Making Hybrids Happen

Enabling offshore hybrid projects
to enhance Europe's energy transition

elia group × Ørsted

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Foreword Action over perfection

When time is of the essence, you need everyone at the table

Offshore wind and grid development are already critical for reaching Europe's climate objectives, securing competitive energy prices, and increasing the continent's energy independence. Their importance will only increase in the coming years. This joint publication is intended to point out the blocking points standing in the way of offshore hybrid development and propose a number of concrete ways to address these.

Why a joint publication?

- Transmission system operators and offshore wind developers can have differing interests when discussing the regulation of offshore wind farms which are connected to more than one market (offshore hybrids).
- However, Ørsted and Elia Group share the conviction that offshore hybrids are an indispensable part of the European energy landscape - making it possible for them to come together and publish this joint paper.

What was the main driver behind this remarkable joint initiative?

Catherine Vandenborre: *Offshore wind potential is not spread equally across Europe. Some countries have a shortage of renewable energy sources - like Belgium and Germany - whilst others, like Denmark, have more renewable energy than they can use domestically. This means that purely national solutions will not be appropriate for a successful energy transition. Just like the European Commission, we believe that combining offshore wind farms and interconnectors (forming hybrid interconnectors) carry several advantages when compared with conventional offshore infrastructure projects, such as radially connected wind farms and point-to-point interconnectors. They will help Europe to harness the full renewable potential of its seas while more effectively distributing the electricity produced among its Member States.*

Olivia Breese: *There is an increasing recognition across Europe that it will be very challenging to meet the targets that we've set out for ourselves as a society.*

"

Our proposals aim to encourage new ways of thinking and discussions between all stakeholders so that we can help Europe harness the full renewable potential of its seas while more effectively distributing the green electricity produced among its countries.

Catherine Vandenborre,
Elia Group's interim CEO

Creative solutions such as those we are proposing are needed to address the unique challenges of the energy transition in a cost-effective way. When time is of the essence, you need everyone at the table: new forms of collaboration along the value chain so that these challenges can be addressed in an integrated and considered manner. If countries or companies approach the energy transition as an opportunity to fight for their slice of the cake only, then we will very quickly descend into a zero-sum game.

Hybrid interconnectors are being promoted by the European Commission. They are cheaper, use up less space and can pave the way towards a future integrated European offshore grid. So why are they so difficult to develop?

Catherine Vandenborre: *The current regulatory framework is designed for developing either generators or interconnectors, not both at the same time - which is what hybrids are. Additionally, current planning approaches are still focused on individual countries, meaning that cross-border and regional solutions are left out. As a result, there is no mechanism for ensuring that the costs of hybrid interconnectors are shared out and borne by all of the parties and countries who benefit from them. TritonLink is a good example of this. The Belgian and Danish grid operators want to develop this hybrid interconnector and have to bear all the costs of it, but other European countries that will not contribute to the interconnector will also feel its positive effects.*

Olivia Breese: *That is why international co-operation and a political focus on the issue from the EU are so important here. If these asymmetrical benefits are not reflected in cost-sharing agreements, the acceleration that we need will be obstructed. The development of an international mechanism may sound complex – but examples of cross-border critical infrastructure already exist and there can be no doubt that the benefits of resolving these regulatory and planning issues significantly outweigh their complexity, both in terms of the speed at which assets can be deployed and also in terms of the cost reduction potential.*

"We must start delivering tangible projects as soon as possible so that we can speed up the learning loops – commercial, technical and regulatory – and deliver more and better projects on an accelerated timeline.

Olivia Breese,
CEO of Ørsted Europe

What specific solutions are you proposing for maximising the effectiveness of offshore wind development?

Olivia Breese: *Our paper proposes four solutions for addressing the fair distribution of risks and benefits amongst transmission system operators, wind farm developers and society at large. Firstly, we need to ensure (1) regional planning at sea basin level that prioritises projects with the highest potential in terms of generating socioeconomic welfare and reaching net zero. In order to identify and prioritise such projects, criteria need to be identified across EU and its North Sea neighbours (the UK and Norway), specifically at the level of its sea basins. We are asking national authorities to give a clear mandate to their system operators which operate in and around sea basins to co-operate and identify the most beneficial layout for connecting up offshore wind zones in their marine spatial plans.*

Catherine Vandenborre: *This regional planning at sea basin level should be accompanied by an (2) Offshore Investment Bank that aims to allocate existing funding streams in a more efficient manner to maximise impact. This includes subsidies from the Connecting Europe Facility for Energy fund (or CEF fund), contributions from Member States and congestion revenues. Additionally, we suggest that private investors should be invited to contribute. They will, of course, receive compensation for their investments.*

Olivia Breese: *The other solutions we propose relate to the need to (3) review the framework for hybrids to make sure that the increased risks are allocated in a conscious and well-thought-through manner. Finally, we need member states and the EU to (4) encourage the development of more hybrid projects from which we can learn to expand the use of hybrid solutions on a larger scale. We must start delivering tangible projects as soon as possible so that we can speed up the learning loops – commercial, technical and regulatory – and deliver more and better projects on an accelerated timeline. My grandmother always said to me: "Don't let the best be the enemy of the good" – in this case, if we wait for the perfect regulatory and commercial solution, then we will be too late to offer the accelerated solutions Europe needs.*

Catherine Vandenborre: *We are launching our vision paper at a crucial moment. The climate agenda is increasingly becoming an investment agenda so that Europe can reduce its dependence on fossil fuels and retain industry. We are facing European elections and new legislative initiatives will further the implementation of the Green Deal. Our proposals aim to encourage new ways of thinking and discussions between all stakeholders so that we can help Europe harness the full renewable potential of its seas while more effectively distributing the green electricity produced among its Member States.*

Executive summary

Transforming Europe's energy system so that it can break free from our reliance on fossil fuels is a pressing necessity, an immense challenge – and a rare chance to secure the continent's future competitiveness, resilience and autonomy. To this end, Europe must mobilise more investments, activate more industrial capacity, and deploy more energy infrastructure in the next two decades than it has done over the past century.

These issues lie at the centre of current European debates. While the Belgian Presidency of the Council of the European Union is building on the European Commission's Grid Action Plan and the Wind Power Package, the Draghi and Letta reports are looking to the next European Commission to put concrete and innovative ideas on the agenda. The latter will focus on the future of the single market and European competitiveness. This paper's aim is to contribute to debates and policymaking related to these areas.

An increasing share of the new infrastructure needed for this shift away from fossil fuels will extend into Europe's marine space. Strong sea winds will become a powerful source of renewable electricity for the continent, and a rising number of interconnectors will traverse our seas and further the integration of our power markets. Together, offshore wind and interconnectors will complement the onshore buildout of the continent's grids and will form an indispensable pillar of our energy system.

This paper outlines the conditions that are required to further strengthen these energy links, since the status quo will not result in a successful energy transition. We are calling on national and European policymakers to engage with us and seek out pragmatic and bold solutions to overcome the barriers which are standing in the way of the cost-effective and value maximising development of offshore wind and offshore grids.

The Ostend Declaration[1], which was signed by the heads of state and government from 9 countries in 2023, outlines the goal of establishing 120 GW of offshore wind capacity in the North Seas by 2030, and at least 300 GW by 2050 – almost ten times the installed capacity today. As for the Baltic Sea, the signatory states of the Marienborg Declaration[2] in 2022 agreed on a combined ambition of reaching at least 19.6 GW of offshore wind capacity by 2030, while recognising the potential for reaching up to 93 GW beyond 2030. In its most recent communication relating to the 2040 climate targets[3], the European Commission makes it clear that Europe requires a substantial expansion and upgrade of our power grids. Reaching such levels and ambitions will require a novel approach to offshore planning, investment, and grid buildout.

Integral to the solution are 'offshore hybrids': projects which combine offshore generation assets (wind farms) with offshore transmission assets (interconnectors). As noted by the European Commission[4], *"Such projects have several advantages over conventional offshore projects. They are cheaper, use less space and pave the way towards a future integrated*

[1] The Ostend Declaration, signed during the North Sea Summit, April 24th, 2023

[2] The Marienborg Declaration, signed during the Baltic Sea Energy Security Summit, August 30th, 2022

[3] EU Commission COM(2024) 63 final

[4] European Commission, DG Ener: North Seas offshore energy clusters study, 2019

energy system in the North Seas region. Ultimately, they can contribute to making the energy transition and decarbonisation happen." Despite their clear benefits, only one hybrid project has been realised to date: the Kriegers Flak - Combined Grid Solution that links Denmark to Germany. It looks likely that only a few additional hybrid projects will be commissioned over the next decade.

European regulators and political decision-makers have an important role to play in changing this outlook. The cost of inaction will be the diminished competitiveness of European industry, and Europe's failure to take decisive action regarding the climate crisis.

In the immediate term, they should focus on helping to kick-start regulatory, technological, and industrial learning by getting further hybrid projects off the ground. In the longer term, they need to establish a sustainable framework that will enable and encourage more offshore hybrids to emerge in future.

Today, offshore hybrids are mainly held back by the lack of appropriate frameworks linked to planning, risk allocation and the asymmetrical way that their benefits are distributed across borders. This paper analyses and proposes solutions linked to four main areas (see next page) that must be addressed to enable Europe to reach net zero. The following four chapters therefore address the topics below in turn.

The result we are aiming for via the proposed improvements

Transmission System Operators (TSOs) which operate in and around a sea basin (for instance, the North Sea or the Baltic Sea) cooperate to identify the most beneficial infrastructure layout, connecting the offshore sites which carry the most potential and the least amount of complexity. They receive a clear mandate from their national authorities to identify the best solutions, targeting a maximisation of the benefits for the whole of Europe and enabling the realisation of net zero.

The countries around a sea basin jointly facilitate the funding of these preferred projects in an expedited way, thanks to a streamlined investment vehicle: the Offshore Investment Bank (OIB). They are joined on a voluntary basis by some landlocked countries which recognise the importance of offshore wind development and are willing to support it.

The necessary political discussions related to the allocation of costs and risks assume a holistic approach to the development of the whole of the sea basin in question and consider the wider benefits achieved by the accelerated development of offshore wind. The EU supports this work through targeted grants, loans and guarantees.

All parties, be it wind developers or TSOs, are able to invest in their projects and do not have to face unmanageable risks. The revenue models which are applied are specifically chosen to ensure each party's interests are aligned with the development of offshore potential. Financing challenges aimed at dealing with the transition to a CAPEX-intensive world are overcome and capital is available to support the development.

The whole of the offshore supply chain trusts the political pledges as it sees them being realised at pace. The capacity to accelerate is build up to enable further developments.

The EU and its close partners, the UK and Norway, achieve their decarbonisation, competitiveness and energy security objectives. Our strategic autonomy and energy independence are much improved.

Industry and end consumers enjoy decarbonised, low-cost electricity. Electricity demand picks up to move away from a reliance on fossil fuels. A new equilibrium is achieved in a flexible system where demand and wind generation can come together, so contributing to making each OIB self-sustaining.

Four main areas to unlock the potential of offshore hybrids

Fair allocation of financial risks and rewards of offshore hybrid projects between the transmission system operators (TSOs) responsible for operating the interconnectors, the wind farm developers, and broader society.

→ **Can be achieved in two alternative ways,** either by means of capability-based 2-sided contracts for difference, or a 'commercial+ approach', to mitigate volume and price risks specifically related to offshore bidding zones and enable PPAs for hybrid generation assets.

Updated planning principles to ensure cross-regional coordination and that the projects which create the highest overall value are realised.

→ **Must rely on close regional coordination** and adapting planning methodology to ensure Europe's ambition of reaching net zero is reflected throughout all long-term grid planning stages.

Funding mechanisms needed to overcome the asymmetrical distribution of investment needs and benefits and ensure that investment levels in hybrid projects are optimised.

→ **Facilitated by the establishment of an *Offshore Investment Bank*** per sea basin, whereby countries around a given sea basin can combine their investment efforts to optimise the buildout from a regional perspective.

Short-term policy and prioritized regulatory treatment can help unlock 'first-wave' hybrid projects and enable regulatory and technological learning so that hybrid solutions can be scaled up.

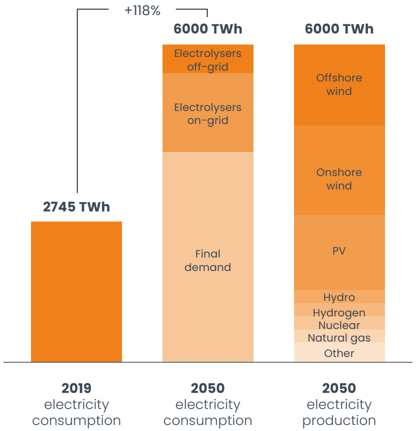
→ **Means immediate inclusion** of offshore hybrid projects into offshore project plans, and and accepting the trade-offs resulting from the current approaches.

Problem statement

Reaching net zero requires a massive increase in investments in renewable capacity and grids

In order for Europe to reach net zero, our energy system will need to be fundamentally reshaped, with an emphasis on replacing fossil fuels with renewable energy sources (RES). This will be accompanied by an increasing electrification of the transport, heating and industrial sectors, for example through the spread of electric vehicles and heat pumps. In addition to this, large-scale hydrogen and e-fuel production will convert green electrons into green molecules, contributing to the decarbonisation of the shipping, aviation, chemicals, and steel sectors (amongst others).

As Europe decarbonises, its consumption of electricity is expected to more than double by 2050, as demonstrated in the next figure.



The EU's demand for electricity is set to double as it approaches net zero[5]

Decarbonising Europe's energy supply at the same time as electrifying demand requires significant investments to be made in our grids so that Europe's vast renewable energy potential can be efficiently harnessed and so that green energy can be transported from where it is produced to where it is consumed. ENTSO-E's Offshore Network Development Plans (ONDPs) outline that an investment of at least €400 billion will be needed in offshore transmission assets in the lead-up to 2050. This is equivalent to spending around €1,000 per inhabitant in the European Union or 0.1% of its GDP (over the course of 30 years).

The challenge related to offshore grids in terms of scale are overlooked

Whilst focus is often placed on the immense investment that is needed in renewable generation, investing in grids and interconnectors is sometimes overlooked. Today, offshore grids only consists of export cables for offshore wind farms and point-to-point interconnectors. These are suited to today's demands. However, Europe's green transformation will increasingly involve exchanging electricity across borders, and require a significantly larger share of generation to come from offshore wind farms. This calls for new solutions to offshore grids. Relying solely on radial and point-to-point connections will either result in too many grid cables with insufficient utilisation rates and unnecessary environmental nuisance being caused – or under-deployment, with the required buildout of offshore wind and interconnectors not materialising, so delaying the energy transition and inflating costs to rate payers. There is a risk of ending up with a spaghetti-like buildout of the grid, as part of which each piece of infrastructure only serves one specific purpose.

[5] TYNDP 2022 – Average of the net-zero scenarios. Data only for the EU

80 GW of hybrid projects by 2050... or even more
ENTSO-E's Offshore Network Development Plans, published in January 2024, signal that offshore wind farms with a collective capacity of up to 80 GW could be delivering their power to onshore consumption centres via hybrid assets by 2050.

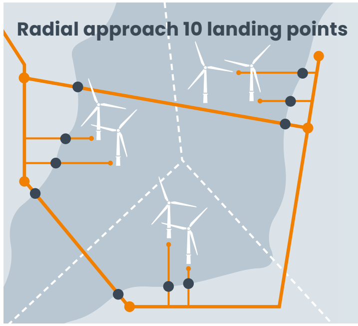
This represents a significant deployment of offshore wind, particularly when compared to Europe's current offshore wind capacity (which is approximately 30 GW). However, the 80 GW figure quoted by ENTSO-E is likely to be a conservative estimate of the true potential held by offshore hybrids, since the modelling used by ENTSO-E relies mostly on wind farms which are radially connected to onshore grids.

The fact that the true potential of offshore hybrids is higher than 80 GW makes sense, as hybrids offer up a unique synergy that extends beyond the benefits of individual interconnectors and the development of renewable generation alone.
By combining generation assets with an interconnector, offshore hybrids increase the use of offshore cables, resulting in a lower CAPEX per MWh delivered to shore. The overall number of offshore cables that are needed is therefore reduced (so avoiding 'spaghettification' across the sea), as are onshore buildout needs, since the total number of landing points is also diminished, and, in some cases, onshore grid lines can be replaced by offshore infrastructure. This offers environmental benefits and minimises the need for landing points along coastal regions.

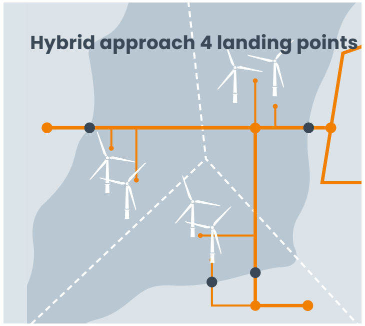
Whilst the majority of planned and targeted offshore wind farms in European waters will still be linked to the coast via radial connections, hybrid projects will, in many cases, offer cost-effective methods for integrating offshore wind into onshore grids and increase system adequacy and robustness.

Offshore hybrids exacerbate specific risks compared to radial projects
The efficient operation of hybrids requires the establishment of new offshore bidding zones (OBZs – see dedicated text box), where the local price establishment and volume allocation is made by considering real grid constraints in the market coupling algorithm, so increasing the efficiency of the dispatching. Without OBZs, TSOs would need to regularly undertake remedial actions such as redispatching or counter-trading to align the market outcome with the physical realities of the grid.

A comparison of radial and hybrid approaches to offshore infrastructure deployment



One offshore wind farm - one export cable.
Interconnections between markets planned separately.



Offshore grid and wind farms planned and built together, combining export cables and interconnectors to multilinked offshore wind farms.

However, this also exposes offshore wind power generators to heightened risks. Since these zones typically carry little to no local demand, generators rely entirely on the transmission of electricity to onshore bidding zones, creating cross-border risks that onshore generators do not experience to the same degree. Such high levels of risk entails premiums on offshore wind, which will make the green transition unnecessarily expensive and reduce the amount of offshore wind compared to an economically optimised energy system. These risks include those listed below.

- **Structural price level and price spread risks:** Offshore wind is put in direct competition with imports and exports from neighbouring bidding zones for the capacity of the interconnector that is connected to the OBZ. This typically drives a lower price level on average compared to a home market approach. On the other side, consumers remain exposed to the price in their own bidding zone, which implies a certain price spread with respect to OBZs. Such a structural price spread makes it practically impossible to establish a power purchase agreement (PPA) to facilitate investment in offshore wind.

- **Price volatility and uncertainty risks:** The target market model in the EU includes the implementation of Advanced Hybrid Coupling (AHC – see dedicated text box). For the OBZ, this means that the price formation will in reality depend on what will be happening in and within many more bidding zones than only the surrounding markets. While AHC is positive from a societal perspective as it allows socioeconomic welfare (SEW) to be optimised given the reality of the grid, it also increases price volatility and uncertainty in OBZs.

- **Volume-based risks linked to competition for interconnector capacity:** Competition with neighbouring bidding zones (cf. structural price level) is key in the allocation of interconnector capacity. This competition is organised through the market coupling algorithm, which does not guarantee priority access for offshore wind. However, as wind is expected to be competitive due to its low marginal costs, this risk might be relatively limited.

- **Volume-based risks linked to competition related to onshore grid capacity:** In addition to competition for interconnector capacity, competition relating to onshore capacity can also limit the allocated amount of energy which can be exported by the OBZ generator (as a result of other trades using the same capacity and generating more SEW). A partial selection of a wind bid in the OBZ will also only clear at the price of that bid (often close to zero), contributing to the aforementioned structural price level risk.

- **Volume-based risks linked to the unavailability of capacity:** Because of the sensitivity related to competition related to grid capacity, offshore wind farms are strongly affected by reductions in the availability of grid capacity.

- **Buildout risks:** Power prices in OBZs are susceptible to changes as the grid is built out. Even a single new interconnector can significantly alter price formation. Such a risk is also present when a wind farm which was initially connected to the shore via a radial connection is then included in a hybrid topology. This risk is non-negligible considering the fast-paced changes that the offshore grid is expected to undergo.

The successful development of hybrid projects requires deliberate decisions to be taken regarding value sharing and risk management. The increased risks for offshore generators in OBZs add an additional layer of complexity on top of already difficult cross-border negotiations that countries hold about offshore hybrids. They prolong negotiations and slow the realisation of hybrid solutions.

Current approaches for planning and funding inadvertently limit collaboration
Reaching net zero in Europe will require unprecedented investments in its sea basins. However, current decision-making practices regarding investments in interconnectors, which are based on ad hoc negotiations for individual projects, will not deliver the needed grid investments. Where EU funding is involved, the conventional Cross-Border Cost Allocation (CBCA) instrument has proven to be complex and time-consuming for every individual project.

Crucially, current planning methodologies fail to fully account for the disparity between a nation's renewable energy ambitions and its potential. For instance, Scandinavian countries hold offshore wind potentials which vastly outstrip their projected energy demand. European planning, however, fails to effectively leverage this excess. Indeed, instead of identifying cross-border synergies, the current approach can inadvertently limit collaboration.

While hybrid projects which are currently under development demonstrate that governments are undertaking commendable actions, this bilateral approach is unlikely to allow Europe to harness its full hybrid potential. The same factors that hinder final investment decisions (FID) in existing projects – namely the uneven distribution of benefits and increased risks for generators – will lead to challenging negotiations being held between countries.

Although the European Agency for the Cooperation of Energy Regulators (ACER) has put guidelines in place for the CBCA instrument to address this challenge, these do not fundamentally ease negotiations.

Limited to no prior experience with offshore hybrids in terms of dealing with these problems
The challenges outlined above cannot easily be solved because the amount of collective experience of hybrid projects is limited. Real-world projects are needed in order to acquire technological and operational expertise and learn valuable lessons, which will optimise future hybrids and refine regulatory frameworks before they are more widely rolled out. Europe needs these initial projects to deliver cost-effective renewable generation and grid capacity for a rapid, fair and just transition; their success will directly benefit European consumers.

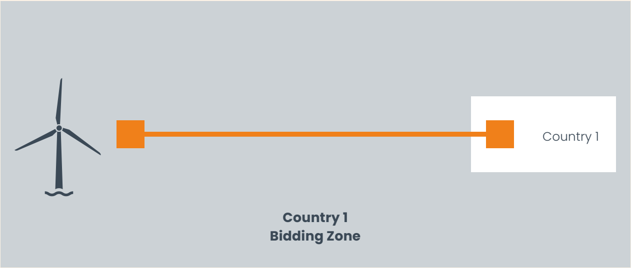
Without these first hybrid projects, future projects are likely to be more poorly developed and will involve lessons being learned on the fly, slowing progress down.

Explainer Price formation for offshore hybrid generators

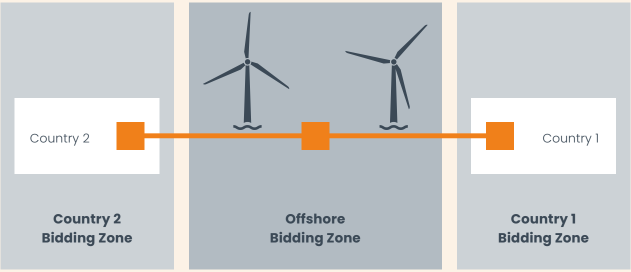
Offshore bidding zones
The conventional arrangement for offshore wind generation has involved a radial connection to shore and the generator being part of the home market. The offshore RES generator commercially and physically feeds electricity into the grid of the country whose territorial waters or Exclusive Economic Zone (EEZ) it is located in and is part of the same bidding zone. In a hybrid context, the offshore wind farm is physically connected to several markets. Placing it in a separate bidding zone ensures that the green electricity can flow to where it is needed and can be fully integrated into the market by simultaneously integrating renewable energy into the system and using cross-border interconnectors for trade. The separate bidding zone is referred to as an OBZ. This setup carries several benefits compared to a home market model:

1. the direct consideration of the capacity of offshore infrastructure in the market;
2. flows are allocated according to the market rather than TSO forecasts;
3. improved usage of grid infrastructure.

Radial/Home Market

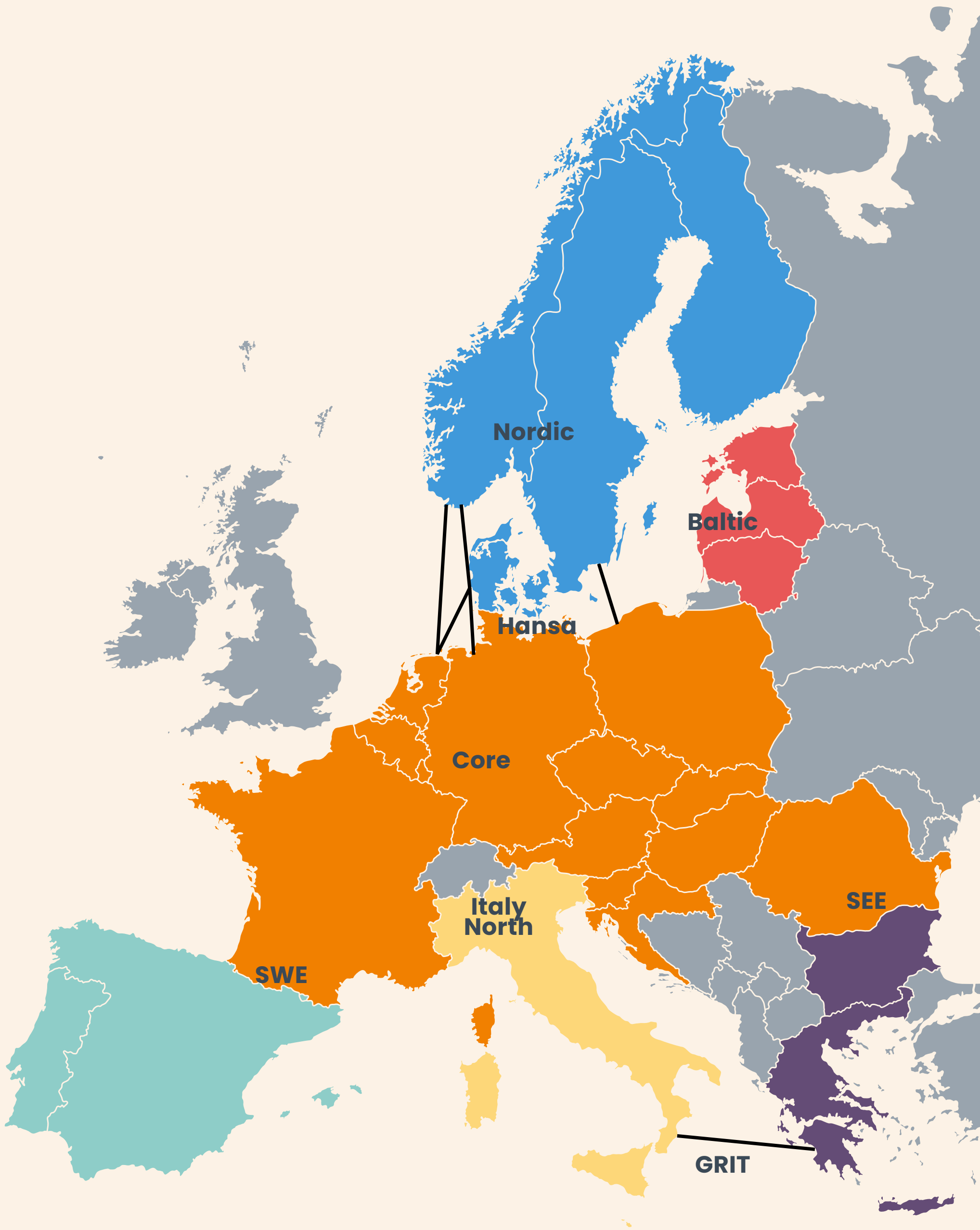


Hybrid/Offshore Bidding Zone



Advanced Hybrid Coupling
AHC is part of Europe's target market design model and will affect OBZs. It is a model of so-called 'external' flows between Capacity Calculation Regions (CCRs) in the market coupling. For each CCR, the capacity calculation process delivers a model of the region's grid.

This allows the market coupling process to look for a path for power flows that can be transported by the grid within a specific CCR. However, external flows (i.e. from other CCRs) also use the capacity of the CCR's internal grid. Today, the market coupling process involves applying Standard Hybrid Coupling, where exchanges are forecasted by the TSOs so that their impact on the grid within a specific CCR can be assessed. This will evolve to AHC, where instead of a TSO forecast, the external flow is treated as an additional variable in the market coupling algorithm. This leads to a more market-driven use of the transmission grid and in turn increases SEW. OBZs will likely be at the border of CCRs and will therefore be connected to interconnectors where A dvanced Hybrid Coupling is applied, which will affect the price formation in the OBZ.



Case study Kriegers Flak combined grid solution project

The Kriegers Flak (KF) – Combined Grid Solution (CGS) interconnector, which was inaugurated in 2020, connects Denmark and Germany together. The interconnector, which gives both countries access to offshore wind produced in the Baltic Sea, is the first and only hybrid offshore interconnector in the world.

The project allows electricity to be traded between Germany and Denmark and, at the same time, is connected to three offshore wind farms, making the wind power they generate available for cross-border electricity trading. No comparable project has yet been completed anywhere else in the world.

On the German side, the Baltic 1 and Baltic 2 wind farms are used as part of CGS. On the Danish side, one offshore wind farm (Kriegers Flak) and its radial connection are used as part of the hybrid interconnector. Two subsea cables, which are 25 km long and have a capacity of approximately 200 MW each, bridge the distance between the Danish and German sides by linking the Baltic 2 and Kriegers Flak substation platforms together.

Master Controller for Interconnector Operation

The hybrid interconnector between Denmark and Germany consists of both hardware and software components. The Master Controller for Interconnector Operation (MIO) acts as the 'brain' of the hybrid interconnector. This digital control unit, which is located in 50Hertz's Control Center in Neuenhagen near Berlin, manages market-based electricity exchanges between Denmark and Germany.

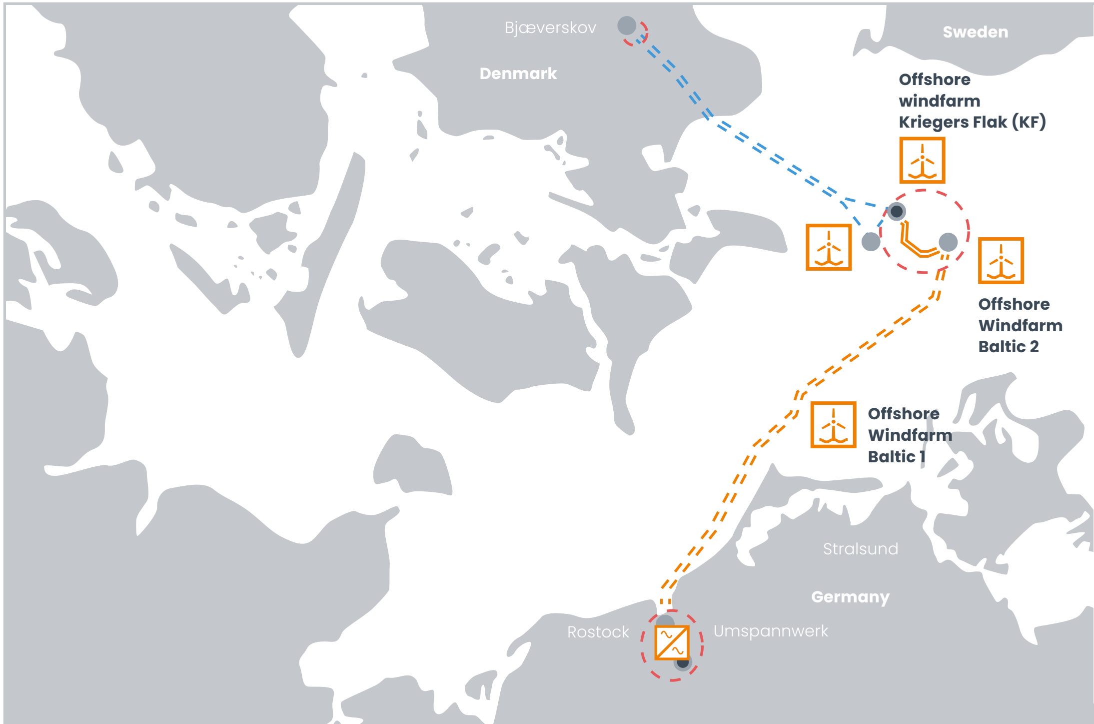
To do so, it must reconcile the requirements of the electricity market and the amount of electricity produced by the wind farms connected to hybrid interconnector (which depends on wind conditions). The MIO aims to enable the most optimal use of the interconnector whilst preventing it from overloading. It employs weather forecasts, ensures the required voltage is kept stable and keeps the system in balance in real time. It makes use of the back-to-back converter in Bentwisch in doing so.

Back-to-back converter station at Bentwisch

Since the German and Danish AC grids are asynchronous, a novel solution was employed to safely connect them: an HVDC back-to-back converter station located in Bentwisch. The first of its kind in Europe, it consists of two converters located in the same building.

Working with our Danish partners was a great success. We will be able to use the experience we have built up with them as we continue to expand our offshore activities and further connect offshore wind in an efficient and flexible manner to different countries. Through the KF-CGS, we have demonstrated that we have the technology and the necessary project knowledge to harness the full potential of the Baltic Sea.

Dr. Henrich Quick,
Head of Offshore
at 50Hertz

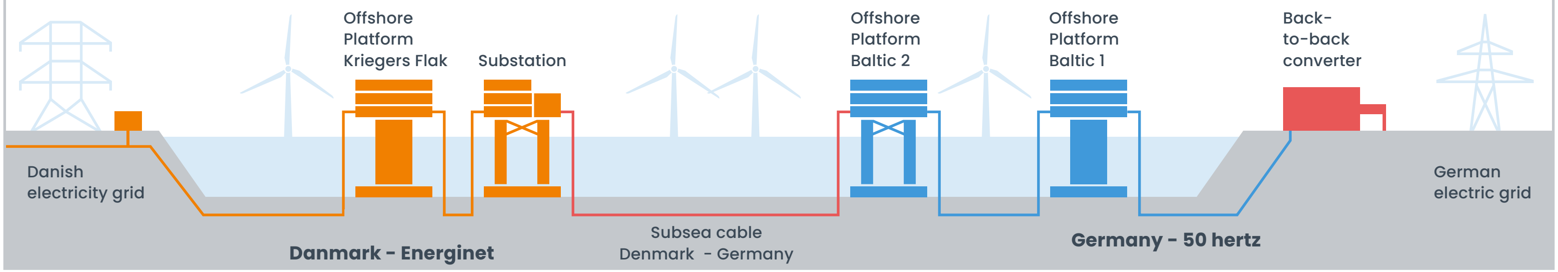


Market Impact Assessment

In 2022 and 2023, the Kriegers Flak-Combined Grid Solution hybrid interconnector improved price convergence between Denmark and Germany (for the day-ahead market in the DK2 - DE/LU bidding zone).

- The hybrid interconnector led to a €5.5/MWh decrease in the average price differential (€7/MWh in 2022 and €4/MWh in 2023).
- The hours when full price convergence has occurred have increased on average by 8% (7% in 2022 and 9% in 2023).

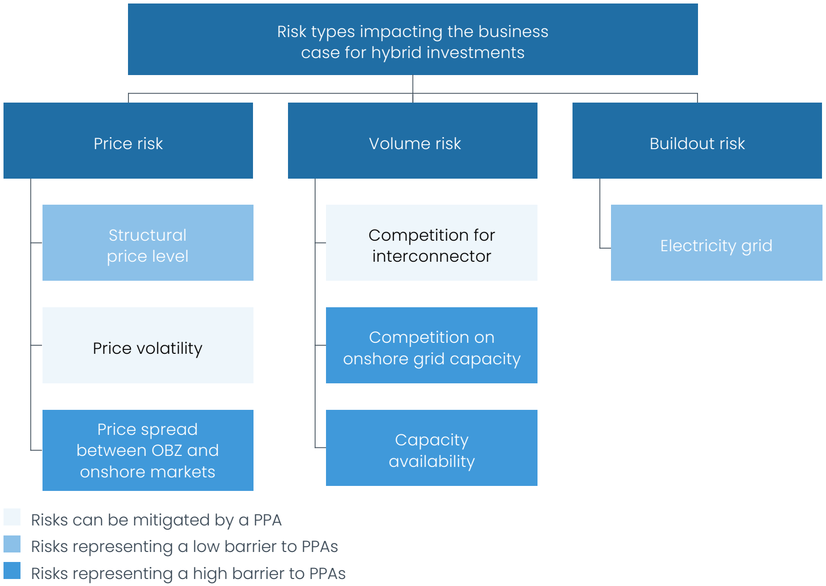
Building on this first positive experience, Elia Group is preparing the next wave of hybrid interconnector projects that will be linked to the Princess Elisabeth Island in the Belgian North Sea and the Danish Bornholm Energy Island.



An efficient risk allocation model with appropriate revenue models to lower costs for society

Successful hybrid projects are immense infrastructure undertakings, each representing years of development and construction, and with upfront investments involving billions of euros. Since such long-term investments are undertaken amidst dynamic economic and regulatory environments, hybrid projects are exposed to a diverse risk profile, which strongly influences their financing costs through risk premiums, and ultimately can make or break a business case.

Making a solid business case for offshore hybrids to the scale needed requires an understanding of the risks that the generating assets and the interconnectors face and the need to efficiently distribute these risks amongst each party. Today, the risk picture results from the envisioned risk picture for a home market model. This might not hold in OBZs where there is no local demand.



Risk types which are heightened in hybrid and OBZ contexts

Increased risk profile of hybrid projects
Conceptually, the risk profile of offshore hybrid projects comprises three overarching categories; price risks, volume risks, and buildout risk, as illustrated by by the figure on the left. These are described in more detail in the probleme statement.

While the risks outlined above are not unique to hybrid projects (since any large energy infrastructure project will be exposed to them), offshore hybrids will be more strongly impacted by these risks than radial infrastructure projects.
This pertains in large part to market design features. The combination of OBZs and AHC ensures the allocation of energy flows which generate the most SEW for the entire internal electricity market, given the available transmission capacity on the grid. However, OBZs and AHC significantly increase the risks involved with respect to a theoretical alternative that involves

offshore wind farms which are radially connected to a home market without any congestion and point-to-point interconnectors.

When comparing an offshore generator in a dedicated OBZ to a generator which is radially connected to a market, both have volume allocations and carry prices that are ultimately linked to the physical capacity of the grid. However, for radially connected offshore wind farms, the diverse local market mitigates this sensitivity, and allows direct trading to occur with local demand, and for which congestion issues are solved after the market via redispatching (at no loss for the generator). By comparison, generators in OBZs will be much more sensitive to price and volume risks inherent to the market. OBZs are beneficial for the system, but is a disadvantage compared to radially connected projects for wind generators.

The importance of efficient risk allocation

A higher amount of risks – particularly risks that are difficult to quantify or control – means investors will require higher returns. Since such returns may not be delivered by the market, unmitigated risks means that the buildout will fall short of policy targets. A fair and efficient allocation of risks, involving risks being carried by the party that is best able to effectively take on and manage them, is therefore needed. Such an efficient allocation of risks will also reduce the total cost for society, since the risk premium will be reduced.

Additionally, the interests of different parties must be aligned with the long-term ambition for offshore wind development. This requires a risk allocation model that extends beyond the success of individual projects.

The buildout of offshore infrastructure is one example of how an inefficient allocation of risks can cause a misalignment of interests. The development of infrastructure may negatively impact individual projects if

the buildout risk is not mitigated. On the contrary, when the different parties are made indifferent to the buildout risks, individual interests and societal goals are aligned and the energy transition can progress at pace.

Regulated model for transmission infrastructure
In some jurisdictions, the approach to the financing of offshore transmission infrastructure has involved the financing of interconnectors using the congestion rent they collect. This approach has worked well as congestion rents from most interconnectors have been significant, and structural differences between markets have meant significant value could be harvested from connecting previously unconnected markets.

Going forward, estimating the amount of congestion income for a single interconnector is challenging since the overall energy system will rapidly and profoundly change. Therefore, as Europe pivots to using more renewable energy – in particular from renewable sources which are weather-dependent - and significant uncertainties arise regarding the amount of demand and its flexibility, the congestion rent financing model will face a growing amount of uncertainty and, by extension, risk. Waiting for certainty that congestion income will be sufficient for every single line will mean that too little infrastructure is built too late on.

A regulated revenue model would therefore be an appropriate way to cover the increased risk profile associated with offshore infrastructure. Such a regulated revenue model is considered by default when monopolistic TSOs oversee the development of infrastructure, but it could equally be applied in jurisdictions where adopting a competitive approach to the development of infrastructure is preferred.

Two approaches to efficiently allocate risk and value related to wind generation
Enabling hybrid projects to play their part in ensuring a fair and just European transition will require the current allocation of risks between asset operators, rate payers and society more widely to be improved. This can be achieved via two alternative approaches to improving the allocation of risks, as follows.

- **capability-based 2-sided contracts for difference** (capability-based CfDs for short), which is one specific support mechanism design;
- **Commercial+** model, under which more targeted measures should be defined and implemented to specifically tackle the most significant risks related to offshore bidding zones.

A two-sided CfD is a type of renumeration scheme which guarantees a fixed price for generators and involves the state as a backer – the latter tops up the market price in case it is lower than the fixed price, and otherwise captures any revenues in excess of the fixed price. CfDs thus involve the dynamic adjustment of the level of support depending on real market prices. What distinguishes a capability-based CfD from other models is that it uses potential for injection rather than real injection as a settlement volume.

This approach carries the advantage of avoiding market distortions, but also provides elaborate risk coverage, as argued in a recent paper published by ENTSO-E[7].

[7] ENTSO-E, Position Paper on Sustainable Contracts for Difference Design, 2024

This should reduce financing costs for generators and hence also the total costs. Moreover, Elia's consultation document on the Princess Elisabeth Zone[8] includes an analysis of the mechanism in the offshore hybrid context specifically, concluding that the approach protects against most risks faced by generators. Indeed, capability-based CfDs should effectively cover all price, volume, and buildout risks if the budget allocation is sufficient. This model is also applicable to offshore wind farms which are linked to the shore via radial connections.

The second approach, Commercial+, specifically targets wind assets within an offshore hybrid topology. It requires a conscious allocation of the increased risks under OBZ and AHC. Risks should be left with investors in offshore wind insofar that they are able to manage them effectively. Otherwise, regulation should facilitate the creation of new market products and/or market design features. Thanks to a Commercial+ framework, usual market instruments, like PPAs, could become central elements in hybrid projects in the same way that they are for radial projects.

It is possible that over time, and through practical experience, the risks will be able to be more accurately assessed. However, for the first few hybrid projects that are established, this would entail an over-allocation of risks on offshore wind farms, which will either fail to attract the required investment or lead to very high overall costs to cover the risks.
Therefore, targeted measures should focus on addressing the risks representing the highest barriers to PPAs, at least in the short and medium term:

- price spread between markets connected by interconnector;
- competition related to onshore grid capacity;
- capacity unavailability.

In addition, structural price level and buildout risks are important to consider.

An example of this approach is transmission access guarantees (TAGs), which are being implemented following the European market design reform. This instrument targets the capacity unavailability risk.

One area of exploration could focus on financial transmission rights (FTRs), under which the right holder pays a fixed price for the right and in return receives the variable congestion income. Thereby, a right holder, who is (for example) situated in an OBZ, gains access to the price of a neighbouring market (or onshore market) by combining its market revenue in the OBZ with the revenue obtained through the FTRs.

However, FTRs in use today are not fit for covering the risk of a new investment. They are sold up to one year in advance only, whereas investment security is required over a much longer period (20 years). In addition, they are fixed volume products, whereas offshore wind generation is variable and is therefore associated with a variable need for export capacity. It would thus relate to a new product, which has the potential to target the price spread risk. It does not by itself adequately address the volume risks.

The Commercial+ approach could further expand on similar principles, to ensure some of the other important risks (related

[8] Elia, Public Consultation Task Force Princess Elisabeth Zone, 2024

to structural price level, competition related to internal grid capacity and/or buildout risks) are also addressed. An alignment of the value and risk picture with radial connected assets could be part of the solution without compromising the efficient dispatch guaranteed by the OBZ. The risk assumed by every party under this model should be carefully and transparently considered to ensure that it contributes to - rather than hinders - the achievement of offshore ambitions.

Either option has the potential to unlock the necessary investments in offshore generation and infrastructure. A choice regarding what is considered an appropriate risk for each party remains, where capability-based CfDs assign a concrete role to the state counterparty (or counterparties) to cover the risk, and the Commercial+ model targets the most problematic risks for wind developers through new products and added market design features.

Calls to action

We are calling for discussions at European level to allow for and encourage different approaches in terms of risk coverage. The reform of the electricity market is providing CfDs with important support, but they need to be designed and applied in an effective manner. The Commercial+ approach must be further developed with regards to what could be an effective mechanism, although it improves the possibility for the direct financing of offshore wind projects, for example by enabling hedging via PPAs.

To ensure the buildout of infrastructure is aligned with long-term ambitions and maintains a fast pace in terms of development, we are calling on countries to apply a regulated model for infrastructure as opposed to a commercial model based on congestion revenues.

Optimal planning of offshore infrastructure

Planning is a key process in the development of our electricity systems. Firstly, planning involves the identification of possible trajectories (or long-term scenarios) for the energy system to meet European ambitions. Secondly, planning involves the identification of system needs: how and where the current energy system should be changed to optimally support these trajectories. Thirdly and finally, planning involves collecting and selecting the infrastructure projects that should answer these needs in the best way.

In the context of offshore wind development, questions that arise at the planning stage cover the sites which need to be connected to the onshore grid, the type of connection involved (radial or hybrid), the markets offshore assets will be connected to, the routing of the infrastructure, and the timing of projects.

Two obstacles in today's approach to planning in offshore development

Two major obstacles are baked into today's approach to planning. These potentially inhibit the identification of the optimal grid configuration. These obstacles are an over-reliance on the bottom-up consolidation of national plans in contrast to more regional coordination; and iterative and tentative planning processes that do not provide the much-needed market clarity to unlock investments.

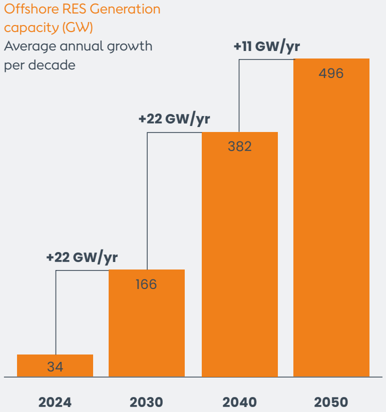
Work on net zero is still too reliant on the bottom-up consolidation of national plans

In accordance with the Trans European Network – Electricity (TEN-E) regulation, ONDPs are built based on non-binding targets for each sea basin. These targets result from the consolidation of national targets which carry a major caveat: against a background of national and EU targets, there is an overall mismatch between the offshore renewable energy potential available within each country on one hand, and the actual demand in these countries on the other.

This approach of consolidation of national targets limits potential collaborations between countries instead of facilitating them. Indeed, countries with limited offshore renewable energy potential may be forced to either restrict their targeted buildout, or over-exploit their limited potential to reach more ambitious targets at all costs. At the same time, countries with vast amounts of offshore renewable energy potential are not incentivised or able to share it with the countries that may need it, and most of their offshore wind deployment is planned to be connected to shore via radial connections by default, without due consideration of hybrid configurations.

In other words, the bottom-up consolidation of national ambitions and development plans does not guarantee the identification of the most valuable projects and grid configurations at a wider European scale, due to the different perspectives of countries which carry renewable energy surpluses and those which lack RES.

Need for speed for generation and transmission[9]



But average speed in the last 10 years was +2.5GW/yr

Today's offshore RES is only 7% of offshore RES forseen in 2050.

Annual installations of offshore RES and infrastructure need to accelerate significantly.

The lack of a concrete and trustworthy approach to planning prevents the confident scaling up of all components of the value chain

To reach the offshore wind targets set for Europe's different sea basins, the annual installation rate must be accelerated significantly: it should reach 22 GW per year on average over the next two decades. This will require all parts of the value chain to be fundamentally transformed, from the manufacturing of individual components through to project development. All told, the investment needs in supply chains alone are estimated to be over €100 billion by 2040.

In such a context, market clarity and investor confidence are key. As sincere as they can be, political pledges only go so far in enabling the required scaling up of the supply chain and trigger the necessary research and development activities, for instance to enable an evolution towards a meshed offshore grid. The planning of the future offshore grid remains too abstract and uncertain to create the necessary level of confidence, and as a result, supply chains are not growing as required.

New approaches to planning

To ensure that the best possible offshore grid topology is established in time, European and national decision-makers, TSOs, energy authorities, governments and relevant EU institutions must address these shortcomings. This can be done by pursuing two avenues of increased coordination.

Increase the focus on projects which maximise benefits for Europe as a whole

The TEN-E regulation has given ENTSO-E the mandate to assess what an optimal energy system that meets the offshore renewable energy targets communicated by Member States could look like. This mandate could be expanded so that ONDPs also inform decision-makers about the potential benefits of a more coordinated approach at sea basin level. Indeed, optimisation possibilities in long-term planning are key for building trust amongst stakeholders and better

[9] ENTSO-E (2024), Offshore Network Development Plans

informing decision-makers about the most valuable projects. Increasing such optimisation possibilities involves:

- considering offshore RES potentials held in the waters of the countries seperate and distinctive from the offshore RES targets per country. While such change may appear semantic, it is critical to the identification of efficient infrastructure to move away from the paradigm where national targets lead de facto to radial connections of wind farms;

- optimising the development of on- and offshore infrastructure in a coordinated way, to (first) correctly reflect possible onshore bottlenecks and (second) allow landlocked countries to harness the offshore RES potential;

- considering all realistic options in terms of infrastructure development and avoiding their limitation based on expert judgment or national preferences.

A more coordinated approach would result in the following.

- The adequate integration of the best offshore RES spots into the system to achieve the final goal of reaching climate neutrality by 2050 at the least cost.

- The identification of a higher share of efficient hybrid systems (instead of classical radial approaches) to connect offshore wind farms to onshore grids. Such hybrid systems can help to harness the full potential of the decorrelation of wind production in remote areas and/or the decorrelation of supply and demand patterns between the connected countries.

- Offshore wind capacity situated in the territorial waters of a country with underutilised resource potential being radially connected to countries whose demand outstrips its offshore resource potential.

Reflect European ambition to reach net zero across all stages of long-term grid planning

Long-terms scenarios must include an energy system pathway that leads to net zero emissions by 2050, in line with European ambitions. This is critical for increasing trust in long-term plans. The identification of system needs should be exclusively performed on scenarios which are aligned with European ambitions. Working with a less ambitious scenario in mind is one way of identifying no-regret infrastructure needs, but focusing efforts on no-regret needs only will not be enough to facilitate the energy transition.

The goal of reaching net zero should also be more strongly reflected in long-term plans and decision-making. Today's long-term plans and decisions are almost exclusively based on the SEW generated across Europe. SEW is indeed an important indicator to consider when identifying infrastructure needs and measuring the relevance of (a set of) projects, since it encompasses all parties from across society (generators, consumers and the beneficiaries of congestion rents). However, SEW calculations only consider the European Emissions Trading System (EU ETS) price of CO_2, as part of the fuel costs. They do not reflect the true societal cost of CO_2 emissions, which significantly exceed the EU ETS price of CO_2.

The societal cost of carbon is not only a way to better consider the damage cost related to climate change. It is also a way to consider the underlying benefit arising from the EU's ambition to reach net zero, a *willingness to pay for imposing the goal as a political constraint.*[10]

In other words, the current approach based on the SEW, might lead to an under-estimation of the real infrastructure needs as well as a lack of attention and support to those projects significantly contributing to a reduction of CO_2 emissions in Europe.
The societal cost of CO_2 emissions should instead be consistently considered at all stages of the network planning, namely in the goal function of the optimizations performed to identify new infrastructure needs as well as in a higher extent in the establishment of the projects of common interest / projects of mutual interest lists, and in the approval of the network plan by the authorities.

Calls to action

Aimed at the EU

- Adapt the mandate provided to ENTSO-E/G so that includes guiding EU decisions regarding offshore targets, in line with the objective of reaching net zero.

Aimed at national authorities

- To allow an efficient use of the seas as true green power plants for Europe, clearly differentiate offshore RES needs and offshore RES held by different Member States and gradually move away from a purely national approach.

- Capitalising on the new approaches to planning elaborated in the previous section, adopt the objective of reaching net zero as one of the main approval criteria by accounting for the real benefit of CO_2 abatement (or societal cost of carbon), to gradually move away from an excessive focus on direct cost minimisation for tariff payers.

- The North Seas Energy Corporation, NSEC, has an especially important role to play in integrating offshore buildout planning and execution between its members in the North Sea and should continue to actively seek out ways to optimise buildout across national borders.

[10] ENTSO-E, Implementation Guidelines for TYNDP 2022 based on 3rd ENTSO-E Guideline for Cost Benefit Analysis of Grid Development Projects, 2023

Reaching net zero requires embracing uncertainty

The future of the energy system is uncertain and is subject to many different parameters, including the evolution of demand, changes in consumption habits, or in the energy mix, changing infrastructure costs, the evolution of legal and regulatory frameworks, changes in fuel prices, and technological changes.

Given that infrastructure projects carry a long lead time, we cannot wait for these uncertainties to be resolved. Instead, this uncertainty should be embraced to ensure investment decisions regarding energy infrastructure can be taken in a timely way that supports the energy transition. Indeed while the deployment of large scale green energy infrastructure, not least offshore, comes with uncertainty – what is certain is that failing to take decisive action will only delay the green transformation and prolong European consumers' dependence on more expensive fossil fuels.

An appropriate instrument for funding and cost allocation

The case for enhancing the current approach to interconnector project funding and cost allocation
In the 2024 ONDPs, nearly 80 GW of hybrid interconnector projects are identified as part of the least-cost solution for the North Sea region in the lead-up to 2050 – and this is likely a conservative estimate, as discussed in the previous sections of this paper.

Historically, the establishment of new interconnectors between two countries has been negotiated and agreed bilaterally. Projects that generate sufficient SEW for the two countries together are typically identified and advanced. Such interconnectors are generally established using a simplified approach in terms of cost allocation: the costs are either split equally between each country, or are shared based on the territorial principle, according to which each country pays for the part of the infrastructure on its soil or within its own exclusive economic zone at sea.

Follwing this approach, projects that do not generate sufficient SEW for one or both countries involved are typically not advanced, even if the SEW generated across Europe could have justified their realisation. EU funding such as the CEF can partly offset the issue. However, experience with the CBCA mechanism since its inception more than 10 years ago shows that it has never been possible to force a country which is not one of the project promotors to contribute in line with the identified SEW. This shortcoming is one of the main reasons why some projects of European interest are not advanced.

Additionally, hybrids interconnectors, an essential part of the development of offshore potential in our seas, are raising additional questions, compared with point-to-point interconnectors, for the reasons outlined below.

- Offshore hybrids naturally involve both the transmission and generation of electricity. This adds another dimension to the negotiations, if one of the improved risk allocation mechanisms mentioned in the section on risk allocation is considered.

- Countries have differing view of these projects depending on whether they have an excess potential of RES or whether they lack sufficient RES to cover their needs. Countries which fall into the first category will typically be mostly exporters, and benefit from such projects via benefits for producers (or producer surplus). Countries which lack RES potential will typically mostly be importers of electricity, and benefit from such projects by securing lower electricity costs for their consumers (consumer surplus). This asymmetry means different countries have different perspectives on the political acceptability of a range of issues, including, for example, funding infrastructure projects through transmission tariffs.

When considering Europe's offshore ambitions, many new (hybrid) interconnectors must be developed. It is unlikely that the aforementioned shortcomings of the current approaches will enable their realisation, meaning a new approach is needed.

Countries located around a specific sea basin should cooperate closely
An important change is required to move away from the logic of ad hoc, project by project negotiations. Countries located around the same sea basin should jointly explore their common endeavours and should cooperate at a structural level. The focus on a whole sea basin area – and, thus, the consideration of a group of projects together instead of on an individual basis - would alleviate the complexity of multilateral negotiations, shifting them away from case-by-case evaluations. The complementarity of the benefits arising from several projects taken together should help the negotiation: the benefits will be better spread out across the sea basin. For instance, a country could agree to develop a project from which it has no direct benefits, in return for the development of another project which carries direct benefits for it later on. Finally, the reduced administrative burden should also contribute to the faster processing, approval and development of projects.

Offshore Investment Bank (OIB)
We propose the establishment of an Offshore Investment Bank (OIB) per sea basin, each of which would coordinate a joint approach across their respective areas. Each OIB will serve as a coordinating investment vehicle for projects of regional relevance in their specific sea basin area. As the European institutions and the Letta and Draghi reports are looking forward to a European single market with a capital markets union at its core, the idea of OIBs resonates very well. They fit the aspiration to unlock funding at European level to stimulate growth and to open up investment opportunities with a high level of investor protection.

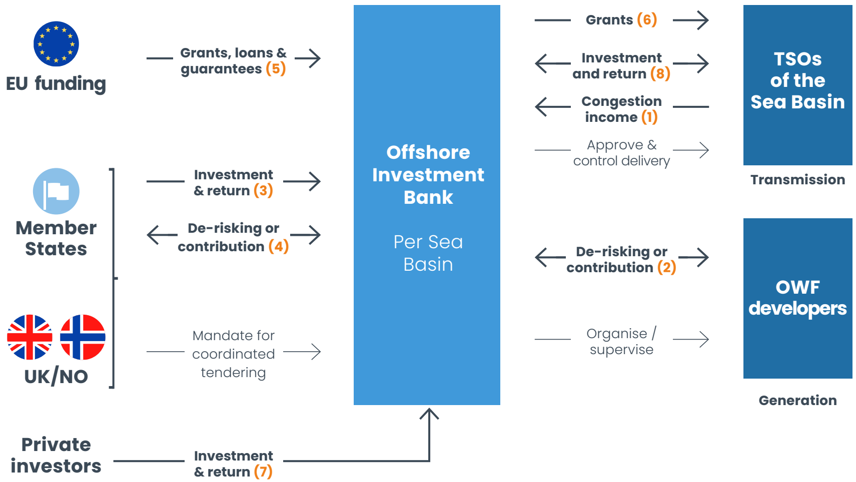
The participants of each OIB would be the countries located around the same sea basin. Other countries, for instance landlocked countries, could join each initiative on a voluntary basis to contribute to the realisation of offshore targets and to enable the funding of RES projects that are more cost-effective than those which are feasible within their own borders.

Sea basins as a geographical perimeter for each OIB would be more appropriate than an EU-wide approach. This would ensure that the countries working together can share a similar perspective in terms of their offshore ambitions, and it would enable non-EU countries such as the United Kingdom and Norway to become more easily involved in the OIB; the latter two are extremely important partners when it comes to development in the North Sea. In terms of investments in transmission, the OIBs would facilitate the financing and funding of the most beneficial projects, as identified in line with the enhanced approach for planning presented in the previous section. In terms of generation, a crucial role of each OIB would be to ensure coordination between individual countries' RES tenders.

Ensuring that projects are handled in a coordinated manner at an early stage across a given sea basin area would provide confidence to supply chain actors and developers, unlocking long-term investments in projects and offering economies of scale and accelerated development opportunities to the countries involved.

In other words, the OIBs would be able to provide a framework that would allow the full benefits of regional hybrid projects to be reaped by resolving misaligned incentives and the asymmetrical distribution of risk/value between transmission and generation actors. The OIBs would be able to tackle these issues in their financing and value re-distribution mechanisms. Some of these flows and interactions are depicted in the next figure and described further in the text.

The structure of the Offshore Investment Bank



The financing mechanism for each bank would include the congestion income from interconnectors (1 – see figure) and potential income from generation assets in the event of high earnings (2). Such windfall profits could be collected through revenue sharing models, including (but not limited to) the models presented in the section on risk allocation (2-sided capability-based CfDs or the Commercial+ approach).

In addition, the countries involved could each invest in their respective OIB (3), as well as provide de-risking measures which could also turn into contributions for them (4) in the event of high prices, as developed above. The relative allocation of national investments, and the parameters used in the definition of each individual country's contribution, would be negotiated, and agreed upon at political level. The parameters to be considered could include, for example, the results of the Sea Basin Cost Benefit Cost Sharing (SB-CBCS – provided that the necessary improvements are brought to ONDPs), the national projected supply and demand balances, national greenhouse gas emissions, GDP, etc.

Relative investments in the OIB could also guide the statistical allocation of RES generation into each country's national RES targets or the contribution to be accounted for in the National Energy and Climate Plan (NECP), and as such provide countries with an additional incentive to contribute. This would allow countries with limited RES potential to meet their renewable energy targets, and/or allow them to do so more cost-effectively than via national buildout alone.

Finally, each OIB serving as counterparty for the de-risking measures would allow the effects of such measures – be they positive or negative – on the state budget to be dampened, and hence enable a better foreseeability of the budgetary balance.

The crucial role played by the EU
In addition to individual countries, the EU also has a role to play through grants, loans and guarantees (5).

In an increasingly interconnected Europe, the benefits of regional infrastructure and generation projects are likely to be felt beyond the borders of the countries of one specific sea basin. The EU should play a role by contributing to the costs to reflect that a project's benefits are accrued beyond the immediate areas concerned. Grants from the CEF fund that are earmarked for offshore developments could typically be channelled through the OIBs to ensure a more seamless distribution to the different transmission projects identified (6).

Furthermore, since the projects in question will be developed with the EU's net zero goal and targets in mind, they are critically dependent on Europe's speedy and widespread decarbonisation - not least the significant increase in the electrification of demand and the pace at which it will develop. The EU should therefore play a part in risk mitigation in case the system does not decarbonise at the speed and scale EU is aiming for.

Finally the European Investment Bank (EIB) should provide loans and guarantees. Loans could typically help to stabilise and make the impact of the de-risking instruments on the state budgets more easy to anticipate. Guarantees can help attract private capital as developed in the next paragraph.

Private capital as contributor to the OIBs
The joint construction of each OIB by countries and the EU, the credibility of the approach to realise political pledges, and the contribution to decarbonisation have the potential to attract private capital (7). Guarantees provided by the EIB could ensure a very low risk profile and a very high rating, which translates into lower cost of capital, and hence a significant lowering of the costs for society for offshore development.

Private investors seeking low risk and long-term investments are likely to find that the OIBs are an attractive opportunity. This capital can be made available for TSOs (8) where necessary (which typically depends on their shareholder structure) to help solve the financing challenges related to the scale of the ambition.

Towards a self-sustaining financing mechanism
It has been widely demonstrated that an RES-based system using offshore hybrids is the cheapest solution when compared to the possible alternatives. Therefore, provided that OIB revenue streams are well designed, a long-term and balanced system will lower the costs for consumers and will not require sustained public finance contributions from the countries which border each OIB's sea basin.

Calls to action
Aimed at the EU
- Help to establish OIBs by organising the necessary up-start discussions and provide administrative assistance through the European Climate, Infrastructure and Environment Executive Agency (CINEA).
- Support and provide guidance related to SB-CBCS recommendations as input for each country's contribution, and help make the link between each OIB and the contribution to NECP.
- Continue to facilitate infrastructure investments through grants, loans and guarantees, including through the CEF and EIB.

Aimed at national governments
- Embrace and establish OIBs in each relevant sea basin and ensure there is sufficient funding for regional projects that can be part of the first OIB projects.
- Ensure that OIBs cover projects with regional benefits (that extend beyond individual national interests), thereby accelerating the delivery of projects.

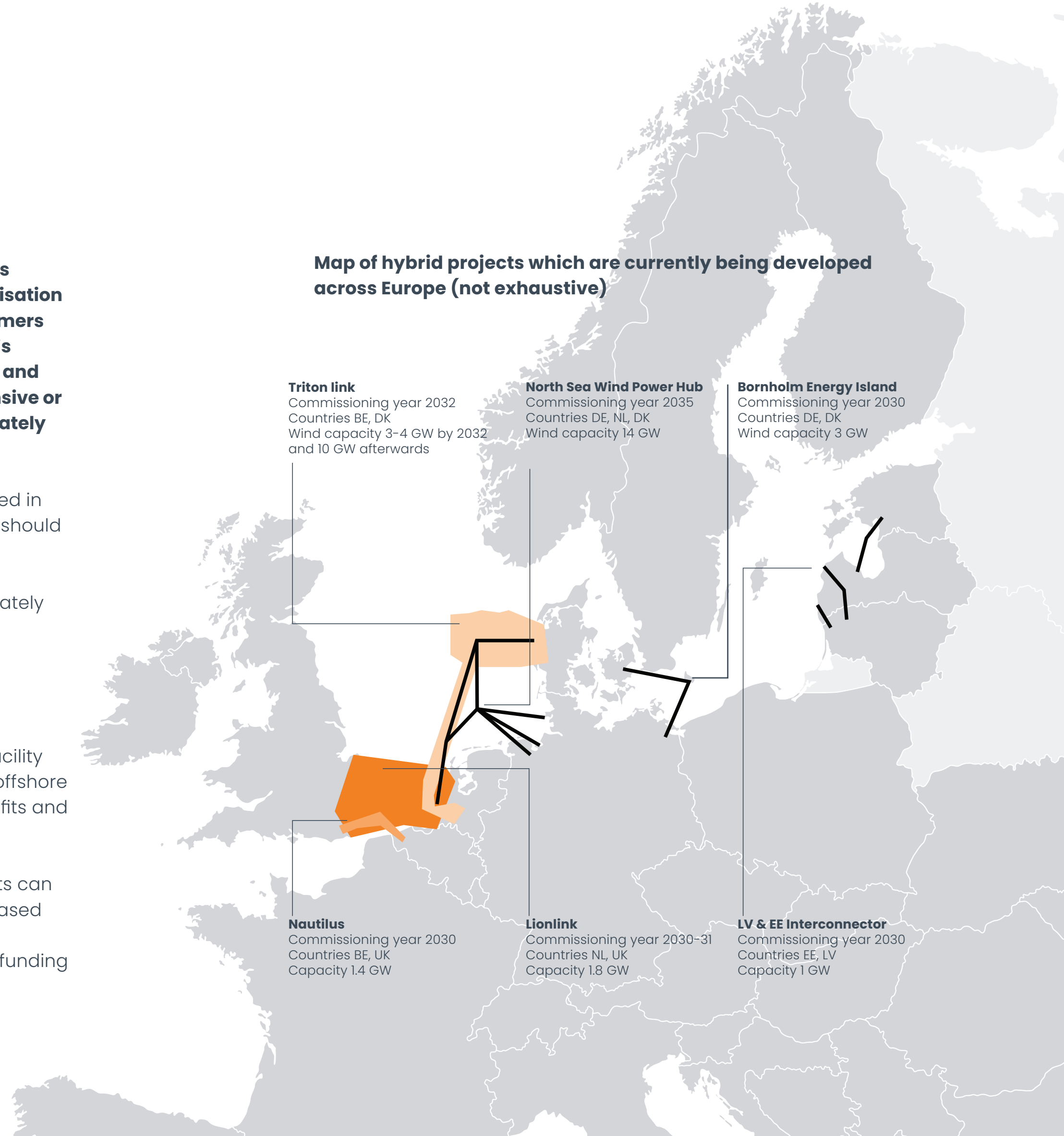
First hybrid projects

Ensuring the success of current and early hybrid projects is crucial. They will facilitate essential learning for the optimisation of future projects and will directly benefit European consumers and industry. Failing to realise them will jeopardise the EU's transition to net zero and render it more expensive. The EU and national governments will be forced to rely on more expensive or less efficient alternative generation and grid assets, ultimately diminishing the success of Europe's energy transition.

Given that the realisation of all of the improvements included in this paper will take time, the list below outlines steps which should be prioritised and quickly addressed.

- Proactive planning: national governments should immediately integrate hybrid options into their offshore project plans. Identifying the best cross-border opportunities should be prioritised, despite the imperfect nature of current methodologies.
- Targeted EU funding: concentrated Connecting Europe Facility funding over a set period should incentivise progress on offshore hybrids which are stalling. This would offset spillover benefits and uncertainties, so moving negotiations forward.
- National risk mitigation: with the EU's support, governments can offer capability-based CfD schemes to address the increased risk faced by generators. While precise costs will remain uncertain pending regulatory changes, the combined EU funding and societal benefits should encourage swift action.

Map of hybrid projects which are currently being developed across Europe (not exhaustive)



Glossary

ACER	The European Agency for the Cooperation of Energy Regulators
AHC	Advanced Hybrid Coupling
CBCA	Cross-border cost allocation
SB-CBCS	Sea Basin Cost Benefit Cost Sharing
CCR	Capacity Calculation Region
CEF	Connecting Europe Facility
CfD	Contracts for difference - a renumeration model for generators which ensures that they benefit from a guaranteed fixed price for the electricity they produce.
EEZ	Exclusive Economic Zone
FID	Final Investment Decision
FTR	Financial transmission right
IoSN	Identification of system need
NECP	National Energy and Climate Plan
NTC	Net Transfer Capacity, a methodology for allocating capacities and renumeration
OBZ	Offshore bidding zone
OFW	Offshore wind
OIB	Offshore Investment Bank, a new proposed entity to fund cross border transmission (hybrid) projects located in the same sea
ONDP	Offshore Network Development Plan
PCI	Projects of Common Interest, a list of infrastructure assets which have been identified by the European Commission as carrying significant cross-border benefits with regard to the EU achieving its energy policy and climate objectives.
PPA	Power purchase agreement
RES	Renewable energy sources
SEW	Socioeconomic Welfare
TAG	Transmission Access Guarantee
TEN-E	Trans-European Networks for Energy
TSO	Transmission system operator