North Seas Grid
Project Pipeline Analysis

Key Findings

October 2013

Research carried out by Baringa Partners for E3G and the European Climate Foundation (ECF)

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Executive Summary (i)

1. There is a significant amount of activity (offshore wind and interconnection) in the project development pipeline in the North Seas region:
   - 124 wind farms greater than 50km from shore (70 GW), 13 bilateral interconnectors (approx. 14 GW with 2 projects not having declared capacity yet) and 3 combined solution projects (up to 19 GW; ISLES project which is up to 16.4 GW is yet to be finalised).
2. Most bilateral interconnection and major offshore wind projects in the project pipeline in the North Seas are evaluated as high risk. This is mainly due to high degree of policy and regulatory uncertainty, and the fact that most projects are in the early stages of development and are unlikely to be commissioned before 2020.
3. Merchant interconnectors are scored as higher risk as they must secure an exemption from the Third Energy Package Directive and face challenges related to cross-border regulation. In comparison, regulated interconnections have lower risk but have weaker investment incentives and must secure consents in more than one country.
4. Only a limited number of projects have indicated intent to be part of a combined grid solution (integration of offshore wind generation and interconnection) which would underpin a fully integrated North Seas Grid in the longer term. Those combined grid projects have high risk of delivery due to regulatory uncertainty and lack of clarity on future revenues.

Executive Summary (ii)

5. The key risk factors for major offshore wind generation projects are political / regulatory (e.g. political or policy uncertainty and lack of clarity on future support schemes) and commercial / financial concerns (e.g. balance sheet constraints of utilities).

6. While unforeseen technological challenges may develop, in particular arising from coordinating offshore generation and interconnection, technological risk is rated as low for most projects. In general, proven technologies exist for offshore wind generation and interconnection.

7. Other risk categories including those related to supply chain constraints, environmental impact and the consenting process are also generally rated as low or medium risk.

The large number of projects in the concept stage in the pipeline shows there is significant interest amongst investors in North Seas energy infrastructure. Therefore, it is essential to manage these risks and ensure important projects are realised.

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Background

- European power sector decarbonisation is a critical path element of meeting Europe's climate change targets and enabling European leadership on climate internationally. Offshore wind represents a key element for European decarbonisation in many scenarios, but is unlikely to be developed at scale unless appropriate inter-regional transmission arrangements are put in place.
- The development of large-scale transmission and market integration will need to be initiated and tested at a regional level before European-wide grid initiatives can be put in place. The North Seas Grid represents one of the most promising examples for delivering these regional-level solutions. The 'North Seas Grid' is a broad concept involving both a major increase in transmission interconnections between the countries of the North Seas Region and the connection and integration of significant levels of offshore and onshore renewables.
- The first step in delivering a North Seas Grid will be investment in early projects to test regulatory arrangements, which are in a critical formative period, and new technologies in the near term, and medium-term efforts to develop offshore hubs and align regulation before the potential development of a more internationally-meshed system post-2020. These are vital for developing confidence in new grid technologies, for gaining experience in the regulatory arrangements needed for offshore grid deployment, and for testing business models and commercial appetites for such projects.
- A risk assessment of the project pipeline in the North Seas can help to identify the way to manage the risk of a "drift" scenario where investment is delayed and projects develop at a slow, fragmented pace

Objectives

1. Map all commercial bilateral interconnection or major offshore wind transmission projects* in the North Seas region that are either in development now or are in the investment pipeline

2. Evaluate the viability of these projects in order to assess what projects are likely to be completed successfully, and what projects have a high risk of failure

3. As a result, informing judgment about whether status quo investments are likely to deliver a North Seas Grid

* Projects with offshore generation at least 50km from shore and/or suitable for being combined with bilateral interconnection.

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Pipeline analysis: approach

Key questions were as follows:

1. What are bilateral interconnection and major offshore wind transmission projects in the North Seas region currently in development?
2. What risks do these projects face and what is the likelihood of commissioning?
3. What likely impact these projects have on the overall development of a North Seas Grid?

- E3G commissioned Baringa Partners to carry out the pipeline analysis.

Step 1: setting out risk categories and criteria for risk assessment

Risk category	Risk factors (examples)
Political / regulatory	unfavourable political environment, changes in long term energy policy, changes in the regulatory regime, uncertainty about subsidy level (FiT, CfD), lack of coordination between stakeholders
Technical	unforeseen difficulties due to use of unproven technology and / or scale of the project, potential incompatibilities, lack of technical expertise, unexpected tough conditions on site
Commercial / Financial	lack of financing, uncertainty about future cash flows, credit risk, exchange rate risk, budget overruns
Consenting	Difficulty in securing consent due to complex rules, across countries, lengthy procedure
Environmental	protest related to environment protection, high costs related to minimise environmental impact
Supply chain	lack of suppliers, lack of components, delays and cost increase caused by suppliers
Grid connection	high cost related to grid connection, long time to receive grid connection, gird connection not available

Risk assessment

Impact criteria guidelines

High	significant project scope change	project delay > 2 years	>20% project cost increase
Medium	some areas of the project scope are affected and changed	project delay 1-2 years	5-20% project cost increase
Low	Minimal scope change	Project delay < 1 year	<5% project cost increase

Likelihood criteria guidelines

High	> 70%
Medium	30-70%
Low	< 30%

Source: Baringa Partners LLP

Step 2: project risk scores based on risk assessment

Risk category	Risk assessment		
Political / regulatory	Impact X Likelihood	=	Risk score
Technical	Impact X Likelihood	=	Risk score
Commercial / financial	Impact X Likelihood	=	Risk score
…	Impact X Likelihood	=	Risk score

Score	Risk assessment	Risk description
6,9	High	The risk is significant, as it is likely or very likely to occur and can have potentially significant impact on the project.
3,4	Medium	The risk is assessed as medium, as it can be characterized by low - high or medium – medium combination of likelihood and impact.
1,2	Low	Low risk is less likely to occur and have less significant impact on the project.

Project risk score

- Project risk score determined by risk scores for particular categories
- Project risk score equal to the highest risk category score
- Project assessed **High**, **Medium** or **Low** risk

- Project assessed **High** risk - at least one risk category assessed as High risk. Project is less likely to be delivered as originally planned.
- Project assessed **Medium** risk - at least one risk category assessed as Medium risk and none has high risk
- Project assessed **Low** risk - all areas assessed as Low risk. The project is likely to be delivered as proposed.

Source: Baringa Partners LLP

Step 3: setting out criteria for assessing project impact on overall North Seas Grid

Project Impact on North Seas Grid

Criteria

- Feasibility to be part of North Seas Grid
- Capacity

→ **High** / **Medium** / **Low**

- Qualitative assessment of the importance of the project on the future development of North Seas Grid
- As the main criteria, evidence (based on information gather in Task 1 and 2) indicating that the project can be part of combined grid solution in the future
- Second criteria, projects with the high capacity

Overall Impact Assessment on North Seas Grid

Name	Project risk	Project Impact on North Seas Grid	Overall Impact on North Seas Grid
Project 1	High	High	**High / Medium / Low**
Project 2	Medium	Medium	
…	Low	Low	

Source: Baringa Partners LLP

Additional points related to risk scoring

- Risk scores are based on judgments based on secondary research from various publicly available sources
- Amount and quality of information available which was used to determine risk scores varied depending on the development stage of the project
- Projects at concept / early planning stage typically had less information available relative to projects which are under construction / consent authorised
- In many cases, where information for each risk category was not available (especially for concept / early planning stage projects), a similar risk score was given to a risk category across projects (without information) in a particular country

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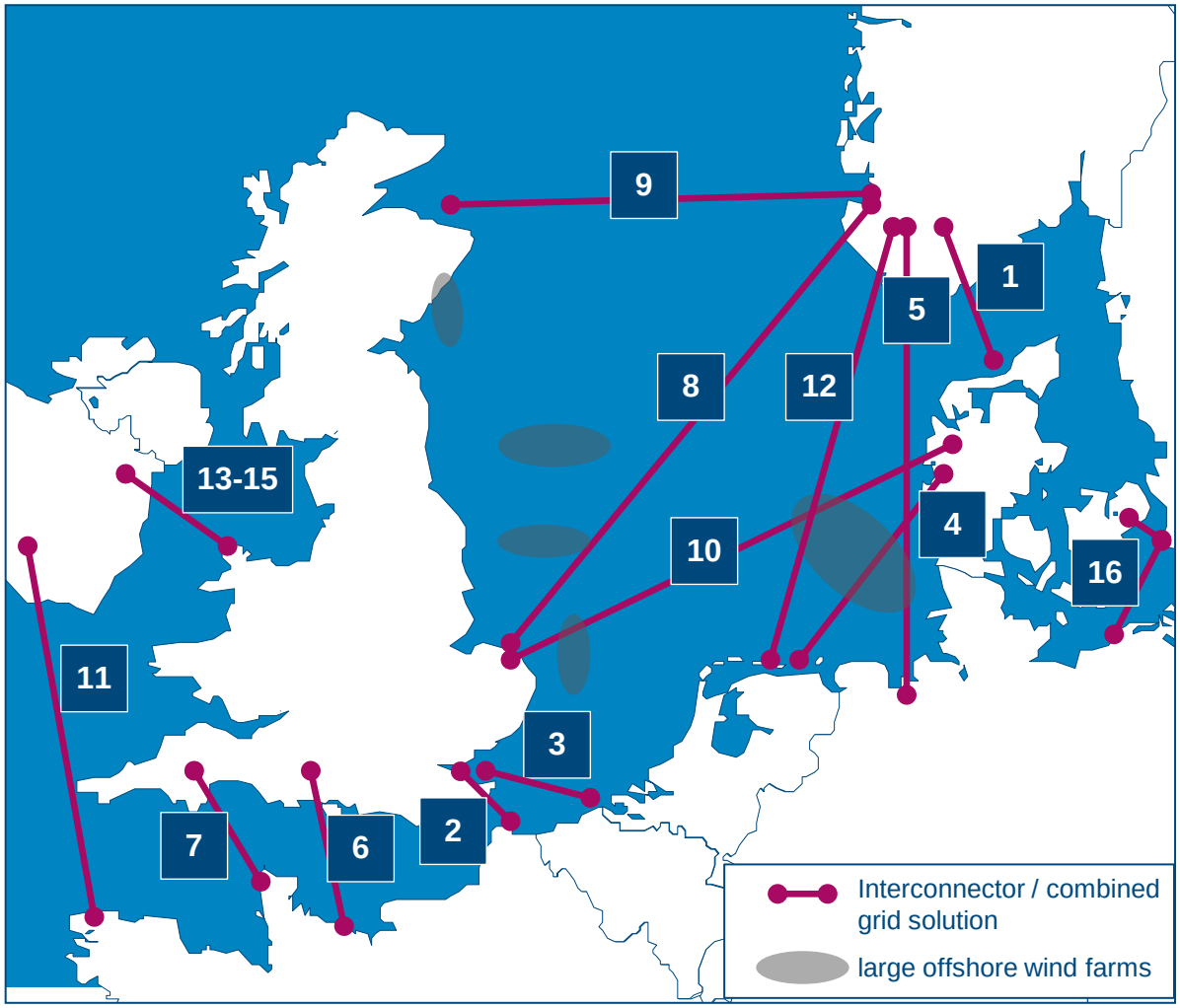
Projects already in the development pipeline represent a major step towards an integrated North Seas region



List of interconnection projects:

1. Skagerrak 4 (DK-NO)
2. ElecLink (FR- GB)
3. Nemo Link (BE-GB)
4. Cobra (DK- NL)
5. Nord Link, NorGer (DE-NO)
6. IFA2 (FR- GB)
7. FABLink (FR- GB)
8. Norwegian (GB- NO)
9. NorthConnect (GB – NO)
10. DK – GB project
11. FR – IE project
12. NorNed2 (NL- NO)
13. EW1 (GB – IE)
14. Energy Bridge (GB- IE)
15. ISLES (GB – IE)
16. Kriegers Flak (DK – DE)

Source: Baringa Partners LLP

Most interconnection projects are in the concept/early planning stage with limited consideration of a combined grid option

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Bilateral interconnectors

13 dedicated interconnectors in the North Seas region with total capacity of approx. **14 GW** (where indicated)

- 9 out of the 13 projects in the concept / early planning stage and likely to get commissioned post 2020
- Skagerrak 4 (No. 1) between Denmark and Norway is the only interconnector with consent authorised
- The remaining 3 projects have consent application submitted:
  - ElecLink (No. 2) between GB and France
  - Nemo Link between GB and Belgium (No. 3)
  - North Connect between Scotland and Norway (No. 9)

Combined grid solution (Offshore wind + interconnector)

3 potential combined grid solutions identified with potential capacity up to **19 GW**

- All the projects in the concept/early planning stage

Renewable energy trading projects

- **2 projects (Greenwire and Codling Bank between GB and Ireland)** were evaluated but are not plotted on the map

Source: Baringa Partners LLP

Currently there are 16 interconnection projects in the pipeline (13 dedicated bilateral and 3 combined solution)

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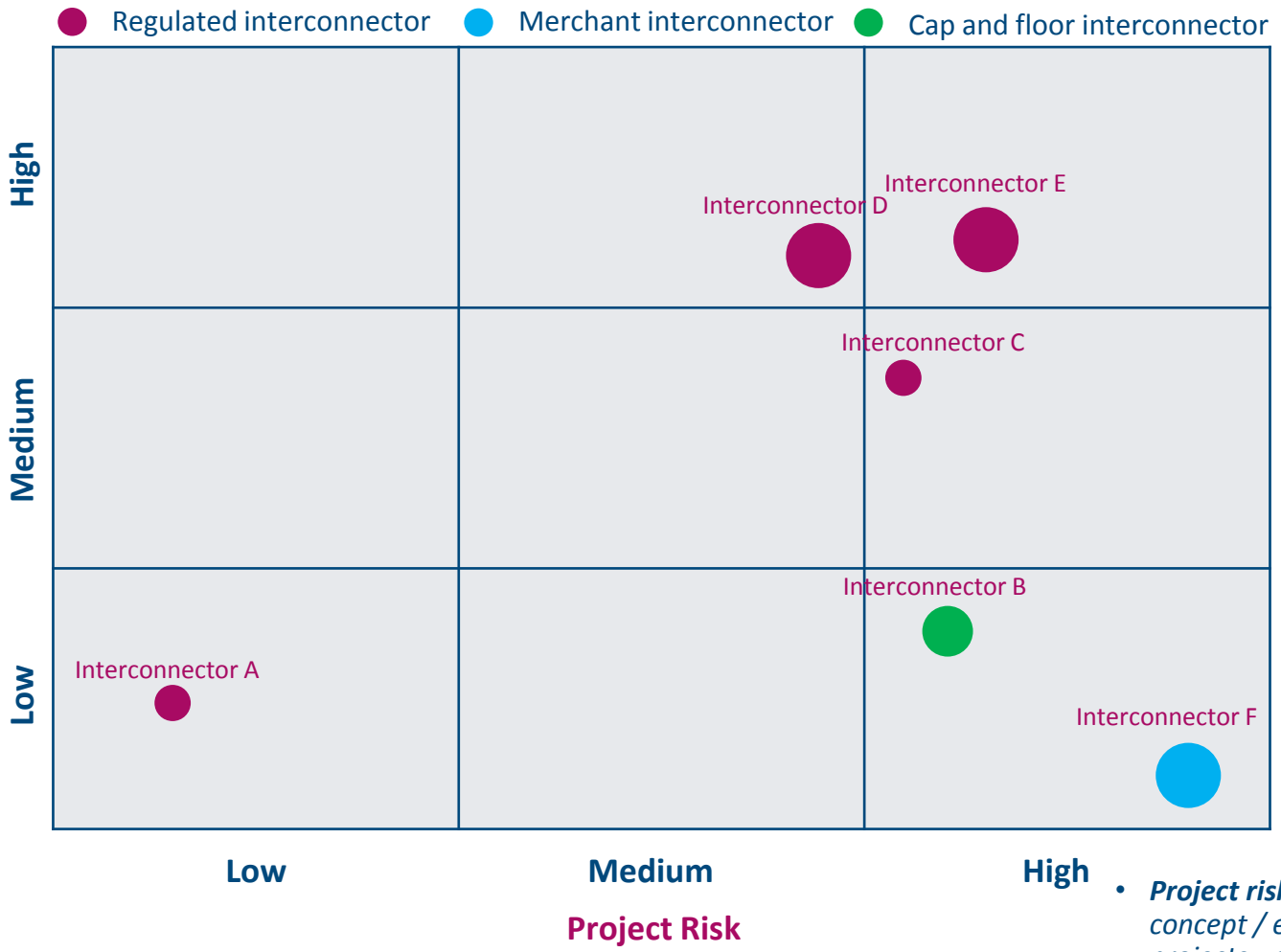
Interconnectors in North Seas Region	13 projects	Up to 14 GW*	8 countries
Combined grid solution	3 projects	Up to 19 GW**	4 countries

**2 interconnectors have not yet declared capacity*
***ISLES potential capacity based on maximum resource potential: upto 16.4 GW*
****2 Renewable energy trading projects were also included in the risk assessment with total capacity of up to 4.1GW*

Source: Baringa Partners LLP

Most interconnectors in the pipeline are medium to high risk - but have high potential to evolve towards a North Seas Grid



- Almost all projects, except Interconnector A, have medium to high project risk of delivery. Merchant projects have higher risk profile compared with regulated projects.
- Significant number of projects, mainly regulated, seem to have the potential to make a significant impact towards building a North Seas Grid. This is due to the large capacity of some projects and/or potential for them to be a combined offshore generation and interconnector project.
- Interconnector F is listed as merchant but this has not been officially decided.

- ***Project risk*** *– Higher risk for the projects in concept / early planning stages relative to projects under construction / consent authorised*
- ***Impact on North Seas Grid*** *– High impact of projects with high capacity (>=1 GW) and planning to be a part of combined grid solution*

Source: Baringa Partners LLP

E3G - Third Generation Environmentalism

Merchant interconnectors are high risk due to the impact of the Third Energy Package and cross-border regulations

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Risk category	Description	Risk score
Political / Regulatory	• Impact of the Third Package Electricity Directive • Impact of the Cross Border Regulations • Uncertainty on who can develop the interconnectors • Uncertainty on future policy changes • Merchant route not compatible with all EU member states	High
Technology	• Proven technology for building interconnectors, albeit increased uncertainty in first few years of operation	Low
Commercial / Financial	• Uncertainty of long term capacity contracts due to regulatory risk can lead to issues with debt finance • Competing project risks - a lot of interconnectors can lead to price convergence	High
Consenting	• Securing permits in more than one country can be challenging for the project	Medium
Environment	• Seabed survey is the most potent risk	Low
Supply chain	• Supply chain is well developed to supply the required equipment to the projects	Low
Grid connection	• Interconnector projects are considered on a 'first come first served' basis, based on the connection application timing • Timing of getting the connection approval critical to FID	Medium

HIGH

Source: Baringa Partners LLP

Regulated interconnectors face lower risk but lack strong investment incentive and must secure consents in more than one country

Risk category	Description	Risk score	
Political / Regulatory	• Regulated interconnectors are typically developed by TSOs • Third Energy Package clauses that impact merchant interconnectors do not impact regulated interconnectors • Uncertainty in policy changes can impact regulated interconnectors to a lesser extent as they have regulated returns	Low	MEDIUM
Technology	• Proven technology for building interconnectors	Low	
Commercial / Financial	• Financing of the projects is typically done by TSOs on balance sheet • Competing project risks - a lot of interconnectors can lead to some interconnectors not being developed	Medium	
Consenting	• Securing permits in more than one country can be challenging for the project	Medium	
Environment	• Seabed survey and cost risk associated with subsea cables can be significant	Low	
Supply chain	• Supply chain is well developed to supply the required equipment to the projects unless all projects get commissioned at same time	Low	
Grid connection	• TSOs themselves develop the interconnectors and give grid connection, grid connection and reinforcement (if required) does not pose a significant risk for development of regulated interconnectors	Low	

Source: Baringa Partners LLP

Combined grid solution projects are high risk due to regulatory uncertainty and lack of clarity on future revenues

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Risk category	Description	Risk score
Political / Regulatory	• Lack of clarity on regulatory treatment of combined grid solutions (how a network which combines generator connection and interconnection would be treated by each jurisdiction and whether it will comply with EU Target Model) • Different regulatory regimes and subsidy levels in interconnected countries	High
Technology	• The technology is in place, however has not been proven in large scale projects yet	High
Commercial / Financial	• Lack of clarity on regulatory treatment / definition of assets leading to difficulty in capital raising (projects are also large scale requiring high funding) • Lack of clarity on future revenues sources and cost sharing of assets	High
Consenting	• Challenges in navigating complex planning and licensing regimes across jurisdictions	Medium
Environment	• Complex environmental assessment due to large scale of the projects and differences in requirements in each country	Medium
Supply chain	• Low levels of competition, constraints in supply chain segments (especially HVDC technology), lack of technical competence and financial strengthand skills shortage	Medium
Grid connection	• Unclear status of transmission assets • Reinforcements of onshore grids and coordination will be necessary	Medium

HIGH

Source: Baringa Partners LLP

Renewables trading projects* face high regulatory risk and uncertainty but lower technology and consenting risk

Risk category	Description	Risk score
Political / Regulatory	• Uncertainty around regulatory treatment of renewables trading projects, especially of transmission assets • Uncertainty around pricing and allocation methods for CfD	High
Technology	• Onshore and offshore wind farm and HVDC interconnector technology are well developed	Low
Commercial / Financial	• Uncertainty around future CfD strike price level • Transmission assets likely to make up a large portion of the total investment cost and there is no regulatory regime in place	High
Consenting	• Current arrangements for permitting are transparent and fair • Some Public opposition against onshore turbines	Low
Environment	• Environmental surveys being carried out for assessed projects	Low
Supply chain	• Supply chain is well placed to deliver projects • HVDC converter and cable may be a bottleneck	Medium
Grid connection	• Grid connection secured for assessed projects • Potential grid reinforcements delays	Medium

HIGH

Source: E3G evaluation based on Baringa Partners LLP

Note: the assessed renewables trading projects are not expected to connect directly to the host country grid or function as interconnectors in the near term

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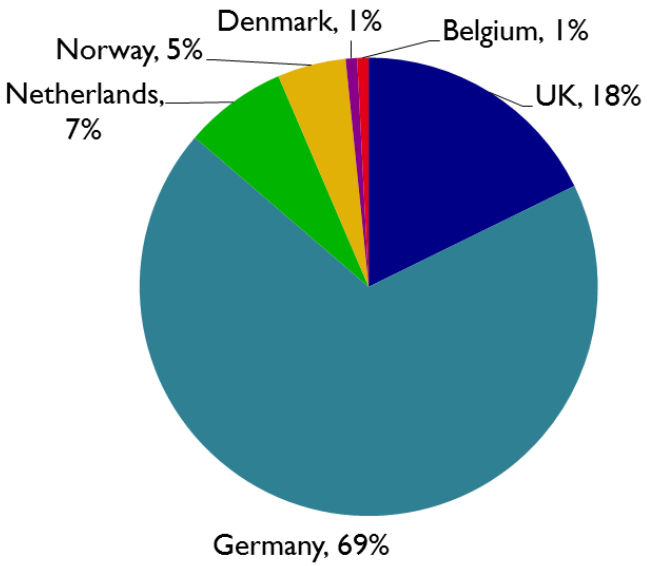
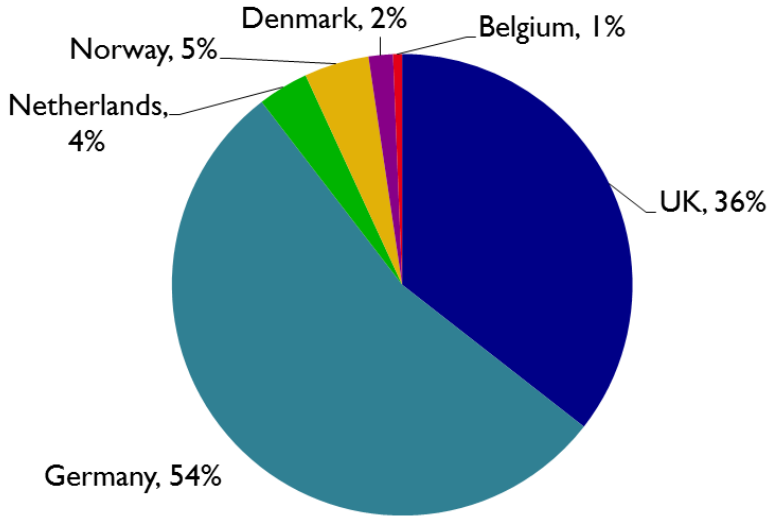
Significant amount of offshore wind capacity is in development in the North Seas region, led by UK and Germany

E3G

Projects by Number (total 124 projects)

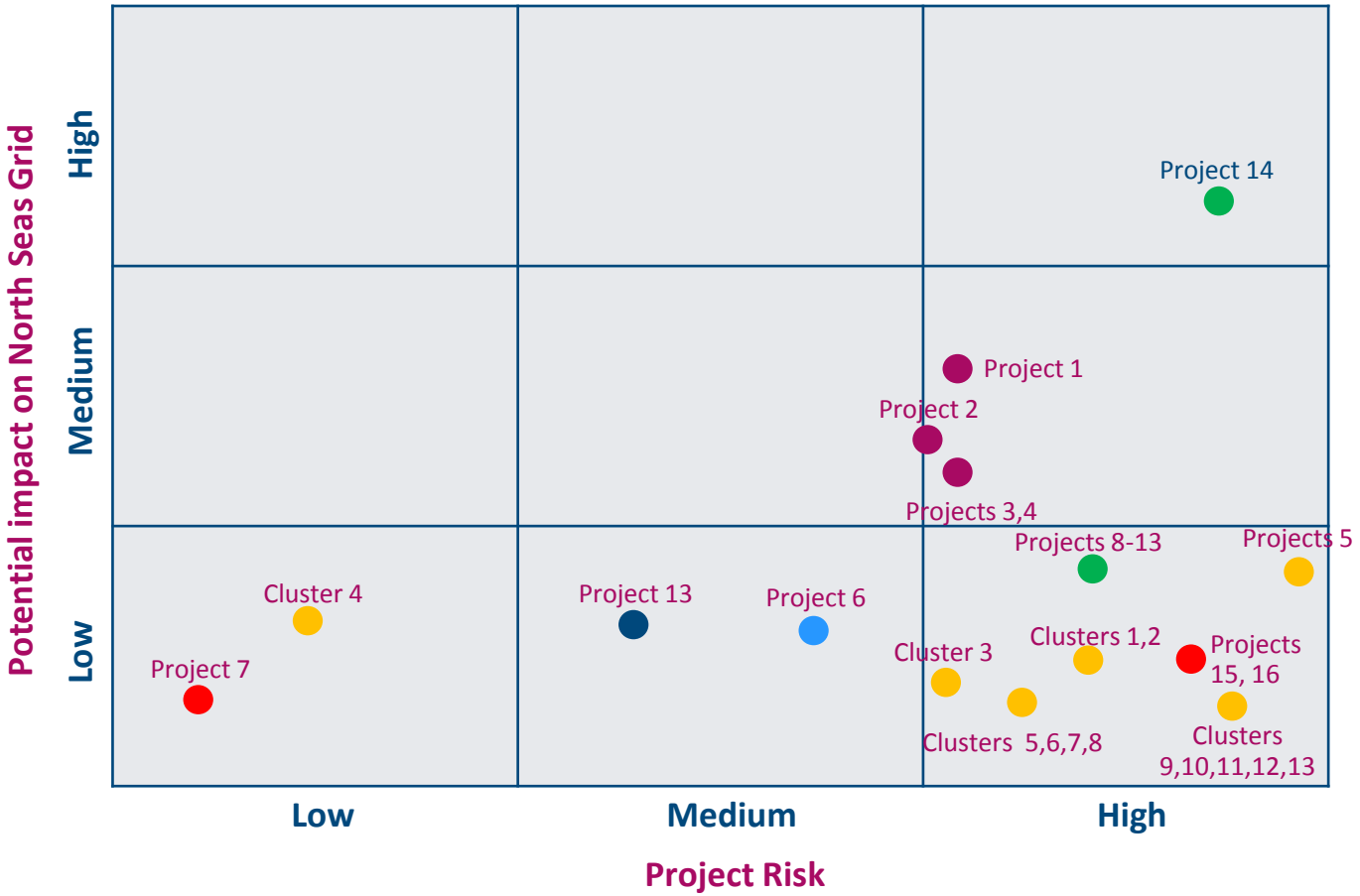


Projects by Capacity (total 70 GW)



- **124 offshore wind projects** located <u>further than 50km from shore</u> with a total capacity of approximately **70 GW.**
- About 95% of projects and capacity located in the **UK, Germany and the Netherlands**
- Projects in **various stages of development** from concept / early planning to the construction stage
- Most projects have plans to get commissioned **post 2015**

Most offshore wind generation projects are evaluated as high risk with low impact on the North Seas Grid



- ***Project risk*** *– Higher risk for the projects in concept / early planning stages relative to projects under construction / consent authorised*
- ***Impact on North Seas Grid*** *– High impact of projects with high capacity (>=1 GW) and planning to be a part of combined grid solution*

Source: Baringa Partners LLP

N.B. See annex for the list of projects

Political/regulatory or commercial/financial challenges are the key risk factors for offshore wind generation projects

E3G

Risk category	Description	Risk score
Political / Regulatory	• NO, NL, DE highest risk; UK medium; BE and DK low risk • High degree of policy uncertainty • Change in subsidy regimes; Reduction in subsidy	High
Commercial / Financial	• Balance sheet constraints of utilities • Lack of access to capital markets • Lack of construction and development finance	High
Technology	• Increased technical profile of projects alongside more challenging site conditions • Shortage of testing and demonstration sites	Low
Consenting	• Lack of resource availability in consenting organisations • Public opposition to offshore wind	Medium
Supply chain	• Constraints in supply chain segments • Lack of technical competence and financial strength • Low levels of competition • Skills shortage	Medium
Grid connection	• Uncertainty about recovery of construction costs, allocation of stranding risk, technical challenges of cooridnating offshore wind and interconnectors(UK) • Financial constraints of TSOs, delays in grid connection (Germany); insufficient onshore grid reinforcements (Belgium);	Medium

HIGH

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Challenges for merchant interconnectors (1): exemption from Third Energy Package and policy/regulatory uncertainty

E3G

Challenge	Description	Impact
Securing an exemption	• Article 9 of the Third Package Electricity Directive – Unbundling – restrictions on joint ownership of generation and interconnection • Article 32 of the Third Package Electricity Directive – Third Party Access – restrictions of capacity allocation and congestion management • Article 37(6) and 37(10) of the Third Package Electricity Directive – Approval of Tariffs – tariffs must be based on approved and transparent methodologies • Article 16(6) of the Cross Border Regulation – revenues resulting from the allocation of interconnec-tion capacity cannot be used to distribute profits to equity holders	• Ability to sell long term capacity contracts in order to raise project debt • Ability of generators, VIUs and some financial players to invest in new interconnection • Ability to distribute profits to equity holders
Uncertainty on future policy changes	• Uncertainty on how long Carbon Price Support will remain in place • Implementation of capacity payments in GB and other markets • Uncertainty on generation capacity mix by 2020 and 2030	• Potential revenue impact due to lower cross border flows, change in price levels and volatility
Regulations for interconnector development	• In GB, the TSO cannot build interconnectors but National Grid International Limited can whereas in other EU countries, TSOs are allowed • Norway has put forward a proposal to put state-controlled grid operator Statnett in charge of all Norwegian interconnector projects	• Potential cancellation of merchant interconnector projects

Source: Baringa Partners LLP

Challenges for merchant interconnectors (2): competing project risk and securing a firm offer for grid connection

Challenge	Description	Impact
Development of competing interconnectors	• Competing project risks - a lot of interconnectors are being built with many of them being regulated interconnectors which can lead to price convergence	• Reduction in stability of cash flows • Reduction in benefits of arbitrage opportunities and congestion rent
Getting a firm offer for grid connection	• Interconnector projects are given firm grid connection based on first come first served basis; projects later may have to wait for further deep or shallow reinforcement	• Revenue impact if a non-firm offer is received
Securing consents	• Since an interconnector passes through various countries, securing consent from multiple agencies in different countries is challenging	• Potential project delays

Source: Baringa Partners LLP

Challenges for regulated interconnectors: lack of strong investment incentive and consenting risk

Challenge	Description	Impact

Lack of strong investment incentive	• TSOs are natural monopolies subject to National Regulatory Authorities (NRA) who impose price controls on electricity transmission giving a regulated rate of return
	• For interconnectors, regulation comes under more than one NRA with different set of rules
	• Under Article 6(6) of Electricity Regulation 1228/2003/EC, the TSO can auction capacity during times of congestion but revenues must be used to
	  • Guarantee availability of capacity
	  • To maintain or invest in new interconnection capacity
	  • Income taken into account by NRAs, used to reduce network tariffs
		• Potential impact on development of less interconnectors with long lead times
		• Incentives to reduce network tariffs might encourage to maximise congestion rent and make TSO act like a merchant investor by restricting capacity

Consenting	• Securing permits in more than one country can be challenging for the project • Regulated interconnector are subject to regulatory approvals. As regulated interconnector costs are passed in the transmission tariffs they are subject to tougher scrutiny by national regulatory bodies especially in terms of existence of potential benefits and investment costs	• Long development time • Some projects may be cancelled due to lack of strong business case

Source: Baringa Partners LLP

Challenges for combined grid solution (1): coordination across countries

E3G

Challenge	Description	Impact
Co-ordination of asset development	• Lack of optimal sizing of the coordinated asset that is developed • Creation of a stranded asset • All wind farms may not necessary be built at the same time and risk of over investment in the hub	• Under-utilisation of the infrastructure developed
European Target model regulations	• As per the European Target Model (TM), interconnectors flows may have to be prioritised over Renewable energy flows • If offshore wind farm is getting connected to an interconnector, it would like to have priority access to safeguard the financial returns • However, this is contradictory to the European TM which can lead to a tension between 'TM versus priority access'	• Financial returns of the offshore wind farms • Compliance issues with European TM

Different subsidy regimes in interconnecting countries	• Different subsidy regimes in countries in which multiple purpose projects are located adds to complexities
	• All jurisdictions will have to offer the minimum level considered acceptable by the market for projects to be bankable in their waters
	• Accounting for the subsidies received by the developer
	  • Different subsidies that a RE generator could claim by being located in one jurisdiction and selling part of its output in a second jurisdiction
	  • Developers should not claim subsidies for the same energy under two different support mechanisms
		• Bankability of offshore wind projects
		• Accounting mechanisms of the subsidy

Source: Baringa Partners LLP

Challenges for combined grid solution (2): different subsidy and licensing regimes

Challenge	Description	Impact
Regulatory treatment of multi-purpose projects	• Costs associated with constructing and operating transmission infrastructure are recovered in different ways for onshore transmission, offshore transmission and interconnection • Duration of the revenue stream and incentives that impact the revenue stream differ according to the regime under which a project is regulated	• Uncertainty of recouping costs and realising revenues
Charging arrangements for the use of assets	• TNUoS charges for onshore and offshore are designed to provide an annual, fixed ex ante charge for use of the network • Charges for use of an interconnector are established through the use of auctions and are variable according to market's valuation of the capacity	• Uncertainty around how charges for use of multiple purpose assets are determined
Type of licence for the asset operator (UK specific)	• Under the current arrangements, operators of offshore transmission assets must hold a transmission licence which differs for the NETSO, TOs and OFTOs • Interconnector operators must hold an interconnector licence • However, as multiple purpose projects could serve the combined function of connecting offshore generation, providing reinforcement of the onshore network and/or linking UK market with that of other Member States, it is unclear in some cases which licensing regime may apply to certain assets	• Lack of clarity around which licensing regime(s) a multiple purpose project sits under

Source: Baringa Partners LLP

Challenges for offshore wind (1): Changes or reductions in subsidies

E3G

Challenge	Description	Impact
Change in subsidy regimes	• Change in UK from ROC subsidy mechanism to CfD from 2017 • Uncertainty on the allocation methods of new subsidy mechanism and structuring of contracts • Contract structures in new mechanism can lead to additional risks for the generator. However, strike prices neutralises this risk to a large extent • Regular change in support instruments in Netherlands - SDE to SDE+ and now a possibility of introducing an obligation scheme leading to uncertainty on how the new subsidy regime will be structured	• Developers accelerating projects that can be brought online before introduction of new subsidy regime eg: UK • Minimal investments in new projects till the time the new mechanism is clearly laid out and the risks are analysed
Reduction in subsidies	• In Germany, the Government proposed a set of changes aimed at limiting the level of support for renewables • Germany has proposed to impose a one year 1.5% retroactive cut to feed-in-tariffs • The Netherlands cut €4.5 bn annual offshore wind subsidy in 2011 • Recent SDE+ scheme in the Netherlands had price tendered auction aimed at generating renewable energy at least cost	• Stadtwerke München announced that it will halt all planned renewable projects not already under construction in Germany • Significant reduction in offshore wind deployment in the Netherlands since past 2-3 years

Source: Baringa Partners LLP

Challenges for offshore wind (2): Balance sheet constraints and a lack of access to financing

E3G

Challenge	Description	Impact
Balance sheet constraints	• Profits available for reinvestment in major capital programmes have reduced for the big utilities in Germany and UK • Financing of offshore wind farm projects on balance sheet • Developers have had to retain construction risk and agreed to complete the project for a fixed price on an agreed timescale in the market deals eg: DONG Energy in Walney, Anholt and Borkum Riffgrund 1 projects in UK, Denmark and Germany respectively	• Limited capital for offshore wind deployment • Higher risk allocation to the developer relative to equity investors
Lack of construction and development financing	• Risk appetite among banks / reduced liquidity as a result of eurozone crisis • Reduction in project debt finance for offshore wind projects from $2.9 bn to $2.1 bn from 2011 to 2012 • Development risk capital is limited • As technology for big and further from shore offshore wind projects is not mature, new equity investors have been reluctant to take construction risk	• Shorter tenure debt financing
Attractiveness of grid regulations (UK specific)	• Generator Build transmission helps developer retain control of construction but may not help to reduce cost if it is a point to point link. However, financing the grid connection can be difficult • Co-ordinated development by OFTO can help in reduction of cost of developing the transmission line but control of development may not be possible	• In case of Generator Build, financing of grid may be difficult • Cost of grid development and financing of the project

Source: Baringa Partners LLP

Challenges for offshore wind (3): supply chain constraints and development of new technology

Challenge	Description	Impact
Constraints in supply chain	• Wind farms are going to be larger (500 MW+), further from the shore and deeper • Huge pressure on supply of High-Voltage (HV) subsea cables, HVDC infrastructure, wind turbines and jacket foundations due to high demand • Installation bottlenecks as the current fleet of vessels are akin to shallow water	• Delay in project timelines • Delay in grid connection
Development of new technology	• Increase in generating capacity, depth of water and the distance from shore of UK and German offshore wind projects with time • New technology needs to be developed to tackle the challenging site conditions and reduction of project cost to make wind technology more competitive vis-à-vis other technologies	• New and unforeseen technical challenges that can lead to high capital costs and delays

Source: Baringa Partners LLP

Challenges for offshore wind (4): Political and regulatory risk assessment for offshore wind projects by country

E3G

Country	Risk score	Description
UK	Medium	• Policy/political uncertainty • Uncertainty around pricing and allocation methods for CfD; and the potential impact of transitional arrangements on deployment rates
Germany	High	• Policy/political uncertainty • Uncertainty around future FiT levels
Netherlands	High	• Policy and political uncertainty • Current support skewed towards biomass and lowest cost technologies
Norway	High	• Lack of political support • Insufficient support for offshore wind • Projects have not been granted subsidy and consent not authorised
Belgium	Low	• Project has been granted a concession to develop offshore wind farm
Denmark	Low	• Stable energy policy

Source: Baringa Partners LLP

Challenges for offshore wind (5): Grid risk assessment for offshore wind projects by country

Country	Risk score	Description
UK	Medium	• Insufficient certainty over cost recovery and allocation of stranding risk • Insufficient understanding of technical challenges of coordination
Germany	Medium	• Capital constraints of the TSO • Delays in grid connection • Insufficient coordination between grid and offshore wind development
Netherlands	Insufficient information	
Norway	Insufficient information	
Belgium	Medium	• Currently no capacity to connect new offshore wind farm – need for onshore grid development • Potential network coordination issues
Denmark	Low	• Reliable grid connection - TSO responsible for grid connection

Source: Baringa Partners LLP

Challenges for offshore wind (6): Risk assessment for remaining risk categories (across all countries)

Risk category	Risk score	Description
Commercial/ Financial	High	• Balance sheet constraints of utilities • High construction risk as a limiting factor for attracting finance • Difficulty in accessing the capital markets • Lack of information on project financing
Supply Chain	Medium	• Constraints in supply chain segments • Low levels of competition • Lack of technical competence and financial strength • Skills shortage
Technology	Low	• More challenging technical profile of deep water projects • Lack of operational data – shortage of testing and demonstration sites
Consenting	Medium	• Many projects awaiting approval • Complex and time-consuming process

Source: Baringa Partners LLP

Contents

Summary – Interconnectors (1/2)

E3G

No.	Proposed Interconnectors	Project name	Capacity (MW)	Development stage	Developer(s)	Regulated / Merchant / Hybrid	Expected commissioning
1	Denmark – Norway	Skagerrak 4	700	Consent Authorised	Energinet.dk, Statnett	Regulated	2014
2	France – GB	ElecLink	1,000	Consent Application Submitted	Eurotunnel, Star Capital Partners	Merchant	2016
3	Belgium – GB	Nemo Link	1,000	Consent Application Submitted	National Grid, Elia	Cap and floor (to be confirmed)	2018
4	Denmark – Netherlands	Cobra	700	Concept/early planning	Tennet, Energinet.dk	Regulated	2018
5	Germany – Norway	Nord Link, NorGer	1,400	Concept/early planning	Tennet, Statnett, KfW	Regulated	2018
6	France - GB	IFA2	1,000	Concept/early planning	National Grid, RTE	Regulated	2020
7	France – GB	FABLink	1,000	Concept/early planning	ARE, Transmission Investment	To be decided	2020
8	GB – Norway	Norwegian	1,400	Concept/early planning	Stattnett, National Grid	Regulated	2020
9	GB (Scotland) – Norway	NorthConnect	1,400	Consent Application Submitted	Agder Energi, E-CO, Lyse, Vattenfall AB	Probably hybrid	2021

Summary – Interconnectors (2/2)

E3G

No.	Proposed Interconnectors	Project name	Capacity (MW)	Development stage	Developer(s)	Regulated / Merchant / Hybrid	Expected commissioning
10	Denmark – GB	-	Not available	Concept/early planning	National Grid, Energinet.dk	To be decided	After 2020
11	France – Ireland	-	Not available	Concept/early planning	Eirgrid, RTE	To be decided	After 2020
12	Netherlands – Norway	NorNed 2	700	Concept/early planning	Stattnett, Tennet	Regulated	After 2020
13	GB – Ireland	EW1	350	Concept/early planning	Imera	Merchant	After 2020

Summary – Combined grid solution projects (offshore wind + interconnector)

E3G

No.	Proposed Interconnectors	Project name	Capacity (MW)	Development stage	Developer(s)	Expected commissioning
14	**GB – Ireland**	Energy Bridge	5000 (Phase I- 1,200 MW)	Concept/early planning	Mainstream Renewable Power, National Grid, REN	2017
15	**GB – Northern Ireland / Ireland**	ISLES (Irish-Scottish Links on Energy Study)	4,800*	Concept/early planning	Scottish Government, Northern Ireland Executive, Government of Ireland	Not available
16	**Denmark - Germany**	Kriegers Flak	1,600	Concept/early planning	50Hertz, Energienet.dk	2018

Summary – Renewable energy trading projects

E3G

No.	Proposed projects	Project name	Capacity (MW)	Development stage	Developer(s)	Expected commissioning
1	GB – Ireland	Greenwire	3,000	Concept/early planning	Element Power, Hudson Clean Energy Partners	2018
2	GB – Ireland	Codling Bank wind farm	1,100	Concept/early planning	Fred Olsen Renewables in partnership with Hazel Shore Ltd.	2019

UK – Offshore wind projects (>50 km from the shore) (1/2)

E3G

No.	Project name	Zone	Capacity (MW)	Development stage	Developers	Expected commissioning
1	Dogger Bank Creyk Beck A (Tranche A)	Zone 3	1200	Concept/early planning	RWE, SSE, Statkraft, Statoil	2017
2	Dogger Bank Creyk Beck B (Tranche A)	Zone 3	1200	Concept/early planning	RWE, SSE, Statkraft, Statoil	2019
3	Dogger Bank Teesside A (Tranche B)	Zone 3	1200	Concept/early planning	RWE, SSE, Statkraft, Statoil	2017
4	Dogger Bank Teesside B (Tranche B)	Zone 3	1200	Concept/early planning	RWE, SSE, Statkraft, Statoil	2018
5	Dogger Bank Teesside C (Tranche B)	Zone 3	1200	Concept/early planning	RWE, SSE, Statkraft, Statoil	NA
6	Dogger Bank Teesside D (Tranche B)	Zone 3	1200	Concept/early planning	RWE, SSE, Statkraft, Statoil	NA
7	Dogger Bank Tranche C	Zone 3	2400	Concept/early planning	RWE, SSE, Statkraft, Statoil	NA
8	Dogger Bank Tranche D	Zone 3	3600	Concept/early planning	RWE, SSE, Statkraft, Statoil	NA
9	East Anglia Three	Zone 5	1200	Concept/early planning	ScottishPower, Vattenfall Wind Power	NA
10	East Anglia Four	Zone 5	1200	Concept/early planning	ScottishPower, Vattenfall Wind Power	NA
11	East Anglia Five	Zone 5	1200	Concept/early planning	ScottishPower, Vattenfall Wind Power	NA
12	East Anglia Six	Zone 5	1200	Concept/early planning	ScottishPower, Vattenfall Wind Power	NA
13	East Anglia Two	Zone 5	1200	Concept/early planning	ScottishPower, Vattenfall Wind Power	NA

UK – Offshore wind projects (>50 km from the shore) (2/2)

E3G

No.	Project name	Zone	Capacity (MW)	Development stage	Developers	Expected commissioning
14	Firth of Forth Phase 2 Charlie	Zone 2	610	Concept/early planning	SSE, Flour	NA
15	Firth of Forth Phase 2 Delta	Zone 2	605	Concept/early planning	SSE, Flour	NA
16	Firth of Forth Phase 2 Echo	Zone 2	605	Concept/early planning	SSE, Flour	NA
17	Hornsea Heron Wind (Project 1)	Zone 4	500	Concept/early planning	Mainstream, Siemens, DONG	2017
18	Hornsea Njord (Project 1)	Zone 4	500	Concept/early planning	Mainstream, Siemens, DONG	2017
19	Hornsea Breesea (Project 2)	Zone 4	500	Concept/early planning	Mainstream, Siemens	2017
20	Hornsea Optimus Wind (Project 2)	Zone 4	500	Concept/early planning	Mainstream, Siemens	2017
21	Hornsea Project Three	Zone 4	1000	Concept/early planning	Mainstream, Siemens	NA
22	Hornsea Project Four	Zone 4	1000	Concept/early planning	Mainstream, Siemens	NA

Germany – Offshore wind projects (>50 km from the shore) (1/6)

E3G

No.	Project name	Cluster	Capacity (MW)	Development stage	Developers	Expected commissioning
1	BARD Offshore 1	6	400	Partial Generation /Under Construction	BARD Holding GmbH	2013
2	DanTysk	5	288	Under Construction	Vattenfall,Stadtwerke Munchen	2014
3	Global Tech 1	8	400	Under Construction	Global Tech I Offshore Wind GmbH	2013
4	Meerwind Ost/Sud	4	288	Under Construction	WindMW GmbH	2013
5	Nordsee Ost	4	295	Under Construction	RWE Innogy GmbH	2013
6	Albatros	8	345	Consent Authorised	Strabag, Northern Energy	2017
7	Borkum Riffgrund I	2	277	Consent Authorised	DONG Energy, Kirkbi, Oticon	2015
8	Borkum Riffgrund II	2	349	Consent Authorised	PNE2 Riff II GmbH	2018
9	Borkum Riffgrund West	1	400	Consent Authorised	PNE2 Riff II GmbH	2015
10	Delta Nordsee 1	3	240	Consent Authorised	Offshore- Windpark Delta Nordsee GmbH	2019
11	Delta Nordsee 2	3	160	Consent Authorised	Offshore- Windpark Delta Nordsee GmbH	2019
12	Demonstrationsprojekt Albatros 1	8	50	Consent Authorised	Windkraft FiT GmbH	NA
13	Deutsche Bucht	6	210	Consent Authorised	Undisclosed PV firm	2015
14	EnBW He Dreiht	7	400	Consent Authorised	EnBW He Dreiht GmbH	2019

Germany – Offshore wind projects (>50 km from the shore) (2/6)

E3G

No.	Project name	Cluster	Capacity (MW)	Development stage	Developers	Expected commissioning
15	EnBW Hohe See	8	400	Consent Authorised	EnBW Hohe See GmbH	2018
16	MEG Offshore 1	2	400	Consent Authorised	Nordsee Offshore MEG 1 GmbH (Windreich AG)	2015
17	Nordlicher Grund	5	320	Consent Authorised	WindMW GmbH (80% Blackstone Group)	2023
18	Sandbank	5	288	Consent Authorised	Vattenfall AB	2018
19	Veja Mate	6	400	Consent Authorised	BARD Holding GmbH	2015
20	Aiolos	11	985	Consent Application Submitted	EOS Offshore Aiolos GmbH	2017
21	Aquamarin	6	520	Consent Application Submitted	BARD Holding GmbH	NA
22	AreaC 1	Unclustered	400	Consent Application Submitted	FC Windenergy GmbH	NA
23	AreaC 2	Unclustered	400	Consent Application Submitted	FC Windenergy GmbH	NA
24	AreaC 3	Unclustered	400	Consent Application Submitted	FC Windenergy GmbH	NA
25	Austerngrund	9	400	Consent Application Submitted	Windreich AG	2015
26	Bernstein	9	520	Consent Application Submitted	BARD Holding GmbH	NA
27	Bight Power 1	7	400	Consent Application Submitted	FC Windenergy GmbH	NA
28	Bight Power 2	7	400	Consent Application Submitted	FC Windenergy GmbH	NA

Germany – Offshore wind projects (>50 km from the shore) (3/6)

E3G

No.	Project name	Cluster	Capacity (MW)	Development stage	Developers	Expected commissioning
29	Borkum Riffgrund West II	1	215	Consent Application Submitted	Energiekontor AG	NA
30	Citrin	9	520	Consent Application Submitted	BARD Holding GmbH	NA
31	Diamant	Unclustered	1040	Consent Application Submitted	BARD Holding GmbH	NA
32	Euklas	Unclustered	1040	Consent Application Submitted	BARD Holding GmbH	NA
33	GAIA I	13	400	Consent Application Submitted	Windreich AG	NA
34	GAIA II	12	200	Consent Application Submitted	Windreich AG	NA
35	GAIA III	12	400	Consent Application Submitted	Windreich AG	NA
36	GAIA IV	12	340	Consent Application Submitted	Windreich AG	NA
37	GAIA V	13	400	Consent Application Submitted	Windreich AG	NA
38	Global Tech II	7	380	Consent Application Submitted	Northern Energy Global Tech II GmbH	NA
39	Global Tech III	7	105	Consent Application Submitted	Northern Energy Global Tech III GmbH	NA
40	H2-20	Unclustered	400	Consent Application Submitted	GEO mbh	NA
41	Horizont I	12	320	Consent Application Submitted	Mainstream Renewable Power	2020
42	Horizont II	11	380	Consent Application Submitted	Mainstream Renewable Power	2020

Germany – Offshore wind projects (>50 km from the shore) (4/6)

E3G

No.	Project name	Cluster	Capacity (MW)	Development stage	Developers	Expected commissioning
43	Horizont III	11	355	Consent Application Submitted	Mainstream Renewable Power	2020
44	HTOD 1	Unclustered	486	Consent Application Submitted	HODS (Hochtief Offshore Development Solutions)	NA
45	HTOD 2	Unclustered	510	Consent Application Submitted	HODS (Hochtief Offshore Development Solutions)	NA
46	HTOD 3	Unclustered	504	Consent Application Submitted	HODS (Hochtief Offshore Development Solutions)	NA
47	HTOD 4	Unclustered	570	Consent Application Submitted	HODS (Hochtief Offshore Development Solutions)	NA
48	HTOD 5	Unclustered	560	Consent Application Submitted	HODS (Hochtief Offshore Development Solutions)	NA
49	Jules Verne	Unclustered	480	Consent Application Submitted	PNE Wind AG	NA
50	Kaikas	10	415	Consent Application Submitted	EOS Offshore Ltd (wpd)	2016
51	Meerwind West	Unclustered	805	Consent Application Submitted	Windland Energieerzeugungs GmbH	NA
52	Nautilus I	Unclustered	480	Consent Application Submitted	PNE Wind AG	NA
53	Nordpassage	5	400	Consent Application Submitted	Vattenfall AB	NA
54	Notos	8	265	Consent Application Submitted	EOS Offshore Ltd (wpd)	2017
55	OWP West	1	400	Consent Application Submitted	STRABAG SE	NA
56	Sandbank Extension	5	200	Consent Application Submitted	Vattenfall AB	NA

Germany – Offshore wind projects (>50 km from the shore) (5/6)

E3G

No.	Project name	Cluster	Capacity (MW)	Development stage	Developers	Expected commissioning
57	SeaStorm I	Unclustered	400	Consent Application Submitted	STRABAG SE	NA
58	SeaStorm II	Unclustered	190	Consent Application Submitted	STRABAG SE	NA
59	SeaWind III	10	285	Consent Application Submitted	STRABAG SE	NA
60	SeaWind IV	10	390	Consent Application Submitted	STRABAG SE	NA
61	Skua	Unclustered	400	Consent Application Submitted	OPG Offshore Projekt	NA
62	Witte Bank	13	590	Consent Application Submitted	Projekt Okovest GmbH	NA
63	Concordia I	Unclustered	480	Concept/early planning	WV Energie AG	NA
64	Concordia II	Unclustered	480	Concept/early planning	WV Energie AG	NA
65	ENOVA Offshore NSWP	Unclustered	3900	Concept/early planning	ENOVA Energiesysteme GmbH & Co.KG	NA
66	Gannet	Unclustered	400	Concept/early planning	OWP Gannet GmbH i.G. (Windreich, Norderland)	NA
67	Heron	Unclustered	400	Concept/early planning	OWP Gannet GmbH i.G. (Windreich, Norderland)	NA
68	HTOD 6	Unclustered	384	Concept/early planning	HODS (Hochtief Offshore Development Solutions)	NA
69	Mainstream	Unclustered	NA	Concept/early planning	Mainstream Renewable Power	NA
70	Nemo	Unclustered	480	Concept/early planning	PNE Wind AG	NA

Germany – Offshore wind projects (>50 km from the shore) (6/6)

E3G

No.	Project name	Cluster	Capacity (MW)	Development stage	Developers	Expected commissioning
71	Neptun 1	Unclustered	560	Concept/early planning	NEPTUN ENERGY Projektgesellschaft GmbH	NA
72	Neptun 2	Unclustered	560	Concept/early planning	NEPTUN ENERGY Projektgesellschaft GmbH	NA
73	Neptun 3	Unclustered	560	Concept/early planning	NEPTUN ENERGY Projektgesellschaft GmbH	NA
74	Neptun 4	Unclustered	560	Concept/early planning	NEPTUN ENERGY Projektgesellschaft GmbH	NA
75	Neptun 5	Unclustered	560	Concept/early planning	NEPTUN ENERGY Projektgesellschaft GmbH	NA
76	Norderland	13	NA	Concept/early planning	Norderland Projekt GmbH	NA
77	Norderland	13	NA	Concept/early planning	Norderland Projekt GmbH	NA
78	NORD-OST PASSAT I	Unclustered	360	Concept/early planning	TAGU	NA
79	NORD-OST PASSAT II	Unclustered	360	Concept/early planning	TAGU	NA
80	NORD-OST PASSAT III	Unclustered	480	Concept/early planning	TAGU	NA
81	Petrel	Unclustered	400	Concept/early planning	OWP Petrel GmbH i.G.	NA
82	ProWind 1	Unclustered	389	Concept/early planning	Wind PROffshore International GmbH	NA
83	ProWind 2	Unclustered	389	Concept/early planning	Wind PROffshore International GmbH	NA
84	ProWind 3	Unclustered	389	Concept/early planning	Wind PROffshore International GmbH	NA
85	Seagull	Unclustered	400	Concept/early planning	OWP Seagull GmbH i.G.	NA

Netherlands – Offshore wind projects (>50 km from the shore)

E3G

No.	Project name	Capacity (MW)	Development stage	Developers	Expected commissioning
1	Breeveertien II	349	Consent Authorised	DONG Energy, SSE	NA
2	Brown Ridge Oost	282	Consent Authorised	Eneco	NA
3	Clearcamp	275	Consent Authorised	Typhoon Offshore BV	NA
4	Den Helder I	468	Consent Authorised	Den Helder Wind Farm BV (DONG Energy, SSE)	NA
5	Gemini	600	Consent Authorised	Typhoon Offshore BV	2016
6	Tromp Binnen	295	Consent Authorised	RWE Innogy GmbH	NA
7	Leeghwater (Demonstration site)	200	Concept/early planning	Far and Large Offshore Wind	NA
8	Ijmuiden	NA	Development Zone	Rijksoverheid	NA
9	Ten nooden van de Waddeneilanden	NA	Development Zone	Rijksoverheid	NA

Denmark, Belgium, Norway – Offshore wind projects (>50 km from the shore)

E3G

No.	Project name	Capacity (MW)	Development stage	Developers	Expected commissioning
Denmark					
1	DanTysk DK	1200	Concept/early planning	Gesellschaft fur Energie und Oekologie	NA
Belgium					
1	THV Mermaid	450	Consent Authorised	Otary, Electrabel	2016
Norway					
1	Aegir Havvindpark	1000	Concept/early planning	OceanWind AS (50% Statec, 50% Grieg)	2016
2	Idunn energipark	1200	Concept/early planning	Fred Olsen Renewables Limited	NA
3	Sorlig Nordsjoen	1000	Concept/early planning	Lyse Energi AS	NA
4	Sorlige Nordsjo I	NA	Development Zone	NVE	NA
5	Sorlige Nordsjo II	NA	Development Zone	NVE	NA
6	Stadthavet	NA	Development Zone	NVE	NA