentivised under the draft SWA to complete any cable repairs as soon and as quickly as possible. In addition the supplier is required to provide full reports of all work undertaken on the cable and enter this information into an online asset management system.

The actual costs relating to the above will not be known until a preferred bidder(s) has been selected and negotiations on services provided and associated terms and conditions agreed. Nemo has based the estimates are largely based on experience of development of the BritNed interconnector, although the impact of using new VSC converter technology in Nemo has not been fully assessed by it.

Trading

Costs associated with trading are forecast to be in excess of €7.8m per annum, €1.2m of which relates to employee costs, €0.4m to exchange fees, €5.7m to market related costs and €0.5m other.

It is assumed that the various market related costs will be deducted from gross revenues to provide net revenue which will be used for the revenue to be assessed under the cap and floor regulatory mechanism. These costs will therefore be excluded from the cost assessment.

Other costs relate to costs associated with running auction and accounting systems.

Administration and general

The total forecast cost of the various items of expenditure included within the Administration and General category amounts to over €10m per annum. This comprises:

- **Insurance:** the largest item of expenditure which has been forecast at €4.65m per annum (see section 12.6 for the breakdown). This estimate has been constructed from some preliminary indicative premium estimates assuming a replacement cost for assets insured of €510m;
- **Employee costs:** forecast to be in excess of €1.2m;
- **Rates and property taxes**: forecast to be €1.3m per annum, €0.8m relating to the UK and €0.5m relating to Belgium;
- **Land rents for converter station sites**: forecast at €0.9m per annum and office rents at €0.3m;
- **Information Technology support costs:** forecast at €0.6m per annum;
- **Legal, professional and consulting costs**: forecast at €0.4m per annum;

- **Customer relations and communications costs**: forecast at €0.4m per annum;
- **Training costs**: forecast at €0.15m per annum; and
- **Utility costs**: forecast at €0.2m per annum, [redacted] and other costs, which include cleaning, printing, postage, subscriptions etc, are forecast at €0.2m per annum. A one off cost of €0.3m has been included in the forecast for an event to launch the Belgium/UK interconnector.

Depreciation charges are based on the capital costs plus interest during construction with an assumed asset life of 25 years.

End of section

14. BPI's cost assessment

14.1 Introduction

The following sections outline our view on reasonable and economic cost estimates that should be used in the preliminary cap and floor mechanism being developed by Ofgem and CREG for project Nemo.

As has previously been stated, the cost forecasts provided by Nemo's are initial estimates and in many cases are, by nature, very broad. It is Nemo's intention to review and refine these forecasts throughout the project development, particularly upon completion of the tendering exercise to select the preferred bidder(s). At that point there will be greater clarity over a number of areas, in particular over the capital expenditure requirements. Nevertheless, in order to provide a preliminary view of the level of costs to be considered for setting the initial cap and floor levels, we have undertaken a thorough review of the forecasts and the evidence available to support the assumptions used.

It is apparent that, as a general theme, the forecasts provided are very conservative and include an element of contingency to allow for unforeseen circumstances and costs; consequently, in our view, they represent a significant over-estimation. Furthermore, in many cases insufficient evidence has been provided or is available to support the level of costs claimed so we have scaled back costs accordingly.

We have assumed that all items included within the completed cost template are subject to the cost assessment with the exception of the following items which we have treated separately:

- **Interest During Construction:** Whilst this is an accepted cost in a project of this nature, we understand that Ofgem and CREG will establish a methodology to incorporate this in the cap and floor mechanism; we therefore make no further comment.
- **Decommissioning Costs:** The template included an amount to cover the present day value of forecast decommissioning costs spread over the construction period. This appears to be an approach adopted by Nemo so that an appropriate accounting provision can be made (we understand that this is a particular requirement of the Belgian authorities). Our cost assessment is not concerned with accounting treatment and we have therefore restricted our comments to the expected unadjusted cost at the end of the project life.
- **Market-related costs:** There is a group of costs including imbalance costs and error accounting that will be set off against revenue, as such they are outside the scope of the cost assessment so we have excluded them from our assessment.
- **Depreciation:** We have reviewed costs on a cash basis rather than an accounting basis. As we have assessed capital expenditure requirements separately we have excluded forecast depreciation charges from our assessment of operating costs, because to include them would effectively be double counting.

The following paragraphs summarise our assessment of the forecast costs and our own recommendations for cost estimates to be used at this stage in the regulatory process.

14.2 Employee costs generally

BPI considers that the on-cost rates that Nemo has applied to the salaries used in its assessment of the Project's costs are excessive; if their calculated costs of salaries were accepted then they would over-recover the true costs to the project. We believe that the employee cost rates used should be sufficient to cover the costs of employment, i.e. salaries, national insurance, pension contributions, holidays, sickness, other contractual payments and associated salary processing costs. It is reasonable to include a further on-cost to cover any overheads not separately provided for in the cost allowances and therefore should not include rent, utilities, IT, accounting and legal services separately identified in the cost template. Should the employee rates include any allowance for these items staff costs will need to be scaled back accordingly.

Despite asking for a breakdown of these costs, none were provided to us. We consider that, on average for the range of personnel listed, a rate of 85% should be applied to raw salaries in order to recover the true direct costs of employment, and that this would be in line with typical employment on-cost rates used in the utility sector.

Although we have not been provided with raw salary costs for the Project teams, we have assumed typical salary ranges for each grade, and by applying an on-cost recovery rate of 85% we estimate that Nemo's declared costs should be reduced by 30% for each grade of staff. We have therefore made reductions to all the employee costs In line with this.

14.3 Development phase

In this section we comment on issues relevant to the Development phase of the Nemo project.

14.3.1 Development costs

There has been a significant amount of expenditure associated with project Nemo that has already been incurred. This includes a number of studies, surveys, professional advice and procurement. It is expected that there will be further significant expenditure that will be required before construction occurs.

This is a discretionary project and there is no guarantee that it will go ahead. If it does not Nemo will bear the development costs themselves. On these grounds there is a case for omitting development costs from the cost assessment for the Cap and Floor mechanism. This is a decision for the NRAs.

It is the intention of Nemo that, should the project proceed, these development costs will be capitalised as part of the project costs. Although we have made a recommendation on the pre-feasibility costs, nonetheless we have assumed that this will be an acceptable approach to the regulator and therefore comment as to the reasonableness of the overall forecast of development costs. Table 14 summarises the cost estimates provided by Nemo.

Table 14: Development cost forecast provided by Nemo (€000s)

	Actual costs to 2012	Estimate of future costs 2012	Total estimated development costs
Employee costs	1,018	2,791	3,809
Marine surveys	3,484	362	3,845
Consents and permissions	358	741	1,099
Wayleaves and easements	20	[redacted]	[redacted]
Land costs	974	1,065	2,039
Environmental studies	1,613	404	2,017
Legal	595	2,161	2,756
Other costs	692	12,001	12,693
Total	**8,754**	[redacted]	[redacted]

Source: Request for Information PH1_003a

Contracted expenditure: The studies and adviser reports that have been produced so far are, in our opinion, consistent with those that would be expected for a project such as Nemo. There was clearly a need to undertake a number of studies to:

- Understand initially the feasibility of the proposed project;
- Select appropriate land sites;
- Select an appropriate subsea route;
- Understand and plan for environmental issues; and
- Develop technical specifications

In addition there will be expenditure associated with on-shore planning, public consultation, stakeholder engagement (including regulatory authorities), and developing procurement approach and contract strategy. The draft contracts issued to prospective contractors attempts to place as much risk as possible with the contractors, including risk over site conditions. When accepting responsibility for the project the contractor must be sure that he has all the necessary information. This may involve repeating, perhaps in more detail, some of the work already carried out by Nemo when developing the project, such as seabed surveys. The contractor must be sure of the conditions of the cable laying route so that the work can be done, ideally without delay. As such, there is an argument that the cost of some of the survey work already undertaken should be removed from the reasonable cost assessment as the successful contractor may include an element of cost for this work in his tender. Indeed, the contractors may undertake their own surveys but we would also expect them to rely significantly on the work already undertaken in their assessment of conditions. For example, we understand that soil samples taken during the surveys commissioned by Nemo will be available to the contractors for their own assessment.

Generally we believe the detailed surveys to date are appropriate in order to achieve the balance between development costs on the one hand and likely additional costs for supplier's risk on the other. However, we also believe that some of the initial studies and associated employee costs should not be included in the Nemo project as they are part of the feasibility studies required for any significant project. These initial studies are considered to be akin to a corporate strategy programme assessing a wide range of strategic options for the parent companies. We propose that once the Nemo project had an agreed route and high level technical design then all previous work should be considered pre-feasibility and discounted.

National Grid and Elia are operating under a joint development agreement (JDA), which provides for a Steering Committee which approves the selection of NGIL and Elia staff and/or contractors to undertake development work. The JDA specifies that the appointment of contractors is to be undertaken through a tender process meeting the procurement and governance requirements of the corporate authority of the hiring party. The external costs which have been incurred up to the end of 2012, amount to €7.7m and Nemo has confirmed to us that all procurement associated with development work has been undertaken in accordance with the JDA and European procurement regulations. The total development costs to the end of 2012 amount to €8.7m but, because the pre-feasibility costs discussed above are not separately available, we would recommend that this is reduced by 30% across the board, apart from land costs, in order to remove the those costs associated with the initial pre-project work. We believe this to be to be a reasonable assumption based on the information made available to us.

The cost template provided to us included an estimate of future development expenditure (i.e. from 2013 onwards) excluding employee costs totals €17.1m. Of this estimate €12m relates to €2.5m per annum as a place marker to cover operating costs to be incurred during the construction period. Nemo has stated that these costs will be firmed up once the tenders have been reviewed. At this stage, in the absence of any evidence to support this level of expenditure we suggest that it is removed from the cost estimate. As for the other external expenditure, whilst we accept that will undoubtedly be further expenditure required insufficient evidence has been provided to support the amount suggested and we therefore recommend that the costs allowed for these items be reduced by 30%. The original forecast included an allowance of €0.13m for further survey work that may have been required but it has now been confirmed that this will not be required and the cost has therefore been removed from the forecast.

14.3.2 Organisation structure and employee costs

The current Development Phase organisational structure comprises a Steering Committee overseeing the work of Technical, Procurement and Regulatory Workstreams. It would appear to be more fluid and less formal than a specific organisational structure.

The Cost Template spreadsheet shows actual employee costs for the Development Phase from 2007 in Belgium and 2009 in the UK up to 2012 together with forecast costs for 2013 and 2014 totalling €3.809m. The actual costs total €1.018m and forecast costs €2.791m, 27% and 73% of the total respectively. We have seen no evidence to support these costs and forecasts although we understand that timesheets are now being completed which should provide evidential breakdown going forward. We have not seen any information to describe the team structure historically or at the present time (2013) and up to 2014.

Given that we have proposed a 30% reduction in employees (34 to 24) for the Construction Phase (Capex) structure (see section 14.4.1) and that we do not have a formal organisation structure for the current Development Phase with identified posts, we propose that the employees for 2013 and 2014 be reduced by around the same percentage whilst leaving the actual posts up to 2012 untouched. Additionally we have reduced the salaries across the board in line with our comments in Section 14.2, Employee costs. Thus we propose that the Development employee costs for 2013 and 2014 be reduced to €0.69m in each year and the total employee costs up to 2012 be reduced to €0.713m.

Fundamentally and looking across all three phases, the available information regarding organisational structure and costs is:

- **Development Phase:** actual and forecast costs but no formal organisational structure or posts to which costs are readily attributable;
- **Construction Phase:** proposed structure but no identifiable cost forecast (see section 14.4.1); and
- **Operation Phase:** proposed structure with forecast costs (see section 14.5.1).

Aside from the reductions proposed above, we question generally the level of employee costs which seem to be quite high. We understand from Request for Information PH1_052 that Opex employee costs include salary, pension, national insurance, any other costs related to the employment of staff and overheads. In the absence of information to the contrary, we shall assume that both Development and Capex employee costs include the same. We have not been given a breakdown of employee costs into salary and employment on-costs.

14.4 Construction phase (Capex)

In this section we comment on capital expenditure issues relevant to the Construction phase of the Project.

14.4.1 Organisation structure and employee costs

Nemo has proposed an organisational structure for the Construction phase which is shown in Figure 10 on page 48. The estimated resource requirements for the Construction phase, expressed as full time equivalents (FTE), during this period are expected to be:

- Business Support 10 FTE
- Cable 6 FTE
- Converter 6 FTE

- Commercial 6 FTE (note commercial is anticipated to have a more pronounced profile, building up to a peak and then declining to a steady state)
- Ops support 6 FTE (this is the average over the last three quarters)
- Total 34 FTE.

We have seen no evidence to support the need for this structure, such as a more detailed breakdown of the individual roles, outline job descriptions, timing of the roles throughout the Construction phase and so on. The minor exception relates to the Commercial team which will grow, presumably towards the end of the Construction Phase when it will be building its customer portfolio. This is a reasonable expectation. Our view is that the total team of 34 is excessive and could reasonably be reduced by ten posts to 24. The reduction could be spread evenly across all five teams although it may be more sensible to ramp each team up or down according to workload. The more technical specialisms would need more people early in this Phase to work with the contractor to develop and finalise the technical specifications. The Commercial team would need fewer, perhaps only one or two people at this time but more towards the end of the phase.

There are no itemised forecast employee costs for the Construction phase organisational structure for 2015-18 set out in the Cost Template spreadsheet. It appears that the costs have been subsumed into other high level costs for that Phase which focus on the expected capex for the major capital items (converter stations, cable, control and protection etc). This seems odd given that such costs have been itemised for the Operational Phase from 2019. We would have expected to see a breakdown.

14.4.2 Capital costs

BPI reviewed the budget capital prices that Nemo had indicated for the supply and installation of the two proposed converter stations and the cable (including both sub-sea and land sections). [redacted].

HVDC is one of the fastest-developing areas in transmission technology today, and costing estimates are continuously reviewed as the larger converters establish a good performance track record throughout the world. However, there are difficulties in being able to arrive at a robust and defendable judgement of what the appropriate costs for this project should be.

Nemo will be built using Voltage Source Converters (VSC) connecting into a HVDC link. The deployment of this technology at this scale is new, and has been chosen to for various technical reasons including the possible delays to the project that could be caused by the infrastructure investments needed to accommodate the application of more typically used Line-Commuted Converter technology (LCC). Most importantly, any cost comparison between LCC and VSC converter stations needs to take into account the technical restrictions on the use of a particular type of cable. XLPE cable technology has developed to the extent that this type of cable may be used with the highest voltage VSC stations. This is possible because the VSC HVDC technology does not require the cables to change polarity as the direction of power flow is changed. The resulting lack of suitable comparators means that it is difficult to establish a robust benchmarking target for the Nemo interconnector.

VSC converters are generally more costly per MW transfer capacity than the LCC equivalent. However, when costing an HVDC link it is important to take account of the costs associated with both the converters and the cable between them. By doing this, it becomes evident that the technical limitation imposed by XLPE cable, in conjunction with the differing costs of the two types of converter, results in short HVDC links being more economic with a CSC design, and long HVDC links being more economic with a VSC design. The cross-over point (the length of a link at which the two technologies cost the same) will depend upon a range of sensitivity factors.

Since commodity prices, particularly metal prices, can affect transmission equipment costs, it follows that any cost benchmarking will not provide a totally reliable indicator of actual project costs. Furthermore, since the developers have naturally sought competitive tenders for the supply and installation of the assets, worldwide supply and demand for these services is bound to influence the final negotiated prices.

Average costs for HVDC converter station installations can also vary widely, depending upon the electrical and environmental factors of the specific application.

Notwithstanding these difficulties, in assessing costs we firstly reviewed the results of recent analysis undertaken for DECC by Baringa Ltd., which was provided to us by NGIL/Elia in response to our request for Information (PH1_040). The study was a high level exercise that compared the costs of 12 recent HVDC schemes around the world, using the combined costs for the converter stations and cable elements of each project. The analysis assessed the cost per kW of capacity for each scheme and placed the Nemo estimates at the lower end of a range of costs, as shown in Table 15.

Table 15: Assessed cost per kW of capacity for various interconnector schemes

Scheme	Cable Length (km)	Rating (MW)	Cost (€m)	Cost/Rating (€/kW)
Malta-Sicily	100	200	200	1,000.0
Spain-France	70	2,000	700	350.0
Estlink	105	650	320	492.3
BritNed	260	1,000	600	600.0
Sardinia-Latina	435	1,000	730	730.0
NordBalt	450	700	580	828.6
NorNed	580	700	650	928.6
Western Bootstrap	485	2,250	1,489	662.0
BassLink	305	600	619	1,031.2
Dolwin 1	165	800	812	1,015.0
E-W	261	500	600	1,200.0
Skaggerak4	228	700	430	614.3
Nemo		**1,000**	**500**	**500.0**

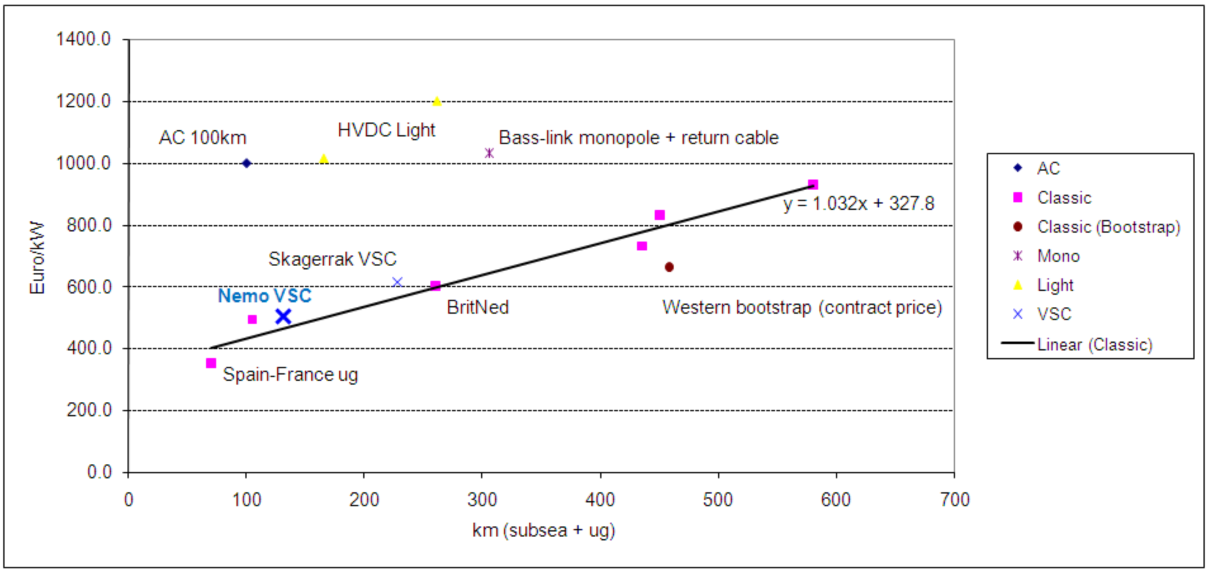
Source: Request for Information PHI_040

Nemo accepts that, as with all generic extrapolations, no two projects are the same and each project needs to be considered on the basis of engineering challenges. Furthermore, the schemes that were reviewed represent a fairly wide mix of associated cable route length and converter technologies.

Nevertheless, from this data, Baringa's analysis shows a trend line for HVDC LCC (classic) schemes as shown in Figure 12 on the next page and the addition of Nemo's estimated Project costs shows it to be consistent with this line.

However, BPI also considers this to be rather imprecise and therefore an unreliable comparison, particularly since total costs will inevitably be heavily influenced by cable length and environmental factors. Amongst the 12 schemes considered in the DECC/Baringa review none were considered to be sufficiently similar to provide anything other than a crude benchmark of costs against which NEMO might be compared.

Figure 12: Trend line for HVDC classic schemes



Source: Request for Information PHI_040

As mentioned in Section 9, Technical Considerations, we point out that Nemo has not provided details of any cost benefit analysis that we would have expected to have been carried out between the two available technologies. Indeed the reduced time to the commissioning date offered by VSC due to an earlier grid connection date at Richborough appears to be the main (or only) consideration for its choice.

For projects of 1,000MW or larger, VSC technology is still in its infancy and it is not unreasonable to expect that it may attract a cost premium at this point in the development cycle due to the inherent technical advantages it can provide over the alternative LCC. It is reasonable, however, to believe that any price differential is likely to reduce overtime. Nonetheless, at the current time and whilst recognising the technical constraints , generally, when comparing like-for-like the capital cost of LCC converters remains lower than VSC. Also we are not aware of any significant savings in on-going maintenance for VSC converters that could potentially reduce the lifetime cost to that of an equivalent LCC arrangement. Whilst we recognise that the cost of the HVDC cable could be a factor, nonetheless our research strongly indicates that LCC technology would be the lower cost option in this case. Consequently, but recognising the transmission system in South East England will need some reinforcement by NGET, we recommend that conventional LCC technology is used for setting the cost allowance at this stage of the regulatory process.

BPI has researched available information from main equipment providers of HVDC systems such as Alstom, Siemens and ABB, to establish a broad benchmark cost for the main capital elements for the Project. This data was supplemented by the findings from further reviews of other, similar costed projects. Estimated average unit costs derived from this exercise are set out in Table 16 .

Table 16: Estimated average unit costs based upon benchmark information

Item	Unit cost (€m)	Quantity	Total (€m)
LCC Converter Station (each)	110.0	2	220.0
Subsea cable (Km)	1.2	130	156.0
Land cable (Km)	1.3	5	6.5
Total			**382.5**

Taking into account all of our analysis, and bearing in mind the difficulties in establishing a reliable benchmark that we have outlined above, BPI recommends that the capital cost for the converter stations and cable circuits is likely to be in the region of €383m. However, it should be recognised that the contracts require a design operational life of 40 years for the main items of plant which is somewhat longer than the proposed initial regulatory regime of 25 years. We therefore make the point that although much electricity transmission equipment inherently has a life expectancy in excess of 40 years, HVDC technology and VSC converters in particular, are still relatively immature so there may be a cost premium for this asset life. From the information and data generally available it has not been possible to determine the value of any such premium.

BPI has also reviewed the additional capital costs provided by Nemo, namely:

- Replacement costs for control and protection
- Replacement costs for auxiliary power
- Replacement costs for telecomms equipment
- Decommissioning
- Other costs (Project Management, Insurance, Miscellaneous)

The 'Other costs' relate to the following:

- Insurance €15m
- Third party works.........................€29m
- Trading systems €2m
- Land costs €2m
- Project management costs €15m
- Miscellaneous €7m
- **Total €70m**

In its report entitled Electricity Transmission Costing Study[13], Parsons Brinckerhoff comment that project management costs for capital projects are typically between 2.5% and 4%. On the basis that the main works will be subject to an EPC contract, we believe the PM costs should be at the lower level. Consequently we believe project management costs will be in the region of €10m.

We assume insurance comprises construction all-risks insurance and third party liability but we believe that €15m is a high-side estimate whilst still recognising market unpredictability. There may also be some double counting if the main contractors also provide construction insurance. It is not clear what the miscellaneous costs include and the €29m for the third party works is similarly not detailed.

We therefore recommend the 'Other costs' are restated thus:

- Insurance €0m
- Third party works.........................€10m
- Trading systems €2m
- Land costs €2m
- Project management costs €10m

[13] Parsons Brinckerhoff – Electricity Transmission Costing Study 31 January 2012, An Independent Report Endorsed by the Institution of Engineering & Technology.

- Miscellaneous €0m
- **Total €24m**

Although some items such as SCADA and metering do not have individual costs attached we do not believe they will be significant and most likely will be captured within the main equipment costs. Consequently BPI's total recommended capital expenditure allowance is shown in Table 17.

Table 17: Capital expenditure

Item	Nemo allowance €000s	BPI's recommended allowance €000s	Comments
Converter stations and cable	[redacted]	383,000	Estimated costs using currently available data.
Replacement costs for control and protection	9,200	2,000	It is accepted that there should be an allowance for digital systems to be upgraded between about years 15 and 20. Based on a life of 25 years we believe €2m at 2011 prices to be a reasonable allowance for refurbishment for the remaining five years.
Replacement costs for auxiliary power	5,700	0	We do not believe the auxiliary power systems are likely to require replacement before the end of 25 years.
Replacement costs for telecomms equipment	100	100	Agreed
Other costs (Project Management, Insurance, Third party works etc)	70,000	24,000	This includes Nemo employee costs during the construction period.
Decommissioning	16,700	4,000	See Section 14.4.3
Total	[redacted]	**413,100**	

Source: Request for Information PHI_003a and Consultant's Assessment

***Note:** See comments in section 13.3.

14.4.3 Decommissioning costs

As discussed in Section 13.3, Nemo estimated the costs associated with decommissioning the Project after twenty five years at €35m at current prices. €21.9m of this amount relates to offshore decommissioning with €13.1m for on shore decommissioning.

Whilst we understand that it is mandatory to set up a provision for cable removal for the permit application for the offshore cable part in Belgium, the removal of the asset at the end of its lifetime may not be mandatory. The competent authorities will determine whether or not Nemo is required to remove its asset. There is also further uncertainty over the lifetime of the project and although twenty five years has been used as a modelling assumption, we note that specifications issued to tenderers for cables and converter stations called for an operational life of forty years.

There is a strong argument that the long term environmental impact may be better if the subsea cable is left in situ at the end of its life rather than removing it which would involve significant disruption to the sea bed and any marine colonies that may have developed over time. We therefore believe that it would be inappropriate to include an amount for sea bed cable decommissioning and recommend that this should not be part of the allowed costs. Indeed, although it is impossible to predict scrap metal prices in 40 years' time, it is perfectly feasible that they will have risen to a level that would make removal of the cable effectively self-financing.

However, it is likely that at the end of the project life it will be expected that the converter station assets in both UK and Belgium may need to be removed and the land returned to its original state, so some allowance should be included for on-shore decommissioning costs. In the absence of any firmer costs, we recommend that an allowance of €2m should be provided for each site and therefore recommend a total decommissioning allowance of €4m. In any case, we consider that the cable life may be in excess of 40 years and with the likelihood that the interconnector will still be required we would expect that the converter stations will be refurbished for on-going use.

14.5 Operational phase (Opex)

In this section we comment on operational expenditure issues relevant to the Operational phase of the Project.

14.5.1 Organisation structure and employee costs

Nemo has proposed an organisational structure for the Operational Phase which is shown in Figure 11 on page 50. Nemo's estimated resource requirements for this structure, expressed as full time equivalents (FTE), during this Phase is set out in Table 14 starting on page 47. The totals and their forecast costs over the project lifetime together with the percentages they represent are set out in Table 18.

We have seen no evidence to support the proposal for this structure other than a comment in PH1_052 that the "…number and cost of staff are in line with BritNed experience except for O&M staffing levels. These are lower than those in BritNed as the personnel required are assumed to be supplied via O&M contracts.". That does not necessarily mean that it will be optimal and we understand that the BritNed organisational structure is under review at the present time, a reasonable expectation being that it will be rationalised as a consequence. As with the Development Phase structure no detailed justification or breakdown of the individual roles, outline job descriptions, timing of the roles etc has been provided and in the absence of any such information it is our view that the organisation is excessive, particularly in relation to the Commercial and Business Support posts which comprise 19.2 of the 24.4 total FTEs.

Table 18: Nemo forecast employee numbers, costs and percentages 2019-2043

Business stream	Nemo employees		Cost €000	
	Number FTE	% of total	Amount	% of total
O&M	5.2	21.3%	17,762.8	20.3%
Commercial	10.0	41.0%	35,232.0	40.2%
Business support	9.2	37.7%	34,644.8	39.5%
TOTAL	**24.4**	**100.0%**	**87,639.6***	**100.0%**

***Note:** Forecast Opex employee costs have been increased annually in the Cost Template by an inflation forecast plus a 1% real increase.

Source: Request for Information PH1_009 and 003a.

Our view is that there is scope to reduce this organisation by eight or so posts. This could be achieved by:

- **O&M:** losing the role of Asset Manager (this appears to be a superfluous management role which reports directly to an Operations and Asset Manager, a post that has no other direct reports) plus one other position;
- **Commercial:** losing one Senior Commercial Analyst, one Commercial Analyst, the Graduate and merging the roles of Customer Relations and Communications Officer (the latter being a 0.6 FTE part-time role in Business Support);
- **Business Support:** losing two Accountants, the role of Legal Support and the 0.6 FTE Communications Officer role noted above and reducing the General Counsel to a 0.4 role (there is already an annual provision for external legal advice in the operating cost forecasts).

Broadly, there seem to be more Commercial Analysts than the business would appear to merit. Investment in appropriate IT systems would assist with this role reduction. Additionally, coupled with quality IT systems, there may be synergies between Commercial Analyst roles and those in the Business Support Finance Team which offer further scope for consolidation.

Applying these headcount changes to the forecast costs together with the salary reductions outlined earlier would yield in the first year of operation the reductions shown in Table 19. As noted under Table 18 above, Nemo's forecast Opex employee costs have been increased annually by an inflation forecast plus a 1% real increase. In our view the 1% real increase should be disallowed and instead costs should be subject to an annual efficiency factor to reflect savings from improvements in operating procedures over time. We recommend that operating and maintenance employee costs and trading employee costs are reduced in real terms by 1% per annum to reflect this and administration employee costs are reduced by 2% per annum as we believe that there will be more scope for savings over time in these costs resulting from advances in technology and process improvements.

Table 19: Employee Costs for 2019 in €000s: Nemo forecast v BPI assessment

Business stream	Nemo's 2019 forecast	BPI's recommended allowance
O&M	629	230
Commercial	1,250	645
Business support	1,230	420
TOTAL	**3,109**	**1,295**

Source: Request for Information PH1_003a and Consultant's assessment.

14.5.2 Operating and maintenance costs

The costs provided by Nemo for the on-going operations and maintenance of the converter stations and interconnector cable are shown in Table 20. A further breakdown of employee costs in respect of O&M is shown in Table 21.

In relation to employee costs and in particular the proposed organisational structure, it is assumed that the number and designation of Operations and Maintenance staff have been based on an equivalent undertaking (BritNed). However, BPI does have reservations about the proposed numbers of staff and their roles, some of which would seemingly involve very similar duties. Additionally, we believe that it may be possible to make cost savings by combining some of the roles with the O&M function with similar projects, if not immediately then certainly in the future. Consequently, and whilst recognising that an O&M contractor is to be retained, we believe it is not unreasonable to reduce the number of staff directly employed in order to reflect cost savings likely to be made over the lifetime of the interconnector.

Table 20: Nemo's forecast of O & M costs (€000s)

	Total over assumed operational lifetime	Annual cost in 2019
Employee costs	17,763	629
Contractors	92,000	3,680
Materials	0	0
Other	0	0
Total maintenance costs	**109,763**	**4,309**

Source: Request for Information PH1_009.

Table 21: Nemo's forecast employee requirements

Staff	Numbers	Monthly rate €	Annual rate €
Operations & Asset Manager	1.0	9,000	108,000
Converter Manager	1.0	11,000	132,000
Asset Manager	1.0	12,000	144,000
Link Operator	2.0	7,000	84,000
SHES Advisor	0.2	12,000	144,000

Source: Request for Information PH1_009.

The overall costs include for the provision of maintenance contracts over the 25 year life of the interconnector; estimated at €92m at 2011 prices. The contracts will include for maintenance of the converter stations (at a schedule that will be recommended by the supplier), consumable spares, and on-going cable checks. It is also accepted that, in part, the contractor costs will include an element of a retainer to ensure that the contractor is able to respond efficiently in order to minimise any down time when there is a need carry out unplanned repairs.

Currently there is a dearth of reliable information regarding on-going interconnector O&M costs, partly because of the small number of possible comparators but also because the annual costs will be dependent upon a number of variables including the overall layout, manufacturers and the technology used, terms and conditions negotiated in the EPC contract, and the standards of service required by the operator.

In a transmission costing study[14] Parsons Brinckerhoff use a 40 year total lifetime operation and maintenance cost that equates to roughly 20% of the total capital cost. The O&M costs estimated by Nemo are roughly 20% of the capital cost but over a considerably shorter period, 25 years. Using the Parsons Brinckerhoff 20% methodology but correcting for a life of 25 years would result in the total O&M costs for Nemo in the region of €52m assuming a capital cost of about €413m (12.5%). However, we also believe that the current Nemo project costs are likely to carry an element of

[14] Parsons Brinckerhoff – Electricity Transmission Costing Study 31 January 2012, An Independent Report Endorsed by the Institution of Engineering & Technology.

contingency and so we have reduced the annual O&M costs to that shown in Table 22. These costs also include the reduction in Nemo staffing as described above. The revised total lifetime operation and maintenance cost has been calculated at 10% of the capital cost which we believe not unreasonable given the general information currently available.

It is likely that Nemo will be able to refine further its O&M costs upon completion of the contract negotiations for the main items of plant. Nonetheless, we believe the revised costs more accurately reflect the likely outturn on the information available and would recommend their use until such time that Nemo is able to provide further justification for an increase.

Table 22: Revised lifetime operating and maintenance costs (BPI's assessment)

Operating and maintenance costs	Nemo's forecast €000		BPI's recommended allowance €000	
	Lifetime	Annual	Lifetime	Annual
Employee Costs	17,763	629	5,110*	230
Contractors	92,000	3,680	35,500	1,420
Materials	0	0	0	0
Other	0	0	0	0
Total	**109,763**	**4,309**	**40,610**	**1,650**

* Nemo forecast includes a 1% per annum real increase. BPI's recommendation includes a 1% per annum real decrease in costs.

14.5.3 Insurance

In section 12.3 we commented that the indicative annual figure for insurance costs given by Nemo seems excessive, as do the proposed sums to be insured, based on our understanding of the Cap and Floor Regime. The Floor would provide a minimum payment provided that availability was "…at or above defined minimum threshold"[15]. If the availability target was not met Ofgem proposed a regime in line with that applicable to OFTO licensees whereby the interconnector licensee would have to "…justify to NRAs why this situation has arisen; and demonstrate that [it had] taken all reasonable steps to ensure interconnector availability will be restored in a timely and efficient manner in order to receive a floor payment". We support this approach. The interpretation must be that the cause of the interruption would have to be something that was beyond the control of the licensee and therefore 'allowable' by NRAs. It would be reasonable to expect, therefore, that such occurrences would be similarly 'allowable' by an insurance company as being something for which an insurance claim would be favourably entertained. The corollary is that if NRAs do not consider the justification to be reasonable, the insurer most probably would not do so either.

Applying this rationale to Property Damage and Business Interruption (PDBI) insurance, our conclusion is that the Business Interruption insurance part of the policy need cover only the amount between the Floor and the expected revenue in the period during which the licensee's business is interrupted. According to the Cost Template spreadsheet, of the €4.12m annual insurance premium for PDBI insurance €0.48m is accounted for by the premium for BI to provide €60m of cover. Thus, whatever the Floor payment provided, let us say €50m by way of illustration, the BI insurance need cover the difference of only €10m. This would reduce significantly the insurance premium. If third party damage was the cause of the interruption, it would be reasonable to assume that the third party (if identified) would carry the liability to cover any costs and losses.

15 From the Ofgem consultation paper 'Cap and Floor Regime for Regulated Electricity Interconnector Investment for application to project NEMO', section 2.66

If the reason for the interruption was not allowable by NRAs, the likelihood is that it was due the action or inaction of the licensee, perhaps by operating the interconnector beyond its technical limit or neglecting maintenance and so on. It would be most unlikely that an insurer would insure against such occurrences, so no premium would be payable in the first place. Failure to carry out maintenance for example, may be due to a contractor and therefore would reasonably form the subject of a separate claim between the interconnector licensee and its contractor.

Aside from the question of the amount of cover and the consequent cost of the premium, we have considered carefully the question as to whether or not the insurance premium itself should be paid by consumers. As Nemo is a discretionary project and essentially a revenue-generating vehicle for the owners, we concluded that as consumers would be funding the Floor payment (in the event that it is allowable) it would not be appropriate for consumers to fund the insurance premium in addition. This is because it is a business risk properly borne by the business and its investors which should be treated as such in any regulatory mechanism.

Overall, we believe that an appropriate preliminary cost estimate for insurance cover during operation is in the order of €2.0m pa. The final amount will depend upon the state of the market and other factors such as the extent to which risks are covered by other parties in the contractual agreements.

14.5.4 Trading

The Cost Template has an item for an annual amount of €0.5m for 'managed services' for auction management and accounting systems. We have assumed that this is in addition to any capital amounts for bespoke development of trading systems which will be included in Capex at €2.0m. We believe that these are reasonable preliminary estimates which will be refined as the project develops.

14.5.5 Customer relations and communications

Included in Nemo's estimated costs is an annual amount of €0.4m for customer relations/communications which totals €10m over the project lifetime. No evidence has been provided to support this amount. It is unclear as to what specific functions are foreseen and to what extent they will not be covered by the employees for which a separate estimate has been provided. It is also unclear as to whether the customer should be expected to underwrite such costs and we therefore recommend that they are removed.

14.5.6 Training

Nemo has estimated training costs of €0.15m per annum which totals €3.7m over the project lifetime. Whilst it is accepted that there will be an element of training required it is likely that this will be subject to peaks and troughs and although requirements in the first year may be in the order of €0.15m we expect that the average annual expenditure should be in the order of €0.05m.

14.5.7 Legal, professional and consultancy

Nemo has estimated legal, professional and consultancy costs of €0.4m per annum which totals €10m over the project lifetime. No evidence has been provided to support this amount. It is unclear as to what specific functions are foreseen and to what extent they will not be covered by the employees for which a separate estimate has been provided. However, we accept that some external resource will be required, for example the auditing of annual reports and we recommend an annual allowance of €0.1m.

14.5.8 Other costs

Nemo have estimated Other costs of €0.18m[16] per annum with an additional €0.3m in the first year of operations for a launch event. We recommend that an annual allowance in the order of €0.01m should be sufficient to cover the on-going items of expenditure identified which includes cleaning, postage and subscriptions. We do not believe that it is appropriate for the customer to underwrite the cost of a Nemo launch event and we therefore recommend that the cost of this is removed from the assessment.

14.5.9 Leases, rent, rates and licence fees

Although some of these costs may be subject to negotiation, such as leases, rents and the licence required from the Crown Estates for the offshore cable route, others will no doubt be subject to government and/or local authority charging rules. A large proportion of these costs will therefore be outside the control of Nemo and could be classified as 'non-controllable costs' and subject to a pass through mechanism.

No evidence has been provided by Nemo to support the estimated costs of these items but at this stage we propose that Nemo's forecasts are used for the cost assessment. As the project progresses and prior to commercial operations the uncertainty around these costs should be removed and more accurate forecasts can then be incorporated into the cap and floor mechanism.

14.5.10 Utilities

Nemo has estimated utility costs of €0.2m per annum to cover its own power consumption and water usage. At this stage we believe that this forecast is rather high and we propose that an allowance of €0.1m is used.

End of section

[16] Please see Appendix 2 for some notes regarding an error in the Nemo formula for calculating 'Other costs' in the Nemo Cost Template.

15. BPI's cost assessment

15.1 Overview

Table 23 provides a summary comparison of the Nemo forecast with our own assessment of costs over the regulatory period. We have shown the forecast amounts that were provided in the cost template and have deducted the items that have been removed for our cost assessment purposes (depreciation, IDC, interest and trading costs that will be deducted from revenue). The costs are in thousands of Euros and are expressed in 2011 prices.

The summary shows our assessment of total costs to be €631.8m compared with Nemo's estimate of €983.7m, a difference of €351.9m.

Tables 24, 25 and 26 on the following pages compare Nemo's forecasts with our assessment in more detail for Development costs, Capital expenditure and Operating costs.

Table 23: Summary comparison of the Nemo forecast with BPI's assessment of costs (€000 total over the regulatory period)

		Nemo forecasts	BPI assessment			Difference
Development Costs	38,319					
less IDC	9,585					
		28,734	12,703			16,031
Capital Expenditure	[redacted]					
less IDC	[redacted]					
		[redacted]	413,100			[redacted]
Operating Costs	1,209,139					
less depreciation	615,121					
less interest	18,284					
less trading costs offset from revenue	152,500					
		423,234	206,018			217,216
		[redacted]	**631,821**			[redacted]

Note: The deduction for trading costs refers to a group of costs that will be set off against revenue: €10m for exchange fees and €142.5m for market related costs – see table 12

15.3 Development costs

Table 24: Comparison of development costs

Nemo assessment (€000s in 2011 prices)

	Total	2006-2012 Actuals	2013 Forecast	2014 Forecast	2015 Forecast	2016 Forecast	2017 Forecast	2018 Forecast
Employee Costs	3,809	1,018	1,400	1,391	-	-	-	-
Surveys	3,845	3,484	277	84	-	-	-	-
Consents and permissions	1,099	358	515	226	-	-	-	-
Wayleaves and easements	474	20	[redacted]	[redacted]	-	-	-	-
Land costs	2,039	974	629	437	-	-	-	-
Environmental studies	2,017	1,613	288	116	-	-	-	-
Legal	2,756	595	1,246	916	-	-	-	-
Other	12,693	692	1,385	616	2,500	2,500	2,500	2,500
	28,733	8,754	5,957	4,022	2,500	2,500	2,500	2,500
Interest	9,585	1,199	797	1,136	1,358	1,528	1,698	1,868
Total Development Cost	**38,319**	**9,954**	[redacted]	[redacted]	**3,858**	**4,028**	**4,198**	**4,368**

BPI assessment (€000s in 2011 prices)

	Total	2006-2012 Actuals	2013 Forecast	2014 Forecast	2015 Forecast	2016 Forecast	2017 Forecast	2018 Forecast
Employee Costs	2,093	713	690	690	-	-	-	-
Surveys	2,562	2,439	64	59				
Consents and permissions	770	251	360	158				
Wayleaves and easements	332	14	152	166				
Land costs	1,720	974	440	306				
Environmental studies	1,412	1,129	202	81				
Legal	1,929	416	872	641				
Other	1,885	485	970	431				
	12,702	6,420	3,750	2,532	-	-	-	-
Interest	To be determined by NRAs							
Total Development Cost	**12,702**	**6,420**	**3,750**	**2,532**	**-**	**-**	**-**	**-**

15.4 Capital costs (Capex)

Table 25: Comparison of capital costs

Nemo assessment (€000s in 2011 prices)

	Total	2015	2016	2017	2018	Replacement Capex (after 15 years)	Decommisisoning after 25 -40 years
Converter Stations	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Control and Protection	9,200					9,200	
Auxilliary Power	5,700					5,700	
Telecomms equipment	100					100	
Decommissioning *	16,716	4,179	4,179	4,179	4,179	-	
Other Costs - Project Management etc	70,000	17,500	17,500	17,500	17,500		
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	15,000	-
Interest During Construction	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Total Capital Expenditure	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	**15,000**	**-**

Note: * Present day value for decommissioning accounting provision

BPI assessment (€000s in 2011 prices)

	Total	2015	2016	2017	2018	Replacement Capex (after 15 years)	Decommisisoning after 25 -40 years
Converter Stations	220,000	55,000	55,000	55,000	55,000		
Cable	163,000	40,750	40,750	40,750	40,750		
Control and Protection	2,000					2,000	
Auxilliary Power	-						
Telecomms equipment	100					100	
Decommissioning**	4,000						4,000
Other Costs - Project Management etc	24,000	6,000	6,000	6,000	6,000		
	413,100	101,750	101,750	101,750	101,750	2,100	4,000
Interest During Construction	To be determined by NRAs						
Total Capital Expenditure	**413,100**	**101,750**	**101,750**	**101,750**	**101,750**	**2,100**	**4,000**

Note: ** Decommissioning represents actual cost at current prices

15.5 Operating costs (Opex)

Table 26: Comparison of operating costs

Nemo assessment (€000s in 2011 prices)

	Total	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
Operating and Maintenance																										
Employee Costs	17,763	629	635	642	648	654	661	668	674	681	688	695	702	709	716	723	730	737	745	752	760	767	775	783	791	799
Contractors	92,000	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680
	109,763	4,309	4,315	4,322	4,328	4,334	4,341	4,348	4,354	4,361	4,368	4,375	4,382	4,389	4,396	4,403	4,410	4,417	4,425	4,432	4,440	4,447	4,455	4,463	4,471	4,479
Trading																										
Employee Costs	35,232	1,247	1,260	1,273	1,285	1,298	1,311	1,324	1,337	1,351	1,364	1,378	1,392	1,406	1,420	1,434	1,448	1,463	1,477	1,492	1,507	1,522	1,537	1,553	1,568	1,584
Other Costs	165,000	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600
	200,232	7,847	7,860	7,873	7,885	7,898	7,911	7,924	7,937	7,951	7,964	7,978	7,992	8,006	8,020	8,034	8,048	8,063	8,077	8,092	8,107	8,122	8,137	8,153	8,168	8,184
Administrative and General																										
Employee Costs	34,645	1,227	1,239	1,251	1,264	1,276	1,289	1,302	1,315	1,328	1,342	1,355	1,369	1,382	1,396	1,410	1,424	1,438	1,453	1,467	1,482	1,497	1,512	1,527	1,542	1,558
Legal, Professional, Consultancy	10,000	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
Information Technology	15,000	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
Customer Relations/Communications	10,000	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
Training	3,750	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Insurance	116,294	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652	4,652
Utilities	5,000	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Other Costs	4,800	480	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180
Non Controllable Costs																										
Leases	22,500	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900
Rent	7,500	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
Rates	32,500	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Licence Fees	3,750	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
	265,739	10,758	10,471	10,483	10,496	10,508	10,521	10,534	10,547	10,560	10,573	10,587	10,600	10,614	10,628	10,642	10,656	10,670	10,685	10,699	10,714	10,729	10,744	10,759	10,774	10,789
Operating Costs before Depreciation and Interest	**575,734**	**22,915**	**22,646**	**22,677**	**22,709**	**22,741**	**22,773**	**22,806**	**22,839**	**22,872**	**22,906**	**22,939**	**22,974**	**23,008**	**23,043**	**23,079**	**23,114**	**23,150**	**23,187**	**23,223**	**23,261**	**23,298**	**23,336**	**23,374**	**23,413**	**23,452**
Depreciation	615,121	24,420	24,420	24,420	24,420	24,420	24,420	24,420	24,420	24,420	24,420	24,420	24,420	24,420	24,420	25,971	24,882	24,882	24,882	24,882	24,882	24,882	24,882	24,882	24,882	23,331
Decommissioning interest charge	18,284	501	517	532	548	564	581	599	617	635	654	674	694	715	736	759	781	805	829	854	879	906	933	961	990	1,019
Total Opex	**1,209,139**	**47,836**	**47,582**	**47,629**	**47,677**	**47,725**	**47,775**	**47,825**	**47,876**	**47,927**	**47,980**	**48,034**	**48,088**	**48,143**	**48,200**	**49,808**	**48,778**	**48,837**	**48,898**	**48,959**	**49,022**	**49,086**	**49,151**	**49,217**	**49,284**	**47,802**

BPI assessment (€000s in 2011 prices)

	Total	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
Operating and Maintenance																										
Employee Costs	5,110	230	228	225	223	221	219	217	214	212	210	208	206	204	202	200	198	196	194	192	190	188	186	184	183	181
Contractors	35,500	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420
	40,610	1,650	1,648	1,645	1,643	1,641	1,639	1,637	1,634	1,632	1,630	1,628	1,626	1,624	1,622	1,620	1,618	1,616	1,614	1,612	1,610	1,608	1,606	1,604	1,603	1,601
Trading																										
Employee Costs	14,331	645	639	632	626	620	613	607	601	595	589	583	577	572	566	560	555	549	544	538	533	528	522	517	512	507
Other Costs	12,500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
	26,831	1,145	1,139	1,132	1,126	1,120	1,113	1,107	1,101	1,095	1,089	1,083	1,077	1,072	1,066	1,060	1,055	1,049	1,044	1,038	1,033	1,028	1,022	1,017	1,012	1,007
Administrative and General																										
Employee Costs	8,327	420	412	403	395	387	380	372	365	357	350	343	336	330	323	317	310	304	298	292	286	280	275	269	264	259
Legal, Professional, Consultancy	2,500	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Information Technology	7,500	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
Customer Relations/Communications	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Training	1,250	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Insurance	50,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Utilities	2,500	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Other Costs	250	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Non Controllable Costs																										
Leases	22,500	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900
Rent	7,500	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
Rates	32,500	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Licence Fees	3,750	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
	138,577	5,630	5,622	5,613	5,605	5,597	5,590	5,582	5,575	5,567	5,560	5,553	5,546	5,540	5,533	5,527	5,520	5,514	5,508	5,502	5,496	5,490	5,485	5,479	5,474	5,469
Operating Costs before Depreciation and Interest	**206,018**	**8,425**	**8,408**	**8,391**	**8,374**	**8,358**	**8,342**	**8,326**	**8,310**	**8,295**	**8,280**	**8,265**	**8,250**	**8,235**	**8,221**	**8,207**	**8,193**	**8,179**	**8,165**	**8,152**	**8,139**	**8,126**	**8,113**	**8,101**	**8,088**	**8,076**
Depreciation	Not included in assessment as provided for under Capital Expenditure allowance																									
Decommissioning interest charge	Not included as expected actual cost of decommisisoning included in Capital expenditure allowance																									
Total Opex	**206,018**	**8,425**	**8,408**	**8,391**	**8,374**	**8,358**	**8,342**	**8,326**	**8,310**	**8,295**	**8,280**	**8,265**	**8,250**	**8,235**	**8,221**	**8,207**	**8,193**	**8,179**	**8,165**	**8,152**	**8,139**	**8,126**	**8,113**	**8,101**	**8,088**	**8,076**

Appendices

Appendix 1: Extract from the Nemo Interconnector Needs Case

General

The electricity industry in Great Britain is undergoing unprecedented change. In the next few years, 12GW of coal-fired power stations will close, as they cannot meet the new requirements of European emissions legislation. At the same time, around 7.5GW of nuclear capacity will come to the end of its operating life. This reduction in existing generating capacity, and consequent reduction in the Plant Margin, means a huge investment in new generating capacity is needed including investment in new interconnection between the UK and Europe and Scandinavia. Furthermore, the need to tackle climate change requires a major investment in generation from low-carbon sources, such as wind, nuclear and efficient gas-fired plant.

Climate Change Targets

The UK has two key environmental targets relating to renewable energy and greenhouse gas emissions. The first of these targets is part of the European Union's (EU) integrated Energy/climate change proposal. This proposal sets a target of 20% of European Energy (including electricity, heat & transport) to come from renewable sources by 2020 (known as the EU 20/20/20 vision). The Renewable Energy Strategy (published in July 2009) identified that, for the UK to meet its share of the EU target (UK's share is 15% of energy sources including electricity, heat and transport), 30% of the UK's electricity would have to come from renewable sources.

The second target is incorporated in the Climate Change Act 2008. This goes further than the EU 20/20/20 vision, and sets a target of 80% reduction in UK greenhouse gas emissions from 1990 levels by 2050. This equates to a 34% reduction in greenhouse gas emissions by 2020 as specified by the Climate Change Committee.

Interconnectors and Electricity Prices

The direction of flow on an interconnector is largely determined by any price differential between the two systems. Power will be bought in the lower priced country and sold in the higher priced country. The price differential between the two countries is referred to as the arbitrage. Where the arbitrage is large, it is likely that the interconnector will flow to its maximum capacity. For example, where wholesale electricity prices in the UK are higher than in Europe, the interconnector would allow power to be bought in Europe and sold in the UK wholesale market. Conversely, where power prices were higher in Europe than in UK, power would be bought in the UK and sold into the European markets. Physical power flows on the interconnector reflect the direction of trade.

Belgium is heavily interconnected with central Europe, so a UK-Belgium link provides further opportunities to trade power between the wider Continental European power markets and the UK, thereby further contributing to downward pressure on wholesale prices.

Interconnectors also tend to reduce the frequency and severity of high price spikes in both interconnected markets.

Supporting Renewable Energy

The UK Government's vision to ensure safe, secure and affordable supplies for the future involves the construction of a new fleet of nuclear generation, rapid expansion of renewable energy (mainly through offshore wind), and the development of interconnector projects. Specifically, the UK is committed to the European Commission's 3rd energy package which states that 15% of the UK's demand for energy needs to be generated from renewable sources by 2020. To meet this target, the UK will need an energy portfolio of 34% wind generating capacity by 2020, rapidly building on 4% wind capacity of today. The vast majority of this wind capacity is expected to be obtained from the Crown Estate's licensed Round 3 Development Zones which has the aim to install 25 GW of offshore wind capacity by 2020. This huge investment into the UK Renewables sector is part of an aspiration to develop a large-scale green industry to boost the UK economy and create jobs.

By its nature, wind generation is intermittent. It is therefore necessary to have plant and equipment that can respond to rapid changes in generating output. Interconnectors, such as the one proposed between the UK and Belgium, provide an effective way to manage these fluctuations in supply and demand.

Policy Support for Interconnectors

European strategy recognises the urgent need to upgrade Europe's energy infrastructure and to interconnect networks across borders to meet the EU's core energy policy objectives of competitiveness, sustainability and security of supply.

These objectives are supported by European policy which facilitates the urgent upgrading and extension of electricity networks, including interconnectors, to maintain existing levels of security of supply and, in particular, to transport and balance electricity from renewable sources, which is expected to more than double in the period 2007 to 2020.

Interconnectors enable power to flow between member state transmission networks and are vital for ensuring a competitive and well-functioning integrated market for energy. Despite the existence of common rules for the internal market in electricity, the European Commission has recognised that the internal market remains fragmented due to insufficient interconnections between national energy networks.

In 2002 the EU Council set a target for all Member States to have electricity interconnections equivalent to at least 10% of their installed production capacity by 2005. The UK is still failing to meet this target. Total UK interconnection capacity amounts to 3.5GW which represents just over 4% of the 85 GW of installed generation capacity.

In December 2009 the UK and Belgium both became signatories to the North Seas Countries Offshore Grid Initiative (NSCOGI) with the objective to coordinate offshore wind and infrastructure developments in the North Sea. Interconnection between countries is a prerequisite to achieving this ambition.

Development of an interconnector of 1,000MW between the UK and Belgium will contribute towards achieving the UK's interconnection capacity target set by the European Council whilst establishing infrastructure identified as a prerequisite to the development of the NSCOGI.

Regulatory

In January 2010, the energy regulator Ofgem (Office of Gas and Electricity Markets) published a consultation on Electricity Interconnector Policy. The target audience was electricity traders, transmission companies, interconnector developers, generators and suppliers, customer representatives and other interested parties across the UK and Europe.

It was acknowledged in this consultation that:

"The GB electricity market currently has limited interconnection with other markets but this is expected to increase significantly in the decade ahead. In part, this reflects the expectation that increased interconnection will help accommodate the expected huge increase in intermittent wind generation and will contribute to security of supply".

To date in Great Britain, interconnectors have been developed as stand-alone projects outside the price-controlled transmission business. By contrast, in other European Member States, it is more common for interconnection to be developed by national transmission companies with revenues underwritten by consumers. Amongst other matters, the Ofgem consultation proposed and sought views on the regulatory treatment of interconnector investment.

Responses to the consultation were received from 21 organisations and interested parties. As part of the next steps from this consultation, Ofgem demonstrated its support for the proposed UK – Belgium Interconnector in proposing to develop a regulatory investment model for the project by working with its regulatory counterpart in Belgium, CREG (Commission de Régulation de l'Électricité et du Gaz) and the Nemo consortium which could be used as an alternative model for this and future interconnector investment.

Conclusion

A number of new interconnector projects are underway in the UK to help meet the need, including connections to Norway and the Republic of Ireland. National Grid Nemo Link Ltd considers that additional connections to mainland Europe are needed to enhance the diversity of supply and ensure the UK is not overly dependent on the limited number of existing interconnectors.

A UK-Belgium interconnector is regarded as the best way to meet this need. Belgium is particularly suitable for a new interconnector not only because of its geographical proximity to the UK, but also because its electricity transmission system is highly connected to Central Europe. A UK-Belgium interconnector will therefore provide enhanced opportunities for the UK to trade with wider European power markets. There is no existing connection between the UK and Belgian transmission systems, so the construction of a new connection is required to achieve these objectives. The proposal to build an interconnector to Belgium is based on:

- **Risk mitigation:** it is prudent to interconnect the UK to different parts of the European Continent. Building all interconnection to a single point reduces security of supply in case of grid problems at that single point.
- **Cost:** a subsea cable route to Belgium is the obvious next best choice after France to minimize the cable route length. France is however already interconnected through the Channel and therefore less suitable from a risk perspective, as explained above.

End of Appendix 1

Appendix 2: An error in the Nemo Cost Template spreadsheet; a note for the record

A small error in a formula was discovered in the Nemo Interconnector Cost Template. BPI was asked to note it in the Report for the record.

In the spreadsheet under the '1_Opex' tab amounts are expressed in €m. The relevant items are recorded against 'Launch event' in row 41 (€0.3m but only in the first year, ie 2019); 'Clean, Print, Postage, Subscriptions' in row 49 (€0.08m across each year from 2019 to 2043); and 'Other Costs' in row 54 (€0.1m across each year from 2019 to 2043).

In the spreadsheet under the 'Cost Template 378029 V2' tab amounts are expressed in €000. In row 138 'Other' Operating costs are summated from rows 41, 49 and 54 in the spreadsheet under the '1_Opex' tab using the formula:

=1000*'1 Opex'!Q41+'1 Opex'!Q54+'1 Opex'!Q49

This is the formula from cell T138, subsequent cells refer correctly to the following columns R, S etc. The error in the formula is that brackets are missing after =1000*. The formula should have read:

=1000*'(1 Opex'!Q41+'1 Opex'!Q54+'1 Opex'!Q49)

The consequence is that 'Other' Operating costs are shown on the spreadsheet as 0.2 (rounded up to one decimal place from 0.18 to 0.2), ie €200 in each year. When the formula is applied correctly a figure of 180.0 is shown, ie €180,000 in each year.

The overall effect is that the 'Grand total' in cell E138 is shown as 304.5, ie €304,500 whereas the correct figure in cell E138 should be 4,800.0, ie €4,800,000, a difference of just under €4.5m.

End of document