WOMBLE BOND DICKINSON | CORNWALL INSIGHT
CREATING CLARITY

Insight Paper

The UK and the energy transition

Leading the way?

May 2022

Contents

Foreword

Richard Cockburn
Partner, Head of Energy
Womble Bond Dickinson

The energy landscape is ever-shifting and geopolitical events have shone a particular spotlight on the UK's energy system. The age-old energy trilemma is in very sharp focus as the UK looks to decarbonise its energy sources, whilst ensuring security of supply and affordability of energy use.

To drive industry conversation and to help our clients and other key stakeholders to understand better how well the UK is performing in its energy transition, we commissioned this report from Cornwall Insight. Our aim was to bring global energy leaders together to debate the challenges and opportunities facing the UK energy sector. The report offers global context, analysis of different energy markets and expert insights which shine a light on the UK's progress in the energy transition.

Throughout the research period for this report, new variables continued to be thrown into the mix – the impact of the invasion of Ukraine, gas supply concerns and new legislation and political strategies were just some of the developments which are typical of the pace at which the energy landscape changes.

This report draws on lessons from around the globe and it becomes increasingly clear that the journey to net zero must be a collaborative one. The UK is well placed to play a key role in global efforts to reduce carbon emissions over the coming decades. The UK is a world leader in areas such as offshore wind, and it is now – after years of delay – forging ahead in carbon capture and storage and hydrogen, but it can still learn much from countries worldwide as the energy transition accelerates.

Executive summary

The United Kingdom is well placed to play a key role in global efforts to dramatically reduce carbon emissions over the coming decades. An urgent need to decarbonise its economy while ensuring security of supply is pushing the UK to develop domestic energy sources in a way that is both environmentally sustainable and socially equitable. While the country has well-founded ambitions to become a leader in specific technologies, such as offshore wind, nuclear and hydrogen, there is still a clear requirement to strengthen supply chains and address the uncertainties of a rapidly changing market for renewables.

In this report, we will assess the main opportunities and challenges facing the UK when it comes to major low carbon technologies, such as solar photovoltaic (PV), onshore and offshore wind, and hydrogen[1]. Some of the key findings are summarised here:

Net zero and energy security needs are set to turbo-charge UK renewables

- Over the past five years, the UK Government has significantly increased its decarbonisation efforts. The UK has the ambition and potential to become a global leader, with national businesses taking a key role in global supply chains of renewable technologies.
- The considerable impact of international tensions on the UK's gas and electricity wholesale prices – and thus on consumer bills – shows that energy dependence is fraught with risk. Hence, the reduction of energy dependence is now clearly becoming a policy priority.
- This was reflected in the publication of the Energy Security Strategy in April 2022, which set out policy and increased ambitions aimed at ensuring an "acceleration in energy independence"[2].
- A key feature of the Energy Security Strategy was policy backing for nuclear, offshore wind and low carbon hydrogen. These technologies are expected to be critical in the UK's journey towards energy independence.
- The UK can rely on its strong reputation as a friendly environment for energy and infrastructure investment, thanks to its robust rule of law and the transparency of its legal system.

Contracts for Difference (CfDs) will continue to play a key role in the UK's renewable roll-out. However, the market which CfDs overlay is uncertain, so the role of this regime may need to evolve in the coming years.

- Thanks to the CfD regime, the UK can boast a very effective scheme to support renewable sources, as highlighted by the success story of offshore wind. This support scheme is heavily reliant on market forces and less costly to the public purse than alternative approaches used in Europe.
- With CfD auction rounds becoming annual, the confidence of global and domestic investors and developers has been further boosted by the expectation of a healthy pipeline of projects across different technologies.
- The Energy Security Strategy proposes to consult on changes to the 2024 CfD auction to incentivise renewables while minimising whole-system costs. This adds uncertainty to the CfD scheme as the market underlying the scheme is likely to be transformed.
- Similarly, the Strategy saw the expansion of the UK Government's Review of Electricity Market Arrangements (REMA) which may impact those considering financing projects. High-level options may be introduced by the Review including locational marginal pricing which would result in the market being turned on its head.
- These potential market developments could contribute to a sense of uncertainty around wholesale, networks and balancing market frameworks until we get to the other side of the initiatives in these areas.
- As we move to a new phase of renewable development, driven by CfDs as well as merchant financing models, it is essential that planning processes are streamlined, and grid constraints are properly tackled.

1 *Please note that the content of this report does not reflect analysis of releases and market updates which occurred after 13 April 2022, as the cut off time for publication finalisation pre-dated them.*

2 *Major acceleration of homegrown power in Britain's plan for greater energy independence - GOV.UK (www.gov.uk).*

The UK needs stronger domestic supply chains to underpin net zero ambitions and boost economic growth

- The country has seen a dramatic ramp-up of renewables, however this has not yet translated in the development of a strong domestic manufacturing supply chain.

- We can no longer bank on learning rates lowering global supply chain prices. This is a big change from the last decade and, when combined with global supply chain pressures due to rising commodity prices and increasing demand, it is evident that supply chains are due to suffer upward cost pressure across the 2020s.
- It is essential that a minimum level of equipment and components are manufactured locally (boosting so called “local content requirements”) to ensure the development of the UK’s sustainable energy infrastructure supply chains, to build up industries and workforce within both established and less established technologies.

The UK has the potential to become a global leader in emerging technologies such as floating offshore wind

- While the UK has been historically successful in directing investment to relatively established technologies, it has struggled to develop less mature technologies.
- Floating offshore wind is a technology which is about to take off in the UK. It is key that the country leverages the significant expertise and know-how that it acquired by developing utility-scale fixed offshore wind over the last decade.
- The Energy Security Strategy will help to pave the way for the technology with an aim to bring forward up to 5GW of floating offshore wind by 2030.
- Investors and developers are becoming increasingly comfortable with offshore wind technologies, and therefore floating wind is already set to become the UK’s next success story.
- An important step now is improving infrastructure and policy around grid connection to accommodate for the roll-out of these technologies.

Policy to engage communities is essential for the future roll-out of land-intensive renewable technologies, such as onshore wind and solar

- Issues around community buy-in are often a key barrier for the development of solar and onshore wind projects.
- Co-location, agri-renewables and repowering will all play important roles in making better use of land available in the UK.
- The UK Government and devolved administrations can play a role in introducing policy and schemes which encourage a platform for dialogue between developers and local communities.

The UK is in a strong position to gain first mover advantage in nascent technologies, such as low carbon hydrogen and carbon capture, usage and storage (CCUS), with industrial clusters emerging as production and consumption hubs

- When it comes to low carbon hydrogen, the UK is rapidly developing a vibrant business ecosystem. Thanks to the publication of the Hydrogen Strategy in 2021, the UK is already catching up with its global competitors[3].
- The Energy Security Strategy raises the UK's ambition for low carbon hydrogen capacity to 10GW by 2030, with at least half of this to come from electrolytic-enabled, or 'green', hydrogen.
- The UK Government recently concluded its consultation on low carbon hydrogen business models. While a critical step in creating clarity for the market going forward, it is now key that these models are finalised and that final investment decisions are reached as soon as possible.
- The UK's industrial clusters are set to become leading hubs for the production and consumption of hydrogen as well as for the full-chain development of CCUS. However, industries and investors urgently need clarity on business models, so that they can make relevant investment decisions.
- The co-location of solar and wind assets with hydrogen and other storage technologies presents considerable opportunities, by enhancing the economics of projects, optimising land consumption, and contributing to the stability of the grid.
- The UK needs to fully exploit first mover advantage in the creation of its own hydrogen and CCUS economy. To this end, the oil and gas industry has a considerable role to play in the energy transition, thanks to its resources, assets, and know-how. Partnerships across different industries will be essential for decarbonising the economy at pace and scale.

3 *For more information, see Cornwall Insight's Low carbon Hydrogen Index which ranks the emerging low carbon hydrogen players, including the UK, in terms of their policy and financing for developing low carbon hydrogen supply chains.*

Chapter 1: The UK and the energy transition

As the world embarks on the colossal effort to reduce carbon emissions and turn the tide of climate change, the United Kingdom is well placed to take a leading role. The recent COP26 summit, hosted by the UK in November 2021, offered an ideal platform for the country to demonstrate this leadership, building on the commitments reached during the 2015 Paris Climate Agreement. The UK Government aimed to place national business centre stage at the conference, calling on corporations to "[set] out clear pathways to get to net zero" and to "help start a green business revolution"[4].

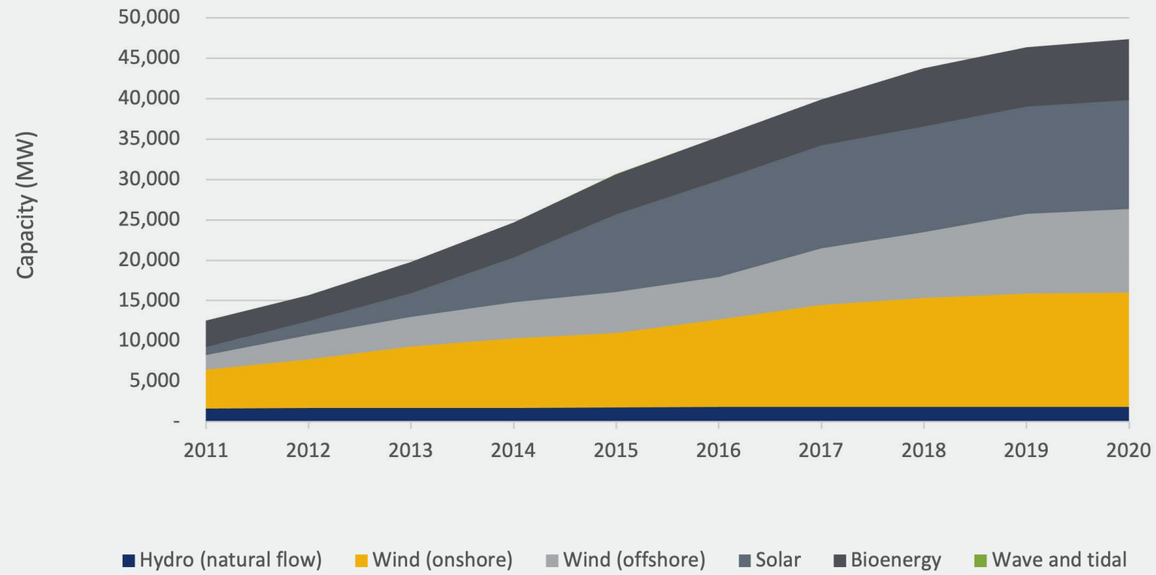
The power generation sector is the largest emission driver in the global economy[5]. In many countries, there has been rapid change in recent years with the development of renewable energy sources and accompanying technology for storage, as well as increased interconnection between countries. This progress is going to need to escalate in the future as we approach global net zero target dates.

Over the last five years, the UK Government has ramped up its decarbonisation of power generation (see Figure 1). In June 2019, the UK was the first large economy to make the target to reach net zero by 2050 legally binding[6]. The Scottish Government took a further step to expedite the achievement of this target by moving the deadline for zero-emissions to 2045 in Scotland[7].

The Johnson Government has identified net zero as a pillar in its COVID-19 economic recovery strategy, with a core narrative of "Build Back Better" and a stated commitment to be at the 'forefront of tackling climate change'[8].

A similar emphasis on net zero is present in the UK Government's 2022 Energy Security Strategy, published in response to recent international tensions and related volatile wholesale gas prices. The Strategy includes increased targets for the development of solar, wind, hydrogen and nuclear. While the Strategy envisages a role for the domestic production of fossil fuels, there is a clear recognition that renewables are the primary route to ensuring the UK's security of supply is sustainable in the long-term.

Figure 1: Capacity installed per technology (MW) UK 2011-2020



Source: Cornwall Insight

Net zero commitments

The global transition to net zero is a core commitment in the Paris Agreement— a legally binding international treaty on climate change — adopted by 196 parties at COP21 in 2015. Reaching net zero entails reducing greenhouse gas (GHG) emissions to a point at which the amount generated is no more than the amount removed. The aspired outcome of this reduction in GHG emissions is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. The Intergovernmental Panel on Climate Change has calculated that in order to achieve this, net zero must be achieved by 2050.

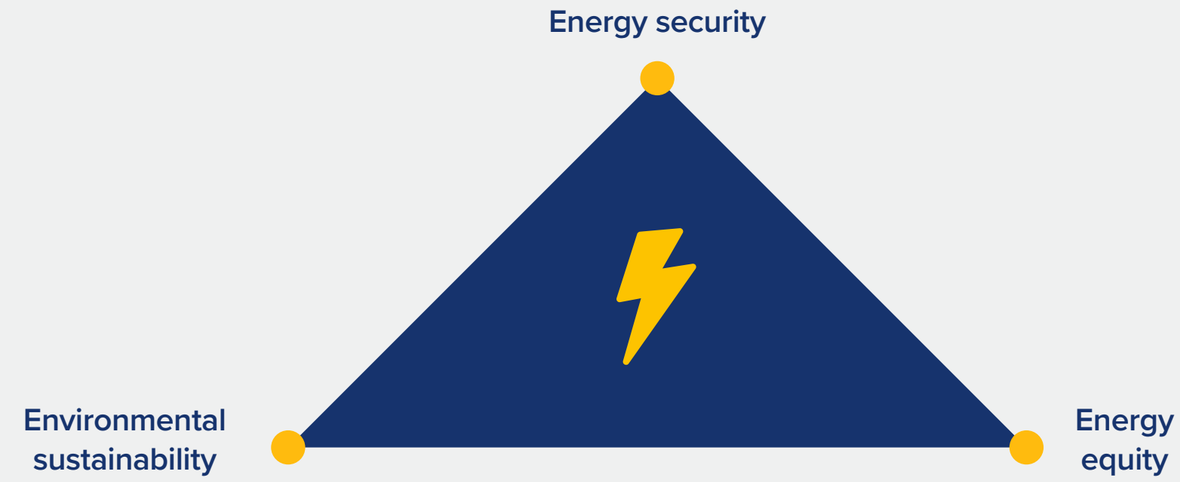
The UK Government adopted this target and made it legally binding. Scotland has been a world leading jurisdiction in setting its target date for net zero at 2045.

4 *COP26 sees UK businesses lead the world in climate change commitments - GOV.UK (www.gov.uk).* **5** *Emissions by sector – Greenhouse Gas Emissions from Energy: Overview – Analysis - IEA.* **6** *UK becomes first major economy to pass net zero emissions law - GOV.UK (www.gov.uk).* **7** *Climate change - gov.scot (www.gov.scot).* **8** *Build Back Better: our plan for growth (HTML) - GOV.UK (www.gov.uk).*

Concerns around energy security and international tensions have also brought to the fore issues related to energy equity in the UK's net zero transition. The price spikes experienced across the UK have highlighted the extent to which high energy prices can severely impact businesses and households, adding to inflationary pressures and threatening post-pandemic economic recovery. In particular, the impact of higher bills as the energy cap rises could result in fuel poverty for low-income customers, plunging them into the "eat or heat" dilemma. Hence, it is essential to ensure that both the net zero transition and the pursuit of energy independence happen – as per the ever-relevant energy trilemma (see Figure 2) – at an affordable cost for consumers and citizens.

The following sections of this chapter provide an overview of the areas of competitive advantage and the challenges facing the UK in realising its ambitions related to the net zero transition, before we turn to explore key transition technologies and the legal and regulatory hurdles for developing these technologies in the UK in comparison to global competitors.

Figure 2: The energy trilemma



Source: World Energy Council

> Concerns around energy security and international tensions have brought to the fore issues related to energy equity in the UK's net zero transition.

1.1. Areas of competitive advantage

A key competitive advantage for the UK as a global leader in the renewables sector is its reputation for being a friendly environment for energy and infrastructure investment. Ranked 8th globally in the World Bank's Ease of Doing Business rankings[9], the UK boasts a strong financial community surrounding the infrastructure and energy sectors. This ecosystem is made up of funds, banks and advisors based in the City of London and across the country. Lawrence Slade, CEO at membership body Global Infrastructure Investor Association (GIIA), noted that this reputation and network help the UK to be 'increasingly popular from an investor's point of view' in comparison to global competitors.

This attractiveness of the UK in the eyes of Environmental, Social and Governance (ESG) driven investors is further bolstered by the country's track record in encouraging sustainability across different industries. Belton Zeigler, Partner at Womble Bond Dickinson, noted that the UK is 'at least a decade ahead of the United States' in ESG business practices. Discussing utilities in particular, he added that this gives British companies 'better green credentials' providing them a 'bit of a leg up' when it comes to attracting investment.

A strong rule of law and relatively transparent legal system are further attractive features for investors and developers considering projects in the UK. Regarding the former, Alejandro Ciruelos, Managing Director at Q-Energy, observed that 'the jurisdiction is safe in the sense that there is a track record of private contracts being preserved over changes or trying to be overridden by public sector policy', especially when 'compared to other jurisdictions in Europe'.

There is also a sense of transparency in terms of setting regulation and policy with open and, in many cases, inclusive discussions. This creates a more positive perception of the UK on the international stage.

Renewables Obligation (RO):

A tradeable green certificate scheme introduced in the UK in 2002 as the then main policy measure to encourage the development of electricity generating capacity using renewable generation technologies.

Feed in Tariffs (FiT):

A payment made to generators of small-scale renewable electricity generation (total installed capacity ≤ 5MW for hydro, wind, Solar PV and anaerobic digestion; ≤ 2kW for CHP) for electricity produced.

Contracts for Difference (CfD):

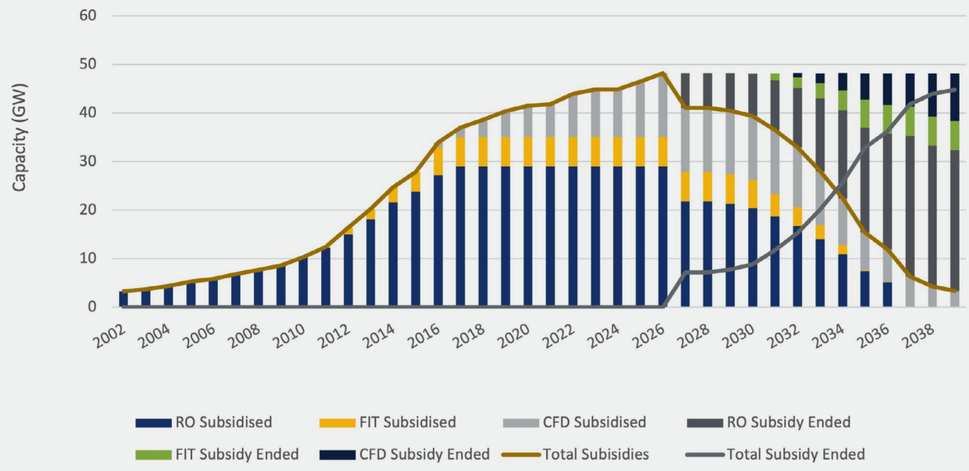
A generator party to a CfD is paid the difference between the 'strike price' – a price for electricity reflecting the cost of investing in a particular low carbon technology – and the 'reference price'– a measure of the average market price for electricity in the GB market.

9 *Rankings (doingbusiness.org).*

In addition, the UK has well-developed policy and regulation related to renewables, underpinned by the Electricity Act of 1989. This act introduced early support for low carbon schemes such as the Non-Fossil Fuel Obligation, which was later replaced by the Renewables Obligation (RO) in 2000. Figure 3 illustrates the capacity installed under each of the schemes active after 2002.

One distinct feature of the UK CfD scheme is that it encourages participation of market forces in decarbonisation, limiting the reliance of these schemes on public funding. The CfD support mechanism has proven to be more economically sustainable than others used across Europe and elsewhere, costing less to the public purse than alternatives, while fostering confidence amongst investors. While recognising the advantages of the CfD scheme, the UK Government included it as a feature of the market to be reviewed through the REMA in the coming year. All changes to the scheme will follow consultation with the wider market.

Figure 3: Capacity supported under each GB subsidy scheme 2002-2020 and expected forecast 2022-2038 (GW)



Source: Cornwall Insight, GOV.UK

Since 2014, Contracts for Difference (CfD) have been awarded to over

16GW

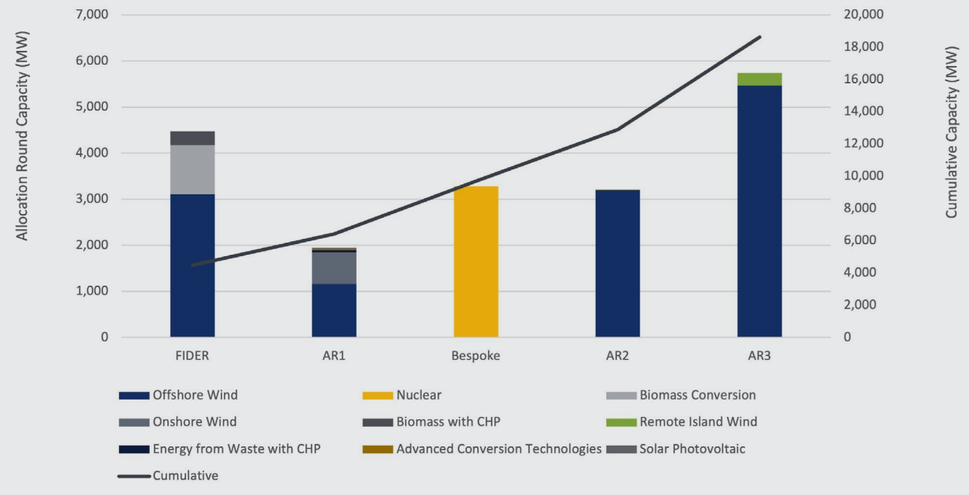
of new renewable electricity capacity, 13GW of which is offshore wind[10].

The scheme has helped to facilitate the reduction of technology costs in wind; the price per unit of offshore wind fell by around

65%

between the first allocation round in 2015 and the third in 2019[11].

Figure 4: Timeline of capacity (MW) awarded per technology across UK Contracts for Difference rounds



Source: Cornwall Insight, LCCC

10 *Contracts for Difference and Capacity Market scheme update 2020 (publishing.service.gov.uk).*

11 *Biggest ever renewable energy support scheme opens - GOV.UK (www.gov.uk).*

1.2. Key challenges

Despite the UK's strengths, there are also challenges in developing renewables. Firstly, the UK has historically directed capital more effectively to established technologies rather than to emerging technologies, limiting the country's potential in these nascent markets. The UK Government's objectives have sought to balance the cost to the consumer with decarbonisation goals. As newer technologies – such as CCUS, low carbon hydrogen and tidal energy – typically have higher costs than more established technologies, there is a risk of overlooking these industries and missing key opportunities. A lack of policy clarity around these technologies could reduce investor confidence and slow their development.

The Brexit process has also posed some challenges to the development of renewables in the UK. Following the referendum in 2016, UK policy was centred around a successful exit from the European Union, meaning that net zero commitments were not prioritised in the national agenda. Hence, a period of opportunity was missed in the late 2010s, with Brexit partially slowing down investment into the UK as the stability of the country's currency and political landscape was called into question. Discussing this, Q-Energy's Alejandro Ciruelos highlighted that following Brexit there were 'certain limitations' in the 'amount international capital wanted to take exposure to sterling' as well as 'uncertainty around the impact on the financial services industry'.

A recent report published by the House of Lords found that the UK Government is likely to miss its target of net zero by 2050, with a lack of policy cohesion and financial incentives being a key cause of this[12]. The report recommended the establishment of a Transformation Taskforce which would help to coordinate the UK's policies around net zero, working across governmental departments to monitor and advise on progress.

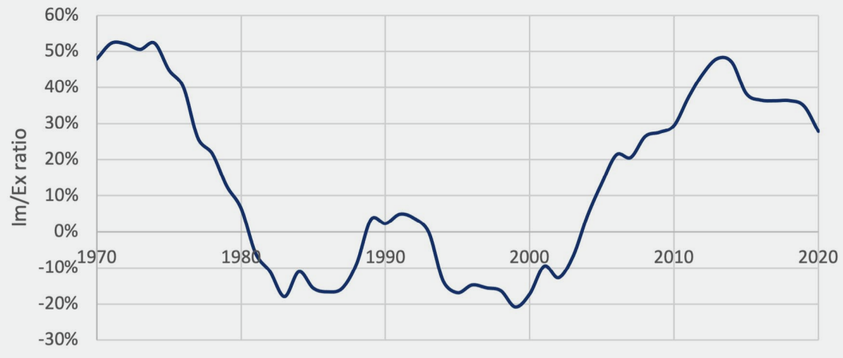
Challenges to the UK's energy transition also extend beyond the UK shoreline. As illustrated in Figure 5, the UK has been a net importer of energy since the early 2000s and this has meant that it has been exposed to recent international tensions, which have led to a rise in gas and wholesale electricity prices (see Figure 6).

As a consequence, in late 2021, the UK saw a retail market crisis as around 30 domestic and business suppliers failed following unprecedented peaks in commodity prices. The approach taken by the UK Government in responding to this crisis going forward will impact the attractiveness of investment into energy infrastructure.

As recognised in the recent Energy Security Strategy increasing renewable capacity and storage, as well as enhancing networks, will limit the impact of these events and ensure more stable and predictable prices in the long-term.

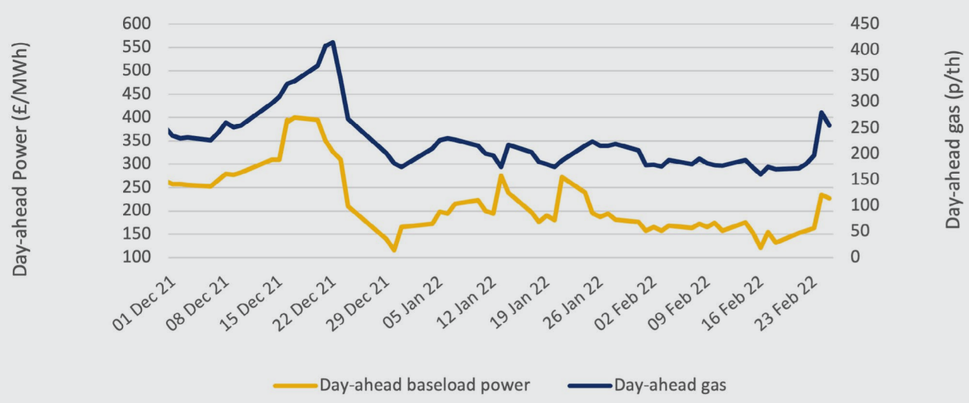
The following chapters will explore key renewable technologies (solar PV, onshore wind, offshore wind, hydrogen & CCUS), discussing past and present barriers and strengths for developing these technologies in the UK, as well as their future potential. Comparisons will be drawn throughout to international competitors.

Figure 5: Import/Export dependency ratio (%)



Source: Cornwall Insight

Figure 6: Day-ahead power (£/MWh) and gas (p/th) prices



Source: Cornwall Insight

12 *UK will miss net zero target without urgent action, warns Lords committee - Committees - UK Parliament.*

Chapter 2: Solar PV

2.1. A resurgent market?

In spite of relatively limited solar irradiation and supply of viable land compared to other jurisdictions, UK solar photovoltaic (PV) developments expanded at pace in the 2000s and early 2010s. This was largely due to the Renewable Obligation (RO) and Feed in Tariff (FiT) schemes. Both the RO and FiT were successful in providing a sense of confidence and security to investors and developers of solar and costs for the technology have fallen dramatically since (see Figure 7). However, this 'boom' was followed by a 'bust', as the schemes were phased out and replaced with the CfD. Solar was excluded from early CfD auction rounds from 2015 to late 2021, leading to a stagnation of the market over this period.

A similar pattern of boom and bust played out across the European continent as governmental support was withdrawn across several highly attractive and profitable solar markets. Tariff cuts had a particularly negative impact on investor confidence in some European countries due to the alleged retroactive effects of the cuts.

In the UK's Energy Security Strategy, solar received less attention than technologies such as offshore wind and hydrogen. There was some ambition with an announcement that the UK's current 14GW of solar capacity "could grow up to 5 times by 2035". However, these plans do not include the hard targets seen elsewhere in the Strategy. Moreover, the UK Government sees its role largely in removing friction around planning. It is banking on cost reduction with an expectation to deliver this through merchant investment.

2.2. The evolution of routes to market

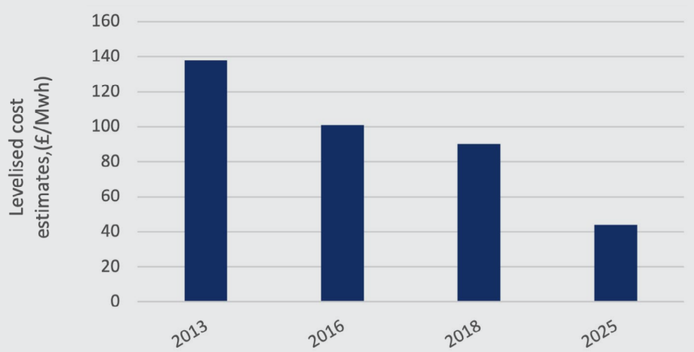
The story for solar in the UK did not end with the closure of RO and FiT. John Puddephatt, Head of Long Term PPA Origination in the Trading & Origination UK department at the developer Statkraft, highlighted that Power Purchase Agreements (PPAs) and Corporate PPAs (CPPAs) have since played a key role in providing a fixed income to generators. This route to market was spearheaded in the UK, with a solar project – the 10MW Clayhill solar project with 6MW of co-located storage – as the first successful subsidy-free PPA to be developed.

Meanwhile, the case of fully merchant solar projects has been less popular in the UK than in southern European countries, due to the UK's weaker solar irradiation. Moreover, concerns around price volatility presents a challenge for the bankability of solar projects, often prompting developers and investors to opt for routes to market with more predictable revenues.

Over the past few years, support for solar PV technology from the UK Government has increased. In January 2020, the Smart Export Guarantee (SEG) was launched. It replaced the FiT in supporting small-scale renewable projects, including solar PV, up to a capacity of 5MW. In 2021, ground-mounted solar of over 10MW was included in the CfD auctions in the UK. The SEG has also helped to broaden the routes to market for the technology in the UK, offering opportunities to combine merchant, PPAs and CfD revenues. This is attractive to developers and investors who prefer to see multiple offtake routes. 'As a developer, when you look at a market and there's only one route to market, then that's a risk', said Zosia Riesner, Director of Power Markets at the global solar developer, Lightsourcebp. Hence, the more options available for offtake, the more confidence that can be built up amongst market participants.

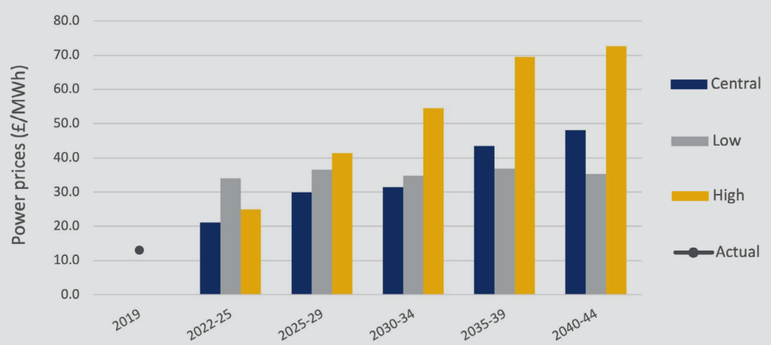
Discussing the CfD, Sebastian Briggs, Partner at Womble Bond Dickinson, noted that the scheme helps to provide certainty of revenue coming in, building confidence for investors facing unpredictable future domestic power prices in the UK (see Figure 8). He went on, however, to question whether the 3GW cap for solar in recent CfD rounds needs to be higher as we observe larger deals coming through at around 500MW, raising concerns that 'the cap very quickly gets eaten up'.

Figure 7: Levelised cost estimates for large scale solar projects



Source: BEIS DECCS , Cornwall Insight

Figure 8: Forecasted UK power prices, 2019-2044



Source: BEIS DECCS , Cornwall Insight

2.3. Is co-location set for the mainstream?

Co-location of solar (or wind) with storage and electric vehicle (EV) charging can significantly enhance the economic viability of a project, by allowing developers to stack revenues and therefore capture more value. In particular, co-locating a battery with a solar or wind asset can help shift the load, as well as releasing power at the most suitable time based on current wholesale market prices. It also has a further benefit of contributing to the stability of the grid. As we move forward towards a power generation mix made up of intermittent renewables 'optimising how we are participating in the grid is going to be really important', and one way of overcoming this is by 'providing the flexibility that storage brings with solar', noted Lightsourcebp's Zosia Riesner. This is particularly important in the UK as short days during the winter period mean that solar power cannot be generated at times of peak consumer demand in the evenings.

Despite the advantages of co-location, it is not a silver bullet and developers face some complications and challenges. Simon Hughes, Partner at Womble Bond Dickinson, observed that the 'legal structure is not as straightforward as you'd want', particularly when hybrid projects involve two separate companies. He added however that '[these issues] are currently being worked through and are not insurmountable'. Lightsourcebp's Zosia Riesner also discussed difficulties with co-location noting that by combining storage with solar, you are 'changing the risk profile of the project' as the project's revenue stack shifts from long-term contracts to participating in the short-term market.

UK land scarcity and mixed community support for solar projects are also issues that require consideration and attention. Christopher Towner, Partner at Womble Bond Dickinson, highlighted that, since the UK's exit from the EU's Common Agricultural Policy, there has been a 'lack of clarity from the UK Government on what it is we're actually asking farmers to do and this has exacerbated issues of low confidence amongst local communities'. He went on to note that the 'trick we seem to be missing at the moment [in resolving this issue] is promoting agri-solar as part of the solution, saying that there is not a choice between energy and land'. Agri-solar or agri-photovoltaics – the simultaneous use of areas of land for solar power generation and agriculture – has been successful in European countries and some US states, where farms producing soft-fruits and potatoes are able to install solar panels above crops in order to benefit from higher profits. Q-Energy's Alejandro Ciruelos also observed that these approaches allow 'government to facilitate local communities in getting organised themselves and getting projects consented', encouraging community buy-in and leading to more land becoming available for solar.

> **"The legal structure is not as straightforward as it could be, particularly when hybrid projects involve two separate companies."**

Chapter 3: Onshore wind

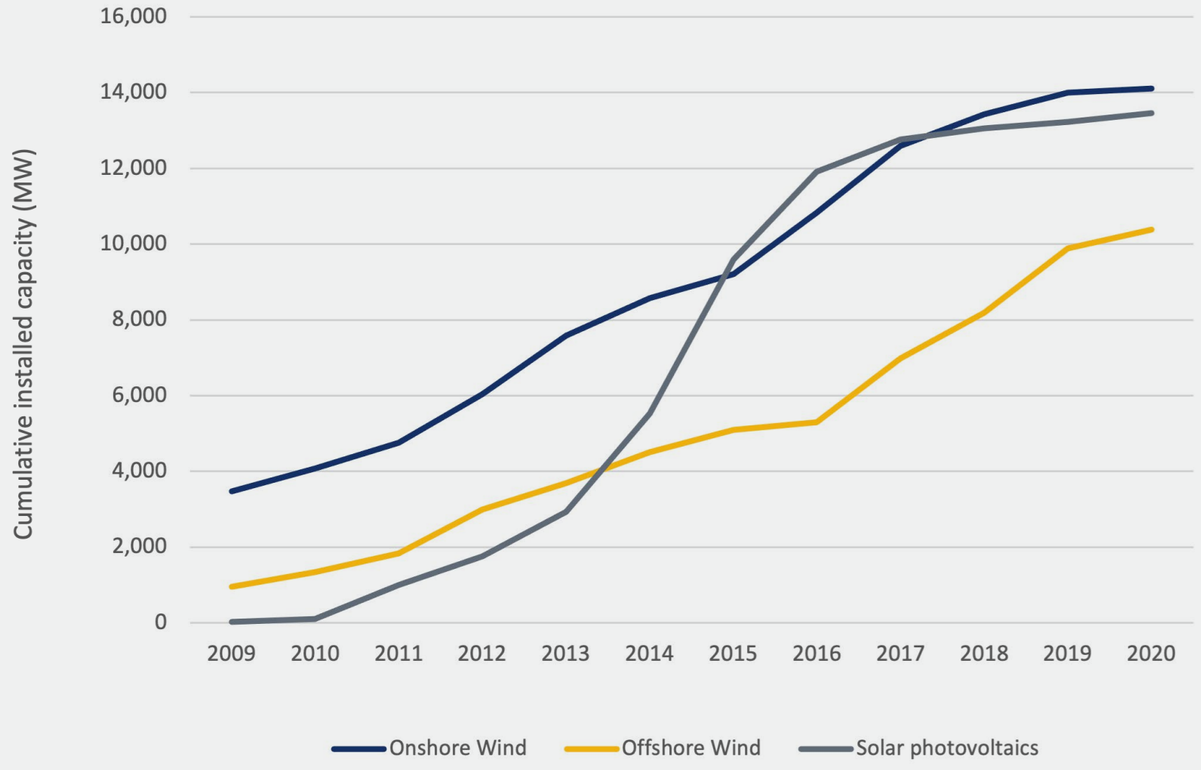
3.1. A bumpy road?

The UK saw a rapid increase in the installed capacity of onshore wind in the early 2010s as capital costs for the technology fell. As with solar, the installation rate of the technology stalled after 2017 following its exclusion from the CfD rounds in 2015 (see Figure 9) which led to the cancelling of projects across the country.

The introduction of planning restrictions in 2015 compounded this stagnation, as projects which did manage to get financing were stalled or refused at the planning stage causing a bottleneck of potential projects. This has discouraged engagement in the market: between 2016 and 2020 just eight onshore wind farm applications for new or extended sites were submitted in England, compared to 237 applications between 2011 and 2015[13]. However, the impact was not felt uniformly across the country, as planning rules have varied in different jurisdictions (see Figure 10). 'The market was fragmented', Womble Bond Dickinson's Sebastian Briggs said, 'north of the border in Scotland, there's a significant amount of activity and new builds – in England and Wales it's a very different story'. Issues around a backlog in planning have been further exacerbated by unevenness of community acceptance for onshore wind farms across the UK.

The UK Government's recent Spring Statement saw new announcements for wind technology in general: VAT was removed from wind turbines, along with water turbines, and both technologies were added to the list of energy saving measures[14]. In the UK Government Energy Security Strategy, which was published shortly after the Spring Statement, onshore wind received little attention and detail in comparison to offshore wind. Where onshore wind was discussed, there was a recognition of the need to engage better with communities to simplify planning and development processes, as the following sections of this chapter will explain.

Figure 9: Annual cumulative installed capacity (MW), UK, 2009-2020



Source: GOV.UK, Cornwall Insight

2016 > 2020

8

onshore wind farm applications for new or extended sites were submitted in England

2011 > 2015

237

onshore wind farm applications for new or extended sites were submitted in England

13 *Renewable Energy Planning Database: quarterly extract - GOV.UK (www.gov.uk).*

14 *Spring Statement 2022 speech - GOV.UK (www.gov.uk).*

3.2. Planning problems

Regulatory barriers for onshore wind continue to be a key challenge facing the technology, compounded by differences in Scottish, English and Welsh planning requirements. A key barrier emerging from the planning restrictions has been the requirement for projects to be agreed upon by local communities. Historically, in many cases it has been difficult to engage with communities in the UK regarding onshore wind developments.

Rapidly declining costs in the early 2010s have meant that the few 'low-hanging fruit' sites which had suitable planning permission and grid connection, have already been built on. Womble Bond Dickinson Partner Anthony Alderman noted that there is a market perception that those sites that 'are left are quite challenging [...] once you look at the site in more detail, you discover all the reasons why everyone else discarded it', and as a result developers and investors are discouraged from developing onshore wind projects.

Repowering by installing more efficient turbines on existing sites, can offer opportunities for project owners to increase revenues. What is more, repowered projects may have an easier ride through the planning process with local communities.

Regarding CfDs, onshore wind was included in the scheme's latest auction round for the first time since 2015. Support for the technology has been capped at 3.5GW of eligible capacity, given the greater focus of the UK Government on scaling up offshore wind and the large proportion of budget which that technology inevitably takes up.

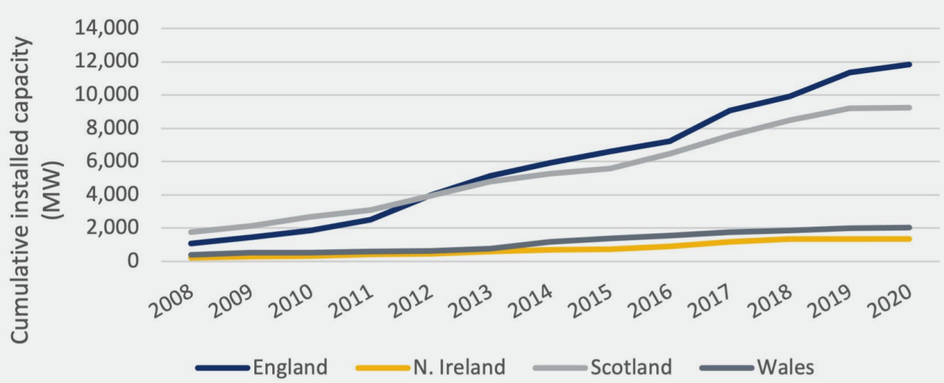
In a joint response, community energy groups[15] from across the UK welcomed the re-inclusion of onshore wind in UK CfDs, though went on to encourage more attention to developing schemes directly related to supporting local generation[16].

A further challenge facing onshore wind, as well as solar, has been grid constraints. Limited access to the grid makes projects that would otherwise be highly attractive challenging. Simon Hughes, Partner at Womble Bond Dickinson, observed that this is a particular risk for potential sites in mid-Wales, a 'primary area where there is a strong wind resource' but a congested grid. Figure 10 illustrates the limited installed capacity in Wales in comparison to England and Scotland.

Onshore wind has also come into conflict with a number of other UK sectors. Firstly, aviation has occasionally blocked the development of onshore wind projects due to clashes with flight paths. This problem is only likely to grow as turbines get bigger.

Secondly, onshore wind, like solar (as mentioned in section 2.3), is a land-intensive technology which will increasingly compete with other forms of agriculture and forestry in the UK. James Samworth, Partner at Greencoat Capital, a renewables investment management firm, observed that this will exacerbate the 'bottleneck in development' for the technology. This issue has been further compounded by the departure of the UK from the EU and the resulting uncertainties around supply and demand for the agricultural sector.

Figure 10: Annual cumulative installed capacity (MW) of onshore wind, UK jurisdictions, 2008-2020



Source: GOV.UK, Cornwall Insight

15 *Community energy groups are not-for-profit organisations which support the delivery of community-led renewables, whether wholly owned and/or controlled by communities or through partnership with commercial or public sector partners.*

16 *15591032846_ContractsforDifference_CEECESCEWresponse.pdf (communityenergyengland.org).*

3.3. Making way for onshore wind

As there is an increasing consensus that the development of onshore wind will be critical to the UK's energy transition, a number of challenges will need to be tackled. Firstly, there is a need to upgrade the existing UK grid to manage onshore wind farms. Suggestions for addressing this include providing incentives for the grid to open up capacity more quickly and providing balancing measures such as energy storage. The first of these areas for improvement was addressed in the Energy Security Strategy where assurances were made for Ofgem to "dramatically reduce timelines for delivering strategic onshore transmission network infrastructure by around three years".

There are certain regions of the UK where efforts should be focused to resolve grid challenges, such as in mid-Wales where wind resource is high, but grid capacity is insufficient. As renewable power capacity is set to increase substantially, this issue will become 'much more difficult over time' observed Charlotte Eddington, Investments Director at direct investment platform Abundance Investment. Lessons can be taken from Germany, a country leading in onshore wind capacity (see Figure 11), but which also faces grid blockages. The German Government is looking to address blockages in the northern region through their hydrogen strategy which emphasises the use of electrolyser capacity to convert northern wind power to hydrogen which will be sent south in pipelines.

As with solar, co-location of onshore wind with storage is an appealing option for maximising grid capacity and smoothing the curve of intermittent generation. Womble Bond Dickinson's Simon Hughes noted that, 'amongst developers [co-location] has been a real hot topic over the last 12 months'.

Facilitating enhanced dialogue with rural communities and the aviation sector is also 'something to be mindful of', as Womble Bond Dickinson's Partner Sebastian Briggs noted. Dialogue will ensure that project applications are less likely to be slowed or fail at the planning stage.

The Energy Security Strategy recognised this issue, with specific measures to be taken in each area of the country. In Scotland, the UK Government will work with the Scottish Government to ensure community and landscape issues are considered. In Wales, the UK government will support work already underway by the Welsh Government. Meanwhile, in England there are plans for 'partnerships with a limited number of supportive communities who wish to host new onshore wind infrastructure in return for guaranteed lower energy bills'. Victoria Redman, Planning Partner at Womble Bond Dickinson said, 'any easing of planning restrictions for onshore wind in England is welcome but challenges still remain'.

Applications will still need to gain the support of the local community, so evidence of compliance with environment requirements and certainty on accessing a grid connection will still be essential. France's concept of débat public (public debate) could provide a potential template and in Denmark policy measures were introduced in the Promotion of Renewable Energy Act 2009[17] to encourage community ownership of wind farm projects.

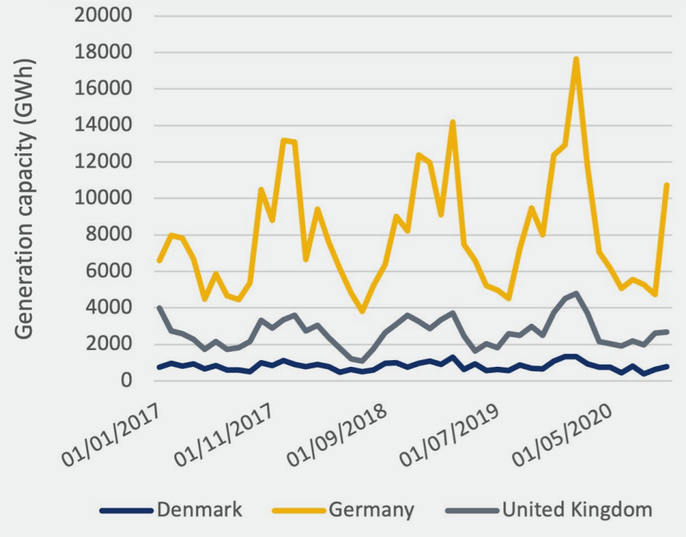
Community engagement will also benefit developers looking to repower onshore wind assets. This will be of increasing importance as a number of projects in the UK are nearing the end of their lifetime and are due to roll-off the CfD support scheme. In some cases, repowering will involve increasing a project's capacity, potentially exacerbating issues around the visual impact on local communities. Therefore, engaging with these communities will allow for smoother implementation of life extension processes.

Moreover, regulatory changes can also help to facilitate the shift to repowering in the UK. Lessons can be taken from Germany where repowered capacity is eligible for new subsidies under the EEG, the country's Renewable Energy Act[18].

Finally, UK supply chains need to be better developed. At present, much of the manufacturing for onshore wind projects is done abroad, undermining the UK's manufacturing sectors. The recent inclusion of supply chain requirements in Round 4 CfD processes should help to abate this issue, as CfD applicants with generation capacity of 300MW or more will be required to complete and have approved a Supply Chain Plan questionnaire.

Nonetheless, issues around supply chains remain. Womble Bond Dickinson's Simon Hughes flagged, for instance, that 'no set timetable is creating huge difficulties within the supply chain'.

Figure 11: Generation capacity (GWh) Germany, Denmark, United Kingdom



Source: Eurostat, Cornwall Insight

17 *FAO.org.*

18 *2009 Amendment of the Renewable Energy Sources Act (EEG 2009) – Policies - IEA.*

Chapter 4: Offshore wind

4.1. A success story

The UK is a global leader in offshore wind with 14GW of offshore wind either fully commissioned or under construction and an ambition to increase this to 50GW by 2030, with 5GW of this to be from floating offshore wind[19]. As Figure 12 illustrates, the UK has been leading in Europe for installed capacity across the past half-decade. Lisa Rushton, Partner at Womble Bond Dickinson, noted that for the US 'there are some lessons to be learned from the UK' in terms of how to 'implement the technology', 'connect energy back to the onshore grid' and 'expedite permitting'. Womble Bond Dickinson Partner Belton Zeigler concurred with this, adding that while the technology itself can be acquired by the US, 'bringing these projects up' requires taking on the 'know-how and practical experience from the UK', which could help the United States to 'jump start this business'.

The technology forms an integral part of the UK's legally binding commitment to reach net zero carbon emissions by 2050 and of the UK Prime Minister's Ten Point Plan for a Green Industrial Revolution. Between 2016 and 2021, investment in the sector was around £19bn, so these targets will provide vital market signals to secure billions in investment, with over £10bn/year[20] to be invested in the sector between 2021 and 2026. The Offshore Wind Sector Deal in March 2019 also proved to be another key signal for investors, as has the emphasis on the technology in the UK Government's recent Energy Security Strategy.

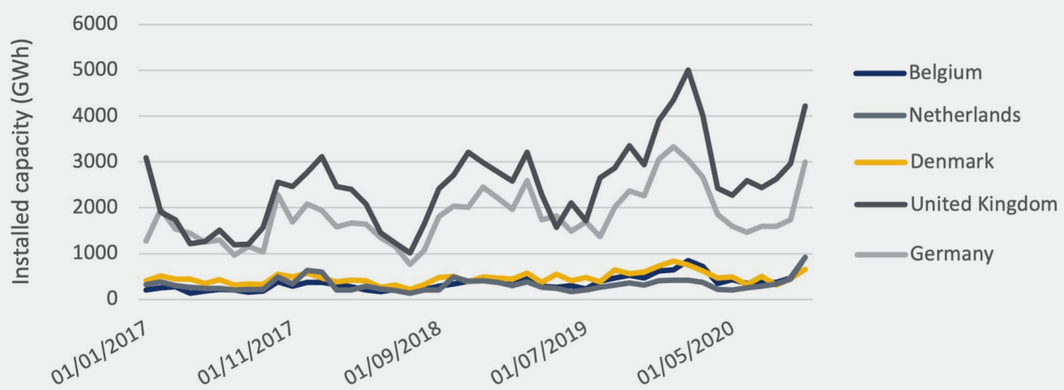
The CfD scheme has boosted the success of the UK's offshore wind industry. Since 2015, contracts have been awarded through a series of competitive auctions known as allocation rounds. As part of the latest CfD auction round, the UK Government announced £200m to support offshore wind projects and help ensure the 40GW of offshore wind capacity is reached by 2030.

The scheme has delivered substantial new investment and contributed to significantly reducing the cost of offshore wind by around 65% since 2015.

The ScotWind leasing rounds have also been a significant contributor to the scale up of offshore wind in the UK[21]. Its outcome was announced in early 2022, marking it as the first round of Offshore Wind Leading in Scottish waters for a decade. 17 projects were selected – totalling 25GW of capacity – and have been offered agreements to reserve the rights to specific seabed areas.

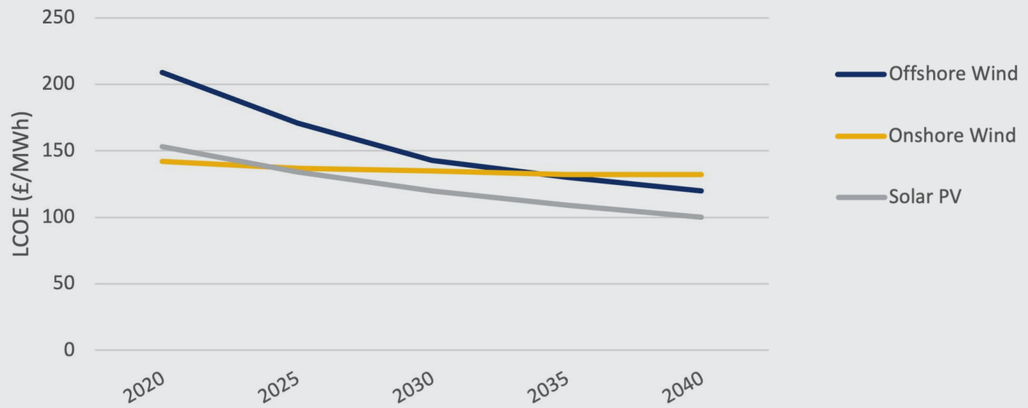
Looking forward, the Levelised Cost of Electricity (LCOE) for the technology in the UK is set to decline further over the next decades dropping below the LCOE of onshore wind, a more established renewable technology, in 2035 (see Figure 13).

Figure 12: Installed capacity of offshore wind 2009-2020



Source: Cornwall Insight, Eurostat

Figure 13: LCOE (£/MWh) estimates for offshore wind 2020-2045



Source: Cornwall Insight, GOV.UK

19 *Major acceleration of homegrown power in Britain's plan for greater energy independence - GOV.UK (www.gov.uk).* 20 *Offshore Wind: Building on the UK's Success, November 2021, OWIC.*
21 *ScotWind offshore wind leasing delivers major boost to Scotland's net zero aspirations - News - Crown Estate Scotland.*

4.2. Ambitious targets, enduring challenges

The goal of 50GW of offshore wind by 2030 will require an ambitious installation target of around 2GW of offshore wind each year. There are concerns around the effectiveness of the current regulation and policy in place to support this. The Offshore Transmission Owner regime has been in place since 2009 and provides a competitive tender process through which offshore transmission assets are sold and licences are granted. Currently the offshore transmission asset for each site is sold via this process to transmission owners under long-term licences and links the offshore generation to the onshore network. A common criticism is that the connection of offshore wind farms to the grid network with many redundant cables is not economically efficient, and risks alienating local communities.

When offshore wind was still an emerging industry, individual site connections were deemed to be the best way forward. However, Womble Bond Dickinson's Sebastian Briggs noted that, as the industry has increased in size, this approach has proven to 'not be terribly efficient'. In particular, the project-specific application of infrastructure connecting assets to the mainland is not sufficiently joined-up, and this lack of cohesion is problematic given the ambitions for scaling up offshore wind.

Progress in this area is being made at present. Ofgem and BEIS are undertaking work on the multipurpose use of interconnectors and on strategic planning for the offshore transmission system, and the outcome of this work will be critical in realising the UK's offshore wind potential. Moreover, the Energy Security Strategy included the establishment of a Future System Operator, as well as the publication of whole-system blueprints for networks including the Holistic Network Design (HND) and Centralised Strategic Network Plan. The HND will identify the strategic infrastructure needed to deliver offshore wind by 2030.

More broadly, with the technology taking such an integral role in the UK's net zero goals, questions need to be asked now around whether 'our planning and permitting is actually in step with our policy direction of travel', noted GIIA's Lawrence Slade.

In contrast with the scale of ambition in the ScotWind leasing round, the latest England and Wales Crown Estate offshore wind leasing round represents just under 8GW of potential new capacity and developers have voiced some frustration that more sites were not made available. This is significantly lower than the 32GW that was secured in the Round 3 leasing round in 2010. However, this is partly countered by the fact that the Crown Estate carried out a lot of upfront work to narrow down the sites available for bidding. This was done to ensure that the sites included in the process were those with the best chance of ultimately being developed so that the risk of sites falling away later on in the process was reduced.

It is clear from the outcomes of both Scotwind and Round 4 that there is a commercial appetite from the industry to bid for sites and an increased number of interested developers. This interest, combined with the auction approach adopted in both processes, has resulted in developers paying much more for sites than they had in previous rounds. The higher costs take the form of annual option fees which will continue to be due until a site is actually ready for leasing and construction. While in some senses a success, these higher costs will inevitably be passed on to consumers at the end of the day. Womble Bond Dickinson's Anthony Alderman commented that 'securing an option over a site is only the first step in the process, getting to the point where a developer can make a final investment decision and draw down its lease means securing its Development Consent Order (DCO) and other consents, securing grid connection and securing a CfD, all of which include significant elements which are outside the control of developers. The scale of the option fees being paid will bring far greater scrutiny on any delays or uncertainty in these other parts of the process.'

> **"Is our planning and permitting actually in step with our policy direction of travel?"**

Womble Bond Dickinson's Victoria Redman went on to say that there is no reason why the Crown Estate can't open more leasing rounds with an increased frequency in order to achieve the UK's targets. There are also separate arrangements available for floating wind which can also support enhanced capacity in the years to come.

Another challenge for the growing offshore wind sector is the lack of a domestic supply chain. Whilst the UK is a global leader in offshore wind, the domestic manufacturing capability of wind turbines and their components has been limited and the development of this technology also risks being a missed opportunity for wider supply chains in the country. Therefore, the full benefit of the growth of the offshore wind sector has not historically been felt as it could be, and the majority of the manufacturing is done overseas in countries such as Germany and Denmark not necessarily equating to job creation in the UK. As the industry scales up, it is important that we approach this in a way 'that the value-added components of the R&D and innovation stay within the country', noted Q-Energy's Alejandro Ciruelos.

Bolstering these domestic supply chains is now more important than ever. The increase in ambition for offshore wind to reach 50GWs by 2030 will place additional pressure on the current supply chain. This pressure will be compounded by the global supply chain squeeze on key materials for wind farms and by a potential plateauing of cost reductions. This issue of upward pressure on supply chain costs will impact countries across the world and it will be key for governments to ensure their regulation and policy responds appropriately.

Freeports set to boost clean energy supply chains

Freeports, defined by the UK Government as special areas within the UK's borders where different economic regulations apply, could significantly enhance the UK's renewable supply chains. Eligible businesses situated in Freeports are set to benefit from a range of tax incentives, creating opportunities for companies that manufacture components and sub-components for sustainable infrastructure and clean energy.

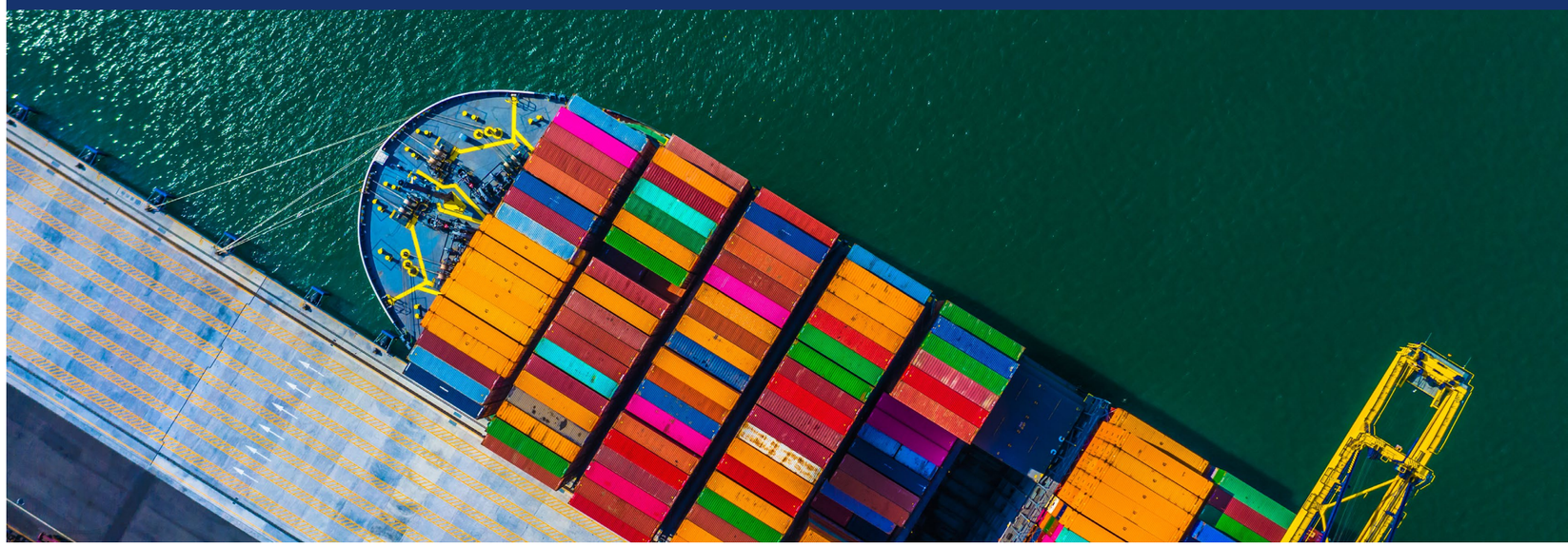
Synergies between freeports and relevant industrial clusters are hoped to create and strengthen domestic supply chains, encouraging the emergence of world-leading renewable powerhouses.

Womble Bond Dickinson's Richard Cockburn noted the role of the new Energy Security Strategy in further establishing a role for freeports in the UK, given the increase in energy from offshore wind to 50GW by 2030 'which strengthens further the business case for Scottish Green Freeports'.

He added that 'The announcement about doubling the hydrogen target also strengthens further the business case for the Scottish Cluster – the original Scottish bid lost out to competition in the first wave of net zero clusters attracting government support.'.

The Teesside and the Humber, which are already leading offshore wind clusters, are especially well-placed to attract investment, with growth expected especially in the manufacturing of turbines, blade materials, monopiles and nacelles.

Scotland has rolled-out a jurisdiction-specific 'Green Freeport' model. Operators and businesses in zoned areas can benefit from a package of tax and other incentives through a combination of devolved and reserved levers. Up to two Green Freeport designations will be awarded in Scotland through an open, transparent and competitive process. A bidding process will begin in the spring, and it is hoped the new sites will open in 2023.



4.3. Realising the potential

While the UK is a global leader in the technology, with comparatively high offshore wind generation capacity (see Figure 12), there is still significant potential to be harnessed. The UK's coastline is particularly well suited to fixed base offshore wind farms, which generally require sea depths of 60m or less. Santiago Blanco, Executive Vice President and Regional Director at the independent engineering and risk management firm, DNV, highlighted that, in comparison to Southern European states, the 'geography of the UK allowed the country to continue developing offshore wind in a much more competitive way'. He highlighted the advantages of the seabed surrounding the UK coastline for fixed base offshore wind. Moreover, this advantage has been further strengthened due to the detailed environmental surveys, mapping and tracking done of the country's seabed primarily from the long-established offshore oil industry. This wealth of previous research allows for developers to assess technical conditions ahead of starting the design of offshore wind projects. There are a number of focus areas for the UK to ensure it makes the most of this natural advantage both for the benefit of its generation mix and for wider supply chains.

In the case of regulation, the UK has recently implemented some important changes which will encourage installation frequency and supply chain expansion. In 2021 major investment announcements totalling over £900m were made in the UK offshore wind manufacturing sector, the greatest level since the industry began. More recently, in the UK's Energy Security Strategy, it was announced that the new targets for offshore wind capacity would support 90,000 jobs in the industry, 30,000 more than previously expected[22]. The Offshore Wind Growth Partnership awarded 76 supply chain companies grants alongside business support totalling £4.5m as part of the offshore wind industry's commitment to increase UK content to 60% by 2030[23]. Prior to this, domestic content represented 48% of total UK offshore wind project value on a lifetime basis[24]. The increase in local content will provide a boost to domestic supply chain manufacturing of offshore wind infrastructure and increase the number of jobs in the sector.

At a glance

£900M

total investments made in the UK offshore wind manufacturing sector in 2021.

90,000

jobs announced in the UK's Energy Security Strategy to support the new targets for offshore wind capacity.

76

supply chain companies grants awarded by the Offshore Wind Growth Partnership, alongside business support totalling £4.5m.

60%

increase to UK content by 2030 committed by the offshore wind industry.

22 *Major acceleration of homegrown power in Britain's plan for greater energy independence - GOV.UK (www.gov.uk).* **23** *About OWGP - Offshore Wind Growth Partnership.*
24 *Offshore Wind Industry Investment in the UK: 2017 Report on Offshore Wind UK Content, RenewableUK.*

The domestic supply chain is also set to benefit from changes made to the CfD allocation rounds. From CfD Allocation Round 4 all applicants for a generating station with a generation capacity of 300MW or more will be required to provide a statement from the BEIS Secretary of State to National Grid ESO approving their Supply Chain Plan for the proposed generation asset. The aim of this process is to encourage competitive, productive, and efficient supply chains for low carbon electricity generation projects and to accelerate investments in established and less established low carbon technologies.

Meanwhile, the more recent announcement in February 2022 that CfD auctions would become annual has been received positively by market players. Greencoat Capital's James Samworth observed that 'what markets want is predictability'. The shift to annual auction rounds helps to provide this, giving players across the supply chain confidence and certainty that there will be a steady pipeline of projects coming to market. It will also help accelerate the deployment of low carbon electricity generation and support investment in the sector by leveraging £90bn of private investment by 2030. The next and first of the annual auctions will open in March 2023.

As offshore wind projects ramp up there is a need for holistic thinking regarding the development of the offshore grid, particularly in the North Sea. Laura Rolo, Offshore Wind Technical Lead SEMELA at DNV, observed that at present there is a perception in the market that 'a lack of planning' has resulted in 'areas being congested'. Rather than individual site-to-beach connections, a more unified approach needs to be considered with better connections among assets, whereby a group of sites are connected and then joined to the grid. These issues have been recognised by the UK Government through the Offshore Transmission Network Review (OTNR)[25]. It is critical that the deliverables identified in this review are achieved at pace in order to keep up with the technology's rapid roll-out.

There is also potential for a North Sea offshore wind grid that is interconnected with Europe. Complexities arise with regard to Brexit, but efficiency would be improved. National Grid Ventures and Dutch transmission system operator TenneT signed an agreement in September 2020 to investigate the feasibility of developing an interconnector to connect up to 4GW of British and Dutch offshore wind which would provide additional capacity of 2GW between the countries. The companies aim to deliver an operational asset by 2029. With the UK targeting 40GW of offshore wind by 2040 and the Dutch targeting 11.5GW by 2030, with a further 20-40GW by 2050, not only will significant amounts of infrastructure be required, but also a close co-operation between countries around the North Sea. Reducing the infrastructure required to meet such targets will also mitigate the environmental impacts on coastal communities, compared to the current approach in which interconnectors and wind farms are developed and connected separately. Other potential projects are looking at the possibility of an 'energy island' or 'energy hub' of offshore wind farms in the North Sea that connects to north-west European countries.

As we move forwards with these offshore wind developments, it is necessary that the consenting process in the UK is simplified. Womble Bond Dickinson's Sebastian Briggs highlighted that, in its design, the DCO process was based around a fixed timeline, however this order has waned over time. Womble Bond Dickinson's Victoria Redman went on to say that the process started off reasonably efficient. However, over time projects continued to get more controversial, particularly due to the volume coming from the east coast of the UK. Challenges arose as specific communities were asked to host the onshore infrastructure needed to support multiple offshore wind projects, resulting in lengthly periods of construction works for their local areas.

> **"It's necessary that the consenting process in the UK is simplified."**

25 *Offshore transmission network review - GOV.UK (www.gov.uk).*

This is partly why the OTNR is taking place. There also needs to be a huge amount of reinforcement along the East Coast from National Grid which will result in hundreds of kilometres of new overhead power lines in order to get the power from the offshore wind farms to where it needs to be. This is only part of the jigsaw that needs to be solved in order for the UK to achieve its net zero ambitions. Womble Bond Dickinson's Victoria Redman added that local communities are demanding a more coordinated approach when it comes to the onshore infrastructure needed for offshore wind farms. They're seeing lots of radial connections for individual offshore farms which has the potential to increase local impacts and isn't very efficient. In the interim, she recommends developers have a clear approach to cooperation at the outset. Engaging with local communities to explain how cumulative construction impacts have been minimised and benefits optimised, through their approach to joint working.

With regards to lengthy planning processes, the UK Government's Energy Security Strategy has brought about some reforms to the planning processes including 'cutting the approval times for new offshore wind farms from 4 years to 1 year' and an overall streamlining which will 'radically reduce the time it takes for new projects to reach construction stages while improving the environment'. Nonetheless, it is important to continue to make every effort to ensure the approach becomes more efficient, in order to foster certainty and stability of UK consenting regimes. Sebastian Briggs went on to add that without this streamlining of the process, there is a risk that potential investors look abroad to countries where there is greater certainty that a project will pass the consenting stage.

British offshore wind capacity is likely to also be expanded further from the coastline with floating offshore wind turbines. Statkraft's John Puddephatt noted that the deployment of floating offshore wind will be advantageous as it can be deployed in deeper waters than conventional turbines, 'opening up areas of the seabed where offshore wind might not have been possible before'.

In January 2022 it was announced that floating offshore wind projects in the UK would receive over £60m in public and private investment to develop the new technology as part of the Floating Offshore Wind Demonstration Programme. Noting the significant contribution it can make, CfD allocation Round 4 ringfenced £24m for floating offshore wind projects. Womble Bond Dickinson's Anthony Alderman echoed the earlier point that floating offshore wind opens up new areas that will support the UK's ambitions beyond the 40GW by 2030 target, as the Climate Change Committee have indicated that 65GW to 125GW will be required by 2020. These deep-water areas would have been previously excluded from traditional fixed turbine offshore wind farms and include sites off Wales and Scotland.

Womble Bond Dickinson's Victoria Redman added that floating offshore wind also solves some of the challenges linked to the Habitats Regulation Assessment. As projects move to deeper waters, then the impact on foraging birds becomes less of an issue which ultimately avoids some of the problems that developers and applications are facing closer to shore.

David Harradine, Executive Director of Project Finance at Dutch bank ABN Amro, highlighted that 'floating offshore wind should be a quicker scale up' compared to the historic scale up of fixed-base offshore wind as it only requires altering 'one feature of the technology in terms of the different foundation type, as opposed to it being a whole new sector'. Hence, projects may be perceived as more bankable as the work required to understand the risk factors associated with the technology change will be reduced, resulting in a faster roll-out and ultimately costs for the technology should decrease at a better pace.

Finally, co-location of assets also presents many new opportunities for the wider offshore wind sector. The Crown Estate has begun facilitating work to identify the key challenges and opportunities associated with the co-location of offshore wind and CCUS. Meanwhile, opportunities are also being assessed for the co-location of offshore wind and hydrogen (discussed further in the next chapter).

Chapter 5: Hydrogen and CCUS

5.1. A nascent and rapidly evolving market

While there is a growing global consensus about hydrogen's potential role in the energy transition, there is still a significant degree of uncertainty around use cases. Low carbon hydrogen can considerably contribute to decarbonising heavy industry, transport, and heat, and can provide long-duration energy storage. But in all those cases, policy commitments and adequate support schemes are essential to support the nascent hydrogen economy.

As the global development of low carbon hydrogen solutions is still in its infancy, the UK currently has the opportunity to gain first mover advantage. The UK is currently among only a handful of countries – alongside the likes of Japan, South Korea, Germany, and Saudi Arabia – that are developing tangible plans to create a hydrogen supply chain.

Across the past few years the UK government has ramped up its publication of policy and strategy documents related to low carbon hydrogen. In August 2021, the UK published its much-awaited Hydrogen Strategy, alongside a consultation on business models for low carbon hydrogen which concluded in April 2022. In April, the hydrogen investor roadmap was also published, as was the UK's Energy Security Strategy, which discussed a role for low carbon hydrogen, increasing capacity ambitions from 5GW by 2030 to 10GW by the same year. As part of the UK's twin-track approach at least half of UK-produced hydrogen will come from electrolysis and the other half from CCUS. Industrial clusters have been identified as key demand centres for low carbon hydrogen and hence will have a significant role to play in developing the UK's low carbon hydrogen supply chains.

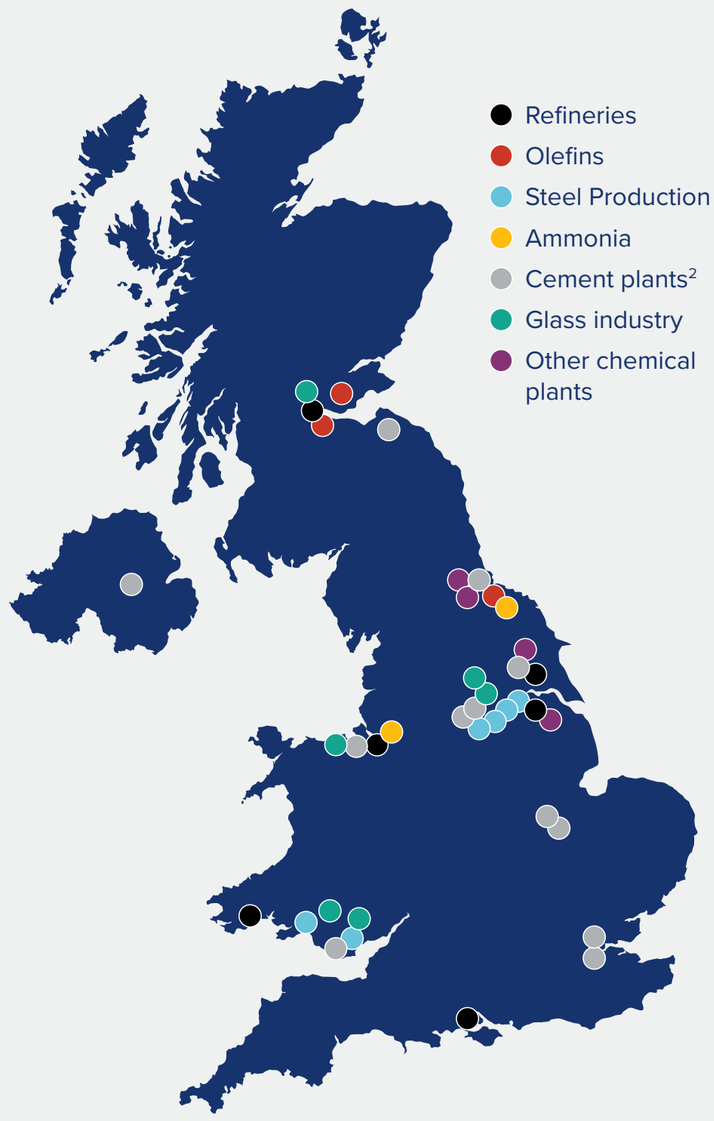
5.2. Uncertainty clouds investment decisions

Questions about the future development of the global hydrogen economy abound. Crucially, it is not clear how exactly future global supply chains of low carbon hydrogen will evolve. While some countries such as Australia are making strides to become global hubs for the production of hydrogen, there is little certainty on whether international shipping of low carbon hydrogen will be economical. Middle Eastern and North African countries, endowed with abundant solar energy, could potentially co-locate hydrogen production with solar farms and then export the hydrogen to Europe by repurposing existing gas pipelines. However, the evolution of these global production hubs and trade routes for hydrogen may well take years, if not decades. In such a fluid international context, the UK seems determined to develop its own hydrogen production to achieve a degree of energy security.

While investors and developers are cautiously observing this space, some believe that a lack of clarity around future business models risks hindering investment. 'We are behind the game' on making these models clear and that could be impeding promising projects across the UK, noted Richard Cockburn, Partner at Womble Bond Dickinson.

Taking into account the details which the UK Government have published to date however, Guy Buckenham, Head of Strategic and Emerging Markets Policy at energy company EDF, welcomed the responses to the consultations on the Net Zero Hydrogen Fund, Hydrogen Business Models and Low Carbon Hydrogen Standard, adding that 'we are studying the details of these proposals and look forward to working with government on the next stages of the process'.

Figure 14: UK industrial locations



Source: Cornwall Insight

2 Cement plants include Kiln, Grinding, and Blending sites. Predominant industrial sites shown in the map to highlight industrial clusters.

5.3. Exploiting first mover advantage

The UK may be on the cusp of a major breakthrough with low carbon hydrogen which could have a meaningful impact for both its decarbonisation and its economy. Dr Simon Schulte, Visiting Research Fellow at the Oxford Institute of Energy Studies, noted the country's technology agnostic approach – remaining open to both green and blue hydrogen unlike other hydrogen leaders such as Germany – allows the UK to harness blue hydrogen as a 'bridging technology'. He added that this less 'idealistic' approach to developing technologies is 'what the UK has often done better than Germany'.

Industrial clusters could become the engine of a new industrial revolution based on low carbon hydrogen, with clusters such as Teesside and Humberside becoming hubs for both production and consumption. With regards to the former, Matt Lewy, Partner at Womble Bond Dickinson highlighted that the UK Government's strategy around domestic hydrogen production has been developing 'hand in glove' with CCUS. The CCUS business models and procurement processes are significantly more advanced than for hydrogen, with CCUS clusters on the North East and North West English coasts awarded priority development status. Once the initial CCUS clusters are in operation, this should facilitate the development of hydrogen production at scale: likely to initially be blue hydrogen using natural gas with CCUS.

Industrial clusters are also likely to become crucial to developing demand for low carbon hydrogen. These clusters have their own emission reduction pathways which will benefit from escalated use of low carbon hydrogen. CCUS-enabled hydrogen has a 'key role' to play here in providing the 'large amounts of low carbon fuel that are necessary to transfer such an industry on the demand side' noted Oxford Institute for Energy Studies' Dr Simon Schulte. This increase in demand will, in turn, push down the prices of hydrogen overall, facilitating improved economics for electrolytic hydrogen. Cornwall Insight has modelled how this demand will look: Figure 14 highlights the industrial clusters with significant hydrogen uptake potential, and Figure 15 gives shape to how this could look in practice across the next few decades[26].

Figure 15: Roadmap of hydrogen penetration in the industrial sector

Source: Cornwall Insight

26 *Industrial decarbonisation key for UK low carbon hydrogen - Cornwall Insight (cornwall-insight.com).*

For this domestic scale up of CCUS-enabled hydrogen to happen, local content requirements would need to be implemented to ensure the expansion of local supply and to keep domestically produced hydrogen economical. It is critical that the UK learns from early oversights in offshore wind where local content percentages were insufficient. Thus far, in the 'procurement process which has been run with CCUS, local content is in there', noted Womble Bond Dickinson's Matt Lewy, however, this prioritisation needs to be maintained in the case of CCUS and accelerated in the case of hydrogen.

> **"It is critical that the UK learns from early oversights in offshore wind where local content percentages were insufficient."**

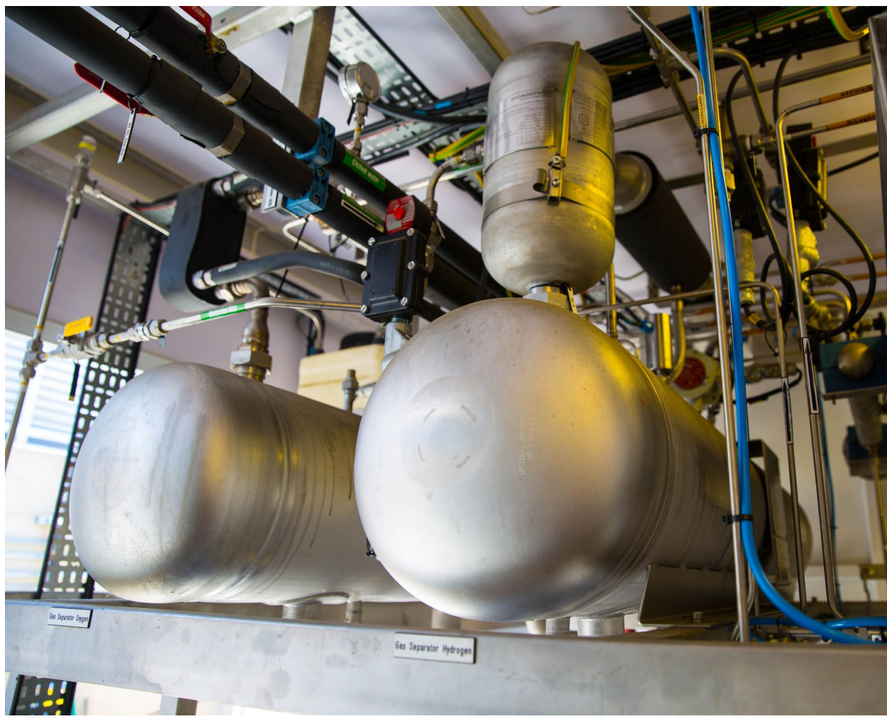
In particular, it is key that open dialogue and engagement with industry is maintained as the market for hydrogen and CCUS develops. A positive step taken so far has been to introduce the UK Hydrogen Advisory Council, co-chaired by Rt Hon Kwasi Kwarteng MP, Secretary of State for Business, Energy and Industrial Strategy, and Sinead Lynch, UK Country Chair of Shell. This structure is intended as the primary forum for BEIS ministerial engagement with representatives from the hydrogen sector. Consultation with the industry is also seen as crucial in other countries, such as in Germany where, the National Hydrogen Council brings together 26 high-level experts from business, science, and civil society to directly advise the governmental Committee for Hydrogen.

Ronnie Quinn, Chief Executive at NECCUS, a consortium that aims to decarbonise Scotland's industry, noted that companies involved in the UK oil and gas industry are significant players that need to be appropriately engaged as we develop low carbon hydrogen markets. These companies hold essential know-how, financial capital and existing infrastructure which will be useful in spurring the supply chains of CCUS and hydrogen. For instance, one key advantage of the UK's heritage in the oil and gas industry has been the exploration of the island's offshore geology. In the CCUS sector, this heritage provides ample, well researched domestic resources for CO2 storage, particularly in the North Sea.

NECCUS's Ronnie Quinn added that a further benefit of engaging with the UK's oil and gas industry comes from the trained people with specialist understanding of these resources, who could support the CCUS sectors. Upskilling will play a role in ensuring successful knowledge transfer between skilled workers from the oil and gas sector and professionals working in the emerging CCUS supply chain. Government engagement with companies in this industry is key here in order to benefit from the experience and resources that these industry giants in energy and infrastructure offer. Womble Bond Dickinson's Lisa Rushton noted that the technical knowledge around how to repurpose existing pipelines for hydrogen is a key lesson which both the US and UK can take from their well-established offshore oil and gas sector.

While industry-government dialogue has many advantages, there is concern around whether the UK Government could – or should – contribute directly to the development of national champions. Low carbon hydrogen from CCUS and electrolysers will be 'used for decarbonising steel, cement and shipping and these are global industries' observed Greencoat Capital's James Samworth. He went on to add that in order to develop a national champion in these nascent industries 'you've got to win in the market globally', which is unrealistic given the supply that would be necessary. Therefore, directing large amounts of public money into these nascent technologies, with a stated aim of creating national champions, could be seen as a futile endeavour.

While CCUS-enabled hydrogen has garnered much attention of late, the UK's "twin-track" approach to hydrogen scale up means there is also a recognition of the important role for green hydrogen. As mentioned above, the UK's recent Energy Security Strategy included an announcement that out of the 10GW of low carbon hydrogen production capacity, at least half will come from electrolytic, or green, hydrogen.



The UK Government is also seeking views on its proposed approach to allocating Hydrogen Business Model and Net Zero Hydrogen Fund support through a joint allocation process for electrolytic hydrogen projects.

Co-location of hydrogen with offshore wind is a key approach for producing green hydrogen. It has the combined benefit of managing intermittent flows of energy from the wind assets and harnessing the country's ample offshore wind power to boost supply of hydrogen for domestic use. Hydrogen can be stored and transported, making more efficient use of any excess energy produced by the offshore turbines.

In terms of timescales for this technology, Richard Cockburn at Womble Bond Dickinson observed that electrolytic hydrogen is set to reach the cost equivalent to CCUS-enabled 'by 2035, or in some developed countries as early as 2030' as the technology improves and more people come into the market. Indeed, hydrogen from solar in the Middle East is claimed to be already on a cost par with CCUS-enabled hydrogen. This technology will have a variety of uses, including for grid balancing, as the processes for producing it can be 'interrupted on a moment's notice', as noted by Womble Bond Dickinson's Belton Zeigler. He added that 'the possibilities are very much there' for electrolytic hydrogen to play a role in industrial decarbonisation through the 'integration of hydrogen with renewable electricity on site'.

The UK has good geological and geographic conditions for producing hydrogen as well as ample demand across sectors (see Figure 16). It is incumbent on the UK Government and industry now to boost demand, harness domestic know-how and shape policy appropriately to develop the industry over the next decade.

Scotland: an emerging CCUS leader

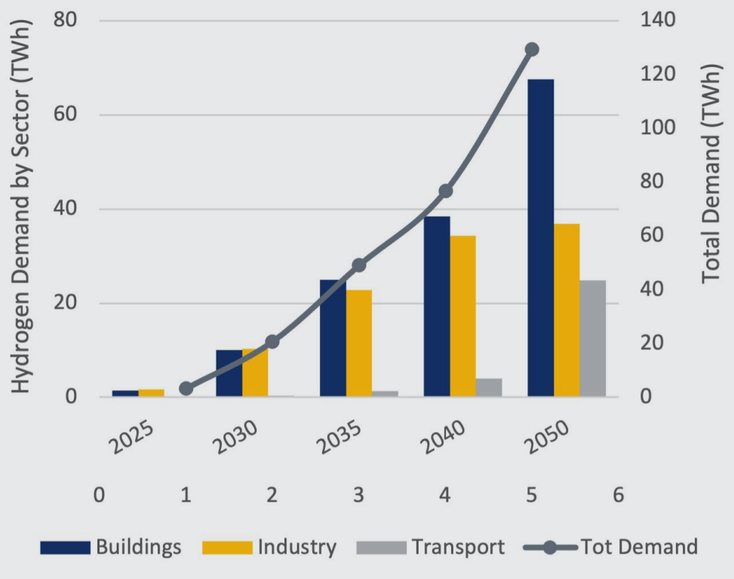
With the objective of reaching net zero by 2045 – five years ahead of the rest of the UK – Scotland is already leading the way in terms of industrial decarbonisation.

The geological storage of carbon under the North Sea's seabed is one of Scotland's key assets, alongside its top-notch industrial heritage. Existing pipelines could be repurposed to transport carbon emissions from industrial clusters into depleted oil and gas fields as well as aquifers.

The Scottish Government announced on 11 April 2022 that it has launched a £5m CO2 Utilisation Challenge Fund. This fund aims to help businesses and organisations develop and commercialise emerging CO2 utilisation technologies, which involves harnessing and converting CO2 and using it to develop products, such as synthetic fuels and proteins used in aquaculture.

The development of a holistic CCUS economy in Scotland and the rest of the UK will generate significant opportunities for Britain's energy supply chain, allowing the retention and creation of skilled jobs.

Figure 16: Forecasted sectoral and total UK demand for hydrogen 2025-2050



Source: Cornwall Insight

> **"The possibilities are very much there for electrolytic hydrogen to play a role in industrial decarbonisation."**

Chapter 6: Leading the way

As the UK looks ahead in its net zero ambitions, it is essential that it seeks to act quickly to remedy and respond to the challenges it faces. Holistic thinking is needed to increase clarity on the long-term direction of travel. It is key to develop a decisive vision for the UK energy transition, reaching net zero goals and energy independence in a way that is environmentally sustainable and socially equitable.

In particular, based on the findings of our research, a number of challenges need to be addressed by government and industry to secure the UK's leadership in the global energy transition:

Guarantee future security of supply

The development of renewables, as well as low carbon hydrogen and CCUS, is crucial for the UK to become energy independent, given increasing uncertainty and tensions on the European continent. Finding a balance between energy security, sustainability, and affordability – the old energy trilemma – will keep on being a priority for the UK as it embarks on the next phase of its energy transition. A more coordinated policy between the US, the UK and the European Union will enable these countries to tackle current threats to energy supply. There is also significant potential for boosting international cooperation and partnerships particularly between the US and the UK, where the two countries could benefit from each other's investment and know-how.

As we move forward in formulating plans to ensure future security of supply, due consideration should be given to increasing capacity caps in future CfD auctions, particularly in the case of solar PV and onshore wind. Following the publication of the Energy Security Strategy which contained updated ambitions for nuclear capacity – taking three projects to final investment decision in this Parliament and the next – it is evident that nuclear is also expected to take a key role in ensuring the UK can manage a self-sufficient, low carbon energy mix in the coming years.

While increasing power generation capacity for renewables is essential, equal impetus needs to be given to ramping up energy storage in order to address the intermittency of solar and wind. The mass development of storage capacity is essential to smooth the imbalances between demand and supply, thus preserving the resilience of the grid. At the same time, coordinated efforts are needed to holistically upgrade transmission and distribution networks, so to ensure that the electricity system is fit for net zero.

Ringfence the crisis of energy suppliers and protect investors

Following the challenges from the retail market crisis in 2021, it is essential that uncertainty and doubt in investment generated by the crisis stays as contained as possible and doesn't spread to other areas of the energy supply chain. For instance, the blanket 'bad companies fail' approach taken by the UK Government and sector regulator may have dented faith in 'soft political' support that market players across the energy sector should expect in the face of volatile market forces[27]. As the sector recovers, the UK Government could demonstrate a more nuanced approach by working quickly to investigate the comprehensive impact of the situation, identifying possible 'fire-breaker options' and signalling a more case-by-case approach to support businesses struggling as a result of the crisis. This would help to signal that the UK Government recognises the complexity of investment and risk taking in the energy sector and help to rebuild confidence.

“While increasing power generation capacity for renewables is essential, equal impetus needs to be given to ramping up energy storage.”

27 *Cornwall Insight has discussed the UK's approach to the energy price spike and failure of suppliers in more depth here: The stakes are higher than they seem: the current energy challenge and net zero - Cornwall Insight (cornwall-insight.com).*

> **Reducing consenting time from up to 4 years down to 1 year, represents an important step towards a more streamlined market.**

Streamline consenting process for renewables

The move to annual CfD auctions is a positive step for renewable development and will enable developers and investors to plan ahead. Whilst there is a need for more capacity for onshore wind and solar PV within the CfD auctions, particularly with an increasing number of larger solar development projects coming online, the move to annual auctions will provide more opportunities for these technologies.

The simplification of the offshore wind planning processes in the Energy Security Strategy, reducing consenting time from up to 4 years down to 1 year, represents an important step towards a more streamlined market. However, onshore wind received less attention with limited detail and less ambitious proposals.

Maximise grid efficiency and encourage co-location

There is also a need for more holistic joined-up thinking to maximise the efficiency of the grid, particularly with regard to offshore wind. This was recognised in the Energy Security Strategy with commitments to establish a Future Systems Operator and to identify a blueprint for the whole system by the end of 2022 in the HND and CSN, the latter of which will identify strategic infrastructure needed to deliver offshore wind by 2030. These developments have been a critical step forward given the heavy ambition for offshore wind and need to connect offshore sites more effectively to the grid alongside opening up international interconnection opportunities.

With the increasing role of renewable generation and intermittent technology on the system in years to come, co-location will become ever more important in balancing supply and demand on the grid. Co-location of battery storage will enable intermittent renewable technologies such as onshore wind and solar to provide flexibility to the grid at the times it is needed.

Ensure local content requirements to boost domestic supply chain and jobs

The Offshore Wind Sector Deal in 2020 increased the amount of locally sourced content for offshore wind farms from 48% to 60% by 2030.

28 *https://www.ogauthority.co.uk/news-publications/news/2022/energy-integration-project/.*

Some would argue that these local content requirements should have been higher from the start. It is important that the less established and more nascent renewables sectors also implement local and higher content requirements much earlier in a way consistent with international trade regulations, therefore learning from the initial oversights made in developing the offshore wind sector. This will help to ensure that as the growth of renewable energy production increases, the domestic industries and the jobs supporting it grow too.

Exploit first mover advantage for low carbon hydrogen and CCUS by developing business friendly models

The high level of uncertainty around regulatory frameworks to support the technology hinders investor confidence. The conclusion of the UK Government's consultation on business models has helped to begin illustrating how the market is expected to look, but more detail is needed as soon as possible.

Research and development needs particular focus, given the shortage of skills and manufacturing within the country. Swift action needs to be taken now to help position the UK as a leader in emerging technologies such as CCUS and hydrogen, particularly as the country has a first-mover advantage. It is critical that the UK Government is proactive in supporting the reskilling of the current energy sector workforce for these technologies and in encouraging the development of these skills in higher education centres. Domestic manufacturing also needs to be specifically developed around the industrial clusters to allow the domestic hydrogen industry and workforce to grow, ensuring the expansion of local supply and keeping domestically produced hydrogen economical.

Develop partnerships internationally and across the energy value chain

The wealth of knowledge, expertise and financial capital in the oil and gas industry will be key to the development and growth of the hydrogen economy, particularly for supply chains. Additionally, the research, exploration and geological documentation done by the UK oil and gas industry means there is already good specialist knowledge and understanding of the resources for CO2 storage, particularly in the North Sea, which can be used for CCUS. One recent example of knowledge sharing between the UK's oil and gas sector and the wider energy sector has been the Energy Integration Project. This project brought together the North Sea Transition Authority, BEIS, Ofgem, The Crown Estate and Crown Estate Scotland and provided a three-year study of potentials for energy integration technologies (CCUS, hydrogen, offshore wind) on the UK Continental Shelf[28].

There is also potential for the offshore wind sector to partner with the nascent hydrogen industry, particularly to increase the potential for electrolytic – or green – hydrogen. The co-location of offshore wind assets with electrolysers provides the benefit of energy storage and a means of transportation. Knowledge from the oil and gas sector will also be critical to maximise the potential that electrolytic hydrogen can provide.

Capture the opportunity

Despite all the challenges highlighted in this report, the UK is in a strong position to make significant progress in the decarbonisation of its economy in the next decade. The UK is already a global offshore wind leader, has some clear competitive advantages in the development of floating technologies at scale, and is paving the way to utility-scale low carbon hydrogen and CCUS. Building on these strong foundations, the country can make significant strides towards environmental sustainability and energy independence, while unlocking investment opportunities, strengthening domestic manufacturing and creating new jobs for generations to come.

> **"Swift action needs to be taken now to help position the UK as a leader in emerging technologies."**

About Womble Bond Dickinson

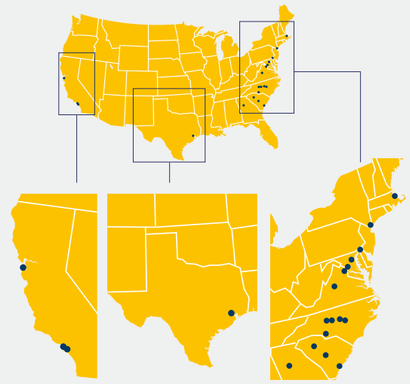
Womble Bond Dickinson (WBD) is a full-service transatlantic law firm providing comprehensive legal services to clients across a wide range of industries and sectors, including energy and natural resources. The firm has more than 400 partners and 1,000 lawyers based across 20 US cities and eight UK cities, including London and Edinburgh. Our reach also extends to Europe, where we have strategic partnerships with law firms in Germany and France. WBD is a UK top 20 law firm by turnover and a Top 100 law firm globally.

In the energy and natural resources sector, our team has several decades of combined experience in both oil and gas and renewable energy. We support clients in all aspects of the energy transition and have particular expertise in offshore wind, decarbonisation of heat, CCUS and hydrogen, onshore generation, energy retail/ supply along with transmission and distribution.

Womble Bond Dickinson at a glance

27 **Locations** across the UK and US

More than **400** **Partners** **1,000** **Lawyers**



US

Atlanta
Baltimore
Boston
Charleston
Charlotte
Charlottesville
Columbia
Greensboro
Greenville
Houston
Irvine
Los Angeles
New York
Raleigh
Research Triangle Park
Silicon Valley
Tysons
Washington, D.C.
Wilmington
Winston-Salem

UK

Bristol
Edinburgh
Leeds
London
Newcastle
Plymouth
Southampton

Consolidating our national reputations and regional heritage under one powerful transatlantic brand

We also have a presence in Teesside at the **Wilton Centre**

Our sectors

Energy & Natural Resources
Healthcare
Manufacturing
Private Wealth
Transport
Financial Institutions
Insurance
Life Sciences & Pharmaceuticals
Public, Government Services & Third Sector
Real Estate
Retail & Hospitality
Technology

Representing more than **600** **Publicly Traded Companies** in the US and UK

+150 Chambers rankings

UK Top 20 Law firm

AmLaw 82 ranked firm

Ranked 102nd **global law firm** by revenue

About Womble Bond Dickinson

Our contributors

Richard Cockburn
Partner
Head of Energy

Chris Towner
Partner

Matt Lewy
Partner

Anthony Alderman
Partner

Vicki Redman
Partner

Simon Hughes
Partner

Sebastian Briggs
Partner

Lisa Rushton
Partner

Belton Zeigler
Partner

About Cornwall Insight

Naomi Potter
Lead Research Analyst

n.potter@cornwall-insight.com
T: +441603 542183

Kate Hill
Lead Research Analyst

k.hill@cornwall-insight.com
T: +441603 542136

Dan Atzori, PhD
Research Partner

d.atzori@cornwall-insight.com
T: +441603 604400

About Cornwall Insight

Getting to grips with the intricacies embedded in energy and water markets can be a daunting task. There is a wealth of information online to help you keep up to date with the latest developments but finding what you are looking for and understanding the impact for your business can be tough. That's where Cornwall Insight comes in, providing independent and objective expertise. You can ensure your business stays ahead of the game by taking advantage of our:

- Publications – Covering the full breadth of the GB energy industry, our reports and publications will help you keep pace with the fast moving, complex and multi-faceted markets by collating all the "must- know" developments and breaking- down complex topics
- Market research and insight – Providing you with comprehensive appraisals of the energy landscape helping you track, understand and respond to industry developments; effectively budget for fluctuating costs and charges; and understand the best route to market f or your power
- Training, events and forums – From new starters to industry veterans, our training courses will ensure your team has the right knowledge and skills to support your business growth ambitions
- Consultancy – Energy market knowledge and expertise utilised to provide you with a deep insight to help you prove your business strategies are viable

For more information about us and our services contact us on **enquiries@cornwall-insight.com** or contact us on **+441603 604400**.

Acknowledgements

For this report, we interviewed leading stakeholders from companies across many sectors. We would like to thank all the individuals and companies who contributed to this report for sharing their insights, including those who wished to remain anonymous.

- Alejandro Ciruelos, Managing Director at Q-Energy
- Santiago Blanco, Executive Vice President and Regional Director at DNV
- Laura Rolo, Offshore Wind Technical Lead SEMELA at DNV
- Guy Buckenham, Head of Strategic and Emerging Markets Policy at EDF Energy
- Dr Simon Schulte, Visiting Research Fellow at Oxford Institute of Energy Studies
- Zosia Riesner, Director of Power Markets at Lightsourcebp
- David Harradine, Executive Director of Project Finance at ABN Amro
- James Samworth, Partner at Greencoat Capital
- Ronnie Quinn, Chief Executive at NECCUS
- Charlotte Eddington, Investments Director at Abundance Investment
- Lawrence Slade, CEO at Global Infrastructure Investor Association
- John Puddephatt, Business Development Manager at Statkraft

re:build Britain | WOMBLE BOND DICKINSON

To find out more about energy transitioning, visit Womble Bond Dickinson's re:build Britain hub here.

womblebonddickinson.com