THE CROWN ESTATE

Offshore wind operational report 2020

thecrownestate.co.uk

The Crown Estate
The Crown Estate manages a unique portfolio, which includes the seabed, natural marine resources and much of the foreshore around England, Wales and Northern Ireland. In this capacity, we are responsible for awarding seabed rights for offshore renewable energy projects as well as marine minerals, gas storage and carbon capture, utilisation and storage, cables and pipelines. We play a unique role in developing and helping sustain UK energy supply and infrastructure, working in collaboration with a wide range of organisations to ensure that this is achieved in a sustainable way, balancing the broad range of interests in the marine environment. Established by an Act of Parliament, as an independent commercial business, we are tasked with generating profit for the Treasury for the benefit of the nation's finances. This has totalled £2.9bn over the last ten years.

Scotland
The seabed around Scotland is managed by a separate organisation, Crown Estate Scotland. This report has been produced by The Crown Estate but, for completeness, publicly available data on offshore wind in Scotland has been included in key sections, such as offshore wind farm status and national metrics. We have also included information on offshore wind operation and development in Scotland pages 17 and 35.

40.7TWh
2020 UK offshore wind electricity production

39%
UK offshore wind generated enough electricity in 2020 to supply the needs of 39% (10.8m) of UK homes

13%
Proportion of total UK electricity generated by offshore wind 2020

16m tonnes
Avoided CO_2


London Array offshore wind farm

Introduction

What will we remember when we look back to the year 2020 in ten years' time? Will it be the pandemic or the economic shocks it caused? Will it be the increasingly alarming reports on climate change and biodiversity loss, or the rise of machine learning and artificial intelligence? With so many big themes competing for headline space, I'm confident that one theme that will shine through is how people came together – in a wide range of ways – to overcome difficult times.

The offshore wind industry has provided a shining example of this; with colleagues working together in new ways to literally keep the lights on and kettles boiling in homes across the country. Operation and construction procedures adapted to social distancing requirements and management meetings moved from office desks to kitchen tables. Displaying an amazing adaptability, people moved their work patterns, created work support bubbles ('bubble' surely one of those words we will remember) so that this vital national infrastructure continued to deliver for the nation. Indeed, on average, offshore wind supplied the electricity needs of 39% of homes across the country.

With a strong project pipeline, the sector is a key enabler for the UK economy to achieve net zero by 2050. Alongside contributions from other technologies, meeting this target will require a tenfold increase in offshore wind generating capacity to about 100GW, one of the biggest infrastructure projects the country has ever undertaken. As we drive this growth, ensuring beneficial impact on communities, jobs and the natural environment must be a critical design consideration, helped by systems planning, by transparency, and by investing in people at an early stage, and there are great examples of each of these in this report.

Our own Offshore Wind Evidence and Change Programme is a collaboration with over 20 organisations, working in partnership with government, to address the need for clear evidence and solution pathways enabling the responsible growth of the sector in an ever-more crowded marine environment.

The sector is in rude health, with 20GW operating or having secured a CfD agreement, and a clear pipeline to the government's target of 40GW by 2030. It is still the world's largest offshore wind market, although countries like China are accelerating their growth, and the market in the US has taken off. There is so much to look forward to in the years ahead, but when we take time to look back at 2020 everyone involved in this sector will be able to share the pride of having kept the lights on through turbulent times.

This report intends to share some insights from a year we will all remember, alongside an overview of the performance and progress of the sector. As ever, we value your feedback.

Huub den Rooijen
Director of Energy, Minerals and Infrastructure
The Crown Estate

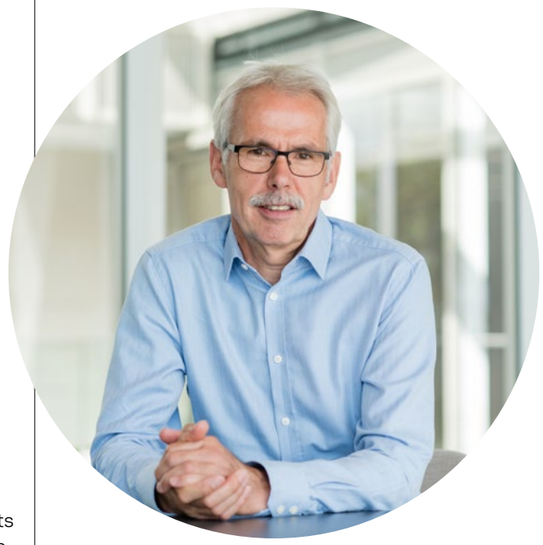


Figure 1: UK electricity generation mix 2020* (2019)

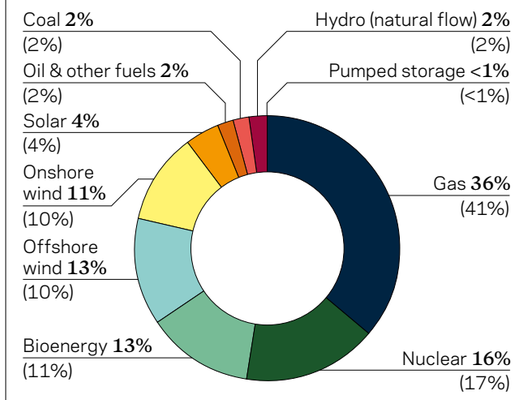
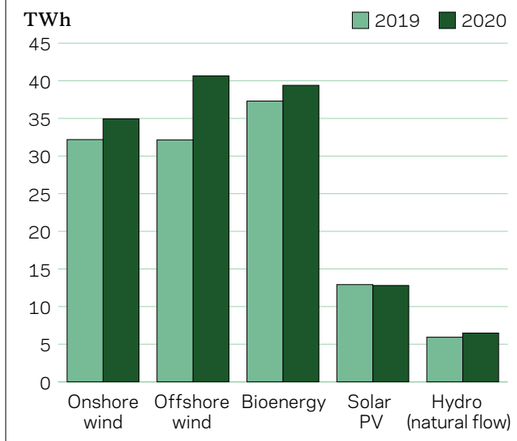


Figure 2: Renewable energy generation by fuel type*



*Source: BEIS energy statistics (provisional)

Offshore wind farm status

The UK is the largest offshore wind market in Europe with 42% of Europe's operating fleet and a growing development pipeline. During 2020, an additional 0.7GW of generating capacity became available, with the addition of East Anglia ONE bringing the UK operational fleet to 10.4GW.

It was a challenging year for construction with additional costs and delays caused by the Covid-19 pandemic. Quarantine and isolation measures have had an impact on international transfer of industry specialists from continental Europe to the UK, although contingencies built into the plans of large near-term projects have mitigated these circumstances and enabled delivery within expected timelines.

The most significant change in 2020 was the shift in project status, with three large projects moving into the under construction phase. Project capacity under construction increased by over 60% from 4.4GW to 7.2GW due to a final investment decision (FID) being reached on Dogger Bank A and B projects. This marked the start of construction on what will be the world's largest offshore wind farm, a title currently held by Hornsea 1. Dogger Bank is also furthest from shore at 130km off the North East English coast. The 1,050MW Seagreen project also achieved FID in June and construction has started onshore for what is expected to be Scotland's largest offshore wind farm.

A culture of innovation and stable regulation, as well as legislative climate commitments, has seen the UK climb EY's Renewable Energy Country Attractiveness Index twice during the year, climbing to 5th place, its highest position in two years.

The Government's 2050 net zero ambitions, combined with its Ten Point Plan and Energy White Paper which set out an aspiration for the UK to achieve 40GW of offshore wind by 2030, have helped fuel momentum in the sector. With 20GW of capacity currently operational, under construction and supported, the UK is now focused on delivering double that over the next 10 years to support these targets and generate enough clean energy to power all UK homes.

For more detail on the UK offshore wind development pipeline, see pages 32-33.

Figure 4: Current European offshore wind generating capacity based on grid-connected turbines, including sites under construction

	GW	Turbines	%
UK	10.4	2,292	42%
Germany	7.7	1,501	31%
Netherlands	2.6	537	10%
Belgium	2.3	399	9%
Denmark	1.7	559	7%
Rest of Europe	0.3	112	1%
Total	25.0	5,400	100%

Figure 3: New European capacity installed in 2020

Netherlands
1.49 GW
172 turbines
52.04%

Belgium
0.71 GW
81 turbines
24.61%

UK
0.43 GW
62 turbines
15.13%

Germany
0.22 GW
32 turbines
7.63%

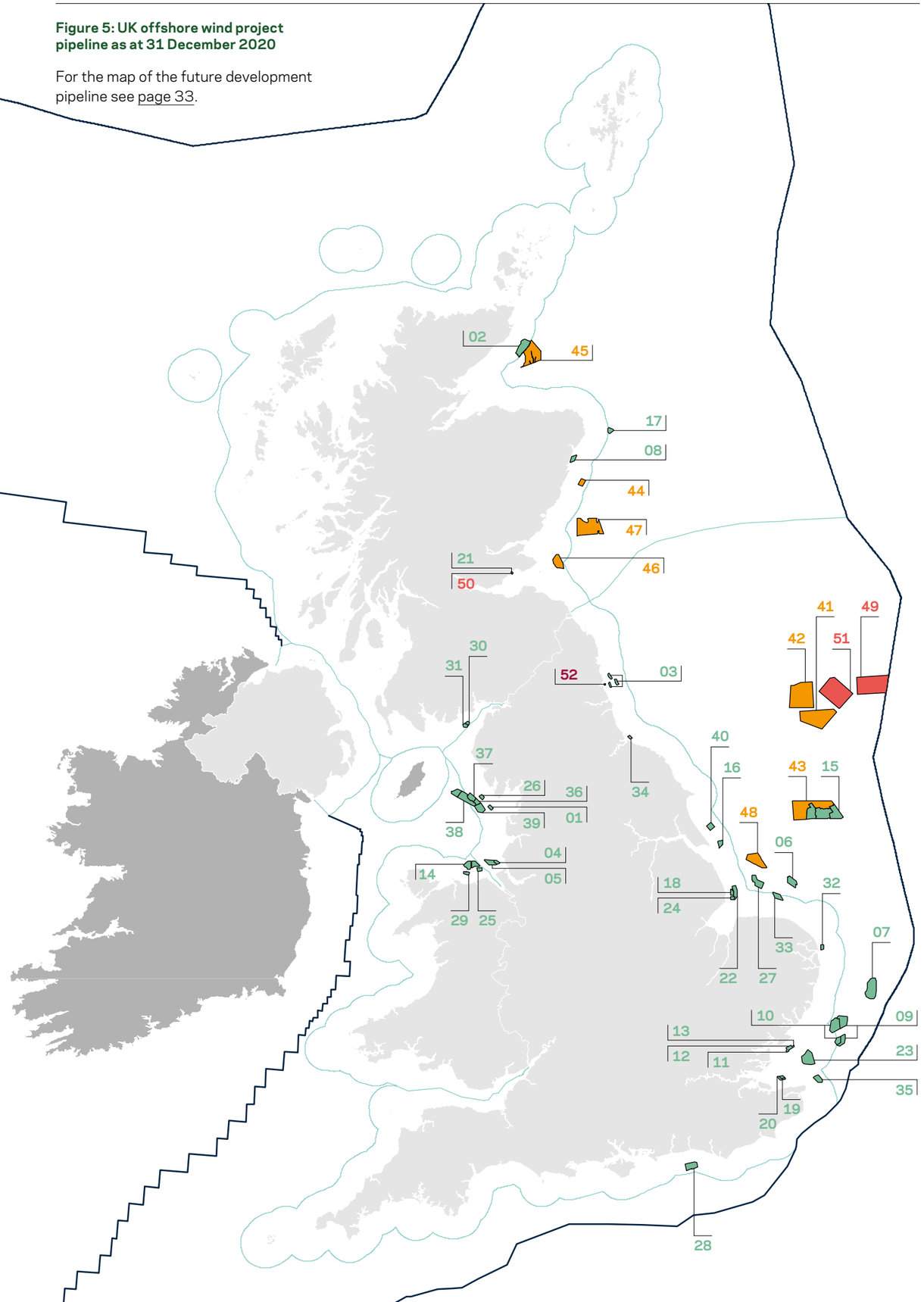
Portugal
0.02 GW
2 turbines
0.59%

TOTAL
2.87 GW
349 turbines

Triton Knoll west offshore substation and jackup vessel Neptune

Figure 5: UK offshore wind project pipeline as at 31 December 2020

For the map of the future development pipeline see page 33.



Operational

Total capacity of wind farms that have been fully commissioned

Capacity MW		
01	Barrow	90
02	Beatrice*	588
03	Blyth Demonstration (Phase 1)	42
04	Burbo Bank	90
05	Burbo Bank Extension	259
06	Dudgeon	402
07	East Anglia ONE**	714
08	European Offshore Wind Deployment Centre*	93
09	Galloper	353
10	Greater Gabbard	504
11	Gunfleet Sands Demonstration	12
12	Gunfleet Sands I	108
13	Gunfleet Sands II	65
14	Gwynt y Môr	576
15	Hornsea 1	1,218
16	Humber Gateway	219
17	Hywind Scotland*	30
18	Inner Dowsing	97
19	Kentish Flats	90
20	Kentish Flats Extension	50
21	Levenmouth Demonstration*	7
22	Lincs	270
23	London Array	630
24	Lynn	97
25	North Hoyle	60
26	Ormonde	150
27	Race Bank	573
28	Rampion	400
29	Rhyl Flats	90
30	Robin Rigg East*	84
31	Robin Rigg West*	90
32	Scroby Sands	60
33	Sheringham Shoal	317
34	Teesside	62
35	Thanet	300
36	Walney 1	184
37	Walney 2	184
38	Walney Extension	659
39	West of Duddon Sands	389
40	Westermost Rough	210
TOTAL		10,415

Under construction

Total capacity of wind farms that are under construction or where the developer has confirmed a final investment decision, but are not yet fully operational

Up to capacity MW		
41	Dogger Bank A	1,235
42	Dogger Bank B	1,235
43	Hornsea 2	1,386
44	Kincardine*	50
45	Moray East*	950
46	Neart na Gaoithe*	448
47	Seagreen*	1050
48	Triton Knoll	857
TOTAL		7,211

Government support on offer

Total capacity of wind farms that have secured a Contract for Difference

Up to capacity MW		
49	Dogger Bank C	1,200
50	Forthwind*	12
51	Sofia Offshore Wind Farm Phase 1	1,400
TOTAL		2,612

Total capacity of wind farms that have been decommissioned

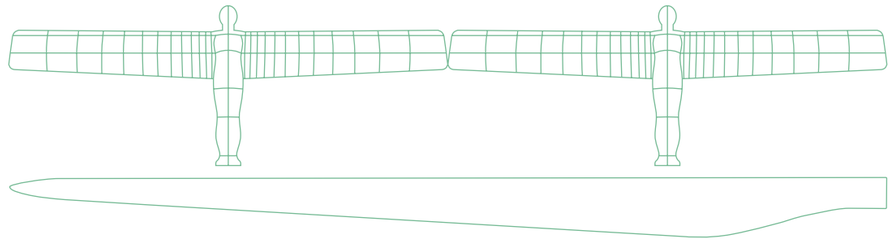
Up to capacity MW		
52	Blyth	4
TOTAL		4

— Territorial Waters Limit
— UK Continental Shelf

* Asset managed by Crown Estate Scotland
** Confirmed Works Completion Date January 2021

107m

Each blade of the wind turbines to be used at Dogger Bank wind farm is 107m long, which is twice the wingspan of the Angel of the North



Offshore wind assets

The UK offshore wind industry continues to grow and in 2020 a new milestone was reached with over 3,000 turbines in operation or under construction (76% and 24% respectively), across 48 offshore wind farms.

The annual capacity of grid connected wind turbines in the UK is illustrated in figure 7 which highlights that the industry has, on average, added around 1GW of capacity per year over the last five years. During 2020, East Anglia ONE became fully operational and contributed an increase of 0.7GW in generating capacity, 0.3GW of which was grid connected at the end of 2019. This additional 0.4GW was 15% of the new capacity added across Europe, as seen on figure 3 on page 4. While the construction rate during 2020 fell in comparison to previous years, it was a significant year of preparation and planning, with seabed and onshore civil works commencing at a number of sites (as shown in figure 6). This is in preparation for what will be an extremely busy and significant period of construction over the next few years. The pipeline of capacity currently under construction amounts to almost 70% of the existing operational fleet.

In recent years wind turbine capacity has increased significantly, and during 2020, Dogger Bank wind farm confirmed that GE would be supplying their 13MW Haliade-X turbine models for deployment at phases A and B of Dogger Bank Wind Farm. There is a possibility that a 14MW version will be used on Phase C which would be double the 7MW turbine capacity recently installed at East Anglia ONE.

Figure 6: Asset activity in 2020

Wind farms which have achieved Final Investment Decision

- Dogger Bank A
- Dogger Bank B
- Seagreen

Wind farms starting onshore construction

- Dogger Bank A
- Dogger Bank B
- Seagreen

Wind farms starting offshore construction

- Hornsea 2
- Neart na Gaoithe
- Triton Knoll

Wind farms under construction

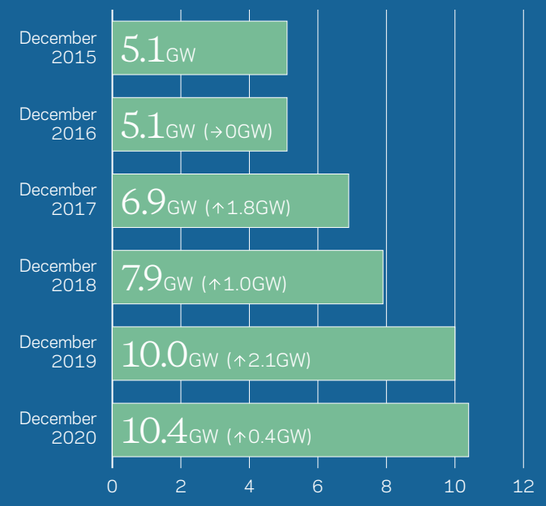
- Dogger Bank A
- Dogger Bank B
- East Anglia ONE
- Hornsea 2
- Kincardine
- Moray East
- Neart na Gaoithe
- Triton Knoll

Wind farms which became fully operational

- East Anglia ONE

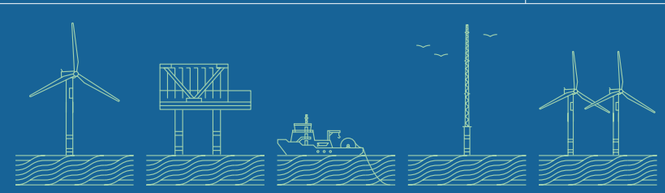
Turbines at sea

Figure 7: GW UK offshore wind grid connected (change from previous year)



Pacific Orca wind farm installation and repair vessel

Figure 8: UK offshore wind assets as at 31 December 2020



	GW	Offshore turbines	Offshore substations	Export cables	Met masts	Wind farms
Operational:	10.4	2,291	33	76	11	40
Under construction:*	7.2	719	11	18	0	8
Total:	**17.6**	**3,010**	**44**	**94**	**11**	**48**

* sites having reached Final Investment Decision and those under construction including partially operating sites.

Health and safety

Here we report on the latest health and safety data from G+ the global health and safety organisation for the offshore industry. Our aim is to provide the best support we can to improve performance of offshore wind health and safety through active engagement with our stakeholders and encouraging active liaison with G+. G+ reports 123 injuries in 2019* compared to 2018 which is an increase of 1.29%. Overall, there has been a decline in number of injuries over the last 6 years. 2019 also saw a 4.24% increase in the total number of injuries, which led to an increase in the global Lost Time Injury Frequency (LTIF**) and Total Recordable Injury Rate (TRIR***). This was largely due to an increase in the number of 'lost workday' injuries. In contrast, the number of 'restricted work day' and 'medical treatment' injuries reduced by 32% and 15% respectively, and there were no fatalities across both periods, as shown in figure 9.

Despite an increase in the total number of incidents from 588 to 633, the UK's LTIF and TRIR of 2.3 and 5.0, outperformed global industry's LTIF and TRIR, which were 2.77 and 5.5.

Comparing the three countries with the most offshore wind sites shows the UK continues to have the best health and safety performance based on LTIF and TRIR, shown in figure 10. However, the UK's outperformance of the global statistics leaves no room for complacency given the increase in number of incidents from the previous year.

Of the 633 incidents that occurred in the UK, 27% were categorised as high potential incidents compared to 29% globally. Incidents relating to 'lifting operations' (47), 'working at height' (31) and 'transit by vessel' (24) ranked first, second and third globally. This is not the case when looking at UK high potential incidents only. Although 'lifting operations' (31) and 'working at height' (20) were ranked first and second, 'routine maintenance' (16) ranked third.

There is scope for the UK to improve, 67% of the high potential incidents that occurred in the global offshore industry in 2019 were in the UK and 78% of those were either a hazard or near hit/miss.

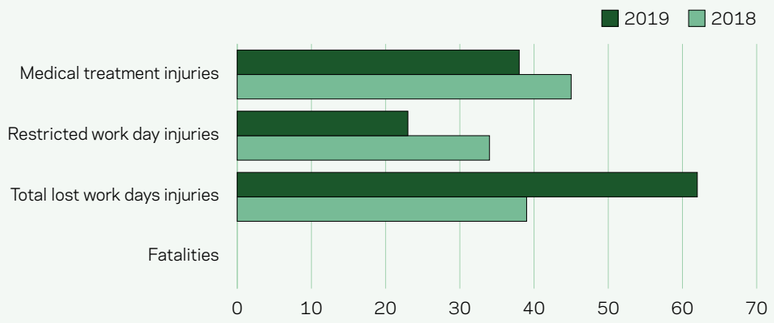
Figure 11 shows the incident categories for the UK, further highlighting the need to continually to improve health and safety performance.

Garrod Evans, Dogger Bank onshore cable works

* *The definitions of these incident categories can be found in the G+ Global Offshore Wind Health and Safety Organisation's 2019 incident data report.*

A time lag in the data means the 2020 global health and safety statistics are not yet available. We have reported the recently published G+ 2019 incident data.

Figure 9: Global offshore wind industry recordable injuries (2018 vs 2019)



Source: G+ Global Offshore Wind Health and Safety Organisation 2018 incident data report

Figure 10: 2019 injury rates and frequency for countries with the largest number of sites

UK

41 sites

2.3 LTIF

5.0 TRIR

Germany

11 sites

9.2 LTIF

13.4 TRIR

Denmark

10 sites

5.8 LTIF

11.0 TRIR

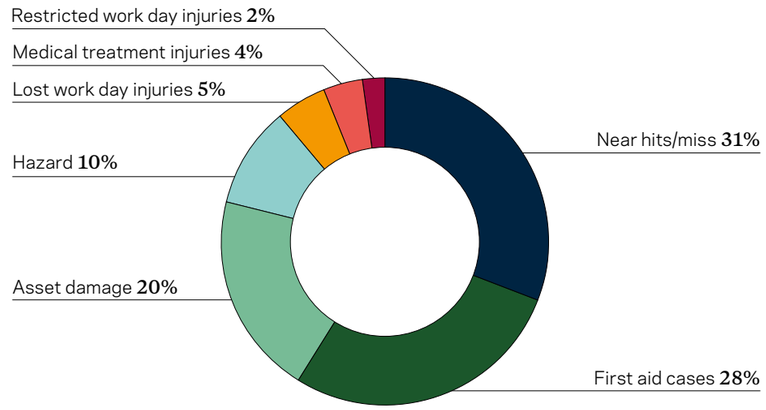
Burbo Bank offshore wind farm

Much of the UK's progress in offshore wind health and safety can be attributed to the power of collaboration between operators and developers through industry groups. There is an appetite to use research and technology to reduce risk. One such example is the Thrive purpose-built safety training hub developed by Ørsted which is "designed to transform behaviours and attitudes to safety" via a "powerful, immersive experience". Another example is the establishment in 2020 by G+ of a Covid-19 group where members and associates share information and good Covid-19 working practices. You can read more detail about Covid-19 measures on page 13.

** *LTIF = The number of recordable injuries (fatalities + lost work day incidents) per 1 000 000 hours worked.*

*** *TRIR = The number of recordable injuries (fatalities + lost work day incidents + restricted work day incidents + medical treatment injuries) per 1 000 000 hours worked.*

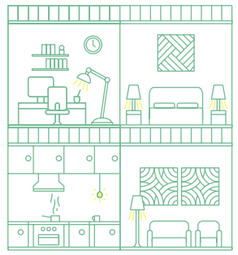
Figure 11: UK incident consequence profile and top three work processes in 2019*



In the UK, the work processes causing the most incidents in 2019 were:
1. Access/egress 12%
2. Lifting operations 11% and
3. Manual handling 9%

Greater Gabbard offshore wind farm blade repairs during the pandemic

Keeping the lights on during a pandemic



40.7TWh

UK offshore wind generated **40.7TWh** last year. That's enough to supply the electricity needs of **10.8m** homes, around **39%** of the UK total

No one could have predicted how our lives would change as the UK entered a national lockdown to help limit the spread of the Covid-19 virus in March 2020. The need to adapt to the pandemic was universal, and here we shine a spotlight on the extraordinary efforts of the sector to maintain offshore electricity generation throughout these difficult times.

With offshore wind supplying enough for 39% of UK domestic electricity needs, the industry is an essential part of the UK's infrastructure. When the UK entered national lockdown in March, teams involved in maintaining, repairing and operating wind farms and transmission assets adapted with speed and agility to quite literally keep the lights on in homes across the country.

As the pandemic evolved and guidelines changed, offshore wind operators and OFTOs risk assessed their operations, adapted plans and introduced mitigations to keep staff safe and to maintain electricity generation. Many also delivered value above and beyond by supporting local communities and donating personal protective equipment (PPE) to local hospitals.

The control measures implemented, as described in figure 12, proved successful and early fears around wind farm availability were set aside as the professionalism of the sector ensured the continuity of the UK's offshore wind fleet.

The challenging circumstances caused by the pandemic followed immediately after three storms and heavy rainfall in February 2020. Whilst this resulted in record wind generation, it also caused access and availability issues offshore. There was also a continuing need for upgrade works and major component exchanges, which were successfully completed despite the difficulties presented by the pandemic.

Together, these factors meant that 2020 was an extraordinarily difficult year for offshore wind teams, which is why it is encouraging to see that several operators are considering the wider implications and increasing their focus on wellbeing, particularly for remote and shift workers.

From a market perspective, the strong supply from renewables in 2020 and reduced demand caused by lockdowns also caused volatility around the wholesale electricity price. It also highlighted system balancing challenges for National Grid Energy Systems Operator which will need to be addressed through a combination of demand side response and frequency response services as renewable energy capacity increases.

Figure 12: Offshore wind pandemic control measures

Some of the control measures that have been implemented to 'Keep the lights on' include, but are not limited to:

- Reduced team sizes and shift pattern changes to limit physical contact where possible
- Introducing operations and maintenance teams work bubbles to ensure resilience and increase social distancing
- Office staff working remotely where possible
- Reduction of people, and installation of protective screens, on crew transfer vessels (CTVs)
- Measures on service operation vessels such as:
  - 50% capacity on board to allow for social distancing
  - Implementing shift times in dining/mess rooms
  - Dedicated cabins for self-isolating
  - On-board medics
  - Limiting access to the on-board gym with pre-booked sessions
  - Extra cleaning
- Introducing sanitising measures and procedures including provision of personal sanitising kits
- Introducing temperature checking and self-declaration/questionnaire at the start of shifts to ensure personnel are safe to go offshore
- Track and trace at work, and in some cases beyond
- Strict protocols and procedures for when cases or contact with Covid-19 were identified
- Flexibility for caring responsibilities, childcare and home-schooling
- Moving to tactical, risk-based and essential servicing where possible
- Introducing Covid-19 testing
- Deep cleaning and laundry of kits to reduce cross-contamination
- Increased PPE requirements such as face masks/shields
- Moving to digital toolbox talks/training
- Contingency and testing for control room staff

Wind farm performance

Fleet Performance Index

The Fleet Performance Index compares metered electricity output against the expected output adjusted for actual wind speed during that period. It gives a direct measure of the performance of the offshore wind farm fleet in England and Wales, without any adjustment for outages.

The analysis only includes fully operational wind farms and excludes the construction period. The analysis includes the whole system of the wind farm and its associated transmission and export of electricity to shore.

The expected power output is derived from satellite measurements of wind speed and theoretical power curves linking wind speed to the power output. This indirect calculation carries a notable uncertainty.

In 2020, the Fleet Performance Index was almost 97%; figure 13 shows the variation in fleet performance over the last ten years, which averages out at 98.1%. 2013 and 2015 were impacted by export cable failures. In 2019 and 2020, fleet performance was affected by cable repairs and grid maintenance.

London Array offshore wind farm

Number of homes that could be supplied by offshore wind farm electricity generation (% of total UK homes)

2014

12%
3.3m homes

2016

15%
4.1m homes

2018

26%
6.9m homes

2020

39%
10.8m homes

2021 *(estimated)*

40%
11m homes

Capacity factor

Figure 14 shows the evolution of the capacity factor and the power output of offshore wind farms in England and Wales, between 2005 and 2020.

The capacity factor is the average power generated over a period, divided by the rated peak power. It indicates how fully a plant's capacity is used.

The capacity factor of offshore wind farms is usually higher than onshore wind farms due to stronger, more stable wind conditions at sea. This is particularly noticeable for the newest wind farms, located far from the coast.

Since 2005, the fleet capacity factor has increased by 50% (30% in 2005 vs 45% in 2020). One reason for this is the development and use of taller turbines with longer blades. These can harness the stronger and less turbulent airflow at higher altitudes and generate more power per unit capacity. Newer wind turbines are capable of capacity factors of 50%. Future wind turbines such as the GE Haliade-X 13MW are expected to be higher at around 60%.

From 2019 to 2020, the power output increased by 29%, due to increased capacity and higher capacity factors of modern turbines as well as higher wind speeds.

Figure 13: Fleet Performance Index – England and Wales

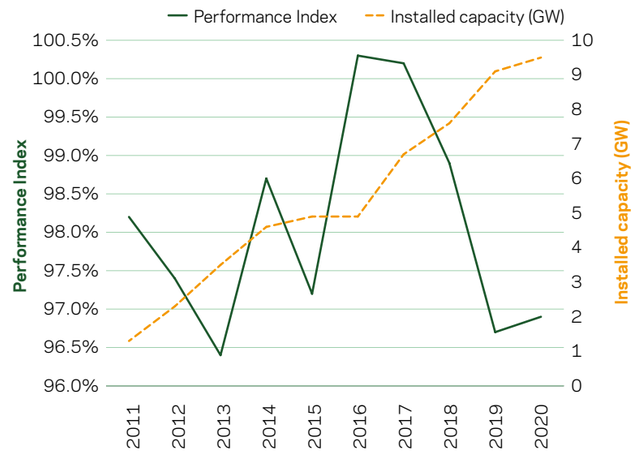


Figure 14: Capacity factor – England and Wales

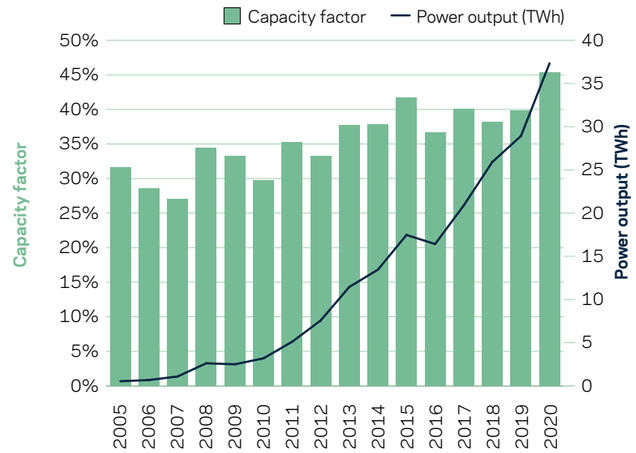
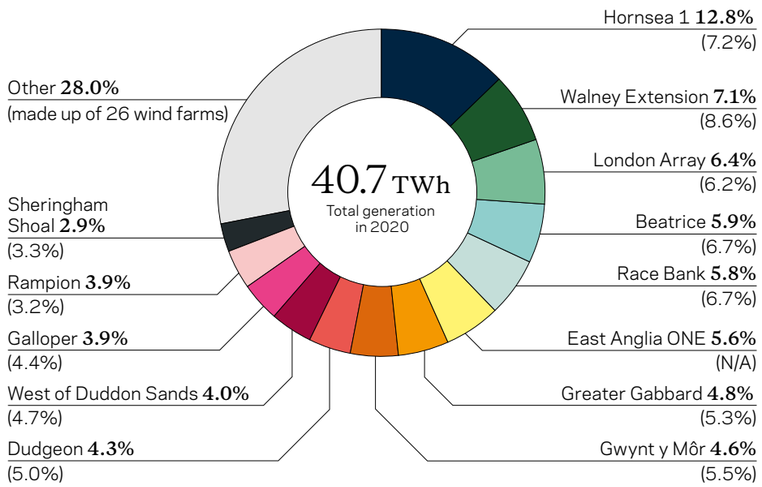


Figure 15: Percentage of electricity generated by UK asset 2020 (vs 2019)



Offshore generation

Figure 15 shows that Hornsea 1 and Walney Extension wind farms generated almost 20% of the UK's total offshore wind power in 2020.

Wind variability

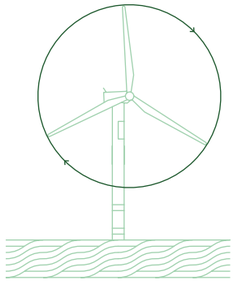
Figure 16 shows the impact on energy production due to monthly wind speed variation in England and Wales. Zero on the graph represents the long-term average.

Three storms in February 2020 – Ciara, Dennis and Jorge – resulted in one of the windiest months on record. This led to a record breaking year for the sector, which saw strong regional variations, particularly in the summer and early autumn. While the severe conditions at sea prevented crews from accessing wind turbines that required maintenance, the power output of the fleet was still an extraordinary 49% above the long-term average. March 2020 followed suit, with a 24% surge in performance.

This enabled renewable energy to provide almost 50% of the UK's electricity in the first calendar quarter, for the first time ever. While the storms certainly helped reach this milestone, it could not have happened without the huge increase in offshore wind capacity in UK waters in recent years.

In December 2020 it was storm Bella's turn to make headlines. With gusts reaching 100mph, the Boxing Day storm enabled wind power to generate 50.7% of the UK's electricity over a period of 24 hours.

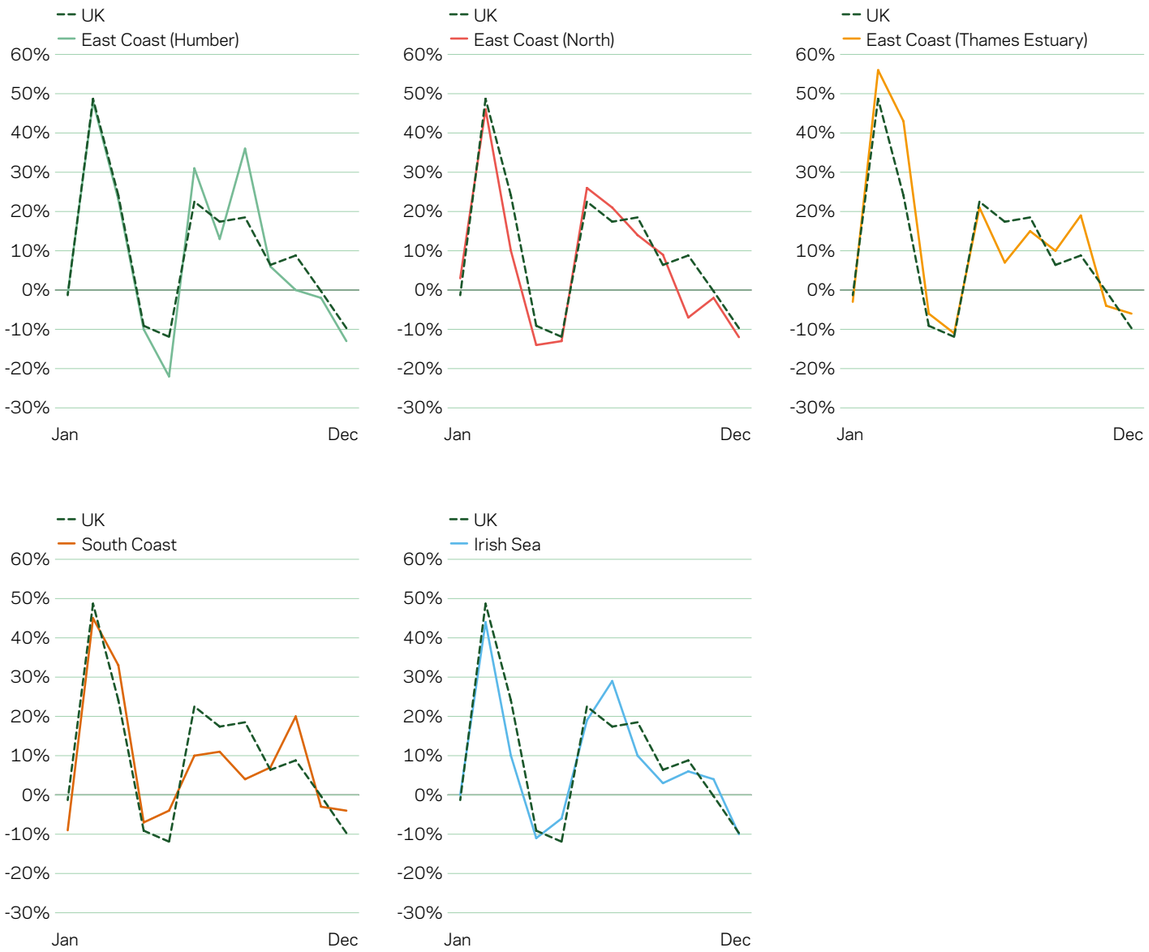
The overall energy deviation at the end of 2020 was 9% above the long-term average.



Next generation

1 rotation of the Haliade-X 13MW turbine will produce enough electricity to power a UK home for two days

Figure 16: Monthly energy deviation due to wind speed in 2020



Crown Estate Scotland operational fleet

Scotland already plays host to several major offshore wind farms such as Beatrice and Robin Rigg, with more currently in development such as Moray East and Neart Na Gaoithe which are currently under construction. This is in addition to also hosting the world's first floating wind farm, Hywind, with a second floating wind farm, Kincardine, under construction.

These projects have been the catalyst for a significant increase in operations and maintenance activities to support them, resulting in improved port infrastructure around Scotland's coast.

In recognition of the opportunity in this area, Crown Estate Scotland has been progressing a programme of work to show how Scotland's ports and harbours can tap into the huge potential created by the development of offshore wind in the years to come. As part of that workstream, a recent report commissioned by Crown Estate Scotland titled Ports for offshore wind: A review of the net zero opportunity for ports in Scotland found that while Scotland already has a strong and thriving ports sector, there are various steps that could be taken to maximise the future potential of Scottish ports to host the major offshore wind projects set to come online in the coming years.

These steps, if applied successfully, could ensure that Scotland's ports are ideally placed to support the major expansion of offshore wind in Scotland, and help the country take a major stride towards net zero. The requirement for more operational wind farms around Scotland and development of them could see:

- steps to increase the port capacity that is suitable for large scale offshore wind developments;
- the establishment of a strategic approach to how offshore wind port facilities are developed; and
- the development of new optimal operation and maintenance facilities which open up the right opportunities.

Crown Estate Scotland
Oighreachd a' Chrùin Alba

Beatrice offshore wind farm

Offshore Transmission Owner (OFTO) performance

At the end of 2020, the OFTO offshore transmission network consisted of 25 offshore substations, supporting over 6.6GW of generating capacity connected by 38 export cable circuits. These interface with either National Grid's National Electricity Transmission System (NETS) or the lower voltage distribution networks owned and operated by Distribution Network Operators (DNO). OFTO ownership details are listed on page 27.

Transmission system availability for OFTOs is published by National Grid each July in the annual NETS Performance Report, the information in this section covers data up to 31 March 2020.

OFTOs are incentivised through the regulatory framework with specific targets for each OFTO with the default level of availability being 98%. Figure 17 shows the trend in availability over the last five years where the average OFTO availability was 98.5% and for 2019/20 was 99.2%, well above the default level.

National Grid collates availability data for each OFTO annually. This includes all outages that originate on an OFTO's system but excludes outages that originate elsewhere. The OFTO availability incentive then adjusts the reported outage data to calculate incentivised performance for each OFTO.

Figure 18 highlights there were few outages and OFTOs maintained transmission system availability for the majority of the year. This enabled the wind farms to transmit electricity to the grid with minimal disruption.

OFTOs can be unavailable for several reasons. These include planned outages required for maintenance or modification of the assets, unplanned outages as a result of plant or equipment failure, e.g. circuit trips and faults, or outages requested by the DNO. Figure 19 shows the breakdown of planned and unplanned system unavailability for 2019/20.

Figure 17: OFTO availability trend

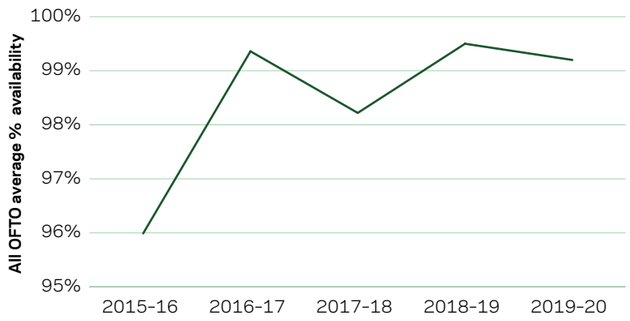
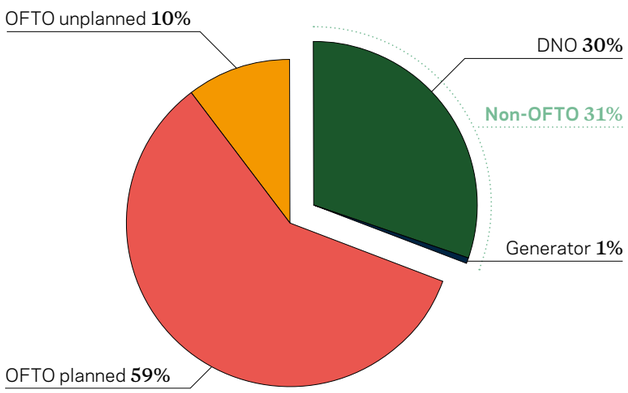


Figure 18: Offshore Transmission Networks % Annual System Availability

OFTO	2015-16	2016-17	2017-18	2018-19	2019-20
Barrow	99.88	100	99.99	100	100
Bubo Bank Extension	N/A	N/A	N/A	98.15	99.67
Dudgeon	N/A	N/A	N/A	100	99.31
Galloper	N/A	N/A	N/A	N/A	100
Greater Gabbard	100	98.78	99.61	99.82	99.78
Gunfleet Sands	100	99.95	99.81	99.97	100
Gwynt y Môr	97.94*	99.71*	100	99.93*	96.1
Humber Gateway	N/A	100	100*	100	99.83
Lincs	100	99.93	99.78	100	99.56
London Array	99.98	98.88	99.80	99.94	99.88
Ormonde	100	99.59	100	100	100
Race Bank	N/A	N/A	N/A	N/A	100
Robin Rigg	99.99	99.99	100	100	99.87
Sheringham Shoal	100	99.95	99.23	99.40	100
Thanet	100*	100*	100	100	100
Walney 1	100	99.62	99.70	100	99.95
Walney 2	92	100	100	91.42	100
West of Duddon Sands	100	99.64	99.45	100	95.42
Westermost Rough	100	100	100	99.73	100

* Figure has been updated as an exceptional event with agreement from OFGEM

Figure 19: 2019 OFTO system unavailability

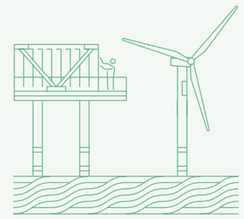


Sheringham Shoal offshore substation

Coordinated grid connections a step closer to reality

As the UK ramps up the deployment of offshore wind in support of 2030 ambitions, the question of how future sites are connected to the grid is becoming increasingly important from a range of perspectives, including environmental, societal and cost. This is particularly the case in areas where the transmission infrastructure, such as substations, cable landings and overhead lines, is in proximity to local communities. The issue is exacerbated by the way in which offshore wind projects are presently connected to the grid, in an uncoordinated, 'first come, first served' basis via separate radial links.

Government and the industry regulator, Ofgem, have recognised the limitations of this approach in light of the scale of deployment required over the coming decades. In July 2020, the Department of Business Energy and Industrial Strategy (BEIS) launched a major policy review, the Offshore Transmission Network Review, which focuses on both minor near-term reforms to facilitate greater coordination of infrastructure in the 2020s, and developing a new policy framework for the longer term. We support this policy evolution and are becoming increasingly involved in the debate given our role in providing access to the seabed in a way which is sensitive to the marine ecosystem while still enabling opportunities for diverse projects. You can read more about grid related studies we are working on with others on page 21.



99.2%

Annual availability of offshore transmission networks for 2019/20

Offshore Wind Evidence + Change Programme

In 2020 we launched the Offshore Wind Evidence and Change Programme

Offshore Wind Evidence and Change Programme

In 2020 we outlined our commitment to address the environmental emergency, with a target to become a net zero carbon business by 2030. We also, along with the UK Government, launched a new partnership to unlock the green energy potential of the UK seabed, whilst protecting and restoring our precious marine environment.

The partnership, called the Offshore Wind Evidence and Change Programme, is gathering and harnessing data and evidence to drive forward the sustainable and co-ordinated expansion of offshore wind, as it gears up to meet the Government's 2030 ambitions for 40GW of offshore wind and beyond.

We are leading the partnership and have committed to a five-year, £25 million 'kickstarter' investment, supported by our partners the Department for Business, Energy and Industrial Strategy (BEIS), and the Department for Environment, Food and Rural Affairs (Defra). This unique collaboration brings together over 20 key organisations including the devolved Governments, industry, regulators and their advisors, as well as the RSPB and the Wildlife Trusts.

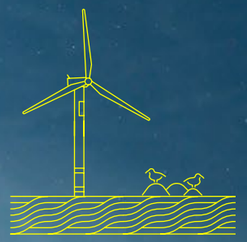
The aim is to build on the UK's global leadership in offshore wind and maximise economic benefits across the whole of the UK. In parallel, the partnership supports the Government's 25-year Environment Plan, which sets out its ambitions to restore nature within a generation, reversing the loss of marine biodiversity.

Over a five-year period, the Programme's strategic research and data projects will provide essential insights to help the sector better understand and address cumulative environmental impacts and interactions with other industries and activities, both around the coast and offshore. This will enable more coordinated and strategic approaches to the delivery of the new infrastructure needed to fulfil the commitment to net zero, ensuring the sector can sustainably meet demand at pace.

Torch Reel

"It is important that we all work together to bring about change and reduce our contribution to climate change. Renewable energy plays a key role in this and as we work to increase renewable sources of energy we must ensure that our precious marine environment is protected at the same time. I am delighted that Defra is a part of this programme, providing expert advice relating to the growing calls on our marine space so that we can deliver offshore developments while protecting our unique marine resources".

Rebecca Pow
Environment Minister



£25m

'Kickstarter' investment for the Programme

Snakelocks in the sun

Projects coming forward through the partnership, include:

Future Offshore Wind Scenarios project
A UK-wide study, being delivered with BEIS and Crown Estate Scotland, to examine and develop a range of spatial deployment scenarios for offshore wind development to 2050 and to assess technical, economic, environmental and system factors, potential opportunities and interactions.

East Coast Grid Spatial Study
This study is being delivered with National Grid Electricity System Operator (ESO), National Grid Electricity Transmission and The Marine Management Organisation. It will help build understanding of the interactions that future offshore wind farms on the east coast of England are likely to face when connecting into the electricity network – such as environmental constraints or access to suitable landing points. It will consider whether alternative approaches to grid connection can mitigate future development impacts.

North Sea Net Gain
This study is being delivered by Cefas with The Rich North Sea Programme in the Netherlands to address gaps in understanding of biodiversity distribution across the seabed. This international data mining campaign will expand data coverage and use modelling techniques to provide a baseline assessment of benthic biodiversity across the North Sea.

For further information about the Offshore Wind Evidence and Change Programme, visit our website.

The programme brings together a variety of organisations:

1. Centre for Environment, Fisheries and Aquaculture Science (Cefas)
2. Crown Estate Scotland
3. Department for Business, Energy and Industrial Strategy
4. Department for the Economy, Northern Ireland
5. Department for Environment, Food and Rural Affairs
6. Department of Agriculture, Environment and Rural Affairs, Northern Ireland
7. Historic England
8. Maritime and Coastguard Agency
9. Joint Nature Conservation Committee
10. Marine Management Organisation
11. National Grid Electricity System Operator
12. National Grid Transmission Owner
13. Natural England
14. Natural Resources Wales
15. NatureScot
16. Offshore Wind Industry Council / Pathways to Growth
17. Office of Gas and Electricity Markets (Ofgem)
18. The Planning Inspectorate
19. RenewableUK
20. Royal Society for the Protection of Birds
21. Scottish Government (including Marine Scotland)
22. Seabed User and Developer Group
23. The Crown Estate
24. The Wildlife Trusts
25. Trinity House
26. Welsh Government

Walney 2 offshore wind farm and substation

Offshore wind farm ownership

19m

UK offshore wind electricity generation in 2020 could have kept 19 million electric cars on the road for a year. That's equivalent to almost half of the UK's conventional car fleet

In 2020 there were three dominant themes in total capacity ownership of the UK operating and under construction offshore wind fleet (see figure 20): utility ownership reduced by 4%, though remains dominant; oil and gas presence increased significantly to 12%, which we discuss in more depth on pages 28-30; and corporate ownership reduced its overall capacity share to 4%. Financial investors appear to have reduced their ownership share to 23%, from 27% in 2019. However, looking beyond this headline figure, the data tells another story. The capacity of the operating and under construction fleet has grown by around 70% during the last four years. Over the same period, financial investors and institutions have effectively doubled their ownership of UK offshore wind capacity, averaging 25% of the market over the last four years, see figure 25 on page 29 for more details. Figure 21 demonstrates the proportions of capacity ownership as at the end of 2020.

Within utilities, the largest change in capacity ownership was SSE increasing it's holding from 4% in 2019 to 13% of the fleet in 2020, the second largest behind Ørsted. SSE's change in position was precipitated by phases A and B of the Dogger Bank projects entering into lease. The completion of the RWE and E.ON asset swap during the summer also meant that Innogy was absorbed into RWE, consolidating RWE's position of holding 10% of the fleet, the third largest capacity stake.

Figure 21: Operational and under construction wind farm ownership as a % of total capacity in 2020 by company

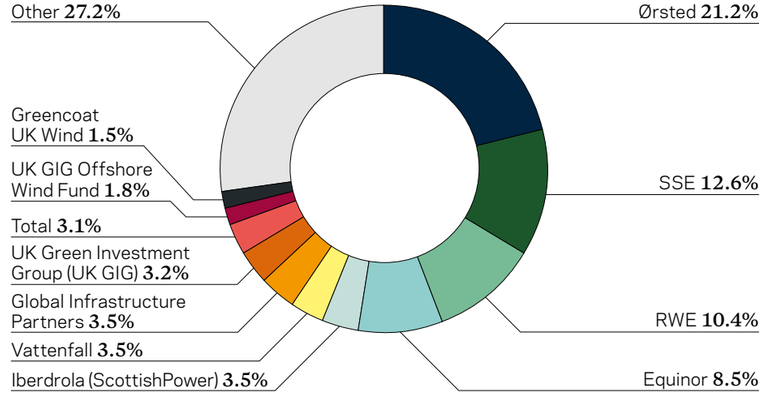
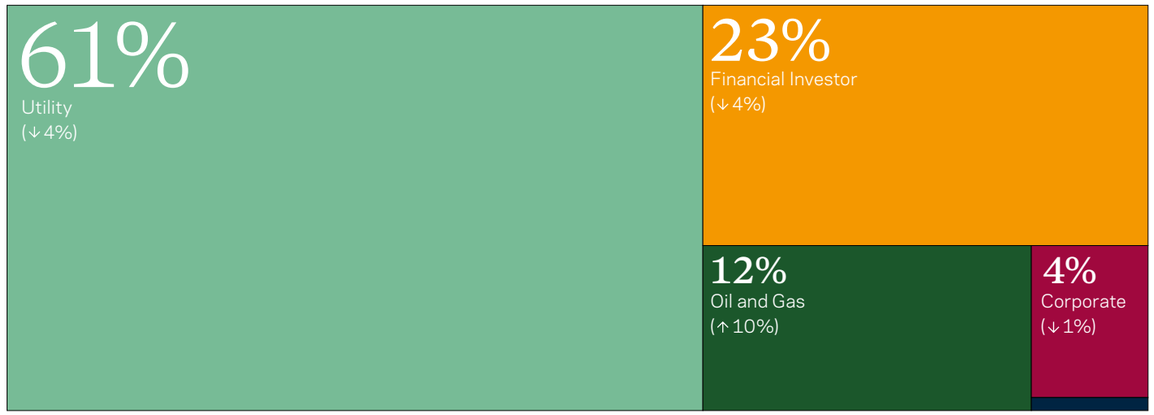


Figure 20: Capacity ownership by category in 2020 vs 2019 (Operational and under construction wind farms) – percentages rounded

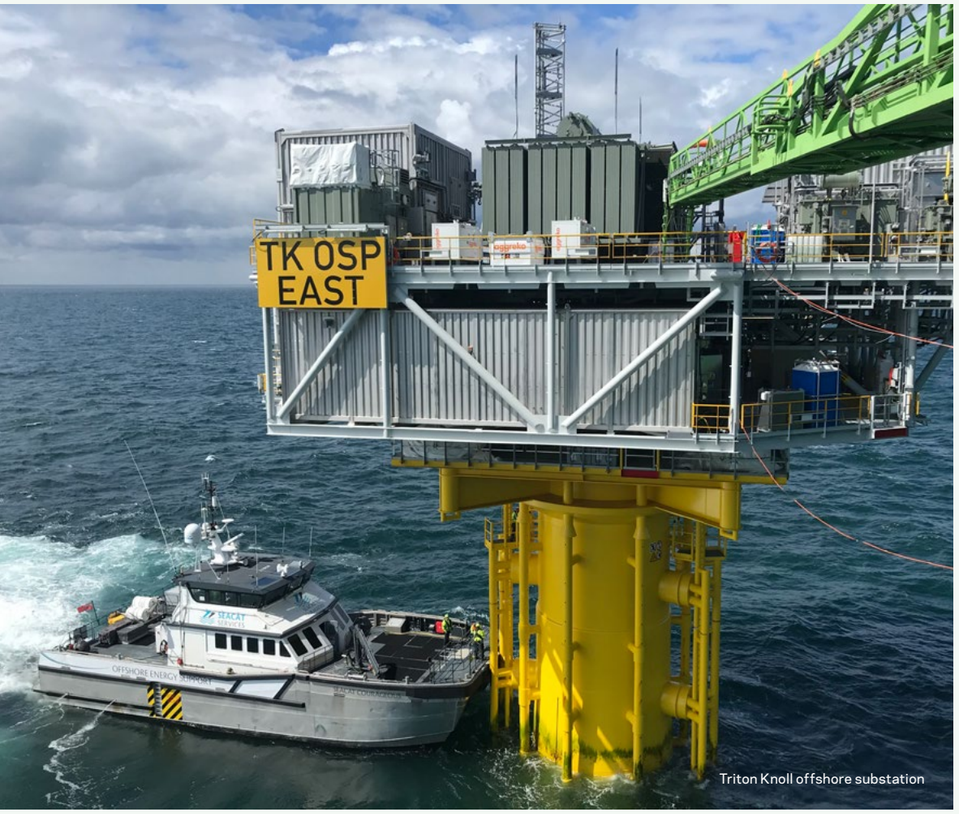


<1% Supply Chain (0%)

Fully operational offshore wind farm ownership as at 31 December 2020, listed alphabetically by project

Project	Operator	Share ownership %
Barrow	Ørsted	100% Ørsted
Beatrice	SSE	40% SSE; 35% Copenhagen Infrastructure Partners; 25% SDIC Power Holding
Blyth Demonstration (Phase 1)	EDF Renewables	100% EDF Renewables
Burbo Bank	Ørsted	100% Ørsted
Burbo Bank Extension	Ørsted	50% Ørsted; 25% KIRKBI Invest A/S; 25% PKA Holding ApS
Dudgeon	Equinor	35% Equinor; 35% Masdar; 30% China Resources
East Anglia ONE	ScottishPower Renewables	60% Iberdrola (ScottishPower); 25.7% UK GIG[6]; 14.3% TRIG
European Offshore Wind Deployment Centre	Vattenfall	100% Vattenfall
Galloper	RWE	25% RWE; 25% Siemens Financial Ser...[11]; 25% UK GIG[6]; 12.5% ESB; 12.5% Sumi...[3]
Greater Gabbard	SSE	50% SSE; 50% RWE
Gunfleet Sands Demonstration	Ørsted	100% Ørsted
Gunfleet Sands I	Ørsted	50.1% Ørsted; 24.95% Dev. Bank of Japan[1]; 24.95% JERA
Gunfleet Sands II	Ørsted	50.1% Ørsted; 24.95% Dev. Bank of Japan[1]; 24.95% JERA
Gwynt y Môr	RWE	50% RWE; 30% Stadtwerke München; 20% Macquarie Infra ...[9]
Hornsea 1	Ørsted	50% Ørsted; 50% Global Infrastructure Partners (GIP)
Humber Gateway	RWE	51% RWE; 38% Greencoat UK Wind; 11% Green...[7]
Hywind Scotland	Equinor	75% Equinor; 25% Masdar
Inner Dowsing	XceCo	61% UK GIG Offshore Wind Fund[8]; 39% BlackRock
Kentish Flats	Vattenfall	100% Vattenfall
Kentish Flats Extension	Vattenfall	100% Vattenfall
Levenmouth Demonstration	ORE Catapult	100% ORE Catapult
Lincs	Ørsted	44% UK GIG Offshore Wind Fund[8]; 31% UK GIG[6]; 25% Ørsted
London Array	London Array Ltd	30% RWE; 25% Ørsted; 25% Caisse dépôt & placem...[10]; 20% Masdar
Lynn	XceCo	61% UK GIG Offshore Wind Fund[8]; 39% BlackRock
North Hoyle	RWE	100% Greencoat UK Wind
Ormonde	Vattenfall	51% Vattenfall; 49% AMF
Race Bank	Ørsted	50% Ørsted; 25% Macquarie European ...[2]; 12.5% Sumi...[3]; 6.25%[4]; 6.25%[5]
Rampion	RWE	30.1% RWE; 25% UK GIG[6]; 24.9% Enbridge Inc.; 20% E.ON
Rhyl Flats	RWE	50.1% RWE; 24.95% Greencoat UK Wind; 24.95% UK GIG Offshore Win...[8]
Robin Rigg East	RWE	100% RWE
Robin Rigg West	RWE	100% RWE
Scroby Sands	RWE	100% RWE
Sheringham Shoal	Equinor	40% Equinor; 40% Equitix; 20% UK GIG[6]
Teesside	EDF Renewables	51% EDF Renewables; 49% Dalmore Capital Ltd
Thanet	Vattenfall	100% Vattenfall
Walney 1	Ørsted	50.1% Ørsted; 25.1% Greencoat UK Wind; 24.8% PGGM
Walney 2	Ørsted	50.1% Ørsted; 25.1% Greencoat UK Wind; 24.8% PGGM
Walney Extension	Ørsted	50% Ørsted; 25% PFA Holding ApS; 25% PKA Holding ApS
Westermost Rough	Ørsted	50% Ørsted; 50% UK GIG[6]
West of Duddon Sands	Ørsted	50% Ørsted; 50% Iberdrola (ScottishPower)

1 Development Bank of Japan
2 Macquarie European Infrastructure Fund 5
3 Sumitomo Corporation
4 Arjun Infrastructure Partners
5 Gravis Capital Management
6 UK Green Investment Group (UK GIG)
7 Greencoat Renewable Income LP
8 UK Green Investment Group (UK GIG) Offshore Wind Fund
9 Macquarie Infrastructure and Real Assets
10 Caisse dépôt & placement Québec
11 Siemens Financial Services



Triton Knoll offshore substation

Offshore Transmission Owner (OFTO) ownership

The divestment of the transmission assets to the offshore transmission owner (OFTO) on the basis of a competitive tender process is a key part of the OFTO regime. Since the first OFTO licence was granted in 2011, a total of 20 licences have been granted. This divestment continued during 2020 with two licences granted under Tender Round 5, three progressing under Tender Round 6, and the launch of Tender Round 7 (see Figure 22).

During the year, OFTO tenders were impacted by earlier tender process delays and the Covid-19 pandemic. This resulted in several tenders being granted exemptions by the Secretary of State to extend the divestment timescales, particularly for those projects close to the end of their Generating Commissioning Clause.

OFTO ownership is dominated by infrastructure investment groups and venture capital companies. As detailed in figure 23, the majority of UK OFTOs, (83%), are owned by just four companies. We have also seen new investors such as Chubu Electric Power Co., Inc., a Japanese utility, investing in recent OFTO transfers. This continues a pattern of Japanese investments in UK offshore wind farms that help gain experience for an emerging offshore wind market in Japan.

As shown in figure 24, OFTOs continue to be managed and operated by a handful of key companies: Transmission Capital Partners, Blue Transmission, Diamond Transmission, Balfour Beatty and Equitix. Whilst the generator no longer owns the transmission assets, a quarter of them continue to be operated and maintained by the generator, with others being operated by another dedicated service provider on behalf of the OFTO.

Figure 22: Offshore Transmission Tenders

Ofgem is responsible for managing the competitive tender process through which offshore transmission licences are granted. The following tender rounds are underway.

For more information on the tender rounds, please refer to Ofgem's website.

Tender Round 5

Licences granted in 2020

Galloper
February 2020

Walney Extension
June 2020

Licences to be granted in 2021

Rampion
Preferred bidder appointed August 2019

Tender Round 6

Licences to be granted in 2021

Beatrice
Preferred bidder appointed December 2019

Hornsea One
Preferred bidder appointed February 2020

East Anglia One
Preferred bidder appointed December 2020

Tender Round 7 – *launched in 2020*

Invitation to Tender (ITT) stage to commence

Triton Knoll
Estimated April 2021

Moray East
Estimated July 2021

Figure 23: OFTO ownership

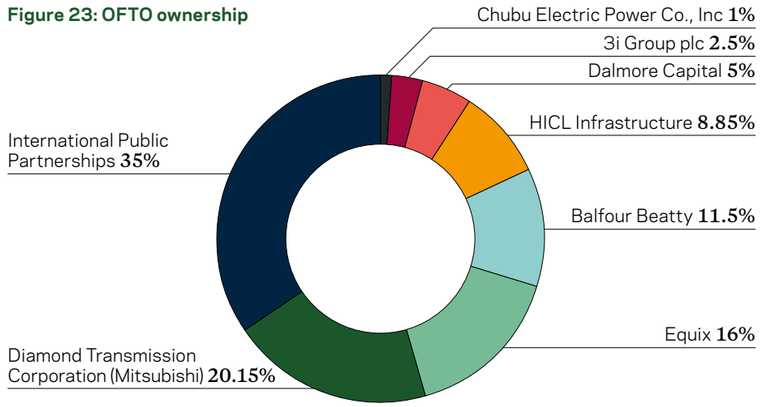


Figure 24: OFTO ownership as at 31 December 2020

OFTO	Export Cable Circuits	Offshore Substations	Ownership %	Operator	O&M Provider
Barrow	1	1	100% International Public Partnerships	Transmission Capital Services	Transmission Investment Services Limited
Burbo Bank Extension	1	1	50% Diamond ...[1] / 50% HICL ...[2]	Diamond Transmission UK	RES
Dudgeon	2	1	100% International Public Partnerships	Transmission Capital Services	Dudgeon Offshore Wind Limited
Galloper	2	1	51% Diamond ...[1] / 49% HICL ...[2]	Diamond Transmission UK	RES
Greater Gabbard	3	2	100% Equitix Ltd	Equitix Management Services	EDS HV Management Limited
Gunfleet Sands	1	1	100% International Public Partnerships	Transmission Capital Services	Transmission Investment Services Limited
Gwynt y Môr	4	2	60% Balfour Beatty / 40% Equitix	Balfour Beatty Investments	Balfour Beatty Power Transmission & Distribution
Humber Gateway	2	1	80% Equitix / 20%...[3]	Balfour Beatty Investments	Balfour Beatty Power Transmission & Distribution
Lincs	2	1	100% International Public Partnerships	Transmission Capital Services	Transmission Investment Services Limited
London Array	4	2	50% Diamond ...[1] / 50% 3i Group plc	Frontier Power	London Array Limited
Ormonde	1	1	100% International Public Partnerships	Transmission Capital Services	Transmission Investment Services Limited
Race Bank	2	2	51% Diamond ...[1] / 49% HICL ...[2]	Diamond Transmission UK	RES
Robin Rigg	2	-	100% International Public Partnerships	Transmission Capital Services	RWE Renewables UK Operations Limited
Sheringham Shoal	2	2	50% Diamond ...[1] / 50% 3i Group plc	Frontier Power	Scira Offshore Energy Limited
Thanet	2	1	80% Equitix / 20%...[3]	Balfour Beatty Investments	Balfour Beatty Power Transmission & Distribution
Walney 1	1	1	50% Diamond ...[1] / 50% 3i Group plc	Frontier Power	RES
Walney 2	1	1	50% Diamond ...[1] / 50% 3i Group plc	Frontier Power	RES
Walney Extension	2	2	51% Diamond ...[1] / 29% ...[2] / 20%...[4]	Diamond Transmission Corporation	RES
Westermost Rough	1	1	100% International Public Partnerships	Transmission Capital Services	Transmission Capital Services
West of Duddon Sands	2	1	100% Dalmore Capital Ltd	Frontier Power	Ørsted & SPR

1 Diamond Transmission Corporation Ltd (subsidiary of Mitsubishi Corporation) 2 HICL Infrastructure 3 Balfour Beatty 4 CHUBU

Investment

2020 was the year that renewables came of age. For the first time, more electricity was generated in the UK by renewables* than by fossil fuels (43% vs 41%). With a maturing offshore wind market, lenders and investors have become much more comfortable with the sector's risk profile and it has formed a key component in the pathway to achieving net zero. 2020 closed with the largest global offshore wind project financing to date for the world's largest offshore wind farm under construction, Dogger Bank phases A and B. The project financing component is to the value of £5.5bn, with 29 banks and three export credit agencies providing senior debt facilities of £4.8 billion and ancillary facilities of £0.7 billion.

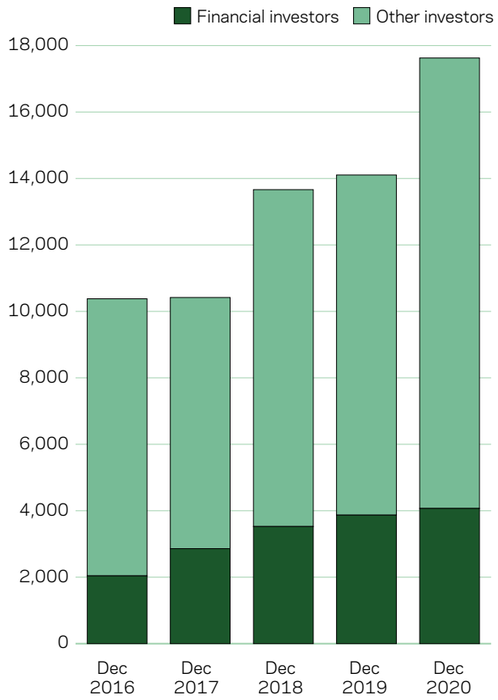
Across Europe, growth was seen in the number of offshore wind corporate Power Purchase Agreements (PPAs) signed. During 2020, Ørsted signed a PPA for Race Bank with Nestlé adding to its earlier Race Bank PPA in 2019 with Northumbrian Water, which was the first of its kind in the UK. National lockdowns and strong renewables penetration on the grid caused more volatility in the wholesale electricity price, highlighting the importance of mitigating merchant risk and stabilising portfolio revenues. This is against a backdrop of two themes: reduced contracts for difference bid prices, and a pressing global requirement for corporates to transition to lower carbon models and to actively demonstrate their reducing carbon footprint to their consumers. This is evidenced by the pivot of oil and gas companies into offshore wind, which we discuss on page 30.

There is a growing regulatory and market backdrop to renewables and offshore wind investment, as more disclosure requirements around sustainable investment are introduced and through the emergence of benchmarks such as 'Paris Aligned' as companies demonstrate their sustainability credentials.

*consisting of bioenergy, hydro (natural flow) solar and wind (BEIS)

Gwynt y Môr offshore wind farm

Figure 25:Operational and under construction portfolio ownership (MW)



↑99% Financial investors increased their ownership of offshore wind (MW) capacity by 99% over the last 4 years

The Renewables Infrastructure Group (TRIG) which invested in East Anglia One during 2020

"We are delighted to be investing in this high quality asset which marks our continued commitment to supporting the global transition to a more sustainable future. East Anglia One is TRIG's fourth investment in the offshore wind sector and its second offshore wind investment in the UK.

"The investment fits well into TRIG's investment strategy, providing subsidised revenues for the next 15 years, lowering overall power price sensitivity of the portfolio and strengthening TRIG's position in the attractive offshore wind market. Offshore wind projects will be crucial to the UK's ambition to meet net zero carbon emissions by 2050, and East Anglia One provides enough clean energy to power the equivalent of more than 630,000 homes."

Figure 26: Transactional activities completed in 2020 in date order

Asset	Seller	Share before sale	Buyer	Buyer share after sale	Value	Timing
Galloper	Innogy	25%	RWE	25%	Unknown	Jun-20
Greater Gabbard	Innogy	50%	RWE	50%	Unknown	Jun-20
Gwynt y Môr	Innogy	50%	RWE	50%	Unknown	Jun-20
Rhyl Flats	Innogy	50.1%	RWE	50.1%	Unknown	Jun-20
Seagreen	SSE	100%	Total	51%	Up to £130m	Jun-20
Walney 1	SSE	25.1%	Greencoat UK Wind Plc	25.1%	£350m	Sep-20
Walney 2	SSE	25.1%	Greencoat UK Wind Plc	25.1%		
East Anglia ONE	UK GIG	40%	The Renewables Infrastructure Group	14.3%	Unknown	Dec-20
Humber Gateway	RWE	100%	Greencoat UK Wind	38%	£500m	Dec-20
			Greencoat Renewable Income LP	11%	£148m	Dec-20

Oil and gas companies pivot into offshore wind

2020 saw the offshore wind capacity share of oil and gas companies increase to 12%, up from 2% in 2019. Facing oversupply and falling prices in their traditional markets, oil and gas majors have been seeking alternative growth streams whilst reducing their carbon exposure.

In June 2020, Total took a 51% stake in the Scottish Seagreen offshore wind project. In addition, in early 2021 Total, in partnership with Macquarie, successfully progressed to the next stage of The Crown Estate's Offshore Leasing Round 4. Total added 13GW of renewables to its worldwide pipeline in 2020 and has set out ambitious green growth goals, with plans to become a top-five player in the sector.

Equinor has committed to becoming a net zero company by 2050, increasing its share of the UK offshore wind fleet from 290MW to almost 1.28GW with the signature of leases at Dogger Bank A and B in partnership with SSE Renewables. Eni also became a partner in December 2020 buying a 20% stake in phases A and B (effective 2021). During the year, BP increased its presence in offshore wind, successfully progressing two projects to the next stage of Leasing Round 4 with joint-venture partner EnBW.

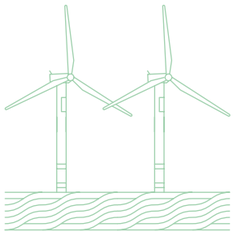
Recharge estimates that the six European oil majors' worldwide net operating renewable capacity already adds up to 8-9GW, and that this could grow to 55GW by 2025. Iberdrola is aiming for 60GW by 2025, while Enel intends to double its renewables capacity by 2030.

Growth in renewables is one of the limited paths available for oil and gas majors to reduce their carbon exposure. Other options include offsetting emissions via afforestation and carbon credits, transforming operations (eg. electric drilling, carbon capture utilisation and storage), and new business models such as electric vehicle charging stations. Listed companies with a strong portfolio of renewable energy projects are reaching market valuations many times the size of their annual earnings, while oil company share prices have recently reached multi-year lows.

With 60 years of experience building offshore infrastructure, oil and gas majors are ideally positioned to manage the technical, logistical and recruitment challenges of installing both fixed foundation and floating offshore wind turbines. Much of the required expertise is similar across the two sectors and we have already seen oil and gas experience utilised to great effect by Ørsted and by Equinor.

For example, Equinor pioneered the world's first commercial floating offshore wind farm, Hywind Scotland, using engineers experienced in the oil and gas sector. Assembled onshore, the turbines were transported on heavy lifting, tug-powered vessels also used to deploy oil and gas platform parts. The firm is hopeful its expertise will help bringing floating offshore wind costs in line with those of piled turbine projects by the end of the decade.

Monopile and transition piece installed at Triton Knoll.



Monopiles and transition pieces at port awaiting load out for Triton Knoll

Development

Pacific Orca wind farm installation vessel

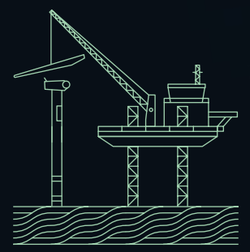
In our 2019 report, we talked of laying the foundations for continued responsible growth of the industry. In 2020, these foundations have served us well as we seek to enable growth of the sector in a way which is sensitive to the environment, our precious marine habitats, communities, and the many other users of the marine environment.

Portfolio growth has been strengthened with 3.4GW of projects granted agreements for lease in the summer of 2020. The third stage of Leasing Round 4 resulted in just under 8GW of preferred projects progressing to the plan-level Habitats Regulations Assessment. With up to 10GW possible from the ScotWind leasing round, figure 28 indicates that, with a potential capacity of 58GW,* the identifiable project fleet looks to be in a strong position to make a major contribution to supporting the Government's target of delivering 40GW by 2030 and beyond.

Following a series of delays, the Development Consent Orders for Norfolk Vanguard and Hornsea Three wind farms were secured, although the order for Thanet Extension was refused and, at the time of writing, the Norfolk Vanguard consent had been overturned in the High Court on process matters. The developer and the department for Business Energy and Industrial Strategy (BEIS) is to consider next steps. As we seek to enable a more co-ordinated approach to the seabed than ever before, the lessons learned from these activities – such as the need for more strategic consideration of cumulative impacts and in-combination impacts on the environment and onshore communities – will continue to inform the work of the Offshore Evidence and Change Programme so that we can build an evidence-base to support sustainable growth of the industry. They will also provide vital insights to studies such as the Offshore Transmissions Network Review and The National Infrastructure Planning Reform Programme, the latter being led by the Ministry of Housing, Communities & Local Government.

Sights are now moving to the 2050 horizon and the significant role that the offshore wind industry has to play in the UK's net zero energy system. Page 34 provides an overview of our offshore wind key resources technical assessment published in December which, alongside the growing evidence base from Offshore Wind Evidence & Change Programme (OWEC), will set the foundations for the next evolution of the offshore wind industry.

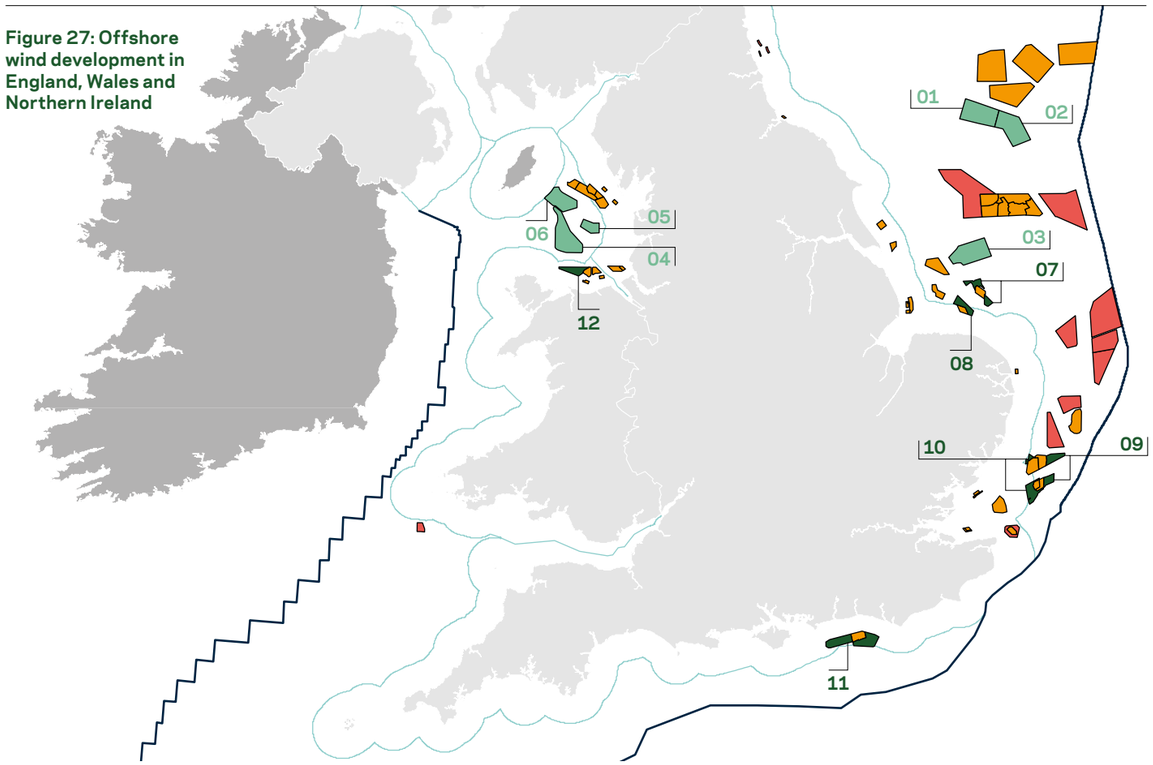
Further information on the OWEC can be found on pages 20–21



3.4GW

of agreements for lease awarded during 2020

Figure 27: Offshore wind development in England, Wales and Northern Ireland



Leasing Round 4 Preferred Projects

Up to capacity MW		
01	RWE Renewables	1,500
02	RWE Renewables	1,500
03	Green Investment Group – Total	1,500
04	Consortium of EnBW and BP	1,500
05	Offshore Wind Limited, a Joint Venture between Cobra Instalaciones y Servicios, S.A. and Flotation Energy plc	480
06	Consortium of EnBW and BP	1,500
TOTAL		7,980

Extensions and Agreements awarded in 2020

Up to capacity MW		
07	Dudgeon Extension	402
08	Sheringham Shoal Extension	317
09	Five Estuaries (Galloper Extension)	353
10	North Falls (Greater Gabbard Extension)	504
11	Rampion 2 (Rampion Extension and Zone 6)	1,200
12	Awel y Môr (Gwynt y Môr Extension)	576
TOTAL		3,352

- Leasing round 4 preferred projects
- Extensions and related awards
- Projects in operation or committed (see figure 5 for details)
- Projects under development or pre-planning

— Territorial Waters Limit
— UK Continental Shelf

Figure 28: All UK offshore wind development pipeline waterfall (gigawatts rounded)

* *Under development/Pre-Planning now sits at 20GW (19,816MW) due to the AfL awarded for Rampion 2 (Zone 6). All other figures remain the same. Cumulative portfolio = 58GW (58,013MW)*

** *Projects under construction or that have government support on offer e.g. awarded a Contract for Difference OR taken FID*

Broad Horizons: Key resource areas for offshore wind

Over the course of 2020, we commissioned Everoze to combine a survey of the evolving technology landscape out to 2040 with spatial data in order to map the technical key resource areas in the waters off England, Wales and Northern Ireland.

Spatial technology profiles for fixed and floating wind were defined through 19 different key resource areas considering viable engineering solutions and the physical characteristics of the sea and seabed.

This work confirms that, in addition to driving down the cost of clean electricity, technological innovation will expand the range of geographical possibilities for offshore wind deployment in the future. Refinement of fixed foundation installation techniques and critically, the entry to the market of full scale floating offshore wind will bring new areas of UK waters within reach, helping to unlock this increasingly important source of renewable energy and support the UK's clean energy future. A summary of the Broad Horizons report can be found on our website. This characterisation for technology types creates one evidence base to be considered against wider environmental considerations and stakeholder uses.

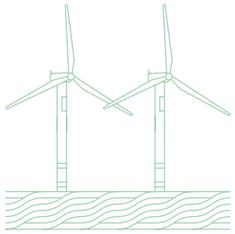
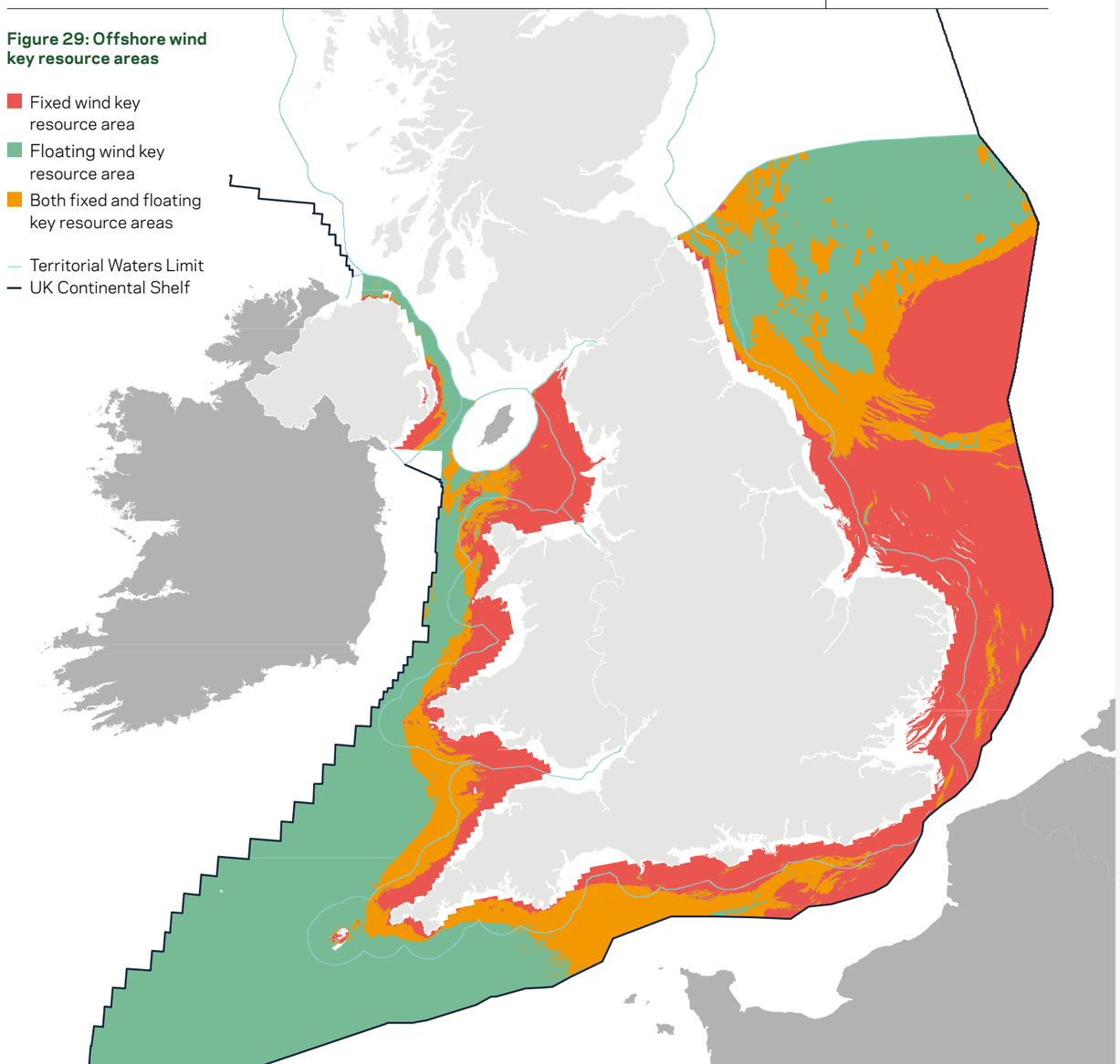


Figure 29: Offshore wind key resource areas



Crown Estate Scotland development

With a number of consented Scottish projects progressing through financing and construction, we have already seen increased opportunities for the Scottish offshore wind supply chain to grow and develop.

The potential pipeline of development is sustained further into the future with those projects progressing through towards consent, resulting in the prospect of a sustained level of development and construction during the coming years.

In addition to these projects already making their way through the development process, there is also the potential for further growth through ScotWind Leasing. Launched in 2020, the first offshore wind leasing round in Scottish waters for a decade has the potential to enable the development of Scotland's new generation of offshore wind farms. The round will offer enough seabed to accommodate a further 10GW of capacity and power every home in Scotland with green electricity, in the process helping the country take a giant step towards getting to net zero carbon emissions by 2045.

Crown Estate Scotland
Oighreachd a' Chrùin Alba

Towers at port for Triton Knoll offshore wind farm

Daniele Clifford and Lucy Mather, Marine Futures interns

Diversity, inclusion and skills

This is our second year highlighting the importance of this subject as we see it as critical to the future of a thriving offshore wind industry and society. An inclusive environment – where people feel they can be themselves and not have to suppress who they are – can lead to strong teams, great results and attract other talented people. Opposite, Danielle Lane, Vattenfall UK country manager and co-chair of the Offshore Wind Industry Council (OWIC) explains why diversity is so important.

Cultural shifts are taking place and, in September 2020, six major energy companies joined an initiative, POWERful Women, to commit to better gender balance at the top of their businesses. BP, Drax, Engie, E.ON UK, Subsea 7 and Wood have joined its Energy Leaders' Coalition in response to the "poor" level of female representation at senior levels in the industry.

In October 2020, OWIC launched its Best Practice Guide to Diversity and Inclusion in Offshore Wind aimed at helping to address gender and ethnicity in the sector.

These commitments to supporting a diverse, collaborative and inclusive culture are shared by The Crown Estate. Over the past year our Diversity & Inclusion Group has formed a number of networks within the business to drive progress in areas such as accessibility and inclusivity, gender, LGBT+, and race, ethnicity and culture. We know we have more to do in this area, and our aspiration is to connect these groups with other networks across the offshore wind and transmission industry, to share best practice and learn from one another. If you would like to find out more, please get touch with us at diversityandinclusion@thecrownestate.co.uk

In 2020 we ran our Marine Futures Internship Programme to focus on the North West of the UK. Working in partnership with Ørsted, Natural England and the North West Wildlife Trusts we welcomed two interns which are focusing on the use of operational wind farms by great cormorants; the implications of guano accumulation and the potential mitigation measures to encourage positive co-location.

"Diversity may seem like a buzzword, but it's fundamental to the success of offshore wind. It's a priority for me because creating teams of people from different backgrounds creates a culture of innovation and problem solving. People with different perspectives challenge each other constructively, meaning we're less likely to suffer from 'group think' and complacency.

"The offshore wind industry understands the importance of diversity, which is why the Sector Deal – now almost two years old – sets clear targets for improving gender and ethnic diversity in the sector. One of the most important things we can do is demonstrate to young people at school today the opportunities which offshore wind offers. It's not about encouraging them to follow STEM subjects for the sake of it – it's showing young people that these are vibrant and exciting careers in an industry which is open to them, whatever their background."

Danielle Lane
Vattenfall UK country manager and co-chair of the OWIC

Skills

Highlighting career pathways to school pupils and forming apprenticeships are critical for widening the pool of opportunity and nurturing talent. Apprenticeships make up 1.8% of the UK offshore wind workforce and the industry has set a target of 2.5% to be reached as soon as possible. There are a growing number of apprenticeship programmes, often in locations where other industries have declined. In 2020, Innogy (now part of RWE) announced that it was making Llandrillo College (Coleg Llandrillo) in North Wales its UK-wide training hub for offshore wind, building on its existing apprenticeship partnership with the college. This also contributes to one of the Offshore Wind Sector Deal's Regional Clusters.

North Wales-based Jones Bros Civil Engineering UK is delivering onshore enabling and cabling works on the first two phases of Dogger Bank wind farm and its apprenticeship scheme has produced more than 40% of its current workforce, with many of its senior managers having started out as apprentices or in a trainee role. It has a strong reputation for engaging with primary and secondary schools as well as colleges, offering site visits and giving career talks to raise awareness of engineering as a career beyond a university audience.

Jones Bros has recruited more than 100 apprentices during the past three years including Mustafa Hamed below.

Update on Offshore Wind Sector Deal gender and ethnicity workforce targets:

Female employees

16%	Baseline (2019)
33%	Target (2030) *(40% if feasible)*
18%	Progress (2020)

Employees being black, Asian and minority ethnic

5%	Baseline (2019)
9%	Target (2030) *(more if feasible)*
5%*	Progress (2020)

* responses on the recent survey on ethnicity were not sufficient to be representative of the industry and so not reported. There has been renewed push on ethnicity data gathering which is also flagged in the Diversity Best Practice Guide released during 2020.

Mustafa Hamed, from Wigan, took up an apprenticeship with Jones Bros, originally working on a highways project in his home town but is now supporting offshore wind projects.

At Dogger Bank, his responsibilities include assisting the section engineers in setting out and undertaking quality assurance checks on the ducting which houses the electrical cabling which will bring power onshore.

Mustafa, who completed his plant operator apprenticeship and is now studying on the higher apprenticeship scheme, says: "I had no prior experience on a site so attended a talk linked to the A49 link road scheme.

"In particular, I was keen to understand more about the qualifications I would receive as well as the career progression opportunities. I'm really glad I went along and followed it up by applying.

"On a day-to-day basis at Dogger Bank, I'm continually adding to my skills and knowledge where I'm learning more about engineering from experienced colleagues. In the future, I want to teach others like me and share my knowledge.

"For Jones Bros to be involved with such a huge renewable energy project, and to play an important role personally, it's a big part of my life. Hopefully, when I'm older and have kids, I can show them what we accomplished."

Marine Data Exchange

The Marine Data Exchange (MDE) manages offshore data collected throughout the lifetime of offshore wind farms in England, Wales and Northern Ireland.

It is a valuable resource, enabling access to vast quantities of environmental and industry data to help a wide range of people and organisations make informed decisions. In 2020, we added 68 new surveys and continue to work with our offshore customers to gather and publish data.

Over half of public downloads are from offshore developers and their consultants, as shown in figure 30, with last year also seeing a 56% increase in downloads made by government bodies and offshore regulators.

We are committed to the continuous improvement of the MDE and have embarked on an exciting journey to make the data more discoverable and accessible. Look out for a fresh new look in summer 2021.

www.marinedataexchange.co.uk

Figure 30: 2020 public survey downloads by user type

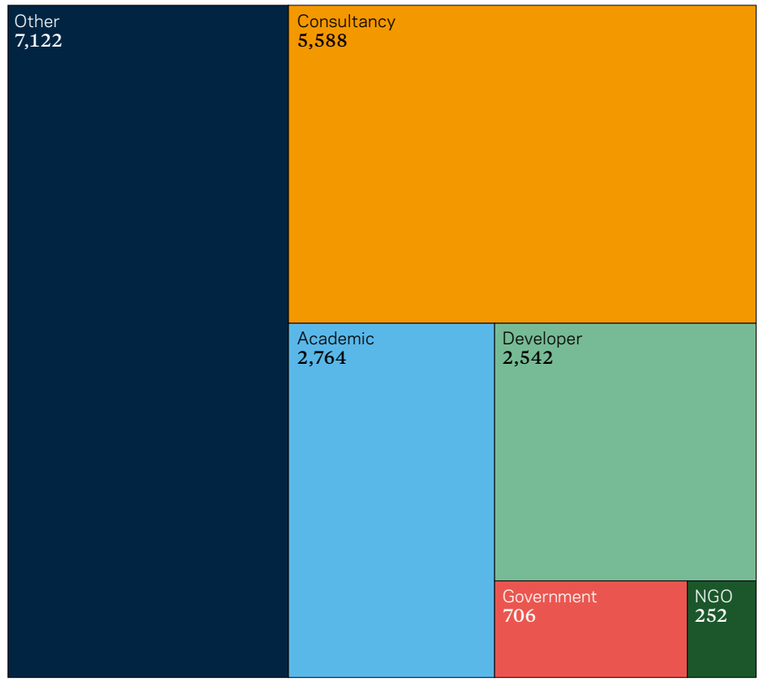
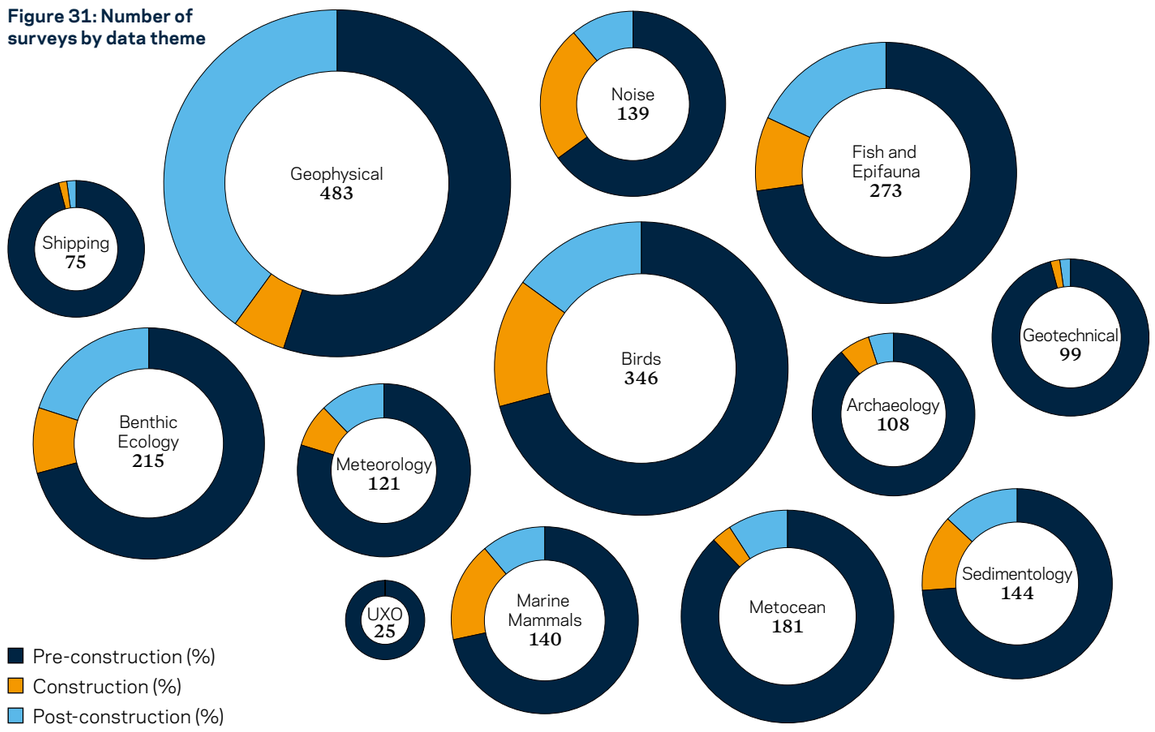


Figure 31: Number of surveys by data theme



Data from
1914 - 2020

2,349
surveys

61%
publicly available

190TB
The equivalent of piles of paper standing as tall as 22,500 London Shards, or 4 return trips from Lands End to John O'Groats

Figure 32: New surveys

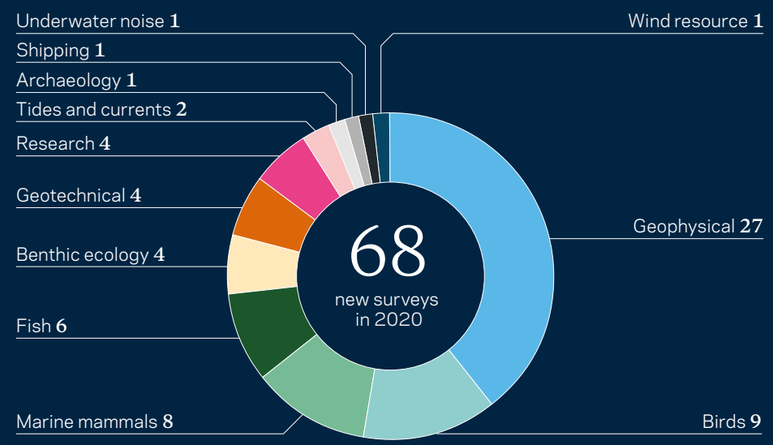
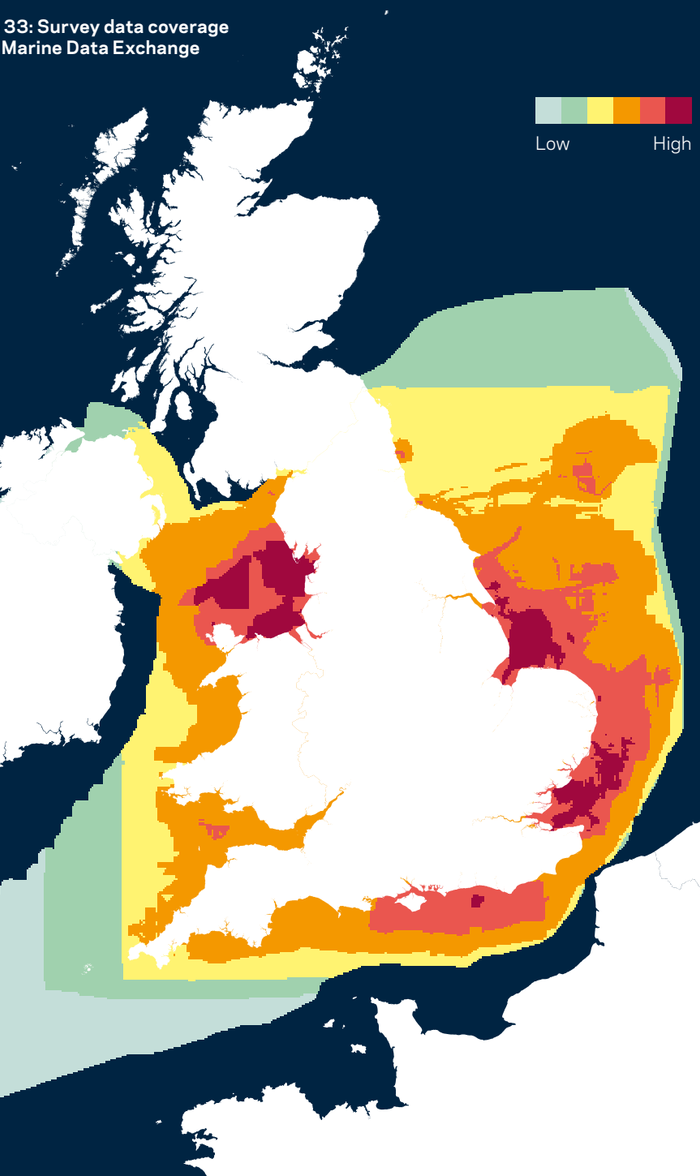


Figure 33: Survey data coverage on the Marine Data Exchange



Carbon dioxide displacement due to renewable energy

Displaced CO_2: Represents the carbon dioxide that would have been emitted by traditional power stations to generate electricity, in the absence of renewable energy.

A study of greenhouse gas emissions of the UK electricity system by R.C. Thomson (2014)[1] demonstrated that wind power displaces coal – and gas-fired power stations, and that partial loading of fossil-fuelled power stations has an efficiency penalty of 11%.

The CO_2 displaced by offshore wind can be calculated by using BEIS' emissions statistics for "all fossil fuels" and subtracting 11% to account for the induced efficiency penalty.

The Crown Estate uses this method to measure the benefit of offshore wind.

Displaced CO_2 in 2020:
16,161,145 tonnes

1 Carbon and Energy Payback of Variable Renewable Generation, Rachel Camilla Thomson (2014)

Related publications by The Crown Estate in 2020

2021 Marine Aggregates Summary Statistics

2020 Marine Aggregates Area Involved Report

2020 Electronic Monitoring System Study

Marine Data Exchange Report 2020

Marine Aggregate Capability & Portfolio Report 2020

Broad Horizons – Key Resource areas for Offshore Wind

Cumulative Effects Assessment Tool – Scoping Study

Review of Seabird Foraging Ranges

Review of Cable Installation, Protection and Habitat Recoverability

Reducing Underwater Noise Review

Review of Seabird Density Data for Plan Level HRA

Longer offshore transmission design life

Our thanks to all those who have provided content in particular:
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Photography: p1. Jason Hawkes; p2. London Array Limited; p5. RWE; p8-9. Jason Hawkes; p9. Ulrich Wirrwa; p10. Equinor and Jones Bros Civil Engineering UK; p11. Ørsted; p12. Greater Gabbard Wind Farm, a joint venture between SSE Renewables and RWE Renewables; p14. London Array Limited; p16. Jason Hawkes; p17. Beatrice Offshore Wind Farm; p19. Equinor and Jose Vega-Lozano, Aerial Vision; p20. Alex Tattersall courtesy of Underwater Photographer of the Year; p20-21. Dan Bolt courtesy of Underwater Photographer of the Year; p22. Frontier Power; p26. RWE; p28. Jason Hawkes; p30. Vattenfall; p31. RWE; p32. Cadeler; p35. RWE; p36. Danielle Lane; p36. Daniele Clifford and Lucy Mather; p37. Equinor and Jones Bros Civil Engineering UK

Correct as of April 2021, unless otherwise stated.

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