Offshore wind sector deal

Enabling efficient development of transmission networks for offshore wind targets

November 2019

Offshore Wind Industry Council

Executive summary

This paper has been produced by the Offshore Wind Industry Council (OWIC) Offshore Transmission Working Group, to support delivery of the Offshore Wind Sector Deal.

It reviews and sets out the emerging grid related barriers to delivering the Sector Deal target of 30GW by 2030, and the national net zero greenhouse gas emission 2050 target, which the Committee on Climate scenarios show will require at least 75GW of offshore wind.[1] In this report we outline the barriers emerging from the experience of the offshore transmission regulatory regime to date, and consider the areas of opportunity in overcoming these barriers and meeting the above targets at the best value for money for the end consumer. A key outcome of identifying areas of barrier and opportunity has been that action is needed now to ensure that long lead-time projects can deliver their full cost-efficient potential in the future.

There is currently around 9GW of offshore wind built and operating with a further 10GW or so being constructed or expected to enter construction soon, with around a further 15GW in development.[2]

Beyond this, new leasing is in progress to deliver at least 7GW in England and Wales[3] and perhaps several GW in Scotland.[4] Further leasing rounds will clearly be needed for the 2050 targets. All of this will massively upscale the amount of offshore transmission. This current practice of connecting offshore wind projects to the onshore grid on a point to point basis may not be the most economic and efficient way forward leading to cost, programme delivery risk and amenity risk that could otherwise be avoided.

Even with the current scale of development, issues with the onshore and offshore transmission regime are becoming apparent and are likely to present barriers to the targets. This paper identifies nine key issues as follows, discussed in more detail in Section 2.

1. Physical space – physical congestion, particularly around the nearshore area, landfall and onshore. Future developments may need to co-ordinate and consolidate their activities to a greater extent than has previously been possible to achieve under current frameworks of engagement.
2. Community impacts – Uncoordinated development of infrastructure onshore with local impacts. .
3. Onshore grid – a lack of capacity to transport offshore wind energy inland and from north to south.
4. Longer offshore transmission lifetimes – a need to extend the lifetime of offshore transmission to make it useable by different and successive projects.
5. Transmission system planning and design – currently the design and development of both the onshore and offshore transmission grid is not as coordinated and efficient as it could be.
6. Interconnectors, hybridisation and jurisdictional issues – a lack of frameworks to integrate offshore wind, transmission and interconnectors between TSO areas. This risks not making best use of intended point-point interconnection projects yet to be designed which through modification into multiterminal solutions could further limit consumer cost over dedicated offshore connection solutions.
7. Co-location of technologies – a lack of frameworks for co-locating different generation and storage technologies and infrastructure across different offshore sectors. This limits optimal use of land and network capacity usage and a such restricts opportunities to otherwise optimise project cost.
8. Costs and value for money – an opportunity that a more coordinated approach could create cost efficiencies across both the onshore and offshore transmission networks. This avoidance of double-handling, re-work or ultimately excessive infrastructure is also societally optimising available resources, and limiting amenity impacts.
9. Delivery – To effect change for projects connecting by 2030, new frameworks and regimes will be required by the early 2020s. These are needed to provide clear directions of travel to enable more integrated activity or otherwise clarify the basis of more separate developments that risk being less efficient.

This paper concludes that work is urgently needed to examine the above issues, determine the extent and locality of problems, identify solutions and set out the route to change to ensure the implementation of solutions enables industry to meet the targets. This process should be overseen by the Department for Business, Energy and Industrial Strategy (BEIS) with input from the offshore wind sector and other key stakeholders. A proposed high level process is outlined in Section 3.

Introduction

1.1 Aims of this paper

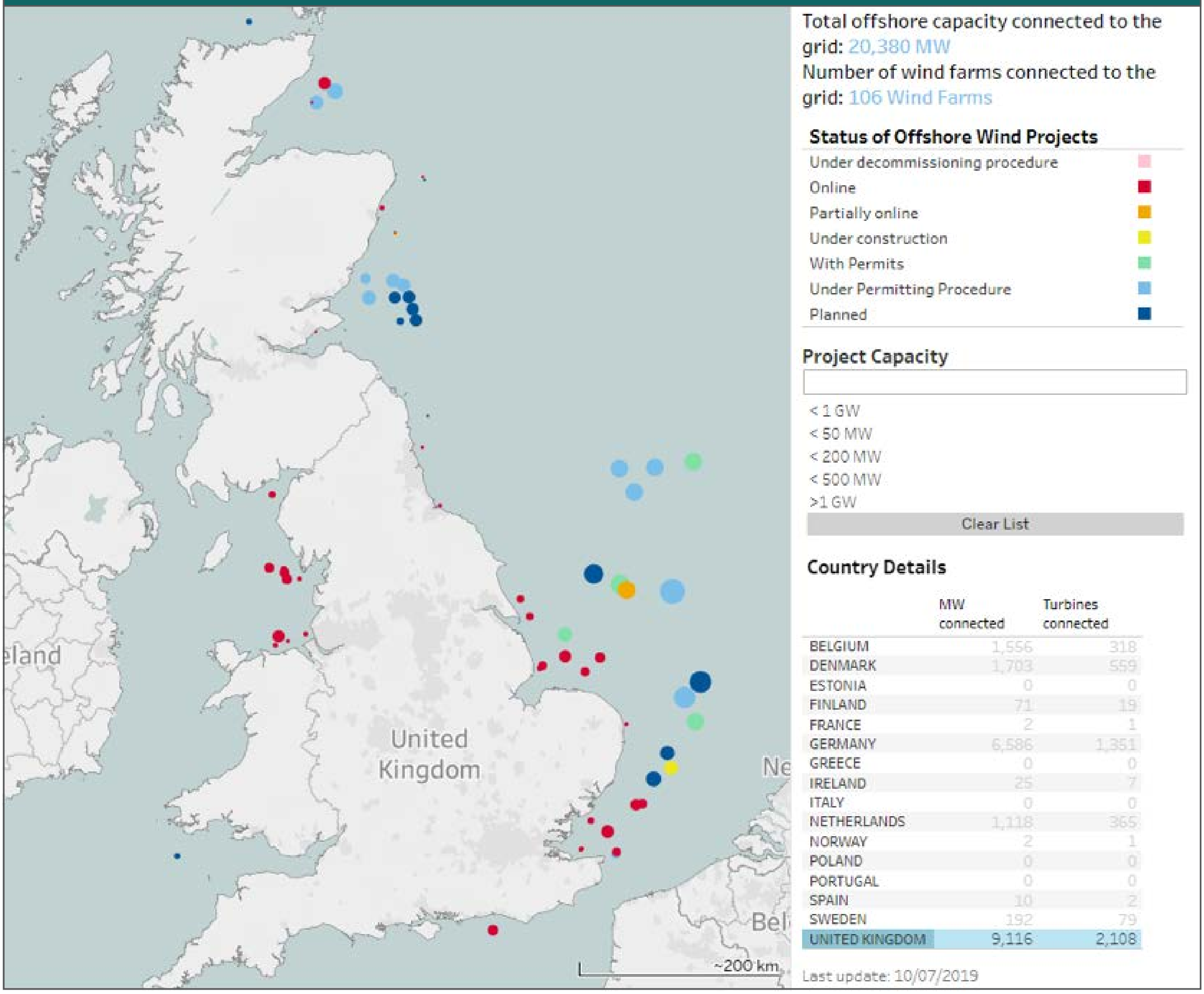
The primary aim of this paper is to set out the barriers presented by the current transmission regime to delivering the offshore wind targets for 2030 and 2050. In addition to this, it highlights the work required to create the right regulatory framework to facilitate a more coordinated approach for the ultimate benefit of consumers (in both price and supply security). This should also create drivers for innovation and the most efficient system.

1.2 Where are we now?

There is currently over 9GW of offshore wind in operation. This operational capacity has been delivered over the last 20 years and earlier projects will soon be candidates for repowering. There is also around 3.7GW currently under construction,[2] a further 5.5GW with CfD support[5] and around 15GW in development processes. If consented and economic, this capacity may be deliverable in the period until 2030. This capacity and its status are shown in Figure 1.1.

On top of this, The Crown Estate (TCE) is expecting to lease at least a further 7GW off England and Wales,[3] and, Crown Estate Scotland additional capacity around the Scottish coast.[4] This capacity will mainly be delivered from 2030 onwards although some may be achievable by 2030.

Figure 1.1: Current offshore wind pipeline and project status



1.3 What do we want to achieve?

The Sector Deal sets out an ambition to deploy at least 30GW of offshore wind by 2030.

Further to this, the Government has recently legislated for net zero greenhouse gas emissions by 2050, with the Committee on Climate Change (CCC) publishing scenarios that suggest at least 75GW of offshore wind will be needed to achieve this,[1] and, according to NGESO's Future Energy Scenarios[6] around 50GW. The difference between these figures is dependent upon the energy mix onshore. This level of offshore wind will require further projects beyond those currently in development.

Overall the aim is to deliver low cost, green and reliable energy from offshore wind to meet the above ambitions. This will require efficiency and innovation in the design of the offshore transmission regime.

1.4 Transmission regime

The existing Offshore Transmission regulatory regime was developed in the mid to late 2000s and was born of relatively small projects where offshore substations and links to shore of 132kV or above were anticipated. Example projects include: Barrow Offshore Wind Farm (90MW and single 132kV connection), and Thanet Offshore Wind Farm (300MW and double 132kV connection).

These regulatory arrangements have supported the delivery, construction and operation of offshore transmission for projects up to 630MW (London Array) and 659MW (Walney Extension) in size with larger and more distant offshore projects in the current pipeline. The current regime has delivered offshore wind, and now a decade of experience suggests the current regime can be adjusted in the short term to improve efficiency, reduce risks and reduce costs.[7] Going further forward however, there are emerging issues that will act as barriers if not addressed and so a new approach may be needed.

2. Barriers and opportunities

2.1 Physical space

Offshore wind developments have tended to be concentrated in certain more favourable areas with excellent wind resource and higher yields. In conjunction with this, the onshore transmission system is also concentrated in certain areas based on incremental design principles and technologies. To date, offshore wind projects have individually connected to the onshore grid, and in some areas, this has led to a level of physical congestion for cable routes. The above issues are particularly compounded in the nearshore area due to interaction with other seabed users such as oil and gas infrastructure, interconnectors, telecoms, dredging and extraction activities. Figure 2.1 below illustrates the concentration of offshore wind in certain areas.

EXAMPLE – In the Heysham area there are five separate offshore wind farms individually routed into Heysham/Middleton substations with a sixth to nearby Stannah. On the above Figure 2.1, this is the northern group of projects ringed on the west coast. This has created routing congestion both offshore and onshore. In addition to this there is congestion with oil and gas infrastructure offshore. Figure 2.2 shows the offshore infrastructure around Heysham.

Recommendation

There is a need to review the situation in locations with concentrated development volumes of offshore wind – in particular the options for routing to onshore connection points. This should include the direction for possible new solutions to be developed by National Grid Electricity System Operator (NGESO). There is a need to establish how much of an issue this is and where, and to ensure there is resource identified to develop appropriate solutions for implementation.

Figure 2.1: Operational offshore wind in 2019 (9GW) and a potential 2030 (30GW) scenario

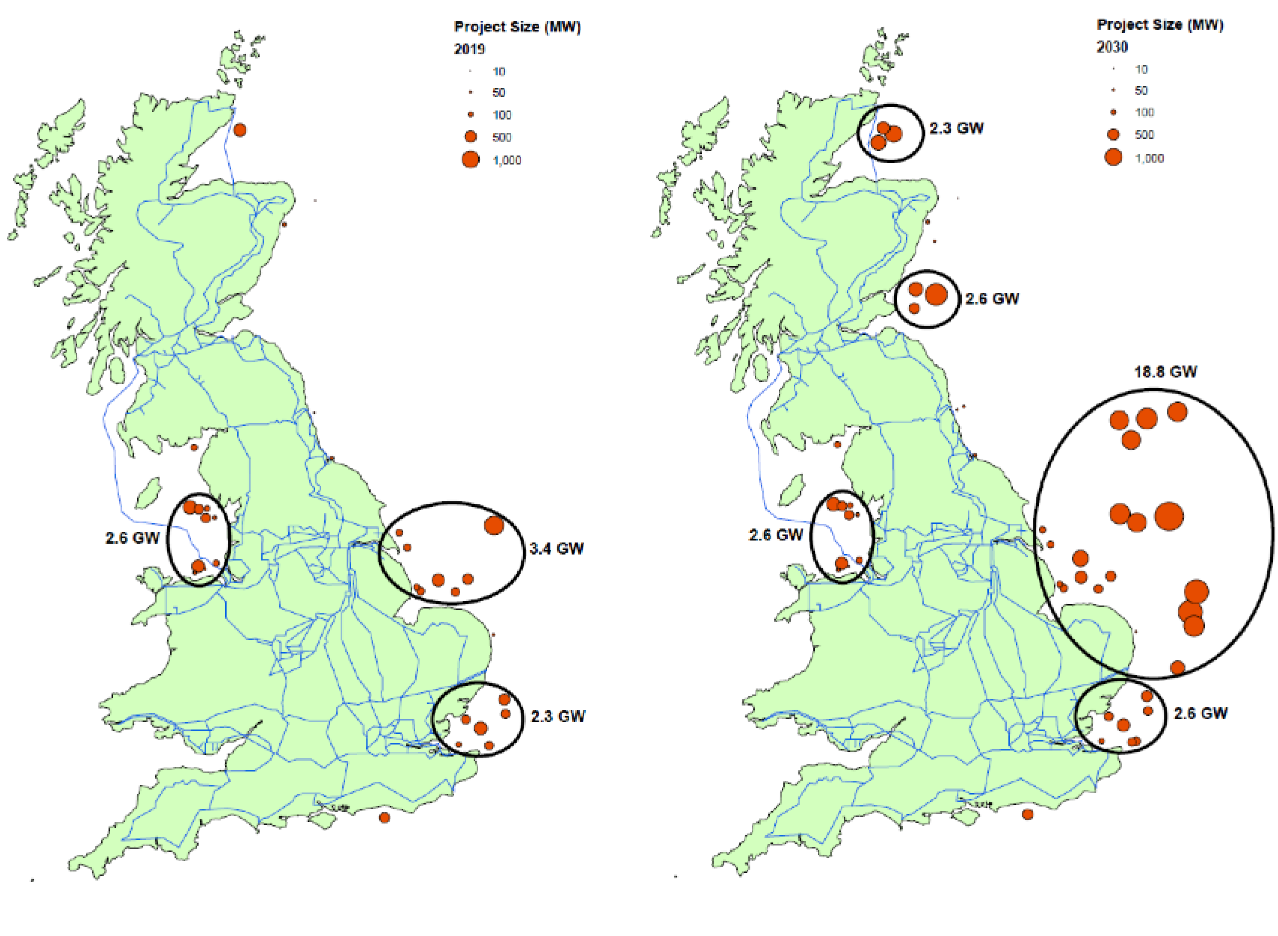
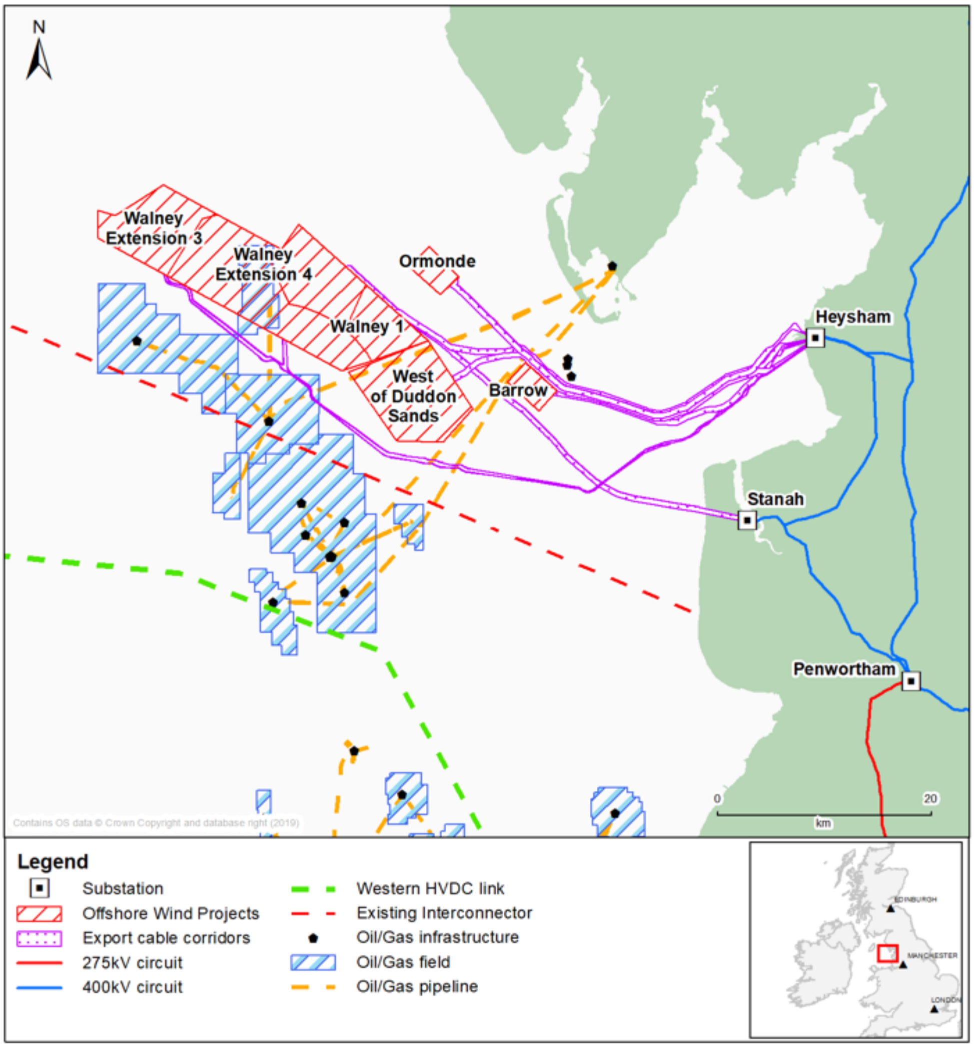


Figure 2.2: Offshore wind, transmission and other offshore infrastructure around Heysham



2.2 Community impacts

Following from the above, some regions are seeing repetition of the same types of onshore construction activity as individual projects deliver their own individual offshore transmission connections. Infrastructure such as substations is accumulating in some localities with little or no apparent coordination between them. This is leading to an increase of concerns raised by stakeholders.

Recommendation

A more coordinated approach should aim to reduce cumulative community impacts.

EXAMPLE – Quote from George Freeman MP, 11 March 2019, House of Commons, Hansard Column 157:

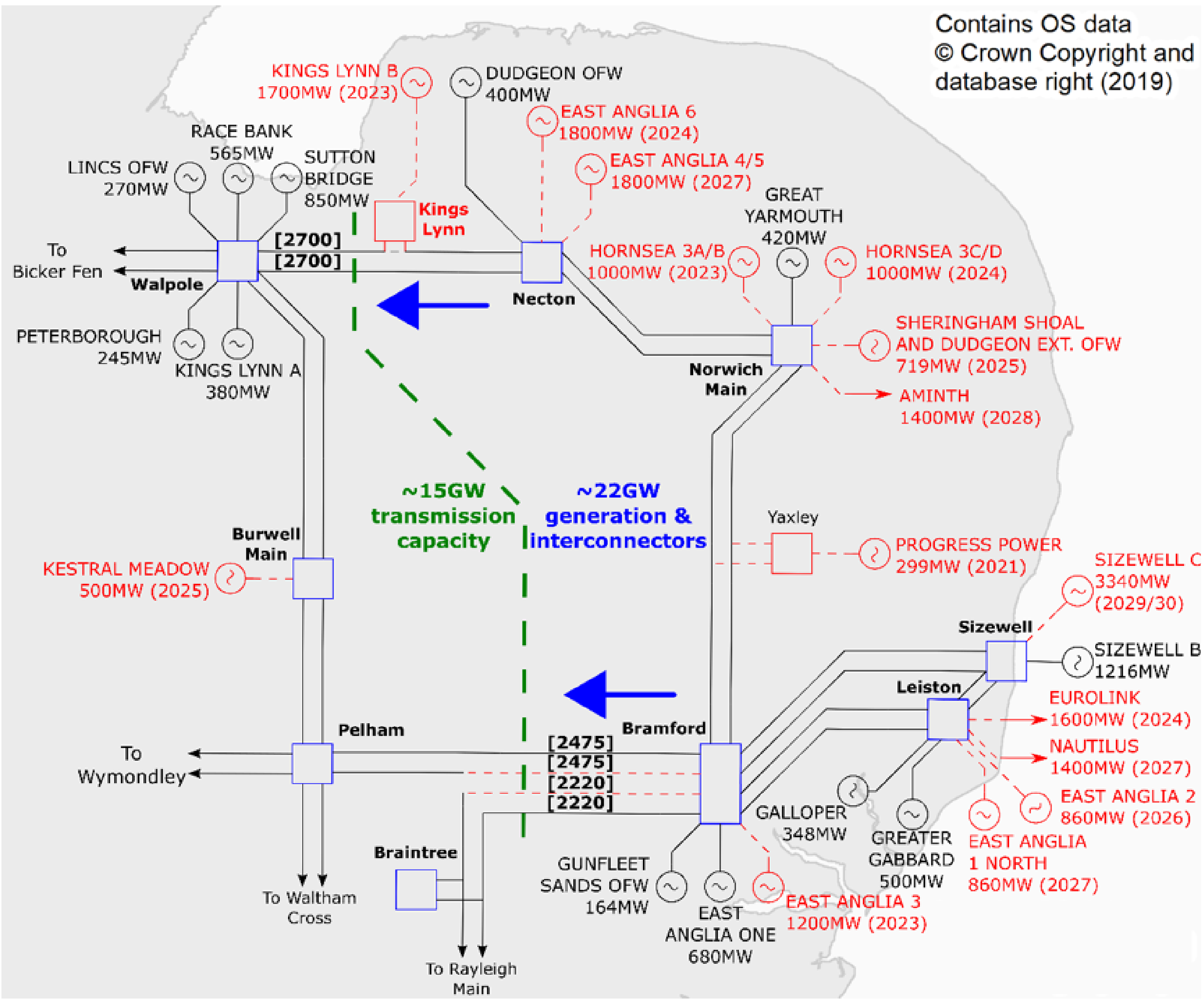
"I have two wind farms connecting through my constituency and there are 10 more coming... Each wind farm applies for its own cabling and its own substation, with the result that we waste energy, we waste huge amounts of land and we massively increase the environmental impact.

2.3 Onshore grid

The onshore transmission grid has hardly changed in terms of geographical layout since the 1970s and was largely developed to connect large thermal plant in the north to demand centres in the South and Midlands. Despite thermal power station closures, it still runs with large north to south power flows, these now being driven by increasing deployment of renewable energy, particularly onshore and offshore wind in the north of England and Scotland. In addition to this, the increasing deployment of offshore wind is now requiring a grid which can transmit large amounts of power inland from coastal regions. Unfortunately, the planning and development of the transmission system has not kept pace with the changing generation background away from fossil fuels and this is evidenced by the definition of transmission (constraint) boundaries by NGESO.[8]

EXAMPLE – East Anglia has around 22GW of connected and planned generation (mainly offshore wind) and interconnectors but only around 10GW of transmission capacity, west and out of the region at present with plans to upgrade this to around 15GW of transmission capacity by 2030 (lines in red from Bramford in Figure 2.3). Similar issues are apparent in the Humber area and far North East of England meaning the east coast transmission system of England will become heavily constrained unless a solution is proactively found and implemented.

Figure 2.3: East Anglia out of region transmission capacity current and future



NGESO recently examined the prospective constraint levels for the addition of a new offshore wind project in the various regions[9] which highlighted the above but to date few solutions have been proposed under the existing processes.. Given the currently visible issues and that NGESO's study concerned a single Round 4 project only, it is difficult to understand how the current onshore grid can accommodate the high volumes of offshore wind that are expected over coming decades or how combined on and offshore solutions can be identified, developed and evaluated.

Recommendation

NGESO to urgently review the barriers to future offshore wind deployment up to 2050 and the capability of the onshore transmission system to accommodate it. There is a need to establish what solutions could be considered and where and when they might be required. It is not clear that NGESO are able to do this within the current framework. Work of this kind should not delay projects already in development.

2.4 Longer offshore transmission lifetimes

Even after a decade of the offshore transmission regime, there is still no clear framework for lifetime extension of offshore transmission assets. Clarity and progress on this issue is an essential short-term goal to squeeze more value from offshore wind assets and offshore transmission. As discussed in the short-term paper,[7] every offshore wind project in operation to date will reach end of lifetime before 2050, so this is an essential consideration in delivering ambitions.

However, most transmission assets have nominal lifetimes around 40 years and, with appropriate replacements and maintenance, could be used for successive offshore wind farms and future offshore transmission developments. This would be more reflective of the way the onshore transmission system is operated and will need to consider design practices also, see Section 2.5.

Recommendation

Work is already in hand with The Crown Estate to examine the physical practicalities of extending offshore transmission asset lifetimes to 60 years. Additional work will be needed to clarify how the offshore regime will treat this lifetime extension, including network charging.

2.5 Transmission system planning and design

To date the offshore regime has only incentivised the development of radial offshore transmission system connections tailored in capacity and utility to the individual project(s) using them for minimum cost purposes. This means that offshore transmission has been designed in an uncoordinated way with low levels of extendibility, i.e. further offshore wind projects or offshore transmission cannot be readily accommodated via existing offshore transmission. Although radial designs are optimal for individual projects, they are not optimal overall for areas where there are numerous projects. Whilst NGESO has a role as the offshore and onshore National Electricity Transmission System Operator (NETSO), the current connection processes hamper it in providing a more economic and efficient overall design in these areas. This is unlike onshore transmission where circuit capacities are normally well above individual project capacities, there is redundancy, interconnection and substations are readily extendable to connect new projects. The framework within the Network Options Assessment (NOA) undertaken by National Grid ESO therefore exists; but may need clarifying or expanding to include offshore generation.

A key system design standard is the National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS)[10] and although this contains chapters for offshore transmission (in particular Chapter 7), these were developed with the earliest of projects in mind and without consideration of the current high volumes that now need to be delivered offshore.

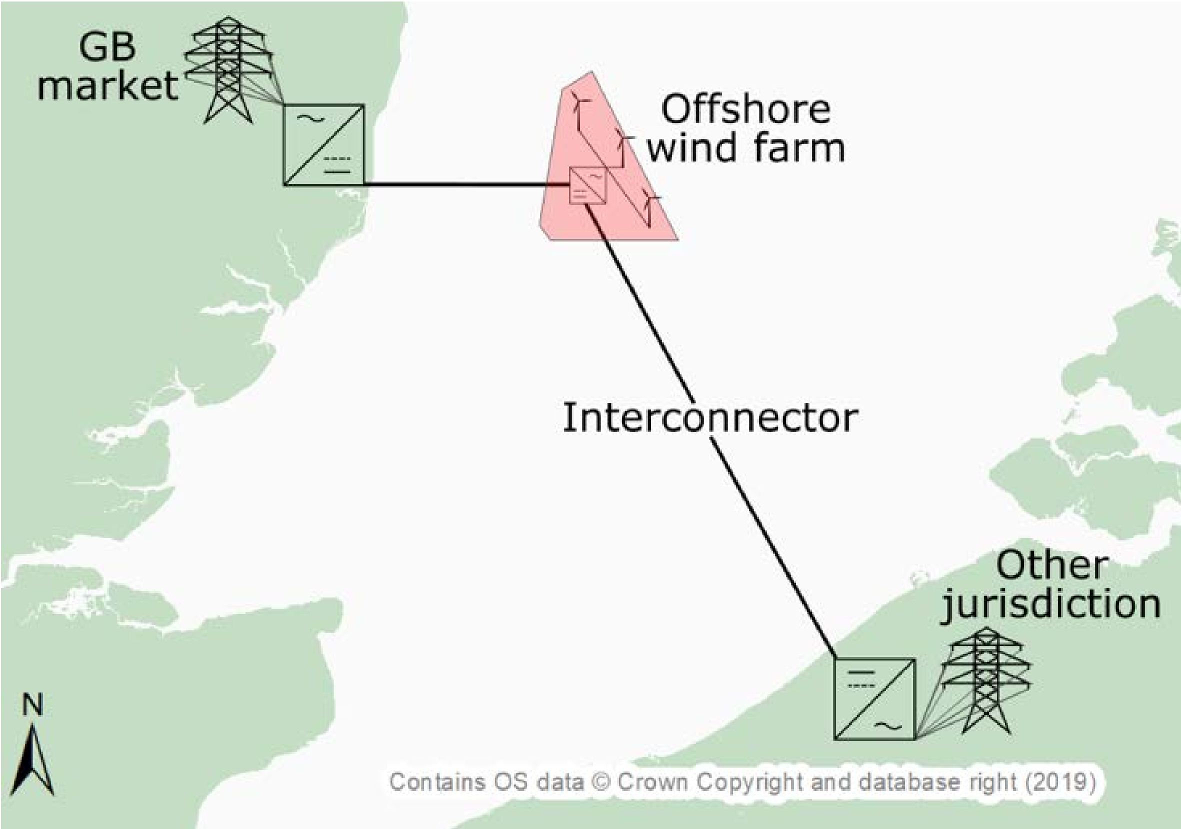
Recommendation

The Electricity Engineering Standards Review, being led by NGESO should be used to understand how offshore transmission could be made extendable and more widely used, similar to onshore transmission. This should include how best to plan the overall offshore grid, and its supporting infrastructure onshore. Any such work would need to include work on underwriting, TNUoS charging and anticipatory investment.

2.6 Interconnectors, hybridisation and jurisdictional issues

Currently there are six interconnectors to Great Britain (GB) in operation (5.3GW). There are, however, twenty under development with a total capacity of just over 26GW.[11] They are subsea point to point links across different jurisdictions (markets) and usually terminate at coastal locations. At present these are entirely separate to offshore wind farms and offshore transmission systems but synergies between the two are technically possible, and, could save the build out of unnecessary infrastructure and allow easy transport of offshore wind power between jurisdictions. Offshore wind connection to an interconnector is shown below.

Figure 2.4: Example of offshore wind farm connected to an interconnector



Recommendation
Assess how a more coordinated approach to development of offshore wind paired with interconnectors could bring value to consumers. To date exploration of the potential of interconnectors paired with offshore wind farms has been ongoing via several different forums (see examples below). As this work has largely been conducted in silos there is merit in bringing together the various strands and stakeholders to ensure a coherent solution can be developed with broad support.

Some of the legal and regulatory barriers to integration that can be foreseen are set out below:

- **Legal challenges:** How will legal frameworks interact across jurisdictions; which licensing regime applies (e.g. OFTO, interconnector, other?); what provisions will apply regarding unbundling and Transmission System Operator (TSO) certification; will any assets be considered to constitute critical national infrastructure and therefore have foreign direct ownership constraints applied to them; how will market support mechanisms be treated; and what decommissioning obligations will apply.
- **Regulatory challenges:** How will regulatory regimes interact; what incentives and development funding support may be available in regard the additional cost and risk; how will anticipatory investment and development approval be handled; what penalty and compensation mechanisms will apply to owners/ operators and users.

EXAMPLES

- **North Seas Energy Cooperation** - An international government forum with 10 European governments bordering the Northern Seas, which includes a specific working group led by BEIS on exploring offshore grids.
- **PROMOTION** - An EU-funded program looking at HVDC meshed grids.
- **North Seas Wind Power Hub** - A Transmission System Operator (TSO)-led forum for exploring a spoke and hub concept for interconnectors and offshore wind.
- **European Commission Hybrid projects study** (Roland Berger) - A study for the European Commission exploring a North Seas offshore energy cluster.

2.7 Co-location of technologies

As the proportion of renewable energy entering the power system increases, it will become increasingly important to consider the role that renewable energy can contribute towards system flexibility and resilience, as well as decarbonising heat and transport. With this in mind, there is considerable merit in co-locating renewable generation with another technology. Combining a dispatchable technology with variable renewable generation enhances the ability for zero-carbon power to be responsive and participate in providing system services.

Whilst guidelines and current codes are compatible with onshore co-location that have seen projects developed onshore, work can be done to deliver the same kind of framework for co-location involving the offshore transmission network.

There are distinct opportunities to deliver offshore wind with co-location with other technologies onshore and potentially offshore. Additionally, collaboration with maritime and industrial sectors may increase the uptake of clean energy in those sectors. These opportunities are present today but are being missed through incomplete and isolated frameworks which do not support these innovative initiatives.

Recommendations

- Tabled work (e.g. NGESO's RIIO-2 business plan) to review grid code standards for offshore transmission could be expanded to consider this opportunity and create a level playing field with other, onshore based co-located projects.
- Other considerations such as licence condition clarifications and reviews of planning frameworks to ensure co-location has been considered. For example, code and licence work on clarifying the role of storage technologies could be complimented with co-location clarifications.

2.8 Costs and value for money

As noted in Section 2.5, the current offshore regulatory regime has driven the development of radial offshore transmission system connections which. Although these are optimal for individual offshore wind projects they are probably not optimal overall for collections of projects or in developing an integrated offshore and onshore transmission system. Whilst future projects already in development will likely connect under the current rules, there is potential to deliver a new regulatory framework for future projects not yet in development. This should enable a more coordinated approach creating the opportunity to deliver significant efficiencies, both economic and in terms of land management.

The challenges from the onshore transmission system have been discussed in Section 2.3. In addition, Ofgem/DECC have already undertaken some studies to evaluate the benefits of greater coordination. The below example is from previous work on this issue.[12]

Recommendation
There is a need to review and revalidate work previously undertaken on delivering a more optimal offshore transmission system and determine what needs to be done to take it forward.

EXAMPLE – In 2012 an Ofgem/DECC commissioned study[12] concluded that up to £3.5 billion could be saved from £24 billion by 2030 in offshore transmission costs by taking a more optimal and integrated approach that designed an offshore transmission grid based on collections of offshore projects and sharing.

2.9 Delivery

It currently takes around 10 years to deliver an offshore wind farm project, with the grid connection being one of the first things to be agreed as it determines the project timeline. The example below if the first (fastest) project to be delivered from Round 3. Figure 2.5 shows a typical offshore wind farm project timeline.

EXAMPLE – Rampion is the first Round 3 offshore wind farm to be delivered. It took 10 years to deliver from the initial site identification by The Crown Estate in 2008, through leasing, consenting and construction to commissioning in 2018. This is a typical timeline for an offshore wind project with many zones of projects taking longer due to project staging.

To meet the government's decarbonisation targets, the rate of offshore wind deployment needs to escalate compared with today's levels. For any new offshore transmission connection arrangements to be reflected in the design of new projects to be delivered around 2030, the technical solutions and regulatory environment of the new regime will be required in the early 2020s. The optimum solution may mean a move away from the point to point connection types we have seen to date to a more coordinated - or even shared approach. This transition will require: new legislative frameworks; bodies to oversee the strategic planning (both spatial and technical); and importantly, the ability to facilitate anticipatory investment.

The timeline for delivery in 2030 and 2050 is shown in Figure 2.6.

Recommendations

- Work to develop more coordinated connection arrangements for offshore wind must be started urgently to be in place by 2030. The transition is likely to require new legislative frameworks, strategic oversight, innovation and anticipatory investment to deliver best value to future consumers. This will need to be delivered in the early 2020s.
- In order to meet the government's decarbonisation targets, it is also important that existing projects in development are not slowed down or delayed by taking a more coordinated approach (a risk presented by the 2019 notification regarding the Connection and Infrastructure Options Note (CION) process on the East Coast of England).

Figure 2.5: Typical offshore wind farm and transmission timeline

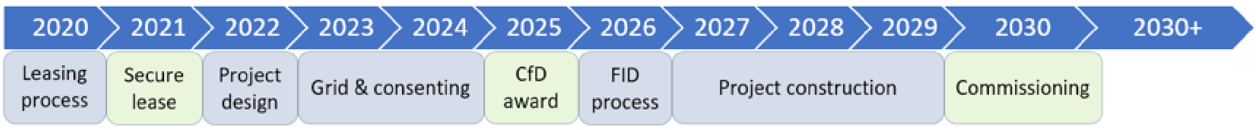
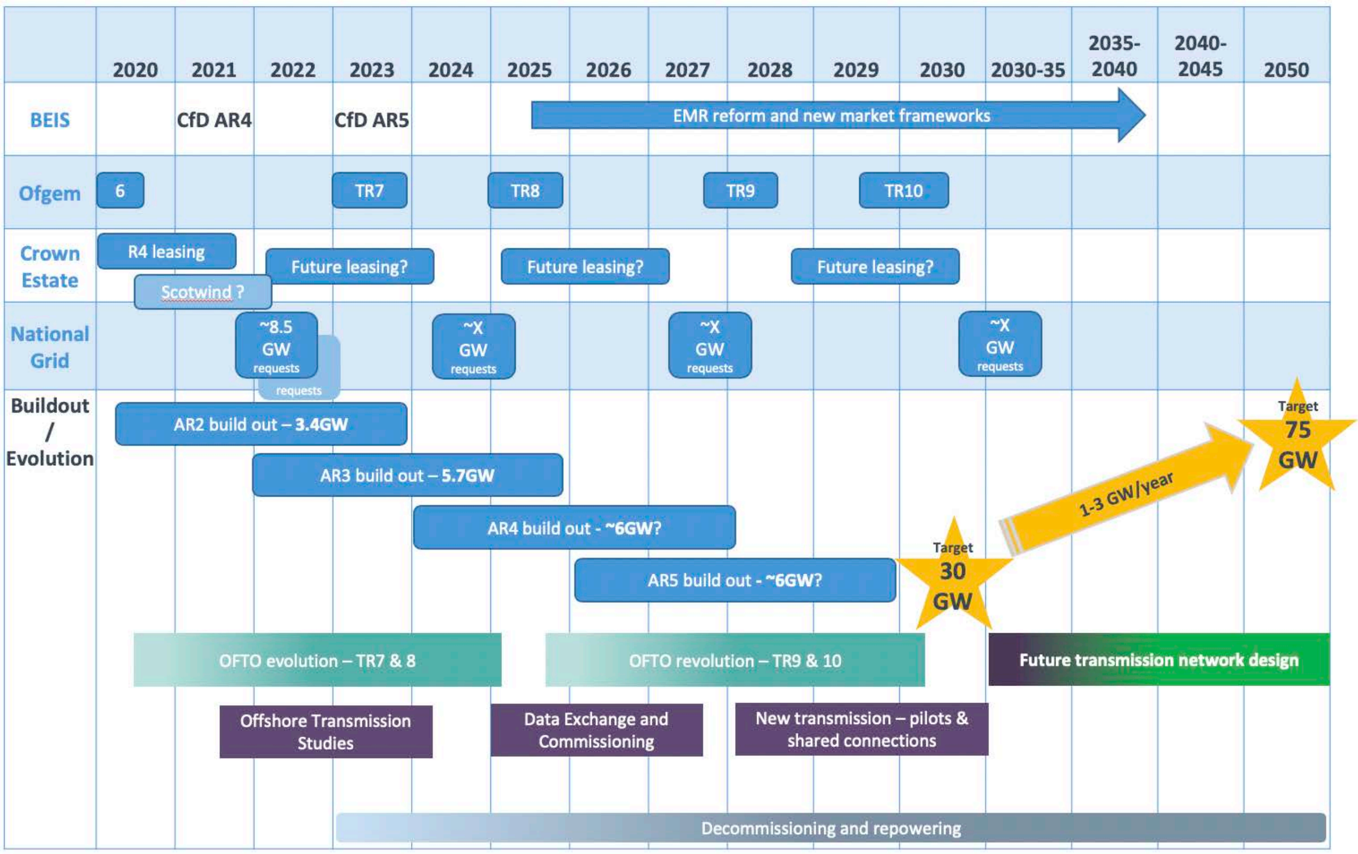


Figure 2.6: Offshore wind 2030 and 2050 timeline



3. Process

The below flow chart sets out a high level process. Along the top are the parties leading or undertaking work at each stage. Through the middle are the process steps with some explanation of what work will be necessary. The bottom row sets out suggested involvement of stakeholders at a very high level. The work has reached the end of the green stage – identifying the issues.

OWIC (industry)	**OWIC** (industry)	**Various** (e.g. NGESO, Ofgem, TCE)	**Various**	**Various**	**ALL**
Identify the aims and ambitions of the Sector Deal and beyond -> 30GW by 2030 -> 75GW by 2050	Identify the present and forseeable future key issues in delivering the aims and ambitions	Review historic work, update and identify historic and new workstreams to take forward	Optioneer potential solutions across a wide range of disciplines from previous and new work	Work to filter solutions then develop the best solutions to implement	Relevant parties implement solutions through legal, regulatory and codes
Aims & Ambitions →	**Identify Issues** →	**Review and agree way forward** →	**Identify Solutions** →	**Assess Solutions** →	**Implement early 2020s**
Consultation with BEIS	Discuss with BEIS the need to progress at pace	BEIS and OWIC to agree process and undertake work	This may pass from BEIS to the relevant stakeholders to take forward, e.g. Ofgem, NGESO		

4. References

1. Committee on Climate Change, “Net Zero - The UK’s contribution to stopping global warming”, May 2019.
2. Department for Business, Energy and Industrial Strategy, “Renewable Energy Planning Database”, 05 November 2019. [Online]. Available: **www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract**.
3. The Crown Estate, “Offshore wind leasing round 4”, 05 November 2019. [Online]. Available: **www.thecrownestate.co.uk/en-gb/what-we-do/on-the-seabed/offshore-wind-leasing-round-4/**.
4. Crown Estate Scotland, “Scottish offshore wind leasing”, 05 November 2019. [Online]. Available: **www.crownestatescotland.com/media-and-notices/news-media-releases-opinion/next-steps-for-new-scottish-offshore-wind-leasing**.
5. Department for Business, Energy and Industrial Strategy, “CfD Round 3 results”, 05 November 2019. [Online]. Available: **www.gov.uk/government/publications/contracts-for-difference-cfd-allocation-round-3-results**.
6. National Grid Electricity System Operator, “Future Energy Scenarios”, July 2019.
7. OWIC working group on offshore transmission, “Offshore wind sector deal - Transmission review - short term solutions paper”, October 2019.
8. National Grid Electricity System Operator, “Electricity Ten Year Statement - Figure A3”, 2018.
9. National Grid Electricity System Operator, “Offshore Wind Constraints Study”, February 2018.
10. National Grid Electricity System Operator, “National Electricity Transmission System Security and Quality of Supply Standard”, 01 April 2019.
11. National Grid Electricity System Operator, “Interconnector register”, 03 October 2019.
12. Ofgem and Department of Energy and Climate Change, “Offshore Transmission Coordination Project Conclusions Report”, 01 March 2012.

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