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Finance Quarterly

In this issue

Offshore Technology Special

How floating wind can fulfil its potential

Tamarindo

Reframing the key issues

Insight, connections and expertise for the global energy transition.

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Editorial

To quote Albert Einstein, "in the midst of every crisis lies great opportunity".

While it would be overly dramatic to describe the offshore wind industry as being in crisis, it is certainly facing some significant challenges that are negatively impacting on the economics of projects. Obstacles include supply chain issues and interest rate rises that are making the cost of borrowing more expensive.

But with a nod to the wise words of the German-born physicist, though the offshore wind industry may be beset by a number of problems, the more astute developers can see some shafts of light amid the storm clouds.

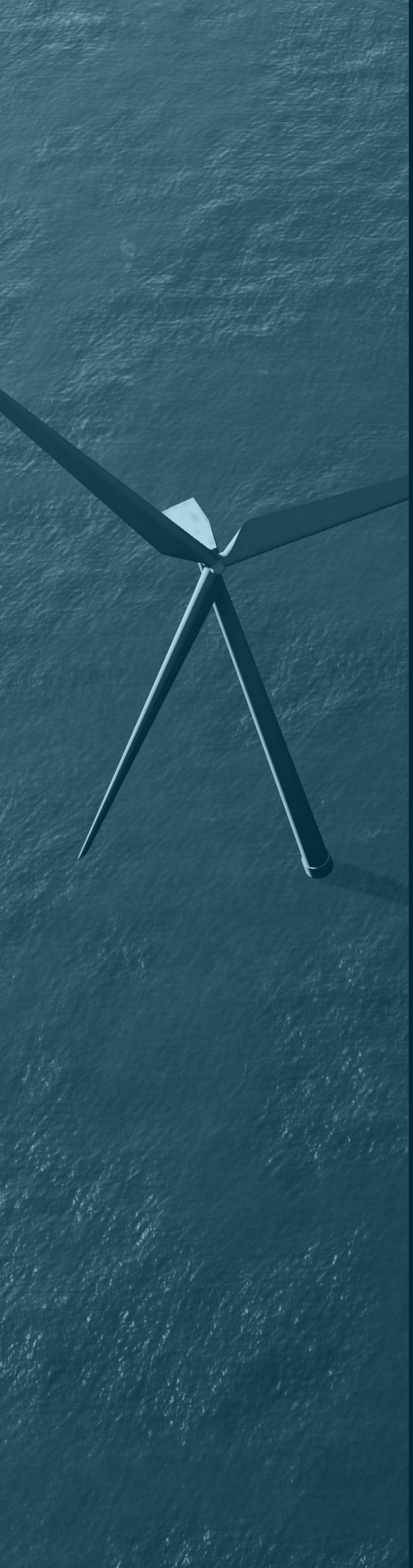
Specifically, the shrewder operators in the market know that now is the time to step back and take stock of the long game, and, to this end, attention is turning to floating wind projects as well as the potential for incorporating energy storage assets and green hydrogen production into offshore wind farms. From the perspective of floating wind, as we highlight in this issue of Finance Quarterly, this is becoming an increasing attractive prospect with the technology's levelised cost of energy set to halve in the next decade. Though there are only currently 14 operational floating wind farms - totalling 227MW – globally, it has been forecast that up to 300GW of floating wind capacity could be installed by 2050.

Floating wind needs finance cost to fall

Key to the proliferation of floating wind will be the speed with which the sector can achieve a scale that facilitates the lowering of costs, and this will require a reduction in the cost of finance. High risk capital and equity will be necessary to fund the first tranche of projects, but then there will be a need for more debt finance as the floating wind industry expands.

Meanwhile, with financing tight, there is a sense that offshore wind developers are adopting a 'back to basics' approach when it comes to projects with the result that plans to incorporate green hydrogen and energy storage into schemes are being shelved. That said, it's vital that developers don't lose sight of the bigger picture, which is that such technologies do much to improve the viability of projects.

As we discover in this issue, the Gulf of Mexico, and Texas in particular, are two areas in the US where there is significant potential for the development of offshore wind projects that include green hydrogen production. Meanwhile, it's argued that energy storage and, especially compressed-air energy storage, could be a perfect fit for offshore wind projects as it enables investors to enhance returns.



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Tamarindo

Floating interest

Developer interest in floating wind has never been higher, but firms need to scale up manufacturing and unlock project finance if the sector is to achieve its global potential. RICHARD HEAP REPORTS

"It's important we see that floating wind has so many positives. The current situation with cost increases is harming floating wind, of course, as it is harming fixed-bottom. But we need to keep the long perspective in mind, and solve for the short-term."

Sonja Indrebø, head of floating wind at developer Corio Generation, is discussing the economic headwinds and technical challenges for firms in the floating wind sector. Over the last seven years, Indrebø has been an influential figure in floating wind: she managed the 30MW Hywind Scotland project, which was the world's largest working floating wind farm when it was commissioned in 2017, during 24 years at Norwegian oil giant Equinor; and joined Corio in February 2023 to lead its floating wind plans.

Indrebø says offshore wind is still an attractive form of electricity generation despite recent cost rises, and that floating wind projects will benefit from that experience as developers seek to reduce the levelised cost of energy (LCOE) at floating projects.

Research from DNV in October 2022 reported that the LCOE of floating wind farms was over €200/MWh, while projects fixed to the seabed were around €60/MWh, but the LCOE of floating wind will halve in the next decade and reach €50/MWh by 2045.

In this analysis, we highlight the latest growth markets for floating wind; the technical challenges to be overcome to reduce project LCOE; and the need for pipeline visibility to help developers take projects to financial close.

Growth projections

The pipeline of floating wind projects in development globally has grown rapidly over the last two years – and a surprising country now occupies the number one spot.

In October 2023, RenewableUK reported that the total capacity of floating wind farms in the development pipeline globally has grown 32% in the last 12 months to 244GW, across 271 projects (see graph 1, p.7). This includes 40GW in Italy, 35GW in the UK and 30.7GW in Ireland. The US is the eighth largest market with projects of 13.8GW.

This shows significant changes from similar research in October 2022 (see graph 2, p.7). Italy rose from having the seventh-largest development pipeline in 2022 (13.3GW) to the largest in 2023, while the US was the only market in the top ten to see a decline year-on-year (-20%). There were also 50 new projects reported in 2023.

Indeed, there is no shortage of bullish predictions about floating wind's potential. The UK's ORE Catapult has forecast that up to 300GW of floating wind capacity could be installed globally by 2050, and identified four characteristics of the likely leading markets.

1. Existing fixed-foundation offshore wind market, because those countries are more likely to have an established supply chain and experienced developer community

2. Presence of pilot floating wind projects, because these give developers and companies in the supply chain a headstart over rival markets.

3. Supportive governments, because the right policies can speed up permitting and consenting of new projects without causing unnecessary delays.

4. Supportive subsidy regimes that give confidence to investors and lenders.

But the total capacity of floating wind remains very low. There are just 14 operational floating wind farms totalling 227MW globally (see graph 3, p.8), led by Norway (94MW in three projects), the UK (80MW in two projects), Portugal (25MW in one project) and China (19MW in three projects); and with three more in construction (see graph 4, p.8).

In August 2023, Equinor commissioned the largest operational floating wind farm to date, the 88MW Hywind Tampen in waters off the coast of Norway. Other significant floating wind farms include the 50MW Kincardine scheme that was commissioned in UK waters in 2021; and the 25MW WindFloat Atlantic project off Portugal. But there must now be a step change to increase the size of new floating schemes.

However, overall, operational floating wind farms represent less than 0.001% of total capacity in development, and the challenges facing this part of the offshore wind industry have grown in the last year. Floating projects face some challenges that are the same as those at fixed-foundation projects, including impacts of inflation, rising interest rates, and disrupted supply chains. But floating wind developers are facing additional logistical, technical and financial obstacles to rolling out new capacity.

Political support

The challenges for developers vary by geography too.

Sian Lloyd Rees, UK managing director at Mainstream Renewable Power and the supply chain champion for Offshore Energies UK, says the biggest obstacle to the rollout of floating wind in the UK is that strike prices in the Contracts for Difference (CfD) regime are set too low. Low strike prices meant developers submitted no bids for CfD support for offshore wind farms – either fixed-bottom or floating – in the UK's latest auction round, where the winners were announced in September 2023. If it is unaffordable for firms to build projects, this restricts investment in the supply chain.

Mainstream is developing the 2.3GW Arven floating wind project off the coast of the Shetland Islands in Scotland in a 50:50 joint venture with Ocean Winds, which is the 50:50 joint venture between EDP Renewables and Engie.

> **"South Korea moved quickly. It's never going to be the biggest floating offshore wind basin in the world, but they moved very quickly in order that their supply chain could learn and supply the technologies and the solutions that were needed"**
>
> **Sian Lloyd Rees, Mainstream Renewable Power**

Outside the UK, Mainstream and Ocean Winds are working with Kumyang Electric in a partnership called Korea Floating Wind (KF Wind), focused on projects in South Korea. These include the 870MW KFW project and 450MW East Blue Power, which combined to make up a 1.3GW complex called KF Wind; and the partners are involved in the group behind the 6GW Ulsan floating wind complex.

South Korea doesn't yet have any floating wind farms in operation, but Lloyd Rees says its government worked quickly to give confidence to companies by awarding licences for its first floating wind farms in 2021. This meant firms in the supply chain had the confidence to invest, and means they are now working to find ways to cut the cost of the LCOE of floating wind farms.

"South Korea moved quickly. It's never going to be the biggest floating offshore wind basin in the world, but they moved very quickly in order that their supply chain could learn and supply the technologies and the solutions that were needed," she says.

Feature continues on page 9

Graph 1

Floating Offshore Wind Development Pipeline by Country (MW) - OCT '23

Source: RenewableUK, October 2023

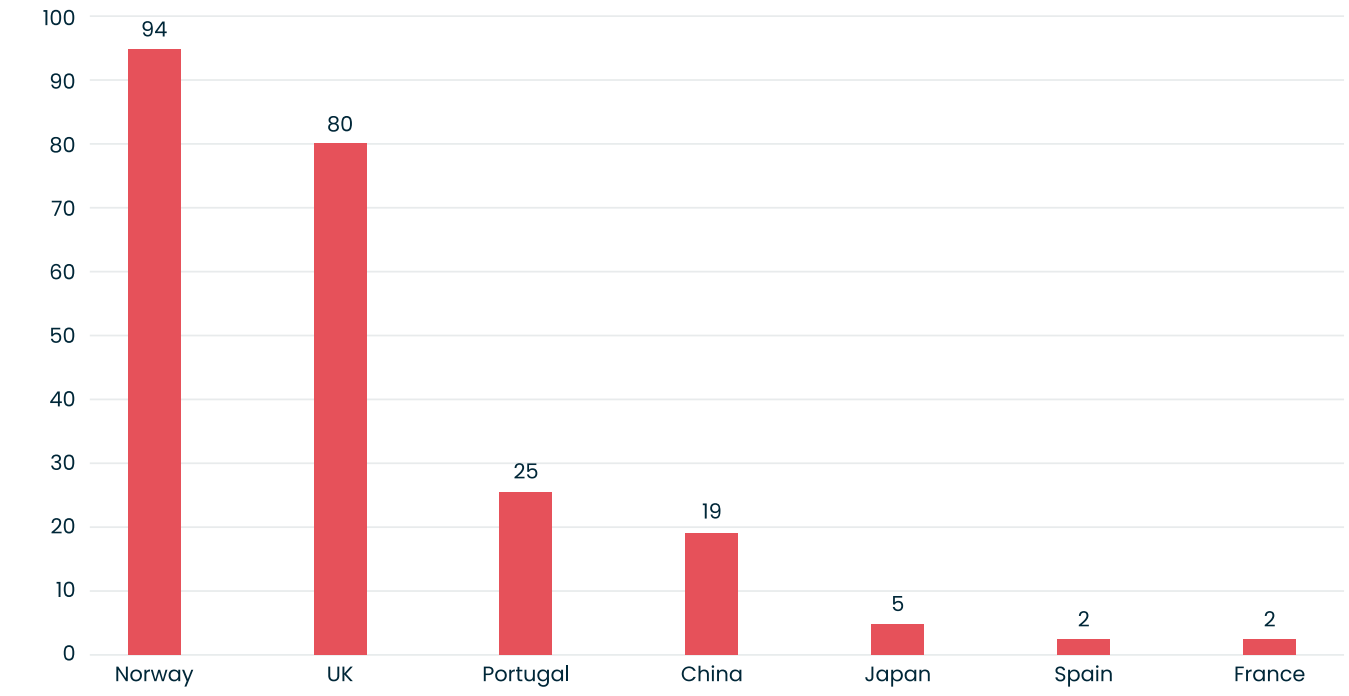
Graph 2

Floating Offshore Wind Development Pipeline by Country (MW) - OCT '22

Source: RenewableUK, October 2022

Graph 3

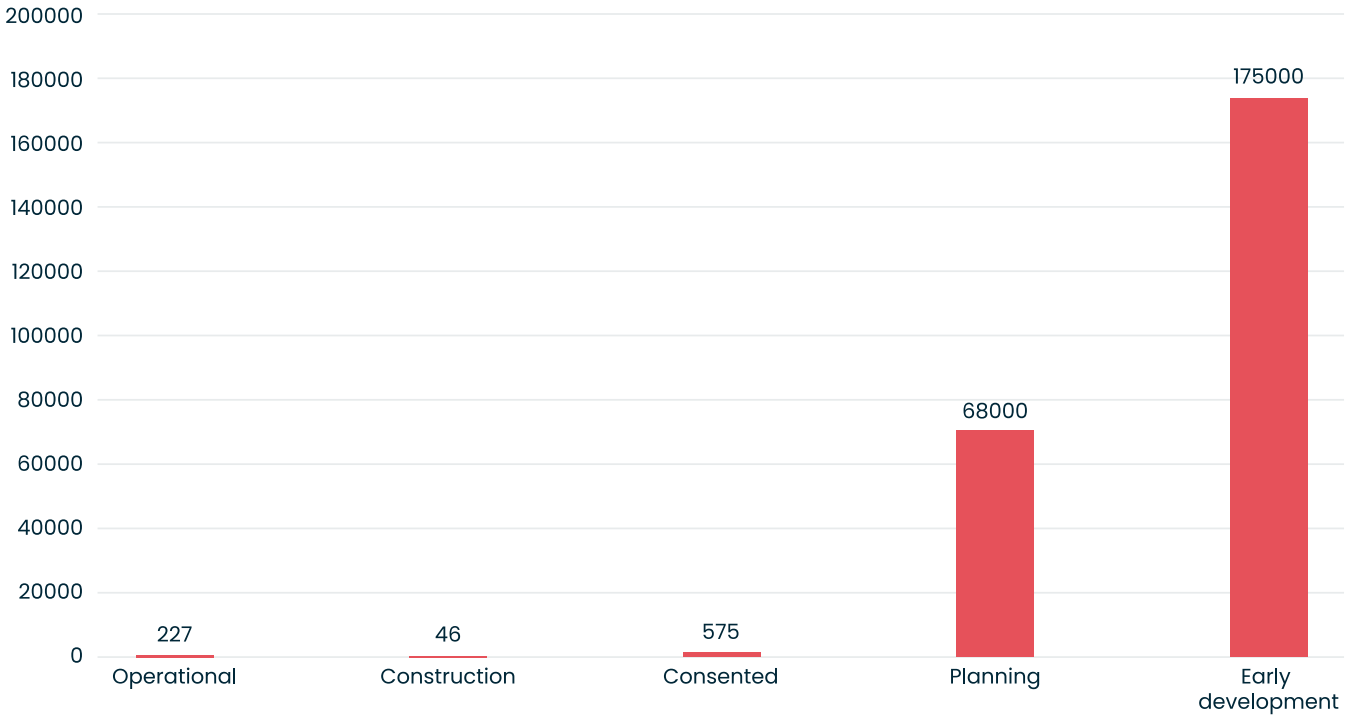
Operational Floating Offshore Wind by Country (MW) - OCT '23



Source: RenewableUK, October 2023

Graph 4

Floating wind projects by stage in the development and operational life cycle (MW) - OCT '23



Source: RenewableUK, October 2023

Support in South Korea has come from national and regional governments. For example, the government of Ulsan Metropolitan City officially backed the 1.3GW KF Wind complex in September 2023, which has given the supply chain the ability to plan and be more efficient.

Lloyd Rees says: "From that one project, we started to identify about 90 incremental improvements that you would make as you start to build the second tranche, and that really is what starts to get the price down. It's rarely one massive technology breakthrough that brings the price down. It's optimisation in all areas."

She adds that optimising floating wind technology should be the priority, rather than reducing costs, as it helps make floating wind farms as cost-effective and productive as they can be.

Corio's Indrebø says South Korea plays an important role in its portfolio too. Corio has 2GW of floating wind projects in South Korea, including three 500MW schemes in the planned Gray Whale complex with Total Energies and SK Ecoplant; and the 500MW Geomundo project that Corio is developing with the same partners.

"Floating wind has three main drivers. Of course, you need wind resources, and you need demand. And South Korea has a very advanced supplier industry, because they are already serving oil and gas, and shipping. There are similarities with the kind of solution that would need to be provided for offshore wind," Indrebø says.

Political support will be important in European markets as well. Indrebø says Corio is looking at floating wind opportunities in countries including Norway, Spain and Portugal. Floating wind in Europe also received a boost in the ScotWind tender in the UK, which concluded in 2022, with floating wind projects accounting for almost 18GW of the total 30GW seabed leases awarded; and France is due to tender a site off the coast of Brittany in northern France for a 250MW floating wind project.

Yet these tenders are reliant on political support. In Norway, tenders for the 1.5GW Utsira Nord floating wind and 1.5GW Sørlige Nordsjø areas have been delayed until 2024, despite the country's strong floating wind potential.

Indrebø says: "When it comes to ports, Norway has quite a good starting point because it is already serving oil and gas from very many locations, and there are quite a lot of deep harbour ports because of the geography of the fjords."

The link with oil and gas is important because companies in that sector know how to install oil rigs on floating foundations. Even so, companies through the floating wind supply chain will only be able to invest in upgrading their operations for the floating wind sector when they have visibility of future tender volumes and timescales. This highlights some of the challenges with the sector moving to gigawatt-scale projects

Manufacturing challenges

Martin Tremblay, offshore wind director for the Americas at engineering firm Wood, says there are arguably currently no ports outside of the Asia-Pacific region that could cope with supplying the floating structures of large scale floating wind farms. The largest working floating wind farm, the 88MW Hywind Tampen, has only 11 turbines, for example.

"For projects that are moving forward, they're doing so because their intended capacity is relatively small. If we were to build an 800MW project, there's no port right now anywhere that can cater for that, at least not in the US. That's one big issue," he says.

Tremblay says another challenge for developers is that every floating wind market has its own regulatory regime, manufacturing base and environmental conditions. This means companies in the floating wind supply chain are currently rolling out bespoke technology in each

market, an approach that may prove to be inefficient for economies of scale.

Tremblay adds that there is currently no clear winning floating foundation type: the main three types are tension leg platform, semi-submersible and spar foundations.

"Some are very simple, which means they can be more easily manufactured, but because of their simplicity, they may require more material or feature higher installation complexity. Or we can have a design that appears to be very cost-effective because it requires a low amount of material, but is then very complex to assemble because it requires a lot of welding or specific expertise that might not be available locally," he says. Procuring that material for a specific design may be difficult locally too.

This is why tenders like France's 250MW Brittany process will be so important, as it will give an interim step for the sector between sub-100MW and 1GW-plus projects. The growth of floating wind projects in nearby countries, including the UK, Norway and France, will be important as it helps create a critical mass of projects. Experts in the Tamarindo community have said the biggest challenge for manufacturers of floating foundations is to achieve production of one foundation per week, as that is needed to underpin the rapid expansion of the floating wind sector.

"For projects that are moving forward, they're doing so because their intended capacity is relatively small. If we were to build an 800MW project, there's no port right now anywhere that can cater for that, at least not in the US. That's one big issue"

Martin Tremblay, Wood

It is not just about the foundations either. Floating wind farms also need innovation in other areas, like the installation and maintenance of dynamic cabling systems to connect floating wind projects to the substation. These cables are usually buried for fixed-foundation offshore wind farms, and 'dynamic' cables face additional risks. In addition, thousands of kilometres of these chains will be required.

Clément Mochet, country manager for France and head of mooring solutions at BlueFloat Energy, agrees that there is a challenge with producing the quantity of components needed in mooring systems. But he adds that companies in the supply chain are used to producing anchoring and mooring systems at this large scale.

"We're not starting from scratch," he says. "The issue is the volume, but I'm not too worried that companies in the supply chain will be able to cope with that demand. Again, we need to provide visibility early as that means they can invest."

This is a logistical challenge for project operators, because anchoring and mooring systems have not been included in their operations and maintenance remit before. There is also the larger issue that floating wind is still a new technology, so there is no experience in the sector of taking a floating project through its full life cycle.

For instance, the question of whether operators and their partners in the supply chain can find ways to replace major components on site, rather than towing turbines to port to fix them there. Mochet says developers and operators should be proactive about sharing insights from operational projects, though accepts this is difficult.

"It's always the same in an emerging industry. As soon as you figure out or discover a problem, and you solve it somehow, this is knowledge that you don't want to share because it is a competitive edge. In offshore oil and gas, it took them decades before they actually managed to sit in the same room and share problems they were experiencing and how they were solving them."

Mochet says the relative youth of the floating wind sector compared to other types of infrastructure may also make it tougher for developers and their partners to secure manufacturing capabilities without early commitments.

Investor confidence

Industrialisation and clarity over operations and maintenance costs play another key role in the sector. They will be vital in giving investors and lenders the confidence in projects that will encourage them to invest, and take projects to financial close.

In France, developers of three floating wind farms off the Mediterranean coast took final investment decisions about their projects last year: EDF and Maple Power's 24MW Provence Grand Large; TotalEnergies, Qair and BW Ideol's 30MW EolMed; and Ocean Winds and Banque des Territories' 30MW Golfe du Lion. This shows that floating wind farms can reach financial close with debt financing, with support from backers including the European Investment Bank and European Commission.

Jerome Guillet, a founder of advisory SNOW who has a 25-year track record in the financing of offshore wind projects in Europe, says industrialisation will help to bring down the cost of floating wind and give investors greater certainty about the financial side of projects. He says this can create a "virtuous circle" for floating wind.

"The question is how quickly you can industrialise to get to the scale where costs are brought down, and a big chunk of bringing down the cost is the cost of finance. You need to have this virtuous circle where your early projects are funded with high-risk capital or mostly equity, and then you manage to finance with some debt, which is still low leverage, expensive, and then you improve all the time. Then we can get to cheaper cost of capital and bring the cost down substantially," he says.

Guillet says the three precedents for debt-financed floating wind projects in France are helpful, as it shows that the industry is going in the right direction. But the early debt-funded projects rely on developers and investors that are willing to take the risk.

> **"What I tell clients is that you have to create the reality. You have to start the projects to get the first one done, even if it costs you money to take the risk, because then you'll be in a much better position for the next one because you have credibility. People will go to you"**
>
> **Jerome Guillet, SNOW**

"What I tell clients is that you have to create the reality. You have to start the projects to get the first one done, even if it costs you money to take the risk, because then you'll be in a much better position for the next one because you have credibility. People will go to you," he says.

This logic applies to developers, and also to the floating foundation manufacturers: "The floater that is actually in the water and built is the one that will be built again and again, because people will see that it works and want to use that one rather than the untested alternatives, however attractive they might look in theory," he says.

Guillet also says that floating wind developers are subject to the increased lending costs that have affected other parts of the sector. Inflation and rising interest rates mean that it is more expensive for companies to borrow money than in more benign economic times: "It's clear that the current round of interest increases is making the whole cycle of improving the cost of funding all that much harder, because you're just at the beginning of the cycle of going down, and you now have to start from an even higher cost of capital."

Even so, the case for floating wind remains strong. This technology enables wind developers to access windier sites further from shore, and help ensure that offshore wind makes an increasingly important contribution to the global energy mix. This is why it is worth developers persisting to address the many challenges that they are facing. ■

GAURAV RANIWALA Q&A

"The whole industry needs a reset"

Gaurav Raniwala, managing director & global head of renewables at GE Vernova's Financial Services business, discusses the need for cooperation and discipline as the global energy system becomes more complex.

Where do you see the biggest opportunity for renewables investors?

The energy transition across the globe is the opportunity of a lifetime for investors. With electrification of industrial load, we expect electricity demand to grow by 50% by 2040. In addition, there are approximately 800 million people in the world who lack reliable energy. When we look at sustainability, we also need to look at how we deliver affordable and reliable power for both electrification and decarbonisation.

At GE Vernova, we do that by advancing technologies across conventional power (gas, small modular nuclear, hydro), wind (onshore and offshore) and electrification (technology, like HVDC and storage, and software solutions).

We are investing in projects in all of the above categories to lead energy transition while also bringing in both private and public capital alongside ours.

Has the Inflation Reduction Act affected your plans?

The IRA was a game-changer. It has put the US at the leading edge of driving the energy transition and incentivising investment in renewables at record levels.

We do see a challenge – which is also an opportunity - with tax equity. The current US market demand for tax equity financing stands at $20bn per annum, but the demand resulting from the IRA is expected to at least double that. While we continue to invest, there is a huge opportunity for corporations, insurance companies, and other financial institutions to get involved and play a significant role in energy transition by growing the tax equity market and we are ready to support them in doing so.

You mentioned green hydrogen. How big is your focus on power-to-X?

We see credible players willing to put development dollars into power-to-X, which is everything from power-to-hydrogen and power-to-ammonia to even power-to-power. This means power can be converted into fuels and transported across the world.

At GE, we see a massive opportunity to bring a lot of these technologies together. As I mentioned, we have offerings across technologies e.g wind, storage, HVDC and so on. Systems are getting very complex and we need integrated solutions that that enable various intermittent resources to come together and deliver reliable power. Firms can't just say, "I sell wind" or "I sell solar".

Does this make financial structuring more complex?

Yes. While we can be innovative, we also need governments to step up a little more to provide the right support.

> We have to allow products to mature over longer cycles and also start dealing with inflation in a more pragmatic manner.

We need to remember this isn't just about trying to get the cheapest electricity, as we have seen in recent years in the race to the lowest levelised cost of energy. Our shared focus is sustainability.

The whole industry needs a reset. We can't be introducing new products at the pace we have been. We have to allow products to mature over longer cycles and also start dealing with inflation in a more pragmatic manner.

Has it been good to see more discipline in the UK's recent CfD auction?

Yes. We've seen in the last three years that significant inflation has hit everyone in the industry, and we aren't going to see a rapid downward slope on technology costs. It's good to see this reset happening, where developers realise they need to be bidding in a sustainable manner.

It isn't just the UK either. We're seeing the same story in US offshore wind, where firms are walking away from power purchase agreements because they are unviable in current market conditions. It's good that there's a realisation that we need to be more disciplined. It's healthy for the industry and should make the whole ecosystem stronger.

Can COP28 help to further this debate?

Absolutely. This is a programme that enables people of different perspectives to come together and exchange ideas, and we see progress every year. I personally believe that COP has a big role in fostering cooperation.

LEIDOS Q&A

BESS 'does not increase' financial risk for offshore wind projects

If battery storage and technologies such as green hydrogen are added to offshore wind projects to reduce LCOE, the viability of such schemes is increased, say Christian Carpenter, Leidos power transaction services VP, and Michael Giampetro, Leidos VP of conventional and emerging technologies

Why should offshore wind developers consider battery storage for their projects? What are the challenges involved?

Christian Carpenter: To the extent that an offshore wind project is not able to contract all of its energy and/or capacity, the use of battery energy storage (BESS) may present an alternative route to market to improve the project's revenues and profits such that the owner's return goals are obtained. The BESS can help smooth capacity and provide ramping, spin, non-spin, and capacity to markets so there is value. However, the availability of revenues for these services (hence, value addition) is a function of the market in question. It is critical that the developer understands the particulars of the market under consideration. The primary challenges include obtaining land near the location of the onshore substation to which the wind farm interconnects and defining a use case for the BESS, which is required to support its design.

How important are these technologies for unlocking additional profitability and revenue streams at offshore wind assets?

CC: Offshore wind continues to be at the higher end of the levelized cost of energy (LCOE) scale in the US relative to other renewable technologies, which makes it difficult, if not impossible, for offshore wind to compete on a level playing field. If BESS and other technologies – such as green hydrogen – can be incorporated with offshore wind projects in a way that reduces LCOE, they could be very important to the viability of offshore wind in the US. Of course, BESS is a not a magic bullet - there are other challenges that must be overcome. Needless to say, the importance of BESS technology to any one project needs to be evaluated based on the unique attributes of that project and its off-taker/market policies.

> Operation and maintenance of BESS facilities is less complex than offshore wind facilities

Does the inclusion of battery storage and green hydrogen in offshore wind projects introduce a new element of risk that makes them difficult to finance in the current economic climate?

Michael Giampetro: The inclusion of BESS with an offshore wind project should not present material incremental risk, particularly from the perspective of financing. Most investors in, and lenders to, large-scale energy projects have familiarity with BESS technologies, and have probably been involved with those technologies in the past. Operation and maintenance of BESS facilities is less complex than offshore wind facilities.

How can authorities at state level reduce risk for developers?

MG: As it relates to energy storage, incentivising the value of firming zero-carbon generation, and re-thinking the value of ancillary services that BESS can provide to the grid.

The missing link?

Economic turmoil is unsettling US offshore wind developers, with the result that plans to combine projects with green hydrogen production and energy storage are falling down the list of priorities – but as Ben Cook discovers, in the longer-term, the proliferation of such projects would appear to be inevitable, with Europe set to take the lead

It's hard times for the US offshore wind sector, which finds itself beset by major challenges at present with supply chain issues and interest rate rises having a negative impact on the profitability of projects. Consequently, the prospect of incorporating green hydrogen production and energy storage facilities into offshore wind projects seems somewhat ambitious given the current economic climate. That said, despite such uncertainty, there is a belief that there is significant potential in the US for the development of offshore wind projects that do make provision for such technologies.

The Gulf of Mexico, and Texas in particular, are seen as areas where there is significant potential for the development of offshore wind projects that include green hydrogen production. This is largely because these areas have extensive oil and gas infrastructure that can be re-purposed for green hydrogen-related uses as well the associated production of methanol, ammonia and sustainable aviation fuel.

It's a similar story with regard to the prospect of offshore wind projects incorporating storage facilities – take-up has been slow up to now, but Leading Light Wind last year included an option for an energy storage facility in its 2.4GW offshore wind project bid to the New Jersey Board of Public Utilities (BPU). Meanwhile, advocates of compressed-air energy storage (CAES) have claimed it is a "great fit" for offshore wind projects, given the fact that the costs associated with increasing the duration of CAES are lower compared to other technologies.

Europe's approach instructive for US

In formulating strategies for the inclusion of green hydrogen production in US offshore wind projects, it is instructive for US developers to look at developments in Europe. Source Galileo, which specialises in the development of offshore wind projects in the UK, Ireland and Norway, has incorporated proposals for green hydrogen production in a number of its planned projects. "We believe the future of offshore wind is in green hydrogen – for example a large amount of our energy is currently supplied by natural gas, and green hydrogen could be used as a replacement for this provided that it can be produced at scale," says Stirling Habbitts, director business development, MD hydrogen at Source Galileo. "If we look at northern Europe, to produce large amounts of green hydrogen at scale – which are not imported and are locally produced – the obvious answer is to go for offshore wind."

Habbitts explains that restrictions associated with electricity grids mean that it can be beneficial to include green hydrogen production in plans for offshore wind projects. "The electricity grids were not designed originally to accommodate large amounts of renewable energy in a dispersed generation model, so there are significant constraints nowadays with connecting further renewable projects to

the grid and this applies to battery projects as well," he says. "Around parts of the coast of Scotland or the west coast of Ireland or off parts of the coast of Norway, for example, you don't necessarily have a very developed electricity network or grid, so relying on the grid in those areas to be able to accept the electricity from large new offshore farms can be a challenge."

Project finance precedents

In this regard, incorporating green hydrogen production into offshore wind projects is a game-changer, according to Habbitts. "If you can produce hydrogen, you can use it potentially to produce derivatives or you can put the hydrogen into dedicated hydrogen pipelines and you can transport it over long distances," he explains. "When you go the hydrogen route, you basically bypass the electricity grid and you don't have the constraints associated with grids."

A number of offshore wind developers are exploring the potential for incorporating green hydrogen production into projects, but at the moment they are in a minority, says Habbitts. He adds that one of the reasons is that financing an offshore wind project incorporating hydrogen can currently be more challenging as such projects are still relatively new, though he says there are precedents that provide encouragement.

One is the announcement earlier this year that NEOM Green Hydrogen Company had concluded a $8.4 billion financing for what it described as the "world's largest green hydrogen production facility", which is being built at Oxagon, in Saudi Arabia's NEOM region. "There is precedent for project finance for green hydrogen projects, and there is precedent for project finance for offshore wind farms, so it should be entirely possible and feasible to obtain project finance for an offshore wind farm that produces green hydrogen," Habbitts says. "A key consideration is the offtake arrangements – for a project finance structure you have to have a reliable, and preferably longer-term, offtake to support the debt service."

> **"When you go the hydrogen route, you basically bypass the electricity grid and you don't have the constraints associated with grids"**
>
> **Stirling Habbitts, Source Galileo**

Habbitts acknowledges that green hydrogen is a relatively new sector, but he stresses that there are projects in Europe and the Middle East that produce green hydrogen via electrolysis that are up and running having secured project finance from banks. He cites the example of Siemens, which last year commissioned one of Germany's largest green hydrogen generation plants – with an electrical capacity of 8.75MW at Wunsiedel Energy Park. Elsewhere, In April last year, it was announced that the European Investment Bank (EIB) and the Official Credit Institute (ICO) would provide Spanish energy company Iberdrola with a combined total of €88 million for the development of a 100MW photovoltaic plant, a 20MWh battery and a 20MW green hydrogen production plant in Puertollano (Ciudad Real), Castilla-La Mancha.

UK's plan for hydrogen factors in offshore wind

Habbitts points out that, across Europe, there are now a number of initiatives aimed at building green hydrogen pipeline networks that take into account the production of green hydrogen by offshore wind farms. "We already have extensive gas networks that are owned by large gas operators," he says. "We know fossil fuel gas will be a reduced part of the future energy mix because of the greenhouse gas emissions it causes, however the infrastructure and the expertise of the gas network sector can be redirected to a hydrogen network."

Stirling Habbitts, Source Galileo

One such initiative in the UK is Project Union, a National Grid Gas Transmission initiative aimed at delivering a "first of a kind hydrogen transmission backbone" for the UK. Through the phased repurposing of existing assets alongside new ones, the National Grid says a hydrogen backbone of around 2,000km will be created, representing around 25% of the UK's current natural gas transmission pipelines. "This approach of primarily repurposing assets is up to five times more cost effective compared to new build," the Project Union

> **"We know fossil fuel gas will be a reduced part of the future energy mix because of the greenhouse gas emissions it causes, however the infrastructure and the expertise of the gas network sector can be redirected to a hydrogen network."**
>
> **Stirling Habbitts, Source Galileo**

Why Project Union is vital:

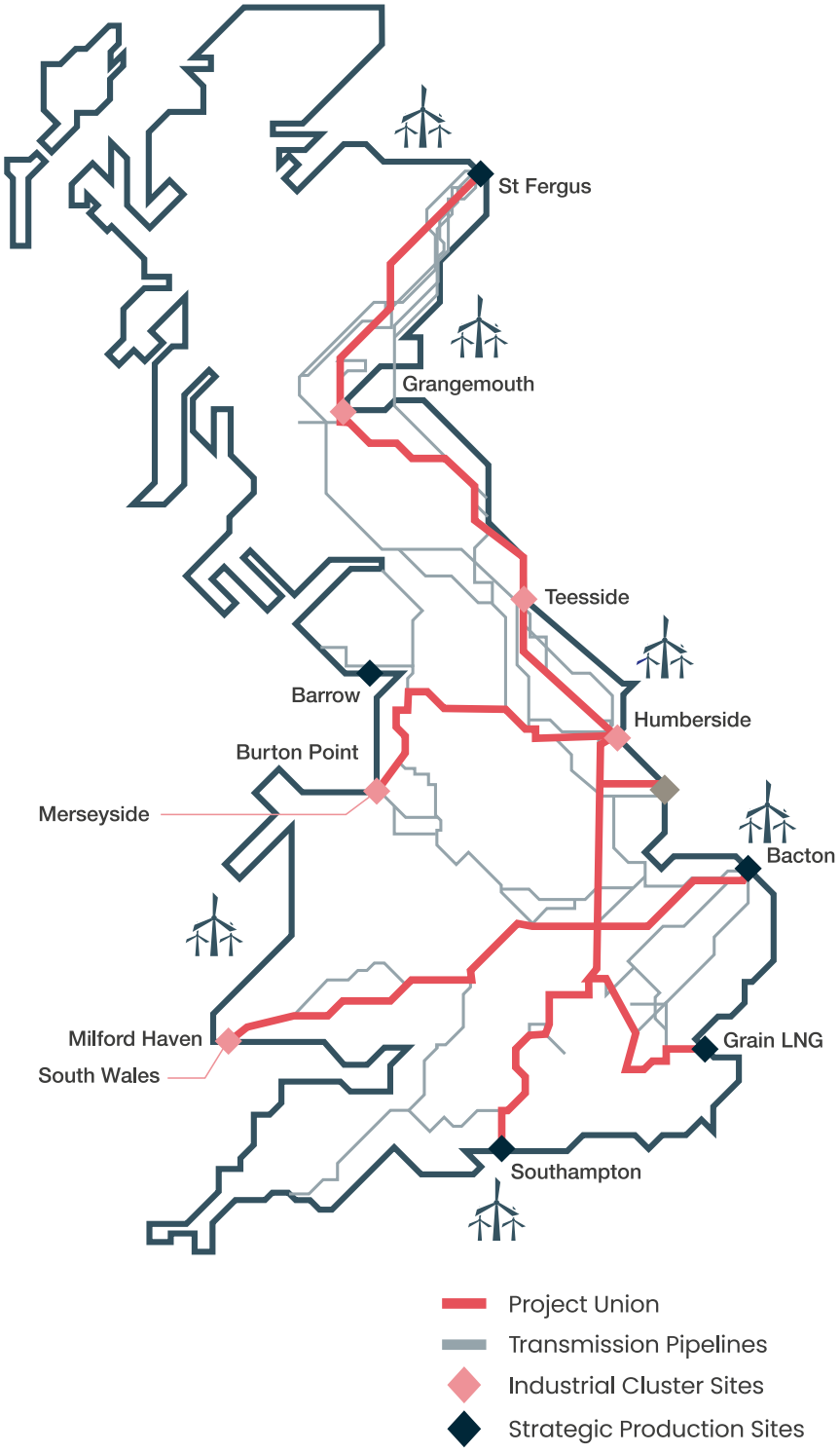
Urgency, pace and scale is required to ensure energy security and independence, **benefiting all UK** consumers to realise the UK's decarbonisation challenge and deliver **legally binding** net zero 2050 commitments

Low carbon hydrogen is required for all net zero scenarios

UK Hydrogen Strategy sets a target of 10GW of hydrogen production equivalent to six million homes

Low carbon hydrogen can **enable decarbonisation of industry and provide optionality** for transport and domestic heating

Investment in **hydrogen transmission** infrastructure is required to **link supply and demand, de-risk investment decisions, and secure inward investment** to realise a hydrogen economy and reduce the impact on the consumer



Project Union is a National Grid Gas Transmission initiative aimed at delivering a "first of a kind hydrogen transmission backbone" for the UK – offshore wind farms have been incorporated into the project

Source: https://www.nationalgas.com/document/139641/download

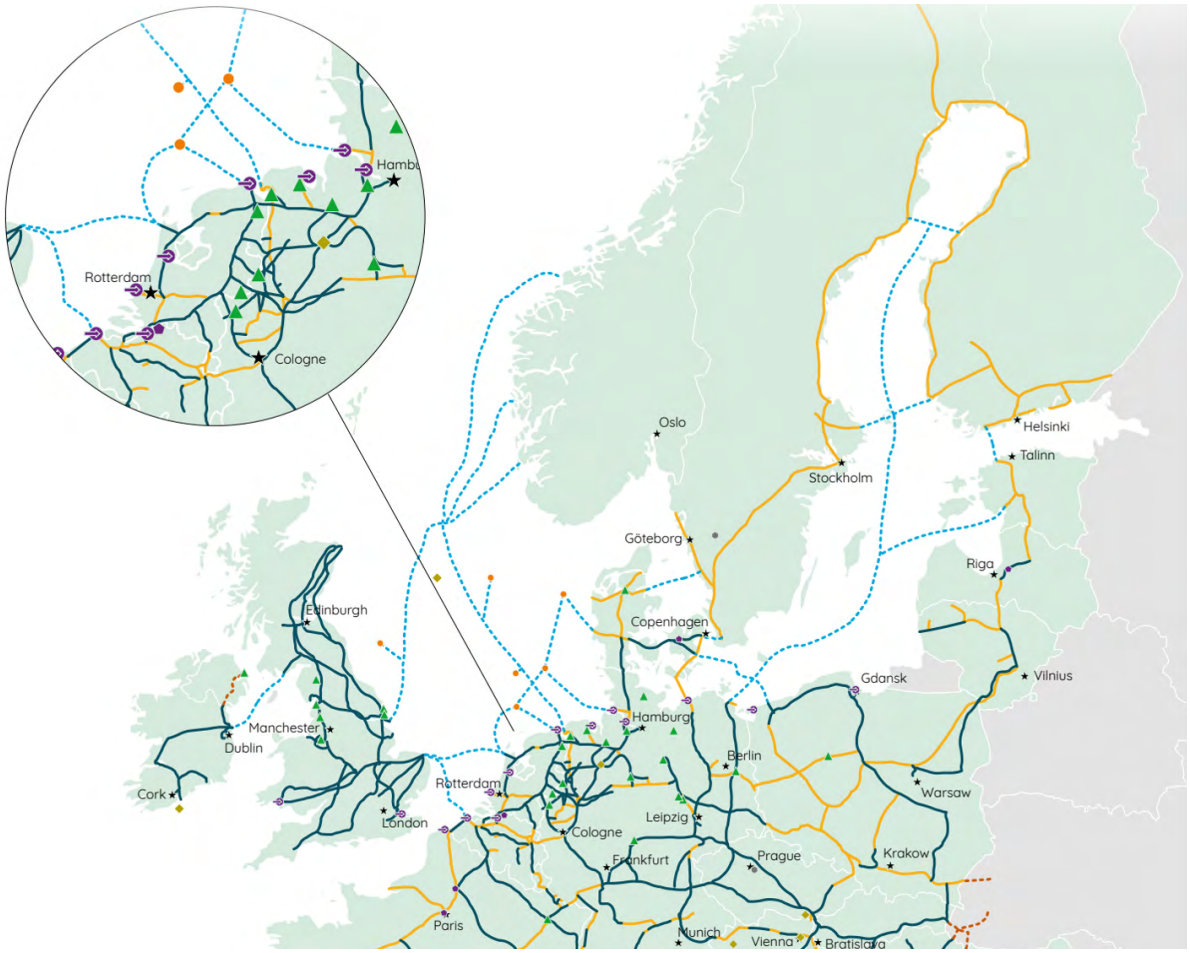
launch report stated. Habbitts highlights that Project Union's plan has taken offshore wind into account. "Offshore wind farms are considered in the plan," he says. "Project Union identifies large industrial clusters where there could be large users of hydrogen, and connects those hydrogen hubs so that hydrogen from offshore wind, for example, in Scotland or in the Celtic Sea, can be moved relatively quickly across the country to where it's needed," Habbitts says. "With a network like this, so much more becomes possible because you can then sign offtake contracts from your wind farm producing hydrogen – for example, in the Celtic Sea – with maybe an industrial party on the other side of the country."

Could US replicate Europe's 'hydrogen backbone'?

In a similar vein to the UK's Project Union, Europe has come up with the European Hydrogen Backbone (EHB) initiative, which aims to "accelerate Europe's decarbonisation journey by defining the critical role of hydrogen infrastructure – based on existing and new pipelines – in enabling the development of a competitive, liquid, pan-European renewable and low-carbon hydrogen market". This initiative makes reference to "significant green hydrogen supply potential based on onshore and offshore wind", which it sees as driving the development of additional supply corridors that can connect Nordic and Baltic hydrogen supply to the rest of Europe.

Habbitts envisages a scenario where the US takes a similar approach. "The US is a few years behind, but I absolutely see the US following suit - I would imagine areas like the Gulf of Mexico, Texas, for example – where there's already a lot of offshore oil and gas infrastructure – would be ideal for bringing in offshore wind," he says. "You can produce hydrogen from offshore wind and use that hydrogen to produce other derivatives, such as methanol or ammonia or sustainable aviation fuel. And the kind of facilities that you have available in petrochemical areas are well suited as a starting point for these kind of projects."

There is indeed a widely held view that the Gulf of Mexico is an area where there are significant opportunities for combining offshore wind with green hydrogen production. Shell has stated that the region is "uniquely situated to facilitate and benefit from green hydrogen production via offshore wind", while the American Clean Power Association has said that green hydrogen would "increase market viability of offshore wind". How soon such ideas become a reality, however, is open to question. A recent auction of offshore wind leases in the Gulf of Mexico – coordinated by the US Bureau of Ocean Energy Management – received a tepid response, with only two bids submitted. BP recently confirmed that its primary focus was Europe, rather than the US, for offshore wind because the company believes there are better opportunities



The European Hydrogen Backbone Initiative recognises the key role offshore wind projects can play in the development of a pan-European hydrogen transport infrastructure (yellow dots on map represent energy hub/offshore wind hydrogen production)

Paul Lavoie, State of Connecticut

there to use electricity to produce green hydrogen.

Connecticut: Battery storage 'bigger opportunity' than green hydrogen

Other market observers see combining US offshore wind with energy storage as a bigger opportunity than hybrid projects that include green hydrogen facilities. Paul Lavoie, chief manufacturing officer for the US state of Connecticut, who is responsible for implementing the strategies and initiatives that are in the state's offshore wind roadmap, says: "When we focus on offshore wind, the most natural partnership that I see is with battery storage." This is partly due to Connecticut's particular economic and entrepreneurial attributes, in Lavoie's view. "I think it [storage] speaks to Connecticut's strength. When you take a look at our state, we have some sophisticated battery storage companies that are working on some really smart solutions," he says. "It's just being driven by what we have expertise in, and what we're currently developing – we're just further along in Connecticut with battery technology."

Elsewhere in the US, New Jersey is a state that could soon be home to an offshore wind project that incorporates energy storage. In August this year, it emerged that Leading Light Wind – the only American-led wind project in the New York Bight – had included an option for a 253MW energy storage facility in its 2.4GW offshore wind project bid to the New Jersey Board of Public Utilities (BPU).

Back to basics for US offshore wind?

In contrast, there is little sign of an imminent surge in offshore wind projects in Connecticut that incorporate energy storage, or green hydrogen for that matter. "I've not had any specific conversations with developers around how they can combine offshore wind with any other technologies," says Lavoie. One of the reasons for this is that there are other matters that are being prioritised in the short-term. "The United States offshore wind industry is in its infancy. We're focused on a couple of projects that are

being marshalled out of Connecticut, and then getting those towers up and running, making sure that we have transmission pipelines back to the mainland to process that energy," Lavoie explains. "I think once the market matures a little bit more we'll be looking at it, it's a natural extension for us to be looking at other technologies to be able to support offshore wind."

There is a sense that US offshore wind developers, which are currently having to deal with a raft of challenges – including supply chain issues, as well as interest rate rises that are negatively impacting on projects' profitability – are intent on not over-complicating project plans. Consequently, there is a reluctance at present to take steps to incorporate storage and green hydrogen production into projects. The extent of the plight of US offshore wind developers was highlighted recently when it emerged that Ørsted had stopped development work on its 1.1GW Ocean Wind 1 and 1.15GW Ocean Wind 2 offshore wind projects in the US due to rising costs and supply chain problems.

The time is coming for offshore wind and storage

Curtis VanWalleghem, CEO of Hydrostor, a Canadian advanced compressed air energy storage company backed by Goldman Sachs, has highlighted the offshore wind sector as a "strong fit" for his company's technology. However, he adds that now may not be the right time for offshore wind projects that include storage and green hydrogen. "Offshore wind developers' projects are big and complicated and they've had a lot of challenges recently, so I think they're trying to keep things very basic," he says. Another factor to consider is that offshore wind projects' need for storage may not be as great as that of onshore wind. VanWalleghem says offshore wind is generally more consistent than onshore wind, and therefore may be less reliant on energy storage, which raises the question of whether including storage in an offshore wind project will always make sense economically. "With regard to storage, you have to use it a lot to get good value from it," he says.

> "When we focus on offshore wind, the most natural partnership that I see is with battery storage"
>
> **Paul Lavoie, chief manufacturing officer, Connecticut**

Curtis VanWalleghem, Hydrostor

VanWalleghem adds that offshore wind developers have not been as open as expected when it comes to discussions about including storage in projects. "We were involved with a couple of groups to try to figure out what to do, and a key consideration is how much do you get penalised if you can't forecast when your offshore wind is coming and whether there is an interconnection bottleneck or something you have to work around, but I haven't seen things be very compelling," he explains. However, the feeling is that it is only a matter of time before projects combining offshore wind and storage come to the fore. VanWalleghem adds: "Doing them [offshore wind and storage] together as one project? I still believe that's coming one day, but I just haven't seen it take off as much as I'd like to see."

When that time does come, VanWalleghem argues that advanced compressed air energy storage is well-placed to become the technology of choice. "Hydrostor's compressed air system has big scale, 400 to 500MW and up and, to me, that's a great fit for offshore wind because the projects are so big," he explains. "We also have a very low marginal cost, so for us going to 20 or 24 hours is quite cost competitive relative to a lot of other technologies."

US offshore wind must not lose sight of benefits of storage

Despite any constraints that offshore wind developers may currently be operating under, it's crucial that they don't lose sight of the benefits of adding storage to their project plans. What are the key points developers should keep in mind? "The first benefit is maximising the use of the interconnection point," says VanWalleghem. "Interconnection is very tough to do and if you've got say a one-gigawatt wind farm, consider whether you need one gigawatt of interconnection or could you get away with 750 or 800MW and have storage and make sure that utilisation factor of that interconnection point is higher." Additionally, developers should also weigh up the potential for energy trading, as well as reducing the cost of curtailment. "Another benefit is being able to predict and sell in the day-ahead market and not get penalties with your offtake," VanWalleghem explains. "You're able to more accurately forecast your output and then also avoid curtailment of any sort and you might be able to optimise some pricing in there."

The current economic climate has led US offshore wind developers to err on the side of caution when it comes to planning potential projects, which means they are shying away from including provision for green hydrogen production and energy storage. However, it's important that they do not lose sight of the bigger picture, which shows that including such facilities in offshore wind projects has the potential to substantially increase their viability. There is a sense that the time is not yet right for the proliferation of such projects in the US, but it is an era that is surely just around the corner. ■

UDO SCHNEIDER Q&A

Financing offshore wind in Poland

Northland Power and Polish utility Orlen last month achieved the €4.7bn financial close at their 1.1GW Baltic Power scheme. Udo Schneider, managing director at Green Giraffe Advisory and advisor on the project, explains how they did it

How long have you worked in Polish offshore wind?

I started working on Polish offshore wind end 2016 when there were great ideas, several seabed permits but no real projects yet, so it has been quite a long time. A lot of people are relieved offshore wind is finally happening in Poland, which is one of the highest carbon emitting countries when it comes to energy production across Europe. In Poland, a 1.1GW project like Baltic Power can really be a game-changer and unlock the potential.

Was it tough to finance Baltic Power in the current market?

It's one of the biggest offshore wind projects in Europe, and there are hardly any other markets that successfully start with a project at that scale. Baltic Power is also using a new turbine generation from Vestas, so it was the first time those turbines had been banked, and of course we see developers struggling with cost increases across the board. So yes, it has been challenging for everyone involved

How did you manage disruption in the supply chain?

Whilst turbine makers are having a difficult time, the market has become a supplier's market. You have to reserve your production slots and, if you get to the end of your contract holding period, you start renegotiating. We see that across all projects. We had to avoid and get the financing in place in time. Nevertheless, like other projects, we had to accommodate some cost increases between bank launch in late 2022 and financial close. In a way it helped that we asked for a rather streamlined process with binding offers from lenders right away.

> In Poland, a 1.1GW project like Baltic Power can really be a game-changer and unlock the potential.

Why did you take that approach?

We "pre-cooked" the deal as much as possible and had been in discussions with various multilateral lenders like ECAs and EIB for a long time – so we took this rather fast track approach to be efficient knowing that we had an attractive project to create sufficient competition. It worked well.

It's also worth noting the project features a tier 1 contractors setup with strong sponsors but it also has an indexed 25-year Contract for Difference (CfD), that could be pegged to the Euro which helped to provide long term certainty to lenders.

Is it tough to get lenders to commit like that in a new market?

It can be. One would argue that it is just another project in the highly accessible Baltic Sea. But it's still a new market and Polish lenders weren't familiar with how offshore wind is financed or contracted. Combining Northland as internationally experienced developer and operator of offshore wind and Orlen as largest energy player in Poland in a truly joint setup was key to the success gave comfort to lenders and since we combined internationally experienced commercial offshore wind lenders, ECA's and EIB helped those first timers to get comfortable.

It sounds like a unique set of circumstances, but are there other lessons that you can take from Baltic Power into other projects?

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You have to have the financing side closely integrated into the procurement process, so you are able to react quickly and adapt. There were several moments when we had to adjust or react quickly to new developments – within the project or in the global offshore market. Various projects were competing for the most experienced contractors at the same time and we had to be fast to support negotiations and allow for quick decisions when needed.

It's also been a truly international project, with people from various nations including France, the Netherlands, the UK, Canada and Germany working alongside Polish experts. The key to the success has been a truly integrated and joint approach to develop and finance the project with hundreds of great people involved.

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