RenewableUK

Offshore wind co-location: integrating offshore wind with flexibility

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Contents

Introduction

Offshore wind will be the backbone of the future energy system. The UK needs to make headway to achieve ambitious targets for both fixed-bottom and floating offshore wind by 2030 and beyond.

Building more flexibility in the system, either via supply side or demand side measures, will be key to achieving ambitious renewable targets. A more flexible system will need supply side technologies like battery storage, medium and long-duration electricity storage and green hydrogen to be rolled out either on their own or alongside renewables (co-locating).

Enabling innovative co-located business models will help use offshore wind generation more efficiently and facilitate deployment of both flexible and energy storage assets. Co-location with renewable generation, both onshore and offshore, will help to smooth the variability of renewable generation and reduce curtailment, while maximising the use of grid connection capacity, enabling more renewable power to be delivered to consumers. Offshore wind generation is particularly at risk of curtailment losses, which introduces more volume risk for generators and reduces the amount of renewable power available to consumers.

Building more flexibility in the system, either via supply side or demand side measures, will be key to achieving ambitious renewable targets. "

This is especially the case in Scotland, where offshore wind development far outpaces demand under the National Energy System Operator (NESO) Future Energy Scenarios. By 2050 total UK offshore wind capacity is expected to range from 81.4GW to 102.6GW, with much of that capacity located in Scotland[1]. However, Scottish electricity demand amounted to 5GW in 2021 and is predicted to reach 9GW by 2045[2]. While the network is being built out to transport this excess power to the higher demand centres in England, there will still be a requirement for significant energy storage to avoid excessive curtailment.

1 Future Energy Scenarios: ESO Pathways to Net Zero

2 Predicted demand not accounting flexible demand

Curtailment of renewables like offshore wind is not solely driven by insufficient network capacity but can also occur due to low system stability — another pressing challenge for generators. Co-located assets, even those with small amounts of energy storage or with grid forming capabilities, can help with stability issues, improving renewable exports and reducing the need for costly grid upgrades.

The drivers of co-location decisions in the offshore wind context are similar to the benefits behind onshore renewable co-location[3] — particularly maximising the value from shared resources including grid connection, access and available land (near the landing point or onshore substation) and in some offshore wind co-location cases, making innovative use of marine infrastructure. Co-located business models can also create efficiency gains in the offshore wind development process and add value to the supply chain and local stakeholders.

Currently, just 3MW of operational battery storage is co-located with offshore wind, 600MW of battery storage is consented and there are a handful of projects in various stages of development exploring offshore wind co-location opportunities with green hydrogen and long duration electricity storage[4].

This paper focuses on how the system benefits of co-location can be realised. It does not seek to consider whether, or argue that, a certain volume of offshore wind should or should not be co-located. Integrating renewable generation into the system is complex, and co-location presents an opportunity to manage the challenge of renewables-dominated system.

The benefits of co-located business models are extensive, but currently developers are unable to capture the full benefits due to a range of regulatory barriers and uncertainties, which this paper outliines. There is an urgent need to articulate the ambition and strategy on the role of offshore wind co-location, whilst addressing the challenges currently faced. Regulatory and spatial clarity will be key to unlocking this investment and innovation, while developing supply chain capability to support actualisation.

This paper considers how offshore wind could co-locate with flexible assets and the barriers to enabling this investment and innovation.

[3] RenewableUK report **Making the most of renewables: the role of onshore co-location in accelerating an integrated energy system**

[4] RenewableUK EnergyPulse database

Policy recommendations

The table below is a summary of the key barriers that affect co-locating offshore wind with flexible assets, alongside proposed recommendations to overcome them. These challenges are specific to the offshore wind co-location case.

No	Issue	Proposed recommendation	Lead	Priority ratng
	Grid challenges			
1	The Offshore Transmission (OFTO) regime creates challenges with respect to ownership boundaries, divestment process and apportioning of costs, Transmission Network Use of System (TNUoS) cost allocation and licencing	Reform the Offshore Transmission Owner (OFTO) regime for an evolving offshore wind sector. The regime does not consider co-location, and there is a need to holistically resolve the issues to mitigate some of the investment risks	DESNZ leads at strategic level, Ofgem oversees delivery	High
2	The hydrogen transport and storage models are currently being designed. This presents an uncertainty for developers, particularly regarding the lack of visibility on tariffs for onshore and offshore hydrogen storage and transportation	Provide visibility on tariffs as part of the hydrogen transport and storage models	DESNZ leads at strategic level, Ofgem oversees delivery	Lower
	Market challenges			
3	The existing Contracts for Difference (CfD) contract restricts the ability to develop offshore wind co-located sites while maintaining the integrity of the CfD. Hybrid metering is needed to leverage offshore co-location models	Signal support for co-located business models for CfD-backed generation. Additional changes are needed to accommodate metering scenarios fit for offshore co-location models. Virtual metering should be explored	DESNZ leads at strategic level, supported by Ofgem and LCCC	High
4	Interactions between the CfD and green hydrogen production (co-located or otherwise)	Investigate and implement policy and regulatory changes to incentivise an interface between offshore wind and green hydrogen, particularly the CfD and Hydrogen Production Business Model (reference prices and time correlation of certifications)	DESNZ	Moderate
5	The optimal role of offshore hydrogen production and its cost competitiveness needs to be investigated to reduce risk and increase deliverability	Enable appropriate market signals to improve cost competitiveness between offshore and onshore hydrogen production. Review alternative co-location models to assess CAPEX footprint	DESNZ	Lower

Planning challenges				
6	A risk of duplicating the onshore and offshore planning requirements on approvals	To improve efficiency and lessen the burden on the planning resource, the planning process could benefit from building in flexibilities that can cater for different requirements by technology	Relevant planning authorities	Moderate
7	Lack of adequate signals in the planning framework for offshore co-location models (including offshore hydrogen production)	Enable hydrogen production (co-location) in future leasing rounds, and options and lease agreements to incentivise hydrogen pipeline development	TCE, CES	Moderate
Regulatory challenges				
8	Lack of strategy on hydrogen export is hindering decisions on offshore wind co-location	Publish a UK Hydrogen Strategy to enable the UK to play a key role in exporting hydrogen, including to where demand could be in continental Europe, whilst maintaining sufficient supply for use in the UK	DESNZ and DBT lead at strategic level, supported by NESO	High
9	Private wire rules are outdated and set at 50MW	Reassess the MW threshold and its relevance to new demand offtake, such as offshore green hydrogen production	DESNZ-led, supported by Ofgem	Moderate
10	Offshore supply licence exemption is geared towards limited use cases	Revisit the licence exemption framework and provide clarity on co-location scenarios that can be permitted	DESNZ-led, supported by Ofgem	Lower

Definition and use cases

Co-location refers to developing multiple generation projects (including energy storage) or combining different technology types using the same grid connection point. In an offshore wind context, co-location of multiple technologies is aimed at maximising the value from shared resources including grid connection, access, land and marine infrastructure, while mitigating volume and revenue risk for generators.

The offshore wind industry is innovating a range of co-location models that aim to capture the benefits and solve some of the system issues in a renewables-dominated grid. Some of these models include co-location with new demand offtakers such as data centres, electrification of oil and gas infrastructure and carbon capture, usage and storage (CCUS) pumping. Co-location with complementary technologies such as wave and tidal as well as floating solar is also actively being explored by the industry. Work is ongoing to develop storage technologies that can be integrated directly with wind turbines and that would service the medium duration of discharge requirements which are rapidly progressing towards commercialisation. It is important that the regulatory regime allows for innovative co-location models with new forms of demand offtake and emerging technologies to continue being explored. These models of co-location are not within the scope of this report. However, some of the challenges identified in this paper are also highly relevant to these types of co-location models and addressing those challenges will unlock some of the barriers faced by those offshore wind co-location cases.

This paper's focus is on co-locating offshore wind with flexibility - electricity storage and green hydrogen, particularly electricity storage technologies such as batteries (usually short-duration), medium and long duration storage technologies (LDES) such as compressed air energy storage, liquid air energy storage, and green hydrogen (electrolysers which can store renewable electricity in the form of hydrogen).

"Work is ongoing to develop storage technologies that can be integrated directly with wind turbines and that would service the medium duration of discharge requirements which are rapidly progressing towards commercialisation."

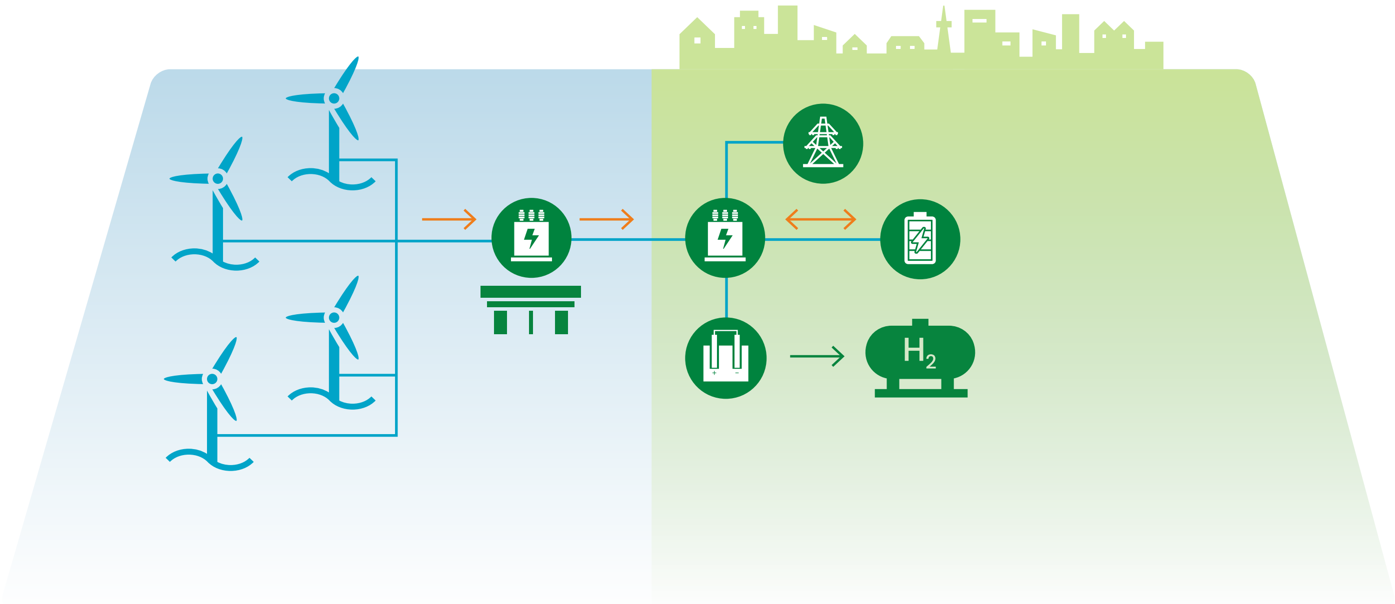
Where to locate flexible technologies is a key question that offshore wind developers face when considering co-location decisions. Sharing a connection point leaves some scope for key decisions on whether flexible assets should be connected in front of the meter (on land and near the point of connection) or behind the meter (with the offshore wind farm meters located at the offshore substation at sea).

Several co-location archetypes, highlighting the various benefits of each co-location case, are presented on the following pages.

1 Offshore wind co-location with flexibility (on land)

1.1 Behind the connection point

Electricity is transmitted from the offshore wind farm to the onshore substation. The storage or electrolyser is located close to the point of landfall (e.g. via a private wire, incorporated into existing single line from the meter) where the export cable connects to the onshore substation.



Advantages of co-locating offshore wind and flexibility on land
On land co-location models are possible and technically deliverable in the near term, but require regulatory reform. The benefits of on land co-location of offshore wind with flexibility include:

- Maximising usage of grid connection as offshore wind landing points tend to have scarce grid connections
- Optimising use of land envelope already reserved for the onshore substation (point of connection)
- More efficient use of planning process and local supply chain activity at the site
- Maximising offshore wind generation during curtailment periods, smoothing out price profiles in a future UK electricity grid that will rely on offshore wind for a third of its demand
- Greater flexibility of either delivering electricity during high-demand

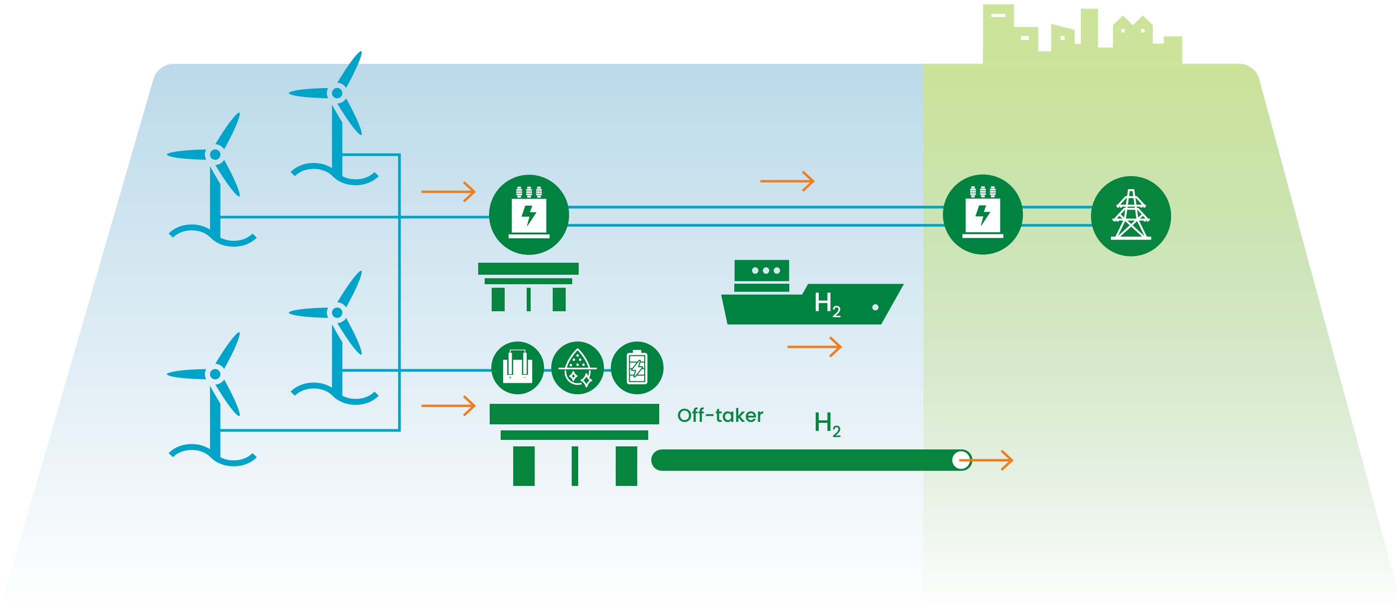
(and high-price) periods or powering hydrogen or storage during low-demand (low-price) periods

- Help spread the risk of offshore wind generation, particularly from above curtailment risk and negative pricing periods for CfD backed offshore wind assets – multiple stacked revenues from flexibility assets
- Clustering of hydrogen infrastructure by locating hydrogen production with (power related) consumption, driving efficiency and reducing the need for pipeline build-out

2 Offshore wind co-location with flexibility (at sea)

2.1 Behind the meter

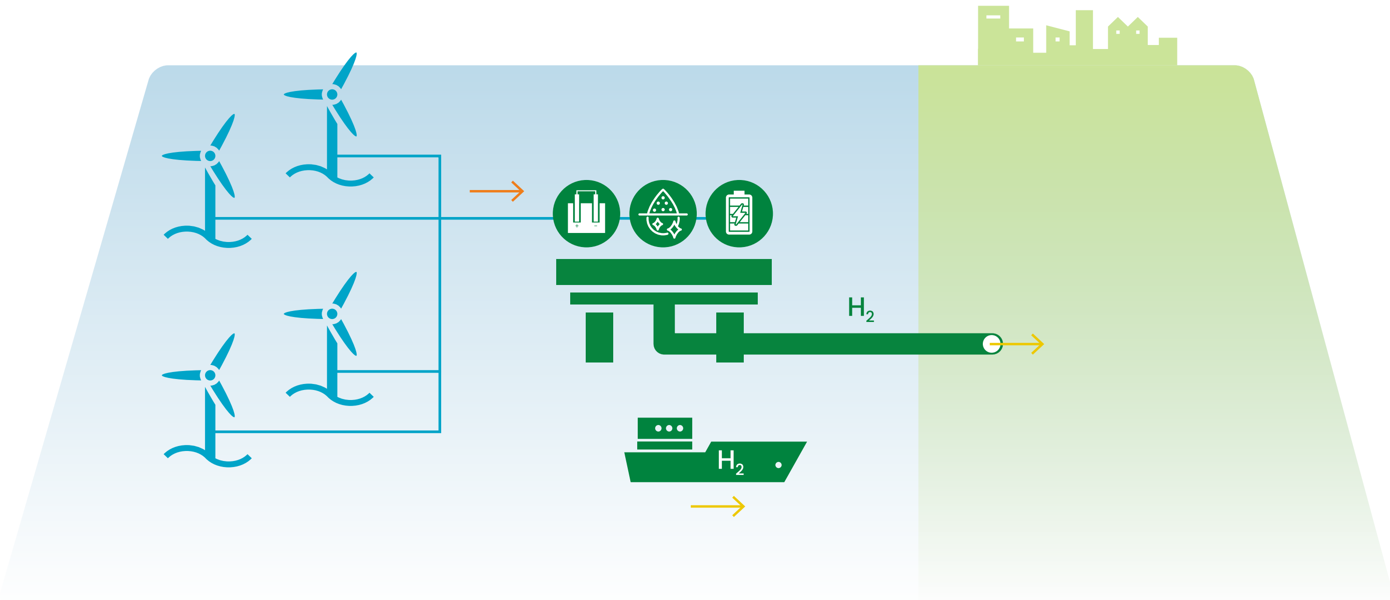
Electricity is transmitted to and used by an offtaker offshore (green hydrogen production or new demand), or to an electricity storage asset. High-voltage lines are used to connect the offshore wind farm to shore, while hydrogen produced can be transported via vessels or a pipeline.



2.2 Off grid co-location

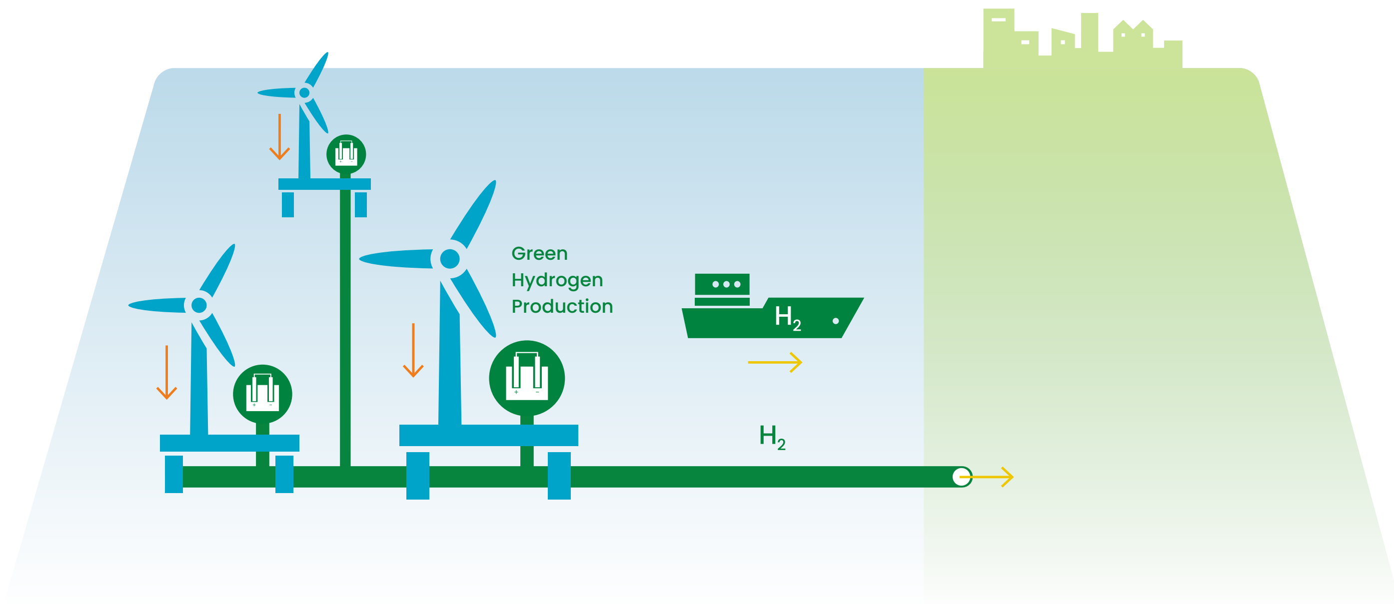
2.2.1 Centralised offshore green hydrogen production (offshore platform)

– Electrolyser located on an offshore platform and connected to an offshore wind farm. Green hydrogen is transported via vessels or a pipeline. Battery storage is integrated onto the offshore platform for stability and critical operation purposes.



2.2.2 Decentralised offshore grid hydrogen production

— Green hydrogen electrolysers are installed and fully integrated into a platform at the base of the floating offshore wind turbine. Hydrogen produced at the base of the platform is transported to shore via vessels or a dedicated pipeline.



Advantages of co-locating offshore wind and flexibility at sea

Offshore wind landing sites could be highly contested, which could present challenges for offshore wind developers exploring opportunities to co-locate flexible technologies on land (near the onshore substation). Depending on the connection arrangements, at sea co-location models will need to overcome some significant technological barriers and regulatory challenges to achieve realisation. The benefits of off grid and behind the meter co-location of offshore wind with flexibility at sea include:

- Making the best use of sea space
- Maximising offshore wind generation during curtailment periods
- Greater flexibility to either deliver electricity during high-demand (and high-price) periods or power hydrogen or storage during low-demand (low-price) period
- Helps spread the risk of offshore wind generation, especially from above curtailment revenue risk for CfD backed offshore wind assets – multiple stacked revenues from flexibility assets
- Conducting electrolysis on a platform could lead to transmission infrastructure cost savings and reduce the cost and transmission line losses and resulting TNUoS charges
- The off grid offshore green hydrogen production eliminates the need for certain electrical infrastructure like offshore and onshore substations, export cables and grid connection charges[5], and instead bears the cost of the offshore pipe to shore (and complex balance of plant associated with hydrogen production) or connecting to a strategically planned main offshore export pipeline
- The availability of enough water of sufficient purity to feed into an electrolysis plant could be a major community and environmental issue. Coordinating with relevant authorities to ensure there is sufficient water to drive an electrolysis plant will be needed to address potential community and environmental concerns
- Additional value lever optionality of offshore location, potentially incorporating additional elements such as operation and maintenance hub, defence, emergency response, storage, and storage.

[5] Green hydrogen in Scotland: A report for Scottish Futures Trust

Challenges to offshore wind co-location models

Grid challenges

- OFTO rules and regulations
- Hydrogen storage and transportation tariffs

Market challenges

- Metering scenarios fit for offshore co-location models
- CfD and Hydrogen Production Business Model interactions
- The optimal role of offshore hydrogen production and its cost competitiveness

Planning challenges

- Risk of duplicating the onshore and offshore requirements on planning approvals
- Adequate signals in planning for offshore co-location models

Regulatory challenges

- National strategy on hydrogen export
- Outdated private wire rules
- Limitations in the offshore supply exemption

Grid challenges and policy recommendations

1. OFTO rules and regulations do not consider co-location and need to holistically resolve the issues to mitigate some of the investment risks

The OFTO regime currently presents significant barriers to co-located business models due to its lack of consideration for co-location. Resolving issues related to ownership boundaries, cost apportionment, and licensing is critical for both onshore and offshore developments. Reforming the regime is foundational to enabling other recommendations and should be prioritised as it affects the financial viability and operational efficiency of co-located projects.

Ownership boundaries

— Offshore wind developers must arrange for suitable land rights as part of the OFTO divestment process[6]. When submitting details of the offshore transmission assets to be divested, the boundaries of any land and structures to be divested are made clear to determine ultimate ownership and avoid the risk of generators being unable to divest assets fully, leading to licence breaches. However, OFTOs are barred from participation in the energy market, so the asset used for provision of balancing and ancillary services must be retained under the wind developer's ownership. The sum total of this set of regulatory requirements could lead to complicated land leasing and boundary lines around certain assets, which could make co-location difficult to implement. The clarity under onshore asset ownership and licensing will provide offshore developers with more certainty and assurance, to create an investment model to install flexible assets onshore.

Divestment process and apportioning costs

— The OFTO cost assessment process under this framework carries a risk of disallowed costs. Developing co-located assets carries a perceived risk for the OFTO as it may incur higher costs or take out larger indemnities to cover the risk from infrastructure being divested,

[6] Offshore Wind Accelerator: Novel Control and Energy Storage for Offshore Wind

thereby raising overall costs of the project. The cost assessment is based on historical benchmarks to ensure investment made is efficient and does not unnecessarily increase the cost to consumers. Historically, Ofgem's cost assessment process has seen approximately 10% of all cost disallowed for almost every project. Using the same historical benchmark for a co-located development is not a fair assessment and the process should be adjusted accordingly.

- In a similar vein, co-locating near the onshore substation places additional risk on wind developers. The cost assessment process bars developers from recovering the costs above and beyond what is required to transfer power from the wind farm to the GB onshore system. The OFTO cost assessment guidance was updated to clarify that infrastructure associated with assets providing balancing and ancillary services would be kept under consideration within the process[7]. However, the clarity provided to date does not eliminate the risk of developers being unable to recover sunk costs. For the co-location case to be successful, it will require a shift in the current approach so that system benefits of co-location are explicitly realised and included.

OFTO licence regime and commercial optimisation

- There are challenges related to the ownership and licensing of ancillary services assets (for example storage assets or grid forming technologies) in current offshore generator and OFTO models of operation. The rules governing the OFTO licence should clarify how an offshore generator and OFTO operated assets provide ancillary services to the grid; for instance, the requirements the co-located asset and the OFTO must meet in respect to reactive power. It also needs to be agreed whether the developer will be able to participate in commercial ancillary services markets if it builds additional capability for ancillary services at the onshore substation (behind the connection point). Simplified licensing processes should be investigated, which could include options such as expedited licensing for co-location or hybrid licensing categories.

TNUoS charges and apportioning of costs under a co-located project

- TNUoS costs and the methodology to apportion costs between the OFTO, generator and co-located asset is also unknown. It is essential that the charging regime does not provide any disincentives to co-location and is able to fairly reflect innovative offshore wind co-

[7] Offshore Transmission: Guidance for Cost Assessment (2022)

location use cases.

- There are two considerations under TNUoS, namely wider TNUoS and the more specific OFTO and local tariffs. In addition to making proper provisions for co-located assets within the TNUoS methodology, the wider TNUoS should be adapted in a way that recognises the benefit co-located assets offer to the network, given co-location could reduce the need for reinforcement or alleviate constraints. Provisions in the tender revenue stream and cost assessment should be made in a fair and equitable way across all relevant parties and should be reflected in specific OFTO local tariffs.

2. Lack of visibility on tariffs for onshore and offshore hydrogen storage and transportation

- The hydrogen transport and storage models are currently being designed. Both onshore and offshore hydrogen storage were eligible for the storage business model, but only onshore transport and pipelines are eligible for the transport business model[8]. The final models have not been released in full yet, which presents an uncertainty for developers considering both onshore and offshore wind hydrogen production cases, particularly the lack of visibility on the tariff structure for hydrogen pipelines.
- Offshore hydrogen pipeline operators will likely be consortia, so there is potential for an offshore transportation cost in addition to entry and exit fees. Other European countries with transmission system operators (TSOs) undertaking offshore and onshore hydrogen networks operation may only charge one exit and entry fee to create a level playfield for different technologies. In the UK, there is a potential risk of double charging to use offshore and onshore hydrogen pipeline systems.
- It will be important to have early visibility of the proposed costs structure for onshore transportation costs, with the initial Project Union pipeline linking to Humber and Teesside coming online by 2028. The next step should be investigating how a level playing field could be created and maintained across offshore and onshore hydrogen pipelines for different technologies transporting hydrogen gas and exporting to Europe.

[8] DESNZ originally consulted on the hydrogen transport and storage models in 2022/2023 with a subsequent consultation on the first allocation round of the hydrogen transport and storage business models in December 2023. **Hydrogen Transport Business Model: Market Engagement on the First Allocation Round**

Market challenges and policy recommendations

3.

Additional provisions needed to accommodate metering scenarios fit for offshore co-location models

Metering in the CfD

- Co-location should be viewed favourably in the CfD process as it means a more efficient use of the limited space available. DESNZ has made encouraging progress on updating the CfD to enable co-location with CfD-backed generation. The current Low Carbon Contracts Company (LCCC) guidance for generators[9] is limited, with storage assets or electrolysers unable to be co-optimised under the same Balancing Mechanism Unit (BMU) as the generator, and there is no capability for co-located assets to import power from the grid. The latter is crucial for stability and a positive business case. Alternatively, CfD generators could divert a proportion of generation to storage or alternative offtakers outside the CfD scheme. However, this is not a viable solution as it does not resolve the main problem of wasted electrons during curtailment events.
- The recent proposal[10] on the use of sub-BMU level metering is a welcome ambition and should enable co-location of CfD-backed generation with other assets. DESNZ has decided that hybrid metering will not be introduced in the upcoming CfD auction[11]. The integration of hybrid metering solutions is essential for accurately measuring and managing energy flows in co-located projects, particularly CfD-backed offshore wind. Studies need to be carried out on the effects hybrid metering could have on the system and the potential cost savings involved. Crucially, the hybrid metering solution should maintain the integrity of the CfD scheme.
- Addressing the metering barrier of co-location models is a complex task for industry, Government and NESO to navigate together. Addressing the complexity and exploring hybrid metering is important for both regulatory compliance and operational optimisation. This should continue to be progressed as a high priority area for future CfD

9 CfD Co-location Generator Guidance

10 Contracts for Difference for Low Carbon Electricity Generation: Consultation on proposed amendments for Allocation Round 7 and future rounds

11 Contracts for Difference for Low Carbon Electricity Generation: Government response to the consultation on policy considerations for future rounds of the Contracts for Difference scheme

auction rounds.

- Unlocking the ability to aggregate financially across the network will be important for offshore wind co-location cases. Virtual metering arrangements is an important next step in unlocking this capability. Secondary BMUs can only be located behind the meter (at the offshore substation at sea, so virtual metering will enable assets located on land and nearby the onshore substation to be treated in a similar way as if they had been located behind the meter. Virtual metering requires data from meters located offshore and onshore to be combined, to make it appear that assets are located behind the meter when they are physically located in front of it (accounting for transmission line losses in the process). This would require more complex metering and communication protocols - similar to the provisions developed by Elexon to enable aggregators and Virtual Lead Parties' actions to be adjusted against the supplier's positions for settlement metering.

4. Interactions between the CfD and green hydrogen production (co-located or otherwise) should be investigated and policy changes implemented to incentivise an interface between offshore wind and green hydrogen

- Currently, CfD-backed offshore wind generation has limited financial incentive to supply power to alternative offtakers or co-location projects. The CfD strongly encourages wind developers to sell electricity on the day-ahead market, mostly irrespective of market price, which significantly limits the availability to sell to alternative offtakers. The incentives do not align as a result of the design of the CfD and the Hydrogen Production Business Model (particularly risks created by price indexation[12]). The resulting commercial risks are challenging to manage without either a transport and storage network or support on the definitions of green hydrogen under the Low Carbon Hydrogen Standard.
- The financial and physical policy mechanisms responsible for facilitating the flow of electricity between renewable energy sources and hydrogen present challenges. Particularly, the need to ascertain their timing and application during negative pricing periods. Further work needs to be carried out to investigate and implement policy

[12] In the Hydrogen Production Business Model (HPBM) the strike price is linked to the CPI for green hydrogen producers. For blue hydrogen, it is both CPI and the natural gas price. Electricity price is one of the largest cost components for green hydrogen producers. The lack of indexation means green hydrogen producers are not protected against fluctuations and may need to lock into long-term PPA contracts or take a long-term view on what power prices will be. This creates risk and adds a premium to these projects.

and regulatory changes to improve the interface between offshore wind and green hydrogen. Enabling electrolysers access to the CfD reference price would also facilitate onshore hydrogen projects accessing low-cost renewables electricity via a power purchase agreement (PPA) even when not co-located. Given that input electricity costs account for nearly 70% of levelised cost of hydrogen production, securing access to cheap offshore wind at the CfD reference price is essential for the hydrogen economy.

CfD reference prices

- Green hydrogen production needs a steady supply of renewable energy due to its operational and economic characteristics. Offshore wind under the CfD should have the option or be incentivised to supply this baseload power to a grid-connected hydrogen electrolyser. This could be in the form of having a dedicated private wire to the grid-connected electrolyser from the outset, with a portion of the wind farm's production dedicated to the green hydrogen facility independent from the CfD.
- Currently CfD reference prices are all linked to the day-ahead market, meaning there is no incentive to trade in the longer-term markets or to enable direct trading with the co-located asset at the reference price. This creates volatility for offtakers as power needs to be sourced from the day-ahead market, creating a price volatility risk that many developers are not willing to take. The challenge is therefore to make CfD power from offshore wind farms available to both co-located and non-co-located demand at a lower risk profile. Government could balance the risk it takes in both the CfD and the Hydrogen Production Business Model (HPBM). The focus should be on moving towards alignment and harmonisation, while addressing the deficiencies of the HPBM. When considering any reform to market arrangements (such as the CfD) to potentially incentivise renewable assets to co-locate, it is also important to consider the additional risk such reforms may expose renewables to, and whether this may lead to efficient outcomes for consumers.

Clarity on permitted CfD volumes for co-location cases

- DESNZ recently confirmed that, from Allocation Round 6 onwards, offshore wind which directly supplies oil and gas facilities will no longer be eligible for a private wire CfD[13]. The industry needs clarity on the various co-location scenarios that would be permitted with consideration of offshore hydrogen production as well as the decarbonisation of marine activities, including transport and the

[13] Contracts for Difference: Allocation Round 6 Government response to consultation on drafting amendments to the CfD contract

CCUS sector. The additional system benefits that co-location of technologies could provide should also be appropriately weighted and part of the offshore supply exemption consideration.

Time correlation

- The Low Carbon Hydrogen Standard (LCHS) places a heavy emphasis on half-hourly time correlation between green electricity generation and hydrogen production. This means accurate metering and guarantees of origin are key. Ensuring compliance with the LCHS relies on metering evidence. Under the LCHS it is essential to procure and cancel Renewable Electricity Guarantees of Origin (REGOs) on an annual basis. REGOs are an important tool but require reform to properly enable this traceability. It will be important to ensure that timestamping is complementary under any sort of certification, particularly if electricity is stored between being generated and used.

5. The optimal role of offshore hydrogen production and its cost competitiveness needs to be investigated to reduce risk and increase deliverability

- There are additional technical obstacles which need to be overcome, some of which are specific to offshore hydrogen production. These include the availability of electrolysers, the need to retrofit existing gas pipelines, and the large requirement for freshwater or the rollout of desalination technology to purify seawater. Coordinating with relevant authorities to ensure there is sufficient water to drive an electrolysis plant will be needed to address potential community and environmental concerns. There is a risk to first-of-a-kind projects such as reliability challenges of offshore hydrogen production which could be addressed via a test integration environment onshore or by test facilities (small to large scale) being located offshore. It will be important for offshore hydrogen production to achieve a similar cost reduction pathway to onshore hydrogen production, particularly as more green hydrogen is deployed onshore and supported under the HPBM. There is a need to investigate how this could be achieved within the existing market frameworks and the HPBM – allowing for developed pathways for both onshore and offshore green hydrogen production. This should include investigating the optimal role of offshore hydrogen production, its cost competitiveness and deliverability. It will be important to outline any potential ambition or strategies for offshore hydrogen production and how it may contribute to the goal of achieving an overall flexible energy system.

Planning challenges and policy recommendations

6.

The risk of duplicating the onshore and offshore requirements on planning approvals should be addressed, with flexibilities that can cater for different requirements by technology needing to be built in

- There are challenges in the planning regime depending on whether co-located technology with offshore wind can be classified as an associated development. Some elements of this will be dictated by whether the technology is located at the point of connection or behind the meter. This can have an impact on whether it can all be progressed under one Development Consent Order (DCO) or several. If the co-located technology is consented under a separate DCO then the developer may need to pursue two parallel consents for the co-located assets, one under the Nationally Significant Infrastructure Project (NSIP) regime and the other under the local Town and Country Planning route. This is inefficient and places additional burden on the planning resource.
- There are efficiency gains to be had when developing and seeking planning consent for both offshore wind and a co-located asset at the same time. However, the different development pathways for offshore wind are much longer than for a battery storage unit, while the regulatory and revenue uncertainty of a co-located business model means that efficiency gains are frequently lost. The planning process could benefit from building in specific flexibilities that can cater for different requirements by technology. Given the devolved nature of the planning process a holistic approach is needed that considers offshore wind co-location business models.

7.

Lack of clarity in consenting and adequate signals in the planning framework for offshore co-location models (including offshore hydrogen production)

- Hydrogen pipelines and storage fall under the oil and gas regime, where the North Sea Transition Authority (NSTA) has been confirmed as the consenting authority[14]. The legislative amendments proposed

[14] Offshore Hydrogen Regulation: government response to consultation

do not cover onshore hydrogen regulation, nor offshore hydrogen production, and DESNZ has acknowledged the complexity of the offshore hydrogen framework straddling different regulatory regimes. There is a difference in hydrogen production regulation between Scotland and the rest of the UK. Hydrogen production is not explicitly regulated in England or Wales but is referenced in the Scotland Act 1998. There is a lack of clarity in consenting arrangements that needs to be resolved, particularly regarding who will be the lead regulator for offshore hydrogen production.

Enabling offshore hydrogen production in consenting arrangements

— Additional provisions in the planning and consenting requirements specific to offshore hydrogen production will encourage the industry to explore, innovate and develop offshore hydrogen production cases. Regulatory authorities need to work together towards a common outcome which supports and encourages offshore hydrogen production. There needs to be a careful consideration of how offshore hydrogen production could be enabled from the onset with appropriate signals provided via future leasing rounds as well as option and lease agreements. The Crown Estate (TCE) and/or Crown Estate Scotland (CES) would need to enable this into the tender design at an early stage. This could be in the form of allowing flexibility in design, potentially enabling different developers for the wind farm or hydrogen, or the offtake, potentially prescribing certain areas of seabed or empowering developers to make decisions. TCE/CES would also need to reference offshore hydrogen production within the Habitat Regulation Assessment when identifying new sites and any potential environmental issues.

Clarity on consenting different offshore co-location activities

— Offshore co-location activities currently fall under a different regulatory and consenting regime to offshore wind, and such regimes could operate under different timelines and processes that may not align. This adds further complexity and could lead to uncertainties as to which regime takes precedence, and which is applicable applicable or enforceable. There needs to be clarity on who consents which component of the co-located projects[15]. If hydrogen pipelines and storage were to sit under a single regime with wind, that would bring hydrogen pipelines and storage outside of all other offshore pipeline and storage regulations and may make repurposing more challenging. There should be consideration of such interactions and how to effectively address the issues they may pose.

[15] While out of scope of this paper, it is worth noting that currently for INTOG projects it is not clear who is responsible for the consenting of cables from an offshore wind farm to the relevant oil and gas infrastructure assets.

Regulatory challenges and policy recommendations

8. Lack of strategy on hydrogen export is hindering project decisions on offshore wind co-location

— There have been rapid developments in the creation of regional and global hydrogen markets to support greater trade in low carbon hydrogen across the value chain. There are two main ways to transport hydrogen to enable trading: using vessels or via pipelines. Evidence suggests that for distances under 4,000 km, pipelines are the most efficient transport route. Strategic planning for both onshore and offshore hydrogen backbones will be extremely important for the sector and wider economy, and will consequently require close coordination across DESNZ, DBT, NSTA, NESO, CES, TCE, the industry and the European counterparty in the case of strategic pipelines enabling exports.

— Establishing a clear strategy for hydrogen export is crucial for the long-term success of both offshore wind and hydrogen. This is particularly the case if many grid connections and their enabling works are dependent on hydrogen development. Without a defined export strategy, developers may face uncertainty in market opportunities and a lack of investment appetite, particularly regarding integration with continental Europe. This is vital for aligning the UK's energy export capabilities with emerging global hydrogen markets. The Scottish Government recently published an export plan outlining steps and enablers to realise export opportunities in Scotland[16]. If the UK is to play a key role in exporting hydrogen, including to where demand could be in continental Europe, whilst maintaining sufficient supply for use in the UK, a comprehensive national hydrogen export strategy needs to be laid out. Clarity on the approach to hydrogen export is needed to support investor confidence.

9. Private wire rules are outdated and set at 50MW

— Currently there is a need to seek a derogation to the 50MW threshold[17] when supplying electricity directly from an offshore wind farm via a private wire. The MW threshold should be reassessed as to whether it continues to be relevant in the case of offshore green hydrogen

[16] A Trading Nation: Realising Scotland's Hydrogen Potential — A Plan for Exports

[17] The Electricity (Class Exemptions from the Requirement for a Licence) Order 2001

production, or new demand offtake given the GW size of offshore wind farms and hydrogen developments that are being built in the UK.

- Updating the private wire rules, particularly the 50 MW threshold, is important for unlocking the potential of co-located business models, including offshore green hydrogen production. This is a key regulatory change needed to support larger-scale developments and must be resolved in order to maximise the potential of co-location.

10. The offshore supply exemption is geared towards limited business cases

- There is a specific class exemption regime for offshore supply i.e. offshore generators supplying offtakers located offshore[18]. Relying on class exemptions which were designed over 20 years ago creates regulatory risk for developers as they could be incorrectly applied in innovative use cases, leading to inadvertent breaches of the rules. DESNZ needs to continue to build on the work done to date on the licence and exemption regime framework, as the persistent lack of clarity around the regime poses significant risk to developing innovative co-location business models and undermines investment.

Clarity on permitted offshore wind supply activities

- Originally designed with oil and gas facilities in mind, the current offshore supply exemption regime is limited to the various co-location use cases that could be put forward. The lack of clarity on permitted co-location scenarios and the timing of when consideration should be made in the offshore wind development cycle presents a risk to developers considering co-location cases at sea.
- An additional disadvantage of the current framework is that, although the process can take up to nine months for DESNZ to reach a decision, it requires a high burden of proof at a relatively early stage of the project development. This is an issue which needs to be addressed to make the offshore supply exemption framework fit for purpose.

[18] DESNZ consulted on the licencing and exemptions framework in 2020/21, with summary of responses published in 2023 where DESNZ acknowledged that the framework was not fit for purpose in light of more innovative co-located business models. **Electricity Licence Exemptions: Call for Evidence**