UK Electricity Interconnection:

Driving competition and innovation in the HVDC supply chain

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Executive Summary

The UK has significant ambition to realise new investment in electricity interconnectors and offshore HVDC connected generation. Without action, the High-Voltage Direct Current (HVDC) supply market in Europe will not meet this demand and realise this ambition. National Grid, the UK Government and Ofgem, can continue to support and develop the market to ensure competition, innovation and skill-building within the HVDC supply chain.

National Grid has developed a number of interconnectors with partners across Europe including BritNed and IFA (in operation); our Nemo and NSL interconnectors (currently in the construction phase) and our interconnectors with France and Denmark (in development), IFA2 and VikingLink.

Competition in HVDC supply in Europe is limited with three European suppliers of HVDC converters and three primary suppliers of HVDC cable. Non-European suppliers face a number of barriers to entry in the European market including meeting different technical standards, developing Engineer, Procure, Construct (EPC) project execution methods, competition from incumbents, weaker supply chain support, high cost of shipping and customer inertia.

HVDC power electronics firms supply cable and converters. There is diversity within HVDC in terms of both cable and converter technologies. HVDC cables are distinguished mainly by their insulation types; principally Mass Impregnated (MI) paper and Cross Linked Polyethylene (XLPE) insulation, employing either copper or aluminium conductors.

All European suppliers have variations of MI products and all have XLPE products but at different stages of technological advancement and maturity. Non-European suppliers all have XLPE products. For converters, there is a choice between the established Line Commutated Converter (LCC) technology, and Voltage Source Converter technology (VSC) which has been significantly developed over the last decade.

The HVDC market is currently in a state of major change and innovation which should increase choice, reduce cost and increase the viability and certainty of interconnector projects.

National Grid has built up a reputation as a consistent, reliable, repeat purchaser of HVDC cable which in turn encourages competition and innovation within its tenders. National Grid's tender and contract management approach has been developed to maximise innovation and competition within the supply chain, for example, through the use of a progressive, risk-based approach to new technologies. National Grid will continue to evolve the market in terms of competition, innovation and skills.

The UK Government and Ofgem can play an important role in supporting and developing the HVDC market. There are a number of ways that this support could be realised, in particular, through supporting initiatives to promote UK HVDC schemes, such as supplier events. This will add to the perceived certainty of projects and to reinforce the supply chain.

For additional supply chain information, please contact Sultana Begum (sultana.begum@nationalgrid.com).

1 Purpose

The purpose of this short paper is to introduce the High-Voltage Direct Current (HVDC)[1] supply market, set out the current state of competition in the supply chain and to show how National Grid has been driving competition, innovation and skills. We explore what role National Grid, other buyers of HVDC, Ofgem and the UK Government could play to encourage beneficial developments, and our view of what developments should be expected in coming years. This paper does not focus on broader procurement activities .i.e. specialist consultancy services, where applicable we will provide updates on future supply chain papers.

2 Background

2.1 Suppliers

Competition in HVDC supply in Europe is limited with three European suppliers of HVDC converters and three primary suppliers of HVDC cable.

Table 1 – European HVDC cable suppliers

Cable manufacturer
ABB (Sweden)
Prysmian Power Link (Italy)
Nexans (Norway)
NKT (Denmark)

Table 2 – European HVDC converter suppliers

Converters
Siemens (Germany)
ABB (Sweden)
GE Grid Solutions (UK – previously Alstom)

Non-European suppliers exist, however, these are also limited in number and generally serve home markets. Other than a recent National Grid/Joint Venture award (the NEMO Link interconnector between Great Britain and Belgium), new entrants have not yet penetrated the European cable and converter markets at voltages above 320kV.

[1] HVDC terminology is generally considered to apply to voltages of 320kV and above for the purposes of this report

Table 3 – Non-European HVDC converter suppliers (NON EXHAUSTIVE)

Manufacturer	LCC Converters[1]	VSC Converters[2]	Other HVDC (Statcom, SVC TSR etc)	European HVDC EPC[3] experience?
NR (China)	Yes	Yes	Yes	No
RXPE (China)	N/A	Yes	Yes	Yes
XUJI (China)	Yes	Yes	Yes	No
XD (China)	Yes	Developing	Yes	No
NARI Group (China)	Yes	Yes	Yes	
Mitsubishi (Japan)	No	Final stages of development	Yes	No

[1] LCC – Line Commutated Converter
[2] VSC – Voltage Source Converter
[3] EPC – Engineer, Procure, Construct

Table 4 – Non-European HVDC cable suppliers (NON EXHAUSTIVE)

Manufacturer	XLPE*	MI*	European submarine HVDC EPC experience?
LS Cables	Yes	Land	No
JPower/Sumitomo	Yes	Yes	NEMO Link
Hengtong	Yes	No	No
ZTT	Yes	No	No
Hanhe Qingdao	Yes	No	No
Orient	Yes	No	No

2.2 Barriers to entry

The non-European suppliers face barriers to entry in the European market in context of the challenge of meeting European technical standards (mainly based on International Electrotechnical Commission), developing Engineer, Procure, Construct (EPC) project execution methods, competition from incumbent suppliers, weaker supply chain support, the high cost of shipping and customer inertia, particularly in respect of perceived and assessed risk.

2.3 Technology

Within the HVDC power electronics market, the most significant technology change in the last decade has been the development of Voltage Source Converter (VSC) technology. VSC technology has several benefits including a significantly reduced land footprint compared to an equivalent Line Commutated Converter (LCC) installation, less impact on the wider connected networks, in terms reduced harmonic and system disturbance, and the capability to provide certain ancillary services to network operators such as Black Start functionality. LCC converters can still provide a more economical alternative in the context of overall project costs, however, land costs, siting amenity and deep network impacts/costs are significant factors against their deployment in project design. VSC has become the default choice for ease of application within the highly integrated networks in Europe.

HVDC cables are distinguished mainly by their insulation types; principally Mass Impregnated (MI) paper and Cross Linked Polyethylene (XLPE) insulation, employing either copper or aluminium conductors. Mass impregnated paper insulated cables consist of layers of Kraft paper around the conductor which are heated, subjected to vacuum and impregnated with high viscosity oil. This cable technology is very mature and has been employed since the 1950s for HVDC applications. A variant of this technology is the use of Paper Polypropylene Laminate (PPL) as the insulating medium, which due to its higher dielectric strength and improved temperature performance allow for increased voltages and currents to be realised and thus increased power transfers.

XLPE-insulated cables have several advantages over the conventional mass impregnated cable technology. The former is generally more mechanically more robust, and they can operate at a higher operating temperature. This allows them to carry more current and hence greater power transfer for a given conductor cross-section.

Both types of cable can be manufactured with both copper and aluminium conductors. Whilst aluminium reduces weight and capital cost, copper has a superior performance, regarding cable losses. The weight considerations are more of constraint for land deployment of cables, whereas for subsea application using specially design vessels this is less of an issue. To minimise loss the cross-section area of aluminium can be increased. However, this can lead to increased manufacturing risk if the cross-sectional area is too large.

MI cable for HVDC application is a more mature technology than XLPE. MI currently offers the highest proven voltage rating, whilst XLPE cable is an emerging technology, offering generally cheaper manufacturing, cheaper jointing and lower installation costs. Significant development activity is now underway amongst several suppliers to extend XLPE product capability up to approximately 500kV to compete with MI. At the current time, the highest operational XLPE in a HVDC subsea application is 320kV. The National Grid/Elia NEMO Link interconnector is currently deploying 400kV XLPE, manufactured by JPS of Japan, for entry into service in 2019. XLPE requires additional time for deployment on a project, approximately an additional year. This is due to the immaturity of the technology making additional testing desirable to obtain a solution suitable for the whole operational life.

The impact of cost and system loss differences and differences between manufacturers mean that the point where one technology becomes more economically advantageous than the other varies from project to project and supplier to supplier. Design voltage is a key factor influencing technology development and choice. Higher voltages generally allow for the same power transfer as lower voltages but with relatively smaller cable losses and conductor cross sectional area. The higher the voltage, the greater the thickness of the insulating material required, the greater the manufacturing cost and the more complex the electrical and mechanical stresses to be addressed in the design of the cable. The cost/voltage equation for cable systems has also to be considered against the requirement for higher voltage converters, with a consequential need for taller buildings, larger land footprints and higher converter losses. Across the portfolio of UK HVDC interconnector projects voltages have risen from 270kV (MI) for the original IFA interconnector to 450kV (MI) for BritNed, 600kV (MI PPL) for Western Link, 515kV (MI) for NSN and 400kV (XLPE) for NEMO Link.

All European suppliers have variations of MI products and all have XLPE products but at different stages of technological advancement and maturity.

2.4 Value chain

The competitiveness of HVDC projects are a product of the value chain that it represents. At a high level, the value chain for a HVDC system comprises of location, design, manufacture, installation, commission and maintain. In value terms for a scheme such as NEMO Link, broadly 50% of the cost is associated with the converter value chain and 50% with the cable value chain. For a scheme such as North Sea Link, the cable portion would be higher due to the larger (longer) cable component. Whilst there are many variables applicable from one project to another the charts below illustrate proportionately how an EPC tendered price may be apportioned between key elements. The chart is illustrative but assumes LCC converter technology and a long (>400Km) MI cable. It should be noted that typically a tendered price will exclude land and permit costs, client project management, insurance, risk and other items.

Figure 1 – LCC converter illustrative cost split

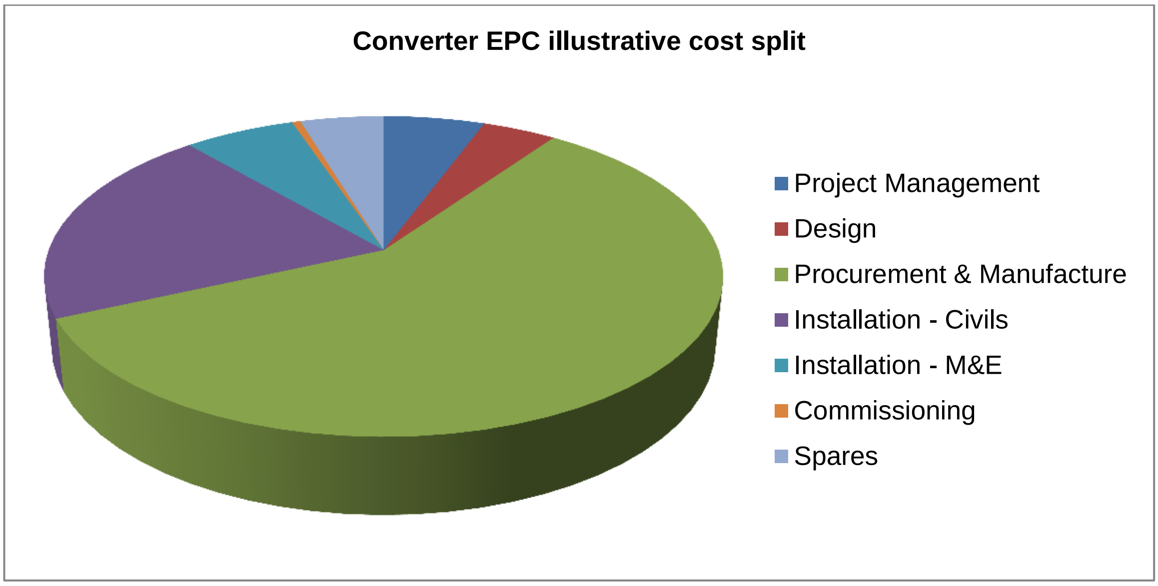
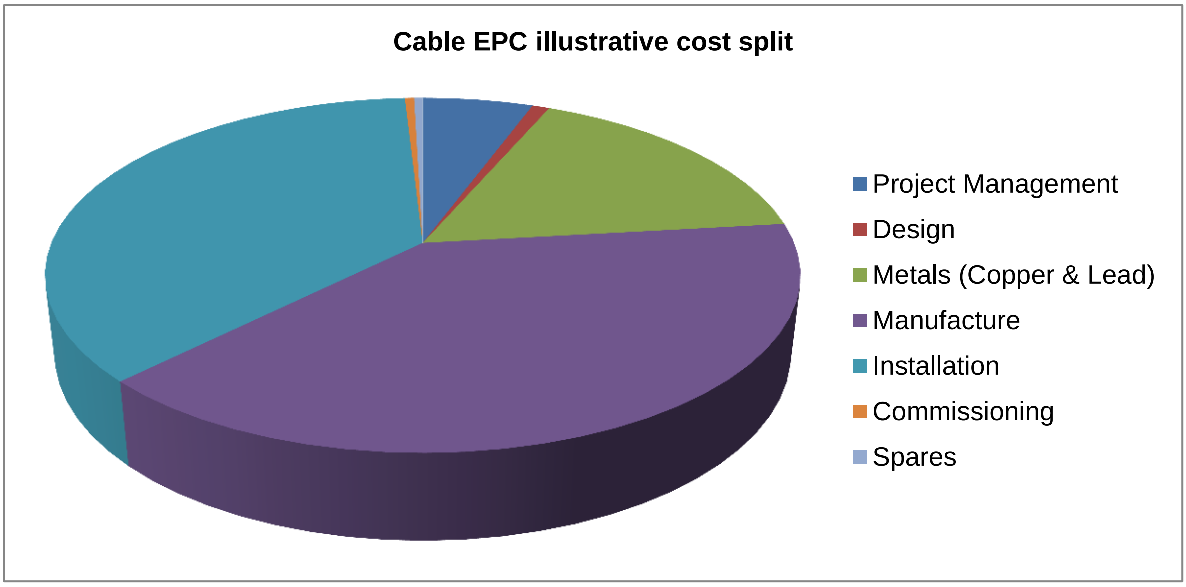


Figure 2 – MI cable illustrative cost split



2.5 Supply chain and procurement strategy

At a high level, the supply chain could be described as design, supply of raw materials, manufacturing, land installation (civil works and equipment install) and marine installation. Most, if not all, HVDC suppliers provide design and manufacturing in-house with the in-house/outsource decision varying by supplier for civil works, equipment install and marine installation.

In Europe clients generally (but not always) procure HVDC systems as design, manufacture, install and commission "turnkey" packages. The reason for a turnkey approach being generally preferred is that the design and construction risks associated with a project can be significantly impacted by each component of the value chain. It is generally determined by clients that turnkey packages are the most efficient way of managing the risks. The majority of client organisations do not have end to end design capability in-house. Although turnkey is preferred, often clients will procure HVDC converters and HVDC cable as separate turnkey packages. This approach means the client takes some risk around the interface between two critical parts of the system, in particular design interactions, discharge of planning conditions, and on-site cooperation to manage delay and damage risk, where a delay to one element can significantly impact completion of the whole project.

Whilst a turnkey approach is commonly used to reduce the overall risk profile of a project, each project requires the contribution from a wide range of competing technology suppliers acting either for the client or the EPC contractor. The table below sets out the types of supply chain roles and their typical client.

Table 5 – Supply chain

Role	Scope	Employer led	Supplier led (via EPC)
Pre-construction			
Feasibility	Technical, economic and political	Yes	
Consenting	Planning, land purchase and wayleaves	Yes	
Route surveys/options	Land/sea	Yes	
Community relations	Engagement	Yes	
Environmental	Impact	Yes	
Legal	Pre-construction agreements	Yes	
Regulatory	Environment	Yes	
Risk	Identification and mitigation	Yes	
Land lease / purchase	Converter sites and cable easements	Yes	
Construction			
Design	System and equipment specification		Yes
Raw materials	Copper etc		Yes
Surveys	Route, Unexploded Ordinance, contaminants		Yes
Detailed consenting	Road closures, port authorities…	Yes	Yes
Civil works			Yes
Marine installation	People, vessels and tools		Yes
Community relations		Yes	Yes

3 Innovation within European HVDC

The table below highlights 6 European HVDC interconnector projects that contained major areas of innovation ranging from technology choice, ratings and voltage, contract award strategy and structure and supplier choice/partnering.

Table 6 – HVDC innovation

Project name	Developer	Commission date	Contract lotting strategy*	Supplier	Innovation
IFA (France-GB)	CEGB/Edf	1986	1-1-2-2	GEC, Alcatel, BICC, Pirelli.	1st large scale UK HVDC interconnector (2 GW)
Western Link (GB)	National Grid / SPT	2017	3	Siemens/Prysmian	1st application of 600Kv and highest rated submarine cable at 2.21GW
East/West (Ireland/GB)	EirGrid	2012	3	ABB	1st application of VSC at scale
Skagerrak 4 (Norway/Denmark)	Statnett / Energinet	2015	1-2-2	ABB/Prysmian/Nexans	1st European application of multi terminal HVDC (Worlds first operational was in China)
NEMO Link (Belgium/GB)	National Grid / Elia	2018	1-2	Siemens/JPower	1st application of 400Kv XLPE and first award to none European supplier
NSN (Norway/GB)	National Grid/ Statnett	2021	1-2-2	ABB/Prysmian/Nexans	Longest HVDC submarine cable project

*1= converter contract, 2 = cable contract, 3 = combined

3.1 Driving innovation within tenders

Over the last two decades, National Grid has built (BritNed, BassLink and IoM) and has in construction (Western Link, Nemo and NSL) a total of six HVDC interconnectors at a total investment value of over £6 billion in 2015 prices, with a further two in development (IFA2 and Viking). We have also deployed numerous applications of power electronic devices on the National Electricity Transmission System (NETS) such SVCs (static var compensators), Statcoms and TSC (thyristor switched capacitor) schemes. Open competitive processes have been used on each occasion. Competition and innovation has been driven in a few key ways;

- Partnerships – By their very nature HVDC interconnectors generally involve at least two partners. Typically, this involves the significant resources and capabilities of another European National Electricity Transmission System Operator (NETSO) in the development and procurement process. This unique aspect means that each interconnector can build on the prior experience of parties' previous in–house projects, meaning that the joint HVDC system procurement strategy benefits from a wider source of best practices, thinking and market experiences. HVDC interconnector projects by definition also have to satisfy the requirements of two asynchronous networks and differing operating parameters, which requires a high level of collaboration with other European NETSOs. However, the advantages of sharing best practices have to be weighed with the reality that partnerships also require compromise. Often, compromise can frustrate the drive for innovation that could be derived from a single party taking forward the procurement. Given that the partners are normally a European NETSO, the approach to procurement from our interconnector partners is often driven from this standpoint and from the regulatory framework and incentives that exists in those territories. This extends into approaches to design, specification, risk modelling, contract approach, and tender evaluation criteria. The impact of partnerships on procurement is therefore an important background consideration.

- A multi-contract lotting strategy at tender stage allows cable and converter suppliers to bid individually and jointly. This allows suppliers the opportunity to benefit from differences in strategy such as a cable focussed approach versus a whole system approach. The approach also encourages new partnerships to be formed which helps drive optionality and value through aggregation. The open/flexible/non-discriminatory approach used by National Grid and its partners has resulted in awards to all European suppliers over six projects and the introduction of a new entrant for the NEMO Link; JPower Systems (JPS) of Japan.

- Use of “output” or”functional” specifications where technically feasible within the tender allows Suppliers to bid their technical differences and innovations.

- National Grid HVDC tenders value risk and whole life cost considerations as part of the tender process which approaches risk in a flexible way to determine which parties are best placed to manage the risk at the economic optimum. These considerations allow suppliers to take different approaches to the structuring of their offers within the confines of a single tender and by repeatedly signalling the importance of these elements suppliers are encouraged to develop their offer to meet client needs over time.

- Options and alternatives are generally permitted and encouraged in National Grid HVDC tenders. This gives Suppliers a vehicle for presenting and valuing their innovations which in turn encourages it. For example, options accepted in recent years have included alternative cable and converter technologies, higher voltages, higher ratings etc.

- A progressive, risk based approach to new technologies has resulted in National Grid HVDC subsea schemes setting a number of worlds firsts including first application of 600kV MI PPL cable, first application of 400kV XLPE cable, world’s longest and highest rated submarine HVDC projects, and the first European customer to award a HVDC contract to a new entrant (JPS).

- National Grid deploys contract and project management approaches that consider long as well as short term objectives and seek to develop suppliers for long term.

Through open and transparent tenders, which encourage the widest possible participation and innovation and by managing contracts with long as well as short term interests in mind National Grid has built up a reputation as a consistent, reliable, repeat purchaser of HVDC which in turn encourages competition and innovation within its tenders.

3.2 Future innovation and market development

The following innovations and developments are anticipated and National Grid will continue to be actively engaged in developing the market and a whole market and supplier specific basis with a view to driving competition, innovation, lower whole life costs and great technical, operational and financial efficiencies.

Table 7 – Future innovations and market development

Innovation	Detail	Market benefit	National Grid action	Potential Ofgem/UK Government action
XLPE	Higher voltage ratings, maturing technology and wider range of suppliers	Cost reduction	Encourage / collaborate	R&D incentives
MI	Higher rated and even more mature products	Cost reduction for longer links	Encourage / collaborate	R&D incentives
VSC	Lower footprints, costs losses	Reduced land costs	Encourage / collaborate	R&D incentives
Multi terminal	Will enable HVDC offshore grids.	Overall efficiency of application	Encourage and look for opportunities to witness / pilot	Support for viable pilot projects proving concept.
Manufacturing capacity expansion	All European suppliers have plans in place and new entrants offer additional capacity too	More efficient pricing and greater availability	Market signalling of certainty of future HVDC pipeline	More market signalling for strength and longevity of interconnection case
New supplier partnerships that change dynamically	Great cooperation between suppliers	Provide new bidding vehicles that could offer different value propositions	Encourage and keep tender options flexible	Encourage collaboration
New entrants	Expect to see more new entrants winning tenders in 1-5 years	Greater competition and choice driving prices down and standards up	Supplier development activities	Lower import tariffs Trade missions
Longer and more comprehensive product warranties	As a market entry strategy and as a response to market entry by incumbents	Potentially reduces whole life costs and increases repair certainty and speed	Allow and value within tenders. Set bar higher progressively.	
Greater risk absorption by suppliers	As a response to new entrants and client demands tempered by experience	Increases cost certainty for client and encourages suppliers to control risk at source	Allow and value within tenders. Set bar higher progressively.	
More efficient pricing	Due to new entrants, maturing technology and all above factors		Continue to allow and drive supplier innovations within tenders	
Promoting local content	Post contract award, encourage EPC contractors to showcase their needs locally to drive a local supply chain	Increased local benefit	Require EPC contractors to showcase their supply chain and logistics requirements	Support supply chain events

Innovation	Detail	Market benefit	National Grid action	Potential Ofgem/UK Government action
Promote education and skills development in Science, Technology, Engineering and Mathematics (STEM)	As a customer, National Grid promotes the STEM agenda in order to assure that the	Complementary to suppliers' agenda	Potential for joint promotion of STEM agenda with EPC contractor(s)	Encourage supply chain STEM agenda

3.3 UK skills

With the exception of GE Grid Solutions, which has a converter factory in the UK, HVDC is dominated by overseas manufacturers. With the exception of manufacturing, the execution of a UK HVDC project requires a significant local presence from the EPC contractor executing the works, the client overseeing the works and the supply chain roles listed in table 5.

3.4 UK benefit

The widely reported benefits of HVDC to the UK include increased security of supply, lower energy prices, carbon reduction and GDP impacts. What is more rarely reported is the impact on the development of UK skills in the supply chain and the client organisation (above), and also the positive impact on local economies during the construction phase.

4 Conclusion

The HVDC market is currently in a state of major change and innovation which should increase choice, reduce cost and increase the viability and certainty of interconnection projects. National Grid can and will continue to support and develop the market however as set out in table 7, UK Government can play an important role in this directly through the support of Ofgem/Department of Energy and Climate Change and through supporting initiatives to promote UK HVDC schemes which will add to the perceived certainty of projects and reinforce the supply chain.

5 Attachments

Attached are two project specific appendices providing background data on the next two National Grid HVDC projects.

Appendix 1 – IFA2 information sheet

Background

IFA2 is being developed as a 1 GW HVDC link between the French (RTE) and British transmission systems. It will be around 240km in length, it will connect to the GB transmission system at the Chilling 400kV substation on the south east Hampshire coast, and will connect to the French transmission system at the Tourbe 400kV substation in the Lower Normandy region of France. The project is being developed jointly by French Transmission System Operator RTE (Réseau de Transport d'Électricité) and National Grid Interconnector Holdings. The future GB interconnector operator, and interconnector licence holder, will be National Grid IFA2 Ltd.

Partners

National Grid has a strong background in developing and delivering subsea interconnectors. With IFA and BritNed already in the portfolio, and NEMO and NSL in construction, IFA2 is seen as a further commitment to National Grid’s commitment to support the provision of clean, renewable and sustainable energy to UK consumers.

Réseau de Transport d'Électricité (Electricity Transmission Network), usually known as RTE, is the electricity transmission system operator of France. It is responsible for the operation, maintenance and development of the French high-voltage transmission system.

RTE is a wholly owned subsidiary of the partially public-owned French generator Électricité de France (EdF), headquartered in Paris. It is a limited liability corporation.

RTE have a strong background in jointly developing, constructing and operating subsea interconnectors: projects include IFA, Inelfe and Midi Provence.

Known technical parameters

The IFA2 project is being developed as an HVDC electricity interconnector with capacity to import 1000MW at the points of connection to the British and French grids (at Chilling and Tourbe substations respectively).

The project is intended to complete commissioning in 2020. A key supply chain risk to achieving this operational target is the capacity of the HVDC cable manufacturing supply chain. To best mitigate and manage this risk, tracking other recent contract awards and future possible project requirements, the partners of IFA2 have sought to increase diversity in cable supply within the scope of mutual agreement, and have ensured that the project is open to both XLPE and MI cable technologies in order to provide as much flexibility as possible in the procurement of cable.

To include the XLPE cable technology in the procurement strategy, the partners undertook due diligence of the state of maturity of the product that was competitively available and deliverable by 2020, and concluded that this was represented by a 320kV cable voltage. As a result, the project is now open to 320kV XLPE cable products and 390kV MI cable products.

The converter technology has been selected as VSC. As noted, there is adequate competition in this sector to conduct an effective procurement process.

The point at which IFA2 will connect to the electricity transmission network in Great Britain is an existing National Grid site off Chilling Lane near Chilling in Hampshire. The proposed location of the converter station is at a site at Daedalus Airfield, near Lee-on-the-Solent in Hampshire

The connection point for IFA2 in France will be at Tourbe 400kV substation, East of Caen in Normandy, where there is also commercially available land for a converter station adjacent to the site.

Supply chain challenges

2020 delivery

The IFA2 project is working to a challenging timeline to deliver benefits to consumers by 2020. To achieve this, appropriate due diligence of the supplier market was necessary to determine what was deliverable. This informed technology choice, but also contract strategy, with a clear preference for the supply chain to remain split based on technologies (converters, cables) without further bundling.

Ensuring adequate competition

To ensure an effective competition, the IFA2 team showcased the project and its requirements with the supply chain over a year in advance of need. This was executed by issuing a request for information, and thereafter having a week of supplier meetings with credible suppliers of VSC converter technology and cable technology.

This process gave suppliers the opportunity to demonstrate their capabilities and differentiator. The process further helped the IFA2 team to shape the eventual procurement strategy – namely to ensure that both XLPE and MI HVDC cable products were sought.

In addition, a pre-qualification questionnaire (PQQ) process was used with criteria to ensure an appropriate amount of competition in the supply of both the cables and converters. This led to new entrants being selected as qualified bidders in both converter equipment supply and cable supply.

The early supplier engagement in 2014 has delivered a good level of interest, with 17 respondents to the initial Official Journal of the European Union (OJEU) contract notice. Shortlisted qualified bidders have now been invited to tender with effect from 30th November.

Procurement approach

The IFA2 contract notice (published on in OJEU journal on 15th July 2015) stated several conditions that the project is now officially bound to, such as:

- Definition of the power capacity as 1000 MW at the receiving ends
- VSC technology

The procurement strategy is based on two main EPC contract lots (converters and cables) but with the option for bidders to provide differentiation from a completely turnkey EPC contract. The description of the lots is as follows:

- Lot 1: HVDC converter station (1 in United Kingdom and 1 in France),
- Lot 2: Marine and onshore HVDC cable and installation and UK HVAC cable and installation,

- Lot 3 (Optional): HVDC converters and HVDC cable and installation and UK HVAC cable and installation (Lot1 + Lot 2).

Eligibility for Lot 3 is conditional upon the bidder having submitted bids for both Lot 1 and Lot 2. If the bidder is a joint venture or a consortium they must be able to demonstrate that their combined Lot 3 bid consists of bidders for Lot 1 and Lot 2.

For the different DC cable technologies, different DC voltages are being considered; namely 320kV for XLPE and 390kV MI cable.

  - The defined voltages of 320kV XLPE and 390kV MI open the opportunity to a maximum number of cable suppliers to enter the tender and to be eligible for lot 3 too.
  - Both voltages will be asked for in Lot 1, in order to maximize the chances of finding a match between Lot 1 and 2.

Tender management plan

Table 8 – Tender management plan for IFA2

Activity	Date
Invitation to tender (ITT) Launch	30th November 2015
EPC Schedules Release	14th December 2015
Document Release 1	18th December 2015
Supplier Launch Events	7th-8th January 2016
Site Visits	18th-20th January 2016
Document Release 2	29th January 2016
Clarification Meeting 1	January 2016
Document Release 3	26th February 2016
Clarification Meeting 2	February 2016
Advertised Tender Return	30th March 2016
Latest Tender Return (for critical path)	Mid-May 2016
Evaluation and Clarification Period	May – July 2016
Documents Release 4	May 2016
Factory visits	TBC
Negotiation Period	July – November 2016
Investment Decision	October 2016
Notice of Intent to Award (Standstill)	November 2016
Contract Award	December 2016

VikingLink

nationalgrid

Appendix 2 – Viking Link information sheet

Background

Viking Link is being developed as a 1.4GW HVDC link between the Danish (Energienet.dk) and British transmission systems. It will be around 750km in length (including onshore cable) and will connect to the 400kV Bicker Fen substation in England and Revsing in Western Denmark. The subsea cable route will cross through several international territorial waters in depths of approximately 50 metres. The project is being developed jointly by Danish Transmission System Operator (TSO) Energinet.dk and National Grid Interconnector Holdings.

Partners

National Grid has a strong background in developing and delivering subsea interconnectors. With IFA and BritNed already in the portfolio, and NEMO Link and NSL in construction, Viking Link is seen as a further commitment to National Grid's commitment to support the provision of clean, renewable and sustainable energy to UK consumers.

Energinet.dk is the Danish national TSO for electricity and natural gas. It is an independent public enterprise owned by the Danish state under the Ministry of Climate and Energy. Their main task is to maintain the overall short-term and long-term security of electricity and gas supply, and to develop the main Danish electricity and gas transmission infrastructure. Energinet.dk achieves this whilst supporting eco-friendly power generation, the development and demonstration of green energy production technologies and calculating the environmental impact of the energy system as a whole.

Energinet.dk has a strong background in jointly developing, constructing and operating subsea interconnectors: projects include KontiSkann, Skagerrak 1, 2, 3 & 4. Energinet.dk will imminently place a contract for a new interconnector, CobraLink, between Denmark and Holland.

Known technical parameters

Table 9 – known technical parameters for Viking Link

Capacity	1400MW (1.4GW)	Preferred HVDC operating voltage	>500kV
HVDC cable technology options	Mass Impregnated >500kV / XLPE 525kV	Subsea HVDC route length	650km
		Onshore HVDC route length (Denmark)	>50km
		Onshore HVDC route length (GB)	>50km
GB HVAC connection location and technology	Bicker Fenn, Lincs, UK	400kV AC cable connection requirement	
DK HVAC connection location and technology	Revsing, Denmark		
Preferred HVDC converter technology	Voltage source (VSC)	HVDC configuration	

Supply chain challenges

Viking Link will be a 750km interconnector with a capacity of 1400MW. Currently, it is too early in the project to determine the exact procurement strategy as there are still a number of unknown factors that will have a significant factor on the approach taken. It must be noted that all project-related supply chain activities are taken in conjunction with our project partners, as by doing so we will gain access to broader range of procurement experience that will allow us to continuously improve our knowledge base. This may in turn allow the project to reach a more predicable outcome.

Due to the anticipated DC cable market manufacturing constraints, both partners feel that it is imperative to engage with the supply chain as early as possible in order to maximise the projects ability to achieve a commissioning date of 2022 to the required operational performance.

To this end, we are jointly planning to hold an open supplier forum day in Q1 2016. Together we feel that early engagement will enable the project to:

- Gain information from the suppliers to help define and target the procurement and contracting strategy to allow the greatest flexibility to achieve the optimum balance of economic, contract and project risk.
- Gather information on the suppliers technical solutions and on new technical developments that should be considered when writing the technical specifications
- Gather information to shape the procurement tender documents including PQQ and ITT.
- Understand the capabilities and capacities of the emerging markets.
- Allow possible new entrants time to prepare and develop their capabilities in order to maximise diversity of supply and competitive tension in a constrained market.
- Opportunity to increase the profile of the project and become a ‘customer of choice’.
- Understand cultural differences and building relationships upfront

Short term next steps

1. Continue with a project supplier engagement plan ahead of invitation to tender (ITT) to continue to engage with a wider supplier base, drive technical innovation, reduce supply chain constraints, and introduce new entrants to the process whilst managing supplier relationships.

2. Continue to develop a lotting / procurement strategy together with our partner that maintains competition whilst delivering an optimum number of tender options, identifying specific skills shortages, and retaining technology flexibility that does not narrow the market.

3. Seek to engage with stakeholders to ensure planning constraints do not overly affect the procurement approach and further narrow the market.