Regulatory set-up for hybrid offshore wind projects

Ørsted

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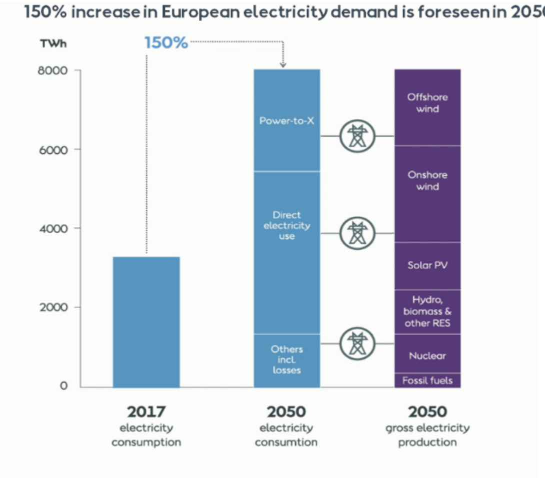
Content

1. Introduction: hybrid projects as an essential enabler of offshore wind expansion

Europe is determined to reach net-zero greenhouse gas (GHG) emissions by 2050. Electrification is identified by the European Commission (EC) as the single most important driver for decarbonisation. Therefore, the EC Long-term Strategy (LTS) estimates electricity demand growth of 150% by 2050 (Figure 1). This explosive growth must be matched by supply from renewable sources, with wind power projected to account for more than half of all supply and offshore wind (OSW) delivering 25%. This implies rapidly building out to a total installed capacity of 400-450GW – against current operational capacity of <25GW (Figure 1).

Figure 1 • Meeting electricity demand growth under the EU clean energy transition



Achieving the foreseen OSW contribution will require a rapid build-out of large-scale projects of ~20GW/yr between 2030 and 2050[1]. But that is only part of the equation: delivering electricity to consumers requires a similar scale and pace of expansion of offshore grids, from 9 to >100 GWx1,000 km (i.e. a 12-fold increase) and a 6-fold increase of transmission asset capacity among countries[2]. With necessary offshore grid investments projected at ~170 bln EUR, delivering these projects in a cost-efficient way will be key to securing the overall cost efficiency of the decarbonised energy system.

Ørsted analysis finds that continuing with an OSW infrastructure based on radial connections is likely to fall short of delivering the generation and transmission capacity needed, and indeed may undermine efforts to attract the scale of investment required.

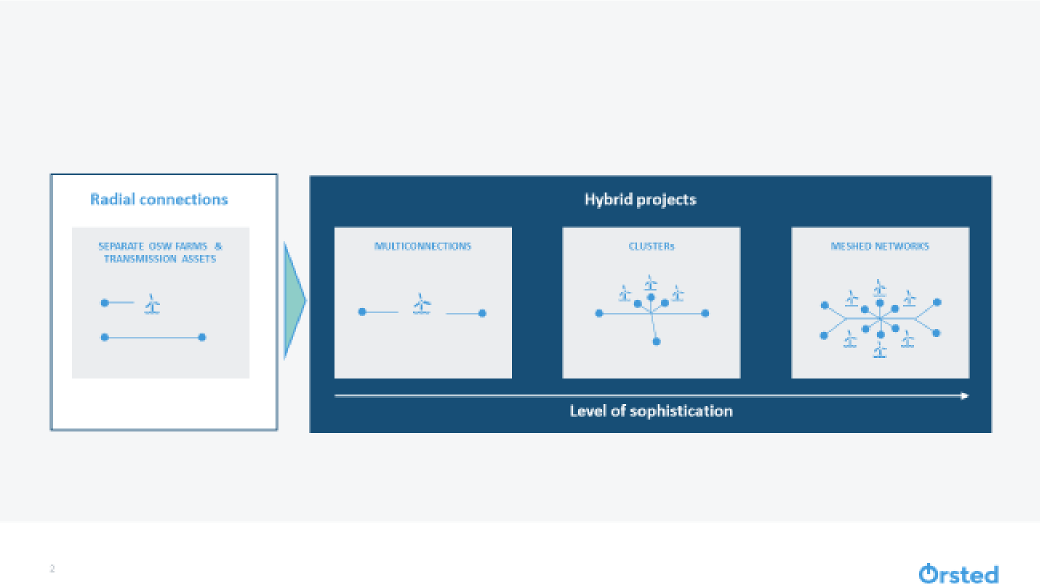
This note proposes development of **hybrid projects,** defined as an OSW farm connected via a transmission asset to at least two markets (Figure 2). This creates the opportunity to use the transmission asset in a dual way: evacuation of produced wind power and as an enabler of trade between two markets, which generates

[1] Assuming a current capacity of 25GW and a need for 400-450GW of capacity in 2050 as assumed in the EC LTS gives an annual build out rate of 19-21 GW/yr. Additional build out will be needed to compensate for decommissioning

[2] EA Energyanalyse (2020). In another study, Wind Europe (Roland Berger, HYBRID PROJECTS: HOW TO REDUCE COSTS AND SPACE OF OFFSHORE DEVELOPMENTS - Figure 8) finds a similar pattern, where investments into offshore grids need to increase around 10-fold within 15 years, and with total investments into offshore grids of 200 bnEUR before 2050.

a more attractive business model than current practices. Over the long term, such hybrids assets can be developed into clusters, hubs, and a meshed offshore grid, thereby unlocking the necessary very large scale build out of offshore wind power.

Figure 2 • Transitioning from radial connection to hybrid models



The need to build out offshore wind and transmission infrastructure must be viewed as an integrated challenge: realising one without the other will not get Europe to net-zero. By contrast, the direct integration of the two, in the shape of hybrid projects, substantially supports the net-zero target in a cost-efficient way while also unlocking socio-economic benefits. Specifically, hybrid assets offer the following advantages:

1. **Enhanced robustness of both offshore wind and transmission projects.** Hybrid projects create the possibility to evacuate offshore wind to serve offtake at more than one market and, at the same time, the possibility to trade. This supports higher use of the transmission asset.
2. **CAPEX savings.** Combining transmission with the grid connection can deliver lifetime savings of 5-10% for selected concrete projects.[3] Considering the need, over time, to move further and further offshore to harvest new wind, the cost savings for large-scale roll-out could be as high as 30%.[4]
3. **Reduced need for new connection points.** Larger clusters will enable larger cables or a higher number of cables connecting to a single landing point. The EU project PROMOTioN finds that with business as usual, 205 GW of offshore wind in the North Sea would imply 231 onshore converter stations. A meshed network reduces this number to as low as 169.[5]
4. **Improved alignment of supply and demand:** Large scale build out is driven by electrification, which will in turn have to be driven by climate policy. The scale and pace will inevitably be uncertain. Hybrids will allow for better matching of supply and demand, making them a "valve" for energy policy.

[3] North Sea Wind Power Hub – concept paper 4 – The benefits.
[4] North Sea Wind Power Hub – concept paper 4 – The benefits.
[5] PROMOTioN - D12.2 Optimal Scenario for the Development of a Future European Offshore Grid, page 205, Table 7-4.

5. **Mobilisation of the massive investments needed.** In light of the short time available and the significant investment need, combining offshore wind and transmission into hybrid projects could improve the business case for both, thereby helping to attract private capital.

2. Hybrids will not be realised without regulatory changes

Established to support existing project structures, aspects of the current regulatory set-up are not well suited to the concept of hybrid projects. Specifically, while there is a robust socio-economic business case for hybrids, and hybrid structures are likely to be inevitable for unlocking a build out of RES at the scale needed, hybrids are very difficult to realise since regulation does not allow for the necessary sharing of costs and revenues that would incentivize all parties optimally. We must ensure that a hybrid asset is clearly defined and treated in national and EU regulation to ensure that costs and revenues can be allocated in a way that commercial value creation can reflect the value for society.

Considering the design of an optimal overall regulatory framework that accommodates hybrids is not a trivial question. Indeed, it must address the interplay of roles and responsibilities, investment incentives and market rules. Some of the challenges inherent in hybrid projects call for changes to the current framework, including:

1. **The need for bilateral, and ideally also multilateral, cooperation**. Offshore wind is a resource that can provide a significant contribution to the decarbonisation of Europe, but the OSW resource is largely concentrated in some areas. Furthermore, at present, energy policies that drive concrete build-out of offshore wind are largely national. To realise the development of hybrids, regulation must support regional approaches with private and public partners from multiple countries.
2. **Integration of planning and prioritizing processes for new offshore wind and new transmission assets**. Deciding which areas to prioritise for offshore wind is typically based on assessing individual site conditions; whether a project could be combined with an interconnector is not factored in. Similarly, regulators typically base decisions for accepting new transmission assets on an overall economic assessment of the congestion rent and changes to consumer and producer surplus of the connection; the potential to attach offshore wind is not factored in. This "silo" approach will not suffice when planning for the required revolution of supply and demand in just 30 years.
3. **Embedding net-zero targets to stimulate anticipatory investments.** Related to the point on integrated planning, the current reality is that regulators approving investment cases do not, in many instances, consider to the need to deliver net-zero. Under current frameworks, they are typically tasked only to make sure consumer bills are as low as possible, by investing as little and as late as possible. As such, current planning and design of transmission asset and OSW projects does not systematically factor in the anticipatory investments needed to facilitate more offshore wind connecting to the same transmission lines. Additionally, there is no well-defined methodology for sharing costs among early and late connections sharing the same infrastructure.
4. **Incentives to align hybrid projects with value to society.** While the socio-economic value of a hybrid project is, in many cases, higher than for a corresponding radially connected OSW farm and a separate transmission asset, the incentives to prioritise a hybrid project for the OSW developer and the grid owner are not aligned. On the contrary, under current frameworks, the business cases for hybrid projects – for both the OSW developer and the offshore grid owner – will tend to be less attractive than the current model of a radially connected OSW farm and a separate interconnector transmission asset. The exact incentives will depend on the way bidding zones are configured, but with today's models either the OSW developer or the grid owner will lose out compared to current structures. Furthermore, hybrid projects raise questions on how the offshore wind can be efficiently

dispatched and what market price can be obtained for the power produced. Similarly, the allocation of transmission asset capacity in a hybrid project is uncertain.

5. **Expanding options to facilitate transmission build-out**. Current regulation is designed to facilitate build out of transmission infrastructure led by grid operators, thereby limiting transmission project's exposure to competition. This approach also limits the possibilities of harvesting cost synergies between the OSW project and the transmission asset, in turning limiting access to capital.

Radially connected OSW farms will remain the norm for some time. However, as the feasibility of hybrid projects will be decisive for getting to 400+GW towards 2050, now is the time to develop a framework that begins to address the challenges presented above. This note seeks to describe such a conceptual framework, outlining new approaches and offering suggestions for long-term considerations and for immediate steps towards realising hybrid projects.

3. Elements of a new approach

To overcome the challenges associated with realising hybrid projects, this note outlines a framework that integrates new approaches across four main elements, each of which will be elaborated in following sections (Figure 3):

- **Planning** to secure a close integration of OSW build-out and interconnections, a regional approach to cost-benefit assessment, and a focus on securing smart anticipatory investments.
- **Risk and revenue sharing between public and private entities** through double-sided contracts for difference (DSCfD), among countries involved and among private entities through open-door and merchant projects.
- **Structures for construction, ownership and operation** that allow for cost optimisation and efficient build-out.
- **Model to secure incentives** for hybrid investments through a reasonable distribution of value generated between the OSW developer and the transmission asset owner.

3.1 Planning to secure integration, regional approaches and smart investment

Finding an efficient and cost-effective layout of the offshore grid requires integration of planning for both OSW projects and transmission projects, as well as cross-border collaboration beyond what is common today. The governance needs to be practical and solution-oriented, and accept that rapid growth of the offshore grid will not necessarily result in an optimal final layout, as actors will have to make decisions despite numerous uncertainties. The overarching certainty is that a slow response will lead to failure in reaching net-zero.

Today, identifying and prioritising new areas for OSW build-out typically focuses on geo-locating reasonable conditions (seabed, wind speeds. etc.). The evolution of electricity demand at the grid connection point and simultaneous assessment of future needs for new transmission asset capacity are not systematically factored into the equations that underpin the prioritisation of new projects.

Additionally, the tendency is to think nationally, rather than regionally, about infrastructure. The default set-up for offshore planning is that national regulators and onshore grid operator(s) govern to the limit of an exclusive economic zone (EEZ) offshore – at which point there is an interface with another EEZ, with its own regulator and grid operator. In fact, grid operators are often instructed to seek projects that optimise national benefits while disregarding wider regional benefits. Two additional aspects tend to disincentivise regional development, including:

- The risk that new transmission assets will create onshore bottlenecks that the grid operator will need to manage.
- The possibility that there is an incentive to increase congestion rent by constructing too little transmission capacity, thereby suppressing the capture price for OSW located in the lower priced zone.

To facilitate this transition, it will also be necessary to incorporate a net-zero objective into maritime spatial planning, including early prioritisation for space for offshore wind.

Suggestion: Promote integrated planning of offshore wind and transmission assets

Prioritisation of new OSW projects should include the possibilities of creating hybrid solutions. Similarly, the priorities and design of new interconnections should evaluate the potential for adjacently locating offshore wind and how doing so would affect overall design of the transmission asset project.

Suggestion: Establish a regional body to ensure coordinated action

To overcome the lack of incentive for national parties to think regionally, the recommendation is to create a regional body that can act as a system architect, tasked with optimising on a regional level. The starting point could be to establish a North Sea and a Baltic Sea independent regional coordination centre (RCC), in addition to the already-planned onshore RCCs. The entity's initial mandate could be as set out in Regulation 2019/943, Article 35, with tasks and responsibilities expanding over time.

Suggestion: Allow for anticipatory investments

As scarcity of landing points and capacity to reach the onshore grid will be an increasing constraint towards 2050, transmission build-out needs to be made as large as possible upfront. Based on congestion rent alone, such anticipatory investments will not be possible to defend immediately; they are, however, a requirement to enable net-zero. A dynamic socio-economic case can be presented to support allowing grid owners to factor in future transmission needs. The related risks and upfront costs of incorporating anticipatory investments should be shared with society[6].

3.2 Sharing risks and revenues between public and private entities

Projections that, under a net-zero target, both supply and demand for electricity need to more than double in just 30 years, create an unprecedented situation for the entire sector, in which lead times have traditionally been quite long. An acceleration of development will have to forge ahead under greater uncertainty on numerous levels (including the pace of consumption growth) and will be highly dependent on a complicated mix of political decisions and technology development.

The need to transform energy use in heavy industry and heavy transport remains a daunting challenge. Consumers such as these require large amounts of energy, both for electrification and for manufacturing hydrogen and green fuels. Finding effective ways to coordinate their "lumpy" transformation with "lumpy" investments in OSW power implies the need for fresh approaches in timing and location of new OSW developments.

It is unlikely that market forces alone can trigger this scale and pace of development, considering that the development of demand will be highly dependent on policy. If the sector follows the past practice of waiting

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[6] For example, through a regulated rate of return instead of a case based on congestion rents alone. This conclusion is echoed by the EU project PROMOTioN (deliverable 12.3 – chapter 4.3.5.2) which, as an alternative to regulated income based on the regulated asset base, suggests fixed income after a competitive tender if built and owned by third party.

for demand increase to materialise before making new investments, both power generation and infrastructure will arrive too late. The sector will have to adapt to the idea of building renewable capacity in anticipation of the timing of the future increase.

The fundamental changes come with new opportunities and also new risks, including uncertainty about whether future revenues will support satisfactory levels of return on anticipatory investments. In a policy-driven economic transformation, there is a strong case to be made for balancing the risks and rewards across private and public entities.

Another disruptive element is that hybrid projects imply connections to multiple countries, raising the question of which country is the natural counterpart for a support regime for the offshore wind. Which country has jurisdiction over the seabed is one aspect, but the likelihood of situations in which the interconnection will manage significant flow of offshore wind to multiple countries other than the host makes the question non-trivial.

Suggestion: Apply double-sided CfD as a risk-sharing mechanism

To minimise risks and judiciously distribute revenues, the recommendation is for society to offer double-sided contracts for difference (DSCfD[7]), awarded through competitive tenders. Due to the low costs of offshore wind, DSCfDs will effectively act as a hedge rather than a subsidy, which has the effect of de-risking for all parties involved.

The proposed risk-sharing will also balance uncertainties in timing arising from rapid electrification and OSW build-out. If electrification advances faster than anticipated, or accelerates after construction, society will be insured against excessive costs from rising electricity prices. If, on the other hand, electrification happens at a slower pace than anticipated, the developer will be insured against too low prices, and the incentives for society to introduce measures to speed up electrification will be enhanced. Inherent in the DSCfD is also the fact that developers remain responsible for project-related risks, which they are best able to mitigate. In effect, risk-sharing serves to align incentives.

Critically, DSCfDs should be tendered at a scale and pace that ensures timely construction of power generation to meet expected new demand while also providing a planning outlook that allows developers and the supply chain to scale up in time.

Suggestion: Facilitate regional cooperation on CfDs among countries

Today's low cost of offshore wind has the advantage that, with a hybrid asset, allocating costs and benefits should be simpler than when offshore wind needed large subsidies. Indeed, the last auction round from the UK,[8] in which the wholesale power price is expected to be above the strike price, suggests that the state will receive payments rather than paying out.

As DSCfDs will primarily be a risk hedge, it is likely that the EEZ-hosts act as the counterpart.

In cases where a split is necessary, joint risk-sharing schemes can be applied. A "benefiter pays" principle would mean that, in a given hour, the country receiving the OSW power flow is the counterpart. Congestion rent is managed as for transmission assets and does not affect the OSW power. For hours having no price

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[7] DSCfD and CfD are used interchangeably in this document.
[8] Follow link to results here.

difference, the DSCfD support/income is split according to where the power flows. Renewable energy accounting (towards RES targets) follows the same allocation.

Landlocked countries, or countries wanting to support OSW build-out in their region, should be able to participate by being the counterpart for the DSCfD, and have the same opportunity to have corresponding OSW capacity and production count towards their national targets.

Another option, which gives more certainty for the split – and could thus be attractive for the involved countries – could be to establish an upfront agreement on the split of benefits and then allocate corresponding levels of risks. For the lifetime of the project, the agreed benefit split would also determine the split of the offshore wind in relation to each country's national RES target.

Suggestion: Allow for open-door / merchant optimisation opportunities

The lumpy nature of new types of the demand, and the fact that individual offtaker decisions can prompt significant demand increases, may create scope for build-out of some merchant offshore wind, without public risk-sharing, based on corporate PPAs.

If a developer expects that high demand will keep power prices consistently and sufficiently high, an investment may be feasible without a publicly awarded CfD. More likely, to ensure stable supply to a specific location, some large-scale users will have an interest in risk-sharing through a corporate power purchase agreement (PPA) – effectively a private CfD. To facilitate such merchant projects, the recommendation is to work towards an open-door process through the following actions:

1. Set up an "open door" to facilitate access to areas identified and establish smooth processes for securing environmental and grid connection permits, as well as other permits necessary to construct the project outside of the CfD-tender regime. Permits should be awarded on a "use it or lose it" basis, backed by well-defined requirements for progression (which should be proportional the complexity of the project).
2. Allowing the industry to build "full scope" projects[9] so that merchant projects can progress – including to build the grid connection – without requiring attention and resources from the grid operator.
3. Give OSW developers access to coastal consumers (where most OSW production is consumed on-site) through establishing a framework that incentivizes large new consumption to locate close to offshore wind landing points
4. Establish a regulatory framework that allows for a regulated rate of return to transmission owners in which the business case for existing offshore wind is not undermined by additional OSW farms connecting. The regulatory framework needs to include cost-reflective transmission tariffs that make it possible for merchant offshore wind to connect to a hub while paying a fair tariff for using the common infrastructure (which might be build-out through public tenders).

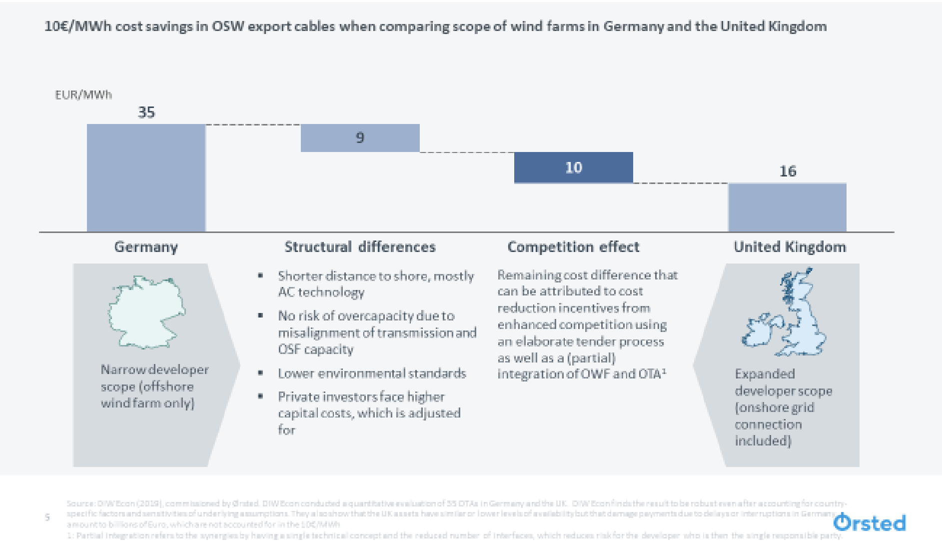
3.3 New approach to construction, ownership and operation

The importance of synergies between transmission and the offshore wind farm and competition for reducing costs of grid connection has been studied by DIW ECON[10] in their comparison of offshore transmission costs for Germany and the UK (Figure 5). Although the projects are not directly comparable, after adjusting for

[9] Offshore wind projects including in its scope the investigation and development of the project, grid connection and offshore transformer station (currently the case in DK and UK).
[10] DIW Econ (2019), *Market design for an efficient transmission of offshore wind energy,* for Ørsted

differences in technology, distance and other factors, 10 €/MWh remains – which can only be attributed to differences in regulation.

Figure 5 • Comparison of offshore transmission costs, Germany and the UK



Several factors contributed to the 10 €/MWh in "competition effect", including:

- Competition throughout design, procurement and construction. Tenders for bits of equipment, as is standard for build by grid operators, lacks competitive pressure across the whole design, which has been shown to stimulate innovation. One example is that building lighter eqipment allows, in turn, for smaller and less costly platforms.
- Optimised interface and compatibilitiy between OSW turbines and the grid connection (e.g. through overplanting, where the size of the wind farm is optimised to fit the cable capacity).
- The ability for OSW developers with a portfolio of projects to leverage large-scale design and procurement, using the same design across several projects.
- Eradicatig interface costs or risks of delays by coordinating and integrating installation campaigns.

Suggestion: Include transmission asset in tenders to capture cost synergies

The significant cost savings and considerable synergies offered by hybrid projects can be reaped to a full extent if both transmission and offshore wind can be developed by the same entity. Including transmission into the tender scope directly exposes the developer to competition, stimulating the cost reduction pressures that follow naturally.

In construction, the hybrid model creates inherent incentives for the OSW developer to ensure timely, efficient and reliable build-out of the transmission cable. If the cable is delayed or construction costs exceed budget, it would directly impact the business case of the OSW asset. The specifications of the tender can ensure the best possible integration and interface with connections to adjacent grids, onshore and offshore.

<u>Suggestion: Establish a framework for ownership and operation of transmission assets that prevents discrimination</u>

An effective regulatory framework can address concerns regarding vertical integration. Today's well-functioning real-time and day-ahead markets, combined with forcefully taking away all control over the dispatch to these markets, resolve problems linked to ownership and operation of the transmission asset.

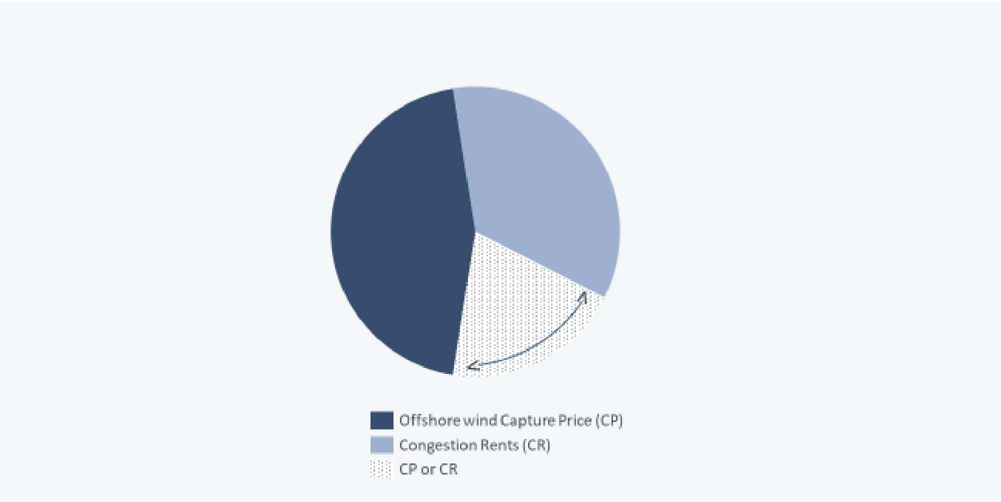
If there are still concerns about unbundling, or until unbundling requirements have been relieved for hybrids, two alternative approaches could be considered. After construction, the transmission asset could be sold to third parties, such as OFTOs. Or, the grid connection could be fully or partially sold to a grid operator or an independent grid owner, with the selling price structured in the same way as regulators manage the asset base in other regulated monopolies. After the transmission asset is sold, the OSW operator would pay for the use of the transmission: this would align incentives and contribute a stable income to the transmission asset. For offshore grids, there is already many years of experience in the UK with the OFTO regime (offshore transmission owner), which compensates developers for the verified costs of the grid connection. To ensure quality, this model would need to include carefully designed incentives.

3.4 Model to secure accurate incentives for hybrid investments

There is a robust socio-economic business case for hybrids, and hybrid structures are likely to be inevitable for unlocking a build out of RES at the scale needed. But today hybrids are very difficult to realise since regulation does not allow for the necessary sharing of costs and revenues that would incentivize all parties optimally. This section examines pros, cons and trade-offs among these players, then proposes regulatory changes that could balance the factors in ways that address the downsides identified.

The overall market income for a hybrid project is made up of two income streams: a) the sale, by the OSW developer, of electricity generated; and b) the congestion rent earned by the grid owner through allowing trade of electricity between high and low price areas. The overall potential earnings (the size of the pie) are a given, but who (the OSW developer or the grid owner) gets how much depends on regulation. In other words, it is a zero-sum game: one party's gain equals the other party's loss (Figure 6).

Figure 6 • Sum of offshore capture price and congestion rent

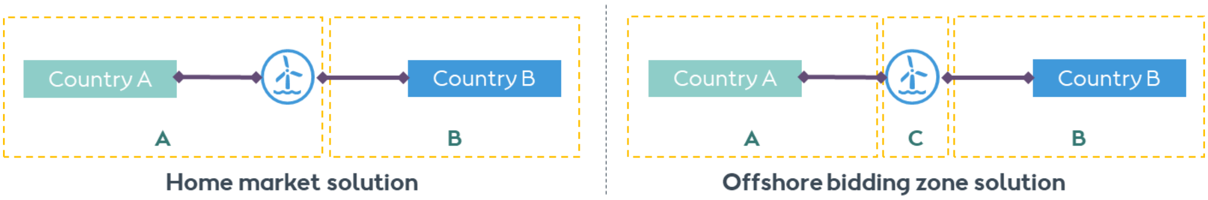


A fundamental novelty for hybrid projects is that transmission lines serve as both feeder lines for offshore wind to shore and as interconnectors. This affects the business case – and thus the willingness to invest – of both OSW developers and grid owners. If transmission lines are treated as a transmission asset only, lower power prices undermine incentives for the offshore wind. If treated as feeder lines only, it reduces congestion rents for the grid owner, thereby undermining the incentives for build-out.

For OSW developers/owners, the economic rationale for hybrid projects would need to be at least as attractive as a comparable OSW project with a radial connection. For a transmission asset funded by congestion rent (CR), the fact that linking to an OSW farm would mean the offshore wind occupies some of the transmission asset capacity would erode the business case.

Under the hybrid model, price-zone delineation is a key determinant of optimal dispatch, which is the main purpose of price zones, but also how the pie is sliced – i.e. how much is capture price for the OSW developer and how much ends up as congestion rent. Here, it is valuable to compare two options: the **home-market solution** and the **offshore bidding zone solution**[11] (Figure 7).

Figure 7 • Comparison of home-market and offshore bidding zone solutions



[11]The offshore bidding zone can either end offshore or at the onshore landing point. This is important if thoughts concerning infeed zones, where large amounts of OSW is fed in and where the conditions to locate demand are set correspondingly to facilitate that new demand locates places where the renewable resource is scarce.

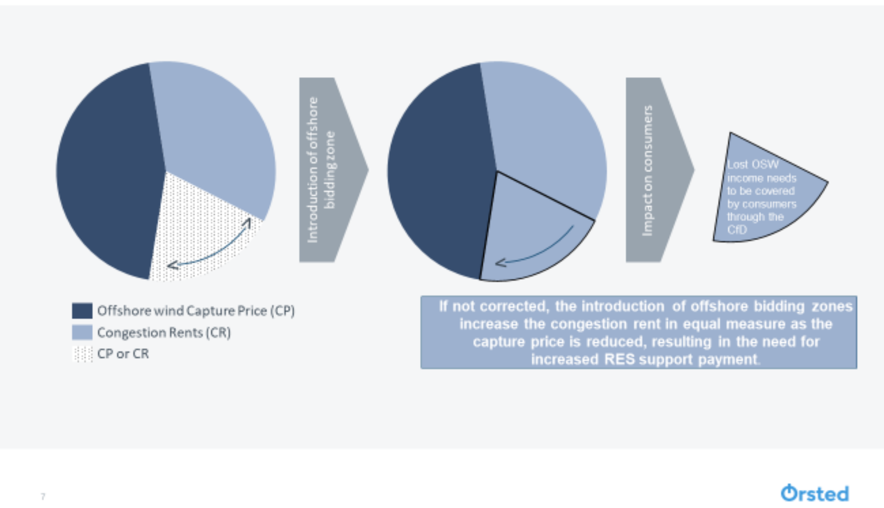
The **home-market solution**, which would include the OSW in the same price-zone as the country in whose waters the wind farm is placed (as is used for Kriegers Flak), has been the most natural starting point for hybrid projects, not least considering that Kriegers Flak receives a subsidy, and is contributing to meeting Denmarks 2020 RES target. In this solution, the market coupling algorithm would still ensure efficient dispatch and the OSW developer would receive the home-market price for all power sold. But, some of the power might be physically sold to another bidding zone, which may have a lower or higher price than the home-market. This would mean that, in some time periods, the physical flow of the power would not be aligned with the realised price. In short, the price received by the OSW developer would not be equal to the value of the power sold, noting that the divergence could be either positive or negative.

For the grid operator, who needs to estimate wind production ahead of releasing residual capacity to the market for trade, the home-market approach would increase balancing risks.

Finally, the home-market solution would mean that offshore electricity prices have little relation to the offshore physics and interconnection capacity. OSW potentials that happen to be located in an EEZ with low onshore home-market electricity prices might be unused while incentives for dimensioning of interconnectivity may not be fully aligned with a physical optimum.

The individual **offshore bidding zones solution,** by contrast, provides correct signals for trade and simple settlement while also allowing for standard balancing. The positive, for the grid owner, is that this solution creates no additional balancing risks when releasing capacity for trade. It could also open for the possibility to link lumpy consumption, onshore, but in the offshore bidding zone, and thereby saving large onshore transmission investments if the lumpy consumption gets the right incentives through tariffs. It comes with a downside for the OSW, however, in the form of a much-reduced business case: congestion rents take all of the bottom slice of the pie shown above (Figure 9). Without an additional revenue allocation mechanism, OSW developers would continue to prefer radially connected projects over the proposed hybrid model.

Figure 9 • Impact of offshore bidding zones on capture price and congestion rent



Given that most offshore wind is developed based on business models built on fixed-price contracts, some may argue that shifting the slicing of the pie is irrelevant. Overall revenue for the OSW developer stays the same even though a smaller share will be market based and a higher share will be in the form of public support.

Ørsted finds several flaws in such an argument:

1. **Support required influences the political appetite for renewable energy build-out.** Higher costs for supporting RES means less political willingness to incentivise further build out.
2. **Risk that lower budgets will constrain roll-out of renewables.** More directly, as CfDs are often financed through a budget allocated to renewable build-out, lower market prices for OSW drive up the cost of support, leaving a smaller share of the budget for build-out. Additionally, the value creation is shifted from the offshore wind to congestion rents. At present, EU legislation restricts the use of congestion rent and will not compensate the increased public expenditure on CfDs. Moreover, the grid owner might be a private company and/or in a different jurisdiction (country) than the OSW farm.
3. **Inefficient use of public funds.** Using increased congestion rent to channel RES support to grid owners is inefficient use of public funds, even if in compliance with EU regulation.
4. **Disconnect between CfD timeframe and asset lifetime.** Usually, the CfD covers a shorter period than the anticipated lifetime of the OSW asset. When the CfD expires, the project will depend on power market revenues. If post-CfD prices are expected to be low, the CfD will have to be higher to support the overall OSW business case.
5. **Disincentive for merchant investments.** The possibility to build merchant OSW is important, particularly for business-to-business contracts. The lower price and shift of revenue from the OSW developer to congestion rent makes merchant investments hard to imagine, meaning that one promising contribution to reach net-zero is cut off.

Lack of protection against curtailment that an OSW farm faces when in its own bidding zone amplifies the preference of OSW developers for radial connections over the hybrid project model. Priority dispatch is no longer applicable to new investments in renewable power (unless demonstration and small-scale)[12], even though the revised Electricity Regulation still clarifies that renewables should be the last to be subject to downward re-dispatching[13]. When in its own bidding zone, curtailment of a given OSW farm is a question of how much cable capacity is made available to the market. Today (under radial connections), grid operators should make at least 70% of the capacity available for the market[14]. Such downward re-configurations of the grid capacity mean that offshore wind faces two additional risks linked to price and volume:

1. **Price risk:** With a separate bidding zone, the price offshore is the highest of the adjacent bidding zones to which there is no congestion. The 30% reduction in capacity may increase the number of hours with congestion towards the high price zone, thereby driving down the OSW capture price.
2. **Volume risk:** It is unclear what the compensation regime would be with only renewable generation in one bidding zone. If the compensation regime is non-existing or weak, the 30% reduction in capacity could lead to occasional zero-prices and hence curtailment.

Four main issues must be considered when weighing home-market and offshore bidding zone solutions: economic rationale, efficient dispatch, balancing risk and curtailment risk. Some have positive impacts under a given solution; others are less favourable or can even be a negative (Table 1).

[12] Article 12 of the Electricity regulation (EU/2019/943).
[13] Article 13 of the Electricity regulation (EU/2019/943).
[14] Article 16 of the Electricity Regulation (EU/2019/943).

Table 1 • Comparison of how solution options impact development decisions

	Home-market solution	Offshore bidding zone solution
Economic rationale for OSW developers	Yes (same as for onshore wind and radial connections)	Reduced compared to radial connections
Efficient dispatch	Yes[15], but incentives for investments and dimensioning may be distorted	Yes
Additional balancing risk for grid operators	Yes	No
Additional curtailment risk	Yes, but risk is compensated for	Yes

Dark green indicate that the model works well for the issue in question, whereas light green indicate that the model does not work well for the issue in question

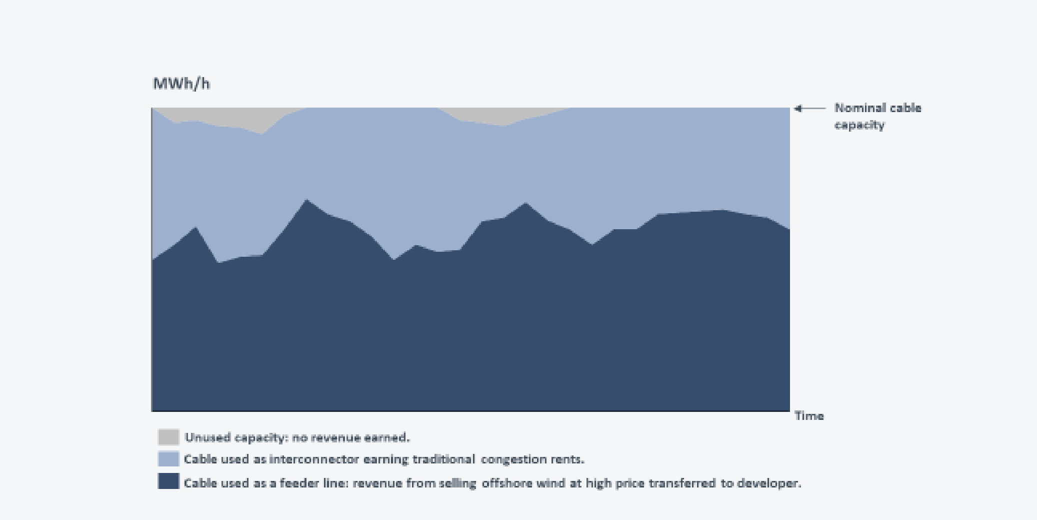
Suggestion: Combine offshore bidding zones with ex-post value redistribution

OSW power should receive the price of the bidding zone to which the power flows; i.e. as long as the physical capacity allows for it, the highest price among the adjacent bidding zones. Market design should ensure optimal dispatch, meaning it pursues the offshore bidding zone model. Within that framework, contracting among involved parties would adjust how the pie is sliced afterwards so that final OSW remuneration corresponds to the adjacent bidding zone with the highest price.

Effectually, congestion rents under a hybrid model should be divided into (a) that received from selling OSW power at the highest price; and (b) that received from pure arbitrage when spare capacity is used to transport power from a low price area to a high price area. Value corresponding to (a) is allocated to the OSW developer, which has the knock-on effect of treating, in a given moment, the part of the transmission asset used to transport power as a grid connection (feeder line) rather than an interconnector, while (b) remains with the economy of the grid owner (as is the case today).

[15] The dispatch would be the same for both solutions (as shown by EU project PROMOTioN in deliverable 12.3 – see Annex V). However, the capacity given to the market by the grid operator would likely be less than 70% with the home-market solution -- and hence require an exemption from Article 16 of the Electricity Regulation. Allocations to the market would depend on the grid operator's wind forecast. The grid operator might want to be risk-averse and not have to counter-trade if volumes available are less than forecasted (and hence less than offered to the market).

Figure 10 • Efficient use of hybrid transmission asset



Establishing a model in which OSW production is in its own price zone, but receives the price of the price-zone to which power flows, serves three main purposes.

1. **Greater transparency.** The value of electricity from the OSW farm is more transparent; revenue reflects nearby demand and nearby value (in the area that receives electricity).
2. **Reduced risk and enhanced viability.** Because it creates a fair reflection of the OSW market value, this model reduces the risk of public cash-out while also increasing the viability of merchant projects.
3. **Enhanced incentives.** By removing distortions in incentives, this model maximises transmission capacity.

Current EU market regulation poses a barrier to realise the offshore bidding zone solution in that it defines congestion income as all revenue from sale in the low price area and purchase in the high price area, including the sale of power from the offshore wind farm. Thereby it is assuming, that the entire asset is an interconnector, rather than a combined asset. EU regulation restricts the use of congestion rent, stipulating that it cannot be redistributed to the OSW farm, if the full transmission asset is defined to be an interconnector – despite serving dual uses. Ørsted sees two options to adjust regulation:

1. **Change Article 19 in the Electricity Regulation** to require that value received from selling OSW power at the highest price is transferred to the OSW asset owner.
2. **Provide, free-of-charge, the financial transmission rights (FTR)** to the OSW developer as part of the tender, to achieve a somewhat similar outcome for the relevant grid operators. The validity should match the economic lifetime of the OSW asset and be given as part of the grid connection permit. Essentially a hedge, FTRs give the holder the right to receive the price difference between two bidding zones – which is equivalent to the congestion rent and selling the power in the adjacent bidding zone. As current regulation requires that FTR holders be compensated in case of curtailment, FTRs can serve as an insurance. Initial assessment suggests this proposed FTR solution would

require a change to the FCA regulation[16], as FTRs currently have to be auctioned and cannot be distributed free of charge.

Suggestion: Use tariffs to secure fair incentives for the transmission asset

The recommendation to secure the right incentives for the transmission component of a hybrid project sees the OSW owner paying a cost-reflective transmission tariff to compensate for its occupation of the grid.

Transmission tariffs[17] thus play two roles in the suggested framework. First, they reflect the value of the grid connection, and hence improve the business case the hybrid transmission asset. Practically speaking, as participation of the OSW developer guarantees some income for the foreseeable future, the OSW developer becomes a firm customer and a de-risker of grid owners: the investment in the transmission asset is less dependent on congestion rent. Second, by being cost-reflective, transmission tariffs solve the considerable challenge that meshed solutions create regarding how to regulate access to and use of existing offshore grid infrastructure, particularly where players have made anticipatory investments. The solution must be able to accommodate for both state-organised tenders (DSCfD) and merchant projects, as both need to contribute to cover the cost of the joint infrastructure.

Transmission tariffs are strongly linked also to bidding zone delineation and how profitability for offshore wind is ensured (as discussed above). As a cluster "fills up", transmission access to certain markets will change. It is important that this does not undermine the business case for offshore wind or impact the capacity to fulfil contractual obligations (e.g. with large consumers in the case of merchant projects). Solutions to transfer back congestion rent or allocate FTRs need to apply for the lifetime of the OSW asset and be resilient against probable further build-out, including the possibility of additional offshore price-zones being added before power reaches consumers onshore.

Design of transmission tariffs therefore needs to take into account how OSW revenues could evolve over time with changes in accessible grid capacities, the possibility of more offshore bidding zones (e.g. in landing zones onshore) and the expiration of the OSW project's DSCfD. If the service delivered (e.g. market access) is changing (e.g. from a high price to a low price area), it might imply the need for a parallel change in the tariff. A lower transmission tariff that reflects a change in service could make offshore wind already connected to a certain hub more likely to welcome additional capacity.

4. Possible immediate steps towards hybrid projects

To efficiently gain experience with the hybrid model, the first projects should be developed in maritime space that is already planned for offshore wind and in line with already identified trajectories for interconnectors in the vicinity. Considering all the challenges to overcome, the first projects are unlikely to be "perfect"; that should not undermine gradual progress towards a comprehensive framework. "Perfection," as it is said, should not be the "enemy of the good", by delaying realisation of the first hybrid projects.

The first hybrid projects (meaning at least two grid connection cables, offshore and onshore transformer stations as well as wind turbines) should be bid out in one tender, based on the assumption that the OSW farm is subsidy-free. As such, the funding commitment agreed in the tender would be based on risk-sharing

[16] Forward Capacity Allocation - Commission Regulation (EU) 2016/1719.

[17] In this context, the term "transmission tariff" means a cost-reflective payment for use of the grid, paid per MWh of OSW power transported to shore. This tariff is hence project-specific, but based on a common methodology to assess an appropriate level. It is distinct from G-charges or consumer transmission tariffs, which apply to a whole group of generators or consumers.

for the offshore wind and the transmission asset, putting maximum competitive pressure on the construction (rather than on transmission assets as is the current case).

After commissioning, the transmission part of the project could be sold to the grid operator(s) or to an offshore transmission owner, based on the actual costs, as has been the practice in the UK for many years. Alternatively, the developer could maintain ownership of transmission and receive a regulated income to keep it in good shape, pay back the investment and open connection to other OSW developers. For both cases, the involved onshore grid operator collects the congestion rent.

To make the hybrid model more attractive for involved member states, the EU CEF[18] could make funding available for studies (and later for construction, if necessary), as long as the project is a renewable cross-border project.

The first step toward realising a hybrid project is for two countries to decide on landing points and determine appropriate (minimum/maximum) transmission capacities (aiming for as large as possible to support later expansions). They should also consider possible linkages to placing of electrolysers, if nearby industry or consumers have existing or future need for hydrogen or hydrogen derivatives.

The bi-lateral agreement should stipulate that the renewable energy delivered by the hybrid project be counted towards the RES target of the country(ies) that is the counterpart for the DSCfD. The agreement should also set out terms that will apply after the DSCfD expires and the broad regulatory framework for involved economic operators. The EC could, as a part of the OSW strategy, develop a standardised set-up for such bi-lateral agreements.

Finding the ideal cost and benefit sharing set-up among member states and economic actors will take time, across several iterations. However, learning is accelerated though the execution of concrete projects, during which challenges arise that one could not anticipate when conceptualising projects on paper.

[18] Connecting Europe Facility.

Glossary

OSW	Offshore wind, the resource.
OSW farm	The physical infrastructure to capture wind and convert it to electricity.
OSW developer	The entity that invests in and constructs an OSW farm, and receives revenues (capture price) for the delivery of electricity into the grid.
Transmission asset	The physical infrastructure that transmits and distributes electricity. In the context of hybrids, the transmission asset serves the dual purpose of being a feeder line (that delivers OSW electricity to shore) and an interconnector that enables trade between countries
Grid owner	The entity, public or private, that invests in and constructs an electricity grid, and receives revenues for the delivery of electricity to end-users.
Grid operator	The entity, public or private, that balances supply and demand across the electricity grid, and receives revenues (congestion rent) for doing so.
Capture price	The wholesale electricity price obtainable by the OSW farm
Strike price	The price received by the OSW developer for the produced electricity. The strike price is the competitive element determined in the tender.
Congestion rent	Revenues earned by the interconnector through trade between two price zones. The congestion rent in a given hour is equal to the price difference between the two zones.
Financial transmission rights (FTRs)	Financial contracts corresponding to capacity on the interconnector. A holder of an FTR receives the price difference between the two bidding zones in a given hour.
"Put option"	A contract giving the owner the right, but not the obligation, to sell, or sell short, a specified amount of resource at a pre-determined price within a specified time frame.
Home market	The market (bidding zone) to which the OSW resource belongs.
Curtailment	Shutting down of an OSW asset when supply exceeds demand and/or the grid is congested.
Double Sided Contract for difference (DSCfD)	A contract between two parties (in this context, the private developer and the State), stipulating that the State will pay to the seller the difference between the current value of an asset and its value at contract time (if the difference is negative, then the developer instead pays back the difference to the State.
Regional coordination centre (RCC)	A proposed entity that would coordinate regulatory frameworks, ownership and operation at a regional (rather than national) level.
Radial connection	A standard model of an OSW farm being connected to a transmission asset onshore.
Hybrid model	An OSW farm connected via a transmission asset to at least two markets (in some cases, may be referred to as a 'multi-linked asset').
Merchant project	An OSW project that is 100% privately funded (i.e. no public involvement).
Anticipatory investment	Investment, by a private or public entity, in any part of a hybrid project in anticipation of future developments in demand or supply, noting that under the bid to reach an carbon-neutral economy in the EU, such investments are made under higher uncertainty than is normal for electricity system developers.