Report 2021

United Kingdom

ORE Catapult's 7MW Levenmouth Demonstration Turbine *(source: ORE Catapult).*

Author *Stephen Wyatt, Offshore Renewable Energy Catapult*

Less favourable weather conditions during 2021 contributed to renewable energy generation falling by 9.5% from 2020 to 121.9 TWh in 2021, although this figure is still the second highest on record. Renewables share of total energy generation fell from 43% to 39% from 2020 to 2021.

IN GENERAL, TOTAL energy production fell to its lowest level in over 50 years due to maintenance in the North Sea and disruptions in nuclear output. Energy demand increased by 5.4% from 2020 as COVID-19 restrictions were eased. However, this figure was still down 8% from 2019. Of the total annual electricity generated from renewables, wind energy provided 53% (29% offshore & 24% onshore).

Offshore wind capacity grew by 873 MW in 2021 to 11.2 GW of cumulative capacity. In terms of onshore capacity, 372 MW was added in 2021, taking the total to 14.5 GW. Despite a greater annual growth in offshore capacity than onshore, only onshore wind saw a corresponding increase in generation from Q4 2020 to Q4 2021 [1].

Research in the wind sector is focused on driving efficiency in O&M through collaboration between

Table 1. Key National Statistics 2021: UK

Total (net) installed wind power capacity*	25.7 GW
Total offshore capacity	11.2 GW
New wind power capacity installed	1.2 GW
Decommissioned capacity (in 2021)	- GW
Total electrical energy output from wind	64.5 TWh
Wind-generated electricity as percent of national electricity demand	22.6%
Average national capacity factor**	28.6 %
Target offshore by 2030	40 TWh
National wind energy R&D budget	5.86 MUSD

industry, academia, and the public sector. Tackling the challenge of grid integration will be vital as wind energy grows beyond 40GW. In addition, it will be vital to develop the local supply chain, deliver on ambitious targets, and maximise the benefit of the sector to the UK economy.

Highlight(s)

- The UK hosted the 26th UN Climate Change Conference of the Parties (COP26) in Glasgow.
- The average rating of new offshore turbines installed was 9.3 MW, an increase of over 2MW from 2020.

Market Development

Targets and Policy

The UK government has allocated over £380m in its Autumn Budget and Spending Review 2021 to boost the offshore wind sector in the country. The amount is expected to support the British government's goal of reaching 40GW offshore wind capacity by 2030. The Budget and Spending Review 2021 presented by the Chancellor of the Exchequer Rishi Sunak has also confirmed an investment of £160m in offshore wind power hubs. According to the government, the investment will help create and protect at least 2,500 jobs in the wider North-East of England. This will enable the sector to support up to 60,000 jobs by the end of this decade, said the government.

The fourth round of the Contracts for Difference (CfD) scheme, which aims to secure 12GW of electricity capacity, opens with £285 million a year of funding for low-carbon technology. The fourth round aims to secure more capacity than the three previous rounds combined with additional offshore wind capacity that could generate electricity equivalent to powering around eight million homes. Offshore wind will be supported by £200 million in funding a year, with £24 million initially allocated for floating offshore wind.

Progress and Operational Details

Renewable energy generation fell by 9.5% in 2021, although this is still the second highest annual generation on record after 2020. While generation from both solar and hydro decreased in 2021, the largest fall for renewable technologies came from the wind with an 11 TWh decrease from 2020 due to less favourable weather conditions. Offshore wind supplied 35 TWh of electricity, while onshore wind supplied 29 TWh, despite a greater onshore cumulative capacity. The average load factor for offshore wind was 37% and for onshore wind 23%, both down on 2020 figures due to lower wind speeds in 2021.

In total, renewable energy capacity grew by 1.6GW in 2021, a rise of 3.4% from 2020 after the recommencement of projects that were delayed due to COVID-19 restrictions. Wind power increased by 1.2 GW, of which offshore installed wind capacity by 873 MW in 2021. The average rating of new offshore turbines installed was 9.3 MW, an increase of over 2MW from 2020 as developers continue to scale up turbine ratings [2]. The first power was generated in December 2021 from Hornsea Two, which will become the largest offshore wind farm in the world once

Photo: Istockphoto.com

fully operational, with 165 8MW turbines supplying 1.3GW [3].

RD&D Activities

Matters Affecting Growth and Work to Remove Barriers

The EU and the UK government are still to finalise the UK's participation in the Horizon Europe (HEU) programme following the UK's exit from the European Union. This has caused some issues with preventing the participation of UK-based organisations in key HEU projects, which is potentially damaging to the UK's ongoing technology development in the offshore renewable energy sector. The UK government continues to seek a solution, including the potential to set up an alternative UK-funded research and innovation programme.

Potential bottlenecks are being addressed by a number of initiatives:

- Supply chain capacity – the Offshore Wind Growth Partnership (OWGP), Offshore Wind. Manufacturing Investment Scheme (OMIS) and Floating Offshore Wind Manufacturing Investment Scheme (FLOWMIS).
- Project consenting – Offshore Wind Acceleration Task Force (OWAT).
- Grid infrastructure – Offshore Transmission Network Review (OTNR) and Holistic Network Design (HND).

National RD&D Priorities and Budget

Offshore Wind Manufacturing Investment Scheme: The Department for Business, Energy and Industrial Strategy (BEIS) launched a £180m programme to support manufacturing investment in the supply chain, including blades, towers, export, and array cables, and other strategically important components [4, 5].

DASA Windfarm Mitigation for UK Air Defence Phase 2: As part of the BEIS £3.6mil Net Zero Innovation Portfolio, this Defence and Security Accelerator (DASA) competition sought technology proposals to permit the coexistence of future offshore wind farms alongside UK Air Defence surveillance systems [6].

BEIS Floating Offshore Wind (FOW) Demonstration Programme: This £31.6m programme consists of seven projects demonstrating an innovative technology to reduce costs and increase floating offshore wind turbine deployment rates [7].

The **Offshore Wind Growth Partnership (OWGP)** announced two £3.5m funding initiatives in 2021, focusing on improving capability, increasing competitiveness, and driving forward business growth within offshore wind and its supply chain [8].

National Research Initiatives and Results

Technology, Innovation & Green Growth for Offshore Renewables (TIGGOR) is a £3.5m programme designed to boost offshore renewable supply chain growth and productivity [9]. By June 2021, £1.7m was used to match-fund five North East England firms (Transmission Dynamics, Kinewell Energy, SMD, Trident Dynamics, and Unasys) to accelerate technology concepts in areas such

Riversimple RASA hydrogen fuel cell electric car
Photo: ORE Catapult

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Photo: ORE Catapult

as remotely operated vehicles, digital twins, cable arrays, and sensors. They now demonstrate their technologies to major stakeholders such as Equinor and EDF Renewables.

SusWIND – an initiative led by The National Composites Centre and delivered in partnership with the Offshore Renewable Energy Catapult to accelerate technology processes and material development addressing the recyclability/future development of composite wind turbine blades [10]. Year One highlights include an interactive digital map of expected volumes and localities of categorised UK blade waste streams with time. In addition, relevant recycling methodologies have been identified, along with a Life cycle Assessment of current blade materials, including CO2 emissions, along with alternative blade material variants [11].

The UK is actively developing post-graduate researchers to work in the wind industry through work done by university **Centres for Doctoral Training (CDTs)**, funded by EPSRC. The four leading CDTs focused on wind energy (AURA, IDCORE, RENU, and WAMESS) commenced over 40 new PhDs annually. ORE Catapult supported a WAMESS-based PhD identifying new mechanisms of combined UV and rain leading edge erosion.

In February 2021, the **Offshore Wind Accelerator (OWA)** published new fibre optic cable design recommendations, based on the findings from the Fibre Optic Cable Protection Assessment project, to mitigate export cable failure risk and achieve cost saving. . Five key recommendations were made which are likely to increase export cable costs by between 0-0.5% depending on the design it replaces; without affecting installation cost [12].

In July 2021, the **Carbon Trust** released the **Floating Wind Joint Industry Project – Phase III** summary report [13]. The report summarises research undertaken by the Floating Wind Joint Industry Project on technical opportunities/challenges to optimise floating offshore wind as it moves toward commercial-scale farms. An in-depth analysis of the challenges/opportunities relating to three critical operations: heavy lift maintenance, tow-to-port and mooring in challenging environments is provided.

Test Facilities and Demonstration Projects

Geographically Distributed – Hardware in the Loop (GD-HIL): a GD real-time HIL test facility joint developed by the University of Strathclyde, Dynamic Power Systems Laboratory (DPSL), Power Networks Demonstration Centre (PNDC), and ORE Catapult to enable different test centres to be combined to meet future testing requirements.

The University of Plymouth secured £1m funding to build the **UK Floating Offshore Wind Turbine Test Facility (UKFOWTT)** - expected completion in 2022 [14]. The primary purpose of UKFOWTT is to enable fundamental and applied research in floating offshore wind topics. This UK facility will enable systematic physical modelling experiments with wind, wave, and currents simultaneously.

Advanced Manufacturing for Next Generation Turbines: The BEIS funded Joule Challenge delivered by ORE Catapult, and the National Composites Centre is developing composite-based technologies beyond blades. ORE Catapult is further supporting this with the development of an advanced manufacturing facility for future offshore wind turbines, which is ready for commissioning and producing novel prototypes.

Milford Haven Energy Kingdom: the project is investigating local renewable energy (including the potential for green hydrogen from offshore wind in the Celtic Sea) to support net-zero transition, and accelerating hydrogen economy. A hydrogen refueller, storage, and electrolysers that produce green hydrogen have been installed to fuel two Riversimple RASA hydrogen fuel cell electric cars.

Root mounted sensor tests. *Photo: Eleven-i*

Collaborative Research

IEA Wind Task 46 Erosion of Wind Turbine Blades: ORE Catapult and the University of Bristol are actively contributing to several work packages. Includes Climate Conditions, Wind Turbine Operations with Erosion; Leading Edge Test Methods; and Erosion Mechanics and Material Properties.

In July 2021, the Industrial Technology Research Institute (ITRI) and ORE Catapult signed a **Memorandum of Understanding on the cooperation of offshore wind generation** [15]. This paves the way for an offshore wind O&M technology innovation programme based on the UK experience and its installed offshore wind power capacity. Technical exchanges will strengthen Taiwan's R&D capacities and contribute to an offshore wind generation ecosystem.

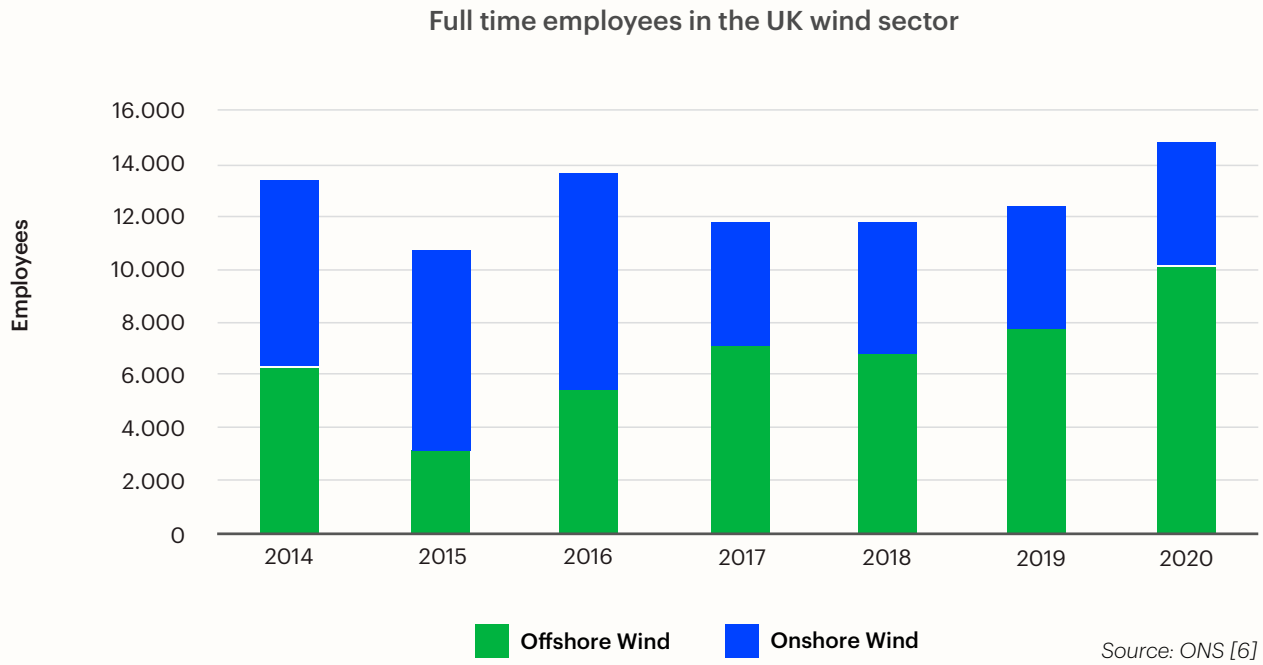
Optimal Sensor Placement: A $2.5m+ US-UK bilateral project led by Tufts University (US) and Transmission Dynamics (UK) to improve commercial-scale structural health monitoring and digital twin technology for offshore wind turbines, helping reduce O&M costs, increase offshore wind industry safety, and extend offshore wind turbine lifespan. [16].

DC Grid Topologies: A collaboration led by the University of Illinois Urbana-Champaign (UIUC) and ORE Catapult delivered in partnership with the Energy System Catapult. The collaboration was funded by the US Department of Energy Advanced Research Projects Agency-Energy (ARPA-E) and Innovate UK. The project explores offshore DC distribution and transmission configurations for an offshore wind turbines to the US electric power grids,

Eleven-I (UK) and Innvotek (UK) are working with GE Renewable Energy and ORE Catapult on robotic solutions as part of the 'Stay Ashore' R&D programme and delivered through the Offshore Wind Innovation Hub's Innovation Exchange (OWiX) in partnership with KTN. Both companies receive technical support, guidance, and demonstration opportunities with GE Renewable Energy and ORE Catapult.

Damage detection sensor tests
Photo: Eleven-i

Prosperity Partnership: A New Partnership in Offshore Wind: This is a £7.64million EPSRC-funded 5-year research programme using leading research insight into cost reduction opportunities. It involves Sheffield, Durham, and Hull universities, alongside Siemens Gamesa Renewable Energy and Ørsted.



Source: ONS [6]

Impact of Wind Energy

Environmental Impact

The easing of COVID-19 restrictions resulted in 285 TWh of electricity demand in 2021, up 1.8% from 2020. This was driven by a 4% increase in industrial electricity consumption as energy requirements for services and industry returned to near pre-pandemic levels.

2021 was the second greenest year on record in terms of electricity generation as renewable energy supplied 39% of the UK's electricity. Shares of both offshore and onshore wind fell in 2021, with the annual average share of wind energy fell to 53% of all renewable energy generation, down from 56% in 2020, with peaks of 61% in both the 1st and 4th quarters of 2021.

After a record-breaking 2020, decarbonization progress continued in 2021 as Easter Monday produced the lowest carbon intensity in history at 39gCO2/kWh [17]; however, as COVID-19 restrictions were eased, the level of greenhouse gas emissions increased by 4.7% from 2020, driven primarily by a 10% increase in CO2 emissions in the transport sector and a 6.3% rise in the public sector. 2021 greenhouse gas emissions were still 5.2% lower than in 2019, showing the impact of the pandemic on the environment [18].

Economic Benefits and Industry Development

Turnover in the UK's low carbon and renewable energy economy (LCREE) was estimated to be £41.2 billion (€49/$55.8 billion) in 2020. The wind sector was responsible for £6.4 billion of this, a 7% increase from 2019, with around 60% of this figure coming from offshore wind.

In terms of employment in the industry, the number of full-time employees (full-time equivalent) increased by an estimated 20% from 2019, with an increase of 2,500 employees in the offshore wind industry, taking the total number of full-time employees in the wind industry to 14,800. The estimated number of full-time employees in the onshore wind industry remained constant at 4,700. The value of the export market is weighted towards the offshore sector at £821 billion, compared to £78 billion for the onshore sector. Figures will not be published for 2021 until the end of 2022.

Next Term

The UK government announced the British Energy Security Strategy in April 2022, which outlined the intention to increase offshore wind capacity from 40GW to 50GW by 2030. The consenting time for offshore wind farms is to decrease from 4 years to 1 year, which will allow projects to reach the construction stage much quicker [20].

The results of the ScotWind Leasing Round were announced in January 2022, where almost 25GW of capacity was allocated across the 14 sites, with around 14GW to be floating offshore projects [21]. To continue the growth of UK wind, the future focus will be on developing the supply chain, in particular for offshore wind.

Photo: Gavin Allanwood / Unsplash

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