Hybrid projects: How to reduce costs and space of offshore developments

North Seas Offshore Energy Clusters study

Roland Berger GmbH
21 December 2018 [revised version 20 May 2019]

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Contract specifications:

Contract no. ENER/B1/2016-326
Project title "Development of the North Seas offshore energy potential – a cluster-based approach"

This study was prepared in friendly cooperation with:

The UK Department for Business, Energy and Industrial Strategy (BEIS), the Belgian Federal Public Service (FPS) Economy, the Dutch Ministry of Economic Affairs and Climate Policy (MoEA), the German Federal Ministry for Economic Affairs (BMWi), the Danish Ministry of Energy, Utilities and Climate (MoEUC), the UK Office of Gas and Electricity Markets (Ofgem), the Belgian Commission for Electricity and Gas Regulation (CREG), the Dutch Authority for Consumers and Markets (ACM), the German Federal Network Agency (BNetzA), the Danish Utility Regulator (DUR), National Grid Ventures, Elia, TenneT TSO B.V., TenneT TSO GmbH, Energinet, EnBW Energie Baden-Württemberg, innogy, Ørsted and Vattenfall.

LEGAL NOTICE

Luxembourg: Publications Office of the European Union, 2019

ISBN: 978-92-76-04093-4
Doi: 10.2833/416539

Abstract

Europe's energy system is changing, driven by society's desire to decarbonise and switch to cleaner, renewable energy sources. The European Commission and the EU Member States back these goals; they have signed the UN's Paris Agreement to limit global temperature rises and agreed to increase the amount of energy produced from renewables.

These aims are only achievable with offshore wind power. To fulfil them, existing offshore assets should be cost-effectively and sustainably expanded to fully utilise the vast wind-energy potential of the North Seas.

Hybrid projects offer a solution. They combine offshore generation and transmission assets, which conventionally operate as separate entities. This enables them to link projects and provides a platform for coordination between countries. Such projects have several advantages over conventional offshore projects. They are cheaper, use less space and pave the way towards a future integrated energy system in the North Seas region. Ultimately, they can contribute to making the energy transition and decarbonisation happen.

As such, there is a clear need to assess the use of hybrid projects in real terms. This study identifies 18 potential hybrid projects, based on existing conventional projects in the North Seas that are in early-stage development. It assesses the five most feasible projects against their conventional reference cases in terms of capital expenditures, lifetime operating expenses and socio-economic welfare.

The study finds that the five projects show cost saving potentials of up to 10%, or up to EUR 2,500 million, depending on the size of the comparable conventional project. But it also finds that hybrid projects face significant legal, regulatory and other barriers. To address these, the study proposes project-specific Action Plans outlining the mitigation measures stakeholders can take. Finally, the study provides recommendations on implementing future hybrid projects, thereby paving the way to a future-proof European energy system.

Executive Summary

The European energy system is rapidly changing. The continent's energy transition is in full swing, with production switching from conventional fuels to renewable sources. This process is being driven by society's desire to decarbonise and mitigate the effects of climate change.

The European Commission and EU Member States actively support these goals. In December 2015 they committed to decarbonisation in Europe by signing the Paris Agreement. This plan, a product of the 21st Conference of the Parties of the United Nations Framework Convention on Climate Change, aims to limit the rise in global temperatures to no more than 2° Celsius above pre-industrial levels, while actually working towards a limit of 1.5° Celsius. EU members have also agreed to produce 32% of consumed energy from renewables by 2030. A rulebook produced at the 24th Conference of the Parties in Katowice in December 2018 supports the implementation of the Paris Agreement. It will help governments measure greenhouse gas emissions, report progress towards curbing carbon use and mobilise USD 100 billion a year to fund climate policy.

These aims, and indeed the energy transition itself, are dependent on offshore wind power. But to fulfil them, existing offshore assets should be cost-effectively and sustainably expanded.

Why hybrid projects?

The vast offshore wind-power potential in the North Seas is one of Europe's greatest renewable assets. The North Seas region has an estimated economically attractive potential of more than 635 GW by 2030. It is already being tapped, with installed wind capacity expected to reach 90 GW in the next ten years. But to fully exploit the potential, wind farms need to be built ever further out to sea. This makes development more complicated and more expensive. If viable projects are to be realised, it is crucial to reduce the costs of and space needed by offshore assets using innovative solutions that efficiently connect wind farms to land. Hybrid projects offer just such a solution.

Traditionally, offshore wind-power projects have a strong national focus with the power transmission line feeding just one national grid. Additionally, offshore generation is usually not coordinated with nearby developments in other countries. Hybrid projects are different; they combine generation and transmission elements, linking two or more countries and providing a platform for coordination between them. In the North Seas, this could, for example, mean a joint development of an offshore wind farm and an interconnector, allowing a Dutch wind farm to be connected to the British and Dutch grids.

Benefits of hybrid projects

Compared to their conventional reference cases, in which generation and transmission assets are developed and operated as separate entities, hybrid projects have several benefits. As well as offering significant potential for cost savings, they take up less space, thereby leaving more space available to other users of the sea and lowering environmental impact. In the North Seas, they also create cross-border links, helping to provide additional interconnection capacity and underpinning the EU's internal energy market. The European offshore industry and job market benefit, too. In short, they can make the energy transition and decarbonisation happen.

The use of hybrid projects to exploit the North Seas' wind-power potential also has political support. In 2016, countries in the North Seas region (Ireland, the United Kingdom, France, Belgium, the Netherlands, Luxembourg, Germany, Denmark, Norway and Sweden) signed the North Seas Energy Cooperation declaration. It aims to strengthen cooperation on energy and improve conditions for the development of offshore wind energy, ensuring a sustainable, secure and affordable energy supply in the region. As part of this, it encourages transmission system operators and offshore wind developers to become early movers in hybrid projects.

Such initiatives are helping hybrid projects to gain momentum. Although only one has been implemented so far – Kriegers Flak, which is nearing commissioning – more and more stakeholders in the North Seas region are now taking an interest and developing a better understanding of project economics and benefits. At the same time, progress in harmonising EU energy policies and regulation has changed perceptions of the challenges developers face in realising them.

However, hybrid projects are more challenging to develop than conventional offshore wind-power projects. For example, they pose significant legal and regulatory barriers. Bearing in mind their key role in the energy transition and decarbonisation, this means there is a clear need to assess their use in practice.

What are the key findings across hybrid projects?

The purpose of this study is to assess hybrid projects in as real terms as possible, or more specifically:

1. To assess the costs and benefits of hybrid projects compared to conventional, separately developed offshore generation and transmission projects (reference cases);
2. To develop concrete Action Plans to overcome barriers to hybrid project development.

It also presents project-specific findings for feasible hybrid projects and gives recommendations on taking them forward.

1. Assessment of costs and benefits

The study identifies 18 potential hybrid projects based on conventional developments in the North Seas which are in the early stages of planning or construction. These are located in four North Seas regions: the Irish Sea / North Channel; the UK-NL-BE cluster; Dogger Bank; and the German Bight.

Starting from 18 hybrid project ideas, the ten most promising hybrid projects are assessed against their reference cases, with the analysis focusing on differences in terms of capital expenditures, lifetime operating expenses and lifetime socio-economic welfare over a 25-year period. Other factors, such as the environment and the European Union's energy policy targets, are also considered. Stakeholders such as transmission system operators, offshore wind farm developers, national ministries and regulatory authorities across Ireland, the United Kingdom, Belgium, the Netherlands, Germany and Denmark were involved throughout the study.

Of the ten hybrid projects, five are found to be significantly more beneficial than their respective reference case:

- The "IJmuiden Ver to UK" hybrid project – connects a Dutch offshore wind farm to British and Dutch electricity markets.
- The "Combined Grid Solution IJmuiden Ver to Norfolk" hybrid project – provides an offshore connection between a Dutch and British offshore wind farm.
- The "COBRA Cable" hybrid project – connects a German offshore wind farm to the Dutch and Danish electricity markets via the COBRA Cable interconnector.
- The "DE OWF to NL" hybrid project – connects a German offshore wind farm to the Dutch electricity market.
- The "North Sea Wind Power Hub" (NSWPH) hybrid project – connects offshore wind farms to several North Seas countries via a hub in proximity to the Dogger Bank area.

The five projects show potential for cost savings of between EUR 300 million and EUR 2,500 million, depending on the size of the comparable conventional project. This translates into 5 to 10% of total project costs. More detail about the findings for each of the five projects can be found in the "What are the project-specific findings?" section.

The assessment findings provide only a starting point for the development of hybrid projects. As projects proceed, more action is required, for example on technical planning, preparation of the supply chain and analyses of electricity flows and operational feasibility. And most importantly, barriers to development need to be overcome.

2. Assessment of barriers and development of Action Plans

Legal, regulatory and other barriers hinder the development of hybrid projects. The study identifies 16 distinct barriers and assesses mitigation options for them. It then proposes concrete actions that transmission system operators, offshore wind farm developers and public authorities can take to overcome these barriers. Only 13 of the 16 barriers are considered in detail for each project as three will be dealt with by measures in the EU's Clean Energy Package, which is in the process of being formally adopted by Member States.

The 13 barriers concern legal requirements, planning procedures and energy market rules in the North Seas countries, or more specifically:

- Uncertainty about responsibility for project development;
- Uncertainty about regulation deriving from jurisdiction over cross-border cable systems;
- Uncertainty about market arrangements;
- Uncertainty about hybrid cable system classification;
- Failure of developers to align planning across assets and countries;
- Uncertainty about responsibility and rules to provide access to maritime space for offshore wind farms (location selection, site pre-investigation and tender execution);
- Uncertainty about responsibility and rules to provide access to maritime space for offshore wind farms (tender design);
- Lack of regulated revenues for anticipatory investments;
- Uncertainty about applicable subsidy schemes for renewably energy sources;
- Limited engagement of public stakeholders;
- Uncertainty regarding the British market;
- Disproportionate allocation of costs and benefits across involved stakeholders;
- Uncertainty about legislative regime for power-to-gas and related infrastructure.

The construction of the Kriegers Flak hybrid project in the Baltic Sea, the one hybrid project nearing commissioning, shows that these barriers are surmountable if stakeholders make a concerted effort. To ease the process, the study proposes Action Plans containing specific mitigation measures to overcome each barrier. In general, the measures tackle ad hoc or project-specific problems. But where they concern all hybrid projects, for example the limited engagement of public stakeholders, they could also be effectively addressed at the North Seas Energy Cooperation.

What are the project-specific findings?

The study produces both cross-project and project-specific findings. The former result from the assessments of the 18 potential hybrid projects versus their respective reference cases and are covered in earlier sections. The latter relate to the five most feasible hybrid projects, with a particular focus on the 13 barriers and their mitigation measures. The five are summarised below.

IJmuiden Ver to UK

This hybrid project connects a Dutch offshore wind farm to the United Kingdom and the Netherlands. Over the 25-year assumed asset lifetime, it yields savings of about EUR 400 million compared to the reference case. These are driven by the elimination of 65 km of cable and an onshore converter station.

The project faces several barriers, although others are bypassed. For example, the developers envisage a market arrangement (division of bidding zones) in which the wind farm only sends electricity to its Dutch home market. This removes the major barrier of defining applicable transnational subsidy schemes for renewables – essentially agreeing which country will foot the bill. Even so, the feasibility of the expected market arrangements and the accompanying national subsidy scheme for renewables still need to be aligned with the relevant state authorities. Other critical barriers remain. These include uncertainty over regulated revenues for anticipatory investments, or the shorter-term set-up costs that help to stave off higher costs in the long term, and the disproportionate allocation of costs and benefits among stakeholders and the two countries. It is unclear if the hybrid cable system classification barrier, or the laws limiting how different cables are allowed to be used for different functions, also applies in this case.

While mitigation of all these barriers is possible, another is making this difficult: uncertainty surrounding the British market. The project's advancement is particularly complex due to the ongoing negotiations regarding the withdrawal of the UK from the European Union, the associated uncertainty regarding the country's participation in the European Union's internal energy market and concerns about future regulation changes.

Combined Grid Solution IJmuiden Ver to Norfolk

The project provides an offshore connection between the offshore substations of a British and a Dutch wind farm. Using the same 25-year assumptions, it yields lifetime savings of about EUR 720 million compared to the reference case, thanks to the elimination of 130 km of cable and two onshore converter stations.

Like the "IJmuiden Ver to UK" hybrid project, the stakeholders envisage a market arrangement where the offshore wind farms only send generated electricity to their home markets – in this case the UK and the Netherlands. Thus, the definition of an applicable, transnational subsidy scheme for renewables is rendered unnecessary. The classification of parts of the overall cable system as a hybrid cable system is also unlikely to be a problem. But again, the envisaged market arrangement, subsidy schemes for renewable energy sources and cable system classification will need to be validated with the relevant authorities.

Barriers do exist, however. The two barriers of uncertainty regarding regulated revenues for required anticipatory investments, and the disproportionate allocation of costs and benefits across the stakeholders and countries involved, will again have to be overcome. And as with the previous project, barrier mitigation and project development are particularly complex because of the ongoing negotiations regarding the UK's withdrawal from the EU. But once the outcome of the negotiations is clear, Vattenfall and TenneT TSO B.V. can take this pilot project forward.

North Sea Wind Power Hub (NSWPH)

The NSWPH connects offshore wind farms to several North Seas countries via a hub near the Dogger Bank area in the North Sea. It promises 25-year lifetime savings of about EUR 2,500 million compared to the reference case. These arise from the elimination of interconnector systems, the installation of electrical equipment on the hub rather than offshore and the provision of operations and maintenance services from the hub rather than from shore.

The international nature of the project dictates several of its barriers. In terms of market arrangement, a dedicated bidding zone needs to be implemented. Due to the unique nature of the project, the introduction of a bidding zone lacking domestic demand is needed. This will require a comprehensive bidding zone review process. In addition, three other barriers will have to be overcome: uncertainty about regulated revenues for required anticipatory investments, the lack of an applicable, transnational subsidy scheme for renewable energy sources and the disproportionate allocation of costs and benefits across the stakeholders and countries. One barrier is removed, however: because hybrid cable systems will be eliminated, they will not require new legal classification. With project commissioning planned for 2035, there is sufficient time to implement mitigation measures against the identified barriers.

COBRA Cable

This project connects a German offshore wind farm to the Netherlands and Denmark via the existing COBRA Cable interconnector. Over the typical asset lifetime of 25 years, it will yield savings of about EUR 390 million compared to the reference case. These occur because the project renders 200 km of cable and an onshore converter station redundant compared to the reference case.

If the project is to be realised, several barriers will need to be addressed. Responsibility for linking the offshore wind farm to the interconnector should be clearly assigned, the applicability of a German subsidy scheme validated and the disproportionate allocation of costs and benefits between stakeholders and countries overcome. As with the market arrangements for the NSWPH project, the implementation of a dedicated bidding zone for the offshore wind farm would require a better understanding of how a bidding zone with no domestic demand would work. A comprehensive bidding zone review process might also be needed. However, establishing a new bidding zone would, at least, remove the need for hybrid cable system classification.

These barriers can be overcome by implementing the mitigation measures identified in this study. But the potential savings should be set against the cost of pausing operations and connecting the COBRA Cable interconnector to the offshore wind farm.

DE OWF to NL

This hybrid project connects a German offshore wind farm to the Netherlands. Assuming the typical asset lifetime of 25 years, it will yield lifetime savings of about EUR 260 million compared to the reference case. These are due to the elimination of 115 km of cable, as the distance to a Dutch onshore connection point is shorter than that to the German one.

While this hybrid project does not involve a hybrid cable system, three major barriers still need to be mitigated when considering a market arrangement of sending power from Germany to the Netherlands: the responsibility for onshore grid connection, the applicability of a German subsidy scheme for renewable energy sources and the disproportionate allocation of costs and benefits across the stakeholders and countries involved.

Compounding these more critical barriers, a lack of engagement and support by public stakeholders is also currently hindering the project. The main concern is that an disproportionate allocation of costs and benefits resulting from expected onshore grid reinforcements might have to be covered by a country that does not receive commensurate benefits. In addition, depending on the agreed project setup, any grid reinforcement costs should be set against the identified lifetime savings. Nevertheless, as soon as public engagement and support can be ensured, stakeholders can advance this pilot project.

How to make hybrid projects a reality?

The study makes four main recommendations on implementing future hybrid projects. These are based on the project-specific assessments performed on the concrete projects, as well as the detailed mitigation measures for their identified barriers.

1. ***Implement HANSAs, project-specific legal agreements to provide security for developers***

   Although the European Union is planning an internal energy market, most countries still place more emphasis on their own energy policies and rules. This hinders the implementation of transnational projects, such as the hybrid projects considered in this study. Such projects require transnational approaches regarding legal and regulatory framework conditions. Hybrid Asset Network Support Agreements address this problem. HANSAs are project-specific, enforceable legal agreements between countries that provide security for developers. They ensure that specific mitigation measures designed to overcome relevant legal and regulatory barriers are developed and implemented, offering both shorter-term certainty and the possibility of informing future legal frameworks.

2. ***Provide public funds to de-risk pilot projects***

   Hybrid projects are riskier than conventional offshore developments. They are largely untested, require collaboration between multiple parties and integrate several projects into one. Developers therefore need incentives to switch from a conventional offshore project to a hybrid one during its early stages; the best time as changes naturally become more difficult and costly in later stages. Public financial support is key to this, helping developers and investors to de-risk pilot hybrid projects and allowing for early-stage alignment across assets and countries. The EU's Connecting Europe Facility provides early-stage and investment support for Project of Common Interest. Additionally, offering EUR 900 million in early-stage co-investments for renewable cross-border projects is considered from 2021.

3. ***Agree rules to fairly share costs and benefits among countries and stakeholders***

   Stakeholders are unlikely to commit to a hybrid project without first knowing what benefits and costs it will bring them. The problem is that each hybrid project generates a unique set of costs and benefits, and these are typically disproportionately distributed. For example, while country A may carry the burden of grid connection costs, country B may benefit from cheaper electricity. Such inequalities call for clear rules governing the fair allocation of costs and benefits, and these should act as a starting point for the development of project-specific solutions.

4. ***Widen the hybrid approach towards an integrated regional energy system (sector coupling)***

   Hybrid projects can be expanded and improved by combining them with so-called power conversion technology. This converts electricity into another source of energy, typically gas, to ease transmission or store fuels during periods of oversupply. In combination, hybrid projects and conversion technology can help to avoid onshore grid congestion and supply risks. Proposed hybrid projects such as the North Sea Wind Power Hub provide an ideal testing ground for this energy system approach, known as sector coupling. It will ultimately be essential in establishing an energy system that can integrate significantly more capacity from renewable sources. The European Commission and national governments should support such moves, for example, with grants to analyse different technological options and conduct feasibility studies.

In conclusion, hybrid projects can make a significant contribution to Europe’s energy transition and its decarbonisation. In the shorter term they reduce costs and needed space, while in the longer term they pave the way towards an integrated and future-proof European energy system in the North Seas region.

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Glossary

Term[1]	Description
Capital expenditures (CAPEX)	Capital expenditures are the funds needed for the development and the construction of the hybrid project. In this study, capital expenditures are assumed to be fully incurred with commissioning of a hybrid project and are therefore not discounted.
Clean Energy Package (CEP)	The Clean Energy Package was adopted by the Member States in December 2018 and will be subject to scrutiny before entering into force in 2019. After entering into force, the new framework needs to be assessed in detail by the relevant project stakeholders.
Combined grid solution (CGS)	Combined grid solutions connect two offshore wind farms located in different exclusive economic zones, which are individually connected to shore of the respective countries.
Connecting Europe Facility (CEF)	The Connecting Europe Facility is an EU funding instrument to promote growth, jobs and competitiveness through targeted infrastructure investment at European level. It supports the development of high performing, sustainable and efficiently interconnected trans-European networks in the fields of transport, energy and digital services.
Contract for Difference (CfD)	A Contract for Difference is a long-term contract, where two parties agree to trade a certain volume of energy for a set strike price. If the market price is higher or lower than the agreed strike price, then the parties settle the difference. Thus, a CfD enables a generator to stabilise its revenues at a pre-agreed level (strike price-level).
Distribution system operator (DSO)	Distribution system operator means a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity (Directive 2007/72/EC).
European Fund for Strategic Investments (EFSI)	The European Fund for Strategic Investments is an initiative launched jointly by the EIB Group – the European Investment Bank and the European Investment Fund – and the European Commission to help overcome the current investment gap in the EU. It provides funding for economically viable projects, especially for projects with a higher risk profile than usually taken on by banks. It focuses on sectors of key importance for the European economy.

[1] Definitions provided by Roland Berger to clarify the specific usage of terms in this study.

Term[1]	Description
European Network of Transmission System Operators for Electricity (ENTSO-E)	ENTSO-E, the European Network of Transmission System Operators for Electricity, represents 43 electricity transmission system operators from 36 countries across Europe. ENTSO-E members share the objective of setting up the internal energy market and ensuring its optimal functioning, and of supporting the ambitious European energy and climate agenda.
Exclusive economic zone (EEZ)	An exclusive economic zone is a maritime zone prescribed by the United Nations Convention on the Law of the Sea. The exclusive economic zone is an area beyond and adjacent to the territorial sea, where the coastal state has sovereign rights for exploring and exploiting the marine resources as well as jurisdiction with regard to the establishment and use of artificial islands, installations and structures.
High voltage alternating current (HVAC)	High voltage alternating current is an electric current, generated by a voltage of more than 100 kV, which periodically reverses direction. High voltage is used for electric power transmission to reduce the energy lost in the resistance of the wires. Short distance HVAC transmission generally has lower overall investment cost than an equivalent DC transmission scheme due to the absence of additionally needed and expensive DC converters for voltage transformations.
High voltage direct current (HVDC)	High voltage direct current is an electric current, generated by a voltage of more than 100 kV, which flows unidirectional. High voltage is used for electric power transmission to reduce the energy lost in the resistance of the wires. Long distance point to point HVDC transmission generally has lower overall investment cost than an equivalent AC transmission scheme due to cheaper cables and very limited losses.
Hybrid Asset Network Support Agreement (HANSA)	A Hybrid Asset Network Support Agreement is a project-specific agreement between countries. It formalises their commitment to support the development and operation of an (electricity) network – based on hybrid cable systems – and the implementation of required actions. A HANSA represents a legally binding commitment to maintain the terms of legislation and regulation in place at the time of the adoption of the HANSA and to clarify ambiguities in European and / or national legislation and regulation, which might obstruct hybrid project development. It thereby provides legal certainty to developers. European legislation and regulation can only be addressed via a HANSA in case of the signing of the agreement by all Member States of the European Union.
Hybrid cable system	Hybrid cable systems are cable systems that fulfil multiple functionalities, such as the transmission of electricity from an offshore wind farm to shore and the transmission of electricity from one country to another to allow for market-to-market flows.
Hybrid project	Hybrid projects are transnational, coordinated offshore energy generation projects. Typically, hybrid projects combine generation and transmission assets across maritime boundaries.

Term[1]	Description
Intergovernmental Agreement (IGA)	An Intergovernmental agreement is an agreement between countries that formalises their commitment to the implementation of required actions for barrier mitigation. An IGA represents a legally binding commitment to adapt legislation and regulation in the future, and thus provides legal certainty to developers.
Memorandum of Understanding (MoU)	A Memorandum of Understanding is a formalisation of the goodwill of the involved parties in the form of a non-binding agreement. An MoU addresses barriers by formalising the agreements of the involved parties with regards to the implementation of required actions to overcome barriers.
Natura 2000	Natura 2000 is a network of core breeding and resting sites for rare and threatened species, and some rare natural habitat types which are protected in their own right. It stretches across all 28 EU countries, both on land and at sea. The aim of the network is to ensure the long-term survival of Europe's most valuable and threatened species and habitats, listed under both the Birds Directive and the Habitats Directive.
Nautical mile (nm)	A nautical mile is a unit of measurement defined as 1.852 kilometres.
North Seas Energy Cooperation	The North Seas Energy Cooperation was formed in 2016 through the Political Declaration on energy cooperation between North Seas Countries (Belgium, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, Norway and Sweden, and later also the UK). The involved countries agreed to further strengthen their energy cooperation to improve conditions for the development of offshore wind energy to ensure a sustainable, secure and affordable energy supply in the area.
North Seas Offshore Energy Cluster	Areas which have the potential to be “North Seas Offshore Energy Clusters” are geographical areas in the exclusive economic zones of any Signatory State to the June 2016 Political Declaration on North Seas Energy Cooperation that border on areas in one or more other Signatory States, where there is a firm intention to invest in offshore infrastructure for the purposes of transporting or generating energy, and where, further linked investment could either reduce costs or provide access to the bordering national market(s) or both.
Offshore Transmission Owner (OFTO)	An Offshore Transmission Owner assumes responsibility for offshore transmission assets in the UK. An OFTO is competitively appointed by the national regulatory authority Ofgem through a tender process and is awarded an OFTO license. The OFTO transmission license does not permit market-to-market flows and OFTOs cannot hold both a transmission and an interconnector license.
Operating expenses (OPEX)	Operating expenses are the funds needed to operate and maintain a hybrid project. In this study, operating expenses are calculated and discounted over a typical asset lifetime.

Term[1]	Description
Power-to-gas	Power-to-gas refers to an electricity conversion pathway that utilizes surplus electricity to allow for the decoupling of power from the electricity sector for use in other sectors. The idea behind power-to-gas is to convert renewable energy to hydrogen using electrolysis or to methane by combining the newly gained hydrogen with carbon dioxide.
Power-to-X	Power-to-X refers to various electricity conversion pathways that utilize surplus electricity to allow for the decoupling of power from the electricity sector for use in other sectors. The X in the terminology refers to the product, that emerges from the electricity conversion (e.g. gas (hydrogen or methane), liquid, syngas, etc.).
PRIMES EUCO30	The PRIMES model is an EU energy system model which simulates energy consumption and the energy supply system in the European Union and each of its Member States. It includes consistent carbon price trajectories. EUCO30 is a scenario, created using the PRIMES model, that reflects the 2030 targets agreed by the European Council. It achieves the at least 40% greenhouse gas emissions reduction target, a 32% share of renewables and the energy efficiency target of 32.5%.
PROgress on Meshed HVDC Offshore Transmission Networks (PROMOTioN)	The PROgress on Meshed HVDC Offshore Transmission Networks project researches the long-term vision of a meshed offshore grid in the North Sea. It is funded under the EU Horizon 2020 programme on "Competitive Low-Carbon Energy" and serves as a link between research, validation and testing of technology and the development of recommendations for meshed offshore grids.
Projects of Common Interest (PCI)	Projects of Common Interest are key cross border infrastructure projects that link the energy systems of EU countries. They are intended to help the EU achieve its energy policy and climate objectives: affordable, secure and sustainable energy for all citizens, and the long-term decarbonisation of the economy in accordance with the Paris Agreement.
Reference case	Reference cases consist of separately developed, uncoordinated offshore generation and transmission projects comparable to the respective hybrid projects (i.e. with the same generation and transmission capacity).
Regulated asset base (RAB)	The regulated asset base is a system of long-term tariff design aimed primarily at encouraging investment in the expansion and modernization of infrastructure. It is the value of net invested capital for regulatory purposes, calculated on the basis of the rules defined by an authority for determining base revenues for the regulated businesses.
Socio-economic welfare (SEW)	The socio-economic welfare can be described as a level of economic satisfaction experienced by participants in an economic system. In the context of offshore wind projects, the socio-economic welfare consists of the producer surplus, the consumer surplus and the congestion rent.

Term[1]	Description
Special-purpose vehicle (SPV)	A special-purpose vehicle is a separate legal entity created by an organization. The SPV is a subsidiary company with its own assets and liabilities, as well as its own legal status. Usually, they are created for a specific objective, often which is to isolate financial risk. As it is a separate legal entity, if the SPV goes bankrupt, the parent company must not carry its obligations.
Ten Year Network Development Plan (TYNDP)	The ENTSO-E ten-year network development plan is Europe's network development plan to 2025, 2030 and 2040. It is published bi-annually and focuses on what the electricity grid should look like to create maximum value for Europeans, ensure continuous access to electricity throughout Europe and deliver on the climate agenda.
Territorial sea	The sovereignty of a coastal State extends, beyond its land territory and internal waters to an adjacent belt of sea, described as the territorial sea. Every State has the right to establish the breadth of its territorial sea up to a limit not exceeding 12 nautical miles.
Transmission system operator (TSO)	Transmission system operator means a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity (Directive 2009/72/EC).
UK Cap and Floor regime	The UK national regulatory agency Ofgem has created the cap and floor regime to encourage investment in electricity interconnectors. Electricity interconnectors generally earn revenue from the allocation of capacity to users who want to flow electricity between the UK and neighbouring countries. Under the UK's regime, a cap as well as a floor exist that represent the maximum and minimum amount of revenue that an electricity interconnector can earn, providing security for the developers.
UK Capacity Market	The Capacity Market is a mechanism introduced by the UK government to ensure that electricity supply continues to meet demand as more volatile and unpredictable renewable generation plants come on stream. Participants will be paid a per MW rate for the capacity they offer to the market. In return, the agreed capacity needs to be available when providers are called upon at any time during the contracted period. Both the capacity payments as well as the Capacity Market obligation are defined in agreements that are awarded to the capacity providers via auctions. However, the mechanism has been declared illegal by the General Court of the EU on November 15, 2018 and it is presently put on hold, with the next capacity auction indefinitely postponed.
United Nations Convention on the Law of the Sea (UNCLOS)	The United Nations Convention on the Law of the Sea entered into force in 1994 and lays down a comprehensive regime of law and order in the world's oceans and seas establishing rules governing all uses of the oceans and their resources. It enshrines the notion that all problems of ocean space are closely interrelated and need to be addressed as a whole.

Term[1]	Description
Voluntary cooperation	Voluntary cooperation, as opposed to a project-specific Memorandum of Understanding (MoU) or a project-specific Hybrid Asset Network Support Agreement (HANSA), does not rely on a formalisation of goodwill of the involved parties but rather is the outcome of the common understanding to jointly work towards a common goal. There is no legally binding element.

List of Abbreviations

Abbreviation	Meaning
(HV)AC	(High voltage) alternating current
(HV)DC	(High voltage) direct current
ACM	Authority for Consumers & Markets, Netherlands
BE	Belgium
BEIS	Department for Business, Energy & Industrial Strategy, UK
BMWi	Federal Ministry for Economic Affairs and Energy, Germany
bn	Billion
BNetzA	Federal Network Agency, Germany
BSH	Federal Maritime and Hydrographic Agency, Germany
CACM	Capacity Allocation and Congestion Management
CAPEX	Capital expenditures
CBA	Cost-benefit analysis
CBCA	Cross-border cost allocation
CEF	Connecting Europe Facility
CEP	Clean Energy Package
CfD	Contract for Difference
CGS	Combined grid solution
CO_2	Carbon dioxide
DE	Germany
DK	Denmark
DSO	Distribution system operator
DUR	Danish Utility Regulator
e.g.	For example (exempli gratia)
EC	European Commission
EEZ	Exclusive economic zone
EFSI	European Fund for Strategic Investments
ENTSO-E	European Network of Transmission System Operators for Electricity
EU	European Union
EUR	Euro
GBP	Pound sterling
G-charges	Generation charges

Abbreviation	Meaning
GW	Gigawatt
HANSA	Hybrid Asset Network Support Agreement
i.e.	That is to say (id est)
IC	Interconnector
IGA	Intergovernmental Agreement
incl.	Including
KF CGS	Kriegers Flak Combined Grid Solution
km	Kilometre
kt/a	Kiloton per year
kV	Kilovolt
kW	Kilowatt
m	Million
MoEA	Ministry of Economic Affairs and Climate Policy, Netherlands
MoEUC	Ministry of Energy, Utilities and Climate, Denmark
MOG	Modular Offshore Grid
MoU	Memorandum of Understanding
MW	Megawatt
MWh	Megawatt hours
MWh/a	Megawatt hours per year
NGV	National Grid Ventures, UK
NL	The Netherlands
nm	Nautical mile
NRA	National regulatory authority
NSWPH	North Sea Wind Power Hub
Ofgem	Office of Gas and Electricity Markets, UK
OFTO	Offshore Transmission Owner, UK
OPEX	Operating expenses
OWF	Offshore wind farm
p.a.	Per year (per annum)
PCI	Projects of Common Interest
PROMOTioN	PROgress on Meshed HVDC Offshore Transmission Networks
RAB	Regulated asset base
reg.	Regarding

Abbreviation	Meaning
RES	Renewable energy sources
RVO	Netherlands Enterprise Agency, Netherlands
SEW	Socio-economic welfare
SPV	Special-purpose vehicle
tbd	To be determined
TSO	Transmission system operator
TYNDP	Ten Year Network Development Plan
UK	The United Kingdom
UK-NL-BE	Cluster UK, Netherlands and Belgium
UNCLOS	United Nations Convention on the Law of the Sea

1. Hybrid projects and the North Seas region

The decarbonisation of European societies constitutes a major target of the European Commission and national governments. In December 2015 they committed to decarbonisation in Europe by signing the Paris Agreement. This plan, a product of the 21st Conference of the Parties of the United Nations Framework Convention on Climate Change, aims to limit the rise in global temperatures to no more than 2° Celsius above pre-industrial levels, while actually working towards a limit of 1.5° Celsius. EU members have also agreed to produce 32% of consumed energy from renewables by 2030. A rulebook produced at the 24th Conference of the Parties in Katowice in December 2018 supports the implementation of the Paris Agreement. It will help governments measure greenhouse gas emissions, report progress towards curbing carbon use and mobilise USD 100 billion a year to fund climate policy.

These aims, and indeed the energy transition itself, are entirely dependent on offshore wind power. To fulfil them, existing offshore assets should be cost-effectively and sustainably expanded.

The vast offshore wind-power potential in the North Seas is one of Europe‘s greatest renewable assets. The North Seas region has an estimated economically attractive potential of more than 635 GW by 2030[2]. It is already being tapped, with installed wind capacity expected to reach 90 GW in the next ten years[3] Based on these numbers, it becomes clear that exploiting the vast wind energy potential of the North Seas region will make a major contribution to the fulfilment of the Paris Climate Agreement and for tackling climate change.

But to fully exploit the potential, wind farms need to be built ever further out to sea. This makes development more complicated and more expensive. If viable projects are to be realised, it is crucial to reduce the costs of and the space needed by offshore assets using innovative solutions that efficiently connect wind farms to land. Hybrid projects offer just such a solution.

Traditionally, offshore wind-power projects have a strong national focus with the power transmission line feeding just one national grid. Additionally, offshore generation is usually not coordinated with nearby developments in other countries. Hybrid projects are different; they combine the generation and transmission elements, linking two or more countries and providing a platform for coordination between them. By contrast, the term reference case applies to offshore developments in the North Seas consisting of separately developed generation and transmission assets. They are used as benchmarks for the evaluation of hybrid projects throughout the study.

The study groups hybrid projects into five concepts (Figure 1).

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[2] WindEurope. 2017. *Unleashing Europe's offshore wind potential.* https://windeurope.org/wp-content/uploads/files/about-wind/reports/Unleashing-Europes-offshore-wind-potential.pdf

[3] Estimate based on assessment of existing studies. Refer to Gorenstein Dedecca, Joao and Rudi A. Hakvoort. 2017. *A review of the North Seas offshore grid modelling: Current and future research*. https://doi.org/10.1016/j.rser.2016.01.112.

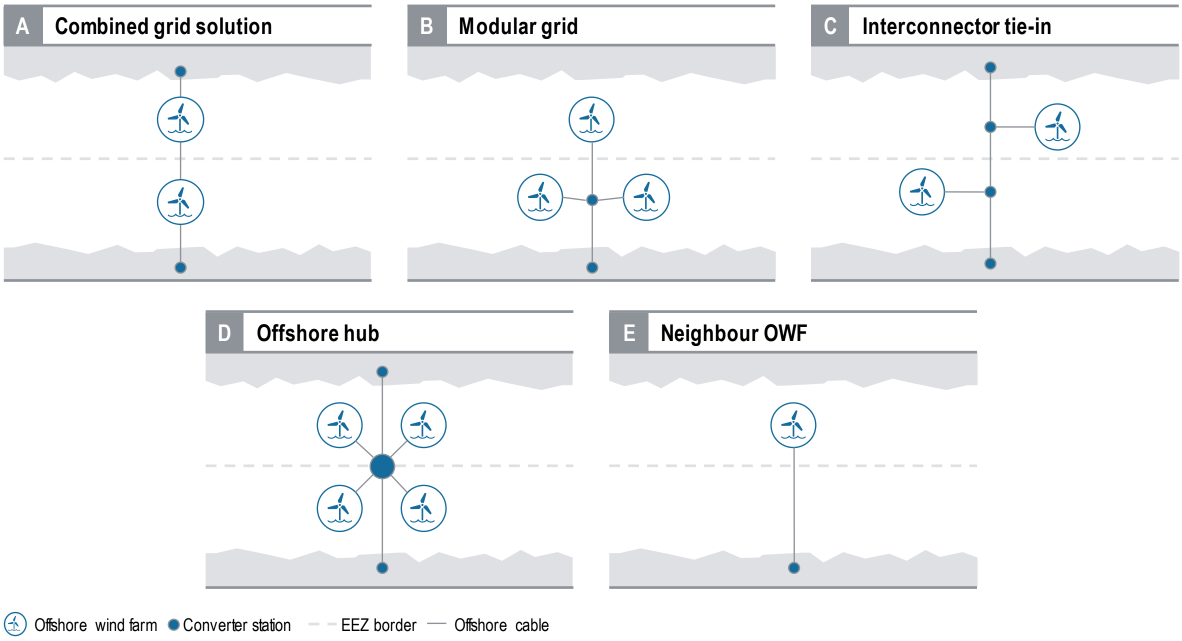


Figure 1: Hybrid project concepts

- A "combined grid solution" connects two offshore wind farms (OWFs) in different exclusive economic zones (EEZs), both of which are individually connected to the shore of their home country. An example is the Kriegers Flak transmission project between Denmark and Germany (see Figure 2).
- A "modular grid" connects multiple OWFs, located in different EEZs, to shore via a single export cable system. Although it lacks a transnational dimension, one example of this concept is the Modular Offshore Grid in Belgium, which connects nine OWFs to shore.
- An "interconnector tie-in" connects an OWF to shore via an interconnector. No examples of this concept currently exist.
- An "offshore hub" connects multiple OWFs to at least two markets via an offshore hub. The proposed North Sea Wind Power Hub is an example of this concept.
- A "neighbour OWF" connects an OWF located in the EEZ of country 1 to the shore of country 2. No examples of this concept currently exist.

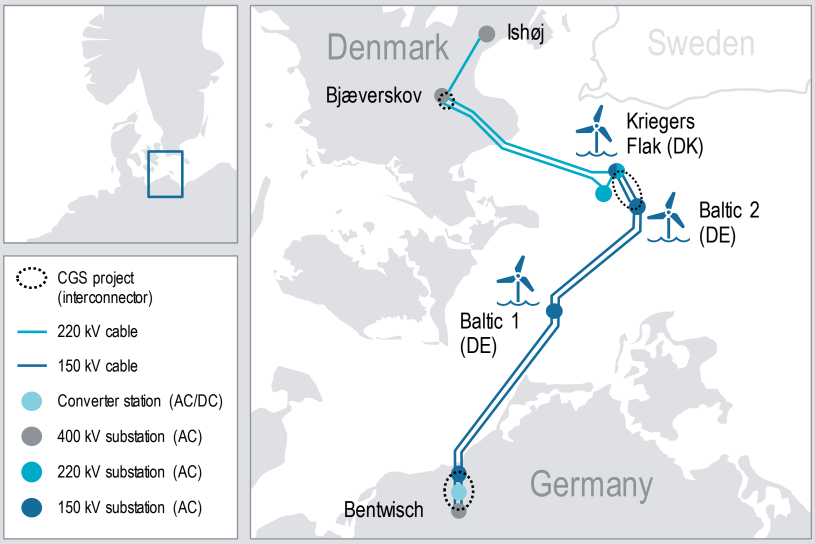
Kriegers Flak Combined Grid Solution

Via an interconnector, the Kriegers Flak Combined Grid Solution (KF CGS) links the offshore substations of the export cable system of the Danish OWF Kriegers Flak (600 MW) and the offshore substation of the export cable system of the German OWFs Baltic 1 (48 MW) and Baltic 2 (288 MW) in the Baltic Sea to onshore connection points in Bentwisch, Germany, and Bjæverskov, Denmark.

The installation should become operational in 2019.[4] Its technical design challenges and additional success factors are briefly outlined in this box.

The KF CGS technical design is based on a connection between the offshore substations of the export cable systems of Kriegers Flak and Baltic 2 via two subsea cables. As the Danish and German OWFs use different voltage levels (150 vs. 220 kV), an offshore transformer module has been fitted on the Danish offshore platform. Additionally, two serially connected voltage source converters will be installed onshore in Bentwisch because the German and Danish electricity grids are not synchronised. An upgraded control system in Berlin controls the entire system. With these technological additions to the design of the OWFs in place, the transmission system operators (TSOs), 50Hertz and Energinet, can physically connect the German and Danish grids.

As well as overcoming several technological challenges, the KF CGS has several advantages. First, Germany and Denmark have closely collaborated on energy issues before. For example, they implemented a cooperative RES subsidy scheme for photovoltaics based on statistical transfers between Germany and Denmark.[5] Second, at an early stage, the stakeholders were able to agree on a feasible technical setup which all parties view as operationally efficient and cost-competitive.



Third, the project clearly fulfils a pilot function, has PCI status and receives up to EUR 150 m in funding from the European Energy Programme for Recovery.[6] Fourth, the project received support from the national regulators in Germany and Denmark, giving the TSOs a clear mandate to collaborate and the opportunity to make anticipatory investments. Additionally, the market-to-market flows increase the level of security of supply in the Eastern Danish bidding zone. Together, these factors facilitate efficient project implementation.

Figure 2: Kriegers Flak Combined Grid Solution

Hybrid projects have several benefits. As well as offering significant potential for cost savings, they take up less space, thereby lowering environmental impact. In the North Seas, they also create cross-

[4] Energinet. 2018. KRIEGERS FLAK – COMBINED GRID SOLUTION. https://en.energinet.dk/Infrastructure-Projects/Projektliste/KriegersFlakCGS

[5] The Government of the Federal Republic of Germany and the Government of the Kingdom of Denmark. 2016. *Agreement on the Establishment of a Framework for the Partial Opening of National Support Schemes to Support the Generation of Energy from Solar Photovoltaic Projects.* https://www.bmwi.de/Redaktion/EN/Downloads/agreement-between-germany-and-denmark.pdf?__blob=publicationFile&v=4

[6] European Commission. 2013. *Fact sheet: Baltic-Kriegers Flak: Combined grid solution.* http://ec.europa.eu/energy/eepr/projects/files/offshore-wind-energy/baltic-kriegers-flak_en.pdf

border links, helping to provide additional interconnection capacity and underpinning the EU's internal energy market. The European offshore industry and job market benefit, too.

The use of hybrid projects to exploit the North Seas' wind-power potential also has political support. In 2016, countries in the North Seas region (Ireland, the United Kingdom, France, Belgium, the Netherlands, Luxembourg, Germany, Denmark, Norway and Sweden) signed the North Seas Energy Cooperation declaration. It aims to strengthen cooperation on energy and improve conditions for the development of offshore wind energy, ensuring a sustainable, secure and affordable energy supply in the region. As part of this, it encourages transmission system operators and offshore wind developers to become early movers in hybrid projects.

Such initiatives are helping hybrid projects to gain momentum. Although only one has been implemented so far – Kriegers Flak, which is nearing commissioning – more and more stakeholders in the North Seas region are now taking an interest and developing a better understanding of project economics and benefits. At the same time, progress in harmonising EU energy policies and regulation has changed perceptions of the challenges developers face in realising them. Additionally, the European Commission is placing an emphasis on cross-border infrastructure projects.[7]

However, hybrid projects are more challenging to develop than conventional offshore wind-power projects. For example, they pose significant legal and regulatory barriers. Bearing in mind their key role in the energy transition and decarbonisation, this means there is a clear need to assess their use in practice.

Against this backdrop, this study analyses potential hybrid projects featuring offshore transmission and generation assets which are currently at an early planning stage. It serves two purposes:

- To assess the costs and benefits of hybrid projects compared to conventional, separately developed offshore generation and transmission projects (reference cases); and
- To develop concrete Action Plans to overcome barriers to hybrid project development.

The study has the ambition to encourage developers to become early movers in hybrid project development and public authorities to commit to them. It also aims to help generate a pipeline of feasible hybrid projects that are beneficial compared to run than their respective reference cases. This represents a first step towards the long-term vision of an integrated offshore grid in the North Seas region (see Figure 3).

Collaboration with the PROMOTioN project

The "PROgress on Meshed HVDC Offshore Transmission Networks" (PROMOTioN) project[8] is exploring the long-term vision of a meshed offshore grid in the North Sea. It is funded by the EU Horizon 2020 programme on "Competitive Low-Carbon Energy". The project builds a bridge between research, validation and testing of technology, and the development of recommendations for meshed offshore grids. Specifically, its objectives regarding meshed offshore grids in the North Seas region are:

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[7] European Commission. 2018. *Factsheet: Connecting Europe Facility*. https://ec.europa.eu/energy/sites/ener/files/documents/cef_factsheet.pdf;

European Commission. 2017. *Communication on strengthening Europe's energy networks*. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52017DC0718&from=EN

[8] PROMOTioN. 2018. *PROMOTioN.* https://www.promotion-offshore.net/

- To identify the technical, financial and regulatory requirements for energy infrastructure priority corridors;
- To facilitate agreement among operators and manufacturers;
- To demonstrate cost-effective HVDC grid technologies;
- To prepare the first phase for the deployment of innovative components;
- To propose market rules and revenue streams; and
- To propose regulations for permitting and environmental compatibility.

The project was launched in 2016 and will be finalised at the end of 2019. Its consortium includes more than 30 partners from 11 countries and is organised in 15 work packages, for which interim results are available.

This study has engaged closely with the PROMOTioN project partners on various occasions. Although there is a thematic overlap, especially regarding PROMOTioN Work Package 7 on regulation and financing, the work of this study focuses on a practical path towards the shorter-term implementation of hybrid projects. The PROMOTioN project, however, focuses on the long-term implementation of a meshed offshore grid and the corresponding technological challenges. Nonetheless, the work of this study and the work of PROMOTioN are complementary.

The inclusion of new technologies, such as those investigated by PROMOTioN, in the hybrid projects presented in this study is feasible, especially considering their potential pilot character. The hybrid projects identified in this study can therefore serve as potential demonstration projects for the technology investigated by PROMOTioN. This comprises circuit breakers, gas-insulated switchgear, network protection systems and extended network control strategies. However, given the developmental status of the PROMOTioN technology, the risks associated with demonstrating the technology in a hybrid project should be shared on an equitable basis.

Figure 3: Collaboration with PROMOTioN project

The hybrid project ideas considered in this study are geographically located in four regional clusters (Figure 4): Irish Sea / North Channel, UK-Netherlands-Belgium (UK-NL-BE), Dogger Bank and German Bight.

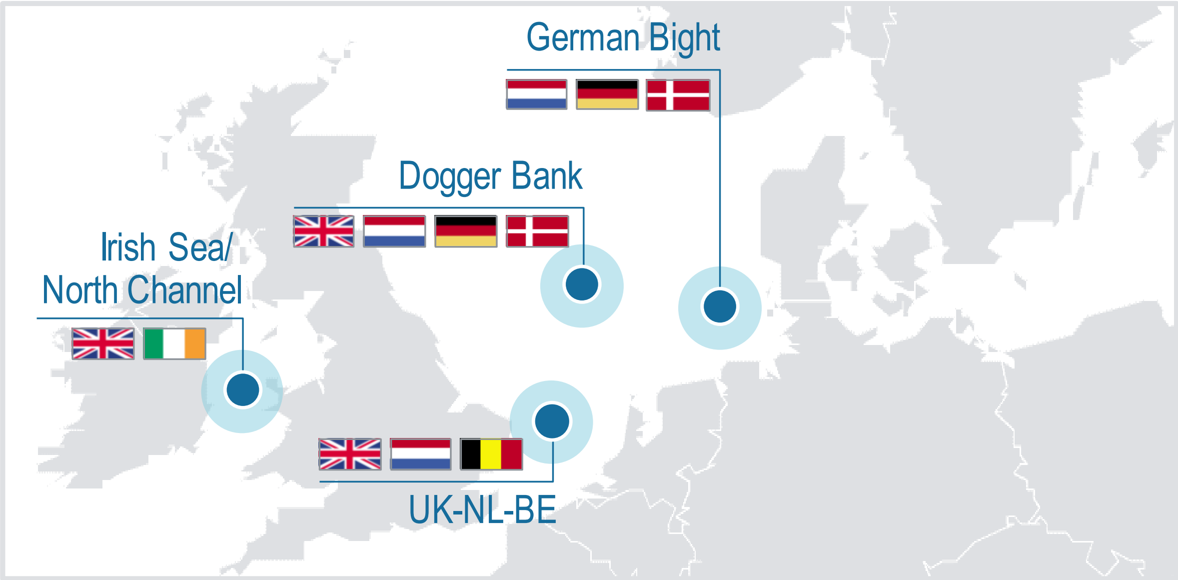

Figure 4: Hybrid project clusters

To summarise the findings, this study breaks down into five main chapters (Figure 5):

- Chapter 1 gives a general introduction to hybrid projects as well as to the context and the purpose of this study.
- Chapter 2 summarises the findings of the assessment of costs and benefits across the hybrid project ideas discussed. In total, 18 hybrid project ideas are identified, all based on an assessment of offshore generation and transmission assets which are due to be commissioned by 2030.[9] These are compared with their respective reference cases to deduce their potential advantages. All work was carried out in close collaboration with stakeholders. The chapter finds that coordinated, transnational development of generation and transmission projects creates potential for synergies.
- Chapter 3 summarises the findings on the barriers facing hybrid projects. The study identifies barriers to the commencement of project development in association with commercial and public stakeholders. The chapter finds that hybrid projects are subject to additional risks compared to their respective reference cases.
- Chapter 4 outlines case studies of ten hybrid project ideas. These compare the costs and socio-economic welfare (SEW)[10] benefits arising from the hybrid projects with their respective reference cases. They also outline project-specific Action Plans – developed with commercial and public stakeholders – that help to overcome the identified barriers in each hybrid project development. The Action Plans define required actions, responsibilities and timelines, and can be used once an individual hybrid project has been given the go-ahead. The chapter finds that concrete mitigation measures can address the additional risk involved in hybrid projects.

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[9] With the exception of the North Sea Wind Power Hub (NSWPH) with a planned commissioning post-2030 (ENTSO-E. 2018. *Project 335 – North Sea Wind Power Hub*. https://tyndp.entsoe.eu/tyndp2018/projects/projects/335).

[10] Socio-economic welfare (SEW) consists of producer surplus, consumer surplus and congestion rent.

- Chapter 5 is the appendix. It includes project-specific documentation about interaction with stakeholders on the assessment of barriers as well as the identification and selection of barrier mitigation measures.

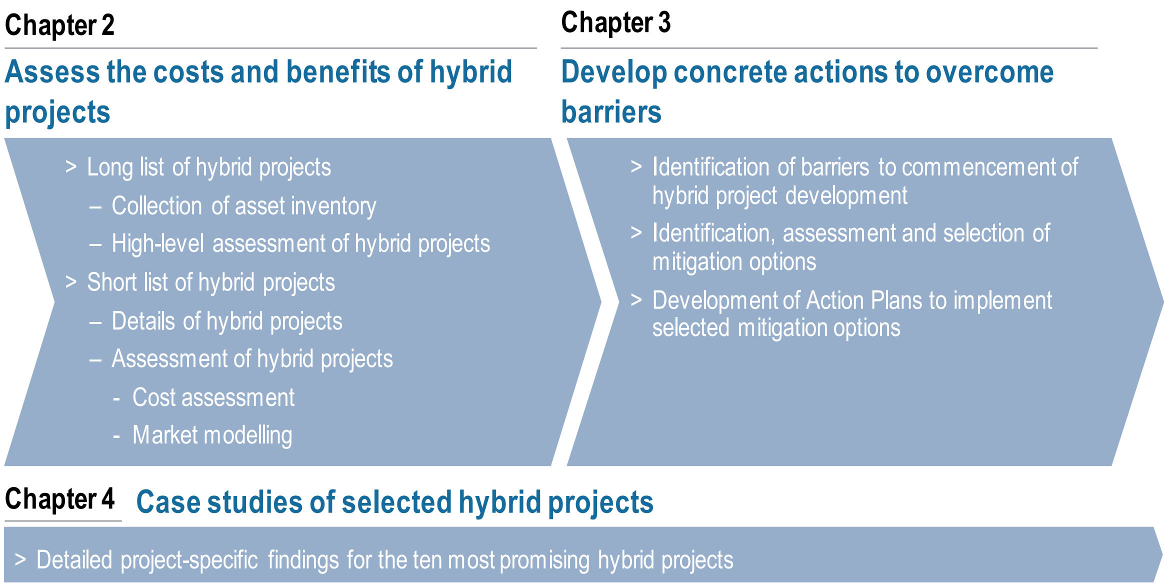

Figure 5: Study methodology

For the remainder of this document,

- **Hybrid projects** and hybrid project ideas always mean the combined development of offshore electricity generation and transmission assets across maritime borders.
- On the other hand, the respective **reference case** always means the conventional, separate development of generation and transmission assets connected to the same countries and with the same capacities as in the corresponding hybrid project.

For example, while an OWF may be connected to two markets via an interconnector in the hybrid project, the interconnector could be a stand-alone, point-to-point interconnector in the reference case.

2. Assessing the costs and benefits of hybrid projects

Key findings

- The study's assessment of costs and benefits shows that hybrid projects can have an advantage over conventional offshore projects. Of the ten hybrid projects assessed in detail, five have an advantage over their respective reference case, while five are at a comparative disadvantage.
- Significant savings can be realised over the project lifetime of advantageous hybrid projects compared to their respective reference case. Depending on project setup and size, these are in the range of EUR 300 m to EUR 2,500 m. This translates into savings of between 5% and 10% of total project costs.
- There are several further benefits. Hybrid projects allow for more efficient use of space in the already crowded North Seas region compared to the respective reference cases. This reduces environmental impact and ensures transmission and generation capacity has a significantly reduced footprint.
- Compared to the respective reference cases, hybrid projects support the development of the internal energy market by providing additional interconnection capacity. They also contribute to a more sustainable energy mix by offering additional OWF generation capacity. In addition, the projects stimulate the offshore industry's competitiveness by providing a platform for the development and implementation of new technologies.
- The assessment findings are only a starting point for the development of hybrid projects. Throughout the development process further action is required, for example, on detailed technical planning, preparation of the supply chain and analyses of electricity flows and operational feasibility.

2.1 Methodology

The assessment of the costs and benefits of hybrid projects involved two main activities, as shown in Figure 6. First, the study identified a long list of hybrid projects; second, it selected a short list of the most promising projects and evaluated these in detail.

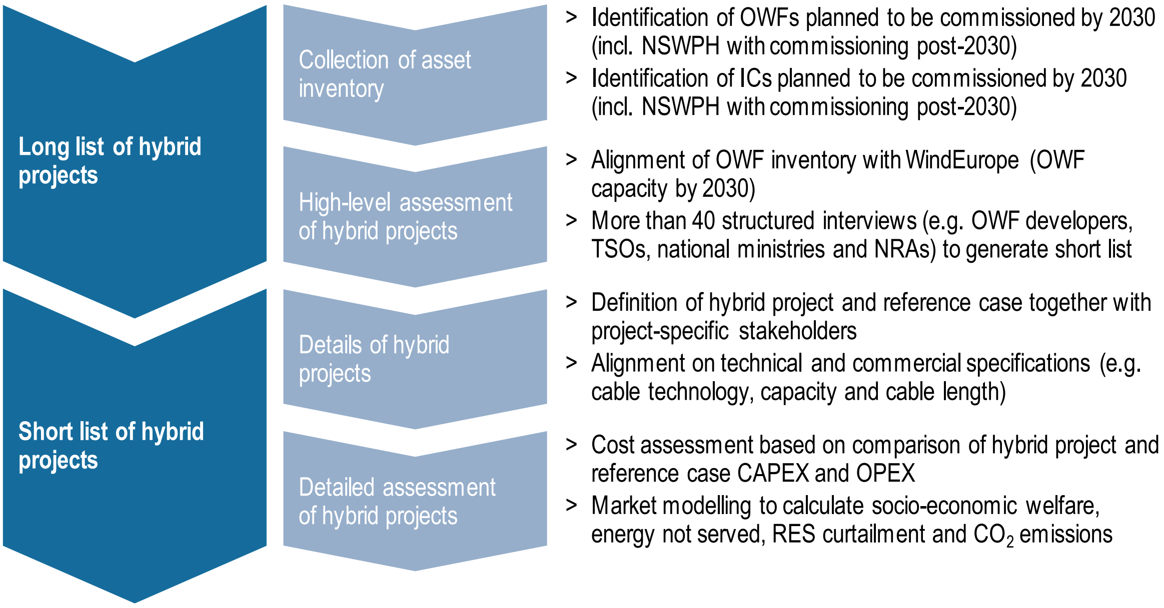

Figure 6: Methodology of demonstrating the advantage of hybrid projects

To draw up the long list of hybrid projects, the study created an inventory of OWFs and interconnectors. This considered all OWFs in the Irish, UK, Belgian, Dutch, German, Danish and Norwegian EEZs that are currently operational or due to be commissioned by 2030. It also considered all interconnectors which link any two of the above-mentioned countries and that are currently operational or due to be commissioned by 2030. Additionally, the study considered the possible generation and transmission infrastructure of the NSWPH, even though this hybrid project has a commissioning horizon beyond 2030. The inventory was aligned with WindEurope's central scenario forecast of installed OWF capacity by 2030.[11] A long list of 18 hybrid project ideas was identified from the inventory.

To select a short list of hybrid projects for further evaluation, the study conducted an initial feasibility check together with the stakeholder group. This was based on four dimensions:

- Technical feasibility ("Can the hybrid project be implemented from a technical perspective?");
- Cable development ("Is the cable system of the hybrid project already implemented or specified?");
- OWF alignment ("Are there early-stage OWFs near to the cable system development?"); and
- Stakeholder constellation ("Is the stakeholder group complex and are there sufficient incentives for stakeholder engagement?").

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[11] The OWF inventory was cross-referenced with WindEurope's forecast of installed OWF capacity by 2030 (WindEurope. 2017. *Wind energy in Europe: Scenarios for 2030.* https://windeurope.org/wp-content/uploads/files/about-wind/reports/Wind-energy-in-Europe-Scenarios-for-2030.pdf). The cross-check found no notable differences in estimated capacities for Ireland and Denmark, slight differences for the UK (~Δ400 MW), Belgium (~Δ280 MW) and the Netherlands (~Δ60 MW) and different expectations for the completion of an individual OWF before 2030 in Germany (~Δ865 MW). Overall, the assessments are aligned.

Hybrid project ideas were only taken forward if all four dimensions were assessed positively. After more than 40 interviews, meetings and a survey involving relevant stakeholders, the study selected a short list of ten hybrid project ideas for further evaluation.

Before evaluating the ten projects, the study looked in more detail at the technical and commercial specifications of the hybrid projects and their reference cases. This was done to enable a better comparison of them. Technical specifications included, for example, generation and transmission capacity, transmission technology, cable system length, required electrical equipment and capacity factors. Commercial specifications included, for example, capital expenditures (CAPEX), development period, construction period, operation / depreciation period, regulated revenues and operating expenses (OPEX).

The evaluation process of the short-listed hybrid projects consisted of two components: cost assessment and market modelling. Both were used to assess whether a hybrid project would deliver lifetime savings over the respective reference case. For the cost assessment component, the study calculated the CAPEX and OPEX of all assets included in the hybrid project and in the reference cases. CAPEX is assumed to be fully incurred with commissioning of the project and is therefore not discounted. OPEX is calculated and discounted over a typical asset lifetime of 25 years,[12] unless the project-specific stakeholders specified a different asset lifetime.

For the market modelling component, the study relied on the expertise of the Joint Research Centre of the European Commission. The modelling was based on the METIS model, which is used by the European Commission to inform evidence-based policy-making.[13] It allows for an hourly optimisation of the European power system, minimising the variable cost of generation while respecting technical and economic operating constraints.

The modelled scenarios feature a specific hybrid project and its reference case, using the same project details as the cost assessment. For each scenario the following indicators were calculated:

- Socio-economic welfare (EUR m p.a.). The socio-economic welfare for a given delivery point (i.e. a given country) is the sum of its consumer surplus, its producer surplus and half of the congestion rent for power transmission lines connected to the delivery point. A consumer surplus occurs when the consumer is willing to pay more for a given product than the current market price. The consumers' benefit equals the value of loss of load (VoLL), which is 15,000 EUR/MWh in the model. A producer surplus occurs when the producers is paid more for a given product than the minimum amount the producer is willing to accept in terms of cost of its production. The congestion rent is the benefit made when transferring energy from a zone to another, meaning the cost saved from using a production from another zone to meet local demand.
- Energy not served (MWh/a). Energy not served is the expected energy not delivered to market demand. The model assumes a value of loss of load of 15,000 EUR/MWh as penalty factor, which ensures that the model minimizes energy not served in the simulation.
- RES curtailment (MWh/a). RES curtailment is the expected energy not produced due to curtailment measured. RES curtailment is minimised in the model using a penalty factor equal to 0.5 EUR/MWh.

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[12] Ioannou, Anastasia, Andrew Anguas, Feargal Brennan. 2018. *A lifecycle techno-economic model of offshore wind energy for different entry and exit instances.* Applied Energy. https://doi.org/10.1016/j.apenergy.2018.03.143

[13] European Commission. 2018. *METIS – Modelling the European Energy System.* https://ec.europa.eu/energy/en/data-analysis/energy-modelling/metis

- CO2 emissions (kt/a). CO_2 emissions measure the variation of the system's emissions of CO_2. The economic value of the emissions is internalised in the producer surplus of the socio-economic welfare. The price of the emissions is consistent with the EUCO30 scenario at 27 EUR/t. To calculate the economic value of the emissions, the model places "coal before gas" in the merit order curve.

Variations in these indicators between the hybrid project and the reference case make it possible to identify the additional benefits related to the hybrid project. The model is based on the following key assumptions.

- The generation mix and demand in 2030 are based on the PRIMES EUCO30 2030 scenario implemented in METIS. It uses adapted capacities for offshore wind according to the inventory of OWFs compiled by this study for the identification of potential hybrid projects.
- The transmission system in 2030 is based on the ENTSO-E TYNDP 2018 and TYNDP 2016. It uses adapted figures for offshore interconnection capacity depending on the inventory of interconnectors compiled by this study for the identification of potential hybrid projects.
- The model represents each country as a single node in the electricity grid and therefore does not consider networks inside countries.
- The model uses a direct current approximation and therefore does not take into account transmission losses.
- The power exchanges between the defined zones are modelled using the Net Transfer Capacity approach.
- The model assumed a price of EUR 27 per ton of CO_2 in line with PRIMES EUCO30 2030, which is internalised in the operating cost of generators.

A detailed explanation of the model, the underlying assumptions and the modelling results are given in Careri, Francesco. [Forthcoming]. *The impact of North Sea electricity projects in a 2030 scenario: Preliminary assessment of system benefits for the pan-European power system through METIS.* Petten: European Commission Joint Research Centre.

2.2 Findings

The study provides a detailed assessment of ten hybrid projects across four regions (Figure 7). The assessment considers the differences between hybrid projects and respective reference cases with regards to CAPEX, OPEX and socio-economic welfare (SEW) over a 25-year operational period. It finds that four hybrid projects have a significant advantage over their respective reference cases. A significant advantage means that lifetime savings are in excess of 5% of the total lifetime costs of the respective reference case. Total lifetime costs consist of CAPEX and OPEX over a typical 25-year operation period. The four advantageous hybrid projects are geographically located in the UK-NL-BE, German Bight and (close to) the Dogger Bank area of the North Seas region. They are:

- IJmuiden Ver to UK: A Dutch OWF in the IJmuiden Ver area is linked to the UK electricity market via an interconnector and to the Dutch electricity market via an export cable system.
- CGS IJmuiden Ver to Norfolk: The UK and Dutch electricity markets are linked by an interconnector between a UK OWF in the Norfolk area and a Dutch OWF in the IJmuiden Ver area. Both OWFs have radial connections to their home markets.
- North Sea Wind Power Hub (NSWPH): OWFs in the Dutch, German and Danish EEZs are connected to the Dutch, German and Western Danish electricity markets via a hub. The hub

features cable connections to the Netherlands, Germany and Denmark which can function as export cable systems and as interconnectors.

- COBRA Cable: The so-called leftover OWF areas in the German Cluster 8 are connected to the Dutch and Western Danish electricity markets via the COBRA Cable interconnector.

Two further hybrid projects demonstrate a moderate advantage over their respective reference cases, where a moderate advantage means lifetime savings of up to 5% of the total lifetime costs of the respective reference case. The two hybrid projects are geographically located in the UK-NL-BE and German Bight area of the North Seas region. They are:

- NeuConnect: The OWFs in the German Cluster 1 (OWP West, Borkum Riffgrund West 1 and Borkum Riffgrund West 2) are linked to the UK and German electricity markets via the NeuConnect interconnector.[14]
- DE OWF to NL: A German OWF is radially connected to the Netherlands only.

The remaining four hybrid projects are at a disadvantage compared to their respective reference cases. This means that implementation of these hybrid projects would lead to additional lifetime costs compared to the respective reference cases. These hybrid projects are geographically located in the Irish Sea / North Channel, UK-NL-BE and German Bight area of the North Seas region. They are:

- Project Irish Sea: An Irish OWF is combined with an interconnector from Ireland to the UK. Both the OWF and the interconnector are linked to the same onshore converter station in Ireland.
- Nautilus: A Belgian OWF is connected to the UK and Belgian electricity markets via the Nautilus interconnector.
- UK OWF connected to BE: A UK OWF is connected to the Belgian electricity market only.
- CGS DE OWF to NL OWF: A Dutch OWF in the extreme eastern part of the Dutch EEZ and a German OWF in the extreme western part of the German EEZ are linked via an interconnector. Both OWFs have radial connections to their home markets.

[14] NeuConnect is not further considered in this study with regard to the assessment of barriers and the development of barrier mitigations as project stakeholders are not sufficiently incentivised to engage in the hybrid project development due to the advanced planning stages of the conventional, separate assets.

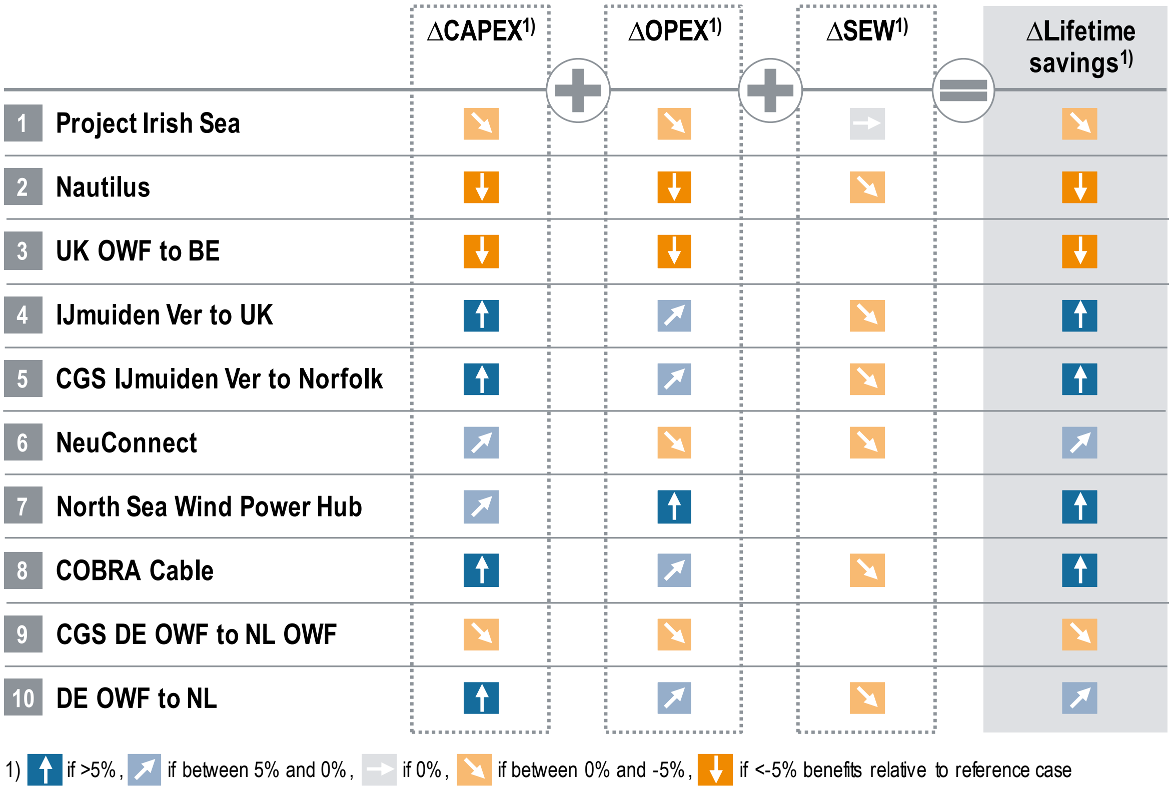

Figure 7: Overview of assessment of costs and benefits across hybrid project ideas

In summary, the assessments of the ten projects considered in detail show that each is unique and needs to be considered on a case-by-case basis. Whether a hybrid project has an advantage over the respective reference case depends on the individual project setup, such as its geographical location or technical layout. Chapters 2.2.1 to 2.2.3 seek to summarise the findings that can serve as instructive starting points for the selection of hybrid project ideas in the future. However, they should not be adopted without thorough individual assessment.

2.2.1 Significant savings over the project lifetime

Based on the sample of ten hybrid project ideas considered in this study, lifetime savings of between 5% and 10% are possible – or EUR 300 m to EUR 2.5 bn in absolute numbers (Figure 8). This is based on a comparison between the implementation and operation of a hybrid project and the implementation and operation of the respective reference case. Cost savings are realised differently for each hybrid project depending on its setup, but can be summarised on the basis of four drivers:

- Reducing kilometres of export cable system. This involves shortening the distance from an OWF to the connection point, either by connecting the OWF to a closer shore than in the reference case, or to an interconnector. Shorter export cable systems reduce the CAPEX and OPEX of an installation.
- Reducing kilometres of interconnector cable. This is achieved by linking OWFs or by connecting an OWF to an additional market via an interconnector instead of having a shore-to-shore interconnector. Fewer kilometres of cable reduce the CAPEX and OPEX of an installation.
- Reducing the number of onshore and offshore substations. This is done by combining OWF export cable systems and interconnectors, which both increases utilisation and decreases the

number of substations. Fewer onshore and offshore substations reduce the CAPEX and OPEX of an installation.

- Realising less expensive operations and maintenance services for offshore installations. This involves creating an offshore hub in close proximity to offshore installations to, for example, accommodate personnel or store spare parts. Less expensive operations and maintenance services reduce the OPEX of an installation.

The SEW is consistently positive for hybrid projects, but also consistently slightly lower than the SEW of the respective reference cases. Thus, while the hybrid project ideas have a positive SEW, their contribution is lower than that of the respective reference cases. This is because hybrid projects utilise cable systems for more than one purpose. For example, in an interconnector tie-in concept (the connection of an OWF to shore via an interconnector), the capacity of the cable system between the countries is used both for market-to-market flows and to send electricity from the OWF to shore. In the market model employed by this study, this concept either results in reduced interconnection capacity or reduced electricity generated in the hybrid OWF due to required curtailment when compared to the reference case, and therefore in lower SEW. However, the market modelling shows that the difference between hybrid project SEW and reference case SEW is consistently small. When extrapolated for a typical 25-year lifetime, the cost savings exceed the difference in SEW by more than a factor of ten.

Due to the increased implementation probability of generation and transmission capacities in real hybrid projects due to increased cost-efficiency, the SEW of hybrid projects can be higher than the SEW of the respective reference case if either generation or transmission capacity is not implemented at full scale in the reference case.

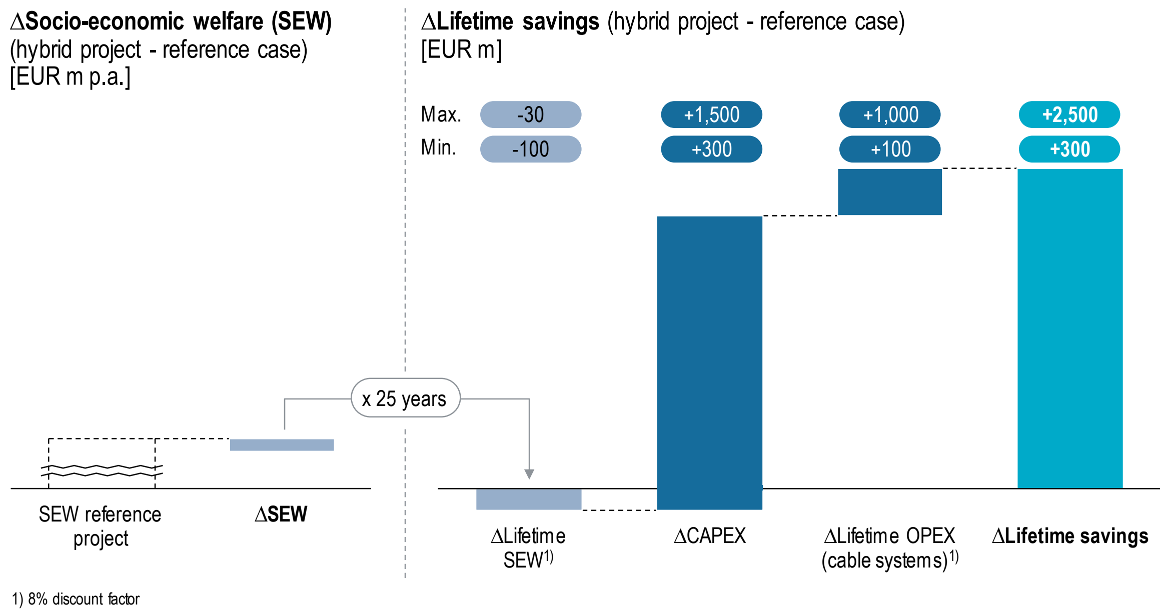

Figure 8: Significant lifetime savings on hybrid projects[15]

[15] SEW assessment based on Careri, Francesco. [Forthcoming]. *The impact of North Sea electricity projects in a 2030 scenario: Preliminary assessment of system benefits for the pan-European power system through METIS.* Petten: European Commission Joint Research Centre.

The main factors that determine whether a hybrid project yields savings compared to its respective reference case are summarised below:

- Interconnector tie-in concepts: Cost savings are realised if an OWF, connected to shore via an interconnector, is located more than 50 kilometres from shore and the conventional setup employs HVDC technology to send electricity to shore. OWFs that are less than 50 kilometres from shore are usually connected to land using HVAC technology, which does not include an offshore converter station – in contrast to an HVDC system – and is therefore less expensive. If cost savings are realised, the larger investment in HVDC technology is offset by lower power losses in the cable system.[16]
- Combined grid solution concepts: Cost savings are realised in a similar way to interconnector tie-in concepts. Significant savings are generated if OWFs connected by an offshore interconnector are located more than 50 kilometres from shore and the conventional setup employs HVDC technology to send electricity to shore. For OWFs located less than 50 kilometres offshore employing HVAC technology, the cost of upgrading to HVDC technology makes no economic sense. So, combined grid solution concepts are likely to generate significant cost savings only where OWFs are located further than 50 kilometres from any shore.
- Neighbour OWF concepts: Cost savings can only be realised via cable savings, meaning the hybrid project must include a connection to a closer onshore connection point than in the reference case. In addition, the avoidance of onshore grid reinforcement can be advantageous, depending on the specific project setup.
- Offshore hub concepts: Cost savings are realised through multiple factors. First, savings are realised by reducing the CAPEX of substations. These can be placed on the hub, removing the need for their own offshore foundations. Second, the space available on an offshore hub allow for larger substations with cheaper designs. Third, offshore hubs allow for the cost-effective maintenance of equipment, accommodation of staff and provision of port and helicopter infrastructure, decreasing OPEX. However, OPEX savings also depend on the distance between an offshore hub and the closest market from where maintenance can be provided. The combined CAPEX and OPEX savings must outweigh the additional cost of building an offshore hub. Other factors can also drive down costs or provide additional revenues. Examples include providing power-to-gas services, providing a basis for training and research activities and offering touristic activities.
- Modular grid concept: This study did not find any modular grid concept-based hybrid project idea which merited inclusion in the detailed assessment. It is therefore not possible to determine whether such a project yields savings or not.

2.2.2 Reduced need for space and environmental impact

Improved transnational coordination is necessary in the North Seas due to the limited space. The area is heavily used for oil and gas, maritime transport and fishing, for example (Figure 9). In addition, there are extensive environmentally protected zones in the region, known as Natura 2000. For

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[16] According to ABB (*Why HVDC: Economic and environmental Advantages.* https://new.abb.com/systems/hvdc/why-hvdc/economic-and-environmental-advantages) the break-even distance for the offshore deployment of HVDC over HVAC technology typically is about 50 km. However, since the break-even distance depends on multiple factors, an analysis must be performed for each individual case.

example, about 30% of the German EEZ is defined as a Natura 2000 area.[17] However, the development of OWFs in or adjacent to Natura 2000 areas is not a priori excluded, as set out in the European Commission's guidance document "Wind energy developments and Natura 2000"[18]. It draws on the EU'S Birds and Habitats Directives[19], which established the organised network of Natura 2000 areas to protect nature and wildlife. That said, the use of such sites for OWF development is either very cost-intensive, due to the need for thorough environmental impact assessments, or simply not envisaged. Many Member States choose to assert that designated Natura 2000 areas are, by definition, "no-go areas" for the development of OWFs.[20]

The Wadden Sea accounts for the largest share of the Natura 2000 area in both the Netherlands and Germany. With a surface area of about 10,000 km^2, the area is directly off the coastline of the two countries. As a result, many cable systems must cross the Wadden Sea Natura 2000 area. To deal with this situation, Germany's Wadden Sea Plan[21] confines such cable systems to a restricted number of corridors that have the least impact on the environment. Indeed, the plan states the requirement "to concentrate cable crossings through the Wadden Sea within a minimum of cable corridors and a minimum of cables, using the best available techniques, e.g. cables with the highest capacity available".

Against this backdrop, hybrid projects help to reduce the space required for offshore power generation and transmission developments. They use fewer substations and fewer or shorter cables to achieve the same generation and transmission capacity. In addition, their reduced need for offshore space compared to their respective reference cases results in a lower environmental impact. Thus, hybrid projects facilitate environmental preservation, while integrating more OWF generation capacity in the energy mix.

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[17] Federal Agency for Nature Conservation. 2014. *Marine Natura 2000 sites in the German North Sea and Baltic Sea.* https://www.bfn.de/en/service/facts-and-figures/nature-conservation/nature-conservation-areas/marine-natura-2000-areas-in-the-north-sea-and-baltic-sea.html

[18] European Commission. 2011. *Wind energy developments and Natura 2000.* http://ec.europa.eu/environment/nature/natura2000/management/docs/Wind_farms.pdf

[19] European Commission. 2015. *The Birds and Habitats Directives*. https://publications.europa.eu/en/publication-detail/-/publication/7230759d-f136-44ae-9715-1eacc26a11af

[20] WindEurope. 2017. *Offshore wind energy in the North Sea: Industry recommendations for the North Seas Energy Forum.* https://windeurope.org/wp-content/uploads/files/policy/position-papers/WindEurope-Offshore-wind-energy-in-the-north-sea.pdf

[21] Common Wadden Sea Secretariat. 2010. *Wadden Sea Plan 2010.* http://www.waddensea-secretariat.org/sites/default/files/downloads/wsp-v2-11-02-03-final-lowres.pdf

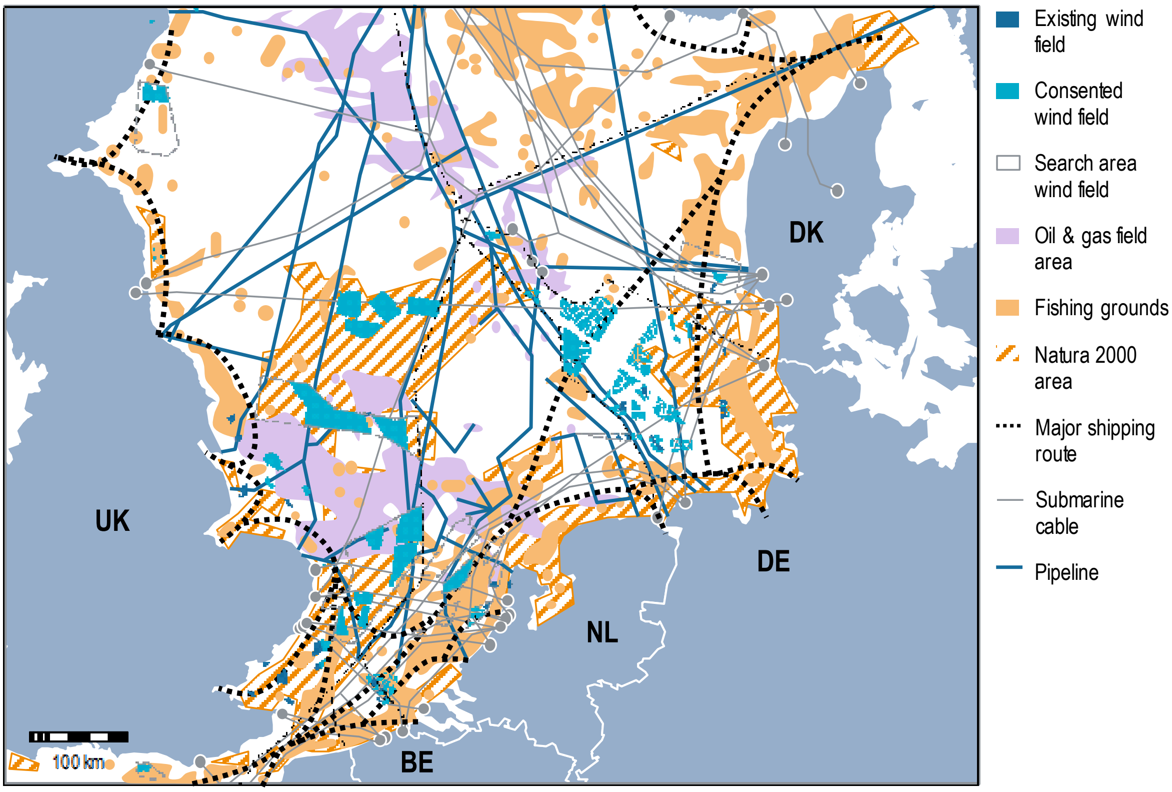

Figure 9: Diagram of the use of offshore space in the North Seas region[22]

2.2.3 Other benefits for society

As well as providing significant savings over the project lifetime, reducing the need for space and easing environmental impact, hybrid projects yield further benefits for society. For example, they support the development of the EU internal energy market through additional interconnection capacity, contribute to a more sustainable energy mix by integrating additional OWF generation capacity and foster the competitiveness of the offshore industry by providing a platform for the development and implementation of new technologies.

Hybrid projects thus contribute to achieving the EU's energy policy targets. The EU has agreed to build an Energy Union and to jointly achieve a set of targets relating to energy and climate policy. Among the goals are an interconnection target of 15% by 2030, an energy efficiency target of 27% by 2030,[23] a CO_2 emissions reduction target of 40% by 2030 and an innovation target to maintain EU

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[22] 4COffshore. 2018. *4COffshore.* https://www.4coffshore.com/offshorewind/;
Submarinecablemap. 2018. *Submarinecablemap.* https://www.submarinecablemap.com/#/;
Globalfishingwatch. 2018. *Globalfishingwatch.* http://globalfishingwatch.org/map/;
Natura2000. 2018. *Natura2000*. http://natura2000.eea.europa.eu/
Offshore Magazine. 2013. *North Sea Offshore Oil & Gas Map*. https://www.offshore-mag.com/content/dam/offshore/print-articles/Volume%2073/08/NorthSeaMap2013-071713Ads.pdf;
Shipmap. 2018. *Shipmap.* https://www.shipmap.org/.

[23] A non-binding energy efficiency target of 32.5% by 2030 was agreed in the Clean Energy Package negotiations.

leadership in renewable energy technology.[24] While the energy efficiency is not affected by hybrid project development, the other three targets are affected. The size of a given hybrid project's effect on these targets needs to be assessed individually.

- In hybrid projects, interconnectors can be established at marginal cost. In essence, part of the development and construction cost for a new interconnector is saved by utilising existing cable infrastructure to transmit electricity from OWFs to shore. Hybrid projects therefore have the potential to catalyse the development of interconnection capacity and contribute to the development of the EU internal energy market via the 2030 interconnection target.
- As hybrid projects reduce the cost and space requirements of OWF developments, they play a part in exploiting the full wind potential of the North Seas region, including farther offshore. Hybrid projects can thus contribute to a more sustainable energy mix by offering additional OWF generation capacity, helping to reach the 2030 CO_2 emissions reduction target.
- Lastly, hybrid projects enable the integration of innovative technology. New concepts such as offshore power-to-gas are gaining momentum, and hybrid setups such as offshore hub concepts could provide the space needed to integrate conversion technology. However, power-to-gas conversion can also take place onshore. The idea behind power-to-gas is to convert renewable energy to hydrogen for transmission or storage during periods of oversupply. Such sector coupling initiatives represent a first step towards more integrated energy systems in the European Union, with many benefits. For example, the NSWPH could transmit offshore power to shore by using power-to-gas infrastructure, optimising costs through the utilisation of existing pipeline systems for transportation. That would limit investments and avoid "not in my back-yard" issues of new electricity transmission infrastructure. Furthermore, the conversion of electricity to gas can contribute to overcoming onshore grid congestion issues, as this kind of coupling provides additional flexibility in storage and transport. In addition, gas would facilitate more integrated uses of energy in other sectors. Initial hydrogen applications in the transport sector include fuel cells installed in cars, buses, trains and ferries[25], while research is being undertaken in heating applications as well.[26] In industry applications, hydrogen has already been used extensively.[27] Linking the power sector (especially electricity from renewables) to other energy sectors – namely energy in buildings, transport and industry – thus creates a more flexible, efficient and environmentally friendly energy system.[28] Hydrogen could also be used as raw material for other products, i.e. power-to-X, where X represents refined products such as methanol, dimethoxyethane or ammonia for use as a fertilizer. Beyond the combination of offshore power generation and power-to-gas, hybrid projects can also contribute to the advancement of conventional offshore technology, such as larger-scale HVDC converter stations, large-scale DC breakers and multi-terminal interconnector technology. In this way, hybrid projects have the potential to provide a platform to catalyse the development and implementation of innovative technology. In summary, hybrid projects contribute to the EU's aim of maintaining its leadership in renewable energy technology.

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[24] European Commission. 2018. *2030 Energy Strategy.* https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2030-energy-strategy

[25] Hydrogen Europe. 2018. *Hydrogen Uses.* https://hydrogeneurope.eu/hydrogen-uses

[26] Dodds, Paul E. et al. 2015. *Hydrogen and fuel cell technologies for heating: A review.* London: University College London, Imperial College London

[27] Hydrogen Europe. 2018. *Hydrogen Uses.* https://hydrogeneurope.eu/hydrogen-uses

[28] WindEurope. 2018. *Breaking new ground.* https://windeurope.org/wp-content/uploads/files/about-wind/reports/WindEurope-breaking-new-ground.pdf

3. Overcoming barriers to hybrid projects

Key findings

- While barriers to the commencement of hybrid project development exist, all can be overcome. They need to be addressed to provide certainty to developers.
- Most barrier mitigation measures need to be implemented by project-specific stakeholders. These include OWF developers, transmission system operators (TSOs), national ministries, national regulatory authorities (NRAs) and other authorities.
- Some barriers necessitate the involvement of the European Commission. This may be because exemptions from European regulations are required, European regulations need to be amended, or because national laws need to be made compliant with European law. Thus, the actions required to implement mitigation measures should become part of the North Seas Energy Cooperation plan, which facilitates hybrid project development.
- As the level of coordination required to implement hybrid projects grows, so do the number of relevant barriers and mitigation measures. For example, if an OWF in a hybrid project sends electricity to markets other than its home market, the barriers relating to market arrangement and RES subsidy schemes need to be considered.
- Different levels of formalisation are required to implement measures to mitigate barriers. Some mitigation measures can be implemented based on voluntary cooperation between project developers. Others, such as defining who is responsible for grid connection and the interconnector, require a project-specific Memorandum of Understanding (MoU), or even a project-specific Hybrid Asset Network Support Agreement (HANSA). Generally, all barriers that can be mitigated through voluntary cooperation should be handled accordingly. Project-specific MoUs and HANSAs should only be deployed where they are absolutely necessary, as the process is more complex and lengthy.
- Power conversion to gas and gas transmission are increasingly seen as complementary to renewable energy sources. However, the combination creates new barriers to project development. For example, there is uncertainty about a legislative regime for power-to-gas and related infrastructure for hydrogen. No dedicated legislative framework exists at the national or European level to regulate power conversion to hydrogen and / or hydrogen transmission. Creating such a framework would pave the way towards more integrated energy systems by coupling energy sectors (power, building, transport, industry).

Legal, regulatory and other barriers hinder the development of hybrid projects. The study seeks to identify these barriers and develop mitigation measures and Action Plans for the five most advantageous hybrid projects. In each case, work focuses on project-specific barriers, and was carried out with the help of relevant project stakeholders. The methodology behind and results of this work are presented in the subchapters below.

3.1 Methodology

The methodology for developing measures to overcome barriers to hybrid projects consists of three main strands (Figure 10). First, the study worked with stakeholders to identify barriers. Second, it devised mitigation options for the identified barriers. Third, this study developed Action Plans to implement the devised mitigation measures and thereby overcome the identified barriers. These plans are intended to be a tool for stakeholders to be used once a given hybrid project has been given the go-ahead.

To begin with, a comprehensive list of barriers hindering the initiation or progress of hybrid project development was drawn up. To identify barriers, stakeholder interaction was crucial. Although primary and secondary research into publicly available documents[29] was conducted, the process of sharing, discussing and revising the list of the most relevant barriers with different stakeholders was an essential part of the research. The stakeholders included OWF developers, transmission system operators (TSOs), national ministries and national regulatory authorities (NRAs). While emphasis was placed on legal and regulatory barriers, this study also included barriers linked to planning procedures, business cases, financing as well as European and national political support.

The study evaluated the most relevant barriers to the five most advantageous hybrid projects. Since each project has a different technical and geographical setup, not all of the barriers identified are relevant to every project. A barrier was deemed to be relevant in cases where, if left unaddressed, it would prevent project development due to its commercial risk. If the commercial risk of a given project becomes too large, project developers have no incentive to drive the project towards implementation.

The most feasible mitigation measures were devised, assessed and selected through continuous interaction with project stakeholders. Based on these selections, Action Plans were developed. These map required implementation activities for all relevant stakeholders. The identified mitigation measures and Action Plans can contribute to the long-term target of harmonising the legal and regulatory framework for hybrid projects in the North Seas region, where this is found to be reasonable (beyond the scope of this study).

As part of the work on barrier mitigation, in addition to voluntary cooperation, a project-specific Memorandum of Understanding (MoU) or a project-specific Hybrid Asset Network Support Agreement (HANSA) were considered. These formal commitments to address barriers include all actions for project-specific mitigation measures. Only one of the two is required for each hybrid project.

- A project-specific MoU formalises the goodwill of the parties involved in the form of a non-binding agreement. An MoU addresses barriers by formalising the agreements of the parties involved with regard to the implementation of required actions to overcome barriers.
- A project-specific HANSA represents a possible shorter-term option to overcome the identified barriers on a project-specific basis and in a legally binding form, thereby allowing project development to start. Network Support Agreements (without the hybrid dimension) are an existing tool used by countries to formalise their commitment to support the development and operation of (electricity) networks. In the past, for example, such agreements have been used to overcome barriers in the development of cross-border gas infrastructure.[30] These agreements represent a legally binding commitment to adapt national legislation and regulation in the future, and thus provide legal certainty to developers. European legislation and regulation can only be adapted in

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[29] The study relied on two databases for general reference, namely the Legal Guide to offshore wind in Northern Europe, provided by CMS, and RES Legal, provided by the European Commission. Secondary research considered, in particular, Hannah Katharina Müller's dissertation (2015. *A legal framework for a transnational offshore grid in the North Sea*, Groningen: University of Groningen.), the PwC, Tractebel Engineering and ECOFYS study for the European Commission (2016. *Study on regulatory matters concerning the development of the North Sea offshore energy potential*. Brussels: European Commission.) and the PROMOTioN project (2018. *Progress on Meshed HVDC Offshore Transmission Networks.* Brussels: European Commission).
[30] For example: Landesbergamt in Clausthal-Zellerfeld, Petroleum Safety Authority Norway. 2004. *Memorandum of Understanding related to the Europipe and Europipe II natural gas pipelines.* Landesbergamt in Clausthal-Zellerfeld, Petroleum Safety Authority Norway. 2004. *Memorandum of Understanding related to the Norpipe pipeline from Ekofisk to Emden.*

consequence of a Network Support Agreement if all Member States of the European Union sign it.

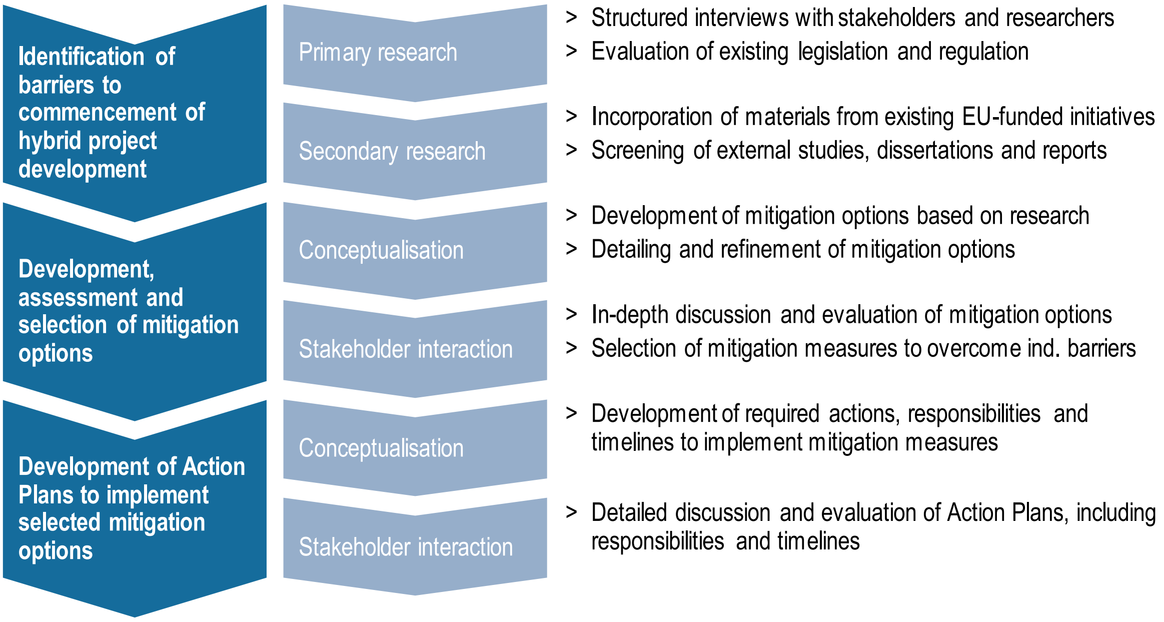

Figure 10: Methodology for overcoming barriers to hybrid projects

3.2 Findings

The study identifies a total of sixteen tangible barriers that are potentially relevant for the implementation of hybrid projects. An overview of the sixteen barriers, mapped onto five hybrid projects, is shown in Figure 11. While mitigation measures to address these barriers are necessary, stakeholders agree that none would render hybrid project development entirely unfeasible as all are surmountable in the foreseeable future. This study presents the most recent efforts towards developing and preparing the implementation of mitigation measures for the identified barriers.

To address the barriers identified, a concerted effort is needed from OWF developers, transmission system operators (TSO) and public stakeholders, such as national governments, national regulators and EU institutions.

- To help pave the way for the efforts of EU institutions, a consolidated Action Plan concerning all barriers requiring the involvement of the European Commission is included at the end of this chapter. This is intended to be used as a tool to help the European Commission work towards overcoming identified barriers.
- To prepare all other parties, including OWF developers, TSOs, national ministries and NRAs, barriers to the five most advantageous hybrid projects are discussed in detail in Chapter 4 of this study.

The detailed findings of interaction with stakeholders regarding the development, assessment and selection of project-specific mitigation options is documented in Chapter 5, in the Appendix to this study. The documentation is structured around the hybrid project ideas that were examined in detail.

	IJmuiden Ver to UK	CGS NL to UK	NSWPH	COBRA Cable	DE OWF to NL
1. Uncertainty about responsibility for project development	■	■	■	■	■
2. Uncertainty about regulation deriving from jurisdiction over cross-border cable systems	■	■	■	■	■
3. Uncertainty about market arrangements	■	■	■	■	■
4. Uncertainty about hybrid cable system classification	■	■	■	■	□
5. Failure of developers to align planning across assets and countries	■	■	■	■	■
6. Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution)	□	□	□	■	■
7. Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)	■	■	■	■	■
8. Discrepancies in responsibilities and requirements for balancing[1)]	□	□	□	□	□
9. Discrepancies in priority dispatch regulation[1)]	□	□	□	□	□
10. Discrepancies in curtailment regulation and compensation[1)]	□	□	□	□	□
11. Lack of regulated revenues for anticipatory investments	■	■	■	□	□
12. Uncertainty about the applicable RES subsidy scheme	■	■	■	■	■
13. Limited engagement of public stakeholders	■	■	■	■	■
14. Uncertainty regarding the UK market	■	■	□	□	□
15. Disproportionate allocation of costs and benefits across involved stakeholders	■	■	■	■	■
16. Uncertainty about legislative regime for power-to-gas and related infrastructure	□	□	■	□	□

■ Relevant barrier for project □ No relevant barrier/relevance uncertain for project 1) Part of CEP negotiations, mitigation to be developed based on CEP results (if required)

Figure 11: Overview of identified barriers mapped onto hybrid projects

Chapters 3.2.1 through 3.2.16 provide a general explanation of the sixteen barriers to hybrid projects. The case studies in Chapters 4.1 through 4.10 present the project-specific evaluation of these barriers, the mitigation measures and the required actions for the five most advantageous hybrid projects.

3.2.1 Uncertainty about responsibility for project development

To develop hybrid projects, the parties responsible for the development and construction as well as operation of the relevant cable systems need to form a group to promote the idea. This breaks down into two subgroups: responsibility for grid connection and responsibility for the interconnector. Both areas are discussed below.

Responsibility for grid connection refers to the obligation to provide a grid connection for an OWF. While an OWF developer can meet the responsibility, usually a national TSO[31] does. Additionally,

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[31] Within the scope of the countries in focus, responsibility for grid connection is organized differently in the UK and in Ireland. Under the UK OFTO regime, an OFTO or an OWF developer can develop and construct the grid connection (UK Electricity Act 2004. Section 6C (1). https://www.legislation.gov.uk/ukpga/2004/20/section/92), but only the OFTO can operate the grid connection due to the European unbundling regulation for electricity grids (European Commission. 2009. *DIRECTIVE 2009/72/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL concerning common rules for the internal market in electricity.* Article 9. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0072&from=EN). Thus, in the case of offshore grid development and construction by the OWF developer (which has so far exclusively been the case in the UK), the constructed asset must be transferred to the OFTO at commissioning. In Ireland, the OWF developer is responsible for the development of the onshore grid connection. While Irish onshore grid connections also underlie the European unbundling regulation for electricity grids, there is no process in place for the transfer of the asset at commissioning (SSE Generation

both the scope of responsibility for grid connection and the distribution of connection charges can differ:

- If the OWF developer is responsible for establishing the grid connection of an OWF, the export cable system needs to be sold to a third party before commissioning. This is due to the EU's unbundling regulation.[32] This model is found in the UK (with the OFTO regime) and in Ireland.[33]
- If a TSO is responsible for developing an OWF's grid connection, the TSO develops, commissions and operates the asset. This model is applied in Belgium, the Netherlands, Germany and Denmark.[34]
- Generators such as OWFs must pay certain charges for a connection to national electricity grids. These charges consist of first connection charges and generation charges (G-charges).
  - First connection charges are a one-off payment, applied to all generators and used to fund required grid expansions or reinforcements. In the context of OWFs, an export cable system can be built in the range between a super shallow and a deep approach. This means there are different models for the distribution of first connection charges between power producers and power consumers. In the super shallow approach, the costs of all assets required for the grid connection of the OWF (including the offshore transformer station) are socialised via transmission tariffs, so the OWF developer pays no charges. In a shallow approach, the OWF developer pays for the entire infrastructure to connect the OWF to the national transmission system (including offshore substations, cables and other necessary equipment). In a deep approach, the OWF developer pays for all costs of the shallow approach plus those for other reinforcements and extensions of the existing national transmission system that are necessary for its grid connection. Of the countries in this study, Ireland, the UK, Belgium and the Netherlands follow a shallow approach, but first connection charges can differ nevertheless.

Ireland Ltd. 2018. *Offshore Wind Energy Revolution 'at Risk'*. http://ireland.sse.com/news-and-views/all-articles/2018/6/offshore-wind-revolution-at-risk/).

[32] European Commission. 2009. *DIRECTIVE 2009/72/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL concerning common rules for the internal market in electricity.* Article 9. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0072&from=EN

[33] UK Electricity Act 2004. Section 6C (1). https://www.legislation.gov.uk/ukpga/2004/20/section/92
Ofgem. 2013. *The Electricity (Competitive Tenders for Offshore Transmission Licenses) Regulations 2013.* https://www.ofgem.gov.uk/ofgem-publications/51634/letter-electricity-competitive-tenders-offshore-transmission-licences-regulations-2013-pdf
Ireland's only operational OWF is Arklow Bank, which is developed as a demonstrator project (SSE Generation Ireland Ltd. 2018. *Arklow Bank Wind Park*. http://ireland.sse.com/what-we-do/our-projects-and-assets/renewable/arklow-bank-wind-park/). Future Irish OWFs will have to adhere to EU unbundling rules.

[34] Dutch Elektriciteitswet 1998. §4 Article 24Aa. https://wetten.overheid.nl/BWBR0009755/2018-07-28#Hoofdstuk3_Paragraaf4_Artikel24Aa
German Erneuerbare-Energien-Gesetz 2017 (EEG 2017). § 8. https://www.gesetze-im-internet.de/eeg_2014/__8.html
German Energiewirtschaftsgesetz (EnWG). § 17b. http://www.gesetze-im-internet.de/enwg_2005/__17b.html
Danish Bekendtgørelse om nettilslutning af vindmøller og pristillæg for vindmølleproduceret elektricitet m.v. Chapter 1 § 2.
https://www.retsinformation.dk/Forms/R0710.aspx?id=188845#id27a00582-d6fa-44ff-ba6f-ebb7689685fd

Germany and Denmark follow a super shallow to (partially) shallow approach. First connection charges can still differ, however.[35]

– G-charges are payments for the utilisation of a grid connection by a generator. They finance the operation of the cable system. G-charges exist in the form of energy-based charges and power-based charges. In the case of energy-based G-charges, producers are charged for every unit of energy produced (i.e. MWh). This approach exists in Belgium and Denmark. With power-based G-charges, producers pay for each unit of transmission capacity connected to the generator (i.e. MW). This approach exists in the UK and Ireland. The Netherlands and Germany do not charge generators at all and the costs are fully socialised. In addition to different systems across the countries in focus in this study, the level of G-charges claimed from generators differs from country to country[36] due to the range of charges and exemptions permitted by Regulation (EU) 838/2010. It lays down guidelines for the inter-transmission system operator compensation mechanism and a common regulatory approach to transmission charging.[37]

If an OWF is physically connected to at least one foreign market, multiple TSOs (or other export cable system developers in Ireland and the UK) may have an interest in assuming responsibility for the grid connection. The TSO, or other entity responsible for onshore grid connections in the EEZ in which the OWF is located, may be interested for business reasons and / or to ensure that development, construction and operation aligns with the other cable systems in the EEZ. In addition, the TSO or other responsible entity in the country where the onshore connection point is located may likewise be interested. This would again be for business reasons and / or due to responsibility for the respective onshore grid (as in the case of a TSO). On the other hand, OWF developers can prefer responsibility in the hands of one country over responsibility in the hands of another country based on the differences in national first connection charge and G-charge regimes.

How responsibility for grid connection is allocated on legal grounds is unclear in the described setup. National law defines who is responsible for grid connection and it can only apply to national territory (including the national EEZ). So, it is unclear whether the responsibility can, under national law, be assigned to OWFs that are located outside the national territory (including the national EEZ).[38] As a result, where an OWF is connected to another country, the TSO or other responsible entity in the other country is unlikely to have a clear mandate to provide the connection. Similarly, no binding

[35] ENTSO-E. 2018. *Overview of transmission tariffs in Europe: Synthesis 2018.* https://docstore.entsoe.eu/Documents/MC%20documents/TTO_Synthesis_2018.pdf; The European Wind Energy Association. 2016. *Position paper on network tariffs and grid connection regimes.* http://www.ewea.org/fileadmin/files/library/publications/position-papers/EWEA-position-paper-on-harmonised-transmission-tariffs-and-grid-connection-regimes.pdf

[36] ENTSO-E. 2018. *Overview of transmission tariffs in Europe: Synthesis 2018.* https://docstore.entsoe.eu/Documents/MC%20documents/TTO_Synthesis_2018.pdf; The European Wind Energy Association. 2016. *Position paper on network tariffs and grid connection regimes.* http://www.ewea.org/fileadmin/files/library/publications/position-papers/EWEA-position-paper-on-harmonised-transmission-tariffs-and-grid-connection-regimes.pdf

[37] European Commission. 2010. *COMMISSION REGULATION (EU) No 838/2010 on laying down guidelines relating to the inter-transmission system operator compensation mechanism and a common regulatory approach to transmission charging*. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1544039239312&uri=CELEX:32010R0838

[38] Müller, Hannah Katharina. 2015. *A legal framework for a transnational offshore grid in the North Sea (Doctoral dissertation)*. Groningen: University of Groningen.

obligations can be placed on the respective TSO or responsible entity if the connection does not reach the national onshore grid.

Responsibility for the interconnector refers to the willingness of TSOs and potential third parties to develop and construct, as well as operate, an interconnector. No dedicated entity is responsible for the development of interconnectors. It is therefore of paramount importance to clarify who takes responsibility for the interconnector in a hybrid project.

Different parties can assume responsibility in the development and construction phase, as well as in the operation phase. In hybrid projects, it may be feasible to have different players responsible for both.

- In the development and construction phase, there is no limitation on the type of stakeholder who could take responsibility for the asset. While interconnectors are typically developed by consortia of national TSOs, private developers – as is the case with the NeuConnect interconnector – can be responsible as well.
- In the operational phase, the types of stakeholder who can assume responsibility for the asset are limited. Due to the European unbundling regulation,[39] generation of electricity is separated from the operation of transmission networks. Depending on the unbundling model of the Member State, generators must either sell off their transmission network or maintain formal ownership, but an independent system operator or a subsidiary must perform operations.

To allow for hybrid project development that includes an OWF physically connected to at least one foreign market, responsibility for both the grid connection and the interconnector needs to be aligned between project stakeholders.

This barrier is relevant for the hybrid projects IJmuiden Ver to UK (Chapter 4.4.3), CGS IJmuiden Ver to Norfolk (Chapter 4.5.3), NSWPH (Chapter 4.7.3), COBRA Cable (Chapter 4.8.3) and DE OWF to NL (Chapter 4.10.3). Please refer to the indicated chapters for the project-specific evaluation of the barrier and barrier mitigation as well as project-specific actions and responsibilities to implement the mitigation.

3.2.2 Uncertainty about regulation deriving from jurisdiction over cross-border cable systems

The United Nations Convention on the Law of the Sea (UNCLOS) specifies the rights and duties of states in offshore territory. It aims to strike a balance between assuring the general rights of the high seas, such as freedom of navigation[40] and the freedom to lay cables and pipelines,[41] and coastal states' right to exploit their natural resources.[42] To achieve this, it defines different maritime zones, each with different rights and duties for states.

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[39] European Commission. 2009. *DIRECTIVE 2009/72/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL concerning common rules for the internal market in electricity*. Article 9. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0072&from=EN

[40] United Nations. 1982. *United Nations Convention on the Law of the Sea.* Part III. http://www.un.org/Depts/los/convention_agreements/texts/unclos/UNCLOS-TOC.htm

[41] United Nations. 1982. *United Nations Convention on the Law of the Sea.* Part VI., Article 79. http://www.un.org/Depts/los/convention_agreements/texts/unclos/UNCLOS-TOC.htm

[42] Müller, Hannah Katharina. 2015. *A legal framework for a transnational offshore grid in the North Sea (Doctoral dissertation).* Groningen: University of Groningen.

In the North Sea, the zones "high seas", "territorial sea" and "exclusive economic zone (EEZ)" are especially relevant. All states enjoy the freedoms of the high seas, which include the freedom of navigation, overflight and laying of submarine cables and pipelines. These freedoms extend across all maritime zones. In the territorial sea, which extends up to 12 nautical miles (nm) from shore, the coastal state enjoys full sovereignty and full jurisdiction, meaning that all national laws apply.[43] However, the coastal state must still observe the rules of international law, which, for example, include allowing for innocent passage (which does not include the freedom to lay cables and pipelines), subject to UNCLOS.[44] In the EEZ, which extends up to 200 nm into the sea adjacent to the territorial sea, the coastal state enjoys exclusive sovereign rights, such as the right to explore and exploit, conserve and manage natural resources, including for the generation of offshore energy.[45] Hence, no other state may, for example, build an offshore wind farm (OWF) in another state's EEZ without the consent of the coastal state.

Jurisdiction over an OWF is clearly defined based on the location of the OWF in one country's EEZ. Since an OWF serves to exploit marine resources within a country's EEZ, the same country has jurisdiction over the OWF installation. The same holds true for the conventional export cable system (i.e. an export cable system linking the OWF to the market of the country in whose EEZ the OWF is located). This is because the cable system is required for the exploitation of the marine resources.[46]

However, for cable systems crossing maritime boundaries, such as interconnectors or export cable systems connecting an OWF to another country, several states can demand regulatory oversight regarding environmental, technical and operational standards. When jurisdiction is concurrent, conflicting regulation may be in place due to a "regime of different jurisdictions".[47]

- Developers of hybrid projects must obtain permits from all countries in whose maritime zones its cable system is physically located. Thus, for cable systems crossing multiple EEZs, permits from all coastal states are required before construction begins. Each country can determine environmental and technical standards by establishing the criteria for the necessary permits. Developers must ensure that they remain compliant with all environmental and technical standards set out by the coastal states as well as by EU law. Such procedure is common with regular interconnectors as well.[48]
- During the operational phase, multiple countries may have jurisdiction over cross-border cable systems. This means they may claim the right to determine the applicable regulations regarding operational standards. This situation is common with regular interconnectors as well.

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[43] United Nations. 1982. *United Nations Convention on the Law of the Sea.* Part II., Article 2, 3. http://www.un.org/Depts/los/convention_agreements/texts/unclos/UNCLOS-TOC.htm

[44] United Nations. 1982. *United Nations Convention on the Law of the Sea.* Part II., Article 17. http://www.un.org/Depts/los/convention_agreements/texts/unclos/UNCLOS-TOC.htm

[45] United Nations. 1982. *United Nations Convention on the Law of the Sea.* Part V., Article 56, 57. http://www.un.org/Depts/los/convention_agreements/texts/unclos/UNCLOS-TOC.htm.

[46] Müller, Hannah Katharina. 2015. *A legal framework for a transnational offshore grid in the North Sea (Doctoral dissertation)*. Groningen: University of Groningen.

[47] Müller, Hannah Katharina. 2015. *A legal framework for a transnational offshore grid in the North Sea (Doctoral dissertation).* Groningen: University of Groningen, 32.

[48] Interconnector developers usually apply for all relevant permits in all jurisdictions which are crossed by the cable. See, for example, the license procedures for the COBRA Cable (TenneT. 2015. *Environmental impact appraisals and planning for interconnectors in the North Sea.* https://renewables-grid.eu/fileadmin/user_upload/Files_RGI/Event_material/Offshore_expert_workshop/4_RGI_Offshore_Workshop_2015_Spits_TenneT.pdf.

As such, applicable operational regulations need to be clarified for hybrid projects that cross maritime borders if the jurisdiction of multiple countries is concurrent.

This barrier is relevant for the hybrid projects IJmuiden Ver to UK (Chapter 4.4.3), CGS IJmuiden Ver to Norfolk (Chapter 4.5.3), NSWPH (Chapter 4.7.3), COBRA Cable (Chapter 4.8.3) and DE OWF to NL (Chapter 4.10.3). Please refer to the indicated chapters for the project-specific evaluation of the barrier and barrier mitigation and project-specific actions as well as responsibilities to implement the mitigation.

3.2.3 Uncertainty about market arrangements

Market arrangements define the conditions for the transmission of electricity from OWFs to shore in hybrid setups. In line with EU law and the national law of countries with a coastline on the North Seas, the conventional market arrangement is that the OWF commercially and physically feeds into its home market, i.e. the grid of the country in whose EEZ the OWF is located. In hybrid setups, however, OWFs may be physically connected to several markets and / or may not be physically connected to their home market. Thus, the direction of commercial electricity flows is unclear.

In hybrid projects where the OWF is physically connected to several markets, the conventional market arrangement is either not feasible or new, innovative market arrangements can be created to capitalise on additional benefits. Commercial OWF flows to multiple markets – for example as backup capacity in case of outages in parts of a cable system – are possible if suitable regulatory approaches can be found. Even though such market arrangements are not in line with existing regulation, the benefits may warrant consideration. This is especially true when considering a potential future meshed-grid approach to support offshore wind development.

In this context, the interests of the various stakeholders need to be balanced. For example, interconnector operators and OWFs connected to shore via interconnectors both have an interest in avoiding congestion on the interconnector to maximise capacity available for trade and / or transmission to shore. Generally, consumers in connected markets have an interest in low energy prices.

To allow for hybrid project development including an OWF physically connected to at least one foreign market, the bidding zone(s) of the OWF needs to be clarified. This defines the market arrangement, and thus the market the OWF commercially feeds into.

This barrier is relevant for the hybrid projects NSWPH (Chapter 4.7.3), COBRA Cable (Chapter 4.8.3) and DE OWF to NL (Chapter 4.10.3). Please refer to the indicated chapters for the project-specific evaluation of the barrier and barrier mitigation and the project-specific actions as well as responsibilities to implement the mitigation.

3.2.4 Uncertainty about hybrid cable system classification

Cable systems in hybrid projects can fulfil two functions: the transmission of electricity from an OWF to shore; and the transmission of electricity between countries. Such cable systems have a hybrid character and therefore do not neatly fit existing legal definitions. As a consequence, either no existing legislation applies to them as no legal definition exists, or multiple legislation applies to them as multiple definitions apply. This is the case at both the national and European level.

- For example, in the UK, there are no applicable definitions for hybrid cable systems under the UK offshore transmission owner (OFTO) regime. This is based on a licensing system, which authorises persons to carry out certain activities. A transmission license authorises a person to transmit electricity but does not permit market-to-market flows. An interconnector license authorises a person to participate in the operation of market-to-market electricity flows. One person cannot hold both a transmission license and an interconnector license (or any other license for that matter).[49] Therefore, existing legislation and regulation does not currently cover hybrid projects that include an asset that requires both a transmission license and an interconnector license.

- In the Netherlands, it is unclear whether current legislation and regulation allows for cable systems with hybrid functionality. Under Dutch law, the Dutch offshore grid comprises the networks intended for the purpose of transporting electricity, and connecting one or more offshore wind farms to the national high-voltage grid.[50] Interconnectors are defined as cross-border networks that link the networks of two countries.[51] It is unclear whether these definitions legally prohibit the hybrid functionality of cable systems in hybrid projects.
- It is also unclear if current German legislation and regulation allows for cable systems with hybrid functionality. Cables connecting offshore wind farms to the national electricity grid become part of the grid on completion[52]. As such, they are defined as connections between technical installations for the uptake, transmission and distribution of electrical energy for general supply[53]. Interconnectors are defined as cables connecting electricity grids or, alternatively, as connections that cross the boundaries between two states and are solely put in place to link the national transmission systems of the two states.[54] It is unclear whether these definitions legally prohibit the hybrid functionality of cable systems in hybrid projects.
- In Denmark, it is conceivable that the hybrid functionality of cable systems may be compatible with existing legislation and regulation. However, the Danish authorities need to validate such an assumption. All power grids at all voltage levels in the territorial sea and in the EEZ of Denmark are subject to approval from the Ministry of Energy Supply and Climate Change.[55] All transmission projects above 100 kV must be approved in accordance with the Executive Order published on Energinet.[56] Thus, both cable systems connecting OWFs to shore and interconnectors are subject to the same regime, so the hybrid functionality of cable systems is unlikely to be legally problematic.

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[49] UK Electricity Act 1989. Section 6 (1)(b) and (e), (2A). https://www.legislation.gov.uk/ukpga/1989/29/contents

[50] Dutch Elektriciteitswet 1998. §1 Article 15a. https://wetten.overheid.nl/BWBR0009755/2018-07-28#Hoofdstuk3_Paragraaf1_Artikel15a

[51] Dutch Elektriciteitswet 1998. §1 Article 1 (as). https://wetten.overheid.nl/BWBR0009755/2018-07-28#Hoofdstuk1_Paragraaf1_Artikel1

[52] German Energiewirtschaftsgesetz (EnWG). § 17d (1). http://www.gesetze-im-internet.de/enwg_2005/__17d.html

[53] German Erneuerbare-Energien-Gesetz 2017 (EEG 2017). § 3 (35). https://www.gesetze-im-internet.de/eeg_2014/__3.html

[54] German Energiewirtschaftsgesetz (EnWG). § 3 (34). http://www.gesetze-im-internet.de/enwg_2005/__3.html

[55] Danish Bekendtgørelse af lov om elforsyning. § 22a. https://www.retsinformation.dk/Forms/R0710.aspx?id=202155

[56] Danish Bekendtgørelse af lov om Energinet. § 4. https://www.retsinformation.dk/Forms/r0710.aspx?id=202154

- EU Directive 2009/72/EC[57] does not provide a definition for hybrid cable systems, and narrowly defines interconnectors as equipment used to link electricity systems. Similarly, Regulation (EC) 714/2009[58] defines interconnectors as a transmission line that crosses or spans a border between Member States, and which connects the national transmission systems of the Member States. So, any reference to the transport of power generated offshore to shore or generation itself is excluded.

To allow for hybrid project development with hybrid cable systems, applicable regulation on the national and European levels needs to be clarified.

This barrier is relevant for the hybrid projects IJmuiden Ver to UK (Chapter 4.4.3), CGS IJmuiden Ver to Norfolk (Chapter 4.5.3), NSWPH (Chapter 4.7.3) and COBRA Cable (Chapter 4.8.3). Please refer to the indicated chapters for the project-specific evaluation of the barrier and barrier mitigation as well as project-specific actions and responsibilities to implement the mitigation.

3.2.5 Failure of developers to align planning across assets and countries

Hybrid projects are complex due to the integration of multiple assets in one project across maritime boundaries. Planning involves three distinct aspects of complexity: geographical, technical and timing alignment.

- Geographical alignment refers to the hybrid-specific alignment of the routing of cable systems and the location of the OWFs included in a project. As hybrid projects depend on the productive combination of transmission and generation assets, the routing of cable systems and the location of generation assets needs to be aligned to maximise cost savings and aide project development. However, the development of OWFs has so far been nationally organised and alignment procedures retain a strong national focus. The development of interconnectors naturally requires cooperation between countries but has so far been focused solely on the development of transmission lines, with no other added functionalities.
- Technical alignment refers to the alignment of the technologies and equipment used to develop the individual assets of the hybrid project. As hybrid projects usually consist of several assets, control systems, communication equipment and other interfaces must function together. Technical standards need to be communicated transparently and early to enable suppliers to design the necessary equipment in accordance with joint standards and thus ensure interoperability.
- Timing alignment refers to the alignment of the development timelines of the individual assets in the hybrid project. With multiple assets involved, the development timelines for each must be aligned to prevent stranded assets and delays that could drive up development costs. Timing alignment is especially relevant in projects with a natural discrepancy in the development start date or in the commissioning date of individual assets. For example, if an OWF is connected to an interconnector late because of a delay in the tender process, it can cause disruptions to the operations of the interconnector and lead to potential revenue losses. This would also probably increase the costs of the hybrid project.

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[57] European Commission. 2009. *DIRECTIVE 2009/72/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL concerning common rules for the internal market in electricity.* Article 2 (13). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0072&from=EN

[58] European Parliament, European Council. 2009. *REGULATION (EC) No. 714/2009 on conditions for access to the network for cross-border exchanges in electricity.* Article 2 (1). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R0714&from=EN

In short, the geographical, technical and timing alignment of planning across assets and countries is paramount in early development stages to avoid delays, increased costs and / or stranded assets. Doing so also encourages the development of hybrid projects.

This barrier is relevant for the hybrid projects IJmuiden Ver to UK (Chapter 4.4.3), CGS IJmuiden Ver to Norfolk (Chapter 4.5.3), NSWPH (Chapter 4.7.3), COBRA Cable (Chapter 4.8.3) and DE OWF to NL (Chapter 4.10.3). Please refer to the indicated chapters for the project-specific evaluation of the barrier and barrier mitigation as well as project-specific actions and responsibilities to implement the mitigation.

3.2.6 Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution)

Access to maritime space for OWFs is usually[59] granted through national tenders. These often[60] involve central location selection and site pre-investigation as well as the actual tender process conducted by national authorities.[61] Location selection and site pre-investigation can be conducted through a centralised or de-centralised process by national authorities or project developers. These processes ultimately lead to the identification of concrete conditions (e.g. water depth, characteristics of seabed and currents) at a preferred site, enabling the evaluation of the feasibility and costs of the envisioned development.

The party responsible for the tender executes an OWF tender as defined in the tender design, which lists the requirements and processes to ensure close coordination and efficiency (see also Chapter 3.2.7). OWF developers normally do not have a strong preference for a certain country's authority, provided that requirements are transparent and processes efficient.

- Exceptions exist regarding an (additional) open-door approach in Ireland, the UK and Denmark. Otherwise, OWF location selection and site pre-investigation are conducted by the country in whose EEZ the OWF is physically located.[62] However, if an OWF is linked to multiple markets or to a foreign market only, those countries will also have an interest in the selection and pre-

[59] Of the countries in focus, Ireland introduced a Renewable Electricity Support Scheme to support renewable energy generation through a tender-based process in 2018. The scheme is still to be approved by the European Commission but will probably not be sufficient. It is not technology-specific, and the potential sizes of future individual auctions as outlined today may be too small compared to typical OWF capacities.

[60] Within the scope of the countries in focus, in Ireland, the UK and Denmark, an open-door approach (additionally) exists, which allows OWF developers to conduct location selection and site pre-investigation activities themselves. Developers use the resultant information to apply to the respective national authorities for permits relevant for the development of a specific site.

[61] In the UK, the access to maritime space for OWFs is given through auctions instead of tenders.

[62] Regarding the UK, see IEA-RETD. 2017. *Comparative Analysis of International Offshore Wind Energy Development: REWIND OFFSHORE*. http://iea-retd.org/wp-content/uploads/2017/03/IEA-RETD-REWind-Offshore-report.pdf

Dutch Wet windenergie op zee. Article 3. https://wetten.overheid.nl/BWBR0036752/2015-07-01#Hoofdstuk2_Artikel3

German Energiewirtschaftsgesetz (EnWG). § 12a. http://www.gesetze-im-internet.de/enwg_2005/__12a.html

Danish Lov om maritim fysisk planlægning. Chapter 3. https://www.retsinformation.dk/Forms/R0710.aspx?id=180281 investigation of the OWF location. This makes it necessary to define the responsibility for and the rules applicable to the OWF location selection and pre-investigation process.

- Except for the cases mentioned above, the party responsible for executing an OWF tender is an authority from the country in whose EEZ the OWF is geographically located. However, if an OWF is physically connected to at least one foreign market, then these countries have an interest in the tender process, too. This makes it necessary to align responsibility for the OWF tender process to initiate the development.

To allow for hybrid project development that includes an OWF physically connected to at least one foreign market, project stakeholders need to align responsibilities and rules for location selection, site pre-investigation and tender execution.

This barrier is relevant for the hybrid projects COBRA Cable (Chapter 4.8.3) and DE OWF to NL (Chapter 4.10.3). Please refer to the indicated chapters for the project-specific evaluation of the barrier and barrier mitigation as well as project-specific actions and responsibilities to implement the mitigation.

3.2.7 Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)

Tender design is usually established by the country in whose EEZ the OWF is geographically located. The design needs to balance the requirements set out for prospective developers in light of the targeted cost competition with the probability of realisation.[63] Where an OWF is included in a transnational hybrid project, it also needs to balance the interest of multiple countries.

- While cost competition is an important target, the probability of realisation also needs to be a focus for innovative hybrid projects.
- If an OWF is physically connected to at least one foreign market, the countries involved will also have an interest in the design of the tender. At present, there is no commonly agreed tender design for hybrid project OWFs that would allow multiple countries to influence the tender requirements. These requirements can be broken down into financial and material requirements, of which the former are easier to coordinate if needed. When it comes to material tender requirements, needs differ. For example, the country in whose EEZ the OWF is located has a strong interest in defining environmental standards, while the country to whose onshore grid the OWF is connected has a strong interest in defining technical and operational requirements.

To allow for hybrid project development that includes an OWF physically connected to at least one foreign market, project stakeholders need to align on tender requirements.

This barrier is relevant for the hybrid projects IJmuiden Ver to UK (Chapter 4.4.3), CGS IJmuiden Ver to Norfolk (Chapter 4.5.3), NSWPH (Chapter 4.7.3), COBRA Cable (Chapter 4.8.3) and DE OWF to NL (Chapter 4.10.3). Please refer to the indicated chapters for the project-specific evaluation of the barrier and barrier mitigation as well as project-specific actions and responsibilities to implement the mitigation.

3.2.8 Discrepancies in responsibilities and requirements for balancing

Generators are assigned balancing responsibility to ensure that the available energy supply is predictable and secure. They must forecast their own production and pay for any imbalances (positive

[63] In the UK, the access to maritime space for OWFs is given through auctions instead of tenders.

or negative deviations from forecasts). This responsibility can be transferred to a third party or direct marketing company.

The EU's Clean Energy Package (CEP) suggests that all market participants are responsible for the imbalances they cause through new installations, including renewable energy generators such as offshore wind farms. Exemptions are foreseen only for small generators, installations that already receive financial support and demonstration projects. Member States may make derogations until the end of 2025 for renewable energy generators of any size. Starting in 2026, however, such derogations will only be applicable to generators with an installed capacity of less than 250 kW.[64] By 2025, there will be no more relevant discrepancies in the responsibility and requirements for balancing across countries. The exception is for imbalance settlement periods, particularly involving the UK with 30 minutes[65] compared to the proposed 15 minutes[66].

Once enacted and translated into national law, the new framework needs to be assessed in detail by project-specific stakeholders. As the translation into national law is still outstanding, no country-specific analysis is possible at the time of writing. However, when it comes to the shorter-term implementation of the considered hybrid projects, it is likely that no further barrier mitigation of the responsibilities and requirements for balancing will be needed. This barrier is therefore not discussed for any of the hybrid projects.

3.2.9 Discrepancies in priority dispatch regulation

Priority dispatch regulation defines which generators must be granted priority access by the grid operator to dispatch electricity into the grid. It also sets out rules that allow grid operators to impose curtailment.

The CEP[67] suggests that priority dispatch will remain in place for existing installations, small-scale renewable installations and demonstration projects. Other installations, irrespective of the technology used, will be subject to non-discriminatory third-party access rules. Priority dispatch will no longer be in place for new offshore wind farms or other new, large renewable energy generators. Generators that have, under previous regulation, enjoyed priority dispatch will continue to do so provided that the installation is not subject to significant modifications.[68]

Once enacted and translated into national law, the new framework needs to be assessed in detail by project-specific stakeholders. As the translation into national law is still outstanding, no country-specific analysis is possible at the time of writing. However, when it comes to the shorter-term

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[64] European Commission. 2018. *COM 2016/861 final; REGULATION on the internal market for electricity.* Article 4. http://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/COM-2016-861-F2-EN-MAIN-PART-1.PDF

[65] ENTSO-E. 2016. *Activation purposes of Balancing Energy Bids – Draft Version 5.* https://docstore.entsoe.eu/Documents/MC%20documents/balancing_ancillary/160519_Activation_Purposes.pdf

[66] European Commission. 2018. *COM 2016/861 final; REGULATION on the internal market for electricity.* Article 7. http://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/COM-2016-861-F2-EN-MAIN-PART-1.PDF

[67] European Commission. 2018. *Clean energy for all Europeans.* https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans

[68] European Commission. 2018. *COM 2016/861 final; REGULATION on the internal market for electricity.* Article 11. http://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/COM-2016-861-F2-EN-MAIN-PART-1.PDF

implementation of the considered hybrid projects, it is likely that no further barrier mitigation of priority dispatch regulation will be needed. This barrier is therefore not discussed for any of the hybrid projects.

3.2.10 Discrepancies in curtailment regulation and compensation

Curtailment refers to the involuntary limitation of the maximum possible output of a generator, given available resources. An independent authority such as the grid operator imposes the limitation. Reasons for curtailment include grid congestion, grid security, necessary controls of the voltage level and excess generation during off-peak demand periods. Curtailment can impact the business cases of renewable energy generators such as OWFs as the amount of electricity generated falls short of the maximum generation possible given the same conditions. In addition, unlike other generators, OWFs cannot save any kind of fuel to compensate for the curtailment.

The CEP[69] suggests that curtailment of renewables should be kept to a strict minimum. In other words, renewable energy sources will only be curtailed if no alternative exists, or if the alternative would result in disproportionate costs or affect the stability of the grid. In addition, renewable energy generators will be compensated for up to 90% of the net revenues lost (including lost financial support) due to curtailment.[70]

Once enacted and translated into national law, the new framework needs to be assessed in detail by project-specific stakeholders. As the translation into national law is still outstanding, no country-specific analysis is possible at the time of writing. However, when it comes to the shorter-term implementation of the considered hybrid projects, it is likely that no further barrier mitigation of curtailment regulation and compensation will be needed. This barrier is therefore not discussed for any of the hybrid projects.

3.2.11 Lack of regulated revenues for anticipatory investments

Anticipatory investments are made to future-proof assets in anticipation of future returns. Stakeholders use them in the present to more simply and cost-efficiently expand transmission infrastructure or generation capacity in the future. In contrast to regular investments, anticipatory investments may not generate an immediate return. For example, a company might build an interconnector with a different technical setup or a higher capacity than needed to perform its current function to enable the future connection of offshore generation capacity. Another example are export cable systems built with a higher capacity than necessary to enable the future connection of additional generation capacity. Commercial players and TSOs carry out anticipatory investments for interconnectors. The responsible national TSOs in EU Member States with a North Seas coastline undertake such investments in export cable systems as they have responsibility for grid connection. The only exceptions are the UK, where the OFTO regime assigns responsibility to OWF developers or OFTOs, and Ireland, where OWF developers are responsible.

Since anticipatory investments inherently carry a greater financial risk than conventional investments, both commercial players and TSOs seek to cover such risks with reimbursement guarantees. One possibility for reimbursement is to include interconnectors and other cable systems in the regulated

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[69] European Commission. 2018. *Clean energy for all Europeans.* https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans

[70] European Commission. 2018. *COM 2016/861 final; REGULATION on the internal market for electricity.* Article 12. http://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/COM-2016-861-F2-EN-MAIN-PART-1.PDF

asset base (RAB). Alternatively, commercial players may seek compensation through subsidy schemes for OWFs. Otherwise, the additional costs linked to anticipatory investments remain with the commercial player or TSO – a significant disincentive to undertaking such investments in the first place. At the same time, it is in the interests of society, and thus of regulatory authorities, to prevent unnecessary investments.

- For conventional cable systems, anticipatory investments are usually included in the national regulatory regime. This is due to the fact that in Belgium, the Netherlands, Germany and Denmark the national TSO is responsible for connecting OWFs to shore. National regulation prescribes when and how – this is, through which cable corridors – OWFs must be connected to the grid. Such planning also includes the construction of cable systems that have a higher capacity than immediately needed to connect additional OWFs to them in the future. The only exception is the UK, where the OFTO regime assigns responsibility to OWF developers or OFTOs, and Ireland, where OWF developers are responsible.
- If developers incur a higher risk for the development, construction and operation of the infrastructure, compared to the risks normally incurred by a comparable project, they can apply for the project to become a Project of Common Interest (PCI) under the guidelines for trans-European energy infrastructure (Regulation (EU) 347/2013)[71]. The regulation allows higher risk assets to be included in the RAB with appropriate incentives. This includes anticipatory investments for export cables and interconnectors. However, this is not a possibility in all countries and is implemented only and to varying degrees for PCIs. In the UK, the Netherlands and Germany, anticipatory investments for PCIs can be included in the RAB of the relevant TSO. Indeed, in the Netherlands and in Germany, such investments are treated as regular investments and TSOs must apply for cost approval. A benchmarking scheme for assessing the efficiency of investments is present in these countries, too[72]. In Ireland, Belgium and Denmark, it is currently unclear whether anticipatory investments for PCIs can be included in the RAB.[73]
- Generally, commercial players constructing and operating an interconnector can also obtain regulated revenues as reimbursement for anticipatory investments by applying to national regulatory authorities for the asset's inclusion in the regulated asset regime. If anticipatory investments for interconnectors cannot be included in the RAB, commercial players can apply for an exemption under Regulation (EC) 714/2009[74]. This allows for an interconnector to become a merchant line, thereby covering investments through congestion rents from the transmission of electricity between different markets with different electricity prices. The Cap and Floor regime offers additional support where links to either the UK or Belgium are envisaged.

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[71] European Parliament, European Council. 2013. *REGULATION (EU) No. 347/2013 on guidelines for trans-European energy infrastructure.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0347&from=en

[72] ACER. 2014. *Recommendation of the Agency for the cooperation of energy regulators No 03/2014.* https://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Recommendations/ACER%20Recommendation%2003-2014.pdf

[73] ACER. 2014. *Recommendation of the Agency for the cooperation of energy regulators No 03/2014.* https://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Recommendations/ACER%20Recommendation%2003-2014.pdf

[74] European Parliament, European Council. 2009. *REGULATION (EC) No. 714/2009 on conditions for access to the network for cross-border exchanges in electricity.* Article 17. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R0714&from=EN

- The UK presents a special case for anticipatory investments in export cable systems as these are developed under the OFTO regime. Anticipatory investments for offshore infrastructure are classified as either "developer-led Wider Network Benefit Investments" (WNBIs) or "Generator-Focused Anticipatory Investments" (GFAIs). WNBIs are investments that provide a benefit to multiple parties, including the demand and generation side as well as onshore and offshore parties. GFAIs are investments in offshore infrastructure that allow for the future connection of additional offshore assets.[75]

It is unclear whether hybrid projects can benefit from anticipatory investments. This is because EU Member States are at different stages in their implementation of the regulation on guidelines for trans-European energy infrastructure, and because there are different national procedures to assess the need for anticipatory investments.

To allow for hybrid project development, it is necessary to provide certainty about the remuneration for anticipatory investments. This helps to clarify the commercial conditions for commercial players and TSOs.

This barrier is relevant for the hybrid projects IJmuiden Ver to UK (Chapter 4.4.3), CGS IJmuiden Ver to Norfolk (Chapter 4.5.3) and NSWPH (Chapter 4.7.3). Please refer to the indicated chapters for the project-specific evaluation of the barrier and barrier mitigation as well as project-specific actions and responsibilities to implement the mitigation.

3.2.12 Uncertainty about applicable RES subsidy scheme

RES subsidy schemes guarantee a revenue per unit of produced energy for generators. Their aim is to nationally expand renewable energy production and thereby contribute to the EU target of 32% renewables in the energy mix.[76] RES subsidy schemes have a strong national focus and the allocation of subsidies and the type of subsidy vary between countries. Ireland has no dedicated RES subsidy scheme for offshore wind, while the UK operates a Contract for Difference (CfD) subsidy scheme. Denmark, the Netherlands and Germany will (for windfarms built from 2020 onwards; feed-in tariff applicable before then) introduce feed-in premiums. Belgium uses a green certificate scheme.[77]

- Non-existent RES subsidy schemes for OWFs: If no subsidy scheme for electricity generated from offshore wind exists, the electricity must be sold at market prices. In this situation, arrangements such as Power Purchase Agreements (PPAs) may guarantee a bilaterally agreed, constant price over the medium-term.
- Feed-in premiums: If a feed-in premium is in place, electricity generated from offshore wind is sold at the market price, but the generator receives a premium. The government guarantees the premium for a specific period of time. It can be set externally by the government, or in competition through a tender procedure. The premium is either constant (for past projects) or sliding, with the latter meaning that the premium amount depends on market prices (i.e. the premium amount decreases if market prices exceed a certain strike price and increases if market prices fall below a certain strike price).

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[75] National Grid. 2015. *User Commitment for Generator Focused Anticipatory Investment (GFAI).* https://www.nationalgrideso.com/sites/eso/files/documents/41074-Conclusions%20Letter%20on%20GFAI%20User%20Commitment%20April%202015%20v1_0.pdf

[76] European Commission. 2018. *Renewable energy: Moving towards a low carbon economy.* https://ec.europa.eu/energy/en/topics/renewable-energy

[77] pwc. 2018. *Unlocking Europe's offshore wind potential: Moving towards a subsidy free industry*. https://www.pwc.nl/nl/assets/documents/pwc-unlocking-europes-offshore-wind-potential.pdf

- Feed-in tariffs / Contracts for Difference (CfD): If a feed-in tariff is in place, electricity generated from offshore wind is sold at the market price, but the generator receives a fixed price irrespective of the market price. The government guarantees this price for a specific period of time. It can be fixed at a set level by the government or it can be determined in competition through a tender procedure. A CfD works in a similar way. If a CfD is in place, electricity generated from offshore wind is sold at the market price and any difference between the market price and an agreed strike price is levelled between the generator and the government. If the market price is higher than the strike price, the generator pays the difference to the government. If the market price is lower than the strike price, the government pays the generator.
- Green certificate schemes: A green certificate scheme involves the issuing of green certificates, typically for each 1 MWh of renewable power produced. They are subsequently traded among suppliers and consumers separately from the generated power. Depending on government policy, both suppliers and consumers may be required to have a minimum percentage of renewable production in their portfolio. This can be acquired through green certificates, thereby generating the needed demand for the certificates. The price of the certificates depends on their scarcity on the market.

From a legal perspective, OWFs are supported through the RES subsidy scheme of the country in whose territorial sea or EEZ the OWF is located. An exception occurs when cooperation mechanisms are provided for in national law. For example, in the UK, the CfD scheme only applies to OWFs located in the UK territorial sea or the UK EEZ, as laid down in the CfD allocation frameworks of the CfD tender rounds so far (2014 and 2017; 2019 in planning).[78] In the Netherlands, subsidies can be given to OWFs in other Member States. But this is on condition that a cooperation mechanism is agreed, the generated electricity is fed into the grid of the other Member State and the electricity prices of the other Member State apply.[79] In Germany, subsidies can also be given to OWFs in other Member States. Here, the conditions are that a cooperation mechanism is agreed, the subsidy is allocated by means of a joint tender (and tenders of the other Member State are opened to German renewable generators), the principle of mutuality is observed and the generated energy is either physically imported or has a comparable effect on the German market.[80] In Denmark, subsidies can only be allocated to OWFs located in Danish territorial waters or the Danish EEZ. This is because tenders for OWF licenses, which are required to obtain financial support, are only conducted for such areas.[81]

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[78] The allocation frameworks define a CfD Unit as "the whole or part of an Eligible Generating Station situated in Great Britain or the territorial waters thereof" with an Offshore CfD Unit being "a CfD Unit which generates electricity by the use of wind and which is situated (or is to be situated) wholly in offshore waters" (DECC (now BEIS). 2014. *CfD: Final Allocation Framework for the October 2014 Allocation Round*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/404405/Contract_for_Difference_Final_Allocation_Framework_for_the_October_2014_Allocation_Round.pdf) The 2017 framework references the 2014 framework (BEIS. 2017. *CfD: Allocation Framework for the second Allocation Round*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/601120/Allocation_Framework_for_the_second_Allocation_Round.pdf.

[79] Dutch Besluit stimulering duurzame energieproductie 2007. §5a Article 55b. https://wetten.overheid.nl/BWBR0022735/2017-04-01#Paragraaf5a_Artikel55b

[80] German Erneuerbare-Energien-Gesetz 2017 (EEG 2017). § 5. https://www.gesetze-im-internet.de/eeg_2014/__5.html

[81] Danish Bekendtgørelse af lov om fremme af vedvarende energi. § 22, § 23 and §37. https://www.retsinformation.dk/Forms/R0710.aspx?id=203053

This conventionally translates into the applicability of the RES subsidy scheme of the country in whose EEZ the OWF installation is geographically located.

But in hybrid projects, OWFs are physically connected to at least one foreign market. This being the case, no RES subsidy scheme or the RES subsidy schemes of different countries could apply, depending on the applicable national legislation and regulations. Uncertainty exists about the commercial flow conditions for the OWF and public acceptance of support for OWFs, both of which hinder project development.

EU Directive 2009/28/EC[82], on the promotion of the use of energy from RES, provides for transnational cooperation mechanisms in the form of statistical transfers, joint projects between Member States and joint support schemes. These mechanisms may be voluntarily used to implement subsidy schemes for transnational (hybrid) projects.

- The subsidy scheme of the OWF's home market can be accessed by compensating the home market country using statistical transfers between the involved countries. The OWF must not be physically connected to the bidding zone of the home market because in a statistical transfer the required amount of RES is deducted from one country's progress towards its RES target and added to the other's. This is an accounting procedure and no actual energy changes hands.
- Under the joint project mechanism, each involved party applies its own national subsidy scheme to the project, or parts of the project. Thus, two or more countries co-fund a hybrid project and share the resulting renewable energy for the purpose of meeting their RES targets. Both statistical transfers and physical transmission of electricity between countries may need to take place, depending on the distribution of costs and benefits of the project for each country.[83]
- Lastly, it's possible to establish a joint support scheme for a hybrid project agreed by all relevant parties. Thus, two or more countries fund a joint support scheme to allow hybrid project development.

Depending on the hybrid project setup, different cooperation mechanisms and, hence, subsidy schemes will apply. It's therefore important to clarify the commercial flow conditions for OWFs included in hybrid projects.

To allow for hybrid project development of an OWF that requires subsidies and is physically connected to at least one foreign market, stakeholders need to clarify the applicability of national RES subsidy schemes relating to OWFs included in a hybrid project. The process should include consideration of EU Directive 2009/28/EC[84].

This barrier is relevant for the hybrid projects NSWPH (Chapter 4.7.3), COBRA Cable (Chapter 4.8.3) and DE OWF to NL (Chapter 4.10.3). Please refer to the indicated chapters for the project-specific evaluation of the barrier and barrier mitigation as well as project-specific actions and responsibilities to implement the mitigation.

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[82] European Parliament, European Council. 2009. *DIRECTIVE 2009/28/EC on the promotion of the use of energy from renewable sources.* Article 6, 7, 9 and 11. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

[83] European Commission. 2013. *Guidance on the use of renewable energy cooperation mechanism.* https://ec.europa.eu/energy/sites/ener/files/documents/com_2013_public_intervention_swd05_en.pdf

[84] Also consider the recast of EU Directive 2009/28/EC, which, at the time of writing, was not yet published.

3.2.13 Limited engagement of public stakeholders

The engagement of public stakeholders is key to the successful implementation of innovative infrastructure projects such as hybrid offshore projects.

- First, public stakeholders can assure project developers of their commitment to a specific hybrid project, including their availability for dialogue and discussion, in one of two ways: a project-specific MoU or a project-specific HANSA between all relevant stakeholders. Such agreements indicate or formalise commitment from the involved parties– commercial (only in the case of an MoU) and public stakeholders.
- Second, public stakeholders can support early-stage hybrid projects by providing financial support for feasibility studies, pilot projects and research and development for innovative, technological solutions. Such early-stage support is particularly important as these activities are usually financed via the balance sheet of the project developers without access to project financing.[85] For example, the Connecting Europe Facility (CEF) and the European Fund for Strategic Investments (EFSI) both provide financial support designed to facilitate cross-border energy projects.
  - CEF provides early-stage and investment support to projects with a PCI status. Additionally, for the period 2021-2027, CEF is considered to specifically target cross-border renewable energy projects with a potential budget of at least 10 % of its overall budget of CEF Energy, which is expected to be EUR 8.65 billion. This budget would not be subject to projects having a PCI status. Funding would cover all renewable energy sources, including offshore wind. To implement hybrid projects, the renewed CEF provides financial support for studies and works. It also offers technical assistance to set up cooperation agreements between stakeholders for pre-feasibility studies, scoping studies, the mapping of potential sites, and the assessment of regulatory and financing conditions. CEF supports such activities up to a maximum of 50%[86] of the costs.[87]
  - EFSI is an initiative under the Juncker Plan launched jointly by the European Commission and the EIB Group – the European Investment Bank and the European Investment Fund –to help bridge the EU's current investment gap. EFSI consists of a EUR 26 bn guarantee from the EU budget, complemented by a EUR 7.5 bn allocation of the EIB's own capital. The total amount of EUR 33.5 bn aims to unlock additional investment of at least EUR 500 bn by 2020 by partially financing projects (that may also prepare the ground for additional investments). EFSI is aimed at projects that have a high risk, including cross-border projects, and that involve sectors of key importance to the European economy.[88] Such projects include investments in renewable

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[85] WindEurope. 2017. *Financing and investment trends.* https://windeurope.org/wp-content/uploads/files/about-wind/reports/Financing-and-Investment-Trends-2017.pdf

[86] In exceptional cases, CEF funding could be increased to a maximum of 75 %.

[87] European Commission. 2018. *European solidarity on Energy: Better integration of the Iberian Peninsula into the EU energy market*. http://europa.eu/rapid/press-release_IP-18-4621_en.htm

European Commission. 2018. *Proposal for a Regulation establishing the Connecting Europe Facility.* https://eur-lex.europa.eu/resource.html?uri=cellar:da5da09e-6a5a-11e8-9483-01aa75ed71a1.0003.03/DOC_1&format=PDF

[88] European Investment Bank. 2018. *What is the European Fund for Strategic Investments (EFSI)?* http://www.eib.org/en/efsi/what-is-efsi/index.htm

energy sources, energy efficiency and electricity networks, including interconnections. This strengthens energy diversification, security of supply and inter-European cooperation.[89]

- Third, public stakeholders can further incentivise project developers by providing financial guarantees to support the de-risking of hybrid projects. Such guarantees reassure project developers about unforeseen situations that may arise as a result of the pilot character of hybrid projects.

To allow for hybrid project development, it is highly beneficial for stakeholders to formalise public commitment – in a project-specific MoU or a project-specific HANSA, for example – and to make public funding support available for early-stage developments or construction.

This barrier is relevant for the hybrid projects IJmuiden Ver to UK (Chapter 4.4.3), CGS IJmuiden Ver to Norfolk (Chapter 4.5.3), NSWPH (Chapter 4.7.3), COBRA Cable (Chapter 4.8.3) and DE OWF to NL (Chapter 4.10.3). Please refer to the indicated chapters for the project-specific evaluation of the barrier and barrier mitigation as well as project-specific actions and responsibilities to implement the mitigation.

3.2.14 Uncertainty regarding the UK market

At the time of writing, uncertainty remains with regard to long-term relations between the UK and the EU. The UK is likely to leave the internal energy market, exposing it to additional costs from de-coupling its electricity market. The outcome of the negotiations regarding the country's withdrawal from the EU may have an impact on the following relevant UK policies:

- The Capacity Market in the UK was introduced in 2014 to increase the security of supply and incentivise investments in renewable energy sources. The Capacity Market, which is currently on hold (see below), pays generators and interconnectors to be available within a time frame of four hours in the event of an unexpected shortage in electricity. Annual auctions are held four years in advance of the potential time of electricity delivery.[90] In the latest auction, for delivery of energy in 2021/2022, the interconnectors that entered the auction secured contracts with a combined capacity of 2.2 GW. Clearance stood at a record low of 8.40 GBP/kW, edging out new coal and gas generation.[91] The UK Capacity Market provides an additional revenue stream for interconnector business cases, beyond revenues from congestion rents. It also incentivises interconnector development. The UK was compelled to include interconnectors into the Capacity Market due to EU competition rules,[92] which are unlikely to apply after the country's withdrawal from the EU. However, on November 15, 2018, the UK Capacity Market was declared illegal by the European Court of Justice and has now been put on hold, with the next capacity auction postponed indefinitely.[93] While there are currently no changes proposed to the Capacity Market,

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[89] European Commission. 2018. *Factsheet: Energy sector*. https://ec.europa.eu/commission/sites/beta-political/files/energy-sector-factsheet-297x210-july18_en.pdf

[90] Ofgem. 2018. *Capacity Market (CM) Rules*. https://www.ofgem.gov.uk/electricity/wholesale-market/market-efficiency-review-and-reform/electricity-market-reform/capacity-market-cm-rules.

[91] Grimwood, Tom. 2018. *Interconnectors beat new gas in record-breaking capacity auction.* https://utilityweek.co.uk/interconnectors-elbow-new-gas-capacity-auction-clears-record-low/.

[92] Flavell, Scott and Alessio Villanacci. 2016. *Impact of Brexit on UK energy security: Analysing the impact of different Brexit scenarios on the UK energy security of supply.* http://energy.sia-partners.com/sites/default/files/impact_of_brexit_on_uk_energy_security_sia_partners.pdf.pdf.

[93] European Court of Justice. 2018. *Judgement of the General Court on State Aid relating to the UK Capacity Market.*

notwithstanding the ECJ's ruling, it may be necessary to re-evaluate its status after the UK's withdrawal from the EU.

- The UK's Cap and Floor regime incentivises interconnector development to the UK by offering a minimum amount of revenue to interconnector developers as a floor (while revenues above the cap must be transferred to the grid operator).[94] The development of new interconnectors means the UK increases its reliance on energy imports. While there are currently no changes proposed to the Cap and Floor regime, it may be necessary to re-evaluate its status after the UK's withdrawal from the EU.
- The EU's Connecting Europe Facility supports cross-border electricity projects of Common Interest (PCIs). It is based on the guidelines for trans-European energy infrastructure (Regulation (EU) 347/2013)[95] and the Connecting Europe Facility Regulation (Regulation (EU) 1316/2013).[96] PCIs benefit from accelerated permit granting procedures and improved regulatory treatment, and can apply for financial support through EU instruments.[97] Without the UK's continued participation in the internal energy market, interconnector projects that link to the country may no longer qualify for PCI status and the associated advantages.

To facilitate hybrid project development that includes links to the UK, developers should clarify the commercial conditions for interconnector business cases in the UK market. These are likely to be affected by the outcome of the negotiations regarding the country's withdrawal from the EU. Specifically, developers should consider the UK Capacity Market, the Cap and Floor regime and the availability of EU support related to the PCI status.

This barrier is relevant for the hybrid projects IJmuiden Ver to UK (Chapter 4.4.3) and CGS IJmuiden Ver to Norfolk (Chapter 4.5.3). Please refer to the indicated chapters for the project-specific evaluation of the barrier and barrier mitigation as well as project-specific actions and responsibilities to implement the mitigation.

3.2.15 Disproportionate allocation of costs and benefits across involved stakeholders

Each offshore wind project is associated with a variety of direct and indirect costs and benefits, with the costs borne by either the project developer or the respective country. By way of compensation, the project developer and the respective country receive certain benefits from the realisation of the

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http://curia.europa.eu/juris/document/document.jsf?text=&docid=207792&pageIndex=0&doclang=en&mode=req&dir=&occ=first&part=1&cid=1430154

Vaughan, Adam. 2018. *UK's backup power subsidies are illegal, European court rules*. https://www.theguardian.com/environment/2018/nov/15/uk-backup-power-subsidies-illegal-european-court-capacity-market

[94] Ofgem. 2016. *Cap and floor regime: unlocking investment in electricity interconnectors.* https://www.ofgem.gov.uk/system/files/docs/2016/05/cap_and_floor_brochure.pdf

[95] European Parliament, European Council. 2013. *REGULATION (EU) No. 347/2013 on guidelines for trans-European energy infrastructure.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0347&from=en

[96] European Parliament, European Council. 2013. *REGULATION (EU) No. 1316/2013 establishing the Connecting Europe Facility*. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32013R1316&from=EN

[97] European Commission. 2018. *Projects of Common Interest.* https://ec.europa.eu/energy/en/topics/infrastructure/projects-common-interest

project. Naturally, the benefits received by one party may represent the costs of another party. The types of hybrid project development costs that can be considered include, but are not limited to:

- the grid connection and interconnector costs associated with the hybrid project, including onshore grid reinforcement costs;
- the costs associated with pre-investigation and selection of the OWF site;
- the tender process for the OWF included in the hybrid project;
- the RES subsidy scheme in place for the OWF included in the hybrid project;
- the responsibility to pay curtailment compensation to the OWF developer;
- forgone congestion rent, given that an interconnector is part of the hybrid project and is negatively impacted by the development of the hybrid project; and
- the liability for maintaining the availability of the grid.

The benefits from the realisation of a hybrid project that can be considered include, but are not limited to:

- the receipt of RES shares from the production of renewable energy / fulfilment of national RES targets;
- the phasing out of CO_2-emitting generation in the national energy mix;
- the reduction in energy prices from the increased supply of renewable energy;
- the revenues from the additional generation; and
- congestion rents from the exchange of electricity between countries.

In a hybrid project, at least two different countries are involved. Certain costs are initially allocated to one of them, whereas certain benefits might initially be allocated to the other. In addition, hybrid project setups can include disincentives for interconnector developers and OWF developers. These may depend on the geographical, regulatory and technical setup of the project and the mitigation measures chosen for the identified barriers. A coordinated reallocation of costs and benefits may be necessary after the initial allocation.

To allow for hybrid project development where stakeholders are disincentivised by the initial allocation of costs and benefits, agreement should be sought on the principles for the reallocation of costs and benefits. This should be between project developers as well as national regulatory authorities and ministries in the respective countries.

This barrier is relevant for the hybrid projects IJmuiden Ver to UK (Chapter 4.4.3), CGS IJmuiden Ver to Norfolk (Chapter 4.5.3), NSWPH (Chapter 4.7.3), COBRA Cable (Chapter 4.8.3) and DE OWF to NL (Chapter 4.10.3). Please refer to the indicated chapters for the project-specific evaluation of the barrier and barrier mitigation as well as project-specific actions and responsibilities to implement the mitigation.

3.2.16 Uncertainty about legislative regime for power-to-gas and related infrastructure

Power-to-gas and related infrastructure used to integrate renewable power generation with other sectors of the EU energy system is a current topic of research and innovation. The technology converts renewable energy to hydrogen, and in combination with RES, especially in hybrid projects, can provide additional flexibility in terms of transport and storage. However, power conversion to hydrogen and hydrogen transmission do not yet have a dedicated legislative framework at either the national or European level.

- Legislation and regulation for (natural / industrial / chemical) gas infrastructure may be applicable to power conversion to hydrogen and hydrogen transmission to some extent. But this does not account for the potential importance of hydrogen in the future energy market as shares of RES in the energy mix increase.
- Established energy market infrastructure providers, such as electricity and gas TSOs and DSOs, depend on an effective legislative framework to incorporate power conversion to hydrogen into hybrid projects and their service offerings.
- New and / or updated European legislation for power conversion to hydrogen should address unbundling, non-discriminatory access to infrastructure, market arrangements and the regulation of tariffs.

To allow for hybrid project development that incorporates power conversion to hydrogen and hydrogen transmission, new and / or updated legislation targeting the hydrogen sector is necessary.

This barrier is relevant for the hybrid project NSWPH (Chapter 4.10.3). Please refer to the indicated chapters for the project-specific evaluation of the barrier and barrier mitigation as well as project-specific actions and responsibilities to implement the mitigation.

3.3 Barrier interdependencies

In alignment with stakeholders, this study identifies existing interdependencies between the sixteen barriers discussed above. Although the barriers were analysed individually, interdependencies exist between them and must be considered when applying barrier mitigation. This means the selection of a given mitigation option for one barrier may preclude the selection of another option for a second barrier. Since the mitigation options for the barriers are highly project-specific, the interdependencies between the mitigation options are discussed in detail alongside the project-specific Action Plans in Chapter 4. An evaluation of the project-specific mitigation options for each project is presented in Chapter 5, the Appendix to this study.

The following paragraphs briefly outline the barrier interdependencies. An overview of the interdependencies is shown in Figure 12.

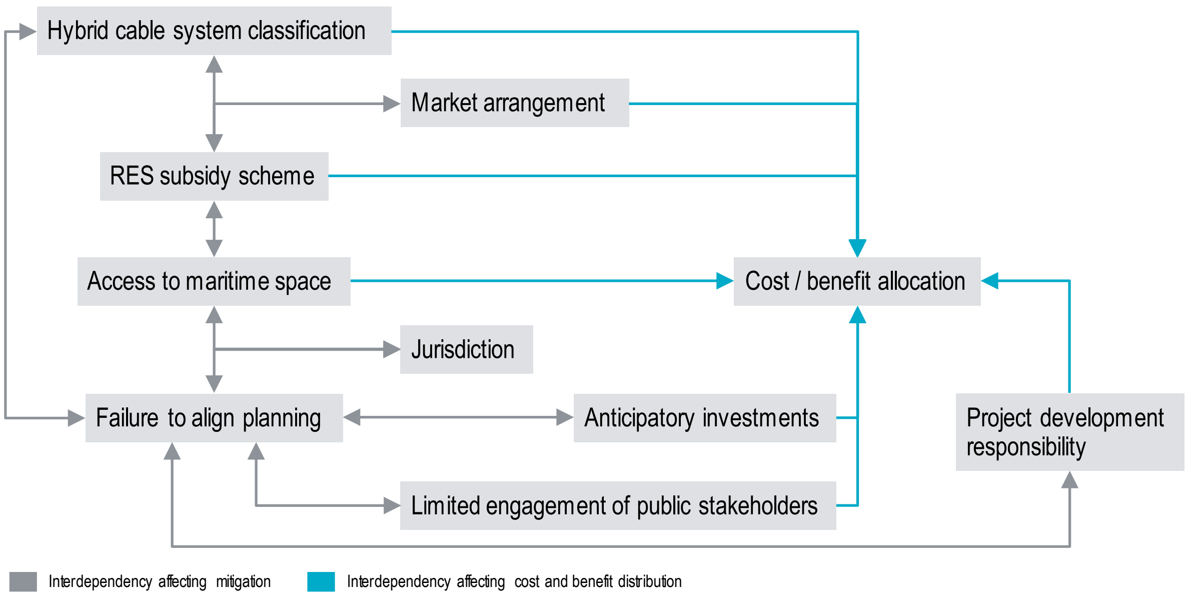


Figure 12: Overview of barrier interdependencies

In general, the choice of the most suitable market arrangement is interdependent with the hybrid cable system classification chosen for the hybrid project's cables, and with the RES subsidy scheme applicable to the OWF. The hybrid cable system classification determines the functionality of the cables included in the project. It thereby affects the transmission conditions of the included OWFs – and vice versa. The transmission conditions of the OWF in turn affect how and at what level an RES subsidy scheme may need to be applied to the OWF – and vice versa.

As RES subsidies are usually awarded in national tender rounds, RES subsidy schemes are interdependent with access to maritime space. The country granting access to maritime space to the OWF is likely to also be the country awarding the subsidy to the OWF.

Alignment on environmental, technical and operational rules under jurisdiction is interdependent with alignment of strict tender requirements for access to maritime space. Furthermore, jurisdiction is interdependent with failure to align planning, as obtaining the required permits and aligning regulation facilitates continuous dialogue and early-stage alignment among developers.

In situations where individual parts of a hybrid project are commissioned significantly earlier than others, the hybrid cable system classification can have an impact on the business case of assets that are already commissioned. As such, the hybrid cable system classification is interdependent with the alignment of planning across assets and countries.

Responsibility for grid connection and / or the development and construction plus operation of interconnectors must be clearly assigned to allow for early-stage alignment and to facilitate continuous dialogue between project developers. Consequently, project development responsibility is interdependent with failure to align planning across assets and countries. In addition, the alignment of planning across assets and countries is interdependent with access to maritime space. This is because the geographical, technical and timing alignment of the OWF included in a hybrid project depends heavily on the permits and licenses granted to the OWF. Furthermore, anticipatory investments need to be considered early in the planning of a hybrid project, both from a technical and timing alignment perspective. Moreover, to assess a hybrid project's early-stage feasibility to align geographical, technical and timing aspects, close collaboration with national and EU funding mechanisms is necessary. It follows that failure to align planning across assets and countries is also interdependent with the engagement of public stakeholders.

Lastly, to choose an appropriate mitigation option for a disproportionate allocation of costs and benefits across involved stakeholders, all barriers that affect a hybrid project's costs and benefits require consideration. Therefore,

- the choice of who is responsible for grid connection and interconnectors is interdependent with this barrier. This is because it defines which stakeholder carries the costs and reaps the benefits of the grid connection and the interconnector in the hybrid setup;
- the choice of market arrangement and the hybrid cable system classification are interdependent with this barrier. This is because both significantly impact the costs and benefits derived by OWF developers and interconnector developers;
- responsibility and rules to provide access to maritime space for OWFs are interdependent with this barrier. This is because location selection, site pre-investigation and tender execution imply costs for the country conducting these activities;
- the choice of an RES subsidy scheme is interdependent with this barrier, as subsidy schemes directly impact the costs and benefits derived by the OWF developers;
- anticipatory investments are interdependent with this barrier, as the remuneration for anticipatory investments presents developers with benefits, and the countries involved with additional costs; and
- limited engagement of public stakeholders is interdependent with this barrier. This is because both the choice of a formalisation of the commitment to a given hybrid project's development and a given hybrid project's public financial support present stakeholders with additional costs and benefits.

3.4 Action Plan for the European Commission

The project-specific Action Plans cover all mitigation measures required to ensure the successful implementation of a specific hybrid project. In addition to these, a separate Action Plan for the European Commission is provided in Figure 13 below. This outlines actions across the considered hybrid projects which necessitate the involvement of the European Commission. It also specifies to what extent the European Commission needs to become active to overcome the barriers described above. It functions as a tool to work towards overcoming the barriers identified.

In its capacity as a supranational institution, the European Commission can act as both a supervisor and a coordinator to encourage all stakeholders to abide by the proposed timelines. Furthermore, it can provide guidance on the compliance of chosen mitigation options with European law, and, if necessary, implement adjustments to European legislation and regulation. Lastly, through its involvement, the European Commission can define a future vision and a clear trend for the future development of the European energy system. Such an energy system may be characterised by sector coupling and the integration of innovative technologies (such as power conversion to gas), all of which is likely to pave the way towards a more efficient, integrated European energy system.

In this regard, he European Commission can engage through the North Seas Energy Cooperation to facilitate coordinated collaboration between stakeholders.

The hybrid project ideas addressed in this study are currently in early development stages, but already include tangible assets and have development timelines in place. As such, both the Action Plan for the European Commission and the project-specific Action Plans foresee the formalisation of mitigation measures for the barriers by the end of 2020. This timeline does not directly apply to the NSWPH hybrid project.

Barrier	2019 / 2020 / 2021	Relevant for hybrid projects	Clarification of role of EC
Project development responsibility	Clarify unbundling exemption for Vattenfall	CGS IJmuiden Ver to Norfolk	EU`s third energy package established unbundling of energy suppliers from network operators. Thus, clarify the possibility of an unbundling exemption for Vattenfall
Market arrangement	Clarify the need for and extent of bidding zone review process	NSWPH, COBRA Cable, DE OWF to NL	Clarify whether a bidding zone review process according to CACM Art. 32 (4) is required and, if so, whether a shortened process might be possible
	Validate whether no additional compensation for cable system operators is required	NSWPH	Support and supervise involved stakeholders regarding cable system compensation
	Assess and agree whether additional compensation for IC operators is required	COBRA Cable	Support and supervise involved stakeholders regarding IC compensation
Hybrid cable system classification	Apply for project-specific exemptions from European regulations	IJmuiden Ver-UK, CGS IJmuiden Ver-Norfolk	Evaluate the application of TSOs and decide whether exemptions from EU regulations is granted
	If required, adjust the regulatory framework on a European level	IJmuiden Ver-UK, CGS IJmuiden Ver-Norfolk	If no exemptions can be granted, provide a EU regulatory framework that allows for successful hybrid project development (e.g. include hybrid definition) in cooperation with the European Parliament and the European Council
	Validate whether no add. compensation for IC operators is required	IJmuiden Ver-UK, CGS IJmuiden Ver -Norfolk	Support and supervise involved stakeholders regarding IC compensation
	Validate whether no additional compensation for cable system operators is required	NSWPH	Support and supervise involved stakeholders regarding cable system compensation
	Assess and agree whether additional compensation for IC operators is required	COBRA Cable	Support and supervise involved stakeholders regarding IC compensation
Public engagement	Align and implement the type of formalisation of public commitment	IJmuiden Ver-UK, CGS IJmuiden Ver -Norfolk, NSWPH, COBRA Cable, DE OWF to NL	Take part in publicly supporting hybrid project through MoU in early project stages. Later, serve as advisor / supervisor for implementing project-specific HANSA
	Support early-stage alignment among developers through public funding	IJmuiden Ver-UK, CGS IJmuiden Ver -Norfolk, NSWPH, COBRA Cable, DE OWF to NL	Provide financial support for feasibility studies, pilot projects as well as R&D to catalyse the development of hybrid projects
	Support de-risking of hybrid project by providing financial guarantees	IJmuiden Ver-UK, CGS IJmuiden Ver -Norfolk, NSWPH, COBRA Cable, DE OWF to NL	Provide financial guarantees to reassure stakeholders in situations which can not be foreseen due to the pilot character of the hybrid project
Allocation of costs / benefits	Ensure consideration of costs and benefits deriving from other barrier mitigations	IJmuiden Ver-UK, CGS IJmuiden Ver -Norfolk, NSWPH, COBRA Cable, DE OWF to NL	Consider all costs / benefits deriving from barrier mitigations where EC is involved to assure an adequate initial allocation of costs and benefits
	Align and agree re-allocation between developers and countries	IJmuiden Ver-UK, CGS IJmuiden Ver -Norfolk, NSWPH, COBRA Cable, DE OWF to NL	Support and supervise the reallocation of costs and benefits among developers and countries
	Validate availability of CEF funding to ensure incentivisation	IJmuiden Ver-UK, CGS IJmuiden Ver -Norfolk, NSWPH, COBRA Cable, DE OWF to NL	Under the premise that hybrid project is a PCI, carry out the evaluation and selection of submitted proposals for CEF funding
Hydrogen legislation	Evaluate existing findings, ongoing legislative efforts and research projects regarding H_2 and sector coupling	NSWPH	Ensure to avoid duplication of work by supporting NSWPH consortium members regarding evaluation of existing findings and research
	Evaluate existing regulation on natural gas and industrial / chemical gas regarding applicability to H_2	NSWPH	Evaluate existing EU regulation on natural / industrial / chemical gas regarding applicability to power conversion to H_2 and H_2 transmission
	Identify key focus areas for future legislative efforts	NSWPH	In cooperation with national ministries and the NSWPH consortium members, identify key focus areas for legislative efforts to prepare for a future legislative framework

Alignment

Figure 13: Barrier mitigation – Action Plan for the European Commission

4. Case studies of selected hybrid projects

Key findings

- The "Project Irish Sea" hybrid project is an adjusted version of an interconnector tie-in concept, connecting an Irish OWF to Ireland and the UK via an interconnector. Implementation of the project results in additional lifetime costs of about EUR 33 m compared to implementation of the reference case. No barrier assessment was conducted for the hybrid project due to the absence of lifetime savings.
- The "Nautilus" hybrid project is an interconnector tie-in concept, with a Belgian OWF connected to the UK and Belgium via the Nautilus interconnector. Implementation of the hybrid project results in additional lifetime costs of about EUR 1,105 m compared to implementation of the reference case. No barrier assessment was conducted for the hybrid project due to the absence of lifetime savings.
- The "UK OWF to BE" hybrid project is a neighbour OWF concept, with a UK OWF radially connected to Belgium. Implementation of the hybrid project results in additional lifetime costs of about EUR 890 m compared to implementation of the reference case. No barrier assessment was conducted for the hybrid project due to the absence of lifetime savings.
- The "IJmuiden Ver to UK" hybrid project is an adjusted version of an interconnector tie-in concept, with a Dutch OWF connected to the Netherlands via an export cable system. An interconnector also links the offshore substation of the Dutch export cable system and the UK market. If barriers are mitigated, implementation of the hybrid project results in lifetime savings of about EUR 400 m compared to implementation of the reference case. Barriers and barrier mitigation measures were assessed in this study and an Action Plan developed for the implementation of mitigation measures. The hybrid project is worth considering and further research by the relevant parties is needed.
- The "CGS IJmuiden Ver to Norfolk" hybrid project is a combined grid solution concept, with an interconnector between the offshore substations of the export cable systems of a UK and a Dutch OWF. It thereby links the UK and the Netherlands. If barriers are mitigated, implementation of the hybrid project results in lifetime savings of about EUR 720 m compared to implementation of the reference case. Barriers and barrier mitigation measures were assessed in this study and an Action Plan developed for the implementation of mitigation measures. The hybrid project is worth considering and further research by the relevant parties is needed.
- The "NeuConnect" hybrid project is an interconnector tie-in concept, with German OWFs connected to the UK and Germany via an interconnector. Implementation of the hybrid project results in lifetime savings of about EUR 47 m compared to implementation of the reference case. No barrier assessment was conducted for the hybrid project due to the relatively low lifetime savings.
- The "North Sea Wind Power Hub" (NSWPH) hybrid project is an offshore hub concept, with a hub near the Dogger Bank area. It links multiple OWFs in its vicinity to the Dutch, German and Western Danish markets. If barriers are mitigated, implementation of the hybrid project results in lifetime savings of about EUR 2.5 bn compared to implementation of the reference case. Barriers and barrier mitigation measures were assessed in this study and an Action Plan developed for the implementation of mitigation measures. The hybrid project is worth considering and further research by the relevant parties is needed.

- The "COBRA Cable" hybrid project is an interconnector tie-in concept, with a German OWF connected to the Netherlands and Denmark via the COBRA Cable interconnector. If barriers are mitigated, implementation of the hybrid project results in lifetime savings of about EUR 390 m compared to implementation of the reference case. Barriers and barrier mitigation measures were assessed in this study and an Action Plan developed for the implementation of mitigation measures. The hybrid project is worth considering and further research by the relevant parties is needed.
- The "CGS DE OWF to NL OWF" hybrid project is a combined grid solution concept, with an interconnector between the offshore substations of the export cable systems of a Dutch and a German OWF. It thereby links the Netherlands and Germany. Implementation of the hybrid project results in additional lifetime costs of about EUR 60 m compared to implementation of the reference case. No barrier assessment was conducted for the hybrid project due to the absence of lifetime savings.
- The "DE OWF to NL" hybrid project is a neighbour OWF concept, with an OWF in a German cluster adjacent to the Dutch EEZ connected to the Netherlands. If barriers are mitigated, implementation of the hybrid project results in lifetime savings of about EUR 260 m compared to implementation of the reference case. Barriers and barrier mitigation measures were assessed in this study and an Action Plan developed for the implementation of mitigation measures. The hybrid project is worth considering and further research by the relevant parties is needed.

To complement the study’s general findings about hybrid project development in the North Seas region, the following chapters use a case study format to summarise the detailed, project-specific findings of the ten hybrid project ideas selected for evaluation. In most cases, the project details, the cost assessment, the results of the market modelling and the project-specific Action Plan are provided. Market modelling is conducted for seven out of the ten hybrid projects. Action Plans are developed for five out of the ten hybrid projects and are intended to be used as a tool by stakeholders once a given hybrid project has been given the go-ahead.

Before detailing the individual projects, it is important to clarify a few (non-exhaustive) qualitative points about the quantitative findings. These are summarised below:

- To help interpret the quantitative results, it is important to note that electrical equipment which is not commercially available was included in the assessment. It is based on a cost multiple, but possibly neglecting required research and development costs. For example, disconnector modules for combining offshore infrastructure were included. These are currently being researched but no conclusion has yet been reached about them.
- Benefits from the utilisation of available interconnector capacity in times of energy scarcity and / or high prices are expected but were not assessed. Such periods often coincide with low RES generation (subject to only minor conflicts of interest regarding usage of interconnector capacity in hybrid setup between the OWF and interconnector).
- To make decisions regarding favourable energy generation and transmission development options, factors other than direct project costs are also important for successful hybrid project development. Such additional factors, for example onshore grid reinforcement costs, must be considered before the beginning of project development but were not considered in this study.
- The impact of offshore developments on municipalities and inhabitants (e.g. through magnetic fields, changes in landscapes etc.), must be evaluated but was not considered in this study. This is particularly important where significant onshore grid reinforcements are required.

- In projects where an OWF is connected to several markets, additional advantages would arise in the event of a fault or congestion at the onshore end of one part of the cable systems. In such a scenario, produced energy could still be transmitted via the other end of the cable system. Thus, generation would not have to halt in the event of a fault or congestion, depending on the commercial and regulatory arrangements allowing for such electricity flows. This additional benefit of a hybrid setup was not assessed in this study.

4.1 Project Irish Sea

The hybrid project idea "Project Irish Sea" is an adjusted version of an interconnector tie-in concept. In the project, an Irish OWF is combined with an interconnector from Ireland to the UK. The onshore substations of the OWF are linked to the onshore transformer station of the interconnector in Ireland. However, the idea shows no lifetime savings compared to the reference case. It may be that other possible benefits from the implementation of the hybrid project compared to the reference case could outweigh the additional costs. But the Project Irish Sea hybrid project is given no detailed further consideration in the scope of this study as any other potential benefits could not be taken into account here.

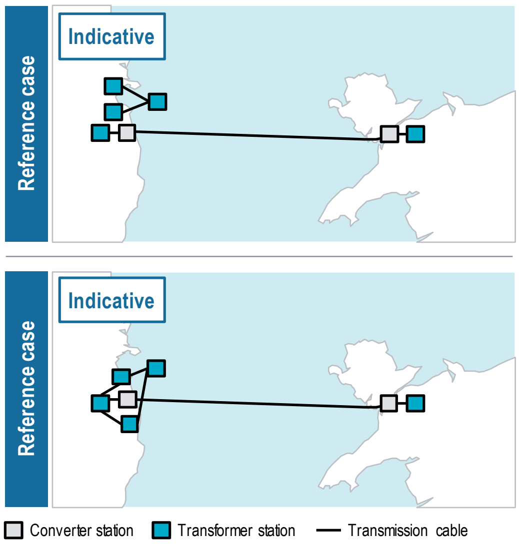
4.1.1 Details of the hybrid project and reference case

The individual assets included in the hybrid project and in the reference case are modelled on the basis of real assets. But the assumed characteristics do not claim to represent the actual characteristics of the assets included in either ongoing or future developments.

In the reference case (Figure 14), the conceptualised interconnector is a stand-alone, point-to-point interconnector between Ireland and the UK. It is constructed based on HVDC technology with 700 MW nominal capacity and a length of 155 km. The conceptualised OWF included in the project idea is located in the Irish EEZ and has a nominal generation capacity of 800 MW. The conceptualised OWF is radially connected to two individual onshore connection points in Ireland. Each of the connecting cable systems consists of a 35 km 220 kV HVAC cable with a nominal capacity of 400 MW. No intermediate offshore transformers are required, as the wind turbines can be connected directly to the high-voltage offshore transformer via the 66-kV array cable system.

In this hybrid project (Figure 14), the conceptualised interconnector is a point-to-point interconnector between Ireland and the UK. It is constructed to the same specifications as in the reference case. The conceptualised OWF is located in the Irish EEZ and has the same specifications as in the reference case. However, in the hybrid project, the onshore substations of the conceptualised OWF are also connected to the onshore transformer station of the interconnector. The two export cable systems each have a length of 45 km. This includes the connection between the onshore substations of the OWF and onshore transformer station of the interconnector. Booth have a nominal capacity of 400 MW.

Geographical mapping



	Reference case	Hybrid case	Difference
Nominal capacity interconnector [MW]			
	700	700	0
Length interconnector [km]			
	155	155	0
Nominal capacity OWF [MW]			
	800	800	0
Length export cable [km]			
	70 (35 + 35)	90 (45 +45)	+ 20
Offshore transformer / converter / switching stations			
	1 / 0 / 0	1 / 0 / 0	0
Onshore transformer / converter stations			
	3 / 2	3 / 2	0

Figure 14: Project Irish Sea – Reference case and hybrid project profile

It is assumed that the development, construction and commissioning of the individual assets (OWF, export cable system and interconnector) are not aligned, as interconnector development requires significantly more time. It is also assumed that the OWF and export cable system will be commissioned in 2028. The interconnector is assumed to be commissioned in 2030, both in the hybrid project and in the reference case.

However, if the commissioning of the OWF, export cable system and interconnector can be aligned, additional benefits can be realised. In the reference case, the onshore substations of the OWF require compensation equipment to feed into the Irish grid. Once onshore connections between the onshore substations of the OWF and the onshore transformation station of the interconnector are in place, the compensation equipment is no longer required. This is because the interconnector capacity can be utilised for compensating the fluctuation in the electricity flow from the OWF. Thus, compared to asynchronous commissioning, simultaneous commissioning of both the OWF and the interconnector would enable savings on the cost of compensation equipment. Asynchronous commissioning requires additional compensation equipment until the commissioning and connection of the OWF to the interconnector.

In general, this hybrid project idea and all development areas and stakeholders are included as examples only as the assessment has been conducted without comprehensive interaction with specific project stakeholders.

4.1.2 Evaluation of hybrid project vs. reference case

To evaluate the hybrid project against the reference case, this study calculates the lifetime savings of the hybrid project. These include the difference in cost and the difference in socio-economic welfare (SEW) between the hybrid project and the reference case. Both the cost assessment – looking at CAPEX and OPEX – and the market modelling-based SEW assessment are based on the technical setup of the hybrid project and the reference case as described in the project details. Additional indicators used in the assessment are energy not served, RES curtailment and CO_2 emissions. CO_2 emissions are internalised in the SEW.

Assuming a typical asset lifetime of 25 years, the hybrid project yields additional lifetime costs of about EUR 33 m compared to the reference case (Figure 15). The additional lifetime costs are driven entirely by an increase in CAPEX and OPEX. OPEX are calculated and discounted over a 25-year period. However, the hybrid project may yield benefits that are not quantified in the scope of this study. These benefits include increased RES shares in the Irish market without added fluctuation of supply, improved transmission conditions for the OWF in the hybrid project and the possibility of avoiding onshore congestion. Onshore congestion can be avoided because the hybrid project setup provides alternative routing for electricity. This takes place via the offshore connection between the two onshore substations of the OWF via the offshore transformer station of the OWF. The SEW is the same for the hybrid project and in the reference case. This is because neither the available interconnector capacity is reduced, nor is the OWF generation curtailed in the hybrid project. Therefore, the SEW has no effect on the lifetime savings of the hybrid project.

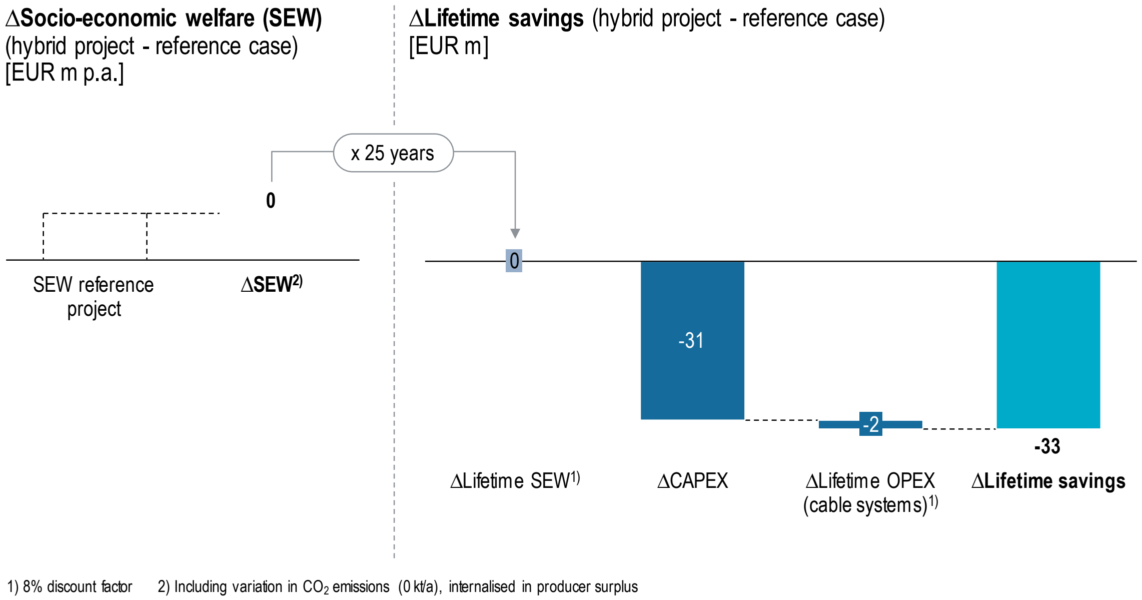


Figure 15: Project Irish Sea – Assessment results[98]

Regarding the cost assessment, the result is driven by the export cable system for which the OWF developer in Ireland is responsible. The costs of the export cable system are higher in the hybrid project than in the reference case. Additional kilometres of export cable system are required in the hybrid project to connect the onshore substations of the OWF to the onshore transformer station of the interconnector. Overall, this results in higher CAPEX and OPEX for the export cable system.

The results of the market modelling are the same for the hybrid project and the reference case. Energy not served is zero in both cases due to the comprehensive nature of, and redundancies in, the European electricity system. Nor is there any difference in curtailment or CO_2 emissions, because OWF electricity generation and interconnection capacities are not affected by the hybrid project setup. As a result, neither setup adversely affects the EU's energy policy target of energy security, nor its

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[98] SEW assessment based on Careri, Francesco. [Forthcoming]. *The impact of North Sea electricity projects in a 2030 scenario: Preliminary assessment of system benefits for the pan-European power system through METIS.* Petten: European Commission Joint Research Centre.

targets regarding the further establishment of the internal energy market and the decarbonisation of the economy.

4.1.3 Development of an Action Plan to overcome barriers

Due to the limited advantage of the hybrid project over the reference case, no project-specific barriers, barrier mitigation measures or Action Plans were assessed or developed.

4.2 Nautilus

The hybrid project idea "Nautilus" is an interconnector tie-in concept. In the project, a Belgian OWF is connected to the UK and Belgian market via the Nautilus interconnector. However, the idea shows additional lifetime costs compared to the reference case, in which the OWF and interconnector are stand-alone assets. Thus, the Nautilus hybrid project is given no detailed further consideration in the scope of this study.

4.2.1 Details of the hybrid project and reference case

The individual assets included in the hybrid project and in the reference case are modelled on the basis of real assets. But the assumed characteristics do not claim to represent the actual characteristics of the assets included in either ongoing or future developments.

In the reference case (Figure 16), Nautilus is a stand-alone, point-to-point interconnector between the UK and Belgium. It is constructed based on HVDC technology with 1,400 MW nominal capacity and a length of 170 km. The OWF included in the project idea is either Site 1 or Site 2 in the Belgian EEZ (still to be tendered), each having a nominal generation capacity of 900 MW. In both cases, the OWF is radially connected to Belgium with a 50 km HVAC export cable system which has a nominal capacity of 900 MW. Like the Modular Offshore Grid (MOG), Site 1 and Site 2 are likely to be connected to shore via a Modular Offshore Grid 2 (MOG 2).[99] However, as the onshore connection concept is still to be defined, a more conservative individual radial connection was assumed in the reference case. No intermediate offshore transformers are required, as the wind turbines can be connected directly to the high-voltage offshore transformer via the 66-kV array cable system.

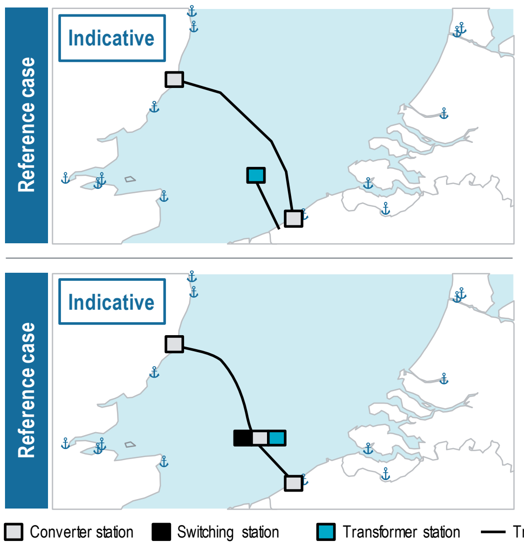
In this hybrid project (Figure 16), Nautilus is a multi-terminal interconnector between the UK and Belgium. It is constructed mostly to the same specifications as in the reference case. However, the length of the interconnector is 210 km due to the rerouting required to allow for the offshore tie-in of the OWF. The OWF (Site 1 or Site 2 in the Belgian EEZ) has the same specifications as in the reference case. It is connected to the interconnector with a very short HVDC export cable system. However, an additional offshore switching station is required to allow for safe connection of the OWF and the interconnector. Due to the rerouting of the interconnector, the hybrid project setup only requires a very short export cable system for the link to the interconnector. The export cable system has a nominal capacity of 900 MW.

For all cable systems, onshore transformer stations are not in the scope of the assessment. As a result, benefits deriving from the hybrid project compared to the reference case – with fewer onshore transformer stations in the hybrid project than in the reference case – have not been considered. Furthermore, onshore grid reinforcement costs are not in the scope of this assessment. But it is important that they are considered before project development would be initiated. The need for

[99] The first wave of Belgian OWFs is connected to shore via the MOG in a coordinated manner. MOG 2 is under consideration to connect the second wave of Belgian OWFs to shore in a similarly coordinated manner.

onshore grid reinforcements can be expected to be lower in the hybrid project compared to the reference case. This is because the OWF does not translate into the need for an additional onshore grid connection point.

Geographical mapping



	Reference case	Hybrid case	Difference
Nominal capacity interconnector [MW]			
	1,400	1,400	0
Length interconnector [km]			
	170	210	+ 40
Nominal capacity OWF [MW]			
	900	900	0
Length export cable [km]			
	50	0	- 50
Offshore transformer / converter / switching stations			
	1 / 0 / 0	1 / 1 / 1	+ 2
Onshore transformer / converter stations			
	0 / 2	0 / 2	0

Figure 16: Nautilus – Reference case and hybrid project profile

It is generally assumed that the development, construction and commissioning of the individual assets (OWF, export cable system and interconnector) can be aligned in the hybrid project to prevent temporarily stranded assets. However, to do so in this case means to delay development of the OWF and the export cable system by three years. This assumes commissioning in 2028 together with the interconnector, instead of 2025 as announced by the Belgian government.

4.2.2 Evaluation of hybrid project vs. reference case

To evaluate the hybrid project against the reference case, this study calculates the lifetime savings of the hybrid project. These include the difference in cost and the difference in socio-economic welfare (SEW) between the hybrid project and the reference case. Both the cost assessment – looking at CAPEX and OPEX – and the market modelling-based SEW assessment are based on the technical setup of the hybrid project and the reference case, as described in the project details. Additional indicators used in the assessment are energy not served, RES curtailment and CO_2 emissions. CO_2 emissions are internalised in the SEW.

Assuming a typical asset lifetime of 25 years, the hybrid project yields significant additional lifetime costs of about EUR 1,105 m compared to the reference case (Figure 17). The additional lifetime costs are driven mostly by an increase of about EUR 1,060 m in CAPEX and OPEX. OPEX are calculated and discounted over a 25-year period. Additionally, a lower hybrid project SEW of EUR 4 m p.a. compared to the reference case translates into additional costs of EUR 45 m from lower lifetime SEW, discounted over 25 years. The small difference in SEW is spread over the entire European electricity system. It is originally driven by the less optimal operational setup of the generation and transmission assets included in the hybrid project compared with the reference case. This means that either available interconnector capacity is reduced or the OWF generation is curtailed, as the two conflict with each other. The result provides a robust basis for the development of an individual radial connection or a MOG 2, as long as both developments are based on HVAC technology.

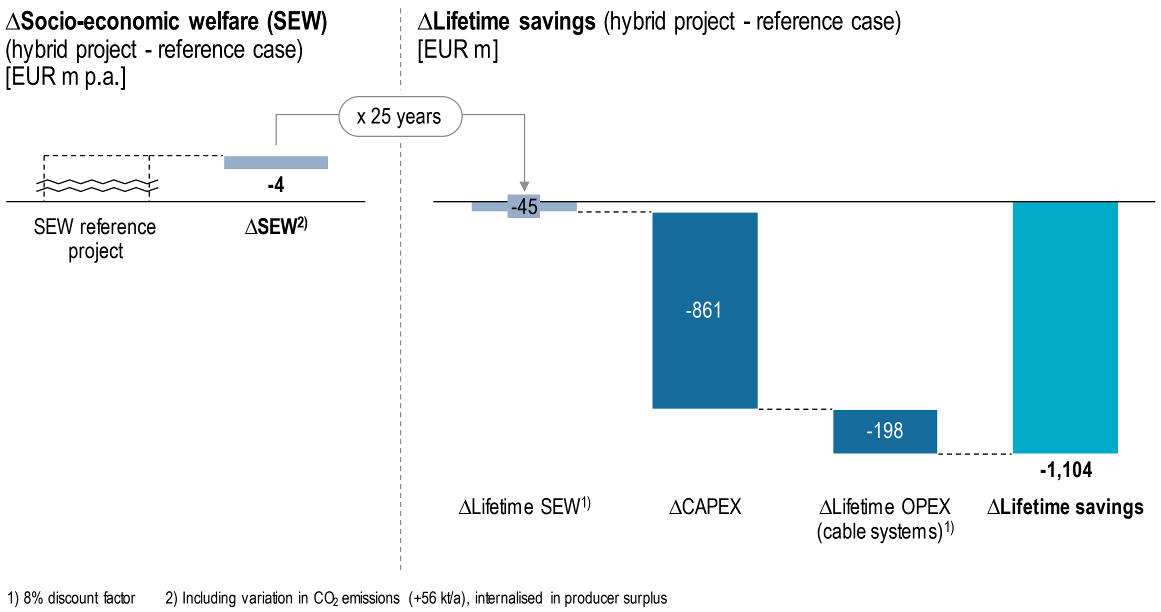


Figure 17: Nautilus – Assessment results[100]

Regarding the cost assessment, the result is driven by the export cable system of the OWF and the interconnector. The cost of the export cable system is higher in the hybrid project than in the reference case. Conversely, the elimination of 50 km of export cable, an additionally required offshore switching station and offshore converter station in the hybrid project compared to the reference case result in higher CAPEX and OPEX for the export cable system. The stations are required to connect the OWF to the interconnector. Furthermore, the cost of the interconnector is higher in the hybrid project than in the reference case. The interconnector must be rerouted to allow for the offshore tie-in of the OWF and retrofitted with multi-terminal technology. These factors result in higher CAPEX and OPEX for the interconnector.

In both the hybrid project and the reference case, energy not served is zero due to the comprehensive nature of and redundancies in the European electricity system. Therefore, neither setup adversely affects the EU's energy policy target of energy security. Compared to the reference case, the effect of the hybrid project on curtailment and CO_2 emissions is very small.[101] This suggests that the hybrid project is unlikely to have a significant impact on the EU's energy policy targets regarding the further establishment of the internal energy market and the decarbonisation of the economy.

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[100] SEW assessment based on Careri, Francesco. [Forthcoming]. *The impact of North Sea electricity projects in a 2030 scenario: Preliminary assessment of system benefits for the pan-European power system through METIS.* Petten: European Commission Joint Research Centre.

[101] The hybrid project generates additional curtailment of 980 MWh/a and additional CO_2 emissions of 56 kt/a (internalised in socio-economic welfare). For more details, please refer to Careri, Francesco. [Forthcoming]. *The impact of North Sea electricity projects in a 2030 scenario: Preliminary assessment of system benefits for the pan-European power system through METIS.* Petten: European Commission Joint Research Centre.

4.2.3 Development of an Action Plan to overcome barriers

Due to the fact that the hybrid project exhibits no advantage over the reference case, no project-specific barriers, barrier mitigation measures or Action Plans were assessed or developed.

4.3 UK OWF to BE

The hybrid project idea "UK OWF to BE" is a neighbour OWF concept. In the project, a UK OWF is radially connected to the Belgian market only. However, the idea shows additional lifetime costs compared to the reference case, in which the OWF is radially connected to the UK market only. Thus, the UK OWF connected to BE hybrid project is given no detailed further consideration in the scope of this study.

4.3.1 Details of the hybrid project and reference case

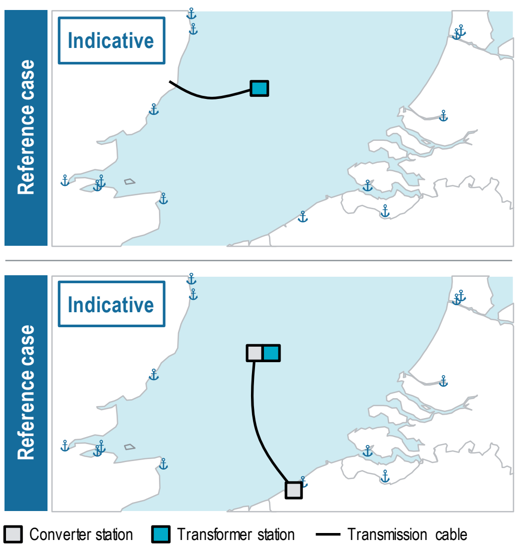
The individual assets included in the hybrid project and in the reference case are modelled on the basis of real assets. But the assumed characteristics do not claim to represent the actual characteristics of the assets included in either ongoing or future developments.

In the reference case (Figure 18), the OWF conceptually included in the project idea is East Anglia One in the UK EEZ. It has a nominal generation capacity of 700 MW. The OWF is radially connected to the UK via a 75 km HVAC export cable system, with a nominal capacity of 700 MW. No intermediate offshore transformers are required, as the wind turbines can be connected directly to the high-voltage offshore transformer via the 66-kV array cable system.

In this hybrid project (Figure 18), the OWF conceptually included in the project idea is East Anglia One in the UK EEZ. It has the same specifications as in the reference case. The OWF is radially connected to Belgium with a 120 km HVDC export cable system, with a nominal capacity of 700 MW.

For all cable systems, onshore transformer stations are not in the scope of the assessment. Furthermore, onshore grid reinforcement costs are not in the scope of this assessment. But it is important that they are considered before project development would be initiated.

Geographical mapping



	Reference case	Hybrid case	Difference
Nominal capacity interconnector [MW]	0	0	0
Length interconnector [km]	0	0	0
Nominal capacity OWF [MW]	700	700	0
Length export cable [km]	75	120	+ 45
Offshore transformer / converter / switching stations	1 / 0 / 0	1 / 1 / 0	+ 1
Onshore transformer / converter stations	0 / 0	0 / 1	+ 1

Figure 18: UK OWF to BE – Reference case and hybrid project profile

It is generally assumed that the development, construction and commissioning of the individual assets (OWF and export cable system) can be aligned in the hybrid project to prevent temporarily stranded assets. It is assumed that both assets will be commissioned in 2028, in both the hybrid project and the reference case.

In general, this hybrid project idea and all development areas and stakeholders are included as examples only as the assessment has been conducted without comprehensive interaction with specific project stakeholders.

4.3.2 Evaluation of hybrid project vs. reference case

To evaluate the hybrid project against the reference case, this study calculates the lifetime savings of the hybrid project. These include the difference in cost between the hybrid project and the reference case. The cost assessment – looking at CAPEX and OPEX – is based on the technical setup of the hybrid project and the reference case as described in the project details. Market modelling was not conducted for this project.

Assuming a typical asset lifetime of 25 years, the hybrid project yields additional lifetime costs of about EUR 890 m compared to the reference case (Figure 19). The additional lifetime costs are driven entirely by an increase in CAPEX and OPEX. OPEX are calculated and discounted over a 25-year period.

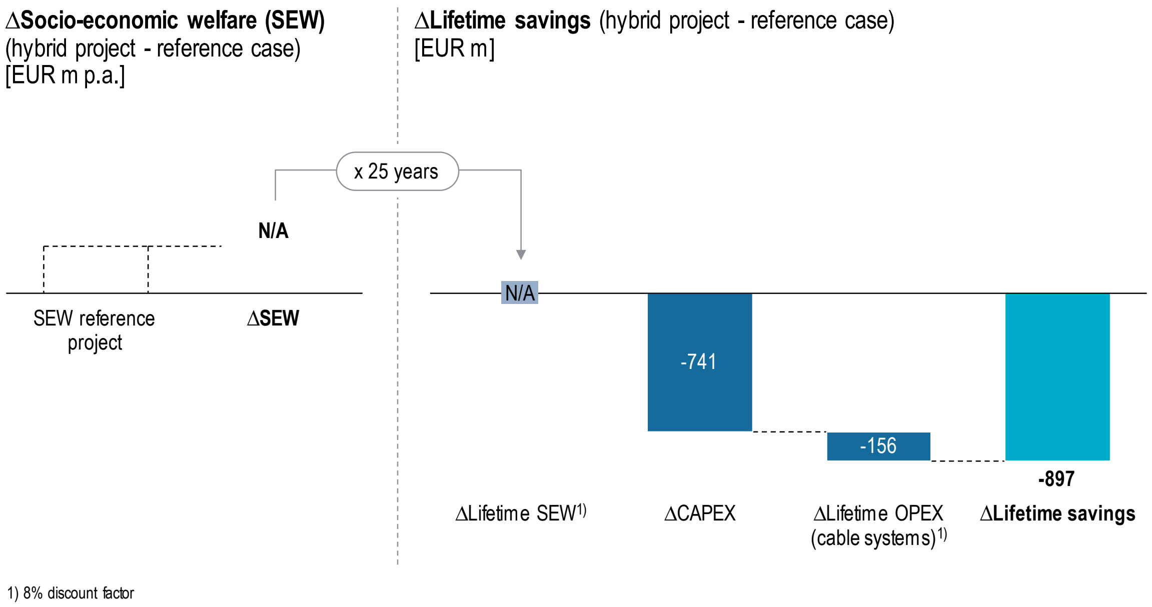


Figure 19: UK OWF to BE – Assessment results

The increase in CAPEX and OPEX is driven by the export cable system of the OWF. The cost of the export cable system is higher in the hybrid project than in the reference case. The need for an additional offshore converter station and onshore converter station, as well as a longer export cable system in the hybrid project compared to the reference case, results in higher CAPEX and OPEX for the export cable system. Due to the increased distance to shore, HVDC technology is required, creating the need for converter stations.

4.3.3 Development of an Action Plan to overcome barriers

Due to the hybrid project showing no advantage over the reference case, no project-specific barriers, barrier mitigation measures or Action Plans were assessed or developed.

4.4 IJmuiden Ver to UK

The hybrid project idea "IJmuiden Ver to UK" is an adjusted version of an interconnector tie-in concept. In the project, a Dutch OWF in the IJmuiden Ver area is connected to the Netherlands via an export cable system. In addition, an interconnector links the offshore substation of the Dutch export cable system and the UK market. The idea shows significant lifetime savings compared to the reference case, in which the OWF and interconnector are stand-alone assets. Thus, the IJmuiden Ver to UK hybrid project is given further consideration in the scope of this study, and an Action Plan for the implementation of barrier mitigation measures is developed. The Action Plan is intended to be used as a tool by stakeholders once the IJmuiden Ver to UK hybrid project has been given the go-ahead.

Both the CGS IJmuiden Ver to Norfolk hybrid project and the IJmuiden Ver to UK hybrid project include the IJmuiden Ver development area and consequently have a similar stakeholder group. However, the projects have different technical and commercial setups and are therefore evaluated separately.

4.4.1 Details of the hybrid project and reference case

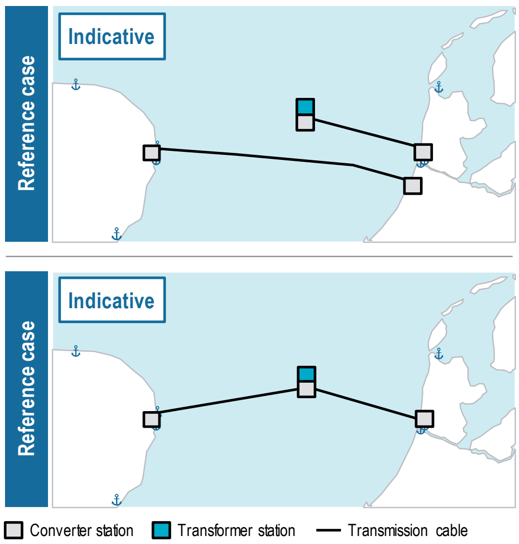
The individual assets included in the hybrid project and in the reference case are modelled on the basis of real assets. But the assumed characteristics do not claim to represent the actual characteristics of the assets included in either ongoing or future developments.

In the reference case (Figure 20), the interconnector is a stand-alone, point-to-point interconnector between the UK and the Netherlands. It is constructed based on HVDC technology with 1,300 MW nominal capacity and a length of 190 km. The OWF included in the project idea is located in the IJmuiden Ver area of the Dutch EEZ and has a nominal generation capacity of 1,300 MW. The OWF is radially connected to the Netherlands via an 80 km HVDC export cable system. No intermediate offshore transformers are required, as the wind turbines can be connected directly to the high-voltage offshore transformer via the 66-kV array cable system. The export cable system has a nominal capacity of 1,300 MW.

In this hybrid project (Figure 20), the interconnector is a point-to-point interconnector between the UK and the offshore substation of the export cable system of the Dutch OWF in the IJmuiden Ver area. It is mostly constructed to the same specifications as in the reference case. However, the length of the interconnector is reduced to 125 km compared to the reference case. The OWF and its export cable system have the same specifications as in the reference case.

For all cable systems, onshore transformer stations are not in the scope of the assessment. As a result, benefits deriving from the hybrid project compared to the reference case – with fewer onshore transformer stations in the hybrid project than in the reference case – have not been considered. Furthermore, onshore grid reinforcement costs are not in the scope of this assessment. But it is important that they are considered before project development would be initiated. The need for onshore grid reinforcements can be expected to be lower in the hybrid project compared to the reference case, as the OWF does not translate into the need for an additional onshore grid connection point.

Geographical mapping



	Reference case	Hybrid case	Difference
Nominal capacity interconnector [MW]			
	1,300	1,300	0
Length interconnector [km]			
	190	125	- 65
Nominal capacity OWF [MW]			
	1,300	1,300	0
Length export cable [km]			
	80	80	0
Offshore transformer / converter / switching stations			
	1 / 1 / 0	1 / 1 / 0	0
Onshore transformer / converter stations			
	0 / 3	0 / 2	- 1

Figure 20: IJmuiden Ver to UK – Reference case and hybrid project profile

It is generally assumed that the development, construction and commissioning of the individual assets (OWF, export cable system and interconnector) can be aligned in the hybrid project to prevent temporarily stranded assets. In line with the expected commissioning of the IJmuiden Ver OWF by 2027, it is assumed that the export cable system and interconnector will be commissioned in 2027. However, the later commissioning of the interconnector would also be possible, as the OWF and export cable system function independently from the interconnector. The assumed commissioning dates are the same for the hybrid project and reference case.

4.4.2 Evaluation of hybrid project vs. reference case

To evaluate the hybrid project against the reference case, this study calculates the lifetime savings of the hybrid project. These include the difference in cost and the difference in socio-economic welfare (SEW) between the hybrid project and the reference case. Both the cost assessment – looking at CAPEX and OPEX – and the market modelling-based SEW assessment are based on the technical setup of the hybrid project and the reference case as described in the project details. Additional indicators included in the assessment are energy not served, RES curtailment and CO_2 emissions. CO_2 emissions are internalised as cost in the SEW.

Assuming a typical asset lifetime of 25 years, the hybrid project yields lifetime savings of about EUR 400 m compared to the reference case (Figure 21). The lifetime savings are driven entirely by a reduction in CAPEX and OPEX of about EUR 460 m. OPEX are calculated and discounted over a 25-year period. However, a lower hybrid project SEW of EUR 5 m p.a. compared to the reference case translates into additional cost from lower lifetime SEW of EUR 60 m, discounted over 25 years. This figure is vastly exceeded by the above-mentioned cost savings, however, so the lifetime savings remain positive. The small difference in SEW is spread over the entire European electricity system. It is originally driven by the less optimal operational setup of the generation and transmission assets included in the hybrid project compared to the reference case. This means that either the available interconnector capacity is reduced or the OWF generation is curtailed, as the two conflict with each other.

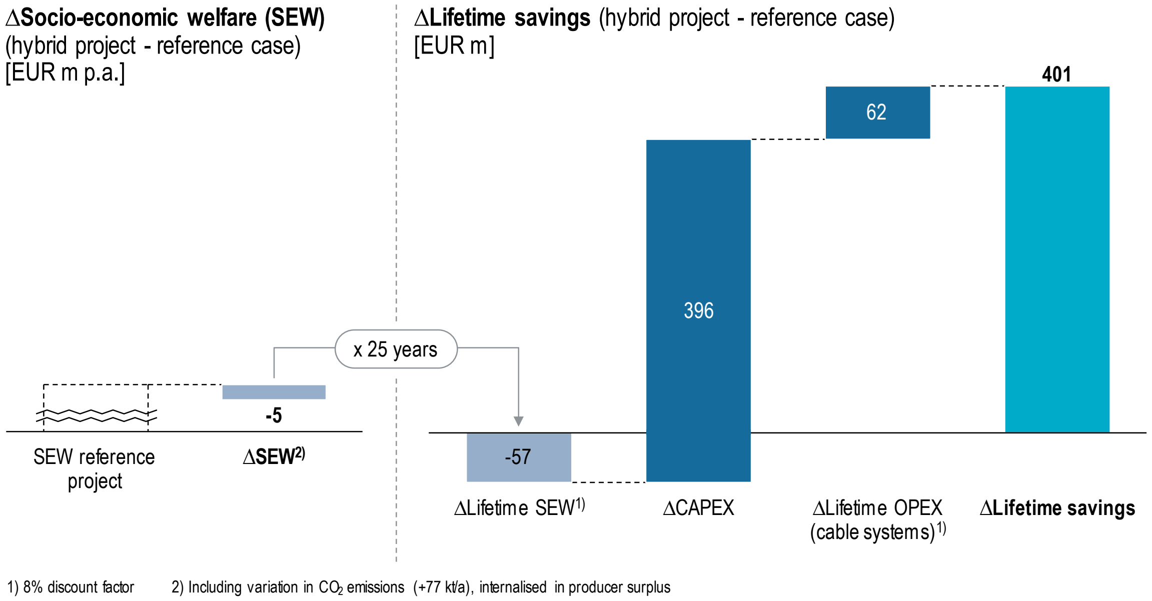


Figure 21: IJmuiden Ver to UK – Assessment results[102]

Regarding the cost assessment, the result is driven by the interconnector only. The cost of the interconnector is lower in the hybrid project than in the reference case. The interconnector requires fewer kilometres of cable in the hybrid project and fewer substations. As the interconnector only links the UK market to the offshore substation of the Dutch export cable system, and does not extend from shore to shore, one onshore converter station and about 65 km of cable are rendered redundant. The hybrid project requires the use of disconnector modules, but the associated costs are negligible compared to the cost savings. The cost of the OWF and its export cable system are the same in the hybrid and the reference case.

In both the hybrid project and reference case, energy not served is zero due to the comprehensive nature of and redundancies in the European electricity system. Therefore, neither setup adversely affects the EU's energy policy target of energy security. Compared to the reference case, the effect of the hybrid project on curtailment and CO_2 emissions is very small.[103] This suggests that the hybrid project is unlikely to have a significant impact on the EU's energy policy targets regarding the further establishment of the internal energy market and the decarbonisation of the economy.

4.4.3 Development of an Action Plan to overcome barriers

This chapter summarises the findings specific to the development of the IJmuiden Ver to UK hybrid project. It builds on the general explanation of the barriers in Chapter 3.2, the general explanation of the interdependencies between barriers in Chapter 3.3 and the findings of project-specific discussions of the barriers and mitigation options in Chapter 5.1.

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[102] SEW assessment based on Careri, Francesco. [Forthcoming]. *The impact of North Sea electricity projects in a 2030 scenario: Preliminary assessment of system benefits for the pan-European power system through METIS.* Petten: European Commission Joint Research Centre.

[103] The hybrid project generates additional curtailment of 1,500 MWh/a and additional CO_2 emissions of 77 kt/a (internalised in socio-economic welfare). For more details, please refer to Careri, Francesco. [Forthcoming]. *The impact of North Sea electricity projects in a 2030 scenario: Preliminary assessment of system benefits for the pan-European power system through METIS.* Petten: European Commission Joint Research Centre.

This study notes that 11 of the 16 identified barriers need to be overcome to allow for the commencement of the IJmuiden Ver to UK hybrid project development. The mitigation measures for 9 of the 11 identified barriers assume that the market arrangement and the RES subsidy scheme applicable to the IJmuiden Ver to UK hybrid project will be validated as follows: The market arrangement foreseen for the IJmuiden Ver to UK hybrid project is that the Dutch OWF transmits its electricity solely to the Dutch market. Therefore, with regard to the hybrid cable system classification, only leftover capacity on the cable systems linking the UK to the Dutch market is available for interconnection. In line with the market arrangement, the RES subsidy scheme applicable to the Dutch OWF is the Dutch RES subsidy scheme (i.e. the SDE+ subsidy scheme with its regular characteristics in terms of type, level and duration of support, as well as the technology coverage). The market arrangement and the RES subsidy scheme as foreseen by the project stakeholders ensure that implementation is highly probable.

Although the barriers are addressed individually, interdependencies exist between them. When developing ways to mitigate one barrier, it is therefore necessary to also consider the mitigation of other barriers. Table 1 provides an overview of the project-specific barriers and barrier mitigation measures, as well as a brief description of the interdependencies to be considered in the development of the individual barrier mitigation measures.

Barrier	Mitigation measure	Interdependencies
Uncertainty about responsibility for project development	Assign responsibility for development and construction as well as operation of the interconnector to a group of players which potentially includes TenneT TSO B.V. and UK interconnector developer	▪ Failure of developers to align planning across assets and countries: clearly assigning responsibility for development, construction and operation of interconnector facilitates continuous dialogue and early-stage alignment
Uncertainty about regulation deriving from jurisdiction over cross-border cable systems	Obtain all required permits and align regulation deriving from concurrent jurisdiction over cross-border cable systems	▪ Failure of developers to align planning across assets and countries: obtaining all required permits and aligning regulation is facilitated by continuous dialogue and early-stage alignment ▪ Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design): aligned regulation relevant for the OWF needs to be reflected in the tender design
Uncertainty about market arrangements	Allow for commercial flows from the OWF included in the hybrid project to the Dutch market only	▪ Uncertainty about hybrid cable system classification: allowing commercial flows only from the OWF to the Dutch market implies defining the export cable system as export cable system with interconnector functionality ▪ Uncertainty about applicable RES subsidy scheme: allowing commercial flows to the

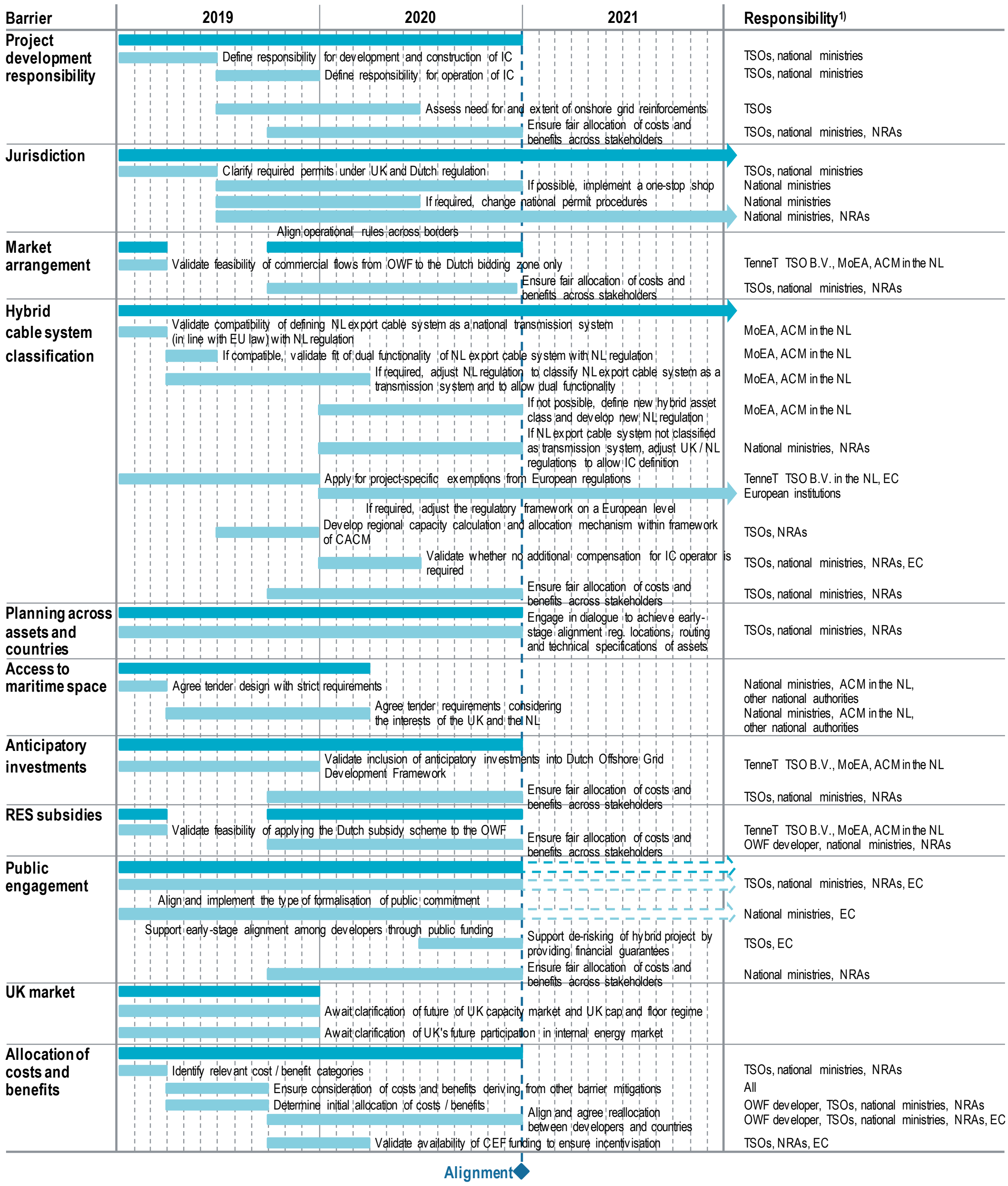
Barrier	Mitigation measure	Interdependencies
		Dutch market only fits with the Dutch subsidy scheme applying to the OWF
Uncertainty about hybrid cable system classification	Define the export cable system as an export cable system with interconnector functionality, which makes it a hybrid cable system, if defining the export cable system as part of the national transmission system is not possible	▪ Uncertainty about market arrangements: export cable system with interconnector functionality fits the foreseen fixed access of OWF to home market ▪ Uncertainty about applicable RES subsidy scheme: export cable system with interconnector functionality fits foreseen national subsidy scheme applying to the OWF
Failure of developers to align planning across assets and countries	Facilitate continuous dialogue and early-stage alignment between the project developers	▪ Uncertainty about responsibility for project development: continuous dialogue and early-stage alignment facilitates clear assignment of responsibility for development, construction and operation of interconnector ▪ Uncertainty about regulation deriving from jurisdiction over cross-border cable systems: continuous dialogue and early-stage alignment facilitates obtaining all required permits and aligning regulation ▪ Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design): continuous dialogue and early-stage alignment are facilitated by an aligned tender design ▪ Lack of regulated revenues for anticipatory investments: continuous dialogue and early-stage alignment among developers is facilitated by validating the availability of regulated revenues for anticipatory investments in the Netherlands ▪ Limited engagement of public stakeholders: continuous dialogue and early-stage alignment are facilitated by formalising public commitment and public funding for feasibility studies, R&D etc.
Uncertainty about responsibility and rules to provide access to maritime	Implement a tender design with strict requirements, which are aligned among the UK and the Netherlands and eliminate all hybrid-specific uncertainties	▪ Uncertainty about regulation deriving from jurisdiction over cross-border cable systems: tender design needs to reflect aligned regulation relevant for the OWF

Barrier	Mitigation measure	Interdependencies
space for OWFs (tender design)		▪ Failure of developers to align planning across assets and countries: aligned tender design is facilitated by continuous dialogue and early-stage alignment ▪ Uncertainty about applicable RES subsidy scheme: tender design in accordance with the rules of Dutch authorities fits with applying a Dutch RES subsidy scheme
Lack of regulated revenues for anticipatory investments	Validate the feasibility of regulated revenues for anticipatory investment under the regulatory regimes in the Netherlands	▪ Failure of developers to align planning across assets and countries: certainty about regulated revenues for anticipatory investments in the Netherlands is facilitated by continuous dialogue and early-stage alignment
Uncertainty about applicable RES subsidy scheme	Apply the Dutch RES subsidy scheme to the OWF included in the hybrid project	▪ Uncertainty about market arrangements: the business case of the OWF and thereby the level of required subsidies are affected by allowing for commercial flows to the Dutch market only ▪ Uncertainty about hybrid cable system classification: the business case of the OWF and thereby the level of required subsidies are affected by defining the export cable system as export cable system with interconnector functionality ▪ Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design): applying a Dutch RES subsidy scheme fits with tender design in accordance with the rules of Dutch authorities
Limited engagement of public stakeholders	Formalise public commitment in the form of a project-specific MoU or HANSA. Also, facilitate feasibility studies and scoping studies for early-stage alignment through public funding, for example	▪ Failure of developers to align planning across assets and countries: formalising public commitment and public funding for feasibility studies, R&D etc. is facilitated by continuous dialogue and early-stage alignment
Uncertainty regarding UK market	Await clarification of the future of UK policies and intended future interaction with the EU's internal energy market	▪ No interdependencies to be considered

Barrier	Mitigation measure	Interdependencies
Disproportionate allocation of costs and benefits across involved stakeholders	Reallocate costs and benefits deriving from the hybrid project where required based on a project-specific process	▪ Uncertainty about responsibility for project development (responsibility for interconnector): costs and benefits deriving from mitigation to be considered ▪ Uncertainty about market arrangements: costs and benefits deriving from mitigation to be considered ▪ Uncertainty about hybrid cable system classification: costs and benefits deriving from mitigation to be considered ▪ Lack of regulated revenues for anticipatory investments: costs and benefits deriving from mitigation to be considered ▪ Uncertainty about applicable RES subsidy scheme: costs and benefits deriving from mitigation to be considered ▪ Limited engagement of public stakeholders: costs and benefits deriving from mitigation to be considered

Table 1: IJmuiden Ver to UK – Barriers, barrier mitigation measures and interdependencies

Combining all the measures needed to mitigate the barriers of relevance to the IJmuiden Ver to UK hybrid project creates an Action Plan that supports the commencement of the development. In addition to placing the required actions on a timeline, the Action Plan also details the stakeholders responsible for each of the actions (Figure 22). The Action Plan is intended to be used as a tool by stakeholders once the IJmuiden Ver to UK hybrid project has received the go-ahead.



1) Responsible stakeholders are OWF developer: tbd in the NL; TSOs: tbd in the UK and TenneT TSO B.V. in the NL; Ministries: BEIS in the UK, MoEA in the NL; NRAs: Ofgem in the UK, ACM in the NL; Other national authorities: Crown Estate in the UK, RVO in the NL; European institutions: European Commission, European Parliament, European Council, European Court of Justice

Figure 22: IJmuiden Ver to UK – Action Plan

The barriers and mitigation measures specific to the IJmuiden Ver to UK hybrid project as well as the actions required to implement the identified mitigation measures are explained in more detail in the subchapters below. As part of the work on barrier mitigation, a project-specific Memorandum of Understanding (MoU) or a project-specific Hybrid Asset Network Support Agreement (HANSA) were considered. Both types of formal commitment to address barriers can include all actions for mitigation measures of relevance to the IJmuiden Ver to UK hybrid project. Thus, it can be sufficient to set up only one type.

Uncertainty about responsibility for project development

Project-specific barrier evaluation: The definition of responsibility for the interconnector and for the grid connections of the OWF will determine who is responsible for the development of the IJmuiden Ver to UK hybrid project.

One party is responsible for the development, construction and operation of the interconnector linking the UK market and the offshore substation of the Dutch export cable system. The definition of which party is responsible for this is determined neither by European law nor by national law, and therefore needs to be aligned between project developers and other stakeholders.

The OWF site is in the Dutch EEZ, where TenneT TSO B.V. is generally responsible for the grid connection based on Dutch law.[104] This responsibility does not need to be reviewed. Thus, there is also no uncertainty regarding the applicability of Dutch first connection charges (shallow approach) and Dutch G-charges (no G-charge) for the OWF.[105]

Barrier mitigation: The mitigation option identified as most feasible for the interconnector is to define a group of players, which potentially includes TenneT TSO B.V. and a UK interconnector developer, who would be responsible for development and construction, as well as operation. This is based on consideration of the interdependencies shown in Table 1, interaction with project stakeholders (see Chapter 5.1.1) and the ease of implementation in terms of the required effort.

The other mitigation option considered in this study was to designate TenneT TSO B.V. as the party responsible for development and construction as well as operation of the interconnector.

The mitigation option identified as most feasible was selected for the following reason: Both mitigation options are covered under existing legislation and regulation. However, the involvement of a potential UK interconnector developer has the advantage of providing further expertise about the development, construction and operation of a cable system connected to the UK market. This is in addition to the expertise TenneT TSO B.V. has gained from the development, construction and operation of the BritNed interconnector (operated together with National Grid Ventures). Even so, the selected mitigation option necessitates additional alignment between TenneT TSO B.V. and the UK interconnector developer to develop and construct the cable system as well as to ensure efficient operation of the cable system.

Irrespective of which mitigation option is selected, this barrier is interdependent with the "failure of developers to align planning across assets and countries" barrier. Clearly defining responsibility for the development and construction as well as operation of the interconnector requires continuous dialogue and early-stage alignment on the hybrid project setup among the defined project promoters. Clearly defined responsibilities and continuous dialogue and alignment, in turn, allow for the commencement of project development.

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[104] Dutch Elektriciteitswet 1998. §4 Article 24Aa. https://wetten.overheid.nl/BWBR0009755/2018-07-28#Hoofdstuk3_Paragraaf4_Artikel24Aa

[105] ENTSO-E. 2018. *Overview of transmission tariffs in Europe: Synthesis 2018.* https://docstore.entsoe.eu/Documents/MC%20documents/TTO_Synthesis_2018.pdf;
The European Wind Energy Association. 2016. *Position paper on network tariffs and grid connection regimes.* http://www.ewea.org/fileadmin/files/library/publications/position-papers/EWEA-position-paper-on-harmonised-transmission-tariffs-and-grid-connection-regimes.pdf

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the IJmuiden Ver to UK hybrid project, the following actions are required:

- Based on the mitigation option of spreading responsibility for the interconnector over a group of players, define who is responsible for development and construction of the interconnector. Options for the allocation of responsibilities include, for example, making TenneT TSO B.V. and a UK interconnector developer responsible for development and construction. With regard to TenneT TSO B.V., validate whether the offshore TSO TenneT TSO B.V., as a separate legal entity from the onshore TSO, is responsible.[106] This can be achieved through voluntary cooperation between TenneT TSO B.V. (and a potential UK interconnector developer) as well as the national ministries and NRAs (the BEIS and Ofgem in the UK, and the MoEA and ACM in the Netherlands).
- Based on the mitigation option of spreading responsibility for the interconnector over a group of players, define who is responsible for operation of the interconnector. Options for the allocation of responsibilities include, for example, making TenneT TSO B.V. and a UK interconnector developer responsible for operation. This can be achieved through voluntary cooperation between TenneT TSO B.V. (and a potential UK interconnector developer), as well as the national ministries and NRAs (the BEIS and Ofgem in the UK, and the MoEA and ACM in the Netherlands).
- Assess the need for and extent of onshore grid reinforcements in the UK to allow for the operation of the interconnector between the UK market and the offshore substation of the export cable system of the IJmuiden Ver OWF. This action can be achieved through voluntary cooperation between TenneT TSO B.V. and a National Grid, the UK onshore TSO.
- Ensure compatibility with measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the UK and the Netherlands of costs and benefits deriving from shared responsibility for the interconnector. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. TenneT TSO B.V. (and a potential UK interconnector developer) as well as the national ministries and NRAs (the BEIS and Ofgem in the UK, and the MoEA and ACM in the Netherlands) assume responsibility for this action.

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 23. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 22.

[106] In the Netherlands, TenneT TSO B.V. holds the licenses needed to act as both onshore TSO and offshore TSO. Clarification is therefore needed whether the interconnector would be developed by the offshore or the onshore TSO. Formally, the two are separate grid operators with different regulatory frameworks for the different assets. So far, the initiative for interconnection development has been with the offshore TSO.

Barrier	Mitigation measure	Actions
Uncertainty about responsibility for project development	> Assign responsibility for interconnector to group of players	> Define responsibility for construction and operation of IC > Assess need for and extent of onshore grid reinforcements > Ensure fair allocation of costs and benefits across stakeholders

Figure 23: IJmuiden Ver to UK barrier mitigation – Uncertainty about responsibility for project development

Uncertainty about regulation deriving from jurisdiction over cross-border cable systems

Project-specific barrier evaluation: The OWF included in the IJmuiden Ver to UK hybrid project idea is located in the Dutch EEZ. The OWF serves to exploit marine resources within the Dutch EEZ and its onshore connection point is located in the Netherlands (and thereby a cable system between the OWF and the onshore connection point does not cross any maritime boundary). As such, the Netherlands has jurisdiction over the OWF installation and the corresponding export cable system belonging to the included OWF.

The interconnector has its connection points on the UK shore and at the offshore substation of the Dutch export cable system. It therefore crosses the UK territorial sea and EEZ as well as the Dutch EEZ. Both the UK and the Netherlands have jurisdiction over the cable and can determine applicable regulations. Thus, jurisdiction over the interconnector might be concurrent and the regulations applicable to the interconnector derived from UK and from Dutch jurisdiction might contradict each other.

Barrier mitigation: The mitigation option identified as most feasible is to obtain all required permits and to align regulation deriving from concurrent jurisdiction over the operation of the cross-border cable system between the countries involved. This is based on consideration of the interdependencies shown in Table 1, interaction with project stakeholders (see Chapter 5.1.2) and the ease of implementation in terms of the required effort.

The other mitigation options besides aligning regulation deriving from concurrent jurisdiction considered in this study were (1) to define regulation deriving from UK jurisdiction as applicable to the interconnector during operation, and (2) to define regulation deriving from Dutch jurisdiction as applicable.

The mitigation option identified as most feasible was selected for the following reasons: While UK jurisdiction is applicable to the interconnector across all relevant maritime zones (UK territorial sea, UK EEZ and Dutch EEZ), operational rules must also be aligned with Dutch regulation. This is due to the connection of a Dutch export cable system to the interconnector. Thus, the selected mitigation option of aligning operational rules deriving from concurrent jurisdiction benefits from the redundancy of further alignment to allow for the connection of the interconnector to the Dutch export cable system. In addition, the selected mitigation option considers the interests of the UK and the Netherlands and can build on existing agreements established for interconnectors between the UK and the Netherlands, such as BritNed. Dutch jurisdiction is not applicable in the relevant maritime zones crossed by the interconnector.

Regarding interdependencies, this barrier is interdependent with the "failure of developers to align planning across assets and countries" and "uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)" barriers. Obtaining all required permits and aligning regulation is facilitated by continuous dialogue and early-stage alignment. Furthermore, aligned operational regulation needs to be reflected in the requirements of the OWF tender.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the IJmuiden Ver to UK hybrid project, the following actions are required:

- For development and construction, clarify the permits needed for the interconnector under UK and Dutch regulations. Compliance with the environmental and technical rules under UK and Dutch regulations can be ensured by obtaining these permits. This can be achieved through voluntary cooperation between TenneT TSO B.V. (and a potential UK interconnector developer) and the national ministries (the BEIS, supported by Marine Management Organisation and The Crown Estate, in the UK, and the MoEA in the Netherlands).
- If possible, implement a one-stop shop on national level to allow for a coordinated process with only one permit required for the interconnector. As stipulated in Regulation (EU) 347/2013,[107] a one-stop shop in terms of a competent authority that integrates or coordinates all permit granting processes should reduce process complexity, as well as increase efficiency and transparency. The scope of a one-stop shop could be extended to provide a consolidated database of environmental data, facilitating easy data exchange between countries. However, the longer-term benefits are accompanied by significant shorter-term setup costs. So, the feasibility of implementing this action in the scope of mitigating barriers to the IJmuiden Ver to UK hybrid project is questionable. Certainty about the implementation can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands, if feasible. The national ministries would assume responsibility for this action (the BEIS, supported by the Environment Agency, in the UK, and the MoEA, supported by the Ministry of Infrastructure and Water Management, in the Netherlands).
- If required, change the national permit procedures for the specific hybrid project. Guidance from project-specific developers in the form of an inventory of environmental and technical rules is required to inform changes to the permit procedures. Certainty about changes can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. The national ministries would assume responsibility for this action (the BEIS, supported by Marine Management Office and Environment Agency, in the UK, and the MoEA, supported by the Ministry of Infrastructure and Water Management, in the Netherlands).
- For the operational phase, align the applicable national regulations arising from concurrent jurisdiction for the specific hybrid project. The required alignment may concern liability issues, control system operations (voltage levels, grid synchronisation etc.) and matters discussed in relation to other barriers. Also consider existing national and EU legal frameworks such as System Operations regulation (Regulation (EU) 2017/1485)[108] and the CACM regulation (Regulation (EU) 2015/1222).[109] Guidance from project-specific developers is required to inform the alignment. Certainty about the alignment of operational rules can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. The

[107] European Parliament, European Council. 2013. *REGULATION (EU) No. 347/2013 on guidelines for trans-European energy infrastructure.* (29). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0347&from=en

[108] European Commission. 2017. *COMMISSION REGULATION (EU) 2017/1485 establishing a guideline on electricity transmission system operation.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R1485&from=DE

[109] European Commission. 2015. *COMMISSION REGULATION (EU) 2015/1222 establishing a guideline on capacity allocation and congestion management.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1222&from=EN

national ministries and NRAs assume responsibility for this action (the BEIS and Ofgem in the UK, and the MoEA and ACM in the Netherlands).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 24. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 22.

Barrier	Mitigation measure	Actions
Uncertainty about regulation deriving from jurisdiction over cross-border cable systems	> Obtain required permits for development and construction of interconnector > Align rules and regulations for operation of interconnector	> Clarify required permits > If possible, implement a one-stop shop > If required, change national permit procedures > Align applicable national regulations (operational rules)

Figure 24: IJmuiden Ver to UK barrier mitigation – Uncertainty about regulation deriving from jurisdiction over cross-border cable systems

Uncertainty about market arrangements

Project-specific barrier evaluation: Clarification of commercial flows is required as the potential OWF site of the IJmuiden Ver to UK hybrid project is located in the Dutch EEZ, whereas the onshore grid connection points are in the UK and the Netherlands. Thus, commercial flows to both the UK and the Dutch markets are possible, and commercial flows for the OWF included in the hybrid project must be clarified.

Barrier mitigation: The mitigation option identified as most feasible is to allow for commercial flows from the OWF included in the hybrid project to the Dutch market only. Therefore, only leftover capacities are available for interconnection and the OWF can transmit its electricity to the Dutch market with priority. This is based on consideration of the interdependencies shown in Table 1 and the ease of implementation in terms of the required effort.

Since this market arrangement was identified as most feasible in interaction with project stakeholders from the beginning, no other mitigation options were considered in detail.

Regarding interdependencies, this barrier is interdependent with the barriers "uncertainty about hybrid cable system classification" and "uncertainty about applicable RES subsidy scheme". Efficient commercial flows from the OWF to the Dutch market only imply defining the export cable system as an export cable system with interconnector functionality. In addition, such a definition may affect the business case of the OWF included in the hybrid project and thereby the level of required subsidies.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the IJmuiden Ver to UK hybrid project, the following actions are required:

- Validate the feasibility of defining the market arrangement as commercial flows from the project's OWF to the Dutch market only. This can be achieved through voluntary cooperation between TenneT TSO B.V., the MoEA and ACM in the Netherlands.
- Ensure compatibility with measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the UK and the Netherlands of costs and benefits deriving from the market arrangement. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. TSOs, the national ministries and

NRAs (the BEIS and Ofgem in the UK, and TenneT TSO B.V., the MoEA and ACM in the Netherlands) assume responsibility for this action.

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 25. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 22.

Figure 25: IJmuiden Ver to UK barrier mitigation – Uncertainty about market arrangements

Uncertainty about hybrid cable system classification

Project-specific barrier evaluation: The export cable system included in the IJmuiden Ver to UK hybrid project functions as a hybrid cable system, as it serves two distinct and legally differentiated functions. According to Regulation (EC) 714/2009,[110] an interconnector is defined as "a transmission line which crosses or spans a border between Member States and which connects the national transmission systems of the Member States." A conventional export cable system provides for the transmission of electricity generated by the OWF to an onshore connection point without crossing borders. In the hybrid setup, the export cable system provides for the transmission of electricity generated by the OWF and market-to-market flows. Such dual functionality prevents the straight-forward classification of the cable system under EU and national legislation and regulations as either an export cable system or an interconnector.

The interconnector included in the hybrid project, i.e. the cable connection from the UK market to the offshore substation of the Dutch export cable system, functions solely as an interconnector. This is because the Dutch OWF transmits electricity to the Dutch market only (market arrangement as foreseen by the project developers). However, this definition is based on the following assumption: a cable system which does not connect two national transmission systems can still be defined as an interconnector when one end is connected to the offshore substation of the Dutch export cable system.

Barrier mitigation: The mitigation option identified as most feasible is to define the export cable system as an export cable system with interconnector functionality. This effectively makes the setup a hybrid cable system. The transmission of power generated by the OWF has priority regarding access to the cable system capacity and only leftover capacity is available for interconnection. This is based on consideration of the interdependencies shown in Table 1, interaction with project stakeholders (see Chapter 5.1.4) and the ease of implementation in terms of the required effort.

The other mitigation option considered in this study was to define the Dutch export cable system as an interconnector with export cable functionality for leftover capacities.

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[110] European Parliament, European Council. 2009. *REGULATION (EC) No. 714/2009 on conditions for access to the network for cross-border exchanges in electricity.* Article 2 (1). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R0714&from=EN

The mitigation option identified as most feasible was selected for the following reasons: For both mitigation options, it is questionable whether they are covered under Dutch regulation. This is because Dutch regulation does not expressly prohibit the dual functionality of a cable system. From a European perspective, however, hybrid cable systems are not covered by existing regulations, and exemptions or, if necessary, adjustments are required for both options. Thus, the mitigation option was selected due to its interdependencies with other barriers, as explained below.

Regarding interdependencies, defining the Dutch export cable system as an export cable system with interconnector functionality for leftover capacities fits the envisaged market arrangement and RES subsidy scheme. This is because it gives the Dutch OWF priority access to the capacity of the Dutch export cable system for the transmission of generated electricity to the Dutch market. As a result, the chosen classification of the export cable system has no impact on the business case of the OWF in the hybrid project. But it does impact the business case of the interconnector when compared to a conventional point-to-point interconnector. Therefore, the requirement for additional compensation for the interconnector operator needs to be assessed. In addition, the European energy policy targets of diversifying and integrating RES as well as reducing greenhouse gas emissions are prioritised when defining the Dutch export cable system as an export cable system whose leftover capacities are available for interconnection.

<u>Actions and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the IJmuiden Ver to UK hybrid project, the following actions are required:

- Validate whether defining the Dutch export cable system as a national transmission system – in line with the definition in EU legislation and regulations – complies with Dutch regulations.[111] This is required to allow the cable system between the UK market and the offshore substation of the export cable system of the Dutch OWF to be defined as an interconnector within the meaning of EU regulations. In addition, validate that an export cable system defined as a national transmission system is legally allowed, under Dutch regulations, to provide for both the transmission of electricity from the Dutch OWF to shore and for interconnection flows. Lastly, assess whether TenneT TSO B.V., as an offshore grid operator, should be allowed to develop interconnection capacity (due to the leftover capacity on the export cable system being available for interconnection) for which it currently needs an explicit mandate from the MoEA. This can be achieved through voluntary cooperation between the MoEA and ACM in the Netherlands, initiated by TenneT TSO B.V.
- If required, preferably adjust Dutch regulations for the specific hybrid project to classify the export cable system as a national transmission system. This should allow both the transmission of electricity from the OWF and interconnection flows. If this is not possible, allow the same dual functionality by defining a new hybrid asset class and developing new regulation for that asset class. Guidance from project-specific developers is required to inform the adjustment of Dutch regulation. Certainty about changes can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. The MoEA and ACM in the Netherlands assume responsibility for this action.
- If required, adjust UK and Dutch regulations for the specific hybrid project to change the definition of an interconnector. Despite the fact the cable system does not connect two national transmission systems, this would allow the cable system between the UK market and the offshore

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[111] Dutch Elektriciteitswet 1998. §1 Article 15a. https://wetten.overheid.nl/BWBR0009755/2018-07-28#Hoofdstuk3_Paragraaf1_Artikel15a
Dutch Elektriciteitswet 1998. §1 Article 1 (as). https://wetten.overheid.nl/BWBR0009755/2018-07-28#Hoofdstuk1_Paragraaf1_Artikel1

substation of the Dutch export cable system to be defined as an interconnector. Certainty about changes can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. The national ministries and NRAs assume responsibility for this action (the BEIS and Ofgem in the UK, and the MoEA and ACM in the Netherlands).

- On a European level, apply for project-specific exemptions from existing European regulation based on the pilot character of the hybrid project. One exemption could possibly concern the definition of a cable system as an interconnector which does not connect two national transmission systems. Another could possibly concern the EU's requirement to make the maximum capacity of interconnectors available for access by third parties.[112] This can be achieved through voluntary cooperation between TenneT TSO B.V. and the European Commission, initiated by the project developers (TenneT TSO B.V.).
- If required, adjust the EU's regulatory framework such that it facilitates hybrid project development. For example, incorporate a hybrid cable system definition in Regulation (EC) 714/2009.[113] Also clarify how the hybrid project's requirements fit with the stipulation of free usage of the "maximum capacity" of interconnectors by third parties. Guidance from project-specific developers is required to inform the adjustment of the existing regulatory framework. Initiated by EU Member States, this can be achieved through the harmonisation of the EU's regulatory framework by the European Commission, the European Parliament and the European Council. The European Court of Justice, which interprets and clarifies existing European law,[114] may need to clarify "maximum capacity" in this context.
- Develop a regional capacity calculation and allocation mechanism that accounts for the hybrid cable system classification (export cable system with interconnector functionality) within the framework of the existing CACM regulation (Regulation (EU) 2015/1222).[115] This can be achieved through voluntary cooperation between TenneT TSO B.V. (and a potential UK interconnector developer) and NRAs (Ofgem in the UK and ACM in the Netherlands).
- Validate whether no additional compensation for the interconnector operator is required, as the interconnector is developed as part of the hybrid project from the beginning. However, the OWF developer is compensated through a RES subsidy scheme by bidding for the required subsidy level in a competitive process. For this, the OWF developer needs clarity on the market conditions applicable to the OWF in the future. The former can be achieved through voluntary cooperation between TenneT TSO B.V. (and a potential UK interconnector developer), national ministries and NRAs (the BEIS and Ofgem in the UK, and the MoEA and ACM in the Netherlands) as well as the European Commission.
- Ensure compatibility with measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the

[112] European Parliament, European Council. 2009. *REGULATION (EC) No. 714/2009 on conditions for access to the network for cross-border exchanges in electricity.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R0714&from=EN

[113] European Parliament, European Council. 2009. *REGULATION (EC) No. 714/2009 on conditions for access to the network for cross-border exchanges in electricity.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R0714&from=EN

[114] European Commission. 2018. *Court of Justice of the European Union (CJEU).* https://europa.eu/european-union/about-eu/institutions-bodies/court-justice_en

[115] European Commission. 2015. *COMMISSION REGULATION (EU) 2015/1222 establishing a guideline on capacity allocation and congestion management.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1222&from=EN

UK and the Netherlands of costs and benefits deriving from the hybrid cable system classification. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. TenneT TSO B.V. (and a potential UK interconnector developer) as well as national ministries and NRAs (the BEIS and Ofgem in the UK, and the MoEA and ACM in the Netherlands) assume responsibility for this action.

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 26. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers and in Figure 22.

Barrier	Mitigation measure	Actions
Uncertainty about hybrid cable system classification	> Define the export cable system as an export cable system with interconnector functionality, which makes it a hybrid cable system, provided that defining the export cable system as part of the national transmission system is not possible	> Validate compatibility of defining NL export cable system as a national transmission system (in line with EU law) with NL regulat. > If compatible, validate fit of dual functionality of NL export cable system with NL regulation > If required, adjust NL regulation to classify NL export cable system as a transmission system and to allow dual functionality > If not possible, define new hybrid asset class and develop new NL regulation > If NL export cable system is not classified as transmission system, adjust UK and NL regulations to allow IC definition > Apply for project-specific exemptions from EU regulations > If required, adjust regulatory framework on European level > Develop regional capacity calculation, allocation mechanism > Validate whether no additional compensation for IC operator is required > Ensure fair allocation of costs and benefits across stakeholders

Figure 26: IJmuiden Ver to UK barrier mitigation – Uncertainty about hybrid cable system classification

Failure of developers to align planning across assets and countries

<u>Project-specific barrier evaluation:</u> The IJmuiden Ver to UK hybrid project is complex. This is due to the inclusion of a Dutch OWF, an export cable system to the Dutch market and an interconnector linking the UK market to the offshore substation of the Dutch export cable system. As all three assets have separate permit, development and construction timelines, geographical alignment is crucial. For example, the location of the offshore substation of the export cable system in the Netherlands must align with the route of the interconnector such that the interconnector can be added later. In addition, interoperability between the different components of the three assets must be ensured, based on the alignment of technical specifications to enable the hybrid project to function.

Barrier mitigation: The mitigation option identified as most feasible is to facilitate continuous dialogue and early-stage alignment between the project developers. Given that the location of the Dutch OWF is determined by the Dutch authorities, project developers need to align on the following: the routing of the cable systems and the location of substations, the technical specifications of the cable systems, the substations and the OWF included in the hybrid project. This is based on consideration of the interdependencies shown in Table 1, interaction with project stakeholders (see Chapter 5.1.5) and the ease of implementation in terms of the required effort.

Apart from continuous dialogue and early-stage alignment between the project developers, no other mitigation options were considered.

Regarding interdependencies, this barrier is interdependent with the following five barriers: "uncertainty about responsibility for project development"; "uncertainty about regulation deriving from jurisdiction over cross-border cable systems"; "uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)"; the "lack of regulated revenues for anticipatory investments" and the "limited engagement of public stakeholders". Continuous dialogue and early-stage alignment are complemented by clearly defining who is responsible for development, construction and operation of the interconnector as well as the need to obtain all relevant permits and align regulation. However, dialogue and alignment themselves are supported by the following measures to mitigate other barriers. An aligned tender design allows for the involvement of and coordination with the developer of the OWF in the hybrid project. Two factors allow for such alignment by decreasing the risk to hybrid project development arising from early-stage project-specific decisions: certainty about the availability of regulated revenues for anticipatory investments; and a formalised public commitment and public financial support.

Action and responsibilities for mitigation implementation: To implement this mitigation measure for the IJmuiden Ver to UK hybrid project, the following action is required:

- Engage in a continuous dialogue to achieve early-stage alignment regarding locations, routing and technical specifications for the individual assets. This can be achieved through voluntary cooperation between TenneT TSO B.V. (and a potential UK interconnector developer) and the national ministries and NRAs (the BEIS, supported by The Crown Estate and Ofgem, in the UK, and the MoEA, supported by RVO and ACM, in the Netherlands).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 27. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 22.

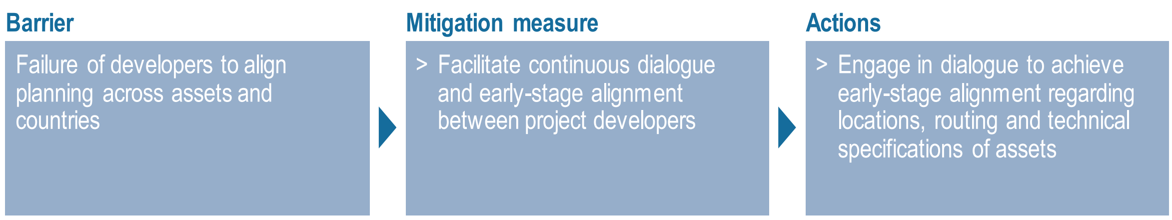

Figure 27: IJmuiden Ver to UK barrier mitigation – Failure of developers to align planning across assets and countries

Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)

Project-specific barrier evaluation: A suitable tender design needs to be chosen for the IJmuiden Ver to UK hybrid project. The OWF in the project setup is located in the Dutch EEZ and an interconnector links the UK market and the offshore substation of the Dutch export cable system. Thus, both the UK and the Netherlands have an interest in defining the requirements for the OWF development in accordance with their respective standards. These may be contradictory. In addition, the tender design needs to ensure that tender candidates can realistically develop the OWF. In consequence, the tender design must clarify which hybrid-specific requirements to include.

Barrier mitigation: The mitigation option identified as most feasible is to implement a tender design with strict tender requirements. These should be aligned among the UK and the Netherlands and also eliminate all hybrid-specific uncertainties for the OWF developer. This is based on consideration of the interdependencies shown in Table 1, interaction with project stakeholders (see Chapter 5.1.7) and the ease of implementation in terms of the required effort.

The other mitigation options considered in this study were (1) to have a strict tender design with requirements aligned among the stakeholders, (2) to have a strict tender design without hybrid-specific uncertainties for the OWF developer and (3) to have a lenient tender design with requirements aligned among the stakeholders and without hybrid-specific uncertainties for the OWF developer.

The mitigation option identified as most feasible was selected for the following reasons: While aligned requirements potentially necessitate amendments to national legislation and regulations, both countries have valid interests in defining certain requirements for the overall tender. Aligned requirements also aid in ensuring the interoperability of the OWF with the other assets of the hybrid project. These factors increase the probability of successful hybrid project implementation. Furthermore, a tender design with strict requirements also increases the probability of successful project implementation, allowing for a possible decrease in the cost efficiency of the OWF development due to more limited competition. Lastly, certainty about hybrid-specific characteristics of the OWF development increases the probability of successful project implementation – and decreases the cost of implementation – by reducing the risk premium otherwise demanded by OWF developers in terms of subsidies.

Regarding interdependencies, this barrier is interdependent with the following three barriers: "uncertainty about regulation deriving from jurisdiction over cross-border cable systems"; the "failure of developers to align planning across assets and countries"; and "uncertainty about applicable RES subsidy scheme". Aligned regulation deriving from UK and Dutch jurisdiction needs to be reflected in the requirements of the OWF tender. In addition, the OWF tender can include an RES subsidy scheme established by the Netherlands. Continuous dialogue and early-stage alignment facilitate an aligned tender design.

Action and responsibilities for mitigation implementation: To implement this mitigation measure for the IJmuiden Ver to UK hybrid project, the following actions are required:

- Agree a tender design with strict requirements. Certainty about the tender design can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. The national ministries and other national authorities assume responsibility for this action (the BEIS and The Crown Estate in the UK, and the MoEA, ACM and RVO in the Netherlands).

Agree tender requirements which take account of the valid interest of the UK and the Netherlands. This means jointly defining material requirements such as technical and operational standards. Environmental standards do not need to be aligned between the UK and the Netherlands, as Dutch environmental standards apply to the OWF. Similarly, financial requirements do not need to be aligned across countries. Guidance from project-specific developers is required to inform the development of project-specific tender requirements. Certainty about tender requirements can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the

Netherlands. The national ministries and other national authorities assume responsibility for this action (the BEIS and The Crown Estate in the UK, and the MoEA, ACM and RVO in the Netherlands).The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 28. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 22.

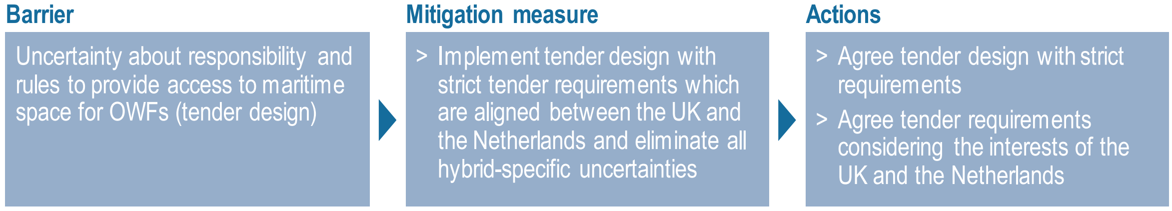

Figure 28: IJmuiden Ver to UK barrier mitigation – Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)

Lack of regulated revenues for anticipatory investments

Project-specific barrier evaluation: Anticipatory investments are necessary to allow for the implementation of the IJmuiden Ver to UK hybrid project. As the interconnector establishes a link between the offshore substation of the Dutch export cable system and the UK market, it is necessary to adapt the technical setup of the substations to support the interconnector link. These adaptations represent additional investment costs for TenneT TSO B.V. as the developer of the substation in anticipation of the future interconnector link. As any investments in grid infrastructure deemed inefficient by regulators are not compensated,[116] the additional costs faced by TenneT TSO B.V. may present an obstacle to hybrid project development.

Barrier mitigation: The mitigation identified as most feasible is to validate the feasibility of regulated revenues for the anticipatory investments under the regulatory regime in the Netherlands. This is based on consideration of the interdependencies shown in Table 1, interaction with project stakeholders (see Chapter 5.1.11) and the ease of implementation in terms of the required effort.

Besides validating the feasibility of regulated revenues for anticipatory investments under the regulatory regime in the Netherlands, no other mitigation option can be considered. The export cable system, which requires anticipatory investments, is geographically located in the Netherlands. The Dutch regime is therefore applicable and must be assessed with regard to the coverage of the specific investments.

Regarding interdependencies, this barrier is interdependent with the "failure of developers to align planning across assets and countries" barrier. Continuous dialogue and early-stage alignment with the MoEA and ACM in the Netherlands support the validation of the coverage of the anticipatory investments with regulated revenues under the Dutch regime.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the IJmuiden Ver to UK hybrid project, the following actions are required:

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[116] ACER. 2014. *Recommendation of the Agency for the cooperation of energy regulators No 03/2014.* https://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Recommendations/ACER%20Recommendation%2003-2014.pdf

- Validate the inclusion of the anticipatory investments in the Dutch Offshore Grid Development Framework[117] to allow for their inclusion in the investment planning of TenneT TSO B.V. This ensures that anticipatory investments for the export cable system of the Dutch OWF are covered by regulated revenues. This action can be based on an existing decision-making process for investments for the offshore grid. It can therefore be achieved through voluntary cooperation between TenneT TSO B.V., the MoEA and ACM in the Netherlands.
- Ensure compatibility with measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the UK and the Netherlands of costs and benefits deriving from regulated revenues for anticipatory investments. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. TenneT TSO B.V. (and a potential UK interconnector developer) and the national ministries and NRAs (the BEIS and Ofgem in the UK, and the MoEA and ACM in the Netherlands) assume responsibility for this action.

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 29. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 22.

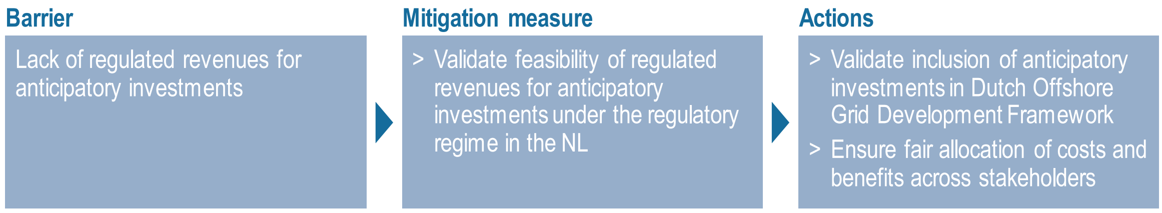

Figure 29: IJmuiden Ver to UK barrier mitigation – Lack of regulated revenues for anticipatory investments

Uncertainty about the applicable RES subsidy scheme

Project-specific barrier evaluation: The OWF included in the IJmuiden Ver to UK hybrid project is located in the Dutch EEZ, which suggests a Dutch RES subsidy scheme. However, due to the connection to the UK market, the following schemes are also possible: a UK subsidy scheme with statistical transfers between the UK and the Netherlands, a joint project or a joint subsidy scheme between the UK and the Netherlands. All are in line with EU Directive 2009/28/EC[118] on the promotion of the use of energy from RES. In summary, the applicability of a support scheme from one of the countries involved or in some joint form is to be determined.

Barrier mitigation: The mitigation option identified as most feasible is to apply the Dutch RES subsidy scheme to the OWF included in the hybrid project. Under this scheme, the Dutch government awards the OWF a premium tariff through the Dutch tender process (i.e. the SDE+ subsidy scheme with its regular characteristics in terms of type, level and duration of support as well as technology coverage). This is based on consideration of the interdependencies shown in Table 1 and the ease of implementation in terms of the required effort,

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[117] Dutch Elektriciteitswet 1998. Article 21. https://wetten.overheid.nl/BWBR0009755/2018-07-28#Hoofdstuk3_Paragraaf3_Artikel21

[118] European Parliament, European Council. 2009. *DIRECTIVE 2009/28/EC on the promotion of the use of energy from renewable sources.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

Since this RES subsidy scheme was identified as applicable in interaction with project stakeholders from the beginning, no other mitigation options were considered in detail.

Regarding interdependencies, this barrier is interdependent with the following three barriers: "uncertainty about market arrangements"; "uncertainty about hybrid cable system classification"; and "uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)". The business case of the OWF in the hybrid project – and thereby potentially the level of required subsidies – is affected by the market arrangement of commercial flows from the OWF only to the Dutch market. Similarly, the level of required subsidies is also impacted by the hybrid cable system classification of defining the export cable system as export cable system with interconnector functionality. Lastly, applying a Dutch subsidy scheme fits with a tender design in accordance with the rules of Dutch authorities.

<u>Actions and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the IJmuiden Ver to UK hybrid project, the following actions are required:

- Validate the feasibility of defining the RES subsidy scheme that is applicable as a Dutch subsidy scheme. This can be achieved through voluntary cooperation between TenneT TSO B.V., the MoEA and ACM in the Netherlands.
- Ensure compatibility with measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the UK and the Netherlands of costs and benefits deriving from the RES subsidy scheme. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. The OWF developer, national ministries and NRAs (the BEIS and Ofgem in the UK, and the MoEA and ACM in the Netherlands) assume responsibility for this action.

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 30. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 22.

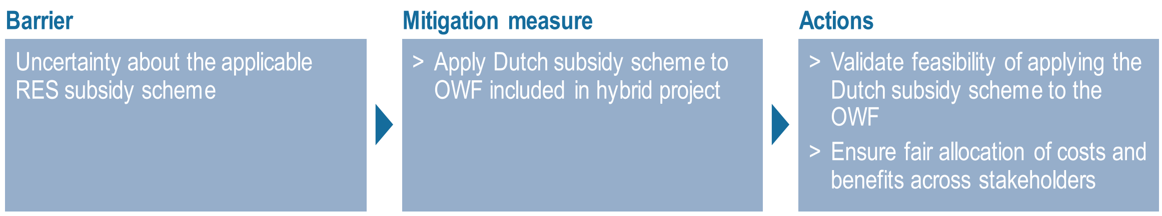

Figure 30: IJmuiden Ver to UK barrier mitigation – Uncertainty about applicable RES subsidy scheme

Limited engagement of public stakeholders

<u>Project-specific barrier evaluation:</u> The support of public stakeholders is needed for successful implementation of the IJmuiden Ver to UK hybrid project, as regulatory and technical barriers must be overcome, and financial support provided across two countries, namely, the UK and the Netherlands.

<u>Barrier mitigation:</u> The mitigation option identified as most feasible is to formalise public commitment in the form of a project-specific MoU or a project-specific HANSA. Feasibility studies and scoping studies for early-stage alignment through public funding, for example, should also be facilitated. Furthermore, adequate de-risking of the hybrid project is required. This is based on consideration of

the interdependencies shown in Table 1, interaction with project stakeholders (see Chapter 5.1.13) and the ease of implementation in terms of the required effort,

Besides formalising public commitment in the form of a project-specific MoU or a project-specific HANSA and facilitating feasibility studies and scoping studies or providing financial guarantees, no other mitigation option was considered.

Regarding interdependencies, this barrier is interdependent with the "failure of developers to align planning across assets and countries" barrier. Continuous dialogue and early-stage alignment between the project developers is facilitated by formalising the commitment of relevant stakeholders of the hybrid project and / or by providing public funding for early-stage activities. These may include feasibility studies, scoping studies and technical research and development.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the IJmuiden Ver to UK hybrid project, the following actions are required:

- Align and implement the type of formalisation of public commitment to allow for the development of the IJmuiden Ver to UK hybrid project. The formalisation of commitment in the form of a project-specific MoU or HANSA is an expression of the goodwill of the stakeholders to support hybrid project development. It assures project developers of public support, e.g. in the form of a dialogue with relevant government bodies. In early project stages, a project-specific MoU provides sufficient certainty for project developers. The stakeholders assuming responsibility are TenneT TSO B.V. (and a potential UK interconnector developer), national ministries and NRAs (the BEIS and Ofgem in the UK, and the MoEA and ACM in the Netherlands), as well as the European Commission. In later project stages, a project-specific HANSA is required to provide project developers with sufficient legal certainty. The stakeholders assuming responsibility include the national ministries (the BEIS in the UK, and the MoEA in the Netherlands) and the European Commission.
- Catalyse the development of the IJmuiden Ver to UK hybrid project by supporting early-stage alignment among developers. Do this through public funding for feasibility studies, pilot projects and R&D for innovative, technological solutions, in addition to existing offshore support schemes. Such public support allows developers to firmly commit to the development of the project. This can be achieved through voluntary cooperation between the national ministries (the BEIS in the UK, and the MoEA in the Netherlands) as well as the European Commission.
- Support the de-risking of the hybrid project by providing financial guarantees. Such guarantees can reassure project developers in situations which cannot be foreseen due to the pilot character of the hybrid project. This can be achieved through voluntary cooperation between the project developers (TenneT TSO B.V. and a potential UK interconnector developer) as well as the European Commission.
- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the UK and the Netherlands of costs and benefits deriving from the engagement of public stakeholders. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. The national ministries and NRAs assume responsibility for this action (the BEIS and Ofgem in the UK, and the MoEA and ACM in the Netherlands).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 31. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 22.

Barrier	Mitigation measure	Actions
Limited engagement of public stakeholders	> Formalise public commitment > Facilitate early-stage alignment through public funding and support de-risking of hybrid project	> Align and implement formalisation of public commitment (in early project stages in form of MoU, later HANSA) > Support early-stage alignment among developers through public funding > Support de-risking of project by providing financial guarantees > Ensure fair allocation of costs and benefits across stakeholders

Figure 31: IJmuiden Ver to UK barrier mitigation – Limited engagement of public stakeholders

Uncertainty regarding the UK market

Project-specific barrier evaluation: The IJmuiden Ver to UK hybrid project stands to benefit from the UK Capacity Market and the UK Cap and Floor regime because it establishes interconnection capacity between the UK and the Netherlands. While there currently are no changes proposed to the UK Capacity Market or the UK Cap and Floor regime, any potential effects of the UK's withdrawal from the EU need to be evaluated after the withdrawal is completed. Thus, it is also unclear whether the IJmuiden Ver to UK hybrid project will benefit from these policies.[119]

Barrier mitigation: Considering interaction with project stakeholders (see Chapter 5.1.14), no immediate actions can be taken. It is necessary to await clarification of future UK policies as well as the UK's intended future interaction with the EU energy market.

Besides awaiting clarification of future UK policies and the future participation of the UK in the EU's internal energy market, no other mitigation option was considered.

Regarding interdependencies, this barrier is not interdependent with any other barrier considered in this study.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the IJmuiden Ver to UK hybrid project, the following actions are required:

- Await clarification of the future of the UK Capacity Market and the UK Cap and Floor regime to clarify the future business case for interconnectors linking to the UK.
- Await clarification on whether the UK intends to participate in the EU's internal energy market in the future to provide planning security for hybrid project developers.

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 32. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 22.

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[119] Vaughan, Adam. 2018. *UK's backup power subsidies are illegal, European court rules*. https://www.theguardian.com/environment/2018/nov/15/uk-backup-power-subsidies-illegal-european-court-capacity-market

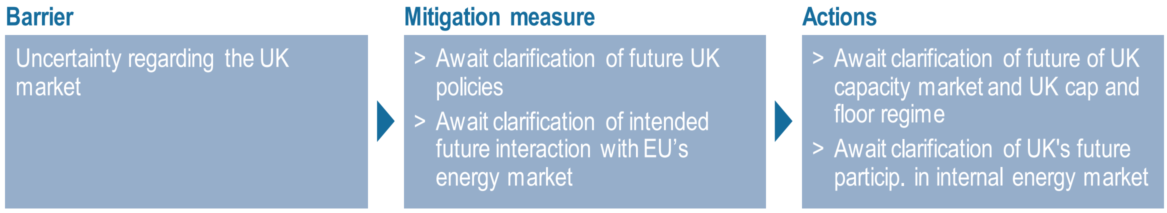

Figure 32: IJmuiden Ver to UK barrier mitigation – Uncertainty regarding the UK market

Disproportionate allocation of costs and benefits across involved stakeholders

Project-specific barrier evaluation: Agreeing on the allocation of costs and benefits in the IJmuiden Ver to UK hybrid project is complex. This is because the OWF is geographically located in the Dutch EEZ and the offshore substation of its export cable system is linked to the UK market by an interconnector. Certain costs and benefits are initially incurred by the UK and certain costs and benefits are initially incurred by the Netherlands due to the technical setup and the details of the hybrid project. In addition, the measures adopted to mitigate other barriers assign costs or distribute benefits to the UK and the Netherlands. Furthermore, developers may realise additional benefits. Thus, costs and benefits are generally not distributed fairly, and no suitable approach exists to reallocate costs and benefits across all stakeholders of the hybrid project.

Barrier mitigation: The mitigation option identified as most feasible is to reallocate costs and benefits deriving from the hybrid project where required, based on a project-specific process. In some respects, the process can be based on the existing methodology given by the Cross-Border Cost Allocations (CBCA) process,[120] which builds on the Cost Benefit Analysis (CBA) conducted by ENTSO-E[121] for Projects of Common Interest. For the CBCA process, benefits such as socio-economic welfare and CO_2 emissions are calculated on a national level to compensate net losers for the implementation of a project through a CBCA decision. The CBCA process provides a good starting point for the reallocation of costs and benefits across countries but is best suited for evaluating cross-border electricity interconnectors. This is based on consideration of the interdependencies shown in Table 1, interaction with project stakeholders (see Chapter 5.1.15) and the ease of implementation in terms of the required effort.

Besides implementing the process resulting in the reallocation of costs and benefits deriving from the implementation of the hybrid project, no other mitigation option was considered.

Regarding interdependencies, this barrier is interdependent with the following six barriers: "uncertainty about responsibility for project development (responsibility for interconnector)"; "uncertainty about market arrangements"; "uncertainty about hybrid cable system classification"; the "lack of regulated revenues for anticipatory investments"; "uncertainty about applicable RES subsidy scheme"; and "limited engagement of public stakeholders". Reallocation also relates to those barriers. This is because their mitigation translates into costs and benefits for specific stakeholders that might

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[120] ACER. 2015. *Recommendation No 5/2015 on good practices for the treatment of the investment requests, including CBCA requests, for electricity and gas PCIs.* https://acer.europa.eu/Official_documents/Acts_of_the_Agency/Recommendations/ACER%20Recommendation%2005-2015.pdf

[121] ENTSO-E. 2018. *2nd ENTSO-E Guideline: For Cost Benefit Analysis of Grid Development Projects.* https://tyndp.entsoe.eu/Documents/TYNDP%20documents/Cost%20Benefit%20Analysis/2018-10-11-tyndp-cba-20.pdf

have to be reallocated together with all other costs and benefits of the hybrid project. Therefore, the costs and benefits deriving from all six interdependent barriers must be considered.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the IJmuiden Ver to UK hybrid project, the following actions are required:

- Identify the relevant cost and benefit categories between the involved stakeholders, covering all significant aspects of the hybrid project. This can be achieved through voluntary cooperation between TenneT TSO B.V. in the Netherlands (and a potential UK interconnector developer) as well as national ministries and NRAs (the MoEA and ACM in the Netherlands, and the BEIS and Ofgem in the UK).
- Ensure that due consideration is given to all costs and benefits deriving from measures adopted to mitigate the following barriers: "uncertainty about responsibility for project development"; "uncertainty about market arrangements"; "uncertainty about hybrid cable system classification"; the "lack of regulated revenues for anticipatory investments"; "uncertainty about applicable RES subsidy scheme"; and the "limited engagement of public stakeholders". This can be achieved through voluntary cooperation between all stakeholders involved in the individual barrier mitigation measures.
- Determine the initial allocation of costs and benefits, covering the cost and benefit categories across all significant aspects of the hybrid project identified in the first step. In this process, developers typically conduct the assessment of costs and benefits, while NRAs oversee and validate results. Thus, this can be achieved through voluntary cooperation between the OWF developer, TenneT TSO B.V. in the Netherlands (and a potential UK interconnector developer) as well as national ministries and NRAs (the BEIS and Ofgem in the UK, and the MoEA and ACM in the Netherlands).
- Align and agree a suitable reallocation of costs and benefits between developers, the UK and the Netherlands. This should be based on the identification of cost and benefit categories among stakeholders as well as the assessment of the initial allocation of costs and benefits along the identified categories. The allocation could closely reflect ongoing practices for implemented interconnectors. These might already be suitable to incentivise all parties involved in the hybrid project. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. The OWF developer, TenneT TSO B.V. in the Netherlands (and a potential UK interconnector developer), and national ministries and NRAs (the BEIS and Ofgem in the UK, and MoEA and ACM in the Netherlands) assume responsibility for this action, as well as the European Commission.
- Validate the availability of CEF funding to ensure adequate incentivisation for all relevant stakeholders if the following applies: the IJmuiden Ver to UK hybrid project is a PCI and adds socio-economic value, but the initial allocation of costs and benefits is not sufficiently balanced to incentivise all countries and stakeholders to implement the hybrid project. While CEF funding cannot resolve viability issues of projects, it is a last resort for PCIs that have received a CBCA decision but are still not commercially viable for each individual stakeholder.[122] This can be achieved through voluntary cooperation between TenneT TSO B.V. and NRAs (Ofgem in the UK and ACM in the Netherlands) as well as the European Commission.

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[122] European Parliament, European Council. 2013. *REGULATION (EU) No. 347/2013 on guidelines for trans-European energy infrastructure.* Article 14. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0347&from=en

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 33. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 22.

Figure 33: IJmuiden Ver to UK barrier mitigation – Disproportionate allocation of costs and benefits across involved stakeholders

4.5 CGS IJmuiden Ver to Norfolk

The hybrid project idea "CGS IJmuiden Ver to Norfolk" is a combined grid solution concept. It connects the UK and the Dutch electricity markets via an interconnector. The interconnector links the offshore substations of the export cable systems of a UK OWF in the Norfolk area and a Dutch OWF in the IJmuiden Ver area. Both OWFs have planned radial connections to their respective markets. The idea shows significant lifetime savings compared to the reference case, in which OWFs and the interconnector are stand-alone assets. Thus, the CGS IJmuiden Ver to Norfolk hybrid project is given further consideration in the scope of this study and an Action Plan for the implementation of measures to mitigate barriers has been developed. The Action Plan is intended to be used as a tool by stakeholders once the CGS IJmuiden Ver to Norfolk hybrid project has been given the go-ahead.

Both the CGS IJmuiden Ver to Norfolk hybrid project and the IJmuiden Ver to UK hybrid project include the IJmuiden Ver development area and consequently have similar stakeholder groups. However, the projects have different technical and commercial setups and are therefore evaluated separately.

4.5.1 Details of the hybrid project and reference case

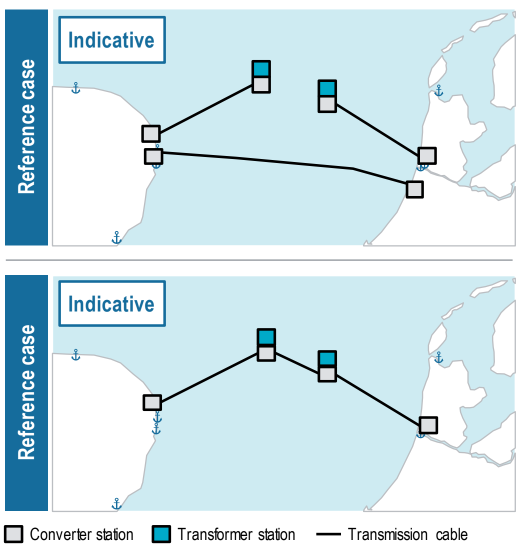
The individual assets included in the hybrid project and in the reference case are modelled on the basis of real assets. But the assumed characteristics do not claim to represent the actual characteristics of the assets included in either ongoing or future developments.

In the reference case (Figure 34), the interconnector is a stand-alone, point-to-point interconnector between the UK and the Netherlands. It is constructed based on HVDC technology with 900 MW nominal capacity and a length of 190 km. The OWFs included in the project idea are in the Norfolk area of the UK EEZ and in the IJmuiden Ver area of the Dutch EEZ. They have nominal generation capacities of 900 MW and 1,300 MW, respectively. The UK OWF is radially connected to the UK via a 100 km HVDC export cable system. The Dutch OWF is radially connected to the Netherlands with an 80 km HVDC export cable system. No intermediate offshore transformers are required, as the wind turbines can be connected directly to the high-voltage offshore transformers via the 66-kV array cable systems. The UK export cable system has a capacity of 900 MW and the Dutch export cable system a nominal capacity of 1,300 MW.

In the hybrid project (Figure 34), the interconnector is a point-to-point interconnector between the two offshore substations of the export cable systems of the Norfolk and IJmuiden Ver OWFs. It is constructed mostly to the same specifications as in the reference case. However, the length of the interconnector is reduced to 60 km compared to the reference case. The OWFs and their export cable system have the same specifications as in the reference case.

For all cable systems, onshore transformer stations are not in the scope of the assessment. As a result, benefits deriving from the hybrid project compared to the reference case – with fewer onshore transformer stations in the hybrid project than in the reference case – have not been considered. Furthermore, onshore grid reinforcement costs are not in the scope of this assessment. But it is important that they are considered before project development would be initiated. The need for onshore grid reinforcements can be expected to be lower in the hybrid project compared to the reference case, as the OWFs do not translate into the need for additional onshore grid connection points.

Geographical mapping



	Reference case	Hybrid case	Difference
Nominal Capacity interconnector [MW]			
	900	900	0
Length interconnector [km]			
	190	60	- 130
Nominal capacity OWF [MW]			
	2,200 (900 + 1,300)	2,200 (900 + 1,300)	0
Length export cable [km]			
	180 (100 + 80)	180 (100 + 80)	0
Offshore transformer / converter / switching stations			
	2 / 2 / 0	2 / 2 / 0	0
Onshore transformer / converter stations			
	0 / 4	0 / 2	- 2

Figure 34: CGS IJmuiden Ver to Norfolk – Reference case and hybrid project profile

It is generally assumed that the development, construction and commissioning of the individual assets (two OWFs, two export cable systems and an interconnector) can be aligned in the hybrid project to prevent temporarily stranded assets. The IJmuiden Ver OWF is expected to be commissioned by 2027 and the Norfolk OWF by 2030 at the latest. Following this, it is assumed that the OWFs, export cable systems and interconnector will be commissioned in 2027. However, the separate commissioning of the OWFs and export cable systems or the later commissioning of the interconnector would also be possible, as both national systems function independently. The assumed commissioning dates are the same for the hybrid project and reference case.

4.5.2 Evaluation of hybrid project vs. reference case

To evaluate the hybrid project against the reference case, this study calculates the lifetime savings of the hybrid project. These include the difference in cost and the difference in socio-economic welfare (SEW) between the hybrid project and the reference case. Both the cost assessment – looking at CAPEX and OPEX – and the market modelling-based SEW assessment are based on the technical setup of the hybrid project and the reference case, as described in the project details. Additional indicators used in the assessment are energy not served, RES curtailment and CO_2 emissions. CO_2 emissions are internalised as cost in the SEW.

Assuming a typical asset lifetime of 25 years, the hybrid project yields lifetime savings of about EUR 720 m compared to the reference case (Figure 35). The lifetime savings are driven entirely by a reduction of CAPEX and OPEX of about EUR 770 m. OPEX are calculated and discounted over a 25-year period. However, a lower hybrid project SEW of EUR 4 m p.a. compared to the reference case translates into additional costs of EUR 48 m from lower lifetime SEW, discounted over 25 years. But because the above-mentioned cost savings significantly exceed these additional costs, the lifetime savings remain positive. The small difference in SEW is spread over the entire European electricity system. It is originally driven by the suboptimal operational setup of the generation and transmission assets included in the hybrid project compared to the reference case. This means that either the available interconnector capacity is reduced or the OWF generation is curtailed as the two conflict with each other.

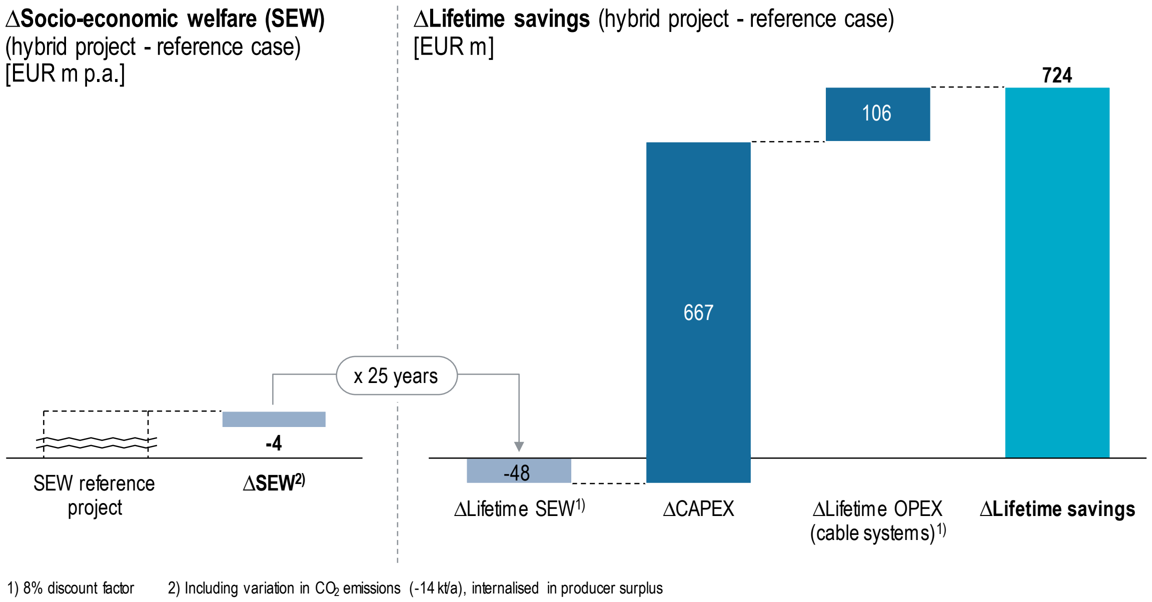


Figure 35: CGS IJmuiden Ver to Norfolk – Assessment results[123]

Regarding the cost assessment, the result is driven by the interconnector only. The cost of the interconnector is lower in the hybrid project than in the reference case. The interconnector requires fewer kilometres of cable in the hybrid project and fewer substations. The interconnector links only the offshore substations of the export cable systems of the UK OWF and the Dutch OWF and does not extend from shore to shore. This renders redundant two onshore converter stations and about 130 km of cable. The hybrid project requires the use of disconnector modules, but these have negligible costs compared to the cost savings. The costs of the OWF and its export cable system are the same in the hybrid and the reference case.

[123] SEW assessment based on Careri, Francesco. [Forthcoming]. *The impact of North Sea electricity projects in a 2030 scenario: Preliminary assessment of system benefits for the pan-European power system through METIS.* Petten: European Commission Joint Research Centre.

In both the hybrid project and the reference case, energy not served is zero due to the comprehensive nature of and redundancies in the European electricity system. Therefore, neither setup adversely affects the EU's energy policy target of energy security. Compared to the reference case, the effect of the hybrid project on curtailment and CO_2 emissions is very small.[124] This suggests that the hybrid project is unlikely to have a significant impact on the EU's energy policy targets on the further establishment of the internal energy market and the decarbonisation of the economy.

4.5.3 Development of an Action Plan to overcome barriers

This chapter summarises the findings specific to the development of the CGS IJmuiden Ver to Norfolk hybrid project. It builds on the general explanation of the barriers in Chapter 3.2, the general explanation of the interdependencies between barriers in Chapter 3.3 and the findings of project-specific discussions of the barriers and mitigation options in Chapter 5.2.

This study notes that 11 of the 16 identified barriers need to be overcome to allow for the commencement of the CGS IJmuiden Ver to Norfolk hybrid project development. The mitigation measures for 9 of the 11 identified barriers assume that the market arrangement and the RES subsidy scheme applicable to the CGS IJmuiden Ver to Norfolk hybrid project will be validated as follows: The foreseen market arrangement is that the UK OWF transmits its electricity solely to the UK market and the Dutch OWF transmits its electricity solely to the Dutch market. Therefore, with regard to the hybrid cable system classification, only leftover capacity on the cable systems linking the UK to the Dutch market is available for interconnection. In line with this market arrangement, the RES subsidy scheme applicable to the UK OWF is the UK RES subsidy scheme. This is a Contract for Difference scheme with its regular characteristics in terms of type, level and duration of support, as well as the technology coverage. The RES subsidy scheme applicable to the Dutch OWF is the Dutch RES subsidy scheme (i.e. the SDE+ subsidy scheme with its regular characteristics in terms of type, level and duration of support, as well as the technology coverage). The market arrangement and the RES subsidy scheme as foreseen by the project stakeholders ensure that implementation is highly probable.

Although the barriers are addressed individually, interdependencies exist between them. When developing ways to mitigate one barrier, it is therefore necessary to also consider the mitigation of other barriers. Table 2 provides an overview of the project-specific barriers and barrier mitigation measures, as well as a brief description of the interdependencies to be considered in the development of the individual barrier mitigation measures.

Barrier	Mitigation measure	Interdependencies
Uncertainty about responsibility for project development	Assign responsibility for development and construction as well as the operation of the interconnector to a group of players, which potentially includes TenneT TSO B.V.	▪ Failure of developers to align planning across assets and countries: clearly assigning responsibility for development, construction and operation of interconnector facilitates continuous dialogue and early-stage alignment

[124] The hybrid project generates additional curtailment of 3,300 MWh/a and additional CO_2 emissions of 14 kt/a (internalised in socio-economic welfare). For more details, please refer to Careri, Francesco. [Forthcoming]. *The impact of North Sea electricity projects in a 2030 scenario: Preliminary assessment of system benefits for the pan-European power system through METIS.* Petten: European Commission Joint Research Centre.

Barrier	Mitigation measure	Interdependencies
	and UK interconnector developer	
Uncertainty about regulation deriving from jurisdiction over cross-border cable systems	Obtain all required permits and align regulation deriving from concurrent jurisdiction over cross-border cable systems	▪ Failure of developers to align planning across assets and countries: obtaining all required permits and aligning regulation is facilitated by continuous dialogue and early-stage alignment ▪ Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design): aligned regulation of relevance to the OWF to be tendered needs to be reflected in the tender design
Uncertainty about market arrangements	Allow for commercial flows from the Dutch OWF to the Dutch market and from the UK OWF to the UK market	▪ Uncertainty about hybrid cable system classification: allowing for only commercial flows from the Dutch OWF to the Dutch market and from the UK to the UK market implies defining the export cable systems as export cable systems with interconnector functionality ▪ Uncertainty about applicable RES subsidy scheme: allowing for only commercial flows from the UK OWF to the UK market and from the Dutch OWF to the Dutch market fits the national subsidy schemes applying to the respective OWFs
Uncertainty about hybrid cable system classification	Define the export cable systems as export cable systems with interconnector functionality, which makes them hybrid cable systems, if it is not possible to define the Dutch export cable system as part of the Dutch national transmission system	▪ Uncertainty about market arrangements: export cable systems with interconnector functionality fits the foreseen fixed access of OWFs to respective home markets ▪ Uncertainty about applicable RES subsidy scheme: export cable systems with interconnector functionality fits the foreseen national subsidy schemes applying to the respective OWFs
Failure of developers to align planning across assets and countries	Facilitate continuous dialogue and early-stage alignment between the project developers	▪ Uncertainty about responsibility for project development: continuous dialogue and early-stage alignment facilitates clear assignment of responsibility for development, construction and operation of interconnector ▪ Uncertainty about regulation deriving from jurisdiction over cross-border cable systems:

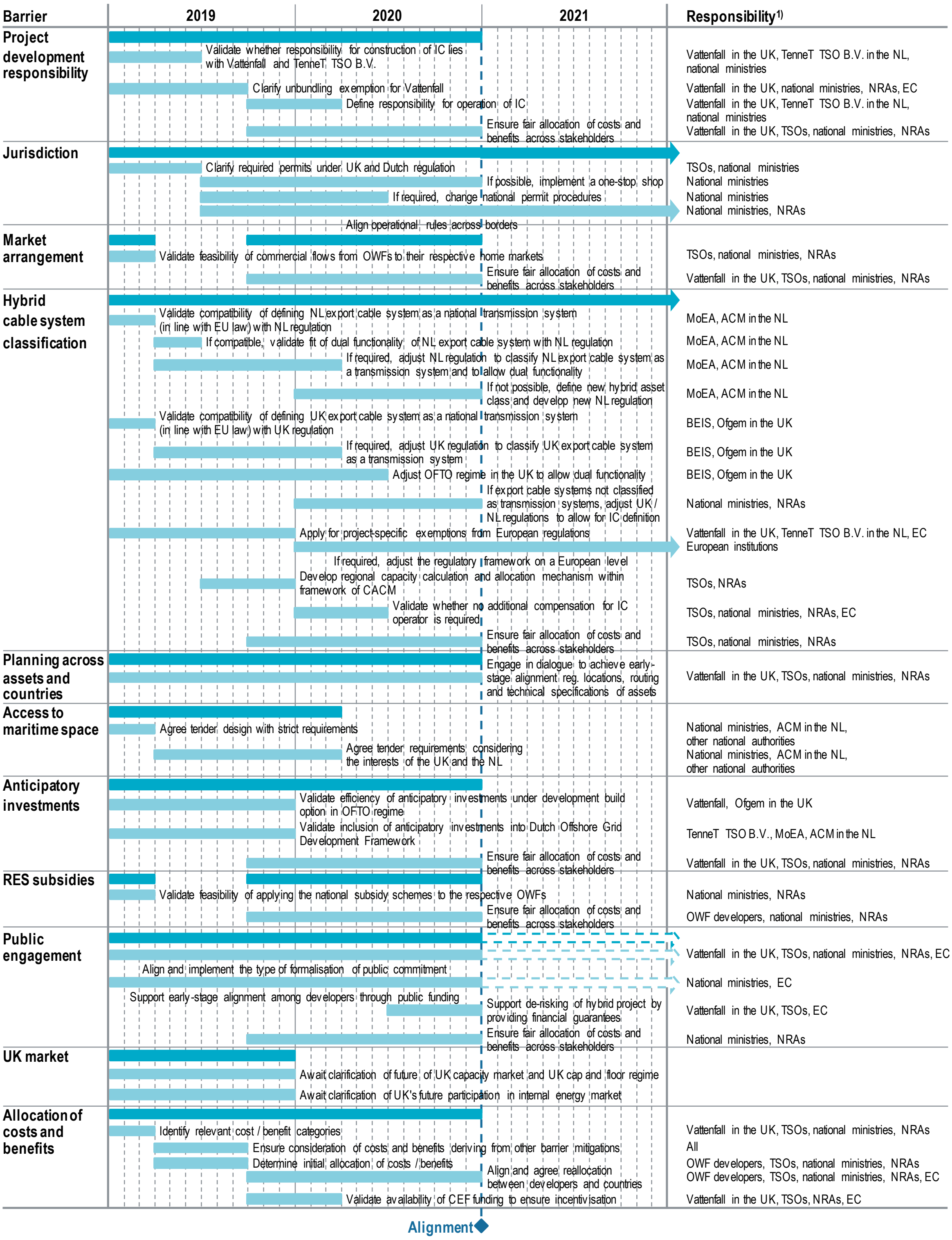
Barrier	Mitigation measure	Interdependencies
		continuous dialogue and early-stage alignment facilitates obtaining all required permits and aligning regulation ▪ Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design): continuous dialogue and early-stage alignment are facilitated by an aligned tender design ▪ Lack of regulated revenues for anticipatory investments: continuous dialogue and early-stage alignment among developers is facilitated by validating the availability of regulated revenues for anticipatory investments in the UK and the Netherlands ▪ Limited engagement of public stakeholders: continuous dialogue and early-stage alignment are facilitated by formalising public commitment and public funding for feasibility studies, R&D etc.
Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)	Implement a tender design with strict requirements which are aligned between the UK and the Netherlands	▪ Uncertainty about regulation deriving from jurisdiction over cross-border cable systems: tender design needs to reflect aligned regulation relevant to the OWFs ▪ Failure of developers to align planning across assets and countries: aligned tender designs are facilitated by continuous dialogue and early-stage alignment ▪ Uncertainty about applicable RES subsidy scheme: implementing a tender design with strict requirements which are aligned between the UK and the Netherlands fits with applying the national RES subsidy schemes to the UK and Dutch OWF respectively
Lack of regulated revenues for anticipatory investments	Validate the feasibility of regulated revenues for anticipatory investment under the regulatory regimes in both the UK and the Netherlands	▪ Failure of developers to align planning across assets and countries: certainty about regulated revenues for anticipatory investments in the UK and the Netherlands is facilitated by continuous dialogue and early-stage alignment

Barrier	Mitigation measure	Interdependencies
Uncertainty about applicable RES subsidy scheme	Apply the subsidy scheme of the Netherlands to the Dutch OWF and the UK subsidy scheme to the UK OWF	▪ Uncertainty about market arrangements: the business case of the OWFs and thereby the level of required subsidies are affected by allowing for commercial flows from the UK OWF to the UK market and from the Dutch OWF to the Dutch market only ▪ Uncertainty about hybrid cable system classification: the business case of the OWFs and thereby the level of required subsidies are affected by defining the export cable systems as export cable systems with interconnector functionality ▪ Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design): applying a UK and a Dutch RES subsidy scheme to the UK and Dutch OWF, respectively, fits with a tender design with strict requirements, which are aligned between the UK and the Netherlands
Limited engagement of public stakeholders	Formalise public commitment in the form of a project-specific MoU or HANSA. Also, facilitate feasibility studies and scoping studies for early-stage alignment through public funding, for example	▪ Failure of developers to align planning across assets and countries: formalising public commitment and public funding for feasibility studies, R&D, etc. if facilitated by continuous dialogue and early-stage alignment
Uncertainty regarding the UK market	Await clarification of the future of UK policies and intended future interaction with the EU's internal energy market	▪ No interdependencies to be considered
Disproportionate allocation of costs and benefits across involved stakeholders	Reallocate costs and benefits deriving from the hybrid project where required, based on a project-specific process	▪ Uncertainty about responsibility for project development (responsibility for interconnector): costs and benefits deriving from mitigation to be considered ▪ Uncertainty about market arrangements: costs and benefits deriving from mitigation to be considered ▪ Uncertainty about hybrid cable system classification: costs and benefits deriving from mitigation to be considered

Barrier	Mitigation measure	Interdependencies
		▪ Lack of regulated revenues for anticipatory investments: costs and benefits deriving from mitigation to be considered ▪ Uncertainty about applicable RES subsidy scheme: costs and benefits deriving from mitigation to be considered ▪ Limited engagement of public stakeholders: costs and benefits deriving from mitigation to be considered

Table 2: CGS IJmuiden Ver to Norfolk – Barriers, barrier mitigation measures and interdependencies

Combining all the measures needed to mitigate the barriers of relevance to the CGS IJmuiden Ver to Norfolk hybrid project creates an Action Plan that supports the commencement of the development. In addition to placing the required actions on a timeline, the Action Plan further details the stakeholders responsible for each of the actions (Figure 36). The Action Plan is intended to be used as a tool by stakeholders once the CGS IJmuiden Ver to Norfolk hybrid project has received the go-ahead.



1) Responsible stakeholders are OWF developers: Vattenfall in the UK and tbd in the NL; TSOs: tbd in the UK and TenneT TSO B.V. in the NL; Ministries: BEIS in the UK, MoEA in the NL; NRAs: Ofgem in the UK, ACM in the NL; Other national authorities: Crown Estate in the UK, RVO in the NL; European institutions: European Commission, European Parliament, European Council, European Court of Justice

Figure 36: CGS IJmuiden Ver to Norfolk – Action Plan

The barriers and mitigation measures specific to the CGS IJmuiden Ver to Norfolk hybrid project and the actions required to implement the identified mitigation measures are explained in more detail in the subchapters below. As part of the work on barrier mitigation, a project-specific Memorandum of Understanding (MoU) or a project-specific Hybrid Asset Network Support Agreement (HANSA) were considered. Both types of formal commitment to address barriers can include all actions for mitigation measures relevant to the CGS IJmuiden Ver to Norfolk hybrid project. Thus, it can be sufficient to set up only one type.

Uncertainty about responsibility for project development

Project-specific barrier evaluation: The definition of responsibility for the interconnector and for the grid connections of the OWFs will determine who is responsible for the development of the CGS IJmuiden Ver to Norfolk hybrid project.

One party is responsible for the development, construction and operation of the interconnector linking the offshore substation of the export cable systems of the UK and Dutch OWF across the border between the UK and Dutch EEZ. The definition of which party is responsible for this is determined neither by European law nor by national law and therefore needs to be aligned between project developers and other stakeholders.

One OWF site is in the UK EEZ, where the OFTO regime applies for the grid connection based on UK law[125]. The other OWF site is in the Dutch EEZ, where TenneT TSO B.V. is generally responsible for the grid connection based on Dutch law.[126] These responsibilities do not need to be reviewed. Thus, there is also no uncertainty regarding the applicability of UK and Dutch first connection charges (shallow approach in the UK and in the Netherlands) and G-charges (power-based G-charge in the UK and no G-charge in the Netherlands) for the respective UK and Dutch OWF.[127]

Barrier mitigation: The mitigation option identified as most feasible is to define a group of players, including TenneT TSO B.V. and Vattenfall, who would be responsible for development and construction of the interconnector. It also involves defining a group of players, potentially including TenneT TSO B.V. in collaboration with Vattenfall or a UK interconnector developer, who would be responsible for operation of the interconnector. This is based on consideration of the interdependencies shown in Table 2, interaction with project stakeholders (see Chapter 5.2.1) and the ease of implementation in terms of the required effort.

For the development and construction of the interconnector, the mitigation options considered in this study were (1) to define TenneT TSO B.V., (2) to define TenneT TSO B.V. and Vattenfall, (3) to define TenneT TSO B.V. and an OFTO and (4) to define TenneT TSO B.V. and a UK interconnector as the parties responsible. For the operation of the interconnector, the mitigation options considered were (1) to define TenneT TSO B.V., (2) to define TenneT TSO B.V. and Vattenfall, (3) to define TenneT TSO B.V. and an OFTO and (4) to define TenneT TSO B.V. and a UK interconnector developer as the parties responsible.

The mitigation options identified as most feasible for development and construction – TenneT TSO B.V. and Vattenfall being responsible – and for operation – TenneT TSO B.V. being responsible in

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[125] UK Electricity Act 2004. Section 6C (1). https://www.legislation.gov.uk/ukpga/2004/20/section/92

[126] Dutch Elektriciteitswet 1998. §4 Article 24Aa. https://wetten.overheid.nl/BWBR0009755/2018-07-28#Hoofdstuk3_Paragraaf4_Artikel24Aa

[127] ENTSO-E. 2018. *Overview of transmission tariffs in Europe: Synthesis 2018.* https://docstore.entsoe.eu/Documents/MC%20documents/TTO_Synthesis_2018.pdf;
The European Wind Energy Association. 2016. *Position paper on network tariffs and grid connection regimes.* http://www.ewea.org/fileadmin/files/library/publications/position-papers/EWEA-position-paper-on-harmonised-transmission-tariffs-and-grid-connection-regimes.pdf

collaboration with Vattenfall or a UK interconnector developer – were selected for the following reasons: While Options (1) and (4) are covered under existing legislation and regulation, Option (2) and Option (3) are not. In Option (2), Vattenfall is not allowed to operate transmission assets due to EU unbundling regulation, and in Option (3), an OFTO cannot hold both a transmission and interconnector licence. In general, the involvement of a UK entity, in the form of collaboration with either Vattenfall, an OFTO or a UK interconnector developer, has the advantage of providing further operational expertise. This is in addition to the operational expertise TenneT TSO B.V. has gained from the operation of the BritNed interconnector (operated together with National Grid Ventures). Except for Option (1), all considered mitigation options necessitate additional alignment between TenneT TSO B.V. and the UK entity to develop and construct the interconnector, and ensure the efficient operation of the cable system. The continued collaboration between Vattenfall and TenneT TSO B.V. should be considered. This is because Vattenfall is likely to make use of the developer build option under the OFTO regime and can apply for an exemption from the unbundling regulation.

Irrespective of which mitigation option is selected, this barrier is interdependent with the "failure of developers to align planning across assets and countries" barrier. Clearly defining responsibility for the development and construction as well as operation of the interconnector requires continuous dialogue and early-stage alignment on the hybrid project setup among the defined project promoters. Clearly defined responsibilities and continuous dialogue and alignment, in turn, allow for the commencement of project development.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the CGS IJmuiden Ver to Norfolk hybrid project, the following actions are required:

- Based on the mitigation option of spreading responsibility for the interconnector over a group of players, validate whether responsibility for the development and construction of the interconnector lies with Vattenfall and TenneT TSO B.V. With regard to TenneT TSO B.V., validate whether the offshore TSO TenneT TSO B.V., as a separate legal entity from the onshore TSO, is responsible.[128] Certainty about development and construction responsibility can be achieved through voluntary cooperation between Vattenfall, TenneT TSO B.V. and the national ministries and NRAs (the BEIS and Ofgem in the UK and the MoEA and ACM in the Netherlands).
- Clarify a potential unbundling exemption for Vattenfall,[129] given that Vattenfall may participate in operation of the interconnector for the purpose of the hybrid project. This can be achieved through voluntary cooperation between Vattenfall and the national ministries and NRAs (the BEIS and Ofgem in the UK as well as the MoEA and ACM in the Netherlands) as well as the European Commission.
- Based on the mitigation option of spreading responsibility for the interconnector over a group of players, define who is responsible for operation of the interconnector. Options for the allocation of responsibilities include, for example, making TenneT TSO B.V. and Vattenfall or TenneT TSO B.V. and a UK interconnector developer responsible for operation. Certainty about operational responsibility can be achieved through voluntary cooperation between TenneT TSO B.V. and

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[128] In the Netherlands, TenneT TSO B.V. holds the licenses needed to act as both onshore TSO and offshore TSO. Clarification is therefore needed whether the interconnector would be developed by the offshore or the onshore TSO. Formally, the two are separate grid operators with different regulatory frameworks for the different assets. So far, the initiative for interconnection development has been with the offshore TSO.

[129] Likely to be addressed by still to be adopted European Commission. 2018. *COM 2016/861 final; REGULATION on the internal market for electricity.* http://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/COM-2016-861-F2-EN-MAIN-PART-1.PDF

Vattenfall or a UK interconnector developer, as well as the national ministries and NRAs (the BEIS and Ofgem in the UK and the MoEA and ACM in the Netherlands).

- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the UK and the Netherlands of costs and benefits deriving from shared responsibility for the interconnector. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. TenneT TSO B.V. and Vattenfall or a UK interconnector developer, as well as the national ministries and NRAs (the BEIS and Ofgem in the UK and the MoEA and ACM in the Netherlands) assume responsibility for this action.

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 37. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 36.

Figure 37: CGS IJmuiden Ver to Norfolk barrier mitigation – Uncertainty about responsibility for project development

Uncertainty about regulation deriving from jurisdiction over cross-border cable systems

Project-specific barrier evaluation: The OWFs included in the CGS IJmuiden Ver to Norfolk hybrid project idea are located in the UK and the Dutch EEZ. As the OWFs serve to exploit marine resources within the UK and the Dutch EEZs, the UK and the Netherlands have jurisdiction over the respective OWF installations. The corresponding export cable systems belonging to the OWFs have their onshore connection points in the UK and the Netherlands. They therefore do not cross the border between the UK and the Dutch EEZ. Thus, the UK and the Netherlands have jurisdiction over the respective export cable systems.

The interconnector has its connection points at the offshore substations of the export cable system of the UK OWF and the Dutch OWF and therefore crosses the UK EEZ and the Dutch EEZ. Both the UK and the Netherlands have jurisdiction over the cable and can determine applicable regulations. Thus, the jurisdiction over the interconnector might be concurrent and the regulations applicable to the interconnector derived from UK and from Dutch jurisdiction might contradict each other.

Barrier mitigation: The mitigation option identified as most feasible is to obtain all required permits and to align regulation deriving from concurrent jurisdiction over the operation of the cross-border cable system between the countries involved. This is based on consideration of the interdependencies shown in Table 2, interaction with project stakeholders (see Chapter 5.2.2) and the ease of implementation in terms of the required effort.

The other mitigation options besides aligning regulation deriving from concurrent jurisdiction considered in this study were (1) to define regulation deriving from UK jurisdiction as applicable to the interconnector during operations, and (2) to define regulation deriving from Dutch jurisdiction as applicable.

The mitigation option identified as most feasible was selected for the following reasons: No regulation deriving either from UK or Dutch jurisdiction is immediately applicable to all the maritime zones that the interconnector crosses. Therefore, alignment between the countries is necessary. While the chances of the UK and the Netherlands agreeing on a single jurisdiction are limited, the alignment of rules deriving from two jurisdictions can be a lengthy process. On the other hand, the selected mitigation option reflects the interests of both countries in alignment and can potentially build on existing agreements established for interconnectors between the UK and the Netherlands, such as BritNed.

Regarding interdependencies, this barrier is interdependent with the barriers "failure of developers to align planning across assets and countries" and "uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)". Obtaining all required permits and aligning regulation is facilitated by continuous dialogue and early-stage alignment. Furthermore, the aligned operational regulation needs to be reflected in the requirements of the OWF tender.

<u>Actions and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the CGS IJmuiden Ver to Norfolk hybrid project, the following actions are required:

- For development and construction, clarify the permits needed for the interconnector under UK and Dutch regulations. Compliance with the environmental and technical rules under UK and Dutch regulations can be ensured by obtaining these permits. This can be achieved through voluntary cooperation between TenneT TSO B.V. (and a potential UK interconnector developer) and the national ministries (the BEIS, supported by the Marine Management Organisation and The Crown Estate, in the UK and the MoEA, supported by the Ministry of Infrastructure and Water Management, in the Netherlands).
- If possible, implement a one-stop shop on the national level to allow for a coordinated process with only one permit required for the interconnector. As stipulated in Regulation (EU) 347/2013[130], a one-stop shop in terms of a competent authority that integrates or coordinates all permit granting processes should reduce process complexity, as well as increase efficiency and transparency. The scope of a one-stop shop could be extended to provide a consolidated database of environmental data, facilitating easy data exchange between countries. However, the longer-term benefits are accompanied by significant shorter-term setup costs. So, the feasibility of implementing this action in the scope of mitigating barriers to the IJmuiden Ver to UK hybrid project is questionable. Certainty about the implementation can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands, if feasible. The national ministries would assume responsibility for this action (the BEIS, supported by the Environment Agency, in the UK and the MoEA, supported by the Ministry of Infrastructure and Water Management, in the Netherlands).
- If required, change the national permit procedures for the specific hybrid project. Guidance from project-specific developers in the form of an inventory of environmental and technical rules is required to inform changes to the permit procedures. Certainty about changes can be achieved

[130] European Parliament, European Council. 2013. *REGULATION (EU) No. 347/2013 on guidelines for trans-European energy infrastructure.* (29). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0347&from=en

by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. The national ministries would assume responsibility for this action (the BEIS, supported by the Marine Management Office and the Environment Agency, in the UK and the MoEA, supported by the Ministry of Infrastructure and Water Management, in the Netherlands).

- For the operational phase, align the applicable national regulations arising from concurrent jurisdiction for the specific hybrid project. The required alignment may concern liability issues, control system operations (voltage levels, grid synchronisation etc.) and matters discussed in relation to other barriers. Also consider existing national and EU legal frameworks such as the System Operations regulation (Regulation (EU) 2017/1485)[131] and the CACM regulation (Regulation (EU) 2015/1222).[132] Guidance from project-specific developers is required to inform the alignment. Certainty about the alignment of operational rules can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. The national ministries and NRAs assume responsibility for this action (the BEIS and Ofgem in the UK and the MoEA and ACM in the Netherlands).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 38. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 36.

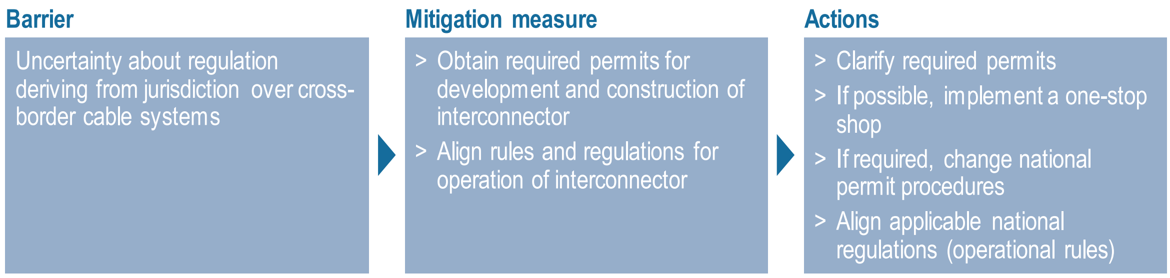

Figure 38: CGS IJmuiden Ver to Norfolk barrier mitigation – Uncertainty about regulation deriving from jurisdiction over cross-border cable systems

Uncertainty about market arrangements

Project-specific barrier evaluation: Clarification of commercial flows is required as the potential OWF sites of the CGS IJmuiden Ver to Norfolk hybrid project are located in the UK and the Dutch EEZ, with onshore grid connection points in both the UK and the Netherlands. Thus, commercial flows of both OWFs to both the UK and the Dutch market are possible. Commercial flows for the OWFs included in the hybrid project must therefore be clarified.

Barrier mitigation: The mitigation option identified as most feasible is to allow commercial flows only from the UK OWF to the UK market, and from the Dutch OWF to the Dutch market. Therefore, only leftover capacities are available for interconnection and the OWFs can transmit their electricity to the

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[131] European Commission. 2017. *COMMISSION REGULATION (EU) 2017/1485 establishing a guideline on electricity transmission system operation.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R1485&from=DE

[132] European Commission. 2015. *COMMISSION REGULATION (EU) 2015/1222 establishing a guideline on capacity allocation and congestion management.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1222&from=EN

respective national markets with priority. This is based on consideration of the interdependencies shown in Table 2 and the ease of implementation in terms of the required effort.

Since this market arrangement was identified as most feasible in interaction with project stakeholders from the beginning, no other mitigation options were considered in detail.

Regarding interdependencies, this barrier is interdependent with the barriers "uncertainty about hybrid cable system classification" and "uncertainty about applicable RES subsidy scheme". Efficient commercial flows from only the UK OWF to the UK market and from only the Dutch OWF to the Dutch market imply defining the export cable systems as export cable systems with interconnector functionality. In addition, such a definition may affect the business case of the OWFs included in the hybrid project and thereby potentially the level of required subsidies.

<u>Action and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the CGS IJmuiden Ver to Norfolk hybrid project, the following actions are required:

- Validate the feasibility of defining the market arrangement as commercial flows from the OWFs included in the hybrid project to their respective home markets only. This can be achieved through voluntary cooperation between the TSOs, national ministries and NRAs (the BEIS and Ofgem in the UK, and TenneT TSO B.V., the MoEA and ACM in the Netherlands).

Ensure compatibility with measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the UK and the Netherlands of costs and benefits deriving from the market arrangement. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. Project developers, the national ministries and NRAs assume responsibility for this action (Vattenfall, the BEIS and Ofgem in the UK, and TenneT TSO B.V., the MoEA and ACM in the Netherlands).The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 39. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 36.

Figure 39: CGS IJmuiden Ver to Norfolk barrier mitigation – Uncertainty about market arrangements

Uncertainty about hybrid cable system classification

<u>Project-specific barrier evaluation:</u> The export cable systems included in the CGS IJmuiden Ver to Norfolk hybrid project function as hybrid cable systems, as they serve two distinct and legally differentiated functions. According to Regulation (EC) 714/2009,[133] an interconnector is defined as "a transmission line which crosses or spans a border between Member States and which connects the national transmission systems of the Member States." A conventional export cable system provides

[133] European Parliament, European Council. 2009. *REGULATION (EC) No. 714/2009 on conditions for access to the network for cross-border exchanges in electricity.* Article 2 (1). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R0714&from=EN

for the transmission of electricity generated by the OWF to an onshore connection point without crossing borders. In the hybrid setup, the export cable systems provide for the transmission of electricity generated by the OWFs to shores and market-to-market flows. Such dual functionality prevents a straight-forward classification of the cable systems under EU and national legislation and regulations as either export cable systems or interconnectors.

The interconnector included in the hybrid project, meaning the cable connection between the offshore substation of the export cable systems of the UK OWF and the Dutch OWF, functions solely as an interconnector. This is because the UK OWF transmits electricity only to the UK market and the Dutch OWF only to the Dutch market (in the market arrangement foreseen by the project developers). However, this definition is based on the assumption that a cable system which does not connect two national transmission systems can still be defined as an interconnector when one end is connected to the offshore substation of the UK export cable system and the other end is connected to the Dutch export cable system.

Barrier mitigation: The mitigation option identified as most feasible is to define the export cable systems as export cable systems with interconnector functionality. This effectively makes export cable systems hybrid cable systems. Thus, the transmission of power generated by the OWFs has priority regarding access to the capacity of the cable systems and only leftover capacity is available for interconnection. This is based on consideration of the interdependencies shown in Table 2, interaction with project stakeholders (see Chapter 5.2.4) and the ease of implementation in terms of the required effort.

The other mitigation option considered in this study was to define the UK and the Dutch export cable systems as interconnectors with export cable functionality for leftover capacities.

The mitigation option identified as most feasible was selected for the following reasons: Neither mitigation option is covered under UK law, since OFTO transmission licenses do not allow for market-to-market flows. Nor can OFTO transmission licenses and interconnector licenses be held by the same party. In the Netherlands, it is questionable whether the two mitigation options are covered under Dutch regulation, as it does not expressly prohibit the dual functionality of a cable system. From a European perspective, however, existing regulations and exemptions do not cover hybrid cable systems. Alternatively, adjustments may be required for both options. Thus, the mitigation option was selected due to its interdependencies with other barriers, as explained below.

Regarding interdependencies, this barrier is interdependent with the barriers "uncertainty about market arrangements" and "uncertainty about applicable RES subsidy scheme". Defining the export cable systems as export cable systems with interconnector functionality for leftover capacities fits the envisaged market arrangement and RES subsidy schemes. This is because it gives the UK and Dutch OWFs priority access to the capacity of the UK and Dutch export cable system for the transmission of generated electricity to the UK and Dutch markets. As a consequence, the selected classification of the export cable systems has no impact on the business case of the OWFs included in the hybrid project. But it does impact on the business case of the interconnector when compared to a conventional point-to-point interconnector. Therefore, the need for additional compensation for the interconnector operator must be assessed. Furthermore, the European energy policy targets of diversifying and integrating RES, as well as reducing greenhouse gas emissions, are prioritised when defining the export cable systems as export cable systems whose leftover capacities are available for interconnection.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the CGS IJmuiden Ver to Norfolk hybrid project, the following actions are required:

- Validate whether defining the Dutch export cable system as a national transmission system in line with the definition in EU legislation and regulations complies with Dutch regulations.[134] This is required to allow the cable system between the offshore substations of the export cable systems of the UK and Dutch OWFs to be defined as an interconnector within the meaning of EU regulations. In addition, validate that an export cable system defined as a national transmission system is, under Dutch regulations, legally allowed to provide for both the transmission of electricity from the Dutch OWF and interconnection flows. Lastly, assess whether TenneT TSO B.V., as an offshore grid operator, should be allowed to develop interconnection capacity (due to the leftover capacity on the export cable system being available for interconnection) for which it currently needs an explicit mandate from the MoEA. This can be achieved through voluntary cooperation between the MoEA and ACM in the Netherlands, initiated by TenneT TSO B.V.
- If required, preferably adjust Dutch regulations for the specific hybrid project to classify the export cable system as a national transmission system. This should allow both the transmission of electricity from the OWF and interconnection flows. If this is not possible, allow the same dual functionality by defining a new hybrid asset class and developing new regulation for that asset class. Guidance from project-specific developers is required to inform the adjustment of Dutch regulation. Certainty about changes can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. The MoEA and ACM in the Netherlands assume responsibility for this action.
- Validate whether defining the UK export cable system as a national transmission system in line with the definition in EU legislation and regulations complies with UK regulations. This is required to allow the cable system between the offshore substations of the export cable systems of the UK and Dutch OWFs to be defined as an interconnector within the meaning of EU regulations. This can be achieved through voluntary cooperation between the BEIS and Ofgem in the UK, initiated by Vattenfall.
- If required, adjust UK regulation to classify the export cable system as a national transmission system. In addition, adjust the UK OFTO regime such that OFTO and / or interconnector licences allow the dual functionality of assets.[135] Guidance from project-specific developers is required to inform the adjustment of the UK OFTO regime. Certainty about changes can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. The BEIS and Ofgem in the UK assume responsibility for this action.
- If required, adjust UK and Dutch regulations for the specific hybrid project to change the definition of an interconnector. Despite the fact the cable system does not connect two national transmission systems, this would this would allow the cable system between the offshore substation of the UK export cable and the offshore substation of the Dutch export cable system to be defined as an interconnector. Certainty about changes can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. The national ministries and NRAs assume responsibility for this action (the BEIS and Ofgem in the UK and the MoEA and ACM in the Netherlands).

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[134] Dutch Elektriciteitswet 1998. §1 Article 15a. https://wetten.overheid.nl/BWBR0009755/2018-07-28#Hoofdstuk3_Paragraaf1_Artikel15a
Dutch Elektriciteitswet 1998. §1 Article 1 (as). https://wetten.overheid.nl/BWBR0009755/2018-07-28#Hoofdstuk1_Paragraaf1_Artikel1

[135] UK Electricity Act 1989. Section 6 (1)(b) and (e), (2A).
https://www.legislation.gov.uk/ukpga/1989/29/contents

- On a European level, apply for project-specific exemptions from existing European regulation based on the pilot character of the hybrid project. One exemption could possibly concern the definition of a cable system as an interconnector which does not connect two national transmission systems. Another could possibly concern the EU's requirement to make the maximum capacity of interconnectors available for access by third parties.[136] Vattenfall and TenneT TSO B.V. can initiate this and achieve it through voluntary cooperation between them and the European Commission.
- If required, adjust the EU's regulatory framework so it facilitates hybrid project development. For example, incorporate a hybrid cable system definition in Regulation (EC) 714/2009[137]. Also, clarify how the hybrid project's requirements fit with the stipulation of free usage of the "maximum capacity" of interconnectors by third parties. Guidance from project-specific developers is required to inform the adjustment of the existing regulatory framework. Initiated by EU Member States, this can be achieved through the harmonisation of the EU's regulatory framework by the European Commission, the European Parliament and the European Council. The European Court of Justice, which interprets and clarifies existing European law,[138] may need to clarify "maximum capacity" in this context.
- Develop a regional capacity calculation and allocation mechanism that accounts for the hybrid cable system classification (export cable systems with interconnector functionality) within the framework of the existing CACM regulation (Regulation (EU) 2015/1222).[139] This can be achieved through voluntary cooperation between TenneT TSO B.V. (and a potential third party in the UK) and NRAs (Ofgem in the UK and ACM in the Netherlands).
- Validate whether no additional compensation for the interconnector operator is required, as the interconnector is developed as part of the hybrid project with a subsidiary purpose from the beginning. However, the OWF developer is compensated through a RES subsidy scheme by bidding for the required subsidy level in a competitive process. For this, the OWF developer needs clarity on the market conditions applicable to the OWF in the future. The former can be achieved through voluntary cooperation between TenneT TSO B.V. (and a potential third party in the UK), national ministries and NRAs (the BEIS and Ofgem in the UK, and the MoEA and ACM in the Netherlands), as well as the European Commission.
- Ensure compatibility with measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the UK and the Netherlands of costs and benefits deriving from the hybrid cable system classification. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. TenneT TSO B.V. (and

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[136] European Parliament, European Council. 2009. *REGULATION (EC) No. 714/2009 on conditions for access to the network for cross-border exchanges in electricity.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R0714&from=EN

[137] European Parliament, European Council. 2009. *REGULATION (EC) No. 714/2009 on conditions for access to the network for cross-border exchanges in electricity.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R0714&from=EN

[138] European Commission. 2018. *Court of Justice of the European Union (CJEU).* https://europa.eu/european-union/about-eu/institutions-bodies/court-justice_en

[139] European Commission. 2015. *COMMISSION REGULATION (EU) 2015/1222 establishing a guideline on capacity allocation and congestion management.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1222&from=EN

a potential third party in the UK) as well as national ministries and NRAs (the BEIS and Ofgem in the UK as well as the MoEA and ACM in the Netherlands) assume responsibility for this action.

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 40. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 36.

Barrier	Mitigation measure	Actions
Uncertainty about hybrid cable system classification	> Define the Dutch export cable system as an export cable system with interconnector functionality , which makes it a hybrid cable system, provided that defining the Dutch export cable system as part of the Dutch national transmission system is not possible > Define the UK export cable system as an export cable system with interconnector functionality	> Validate compatibility of defining NL export cable system as a national transmission system (in line with EU law) with NL regulat. > If compatible, validate fit of dual functionality of NL export cable system with NL regulation > If required, adjust NL regulation to classify NL export cable system as a transmission system and to allow dual functionality > If not possible, define new hybrid asset class and develop new NL regulation > Validate compatibility of defining UK export cable system as a national transmission system (in line with EU law) with UK regulat. > If required, adjust UK regulation to classify UK export cable system as a transmission system > Adjust the UK OFTO regime to allow dual functionality > If export cable systems are not classified as transmission systems, adjust UK / NL regulation to allow IC definition > Apply for project-specific exemptions from EU regulations > If required, adjust regulatory framework on European level > Develop regional capacity calculation, allocation mechanism > Validate whether no additional compensation for IC operator is required > Ensure fair allocation of costs and benefits across stakeholders

Figure 40: CGS IJmuiden Ver to Norfolk barrier mitigation – Uncertainty about hybrid cable system classification

Failure of developers to align planning across assets and countries

Project-specific barrier evaluation: Several factors make the CGS IJmuiden Ver to Norfolk hybrid project complex. These are the inclusion of a UK OWF, a Dutch OWF, an export cable system to the UK market and one to the Dutch market, and an interconnector linking the offshore substations of the export cable systems of the UK OWF and the Dutch OWF. As all five assets have separate permit, development and construction timelines, geographical alignment is crucial. For example, the locations of the offshore substations of the export cable systems in the UK and the Netherlands must align with the route for the interconnector so the interconnector can be added later. The UK OWF has been tendered but can still consider an interconnector route, as the permits for the assets have not yet been finalised. The Dutch OWF in the IJmuiden Ver area is yet to be tendered, with the possibility of considering an interconnector route in the subsequent permit procedures. In addition, interoperability between the different components of the five assets must be ensured based on the alignment of technical specifications to enable the hybrid project to function.

Barrier mitigation: The mitigation option identified as most feasible is to facilitate continuous dialogue and early-stage alignment between the project developers. Given that the UK and Dutch authorities respectively determine the location of the UK OWF and the Dutch OWF, project developers need to align on the following: the routing of the cable systems, the location of substations and the technical specifications of the cable systems, the substations and the OWFs included in the hybrid project. This is based on consideration of the interdependencies shown in Table 2, interaction with project stakeholders (see Chapter 5.2.5) and the ease of implementation in terms of the required effort.

Apart from continuous dialogue and early-stage alignment between the project developers, no other mitigation options were considered.

Regarding interdependencies, this barrier is interdependent with the following four barriers: "uncertainty about responsibility for project development"; "uncertainty about regulation deriving from jurisdiction over cross-border cable systems"; "uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)"; the "lack of regulated revenues for anticipatory investments" and the "limited engagement of public stakeholders". Continuous dialogue and early-stage alignment are complemented by clearly defining who is responsible for development, construction and operation of the interconnector as well as the need to obtain all relevant permits and align regulation. However, dialogue and alignment themselves are supported by the following measures to mitigate other barriers. An aligned tender design allows for the involvement of and coordination with the developer of the OWF included in the hybrid project. Two factors allow for such alignment by decreasing the risk to hybrid project development arising from early-stage project-specific decisions: certainty about the availability of regulated revenues for anticipatory investments; and a formalised public commitment and public financial support.

Action and responsibilities for mitigation implementation: To implement this mitigation measure for the CGS IJmuiden Ver to Norfolk hybrid project, the following action is required:

- Engage in a continuous dialogue to achieve early-stage alignment regarding the locations, routing and technical specifications for the individual assets. This can be achieved through voluntary cooperation between Vattenfall and TenneT TSO B.V. (and a potential third party in the UK) and the national ministries and NRAs (the BEIS, supported by The Crown Estate and Ofgem, in the UK, and the MoEA, supported by RVO and ACM, in the Netherlands).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 41. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 36.

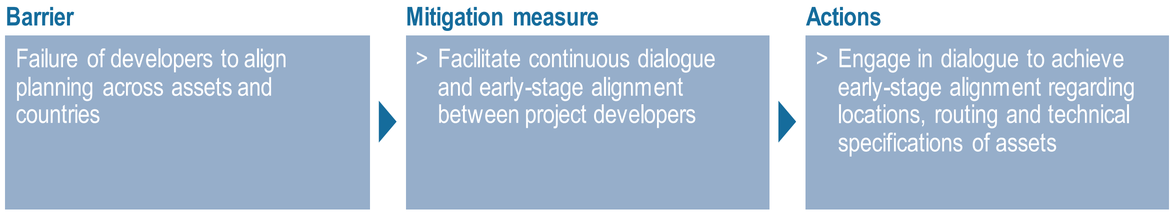

Figure 41: CGS IJmuiden Ver to Norfolk barrier mitigation – Failure of developers to align planning across assets and countries

Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)

<u>Project-specific barrier evaluation:</u> A suitable tender design needs to be chosen for the CGS IJmuiden Ver to Norfolk hybrid project. The OWFs included in the project setup are located in the UK and the Dutch EEZ and the offshore substations of their export cable systems are linked via an interconnector. Thus, both the UK and the Netherlands have an interest in defining the requirements for the OWF development in accordance with their respective standards. These may be contradictory. In addition, the tender designs need to ensure that tender candidates can realistically develop the OWF. In consequence, the tender design must clarify which hybrid-specific requirements to include.

<u>Barrier mitigation:</u> The mitigation option identified as most feasible is to implement a tender design with strict tender requirements. These should be aligned between the UK and the Netherlands and also eliminate all hybrid-specific uncertainties for the OWF developers. This is based on consideration of the interdependencies shown in Table 2, interaction with project stakeholders (see Chapter 5.2.7) and the ease of implementation in terms of the required effort

The other mitigation options considered in this study were (1) to have a strict tender design with requirements aligned among the stakeholders, (2) to have a strict tender design without hybrid-specific uncertainties for the OWF developer and (3) to have a lenient tender design with requirements aligned among the stakeholders and without hybrid-specific uncertainties for the OWF developer.

The mitigation option identified as most feasible was selected for the following reasons: While aligned requirements potentially necessitate amendments to national legislation and regulations, both countries have valid interests in defining certain requirements for the tenders. Aligned requirements also aid in ensuring the interoperability of the OWFs with the other assets of the hybrid project. These factors increase the probability of successful hybrid project implementation. Furthermore, a tender design with strict requirements also increases the probability of successful project implementation, allowing for a possible decrease in the cost efficiency of the OWF development due to more limited competition. Lastly, certainty about hybrid-specific characteristics of the OWF development increases the probability of successful project implementation – and decreases the cost of implementation – by reducing the risk premium otherwise demanded by OWF developers in terms of subsidies.

Regarding interdependencies, this barrier is interdependent with the following three barriers: "uncertainty about regulation deriving from jurisdiction over cross-border cable systems"; the "failure of developers to align planning across assets and countries"; and "uncertainty about applicable RES subsidy scheme". Aligned regulation deriving from UK and Dutch jurisdiction needs to be reflected in the requirements of the OWF tenders. In addition, the OWF tenders can include a RES subsidy scheme established by the UK and the Netherlands, respectively. Continuous dialogue and early-stage alignment facilitate aligned tender designs.

<u>Actions and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the CGS IJmuiden Ver to Norfolk hybrid project, the following actions are required:

- Agree a tender design with strict requirements. Certainty about the tender design can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. The national ministries and other national authorities assume responsibility for this action (the BEIS and The Crown Estate in the UK, and the MoEA, ACM and RVO in the Netherlands).
- Agree tender requirements which take account of the valid interests of the UK and the Netherlands. This means jointly defining material requirements such as technical and operational standards. Environmental standards do not need to be aligned between the UK and the Netherlands, as national environmental standards apply to the respective OWFs. Similarly, financial requirements do not need to be aligned across countries. Guidance from project-specific developers is required to inform the development of project-specific tender requirements. Certainty about tender requirements can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. The national ministries and other national authorities assume responsibility for this action (the BEIS and The Crown Estate in the UK, and the MoEA, ACM and RVO in the Netherlands).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 42. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 36.

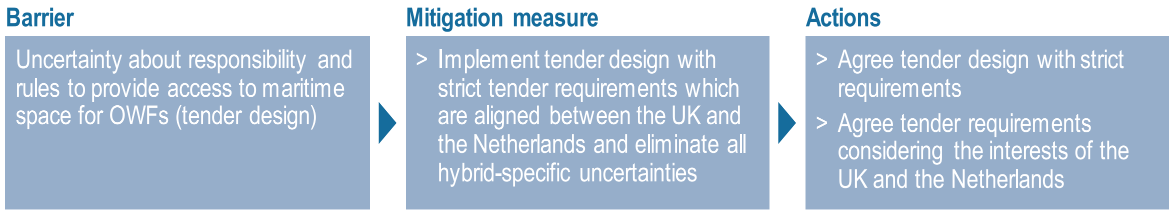

Figure 42: CGS IJmuiden Ver to Norfolk barrier mitigation – Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)

Lack of regulated revenues for anticipatory investments

Project-specific barrier evaluation: Anticipatory investments are necessary to allow for the implementation of the CGS IJmuiden Ver to Norfolk hybrid project. As the interconnector establishes a link between the offshore substations of the export cable systems of the UK OWF and the Dutch OWF, it is necessary to adapt the technical setup of the substations to support the interconnector link. These adaptations represent additional costs for the developers of the substations – that is, for Vattenfall in the UK and for TenneT TSO B.V. in the Netherlands. This necessitates additional investments in anticipation of the interconnector link. As any investments in grid infrastructure deemed inefficient by regulators are not compensated,[140] the additional costs developers face may present an obstacle to hybrid project development.

Barrier mitigation: The mitigation identified as most feasible is to validate the feasibility of regulated revenues for the anticipatory investments under the regulatory regimes in both the UK and the Netherlands. This is based on consideration of the interdependencies shown in Table 2, interaction

[140] ACER. 2014. *Recommendation of the Agency for the cooperation of energy regulators No 03/2014.* https://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Recommendations/ACER%20Recommendation%2003-2014.pdf

with project stakeholders (see Chapter 5.2.11) and the ease of implementation in terms of the required effort.

Besides validating the feasibility of regulated revenues for anticipatory investments under the regulatory regime in the UK and in the Netherlands, no other mitigation option can be considered. The UK export cable system, which requires anticipatory investments, is geographically located in the UK. The UK regime is therefore applicable and must be assessed with regard to the coverage of the specific investments. The Dutch export cable system, which also requires anticipatory investments, is geographically located in the Netherlands. The Dutch regime is therefore applicable and must be assessed with regard to the coverage of the specific investments.

Regarding interdependencies, this barrier is interdependent with the "failure of developers to align planning across assets and countries" barrier. Continuous dialogue and early-stage alignment with the BEIS and Ofgem in the UK, as well as the MoEA and ACM in the Netherlands, support the validation of the coverage of the anticipatory investments with regulated revenues under the UK and Dutch regimes, respectively.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the CGS IJmuiden Ver to Norfolk hybrid project, the following actions are required:

- Validate the efficiency of the anticipatory investment under the developer build option of the OFTO regime. This ensures that anticipatory investments for the export cable system of the UK OWF in the hybrid project are covered by regulated revenues.[141] If they are, the anticipatory investment can be factored into the calculation of the final transfer value of the export cable system to the OFTO. This can be achieved by voluntary cooperation between Vattenfall and Ofgem in the UK.
- Validate the inclusion of the anticipatory investments in the Dutch Offshore Grid Development Framework[142] to allow for their inclusion in the investment planning of TenneT TSO B.V. This ensures that anticipatory investments for the export cable system of the Dutch OWF are covered by regulated revenues. This action can be based on an existing decision-making process for investments for the offshore grid. It can therefore be achieved through voluntary cooperation between TenneT TSO B.V., the MoEA and ACM in the Netherlands.
- Ensure compatibility with measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the UK and the Netherlands of costs and benefits deriving from regulated revenues for anticipatory investments. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. Vattenfall, TenneT TSO B.V. (and a potential third party in the UK) and the national ministries and NRAs (the BEIS and Ofgem in the UK and the MoEA and ACM in the Netherlands) assume responsibility for this action.

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 43. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 36.

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[141] Ofgem. 2017. *Offshore Transmission: Updated Guidance for Cost Assessment.* https://www.ofgem.gov.uk/system/files/docs/2017/07/170629_update_cost_assessment_guidance__0.pdf

[142] Dutch Elektriciteitswet 1998. Article 21. https://wetten.overheid.nl/BWBR0009755/2018-07-28#Hoofdstuk3_Paragraaf3_Artikel21

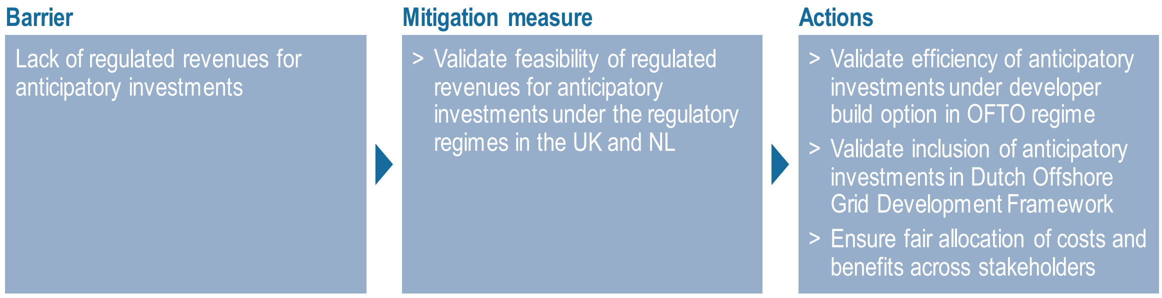

Figure 43: CGS IJmuiden Ver to Norfolk barrier mitigation – Lack of regulated revenues for anticipatory investments

Uncertainty about applicable RES subsidy scheme

Project-specific barrier evaluation: The OWFs included in the CGS IJmuiden Ver to Norfolk hybrid project are located in the UK and Dutch EEZs. Due to the connection to both the UK and the Dutch markets, the application of a UK subsidy scheme and a Dutch subsidy scheme are generally conceivable. In addition to applying the respective national subsidy schemes to the OWFs depending on their location, the following schemes involving both countries are also possible: a UK and / or Dutch subsidy scheme with statistical transfers between the UK and the Netherlands applicable to both OWFs, a joint project or a joint subsidy scheme between the UK and the Netherlands. All are in line with EU Directive 2009/28/EC[143] on the promotion of the use of energy from RES. In summary, the applicability of a support scheme from one of the countries involved or in some joint form is to be determined.

Barrier mitigation: The mitigation option identified as most feasible is to apply the subsidy scheme of the Netherlands to the Dutch OWF and to apply the UK subsidy scheme to the UK OWF. Under this option, the UK government awards the UK OWF a CfD (i.e. a subsidy with its regular characteristics in terms of type, level and duration of support as well as technology coverage). And the Dutch government awards the Dutch OWF a premium tariff through the Dutch tender process (i.e. the SDE+ subsidy scheme with its regular characteristics in terms of type, level and duration of support as well as technology coverage). This is based on consideration of the interdependencies shown in Table 2 and the ease of implementation in terms of the required effort.

Since the applicability of these RES subsidy schemes was identified as most feasible in interaction with project stakeholders from the beginning, no other mitigation options were considered in detail.

Regarding interdependencies, this barrier is interdependent with the following three barriers: "uncertainty about market arrangements", "uncertainty about hybrid cable system classification" and "uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)". The business cases of the OWFs in the hybrid project – and thereby potentially the level of required subsidies – are affected by the market arrangement of commercial flows from the Dutch OWF to the Dutch market only, and from the UK OWF to the UK market only. Similarly, the level of required subsidies is also impacted by the hybrid cable system classification of defining the export cable systems as export cable systems with interconnector functionality. Lastly, applying a UK and a Dutch subsidy scheme to the respective OWFs fits with a tender design with strict tender requirements aligned between the UK and the Netherlands.

[143] European Parliament, European Council. 2009. *DIRECTIVE 2009/28/EC on the promotion of the use of energy from renewable sources.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the CGS IJmuiden Ver to Norfolk hybrid project, the following actions are required:

- Validate the feasibility of applying the subsidy scheme of the Netherlands to the Dutch OWF and the UK subsidy scheme to the UK OWF. This can be achieved through voluntary cooperation between national ministries and NRAs (the BEIS and Ofgem in the UK and the MoEA and ACM in the Netherlands).
- Ensure compatibility with measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the UK and the Netherlands of costs and benefits deriving from the RES subsidy scheme. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. OWF developers, national ministries and NRAs assume responsibility for this action (Vattenfall, the BEIS and Ofgem in the UK, and the MoEA and ACM in the Netherlands).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 44. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 22.

Figure 44: CGS IJmuiden Ver to Norfolk barrier mitigation – Uncertainty about applicable RES subsidy scheme

Limited engagement of public stakeholders

Project-specific barrier evaluation: The support of public stakeholders is needed for successful implementation of the CGS IJmuiden Ver to Norfolk hybrid project as regulatory and technical barriers must be overcome and financial support provided across two countries, namely, the UK and the Netherlands.

Barrier mitigation: The mitigation option identified as most feasible is to formalise public commitment in the form of a project-specific MoU or a project-specific HANSA. Feasibility studies and scoping studies for early-stage alignment through public funding, for example, should also be facilitated. Furthermore, adequate de-risking of the hybrid project is required. This is based on consideration of the interdependencies shown in Table 2, interaction with project stakeholders (see Chapter 5.2.13) and the ease of implementation in terms of the required effort.

Besides formalising public commitment in the form of a project-specific MoU or a project-specific HANSA and facilitating feasibility studies and scoping studies or providing financial guarantees, no other mitigation option was considered.

Regarding interdependencies, this barrier is interdependent with the "failure of developers to align planning across assets and countries" barrier. Continuous dialogue and early-stage alignment between the project developers is facilitated by formalising the commitment of relevant stakeholders of the hybrid project and / or by providing public funding for early-stage activities. These may include feasibility studies, scoping studies and technical research and development.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the CGS IJmuiden Ver to Norfolk hybrid project, the following actions are required:

- Align and implement the type of formalisation of public commitment to allow for the development of the CGS IJmuiden Ver to Norfolk hybrid project. The formalisation of commitment in the form of a project-specific MoU or a project-specific HANSA is an expression of the goodwill of the stakeholders to support hybrid project development. It assures project developers of public support, e.g. in the form of a dialogue with relevant government bodies. In early project stages, a project-specific MoU provides sufficient certainty for project developers. The stakeholders assuming responsibility are Vattenfall, TenneT TSO B.V. (and a potential third party in the UK), and national ministries and NRAs (the BEIS and Ofgem in the UK and the MoEA and ACM in the Netherlands), as well as the European Commission. In later project stages, a project-specific HANSA is required to provide project developers with sufficient legal certainty. The stakeholders assuming responsibility include the national ministries (the BEIS in the UK and the MoEA in the Netherlands) and the European Commission.
- Catalyse the development of the CGS IJmuiden Ver to Norfolk hybrid project by supporting early-stage alignment among developers. Do this through public funding for feasibility studies, pilot projects and R&D for innovative, technological solutions, in addition to existing offshore support schemes. Such public support allows developers to firmly commit to the development of the project. This can be achieved through voluntary cooperation between the national ministries (the BEIS in the UK and the MoEA in the Netherlands) and the European Commission.
- Support the de-risking of the hybrid project by providing financial guarantees. Such guarantees can reassure project developers in situations which cannot be foreseen due to the pilot character of the hybrid project. This can be achieved through voluntary cooperation between the project developers (Vattenfall and TenneT TSO B.V., and a potential third party in the UK) as well as the European Commission.
- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the UK and the Netherlands of costs and benefits deriving from the engagement of public stakeholders. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. The national ministries and NRAs assume responsibility for this action (the BEIS and Ofgem in the UK and the MoEA and ACM in the Netherlands).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 45. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 36.

Barrier	Mitigation measure	Actions
Limited engagement of public stakeholders	> Formalise public commitment > Facilitate early-stage alignment through public funding and support de-risking of hybrid project	> Align and implement formalisation of public commitment (in early project stages in form of MoU, later HANSA) > Support early-stage alignment among developers through public funding > Support de-risking of project by providing financial guarantees > Ensure fair allocation of costs and benefits across stakeholders

Figure 45: CGS IJmuiden Ver to Norfolk barrier mitigation – Limited engagement of public stakeholders

Uncertainty regarding the UK market

Project-specific barrier evaluation: The CGS IJmuiden Ver to Norfolk hybrid project stands to benefit from the UK Capacity Market and the UK Cap and Floor regime because it establishes interconnection capacity between the UK and the Netherlands. While there are currently no changes proposed to the UK Capacity Market or the UK Cap and Floor regime, any potential effects of the UK's withdrawal from the EU need to be evaluated after the withdrawal is completed. Thus, it is unclear whether the CGS IJmuiden Ver to Norfolk hybrid project will benefit from these policies.[144]

Barrier mitigation: Considering interaction with project stakeholders (see Chapter 5.2.14), no immediate actions can be taken. It is necessary to await clarification of future UK policies as well as the UK's intended future interaction with the EU energy market.

Besides awaiting clarification of future UK policies and the future participation of the UK in the EU's internal energy market, no other mitigation option was considered.

Regarding interdependencies, this barrier is not interdependent with any other barrier considered in this study.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the CGS IJmuiden Ver to Norfolk hybrid project, the following actions are required:

- Await clarification of the future of the UK Capacity Market and the UK Cap and Floor regime to clarify the future business case for interconnectors linking to the UK.
- Await clarification on whether the UK intends to participate in the EU’s internal energy market in the future to provide planning security for hybrid project developers.

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 46. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 36.

[144] Vaughan, Adam. 2018. *UK's backup power subsidies are illegal, European court rules*. https://www.theguardian.com/environment/2018/nov/15/uk-backup-power-subsidies-illegal-european-court-capacity-market

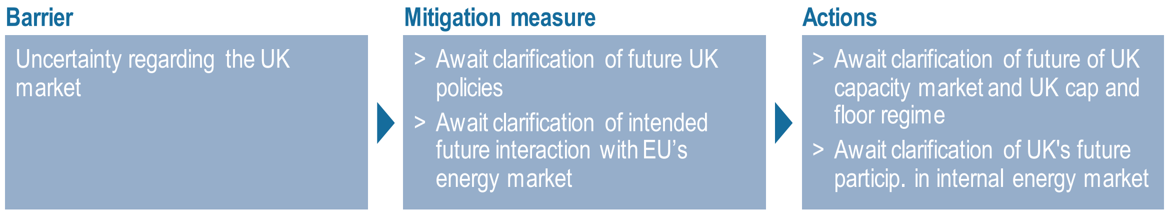

Figure 46: CGS IJmuiden Ver to Norfolk barrier mitigation – Uncertainty regarding the UK market

Disproportionate allocation of costs and benefits across involved stakeholders

Project-specific barrier evaluation: Agreeing on the allocation of costs and benefits for the CGS IJmuiden Ver to Norfolk hybrid project is complex. This is because he OWFs are geographically located in the UK and Dutch EEZs and the offshore substations of their export cable systems are linked by an interconnector. Certain costs and benefits are initially incurred by the UK and certain costs and benefits are initially incurred by the Netherlands due to the technical setup and the details of the hybrid project. In addition, the measures adopted to mitigate other barriers assign costs or distribute benefits to the UK and the Netherlands. Furthermore, developers may realise additional benefits. Thus, costs and benefits are generally not distributed fairly, and no suitable approach exists to reallocate costs and benefits across all stakeholders of the hybrid project.

Barrier mitigation: The mitigation option identified as most feasible is to reallocate costs and benefits deriving from the hybrid project where required, based on a project-specific process. In some respects, the process can be based on the existing methodology given by the Cross-Border Cost Allocations (CBCA) process[145]. It builds on the Cost Benefit Analysis (CBA) conducted by ENTSO-E[146] for Projects of Common Interest. In the CBCA process, benefits such as socio-economic welfare and CO_2 emissions are calculated on a national level to compensate net losers for the implementation of a project through a CBCA decision. The CBCA process provides a good starting point for the reallocation of costs and benefits across countries but is best suited for evaluating cross-border electricity interconnectors. This is based on consideration of the interdependencies shown in Table 2, interaction with project stakeholders (see Chapter 5.2.15) and the ease of implementation in terms of the required effort.

Besides implementing the process resulting in the reallocation of costs and benefits deriving from the implementation of the hybrid project, no other mitigation option was considered.

Regarding interdependencies, this barrier is interdependent with the following six barriers: "uncertainty about responsibility for project development (responsibility for interconnector)"; "uncertainty about market arrangements"; "uncertainty about hybrid cable system classification"; the "lack of regulated revenues for anticipatory investments"; "uncertainty about applicable RES subsidy scheme"; and the "limited engagement of public stakeholders". Reallocation also relates to those barriers. This is because their mitigation translates into costs and benefits for specific stakeholders

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[145] ACER. 2015. *Recommendation No 5/2015 on good practices for the treatment of the investment requests, including CBCA requests, for electricity and gas PCIs.* https://acer.europa.eu/Official_documents/Acts_of_the_Agency/Recommendations/ACER%20Recommendation%2005-2015.pdf

[146] ENTSO-E. 2018. *2nd ENTSO-E Guideline: For Cost Benefit Analysis of Grid Development Projects.* https://tyndp.entsoe.eu/Documents/TYNDP%20documents/Cost%20Benefit%20Analysis/2018-10-11-tyndp-cba-20.pdf

that might have to be reallocated together with all other costs and benefits of the hybrid project. Therefore, the costs and benefits deriving from all six interdependent barriers must be considered.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the CGS IJmuiden Ver to Norfolk hybrid project, the following actions are required:

- Identify the relevant cost and benefit categories between the involved stakeholders, covering all significant aspects of the hybrid project. This can be achieved through voluntary cooperation between Vattenfall and TenneT TSO B.V. in the Netherlands (and a potential third party in the UK) as well as national ministries and NRAs (the MoEA and ACM in the Netherlands and the BEIS and Ofgem in the UK).
- Ensure that due consideration is given to all costs and benefits deriving from measures adopted to mitigate the following barriers: "uncertainty about responsibility for project development"; "uncertainty about market arrangements"; "uncertainty about hybrid cable system classification"; the "lack of regulated revenues for anticipatory investments"; "uncertainty about applicable RES subsidy scheme"; and the "limited engagement of public stakeholders". This can be achieved through voluntary cooperation between all stakeholders involved in the individual barrier mitigation measures.
- Determine the initial allocation of costs and benefits, covering the cost and benefit categories across all significant aspects of the hybrid project identified in the first step. In this process, developers typically conduct the assessment of costs and benefits, while NRAs oversee and validate results. Thus, this can be achieved through voluntary cooperation between the OWF developers (including Vattenfall), TenneT TSO B.V. in the Netherlands (and a potential third party in the UK) as well as national ministries and NRAs (the BEIS and Ofgem in the UK, and the MoEA and ACM in the Netherlands).
- Align and agree a suitable reallocation of costs and benefits between developers, the UK and the Netherlands. This should be based on the identification of cost and benefit categories among stakeholders as well as the assessment of the initial allocation of costs and benefits along the identified categories. The allocation could closely reflect ongoing practices for implemented interconnectors. These might already be suitable to incentivise all parties involved in the hybrid project. Particularly, the reallocation of costs must ensure that Vattenfall has an incentive to implement the hybrid project due to its increased responsibility under the UK OFTO regime. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the UK and the Netherlands. OWF developers (including Vattenfall), TenneT TSO B.V. in the Netherlands (and a potential third party in the UK) and national ministries and NRAs (the BEIS and Ofgem in the UK and MoEA and ACM in the Netherlands) assume responsibility for this action, as well as the European Commission.
- Validate the availability of CEF funding to ensure adequate incentivisation for all relevant stakeholders if the following applies: the CGS IJmuiden Ver to Norfolk hybrid project is a PCI and adds socio-economic value, but the initial allocation of costs and benefits is not sufficiently balanced to incentivise all countries and stakeholders to implement the hybrid project. While CEF funding cannot resolve viability issues of projects, it is a last resort for PCIs that have received a CBCA decision but are still not commercially viable for each individual stakeholder.[147] This can be achieved through voluntary cooperation between Vattenfall, TenneT TSO B.V. in the

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[147] European Parliament, European Council. 2013. *REGULATION (EU) No. 347/2013 on guidelines for trans-European energy infrastructure.* Article 14. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0347&from=en

Netherlands (and a potential third party in the UK) and NRAs (Ofgem in the UK and ACM in the Netherlands) as well as the European Commission.

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 47. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 36.

Figure 47: CGS IJmuiden Ver to Norfolk barrier mitigation – Disproportionate allocation of costs and benefits across involved stakeholders

4.6 NeuConnect

The hybrid project idea "NeuConnect" is an interconnector tie-in concept. In the project, the OWFs in the German Cluster 1 (OWP West, Borkum Riffgrund West 1 and Borkum Riffgrund West 2) are connected to the UK and to Germany via the NeuConnect interconnector. However, the idea shows small lifetime savings compared to the reference case, in which the OWF and interconnector are stand-alone assets. In addition, both the interconnector and OWF assets have already reached advanced stages of the permitting procedure, which do not cover the hybrid setup. Thus, the NeuConnect hybrid project is given no detailed further consideration in the scope of this study.

4.6.1 Details of the hybrid project and reference case

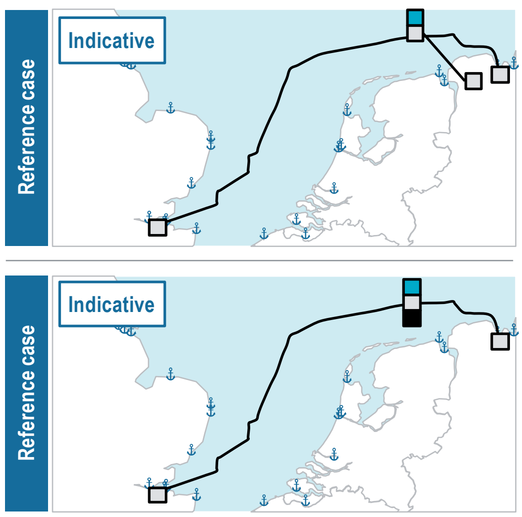
The individual assets included in the hybrid project and in the reference case are modelled on the basis of real assets. But the assumed characteristics do not claim to represent the actual characteristics of the assets included in either ongoing or future developments.

In the reference case (Figure 48), NeuConnect is a stand-alone, point-to-point interconnector between the UK and Germany, constructed based on HVDC technology with 1,400 MW nominal capacity and a length of 675 km. The three OWFs included in the project idea are OWP West, Borkum Riffgrund West 1 and Borkum Riffgrund West 2 in Cluster 1 of the German EEZ. They have a total nominal generation capacity of 900 MW. The OWFs are connected to Germany via a locally coordinated export cable system featuring a 130 km of HVDC technology. No intermediate offshore transformers are required, as the wind turbines can be connected directly to the high-voltage offshore transformer via the 66-kV array cable system. The export cable system has a nominal capacity of 900 MW.

In the hybrid project (Figure 48), NeuConnect is a multi-terminal interconnector between the UK and Germany, otherwise constructed to the same specifications as in the reference case. The OWFs have the same specifications as in the reference case. The OWFs are connected to NeuConnect via a 10 km HVDC export cable system. The export cable system has a nominal capacity of 900 MW.

For all cable systems, onshore transformer stations are not in the scope of the assessment. As a result, benefits deriving from the hybrid project compared to the reference case – with fewer onshore transformer stations in the hybrid project than in the reference case – have not been considered. Furthermore, onshore grid reinforcement costs are not in the scope of this assessment. But it is important that they are considered before project development would be initiated. The need for onshore grid reinforcements can be expected to be lower in the NeuConnect hybrid project compared to the reference case, as the OWFs do not need an additional onshore grid connection point.

Geographical mapping



	Reference case	Hybrid case	Difference
Nominal capacity interconnector [MW]			
	1,400	1,400	0
Length interconnector [km]			
	675	675	0
Nominal capacity OWF [MW]			
	900	900	0
Length export cable [km]			
	130	10	- 120
Offshore transformer / converter / switching stations			
	1 / 1 / 0	1 / 1 / 1	+ 1
Onshore transformer / converter stations			
	0 / 3	0 / 2	- 1

Converter station Switching station Transformer station Transmission cable

Figure 48: NeuConnect – Reference case and hybrid project profile

It is generally assumed that the development, construction and commissioning of the individual assets (OWFs, export cable system and interconnector) can be aligned in the hybrid project to prevent temporarily stranded assets. However, to do so in this case means to prolong the lifetime of the locally coordinated export cable system by one year (as the OWFs are expected to be commissioned in 2024 and 2025) and the lifetime of the interconnector by two years (as the interconnector is expected to be commissioned in 2023) compared to the typical lifetime of 25 years for offshore assets.

4.6.2 Evaluation of hybrid project vs. reference case

To evaluate the hybrid project against the reference case, this study calculates the lifetime savings of the hybrid project. These include the difference in cost and the difference in socio-economic welfare (SEW) between the hybrid project and the reference case. Both the cost assessment – looking at CAPEX and OPEX – and the market modelling-based SEW assessment are based on the technical setup of the hybrid project and the reference case as described in the project details. Additional indicators used in the assessment are energy not served, RES curtailment and CO_2 emissions. CO_2 emissions are internalised in the SEW.

Assuming a typical asset lifetime of 25 years, the hybrid project yields lifetime savings of about EUR 50 m compared to the reference case (Figure 49). The lifetime savings are driven entirely by a reduction in CAPEX of about EUR 125 m. However, additional lifetime costs of about EUR 15 m from increased OPEX, and additional lifetime costs of EUR 60 m from lower lifetime SEW, reduce the CAPEX effect. Both OPEX and SEW are calculated and discounted over a 25-year period. The small difference in SEW is spread over the entire European electricity system. It is originally driven by the suboptimal operational setup of the generation and transmission assets included in the hybrid project compared to the reference case. This means that either the available interconnector capacity is reduced or the OWF generation is curtailed as the two conflict with each other. Overall, OPEX is higher in the hybrid project compared to the reference case, as CAPEX savings are the result of a reduction of kilometres of cable system, which has low relative OPEX, and additional substation infrastructure, which has higher relative OPEX.

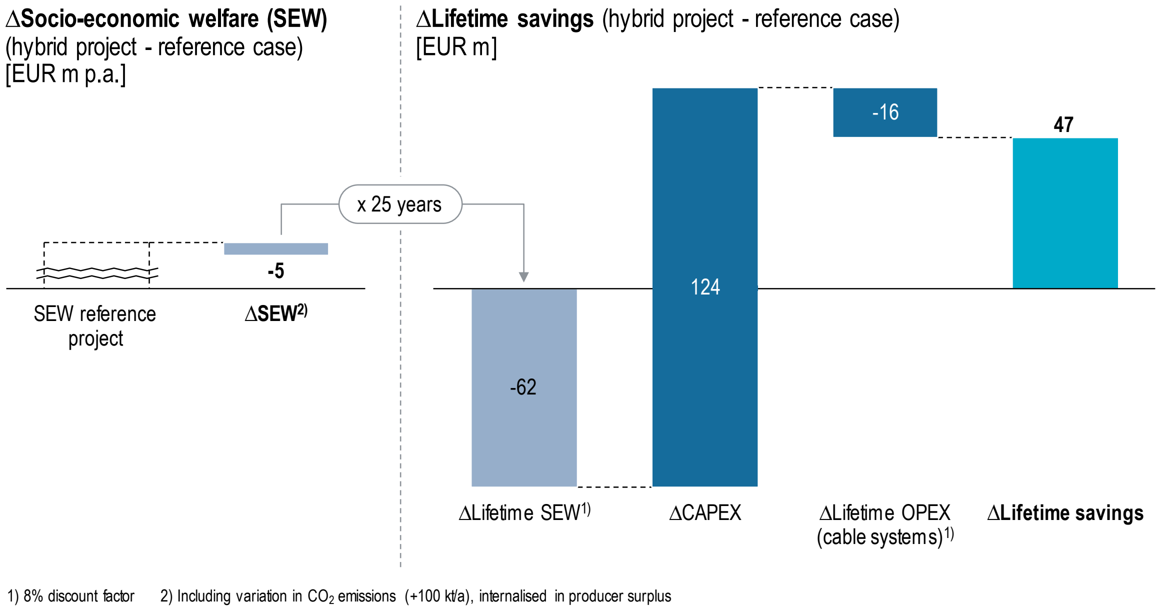


Figure 49: NeuConnect – Assessment results[148]

Regarding the cost assessment, the result is driven by the export cable system but is reduced by the interconnector. The cost of the export cable system is lower in the hybrid project than in the reference case. The export cable system requires fewer kilometres of cable in the hybrid project. As the export cable system only links the OWFs to NeuConnect and does not reach the German shore, one onshore converter station and about 120 km of export cable system are rendered redundant. However, an additional offshore switching station is required in the hybrid project to allow for safe the connection of the OWFs to the interconnector. These factors result in lower CAPEX and OPEX for the export cable system. The cost of the interconnector is higher in the hybrid project than in the reference case, as the interconnector requires multi-terminal technology.

In both the hybrid project and the reference case, energy not served is zero due to the comprehensive nature of and redundancies in the European electricity system. Therefore, neither setup adversely affects the EU's energy policy target of energy security. Compared to the reference case, the effect of the hybrid project on curtailment and CO_2 emissions is very small.[149] This suggests that the hybrid

[148] SEW assessment based on Careri, Francesco. [Forthcoming]. *The impact of North Sea electricity projects in a 2030 scenario: Preliminary assessment of system benefits for the pan-European power system through METIS.* Petten: European Commission Joint Research Centre.

[149] The hybrid project generates additional curtailment of 1,700 MWh/a and additional CO_2 emissions of 100 kt/a (internalised in socio-economic welfare). For more details, please refer to Careri, Francesco. [Forthcoming]. *The impact of North Sea electricity projects in a 2030 scenario:*

project is unlikely to have a significant impact on the EU's energy policy targets on the further establishment of the internal energy market and the decarbonisation of the economy.

4.6.3 Development of an Action Plan to overcome barriers

Due to the limited advantage of the hybrid project over the reference case, no project-specific barriers, barrier mitigation measures or Action Plans were assessed or developed.

4.7 North Sea Wind Power Hub (NSWPH)

The hybrid project idea "North Sea Wind Power Hub" (NSWPH) is an offshore hub concept. In the project, OWFs in the Dutch, German and Danish EEZs are connected to the Dutch, German and Western Danish markets via a hub. The hub features cable connections to the Netherlands, Germany and Denmark which can function as export cable systems and as interconnectors. The addition of a connection to the UK is under consideration. The idea shows significant lifetime savings compared to the reference case, in which OWFs and interconnectors are stand-alone assets. Thus, the NSWPH hybrid project is given further consideration in the scope of this study, and an Action Plan for the implementation of barrier mitigation measures is developed. The Action Plan is intended to be used as a tool by stakeholders once the NSWPH hybrid project has been given the go-ahead.

4.7.1 Details of the hybrid project and reference case

The individual assets included in the hybrid project and in the reference case are modelled on the basis of real assets. But the assumed characteristics do not claim to represent the actual characteristics of the assets included in either ongoing or future developments.

In the reference case (Figure 51), the interconnectors are stand-alone, point-to-point interconnectors between the Netherlands and Denmark (offshore), and between the Netherlands and Germany (onshore). They are constructed based on HVDC technology offshore and HVAC technology onshore. They have 2,000 MW nominal capacity and a length of 329 km, and 200 MW nominal capacity and a length of 10 km, respectively. These capacities reflect the cable system capacities utilised for interconnection purposes in the hybrid project after the transmission of electricity generated by the OWFs (Figure 50). Generated electricity is defined by the nominal generation capacity and average capacity factor per OWF of 45%. Thus, in the reference case, no interconnector from Germany to Denmark is constructed, as no capacity is utilised for interconnection purposes between these two countries in the hybrid project. The OWFs included in the project idea are in proximity to the Dogger Bank area of the Dutch, German and Danish EEZs, with a total nominal generation capacity of 12,000 MW. The OWFs are radially connected to shore, with two export cable systems to the Netherlands, three export cable systems to Germany and one export cable system to Denmark. These have a total length in the range of 2,100 to 2,400 km. Each export cable system has a nominal capacity of 2,000 MW and uses HVDC technology. No intermediate offshore transformers are required, as the wind turbines can be connected directly to the high-voltage offshore transformers via the 66-kV array cable systems.

Preliminary assessment of system benefits for the pan-European power system through METIS. Petten: European Commission Joint Research Centre.

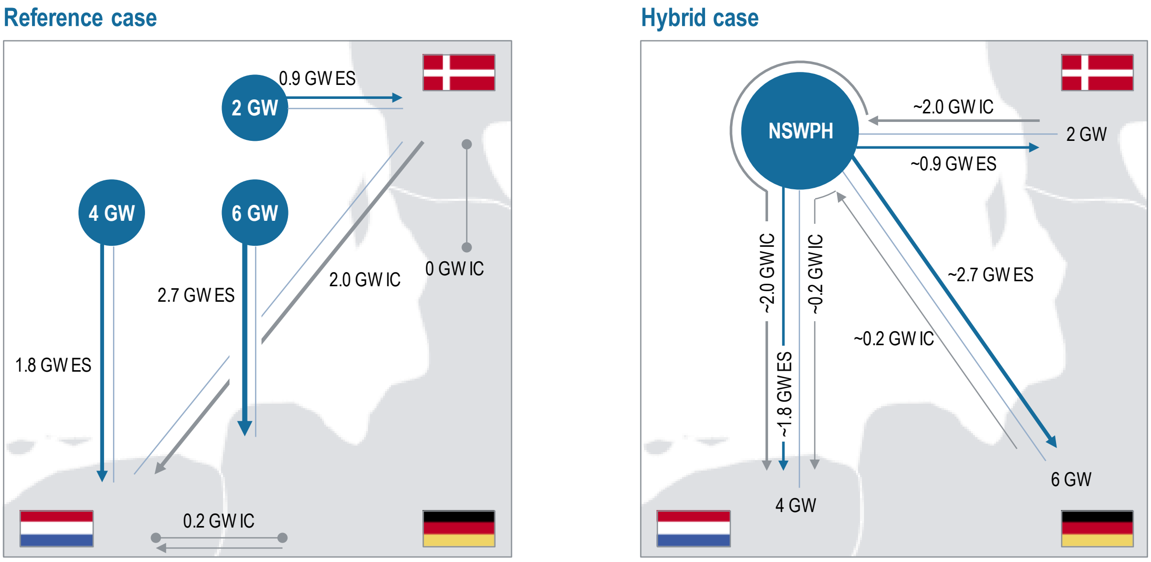


Figure 50: North Sea Wind Power Hub (NSWPH) – Assumed commercial electricity flows in the reference and hybrid projects

In the hybrid project (Figure 51), the NSWPH is a hub to collect and then transmit offshore power to the Netherlands, Germany and Demark. No stand-alone interconnector is included in the hybrid project, as interconnection capacity is provided by the linkage of the export cable systems on the hub. However, the nominal interconnection capacity between the Netherlands and Denmark is 2,000 MW, between the Netherlands and Germany 200 MW and between Germany and Denmark 0 MW (Figure 50). These are based on an exogenous price forecast[150] and the cable system capacities utilised for the transmission of electricity generated offshore to the connected shores. The OWFs and the export cable systems between the hub and the national markets have the same specifications as in the reference case. The NSWPH consortium is considering the inclusion of power-to-gas infrastructure on the hub or onshore in combination with the NSWPH hybrid project. For example, the NSWPH could transmit offshore power to shore by using power-to-gas infrastructure, optimising costs by using existing pipeline systems for transport. This would limit investments and avoid "not in my back-yard" issues for new electricity transmission infrastructure. However, the inclusion of power-to-gas infrastructure was not quantitatively assessed as part of this study.

For all cable systems, onshore (as opposed to on-hub) transformer stations are not in the scope of the assessment. As a result, benefits deriving from the hybrid project compared to the reference case – with fewer onshore transformer stations in the hybrid project than in the reference case – have not been considered. Furthermore, onshore grid reinforcement costs are not in the scope of this assessment. But it is important that they are considered before project development would be initiated. The need for onshore grid reinforcements can be expected to be lower in the hybrid project compared to the reference case, as the elimination of interconnectors translates into the need for fewer onshore grid connection points.

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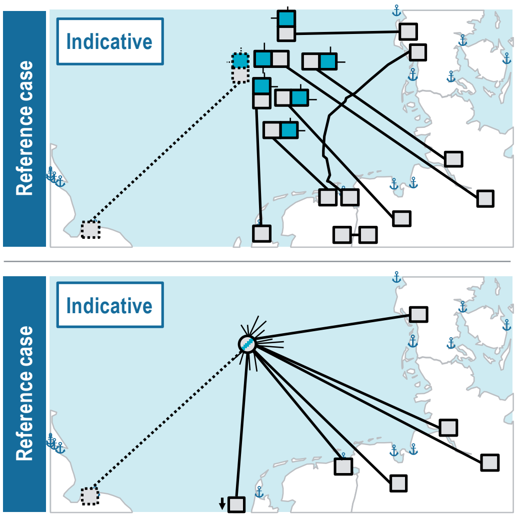
[150] The exogenous price forecast is based on average wholesale prices calculated in the PRIMES market model used for the EU reference scenario 2016. It was adjusted using historical price data available on the ENTSO-E transparency platform. In the Netherlands, the price rises from EUR 50.3 in 2020 to EUR 59.3 in 2030 before falling back to EUR 56.7 in 2050. In Germany, the price continuously falls from EUR 39.4 in 2020 to EUR 30.8 in 2050. In Denmark, the price rises from EUR 25.1 in 2020 to EUR 26.6 in 2030 before falling back to EUR 22.7 in 2035 and maintaining this price level until 2045. The price eventually falls to EUR 19.2 in 2050.

Geographical mapping



	Reference case	Hybrid case[1)]	Difference
Nominal capacity interconnector [MW]			
	~ 2,000 (DK-NL), ~ 200 (NL-DE)	Up to 4,000 (to NL), 6,000 (to DE), 2,000 (to DK)	0
Length interconnector [km]			
	339 (329 + 10)	0	- 339
Nominal capacity OWF [MW]			
	12,000	12,000	0
Length export cable [km]			
	2,100 – 2,400	2,100 – 2,400	0
Offshore transformer / converter / switching stations			
	6 / 6 / 0	6 / 6 / 6	+ 6
Onshore transformer / converter stations			
	0 / 10	0 / 6	- 4

Converter station Transformer station Transmission cable 1) Additional value provided by inclusion of power-to-gas infrastructure in final project setup

Figure 51: North Sea Wind Power Hub (NSWPH) – Reference case and hybrid project profile

It is generally assumed that the development, construction and commissioning of the individual assets (multiple OWFs, multiple export cable systems and a hub) can be aligned in the hybrid project to prevent temporarily stranded assets. It is assumed that the hub, the OWFs and the cable systems will be commissioned in 2035, both in the hybrid project and in the reference case. However, the separate commissioning of the individual OWFs and export cable systems would also be possible. This is also the case with the later commissioning of some of the OWFs and export cable systems linking the hub to the Dutch, German and Western Danish bidding zone. The assumed commissioning dates are the same for the hybrid project and the reference case.

4.7.2 Evaluation of hybrid project vs. reference case

To evaluate the hybrid project against the reference case, this study calculates the lifetime savings of the hybrid project. These include the difference in cost between the hybrid project and the reference case. The cost assessment – looking at CAPEX and OPEX – is based on the technical setup of the hybrid project and the reference case, as described in the project details. Market modelling was not conducted for this project.

Assuming a typical asset lifetime of 25 years, the hybrid project yields lifetime savings of about EUR 2.5 bn compared to the reference case (Figure 52). The lifetime savings are driven entirely by a reduction in CAPEX and OPEX. OPEX are calculated and discounted over a 25-year period.

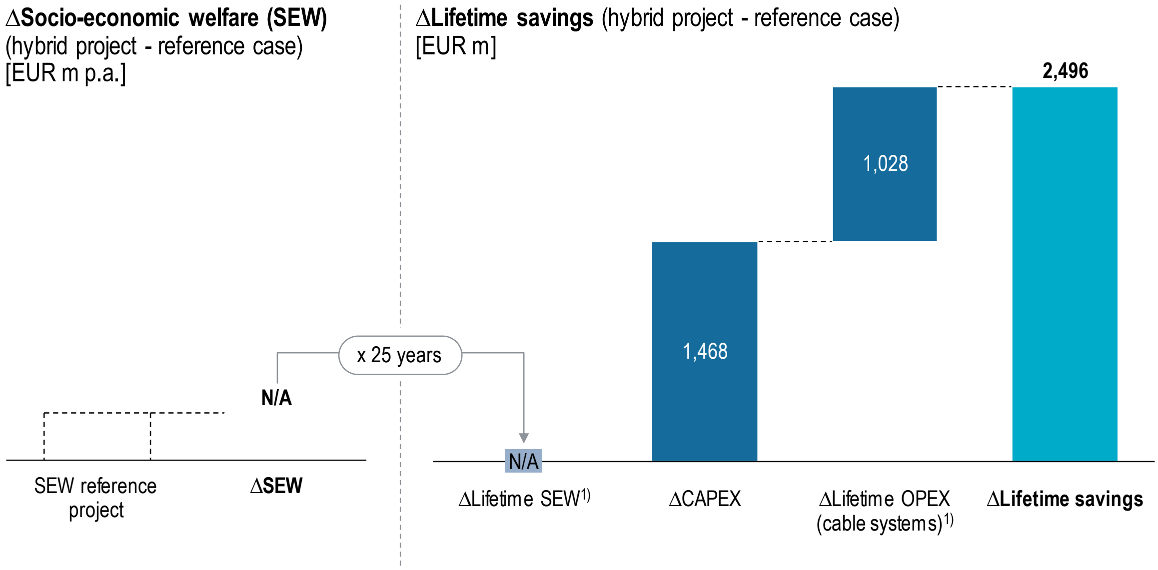


Figure 52: North Sea Wind Power Hub (NSWPH) – Assessment results

The decrease in CAPEX and OPEX is driven by the shared utilisation of the hub and the cable systems for the transmission of electricity between countries in the hybrid project. Thus, the hub decreases overall CAPEX and OPEX compared to stand-alone OWF projects and point-to-point interconnectors, due to eliminated and more cost-efficient assets. Regarding the elimination of assets, no additional interconnector systems are required in the hybrid project, making more than 300 km of interconnector cable and four onshore converter stations redundant. Regarding the more cost-efficient assets, offshore substation infrastructure required in the reference case can be realised as on-hub substation infrastructure in the hybrid project. This eliminates the need for underwater foundations and potentially allows for less costly and larger technical designs which are not constrained by space limits, as on an offshore platform. In addition, lower OPEX resulting from the utilisation of the hub as a maintenance hub in the hybrid project contributes to the overall lifetime savings.

In addition to the quantitatively assessed lifetime savings, the NSWPH may provide additional benefits through the inclusion of power-to-gas infrastructure on the hub, or onshore in combination with the NSWPH hybrid project. An extended hub lifetime may also facilitate the re-powering of the on-hub electrical infrastructure, thereby further decreasing lifetime costs.

4.7.3 Development of an Action Plan to overcome barriers

This chapter summarises the findings specific to the development of the NSWPH hybrid project. It builds on the general explanation of the barriers in Chapter 3.2, the general explanation of the interdependencies between barriers in Chapter 3.3 and the findings of project-specific discussions of the barriers and mitigation options in Chapter 5.3.

This study notes that 11 of the 16 identified barriers need to be overcome to allow for the commencement of the NSWPH hybrid project development. Although the barriers are addressed individually, interdependencies exist between them. When developing ways to mitigate one barrier, it is therefore necessary to also consider the mitigation of other barriers. Table 3 provides an overview of the project-specific barriers and barrier mitigation measures, as well as a brief description of the interdependencies to be considered in the development of the individual barrier mitigation measures.

Barrier	Mitigation measure	Interdependencies
Uncertainty about responsibility for project development	Assign responsibility for grid connection to the TSO of the country in whose EEZ the OWF is located, namely, TenneT TSO B.V., TenneT TSO GmbH and Energinet	▪ Failure of developers to align planning across assets and countries: clearly assigning grid connection responsibility facilitates continuous dialogue and early-stage alignment
Uncertainty about regulation deriving from jurisdiction over cross-border cable systems	Obtain all required permits and align regulation deriving from concurrent jurisdiction over cross-border cable systems	▪ Failure of developers to align planning across assets and countries: obtaining all required permits and aligning regulation is facilitated by continuous dialogue and early-stage alignment ▪ Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design): aligned regulation relevant for the OWFs needs to be reflected in the tender designs
Uncertainty about market arrangements	Implement a dedicated bidding zone for the OWFs included in the hybrid project	▪ Uncertainty about hybrid cable system classification: a dedicated bidding zone implies defining the cable systems as interconnectors ▪ Uncertainty about applicable RES subsidy scheme: a dedicated bidding zone affects the business cases of the OWFs and thereby the level of required subsidies
Uncertainty about hybrid cable system classification	Define the cable systems as interconnectors	▪ Uncertainty about market arrangements: defining the cable systems as interconnectors implies establishing a dedicated bidding zone ▪ Uncertainty about applicable RES subsidy scheme: defining the cable systems as interconnectors, which is required due to the market arrangement of a dedicated bidding zone, affects the business cases of the OWFs and thereby the level of required subsidies
Failure of developers to align planning across assets and countries	Facilitate continuous dialogue and early-stage alignment between the project developers	▪ Uncertainty about responsibility for project development: continuous dialogue and early-stage alignment facilitates clear assignment of responsibility for grid connection ▪ Uncertainty about regulation deriving from jurisdiction over cross-border cable systems:

Barrier	Mitigation measure	Interdependencies
		continuous dialogue and early-stage alignment facilitates obtaining all required permits and aligning regulation ▪ Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design): continuous dialogue and early-stage alignment facilitates an aligned tender design ▪ Lack of regulated revenues for anticipatory investments: continuous dialogue and early-stage alignment among developers is facilitated by validating the availability of regulated revenues for anticipatory investments in the Netherlands, Germany and Denmark ▪ Limited engagement of public stakeholders: continuous dialogue and early-stage alignment are facilitated by formalising public commitment and public funding for feasibility studies, R&D etc.
Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)	Implement a tender design with strict requirements which are aligned between the Netherlands, Germany and Denmark. It should reflect that OWFs are located across three EEZs but connected to the same hub	▪ Uncertainty about regulation deriving from jurisdiction over cross-border cable systems: tender design needs to reflect aligned regulation relevant to the OWFs ▪ Failure of developers to align planning across assets and countries: aligned tender designs are facilitated by continuous dialogue and early-stage alignment ▪ Uncertainty about applicable RES subsidy scheme: a tender with aligned, strict requirements includes a joint support scheme established by the Netherlands, Germany and Denmark
Lack of regulated revenues for anticipatory investments	Validate the feasibility of regulated revenues for anticipatory investments under the regulatory regimes in the Netherlands, Germany and Denmark; adjust the system in Denmark if required	▪ Failure of developers to align planning across assets and countries: certainty about regulated revenues for anticipatory investments is facilitated by continuous dialogue and early-stage alignment

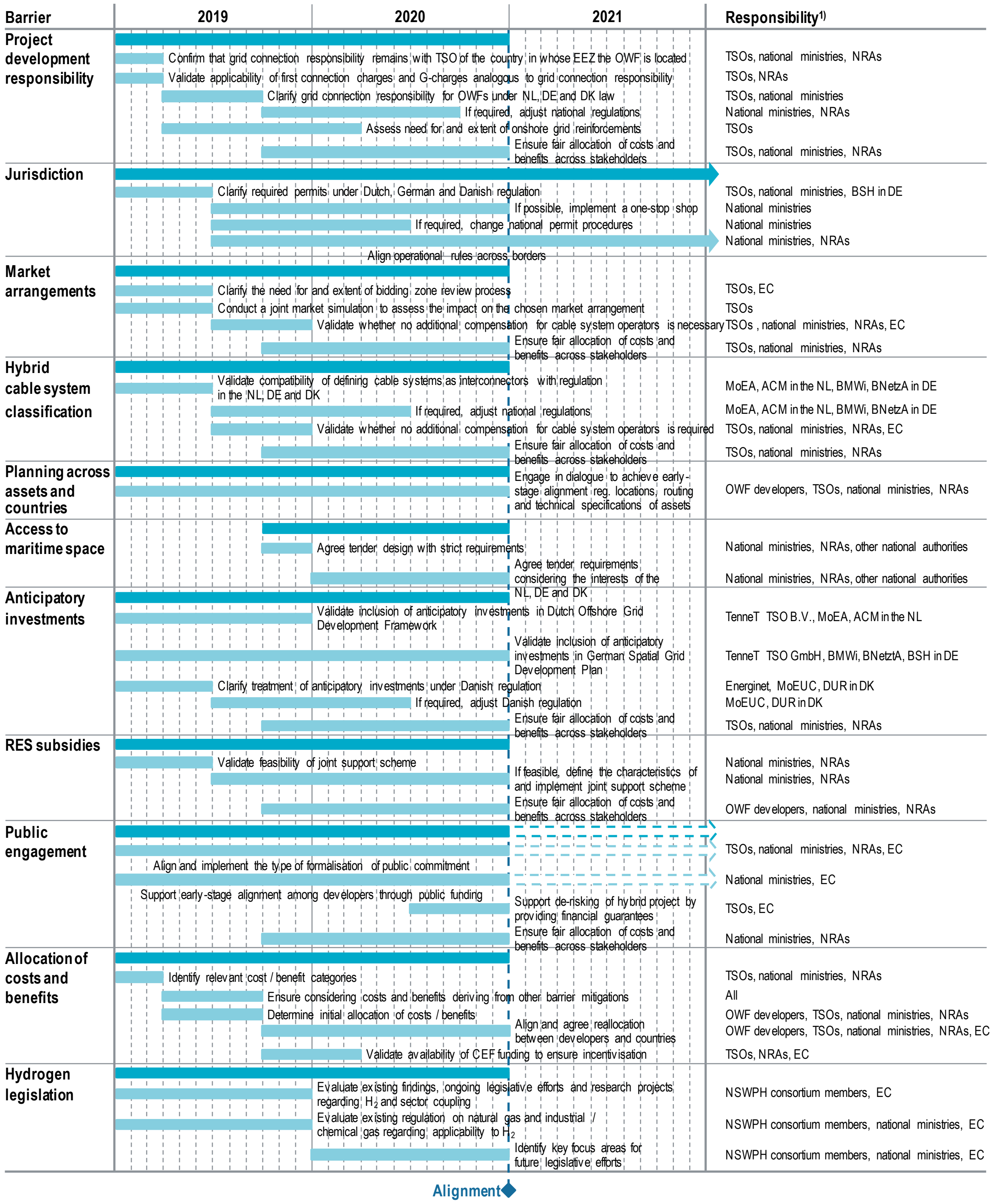
Barrier	Mitigation measure	Interdependencies
Uncertainty about applicable RES subsidy scheme	Establish a joint support scheme between the Netherlands, Germany and Denmark for the OWFs included in the hybrid project	▪ Uncertainty about market arrangements: the business cases of the OWFs and thereby the level of required subsidies are affected by a dedicated bidding zone ▪ Uncertainty about hybrid cable system classification: the business cases of the OWFs and thereby the level of required subsidies are affected by the market arrangement of a dedicated bidding zone. This requires defining the cable systems as interconnectors ▪ Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design): applying a joint support scheme established by the Netherlands, Germany and Denmark fits a tender design aligned between the three countries
Limited engagement of public stakeholders	Formalise public commitment in the form of a project-specific MoU or HANSA. Also, facilitate feasibility studies and scoping studies for early-stage alignment through public funding, for example	▪ Failure of developers to align planning across assets and countries: formalising public commitment and public funding for feasibility studies, R&D, etc. is facilitated by continuous dialogue and early-stage alignment
Disproportionate allocation of costs and benefits across involved stakeholders	Reallocate costs and benefits deriving from the hybrid project where required based on a project-specific process	▪ Uncertainty about responsibility for project development (responsibility for grid connection): costs and benefits deriving from mitigation to be considered ▪ Uncertainty about market arrangements: costs and benefits deriving from mitigation to be considered ▪ Uncertainty about hybrid cable system classification: costs and benefits deriving from mitigation to be considered ▪ Lack of regulated revenues for anticipatory investments: costs and benefits deriving from the mitigation to be considered ▪ Uncertainty about applicable RES subsidy scheme: costs and benefits deriving from mitigation to be considered

Barrier	Mitigation measure	Interdependencies
		▪ Limited engagement of public stakeholders: costs and benefits deriving from mitigation to be considered
Uncertainty about legislative regime for power-to-gas and related infrastructure	Provide guidance on sector coupling and assure NSWPH stakeholders of future legislative support to allow for the integration of gas conversion in the hybrid project idea	▪ No interdependencies to be considered

Table 3: North Sea Wind Power Hub (NSWPH) – Barriers, barrier mitigation measures and interdependencies

Combining all the measures needed to mitigate the barriers of relevance to the NSWPH hybrid project creates an Action Plan that supports the commencement of the development. In addition to placing the required actions on a timeline, the Action Plan further details the stakeholders responsible for each of the actions (Figure 53). The Action Plan is intended to be used as a tool by stakeholders once the NSWPH hybrid project has received the go-ahead.

While the Action Plan is currently structured such that barrier mitigation measures are planned until the end of 2020, it is conceivable that the formalisation of some mitigation measures might also be sufficient post-2020. This is because the NSWPH hybrid project idea is currently planned to be commissioned by 2035. The Action Plan for the project can therefore possibly be given a longer timeframe than indicated.



1) Responsible stakeholders are OWF developers: tbd; TSOs: TenneT TSO B.V. in the NL, TenneT TSO GmbH in DE, Energinet in DK; Ministries: MoEA in the NL, BMWi in DE, MoEUC in DK; NRAs: ACM in the NL, BNetzA in DE, DUR in DK; Other national authorities: RVO in the NL, BSH in DE; NSWPH consortium members: TenneT TSO B.V., TenneT TSO GmbH, Energinet, Gasunie, Port of Rotterdam

Figure 53: North Sea Wind Power Hub (NSWPH) – Action Plan

The barriers and mitigation measures specific to the NSWPH hybrid project and the actions required to implement the identified mitigation measures are explained in more detail in the subchapters below. As part of the work on barrier mitigation, a project-specific Memorandum of Understanding (MoU) or a project-specific Hybrid Asset Network Support Agreement (HANSA) were considered. Both types of formal commitment to address barriers can include all actions for mitigation measures of relevance to the NSWPH hybrid project. Thus, it can be sufficient to set up only one type.

Uncertainty about responsibility for project development

Project-specific barrier evaluation: The definition of responsibility for the cable systems between the hub and the markets, as well as for the grid connections of the OWFs to the hub, will determine who is responsible for the development of the NSWPH hybrid project.

The definition of the party responsible for the OWFs' connections to the hub is complex. This is because the potential OWF sites are located in the Dutch, German and Danish EEZs but are connected to the hub instead of to an onshore connection point located in the home country of the respective OWF. The hub is expected to be located in one country's EEZ. Thus, based on the responsibility for grid connection as stipulated by Dutch, German and Danish national law, no generally suitable definition of grid connection responsibility exists for this specific hybrid project setup.

Responsibility for the cable systems between the hub and the markets of the Netherlands, Germany and Western Denmark is assumed jointly by the TSOs involved in the NSWPH consortium. These are TenneT TSO B.V., TenneT TSO GmbH and Energinet. This responsibility does not need to be reviewed.

Barrier mitigation: The mitigation option identified as most feasible is to assign responsibility for grid connection to the TSO of the country in whose EEZ the OWF is located, namely, TenneT TSO B.V., TenneT TSO GmbH or Energinet. This is based on consideration of the interdependencies shown in Table 3, interaction with project stakeholders (see Chapter 5.3.1) and the ease of implementation in terms of the required effort.

The other mitigation options considered in this study were to make (1) the NSWPH consortium and (2) the developer of the respective OWF responsible for the OWF's grid connection to the hub.

The mitigation option identified as most feasible was selected for the following reasons: While amendments to national legislation and regulations may be required for the selected mitigation option, the other two options are not covered under existing European and / or national legislation and regulations as well. While the NSWPH consortium does not exclusively consist of TSOs who are generally responsible for OWFs in a national context, OWF developers are actually prohibited from taking on responsibility for grid connection due to the EU's unbundling regulation.[151] Furthermore, assigning responsibility to the respective national TSO has the advantage of ensuring the required grid connection expertise. It also eliminates the financial risk from delays or failures of the grid connection for OWF developers, as compensation is guaranteed by national regulations. In addition, the efficient integration of the individual grid connection developments is ensured due to the involvement of the respective TSOs, namely, TenneT TSO B.V., TenneT TSO GmbH and Energinet in the NSWPH consortium.

Irrespective of which mitigation option is selected, this barrier is interdependent with the "failure of developers to align planning across assets and countries". Clearly defining responsibility for the grid connection requires continuous dialogue and early-stage alignment on the hybrid project setup among the defined project promoters. Clearly defined responsibilities and continuous dialogue and alignment, in turn, allow for the commencement of project development.

[151] European Commission. 2009. *DIRECTIVE 2009/72/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL concerning common rules for the internal market in electricity.* Article 9. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0072&from=EN

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the NSWPH hybrid project, the following actions are required:

- Confirm that responsibility for the grid connection remains with the TSO for the country in whose EEZ the OWF is located. Certainty about grid connection responsibility can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The TSOs (TenneT TSO B.V., TenneT TSO GmbH and Energinet) as well as national ministries and NRAs (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark) assume responsibility for this action.
- Validate the applicability of first connection charges and G-charges analogous to the grid connection responsibility by the three TSOs involved: Dutch (shallow first connection charges and no G-charges); German (shallow to super-shallow first connection charges and no G-charges); and Danish (super-shallow to partially shallow first connection charges and energy-based G-charges).[152] This action can be achieved through voluntary cooperation between TenneT TSO B.V., TenneT TSO GmbH and Energinet, as well as the NRAs (ACM in the Netherlands, BNetzA in Germany and DUR in Denmark).
- Ensure compatibility with existing regulations by clarifying responsibility for grid connection for the OWFs under Dutch, German and Danish law.[153] This can be achieved through voluntary cooperation between TenneT TSO B.V., TenneT TSO GmbH and Energinet, as well as the MoEA in the Netherlands, the BMWi in Germany and the MoEUC in Denmark.
- If required, adjust Dutch, German and Danish regulations to allow the respective TSOs to assume responsibility for the connection of the OWFs to the hub which is located in a different country's EEZ. Guidance from project-specific developers is required to inform the adjustment of the Dutch, German and Danish regulations. Certainty about Dutch, German and Danish regulations can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The MoEA and ACM in the Netherlands, the BMWi and BNetzA in Germany as well as the MoEUC and DUR in Denmark assume responsibility for this action.
- Assess the need for and extent of onshore grid reinforcements in the Netherlands, Germany and Denmark to allow for the operation of the interconnectors between the hub and the Dutch, German and Danish markets. This action can be achieved through voluntary cooperation between TenneT TSO B.V., TenneT TSO GmbH and Energinet.

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[152] ENTSO-E. 2018. *Overview of transmission tariffs in Europe: Synthesis 2018.* https://docstore.entsoe.eu/Documents/MC%20documents/TTO_Synthesis_2018.pdf;
The European Wind Energy Association. 2016. *Position paper on network tariffs and grid connection regimes.* http://www.ewea.org/fileadmin/files/library/publications/position-papers/EWEA-position-paper-on-harmonised-transmission-tariffs-and-grid-connection-regimes.pdf

[153] Dutch Elektriciteitswet 1998. §4 Article 24Aa. https://wetten.overheid.nl/BWBR0009755/2018-07-28#Hoofdstuk3_Paragraaf4_Artikel24Aa
German Erneuerbare-Energien-Gesetz 2017 (EEG 2017). § 8. https://www.gesetze-im-internet.de/eeg_2014/__8.html
German Energiewirtschaftsgesetz (EnWG). § 17b. http://www.gesetze-im-internet.de/enwg_2005/__17b.html
Danish Bekendtgørelse om nettilslutning af vindmøller og pristillæg for vindmølleproduceret elektricitet m.v. Chapter 1 § 2.
https://www.retsinformation.dk/Forms/R0710.aspx?id=188845#id27a00582-d6fa-44ff-ba6f-ebb7689685fd

- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the Netherlands, Germany and Denmark of costs and benefits deriving from responsibility for grid connection. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The TSOs as well as the national ministries and NRAs assume responsibility for this action (TenneT TSO B.V., the MoEA and ACM in the Netherlands; TenneT TSO GmbH, the BMWi and BNetzA in Germany; and Energinet, the MoEUC and DUR in Denmark).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 54. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 53.

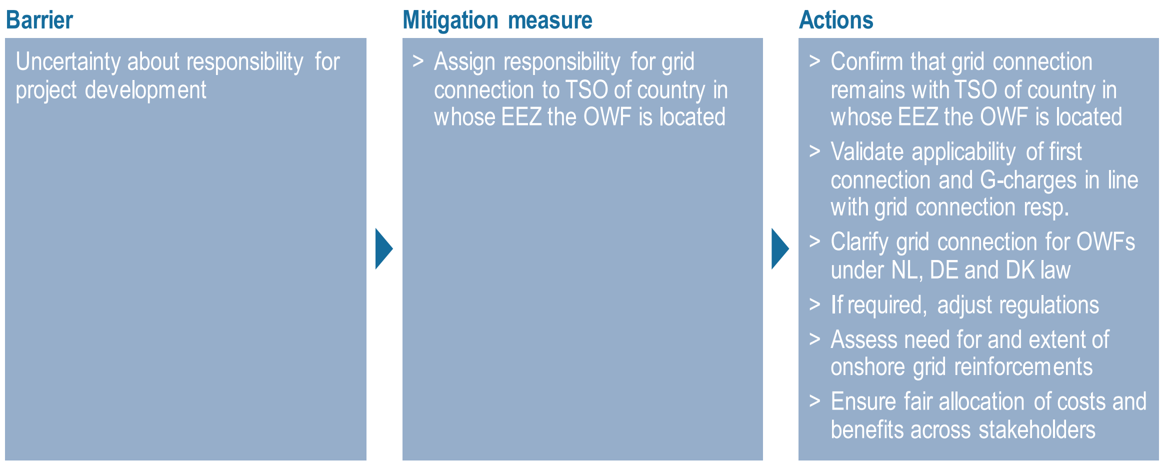

Figure 54: North Sea Wind Power Hub (NSWPH) barrier mitigation – Uncertainty about responsibility for project development

Uncertainty about regulation deriving from jurisdiction over cross-border cable systems

<u>Project-specific barrier evaluation:</u> The OWFs included in the NSWPH hybrid project idea are located in the Dutch, German and Danish EEZs. They serve to exploit marine resources within the Dutch, German and Danish EEZs. As such, the Netherlands, Germany and Denmark, respectively, have jurisdiction over the OWF installations and their export cable systems, which link the OWFs to the hub. Thus, there are no contradictory regulations arising from jurisdiction over the OWFs and export cable systems. Furthermore, the country in whose EEZ the hub is located – assuming that the offshore installation is located in a single country's EEZ – has jurisdiction over it. So again, there are no contradictory regulations.

However, the cable systems linking the NSWPH to shore have onshore connection points in the Netherlands, Germany and Western Denmark. They therefore cross the Dutch territorial sea and EEZ, the German territorial sea and EEZ, and the Danish territorial sea and EEZ. Depending on the location of the NSWPH, some of the cables cross maritime boundaries between the countries. Once individual cables cross maritime boundaries, several countries have a claim to determining whose regulations apply to them. Thus, the jurisdiction over the cable systems linking the NSWPH to shore might be concurrent and the regulations applicable to the cable systems derived from Dutch, German and Danish jurisdiction might contradict each other.

<u>Barrier mitigation:</u> The mitigation option identified as most feasible is to obtain all required permits and to align regulations deriving from concurrent jurisdiction over the operation of cross-border cable

systems between the hub and the countries involved. For the development and construction as well as for the operational phase, such procedures are also common for regular interconnectors. This is based on consideration of the interdependencies shown in Table 3, interaction with project stakeholders (see Chapter 5.3.2) and the ease of implementation in terms of the required effort.

The other mitigation option considered in this study besides aligning regulation deriving from concurrent jurisdiction was to define regulation deriving from Dutch, German and Danish jurisdiction as applicable to the respective cable systems between the hub and the Dutch, German and Western Danish bidding zones during operations.

The mitigation option identified as most feasible was selected for the following reasons: The respective countries' jurisdiction is applicable to the cable systems across all relevant maritime zones (own territorial sea and own or foreign EEZs). However, operational rules must be aligned across countries anyway due to the cable systems which link the onshore connection points in the Netherlands, Germany and Denmark to the same hub. In addition, the selected mitigation option considers the interests of the three countries and can build on existing agreements established for interconnectors between them.

Regarding interdependencies, this barrier is interdependent with the barriers "failure of developers to align planning across assets and countries" and "uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)". Obtaining all required permits and aligning regulation is facilitated by continuous dialogue and early-stage alignment. Furthermore, the aligned operational regulations must be reflected in the requirements of the OWF tenders.

<u>Actions and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the NSWPH hybrid project, the following actions are required:

- For development and construction, clarify the necessary permits for the cables linking the NSWPH to shore under Dutch, German and Danish regulations. Compliance with environmental and technical rules under Dutch, German and Danish regulations can be ensured by obtaining these permits. This can be achieved through voluntary cooperation between the TSOs (TenneT TSO B.V. in the Netherlands, TenneT TSO GmbH in Germany and Energinet in Denmark) and the national ministries (the MoEA, supported by the Ministry of Infrastructure and Water Management, in the Netherlands; the BMWi and the German Federal Maritime and Hydrographic Agency (BSH), supported by the Federal Environment Agency, in Germany; and the MoEUC, supported by the Danish Environmental Protection Agency, in Denmark).
- If possible, implement a one-stop shop on the national (or even European) level to allow for a coordinated process with only one permit required for the cable systems. As stipulated in Regulation (EU) 347/2013,[154] a one-stop shop in terms of a competent authority that integrates or coordinates all permit granting processes should reduce process complexity, as well as increase efficiency and transparency. The scope of a one-stop shop could be extended to provide a consolidated database of environmental data, facilitating easy data exchange between countries. However, the longer-term benefits are accompanied by significant shorter-term setup costs. So, the feasibility of implementing this action in the scope of mitigating barriers to the NSWPH hybrid project is questionable. Certainty about the implementation can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark, if feasible. The national ministries would assume responsibility for this action (the

[154] European Parliament, European Council. 2013. *REGULATION (EU) No. 347/2013 on guidelines for trans-European energy infrastructure.* (29). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0347&from=en

MoEA, supported by the Ministry of Infrastructure and Water Management, in the Netherlands; the BMWi, supported by the Federal Environment Agency, in Germany; and the MoEUC, supported by Danish Environmental Protection Agency, in Denmark).

- If required, change the national permit procedures for the specific hybrid project. Guidance from project-specific developers in the form of an inventory of environmental and technical rules is required to inform changes to the permit procedures. Certainty about changes can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The national ministries would assume responsibility for this action (the MoEA, supported by the Ministry of Infrastructure and Water Management, in the Netherlands; the BMWi, supported by regional governments and the Federal Environment Agency, in Germany; and the MoEUC, supported by Danish Environmental Protection Agency, in Denmark).
- For the operational phase, align the applicable national regulations arising from concurrent jurisdiction for the specific hybrid project. The required alignment may concern liability issues, control system operations (voltage levels, grid synchronisation etc.) and matters discussed in relation to other barriers. Also consider existing national and EU legal frameworks such as the System Operations regulation (Regulation (EU) 2017/1485)[155] and the CACM regulation (Regulation (EU) 2015/1222).[156] Guidance from project-specific developers is required to inform the alignment. Certainty about the alignment of operational rules can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The national ministries and NRAs assume responsibility for this action (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 55. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 53.

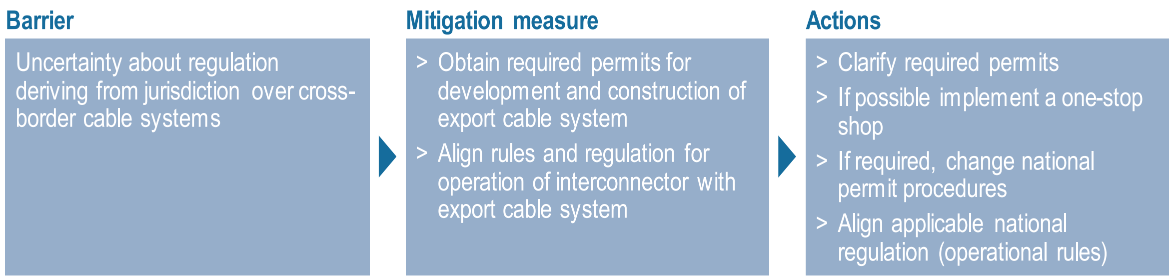

Figure 55: North Sea Wind Power Hub (NSWPH) barrier mitigation – Uncertainty about regulation deriving from jurisdiction over cross-border cable systems

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[155] European Commission. 2017. *COMMISSION REGULATION (EU) 2017/1485 establishing a guideline on electricity transmission system operation.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R1485&from=DE

[156] European Commission. 2015. *COMMISSION REGULATION (EU) 2015/1222 establishing a guideline on capacity allocation and congestion management.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1222&from=EN

Uncertainty about market arrangements

Project-specific barrier evaluation: The clarification of commercial flows is required for the NSWPH hybrid project. This is because the potential OWF sites are located in the Dutch, German and Danish EEZs, with onshore grid connection points in the Netherlands, Germany and Denmark via the hub. Thus, commercial flows to the hub and / or to the Dutch, German and Danish markets are possible. Commercial flows for the OWFs included in the hybrid project must therefore be clarified.

Barrier mitigation: The mitigation option identified as most feasible is to implement a dedicated bidding zone for the OWFs included in the hybrid project. This is based on consideration of the interdependencies shown in Table 3, interaction with project stakeholders (see Chapter 5.3.3) and the ease of implementation in terms of the required effort.

The other mitigation options considered in this study were (1) to implement commercial flows of the OWFs to their respective home markets only, (2) to implement dynamic commercial flows of the OWFs to the high-price market, and (3) to implement dynamic commercial flows of the OWFs to the low-price market.

The mitigation option identified as most feasible was selected for the following reasons: Implementing a dedicated bidding zone for the OWFs included in the hybrid project is covered under existing market regulation. But it may necessitate a comprehensive bidding zone review process. Also, Option (1), which implements commercial flows of the OWFs to the respective home markets only, is covered under existing market regulation. However, the other mitigation options are not covered under existing market regulation. This is because they violate the existing CACM regulation (Regulation (EU) 2015/1222)[157] regarding the requirement for the stability of bidding zones across market time frames for options (2) and (3). The selected mitigation option has no business case implications for the OWFs in the hybrid project or for the cable systems between the hub and the Dutch, German and Western Danish bidding zones. However, all other considered mitigation options have negative business case implications either for the OWFs or for the cable systems and might therefore require additional compensation. The selected mitigation option also allows for the transmission of electricity generated by the OWFs in the hybrid project to other markets in case of outages or maintenance of single cable systems. It can therefore reduce the curtailment of the OWFs. This is also the case with the mitigation options to commercially connect the OWFs to the high-price or low-price market,

Regarding interdependencies, this barrier is interdependent with the barriers "uncertainty about hybrid cable system classification" and "uncertainty about applicable RES subsidy scheme". The implementation of a new bidding zone for the OWFs included in the hybrid project implies defining the cable systems between the respective countries and the hub as interconnectors. In addition, such a definition may affect the business case of the OWFs included in the hybrid project and thereby potentially the level of required subsidies.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the NSWPH hybrid project, the following actions are required:

- Clarify whether a bidding zone review process in accordance with the CACM regulation (Regulation (EU) 2015/1222) Article 32 (4)[158] is required to establish an additional bidding zone

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[157] European Commission. 2015. *COMMISSION REGULATION (EU) 2015/1222 establishing a guideline on capacity allocation and congestion management.* Article 33. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1222&from=EN

[158] European Commission. 2015. *COMMISSION REGULATION (EU) 2015/1222 establishing a guideline on capacity allocation and congestion management.* Article 32 (4). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1222&from=EN

containing the OWFs included in the NSWPH hybrid project. It is especially important to clarify whether the regular bidding zone review process should be adhered to, or whether a shortened bidding zone review process is possible. Clarification is also required on the feasibility of establishing a bidding zone without consumers and compatible with the CACM regulation. This action can be achieved through voluntary cooperation between TenneT TSO B.V., TenneT TSO GmbH and Energinet, as well as the European Commission.

- Conduct a joint market simulation between Nordpool and EPEX Spot, for example, to assess the impact of the different market arrangements. Insights into the effects of the market arrangements are especially important in these three areas: congestion of the cable systems linking the artificial hub to the markets; efficient price formation across the different bidding zones; and curtailment of the OWFs linked to the artificial hub. This action can be achieved through voluntary cooperation between TenneT TSO B.V., TenneT TSO GmbH and Energinet.
- Validate whether no additional compensation is required for the cable system operators, as the cable systems are developed as part of the hybrid project from the beginning. Consider also the results of the joint market simulation. OWF developers, however, are compensated through a RES subsidy scheme by bidding for the required subsidy level in a competitive process. For this, OWF developers need clarity on the market conditions applicable to the OWFs in the future. This can be achieved through voluntary cooperation between TenneT TSO B.V., TenneT TSO GmbH and Energinet, as well as national ministries and NRAs (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark) and the European Commission.
- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the Netherlands, Germany and Denmark of costs and benefits deriving from the different market arrangements. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. TSOs as well as the national ministries and NRAs assume responsibility for this action (TenneT TSO B.V., the MoEA and ACM in the Netherlands; TenneT TSO GmbH, the BMWi and BNetzA in Germany; and Energinet, the MoEUC and DUR in Denmark).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 56. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 53.

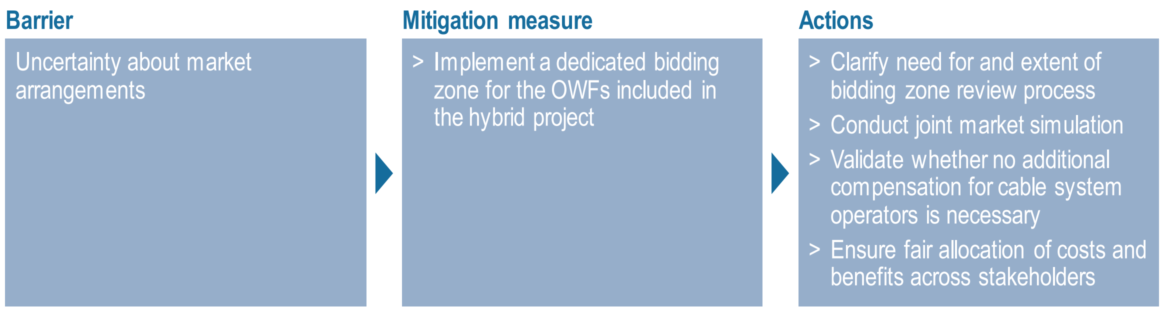

Figure 56: North Sea Wind Power Hub (NSWPH) barrier mitigation – Uncertainty about market arrangements

Uncertainty about hybrid cable system classification

Project-specific barrier evaluation: The cable systems linking the NSWPH to the Dutch, German and Western Danish markets function as hybrid cable systems. This is because they serve two distinct and legally differentiated functions. Regulation (EC) 714/2009[159] defines an interconnector as "a transmission line which crosses or spans a border between Member States and which connects the national transmission systems of the Member States." A conventional export cable system provides for the transmission of electricity generated by the OWF to an onshore connection point without crossing borders. In the hybrid setup, the cable systems provide for the transmission of electricity generated by the OWFs to shores via the hub and market-to-market flows. Such dual functionality prevents straight-forward classification of the cable systems under EU and national legislation and regulations as either export cable systems or interconnectors.

Barrier mitigation: The mitigation option identified as most feasible is to define the cable systems as interconnectors between the new bidding zone established for the hub, and the Dutch, German and Western Danish bidding zones. This is based on consideration of the interdependencies shown in Table 3, interaction with project stakeholders (see Chapter 5.3.4) and the ease of implementation in terms of the required effort,

The other mitigation options considered in this study were (1) to define the cable systems between the hub and the Dutch, German and Western Danish bidding zones as export cable systems with leftover capacities available for interconnector functionality, and (2) to define them as interconnectors with leftover capacities available for transmission from the OWFs to shore via the hub.

The mitigation option identified as most feasible was selected for the following reasons: The mitigation option to define the cable systems between the hub and the Dutch, German and Western Danish bidding zones as interconnectors is covered under all relevant national regulations. This is provided connections involving a new dedicated bidding zone are covered. The other considered mitigation options may possibly be covered under Dutch and Danish regulations, but not under German regulations, which expressly prohibit the dual functionality of cable systems. Also, from a European perspective, the other considered mitigation options are not covered under existing regulations. Furthermore, the mitigation option was selected due to its interdependencies with other barriers.

Regarding interdependencies, defining the cable systems between the hub and the Dutch, German and Western Danish bidding zones as interconnectors is interdependent with the following two barriers: "uncertainty about market arrangements" and "uncertainty about applicable RES subsidy scheme". Defining the cable systems between the hub and the Dutch, German and Western Danish bidding zones as interconnectors fits the implementation of a new bidding zone for the OWFs in the hybrid project. In addition, such a definition may affect the business case of the OWFs in the hybrid project. This is due to the uncertain market price in the new dedicated bidding zone, which applies to the OWFs included in the hybrid project and thereby potentially affects the level of required subsidies.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the NSWPH hybrid project, the following actions are required:

- Validate whether defining the cable systems as interconnectors between the new bidding zone established for the hub and the Dutch, German and Western Danish bidding zones complies with Dutch, German and Danish regulations. Validation is required, as the cable systems connect bidding zones but not necessarily countries. This can be achieved through voluntary cooperation

[159] European Parliament, European Council. 2009. *REGULATION (EC) No. 714/2009 on conditions for access to the network for cross-border exchanges in electricity.* Article 2 (1). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R0714&from=EN

between the national ministries and NRAs (the MoEA and ACM in the Netherlands, the BMWi and BNetzA in Germany and the MoEUC and DUR in Denmark), initiated by the TSOs.

- If required, adjust Dutch, German and Danish regulations to allow for interconnectors between the newly established bidding zone and national bidding zones in the hybrid project. Guidance from project-specific developers is required to inform the adjustment of Dutch, German and Danish regulations. Certainty about changes can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The national ministries and NRAs assume responsibility for this action (the MoEA and ACM in the Netherlands, the BMWi and BNetzA in Germany and the MoEUC and DUR in Denmark).
- Validate whether no additional compensation for the cable system operators is required, as the cable systems are developed as part of the hybrid project from the beginning. OWF developers, however, are compensated through a RES subsidy scheme by bidding for the required subsidy level in a competitive process. For this, OWF developers need clarity on the market conditions applicable to the OWFs in the future. This can be achieved through voluntary cooperation between TenneT TSO B.V., TenneT TSO GmbH and Energinet as well as national ministries and NRAs (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark) and the European Commission.
- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the Netherlands, Germany and Denmark of costs and benefits deriving from the classification of the cable systems as interconnectors. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. TSOs as well as the national ministries and NRAs assume responsibility for this action (TenneT TSO B.V., the MoEA and ACM in the Netherlands; TenneT TSO GmbH, the BMWi and BNetzA in Germany; and Energinet, the MoEUC and DUR in Denmark).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 57. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 53.

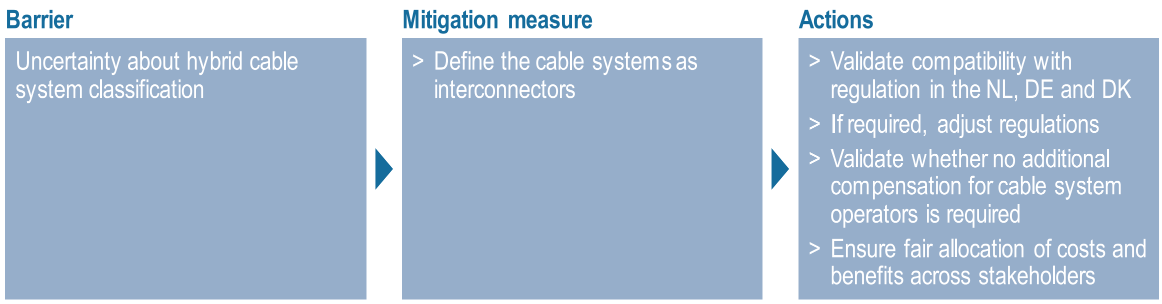

Figure 57: North Sea Wind Power Hub (NSWPH) barrier mitigation – Uncertainty about hybrid cable system classification

Failure of developers to align planning across assets and countries

<u>Project-specific barrier evaluation:</u> Several alignment issues make the NSWPH hybrid project complex: the inclusion of the OWFs in the Dutch, German and Danish EEZs; cable systems linking the hub to the Dutch, German and Western Danish markets; and the hub itself. As the various assets have separate permit, development and construction timelines, geographical alignment is crucial. In

addition, interoperability between the different components of the various assets must be ensured to enable the hybrid project to function.

Barrier mitigation: The mitigation option identified as most feasible is to facilitate a continuous dialogue and early-stage alignment between the project developers. Given that the location of the Dutch, German and Danish OWFs is determined by the Dutch, German and Danish authorities respectively, the project developers need to align on the following: the routing of the cable systems, the location of substations and the specifications of the cable systems, substations, OWFs and the offshore hub in the hybrid project. This is based on consideration of the interdependencies shown in Table 3, interaction with project stakeholders (see Chapter 5.3.5) and the ease of implementation in terms of the required effort.

Apart from continuous dialogue and early-stage alignment between the project developers, no other mitigation options were considered.

Regarding interdependencies, this barrier is interdependent with the following five barriers: "uncertainty about responsibility for project development"; "uncertainty about regulation deriving from jurisdiction over cross-border cable systems"; "uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)"; the "lack of regulated revenues for anticipatory investments"; and the "limited engagement of public stakeholders". Continuous dialogue and early-stage alignment are complemented by clearly defining who is responsible for the development, construction and operation of the cable systems as well as the need to obtain all required permits and align regulation. However, dialogue and alignment themselves are supported by the following measures to mitigate other barriers. Aligned OWF tenders allow for the involvement of and coordination with the developer of the OWF in the hybrid project. Two factors allow for such alignment by decreasing the risk to hybrid project development arising from early-stage project-specific decisions: certainty about the availability of regulated revenues for anticipatory investments; and a formalised public commitment and public financial support.

Action and responsibilities for mitigation implementation: To implement this mitigation measure for the NSWPH hybrid project, the following action is required:

- Engage in a continuous dialogue to achieve early-stage alignment regarding the locations, routing and technical specifications of the individual assets. This can be achieved through voluntary cooperation between the OWF developers and TenneT TSO B.V., TenneT TSO GmbH and Energinet, as well as national ministries and NRAs (the MoEA, supported by RVO and ACM, in the Netherlands; the BMWi, supported by the BSH and BNetzA, in Germany; and the MoEUC and DUR in Denmark).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 58. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 53.

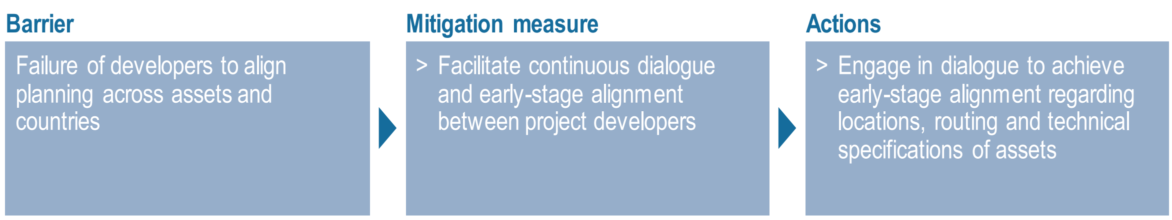

Figure 58: North Sea Wind Power Hub (NSWPH) barrier mitigation – Failure of developers to align planning across assets and countries

Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)

Project-specific barrier evaluation: A suitable tender design needs to be chosen for the NSWPH hybrid project. The OWFs in the project setup are located in the Dutch, German and Danish EEZs and are connected to onshore connection points in the Netherlands, Germany and Denmark via the hub. As the hub links multiple OWFs to shore via common infrastructure, the design of the OWFs must adapt to the technical setup of the NSWPH and its associated infrastructure. Thus, hybrid-specific requirements (e.g. technical changes to control systems on substations) must be fulfilled.

Barrier mitigation: The mitigation option identified as most feasible is to implement a tender design with strict requirements. These should be aligned between the Netherlands, Germany and Denmark and reflect that OWFs are located in three EEZs but connected to the same hub. Furthermore, the tender requirements should eliminate all hybrid-specific uncertainties for the OWF developers. This is based on consideration of the interdependencies shown in Table 3, interaction with project stakeholders (see Chapter 5.3.7) and the ease of implementation in terms of the required effort.

The other mitigation options considered in this study were (1) to have a strict tender design with requirements aligned among the stakeholders, (2) to have a strict tender design without hybrid-specific uncertainties for the OWF developer, and (3) to have a lenient tender design with requirements aligned among the stakeholders and without hybrid-specific uncertainties for the OWF developer.

The mitigation option identified as most feasible was selected for the following reasons: While aligned requirements potentially necessitate amendments to national legislation and regulations, the Netherlands, Germany and Denmark have valid interests in defining certain requirements for the tenders of the OWFs connected to the hub. Aligned requirements also aid in ensuring the interoperability of the OWFs with the other assets of the hybrid project. All of these factors increase the probability of successful hybrid project implementation. Furthermore, a tender design with strict requirements also increases the probability of successful project implementation, allowing for a possible decrease in the cost efficiency of the OWF development due to more limited competition. Lastly, certainty about hybrid-specific characteristics of the OWF development increases the probability of successful project implementation – and decreases the cost of implementation – by reducing the risk premium otherwise demanded by OWF developers in terms of subsidies.

Regarding interdependencies, this barrier is interdependent with the following three barriers: "uncertainty about regulation deriving from jurisdiction over cross-border cable systems"; the "failure of developers to align planning across assets and countries"; and "uncertainty about applicable RES subsidy scheme". Aligned regulation deriving from Dutch, German and Danish jurisdiction needs to be reflected in the requirements of the OWF tenders. In addition, the OWF tenders can include a joint support scheme established by the Netherlands, Germany and Denmark. Continuous dialogue and early-stage alignment facilitate aligned tender designs.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the NSWPH hybrid project, the following actions are required:

- Agree a tender design with strict requirements. Certainty about the tender design can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The national ministries, NRAs and other national authorities assume responsibility for this action (the MoEA, ACM and RVO in the Netherlands; the BMWi, BNetzA and BSH in Germany; and the MoEUC and DUR in Denmark).
- Agree tender requirements which take account of the valid interest of the Netherlands, Germany and Denmark. This means jointly defining material requirements such as technical and

operational standards in alignment with the requirements of the NSWPH hybrid project deriving from the connection of all OWFs to shore via the hub. Environmental standards do not need to be aligned between the Netherlands, Germany and Denmark, as national environmental standards apply to the respective OWFs. Similarly, financial requirements do not need to be aligned across countries. Guidance from project-specific developers is required to inform the development of project-specific tender requirements. Certainty about tender requirements can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The national ministries, NRAs and other national authorities assume responsibility for this action (the MoEA, ACM and RVO in the Netherlands; the BMWi, BNetzA and BSH in Germany; and the MoEUC and DUR in Denmark).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 59. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 53.

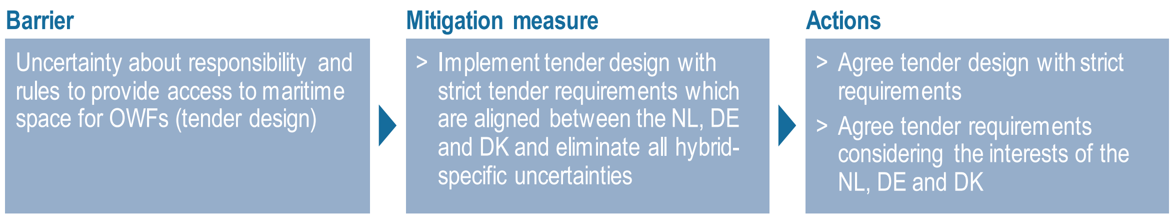

Figure 59: North Sea Wind Power Hub (NSWPH) barrier mitigation – Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)

Lack of regulated revenues for anticipatory investments

Project-specific barrier evaluation: Anticipatory investments are necessary to allow for the implementation of the NSWPH hybrid project. While the offshore hub is important for the realisation of the hybrid project, it also represents significant, additional costs for its developers, even though not all OWFs will be connected to the hub when it is commissioned. Any investments in grid infrastructure deemed inefficient by regulators are not compensated,[160] so the additional costs to developers may present an obstacle to hybrid project development.

Barrier mitigation: The mitigation option identified as most feasible is to validate the feasibility of regulated revenues for the anticipatory investments under the regulatory regime in the Netherlands, Germany and Denmark, and to adjust the regime in Denmark if required. This is based on consideration of the interdependencies shown in Table 3, interaction with project stakeholders (see Chapter 5.3.11) and the ease of implementation in terms of the required effort.

Besides validating the feasibility of regulated revenues for anticipatory investments under the regulatory regime in the Netherlands, Germany and Denmark (with adjustments in Denmark, if necessary), no other mitigation option can be considered. For cable systems requiring anticipatory investments that are geographically located in the Netherlands and the hub, the Dutch regime is applicable. It must therefore be assessed with regard to the coverage of the specific investments. For cable systems requiring anticipatory investments that are geographically located in Germany and the

[160] ACER. 2014. *Recommendation of the Agency for the cooperation of energy regulators No 03/2014.* https://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Recommendations/ACER%20Recommendation%2003-2014.pdf

hub, the German regime is applicable. It must therefore be assessed with regard to the coverage of the specific investments. Lastly, for the cable system requiring anticipatory investments that are geographically located in Denmark and the hub, the Danish regime is applicable. It must therefore also be assessed with regard to the coverage of the specific investments.

Regarding interdependencies, this barrier is interdependent with the "failure of developers to align planning across assets and countries". Continuous dialogue and early-stage alignment with the MoEA and ACM in the Netherlands, the BMWi and BNetzA in Germany and the MoEUC and DUR in Denmark support the validation of the coverage of the anticipatory investments with regulated revenues under the Dutch, German and Danish regimes, respectively.

<u>Actions and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the NSWPH hybrid project, the following actions are required:

- Validate the inclusion of the anticipatory investments in the Dutch Offshore Grid Development Framework[161] to allow for their inclusion in the investment planning of TenneT TSO B.V. This ensures that a share of the anticipatory investments for the hub and the cable systems between the hub and the (Dutch) market is covered by regulated revenues. This action can be based on an existing decision-making process for investments for the offshore grid. It can therefore be achieved through voluntary cooperation between TenneT TSO B.V., MoEA and ACM in the Netherlands.
- Validate the inclusion of the anticipatory investments in the German Spatial Grid Development Plan[162] and Maritime Spatial Plan[163] to allow for their inclusion in the investment planning of TenneT TSO GmbH. This will ensure that a share of the anticipatory investments for the hub and the cable systems between the hub and the (German) market is covered by regulated revenues. This action can be based on an existing decision-making process for investments for the offshore grid. It can therefore be achieved through voluntary cooperation between TenneT TSO GmbH (together with 50Hertz, Amprion and TransnetBW), BMWi, BNetzA and BSH in Germany.
- Clarify the treatment of the anticipatory investments in Denmark to validate their coverage by regulated revenues. This will ensure that a share of the anticipatory investments for the hub and the cable systems between the hub and the (Western Danish) market is covered by regulated revenues. This can be achieved through voluntary cooperation between Energinet, MoEUC and DUR in Denmark.
- If required, adjust Danish regulation to support the anticipatory investments needed for implementation of the NSWPH hybrid project. Guidance from project-specific developers is required to inform the adjustment of Danish regulation. Note that Denmark’s regulatory framework for TSO investments is currently being reviewed, with updated legislation expected in mid-2019.[164] Against this backdrop, further adjustments might not be necessary. Otherwise, adjustments can be achieved by addressing this issue as part of the project-specific HANSA

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[161] Dutch Elektriciteitswet 1998. Article 21. https://wetten.overheid.nl/BWBR0009755/2018-07-28#Hoofdstuk3_Paragraaf3_Artikel21

[162] BMWi. 2017. *Gesetz zur Entwicklung und Förderung der Windenergie auf See.* §5. https://www.gesetze-im-internet.de/windseeg/__5.html

[163] BMWi. 2005. *Gesetz über die Elektrizitäts- und Gasversorgung.* §17. http://www.gesetze-im-internet.de/enwg_2005/__17a.html

[164] Danish Energy Agreement 2018. https://en.efkm.dk/media/12307/energy-agreement-2018.pdf

between the Netherlands, Germany and Denmark. The MoEUC and DUR in Denmark assume responsibility for this action.

- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the Netherlands, Germany and Denmark of costs and benefits deriving from coverage of anticipatory investments. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The TSOs as well as the national ministries and NRAs assume responsibility for this action (TenneT TSO B.V., the MoEA and ACM in the Netherlands; TenneT TSO GmbH, the BMWi and BNetzA in Germany; and Energinet, the MoEUC and DUR in Denmark).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 60. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 53.

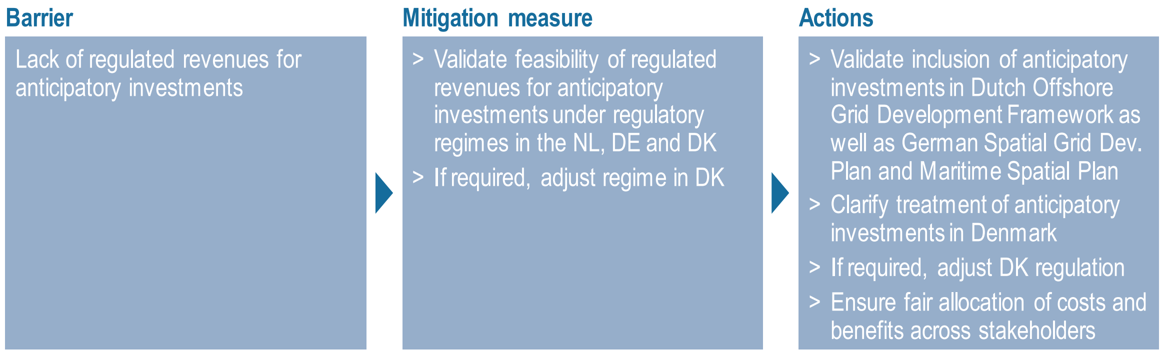

Figure 60: North Sea Wind Power Hub (NSWPH) barrier mitigation – Lack of regulated revenues for anticipatory investments

Uncertainty about applicable RES subsidy scheme

<u>Project-specific barrier evaluation:</u> The OWFs included in the NSWPH hybrid project are located in the Dutch, German or Danish EEZs. Thus, subsidy schemes of the Netherlands, Germany and Denmark could apply to the respective OWFs. In addition, a joint project or a joint support scheme between the Netherlands, Germany and Denmark are possible, in line with EU Directive 2009/28/EC[165] on the promotion of the use of energy from RES. In summary, the applicability of a support scheme from one of the countries involved or in some joint form is to be determined.

<u>Barrier mitigation:</u> The mitigation option identified as most feasible is to establish a joint support scheme between the Netherlands, Germany and Denmark for the OWFs included in the NSWPH hybrid project. This is based on consideration of the interdependencies shown in Table 3, interaction with project stakeholders (see Chapter 5.3.12) and the ease of implementation in terms of the required effort.

The other mitigation options considered in this study were (1) to apply the national subsidy schemes to the OWFs, depending on their location, or (2) to apply no subsidy scheme.

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[165] European Parliament, European Council. 2009. *DIRECTIVE 2009/28/EC on the promotion of the use of energy from renewable sources.* Article 6, 7, 9 and 11.https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

The mitigation option identified as most feasible was selected for the following reasons: The legal feasibility of applying location-dependent national subsidy schemes to the OWFs depends on the clarification of the onshore connection point and is therefore uncertain. The feasibility of tendering the OWFs without a subsidy scheme depends on the ability of OWF developers to ensure project bankability through offtake securities, such as power purchase agreements. Establishing a joint support scheme across the Netherlands, Germany and Denmark is legally covered and ensures project bankability. But it might be problematic due to the extended timeline, which is needed to agree the specifications of the scheme and formulate the necessary legally binding agreement between the Netherlands, Germany and Denmark.

Regarding interdependencies, this barrier is interdependent with the following three barriers: "uncertainty about market arrangements"; "uncertainty about hybrid cable system classification"; and "uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)". A dedicated bidding zone for the NSWPH is accompanied by defining the cable systems linking the hub to shore as interconnectors. The market price established in the bidding zone affects the business case of the OWFs included in the hybrid project and thereby the level of required RES subsidies. Furthermore, applying a joint support scheme established by the Netherlands, Germany and Denmark to the NSWPH hybrid project fits with a tender design with aligned, strict requirements.

<u>Actions and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the NSWPH hybrid project, the following actions are required:

- Validate the feasibility of a joint support scheme between the Netherlands, Germany and Denmark for all OWFs included in the NSWPH hybrid project. In most cases, the voluntary cooperation of EU Members States in a joint support scheme in line with EU Directive 2009/28/EC[166] requires the statistical transfer of a specified amount of energy produced from RES between countries. In addition, the European Commission needs to be notified of the following: the allocation of energy across countries at the latest three months after the end of the first year in which it takes effect; the total amount of energy from RES received within three months of the end of each year; and the allocation of energy across countries according to the notified distribution rule. The Netherlands, Germany and Denmark also have additional, national requirements. The Netherlands require that the generated electricity must not be fed into the Dutch grid and that the electricity prices of the relevant area apply.[167] In Germany, the requirements are the mutuality of the scheme, the possibility of physical transmission of electricity to Germany (or a similar effect on the German electricity market), plus an Intergovernmental Agreement (IGA) between the countries involved.[168] For example, the existing joint support scheme for RES between Norway and Sweden is based on an IGA between the two countries.[169] In Denmark, existing legislation only allows subsidies to be allocated to OWFs located in Danish territorial waters or the Danish EEZ. This is because tenders for OWF licences, on which financial

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[166] European Parliament, European Council. 2009. *DIRECTIVE 2009/28/EC on the promotion of the use of energy from renewable sources.* Article 11. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

[167] Dutch Besluit stimulering duurzame energieproductie 2007. §5a Article 55b. https://wetten.overheid.nl/BWBR0022735/2017-04-01#Paragraaf5a_Artikel55b

[168] German Erneuerbare-Energien-Gesetz 2017 (EEG 2017). § 5 (3). https://www.gesetze-im-internet.de/eeg_2014/__8.html

[169] Statnett. 2011. *Agreement between the Government of the Kingdom of Norway and the Government of the Kingdom of Sweden on a common market for electricity certificates.* http://www.statnett.no/Global/Dokumenter/Kraftsystemet/Elsertifikater/swedish_norwegian_treaty.pdf

support depends, are conducted only for these areas.[170] This action can be achieved through voluntary cooperation between the MoEA and ACM in the Netherlands, the BMWi and BNetzA in Germany and the MoEUC and DUR in Denmark.

- If feasible, define the characteristics of and implement the joint support scheme for the specific hybrid project. In terms of the characteristics of the joint support scheme, establish the type, level and duration of support, plus the technology coverage. Clarify the commercial flow conditions for OWFs in the NSWPH hybrid project as part of this process. Due to the additional requirements in the Netherlands, Germany and Denmark, certainty about Dutch, German and Danish regulations can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The MoEA and ACM in the Netherlands, the BMWi and BNetzA in Germany and the MoEUC and DUR in Denmark assume responsibility for this action.
- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the Netherlands, Germany and Denmark of costs and benefits deriving from the joint support scheme. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The OWF developers as well as national ministries and NRAs (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark) assume responsibility for this action.

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 61. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 53.

Figure 61: North Sea Wind Power Hub (NSWPH) barrier mitigation – Uncertainty about applicable RES subsidy scheme

Limited engagement of public stakeholders

<u>Project-specific barrier evaluation:</u> The support of public stakeholders is needed for successful implementation of the NSWPH hybrid project, as regulatory and technical barriers must be overcome and financial support provided across three countries, namely, the Netherlands, Germany and Denmark.

<u>Barrier mitigation:</u> The mitigation option identified as most feasible is to formalise public commitment in the form of a project-specific MoU or a project-specific HANSA. Feasibility studies and scoping studies for early-stage alignment through public funding, for example, should also be facilitated. Furthermore, adequate de-risking of the hybrid project is required. This is based on consideration of

[170] Danish Bekendtgørelse af lov om fremme af vedvarende energi. § 22, § 23 and §37. https://www.retsinformation.dk/Forms/R0710.aspx?id=203053

the interdependencies shown in Table 3, interaction with project stakeholders (see Chapter 5.3.13) and the ease of implementation in terms of the required effort.

Besides formalising public commitment in the form of a project-specific MoU or a project-specific HANSA and facilitating feasibility studies and scoping studies or providing financial guarantees, no other mitigation option was considered.

Regarding interdependencies, this barrier is interdependent with the "failure of developers to align planning across assets and countries" barrier. Continuous dialogue and early-stage alignment between the project developers is facilitated by formalising the commitment of relevant stakeholders of the hybrid project and / or by providing public funding for early-stage activities. These may include feasibility studies, scoping studies and technical research and development.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the NSWPH hybrid project, the following actions are required:

- Align and implement the type of formalisation of public commitment to allow for the development of the NSWPH hybrid project. The formalisation of commitment in the form of a project-specific MoU or a project-specific HANSA is an expression of the goodwill of the stakeholders to support hybrid project development. It assures project developers of public support, e.g. in the form of dialogue with relevant government bodies. In early project stages, a project-specific MoU provides sufficient certainty for project developers. The stakeholders assuming responsibility are TenneT TSO B.V., TenneT TSO GmbH, Energinet and the national ministries and NRAs (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark). They also include the European Commission. In later project stages, a project-specific HANSA is required to provide project developers with sufficient legal certainty. The stakeholders assuming responsibility include the national ministries (the MoEA in the Netherlands, the BMWi in Germany and the MoEUC in Denmark) and the European Commission.
- Catalyse the development of the NSWPH hybrid project by supporting early-stage alignment among developers. Do this through public funding for feasibility studies, pilot projects and R&D for innovative, technological solutions, in addition to existing offshore support schemes. Such public support allows developers to firmly commit to the development of the project. This can be achieved through voluntary cooperation between the national ministries (the MoEA in the Netherlands, the BMWi in Germany and the MoEUC in Denmark) and the European Commission.
- Support the de-risking of the hybrid project by providing financial guarantees. Such guarantees can reassure project developers in situations, which cannot be foreseen due to the pilot character of the hybrid project. This can be achieved through voluntary cooperation between the TSOs (TenneT TSO B.V., TenneT TSO GmbH and Energinet) as well as the European Commission.
- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the Netherlands, Germany and Denmark of costs and benefits deriving from the engagement of public stakeholders. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The national ministries and NRAs assume responsibility for this action (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 62. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 53.

Barrier	Mitigation measure	Actions
Limited engagement of public stakeholders	> Formalise public commitment > Facilitate early-stage alignment through public funding and support de-risking of hybrid project	> Align and implement formalisation of public commitment (in early project stages in form of MoU, later HANSA) > Support early-stage alignment among developers through public funding > Support de-risking of project by providing financial guarantees > Ensure fair allocation of costs and benefits across stakeholders

Figure 62: North Sea Wind Power Hub (NSWPH) barrier mitigation – Limited engagement of public stakeholders

Disproportionate allocation of costs and benefits across involved stakeholders

<u>Project-specific barrier evaluation:</u> Agreeing on the allocation of costs and benefits in the NSWPH hybrid project is complex. The OWFs are geographically located in the Dutch, German and Danish EEZs and are connected to shore via the hub, which also provides interconnection capacity. Certain costs and benefits are initially incurred by the Netherlands, by Germany and by Denmark due to the technical setup and the details of the hybrid project. In addition, the measures adopted to mitigate other barriers assign costs or distribute benefits to the Netherlands, Germany or Denmark. Furthermore, developers may realise additional benefits. Thus, costs and benefits are generally not distributed fairly, and no suitable approach exists to reallocate costs and benefits across all stakeholders of the hybrid project.

<u>Barrier mitigation:</u> The mitigation option identified as most feasible is to reallocate costs and benefits deriving from the hybrid project where required, based on a project-specific process. In some respects, the process can be based on the existing methodology given by the Cross-Border Cost Allocations (CBCA) process.[171] It builds on the Cost Benefit Analysis (CBA) conducted by ENTSO-E[172] for Projects of Common Interest. In the CBCA process, benefits such as socio-economic welfare and CO_2 emissions are calculated on a national level to compensate net losers for the implementation of a project through a CBCA decision. The CBCA process provides a good starting point for the reallocation of costs and benefits across countries but is best suited for evaluating cross-border electricity interconnectors. This is based on consideration of the interdependencies shown in Table 3, interaction with project stakeholders (see Chapter 5.3.15) and the ease of implementation in terms of the required effort.

Besides implementing the process resulting in the reallocation of costs and benefits deriving from the implementation of the hybrid project, no other mitigation option was considered.

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[171] ACER. 2015. *Recommendation No 5/2015 on good practices for the treatment of the investment requests, including CBCA requests, for electricity and gas PCIs.* https://acer.europa.eu/Official_documents/Acts_of_the_Agency/Recommendations/ACER%20Recommendation%2005-2015.pdf

[172] ENTSO-E. 2018. *2nd ENTSO-E Guideline: For Cost Benefit Analysis of Grid Development Projects.* https://tyndp.entsoe.eu/Documents/TYNDP%20documents/Cost%20Benefit%20Analysis/2018-10-11-tyndp-cba-20.pdf

Regarding interdependencies, this barrier is interdependent with the following six barriers: "uncertainty about responsibility for project development (grid connection responsibility)"; "uncertainty about market arrangements"; "uncertainty about hybrid cable system classification"; the "lack of regulated revenues for anticipatory investments"; "uncertainty about applicable RES subsidy scheme"; and the "limited engagement of public stakeholders". Reallocation also relates to those barriers. This is because their mitigation translates into costs and benefits for specific stakeholders that might have to be reallocated together with all other costs and benefits of the hybrid project. Therefore, the costs and benefits deriving from all six interdependent barriers must be considered.

<u>Actions and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the NSWPH hybrid project, the following actions are required:

- Identify relevant cost and benefit categories between the involved stakeholders, covering all significant aspects of the hybrid project. This can be achieved through voluntary cooperation between TSOs (TenneT TSO B.V. in the Netherlands, TenneT TSO GmbH in Germany and Energinet in Denmark) as well as national ministries and NRAs (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark).
- Ensure that due consideration is given to all costs and benefits deriving from measures adopted to mitigate the following barriers: "uncertainty about responsibility for project development"; "uncertainty about market arrangements"; "uncertainty about hybrid cable system classification"; the "lack of regulated revenues for anticipatory investments"; "uncertainty about applicable RES subsidy scheme"; and the "limited engagement of public stakeholders". This can be achieved through voluntary cooperation between all stakeholders involved in the individual barrier mitigation measures.
- Determine the initial allocation of costs and benefits, covering the cost and benefit categories across all significant aspects of the hybrid project identified in the first step. In this process, developers typically conduct the assessment of costs and benefits, while NRAs oversee and validate results. Thus, this can be achieved through voluntary cooperation between OWF developers, TenneT TSO B.V. in the Netherlands, TenneT TSO GmbH in Germany and Energinet in Denmark as well as national ministries and NRAs (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark).
- Align and agree a suitable reallocation of costs and benefits between developers, the Netherlands, Germany and Denmark. This should be based on the identification of cost and benefit categories among stakeholders as well as the assessment of the initial allocation of costs and benefits across the identified categories. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. OWF developers, TenneT TSO B.V. in the Netherlands, TenneT TSO GmbH in Germany and Energinet in Denmark as well as national ministries and NRAs (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark) assume responsibility for this action, as well as the European Commission.
- Validate the availability of CEF funding to ensure adequate incentivisation for all relevant stakeholders if the following applies: the NSWPH hybrid project is a PCI and adds socio-economic value, but the initial allocation of costs and benefits is not sufficiently balanced to incentivise all countries and stakeholders to implement the hybrid project. While CEF funding cannot resolve viability issues of projects, it is a last resort for PCIs that have received a CBCA decision but are

still not commercially viable for each individual stakeholder.[173] This can be achieved through voluntary cooperation between TSOs, namely, TenneT TSO B.V. in the Netherlands, TenneT TSO GmbH in Germany and Energinet in Denmark, and NRAs (ACM in the Netherlands, BNetzA in Germany and DUR in Denmark) as well as the European Commission.

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 63. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 53.

Figure 63: North Sea Wind Power Hub (NSWPH) barrier mitigation – Disproportionate allocation costs and benefits across involved stakeholders

Uncertainty about legislative regime for power-to-gas and related infrastructure

Project-specific barrier evaluation: The inclusion of power-to-gas and gas transmission infrastructure is considered in the NSWPH hybrid project, specifically power-to-hydrogen conversion and hydrogen transmission. However, including hydrogen infrastructure on the hub is complicated without a dedicated framework for hydrogen legislation. Currently, most hybrid project designs focus on the combination of generation and transmission infrastructure and do not incorporate power conversion to gas or gas transmission. However, depending on the technical setup of the project, the inclusion of power-to-hydrogen and hydrogen transmission infrastructure might be beneficial, as in the case of the NSWPH hybrid project. Thus, the clarification of national and European regulations in terms of unbundling, market arrangements and the regulation of tariffs is necessary. In addition, the progressive integration of energy systems across sectors, which boosts flexibility in the electricity grid as extra renewable energy capacity is added, depends on non-discriminatory access to infrastructure across sectors.

Barrier mitigation: The mitigation option identified as most feasible is to provide guidance on sector coupling and to reassure NSWPH stakeholders of future legislative support to allow for the integration of hydrogen conversion. A dedicated legislative framework is needed in the longer term for power conversion to hydrogen and hydrogen transmission. This would enable the European energy system to adapt to new technologies and help European Member States achieve their climate policy targets. It would also address unbundling, non-discriminatory access to infrastructure, market arrangements and the regulation of tariffs. This is based on consideration of the interaction with project stakeholders (see Chapter 5.3.16) and the ease of implementation in terms of the required effort.

[173] European Parliament, European Council. 2013. *REGULATION (EU) No. 347/2013 on guidelines for trans-European energy infrastructure.* Article 14. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0347&from=en

Besides providing guidance on sector coupling and assuring NSWPH stakeholders of the future legislative support for the inclusion of hydrogen conversion and transmission in the hybrid project idea, no other mitigation option was considered.

Regarding interdependencies, this barrier is not interdependent with any other barrier considered in this study for this hybrid project.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the NSWPH hybrid project, the following actions are required:

- To avoid duplication of work, evaluate existing findings and ongoing legislative efforts as well as research projects regarding power conversion to hydrogen, hydrogen transmission and sector coupling on the European level. This can be achieved through voluntary cooperation between the NSWPH consortium members, particularly Gasunie and Energinet, as well as the European Commission.
- Evaluate the existing regulations for (natural / industrial / chemical) gas as possible starting points for application to power conversion to hydrogen and hydrogen transmission before implementing a dedicated legislative framework. Base this on the assessment of the status quo of the legislative efforts regarding power conversion to hydrogen and hydrogen transmission. New and / or updated European legislation regarding power conversion to hydrogen and hydrogen transmission should address unbundling, non-discriminatory access to infrastructure, market arrangements and the regulation of tariffs. This can be achieved through voluntary cooperation between the NSWPH consortium members, particularly Gasunie and Energinet, as well as the national ministries (the MoEA in the Netherlands, the BMWi in Germany and the MoEUC in Denmark), as well as the European Commission.
- Take advantage of the experience gained from initial larger-scale power conversion to hydrogen and hydrogen transmission projects (e.g. the onshore project Element One[174]). Use this to establish the NSWPH hybrid project as a pilot project for the large-scale coupling of renewable power generation with other sectors of the energy system. In this context, and building on the assessment of possible starting points for dedicated hydrogen legislation, identify focus areas for future legislative efforts to prepare for a future legislative framework for hydrogen. This can be achieved through voluntary cooperation between the NSWPH consortium members, particularly Gasunie and Energinet as well as the national ministries (the MoEA in the Netherlands, the BMWi in Germany and the MoEUC in Denmark), as well as the European Commission.

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 64. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 53.

[174] TenneT Holding B.V. 2018. *Gasunie, TenneT and Thyssengas reveal detailed, green ‘sector coupling’ plans using power-to-gas technology.* https://www.tennet.eu/news/detail/gasunie-tennet-and-thyssengas-reveal-detailed-green-sector-coupling-plans-using-power-to-gas-tec/

Barrier	Mitigation measure	Actions
Uncertainty about legislative regime for power-to-gas and related infrastructure	> Provide guidance on sector coupling > Assure stakeholders of future legislative support for integration of H_2 conversion in hybrid project idea	> Evaluate existing findings, ongoing legislative efforts and research projects regarding H_2 and sector coupling > Evaluate existing regulation on gas regarding applicability to H_2 > Identify key focus areas for future legislative efforts

Figure 64: North Sea Wind Power Hub (NSWPH) barrier mitigation – Uncertainty about legislative regime for power-to-gas and related infrastructure

4.8 COBRA Cable

The hybrid project idea "COBRA Cable" is an interconnector tie-in concept. In the project, the so-called leftover OWF areas in the German Cluster 8 are connected to the Netherlands and to Denmark via the COBRA Cable interconnector. The OWF is connected to multiple markets, rendering a conventional connection of the OWF to a German onshore connection point redundant. The idea shows significant lifetime savings compared to the reference case, in which the OWF and the interconnector are stand-alone assets. Thus, the COBRA Cable hybrid project is given further consideration in the scope of this study, and an Action Plan for the implementation of barrier mitigation measures is developed. The Action Plan is intended to be used as a tool by stakeholders once the COBRA Cable hybrid project has been given the go-ahead.

4.8.1 Details of hybrid project and reference case

The individual assets included in the hybrid project and in the reference case are modelled on the basis of real assets. But the assumed characteristics do not claim to represent the actual characteristics of the assets included in either ongoing or future developments.

In the reference case (Figure 65), COBRA Cable is a stand-alone, point-to-point interconnector between the Netherlands and Denmark. It is constructed based on HVDC technology with 700 MW nominal capacity and a length of 329 km. The OWF included in the project idea is a so-called leftover area in Cluster 8 of the German EEZ. A leftover area is an area that remains undeveloped adjacent to already tendered or developed OWF areas. Usually, leftover areas cannot be economically connected to shore based on conventional export cable systems. According to the BSH, the leftover areas in Cluster 8 have a nominal generation capacity of 425 MW. The OWF is radially connected to Germany via a 200 km HVDC export cable system. No intermediate offshore transformers are required, as the wind turbines can be connected directly to the high-voltage offshore transformer via the 66-kV array cable system. The export cable system has a nominal capacity of 425 MW.[175]

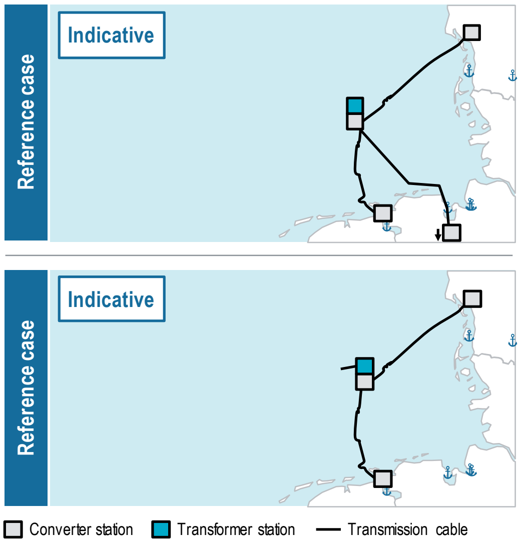
In the hybrid project (Figure 65), COBRA Cable is a multi-terminal interconnector between the Netherlands and Denmark, otherwise constructed to the same specifications as in the reference case. The OWF has the same location and specifications as in the reference case. The OWF is connected to the interconnector via a very short HVDC export cable system. Due to the location of the OWF

[175] Alternatively, a connection of the leftover area via the locally coordinated export cable system of the German OWF Cluster 10 is considered post 2030. However, since the latter is still uncertain, e.g. due to the required crossing of major shipping lanes, this study uses the radial connection to shore as in the reference case.

close to the interconnector, the hybrid project setup only requires a very short export cable system for the link to the interconnector. The export cable system has a nominal capacity of 425 MW.

For all cable systems, onshore transformer stations are not in the scope of the assessment. As a result, benefits deriving from the hybrid project compared to the reference case – with fewer onshore transformer stations in the hybrid project than in the reference case – have not been considered. Furthermore, onshore grid reinforcement costs are not in the scope of this assessment. But it is important that they are considered before project development would be initiated. The need for onshore grid reinforcements can be expected to be lower in the hybrid project compared to the reference case, as the OWF does not need an additional onshore grid connection point.

Geographical mapping



	Reference case	Hybrid case	Difference
Nominal capacity interconnector [MW]			
	700	700	0
Length interconnector [km]			
	329	329	0
Nominal capacity OWF [MW]			
	425	425	0
Length export cable [km]			
	200	0	- 200
Offshore transformer / converter / switching stations			
	1 / 1 / 0	1 / 1 / 0	0
Onshore transformer / converter stations			
	0 / 3	0 / 2	- 1

Figure 65: COBRA Cable – Reference case and hybrid project profile

It is assumed that the development, construction and commissioning of the individual assets (OWF, export cable system and interconnector) can be aligned in the hybrid project to prevent temporarily stranded assets. However, to do so in this case means bringing forward the development of the OWF and the export cable system by twelve years (commissioning in 2023) – if it is developed at all in the reference case. It also requires prolonging the lifetime of the interconnector by four years (as the interconnector is expected to be commissioned in 2019[176]) compared to the standard offshore asset lifetime of 25 years.

4.8.2 Evaluation of hybrid project vs. reference case

To evaluate the hybrid project against the reference case, this study calculates the lifetime savings of the hybrid project. These include the difference in cost and the difference in socio-economic welfare (SEW) between the hybrid project and the reference case. Both the cost assessment – looking at CAPEX and OPEX – and the market modelling-based SEW assessment are based on the technical setup of the hybrid project and the reference case, as described in the project details. Additional

[176] TenneT Holding B.V., Energinet. 2018. *COBRACable.* http://www.cobracable.eu/

indicators included in the assessment are energy not served, RES curtailment and CO_2 emissions. CO_2 emissions are internalised as cost in the SEW.

Assuming a typical asset lifetime of 25 years, the hybrid project yields lifetime savings of about EUR 390 m compared to the reference case (Figure 66). The lifetime savings are derived entirely from a reduction of CAPEX and OPEX of about EUR 420 m. OPEX are calculated and discounted over a 25-year period. However, a lower hybrid project SEW of EUR 3 m p.a. compared to the reference case translates into additional costs from lifetime SEW of about EUR 30 m, discounted over 25 years. The above-mentioned cost savings significantly exceed this figure. Lifetime savings therefore remain positive. The small difference in SEW is spread over the entire European electricity system. It is originally driven by the suboptimal operational setup of the generation and transmission assets included in the hybrid project compared to the reference case. This means that either the available interconnector capacity is reduced or the OWF generation is curtailed as the two conflict with each other.

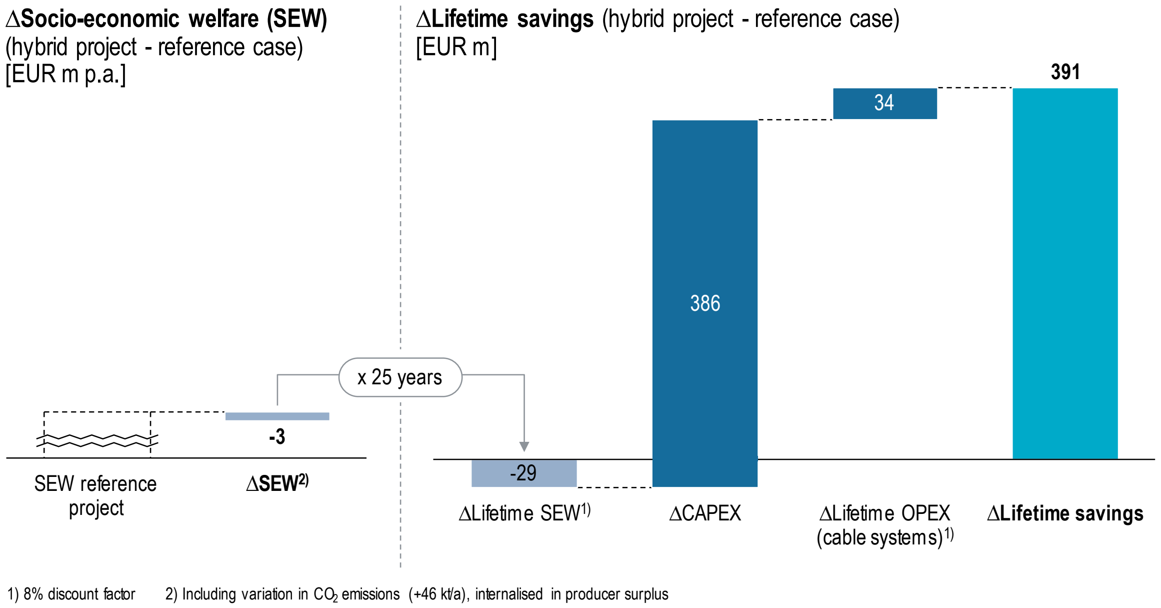


Figure 66: COBRA Cable – Assessment results[177]

Regarding the cost assessment, the result is driven by the OWF and the export cable system, although it is slightly reduced by the interconnector. The cost of the OWF is lower in the hybrid project than in the reference case. The OWFs can be commissioned earlier compared to the alternate possibility of post-2030 connection, and thus benefit from lower (i.e. less inflated) OPEX. In addition, the cost of the export cable system is lower in the hybrid project than in the reference case. The export cable system links only the OWF to the interconnector and does not reach the German shore, rendering redundant one onshore converter station and about 200 km of export cable system. The hybrid project requires the use of disconnector modules, but these incur only negligible costs compared to the cost savings. The cost of the interconnector is higher in the hybrid project than in the reference case because the interconnector requires multi-terminal technology.

[177] SEW assessment based on Careri, Francesco. [Forthcoming]. *The impact of North Sea electricity projects in a 2030 scenario: Preliminary assessment of system benefits for the pan-European power system through METIS.* Petten: European Commission Joint Research Centre.

In both the hybrid project and the reference case, energy not served is zero due to the comprehensive nature of and the redundancies in the European electricity system. Therefore, neither setup adversely affects the EU's energy policy target of energy security. Compared to the reference case, the effect of the hybrid project on curtailment and CO_2 emissions is very small[178]. This suggests that the hybrid project is unlikely to have a significant impact on the EU's energy policy targets on the further establishment of the internal energy market and the decarbonisation of the economy.

4.8.3 Development of an Action Plan to overcome barriers

This chapter summarises the findings specific to the development of the COBRA Cable hybrid project. It builds on the general explanation of the barriers in Chapter 3.2, the general explanation of the interdependencies between barriers in Chapter 3.3 and the findings of project-specific discussions of the barriers and mitigation options in Chapter 5.4.

This study notes that 10 of the 16 identified barriers need to be overcome to allow for the commencement of the COBRA Cable hybrid project development. Although the barriers are addressed individually, interdependencies exist between them. When developing ways to mitigate one barrier, it is therefore necessary to also consider the mitigation of other barriers. Table 4 provides an overview of the project-specific barriers and barrier mitigation measures, as well as a brief description of the interdependencies to be considered in the development of the individual barrier mitigation measures.

Barrier	Mitigation measures	Interdependencies
Uncertainty about responsibility for project development	Assign responsibility for grid connection to TenneT TSO GmbH, in close collaboration with the owners and operators of the COBRA Cable interconnector, TenneT TSO B.V. and Energinet	▪ Failure of developers to align planning across assets and countries: clearly assigning grid connection responsibility facilitates continuous dialogue and early-stage alignment
Uncertainty about regulation deriving from jurisdiction over cross-border cable systems	Obtain all required permits and align regulation deriving from concurrent jurisdiction over cross-border cable systems	▪ Failure of developers to align planning across assets and countries: obtaining all required permits and aligning regulation is facilitated by continuous dialogue and early-stage alignment ▪ Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design): aligned regulation relevant to the OWF needs to be reflected in the tender design

[178] The hybrid project generates additional curtailment of 2,100 MWh/a and additional CO_2 emissions of 46 kt/a (internalised in socio-economic welfare). For more details, please refer to Careri, Francesco. [Forthcoming]. *The impact of North Sea electricity projects in a 2030 scenario: Preliminary assessment of system benefits for the pan-European power system through METIS.* Petten: European Commission Joint Research Centre.

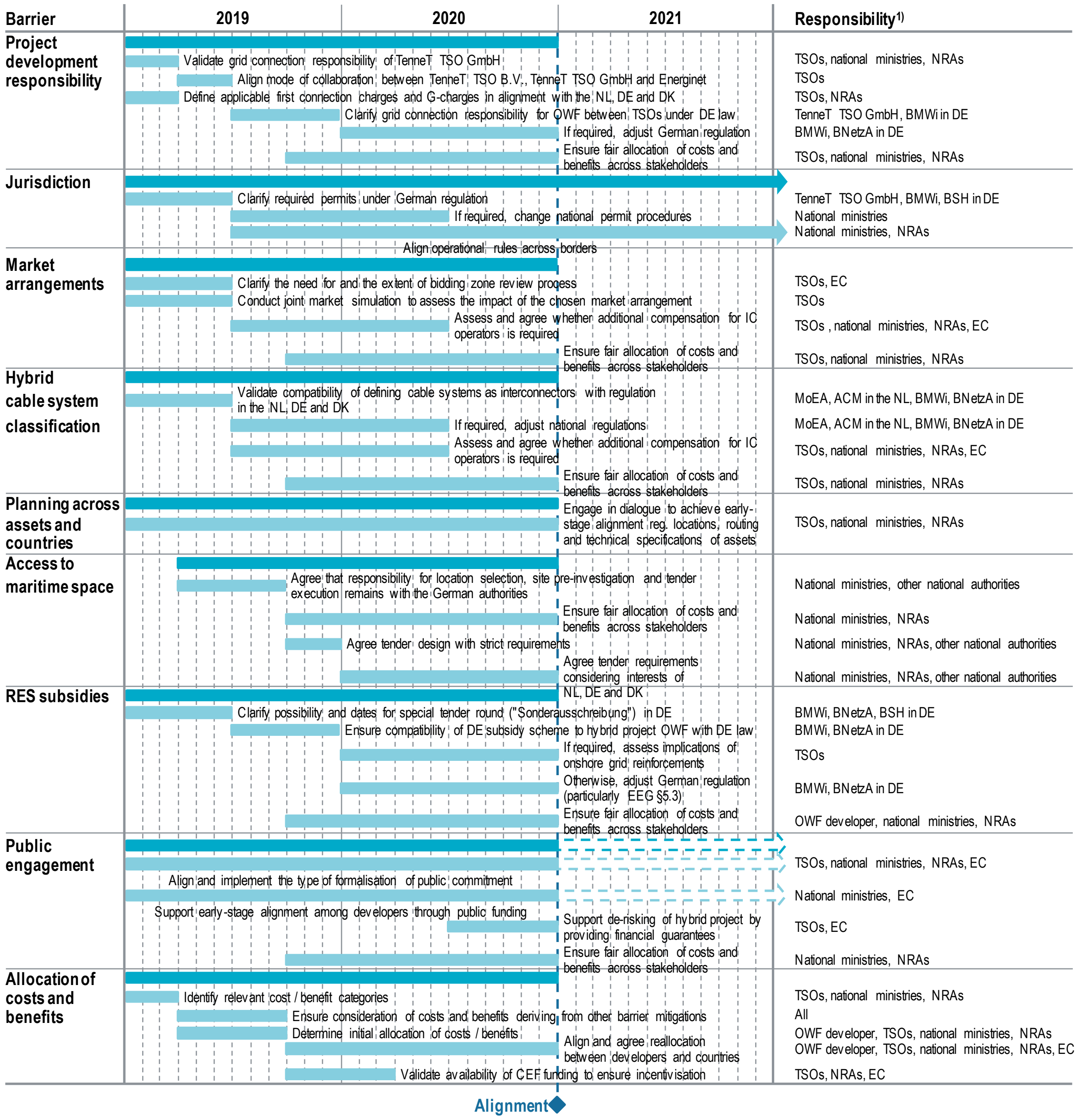
Barrier	Mitigation measures	Interdependencies
Uncertainty about market arrangements	Implement a dedicated bidding zone for the OWF included in the hybrid project	▪ Uncertainty about hybrid cable system classification: a dedicated bidding zone implies defining the cable systems as interconnectors ▪ Uncertainty about applicable RES subsidy scheme: a dedicated bidding zone affects the business case of the OWF and thereby the level of required subsidies
Uncertainty about hybrid cable system classification	Define the cable systems as interconnectors	▪ Uncertainty about market arrangements: defining the cable systems as interconnectors implies establishing a dedicated bidding zone ▪ Failure of developers to align planning across assets and countries: defining the cable systems as interconnectors most closely aligns with the existing COBRA Cable business case. It therefore facilitates continuous dialogue and early-stage alignment ▪ Uncertainty about applicable RES subsidy scheme: defining the cable systems as interconnectors, which is required due to the market arrangement of a dedicated bidding zone, affects the business case of the OWF and thereby the level of required subsidies
Failure of developers to align planning across assets and countries	Facilitate continuous dialogue and early-stage alignment between the project developers	▪ Uncertainty about responsibility for project development: continuous dialogue and early-stage alignment facilitates clear assignment of responsibility for grid connection ▪ Uncertainty about regulation deriving from jurisdiction over cross-border cable systems: continuous dialogue and early-stage alignment facilitates obtaining all required permits and aligning regulation ▪ Uncertainty about hybrid cable system classification: continuous dialogue and early-stage alignment are facilitated by defining the cable systems as interconnectors as this most closely aligns with the existing COBRA Cable business case

Barrier	Mitigation measures	Interdependencies
		▪ Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution): continuous dialogue and early-stage alignment are facilitated by an aligned OWF location ▪ Limited engagement of public stakeholders: continuous dialogue and early-stage alignment are facilitated by formalising public commitment and public funding for feasibility studies, R&D etc.
Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution)	Conduct location selection, site pre-investigation and tender execution by, and in accordance with, the rules of German authorities	▪ Failure of developers to align planning across assets and countries: location selection, site pre-investigation and tender execution by, and in accordance with, the rules of German authorities provides clarity on OWF location ▪ Uncertainty about applicable RES subsidy scheme: location selection, site pre-investigation and tender execution by, and according to, the rules of German authorities fits provision of a subsidy scheme by German authorities
Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)	Implement a tender design with strict requirements which are aligned between the Netherlands, Germany and Denmark	▪ Uncertainty about regulation deriving from jurisdiction over cross-border cable systems: tender design needs to reflect aligned regulation relevant for the OWF ▪ Failure of developers to align planning across assets and countries: aligned tender design is facilitated by continuous dialogue and early-stage alignment ▪ Uncertainty about applicable RES subsidy scheme: a tender with aligned, strict requirements includes a German subsidy scheme aligned with the Netherlands and Denmark
Uncertainty about applicable RES subsidy scheme	Apply the German RES subsidy scheme to the hybrid project OWF, potentially with statistical transfers between countries	▪ Uncertainty about market arrangement: the business case of the OWF and thereby the level of required subsidies are affected by a dedicated bidding zone ▪ Uncertainty about hybrid cable system classification: the business case of the OWF

Barrier	Mitigation measures	Interdependencies
		and thereby the level of required subsidies are affected by the market arrangement of an own bidding zone. This requires defining the cable systems as interconnectors ▪ Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution and tender design): applying a German RES subsidy scheme fits location selection, site pre-investigation, tender execution and tender design by, and in accordance with, the rules of German authorities
Limited engagement of public stakeholders	Formalise public commitment in the form of a project-specific MoU or HANSA. Also, facilitate feasibility studies and scoping studies for early-stage alignment through public funding, for example	▪ Failure of developers to align planning across assets and countries: formalising public commitment and public funding for feasibility studies, R&D, etc. is facilitated by continuous dialogue and early-stage alignment
Disproportionate allocation of costs and benefits across involved stakeholders	Reallocate costs and benefits deriving from the hybrid project where required, based on a project-specific process	▪ Uncertainty about responsibility for project development (responsibility for grid connection): costs and benefits deriving from mitigation to be considered ▪ Uncertainty about market arrangement: costs and benefits deriving from mitigation to be considered ▪ Uncertainty about hybrid cable system classification: costs and benefits deriving from mitigation to be considered ▪ Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution): costs deriving from mitigation to be considered ▪ Uncertainty about applicable RES subsidy scheme: costs and benefits deriving from mitigation to be considered ▪ Limited engagement of public stakeholders: costs and benefits deriving from mitigation to be considered

Table 4: COBRA Cable – Barriers, barrier mitigation measures and interdependencies

Combining all the measures needed to mitigate the barriers of relevance to the COBRA Cable hybrid project creates an Action Plan that supports the commencement of the development. In addition to placing the required actions on a timeline, the Action Plan also details the stakeholders responsible for each of the actions (Figure 67). The Action Plan is intended to be used as a tool by stakeholders once the COBRA Cable hybrid project has received the go-ahead.



1) Responsible stakeholders are OWF developer: tbd; TSOs: TenneT TSO B.V. in the NL, TenneT TSO GmbH in DE, Energinet in DK; Ministries: MoEA in the NL, BMWi in DE, MoEUC in DK; NRAs: ACM in the NL, BNetzA in DE, DUR in DK; Other national authorities: RVO in the NL, BSH in DE

Figure 67: COBRA Cable – Action Plan

The barriers and mitigation measures specific to the COBRA Cable hybrid project and the actions required to implement the identified mitigation measures are explained in more detail in the subchapters below. As part of the work on barrier mitigation, a project-specific Memorandum of Understanding (MoU) or a project-specific Hybrid Asset Network Support Agreement (HANSA) were considered. Both types of formal commitment to address barriers can include all actions for mitigation measures of relevance to the COBRA Cable hybrid project. Thus, it can be sufficient to set up only one type.

Uncertainty about responsibility for project development

Project-specific barrier evaluation: The definition of responsibility for the interconnector and for the grid connection of the OWF will determine who is responsible for the development of the COBRA Cable hybrid project.

The definition of the party responsible for the OWF's connection to the interconnector is complex. The potential OWF site is located in the German EEZ, where TenneT TSO GmbH is generally responsible for grid connection based on German law.[179] This assumes an onshore connection point in the area where TenneT TSO GmbH would be responsible. However, the onshore grid connection points of the interconnector are in the Netherlands and Denmark, where TenneT TSO B.V. and Energinet are generally responsible for grid connection. Thus, for this specific hybrid project setup, no suitable definition of grid connection responsibility exists.

TenneT TSO B.V. and Energinet have been responsible for development and construction and are the parties responsible for operating the COBRA Cable interconnector. This responsibility does not need to be reviewed.[180]

Barrier mitigation: The mitigation option identified as most feasible is to assign responsibility for grid connection to TenneT TSO GmbH in close collaboration with the owners and operators of the COBRA Cable interconnector, TenneT TSO B.V. and Energinet. This is based on consideration of the interdependencies shown in Table 4, interaction with project stakeholders (see Chapter 5.4.1) and the ease of implementation in terms of the required effort.

The other mitigation options considered in this study were to make (1) TenneT TSO B.V. and Energinet, (2) the OWF developer and (3) TenneT TSO B.V., TenneT TSO GmbH and Energinet responsible for the OWF's grid connection to the COBRA Cable interconnector.

The mitigation option identified as most feasible was selected for the following reasons: Due to the EU's unbundling regulation,[181] OWF developers are prohibited from taking on responsibility for grid connection. The allocation of grid connection responsibility to TenneT TSO B.V. and Energinet or jointly to TenneT TSO B.V., TenneT TSO GmbH and Energinet also requires clarification regarding legal and regulatory coverage. The same holds true if responsibility is assigned only to TenneT TSO GmbH. In the selected mitigation option, the risk towards project realisation can be mitigated by efficient cooperation between TenneT TSO GmbH and the operators of the COBRA Cable interconnector (TenneT TSO B.V. and Energinet). The selected mitigation option therefore allows all relevant stakeholders to maintain appropriate influence and interest in the project in addition to most closely aligning with current practice.

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[179] If the onshore connection point is located in the area of responsibility of Amprion in the reference case, then Amprion would be responsible for the listed actions instead of TenneT TSO GmbH (German Erneuerbare-Energien-Gesetz 2017 (EEG 2017). § 8. https://www.gesetze-im-internet.de/eeg_2014/__8.html).

[180] TenneT Holding B.V. 2018. *COBRAcable.* https://www.tennet.eu/our-grid/international-connections/cobracable/

[181] European Commission. 2009. *DIRECTIVE 2009/72/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL concerning common rules for the internal market in electricity.* Article 9. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0072&from=EN

Irrespective of which mitigation option is selected, this barrier is interdependent with the "failure of developers to align planning across assets and countries" barrier. Clearly defining responsibility for the grid connection requires continuous dialogue and early-stage alignment on the hybrid project setup among the defined project promoters. Clearly defined responsibilities and continuous dialogue and alignment, in turn, allow for the commencement of project development.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the COBRA Cable hybrid project, the following actions are required:

- Validate the assignment of responsibility to TenneT TSO GmbH to ensure that the integration of the OWF in the interconnector is successful. Certainty about grid connection responsibility can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The TSOs (TenneT TSO B.V., TenneT TSO GmbH and Energinet) and national ministries and NRAs (the MoEA and ACM in the Netherlands, the BMWi and BNetzA in Germany and the MoEUC and DUR in Denmark) assume responsibility for this action.
- Agree a mode of collaboration between TenneT TSO GmbH and the owners and operators of the COBRA Cable interconnector, TenneT TSO B.V. and Energinet. This action can be achieved through voluntary cooperation between TenneT TSO GmbH, TenneT TSO B.V. and Energinet.
- Define the applicable first connection charges and G-charges in alignment with the three involved countries: the Netherlands (shallow first connection charges and no G-charges); Germany (shallow to super-shallow first connection charges and no G-charges); and Denmark (super-shallow to partially shallow first connection charges and energy-based G-charges). [182] This action can be achieved through voluntary cooperation between TenneT TSO B.V., TenneT TSO GmbH and Energinet as well as the NRAs – ACM in the Netherlands, BNetzA in Germany and DUR in Denmark.
- Validate the applicability of German law and ensure compatibility with existing regulations. Do this by clarifying which TSO is responsible for OWF grid connection under German law.[183] This can be achieved through voluntary cooperation between TenneT TSO GmbH and the BMWi in Germany.
- If required, adjust German regulations to allow responsibility for grid connection to be assigned to TenneT TSO GmbH. This is despite the onshore connection points being located in the Netherlands and Denmark. Guidance from project-specific developers is required to inform the adjustment of German regulations. Achieve certainty about German regulations by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The BMWi and BNetzA in Germany assume responsibility for this action.

Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the Netherlands, Germany and Denmark of costs and benefits deriving from responsibility for grid

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[182] ENTSO-E. 2018. *Overview of transmission tariffs in Europe: Synthesis 2018.* https://docstore.entsoe.eu/Documents/MC%20documents/TTO_Synthesis_2018.pdf;

The European Wind Energy Association. 2016. *Position paper on network tariffs and grid connection regimes.* http://www.ewea.org/fileadmin/files/library/publications/position-papers/EWEA-position-paper-on-harmonised-transmission-tariffs-and-grid-connection-regimes.pdf

[183] German Erneuerbare-Energien-Gesetz 2017 (EEG 2017). § 8. https://www.gesetze-im-internet.de/eeg_2014/__8.html

connection. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the three countries. The TSOs, national ministries and NRAs assume responsibility for this action (TenneT TSO B.V., the MoEA and ACM in the Netherlands; TenneT TSO GmbH, the BMWi and BNetzA in Germany; and Energinet, the MoEUC and DUR in Denmark) The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 68. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 67.

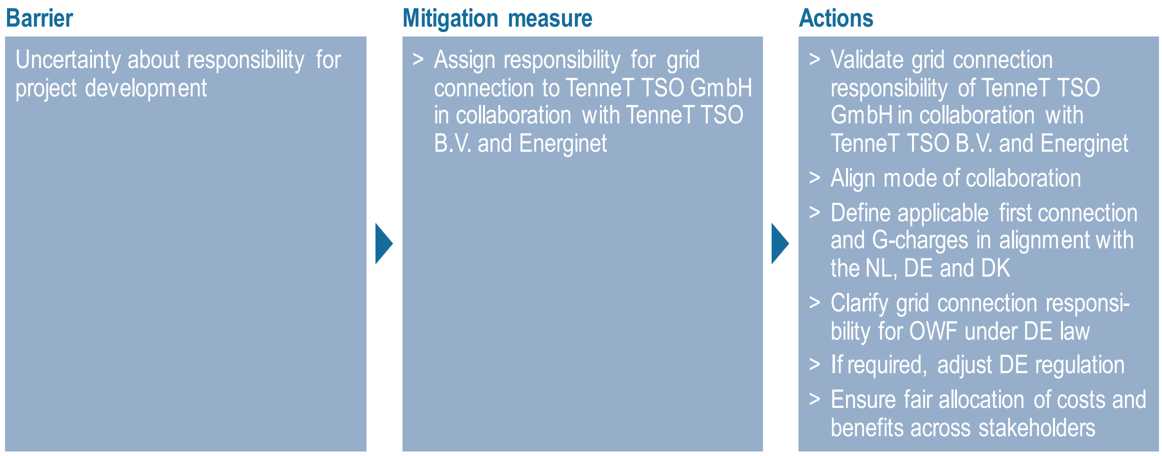

Figure 68: COBRA Cable barrier mitigation – Uncertainty about responsibility for project development

Uncertainty about regulation deriving from jurisdiction over cross-border cable systems

<u>Project-specific barrier evaluation:</u> The interconnector of the COBRA Cable hybrid project has its onshore connection points in the Netherlands and in Denmark. It thereby crosses the Dutch territorial sea and EEZ, the German EEZ and the Danish territorial sea and EEZ. Since Germany must grant the freedom of the high seas to lay cables, the Netherlands and Denmark can claim jurisdiction over the cable. They have done so through an agreement formulated by the project partners TenneT TSO B.V. and Energinet, who jointly construct and operate the interconnector.[184]

However, since the OWF serves to exploit marine resources within the German EEZ, Germany has jurisdiction over the OWF installation and the export cable system (jurisdiction ends at the offshore converter station). Thus, the jurisdiction over the cable system, which includes the interconnector and the export cable system, might be concurrent. As a result, the regulation applicable to the export cable system derived from German jurisdiction, and to the interconnector derived from the agreement formed by TenneT TSO B.V. and Energinet, might contradict each other.

<u>Barrier mitigation:</u> The mitigation option identified as most feasible is to obtain all required permits and to align regulation deriving from concurrent jurisdiction over the operation of the cross-border cable system between the countries involved. This is based on consideration of the interdependencies shown in Table 4, interaction with project stakeholders (see Chapter 5.4.2) and the ease of implementation in terms of the required effort.

[184] TenneT Holding B.V., Energinet. 2018. COBRACable. http://www.cobracable.eu/

The other mitigation option considered besides aligning regulation deriving from concurrent jurisdiction was to define regulation deriving from German jurisdiction as applicable to the cable systems linking the German OWF to the COBRA Cable interconnector.

The mitigation option identified as most feasible was selected for the following reasons: The application of operational rules deriving from German regulation is legally feasible. But additional alignment would be necessary as different operational regulations apply to the COBRA Cable interconnector as compared to the cable system connecting the German OWF to the COBRA Cable interconnector. At the same time, the alignment of operational rules deriving from Dutch, German and Danish regulations can be a lengthy process. However, such alignment reflects the interests of all countries involved in the alignment. It can potentially be based on the existing agreements established for the COBRA Cable interconnector between the Netherlands, Germany and Denmark.

Regarding interdependencies, this barrier is interdependent with the following two barriers: "failure of developers to align planning across assets and countries" and "uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)". Obtaining all required permits and aligning regulation is facilitated by continuous dialogue and early-stage alignment. Furthermore, aligned operational regulation needs to be reflected in the requirements of the OWF tender.

<u>Actions and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the COBRA Cable hybrid project, the following actions are required:

- For development and construction, clarify the permits for the export cable system that are required under German regulations. Compliance with the environmental and technical rules under German regulations can be ensured by obtaining these permits. This can be achieved through voluntary cooperation between TenneT TSO GmbH, the BMWi and the BSH (supported by the Federal Environment Agency).
- If required, change the national permit procedures for the specific hybrid project. Guidance from project-specific developers in the form of an inventory of environmental and technical rules is required to inform changes to the permit procedures. Certainty about changes can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The national ministries would assume responsibility for this action (the MoEA in the Netherlands, the BMWi in Germany (supported by regional governments) and the MoEUC in Denmark).
- For the operational phase, align the applicable national regulations arising from concurrent jurisdiction for the specific hybrid project. The required alignment may concern liability issues, control system operations (voltage levels, grid synchronisation etc.) and matters discussed in relation to other barriers. Also consider existing national and EU legal frameworks such as the System Operations regulation (Regulation (EU) 2017/1485)[185] and the CACM regulation (Regulation (EU) 2015/1222)[186]. Guidance from project-specific developers is required to inform the alignment. Certainty about the alignment of operational rules can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The national ministries and NRAs assume responsibility for this action (the MoEA and

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[185] European Commission. 2017. *Commission Regulation (EU) 2017/1485 establishing a guideline on electricity transmission system operation.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R1485&from=DE

[186] European Commission. 2015. *COMMISSION REGULATION (EU) 2015/1222 establishing a guideline on capacity allocation and congestion management.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1222&from=EN

ACM in the Netherlands, the BMWi and BNetzA in Germany as well as the MoEUC and DUR in Denmark).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 69. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 67.

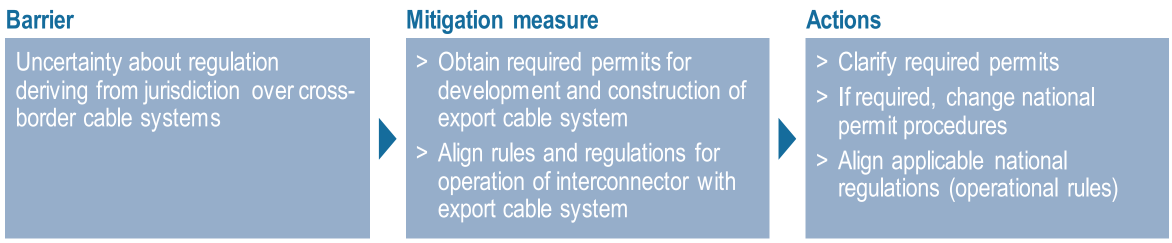

Figure 69: COBRA Cable barrier mitigation – Uncertainty about regulation deriving from jurisdiction over cross-border cable systems

Uncertainty about market arrangements

Project-specific barrier evaluation: The clarification of commercial flows is required for the COBRA Cable hybrid project. This is because the potential OWF site is located in the German EEZ, whereas the onshore grid connection points of the interconnector, connecting the OWF to shore, are in the Netherlands and Denmark. So, while the OWF physically feeds electricity into the Dutch or Danish markets, commercial flows to the Dutch, (virtually) to the German or to the Danish market are possible. Hence commercial flows for the OWF included in the hybrid project must be clarified.

Barrier mitigation: The mitigation option identified as most feasible is to implement a dedicated bidding zone for the OWF in the hybrid project. This is based on consideration of the interdependencies shown in Table 4, interaction with project stakeholders (see Chapter 5.4.3) and the ease of implementation in terms of the required effort.

The other mitigation options considered in this study were (1) to implement commercial flows either to the Dutch or the Danish bidding zone, (2) to implement commercial (virtual) flows to the German market, (3) to implement dynamic commercial flows from the OWF to the high-price market and (4) to implement dynamic commercial flows from the OWF to the low-price market.

The mitigation option identified as most feasible was selected for the following reasons: Implementing a dedicated bidding zone for the OWF in the hybrid project is covered under existing market regulations, although it may necessitate a comprehensive bidding zone review process. The other mitigation options are not covered under existing market regulations. Indeed, options (3) and (4) violate the existing CACM regulation (Regulation (EU) 2015/1222)[187] regarding the requirement for the stability of bidding zones across market time frames. Furthermore, while the selected mitigation option has no business case implications for the OWF in the hybrid project, establishing a dedicated bidding zone does impact the business case of the COBRA Cable interconnector. This potentially makes additional compensation necessary. However, the need for additional compensation is also given for either the OWF in options (1) and (4), or the interconnector in options (2) and (3). The selected mitigation option also allows for the transmission of electricity generated by the OWF in the

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[187] European Commission. 2015. *COMMISSION REGULATION (EU) 2015/1222 establishing a guideline on capacity allocation and congestion management.* Article 33. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1222&from=EN

hybrid project to the other market in case of outages or maintenance. It can therefore reduce the curtailment of the OWF.

Regarding interdependencies, this barrier is interdependent with the following two barriers: "uncertainty about hybrid cable system classification" and "uncertainty about applicable RES subsidy scheme". The implementation of a new bidding zone for the OWF in the hybrid project requires a change in definition of the cable systems. It implies defining the cable systems as interconnectors between the new bidding zone established for the German OWF and the Dutch and Western Danish bidding zones. Such a definition may affect the business case of the OWF in the hybrid project and thereby potentially the level of required subsidies.

<u>Actions and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the COBRA Cable hybrid project, the following actions are required:

- Clarify whether a bidding zone review process in accordance with the CACM regulation (Regulation (EU) 2015/1222) Article 32 (4)[188] is required to establish an additional bidding zone containing only the OWF in the COBRA Cable hybrid project. It is especially important to clarify whether the regular bidding zone review process should be adhered to, or whether a shortened bidding zone review process is possible. Clarification is also required on the feasibility of establishing a bidding zone without consumers, and to compatibility with the CACM regulation. This action can be achieved through voluntary cooperation between TenneT TSO B.V., TenneT TSO GmbH and Energinet, as well as the European Commission, initiated by the BMWi in Germany.
- Conduct a joint market simulation between Nordpool and EPEX Spot, for example, to assess the impact of the different market arrangements. Insights into the effects of the market arrangements are especially important in these three areas: congestion of the COBRA Cable interconnector; efficient price formation across the different bidding zones; and curtailment of the OWF linked to the COBRA Cable. This action can be achieved through voluntary cooperation between TenneT TSO B.V., TenneT TSO GmbH and Energinet, initiated by the BMWi in Germany.
- Assess and agree whether additional compensation for the interconnector operators is required, as the interconnector was not developed as part of the hybrid project from the beginning. Due consideration should be given to the results of the joint market simulation. The OWF developer, however, is compensated through an RES subsidy scheme by bidding for the required subsidy level in a competitive process. For this, the OWF developer needs clarity on the market conditions applicable to the OWF in the future. This can be achieved through voluntary cooperation between TenneT TSO B.V., TenneT TSO GmbH and Energinet as well as national ministries and NRAs (the MoEA and ACM in the Netherlands, the BMWi and BNetzA in Germany, and the MoEUC and DUR in Denmark). Cooperation should also take place with the European Commission.
- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Achieve this through the fair reallocation among the Netherlands, Germany and Denmark of costs and benefits deriving from the market arrangement. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the three countries. TSOs as well as the national ministries and NRAs assume responsibility for this action (TenneT TSO

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[188] European Commission. 2015. *COMMISSION REGULATION (EU) 2015/1222 establishing a guideline on capacity allocation and congestion management.* Article 32 (4). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1222&from=EN

B.V., the MoEA and ACM in the Netherlands; TenneT TSO GmbH, the BMWi and BNetzA in Germany; and Energinet, the MoEUC and DUR in Denmark).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 70. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 67.

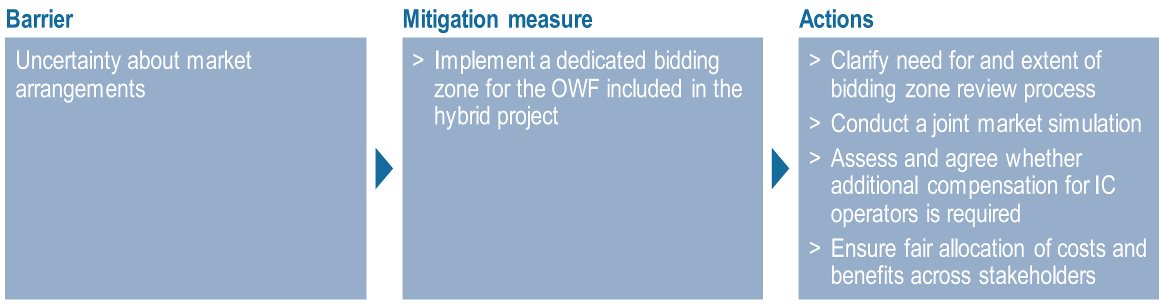

Figure 70: COBRA Cable barrier mitigation – Uncertainty about market arrangements

Uncertainty about hybrid cable system classification

<u>Project-specific barrier evaluation:</u> The interconnector included in the COBRA Cable hybrid project functions as a hybrid cable system. This is because it serves two distinct and legally differentiated functions. Regulation (EC) 714/2009[189] defines an interconnector as "a transmission line which crosses or spans a border between Member States and which connects the national transmission systems of the Member States." A conventional export cable system provides for the transmission of electricity generated by the OWF to an onshore connection point without crossing borders. But in the hybrid setup, the COBRA Cable interconnector provides for the transmission of electricity generated by the OWF and market-to-market flows. Such dual functionality prevents straight-forward classification of the cable system under both EU and national legislation and regulations as either an export cable system or an interconnector.

<u>Barrier mitigation:</u> The mitigation option identified as most feasible is to define the cable systems as interconnectors between the new bidding zone established for the German OWF and the Dutch and Western Danish bidding zones. This is based on consideration of the interdependencies shown in Table 4, interaction with project stakeholders (see Chapter 5.4.4) and the ease of implementation in terms of the required effort.

The other mitigation options considered in this study were to (1) define the cable systems between the German OWF and the Dutch and Western Danish bidding zones as export cable systems, with leftover capacities available for interconnector functionality and to (2) define them as interconnectors with leftover capacities available for transmission from the OWF to the shores.

The mitigation option identified as most feasible was selected for the following reasons: The mitigation option to define the cable systems between the German OWF and the Dutch and Western Danish bidding zones as interconnectors is based on the existing regulatory framework for interconnectors. By contrast, the other considered mitigations options require the definition of a new asset class and

[189] European Parliament, European Council. 2009. *REGULATION (EC) No. 714/2009 on conditions for access to the network for cross-border exchanges in electricity.* Article 2 (1). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R0714&from=EN

therefore changes in European and potentially in national regulatory frameworks. The mitigation option was also selected due to its interdependencies with other barriers.

Regarding interdependencies, defining the cable systems between the German OWF and the Dutch and Western Danish bidding zones as interconnectors is interdependent with three other barriers. These are: "uncertainty about market arrangements"; the "failure of developers to align planning across assets and countries"; and "uncertainty about applicable RES subsidy scheme". Defining the cable systems between the German OWF and the Dutch and Western Danish bidding zones as interconnectors fits the implementation of a new bidding zone for the OWF in the hybrid project. In addition, such a definition may affect the business case of the OWF included in the hybrid project. This is due to potential curtailment of the OWF and thereby potentially the level of required subsidies. Curtailment of the OWF could be a consequence of competition for capacity on the cable systems linking the new bidding zone (including the German OWF) to the Dutch and Western Danish bidding zones between the transmission of electricity from the German OWF to shore and interconnector flows between the connected markets. Lastly, defining the cable systems as interconnectors most closely aligns with the existing COBRA Cable business case. This therefore facilitates continuous dialogue and early-stage alignment.

<u>Actions and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the COBRA Cable hybrid project, the following actions are required:

- Validate whether defining the cable systems as interconnectors between the new bidding zone established for the German OWF and the Dutch and Western Danish bidding zones complies with Dutch, German and Danish regulations. This is required because the cable systems connect bidding zones but not necessarily countries. This can be achieved through voluntary cooperation between the national ministries and NRAs (the MoEA and ACM in the Netherlands and the BMWi and BNetzA in Germany). It can be initiated by the TSOs.
- If required, adjust Dutch, German and Danish regulations to allow for interconnectors between the newly established bidding zone and national bidding zones in the hybrid project. Guidance from project-specific developers is required to inform the adjustment of Dutch, German and Danish regulations. Certainty about changes can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The national ministries and NRAs assume responsibility for this action (the MoEA and ACM in the Netherlands as well as the BMWi and BNetzA in Germany).
- Assess and agree whether additional compensation for the interconnector operators is required, as the interconnector was not developed as part of the hybrid project from the beginning. The OWF developer, however, is compensated through an RES subsidy scheme by bidding for the required subsidy level in a competitive process. For this, the OWF developer needs clarity on the market conditions applicable to the OWF in the future. This can be achieved through voluntary cooperation between TenneT TSO B.V., TenneT TSO GmbH and Energinet as well as national ministries and NRAs (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark). Cooperation should also take place with the European Commission.
- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the Netherlands, Germany and Denmark of costs and benefits deriving from the classification of the cable systems as interconnectors. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the three countries. TSOs as well as the national ministries and NRAs assume responsibility for

this action (TenneT TSO B.V., the MoEA and ACM in the Netherlands; TenneT TSO GmbH, the BMWi and BNetzA in Germany; and Energinet, the MoEUC and DUR in Denmark).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 71. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 67.

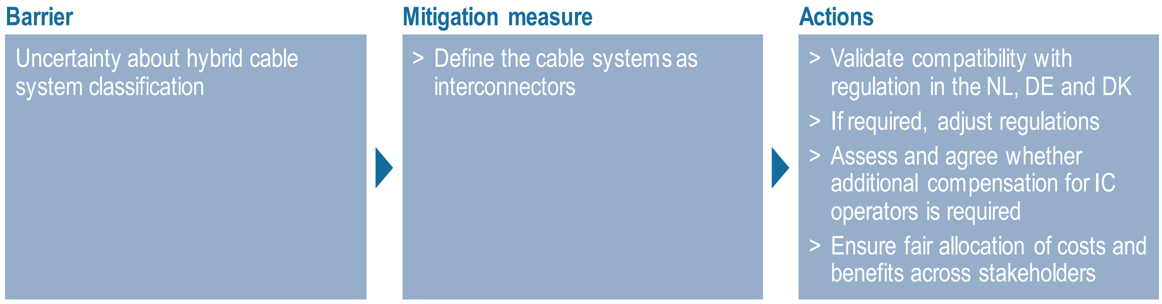

Figure 71: COBRA Cable barrier mitigation – Uncertainty about hybrid cable system classification

Failure of developers to align planning across assets and countries

Project-specific barrier evaluation: The COBRA Cable hybrid project is made complex by the integration of the German OWF, the export cable system linking the German OWF to the COBRA Cable interconnector and the COBRA Cable interconnector. As all three assets have separate permit, development and construction timelines, geographical alignment is crucial. IN ad, interoperability between the different components of the three assets – based on the alignment of technical specifications – must be ensured to enable the hybrid project to function.

Barrier mitigation: The mitigation option identified as most feasible is to facilitate a continuous dialogue and early-stage alignment between the project developers. Given that the German authorities determine the location of the German OWF and the routing of the COBRA Cable interconnector is set, project developers need to align on the following: the routing of the export cable system and the location of substations, the specifications of the export cable system, the substations and the OWF in the hybrid project. This is based on consideration of the interdependencies shown in Table 4, interaction with project stakeholders (see Chapter 5.4.5) and the ease of implementation in terms of the required effort.

Apart from continuous dialogue and early-stage alignment between the project developers, no other mitigation options were considered.

Regarding interdependencies, this barrier is interdependent with the following five barriers: "uncertainty about responsibility for project development"; "uncertainty about regulation deriving from jurisdiction over cross-border cable systems"; "uncertainty about hybrid cable system classification"; "uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution and tender design)"; and the "limited engagement of public stakeholders". Continuous dialogue and early-stage alignment are complemented by clearly defining responsibility for the development, construction and operation of the grid connection, as well as the need to obtain all required permits and align regulation. However, dialogue and alignment themselves are supported by the following measures to mitigate other barriers. Aligned OWF locations allow for the involvement of and coordination with the developer of the OWF in the hybrid project. Two factors allow for such alignment by decreasing the risk to hybrid project development arising from early-stage project-specific decisions: clearly defining the cable systems as interconnectors, which most closely aligns with the existing COBRA Cable business case; and formalising public commitment and public financial support.

Action and responsibilities for mitigation implementation: To implement this mitigation measure for the COBRA Cable hybrid project, the following action is required:

- Engage in a continuous dialogue to achieve early-stage alignment regarding locations, routing and technical specifications for the individual assets. This can be achieved through voluntary cooperation between TenneT TSO B.V., TenneT TSO GmbH and Energinet as well as national ministries and NRAs (the MoEA, supported by RVO and ACM, in the Netherlands; the BMWi, supported by the BSH, and BNetzA, in Germany; and the MoEUC and DUR in Denmark).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 72. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 67.

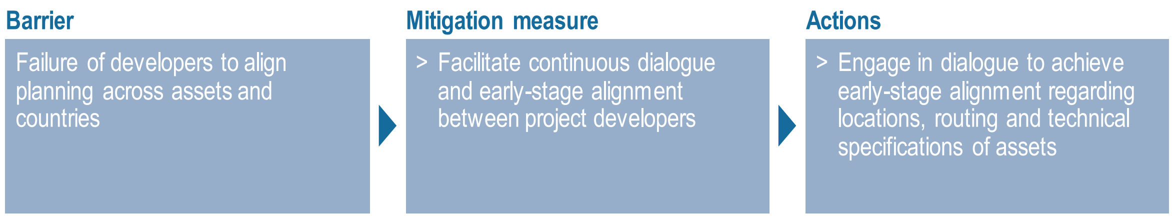

Figure 72: COBRA Cable barrier mitigation – Failure of developers to align planning across assets and countries

Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution)

Project-specific barrier evaluation: The location selection, site pre-investigation and tender execution of the COBRA Cable OWF is conducted by German authorities as it is located in the German EEZ. Due to existing national and international law, the construction of installations in a given country's EEZ can only be granted by the coastal state. However, in the COBRA Cable hybrid project, Dutch, German and Danish stakeholders have an interest in those activities because both the interoperability of the components and the compliance with all national and European regulations must be ensured.

Barrier mitigation: The mitigation option identified as most feasible is to conduct location selection, site pre-investigation and tender execution by and in accordance with the rules of the German authorities. This is based on consideration of the interdependencies shown in Table 4, interaction with project stakeholders (see Chapter 5.4.1) and the ease of implementation in terms of the required effort.

Regarding the responsibility for location selection and site pre-investigation, the other mitigation options considered in this study were to assign responsibility (1) to Dutch and / or Danish authorities and (2) to the OWF developer. The mitigation option identified as most feasible was selected for the following reasons: Legal and regulatory applicability of any responsibility other than German responsibility is not given. Furthermore, additional alignment and coordination would be necessary otherwise, which likely extends the timelines of the processes.

Regarding the responsibility for tender execution, the other mitigation options considered in this study were to assign Dutch and / or Danish responsibility. The mitigation option identified as most feasible was selected for the following reasons: Tender execution by any party other than German authorities entails considerable uncertainties regarding legal and regulatory applicability and is unlikely to be publicly supported. Additionally, tender execution by German authorities is most closely aligned with ongoing procedures. It is therefore likely to be more efficient than aligning procedures for execution by other parties.

Regarding interdependencies, this barrier is interdependent with the following two barriers: "failure of developers to align planning across assets and countries" and "uncertainty about applicable RES subsidy scheme". Clarifying responsibility for location selection, site pre-investigation and tender execution helps to determine the OWF location, which thereby facilitates continuous dialogue and early-stage alignment. Furthermore, location selection, site pre-investigation and tender execution by and in accordance with the rules of German authorities fits the provision of a subsidy scheme by German authorities.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the COBRA Cable hybrid project, the following actions are required:

- Facilitate the development of the COBRA Cable hybrid project by agreeing that the responsibility for location selection, site pre-investigation and tender execution remains with the German authorities. Certainty on these three factors can be achieved by addressing this issue in the project-specific HANSA between the Netherlands, Germany and Denmark. The national ministries and other national authorities assume responsibility for this action (the MoEA (supported by the Dutch Ministry of Infrastructure and Water Management) and RVO in the Netherlands; the BMWi and BSH in Germany; and the MoEUC in Denmark).
- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the Netherlands, Germany and Denmark of costs and benefits deriving from the responsibility for location selection, site pre-investigation and tender execution. Certainty about the allocation of costs and benefits can be achieved by addressing this issue in the project-specific HANSA between the three countries. The national ministries and NRAs assume responsibility for this action (the MoEA and ACM in the Netherlands; the BMWi and BNetzA, supported by the Federal Environment Agency, in Germany; and the MoEUC and DUR in Denmark).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 73. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 67.

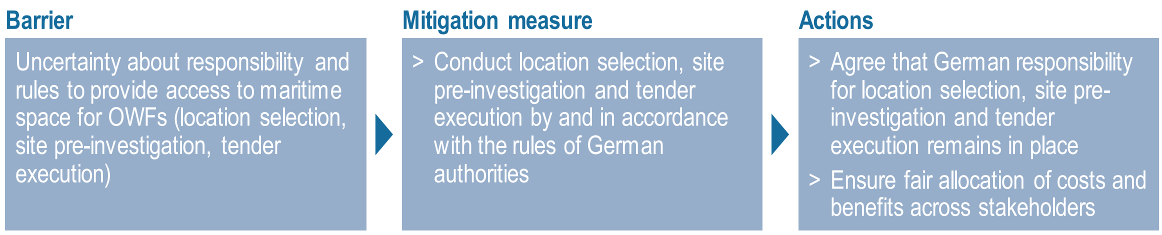

Figure 73: COBRA Cable barrier mitigation – Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution)

Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)

Project-specific barrier evaluation: A suitable tender design needs to be chosen for the COBRA Cable hybrid project. The OWF included in the project setup is located in the German EEZ and is linked to onshore connection points in the Netherlands and Denmark via the COBRA Cable interconnector. As this interconnector is scheduled to be commissioned in 2019.[190] the design of the OWF to be linked to the COBRA Cable at a later point must adapt to the interconnector’s operational and technical setup. Thus, the Netherlands, Germany and Denmark have an interest in defining the requirements for the OWF development in accordance with their respective standards. These may be contradictory. In addition, the tender design needs to ensure that tender candidates can realistically develop the OWF.

Barrier mitigation: The mitigation option identified as most feasible is to implement a tender design with strict requirements. These should be aligned between the Netherlands, Germany and Denmark and eliminate all hybrid-specific uncertainties for the OWF developer. This is based on consideration of the interdependencies shown in Table 4, interaction with project stakeholders (see Chapter 5.4.7) and the ease of implementation in terms of the required effort.

The other mitigation options considered in this study were (1) to have a strict tender design with requirements aligned among the stakeholders, (2) to have a strict tender design without hybrid-specific uncertainties for the OWF developer, and (3) to have a lenient tender design with requirements aligned among the stakeholders and without hybrid-specific uncertainties for the OWF developer.

The mitigation option identified as most feasible was selected for the following reasons: While aligned requirements potentially necessitate amendments to national legislation and regulations, the Netherlands, Germany and Denmark have valid interests in defining certain requirements for the tender of the OWF connected to the COBRA Cable interconnector. Aligned requirements also aid in ensuring the interoperability of the OWF with the other assets of the hybrid project. All of these factors increase the probability of successful hybrid project implementation. Furthermore, a tender design with strict requirements also increases the probability of successful project implementation, allowing for a possible decrease in the cost efficiency of the OWF development due to more limited competition. Lastly, certainty about hybrid-specific characteristics of the OWF development increases the probability of successful project implementation – and decreases the cost of implementation – by reducing the risk premium otherwise demanded by OWF developers in terms of subsidies.

Regarding interdependencies, this barrier is interdependent with the following three barriers: "uncertainty about regulation deriving from jurisdiction over cross-border cable systems"; the "failure of developers to align planning across assets and countries"; and "uncertainty about applicable RES subsidy scheme". Aligned regulation deriving from Dutch, German and Danish jurisdiction needs to be reflected in the requirements of the OWF tender. In addition, the OWF tender can include a German subsidy scheme aligned with the Netherlands and Denmark, involving statistical transfers between the three countries. Continuous dialogue and early-stage alignment facilitate an aligned tender design.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the COBRA Cable hybrid project, the following actions are required:

- Agree a tender design with strict requirements. Certainty about the tender design can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The national ministries, NRAs and other national authorities assume responsibility for this action (the MoEA, ACM and RVO in the Netherlands; the BMWi, BNetzA and BSH in Germany; and the MoEUC and DUR in Denmark).

[190] TenneT Holding B.V., Energinet. 2018. *COBRACable*. http://www.cobracable.eu/

- Agree tender requirements which take account of the valid interest of all three countries. In the Netherlands and Denmark, this means defining material requirements such as technical and operational standards in alignment with the specifics of the COBRA Cable interconnector. In Germany it means defining environmental standards. Like environmental standards, financial requirements do not need to be aligned across countries. Guidance from project-specific developers is required to inform the development of project-specific tender requirements. Certainty about tender requirements can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The national ministries, NRAs and other national authorities assume responsibility for this action (the MoEA, ACM and RVO in the Netherlands; the BMWi, BNetzA and BSH in Germany; and the MoEUC and DUR in Denmark).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 74. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 67.

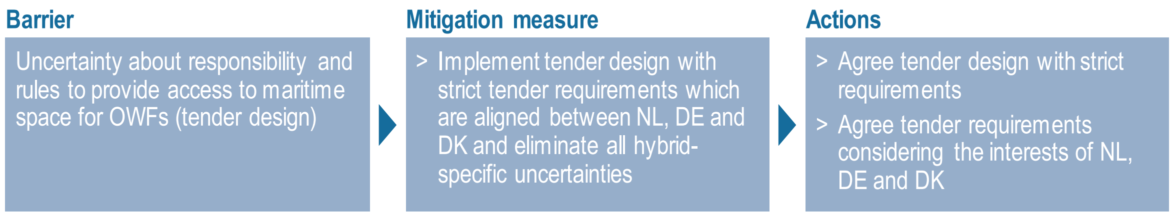

Figure 74: COBRA Cable barrier mitigation – Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)

Uncertainty about applicable RES subsidy scheme

Project-specific barrier evaluation: The OWF included in the COBRA Cable hybrid project is located in the German EEZ, which suggests a German RES subsidy scheme. However, the following schemes are also possible: a Dutch or Danish subsidy scheme, and a joint project or a joint support scheme between the Netherlands, Germany and Denmark. All are in line with EU Directive 2009/28/EC[191] on the promotion of the use of energy from RES. In summary, the applicability of a support scheme from one of the countries involved or in some joint form is to be determined.

Barrier mitigation: The mitigation option identified as most feasible is to apply the German RES subsidy scheme to the OWF in the hybrid project, potentially with statistical transfers between countries. This means the German government awards the OWF a premium tariff through the German tender process, potentially through a special additional tender round ("Sonderausschreibung").[192] This is based on consideration of the interdependencies shown in Table 4, interaction with project stakeholders (see Chapter 5.4.12) and the ease of implementation in terms of the required effort.

The other mitigation options considered in this study were (1) to apply a Dutch subsidy scheme, (2) to apply a Danish subsidy scheme, (3) to apply a joint project between the Netherlands, Germany and Denmark or (4) to apply no subsidy scheme.

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[191] European Parliament, European Council. 2009. *DIRECTIVE 2009/28/EC on the promotion of the use of energy from renewable sources.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

[192] CDU, CSU, SPD. 2018. *Koalitionsvertrag zwischen CDU, CSU und SPD.* https://www.cdu.de/system/tdf/media/dokumente/koalitionsvertrag_2018.pdf?file=1

The mitigation option identified as most feasible was selected for the following reasons: The legal feasibility of applying a Dutch or Danish subsidy scheme to the German OWF is not given. The feasibility of tendering the OWF without a subsidy scheme depends on the ability of OWF developers to obtain offtake securities such as power purchase agreements. Such agreements ensure the bankability of the OWF investment. Establishing a joint project between the Netherlands, Germany and Denmark is legally covered and provides the necessary bankability. But it might be problematic due to the extended timeline, which is needed to agree the specifications of the scheme and formulate the necessary legal agreements. In addition, the national regulations in the Netherlands, Germany and Denmark and the specifications of the COBRA Cable hybrid project render a joint support scheme difficult. The Netherlands require that the generated electricity must not be fed into the Dutch grid and that the electricity prices of the relevant area apply.[193] Additional requirements in Germany are the mutuality of the scheme, the possibility of physical transmission of electricity to Germany (or a similar effect on the German electricity market), plus an Intergovernmental Agreement (IGA) between the countries involved.[194] In Denmark, existing legislation only allows subsidies to be allocated to OWFs located in Danish territorial waters or the Danish EEZ. This is because tenders for OWF licences, on which financial support depends, are conducted only in these areas.[195] In addition, the requirements laid down in the EU Directive 2009/28/EC[196] must be fulfilled. Applying the German subsidy scheme to the OWF is potentially viable from a legal and regulatory perspective. Nonetheless, the date and duration of a special tender round are unknown and could potentially delay project development.

Regarding interdependencies, this barrier is interdependent with the following three barriers: "uncertainty about market arrangements"; "uncertainty about hybrid cable system classification"; and "uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution and tender design)". A new dedicated bidding zone for the hybrid OWF is accompanied by defining the cable systems as interconnectors linking the new bidding zone to shore. The market price established in the new bidding zone affects the business case of the OWF included in the hybrid project and thereby the level of required RES subsidies. Furthermore, applying a German subsidy, potentially involving statistical transfers between the three countries to the OWF fits with location selection, site pre-investigation and tender execution by and in accordance with the rules of German authorities. It also fits with a tender design with aligned, strict requirements.

<u>Actions and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the COBRA Cable hybrid project, the following actions are required:

- Clarify the possibility and the dates for a special tender round ("Sonderaussschreibung") in Germany to allow for a timely award of the subsidy scheme to the OWF. This can be achieved through voluntary cooperation between the BMWi, the BNetzA and BSH in Germany.
- Ensure that the envisaged mitigation of assigning a German subsidy scheme to the OWF included in the hybrid project complies with German law. German subsidy schemes have regular

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[193] Dutch Besluit stimulering duurzame energieproductie 2007. §5a Article 55b. https://wetten.overheid.nl/BWBR0022735/2017-04-01#Paragraaf5a_Artikel55b

[194] German Erneuerbare-Energien-Gesetz 2017 (EEG 2017). § 5 (3). https://www.gesetze-im-internet.de/eeg_2014/__8.html

[195] Danish Bekendtgørelse af lov om fremme af vedvarende energi. § 22, § 23 and §37. https://www.retsinformation.dk/Forms/R0710.aspx?id=203053

[196] European Parliament, European Council. 2009. *DIRECTIVE 2009/28/EC on the promotion of the use of energy from renewable sources.* Article 11. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

characteristics in terms of type, level and duration of support as well as technology coverage. Clarify whether statistical transfers to the renewable energy target of Germany based on the electricity generated by the OWF in the hybrid project – which commercially and physically feeds electricity into the Dutch or Danish market – are required to access the German subsidy scheme. This assumes that the electricity physically flowing into the Dutch or Danish market has a similar effect on the German market as if the electricity would be physically flowing into the German market. Pay particular attention to the stipulations laid down in the Renewable Energy Sources Act (EEG) §5 (3)[197], i.e. with regard to the mutuality of the scheme and the possible coverage of the scheme in an IGA. This can be achieved through voluntary engagement of the BMWi and the BNetzA in Germany.

- It may be that statistical transfers to Germany are required but are not sufficient to allow for the applicability of the German RES subsidy scheme to the OWF in the hybrid project. If so, assess the implications of the required onshore grid reinforcements to allow for the physical transmission of electricity from the Netherlands or Denmark to Germany. This action could be achieved through voluntary cooperation between TenneT TSO B.V., TenneT TSO GmbH and Energinet.
- Otherwise, adjust German regulations, particularly the Renewable Energy Sources Act (EEG) §5 (3), to ensure that statistical transfers to Germany are sufficient for applying the German RES subsidy scheme to the OWF in the hybrid project. Guidance from project-specific developers is required to inform the adjustment of German regulation. Certainty about German regulation can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The BMWi and BNetzA in Germany would assume responsibility for this action.
- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the Netherlands, Germany and Denmark of costs and benefits deriving from the RES subsidy scheme. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the three countries. The OWF developer, national ministries and NRAs assume responsibility for this action (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 75. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 67.

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[197] German Erneuerbare-Energien-Gesetz 2017 (EEG 2017). § 5 (3). https://www.gesetze-im-internet.de/eeg_2014/__8.html

Barrier	Mitigation measure	Actions
Uncertainty about applicable RES subsidy scheme	> Apply German subsidy scheme to OWF included in hybrid project	> Clarify possibility and dates for special tender round in DE > Ensure compatibility of envisaged mitigation option with DE law > If required, assess implications of onshore grid reinforcement > Otherwise, adjust DE regulation > Ensure fair allocation of costs and benefits across stakeholders

Figure 75: COBRA Cable barrier mitigation – Uncertainty about applicable RES subsidy scheme

Limited engagement of public stakeholders

Project-specific barrier evaluation: The support of public stakeholders is needed for the successful implementation of the COBRA Cable hybrid project as regulatory and technical barriers must be overcome and financial support provided across three countries, namely, the Netherlands, Germany and Denmark.

Barrier mitigation: The mitigation option identified as most feasible is to formalise public commitment in the form of a project-specific MoU or a project-specific HANSA. Feasibility studies and scoping studies for early-stage alignment through public funding, for example, should also be facilitated. Furthermore, adequate de-risking of the hybrid project is required. This is based on consideration of the interdependencies shown in Table 4, interaction with project stakeholders (see Chapter 5.4.13) and the ease of implementation in terms of the required effort.

Besides formalising public commitment in the form of a project-specific MoU or a project-specific HANSA and facilitating feasibility studies and scoping studies or providing financial guarantees, no other mitigation option was considered.

Regarding interdependencies, this barrier is interdependent with the "failure of developers to align planning across assets and countries" barrier. Continuous dialogue and early-stage alignment between the project developers is facilitated by formalising the commitment of relevant stakeholders of the hybrid project and / or by providing public funding for early-stage activities. These may include feasibility studies, scoping studies and technical research and development.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the COBRA Cable hybrid project, the following actions are required:

- Align and implement the type of formalisation of public commitment to allow for the development of the COBRA Cable hybrid project. The formalisation of commitment in the form of a project-specific MoU or a project-specific HANSA is an expression of the goodwill of the stakeholders to support hybrid project development. It assures project developers of public support, e.g. in the form of dialogue with relevant government bodies. In early project stages, a project-specific MoU provides sufficient certainty for project developers. The stakeholders assuming responsibility are TenneT TSO B.V., TenneT TSO GmbH, Energinet and the national ministries and NRAs (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark). They also include the European Commission. In later project stages, a project-specific HANSA is required to provide project developers with sufficient legal certainty. The stakeholders assuming responsibility include the national ministries (the MoEA in the Netherlands, the BMWi in Germany and the MoEUC in Denmark) and the European Commission.
- Catalyse the development of the COBRA Cable hybrid project by supporting the early-stage alignment among developers. Do this through public funding for feasibility studies, pilot projects

and R&D for innovative, technological solutions in addition to existing offshore support schemes. Such public support allows developers to firmly commit to the development of the project. This can be achieved through voluntary cooperation between the national ministries (the MoEA in the Netherlands, the BMWi in Germany and the MoEUC in Denmark) and the European Commission.

- Support the de-risking of the hybrid project by providing financial guarantees. Such guarantees can reassure project developers in situations which cannot be foreseen due to the pilot character of the hybrid project. This can be achieved through voluntary cooperation between the TSOs (TenneT TSO B.V., TenneT TSO GmbH and Energinet) and the European Commission.
- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the Netherlands, Germany and Denmark of costs and benefits deriving from the engagement of public stakeholders. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the three countries. The national ministries and NRAs assume responsibility for this action. (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 76. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 67.

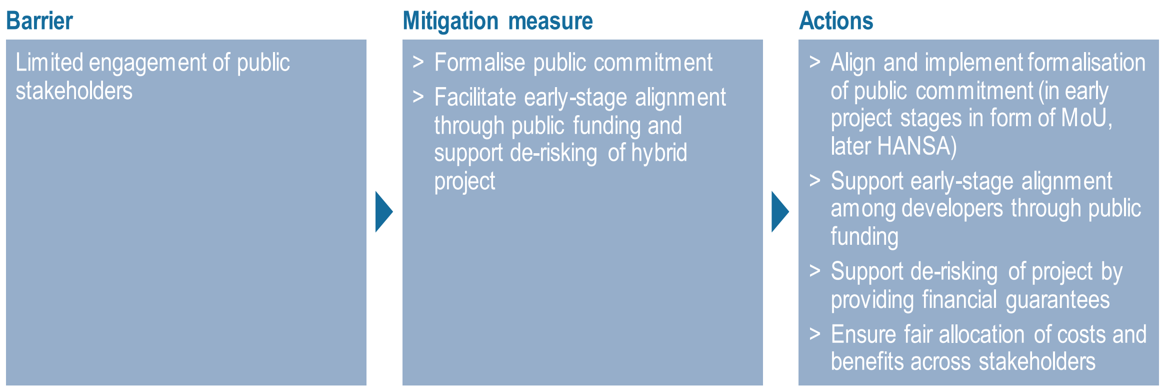

Figure 76: COBRA Cable barrier mitigation – Limited engagement of public stakeholders

Disproportionate allocation of costs and benefits across involved stakeholders

Project-specific barrier evaluation: Agreeing on the allocation of costs and benefits in the COBRA Cable hybrid project is complex. The OWF site is geographically located in the German EEZ, whereas the onshore grid connection points are in the Netherlands and Denmark. Certain costs and benefits are initially incurred by Germany and certain costs and benefits are initially incurred by the Netherlands and Denmark due to the technical setup and the details of the hybrid project. In addition, the measures adopted to mitigate other barriers assign costs or distribute benefits to the Netherlands, Germany and Denmark. Furthermore, developers may realise additional benefits. Thus, costs and benefits are generally not distributed fairly, and no suitable approach exists to reallocate the costs and benefits across all stakeholders of the hybrid project.

Barrier mitigation: The mitigation option identified as most feasible is to reallocate costs and benefits deriving from the hybrid project where required, based on a project-specific process. In some respects, the process can be based on the existing methodology given by the Cross-Border Cost

Allocations (CBCA) process.[198] It builds on the Cost Benefit Analysis (CBA) conducted by ENTSO-E[199] for Projects of Common Interest. In the CBCA process, benefits such as socio-economic welfare and CO_2 emissions are calculated on a national level to compensate net losers for the implementation of a project through a CBCA decision. The CBCA process provides a good starting point for the reallocation of costs and benefits across countries but is best suited for evaluating cross-border electricity interconnectors. This is based on consideration of the interdependencies shown in Table 4, interaction with project stakeholders (see Chapter 5.4.15) and the ease of implementation in terms of the required effort.

Besides implementing the process resulting in the reallocation of costs and benefits deriving from the implementation of the hybrid project, no other mitigation option was considered.

Regarding interdependencies, this barrier is interdependent with the following six barriers: "uncertainty about responsibility for project development (grid connection responsibility)"; "uncertainty about market arrangements"; "uncertainty about hybrid cable system classification"; "uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution)"; "uncertainty about applicable RES subsidy scheme"; and the "limited engagement of public stakeholders". Reallocation also relates to those barriers. This is because their mitigation translates into costs and benefits for specific stakeholders that might have to be reallocated together with all other costs and benefits of the project. Therefore, the costs and benefits deriving from all six interdependent barriers must be considered.

<u>Actions and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the COBRA Cable hybrid project, the following actions are required:

- Identify relevant cost and benefit categories between the involved stakeholders, covering all significant aspects of the hybrid project. This can be achieved through voluntary cooperation between TSOs (TenneT TSO B.V. in the Netherlands, TenneT TSO GmbH in Germany and Energinet in Denmark) as well as national ministries and NRAs (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark).
- Ensure that due consideration is given to all costs and benefits deriving from measures adopted to mitigate the following barriers: "uncertainty about responsibility for project development"; "uncertainty about market arrangement"; "uncertainty about hybrid cable system classification"; "uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution)"; "uncertainty about applicable RES subsidy scheme"; and the "limited engagement of public stakeholders". This can be achieved through voluntary cooperation between all stakeholders involved in the individual barrier mitigations.
- Determine the initial allocation of costs and benefits, covering the cost and benefit categories across all significant aspects of the hybrid project identified in the first step. In this process, developers typically conduct the assessment of costs and benefits, while NRAs oversee and validate results. Thus, this can be achieved through voluntary cooperation between OWF

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[198] ACER. 2015. *Recommendation No 5/2015 on good practices for the treatment of the investment requests, including CBCA requests, for electricity and gas PCIs.* https://acer.europa.eu/Official_documents/Acts_of_the_Agency/Recommendations/ACER%20Recommendation%2005-2015.pdf

[199] ENTSO-E. 2018. *2nd ENTSO-E Guideline: For Cost Benefit Analysis of Grid Development Projects.* https://tyndp.entsoe.eu/Documents/TYNDP%20documents/Cost%20Benefit%20Analysis/2018-10-11-tyndp-cba-20.pdf

developer, TenneT TSO B.V. in the Netherlands, TenneT TSO GmbH in Germany and Energinet in Denmark, as well as national ministries and NRAs (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark).

- Align and agree a suitable reallocation of costs and benefits between developers, the Netherlands, Germany and Denmark. This should be based on the identification of cost and benefit categories among stakeholders as well as the assessment of the initial allocation of costs and benefits across the identified categories. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands, Germany and Denmark. The OWF developer, TenneT TSO B.V. in the Netherlands, TenneT TSO GmbH in Germany and Energinet in Denmark, and national ministries and NRAs (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark) assume responsibility for this action, as well as the European Commission.
- Validate the availability of CEF funding to ensure adequate incentivisation for all relevant stakeholders if the following applies: the COBRA Cable hybrid project is a PCI and adds socio-economic value, but the initial allocation of costs and benefits is not sufficiently balanced to incentivise all countries and stakeholders to implement the hybrid project. While CEF funding cannot resolve viability issues of projects, it is a last resort for PCIs that have received a CBCA decision but are still not commercially viable for each individual stakeholder.[200] This can be achieved through voluntary cooperation between TSOs (TenneT TSO B.V. in the Netherlands, TenneT TSO GmbH in Germany and Energinet in Denmark) and NRAs (ACM in the Netherlands, BNetzA in Germany and DUR in Denmark) as well as the European Commission.

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 77. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 67.

Figure 77: COBRA Cable barrier mitigation – Disproportionate allocation of costs and benefit across involved stakeholders

4.9 CGS DE OWF to NL OWF

The hybrid project idea "CGS DE OWF to NL OWF" is a combined grid solution concept. In the project, a Dutch OWF in the extreme eastern part of the Dutch EEZ and a German OWF in the extreme western part of the German EEZ are connected, via the offshore substations of their export cable systems, by an interconnector. Both OWFs have radial connections to their respective home markets.

[200] European Parliament, European Council. 2013. *REGULATION (EU) No. 347/2013 on guidelines for trans-European energy infrastructure.* Article 14. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0347&from=en

However, the idea shows additional lifetime costs compared to the reference case, in which the OWFs are radially connected to their respective national markets only. Thus, the CGS DE OWF to NL OWF hybrid project is given no detailed further consideration in the scope of this study.

4.9.1 Details of the hybrid project and reference case

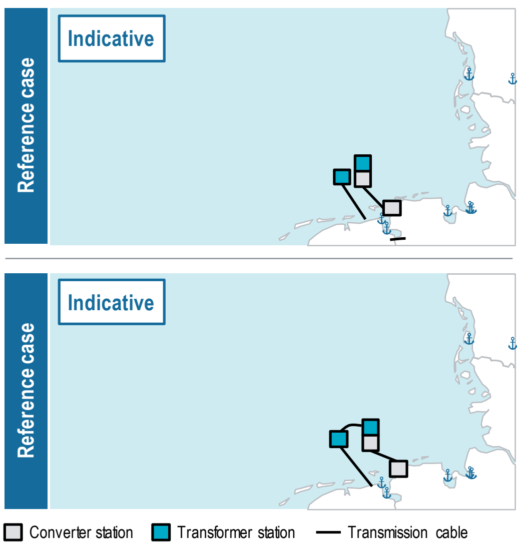
The individual assets included in the hybrid project and in the reference case are modelled on the basis of real assets. But the assumed characteristics do not claim to represent the actual characteristics of the assets included in either ongoing or future developments.

In the reference case (Figure 78), the interconnector is a stand-alone, point-to-point onshore interconnector between the Netherlands and Germany. It is constructed based on HVAC technology with 700 MW nominal capacity and a length of 10 km. The OWFs included in the project idea are an OWF in the eastern area of the Dutch EEZ (e.g. the recently announced Ten noorden van de Waddeneilanden Zoekgebieden development area) and an OWF in the western part of the German EEZ. Each has a nominal generation capacity of 700 MW. The Dutch OWF is radially connected to the Dutch market with a 70 km HVAC export cable system. The German OWF is radially connected to the German market with an 80 km HVDC system. No intermediate offshore transformers are required, as the wind turbines can be connected directly to the high-voltage offshore transformers via the 66-kV array cable systems. Both export cable systems have a nominal capacity of 700 MW.

In the hybrid project (Figure 78), the interconnector is a point-to-point offshore interconnector between the offshore transformer station of the export cable system of the Dutch OWF and the offshore transformer station of the export cable system of the German OWF. It is constructed to the same specifications as in the reference case. However, the length of the interconnector is 40 km. The OWFs and their export cable system have the same specifications as in the reference case.

For all cable systems, onshore transformer stations are not in the scope of the assessment. Furthermore, onshore grid reinforcement costs are not in the scope of this assessment. But it is important that they are considered before project development would be initiated.

Geographical mapping



	Reference case	Hybrid case	Difference
Nominal capacity interconnector [MW]			
	700	700	0
Length interconnector [km]			
	10	40	30
Nominal capacity OWF [MW]			
	1,400 (2 x 700)	1,400 (2 x 700)	0
Length export cable [km]			
	150 (70 + 80)	150 (70 + 80)	0
Offshore transformer / converter / switching stations			
	2 / 1 / 0	2 / 1 / 0	0
Onshore transformer / converter stations			
	0 / 1	0 / 1	0

Figure 78: CGS DE OWF to NL OWF – Reference case and hybrid project profile

It is generally assumed that the development, construction and commissioning of the individual assets (two OWFs, two export cable systems and interconnector) can be aligned in the hybrid project to prevent temporarily stranded assets. It is assumed that the OWFs, export cable systems and interconnector will be commissioned in 2028, both in the hybrid project and in the reference case.

In general, this hybrid project idea and all development areas and stakeholders are included as examples only, as the assessment was conducted without comprehensive interaction with specific project stakeholders.

4.9.2 Evaluation of hybrid project vs. reference case

To evaluate the hybrid project against the reference case, this study calculates the lifetime savings of the hybrid project. These include the difference in cost between the hybrid project and the reference case. The cost assessment – looking at CAPEX and OPEX – is based on the technical setup of the hybrid project and the reference case, as described in the project details. Market modelling was not conducted for this project.

Assuming a typical asset lifetime of 25 years, the hybrid project yields additional lifetime cost of about EUR 60 m compared to the reference case (Figure 79). The additional lifetime costs are driven entirely by an increase in CAPEX and OPEX. OPEX are calculated and discounted over a 25-year period.

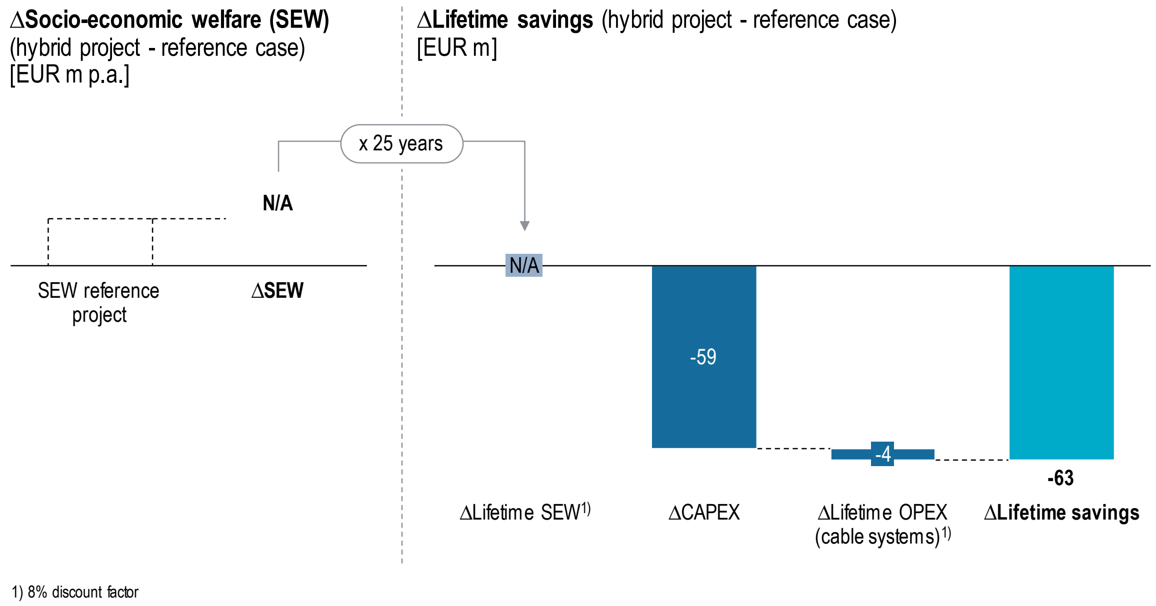


Figure 79: CGS DE OWF to NL OWF – Assessment results

The increase in CAPEX and OPEX is driven by the interconnector only. The cost of the interconnector is higher in the hybrid project than in the reference case. The interconnector requires more kilometres of cable in the hybrid project compared to the reference case, as the onshore interconnector can be built with a comparatively short cable. In addition, the hybrid setup requires the use of disconnector modules. The cost of the OWFs and its export cable systems are the same in the hybrid project and in the reference case.

4.9.3 Development of an Action Plan to overcome barriers

As the hybrid project presents no advantage over the reference case, no project-specific barriers, barrier mitigation measures or Action Plans were assessed or developed.

4.10 DE OWF to NL

The hybrid project idea "DE OWF to NL" is a neighbour OWF concept. In the project, a German OWF is radially connected to the Netherlands only. The idea shows lifetime savings compared to the reference case, in which the OWF is connected to Germany. Thus, the DE OWF to NL hybrid project is given further consideration in the scope of this study and an Action Plan for the implementation of barrier mitigation measures is developed. The Action Plan is intended to be used as a tool by stakeholders once the DE OWF to NL hybrid project has been given the go-ahead.

4.10.1 Details of the hybrid project and reference case

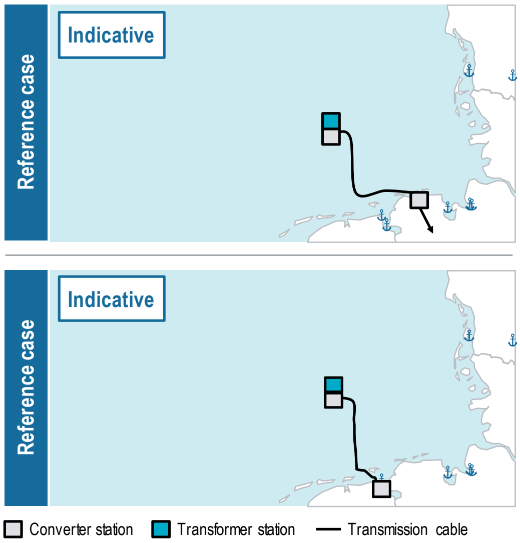
The individual assets included in the hybrid project and in the reference case are modelled on the basis of real assets. But the assumed characteristics do not claim to represent the actual characteristics of the assets included in either ongoing or future developments.

In the reference case (Figure 80), the OWF included in the project idea is located in a German Cluster adjacent to the Dutch EEZ. It has a nominal generation capacity of 1,200 MW. The OWF is radially connected to Germany with a 260 km HVDC export cable system. No intermediate offshore transformers are required, as the wind turbines can be connected directly to the high-voltage offshore transformer via the 66-kV array cable system. The export cable system has a nominal capacity of 1,200 MW.

In the hybrid project (Figure 80), the OWF has the same location and specifications as in the reference case. However, the OWF is radially connected to the Netherlands with a 145 km HVDC export cable system, which is otherwise constructed to the same specifications as in the reference case.

For all cable systems, onshore transformer stations are not in the scope of the assessment. Furthermore, onshore grid reinforcement costs are not in the scope of this assessment. But it is important that they are considered before project development would be initiated. In the DE OWF to NL hybrid project, onshore grid reinforcements are required in both the hybrid project and the reference case. This is because the connection of the OWF translates into the need for an onshore grid connection point in either the Netherlands or Germany.

Geographical mapping



	Reference case	Hybrid case	Difference
Nominal capacity interconnector [MW]			
	0	0	0
Length interconnector [km]			
	0	0	0
Nominal capacity OWF [MW]			
	1,200	1,200	0
Length export cable [km]			
	260	145	- 115
Offshore transformer / converter / switching stations			
	1 / 1 / 0	1 / 1 / 0	0
Onshore transformer / converter stations			
	0 / 1	0 / 1	0

Figure 80: DE OWF to NL – Reference case and hybrid project profile

It is generally assumed that the development, construction and commissioning of the individual assets (OWF and export cable system) can be aligned in the hybrid project to prevent temporarily stranded assets. It is assumed that the OWF and export cable system will be commissioned before 2030, both in the hybrid project and in the reference case.

4.10.2 Evaluation of hybrid project vs. reference case

To evaluate the hybrid project against the reference case, this study calculates the lifetime savings of the hybrid project. These include the difference in cost and the difference in socio-economic welfare (SEW) between the hybrid project and the reference case. Both the cost assessment – looking at CAPEX and OPEX – and the market modelling-based SEW assessment are based on the technical setup of the hybrid project and the reference case, as described in the project details. Additional indicators used in the assessment are energy not served, RES curtailment and CO_2 emissions. CO_2 emissions are internalised as cost in the SEW.

Assuming a typical asset lifetime of 25 years, the hybrid project yields lifetime savings of about EUR 260 m compared to the reference case (Figure 81). The lifetime savings are driven entirely by a reduction in CAPEX and OPEX of about EUR 300 m. OPEX are calculated and discounted over a 25-year period. However, a lower hybrid project SEW of EUR 3 m p.a. compared to the reference case translates into additional cost from lifetime SEW of about EUR 40 m, discounted over 25 years. However, as the above-mentioned cost savings significantly exceed these additional costs, the lifetime savings remain positive. The small difference in SEW is spread over the entire European electricity system. It is originally driven by the shift in low-margin cost power generation from Germany to the Netherlands in consequence of the connection of the OWF to the Netherlands in the hybrid project.

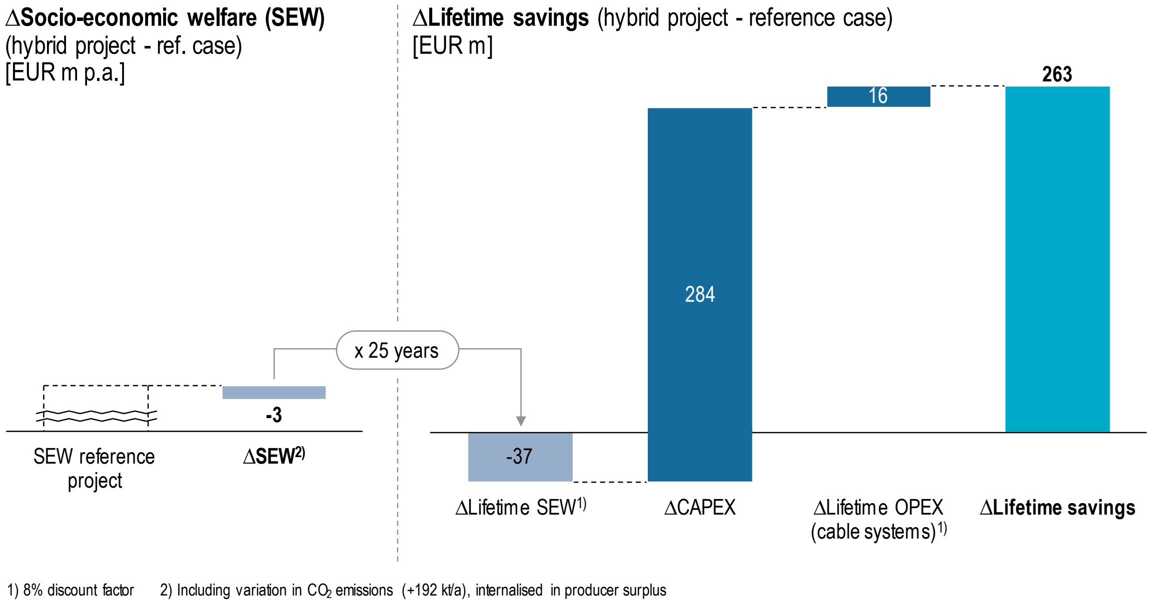


Figure 81: DE OWF to NL – Assessment results[201]

Regarding the cost assessment, the result is driven by the export cable system. The cost of the export cable system is lower in the hybrid project than in the reference case. This is because 115 kilometres of export cable system are rendered redundant in the hybrid project compared to the reference case, lowering CAPEX and OPEX for the export cable system. This difference is slightly reduced by more expensive power losses in the hybrid project (OWF connected to the Netherlands) compared to the reference case (OWF connected to Germany). These are due to higher electricity prices in the Netherlands than in Germany.

In both the hybrid project and the reference case, energy not served is zero due to the comprehensive nature of and redundancies in the European electricity system. Therefore, neither setup adversely affects the EU's energy policy target of energy security. Compared to the reference case, the effect of the hybrid project on curtailment and CO_2 emissions is very small.[202] This suggests that the hybrid project is unlikely to have a significant impact on the EU's energy policy targets on the further establishment of the internal energy market and the decarbonisation of the economy.

4.10.3 Development of an Action Plan to overcome barriers

This chapter summarises the findings specific to the development of the DE OWF to NL hybrid project. It builds on the general explanation of the barriers in Chapter 3.2, the general explanation of the interdependencies between barriers in Chapter 3.3 and the findings of project-specific discussions of the barriers and mitigation options in Chapter 5.5.

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[201] SEW assessment based on Careri, Francesco. [Forthcoming]. *The impact of North Sea electricity projects in a 2030 scenario: Preliminary assessment of system benefits for the pan-European power system through METIS.* Petten: European Commission Joint Research Centre.

[202] The hybrid project results in less curtailment of 875 MWh/a and additional CO_2 emissions of 192 kt/a (internalised in socio-economic welfare). For more details, please refer to Careri, Francesco. [Forthcoming]. *The impact of North Sea electricity projects in a 2030 scenario: Preliminary assessment of system benefits for the pan-European power system through METIS.* Petten: European Commission Joint Research Centre.

This study notes that 9 of the 16 identified barriers need to be overcome to allow for the commencement of the DE OWF to NL hybrid project development. Although the barriers are addressed individually, interdependencies exist between them. When developing ways to mitigate one barrier, it is therefore necessary to also consider the mitigation of other barriers. Table 5 provides an overview of the project-specific barriers and barrier mitigation measures, as well as a brief description of the interdependencies to be considered in the development of the individual barrier mitigation measures.

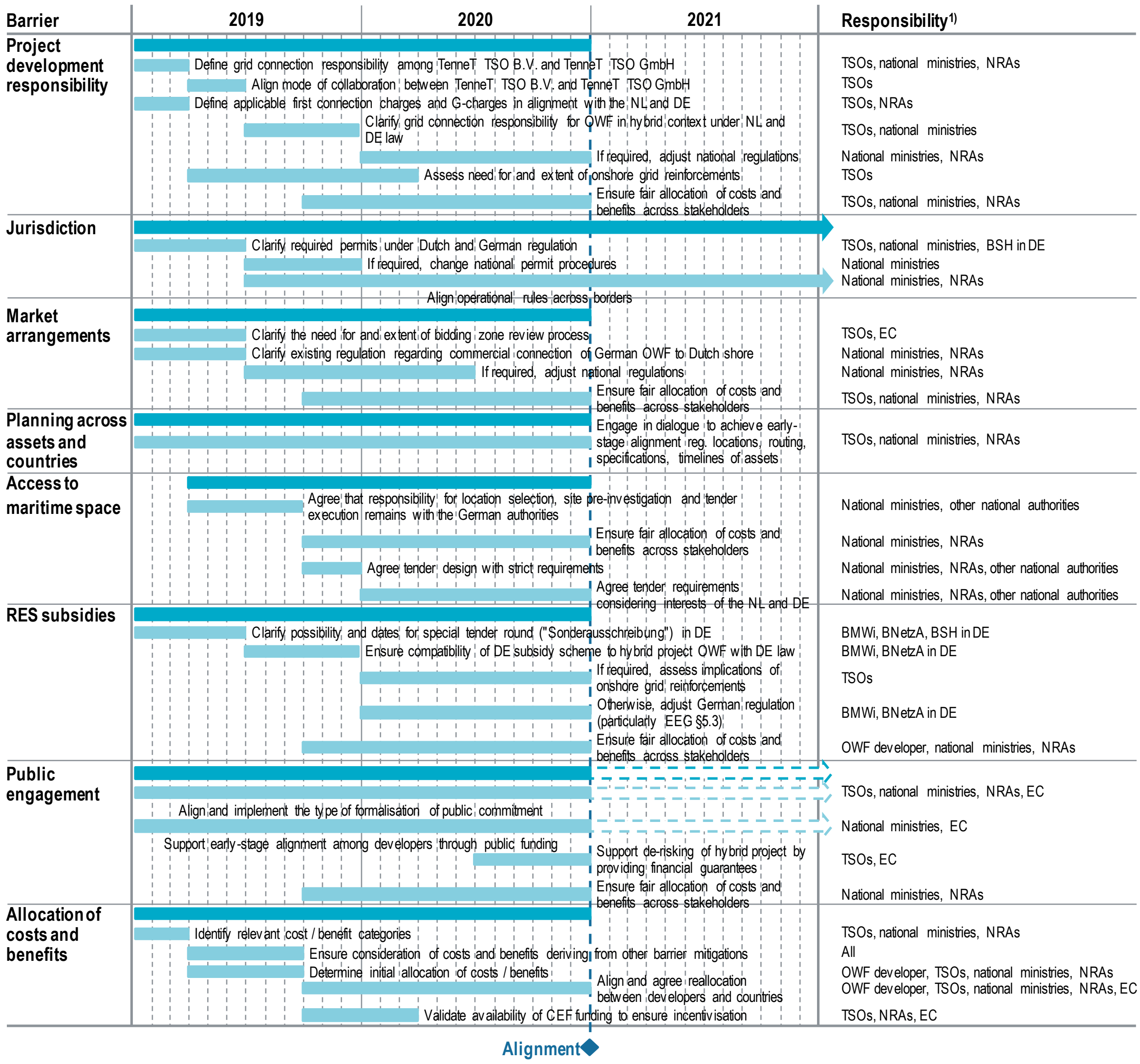
Barrier	Mitigation measure	Interdependencies
Uncertainty about responsibility for project development	Assign responsibility for grid connection to either TenneT TSO B.V. or TenneT TSO GmbH, each in close collaboration with the other entity	▪ Failure of developers to align planning across assets and countries: clearly assigning grid connection responsibility facilitates continuous dialogue and early-stage alignment
Uncertainty about regulation deriving from jurisdiction over cross-border cable systems	Obtain all required permits and align regulation deriving from concurrent jurisdiction over cross-border cable systems	▪ Failure of developers to align planning across assets and countries: obtaining all required permits and aligning regulation is facilitated by continuous dialogue and early-stage alignment ▪ Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design): aligned regulation of relevance to the OWF needs to be reflected in the tender design
Uncertainty about market arrangements	Allow for commercial flows from the OWF included in the hybrid project to the Dutch bidding zone only	▪ Uncertainty about applicable RES subsidy scheme: commercial flows from the OWF to the Dutch bidding zone affect the business case of the OWF and thereby possibly the level of required subsidies
Failure of developers to align planning across assets and countries	Facilitate continuous dialogue and early-stage alignment between the project developers	▪ Uncertainty about responsibility for project development: continuous dialogue and early-stage alignment facilitates clearly assigning grid connection responsibility ▪ Uncertainty about regulation deriving from jurisdiction over cross-border cable systems: continuous dialogue and early-stage alignment facilitates obtaining all required permits and aligning regulation ▪ Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution and tender design):

Barrier	Mitigation measure	Interdependencies
		continuous dialogue and early-stage alignment are facilitated by an aligned OWF location ▪ Limited engagement of public stakeholders: continuous dialogue and early-stage alignment are facilitated by formalising public commitment and public funding for feasibility studies, R&D etc.
Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution)	Conduct location selection, site pre-investigation and tender execution by and in accordance with the rules of German authorities	▪ Failure of developers to align planning across assets and countries: location selection, site pre-investigation and tender execution by and in accordance with the rules of German authorities provides clarity on OWF location ▪ Uncertainty about the applicable RES subsidy scheme: location selection, site pre-investigation and tender execution by and in accordance with the rules of German authorities fits provision of a subsidy scheme by German authorities
Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)	Implement a tender design with strict requirements which are aligned between the Netherlands and Germany	▪ Uncertainty about regulation deriving from jurisdiction over cross-border cable systems: tender design needs to reflect aligned regulation relevant for the OWF ▪ Failure of developers to align planning across assets and countries: aligned tender design is facilitated by continuous dialogue and early-stage alignment ▪ Uncertainty about applicable RES subsidy scheme: a tender with aligned, strict requirements includes a German subsidy scheme aligned with the Netherlands
Uncertainty about applicable RES subsidy scheme	Apply the German RES subsidy scheme to the OWF included in the hybrid project, with statistical transfers between countries	▪ Uncertainty about market arrangement: the business case of the OWF and thereby possibly the level of required subsidies are affected by commercial flows from the OWF to the Dutch bidding zone only ▪ Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution and tender design): applying a German subsidy scheme aligned with the Netherlands fits location selection,

Barrier	Mitigation measure	Interdependencies
		site pre-investigation, tender execution and tender design by and in accordance with the rules of German authorities
Limited engagement of public stakeholders	Formalise public commitment in the form of a project-specific MoU or HANSA. Also, facilitate feasibility studies and scoping studies for early-stage alignment through public funding, for example	▪ Failure of developers to align planning across assets and countries: formalising public commitment and public funding for feasibility studies, R&D etc. is facilitated by continuous dialogue and early-stage alignment
Disproportionate allocation of costs and benefits across involved stakeholders	Reallocate costs and benefits deriving from the hybrid project where required, based on a project-specific process	▪ Uncertainty about responsibility for project development (grid connection responsibility): costs and benefits deriving from mitigation to be considered, including onshore grid reinforcement cost ▪ Uncertainty about market arrangements: costs and benefits deriving from mitigation to be considered ▪ Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution): costs deriving from mitigation to be considered ▪ Uncertainty about applicable RES subsidy scheme: costs and benefits deriving from mitigation to be considered ▪ Limited engagement of public stakeholders: costs and benefits deriving from mitigation to be considered

Table 5: DE OWF to NL – Barriers, barrier mitigations and interdependencies

Combining all the measures needed to mitigate the barriers of relevance to the DE OWF to NL hybrid project creates an Action Plan that supports the commencement of the development. In addition to placing the required actions on a timeline, the Action Plan further details the stakeholders responsible for each of the actions (Figure 82). The Action Plan is intended to be used as a tool by stakeholders once the DE OWF to NL hybrid project has received the go-ahead.



1) Responsible stakeholders are OWF developer: tbd; TSOs: TenneT TSO B.V. in the NL and TenneT TSO GmbH in DE; Ministries: MoEA in the NL and BMWi in DE; NRAs: ACM in the NL and BNetzA in DE; Other national authorities: RVO in the NL, BSH in DE

Figure 82: DE OWF to NL – Action Plan

The barriers and mitigation measures specific to the DE OWF to NL hybrid project and the actions required for the implementation of the identified mitigation measures are explained in more detail in the subchapters below. As part of the work on barrier mitigation, a project-specific Memorandum of Understanding (MoU) or a project-specific Hybrid Asset Network Support Agreement (HANSA) were considered. Both types of formal commitment to address barriers can include all actions for mitigation measures of relevance to the DE OWF to NL hybrid project. Thus, it can be sufficient to set up only one type.

Uncertainty about responsibility for project development

Project-specific barrier evaluation: The definition of responsibility for the grid connection of the OWF will determines who is responsible for the development of the DE OWF to NL hybrid project.

Defining the party responsible for grid connection is complex. This is because the potential OWF site is in the German EEZ, where TenneT TSO GmbH is generally responsible for the grid connection based on German law[203] (assuming an onshore connection point in the area where TenneT TSO GmbH would be responsible). But the onshore grid connection point is in the Netherlands, where TenneT TSO B.V. is generally responsible for the grid connection based on Dutch law.[204] Thus, for this specific hybrid project setup, no suitable definition of grid connection responsibility exists.

Barrier mitigation: The mitigation option identified as most feasible is to assign responsibility for grid connection to either TenneT TSO B.V. or TenneT TSO GmbH, each in close collaboration with the other entity. This is based on consideration of the interdependencies shown in Table 5, interaction with project stakeholders (see Chapter 5.5.1) and the ease of implementation in terms of the required effort.

The other mitigation option considered in this study was to make TenneT TSO B.V. and TenneT TSO GmbH jointly responsible for the grid connection of the OWF to the Dutch market.

The mitigation option identified as most feasible was selected for the following reasons: The allocation of responsibility for grid connection to either TenneT TSO B.V. or to TenneT TSO GmbH, or jointly to TenneT TSO B.V. and TenneT TSO GmbH, still requires clarification regarding legal and regulatory coverage. However, in the case of joint responsibility, operational feasibility depends heavily on efficient cooperation between TenneT TSO B.V. and TenneT TSO GmbH. In addition, TenneT TSO B.V. benefits from general and project-specific knowledge regarding grid connection requirements.

Irrespective of which mitigation option is selected, this barrier is interdependent with the "failure of developers to align planning across assets and countries" barrier. Clearly defining responsibility for the grid connection requires continuous dialogue and early-stage alignment on the hybrid project setup among the defined project promoters. Clearly defined responsibilities and continuous dialogue and alignment, in turn, allow for the commencement of project development.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the DE OWF to NL hybrid project, the following actions are required:

- Define responsibility for grid connection among TenneT TSO B.V. and TenneT TSO GmbH. Certainty about grid connection responsibility can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands and Germany. The TSOs (TenneT TSO B.V. and TenneT TSO GmbH), as well as national ministries and NRAs (the MoEA and ACM in the Netherlands, and the BMWi and BNetzA in Germany) assume responsibility for this action.
- Agree a mode of collaboration between TenneT TSO B.V. and TenneT TSO GmbH. This action can be achieved through voluntary cooperation between TenneT TSO GmbH and TenneT TSO B.V.
- Define the applicable first connection charges and G-charges in alignment between the Netherlands (shallow first connection charges and no G-charges) and Germany (shallow to super-shallow first connection charges and no G-charges).[205] This action can be achieved

[203] If the onshore connection point is located in the area of responsibility of Amprion in the reference case, then Amprion would be responsible for the listed actions instead of TenneT TSO GmbH (German Erneuerbare-Energien-Gesetz 2017 (EEG 2017). § 8. https://www.gesetze-im-internet.de/eeg_2014/__8.html).

[204] Dutch Elektriciteitswet 1998. §4 Article 24Aa. https://wetten.overheid.nl/BWBR0009755/2018-07-28#Hoofdstuk3_Paragraaf4_Artikel24Aa

[205] ENTSO-E. 2018. *Overview of transmission tariffs in Europe: Synthesis 2018.* https://docstore.entsoe.eu/Documents/MC%20documents/TTO_Synthesis_2018.pdf;
The European Wind Energy Association. 2016. *Position paper on network tariffs and grid*

through voluntary cooperation between TenneT TSO B.V. and TenneT TSO GmbH, as well as the NRAs (ACM in the Netherlands and BNetzA in Germany).

- Ensure compatibility with existing regulations by clarifying who is responsible for grid connection for the OWF between the TSOs under Dutch and German law.[206] This can be achieved through voluntary cooperation between TenneT TSO B.V., TenneT TSO GmbH and the national ministries (the MoEA in the Netherlands, and the BMWi in Germany).
- If required, adjust Dutch and German regulations to allow grid connection responsibility to be assigned to either TenneT TSO B.V. or TenneT TSO GmbH. This is despite the fact that the OWF site and the onshore connection point are not located in the same country. Guidance from project-specific developers is required to inform the adjustment of Dutch and German regulation. Certainty about Dutch and German regulations can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands and Germany. The national ministries and NRAs assume responsibility for this action (the MoEA and ACM in the Netherlands, and the BMWi and BNetzA in Germany).
- Assess the need for and extent of onshore grid reinforcements in the Netherlands to allow for the operation of the grid connection of the German OWF to the Dutch onshore connection point. This action can be achieved through voluntary cooperation between TenneT TSO B.V. and TenneT TSO GmbH.
- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the Netherlands and Germany of costs and benefits deriving from the grid connection responsibility (including possible onshore grid reinforcement costs). Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the two countries. The TSOs, national ministries and NRAs assume responsibility for this action (TenneT TSO B.V., the MoEA and ACM in the Netherlands, and TenneT TSO GmbH, the BMWi and BNetzA in Germany).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 83. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 82.

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connection regimes. http://www.ewea.org/fileadmin/files/library/publications/position-papers/EWEA-position-paper-on-harmonised-transmission-tariffs-and-grid-connection-regimes.pdf

[206] Dutch Elektriciteitswet 1998. §4 Article 24Aa. https://wetten.overheid.nl/BWBR0009755/2018-07-28#Hoofdstuk3_Paragraaf4_Artikel24Aa
German Erneuerbare-Energien-Gesetz 2017 (EEG 2017). § 8. https://www.gesetze-im-internet.de/eeg_2014/__8.html

Barrier	Mitigation measure	Actions
Uncertainty about responsibility for project development	> Assign responsibility for grid connection to either TenneT TSO B.V. or TenneT TSO GmbH	> Define grid connection responsibility among TenneT TSO B.V. and TenneT TSO GmbH > Align mode of collaboration between stakeholders > Define applicable first connection and G-charges in alignment with the NL and DE > Clarify grid connection responsibility for OWF under Dutch and German law > If required, adjust regulations > Assess need for and extent of onshore grid reinforcements > Ensure fair allocation of costs and benefits across stakeholders

Figure 83: DE OWF to NL barrier mitigation – Uncertainty about responsibility for project development

Uncertainty about regulation deriving from jurisdiction over cross-border cable systems

Project-specific barrier evaluation: The OWF included in the DE OWF to NL hybrid project idea is located in the German EEZ. As the OWF serves to exploit marine resources within the German EEZ, Germany has jurisdiction over the OWF installation.

The situation with the export cable system is more complex. As it is required to exploit the natural resources in the German EEZ via the OWF and part of it is located in the German EEZ, Germany can claim jurisdiction over the cable (the Netherlands must grant the freedom of the high seas to lay cables as part is also located in the Dutch EEZ). However, the export cable system has its onshore connection point in the Netherlands and therefore crosses the Dutch territorial sea. Thus, the Netherlands can also claim jurisdiction over the cable. In consequence, the jurisdiction over the export cable system might be concurrent and the regulations applicable to the export cable system derived from Dutch and from German jurisdiction might contradict each other.

Barrier mitigation: The mitigation option identified as most feasible is to obtain all required permits, and to align regulation deriving from concurrent jurisdiction over the operation of the cross-border cable system between the countries involved. This is based on consideration of the interdependencies shown in Table 5, interaction with project stakeholders (see Chapter 5.5.2) and the ease of implementation in terms of the required effort.

The other mitigation options considered in this study besides aligning regulation deriving from concurrent jurisdiction were to define regulation deriving from (1) Dutch jurisdiction and (2) German jurisdiction as applicable to the export cable system linking the German OWF to the Dutch market.

The mitigation option identified as most feasible was selected for the following reasons: Additional alignment is necessary because the application of operational rules deriving from Dutch or German jurisdiction is legally uncertain. The alignment of operational rules deriving from Dutch and German jurisdiction can be a lengthy process, but it is in the interests of both the Netherlands and Germany.

Regarding interdependencies, this barrier is interdependent with the barriers "failure of developers to align planning across assets and countries" and "uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)". Obtaining all required permits and aligning regulation is facilitated by a continuous dialogue and early-stage alignment. Furthermore, aligned operational regulation needs to be reflected in the requirements of the OWF tender.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the DE OWF to NL hybrid project, the following actions are required:

- For development and construction, clarify the necessary permits of the export cable system under Dutch and German regulations. Compliance with the environmental and technical rules under Dutch and German regulations can be ensured by obtaining the permits. This can be achieved through voluntary cooperation between TenneT TSO B.V., TenneT TSO GmbH and the national ministries (the MoEA in the Netherlands, and the BMWi and the BSH in Germany, supported by the Federal Environment Agency).
- If required, change the national permit procedures for the specific hybrid project. Guidance from project-specific developers in the form of an inventory of environmental and technical rules is required to inform changes to the permit procedures. Certainty about changes can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands and Germany. The national ministries would assume responsibility for this action (the MoEA in the Netherlands, and the BMWi, supported by regional governments, in Germany).
- For the operational phase, align the applicable national regulations arising from concurrent jurisdiction for the specific hybrid project. The required alignment may concern liability issues, control system operations (voltage levels, grid synchronisation etc.) and matters discussed in relation to other barriers. Also consider existing national and EU legal frameworks such as the System Operations regulation (Regulation (EU) 2017/1485)[207] and the CACM regulation (Regulation (EU) 2015/1222).[208] Guidance from project-specific developers is required to inform the alignment. Certainty about the alignment of operational rules can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands and Germany. The national ministries and NRAs assume responsibility for this action (the MoEA and ACM in the Netherlands, and the BMWi and BNetzA in Germany).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 84. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 82.

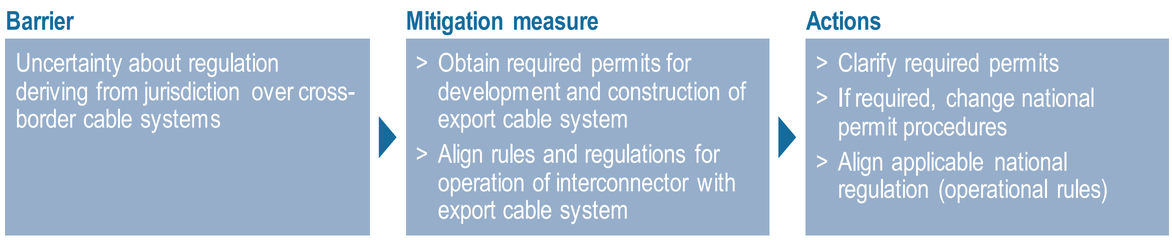

Figure 84: DE OWF to NL barrier mitigation – Uncertainty about regulation deriving from jurisdiction over cross-border cable systems

[207] European Commission. 2017. *COMMISSION REGULATION (EU) 2017/1485 establishing a guideline on electricity transmission system operation.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R1485&from=DE

[208] European Commission. 2015. *COMMISSION REGULATION (EU) 2015/1222 establishing a guideline on capacity allocation and congestion management.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1222&from=EN

Uncertainty about market arrangements

Project-specific barrier evaluation: Clarification of commercial flows is required as the potential OWF site of the DE OWF to NL hybrid project is located in the German EEZ, whereas the onshore grid connection point is in the Netherlands. So, while the OWF physically transmits electricity to the Dutch market, commercial flows to the Dutch or (virtually) to the German market are possible. Commercial flows for the OWF in the hybrid project must therefore be clarified.

Barrier mitigation: The mitigation option identified as most feasible is to allow commercial flows from the OWF included in the hybrid project to the Dutch bidding zone only. This is based on consideration of the interdependencies shown in Table 5, interaction with project stakeholders (see Chapter 5.5.3) and the ease of implementation in terms of the required effort,

The other mitigation options considered in this study were (1) to implement commercial (virtual) flows to the German bidding zone and (2) to implement dynamic commercial flows of the OWF to the high-price market.[209]

The mitigation option identified as most feasible was selected for the following reasons: While the legal feasibility is not given for any of the mitigation options, Option (2) violates the existing CACM regulation (Regulation (EU) 2015/1222)[210] regarding the requirement for stable bidding zones across market time frames. Options (1) and (2) do not require additional compensation for price discrimination of the OWF included in the hybrid project. But the selected mitigation option does not require onshore grid reinforcements regarding interconnector capacity between the Netherlands and Germany.

Regarding interdependencies, this barrier is interdependent with the "uncertainty about applicable RES subsidy scheme" barrier. The implementation of fixed access to the Dutch bidding zone may affect the business case of the OWF in the hybrid project and thereby potentially the level of required subsidies.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the DE OWF to NL hybrid project, the following actions are required:

- Clarify whether a bidding zone review process in accordance with the CACM regulation (Regulation (EU) 2015/1222) Article 32 (4)[211] is required for the physical and commercial connection of a German OWF to a Dutch onshore connection point. It is especially important to clarify whether the regular bidding zone review process should be adhered to, or whether a shortened bidding zone review process is possible. Furthermore, clarification is required with respect to the necessity of assigning the German OWF to the Dutch bidding zone to realise the envisaged market arrangement. This action can be achieved through voluntary cooperation between TenneT TSO B.V. and TenneT TSO GmbH, as well as the European Commission. It can be initiated by the BMWi in Germany,

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[209] Dynamic flows to the low-price market disproportionately disadvantage the OWF (always receives the lowest market price) and do not carry a benefit, since no interconnector is involved in the setup. Therefore, dynamic flows to the low-price market were not considered.

[210] European Commission. 2015. *COMMISSION REGULATION (EU) 2015/1222 establishing a guideline on capacity allocation and congestion management.* Article 33. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1222&from=EN

[211] European Commission. 2015. *COMMISSION REGULATION (EU) 2015/1222 establishing a guideline on capacity allocation and congestion management.* Article 32 (4). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1222&from=EN

- Clarify whether existing Dutch and German regulations cover the commercial connection of a German OWF solely to a Dutch onshore connection point. Thus, the existing Dutch and German market regulations need to be assessed with respect to inadequate national regulations and any amendments which may be necessary. This can be achieved through voluntary cooperation between the national ministries and NRAs (the MoEA and ACM in the Netherlands, and the BMWi and BNetzA in Germany), initiated by the BMWi in Germany.
- If required, adjust national regulations to allow the implementation of the hybrid project with the given market arrangement. Guidance from project-specific developers is required to inform the adjustment of Dutch and German regulations. Certainty regarding legislative changes can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands and Germany. The national ministries and NRAs assume responsibility for this action (the MoEA and ACM in the Netherlands, and the BMWi and BNetzA in Germany).
- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the Netherlands and Germany of costs and benefits deriving from the market arrangement. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the two countries. TSOs, the national ministries and NRAs assume responsibility for this action (TenneT TSO B.V., the MoEA and ACM in the Netherlands, and TenneT TSO GmbH, the BMWi and BNetzA in Germany).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 85. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 82.

Figure 85: DE OWF to NL barrier mitigation – Uncertainty about market arrangements

Failure of developers to align planning across assets and countries

Project-specific barrier evaluation: The integration of a German OWF and an export cable system from the German OWF to a Dutch onshore connection point makes the DE OWF to NL hybrid project complex. As the two assets have separate permit, development and construction timelines, geographical and timing alignment is crucial. In addition, interoperability between the different components of the two assets must be ensured to enable the hybrid project to function.

Barrier mitigation: The mitigation option identified as most feasible is to facilitate a continuous dialogue and early-stage alignment between the project developers. Given that the location of the German OWF is determined by the German authorities, project developers need to align on the following: the routing of the export cable system and the location of substations, the specifications of the export cable system, substations and the OWF as well as the timelines for the hybrid project's individual assets. This is based on consideration of the interdependencies shown in Table 5, interaction with project stakeholders (see Chapter 5.5.5) and the ease of implementation in terms of the required effort.

Apart from continuous dialogue and early-stage alignment between the project developers, no other mitigation options were considered.

Regarding interdependencies, this barrier is interdependent with the following four barriers: "uncertainty about responsibility for project development (responsibility for grid connection)"; "uncertainty about regulation deriving from jurisdiction over cross-border cable systems"; "uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution)"; and the "limited engagement of public stakeholders". Continuous dialogue and early-stage alignment are complemented by clearly defining the responsibility for the development, construction and operation of the grid connection of the German OWF as well as the need to obtain all required permits and align regulation. However, dialogue and alignment themselves are supported by the following mitigations to other barriers. An aligned OWF location allows for the involvement of and coordination with the developer of the OWF in the hybrid project. Formalised public commitment and public financial support decrease the risk to development arising from early-stage project-specific decisions and therefore allow for such alignment.

<u>Action and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the DE OWF to NL hybrid project, the following action is required:

- Engage in a continuous dialogue to achieve early-stage alignment regarding the locations, routing, technical specifications and timelines of the individual assets. This can be achieved through voluntary cooperation between TenneT TSO B.V. and TenneT TSO GmbH, as well as national ministries and NRAs (the MoEA, supported by RVO and ACM, in the Netherlands, and the BMWi, supported by the BSH and BNetzA, in Germany).

The barrier, its mitigation and the actions required to implement mitigation are summarised in Figure 86. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 82.

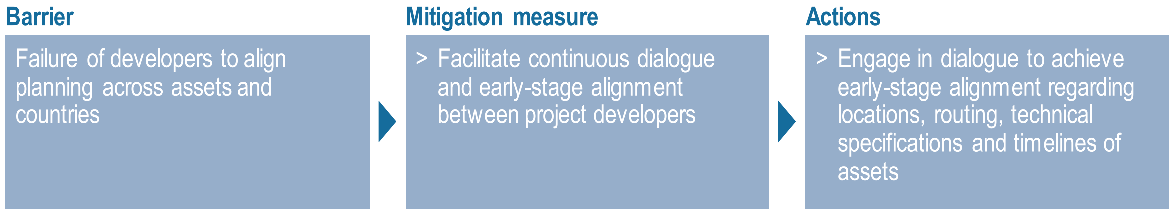

Figure 86: DE OWF to NL barrier mitigation – Failure of developers to align planning across assets and countries

Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution)

<u>Project-specific barrier evaluation:</u> The location selection, site pre-investigation and tender execution of the DE OWF to NL OWF is conducted by German authorities as it is located in the German EEZ. Due to existing national and international law, the construction of installations in a given country's EEZ can only be granted by the coastal state. However, in the DE OWF to NL hybrid project, Dutch and German stakeholders have an interest because both the interoperability of the components and the compliance with all national and European regulations must be ensured.

<u>Barrier mitigation:</u> The mitigation option identified as most feasible is to conduct location selection, site pre-investigation and tender execution by and in accordance with the rules of the German authorities. This is based on consideration of the interdependencies shown in Table 5, interaction

with project stakeholders (see Chapter 5.5.6) and the ease of implementation in terms of the required effort.

Regarding the responsibility for location selection and site pre-investigation, the other mitigation options considered in this study were to assign responsibility (1) to Dutch authorities and (2) to the OWF developer. The mitigation option identified as most feasible was selected for the following reasons: Legal and regulatory applicability of any responsibility other than German responsibility is not given. Furthermore, additional alignment and coordination would otherwise be necessary, which would likely extend the timelines for the procedures.

Regarding the responsibility for tender execution, the other mitigation option considered in this study was to assign Dutch responsibility. The mitigation option identified as most feasible was selected for the following reasons: Tender execution by any party other than German authorities entails considerable uncertainties regarding legal and regulatory applicability. It is unlikely to be publicly supported. In addition, tender execution by German authorities is most closely aligned with ongoing procedures and is therefore likely to be more efficient.

Regarding interdependencies, this barrier is interdependent with the barriers "failure of developers to align planning across assets and countries" and "uncertainty about applicable RES subsidy scheme". Clarifying responsibility for location selection, site pre-investigation and tender execution helps to determine the OWF location, which thereby facilitates continuous dialogue and early-stage alignment. Furthermore, location selection, site pre-investigation and tender execution by and in accordance with the rules of German authorities fits the provision of a subsidy scheme by German authorities.

<u>Actions and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the DE OWF to NL hybrid project, the following actions are required:

- Facilitate the development of the DE OWF to NL hybrid project by agreeing that the responsibility for location selection, site pre-investigation and tender execution remains with the German authorities. Certainty on these three factors can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands and Germany. The national ministries and other national authorities assume responsibility for this action (the MoEA and RVO in the Netherlands, and the BMWi and BSH in Germany).
- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the Netherlands and Germany of costs and benefits deriving from the responsibility for location selection, site pre-investigation and tender execution. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the two countries. The national ministries and NRAs assume responsibility for this action (the MoEA and ACM in the Netherlands, supported by the Dutch Ministry of Infrastructure and Water Management; and the BMWi and BNetzA, supported by the Federal Environment Agency, in Germany).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 87. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 82.

Barrier	Mitigation measure	Actions
Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution)	> Conduct location selection, site pre-investigation and tender execution by and in accordance with the rules of German authorities	> Agree that German responsibility for location selection, site pre-investigation and tender execution remains in place > Ensure fair allocation of costs and benefits across stakeholders

Figure 87: DE OWF to NL barrier mitigation – Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution)

Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)

<u>Project-specific barrier evaluation:</u> A suitable tender design needs to be chosen for the DE OWF to NL hybrid project. The OWF included in the project setup is located in the German EEZ and is linked to an onshore connection point in the Netherlands. Thus, both the Netherlands and Germany have an interest in defining the requirements for the OWF development according to their respective standards. These may be contradictory. In addition, the tender design needs to ensure that the tender candidates can realistically develop the OWF. In consequence, the tender design must clarify which hybrid-specific requirements to include.

<u>Barrier mitigation:</u> The mitigation option identified as most feasible is to implement a tender design with strict requirements. These should be aligned between the Netherlands and Germany and eliminate all hybrid-specific uncertainties for the OWF developer. This is based on consideration of the interdependencies shown in Table 5, interaction with project stakeholders (see Chapter 5.5.7) and the ease of implementation in terms of the required effort.

The other mitigation options considered in this study were (1) to have a strict tender design with requirements aligned among the stakeholders, (2) to have a strict tender design without hybrid-specific uncertainties for the OWF developer and (3) to have a lenient tender design with requirements aligned among the stakeholders and without hybrid-specific uncertainties for the OWF developer.

The mitigation option identified as most feasible was selected for the following reasons: While aligned requirements potentially necessitate amendments to national legislation and regulations, the Netherlands and Germany have valid interests in defining certain requirements for the tender of the OWF connected to the Dutch market. Aligned requirements also aid in ensuring the interoperability of the OWF with the other assets of the hybrid project. All of these factors increase the probability of successful hybrid project implementation. Furthermore, a tender design with strict requirements also increases the probability of successful project implementation, allowing for a possible decrease in the cost efficiency of the OWF development due to more limited competition. Lastly, certainty about hybrid-specific characteristics of the OWF development increases the probability of successful project implementation – and decreases the cost of implementation – by reducing the risk premium otherwise demanded by OWF developers in terms of subsidies.

Regarding interdependencies, this barrier is interdependent with the following three barriers: "uncertainty about regulation deriving from jurisdiction over cross-border cable systems"; the "failure of developers to align planning across assets and countries"; and "uncertainty about applicable RES subsidy scheme". Aligned regulation deriving from Dutch and Danish jurisdiction needs to be reflected in the requirements of the OWF tender. In addition, the OWF tender can include a German subsidy scheme aligned with the Netherlands, involving statistical transfers between the two countries. Continuous dialogue and early-stage alignment facilitate an aligned tender design.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the DE OWF to NL hybrid project, the following actions are required:

- Agree a tender design with strict requirements. Certainty about the tender design can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands and Germany. The national ministries, NRAs and other national authorities assume responsibility for this action (the MoEA, ACM and RVO in the Netherlands, and the BMWi, BNetzA and BSH in Germany).
- Agree tender requirements which take account of the valid interest of the Netherlands in defining material requirements such as technical and operational standards, and of Germany in defining environmental standards. Furthermore, align financial requirements considering the valid interests of both the Netherlands and Germany. Guidance from project-specific developers is required to inform the development of project-specific tender requirements. Certainty about tender requirements can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands and Germany. The national ministries, NRAs and other national authorities assume responsibility for this action (the MoEA, ACM and RVO in the Netherlands, and the BMWi, BNetzA and BSH in Germany).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 88. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 82.

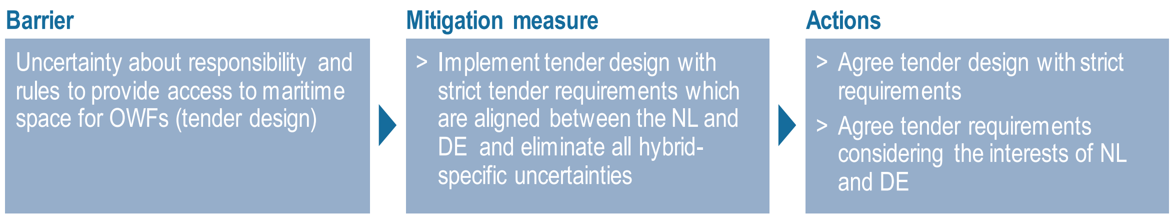

Figure 88: DE OWF to NL barrier mitigation – Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)

Uncertainty about applicable RES subsidy scheme

Project-specific barrier evaluation: In the context of the DE OWF to NL hybrid project, the OWF included in the hybrid project is located in the German EEZ. Thus, a German subsidy scheme could apply. A Dutch subsidy scheme is also possible. In addition, a joint project or a joint subsidy scheme between the Netherlands and Germany could apply, in line with EU Directive 2009/28/EC[212] on the promotion of the use of energy from RES. In summary, the applicability of a support scheme from one of the countries involved or in some joint form is to be determined.

Barrier mitigation: The mitigation option identified as most feasible is to apply the German RES subsidy scheme to the OWF included in the hybrid project, potentially with statistical transfers between countries. Such a move would mean the German government awards the OWF a premium tariff through the German tender process, potentially through a special additional tender round

[212] European Parliament, European Council. 2009. *DIRECTIVE 2009/28/EC on the promotion of the use of energy from renewable sources.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

("Sonderausschreibung")[213]. This is based on consideration of the interdependencies shown in Table 5, interaction with project stakeholders (see Chapter 5.5.12) and the ease of implementation in terms of the required effort.

The other mitigation options considered in this study were (1) to apply a Dutch subsidy scheme, (2) to apply a joint project between the Netherlands and Germany and (3) to apply no subsidy scheme.

The mitigation option identified as most feasible was selected for the following reasons: The legal feasibility of applying a Dutch subsidy scheme to the German OWF is not given. The feasibility of tendering the OWF without a subsidy scheme depends on the ability of the OWF developer to obtain offtake securities such as power purchase agreements. Such agreements ensure the bankability of the OWF investment. Establishing a joint project between the Netherlands and Germany is legally covered and provides the necessary bankability. But it might be problematic due to the extended timeline, which is needed to agree the specifications of the scheme and to formulate the necessary legal agreement. Applying the German subsidy scheme to the OWF is potentially viable from a legal and regulatory perspective. Nonetheless, the date and duration of a special tender round is unknown and could potentially delay project development.

Regarding interdependencies, this barrier is interdependent with the following two barriers: "uncertainty about market arrangements" and "uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution and tender design)". Implementing commercial flows of the OWF to only the Dutch market affects the business case and thereby the level of required RES subsidies. Furthermore, applying a German subsidy scheme aligned with the Netherlands to the German OWF fits with location selection, site pre-investigation and tender execution by and in accordance with German rules. Such a scheme may potentially involve statistical transfers between the two countries. It also fits a tender design with aligned, strict requirements.

<u>Actions and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the DE OWF to NL hybrid project, the following actions are required:

- Clarify the possibility and the dates for a special tender round ("Sonderaussschreibung") in Germany to allow for a timely award of the subsidy scheme to the OWF. This can be achieved through voluntary cooperation between the BMWi, the BNetzA and BSH in Germany.
- Ensure that the envisaged mitigation of assigning a German subsidy scheme to the OWF in the hybrid project complies with German law. German subsidy schemes have regular characteristics in terms of type, level and duration of support as well as technology coverage. Clarify whether statistical transfers to the renewable energy target of Germany based on the electricity generated by the OWF in the hybrid project – which commercially and physically feeds electricity into the Dutch market – are required to access the German subsidy scheme. This assumes that the electricity physically flowing into the Dutch market has a similar effect on the German market as if the electricity would be physically flowing into the German market. Pay particular attention to the stipulations laid down in the Renewable Energy Sources Act (EEG) §5 (3)[214], i.e. with regard to the mutuality of the scheme and the possible coverage of the scheme in an IGA. This action can be achieved through voluntary cooperation between the MoEA and ACM in the Netherlands as well as the BMWi and BNetzA in Germany.

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[213] CDU, CSU, SPD. 2018. *Koalitionsvertrag zwischen CDU, CSU und SPD.* https://www.cdu.de/system/tdf/media/dokumente/koalitionsvertrag_2018.pdf?file=1

[214] German Erneuerbare-Energien-Gesetz 2017 (EEG 2017). § 5 (3). https://www.gesetze-im-internet.de/eeg_2014/__8.html

- It may be that statistical transfers to Germany are required but are not sufficient to allow for the applicability of the German RES subsidy scheme to the OWF in the hybrid project. If so, assess the implications of the required onshore grid reinforcements to allow for the physical transmission of electricity from the Netherlands to Germany. This action could be achieved through voluntary cooperation between TenneT TSO B.V. and TenneT TSO GmbH.
- Otherwise, adjust German regulations, particularly the Renewable Energy Sources Act (EEG) §5 (3), to ensure that statistical transfers to Germany are sufficient to allow for the applicability of the German RES subsidy scheme to the OWF in the hybrid project. Guidance from project-specific developers is required to inform the adjustment of German regulation. Certainty about German regulation can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands and Germany. The BMWi and BNetzA in Germany would assume responsibility for this action.
- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the Netherlands and Germany of costs and benefits deriving from the RES subsidy scheme. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the two countries. The OWF developer as well as national ministries and NRAs (the MoEA and ACM in the Netherlands, and the BMWi and BNetzA in Germany) assume responsibility for this action.

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 89. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 82.

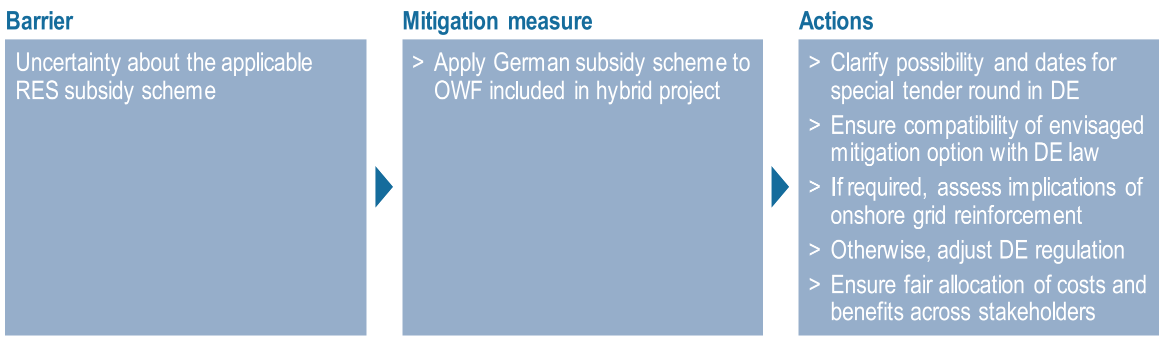

Figure 89: DE OWF to NL barrier mitigation – Uncertainty about applicable RES subsidy scheme

Limited engagement of public stakeholders

Project-specific barrier evaluation: The support of public stakeholders is needed for the successful implementation of the DE OWF to NL hybrid project, as regulatory and technical barriers must be overcome, and financial support provided across two countries, namely, the Netherlands and Germany.

Barrier mitigation: The mitigation option identified as most feasible is to formalise public commitment in the form of a project-specific MoU or a project-specific HANSA. Feasibility studies and scoping studies for early-stage alignment through public funding, for example, should also be facilitated. Furthermore, adequate de-risking of the hybrid project is required. This is based on consideration of the interdependencies shown in Table 5, interaction with project stakeholders (see Chapter 5.5.13) and the ease of implementation in terms of the required effort.

Besides formalising public commitment in the form of a project-specific MoU or a project-specific HANSA and facilitating feasibility studies and scoping studies or providing financial guarantees, no other mitigation option was considered.

Regarding interdependencies, this barrier is interdependent with the "failure of developers to align planning across assets and countries" barrier. Continuous dialogue and early-stage alignment between the project developers is facilitated by formalising the commitment of relevant stakeholders of the hybrid project and / or by providing public funding for early-stage activities. These may include feasibility studies, scoping studies as well as technical research and development.

Actions and responsibilities for mitigation implementation: To implement this mitigation measure for the DE OWF to NL hybrid project, the following actions are required:

- Align and implement the type of formalisation of public commitment to allow for the development of the DE OWF to NL hybrid project. The formalisation of commitment in the form of a project-specific MoU or a project-specific HANSA is an expression of the goodwill of the stakeholders to support hybrid project development. It assures project developers of public support, e.g. in the form of dialogue with relevant government bodies. In early project stages, a project-specific MoU provides sufficient certainty for project developers. The stakeholders assuming responsibility are TenneT TSO B.V., TenneT TSO GmbH and the national ministries and NRAs (the MoEA and ACM in the Netherlands, and the BMWi and BNetzA in Germany), as well as the European Commission. In later project stages, a project-specific HANSA is required to provide project developers with sufficient legal certainty. The stakeholders assuming responsibility include the national ministries (the MoEA in the Netherlands and the BMWi in Germany), as well as the European Commission.
- Catalyse the development of the DE OWF to NL hybrid project by supporting the early-stage alignment among developers. Do this through public funding for feasibility studies, pilot projects as well as R&D for innovative, technological solutions, in addition to existing offshore support schemes. Such public support allows developers to firmly commit to the development of the project. This can be achieved through voluntary cooperation between the national ministries (the MoEA in the Netherlands and the BMWi in Germany), as well as the European Commission.
- Support the de-risking of the hybrid project by providing financial guarantees. Such guarantees can reassure project developers in situations which cannot be foreseen due to the pilot character of the hybrid project. This can be achieved through voluntary cooperation between the TSOs (TenneT TSO B.V. and TenneT TSO GmbH) and the European Commission.
- Ensure compatibility with the measures adopted to mitigate the barrier "disproportionate allocation of costs and benefits across involved stakeholders". Do this through the fair reallocation among the Netherlands and Germany of costs and benefits deriving from the engagement of public stakeholders. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the two countries. The national ministries and NRAs assume responsibility for this action (the MoEA and ACM in the Netherlands, and the BMWi and BNetzA in Germany).

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 90. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 82.

Figure 90: DE OWF to NL barrier mitigation – Limited engagement of public stakeholders

Disproportionate allocation of costs and benefits across involved stakeholders

<u>Project-specific barrier evaluation:</u> Agreeing on the allocation of costs and benefits in the DE OWF to NL hybrid project is complex. The potential OWF site is geographically located in the German EEZ, whereas the onshore grid connection point is in the Netherlands. Due to the technical setup and the details of the hybrid project, certain costs and benefits are initially incurred by Germany and certain costs and benefits are initially incurred by the Netherlands. In addition, the measures adopted to mitigate other barriers assign costs or distribute benefits to the Netherlands and Germany. Furthermore, developers may realise additional benefits. Thus, costs and benefits are generally not distributed fairly, and no suitable approach exists to reallocate the costs and benefits across all stakeholders of the hybrid project.

<u>Barrier mitigation:</u> The mitigation option identified as most feasible is to reallocate costs and benefits deriving from the hybrid project where required, based on a project-specific process. In some respects, the process can be based on the existing methodology given by the Cross-Border Cost Allocations (CBCA) process.[215] It builds on the Cost Benefit Analysis (CBA) conducted by ENTSO-E[216] for Projects of Common Interest. In the CBCA process, benefits such as socio-economic welfare and CO_2 emissions are calculated on a national level to compensate net losers for the implementation of a project through a CBCA decision. The CBCA process provides a good starting point for the reallocation of costs and benefits across countries but is best suited for evaluating cross-border electricity interconnectors. This is based on consideration of the interdependencies shown in Table 5, interaction with project stakeholders (see Chapter 5.5.15) and the ease of implementation in terms of the required effort.

Besides implementing the process resulting in the reallocation of costs and benefits deriving from the implementation of the hybrid project, no other mitigation option was considered.

Regarding interdependencies, this barrier is interdependent with the following five barriers: "uncertainty about responsibility for project development (grid connection responsibility)"; "uncertainty

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[215] ACER. 2015. *Recommendation No 5/2015 on good practices for the treatment of the investment requests, including CBCA requests, for electricity and gas PCIs.* https://acer.europa.eu/Official_documents/Acts_of_the_Agency/Recommendations/ACER%20Recommendation%2005-2015.pdf

[216] ENTSO-E. 2018*. 2nd ENTSO-E Guideline: For Cost Benefit Analysis of Grid Development Projects.* https://tyndp.entsoe.eu/Documents/TYNDP%20documents/Cost%20Benefit%20Analysis/2018-10-11-tyndp-cba-20.pdf

about market arrangements"; "uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution)"; "uncertainty about applicable RES subsidy scheme"; and the "limited engagement of public stakeholders". Reallocation also relates to those barriers. This is because their mitigation translates into costs and benefits for specific stakeholders that might have to be reallocated together with all other costs and benefits of the hybrid project. Therefore, the costs and benefits deriving from all five interdependent barriers must be considered.

<u>Actions and responsibilities for mitigation implementation:</u> To implement this mitigation measure for the DE OWF to NL hybrid project, the following actions are required:

- Identify relevant cost and benefit categories between the involved stakeholders, covering all significant aspects of the hybrid project. This can be achieved through voluntary cooperation between TSOs (TenneT TSO B.V. in the Netherlands and TenneT TSO GmbH in Germany) as well as national ministries and NRAs (the MoEA and ACM in the Netherlands, and the BMWi and BNetzA in Germany).
- Ensure that due consideration is given to all costs and benefits deriving from measures adopted to mitigate the following barriers: "uncertainty about responsibility for project development"; "uncertainty about market arrangements"; "uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation, tender execution)"; "uncertainty about applicable RES subsidy scheme"; and the "limited engagement of public stakeholders". This can be achieved through voluntary cooperation between all stakeholders involved in the individual barrier mitigations.
- Determine the initial allocation of costs and benefits, covering the cost and benefit categories across all significant aspects of the hybrid project identified in the first step. In this process, developers typically conduct the assessment of costs and benefits, while NRAs oversee and validate results. Thus, this can be achieved through voluntary cooperation between OWF developers (TenneT TSO B.V. in the Netherlands and TenneT TSO GmbH in Germany) as well as national ministries and NRAs (the MoEA and ACM in the Netherlands, and the BMWi and BNetzA in Germany).
- Align and agree a suitable reallocation of costs and benefits between developers, the Netherlands and Germany. Base this on the identification of cost and benefit categories among stakeholders as well as the assessment of the initial allocation of costs and benefits across the identified categories. Certainty about the allocation of costs and benefits can be achieved by addressing this issue as part of the project-specific HANSA between the Netherlands and Germany. OWF developers (TenneT TSO B.V. in the Netherlands and TenneT TSO GmbH in Germany) as well as national ministries and NRAs (the MoEA and ACM in the Netherlands; the BMWi and BNetzA in Germany; and the MoEUC and DUR in Denmark) assume responsibility for this action, as well as the European Commission.
- Validate the availability of CEF funding to ensure adequate incentivisation for all relevant stakeholders if the following applies: the DE OWF to NL hybrid project is a PCI and adds socio-economic value, but the initial allocation of costs and benefits is not sufficiently balanced to incentivise all countries and stakeholders to implement the hybrid project. While CEF funding cannot resolve viability issues of projects, it is a last resort for PCIs that have received a CBCA

decision but are still not commercially viable for each individual stakeholder[217]. This can be achieved through voluntary cooperation between TSOs (TenneT TSO B.V. in the Netherlands and TenneT TSO GmbH in Germany) as well as NRAs (ACM in the Netherlands and BNetzA in Germany), and the European Commission.

The barrier, its mitigation and the actions required to implement the mitigation are summarised in Figure 91. The actions required to implement the mitigation measure and the stakeholders responsible for the individual actions are summarised across barriers in Figure 82.

Figure 91: DE OWF to NL barrier mitigation – Disproportionate allocation of costs and benefits across involved stakeholders

[217] European Parliament, European Council. 2013. *REGULATION (EU) No. 347/2013 on guidelines for trans-European energy infrastructure.* Article 14. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0347&from=en

5. Appendix

Throughout the course of this study, the relevant barriers were identified in interaction with the project-specific stakeholders and based on desk research. In the same way, mitigation options were developed and assessed for each of the barriers relevant for a specific hybrid project. Generally, the project-specific stakeholders include OWF developers, TSOs, national ministries and NRAs.

The following five Subchapters 5.1 to 5.5 summarise the barriers and barrier mitigations for each of the selected five hybrid project ideas IJmuiden Ver to UK, CGS IJmuiden Ver to Norfolk, COBRA Cable, North Sea Wind Power Hub (NSWPH) and DE OWF to NL. The dimensions considered in the assessment represent a list of important factors, which, however, are not necessarily comprehensive. Where necessary, the summary of the interactions includes interpretations of the topics discussed to efficiently present a complete picture.

5.1 IJmuiden Ver to UK

Throughout stakeholder interaction, 11 out of 16 barriers are identified as relevant for the implementation of the IJmuiden Ver to UK hybrid project idea. The results of the interaction with stakeholders with regard to all barriers – relevant and not relevant – are summarised in the ensuing subchapters.

5.1.1 Uncertainty about responsibility for project development

The barrier "uncertainty about responsibility for project development" is divided into three subtopics, grid connection responsibility, responsibility for the development and construction of the interconnector and responsibility for the operation of the interconnector. The three subtopics are addressed individually in the following.

Grid connection responsibility

This subtopic of the barrier is not relevant for the IJmuiden Ver to UK hybrid project.

Under Dutch law, the operator of the offshore grid, which is TenneT TSO B.V., has an obligation to connect any OWF to the onshore grid, which fulfils the technical requirements set out in the law. Therefore, responsibility for the development and construction as well as operation of the Dutch export cable system is clearly assigned to TenneT TSO B.V. and not further discussed in this study.

Responsibility for development and construction of interconnector

This subtopic of the barrier is relevant for the IJmuiden Ver to UK hybrid project.

To address this barrier, two mitigation options are assessed with regard to their applicability (Table 6) – excluding the implications of interdependencies with other barriers.

- Option 1 "TenneT TSO B.V. is responsible": The Dutch TSO, TenneT TSO B.V., is responsible for the development and construction of the interconnector between the UK market and the offshore substation of the export cable system of the Dutch OWF.
- Option 2 "TenneT TSO B.V. and UK interconnector developer are responsible": The Dutch TSO, TenneT TSO B.V., and a UK interconnector developer are responsible for the development and construction of the interconnector between the UK market and the offshore substation of the export cable system of the Dutch OWF.

	Option 1: TenneT TSO B.V. is responsible	Option 2: TenneT TSO B.V. and UK interconnector developer are responsible
Legal / regulatory coverage	Covered in UK and NL legislation and regulation – EU network codes such as "HVDC Connections" support technical standardisation	Covered in UK and NL legislation and regulation – EU network codes such as "HVDC Connections" support technical standardisation
Costs	Costs are with NL	Costs are with NL and UK IC developer
Financial risk	Financial risk is with TenneT TSO B.V. (offshore grid operator), and thus with NL, therefore low risk towards project realisation	Financial risk is with TenneT TSO B.V. (offshore grid operator) and UK IC developer, and thus with NL and UK IC developer, therefore uncertain risk towards project realisation
Development risk	Alignment of development not needed for a single developer and also not across parts of entire cable system due to congruent responsibilities, therefore low risk towards project realisation	Alignment of development needed for multiple developers and additionally across parts of entire cable system due to differing responsibilities, therefore uncertain risk towards project realisation
Market-specific expertise	Knowledge on general and project-specific grid connection requirements given for TenneT TSO B.V. in the NL and to some extent in the UK (from BritNed)	Knowledge on general and project-specific grid connection requirements given for UK IC developer in the UK and for TenneT TSO B.V. in the NL
Summary	Covered under UK and NL legal and regulatory regime and with low risk towards project realisation but only with market-specific expertise in the NL	Covered under UK and NL legal and regulatory regime and market-specific expertise in the UK and the NL, but with uncertain risk towards project realisation

Table 6: IJmuiden Ver to UK – Assessment of options for responsibility during IC development and construction phase

In summary, the interaction with stakeholders shows both options – TenneT TSO B.V. being responsible for the development and construction of the interconnector (Option 1) as well as TenneT TSO B.V. together with a UK interconnector developer being responsible (Option 2) – have advantages and disadvantages. While TenneT TSO B.V. is legally allowed and able to develop and construct the interconnector on its own (Option 1), the collaboration with a UK interconnector developer is also possible and would make sense as a UK interconnector developer can contribute additional market-specific expertise regarding the connection to the UK market (Option 2). On the other hand, the risk towards project realisation can be reduced if TenneT TSO B.V. is responsible for the development and construction of the entire cable system of the hybrid project (Option 1).

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the IJmuiden Ver to UK hybrid project must also take into account the interdependencies between the individual barriers.

Responsibility for operation of interconnector

This subtopic of the barrier is relevant for the IJmuiden Ver to UK hybrid project.

To address this subtopic of the barrier, two mitigation options are assessed with regard to their applicability (Table 7) – excluding the implications of interdependencies with other barriers.

- Option 1 "TenneT TSO B.V. is responsible": The Dutch TSO, TenneT TSO B.V., is responsible for the operation of the interconnector (only interconnector cable) between the UK market and the offshore substation of the export cable system of the Dutch OWF.
- Option 2 "TenneT TSO B.V. and UK interconnector developer are responsible": The Dutch TSO, TenneT TSO B.V., and a UK interconnector developer are responsible for the operation of the interconnector (only interconnector cable) between the UK market and the offshore substation of the export cable system of the Dutch OWF.

	Option 1: TenneT TSO B.V. is responsible	Option 2: TenneT TSO B.V. and UK interconnector developer are responsible
Legal / regulatory coverage	Covered in UK and NL legislation and regulation – EU network codes, such as "System Operations", and EU Regulations, such as "Electricity cross-border exchanges", support technical standardisation	Covered in UK and NL legislation and regulation – EU network codes, such as "System Operations", and EU Regulations, such as "Electricity cross-border exchanges", support technical standardisation
Costs	Costs are with NL	Costs are with NL and UK IC developer
Operational risk	Alignment of operations not needed for a single developer and also not across parts of entire cable system due to congruent responsibilities, therefore low risk towards project realisation	Alignment of operations needed for multiple developers and additionally across parts of the entire cable system due to differing responsibilities, therefore uncertain risk towards project realisation
Market-specific expertise	Knowledge on general and project-specific operational requirements given for TenneT TSO B.V. in the NL and to some extent in the UK (from BritNed)	Knowledge on general and project-specific operational requirements given for UK IC developer in the UK and for TenneT TSO B.V. in the NL
Summary	Covered under UK and NL legal and regulatory regime and with low risk towards project realisation but only with market-specific expertise in the NL	Covered under UK and NL legal and regulatory regime and with market-specific expertise in the UK and the NL, but with uncertain risk towards project realisation

Table 7: IJmuiden Ver to UK – Assessment of options for responsibility during IC operation phase

In summary, this interaction with stakeholders shows that both options – TenneT TSO B.V. being responsible for the operation of the interconnector (Option 1) as well as TenneT TSO B.V. together with a UK interconnector developer being responsible (Option 2) – have advantages and disadvantages. While TenneT TSO B.V. is legally allowed and able to operate the interconnector on its own (Option 1), the collaboration with a UK interconnector developer is also possible (Option 2). The collaboration with a UK interconnector developer (Option 2) provides additional market-specific expertise on operational requirements in the UK. On the other hand, the risk towards project realisation can be minimised if TenneT TSO B.V. is responsible for the operation of the entire cable system of the hybrid project (Option 1).

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the IJmuiden Ver to UK hybrid project must also take into account the interdependencies between the individual barriers.

5.1.2 Uncertainty about regulation deriving from jurisdiction over cross-border cable systems

This barrier is relevant for the IJmuiden Ver to UK hybrid project.

To address this barrier, three mitigation options are assessed with regard to their applicability (Table 8) – excluding the implications of interdependencies with other barriers. The assessment concentrates on the jurisdiction applicable to the operation of the interconnector since the development and construction of the interconnector constitute no barrier. Furthermore, Dutch regulation is applicable to the OWF and the export cable system.

- Option 1 "UK jurisdiction's regulations": In addition to European law, UK regulation applies to the operation of the interconnector between the UK market and the offshore substation of the export cable of the Dutch OWF across the UK territorial sea, the UK EEZ and the Dutch EEZ.
- Option 2 "Dutch jurisdiction's regulations": In addition to European law, Dutch regulation applies to the operation of the interconnector between the UK market and the offshore substation of the export cable of the Dutch OWF across the UK territorial sea, the UK EEZ and the Dutch EEZ.
- Option 3 "Alignment of jurisdictions' regulations": Based on negotiations between the UK and the Netherlands, a new combination of regulations applies to the operation of the interconnector between the UK market and the offshore substation of the export cable system of the Dutch OWF across the UK territorial sea, the UK EEZ and the Dutch EEZ – in addition to European law. The new combination of regulations over the operation of the interconnector can potentially be based on existing agreements established for the interconnectors between the UK and the Netherlands, such as BritNed.

	Option 1: UK jurisdiction's regulations	**Option 2: Dutch jurisdiction's regulations**	**Option 3: Alignment of jurisdictions' regulations, e.g. based on BritNed**
Rights and duties in UK territorial sea during operation	No uncertainty since the UK has jurisdiction and UK operational rules apply since cable crosses UK territorial sea	Uncertainty and thus alignment required since the UK has jurisdiction and UK operational rules apply since cable crosses UK territorial sea	Alignment required to combine operational rules deriving from jurisdictions of the UK and the NL for UK territorial sea through involvement of the UK and the NL

	Option 1: UK jurisdiction's regulations	**Option 2: Dutch jurisdiction's regulations**	**Option 3: Alignment of jurisdictions' regulations, e.g. based on BritNed**
Rights and duties in UK EEZ during operation	No uncertainty since the UK has jurisdiction and UK operational rules apply since cable crosses UK territorial sea and not the NL territorial sea as well as does not serve exploitation of the NL EEZ	Uncertainty and thus alignment required since the UK has jurisdiction and UK operational rules apply since cable crosses UK territorial sea and not NL territorial sea as well as does not serve exploitation of the NL EEZ	Alignment required to combine operational rules deriving from jurisdictions of the UK and the NL for UK EEZ through involvement of the UK and the NL
Rights and duties in NL EEZ during operation	No uncertainty since the NL has jurisdiction, but NL operational rules do not apply since the cable neither crosses NL territorial sea nor serves the economic exploitation of the NL EEZ	Uncertainty and thus alignment required since the NL has jurisdiction, but NL operational rules do not apply since the cable neither crosses NL territorial sea nor serves the economic exploitation of the NL EEZ	Alignment required to combine operational rules deriving from jurisdictions of the UK and the NL for NL EEZ through involvement of the UK and the NL
Hybrid project requirements	Alignment of operational rules between the UK and the NL required because of connection of NL OWF to the interconnector via offshore substation of export cable system	No additional alignment of operational rules required	No additional alignment of operational rules required
Timeline	Alignment may extend timeline of project	Alignment may extend timeline of project	Alignment may extend timeline of project
Others			Provisions for assigning liability in case of grid connection failure need to be implemented
Summary	Alignment of operational rules required to allow for a combination of assets in hybrid project	Uncertainty and thus alignment required to ensure applicability of Option 2 since UK rules apply in all relevant maritime zones	Alignment required to ensure applicability of Option 3 since UK rules apply in all relevant maritime zones

Table 8: IJmuiden Ver to UK – Assessment of options for regulation deriving from jurisdiction deriving from cross-border cable systems

In summary, the interaction with stakeholders shows that all options – the agreement on the applicability of operational rules to the interconnector based on UK (Option 1) or Dutch jurisdiction

(Option 2) as well as the alignment of rules deriving from the UK and Dutch jurisdiction (Option 3) – have advantages and disadvantages. While chances of an agreement among the UK and the Netherlands on a single jurisdiction are limited, the alignment of rules deriving from two jurisdictions can be a lengthy process. Yet, Option 3 reflects the interests of both countries in the alignment and can potentially build on existing agreements established for the interconnectors between the UK and the Netherlands, such as BritNed.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the IJmuiden Ver to UK hybrid project must also take into account the interdependencies between the individual barriers.

5.1.3 Uncertainty about market arrangements

This barrier is relevant for the IJmuiden Ver to UK hybrid project.

In the context of the IJmuiden Ver to UK hybrid project, the market arrangement is foreseen to be commercial flows to the home market, this is, of the Dutch OWF only to the Netherlands. Since this market arrangement was identified in the interaction with project stakeholders as most feasible from the beginning, no other mitigation options were considered in detail. Leftover capacities on its export cable system are foreseen to be available for interconnector trade.

Considering the identification of the market arrangement by the stakeholders, the validation of this mitigation option as appropriate for the IJmuiden Ver to UK hybrid project must also take into account the interdependencies between the individual barriers.

5.1.4 Uncertainty about hybrid cable system classification

This barrier is relevant for the IJmuiden Ver to UK hybrid project.

To address this barrier, two mitigation options are assessed with regard to their applicability (Table 9) – excluding the implications of interdependencies with other barriers. The assessment concentrates on the export cable system between Dutch OWF and the Dutch market. The interconnector included in the hybrid project, meaning the cable connection from the offshore substation of the export cable system of the Dutch OWF to the UK market, functions solely as an interconnector as the Dutch OWF only transmits electricity to the Dutch market (market arrangement as foreseen by the project developers).

- Option 1 "Export system with interconnector functionality": The Dutch export cable is a hybrid cable system which allows for the transmission of electricity from the Dutch OWF to the Dutch market. Hence, the Dutch export cable system (together with the interconnector) only provides leftover capacities for the interconnector functionality between the UK and the Dutch bidding zone.
- Option 2 "Interconnector with export cable functionality": The Dutch export cable system is a hybrid cable system which allows for the transmission of electricity from the Dutch OWF to the Dutch market only with leftover capacities. Hence, the Dutch export cable system (together with the interconnector) primarily provides interconnector functionality between the UK and the Dutch bidding zone.

	Option 1: Export cable with IC functionality	Option 2: IC with export cable functionality
NL national legal / regulatory coverage	Potentially covered as NL regulation does not expressly prohibit dual functionality of cables but legal / regulatory feasibility to be validated	Potentially covered as NL regulation does not expressly prohibit dual functionality of cables but legal / regulatory feasibility to be validated
EU legal / regulatory coverage	Not covered under Electricity Directive because it does not include an add. definition for hybrid cable systems; EU Regulation 714/2009 prescribes that "maximum capacity of the interconnections […] shall be made available to market participants" with clarity needed whether "maximum" refers to nominal or leftover capacities of cable systems in hybrid projects	Not covered under Electricity Directive because it does not include an add. definition for hybrid cable systems; EU Regulation 714/2009 prescribes that "maximum capacity of the interconnections […] shall be made available to market participants" with clarity needed whether "maximum" refers to nominal or leftover capacities of cable systems in hybrid projects
Potential for curtailment of OWF	OWF can transmit electricity to shore at full generation capacity, and thus no business case implications and minimised curtailment	OWF can transmit electricity to shore depending on leftover capacity of cable system, and thus negative business case implications due to additional curtailment
Potential for congestion of IC	Capacity available for trade is significantly reduced, and thus negative business case implications for IC functionality of the entire cable system	Full capacity is available for trade, and thus no business case implications for IC functionality of the entire cable system
Compensation	Due to joint development of transmission assets in hybrid project, optimisation of business case of cable system as a whole given; potentially no additional compensation necessary	Due to foregone revenues from additional curtailment, additional compensation for OWF required
Third party access	Third party access only given for leftover capacities after transmission of electricity from OWF to shore	Third party access given
Impact on EU's energy policy targets	Priority on primary targets of diversification and integration of RES as well as on GHG emission reductions over secondary target of maximised IC capacity	Priority on secondary target of maximised IC capacity over primary targets of diversification and integration of RES as well as on GHG emission reductions
Summary	Not covered under existing EU regulation, but potentially covered under NL regulation; potential for negative business case implications for IC may necessitate additional compensation	Not covered under existing EU regulation, but potentially covered under NL regulation; negative business case implications for OWF necessitate additional compensation

Table 9: IJmuiden Ver to UK – Assessment of options for hybrid cable system classification

In summary, the interaction with stakeholders shows that both options – an export cable with interconnector functionality (Option 1) and an interconnector with export cable functionality (Option 2) – have advantages and disadvantages. Both, Option 1 and 2 require changes in the European and potentially in the Dutch legal and regulatory frameworks. Option 2 has unfavourable implications for the business case of the OWF developer since the developer has no priority access to transmission capacity. Contrary, in Option 1, the interconnector developer has no priority access to the capacity of the cable system resulting in unfavourable implications for the business case for the interconnector. However, in Option 1 the interconnector developer might be able to optimise the entire cable system to counterbalance the implications in consequence of the connection of the OWF to it. Furthermore, Option 2 prioritises the secondary EU energy policy target of maximised electricity interconnection capacity over the primary targets of diversification and integration of RES as well as greenhouse gas emission reduction.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the IJmuiden Ver to UK hybrid project must also take into account the interdependencies between the individual barriers.

5.1.5 Failure of developers to align planning across assets and countries

The barrier "failure of developers to align planning across assets and countries" is divided into three subtopics, geographical alignment, technical alignment and timing alignment. The three subtopics are addressed individually in the following.

Geographical alignment

This subtopic of the barrier is relevant for the IJmuiden Ver to UK hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of failed geographical alignment across assets and countries, but rather that a process towards the mitigation of the barrier must be followed. The process consists of the continuous exchange between project developers and other stakeholders to allow for the achievement of early-stage, geographical alignment.

Considering the results of the interaction with the stakeholders, the mitigation process to be followed for the IJmuiden Ver to UK hybrid project must also take into account the interdependencies between the individual barriers.

Technical alignment

This subtopic of the barrier is relevant for the IJmuiden Ver to UK hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of failed technical alignment across assets and countries, but rather that a process towards the mitigation of the barrier must be followed. The process consists of the continuous exchange between project developers and other stakeholders to allow for the achievement of early-stage, technical alignment.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the IJmuiden Ver to UK hybrid project must also take into account the interdependencies between the individual barriers.

Timing alignment

This subtopic of the barrier is not relevant for the IJmuiden Ver to UK hybrid project.

In the context of the IJmuiden Ver to UK hybrid project, timing alignment is not relevant since the OWF can function as a stand-alone asset with the interconnector between the offshore substation of the export cable system of the Dutch OWF and the UK onshore connection point as an additional asset that can be added later in time. Thus, the timelines do not need to be aligned provided that geographical and technical alignment have taken place.

5.1.6 Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation and tender execution)

The barrier "uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation and tender execution)" is divided into two subtopics, location selection and site pre-investigation as well as tender execution. The two subtopics are addressed individually in the following.

Location selection and site pre-investigation

This subtopic of the barrier is not relevant for the IJmuiden Ver to UK hybrid project.

In the context of the IJmuiden Ver to UK hybrid project, there is no uncertainty concerning location selection and site pre-investigation responsibility and procedures since the Dutch authorities are responsible and Dutch procedures are applicable to the Dutch OWF included in the hybrid project.

Tender responsible party

This subtopic of the barrier is not relevant for the IJmuiden Ver to UK hybrid project.

In the context of the IJmuiden Ver to UK hybrid project, there is no uncertainty concerning determination of the tender responsible party since responsibility lies with Dutch authorities for the tender of the Dutch OWF included in the hybrid project.

5.1.7 Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)

This barrier is relevant for the IJmuiden Ver to UK hybrid project.

To address this barrier, four mitigation options are assessed with regard to their applicability (Table 10) – excluding the implications of interdependencies with other barriers.

- Option 1 "Strict design with aligned requirements and without hybrid-specific uncertainties": A tender design with strict pre-qualification requirements implies that extensive pre-qualification requirements are defined to ensure hybrid-specific and general capabilities to develop the IJmuiden Ver to UK hybrid project. The requirements are aligned among the UK and the Netherlands, including a jointly agreed set of financial requirements and a certain set of both UK and Dutch rules related to the OWF site (e.g. environmental details) and a certain set of both UK and Dutch rules related to the grid connection of the OWF (e.g. technical and operational details such as system integration or frequency control). Furthermore, all uncertainties arising from the hybrid character of the OWF development are clarified prior to the tender.
- Option 2 "Strict design with aligned requirements": A tender design with strict pre-qualification requirements implies that extensive pre-qualification requirements are defined to ensure hybrid-specific and general capabilities to develop the IJmuiden Ver to UK hybrid project. The requirements are aligned among the UK and the Netherlands, including a jointly agreed set of financial requirements and a certain set of both UK and Dutch rules related to the OWF site (e.g. environmental details) and a certain set of both UK and Dutch rules related to the grid connection

of the OWF (e.g. technical and operational details such as system integration or frequency control). Furthermore, the uncertainties arising from the hybrid character of the OWF development are not clarified prior to the tender.

- Option 3: "Strict design without hybrid-specific uncertainties": A tender design with strict pre-qualification requirements implies that extensive pre-qualification requirements are defined to ensure hybrid-specific and general capabilities to develop the IJmuiden Ver to UK hybrid project. The requirements are either defined by the UK or by the Netherlands and not aligned. Furthermore, all uncertainties arising from the hybrid character of the OWF development are clarified prior to the tender.
- Option 4 "Lenient design with aligned requirements and without hybrid-specific uncertainties": A tender design with lenient pre-qualification requirements is chosen, implying that only limited pre-qualification requirements are defined to ensure competition and low prices. The requirements are aligned among the UK and the Netherlands, including a jointly agreed set of financial requirements and a certain set of both UK and Dutch rules related to the OWF site (e.g. environmental details) and a certain set of both UK and Dutch rules related to the grid connection of the OWF (e.g. technical and operational details such as system integration or frequency control). Furthermore, all uncertainties arising from the hybrid character of the OWF development are clarified prior to the tender.

	Option 1: Strict design, aligned requirements and no uncertainties	Option 2: Strict design and aligned requirements	Option 3: Strict design and no uncertainties	Option 4: Lenient design, aligned requirements and no uncertainties
Legal / regulatory coverage	Not covered and potential amendments to national legislation and regulation necessary since multiple countries are involved in defining tender design	Not covered and potential amendments to national legislation and regulation necessary since multiple countries are involved in defining tender design	Covered and no amendments to national legislation and regulation necessary since only one country is involved in defining tender design	Not covered and potential amendments to national legislation and regulation necessary since multiple countries are involved in defining tender design
Alignment of requirements	Financial, technical and operational requirements aligned; environmental requirements defined by the NL	Financial, technical and operational requirements aligned; environmental requirements defined by the NL	No alignment of requirements	Financial, technical and operational requirements aligned; environmental requirements defined by the NL

	Option 1: Strict design, aligned requirements and no uncertainties	Option 2: Strict design and aligned requirements	Option 3: Strict design and no uncertainties	Option 4: Lenient design, aligned requirements and no uncertainties
Hybrid-specific un-certainties	All uncertainties arising from hybrid-specific setup are clarified, e.g. liability, applicable jurisdiction, grid connection responsibility, hybrid cable system classification	Uncertainties arising from hybrid character of development not entirely clarified such that uncertainty remains for OWF developer	All uncertainties arising from hybrid-specific setup are clarified, e.g. liability, applicable jurisdiction, grid connection responsibility, hybrid cable system classification	All uncertainties arising from hybrid-specific setup are clarified, e.g. liability, applicable jurisdiction, grid connection responsibility, hybrid cable system classification
Realisation probability	Applying OWF developers are aware of all specifications and requirements and can align planning and financing right from the beginning	Applying OWF developers are aware of all specifications and requirements and can align planning and financing right from the beginning	Applying OWF developers are aware of all specifications and requirements and can align planning and financing right from the beginning; however, it is questionable whether an OWF connected to two countries can be tendered without alignment of tender requirements	Applying OWF developers are not aware of most specifications and requirements, which might result in significant cost overruns / delays after the tender process
Cost efficiency	Due to strict requirements and specifications, less developers expected to apply – cost efficiency of offers expected to decrease with fewer applicants	Due to strict requirements and specifications, less developers expected to apply – cost efficiency of offers expected to decrease with fewer applicants	Due to strict requirements and specifications, less developers expected to apply – cost efficiency of offers expected to decrease with fewer applicants	Due to lenient requirements and specifications, many developers expected to apply – cost efficiency of offers expected to increase with more applicants

	Option 1: Strict design, aligned requirements and no uncertainties	Option 2: Strict design and aligned requirements	Option 3: Strict design and no uncertainties	Option 4: Lenient design, aligned requirements and no uncertainties
Summary	Legal and regulatory coverage to be assessed and potentially decreases cost efficiency	Legal and regulatory coverage to be assessed and decreases cost efficiency, particularly due to remaining hybrid uncertainties	Legal and regulatory coverage given, but with limited chance of realisation due to non-consideration of one country's interest in defining tender requirements	Legal and regulatory coverage to be assessed and strongly decreases probability of project realisation

Table 10: IJmuiden Ver to UK – Assessment of options for tender design

In summary, the interaction with stakeholders shows that all four options – a strict or lenient tender design with aligned requirements and certainty about hybrid-specific characteristics of the OWF development (Option 1 and 4), a strict tender design with aligned requirements (Option 3) as well as a strict tender design with certainty about hybrid-specific characteristics of the OWF development (Option 2) – have advantages and disadvantages. While a tender design with strict requirements (Options 1, 2 and 3) increases the probability of successful project implementation, a tender design with lenient requirements (Option 4) decreases the cost of implementation through competition. Furthermore, certainty about hybrid-specific characteristics of the OWF development (Options 1, 3 and 4) increases the probability of successful project implementation and decreases the cost of implementation by reducing the risk premium otherwise demanded by OWF developers in terms of subsidies. Lastly, aligned requirements (Options 1, 2 and 4) aid in ensuring the interoperability of the OWF with the other assets of the hybrid project and thereby increase the probability of successful hybrid project implementation.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the IJmuiden Ver to UK hybrid project must also take into account the interdependencies between the individual barriers.

5.1.8 Discrepancies in responsibilities and requirements for balancing

In the context of the IJmuiden Ver to UK hybrid project, there is no discrepancy concerning the balancing responsibility and requirements in the shorter term since the balancing regulation of the Netherlands applies to the Dutch OWF included in the hybrid project. Furthermore, the topic is addressed in the Clean Energy Package such that in the longer term the translation into Dutch law needs to be assessed in detail by the project-specific stakeholders.

5.1.9 Discrepancies in priority dispatch regulation

In the context of the IJmuiden Ver to UK hybrid project, there is no discrepancy concerning the priority dispatch regulation in the shorter term since the Dutch priority dispatch regulation applies to the Dutch OWF included in the hybrid project. Furthermore, the topic is addressed in the Clean Energy Package such that in the longer term the translation into Dutch law needs to be assessed in detail by the project-specific stakeholders.

5.1.10 Discrepancies in curtailment regulation and compensation

In the context of IJmuiden Ver to UK hybrid project, there is no discrepancy concerning the curtailment and curtailment compensation regulation in the shorter term since the Dutch curtailment regulation applies to the Dutch OWF included in the hybrid project. Furthermore, the topic is addressed in the Clean Energy Package, such that in the longer term the translation into Dutch law needs to be assessed in detail by the project-specific stakeholders.

5.1.11 Lack of regulated revenues for anticipatory investments

This barrier is relevant for the IJmuiden Ver to UK hybrid project.

To address this barrier, only the Dutch regulatory regime is assessed with regard to its applicability to cover anticipatory investments (Table 11) – excluding the implications of interdependencies with other barriers. The assessment concentrates on the Dutch regime since the anticipatory investments have to be undertaken during the development of the export cable system, for which TenneT TSO B.V. is responsible.

	Dutch regulation
Legal / regulatory coverage	Anticipatory investments for export cable systems and interconnectors are considered under Dutch regulation
Treatment of anticipatory investments	Anticipatory investments are treated exactly the same as non-anticipatory investments, but must be included in Offshore Grid Development Framework by the Dutch government
Efficiency benchmark	Efficiency benchmark exists and regulatory regime provides for standard procedures to assess appropriate investments
Public opinion	Public support required for inclusion of investment in Offshore Grid Development Framework
Risk to project realisation	No risk since TSO can cover investments through their inclusion in the RAB
Risk of stranded asset	Risk of stranded transmission investment exists with coverage under Dutch regulation uncertain
Summary	Anticipatory investments are treated as regular investments but are taken at discretion of government through inclusion in Offshore Grid Development Framework

Table 11: IJmuiden Ver to UK – Assessment of regulatory regimes for anticipatory investments

In summary, the interaction with stakeholders shows that the inclusion of the hybrid project in the Offshore Grid Development Framework in the Netherlands needs to be agreed, since the risk of non-recovery of anticipatory investments is likely to be prohibitive otherwise. Still, the efficiency of anticipatory investments must be assessed to ensure the sensible expansion of infrastructure.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the IJmuiden Ver to UK hybrid project must also take into account the interdependencies between the individual barriers.

5.1.12 Uncertainty about applicable RES subsidy scheme

This barrier is not relevant for the IJmuiden Ver to UK hybrid project.

In the context of the IJmuiden Ver to UK hybrid project, there is no uncertainty concerning the applicability of national subsidy schemes since the national subsidy scheme of the Netherlands applies to the OWF included in the hybrid project.

5.1.13 Limited engagement of public stakeholders

The barrier "limited engagement of public stakeholders" is divided into two subtopics, formalised public support and financial support. The two subtopics are addressed individually in the following.

Formalisation of commitment from public stakeholders

This subtopic of the barrier is relevant for the IJmuiden Ver to UK hybrid project.

To address this barrier, two mitigation options are assessed with regard to their applicability (Table 12) – excluding the implications of interdependencies with other barriers.

- Option 1 "Memorandum of Understanding (MoU)": A Memorandum of Understanding is a formalisation of the goodwill of the involved parties in form of a non-binding agreement. An MoU addresses barriers by formalising the agreements of the involved parties with regard to the implementation of required actions to overcome the barriers. It can involve all project stakeholders, such as OWF developers, TSOs, national ministries and NRAs as well as the European Commission.
- Option 2 "Hybrid Asset Network Support Agreement (HANSA)": A project-specific Hybrid Asset Network Support Agreement is a legally-binding commitment to adapt national legislation and regulation in the future, and thus provides legal certainty to developers. European legislation and regulation can only be adapted via a project-specific HANSA if all Member States of the European Union sign the agreement. It only directly involves public stakeholders, such as national ministries.

	Option 1: Memorandum of Understanding (MoU)	Option 2: Hybrid Asset Network Support Agreement (HANSA)
Required effort	Some interaction and alignment required among project developers and stakeholders to facilitate signing of agreement	Significant interaction and alignment among political project stakeholders required to facilitate signing of agreement
Provided certainty	Intentional character of signed agreement sufficient for hybrid projects in early development stage	Legally binding commitment to topics covered by signed agreement directly facilitates project development, but is only required at a later development stage of hybrid projects

	Option 1: Memorandum of Understanding (MoU)	Option 2: Hybrid Asset Network Support Agreement (HANSA)
Summary	Reasonable effort to align agreement required prior to signing and non-legally binding commitment sufficient in early project development stages	Significant effort for alignment of agreement required prior to signing but provides legal certainty and therefore suitable in later development stages

Table 12: IJmuiden Ver to UK – Assessment of options for formalisation of commitment from public stakeholders

In summary, the interaction with stakeholders shows that both options – a project-specific Memorandum of Understanding (Option 1) and a project-specific Hybrid Asset Network Support Agreement (Option 2) – have advantages and disadvantages. While less effort is usually required to align and sign a project-specific MoU, an MoU is not legally binding, and thus the commitment of public stakeholders provides limited certainty, for example, about legal and regulatory changes for project developers (Option 1). However, while a project-specific HANSA provides legal certainty about the commitment of stakeholders to implement legal and regulatory changes, the alignment process requires more effort (Option 2).

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the IJmuiden Ver to UK hybrid project must also take into account the interdependencies between the individual barriers as well as the development stage of the hybrid project.

Financial support

This subtopic of the barrier is relevant for the IJmuiden Ver to UK hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of limited financial support, but rather that a portfolio of support programmes is available, and their usage needs to be increased to facilitate the implementation of hybrid projects. In the past, hybrid project development and / or considerations, such as the Combined Grid Solution Kriegers Flak in the Baltic Sea and the Interconnector tie-in COBRA Cable in the North Sea, indicate that such support is required to de-risk and thereby allow for the realisation of pilot projects. In this context, financial support can come in various forms, such as co-financing for early-stage feasibility studies, scoping studies or R&D, co-financing of development and construction or guarantees for the operational phase. Generally, financial support programmes are available on national and European level and should be as specifically targeted at hybrid projects as possible. The target is to increase the awareness for and the usage of existing financial support programmes and thereby foster the development of hybrid projects.

Considering the results of the interaction with the stakeholders, the mitigation of this barrier for the IJmuiden Ver to UK hybrid project must also take into account the interdependencies between the individual barriers.

5.1.14 Uncertainty regarding the UK market

The barrier "uncertainty regarding the UK market" is divided into two subtopics, UK Capacity Market and UK Cap and Floor regime as well as EU internal energy market. The two subtopics are addressed individually in the following.

UK Capacity Market and Cap and Floor regime

This subtopic of the barrier is relevant for the IJmuiden Ver to UK hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of uncertainty about the continuance of the UK Capacity Market – which has been declared illegal by the General Court of the EU on November 15, 2018 and it is presently put on hold, with next the capacity auction indefinitely postponed – as well as the Cap and Floor regime, particularly in the context of the negotiations regarding the withdrawal of the UK from the EU, but rather that a process towards the mitigation of the barrier must be followed. The process consists of awaiting the finalisation of the negotiations between the UK and the European Union to allow for the clarification of the future of the UK Capacity Market and Cap and Floor regime.

Considering the results of the interaction with the stakeholders, the mitigation process to be followed for the IJmuiden Ver to UK hybrid project must also take into account the interdependencies between the individual barriers.

EU internal energy market

This subtopic of the barrier is relevant for the IJmuiden Ver to UK hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of uncertainty about the continuance of the participation of the UK in the EU internal energy market, particularly in the context of the negotiations regarding the withdrawal of the UK from the EU, but rather that a process towards the mitigation of the barrier must be followed. The process consists of awaiting the finalisation of the negotiations between the UK and the European Union to allow for the clarification of the future of the UK's participation in the EU internal energy market.

Considering the results of the interaction with the stakeholders, the mitigation process to be followed for the IJmuiden Ver to UK hybrid project must also take into account the interdependencies between the individual barriers.

5.1.15 Disproportionate allocation of costs and benefits across involved stakeholders

This barrier is relevant for the IJmuiden Ver to UK hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of disproportionate allocation of costs and benefits across involved stakeholders, but rather that a process towards the mitigation of the barrier must be followed. Generally, the process consists of the identification and alignment of cost and benefit categories, the determination of the initial allocation of costs and benefits, the agreement on a re-allocation of costs and benefits as well as – if required and available – the usage of CEF funding to ensure the individual incentivisation of all stakeholders. This can build on the existing process for Cost Benefit Analyses (CBA) and Cross-Border Cost Allocations (CBCA) as defined by ENTSO-E for cross-border electricity interconnectors, which needs to be adjusted according to the specifications of each individual hybrid project. The process should allow for the incentivisation of all relevant stakeholders to implement the hybrid project.

Considering the results of the interaction with the stakeholders, the mitigation process to be followed for the IJmuiden Ver to UK hybrid project must also take into account the interdependencies between the individual barriers.

5.1.16 Uncertainty about legislative regime for power-to-gas and related infrastructure

This barrier is not relevant for the IJmuiden Ver to UK hybrid project.

In the context of the IJmuiden Ver to UK hybrid project, it is currently not planned to include power conversion to gas and / or gas transmission solutions. Thus, there is no need for and consequently no uncertainty regarding the legislative regime for power conversion to gas and gas transmission for the specific hybrid project idea.

5.2 CGS IJmuiden Ver to Norfolk

Throughout stakeholder interaction, 9 out of 16 barriers are identified to be relevant for the implementation of the CGS IJmuiden Ver to Norfolk hybrid project idea. The results of the interaction with stakeholders with regard to all barriers – relevant and not relevant – are summarised in the ensuing subchapters.

5.2.1 Uncertainty about responsibility for project development

The barrier "uncertainty about responsibility for project development" is divided into three subtopics, grid connection responsibility, responsibility for the development and construction of the interconnector and responsibility for the operation of the interconnector. The three subtopics are addressed individually in the following.

Grid connection responsibility

This subtopic of the barrier is not relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

The OWF sites are in the UK EEZ, where the OFTO regime applies for the grid connection, and in the Dutch EEZ, where the responsibility for development, construction as well as operation of the Dutch export cable system is assigned to the offshore grid operator TenneT TSO B.V. Therefore, responsibility for the development and construction as well as operation of the UK and Dutch export cable system lies with Vattenfall and an OFTO under the developer build option in the UK and TenneT TSO B.V. in the Netherlands. The responsibility is not further discussed in this study.

Responsibility for development and construction of interconnector

This subtopic of the barrier is relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

To address this barrier, four mitigation options are assessed with regard to their applicability (Table 13) – excluding the implications of interdependencies with other barriers.

- Option 1 "TenneT TSO B.V. is responsible": The Dutch TSO, TenneT TSO B.V., is responsible for the development and construction of the interconnector (only interconnector cable) between the offshore substations of the export cable systems of the UK OWF and the Dutch OWF.
- Option 2 "TenneT TSO B.V. and Vattenfall are responsible": The Dutch TSO, TenneT TSO B.V., and the OWF developer, Vattenfall, are responsible for the development and construction of the interconnector (only interconnector cable) between the offshore substations of the export cable systems of the UK OWF and the Dutch OWF.
- Option 3 "TenneT TSO B.V. and OFTO are responsible": The Dutch TSO, TenneT TSO B.V., and a to be determined UK OFTO are responsible for the development and construction of the interconnector (only interconnector cable) between the offshore substations of the export cable systems of the UK OWF and the Dutch OWF.

- Option 4 "TenneT TSO B.V. and UK interconnector developer are responsible": The Dutch TSO, TenneT TSO B.V., and a UK interconnector developer are responsible for the development and construction of the interconnector (only interconnector cable) between the offshore substations of the export cable systems of the UK OWF and the Dutch OWF.

	Option 1: TenneT TSO B.V. is responsible	**Option 2: TenneT TSO B.V. and Vattenfall are responsible**	**Option 3: TenneT TSO B.V. and OFTO are responsible**	**Option 4: TenneT TSO B.V. and UK interconnector developer are responsible**
Legal / regulatory coverage	Covered in UK and NL legislation and regulation – EU network codes such as "HVDC Connections" support technical standardisation	Covered in UK and NL legislation and regulation (unbundling applies only after commissioning) – EU network codes such as "HVDC Connections" support technical standardisation	Not covered in UK legislation and regulation since one OFTO cannot hold both transmission and IC license but covered in NL legislation and regulation – EU network codes such as "HVDC Connections" support technical standardisation	Covered in UK and NL legislation and regulation – EU network codes such as "HVDC Connections" support technical standardisation
Costs	Costs are with NL	Costs are with NL and OWF developer	Costs are with UK and NL	Costs are with NL and UK IC developer
Financial risk	Financial risk is with TenneT TSO B.V. (offshore grid operator), and thus with NL, therefore no risk towards project realisation	Financial risk is with TenneT TSO B.V. (offshore grid operator) and OWF developer, and thus with NL and OWF developer, therefore risk towards project realisation in case of cost overrun for OWF developer	Financial risk is with TenneT TSO B.V. (offshore grid operator) and OFTO, and thus with NL and OFTO, therefore risk towards project realisation in case of cost overrun for OFTO	Financial risk is with TenneT TSO B.V. (offshore grid operator) and UK IC developer, and thus with NL and UK IC developer, therefore risk towards project realisation

	Option 1: TenneT TSO B.V. is responsible	Option 2: TenneT TSO B.V. and Vattenfall are responsible	Option 3: TenneT TSO B.V. and OFTO are responsible	Option 4: TenneT TSO B.V. and UK interconnector developer are responsible
Development risk	Alignment of development not needed for single developer but across parts of entire cable system due to differing responsibilities, therefore low risk towards project realisation	Alignment of development needed for multiple developers and additionally across parts of entire cable system due to differing responsibilities, therefore uncertain risk towards project realisation	Alignment of development needed for multiple developers and additionally across parts of entire cable system due to differing responsibilities, therefore uncertain risk towards project realisation	Alignment of development needed for multiple developers and additionally across parts of entire cable system due to differing responsibilities, therefore uncertain risk towards project realisation
Market-specific expertise	Knowledge on general and project-specific grid connection requirements given for TenneT TSO B.V. in the NL and to some extent in the UK (from BritNed)	Knowledge on general and project-specific grid connection requirements given for Vattenfall in the UK and for TenneT TSO B.V. in the NL	Knowledge on general and project-specific grid connection requirements given for OFTO in the UK and for TenneT TSO B.V. in the NL	Knowledge on general and project-specific grid connection requirements given for UK interconnector developer in the UK and for TenneT TSO B.V. in the NL
Summary	Covered under UK and NL legal and regulatory regime and with low risk towards project realisation but only with market-specific expertise in the NL	Covered under UK and NL legal and regulatory regime and market-specific expertise in the UK and the NL, but with uncertain risk towards project realisation	Not covered under UK legal and regulatory regime and with uncertain risk towards project realisation but market-specific expertise in the UK and the NL	Covered under UK and NL legal and regulatory regime and market-specific expertise in the UK and the NL, but with uncertain risk towards project realisation

Table 13: CGS IJmuiden Ver to Norfolk – Assessment of options for responsibility during IC development and construction phase

In summary, the interaction with stakeholders shows that all four options – TenneT TSO B.V. being responsible for the development and construction of the interconnector (Option 1) as well as TenneT TSO B.V. together with Vattenfall (Option 2), a to be determined UK OFTO (Option 3) or a UK interconnector developer being responsible (Option 4) – have advantages and disadvantages. While TenneT TSO B.V. is legally allowed and able to develop and construct the interconnector on its own (Option 1), the collaboration with Vattenfall or with a UK interconnector developer is also possible and would make sense as a UK entity can contribute additional market-specific expertise about the connection to the UK market (Options 2 and 4). A collaboration between TenneT TSO B.V. and an OFTO (Option 3) is not covered under the UK legal and regulatory regime. Compared to shared responsibility between TenneT TSO B.V. and Vattenfall, an OFTO or a UK interconnector developer (Options 2, 3 and 4), the risk towards project realisation can be reduced if TenneT TSO B.V. is solely responsible for the development and construction of the interconnector (Option 1).

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the CGS IJmuiden Ver to Norfolk hybrid project must also take into account the interdependencies between the individual barriers.

Responsibility for operation of interconnector

This subtopic of the barrier is relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

To address this subtopic of the barrier, four mitigation options are assessed with regard to their applicability (Table 14) – excluding the implications of interdependencies with other barriers.

- Option 1 "TenneT TSO B.V. is responsible": The Dutch TSO, TenneT TSO B.V., is responsible for the operation of the interconnector (only interconnector cable) between the offshore substations of the export cable systems of the UK OWF and the Dutch OWF.
- Option 2 "TenneT TSO B.V. and Vattenfall are responsible": The Dutch TSO, TenneT TSO B.V., and the OWF developer, Vattenfall, are responsible for the operation of the interconnector (only interconnector cable) between the offshore substations of the export cable systems of the UK OWF and the Dutch OWF.
- Option 3 "TenneT TSO B.V. and OFTO are responsible": The Dutch TSO, TenneT TSO B.V., and a to be determined UK OFTO are responsible for the operation of the interconnector (only interconnector cable) between the offshore substations of the export cable systems of the UK OWF and the Dutch OWF.
- Option 4 "TenneT TSO B.V. and UK interconnector developer are responsible": The Dutch TSO, TenneT TSO B.V., and UK interconnector developer are responsible for the operation of the interconnector (only interconnector cable) between the offshore substations of the export cable systems of the UK OWF and the Dutch OWF.

	Option 1: TenneT TSO B.V. is responsible	Option 2: TenneT TSO B.V. and Vattenfall are responsible	Option 3: TenneT TSO B.V. and OFTO are responsible	Option 4: TenneT TSO B.V. and UK interconnector developer are responsible
Legal / regulatory coverage	Covered in UK and NL legislation and regulation – EU network codes, such as "System Operations", and EU Regulations, such as "Electricity cross-border exchanges", support technical standardisation	Not covered in UK, NL and EU legislation and regulation (unbundling applies for OWF developer) – EU network codes, such as "System Operations", and EU Regulations, such as "Electricity cross-border exchanges", support technical standardisation	Not covered in UK legislation and regulation since one OFTO cannot hold both transmission and IC license but covered in NL legislation and regulation – EU network codes, such as "System Operations", and EU Regulations, such as "Electricity cross-border exchanges", support technical standardisation	Covered in UK and NL legislation and regulation – EU network codes, such as "System Operations", and EU Regulations, such as "Electricity cross-border exchanges", support technical standardisation
Costs	Costs are with NL	Costs are with NL and OWF developer	Costs are with UK and NL	Costs are with NL and UK IC developer
Operational risk	Alignment of operations not needed for single developer but across parts of entire cable system due to differing responsibilities, therefore low risk towards project realisation	Alignment of operations needed for multiple developers and additionally across parts of entire cable system due to differing responsibilities, therefore uncertain risk towards project realisation	Alignment of operations needed for multiple developers and additionally across parts of entire cable system due to differing responsibilities, therefore uncertain risk towards project realisation	Alignment of operations needed for multiple developers and additionally across parts of entire cable system due to differing responsibilities, therefore uncertain risk towards project realisation

	Option 1: TenneT TSO B.V. is responsible	Option 2: TenneT TSO B.V. and Vattenfall are responsible	Option 3: TenneT TSO B.V. and OFTO are responsible	Option 4: TenneT TSO B.V. and UK interconnector developer are responsible
Market-specific expertise	Knowledge on general and project-specific operational requirements given for TenneT TSO B.V. in the NL and to some extent in the UK (from BritNed)	Knowledge on general and project-specific operational requirements given for Vattenfall in the UK and for TenneT TSO B.V. in the NL	Knowledge on general and project-specific operational requirements given for OFTO in the UK and for TenneT TSO B.V. in the NL	Knowledge on general and project-specific operational requirements given for UK IC developer in the UK and for TenneT TSO B.V. in the NL
Summary	Covered under UK and NL legal and regulatory regime and with low risk towards project realisation but only with market-specific expertise in the NL	Not covered under EU and national legal and regulatory regime and with uncertain risk towards project realisation, but with market-specific expertise in the UK and the NL	Not covered under UK legal and regulatory regime and with uncertain risk towards project realisation, but with market-specific expertise in the UK and the NL	Covered under UK and NL legal and regulatory regime and with market-specific expertise in the UK and the NL, but with uncertain risk towards project realisation

Table 14: CGS IJmuiden Ver to Norfolk – Assessment of options for responsibility during IC operation phase

In summary, this interaction with stakeholders shows that all four options – TenneT TSO B.V. being responsible for the operation of the interconnector (Option 1) as well as TenneT TSO B.V. together with Vattenfall (Option 2), a to be determined UK OFTO (Option 3) or a UK interconnector developer being responsible (Option 4) – have advantages and disadvantages. While TenneT TSO B.V. is legally allowed and able to operate the interconnector on its own (Option 1), the collaboration with a UK interconnector developer is also possible and would make sense as a UK entity can contribute additional market-specific expertise about the operation of a cable system connected to the UK market (Option 4). A collaboration between TenneT TSO B.V. and Vattenfall (Option 2) or an OFTO (Option 3) is not covered under EU and / or UK legal and regulatory regime. Compared to shared responsibility between TenneT TSO B.V. and Vattenfall, an OFTO or a UK interconnector developer (Options 2, 3 and 4), the risk towards project realisation can be reduced if TenneT TSO B.V. is solely responsible for the operation of the interconnector (Option 1).

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the CGS IJmuiden Ver to Norfolk hybrid project must also take into account the interdependencies between the individual barriers.

5.2.2 Uncertainty about regulation deriving from jurisdiction over cross-border cable systems

This barrier is relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

To address this barrier, three mitigation options are assessed with regard to their applicability (Table 15) – excluding the implications of interdependencies with other barriers. The assessment concentrates on the regulation applicable to the operation of the interconnector since the development and construction of the interconnector constitute no barrier. Furthermore, the UK as well as the Dutch regulation is applicable to the UK and Dutch OWFs and export cable systems, respectively.

- Option 1 "UK jurisdiction's regulations": In addition to European law, UK regulation applies to the operation of the interconnector linking the offshore substations of the two export cable systems of the UK and Dutch OWFs across both the UK and the Dutch EEZ.
- Option 2 "Dutch jurisdiction's regulations": In addition to European law, Dutch regulation applies to the operation of the interconnector linking the offshore substations of the two export cable systems of the UK and Dutch OWFs across both the UK and the Dutch EEZ.
- Option 3 "Alignment of jurisdictions' regulations": Based on negotiations between the UK and the Netherlands, a new combination of regulations applies to the operation of the interconnector linking the offshore substations of the two export cable systems of the UK and Dutch OWFs across both the UK and the Dutch EEZ – in addition to European law. The new combination of regulations over the operation of the interconnector can potentially be based on existing agreements established for the interconnectors between the UK and the Netherlands, such as BritNed.

	Option 1: UK jurisdiction's regulations	**Option 2: Dutch jurisdiction's regulations**	**Option 3: Alignment of jurisdictions' regulations, e.g. based on BritNed**
Rights and duties in UK EEZ during operation	Uncertainty and thus alignment required since neither country has clear jurisdiction since cable neither crosses the UK nor the NL territorial seas as well as does not serve exploitation of the UK nor the NL EEZ	Uncertainty and thus alignment required since neither country has clear jurisdiction since cable neither crosses the UK nor the NL territorial seas as well as does not serve exploitation of the UK nor the NL EEZ	Alignment required to combine operational rules deriving from jurisdictions of the UK and the NL for UK EEZ through involvement of the UK and the NL
Rights and duties in NL EEZ during operation	Uncertainty and thus alignment required since neither country has clear jurisdiction since cable neither crosses the UK nor the NL territorial seas as well as does not serve exploitation of the UK nor the NL EEZ	Uncertainty and thus alignment required since neither country has clear jurisdiction since cable neither crosses the UK nor the NL territorial seas as well as does not serve exploitation of the UK nor the NL EEZ	Alignment required to combine operational rules deriving from jurisdictions of the UK and the NL for NL EEZ through involvement of the UK and the NL

	Option 1: UK jurisdiction's regulations	Option 2: Dutch jurisdiction's regulations	Option 3: Alignment of jurisdictions' regulations, e.g. based on BritNed
Hybrid project requirements	Alignment of operational rules between the UK and the NL required because of a connection of the NL OWF to the interconnector via the offshore substation of the Dutch export cable system	Alignment of operational rules between the UK and the NL required because of a connection of the UK OWF to the interconnector via the offshore substation of the UK export cable system	No additional alignment of operational rules required
Timeline	Alignment may extend the timeline of the project	Alignment may extend the timeline of the project	Alignment may extend the timeline of the project
Others			Provisions for assigning liability in case of grid connection failure need to be implemented
Summary	Uncertainty and thus alignment required to ensure applicability of Option 1 since no clear rules apply in all relevant maritime zones	Uncertainty and thus alignment required to ensure applicability of Option 2 since no clear rules apply in all relevant maritime zones	Alignment required to ensure applicability of Option 3 since no clear rules apply in all relevant maritime zones

Table 15: CGS IJmuiden Ver to Norfolk – Assessment of options for regulation deriving from jurisdiction deriving from cross-border cable systems

In summary, the interaction with stakeholders shows that all three options – the agreement on the applicability of operational rules to the interconnector based on UK (Option 1) or Dutch jurisdiction (Option 2) as well as the alignment of rules deriving from the UK and Dutch jurisdiction (Option 3) – have advantages and disadvantages. While chances of an agreement among the UK and the Netherlands on a single jurisdiction are limited, the alignment of rules deriving from two jurisdictions can be a lengthy process. Yet, Option 3 reflects the interest of both countries in the alignment and can potentially build on existing agreements established for the interconnectors between the UK and the Netherlands, such as BritNed.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the CGS IJmuiden Ver to Norfolk hybrid project must also take into account the interdependencies between the individual barriers.

5.2.3 Uncertainty about market arrangements

This barrier is relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

In the context of the CGS IJmuiden Ver to Norfolk hybrid project, the market arrangement is foreseen to be commercial flows to the home market, this is, of the UK OWF only to the UK and of the Dutch OWF only to the Netherlands. Since this market arrangement was identified in the interaction with project stakeholders as most feasible from the beginning, no other mitigation options were considered in detail. Leftover capacities on the export cable systems of the OWFs are foreseen to be available for interconnector trade.

Considering the identification of the market arrangement by the stakeholders, the validation of this mitigation option as appropriate for the CGS IJmuiden Ver to Norfolk hybrid project must also take into account the interdependencies between the individual barriers.

5.2.4 Uncertainty about hybrid cable system classification

This barrier is relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

To address this barrier, two mitigation options are assessed with regard to their applicability (Table 16) – excluding the implications of interdependencies with other barriers. The assessment concentrates on the export cable systems between the UK OWF and the UK market as well as the Dutch OWF and the Dutch market. The interconnector included in the hybrid project, meaning the cable connection from the offshore substation of the export cable systems of the UK OWF and the Dutch OWF functions solely as an interconnector since each OWF only transmits electricity to its respective home market (market arrangement as foreseen by the project developers).

- Option 1 "Export system with interconnector functionality": The UK and the Dutch export cable system are hybrid cable systems which allow for the transmission of electricity from the UK and the Dutch OWF to the UK and the Dutch markets, respectively. Hence, the UK and the Dutch export cable system (together with the interconnector and the other export cable system) only provide leftover capacities for the interconnector functionality between the UK and the Dutch bidding zone.
- Option 2 "Interconnector with export system functionality": The UK and the Dutch export cable system are hybrid cable systems which allow for the transmission of electricity from the UK and the Dutch OWF to the UK and the Dutch market, respectively, only with leftover capacities. Hence, the UK and the Dutch export cable system (together with the interconnector and the other export cable system) primarily provide interconnector functionality between the UK and the Dutch bidding zone.

	Option 1: Export cable with IC functionality	**Option 2: IC with export cable functionality**
UK national legal / regulatory coverage	Not covered as OFTO transmission license does not permit market-to-market flows and one OFTO cannot hold both a transmission and an interconnector license	Not covered as OFTO transmission license does not permit market-to-market flows and one OFTO cannot hold both a transmission and an interconnector license
NL national legal / regulatory coverage	Potentially covered as NL regulation does not expressly prohibit dual functionality of cables but legal / regulatory feasibility to be validated	Potentially covered as NL regulation does not expressly prohibit dual functionality of cables but legal / regulatory feasibility to be validated

	Option 1: Export cable with IC functionality	**Option 2: IC with export cable functionality**
EU legal / regulatory coverage	Not covered under Electricity Directive because it does not include an add. definition for hybrid cable systems; EU Regulation 714/2009 prescribes that "maximum capacity of the interconnections […] shall be made available to market participants" with clarity needed whether "maximum" refers to nominal or leftover capacities of cable systems in hybrid projects	Not covered under Electricity Directive because it does not include an add. definition for hybrid cable systems; EU Regulation 714/2009 prescribes that "maximum capacity of the interconnections […] shall be made available to market participants" with clarity needed whether "maximum" refers to nominal or leftover capacities of cable systems in hybrid projects
Potential for curtailment of OWF	OWFs can transmit electricity to shore at full generation capacity, and thus no business case implications and minimised curtailment	OWFs can transmit electricity to shore depending on leftover capacity of cable systems, and thus negative business case implications due to additional curtailment
Potential for congestion of IC	Capacity available for trade is significantly reduced, and thus negative business case implications for IC functionality of the entire cable system	Full capacity is available for trade, and thus no business case implications for IC functionality of the entire cable system
Compensation	Due to joint development of transmission assets in hybrid project, optimisation of business case of cable system as a whole given; potentially no additional compensation necessary	Due to foregone revenues from additional curtailment, additional compensation for OWFs required
Third party access	Third party access only given for leftover capacities after transmission of electricity from OWFs to shores	Third party access given
Impact on EU's energy policy targets	Priority on primary targets of diversification and integration of RES as well as on GHG emission reductions over secondary target of maximised IC capacity	Priority on secondary target of maximised IC capacity over primary targets of diversification and integration of RES as well as on GHG emission reductions
Summary	Not covered under existing EU regulation, but potentially covered under NL regulation; potential for negative business case implications for IC may necessitate additional compensation	Not covered under existing EU regulation, but potentially covered under NL regulation; negative business case implications for OWFs necessitate additional compensation

Table 16: CGS IJmuiden Ver to Norfolk – Assessment of options for hybrid cable system classification

In summary, the interaction with stakeholders shows that both options – an export cable with interconnector functionality (Option 1) and an interconnector with export cable functionality (Option 2) – have advantages and disadvantages. Both, Option 1 and 2 require changes in the European and UK regulatory framework as well as potentially in the Dutch legal and regulatory framework. Option 2 has unfavourable implications for the business case of the OWF developers since the developers have no priority access to transmission capacity. Contrary, in Option 1, the interconnector developers have no priority access to the capacity of the cable system resulting in unfavourable implications for the business case for the interconnector. However, the interconnector developers might be able to optimise the entire cable system to counterbalance implications in consequence of the connection of the OWFs to it. Furthermore, Option 2 prioritises the secondary EU energy policy target of maximised electricity interconnection capacity over the primary targets of diversification and integration of RES as well as greenhouse gas emission reduction.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the CGS IJmuiden Ver to Norfolk hybrid project must also take into account the interdependencies between the individual barriers.

5.2.5 Failure of developers to align planning across assets and countries

The barrier "failure of developers to align planning across assets and countries" is divided into three subtopics, geographical alignment, technical alignment and timing alignment. The three subtopics are addressed individually in the following.

Geographical alignment

This subtopic of the barrier is relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of failed geographical alignment across assets and countries, but rather that a process towards the mitigation of the barrier must be followed. The process consists of the continuous exchange between project developers and other stakeholders to allow for the achievement of early-stage, geographical alignment.

Considering the results of the interaction with the stakeholders, the mitigation process to be followed for the CGS IJmuiden Ver to Norfolk hybrid project must also take into account the interdependencies between the individual barriers.

Technical alignment

This subtopic of the barrier is relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of failed technical alignment across assets and countries, but rather that a process towards the mitigation of the barrier must be followed. The process consists of the continuous exchange between project developers and other stakeholders to allow for the achievement of early-stage, technical alignment.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the IJmuiden Ver to UK hybrid project must also take into account the interdependencies between the individual barriers.

Timing alignment

This subtopic of the barrier is not relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

In the context of the CGS IJmuiden Ver to Norfolk hybrid project, timing alignment is not relevant since the two OWFs can function as stand-alone assets with the interconnector between the offshore substations of the export cable systems of the OWFs as an additional asset that can be added later in time. Thus, the timelines do not need to be aligned provided that geographical and technical alignment have taken place.

5.2.6 Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation and tender execution)

The barrier "uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation and tender execution)" is divided into two subtopics, location selection and site pre-investigation as well as tender execution. The two subtopics are addressed individually in the following.

Location selection and site pre-investigation

This subtopic of the barrier is not relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

In the context of the CGS IJmuiden Ver to Norfolk hybrid project, there is no uncertainty concerning location selection and site pre-investigation responsibility and procedures since the UK and Dutch authorities are responsible and UK and Dutch procedures are applicable, respectively, for the UK OWF and the Dutch OWF included in the hybrid project.

Tender responsible party

This subtopic of the barrier is not relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

In the context of the CGS IJmuiden Ver to Norfolk hybrid project, there is no uncertainty concerning determination of the tender responsible party since the respective party of the national tender procedure is responsible for the tenders of the UK OWF and the Dutch OWF included in the hybrid project.

5.2.7 Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)

This barrier is relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

To address this barrier, four mitigation options are assessed with regard to their applicability (Table 17) – excluding the implications of interdependencies with other barriers.

- Option 1 "Strict design with aligned requirements and without hybrid-specific uncertainties": A tender design with strict pre-qualification requirements implies that extensive pre-qualification requirements are defined to ensure hybrid-specific and general capabilities to develop the CGS IJmuiden Ver to Norfolk hybrid project. The requirements are aligned among the UK and the Netherlands, including a jointly agreed set of financial requirements and a certain set of both UK and Dutch rules related to the OWF sites (e.g. environmental details) and a certain set of both UK and Dutch rules related to the grid connection of the OWFs (e.g. technical and operational details such as system integration or frequency control). Furthermore, all uncertainties arising from the hybrid character of the OWF developments are clarified prior to the tender.
- Option 2 "Strict design with aligned requirements": A tender design with strict pre-qualification requirements implies that extensive pre-qualification requirements are defined to ensure hybrid-specific and general capabilities to develop the CGS IJmuiden Ver to Norfolk hybrid project. The requirements are aligned among the UK and the Netherlands, including a jointly agreed set of financial requirements and a certain set of both UK and Dutch rules related to the OWF sites (e.g. environmental details) and a certain set of both UK and Dutch rules related to the grid connection of the OWFs (e.g. technical and operational details such as system integration or frequency control). Furthermore, the uncertainties arising from the hybrid character of the OWF developments are not clarified prior to the tender.

- Option 3: "Strict design without hybrid-specific uncertainties": A tender design with strict pre-qualification requirements implies that extensive pre-qualification requirements are defined to ensure hybrid-specific and general capabilities to develop the CGS IJmuiden Ver to Norfolk hybrid project. The requirements are either defined by the UK or by the Netherlands and not aligned. Furthermore, all uncertainties arising from the hybrid character of the OWF developments are clarified prior to the tender.
- Option 4 "Lenient design with aligned requirements and without hybrid-specific uncertainties": A tender design with lenient pre-qualification requirements is chosen, implying that only limited pre-qualification requirements are defined to ensure competition and low prices. The requirements are aligned among the UK and the Netherlands, including a jointly agreed set of financial requirements and a certain set of both UK and Dutch rules related to the OWF sites (e.g. environmental details) and a certain set of both UK and Dutch rules related to the grid connection of the OWFs (e.g. technical and operational details such as system integration or frequency control). Furthermore, all uncertainties arising from the hybrid character of the OWF developments are clarified prior to the tender.

	Option 1: Strict design, aligned requirements and no uncertainties	**Option 2: Strict design and aligned requirements**	**Option 3: Strict design and no uncertainties**	**Option 4: Lenient design, aligned requirements and no uncertainties**
Legal / regulatory coverage	Not covered and potential amendments to national legislation and regulation necessary since multiple countries are involved in defining tender design	Not covered and potential amendments to national legislation and regulation necessary since multiple countries are involved in defining tender design	Covered and no amendments to national legislation and regulation necessary since only one country is involved in defining tender design	Not covered and potential amendments to national legislation and regulation necessary since multiple countries are involved in defining tender design
Alignment of requirements	Financial, technical and operational requirements aligned; environmental requirements defined by the UK and the NL for corresponding OWFs	Financial, technical and operational requirements aligned; environmental requirements defined by the UK and the NL for corresponding OWFs	No alignment of requirements	Financial, technical and operational requirements aligned; environmental requirements defined by the UK and the NL for corresponding OWFs

	Option 1: Strict design, aligned requirements and no uncertainties	Option 2: Strict design and aligned requirements	Option 3: Strict design and no uncertainties	Option 4: Lenient design, aligned requirements and no uncertainties
Hybrid-specific un-certainties	All uncertainties arising from hybrid-specific setup are clarified, e.g. liability, applicable jurisdiction, grid connection responsibility, hybrid cable system classification	Uncertainties arising from hybrid character of development not entirely clarified such that uncertainty remains for OWF developer	All uncertainties arising from hybrid-specific setup are clarified, e.g. liability, applicable jurisdiction, grid connection responsibility, hybrid cable system classification	All uncertainties arising from hybrid-specific setup are clarified, e.g. liability, applicable jurisdiction, grid connection responsibility, hybrid cable system classification
Realisation probability	Applying OWF developers are aware of all specifications and requirements and can align planning and financing right from the beginning	Applying OWF developers are aware of all specifications and requirements and can align planning and financing right from the beginning	Applying OWF developers are aware of all specifications and requirements and can align planning and financing right from the beginning; however, it is questionable whether OWFs connected to two countries can be tendered without alignment of tender requirements	Applying OWF developers are not aware of most specifications and requirements, which might result in significant cost overruns / delays after the tender process
Cost efficiency	Due to strict requirements and specifications, less developers expected to apply – cost efficiency of offers expected to decrease with fewer applicants	Due to strict requirements and specifications, less developers expected to apply – cost efficiency of offers expected to decrease with fewer applicants	Due to strict requirements and specifications, less developers expected to apply – cost efficiency of offers expected to decrease with fewer applicants	Due to lenient requirements and specifications, many developers expected to apply – cost efficiency of offers expected to increase with more applicants

	Option 1: Strict design, aligned requirements and no uncertainties	Option 2: Strict design and aligned requirements	Option 3: Strict design and no uncertainties	Option 4: Lenient design, aligned requirements and no uncertainties
Summary	Legal and regulatory coverage to be assessed and potentially decreases cost efficiency	Legal and regulatory coverage to be assessed and decreases cost efficiency, particularly due to remaining hybrid uncertainties	Legal and regulatory coverage given, but with limited chance of realisation due to non-consideration of one country's interest in defining tender requirements	Legal and regulatory coverage to be assessed and strongly decreases probability of project realisation

Table 17: CGS IJmuiden Ver to Norfolk – Assessment of options for tender design

In summary, the interaction with stakeholders shows that all four options – a strict or lenient tender design with aligned requirements and certainty about hybrid-specific characteristics of the OWF development (Option 1 and 4), a strict tender design with aligned requirements (Option 3) as well as a strict tender design with certainty about hybrid-specific characteristics of the OWF development (Option 2) – have advantages and disadvantages. While a tender design with strict requirements (Options 1, 2 and 3) increases the probability of successful project implementation, a tender design with lenient requirements (Option 4) decreases the cost of implementation through competition. Furthermore, certainty about hybrid-specific characteristics of the OWF development (Option 1, 3 and 4) increases the probability of successful project implementation and decreases the cost of implementation by reducing the risk premium otherwise demanded by OWF developers in terms of subsidies. Lastly, aligned requirements (Options 1, 2 and 4) aid in ensuring the interoperability of the OWF with the other assets of the hybrid project and thereby increase the probability of successful hybrid project implementation.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the CGS IJmuiden Ver to Norfolk hybrid project must also take into account the interdependencies between the individual barriers.

5.2.8 Discrepancies in responsibilities and requirements for balancing

In the context of the CGS IJmuiden Ver to Norfolk hybrid project, there is no discrepancy concerning the balancing responsibility and requirements in the shorter term since UK and Dutch responsibilities and requirements apply to the UK OWF and the Dutch OWF included in the hybrid project, respectively. Furthermore, the topic is addressed in the Clean Energy Package such that, for the Dutch OWF, the translation into Dutch law needs to be assessed in detail by the project-specific stakeholders in the longer term.

5.2.9 Discrepancies in priority dispatch regulation

In the context of the CGS IJmuiden Ver to Norfolk hybrid project, there is no discrepancy concerning priority dispatch regulation in the shorter term since UK and Dutch priority dispatch regulation applies to the OWFs included in the hybrid project, respectively. Furthermore, the topic is addressed in the Clean Energy Package, such that, for the Dutch OWF, the translation into Dutch law needs to be assessed in detail by the project-specific stakeholders in the longer term.

5.2.10 Discrepancies in curtailment regulation and compensation

In the context of CGS IJmuiden Ver to Norfolk hybrid project, there is no discrepancy concerning curtailment and curtailment compensation regulation in the shorter term since UK and Dutch curtailment regulation applies to the UK OWF and the Dutch OWF included in the hybrid project, respectively. Furthermore, the topic is addressed in the Clean Energy Package, such that, for the Dutch OWF, the translation into Dutch law needs to be assessed in detail by the project-specific stakeholders in the longer term.

5.2.11 Lack of regulated revenues for anticipatory investments

This barrier is relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

To address this barrier, four mitigation options are assessed with regard to their applicability (Table 18) – excluding the implications of interdependencies with other barriers.

- Case 1: Anticipatory investments under Dutch regulation. Anticipatory investments for export cable systems are necessary due to the timeline of the specific hybrid project. In the case of unaligned development, the OWF and export cable system are expected to be developed first but must take into account the addition of the interconnector at a later point in time in their technical design. Dutch export cable systems are developed by TenneT TSO B.V.
- Case 2: Anticipatory investments for export cable systems under the developer build option of the UK OFTO regime. Anticipatory investments for export cable systems are necessary due to the timeline of the specific hybrid project. In the case of unaligned development, the OWF and export cable system are expected to be developed first but must take into account the addition of the interconnector at a later point in time in their technical design. UK export cable systems are developed by OWF developers and transferred to an OFTO before commissioning.
- Case 3: Anticipatory investments for export cable systems under the OFTO build option of the UK OFTO regime. Anticipatory investments for export cable systems are necessary due to the timeline of the specific hybrid project. In the case of unaligned development, the OWFs and export cable systems are expected to be developed first but must take into account the addition of the interconnector at a later point in time in their technical design. UK export cable systems are developed by OFTOs.
- Case 4: Anticipatory investments for interconnectors under the UK Cap and Floor regime. No anticipatory investments for the interconnector are expected due to the timeline of the specific hybrid project. In the case of unaligned development, the interconnector is expected to be developed last. Interconnectors are developed by third parties.

	Case 1: Dutch regulation	Case 2: UK regulation – Developer build	Case 3: UK regulation – OFTO build	Case 4: UK regulation – Cap and Floor
	Concerned asset: Export cable system	**Concerned asset: Export cable system**	**Concerned asset: Export cable system**	**Concerned asset: Interconnector**
Legal / regulatory coverage	Anticipatory investments for export cable systems and interconnectors are considered under Dutch regulation	Anticipatory investments for export cable systems are considered under OFTO regime	Anticipatory investments for export cable systems are considered under OFTO regime	Anticipatory investments for interconnectors are considered under Cap and Floor regime
Treatment of anticipatory investments	Anticipatory investments are treated exactly the same way as non-anticipatory investments, but must be included in Offshore Grid Development Framework by the Dutch government	Risk remains with developer since anticipatory investment are subject to determination of final transfer value	Risk remains with OFTO since anticipatory investment are subject to valuation	Risk remains with developer since anticipatory investments must be deemed to be in consumer's best interest to be included in determination of cap and floor levels
Efficiency benchmark	Efficiency benchmark exists and regulatory regime provides for standard procedures to assess appropriate investments	Efficiency benchmark is carried out on a project-by-project basis for both WNBI[218] and GFAI[219], such that criteria remain unclear	Efficiency benchmark is carried out on a project-by-project basis for both WNBI[220] and GFAI[221], such that criteria remain unclear	Efficiency benchmark is carried out on a project-by-project basis such that criteria remain unclear
Public opinion	Public support required for inclusion of investment in Offshore Grid Development Framework	Public support given if benchmark ensures that investment is efficient	Public support given if benchmark ensures that investment is efficient	Public support given if benchmark ensures that investment is efficient

[218] Developer-led Wider Network Benefit Investment
[219] Generator Focused Anticipatory Investment
[220] Developer-led Wider Network Benefit Investment
[221] Generator Focused Anticipatory Investment

	Case 1: Dutch regulation	Case 2: UK regulation – Developer build	Case 3: UK regulation – OFTO build	Case 4: UK regulation – Cap and Floor
	Concerned asset: Export cable system	**Concerned asset: Export cable system**	**Concerned asset: Export cable system**	**Concerned asset: Interconnector**
Risk to project realisation	No risk since TSO can cover investments through their inclusion in the RAB	No assurance given to developer that expended costs will be recovered	No assurance given to developer that expended costs will be recovered	No assurance given to developer that expended costs will be recovered
Risk of stranded asset	Risk of stranded transmission investment exists with coverage under Dutch regulation uncertain	Risk of stranded transmission investment exists and may be internalised / only covered under user commitment arrangement given special circumstances	Risk of stranded transmission investment exists but may be covered under existing user commitment arrangement	Risk of stranded transmission investment not applicable for compensation under Cap and Floor regime
Summary	Anticipatory investments are treated as regular investments but are taken at discretion of government through inclusion in Offshore Grid Development Framework	Risk of non-recovery of anticipatory investment is prohibitive	Risk of non-recovery of anticipatory investment is prohibitive	Risk of non-recovery of anticipatory investment is prohibitive

Table 18: CGS IJmuiden Ver to Norfolk – Assessment of regulatory regimes for anticipatory investments

In summary, the interaction with stakeholders shows that reimbursement needs to be assured under UK legislation and that the inclusion of the hybrid project in the Offshore Grid Development Framework in the Netherlands needs to be agreed, since the risk of non-recovery of costs is likely to be prohibitive otherwise. Still, the efficiency of anticipatory investments must be assessed to ensure the sensible expansion of infrastructure.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the CGS IJmuiden Ver to Norfolk hybrid project must also take into account the interdependencies between the individual barriers.

5.2.12 Uncertainty about applicable RES subsidy scheme

This barrier is not relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

In the context of the CGS IJmuiden Ver to Norfolk hybrid project, there is no uncertainty concerning the applicability of national subsidy schemes since the respective national subsidy schemes of the Netherlands and the UK apply to the OWFs included in the hybrid project.

5.2.13 Limited engagement of public stakeholders

The barrier "limited engagement of public stakeholders" is divided into two subtopics, formalised public support and financial support. The two subtopics are addressed individually in the following.

Formalisation of commitment from public stakeholders

This subtopic of the barrier is relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

To address this barrier, two mitigation options are assessed with regard to their applicability (Table 19) – excluding the implications of interdependencies with other barriers.

- Option 1 "Memorandum of Understanding (MoU)": A Memorandum of Understanding is a formalisation of the goodwill of the involved parties in form of a non-binding agreement. An MoU addresses barriers by formalising the agreements of the involved parties with regard to the implementation of required actions to overcome the barriers. It can involve all project stakeholders, such as OWF developers, TSOs, national ministries and NRAs as well as the European Commission.
- Option 2 "Hybrid Asset Network Support Agreement (HANSA)": A project-specific Hybrid Asset Network Support Agreement is a legally-binding commitment to adapt national legislation and regulation in the future, and thus provides legal certainty to developers. European legislation and regulation can only be adapted via a project-specific HANSA if all Member States of the European Union sign the agreement. It only directly involves public stakeholders, such as national ministries.

	Option 1: Memorandum of Understanding (MoU)	Option 2: Hybrid Asset Network Support Agreement (HANSA)
Required effort	Some interaction and alignment required among project developers and stakeholders to facilitate signing of agreement	Significant interaction and alignment among political project stakeholders required to facilitate signing of agreement
Provided certainty	Intentional character of signed agreement sufficient for hybrid projects in early development stage	Legally binding commitment to topics covered by signed agreement directly facilitates project development, but is only required at a later development stage of hybrid projects
Summary	Reasonable effort to align agreement required prior to signing and non-legally binding commitment sufficient in early project development stages	Significant effort for alignment of agreement required prior to signing but provides legal certainty and therefore suitable in later development stages

Table 19: CGS IJmuiden Ver to Norfolk – Assessment of options for formalisation of commitment from public stakeholders

In summary, the interaction with stakeholders shows that both options – a project-specific Memorandum of Understanding (Option 1) and a project-specific Hybrid Asset Network Support

Agreement (Option 2) – have advantages and disadvantages. While less effort is usually required to align and sign a project-specific MoU, an MoU is not legally binding, and thus the commitment of public stakeholders provides limited certainty, for example, about legal and regulatory changes for project developers (Option 1). However, while a project-specific HANSA provides legal certainty about the commitment of stakeholders to implement legal and regulatory changes, the alignment process requires more effort (Option 2).

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the CGS IJmuiden Ver to Norfolk hybrid project must also take into account the interdependencies between the individual barriers as well as the development stage of the hybrid project.

Financial support

This subtopic of the barrier is relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of limited financial support, but rather that a portfolio of support programmes is available, and their usage needs to be increased to facilitate the implementation of hybrid projects. In the past, hybrid project development and / or considerations, such as the Combined Grid Solution Kriegers Flak in the Baltic Sea and the Interconnector tie-in COBRA Cable in the North Sea, indicate that such support is required to de-risk and thereby allow for the realisation of pilot projects. In this context, financial support can come in various forms, such as co-financing for early-stage feasibility studies, scoping studies or R&D, co-financing of development and construction or guarantees for the operational phase. Generally, financial support programmes are available on national and European level and should be as specifically targeted at hybrid projects as possible. The target is to increase the awareness for and the usage of existing financial support programmes and thereby foster the development of hybrid projects.

Considering the results of the interaction with the stakeholders, the mitigation of this barrier for the CGS IJmuiden Ver to Norfolk hybrid project must also take into account the interdependencies between the individual barriers.

5.2.14 Uncertainty regarding the UK market

The barrier "uncertainty regarding the UK market" is divided into two subtopics, UK Capacity Market and UK Cap and Floor regime as well as EU internal energy market. The two subtopics are addressed individually in the following.

UK Capacity Market and Cap and Floor regime

This subtopic of the barrier is relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of uncertainty about the continuance of the UK Capacity Market – which has been declared illegal by the General Court of the EU on November 15, 2018 and it is presently put on hold, with next the capacity auction indefinitely postponed – as well as the Cap and Floor regime, particularly in the context of the negotiations regarding the withdrawal of the UK from the EU, but rather that a process towards the mitigation of the barrier must be followed. The process consists of awaiting the finalisation of the negotiations between the UK and the European Union to allow for the clarification of the future of the UK Capacity Market and Cap and Floor regime.

Considering the results of the interaction with the stakeholders, the mitigation process to be followed for the CGS IJmuiden Ver to Norfolk hybrid project must also take into account the interdependencies between the individual barriers.

EU internal energy market

This subtopic of the barrier is relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of uncertainty about the continuance of the participation of the UK in the EU internal energy market, particularly in the context of the negotiations regarding the withdrawal of the UK from the EU, but rather that a process towards the mitigation of the barrier must be followed. The process consists of awaiting the finalisation of the negotiations between the UK and the European Union to allow for the clarification of the future of the UK's participation in the EU internal energy market.

Considering the results of the interaction with the stakeholders, the mitigation process to be followed for the CGS IJmuiden Ver to Norfolk hybrid project must also take into account the interdependencies between the individual barriers.

5.2.15 Disproportionate allocation of costs and benefits across involved stakeholders

This barrier is relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of disproportionate allocation of costs and benefits across involved stakeholders, but rather that a process towards the mitigation of the barrier must be followed. Generally, the process consists of the identification and alignment of cost and benefit categories, the determination of the initial allocation of costs and benefits, the agreement on a re-allocation of costs and benefits as well as – if required and available – the usage of CEF funding to ensure the individual incentivisation of all stakeholders. This can build on the existing process for Cost Benefit Analyses (CBA) and Cross-Border Cost Allocations (CBCA) as defined by ENTSO-E for cross-border electricity interconnectors, which needs to be adjusted according to the specifications of each individual hybrid project. The process should allow for the incentivisation of all relevant stakeholders to implement the hybrid project.

Considering the results of the interaction with the stakeholders, the mitigation process to be followed for the CGS IJmuiden Ver to Norfolk hybrid project must also take into account the interdependencies between the individual barriers.

5.2.16 Uncertainty about legislative regime for power-to-gas and related infrastructure

This barrier is not relevant for the CGS IJmuiden Ver to Norfolk hybrid project.

In the context of the CGS IJmuiden Ver to Norfolk hybrid project, it is currently not planned to include power conversion to gas and / or gas transmission solutions. Thus, there is no need for and consequently no uncertainty regarding the legislative regime for power conversion to gas and gas transmission for the specific hybrid project idea.

5.3 North Sea Wind Power Hub (NSWPH)

Throughout stakeholder interaction, 11 out of 16 barriers are identified to be relevant for the implementation of the NSWPH hybrid project idea. The results of the interaction with stakeholders with regard to all barriers – relevant and not relevant – are summarised in the ensuing subchapters.

5.3.1 Uncertainty about responsibility for project development

The barrier "uncertainty about responsibility for project development" is divided into three subtopics, grid connection responsibility, responsibility for the development and construction of the interconnector and responsibility for the operation of the interconnector. The three subtopics are addressed individually in the following.

Grid connection responsibility

This subtopic of the barrier is relevant for the NSWPH hybrid project.

To address this barrier, three mitigation options are assessed with regard to their applicability (Table 20) – excluding the implications of interdependencies with other barriers.

- Option 1 "Entity of country in whose EEZ OWF is located is responsible": The respective national TSO is responsible for the connection of the OWFs to the hub, depending on the location of the OWFs (e.g. the Dutch TSO, TenneT TSO B.V., is responsible for the grid connection of the OWFs located in the Dutch EEZ).
- Option 2 "Consortium is responsible": The consortium, consisting of the Dutch TSO, TenneT TSO B.V., the German TSO, TenneT TSO GmbH, the Danish TSO, Energinet, Gasunie and the Port of Rotterdam, is responsible for the connection of a given OWF to the hub.
- Option 3 "OWF developer is responsible": The OWF developer is responsible for the connection of a given OWF to the hub.

	Option 1: Entity of country in whose EEZ OWF is located is responsible	Option 2: Consortium is responsible	Option 3: OWF developer is responsible
Legal / regulatory coverage	Not fully covered in NL, DE and DK legislation and regulation (connection to offshore structure potentially in other EEZ), but only amendments necessary – EU network codes such as "Requirements for generators" support technical standardisation	Not covered in NL, DE and DK legislation and regulation – EU network codes such as "Requirements for generators" support technical standardisation	Not covered in NL, DE, DK and EU legislation and regulation (unbundling applies for OWF developer) – EU network codes such as "Requirements for generators" support technical standardisation

	Option 1: Entity of country in whose EEZ OWF is located is responsible	Option 2: Consortium is responsible	Option 3: OWF developer is responsible
Costs	Costs are with NL, DE and DK, including liability for grid connection delay or unavailability of grid	Costs are with consortium, including liability for grid connection delay or unavailability of grid	Costs are with OWF developer, including liability for grid connection delay or unavailability of grid
Financial risk	Financial risk is with TenneT TSO B.V., TenneT TSO GmbH and Energinet, and thus with NL, DE and DK, therefore no risk towards project realisation	Financial risk is with consortium and thus with NL, DE and DK, therefore no major risk towards project realisation	Financial risk is with OWF developer, therefore risk towards project realisation
Development risk	Alignment of development not needed for single developer but across parts of the entire cable system due to differing responsibilities, therefore low risk towards project realisation	Alignment of development not needed for single developer but across parts of the entire cable system due to differing responsibilities, therefore low risk towards project realisation	Alignment of development not needed for single developer but across parts of the entire cable system due to differing responsibilities, therefore low risk towards project realisation
Operational risk	Alignment of operations not needed for single developer but across parts of the entire cable system due to differing responsibilities, therefore low risk towards project realisation	Alignment of operations not needed for single developer but across parts of the entire cable system due to differing responsibilities, therefore low risk towards project realisation	Alignment of operations not needed for single developer but across parts of the entire cable system due to differing responsibilities, therefore low risk towards project realisation
Market-specific expertise	Knowledge on general and project-specific grid connection and operational requirements given for TenneT TSO B.V., TenneT TSO GmbH and Energinet in NL, DE and DK, respectively	Knowledge on general and project-specific grid connection and operational requirements given for TenneT TSO B.V., TenneT TSO GmbH and Energinet in NL, DE and DK, respectively	Knowledge on general and project-specific grid connection and operational requirements not given for OWF developers
Risk for OWF developer	No financial risk for OWFs in case of delays or failure in grid connection, as compensation is guaranteed by regulation in NL, DE and DK	No financial risk for OWFs in case of delays or failure in grid connection, as compensation is guaranteed by regulation in NL, DE and DK	Financial risk for OWFs in case of delays and failure in grid connection, as OWF developers are fully liable

	Option 1: Entity of country in whose EEZ OWF is located is responsible	Option 2: Consortium is responsible	Option 3: OWF developer is responsible
First connection charges and G-charges	Shallow first connection charges and no G-charges in the NL, shallow to super-shallow first connection charges and no G-charges in DE, super-shallow to partially shallow first connection charges and energy-based G-charges in DK	Shallow first connection charges and no G-charges in the NL, shallow to super-shallow first connection charges and no G-charges in DE, super-shallow to partially shallow first connection charges and energy-based G-charges in DK	Uncertainty about first connection charges and G-charges faced by OWF developers
Summary	Not fully covered under NL, DE and DK legal and regulatory regime, but with low risk towards project realisation	Not covered under NL, DE and DK legal and regulatory regime, but with low risk towards project realisation	Not covered under NL, DE, DK and EU legal and regulatory regime, but with some risk (for OWF developers) towards project realisation

Table 20: North Sea Wind Power Hub (NSWPH) – Assessment of options for grid connection responsibility

In summary, the interaction with stakeholders shows that only two options – to allocate the responsibility to the entity of the country in whose EEZ the OWF is located (Option 1), to the consortium of the NSWPH hybrid project (Option 2) and to the OWF developers (Option 3) – have advantages and disadvantages. Under the current legal and regulatory framework Option 1 might require amendments to the legal and regulatory regime, while Options 2 and 3 are not covered. The risk towards project realisation is similar across all mitigation options. Furthermore, the inclusion of the relevant TSOs in Options 1 and 2 ensures required market-specific expertise and insures OWF developers in case of a delay or a failure of their grid connection.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the NSWPH hybrid project must also take into account the interdependencies between the individual barriers.

Responsibility for development and construction of interconnector

This subtopic of the barrier is not relevant for the NSWPH hybrid project.

Due to the scale and ambition of the NSWPH hybrid project, it is jointly undertaken by a consortium consisting of TenneT TSO B.V., TenneT TSO GmbH, Energinet, Gasunie and the Port of Rotterdam. Thus, the responsibility to develop and construct the hub as well as the cable systems connecting the hub to its onshore connection points in the Netherlands, Germany and Denmark is assumed by the consortium members. The responsibility is not further discussed in this study.

Responsibility for operation of interconnector

This subtopic of the barrier is not relevant for the NSWPH hybrid project.

Due to the scale and ambition of the NSWPH hybrid project, it is jointly undertaken by a consortium consisting of TenneT TSO B.V., TenneT TSO GmbH, Energinet, Gasunie and the Port of Rotterdam.

Thus, the responsibility to operate the hub as well as the cable systems connecting the hub to its onshore connection points in the Netherlands, Germany and Denmark is assumed by the consortium members. The responsibility is not further discussed in this study.

5.3.2 Uncertainty about regulation deriving from jurisdiction over cross-border cable systems

This barrier is relevant for the NSWPH hybrid project.

To address this barrier, two mitigation options are assessed with regard to their applicability (Table 21) – excluding the implications of interdependencies with other barriers. The assessment concentrates on the jurisdiction applicable to the cable systems linking the NSWPH to the Dutch, German and Western Danish market. The jurisdiction over the OWFs and the cable systems linking them to the hub as well as the hub itself is determined through the location of these assets.

- Option 1 "Individual national jurisdiction's regulations": In addition to European law, Dutch regulation applies to cables linking the NSWPH to the Dutch market, German regulation applies to cables linking the NSWPH to the German market and Danish regulation applies to cables linking the NSWPH to the Western Danish market. Each coastal state defines and enforces applicable regulation regarding the corresponding cables in its maritime zones.
- Option 2 "Alignment of jurisdictions' regulations": Based on negotiations between the Netherlands, Germany and Denmark, a new combination of regulations applies to all cable systems linking the NSWPH to shores – in addition to European law. Coastal states jointly define and enforce applicable regulation regarding all cable systems across the Dutch, the German and the Danish maritime zones. The new combination of regulations over the cable systems can potentially be based on existing interconnector agreements.

	Option 1: Individual national jurisdiction's regulations	Option 2: Alignment of jurisdictions' regulations, e.g. based on existing interconnector agreements
Rights and duties in NL territorial sea during operation	No uncertainty for cables to the NL since the NL has jurisdiction and NL operational rules apply since cables cross NL territorial sea	Alignment required to combine operational rules deriving from jurisdictions of the NL, DE and DK for the NL territorial sea through involvement of the NL, DE and DK
Rights and duties in NL EEZ during operation	No uncertainty for cables to the NL since the NL has jurisdiction and NL operational rules apply since cables cross NL territorial sea and not DE and DK territorial sea as well as do not serve exploitation of DE and DK EEZ	Alignment required to combine operational rules deriving from jurisdictions of the NL, DE and DK for the NL EEZ through involvement of the NL, DE and DK
Rights and duties in DE territorial sea during operation	No uncertainty for cables to DE since DE has jurisdiction and DE operational rules apply since cables cross DE territorial sea	Alignment required to combine operational rules deriving from jurisdictions of the NL, DE and DK for DE territorial sea through involvement of the NL, DE and DK

	Option 1: Individual national jurisdiction's regulations	Option 2: Alignment of jurisdictions' regulations, e.g. based on existing interconnector agreements
Rights and duties in DE EEZ during operation	No uncertainty for cables to the DE since DE has jurisdiction and DE operational rules apply since cables cross DE territorial sea and not the NL and DK territorial sea as well as do not serve exploitation of the NL and DK EEZ	Alignment required to combine operational rules deriving from jurisdictions of the NL, DE and DK for DE EEZ through involvement of the NL, DE and DK
Rights and duties in DK territorial sea during operation	No uncertainty for cables to DK since DK has jurisdiction and DK operational rules apply since cables cross DK territorial sea	Alignment required to combine operational rules deriving from jurisdictions of the NL, DE and DK for DK territorial sea through involvement of the NL, DE and DK
Rights and duties in DK EEZ during operation	No uncertainty for cables to DK since the DK has jurisdiction and DK operational rules apply since cables cross DK territorial sea and not the NL and DE territorial sea as well as do not serve exploitation of the NL and DE EEZ	Alignment required to combine operational rules deriving from jurisdictions of the NL, DE and DK for DK EEZ through involvement of the NL, DE and DK
Hybrid project requirements	Alignment of operational rules between the NL, DE and DK required because of connection of the respective countries' cable systems to the hub	No additional alignment of operational rules required
Timeline	Alignment may extend timeline of project	Alignment may extend timeline of project
Others		Provisions for assigning liability in case of grid connection failure need to be implemented
Summary	Alignment of operational rules required to allow for a combination of assets in hybrid project	Alignment required to ensure applicability of Option 2 since no clear rules apply in all relevant maritime zones

Table 21: North Sea Wind Power Hub (NSWPH) – Assessment of options for regulation deriving from jurisdiction deriving from cross-border cable systems

In summary, the interaction with stakeholders shows that both options – the agreement on applying operational rules to the cable systems linking the NSWPH to shore based on individual national jurisdiction (national regulation applies to the cables linking the NSWPH to the respective national markets) (Option 1) as well as the alignment of rules deriving from the Dutch, German and Danish jurisdiction (Option 2) – have advantages and disadvantages. While the feasibility of applying individual national regulations to the cable systems is potentially impeded by the necessity of connecting all cable systems to the same hub, the alignment of rules deriving from three jurisdictions can be a lengthy process. Yet, Option 2 reflects the interests of all involved countries in the alignment and can potentially be based on existing agreements established for interconnectors.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the NSWPH hybrid project must also take into account the interdependencies between the individual barriers.

5.3.3 Uncertainty about market arrangements

This barrier is relevant for the NSWPH hybrid project.

To address this barrier, four mitigation options are assessed with regard to their applicability (Table 22) – excluding the implications of interdependencies with other barriers.

- Option 1 "Commercial flows to home market": With commercial flows of the OWFs to their home markets, the OWFs commercially transmit only to the market of the country in whose EEZ they are physically located.
- Option 2 "Dynamic flows to high-price market": With commercial flows to the dynamic high-price market, the OWFs always commercially transmit their electricity to the market of the Netherlands, Germany and Denmark that has the highest price.
- Option 3 "Dynamic flows to low-price market": With commercial flows to the dynamic low-price market, the OWFs always commercially transmit their electricity to the market of the Netherlands, Germany and Denmark that has the lowest price.
- Option 4 "Dedicated bidding zone": With a dedicated bidding zone, the OWFs always commercially feed their electricity into a dedicated bidding zone, newly established for the OWFs included in the NSWPH hybrid project.

	Option 1: Commercial flows to home market	Option 2: Dynamic flows to high-price market	Option 3: Dynamic flows to low-price market	Option 4: Dedicated bidding zone
Legal / regulatory coverage	Covered under existing market regulation	Not covered under existing market regulation, particularly in violation of CACM requirement of stability of bidding zones across market time frames	Not covered under existing market regulation, particularly in violation of CACM requirement of stability of bidding zones across market time frames	Covered under existing market regulation as new bidding zone can be treated as home market after bidding zone review process

	Option 1: Commercial flows to home market	Option 2: Dynamic flows to high-price market	Option 3: Dynamic flows to low-price market	Option 4: Dedicated bidding zone
Price determination	Home market price applies	Price determination problematic when transmission of generated electricity to high-price market not possible (limited capacity) – alternative price determination needed	Price determination problematic when transmission of generated electricity to low-price market not possible (limited capacity) – alternative price determination needed	Dedicated bidding zone price applies
Price effects	Effect of decreasing prices in home market, as OWFs produce at close to zero marginal costs – indirect price effects through available IC capacity	Effect of decreasing prices in the high-price market, as OWFs produce at close to zero marginal costs – indirect price effects through available IC capacity	Effect of decreasing prices in the low-price market, as OWFs produce at close to zero marginal costs – indirect price effects through available IC capacity	Effect of decreasing prices in the dedicated bidding zone, as OWFs produce at close to zero marginal costs – indirect price effects through available IC capacity
Price discrimination of OWFs	Not discriminatory against any OWF as hybrid OWFs and other OWFs in the NL, DE or DK bidding zones receive same prices	Discriminatory against any other OWF in the NL, DE or DK bidding zones, as hybrid OWFs always receive high price of NL, DE or DK market	Discriminatory against hybrid OWFs as they always receive low price of NL, DE or DK market	Not discriminatory against any OWF as hybrid OWFs and OWFs in the NL, DE or DK bidding zones receive price of their bidding zone
Conflict between transmission from OWFs to shores and IC functionality	Conflict since commercial IC flows and commercial OWF flows are in same direction at times	Conflict since commercial IC flows and commercial OWF flows are always in same direction	No conflict, since commercial IC flows and commercial OWF flows are always in opposite direction	No conflict, since commercial IC flows are between bidding zones only and commercial OWF flows are to dedicated bidding zone only

	Option 1: Commercial flows to home market	Option 2: Dynamic flows to high-price market	Option 3: Dynamic flows to low-price market	Option 4: Dedicated bidding zone
Compensation	Negative business case implications for hybrid OWFs or ICs from conflict for cable system capacity, and thus additional compensation necessary	Negative business case implications for hybrid OWFs or ICs from conflict for cable system capacity, and thus additional compensation necessary	Negative business case implications for hybrid OWFs from price discrimination, and thus additional compensation necessary	No business case implications for hybrid OWFs or ICs, and thus no additional compensation necessary
Outages	In case of outages of single cable systems, transmission of electricity only possible via other cable systems to home market	In case of outages of single cable systems, transmission of electricity via all unaffected cable systems possible (also to other markets)	In case of outages of single cable systems, transmission of electricity via all unaffected cable systems possible (also to other markets)	In case of outages of single cable systems, transmission of electricity via all unaffected cable systems possible (also to other markets)
Summary	Legal and regulatory coverage given, not discriminatory against any OWF but negative business case implications for OWFs or ICs from conflict for cable system capacity	Legal and regulatory coverage not given, discriminatory against other OWFs and negative business case implications for OWFs or ICs from conflict for cable system capacity	Legal and regulatory coverage not given, discriminatory against hybrid OWFs and negative business case implications for OWFs from price discrimination	Legal and regulatory coverage given, not discriminatory against any OWF and no negative business case implications for OWFs or ICs

Table 22: North Sea Wind Power Hub (NSWPH) – Assessment of options for market arrangement

In summary, the interaction with stakeholders shows that all four options – OWFs always commercially evacuating electricity to the bidding zone of their respective home market (Option 1), OWFs commercially evacuating electricity to the higher-price or lower-price market of the Netherlands, Germany and Denmark (Option 2 and 3) as well as establishing a dedicated bidding zone for the OWFs included in the NSWPH hybrid project (Option 4) – have advantages and disadvantages. While Option 2 and 3 violate the European CACM regulation, commercially evacuating electricity to the OWFs' home markets is covered under existing market regulation (Option 1). Legal and regulatory coverage for a dedicated bidding zone is given (Option 4), however, the necessity and extent of a bidding zone review process needs to be clarified. Furthermore, depending on the chosen mitigation option, negative business case implications for hybrid OWFs or ICs require additional compensation from the conflict for cable system capacity (Options 1 and 2) or from price discrimination for hybrid OWFs (Option 3).

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the NSWPH hybrid project must also take into account the interdependencies between the individual barriers.

5.3.4 Uncertainty about hybrid cable system classification

This barrier is relevant for the NSWPH hybrid project.

To address this barrier, three mitigation options are assessed with regard to their applicability (Table 23) – excluding the implications of interdependencies with other barriers. The assessment concentrates on the cable systems linking the NSWPH to the Dutch, German and Western Danish market. The cables linking the OWFs to the hub have no dual functionality.

- Option 1 "Export system with interconnector functionality": Cable systems linking the NSWPH to shore are hybrid cable systems which allow for the transmission of electricity from the hub to the Dutch, German and Western Danish markets with priority. Hence, the Dutch, German and Danish export cable systems only provide interconnector functionality between the Dutch, German and Western Danish bidding zone for leftover capacities.
- Option 2 "Interconnector with export system functionality": Cable systems linking the NSWPH to shore are hybrid cable systems which allow for the transmission of electricity from the hub to the Dutch, German and Western Danish markets only with leftover capacities. Hence, the Dutch, German and Danish export cable systems primarily provide interconnector functionality between the Dutch, German and Western Danish bidding zone.
- Option 3 "Interconnector (with dedicated bidding zone)": Cable systems linking the NSWPH to shore are interconnectors and do not allow for the transmission of OWF-generated electricity to shores. This option is included for compatibility with the market arrangement of a dedicated bidding zone, where OWFs only feed electricity to the dedicated bidding zone and interconnectors link the dedicated bidding zone to other markets.

	Option 1: Export system with IC functionality	**Option 2: IC with export system functionality**	**Option 3: Interconnector (with dedicated bidding zone)**
NL national legal / regulatory coverage	Potentially covered as NL regulation does not expressly prohibit dual functionality of cables but legal / regulatory feasibility to be validated	Potentially covered as NL regulation does not expressly prohibit dual functionality of cables but legal / regulatory feasibility to be validated	Covered under NL regulation as regular interconnector, but legal coverage of connection involving new bidding zone to be validated

	Option 1: Export system with IC functionality	Option 2: IC with export system functionality	Option 3: Interconnector (with dedicated bidding zone)
DE national legal / regulatory coverage	Not covered as DE regulation does not allow for dual functionality since cable systems linking two bidding zones are defined as ICs and must solely have that purpose and export cables are defined as connections between technical installations solely for the uptake, transmission and distribution of electrical energy for general supply	Not covered as DE regulation does not allow for dual functionality since cable systems linking two bidding zones are defined as ICs and must solely have that purpose and export cables are defined as connections between technical installations solely for the uptake, transmission and distribution of electrical energy for general supply	Covered under DE regulation as regular interconnector, but legal coverage of connection involving new bidding zone to be validated
DK national legal / regulatory coverage	Potentially covered but needs to be validated since both export cables and ICs a part of the same regulatory regime and subject to approval by the ministry	Potentially covered but needs to be validated since both export cables and ICs a part of the same regulatory regime and subject to approval by the ministry	Covered under DK regulation as regular interconnector, but legal coverage of connection involving new bidding zone to be validated
EU legal / regulatory coverage	Not covered under Electricity Directive because it does not include an add. definition for hybrid cable systems; EU Regulation 714/2009 prescribes that "maximum capacity of the interconnections […] shall be made available to market participants" with clarity needed whether "maximum" refers to nominal or leftover capacities of cable systems in hybrid projects	Not covered under Electricity Directive because it does not include an add. definition for hybrid cable systems; EU Regulation 714/2009 prescribes that "maximum capacity of the interconnections […] shall be made available to market participants" with clarity needed whether "maximum" refers to nominal or leftover capacities of cable systems in hybrid projects	Covered under Electricity Directive because cable functions as regular interconnector such that maximum capacity is made available to market participants
Potential for curtailment of OWF	OWFs can transmit electricity at full generation capacity, and thus no business case implications and minimised curtailment	OWFs can transmit electricity depending on leftover capacity of cable systems, and thus negative business case implications due to additional curtailment	No business case implications

	Option 1: Export system with IC functionality	**Option 2: IC with export system functionality**	**Option 3: Interconnector (with dedicated bidding zone)**
Potential for congestion of IC	Capacity available for trade is significantly reduced, and thus negative business case implications for IC functionality of the entire cable system	Full capacity is available for trade, and thus no business case implications for IC functionality of the entire cable system	Full capacity is available for trade, and thus no business case implications for IC functionality of the entire cable system
Compensation	Due to joint development of transmission assets in hybrid project, optimisation of business case of cable system as a whole given; potentially no additional compensation necessary	Due to foregone revenues from additional curtailment, additional compensation for OWFs required	No additional compensation required
Third party access	Third party access only given for leftover capacities after transmission of electricity from OWFs to shores	Third party access given	Third party access given
Impact on EU's energy policy targets	Priority on primary targets of diversification and integration of RES as well as on GHG emission reductions over secondary target of maximised IC capacity	Priority on secondary target of maximised IC capacity over primary targets of diversification and integration of RES as well as on GHG emission reductions	Primary targets of diversification and integration of RES as well as on GHG emission reductions and secondary target of maximised IC capacity are prioritised
Summary	Not covered under existing EU and DE regulation, but potentially covered under NL and DK regulation; potential for negative business case implications for ICs may necessitate additional compensation	Not covered under existing EU and DE regulation, but potentially covered under NL and DK regulation; negative business case implications for OWFs necessitate additional compensation	Covered under existing EU as well NL, DE and DK regulations with validation for connection to dedicated bidding zone needed and no business case implications

Table 23: North Sea Wind Power Hub (NSWPH) – Assessment of options for hybrid cable system classification

In summary, the interaction with stakeholders shows that all three options – an export cable with interconnector functionality (Option 1), an interconnector with export cable functionality (Option 2) as well as an interconnector (with dedicated bidding zone) (Option 3) – have advantages and disadvantages. Both, Option 1 and 2 require changes in the European and potentially in the national legal and regulatory frameworks. By contrast, Option 3 is based on the existing legal and regulatory framework for interconnectors and therefore does not require changes to European and national regulation if the connection of an interconnector to a new bidding zone is covered. However, Option 2 has unfavourable implications for the business case of the OWF developers since the developers have no priority access to transmission capacity. Contrary, in Option 1, the interconnectors have no priority access to the capacity of the cable system resulting in unfavourable implications for the business case of the interconnector. In Option 3, the OWFs feed electricity to the new bidding zone and the interconnectors link the new bidding zone to other markets, and thus there are no business case implications for the OWFs and interconnectors. Furthermore, in contrast to Option 1, Option 2 prioritises the secondary EU energy policy target of maximised electricity interconnection capacity over the primary targets of diversification and integration of RES as well as greenhouse gas emission reduction, while Option 3 prioritises both targets.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the NSWPH hybrid project must also take into account the interdependencies between the individual barriers.

5.3.5 Failure of developers to align planning across assets and countries

The barrier "failure of developers to align planning across assets and countries" is divided into three subtopics, geographical alignment, technical alignment and timing alignment. The three subtopics are addressed individually in the following.

Geographical alignment

This subtopic of the barrier is relevant for the NSWPH hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of failed geographical alignment across assets and countries, but rather that a process towards the mitigation of the barrier must be followed. The process consists of the continuous exchange between project developers and other stakeholders to allow for the achievement of early-stage, geographical alignment.

Considering the results of the interaction with the stakeholders, the mitigation process to be followed for the NSWPH hybrid project must also take into account the interdependencies between the individual barriers.

Technical alignment

This subtopic of the barrier is relevant for the NSWPH hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of failed technical alignment across assets and countries, but rather that a process towards the mitigation of the barrier must be followed. The process consists of the continuous exchange between project developers and other stakeholders to allow for the achievement of early-stage, technical alignment.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the NSWPH hybrid project must also take into account the interdependencies between the individual barriers.

Timing alignment

This subtopic of the barrier is not relevant for the NSWPH hybrid project.

In the context of the NSWPH hybrid project, a separate commissioning of the individual OWFs located in the Dutch, German or Danish EEZ and their export cable systems or a later commissioning of some of the OWFs and export cable systems compared to the hub and the cable systems linking the hub to the Dutch, German and Western Danish bidding zone is possible. The hub can independently provide interconnector capacity between the Netherlands, Germany and Denmark.

5.3.6 Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation and tender execution)

The barrier "uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation and tender execution)" is divided into two subtopics, location selection and site pre-investigation as well as tender execution. The two subtopics are addressed individually in the following.

Location selection and site pre-investigation

This subtopic of the barrier is not relevant for the NSWPH hybrid project.

In the context of the NSWPH hybrid project, there is no uncertainty concerning location selection and site pre-investigation responsibility and procedures since the respective national authorities are responsible and the respective national procedures are applicable for the OWFs in the Dutch EEZ, German EEZ and Danish EEZ. However, the national location selection and site pre-investigation responsibility and procedures must be in alignment with the location of the NSWPH to allow for an efficient inclusion of OWFs in the hybrid project.

Tender responsible party

This subtopic of the barrier is not relevant for the NSWPH hybrid project.

In the context of the NSWPH hybrid project, there is no uncertainty concerning determination of the tender responsible party since the respective party of the national tender procedure is responsible for the tenders of the OWFs in the Dutch EEZ, German EEZ and Danish EEZ.

5.3.7 Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)

This barrier is relevant for the NSWPH hybrid project.

To address this barrier, four mitigation options are assessed with regard to their applicability (Table 24) – excluding the implications of interdependencies with other barriers.

- Option 1 "Strict design with aligned requirements and without hybrid-specific uncertainties": A tender design with strict pre-qualification requirements implies that extensive pre-qualification requirements are defined to ensure hybrid-specific and general capabilities to develop the NSWPH hybrid project. The requirements are aligned among the Netherlands, Germany and Denmark, including a jointly agreed set of financial requirements and a certain set of both Dutch, German and Danish rules related to the OWF sites (e.g. environmental details) and a certain set of both Dutch, German and Danish rules related to the grid connection of the OWFs (e.g. technical and operational details such as system integration or frequency control). Furthermore, all uncertainties arising from the hybrid character of the OWF development are clarified prior to the tender.
- Option 2 "Strict design with aligned requirements": A tender design with strict pre-qualification requirements implies that extensive pre-qualification requirements are defined to ensure hybrid-specific and general capabilities to develop the NSWPH hybrid project. The requirements are aligned among the Netherlands, Germany and Denmark, including a jointly agreed set of financial

requirements and a certain set of both Dutch, German and Danish rules related to the OWF sites (e.g. environmental details) and a certain set of both Dutch, German and Danish rules related to the grid connection of the OWFs (e.g. technical and operational details such as system integration or frequency control).

- Option 3: "Strict design without hybrid-specific uncertainties": A tender design with strict pre-qualification requirements implies that extensive pre-qualification requirements are defined to ensure hybrid-specific and general capabilities to develop the NSWPH hybrid project. Furthermore, all uncertainties arising from the hybrid character of the OWF development are clarified prior to the tender.
- Option 4 "Lenient design with aligned requirements and without hybrid-specific uncertainties": A tender design with lenient pre-qualification requirements is chosen, implying that only limited pre-qualification requirements are defined to ensure competition and low prices. The requirements are aligned among the Netherlands, Germany and Denmark, including a jointly agreed set of financial requirements and a certain set of both Dutch, German and Danish rules related to the OWF sites (e.g. environmental details) and a certain set of both Dutch, German and Danish rules related to the grid connection of the OWFs (e.g. technical and operational details such as system integration or frequency control). Furthermore, all uncertainties arising from the hybrid character of the OWF development are clarified prior to the tender.

	Option 1: Strict design, aligned requirements and no uncertainties	**Option 2: Strict design and aligned requirements**	**Option 3: Strict design and no uncertainties**	**Option 4: Lenient design, aligned requirements and no uncertainties**
Legal / regulatory coverage	Not covered and potential amendments to national legislation and regulation necessary since multiple countries are involved in defining tender design	Not covered and potential amendments to national legislation and regulation necessary since multiple countries are involved in defining tender design	Covered and no amendments to national legislation and regulation necessary since only one country is involved in defining tender design	Not covered and potential amendments to national legislation and regulation necessary since multiple countries are involved in defining tender design
Alignment of requirements	Financial, technical and operational requirements aligned; environmental requirements defined by the country in whose EEZ the OWF is located	Financial, technical and operational requirements aligned; environmental requirements defined by the country in whose EEZ the OWF is located	No alignment of requirements	Financial, technical and operational requirements aligned; environmental requirements defined by the country in whose EEZ the OWF is located

	Option 1: Strict design, aligned requirements and no uncertainties	Option 2: Strict design and aligned requirements	Option 3: Strict design and no uncertainties	Option 4: Lenient design, aligned requirements and no uncertainties
Hybrid-specific un-certainties	All uncertainties arising from hybrid-specific setup are clarified, e.g. liability, applicable jurisdiction, grid connection responsibility, RES subsidy scheme	Uncertainties arising from hybrid character of development not entirely clarified such that uncertainty remains for OWF developer	All uncertainties arising from hybrid-specific setup are clarified, e.g. liability, applicable jurisdiction, grid connection responsibility, RES subsidy scheme	All uncertainties arising from hybrid-specific setup are clarified, e.g. liability, applicable jurisdiction, grid connection responsibility, RES subsidy scheme
Realisation probability	Applying OWF developers are aware of all specifications and requirements and can align planning and financing right from the beginning	Applying OWF developers are aware of all specifications and requirements and can align planning and financing right from the beginning	Applying OWF developers are aware of all specifications and requirements and can align planning and financing right from the beginning; however, it is questionable whether OWFs connected to multiple countries can be tendered without alignment of tender requirements	Applying OWF developers are not aware of most specifications and requirements, which might result in significant cost overruns / delays after the tender process
Cost efficiency	Due to strict requirements and specifications, less developers expected to apply – cost efficiency of offers expected to decrease with fewer applicants	Due to strict requirements and specifications, less developers expected to apply – cost efficiency of offers expected to decrease with fewer applicants	Due to strict requirements and specifications, less developers expected to apply – cost efficiency of offers expected to decrease with fewer applicants	Due to lenient requirements and specifications, many developers expected to apply – cost efficiency of offers expected to increase with more applicants

	Option 1: Strict design, aligned requirements and no uncertainties	Option 2: Strict design and aligned requirements	Option 3: Strict design and no uncertainties	Option 4: Lenient design, aligned requirements and no uncertainties
Summary	Legal and regulatory coverage to be assessed and potentially decreases cost efficiency	Legal and regulatory coverage to be assessed and decreases cost efficiency, particularly due to remaining hybrid uncertainties	Legal and regulatory coverage given, but with limited chance of realisation due to non-consideration of two countries' interest in defining tender requirements	Legal and regulatory coverage to be assessed and strongly decreases probability of project realisation

Table 24: North Sea Wind Power Hub (NSWPH) – Assessment for options of tender design

In summary, the interaction with stakeholders shows that all four options – a strict or lenient tender design with aligned requirements and certainty about hybrid-specific characteristics of the OWF development (Option 1 and 4), a strict tender design with aligned requirements (Option 3) as well as a strict tender design with certainty about hybrid-specific characteristics of the OWF development (Option 2) – have advantages and disadvantages. While a tender design with strict requirements (Options 1, 2 and 3) increases the probability of successful project implementation, a tender design with lenient requirements (Option 4) decreases the cost of implementation through competition. Furthermore, certainty about hybrid-specific characteristics of the OWF development (Options 1, 3 and 4) increases the probability of successful project implementation and decreases the cost of implementation by reducing the risk premium otherwise demanded by OWF developers in terms of subsidies. Lastly, aligned requirements (Options 1, 2 and 4) aid in ensuring the interoperability of the OWFs with the other assets of the hybrid project and thereby increase the probability of successful hybrid project implementation.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the NSWPH hybrid project must also take into account the interdependencies between the individual barriers.

5.3.8 Discrepancies in responsibilities and requirements for balancing

In the context of the NSWPH hybrid project, there is no discrepancy in the applicability of national balancing responsibility and requirements in the shorter term. Since each generator must always be part of only one bidding zone according to the existing CACM regulation and since the participation of one generator in different bidding zones at different times would be highly challenging for the operation of the entire energy system, an OWF physically connected to multiple bidding zones can only commercially feed its electricity into one bidding zone. Furthermore, the topic is addressed in the Clean Energy Package. It is likely that no further barrier mitigation regarding balancing responsibilities and requirements is needed for the implementation of the NSWPH hybrid project. However, in the longer term the translation into Dutch, German and Danish law needs to be assessed in detail by the project-specific stakeholders.

5.3.9 Discrepancies in priority dispatch regulation

In the context of the NSWPH hybrid project, there is no discrepancy in the applicability of national priority dispatch regulation in the shorter term. Since each generator must always be part of only one bidding zone according to the existing CACM regulation and since the participation of one generator in different bidding zones at different times would be highly challenging for the operation of the entire energy system, an OWF physically connected to multiple bidding zones can only commercially feed its electricity into one bidding zone. Furthermore, the topic is addressed in the Clean Energy Package. It is likely that no further barrier mitigation regarding priority dispatch regulation is needed for the implementation of the NSWPH hybrid project. However, in the longer term the translation into Dutch, German and Danish law needs to be assessed in detail by the project-specific stakeholders.

5.3.10 Discrepancies in curtailment regulation and compensation

In the context of NSWPH hybrid project, there is no discrepancy in the applicability of national curtailment regulation and compensation in the shorter term. Since each generator must always be part of only one bidding zone according to the existing CACM regulation and since the participation of one generator in different bidding zones at different times would be highly challenging for the operation of the entire energy system, an OWF physically connected to multiple bidding zones can only commercially feed its electricity into one bidding zone. Furthermore, the topic is addressed in the Clean Energy Package. It is likely that no further barrier mitigation regarding curtailment regulation and compensation is needed for the implementation of the NSWPH hybrid project. However, in the longer term the translation into Dutch, German and Danish law needs to be assessed in detail by the project-specific stakeholders.

5.3.11 Lack of regulated revenues for anticipatory investments

This barrier is relevant for the NSWPH hybrid project.

To address this barrier, three mitigation options are assessed with regard to their applicability (Table 25) – excluding the implications of interdependencies with other barriers.

- Case 1: Anticipatory investments under Dutch regulation are possible. Anticipatory investments for export cable systems, interconnectors and the hub are necessary due to the timeline of the specific hybrid project. In the case of unaligned development, the hub is expected to be developed first with the connections of the OWFs to the NSWPH following after the commissioning. Therefore, the additions in the technical design of the hub must be taken into account. Export cable systems, interconnectors and the hub are developed by, among others, the national TSO, TenneT TSO B.V.
- Case 2: Anticipatory investments under German regulation are possible. Anticipatory investments for export cable systems, interconnectors and the hub are necessary due to the timeline of the specific hybrid project. In the case of unaligned development, the hub is expected to be developed first with the connections of the OWFs to the NSWPH following after the commissioning. Therefore, the additions in the technical design of the hub must be taken into account. Export cable systems, interconnectors and the hub are developed by, among others, the national TSO, i.e. TenneT TSO GmbH.
- Case 3: Anticipatory investments under Danish regulation are not foreseen. Anticipatory investments for export cable systems, interconnectors and the hub are necessary due to the timeline of the specific hybrid project. In the case of unaligned development, the hub is expected to be developed first with the connections of the OWFs to the NSWPH following after the commissioning. Therefore, the additions in the technical design of the hub must be taken into

account. Export cable systems, interconnectors and the hub are developed by, among others, the national TSO, Energinet.

	Dutch regulation	German regulation	Danish regulation
	Concerned asset: Export cable systems, interconnectors and hub	**Concerned asset: Export cable systems, interconnectors and hub**	**Concerned asset: Export cable systems, interconnectors and hub**
Legal / regulatory coverage	Anticipatory investments for cables and installations are considered under Dutch regulation	Anticipatory investments for cables and installations are considered under German regulation	Anticipatory investments for cables and installations are not considered under Danish regulation
Treatment of anticipatory investments	Anticipatory investments are treated exactly the same as non-anticipatory investments, but must be included in Offshore Grid Development Framework by the Dutch government	Anticipatory investments are subject to approval by the regulatory authority (BNetzA) and thus must be included in the Spatial Grid Development Plan and Maritime Spatial Plan	No provisions for anticipatory investments
Efficiency benchmark	Efficiency benchmark exists but regulatory regime provides for standard procedures to assess appropriate investments	Efficiency benchmark exists but regulatory regime provides for standard procedures to assess appropriate investments	No provisions for anticipatory investments
Public opinion	Public support given if investment is in line with Offshore Grid Development Framework	Public support given if investment is in line with Spatial Grid Development Plan and Maritime Spatial Plan	Public support depends on the introduction of adequate legal / regulatory provisions
Risk to project realisation	No risk since TSO can cover investments in its RAB and Offshore Grid Development Framework determines investments	No risk since TSO can cover investments in its RAB and Spatial Grid Development Plan and Maritime Spatial Plan determine investments	No provisions for anticipatory investments, and thus currently large risk to project realisation
Risk of stranded asset	Risk of stranded transmission investment exists with coverage under Dutch regulation uncertain	No risk of stranded transmission investments as investments are fully covered under German regulation	No provisions for anticipatory investments, and thus currently large risk of stranded assets

	Dutch regulation	German regulation	Danish regulation
	Concerned asset: Export cable systems, interconnectors and hub	**Concerned asset: Export cable systems, interconnectors and hub**	**Concerned asset: Export cable systems, interconnectors and hub**
Summary	Anticipatory investments are treated as regular investments at discretion of government through inclusion in Offshore Grid Development Framework	Anticipatory investments are subject to regulator's approval	No provisions for anticipatory investments

Table 25: North Sea Wind Power Hub (NSWPH) – Assessment of regulatory regimes for anticipatory investments

In summary, the interaction with stakeholders shows that it is necessary to clarify the assurance of reimbursements in the Netherlands and Germany and establish reimbursement in Denmark to enable TSOs or other commercial players to engage in anticipatory investments. At the same time, the efficiency of anticipatory investments must be assessed to ensure the sensible expansion of infrastructure.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the NSWPH hybrid project must also take into account the interdependencies between the individual barriers.

5.3.12 Uncertainty about RES subsidy scheme

This barrier is relevant for the NSWPH hybrid project.

To address this barrier, three mitigation options are assessed with regard to their applicability (Table 26) – excluding the implications of interdependencies with other barriers.

- Option 1 "National subsidy scheme": The respective national country, with payments organised through the respective TSOs, is responsible for the subsidy scheme of a given OWF, depending on the location of the OWF. Consequently, the Netherlands are responsible for the OWFs located in the Dutch EEZ, Germany is responsible for the OWFs in the German EEZ and Denmark is responsible for the OWFs in the Danish EEZ.
- Option 2 "Joint support scheme": According to EU Directive 2009/28/EC Member States may establish and co-fund a joint support scheme to spur renewable energy production. In this context, the OWFs included in the NSWPH hybrid project are supported through a joint support scheme of the stakeholder countries, the Netherlands, Germany and Denmark. Regardless of their location, the same joint support scheme applies to all OWFs as long as they are included in the NSWPH hybrid project.
- Option 3 "No subsidy scheme": The OWFs included in the NSWPH hybrid project are tendered without a subsidy scheme (i.e. comparable to zero-subsidy bids) and neither a subsidy scheme of the Netherlands, Germany nor Denmark nor a joint support scheme is needed.

	Option 1: National subsidy scheme	Option 2: Joint support scheme	Option 3: No subsidy scheme
Legal / regulatory provisions	Covered in national legal and regulatory regime in NL, DE and DK but applicability to project to be clarified due to connection of OWFs to shore via hub (uncertainty about onshore connection point)	Covered by EU Directive 2009/28/EC on a European level but legally binding document between NL, DE and DK needs to be formulated to establish joint support scheme	Covered in national legal and regulatory regime
Costs	Costs borne by the NL, DE and DK	Costs borne jointly by the NL, DE and DK	No costs must be borne by the NL, DE and DK
Mechanism	Sliding feed-in premium in NL and DE (for tenders from 2020 onwards), feed-in tariff in DK	Support scheme type, level of support, duration and technological coverage to be agreed upon	No mechanism necessary
Project bankability	Bankability in NL, DE and DK ensured through subsidy schemes	Bankability ensured through joint support scheme	Bankability of project depends on other offtake securities, such as long-term power purchase agreements
Public opinion	Public opinion in NL, DE and DK can be opposed to funding RES generation potentially transmitted to other countries with public funds	Public opinion in NL, DE and DK can be opposed to funding RES generation potentially transmitted to other countries with public funds	Public opinion neutral since no public funds used
Timeline	Uncertain timeline in NL, DE and DK as OWF sites are not foreseen in existing (central) plans but tender processes in place	Uncertain timeline in NL, DE and DK as OWF sites are not foreseen in existing (central) plans and joint support scheme must be established	Uncertain timeline in NL, DE and DK as OWF sites are not foreseen in existing (central) plans but tender processes in place
Summary	Covered in national legal and regulatory regime with clarity on onshore connection point needed, bankability ensured but public opinion potentially opposed and uncertain timeline	Covered in EU and national legal and regulatory regime with legal agreement required, bankability ensured but public opinion potentially opposed and uncertain timeline	Covered in national legal and regulatory regime but bankability only ensured with offtake securities and uncertain timeline

Table 26: North Sea Wind Power Hub (NSWPH) – Assessment of options for RES subsidy schemes

In summary, the interaction with stakeholders shows that all three options – applying the national subsidy scheme of the country in whose EEZ the OWF is located to the respective OWF (Option 1), establishing a joint support scheme (Option 2) as well as tendering OWF sites without a subsidy scheme (i.e. comparable to zero-subsidy bids) (Option 3) – have advantages and disadvantages. While the feasibility of Option 1 depends on the applicability of the national subsidy schemes to the hybrid project OWFs due to needed clarity on the onshore connection point, the feasibility of tendering without a subsidy scheme (Option 3) largely depends on the ability of OWF developers to secure offtake securities like power purchase agreements to ensure the bankability of the project. Establishing a joint support scheme of the Netherlands, Germany and Denmark is legally covered and provides the necessary bankability but might be problematic due to the extended timeline which is needed to agree the specifications of the scheme and to formulate a legally binding document between the Netherlands, Germany and Denmark.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the NSWPH hybrid project must also take into account the interdependencies between the individual barriers.

5.3.13 Limited engagement of public stakeholders

The barrier "limited engagement of public stakeholders" is divided into two subtopics, formalised public support and financial support. The two subtopics are addressed individually in the following.

Formalisation of commitment from public stakeholders

This subtopic of the barrier is relevant for the NSWPH hybrid project.

To address this barrier, two mitigation options are assessed with regard to their applicability (Table 27) – excluding the implications of interdependencies with other barriers.

- Option 1 "Memorandum of Understanding (MoU)": A Memorandum of Understanding is a formalisation of the goodwill of the involved parties in form of a non-binding agreement. An MoU addresses barriers by formalising the agreements of the involved parties with regard to the implementation of required actions to overcome the barriers. It can involve all project stakeholders, such as OWF developers, TSOs, national ministries and NRAs as well as the European Commission.
- Option 2 "Hybrid Asset Network Support Agreement (HANSA)": A project-specific Hybrid Asset Network Support Agreement is a legally-binding commitment to adapt national legislation and regulation in the future, and thus provides legal certainty to developers. European legislation and regulation can only be adapted via a project-specific HANSA if all Member States of the European Union sign the agreement. It only directly involves public stakeholders, such as national ministries.

	Option 1: Memorandum of Understanding (MoU)	Option 2: Hybrid Asset Network Support Agreement (HANSA)
Required effort	Some interaction and alignment required among project developers and stakeholders to facilitate signing of agreement	Significant interaction and alignment among political project stakeholders required to facilitate signing of agreement

	Option 1: Memorandum of Understanding (MoU)	Option 2: Hybrid Asset Network Support Agreement (HANSA)
Provided certainty	Intentional character of signed agreement sufficient for hybrid projects in early development stage	Legally binding commitment to topics covered by signed agreement directly facilitates project development, but is only required at a later development stage of hybrid projects
Summary	Reasonable effort to align agreement required prior to signing and non-legally binding commitment sufficient in early project development stages	Significant effort for alignment of agreement required prior to signing but provides legal certainty and therefore suitable in later development stages

Table 27: North Sea Wind Power Hub (NSWPH) – Assessment of options for formalisation of commitment from public stakeholders

In summary, the interaction with stakeholders shows that both options – a project-specific Memorandum of Understanding (Option 1) and a project-specific Hybrid Asset Network Support Agreement (Option 2) – have advantages and disadvantages. While less effort is usually required to align and sign a project-specific MoU, an MoU is not legally binding, and thus the commitment of public stakeholders provides limited certainty, for example, about legal and regulatory changes for project developers (Option 1). However, while a project-specific HANSA provides legal certainty about the commitment of stakeholders to implement legal and regulatory changes, the alignment process requires more effort (Option 2).

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the NSWPH hybrid project must also take into account the interdependencies between the individual barriers as well as the development stage of the hybrid project.

Financial support

This subtopic of the barrier is relevant for the NSWPH hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of limited financial support, but rather that a portfolio of support programmes is available and their usage needs to be increased to facilitate the implementation of hybrid projects. In the past, hybrid project development and / or considerations, such as the Combined Grid Solution Kriegers Flak in the Baltic Sea and the Interconnector tie-in COBRA Cable in the North Sea, indicate that such support is required to de-risk and thereby allow for the realisation of pilot projects. In this context, financial support can come in various forms, such as co-financing for early-stage feasibility studies, scoping studies or R&D, co-financing of development and construction or guarantees for the operational phase. Generally, financial support programmes are available on national and European level and should be as specifically targeted at hybrid projects as possible. The target is to increase the awareness for and the usage of existing financial support programmes and thereby foster the development of hybrid projects.

Considering the results of the interaction with the stakeholders, the mitigation of this barrier for the NSWPH hybrid project must also take into account the interdependencies between the individual barriers.

5.3.14 Uncertainty regarding the UK market

The barrier "uncertainty regarding the UK market" is divided into two subtopics, UK Capacity Market and UK Cap and Floor regime as well as EU internal energy market. The two subtopics are addressed individually in the following.

UK Capacity Market and Cap and Floor regime

This subtopic of the barrier is not relevant for the NSWPH hybrid project.

In the context of the NSWPH hybrid project, no commercial nor public UK stakeholders are involved. Thus, there is no uncertainty regarding the UK Capacity Market and Cap and Floor regime for the specific hybrid project idea.

EU internal energy market

This subtopic of the barrier is not relevant for the NSWPH hybrid project.

In the context of the NSWPH hybrid project, no commercial nor public UK stakeholders are involved. Thus, there is no uncertainty regarding the participation in the EU internal energy market for the specific hybrid project idea.

5.3.15 Disproportionate allocation of costs and benefits across involved stakeholders

This barrier is relevant for the NSWPH hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of disproportionate allocation of costs and benefits across involved stakeholders, but rather that a process towards the mitigation of the barrier must be followed. Generally, the process consists of the identification and alignment of cost and benefit categories, the determination of the initial allocation of costs and benefits, the agreement on a re-allocation of costs and benefits as well as – if required and available – the usage of CEF funding to ensure the individual incentivisation of all stakeholders. This can build on the existing process for Cost Benefit Analyses (CBA) and Cross-Border Cost Allocations (CBCA) as defined by ENTSO-E for cross-border electricity interconnectors, which needs to be adjusted according to the specifications of each individual hybrid project. The process should allow for the incentivisation of all relevant stakeholders to implement the hybrid project.

Considering the results of the interaction with the stakeholders, the mitigation process to be followed for the NSWPH hybrid project must also take into account the interdependencies between the individual barriers.

5.3.16 Uncertainty about legislative regime for power-to-gas and related infrastructure

This barrier is relevant for the NSWPH hybrid project.

In summary, the interaction with stakeholders shows that the integration of power conversion to hydrogen and hydrogen transmission in the NSWPH hybrid project has multiple advantages. Coupling power generation with the production of hydrogen represents a first step towards a more integrated energy system in the European Union. The utilisation of existing gas pipelines for the transport of converted hydrogen to shore might optimise costs. The conversion of electricity to hydrogen can further contribute to overcome onshore grid congestion issues since the coupling provides additional flexibility in storage and transport such that energy can be traded more flexibly in the market. However, power conversion to hydrogen and hydrogen transmission so far remain without a dedicated legislative framework both on the national and the European level. Legislation and regulation of natural / industrial / chemical gas infrastructure may be starting points for an application to power conversion to hydrogen and hydrogen transmission, but do not account for the potential importance of hydrogen in the future energy market with increasing shares of RES in the energy mix. New and / or updated European legislation in the hydrogen sector needs to consider unbundling, non-discriminatory access to infrastructure, market arrangements and regulation of tariffs. Established energy market infrastructure providers such as electricity and gas TSOs and DSOs depend on an effective legislative framework to incorporate power conversion to hydrogen and hydrogen transmission into their existing asset base and service offering.

5.4 COBRA Cable

Throughout stakeholder interaction, 10 out of 16 barriers are identified to be relevant for the implementation of the COBRA Cable hybrid project idea. The results of the interaction with stakeholders with regard to all barriers – relevant and not relevant – are summarised in the ensuing subchapters.

5.4.1 Uncertainty about responsibility for project development

The barrier "uncertainty about responsibility for project development" is divided into three subtopics, grid connection responsibility, responsibility for the development and construction of the interconnector and responsibility for the operation of the interconnector. The three subtopics are addressed individually in the following.

Grid connection responsibility

This subtopic of the barrier is relevant for the COBRA Cable hybrid project.

To address this barrier, three mitigation options are assessed with regard to their applicability (Table 28) – excluding the implications of interdependencies with other barriers.

- Option 1 "TenneT TSO B.V. and Energinet are responsible": The Dutch TSO, TenneT TSO B.V., and the Danish TSO, Energinet, are responsible for the connection of the German OWF to the interconnector operated by the two TSOs.
- Option 2 "TenneT TSO GmbH is responsible": The German TSO, TenneT TSO GmbH, is responsible for the connection of the German OWF to the interconnector.
- Option 3 "OWF developer is responsible": The OWF developer is responsible for the connection of the German OWF to the interconnector.
- Option 4 "TenneT TSO B.V., TenneT TSO GmbH and Energinet are responsible": The Dutch TSO, TenneT TSO B.V., the German TSO, TenneT TSO GmbH and the Danish TSO, Energinet are responsible for the connection of the German OWF to the interconnector.

	Option 1: TenneT TSO B.V. and Energinet are responsible	Option 2: TenneT TSO GmbH is responsible	Option 3: OWF developer is responsible	Option 4: TenneT TSO B.V., TenneT TSO GmbH and Energinet are responsible
Legal / regulatory coverage	Not covered in NL and DK (OWF location defines responsibility) as well as DE legislation and regulation (OWF location and onshore connection point define responsibility) – EU network codes, such as "HVDC Connections" and "Requirements for generators", support technical standardisation	Not covered in DE legislation and regulation (OWF location and onshore connection point define responsibility) – EU network codes, such as "HVDC Connections" and "Requirements for generators", support technical standardisation	Not covered in NL, DE, DK and EU legislation and regulation (unbundling applies for OWF developer) – EU network codes, such as "HVDC Connections" and "Requirements for generators", support technical standardisation	Not covered in NL and DK (OWF location defines responsibility) as well as DE legislation and regulation (OWF location and onshore connection point define responsibility) – EU network codes, such as "HVDC Connections" and "Requirements for generators", support technical standardisation
Costs	Costs are with NL and DK, including liability for grid connection delay or unavailability of grid	Costs are with DE, including liability for grid connection delay or unavailability of grid	Costs are with OWF developer, including liability for grid connection delay or unavailability of grid	Costs are with NL, DE and DK, including liability for grid connection delay or unavailability of grid
Financial risk	Financial risk is with TenneT TSO B.V. (offshore grid operator) and Energinet, and thus with NL and DK, therefore no risk towards project realisation	Financial risk is with TenneT TSO GmbH, and thus with DE, therefore no risk towards project realisation	Financial risk is with OWF developer, therefore risk towards project realisation	Financial risk is with TenneT TSO B.V. (offshore grid operator), TenneT TSO GmbH and Energinet, and thus with NL, DE and DK, therefore no risk towards project realisation

	Option 1: TenneT TSO B.V. and Energinet are responsible	Option 2: TenneT TSO GmbH is responsible	Option 3: OWF developer is responsible	Option 4: TenneT TSO B.V., TenneT TSO GmbH and Energinet are responsible
Development risk	Alignment of development needed for multiple developers but not additionally across parts of entire cable system due to congruent responsibilities, therefore low risk towards project realisation	Alignment of development not needed for a single developer but across parts of entire cable system due to differing responsibilities, therefore uncertain risk towards project realisation	Alignment of development not needed for a single developer but across parts of entire cable system due to differing responsibilities, therefore uncertain risk towards project realisation	Alignment of development needed for multiple developers and additionally across parts of entire cable system due to differing responsibilities, therefore low risk towards project realisation
Operational risk	Alignment of operations needed for multiple developers but not additionally across parts of entire cable system due to congruent responsibilities, therefore low risk towards project realisation	Alignment of operations not needed for a single developer but across parts of entire cable system due to differing responsibilities, therefore uncertain risk towards project realisation	Alignment of operations not needed for a single developer but across parts of entire cable system due to differing responsibilities, therefore uncertain risk towards project realisation	Alignment of operations needed for multiple developers and additionally across parts of entire cable system due to differing responsibilities, therefore low risk towards project realisation
Market-specific expertise	Knowledge on general and project-specific grid connection and operational requirements partially given for TenneT TSO B.V. and Energinet in NL and DK, respectively	Knowledge on general and project-specific grid connection and operational requirements partially given for TenneT TSO GmbH in DE	Knowledge on general and project-specific grid connection and operational requirements not given for OWF developers	Knowledge on general and project-specific grid connection and operational requirements given for TenneT TSO B.V., TenneT TSO GmbH and Energinet in NL, DE and DK, respectively

	Option 1: TenneT TSO B.V. and Energinet are responsible	Option 2: TenneT TSO GmbH is responsible	Option 3: OWF developer is responsible	Option 4: TenneT TSO B.V., TenneT TSO GmbH and Energinet are responsible
Risk for OWF developer	No financial risk for OWF in case of delays or failure in grid connection, as compensation is guaranteed by regulation in NL and DK	No financial risk for OWF in case of delays or failure in grid connection, as compensation is guaranteed by regulation in DE	Financial risk for OWF in case of delays and failure in grid connection, as OWF developer is fully liable	No financial risk for OWF in case of delays or failure in grid connection, as compensation is guaranteed by regulation in NL, DE and DK
First connection charges and G-charges	Shallow first connection charges and no G-charges in the NL, shallow to super-shallow first connection charges and no G-charges in DE, super-shallow to partially shallow first connection charges and energy-based G-charges in DK	Shallow first connection charges and no G-charges in the NL, shallow to super-shallow first connection charges and no G-charges in DE, super-shallow to partially shallow first connection charges and energy-based G-charges in DK	Uncertainty about first connection charges and G-charges faced by OWF developers	Shallow first connection charges and no G-charges in the NL, shallow to super-shallow first connection charges and no G-charges in DE, super-shallow to partially shallow first connection charges and energy-based G-charges in DK
Summary	Not covered under NL, DE and DK legal and regulatory regime, but with low risk towards project realisation	Not covered under NL, DE and DK legal and regulatory regime and with uncertain risk towards project realisation	Not covered under NL, DE, DK and EU legal and regulatory regime and with uncertain risk towards project realisation	Not covered under NL, DE and DK legal and regulatory regime and with uncertain risk towards project realisation

Table 28: COBRA Cable – Assessment of options for grid connection responsibility

In summary, the interaction with stakeholders shows that only three options – to allocate the responsibility to TenneT TSO B.V. and Energinet (Option 1), to TenneT TSO GmbH (Option 2), to the OWF developer (Option 3) as well as to the consortium of TenneT TSO B.V., TenneT TSO GmbH and Energinet (Option 4) – have advantages and disadvantages. All options are not covered under current legal and regulatory frameworks. The allocation of responsibility to the Dutch and Danish entity (Option 1) features a low risk towards project realisation whereas the other options feature an uncertain risk towards project realisation due to required alignment across developers and across all parts of the entire cable system (interconnector and export cable system). With regard to required market-specific expertise, only developers in Option 4 can provide such expertise across all markets. The inclusion of TSOs in Options 1, 2 and 4 insures OWF developers in case of a delay or a failure of their grid connection.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the COBRA Cable hybrid project must also take into account the interdependencies between the individual barriers.

Responsibility for development and construction of interconnector

This subtopic of the barrier is not relevant for the COBRA Cable hybrid project.

The COBRA Cable interconnector itself is developed and constructed by TenneT TSO B.V. and Energinet and is planned to be commissioned in 2019. The responsibility for the interconnector is not further discussed in this study.

Responsibility for operation of interconnector

This subtopic of the barrier is not relevant for the COBRA Cable hybrid project.

The COBRA Cable interconnector itself is planned to be commissioned in 2019 and subsequently operated by TenneT TSO B.V. and Energinet. The responsibility for the interconnector is not further discussed in this study.

5.4.2 Uncertainty about regulation deriving from jurisdiction over cross-border cable systems

This barrier is relevant for the COBRA Cable hybrid project.

To address this barrier, two mitigation options are assessed with regard to their applicability (Table 29) – excluding the implications of interdependencies with other barriers. The assessment concentrates on the jurisdiction applicable to the cable system connecting the German OWF to the COBRA Cable interconnector. The OWF underlies German jurisdiction in line with the installation exploiting wind as a natural resource within the German EEZ.

- Option 1 "German jurisdiction's regulations": In addition to European law, German regulation applies to the cable system connecting the OWF to the COBRA Cable interconnector.
- Option 2 "Alignment of jurisdictions' regulations": Based on negotiations between the Netherlands, Germany and Denmark, a new combination of regulations applies to the cable system connecting the OWF to the COBRA Cable interconnector – in addition to European law. This new combination of regulations can potentially be based on the existing agreement between the Netherlands and Denmark concerning the COBRA Cable interconnector.

	Option 1: German jurisdiction's regulations	Option 2: Alignment of jurisdictions' regulations, based on COBRA Cable IC agreement
Rights and duties in DE EEZ during operation	No uncertainty since DE has jurisdiction and DE operational rules apply since cable does not cross NL and DK territorial sea and serves exploitation of DE EEZ	Alignment required to combine operational rules deriving from jurisdictions of the NL, DE and DK for DE EEZ through involvement of the NL, DE and DK

	Option 1: German jurisdiction's regulations	Option 2: Alignment of jurisdictions' regulations, based on COBRA Cable IC agreement
Hybrid project requirements	Alignment of operational rules between DE and the NL as well as DK required because of connection of DE OWF to the COBRA Cable interconnector via the export cable system	No additional alignment of operational rules required
Timeline	Alignment may extend timeline of project	Alignment may extend timeline of project
Others		Provisions for assigning liability in case of grid connection failure need to be implemented
Summary	Alignment of operational rules required to allow for a combination of assets in hybrid project	Alignment required to ensure applicability of Option 2 since DE rules apply in DE EEZ

Table 29: COBRA Cable – Assessment of options for regulation deriving from jurisdiction deriving from cross-border cable systems

In summary, the interaction with stakeholders shows that both options – the agreement of applicability of operational rules to the cable system connecting the OWF to the COBRA Cable interconnector based on German jurisdiction (Option 1) as well as the alignment of rules deriving from the Dutch, German and Danish jurisdiction (Option 2) – have advantages and disadvantages. While the alignment of jurisdictions' regulations and the corresponding involvement of all three countries (Option 2) ensures feasibility, the alignment of operational rules deriving from three jurisdictions can be a lengthy process. Yet, Option 2 reflects the interests of all involved countries in the alignment and can potentially be based on the existing agreement between the Netherlands, Germany and Denmark established for the COBRA Cable interconnector. Furthermore, the application of German regulation (Option 1) requires cross-border alignment as well, due to differing regulation applying to the COBRA Cable interconnector and the connection of the OWF to the interconnector.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the COBRA Cable hybrid project must also take into account the interdependencies between the individual barriers.

5.4.3 Uncertainty about market arrangements

This barrier is relevant for the COBRA Cable hybrid project.

To address this barrier, five mitigation options are assessed with regard to their applicability (Table 30) – excluding the implications of interdependencies with other barriers.

- Option 1 "Commercial flows either to the Dutch or to Danish market": With commercial flows to either the Netherlands or Denmark, the German OWF is always feeding its electricity commercially into the Dutch or Danish market, thus into the bidding zones to which the OWF is connected.

- Option 2 "Commercial (virtual) flows to home market": With commercial (virtual) flows to the home market, this is, Germany, the German OWF always transmits its electricity commercially to the German market, and thus into the bidding zone in which the OWF is physically located.
- Option 3 "Dynamic flows to high-price market": With commercial flows to the dynamic high-price market, the German OWF always commercially transmits its electricity to the higher-price market. This might either be the Dutch or the Danish market.
- Option 4 "Dynamic flows to low-price market": With commercial flows to the dynamic low-price market, the German OWF always commercially transmits its electricity into the lower-price market. This might either be the Dutch or the Danish market.
- Option 5 "Dedicated bidding zone": With a dedicated bidding zone, the German OWF always commercially feeds its electricity to its dedicated bidding zone, newly established for the OWF included in the hybrid project.

	Option 1: Commercial flows either to the Dutch or to Danish market	Option 2: Commercial (virtual) flows to home market	Option 3: Dynamic flows to high-price market	Option 4: Dynamic flows to low-price market	Option 5: Dedicated bidding zone
Legal / regulatory coverage	Not covered under existing market regulation	Not covered under existing market regulation	Not covered under existing market regulation, particularly in violation of CACM requirement of stability of bidding zones across market time frames	Not covered under existing market regulation, particularly in violation of CACM requirement of stability of bidding zones across market time frames	Covered under existing market regulation as new bidding zone can be treated as home market after bidding zone review process
Price determination	Either Dutch or Western Danish market prices apply	Home market price applies	Price determination problematic when transmission of generated electricity to high-price market not possible (limited capacity) – alternative price determination needed	Price determination problematic when transmission of generated electricity to low-price market not possible (limited capacity) – alternative price determination needed	Dedicated bidding zone price applies

	Option 1: Commercial flows either to the Dutch or to Danish market	**Option 2: Commercial (virtual) flows to home market**	**Option 3: Dynamic flows to high-price market**	**Option 4: Dynamic flows to low-price market**	**Option 5: Dedicated bidding zone**
Price effects	Effect of decreasing prices in NL or DK, as OWF produces at close to zero marginal costs – indirect price effects through available IC capacity	Effect of decreasing prices in home market, as OWF produces at close to zero marginal costs – indirect price effects through available IC capacity	Effect of decreasing prices in the high-price market, as OWF produces at close to zero marginal costs – indirect price effects through available IC capacity	Effect of decreasing prices in the low-price market, as OWF produces at close to zero marginal costs – indirect price effects through available IC capacity	Effect of decreasing prices in the dedicated bidding zone, as OWF produces at close to zero marginal costs – indirect price effects through available IC capacity
Price discrimination of OWFs	Discriminatory against hybrid OWF if DE market price is higher than NL or DK market price, which it receives	Not discriminatory against any OWF as hybrid OWF and other OWFs in DE bidding zone receive same prices	Discriminatory against any other OWF in the DE bidding zones, as hybrid OWF always receives high price of NL or DK market	Discriminatory against hybrid OWF as it always receives low price of NL or DK market	Not discriminatory against any OWF as hybrid OWF and OWFs in DE bidding zone receive price of their bidding zone
Conflict between transmission from OWF to shore and IC functionality	Conflict since commercial IC flows and commercial OWF flows are in same direction at times	No conflict, since commercial IC flows either to NL or DK market and commercial OWF flows (virtually) to DE market	Conflict since commercial IC flows and commercial OWF flows are always in same direction	No conflict, since commercial IC flows and commercial OWF flows are always in opposite direction	No conflict, since commercial IC flows are between bidding zones only and commercial OWF flows are to dedicated bidding zone only

	Option 1: Commercial flows either to the Dutch or to Danish market	Option 2: Commercial (virtual) flows to home market	Option 3: Dynamic flows to high-price market	Option 4: Dynamic flows to low-price market	Option 5: Dedicated bidding zone
Compensation	Negative business case implications for hybrid OWF from price discrimination and for hybrid OWF or IC from conflict for cable system capacity, and thus additional compensation necessary	No business case implications for hybrid OWF or IC, and thus no additional compensation necessary	Negative business case implications for hybrid OWF or IC from conflict for cable system capacity, and thus additional compensation necessary	Negative business case implications for hybrid OWF from price discrimination, and thus additional compensation necessary	No business case implications for hybrid OWF or ICs, and thus no additional compensation necessary
Outages	No backup cable system available	No backup cable system available	No backup cable system available	No backup cable system available	In case of outages of one cable system (NL to dedicated bidding zone or DK to dedicated bidding zone), transmission of electricity from OWF to shore via unaffected cable system possible

	Option 1: Commercial flows either to the Dutch or to Danish market	Option 2: Commercial (virtual) flows to home market	Option 3: Dynamic flows to high-price market	Option 4: Dynamic flows to low-price market	Option 5: Dedicated bidding zone
Others					Though no conflict for cable system capacity, congruence of business cases of new ICs and COBRA Cable unclear
Summary	Legal and regulatory coverage not given, discriminatory against hybrid OWF and negative business case implications for OWF from price discrimination as well as for OWF or IC from conflict for cable system capacity	Legal and regulatory coverage not given, not discriminatory against any OWF and no negative business case implications for OWF or IC	Legal and regulatory coverage not given, discriminatory against other OWFs and negative business case implications for OWF or IC from conflict for cable system capacity	Legal and regulatory coverage not given, discriminatory against hybrid OWF and negative business case implications for OWF from price discrimination	Legal and regulatory coverage given, not discriminatory against any OWF and no negative business case implications for OWF but unclear for ICs

Table 30: COBRA Cable – Assessment of options for market arrangement

In summary, the interaction with stakeholders shows that all five options – OWF always commercially evacuating electricity to either the Dutch or Danish market (Option 1) or (virtually) to the German market (Option 2), OWF commercially evacuating electricity to the higher-price or lower-price market of the Netherlands and Denmark (Option 3 and 4) as well as establishing a dedicated bidding zone for the OWF included in the hybrid project (Option 5) – have advantages and disadvantages. While legal and regulatory coverage is not given for Options 1, 2, 3 and 4, with Options 3 and 4 violating the European CACM requirement of stability of bidding zones across market time frames. Yet, legal and regulatory coverage for a dedicated bidding zone is given (Option 5). However, the necessity and extent of a bidding zone review process needs to be clarified. In case of commercial (virtual) flows to Germany (Option 2), there may be a need for onshore grid reinforcements. Furthermore, depending on the chosen mitigation option, negative business case implications for the hybrid OWF or IC(s) require additional compensation from the conflict for cable system capacity (Options 1 and 3) or from price discrimination for the hybrid OWF (Options 1 and 4).

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the COBRA Cable hybrid project must also take into account the interdependencies between the individual barriers.

5.4.4 Uncertainty about hybrid cable system classification

This barrier is relevant for the COBRA Cable hybrid project.

To address this barrier, three mitigation options are assessed with regard to their applicability (Table 31) – excluding the implications of interdependencies with other barriers. The assessment concentrates on the COBRA Cable interconnector. The export cable connecting the DE OWF to the interconnector has no dual functionality.

- Option 1 "Export system with interconnector functionality": The COBRA Cable interconnector is a hybrid cable system, which allows for the transmission of electricity from the German OWF to the Dutch and Western Danish markets. Hence, the cable system only provides interconnector functionality between the Dutch and Western Danish bidding zone with leftover capacities.
- Option 2 "Interconnector with export system functionality": The COBRA cable interconnector is a hybrid cable system, which allows for the transmission of electricity from the German OWF to the Dutch and Western Danish markets only with leftover capacities. Hence, the cable system primarily provides interconnector functionality between the Dutch and Western Danish bidding zone.
- Option 3 "Interconnector (with dedicated bidding zone)": Cable systems linking the German OWF to shore are interconnectors. This option is included for compatibility with the market arrangement of a dedicated bidding zone, where the OWF only feeds electricity to the dedicated bidding zone and interconnectors link the dedicated bidding zone to the Netherlands and Denmark.

	Option 1: Export cable with IC functionality	Option 2: IC with export cable functionality	Option 3: Interconnector (with dedicated bidding zone)
NL national legal / regulatory coverage	Potentially covered as NL regulation does not expressly prohibit dual functionality of cables but legal / regulatory feasibility to be validated	Potentially covered as NL regulation does not expressly prohibit dual functionality of cables but legal / regulatory feasibility to be validated	Covered under NL regulation as regular interconnector, but legal coverage of connection involving new bidding zone to be validated
DE national legal / regulatory coverage	Not covered as DE regulation does not allow for dual functionality since cable systems linking two bidding zones are defined as ICs and must solely have that purpose and export cables are defined as connections between technical installations solely for the uptake, transmission and distribution of electrical energy for general supply	Not covered as DE regulation does not allow for dual functionality since cable systems linking two bidding zones are defined as ICs and must solely have that purpose and export cables are defined as connections between technical installations solely for the uptake, transmission and distribution of electrical energy for general supply	Covered under DE regulation as regular interconnector, but legal coverage of connection involving new bidding zone to be validated
DK national legal / regulatory coverage	Potentially covered but needs to be validated since both export cables and ICs a part of the same regulatory regime and subject to approval by the ministry	Potentially covered but needs to be validated since both export cables and ICs a part of the same regulatory regime and subject to approval by the ministry	Covered under DK regulation as regular interconnector, but legal coverage of connection involving new bidding zone to be validated
EU legal / regulatory coverage	Not covered under Electricity Directive because it does not include an add. definition for hybrid cable systems; EU Regulation 714/2009 prescribes that "maximum capacity of the interconnections […] shall be made available to market participants" with clarity needed whether "maximum" refers to nominal or leftover capacities of cable systems in hybrid projects	Not covered under Electricity Directive because it does not include an add. definition for hybrid cable systems; EU Regulation 714/2009 prescribes that "maximum capacity of the interconnections […] shall be made available to market participants" with clarity needed whether "maximum" refers to nominal or leftover capacities of cable systems in hybrid projects	Covered under Electricity Directive because cable functions as regular interconnector such that maximum capacity is made available to market participants

	Option 1: Export cable with IC functionality	Option 2: IC with export cable functionality	Option 3: Interconnector (with dedicated bidding zone)
Potential for curtailment of OWF	OWF can transmit electricity at full generation capacity, and thus no business case implications and minimised curtailment	OWF can transmit electricity depending on leftover capacity of cable systems, and thus negative business case implications due to additional curtailment	No business case implications
Potential for congestion of IC	Capacity available for trade is significantly reduced, and thus negative business case implications for IC functionality of the entire cable system	Full capacity is available for trade, and thus no business case implications for IC functionality of the entire cable system	Full capacity is available for trade, and thus no business case implications for IC functionality of the entire cable system
Compensation	Due to joint development of transmission assets in hybrid project, optimisation of business case of cable system as a whole given; potentially no additional compensation necessary	Due to foregone revenues from additional curtailment, additional compensation for OWF required	No additional compensation required
Third party access	Third party access only given for leftover capacities after transmission of electricity from OWF to shore	Third party access given	Third party access given
Impact on EU's energy policy targets	Priority on primary targets of diversification and integration of RES as well as on GHG emission reductions over secondary target of maximised IC capacity	Priority on secondary target of maximised IC capacity over primary targets of diversification and integration of RES as well as on GHG emission reductions	Primary targets of diversification and integration of RES as well as on GHG emission reductions and secondary target of maximised IC capacity are prioritised

	Option 1: Export cable with IC functionality	Option 2: IC with export cable functionality	Option 3: Interconnector (with dedicated bidding zone)
Summary	Not covered under existing EU and DE regulation, but potentially covered under NL and DK regulation; potential for negative business case implications for IC may necessitate additional compensation	Not covered under existing EU and DE regulation, but potentially covered under NL and DK regulation; negative business case implications for OWF necessitate additional compensation	Covered under existing EU as well NL, DE and DK regulations with validation for connection to dedicated bidding zone needed and no business case implications

Table 31: COBRA Cable – Assessment of options for hybrid cable system classification

In summary, the interaction with stakeholders shows that all three options – an export cable with interconnector functionality (Option 1), an interconnector with export cable functionality (Option 2) as well as an interconnector (with dedicated bidding zone) (Option 3) – have advantages and disadvantages. Both, Option 1 and 2 require changes in the European and potentially in the national legal and regulatory frameworks. By contrast, Option 3 is based on the existing legal and regulatory framework for interconnectors and therefore does not require changes to European and national regulation if the connection of an interconnector to a new bidding zone is covered. However, Option 2 has unfavourable implications for the business case of the OWF developer since the developer has no priority access to transmission capacity. Contrary, in Option 1, interconnector trade has no priority on the cable system resulting in unfavourable implications for the business case of the interconnector. In Option 3, the OWF feeds electricity to the new bidding zone and the interconnectors link the new bidding zone to other the Netherlands and Denmark, and thus there are no business case implications for the OWF and interconnectors. Furthermore, in contrast to Option 1, Option 2 prioritises the secondary EU energy policy target of maximised electricity interconnection capacity over the primary targets of diversification and integration of RES as well as greenhouse gas emission reduction, while Option 3 prioritises both targets.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the COBRA Cable hybrid project must also take into account the interdependencies between the individual barriers.

5.4.5 Failure of developers to align planning across assets and countries

The barrier "failure of developers to align planning across assets and countries" is divided into three subtopics, geographical alignment, technical alignment and timing alignment. The three subtopics are addressed individually in the following.

Geographical alignment

This subtopic of the barrier is relevant for the COBRA Cable hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of failed geographical alignment across assets and countries, but rather that a process towards the mitigation of the barrier must be followed. The process consists of the continuous exchange between project developers and other stakeholders to allow for the achievement of early-stage, geographical alignment.

Considering the results of the interaction with the stakeholders, the mitigation process to be followed for the COBRA Cable hybrid project must also take into account the interdependencies between the individual barriers.

Technical alignment

This subtopic of the barrier is relevant for the COBRA Cable hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of failed technical alignment across assets and countries, but rather that a process towards the mitigation of the barrier must be followed. The process consists of the continuous exchange between project developers and other stakeholders to allow for the achievement of early-stage, technical alignment.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the COBRA Cable hybrid project must also take into account the interdependencies between the individual barriers.

Timing alignment

This subtopic of the barrier is not relevant for the COBRA Cable hybrid project.

In the context of the COBRA Cable hybrid project, timing alignment is not relevant since the COBRA Cable interconnector is planned to be commissioned in 2019, with construction and installation having commenced in 2017. Therefore, it is not possible to align the time lines of a connection of the OWF to the interconnector with the development of the interconnector.

5.4.6 Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation and tender execution)

The barrier "uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation and tender execution)" is divided into two subtopics, location selection and site pre-investigation as well as tender execution. The two subtopics are addressed individually in the following.

Location selection and site pre-investigation

This subtopic of the barrier is relevant for the COBRA Cable hybrid project.

To address this barrier, three mitigation options are assessed with regard to their applicability (Table 32) – excluding the implications of interdependencies with other barriers. However, it is also possible that site pre-investigation has already taken place in this specific example, as leftover areas in an otherwise tendered cluster are considered for the OWF location.

- Option 1 "Dutch and / or Danish responsibility": The Netherlands and / or Denmark conduct the location selection and site pre-investigation for the OWF site in the German Cluster 8 as part of the respective centrally organised pre-investigation models, following standardised national processes and timelines. Site decisions determine where OWF development can take place.
- Option 2 "German responsibility": Germany conducts the location selection and site pre-investigation for the OWF site in the German Cluster 8 as part of the centrally organised pre-investigation based on the Spatial Grid Development Plan, following standardised national processes and timelines. Site decisions determine where OWF development can take place.

- Option 3 "Responsibility of OWF developer": The potential OWF developer conducts location selection and site pre-investigation for the OWF site in the German Cluster 8 within the context of an open-door approach. All costs of the pre-investigation and site selection process are borne by the OWF developer. Following the final site decision by the potential OWF developer, the candidate applies for the necessary licenses to develop the OWF based on the results of the pre-investigation. The extent to which a government shapes and controls the investigations that are part of the open-door process by specific regulatory requirements that must be met varies across the Netherlands, Germany and Denmark.

	Option 1: Dutch and / or Danish responsibility	**Option 2: German responsibility**	**Option 3: Responsibility of OWF developer**
Legal / Regulatory coverage	Not covered by DE legislation and regulation	Covered by DE legislation and regulation, can potentially become part of special tender process ("Sonderausschreibung")	Not covered by DE legislation and regulation
Costs	Costs are with NL / DK	Costs are with DE	Costs are with OWF developer
Process	Unclear process as DE OWF site must be included in central development plan in NL (National Water Plan) and in processes in DK, especially if both countries jointly pre-investigate the potential site	Clear process as OWF site is included in Spatial Grid Development Plan in DE by standard procedure, maybe even with lean processes under DE special tender process ("Sonderausschreibung")	Clear process as no new process is necessary, but alignment with DE Spatial Development Plan required
Timeline	Unclear timeline in NL (National Water Plan) and DK, expecting possible delays due to additional coordination between NL, DE and DK	Clear timeline as OWF site is included in central DE Spatial Development Plan for tender post-2030, but shorter timeline under DE special tender process ("Sonderausschreibung") possible; leftover area then potentially tendered by 2023	Unclear timeline as timeline is determined by OWF developer and alignment with DE Spatial Development Plan required

	Option 1: Dutch and / or Danish responsibility	Option 2: German responsibility	Option 3: Responsibility of OWF developer
Coordinated use of offshore areas	Weakens coordinated use of limited offshore areas since shared responsibility of NL and DK potentially hinders effective usage (maximisation of societal benefits) of sites in DE	Strengthens coordinated use of limited offshore areas, potentially maximising the societal benefit of overall wind potential in DE, and is most suitable as case site has already been pre-investigated	Weakens coordinated use of limited offshore areas since shared responsibility potentially hinders effective usage (maximisation of societal benefits) of sites; potential decrease in quality of investigation, as OWF developer fears sunk costs, and thus performs cost-efficient investigation
Summary	Not covered in DE legislation and regulation, and unclear processes and timelines as coordination between NL / DK and DE needs to take place	Covered in DE legislation and regulation, and clear processes and timelines in DE	Not covered in DE legislation and regulation, and unclear processes and timelines as additional alignment with DE Spatial Grid Development Plan required

Table 32: COBRA Cable – Assessment of options for location selection and site pre-investigation

In summary, the interaction with stakeholders shows that both options – assigning responsibility to Dutch and / or Danish authorities (Option 1), assigning responsibility to German authorities (Option 2) and assigning responsibility to OWF developer (Option 3) – have advantages and disadvantages. Both, Option 1 and 3, are not covered in German legislation and regulation in contrast to Option 2. Additionally, only Option 1 has a clear process and timeline whereas processes and timelines in are unclear due to additional alignment between the Netherlands and Denmark (Option 1) and alignment with the German Spatial Grid Development Plan (Option 3).

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the COBRA Cable hybrid project must also take into account the interdependencies between the individual barriers.

Tender responsible party

This subtopic of the barrier is relevant for the COBRA Cable hybrid project.

To address this barrier, three mitigation options are assessed with regard to their applicability (Table 33) – excluding the implications of interdependencies with other barriers.

- Option 1 "Dutch and / or Danish responsibility": The Netherlands (RVO) or Denmark (DUR) execute the tender for the OWF site in the German EEZ as a one-stop shop authority either following Dutch or Danish tender process specifications or German tender process specifications.
- Option 2 "German responsibility": Germany (BNetzA) executes the tender for the OWF site in the German EEZ as a one-stop shop authority following German tender process specifications based on the Spatial Grid Development Plan.

	Option 1: Dutch and / or Danish responsibility	Option 2: German responsibility
Legal / regulatory coverage	Not covered by DE legislation and regulation	Covered in DE legislation and regulation but special provisions need to be made regarding the planned grid connection of the OWF
Costs	Costs are with NL / DK	Costs are with DE
Process efficiency	Unclear process efficiency since it depends on familiarity of responsible party with the tender process (either Dutch, Danish or German)	Efficient process since responsible party is familiar with tender process
Public opinion	Negative, as public opinion in Germany can be opposed to surrendering sovereignty over the German EEZ	Positive, as public opinion in Germany in favour of maintaining sovereignty over the German EEZ
Other	Potential OWF site might already be part of the DE Spatial Grid Development Plan, if it is integral part of a larger OWF site or linked to other DE sites – unclear whether NL or DK can efficiently conduct tender of part of a larger site and / or is allowed to do so	As potential OWF site is a leftover area (part of a larger OWF site), it might already be included in DE Spatial Grid Development Plan and German process might apply
Summary	Not covered in DE legislation and regulation, unclear process efficiency and DE public opinion potentially opposed	Covered in DE legislation and regulation, efficient process and DE public opinion in support

Table 33: COBRA Cable – Assessment of options for tender responsible party

In summary, the interaction with stakeholders shows both options – assigning responsibility for the tender execution to Dutch and / or Danish authorities (Option 1) and German authorities (Option 2) – have advantages and disadvantages. Assigning responsibility to Dutch or Danish authorities (Option 1) is not covered in German legislation and regulation, requires alignment and is not supported by the public. Assigning responsibility to German authorities (Option 2) is covered in German legislation and regulation, does not require alignment and is supported by the public.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the COBRA Cable hybrid project must also take into account the interdependencies between the individual barriers.

5.4.7 Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)

This barrier is relevant for the COBRA Cable hybrid project.

To address this barrier, four mitigation options are assessed with regard to their applicability (Table 34) – excluding the implications of interdependencies with other barriers.

- Option 1 "Strict design with aligned requirements and without hybrid-specific uncertainties": A tender design with strict pre-qualification requirements implies that extensive pre-qualification requirements are defined to ensure hybrid-specific and general capabilities to develop the COBRA Cable hybrid project. The requirements are aligned among the Netherlands, Germany and Denmark, including a jointly agreed set of financial requirements and a certain set of both Dutch, German and Danish rules related to the OWF site (e.g. environmental details) and a certain set of both Dutch, German and Danish rules related to the grid connection of the OWF (e.g. technical and operational details such as system integration or frequency control). Furthermore, all uncertainties arising from the hybrid character of the OWF development are clarified prior to the tender.
- Option 2 "Strict design with aligned requirements": A tender design with strict pre-qualification requirements implies that extensive pre-qualification requirements are defined to ensure hybrid-specific and general capabilities to develop the COBRA Cable hybrid project. The requirements are aligned among the Netherlands, Germany and Denmark, including a jointly agreed set of financial requirements and a certain set of both Dutch, German and Danish rules related to the OWF site (e.g. environmental details) and a certain set of both Dutch, German and Danish rules related to the grid connection of the OWF (e.g. technical and operational details such as system integration or frequency control).
- Option 3: "Strict design without hybrid-specific uncertainties": A tender design with strict pre-qualification requirements implies that extensive pre-qualification requirements are defined to ensure hybrid-specific and general capabilities to develop the COBRA Cable hybrid project. Furthermore, all uncertainties arising from the hybrid character of the OWF development are clarified prior to the tender.
- Option 4 "Lenient design with aligned requirements and without hybrid-specific uncertainties": A tender design with lenient pre-qualification requirements is chosen, implying that only limited pre-qualification requirements are defined to ensure competition and low prices. The requirements are aligned among the Netherlands, Germany and Denmark, including a jointly agreed set of financial requirements and a certain set of both Dutch, German and Danish rules related to the OWF site (e.g. environmental details) and a certain set of both Dutch, German and Danish rules related to the grid connection of the OWF (e.g. technical and operational details such as system integration or frequency control). Furthermore, all uncertainties arising from the hybrid character of the OWF development are clarified prior to the tender.

	Option 1: Strict design, aligned requirements and no uncertainties	Option 2: Strict design and aligned requirements	Option 3: Strict design and no uncertainties	Option 4: Lenient design, aligned requirements and no uncertainties
Legal / regulatory coverage	Not covered and potential amendments to national legislation and regulation necessary since multiple countries are involved in defining tender design	Not covered and potential amendments to national legislation and regulation necessary since multiple countries are involved in defining tender design	Covered and no amendments to national legislation and regulation necessary since only one country is involved in defining tender design	Not covered and potential amendments to national legislation and regulation necessary since multiple countries are involved in defining tender design
Alignment of requirements	Financial requirements aligned; technical and operational requirements defined by the NL and DK; environmental requirements defined by DE	Financial requirements aligned; technical and operational requirements defined by the NL and DK; environmental requirements defined by DE	No alignment of requirements	Financial requirements aligned; technical and operational requirements defined by the NL and DK; environmental requirements defined by DE
Hybrid-specific un-certainties	All uncertainties arising from hybrid-specific setup are clarified, e.g. liability, applicable jurisdiction, grid connection responsibility, RES subsidy scheme	Uncertainties arising from hybrid character of development not entirely clarified such that uncertainty remains for OWF developer	All uncertainties arising from hybrid-specific setup are clarified, e.g. liability, applicable jurisdiction, grid connection responsibility, RES subsidy scheme	All uncertainties arising from hybrid-specific setup are clarified, e.g. liability, applicable jurisdiction, grid connection responsibility, RES subsidy scheme

	Option 1: Strict design, aligned requirements and no uncertainties	Option 2: Strict design and aligned requirements	Option 3: Strict design and no uncertainties	Option 4: Lenient design, aligned requirements and no uncertainties
Realisation probability	Applying OWF developers are aware of all specifications and requirements and can align planning and financing right from the beginning	Applying OWF developers are aware of all specifications and requirements and can align planning and financing right from the beginning	Applying OWF developers are aware of all specifications and requirements and can align planning and financing right from the beginning; however, it is questionable whether an OWF connected to two countries can be tendered without alignment of tender requirements	Applying OWF developers are not aware of most specifications and requirements, which might result in significant cost overruns / delays after the tender process
Cost efficiency	Due to strict requirements and specifications, less developers expected to apply – cost efficiency of offers expected to decrease with fewer applicants	Due to strict requirements and specifications, less developers expected to apply – cost efficiency of offers expected to decrease with fewer applicants	Due to strict requirements and specifications, less developers expected to apply – cost efficiency of offers expected to decrease with fewer applicants	Due to lenient requirements and specifications, many developers expected to apply – cost efficiency of offers expected to increase with more applicants
Summary	Legal and regulatory coverage to be assessed and potentially decreases cost efficiency	Legal and regulatory coverage to be assessed and decreases cost efficiency, particularly due to remaining hybrid uncertainties	Legal and regulatory coverage given, but with limited chance of realisation due to non-consideration of two countries' interest in defining tender requirements	Legal and regulatory coverage to be assessed and strongly decreases probability of project realisation

Table 34: COBRA Cable – Assessment of options for tender design

In summary, the interaction with stakeholders shows that all four options – a strict or lenient tender design with aligned requirements and certainty about hybrid-specific characteristics of the OWF development (Option 1 and 4), a strict tender design with aligned requirements (Option 3) as well as a strict tender design with certainty about hybrid-specific characteristics of the OWF development (Option 2) – have advantages and disadvantages. While a tender design with strict requirements (Options 1, 2 and 3) increases the probability of successful project implementation, a tender design with lenient requirements (Option 4) decreases the cost of implementation through competition. Furthermore, certainty about hybrid-specific characteristics of the OWF development (Options 1, 3 and 4) increases the probability of successful project implementation and decreases the cost of implementation by reducing the risk premium otherwise demanded by OWF developers in terms of subsidies. Lastly, aligned requirements (Options 1, 2 and 4) aid in ensuring the interoperability of the OWF with the other assets of the hybrid project and thereby increase the probability of successful hybrid project implementation.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the COBRA Cable hybrid project must also take into account the interdependencies between the individual barriers.

5.4.8 Discrepancies in responsibilities and requirements for balancing

In the context of the COBRA Cable hybrid project, there is no discrepancy in the applicability of national balancing responsibility and requirements in the shorter term. Since each generator must always be part of only one bidding zone according to the existing CACM regulation and since the participation of one generator in different bidding zones at different times would be highly challenging for the operation of the entire energy system, an OWF physically connected to multiple bidding zones can only commercially feed its electricity into one bidding zone. Furthermore, the topic is addressed in the Clean Energy Package. It is likely that no further barrier mitigation regarding balancing responsibilities and requirements is needed for the implementation of the COBRA Cable hybrid project. However, in the longer term the translation into Dutch, German and Danish law needs to be assessed in detail by the project-specific stakeholders.

5.4.9 Discrepancies in priority dispatch regulation and compensation

In the context of the COBRA Cable hybrid project, there is no discrepancy in the applicability of national priority dispatch regulation. Since each generator must always be part of only one bidding zone according to the existing CACM regulation and since the participation of one generator in different bidding zones at different times would be highly challenging for the operation of the entire energy system, an OWF physically connected to multiple bidding zones can only commercially feed its electricity into one bidding zone. Furthermore, the topic is addressed in the Clean Energy Package. It is likely that no further barrier mitigation regarding priority dispatch regulation and compensation is needed for the implementation of the COBRA Cable hybrid project. However, in the longer term the translation into Dutch, German and Danish law needs to be assessed in detail by the project-specific stakeholders.

5.4.10 Discrepancies in curtailment regulation and compensation

In the context of COBRA Cable hybrid project, there is no discrepancy in the applicability of national curtailment regulation and compensation. Since each generator must always be part of only one bidding zone according to the existing CACM regulation and since the participation of one generator in different bidding zones at different times would be highly challenging for the operation of the entire energy system, an OWF physically connected to multiple bidding zones can only commercially feed its electricity into one bidding zone. Furthermore, the topic is addressed in the Clean Energy Package. It is likely that no further barrier mitigation regarding curtailment regulation and compensation is needed for the implementation of the COBRA Cable hybrid project. However, in the longer term the translation into Dutch, German and Danish law needs to be assessed in detail by the project-specific stakeholders.

5.4.11 Lack of regulated revenues for anticipatory investments

This barrier is not relevant for the COBRA Cable hybrid project.

In the context of the COBRA Cable hybrid project, additional anticipatory investments beyond the EBRD funding to support a future OWF connection to it are not expected.

5.4.12 Uncertainty about applicable RES subsidy scheme

This barrier is relevant for the COBRA Cable hybrid project.

To address this barrier, five mitigation options are assessed with regard to their applicability (Table 35) – excluding the implications of interdependencies with other barriers.

- Option 1 "Dutch subsidy scheme": According to EU Directive 2009/28/EC, the Dutch government can fund the German OWF included in the hybrid project with a premium tariff through the SDE+ scheme (sliding feed-in premium), potentially with statistical transfers between the involved countries.
- Option 2 "German subsidy scheme": The German government awards the OWF included in the hybrid project a premium tariff (sliding feed-in premium), potentially with statistical transfers between the involved countries.
- Option 3 "Danish subsidy scheme": According to EU Directive 2009/28/EC, the Danish government awards the OWF included in the hybrid project a premium tariff, potentially with statistical transfers between the involved countries.
- Option 4 "Joint project between the Netherlands, Germany and Denmark": According to EU Directive 2009/28/EC Member States may co-fund an energy project that relates to the production of electricity from renewable energy sources. In this context, a joint project implies that the Netherlands, Germany and Denmark are financing parts of the hybrid project by applying their own national subsidy schemes.
- Option 5 "No subsidy scheme": The OWF included in the COBRA Cable hybrid project is tendered without a subsidy scheme (i.e. comparable to zero-subsidy bids) and neither a subsidy scheme of the Netherlands, Germany nor Denmark nor a joint project is needed.

	Option 1: Dutch subsidy scheme	Option 2: German subsidy scheme	Option 3: Danish subsidy scheme	Option 4: Joint project between NL, DE and DK	Option 5: No subsidy scheme
Legal / regulatory provisions	Not covered by NL legal and regulatory regime as OWF is located in DE	Potentially covered by DE legal and regulatory regime but clarification required with regard to need for statistical transfers due to and applicability despite onshore connection points in the NL and DK	Not covered by DK legal and regulatory regime as OWF is located in DE	Covered by EU Directive 2009/28/EC on a European level but legally binding document between NL, DE and DK needs to be formulated to establish joint project	Covered in national legal and regulatory regime
Costs	Costs borne only by the NL	Costs borne only by DE	Costs borne only by DK	Costs borne jointly by the NL, DE and DK	No costs must be borne by the NL, DE and DK
Mechanism	Sliding feed-in premium	Sliding feed-in premium	Feed-in tariff	Sliding feed-in premium in NL, DE and feed-in tariff in DK	No mechanism necessary
Project bankability	Bankability ensured through subsidy scheme	Bankability ensured through subsidy scheme	Bankability ensured through subsidy scheme	Bankability ensured through joint project	Bankability of project depends on other offtake securities, such as long-term power purchase agreements

	Option 1: Dutch subsidy scheme	Option 2: German subsidy scheme	Option 3: Danish subsidy scheme	Option 4: Joint project between NL, DE and DK	Option 5: No subsidy scheme
Public opinion	Dutch public opinion can be opposed to funding DE OWF with NL public funds	German public opinion can be opposed to funding DE OWF without DE connection with DE public funds	Danish public opinion can be opposed to funding DE OWF with DK public funds	Public opinion in NL, DE and DK can be opposed to funding RES generation potentially transmitted to other countries with public funds	Public opinion neutral since no public funds used
Timeline	Uncertain timeline as OWF inclusion into NL National Water Plan necessary but process not established	Uncertain timeline as OWF site is foreseen in DE central plans (leftover area) and potentially included in a special tender, but with unknown date	Uncertain timeline as OWF inclusion into DK plans necessary but process not established	Uncertain timeline in DE as OWF site is foreseen in DE central plans (leftover area) but joint project must be established	Uncertain timeline as OWF site is foreseen in DE central plans (leftover area) and potentially included in a special tender, but with unknown date
Summary	Not covered in NL legal and regulatory regime, bankability ensured but public opinion potentially opposed and uncertain timeline	Potentially covered in DE legal and regulatory regime, bankability ensured but public opinion potentially opposed and uncertain timeline	Not covered in DK legal and regulatory regime, bankability ensured but public opinion potentially opposed and uncertain timeline	Covered in EU and national legal and regulatory regime with legal agreement required, bankability ensured but public opinion potentially opposed and uncertain timeline	Covered in national legal and regulatory regime but bankability only ensured with offtake securities and uncertain timeline

Table 35: COBRA Cable – Assessment of options for RES subsidy schemes

In summary, the interaction with stakeholders shows that all five options – applying a Dutch (Option 1), German (Option 2) or Danish subsidy scheme (Option 3) to the German OWF, establishing a joint project (Option 4) as well as tendering the OWF site without a subsidy scheme (i.e. comparable to zero-subsidy bids) (Option 5) – have advantages and disadvantages. While applying the Dutch or

Danish subsidy scheme are not covered under the respective national legislation and regulation, applying the German subsidy scheme or no subsidy scheme are (potentially) covered. For the German subsidy scheme, it needs to be clarified whether statistical transfers between the involved countries are required. While the bankability of the OWF supported under Options 1 to 4 is given, the bankability of an OWF tendered without a subsidy scheme (Option 5) largely depends on the ability of the OWF developer to obtain offtake securities like power purchase agreements. Establishing a joint project between the Netherlands, Germany and Denmark is legally covered and provides the necessary bankability but might be problematic due to the extended timeline which is needed to agree the specifications of the scheme and to formulate a legally binding document between the Netherlands, Germany and Denmark.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the COBRA Cable hybrid project must also take into account the interdependencies between the individual barriers.

5.4.13 Limited engagement of public stakeholders

The barrier "limited engagement of public stakeholders" is divided into two subtopics, formalised public support and financial support. The two subtopics are addressed individually in the following.

Formalisation of commitment from public stakeholders

To address this barrier, two mitigation options are assessed with regard to their applicability (Table 36) – excluding the implications of interdependencies with other barriers.

- Option 1 "Memorandum of Understanding (MoU)": A Memorandum of Understanding is a formalisation of the goodwill of the involved parties in form of a non-binding agreement. An MoU addresses barriers by formalising the agreements of the involved parties with regard to the implementation of required actions to overcome the barriers. It can involve all project stakeholders, such as OWF developers, TSOs, national ministries and NRAs as well as the European Commission.
- Option 2 "Hybrid Asset Network Support Agreement (HANSA)": A project-specific Hybrid Asset Network Support Agreement is a legally-binding commitment to adapt national legislation and regulation in the future, and thus provides legal certainty to developers. European legislation and regulation can only be adapted via a project-specific HANSA if all Member States of the European Union sign the agreement. It only directly involves public stakeholders, such as national ministries.

	Option 1: Memorandum of Understanding (MoU)	Option 2: Hybrid Asset Network Support Agreement (HANSA)
Required effort	Some interaction and alignment required among project developers and stakeholders to facilitate signing of agreement	Significant interaction and alignment among political project stakeholders required to facilitate signing of agreement
Provided certainty	Intentional character of signed agreement sufficient for hybrid projects in early development stage	Legally binding commitment to topics covered by signed agreement directly facilitates project development, but is only required at a later development stage of hybrid projects

	Option 1: Memorandum of Understanding (MoU)	Option 2: Hybrid Asset Network Support Agreement (HANSA)
Summary	Reasonable effort to align agreement required prior to signing and non-legally binding commitment sufficient in early project development stages	Significant effort for alignment of agreement required prior to signing but provides legal certainty and therefore suitable in later development stages

Table 36: COBRA Cable – Assessment of options for formalisation of commitment from public stakeholders

In summary, the interaction with stakeholders shows that both options – a project-specific Memorandum of Understanding (Option 1) and a project-specific Hybrid Asset Network Support Agreement (Option 2) – have advantages and disadvantages. While less effort is usually required to align and sign a project-specific MoU, an MoU is not legally binding, and thus the commitment of public stakeholders provides limited certainty, for example, about legal and regulatory changes for project developers (Option 1). However, while a project-specific HANSA provides legal certainty about the commitment of stakeholders to implement legal and regulatory changes, the alignment process requires more effort (Option 2).

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the COBRA Cable hybrid project must also take into account the interdependencies between the individual barriers as well as the development stage of the hybrid project.

Financial support

This subtopic of the barrier is relevant for the COBRA Cable hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of limited financial support, but rather that a portfolio of support programmes is available and their usage needs to be increased to facilitate the implementation of hybrid projects. In the past, hybrid project development and / or considerations, such as the Combined Grid Solution Kriegers Flak in the Baltic Sea and the Interconnector tie-in COBRA Cable in the North Sea, indicate that such support is required to de-risk and thereby allow for the realisation of pilot projects. In this context, financial support can come in various forms, such as co-financing for early-stage feasibility studies, scoping studies or R&D, co-financing of development and construction or guarantees for the operational phase. Generally, financial support programmes are available on national and European level and should be as specifically targeted at hybrid projects as possible. The target is to increase the awareness for and the usage of existing financial support programmes and thereby foster the development of hybrid projects.

Considering the results of the interaction with the stakeholders, the mitigation of this barrier for the COBRA Cable hybrid project must also take into account the interdependencies between the individual barriers.

5.4.14 Uncertainty regarding the UK market

The barrier "uncertainty regarding the UK market" is divided into two subtopics, UK Capacity Market and UK Cap and Floor regime as well as EU internal energy market. The two subtopics are addressed individually in the following.

UK Capacity Market and Cap and Floor regime

This subtopic of the barrier is not relevant for the COBRA Cable hybrid project.

In the context of the COBRA Cable hybrid project, no commercial nor public UK stakeholders are involved. Thus, there is no uncertainty regarding the UK Capacity Market and Cap and Floor regime for the specific hybrid project idea.

EU internal energy market

This subtopic of the barrier is not relevant for the COBRA Cable hybrid project.

In the context of the COBRA Cable hybrid project, no commercial nor public UK stakeholders are involved. Thus, there is no uncertainty regarding the participation in the EU internal energy market for the specific hybrid project idea.

5.4.15 Disproportionate allocation of costs and benefits across involved stakeholders

This barrier is relevant for the COBRA Cable hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of disproportionate allocation of costs and benefits across involved stakeholders, but rather that a process towards the mitigation of the barrier must be followed. Generally, the process consists of the identification and alignment of cost and benefit categories, the determination of the initial allocation of costs and benefits, the agreement on a re-allocation of costs and benefits as well as – if required and available – the usage of CEF funding to ensure the individual incentivisation of all stakeholders. This can build on the existing process for Cost Benefit Analyses (CBA) and Cross-Border Cost Allocations (CBCA) as defined by ENTSO-E for cross-border electricity interconnectors, which needs to be adjusted according to the specifications of each individual hybrid project. The process should allow for the incentivisation of all relevant stakeholders to implement the hybrid project.

Considering the results of the interaction with the stakeholders, the mitigation process to be followed for the COBRA Cable hybrid project must also take into account the interdependencies between the individual barriers.

5.4.16 Uncertainty about legislative regime for power-to-gas and related infrastructure

This barrier is not relevant for the COBRA Cable hybrid project.

In the context of the COBRA Cable hybrid project, it is currently not planned to include power conversion to gas and / or gas transmission solutions. Thus, there is no need for and consequently no uncertainty regarding the legislative regime for power conversion to gas and gas transmission for the specific hybrid project idea.

5.5 DE OWF to NL

Throughout stakeholder interaction, 12 out of 16 barriers are identified to be relevant for the implementation of the DE OWF to NL hybrid project idea. The results of the interaction with stakeholders with regard to all barriers – relevant and not relevant – are summarised in the ensuing subchapters.

5.5.1 Discrepancies in national grid connection responsibility

The barrier "uncertainty about responsibility for project development" is divided into three subtopics, grid connection responsibility, responsibility for the development and construction of the interconnector and responsibility for the operation of the interconnector. The three subtopics are addressed individually in the following.

Grid connection responsibility

This subtopic of the barrier is relevant for the DE OWF to NL hybrid project.

To address this barrier, three mitigation options are assessed with regard to their applicability (Table 37) – excluding the implications of interdependencies with other barriers.

- Option 1 "TenneT TSO B.V. is responsible": The Dutch TSO, TenneT TSO B.V., is responsible for the connection of the German OWF to the Dutch onshore grid.
- Option 2 "TenneT TSO GmbH is responsible": The German TSO, TenneT TSO GmbH, is responsible for the connection of the German OWF to the Dutch onshore grid.
- Option 3 "TenneT TSO B.V. and TenneT TSO GmbH are responsible": The Dutch TSO, TenneT TSO B.V., and the German TSO, TenneT TSO GmbH, are jointly responsible for the connection of the German OWF to the Dutch onshore grid.

	Option 1: TenneT TSO B.V. is responsible	Option 2: TenneT TSO GmbH is responsible	Option 3: TenneT TSO B.V. and TenneT TSO GmbH are responsible
Legal / regulatory coverage	Not covered in NL (OWF location defines responsibility) as well as DE legislation and regulation (OWF location and onshore connection point define responsibility) – EU network codes, such as "HVDC Connections" and "Requirements for generators", support technical standardisation	Not covered in DE legislation and regulation (OWF location and onshore connection point define responsibility) – EU network codes, such as "HVDC Connections" and "Requirements for generators", support technical standardisation	Not covered in NL (OWF location defines responsibility) as well as DE legislation and regulation (OWF location and onshore connection point define responsibility) – EU network codes, such as "HVDC Connections" and "Requirements for generators", support technical standardisation
Costs	Costs are with NL, including liability for grid connection delay or unavailability of grid	Costs are with DE, including liability for grid connection delay or unavailability of grid	Costs are with NL and DE, including liability for grid connection delay or unavailability of grid
Financial risk	Financial risk in case of delay or failure of grid connection is with TenneT TSO B.V., and thus with the NL, therefore no risk towards project realisation	Financial risk in case of delay or failure of grid connection is with TenneT TSO GmbH, and thus with DE, therefore no risk towards project realisation	Financial risk in case of delay or failure of grid connection is with TenneT TSO B.V. and TenneT TSO GmbH, and thus with the NL and DE, therefore no risk towards project realisation

	Option 1: TenneT TSO B.V. is responsible	Option 2: TenneT TSO GmbH is responsible	Option 3: TenneT TSO B.V. and TenneT TSO GmbH are responsible
Development risk	Alignment of development not needed for a single developer and also not across parts of entire cable system due to congruent responsibilities, therefore low risk towards project realisation	Alignment of development not needed for a single developer but across parts of entire cable system due to differing responsibilities, therefore uncertain risk towards project realisation	Alignment of development needed for multiple developers and additionally across parts of entire cable system due to differing responsibilities, therefore uncertain risk towards project realisation
Operational risk	Alignment of operations not needed for a single developer and also not across parts of entire cable system due to congruent responsibilities, therefore low risk towards project realisation	Alignment of operations not needed for a single developer but across parts of entire cable system due to differing responsibilities, therefore uncertain risk towards project realisation	Alignment of operations needed for multiple developers and additionally across parts of entire cable system due to differing responsibilities, therefore uncertain risk towards project realisation
Market-specific expertise	Knowledge on general and project-specific grid connection and operational requirements partially given for TenneT TSO B.V. in the NL	Knowledge on general and project-specific grid connection and operational requirements partially given for TenneT TSO GmbH in DE	Knowledge on general and project-specific grid connection and operational requirements given for TenneT TSO B.V. and TenneT TSO GmbH in the NL and DE, respectively
Risk for OWF developer	No financial risk for OWF in case of delays or failure in grid connection, as compensation is guaranteed by regulation in the NL	No financial risk for OWF in case of delays or failure in grid connection, as compensation is guaranteed by regulation in the DE	No financial risk for OWF in case of delays or failure in grid connection, as compensation is guaranteed by regulation in the NL and DE
First connection charges and G-charges	Shallow first connection charges and no G-charges in the NL and shallow to super-shallow first connection charges and no G-charges in DE	Shallow first connection charges and no G-charges in the NL and shallow to super-shallow first connection charges and no G-charges in DE	Shallow first connection charges and no G-charges in the NL and shallow to super-shallow first connection charges and no G-charges in DE
Summary	Not covered under NL and DE legal and regulatory regime, but with low risk towards project realisation	Not covered under DE legal and regulatory regime and with uncertain risk towards project realisation	Not covered under NL and DE legal and regulatory regime and with uncertain risk towards project realisation

Table 37: DE OWF to NL – Assessment of options for grid connection responsibility

In summary, the interaction with stakeholders shows that all three options – to allocate the responsibility to TenneT TSO B.V. (Option 1), to TenneT TSO GmbH (Option 2) as well as to the consortium of TenneT TSO B.V. and TenneT TSO GmbH (Option 3) – have advantages and disadvantages. However, the allocation of responsibility to the Dutch (Option 1) and German entity (Option 2) as well as to the Dutch and German entities together (Option 3) still require clarification regarding the legal and regulatory coverage. The risk towards project realisation is low for Option 1 but uncertain for Options 2 and 3. Furthermore, the inclusion of the relevant TSOs in Option 3 ensures required market-specific expertise, in contrast to Options 1 and 2. However, all options insure the OWF developer in case of a delay or a failure of its grid connection.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the DE OWF to NL hybrid project must also take into account the interdependencies between the individual barriers.

Responsibility for development and construction of interconnector

This subtopic of the barrier is not relevant for the DE OWF to NL hybrid project.

Due to the radial connection of the German OWF to the Dutch onshore grid, no interconnector is included in the hybrid project.

Responsibility for operation of interconnector

This subtopic of the barrier is not relevant for the DE OWF to NL hybrid project.

Due to the radial connection of the German OWF to the Dutch onshore grid, no interconnector is included in the hybrid project.

5.5.2 Uncertainty about regulation deriving from jurisdiction over cross-border cable systems

This barrier is relevant for the DE OWF to NL hybrid project.

To address this barrier, two mitigation options are assessed with regard to their applicability (Table 38) – excluding the implications of interdependencies with other barriers. The assessment concentrates on the jurisdiction applicable to the export cable system. The OWF underlies German jurisdiction in line with the installation exploiting wind as a natural resource within the German EEZ.

- Option 1 "Dutch jurisdiction's regulations": In addition to European law, Dutch jurisdiction applies to the export cable system from the OWF to the Dutch onshore connection point, thus including the part of the cable system geographically located in the German EEZ.
- Option 2 "German jurisdiction's regulations": In addition to European law, German jurisdiction applies to the export cable system from the OWF to the Dutch onshore connection point, thus including the part of the cable system geographically located in the Dutch EEZ and territorial sea.
- Option 3 "Alignment of jurisdictions' regulations": Based on negotiations between the Netherlands and Germany, a new combination of regulations applies to the export cable system from the OWF to the Dutch onshore connection point – in addition to European law. The new combination of regulations over the cable systems can potentially be based on existing interconnector agreements.

	Option 1: Dutch jurisdiction's regulations	Option 2: German jurisdiction's regulations	Option 3: Alignment of jurisdictions' regulations, based on existing IC agreement
Rights and duties in DE EEZ during operation	Uncertainty and thus alignment required since neither country has clear jurisdiction since cable crosses NL territorial sea but also serves exploitation of the DE EEZ	Uncertainty and thus alignment required since neither country has clear jurisdiction since cable crosses NL territorial sea but also serves exploitation of the DE EEZ	Alignment required to combine operational rules deriving from jurisdictions of the NL and DE for DE EEZ through involvement of the NL and DE
Rights and duties in NL EEZ during operation	Uncertainty and thus alignment required since neither country has clear jurisdiction since cable crosses NL territorial sea but also serves exploitation of the DE EEZ	Uncertainty and thus alignment required since neither country has clear jurisdiction since cable crosses NL territorial sea but also serves exploitation of the DE EEZ	Alignment required to combine operational rules deriving from jurisdictions of the NL and DE for NL EEZ through involvement of the NL and DE
Rights and duties in NL territorial sea / onshore during operation	No uncertainty since the NL has jurisdiction and NL operational rules apply since cable crosses NL territorial sea	Uncertainty and thus alignment required since the NL has jurisdiction and NL operational rules apply since cable crosses NL territorial sea	Alignment required to combine operational rules deriving from jurisdictions of the NL and DE for NL territorial sea through involvement of the NL and DE
Hybrid project requirements	Alignment of operational rules between the NL and DE required because of connection of DE OWF to the Dutch market via an export cable system	Alignment of operational rules between the NL and DE required because of connection of DE OWF to the Dutch market via an export cable system	No additional alignment of operational rules required
Timeline	Alignment may extend timeline of project	Alignment may extend timeline of project	Alignment may extend timeline of project
Other			Provisions for assigning liability in case of grid connection failure need to be implemented
Summary	Uncertainty and thus alignment required to ensure applicability of Option 1 since no clear rules apply in the NL and DE EEZs	Uncertainty and thus alignment required to ensure applicability of Option 2 since no clear rules apply in the NL and DE EEZs	Alignment required to ensure applicability of Option 3 since no clear rules apply in the NL and DE EEZs

Table 38: DE OWF to NL – Assessment of options for regulation deriving from jurisdiction deriving from cross-border cable systems

In summary, the interaction with stakeholders shows that all three options – the agreement on the applicability of operational rules to the export cable system based on German (Option 1) or Dutch jurisdiction (Option 2) as well as the alignment of regulations deriving from the Dutch and German jurisdiction (Option 3) – have advantages and disadvantages. While chances of an agreement among the Netherlands and Germany on a single jurisdiction are limited, the alignment of regulations deriving from two jurisdictions can be a lengthy process. Yet, Option 3 reflects the interest of both countries in the alignment and can potentially build on existing agreements established for the interconnectors between the Netherlands and Germany.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the DE OWF to NL hybrid project must also take into account the interdependencies between the individual barriers.

5.5.3 Uncertainty about market arrangements

This barrier is relevant for the DE OWF to NL hybrid project.

To address this barrier, five mitigation options are assessed with regard to their applicability (Table 39) – excluding the implications of interdependencies with other barriers.

- Option 1 "Commercial flows to the Dutch market": With commercial flows to the Netherlands, the German OWF is always commercially evacuating its electricity to the Dutch market, and thus into the bidding zone to which the OWF is physically connected.
- Option 2 "Commercial (virtual) flows to home market": With commercial (virtual) flows to its home market, this is, Germany, the German OWF always transmits its electricity commercially to the German market, and thus into the bidding zone in which the OWF is physically located.
- Option 3 "Dynamic flows to high-price market": With a dynamic flow to the high-price market, the German OWF always commercially transmits its electricity to the higher-price market of the Netherlands and Germany.

	Option 1: Commercial flows to the Dutch market	Option 2: Fixed (virtual) access to home market	Option 3: Dynamic flows to high-price market
Legal / regulatory coverage	Not covered under existing market regulation	Not covered under existing market regulation	Not covered under existing market regulation, particularly in violation of CACM requirement of stability of bidding zones across market time frames

	Option 1: Commercial flows to the Dutch market	Option 2: Fixed (virtual) access to home market	Option 3: Dynamic flows to high-price market
Price determination	Dutch market price applies	Home market price applies	Price determination problematic when transmission of generated electricity to high-price market not possible (limited capacity) – alternative price determination needed
Price effects	Effect of decreasing prices in NL as OWF produces at close to zero marginal costs	Effect of decreasing prices in home market, as OWF produces at close to zero marginal costs	Effect of decreasing prices in the high-price market, as OWF produces at close to zero marginal costs
Price discrimination of OWFs	Discriminatory against hybrid OWF if DE market price is higher than NL market price, which it receives	Not discriminatory against any OWF as hybrid OWF and other OWFs in DE bidding zone receive same prices	Discriminatory against any other OWF in the DE bidding zones, as hybrid OWF always receives high price of NL or DE market
Compensation	Negative business case implications for hybrid OWF from price discrimination, and thus additional compensation necessary	No business case implications for hybrid OWF, and thus no additional compensation necessary	No business case implications for hybrid OWF, and thus no additional compensation necessary
Outages	No backup cable system available	No backup cable system available	No backup cable system available
Summary	Legal and regulatory coverage not given, discriminatory against hybrid OWF and negative business case implications for OWF from price discrimination	Legal and regulatory coverage not given, not discriminatory against any OWF and no negative business case implications for OWF	Legal and regulatory coverage not given, discriminatory against other OWFs and no negative business case implications for OWF

Table 39: DE OWF to NL – Assessment of options for market arrangements

In summary, the interaction with stakeholders shows that all three options – the OWF always commercially evacuating electricity to the Dutch market (Option 1) or to the German market (Option 2) as well as the OWF commercially evacuating electricity to the higher-price market of the Netherlands and Germany (Option 3) – have advantages and disadvantages. Legal and regulatory coverage is not given for all options, with Option 3 violating the European CACM requirement of stability of bidding zones across market time frames. In case of commercial (virtual) flows to Germany

(Options 2 and 3) there may be a need for onshore grid reinforcements. Furthermore, due to negative business case implications from price discrimination in Option 1, additional compensation for the hybrid OWF is required.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the DE OWF to NL hybrid project must also take into account the interdependencies between the individual barriers.

5.5.4 Uncertainty about hybrid cable system classification

This barrier is not relevant for the DE OWF to NL hybrid project.

In the context of the DE OWF to NL hybrid project, the included cable system has no interconnector functionality. Thus, the cable system only serves one distinct and legally defined function, which is providing for the transmission of electricity generated by the OWF in the hybrid setup to shore. In consequence, there is a definition and applicable rules for the cable system under national and EU law.

5.5.5 Failure of developers to align planning across assets and countries

The barrier "failure of developers to align planning across assets and countries" is divided into three subtopics, geographical alignment, technical alignment and timing alignment. The three subtopics are addressed individually in the following.

Geographical alignment

This subtopic of the barrier is relevant for the DE OWF to NL hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of failed geographical alignment across assets and countries, but rather that a process towards the mitigation of the barrier must be followed. The process consists of the continuous exchange between project developers and other stakeholders to allow for the achievement of early-stage, geographical alignment.

Considering the results of the interaction with the stakeholders, the mitigation process to be followed for the DE OWF to NL hybrid project must also take into account the interdependencies between the individual barriers.

Technical alignment

This subtopic of the barrier is relevant for the DE OWF to NL hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of failed technical alignment across assets and countries, but rather that a process towards the mitigation of the barrier must be followed. The process consists of the continuous exchange between project developers and other stakeholders to allow for the achievement of early-stage, technical alignment.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the DE OWF to NL hybrid project must also take into account the interdependencies between the individual barriers.

Timing alignment

This subtopic of the barrier is relevant for the DE OWF to NL hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of failed timing alignment across assets and countries, but rather that a process towards the mitigation of the barrier must be followed. The process consists of the continuous exchange between project developers and other stakeholders to allow for the achievement of early-stage, timing alignment.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the DE OWF to NL hybrid project must also take into account the interdependencies between the individual barriers.

5.5.6 Uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation and tender execution)

The barrier "uncertainty about responsibility and rules to provide access to maritime space for OWFs (location selection, site pre-investigation and tender execution)" is divided into two subtopics, location selection and site pre-investigation as well as tender execution. The two subtopics are addressed individually in the following.

Location selection and site pre-investigation

This subtopic of the barrier is relevant for the DE OWF to NL hybrid project.

To address this barrier, three mitigation options are assessed with regard to their applicability (Table 40) – excluding the implications of interdependencies with other barriers.

- Option 1 "Dutch responsibility": The Netherlands conduct the location selection and site pre-investigation for the OWF site in the German EEZ as part of the centrally organised pre-investigation based on the National Water Plan, following standardised national processes and timelines. Site decisions determine where OWF development can take place.
- Option 2 "German responsibility": Germany conducts the location selection and site pre-investigation for the OWF site in the German EEZ as part of the centrally organised pre-investigation based on the Spatial Grid Development Plan, following standardised national processes and timelines. Site decisions determine where OWF development can take place.
- Option 3 "Responsibility of OWF developer": The potential OWF developer conducts location selection and site pre-investigation for the OWF site in the German EEZ within the context of an open-door approach. Following the final site decision by the potential OWF developer, the candidate applies for the necessary licenses to develop the OWF based on the results of the pre-investigation. The extent to which a government shapes and controls the investigations that are part of the open-door process by specific regulatory requirements that must be met varies across the Netherlands and Germany.

	Option 1: Dutch responsibility	Option 2: German responsibility	Option 3: Responsibility of OWF developer
Legal / regulatory coverage	Not covered by DE legislation and regulation	Covered by DE legislation and regulation, can potentially become part of special tender process ("Sonderausschreibung")	Not covered by DE legislation and regulation
Costs	Costs are with NL	Costs are with DE	Costs are with OWF developer
Process	Unclear process as DE OWF site must be included in central development plan in NL (National Water Plan)	Clear process as OWF site is included in Spatial Grid Development Plan in DE by standard procedure, maybe even with lean processes under DE special tender process ("Sonderausschreibung")	Clear process as no new process is necessary, but alignment with DE Spatial Development Plan required
Timeline	Unclear timeline in NL (National Water Plan), expecting possible delays due to additional coordination between NL and DE	Clear timeline as OWF site is included in central DE Spatial Development Plan for tender post-2030, but shorter timeline under DE special tender process ("Sonderausschreibung") possible; leftover area then potentially tendered by 2023	Unclear timeline as timeline is determined by OWF developer and alignment with DE Spatial Development Plan required
Coordinated use of offshore areas	Weakens coordinated use of limited offshore areas since responsibility of NL potentially hinders effective usage (maximisation of societal benefits) of sites in DE	Strengthens coordinated use of limited offshore areas, potentially maximising the societal benefit of overall wind potential in DE, and is most suitable as case site has already been pre-investigated	Weakens coordinated use of limited offshore areas since shared responsibility potentially hinders effective usage (maximisation of societal benefits) of sites; potential decrease in quality of investigation, as OWF developer fears sunk costs, and thus performs cost-efficient investigation

	Option 1: Dutch responsibility	Option 2: German responsibility	Option 3: Responsibility of OWF developer
Summary	Not covered in DE legislation and regulation, and unclear processes and timelines as coordination between NL and DE needs to take place	Covered in DE legislation and regulation, and clear processes and timelines in DE	Not covered in DE legislation and regulation, and unclear processes and timelines as additional alignment with DE Spatial Grid Development Plan required

Table 40: DE OWF to NL – Assessment of options for location selection and site pre-investigation

In summary, the interaction with stakeholders shows that both options – assigning responsibility to Dutch authorities (Option 1), assigning responsibility to German authorities (Option 2) and assigning responsibility to OWF developer (Option 3) – have advantages and disadvantages. Both, Option 1 and 3, are not covered in German legislation and regulation in contrast to Option 2. Additionally, only Option 1 has a clear process and timeline whereas processes and timelines in are unclear due to additional alignment between the Netherlands (Option 1) and alignment with the German Spatial Grid Development Plan (Option 3).

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the DE OWF to NL Cable hybrid project must also take into account the interdependencies between the individual barriers.

Tender responsible party

This subtopic of the barrier is relevant for the DE OWF to NL hybrid project.

To address this barrier, three mitigation options are assessed with regard to their applicability (Table 41) – excluding the implications of interdependencies with other barriers.

- Option 1 "Dutch responsibility": The Netherlands (RVO) conducts the tender execution for the OWF site in the German EEZ as one-stop shop authority following either Dutch tender process specifications or German tender process specifications. All costs of the tender execution are borne by the Dutch government.
- Option 2 "German responsibility": Germany (BNetzA) conducts the tender execution for the OWF site in the German EEZ as one-stop shop authority following German tender process specifications based on the Spatial Grid Development Plan.

	Option 1: Dutch responsibility	Option 2: German responsibility
Legal / regulatory coverage	Not covered by DE legislation and regulation	Covered in DE legislation and regulation but special provisions need to be made regarding the planned grid connection of the OWF
Costs	Costs are with NL	Costs are with DE

	Option 1: Dutch responsibility	Option 2: German responsibility
Process efficiency	Unclear process efficiency since it depends on familiarity of responsible party with the tender process (either Dutch or German)	Efficient process since responsible party is familiar with tender process
Public opinion	Negative, as public opinion in Germany can be opposed to surrendering sovereignty over the German EEZ	Positive, as public opinion in Germany in favour of maintaining sovereignty over the German EEZ
Other	Potential OWF site might already be part of the DE Spatial Grid Development Plan, if it is integral part of a larger OWF site or linked to other DE sites – unclear whether NL can efficiently conduct tender of part of a larger site and / or is allowed to do so	As potential OWF site is a leftover area (part of a larger OWF site), it might already be included in DE Spatial Grid Development Plan and German process might apply
Summary	Not covered in DE legislation and regulation, unclear process efficiency and DE public opinion potentially opposed	Covered in DE legislation and regulation, efficient process and DE public opinion in support

Table 41: DE OWF to NL – Assessment of options for tender responsible party

In summary, the interaction with stakeholders shows both options – assigning responsibility for the tender execution to Dutch authorities (Option 1) and German authorities (Option 2) – have advantages and disadvantages. Assigning responsibility to Dutch authorities (Option 1) is not covered in German legislation and regulation, requires alignment and is not supported by the public. Assigning responsibility to German authorities (Option 2) is covered in German legislation and regulation, does not require alignment and is supported by the public.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the DE OWF to NL hybrid project must also take into account the interdependencies between the individual barriers.

5.5.7 Uncertainty about responsibility and rules to provide access to maritime space for OWFs (tender design)

This barrier is relevant for the DE OWF to NL hybrid project.

To address this barrier, four mitigation options are assessed with regard to their applicability (Table 42) – excluding the implications of interdependencies with other barriers.

- Option 1 "Strict design with aligned requirements and without hybrid-specific uncertainties": A tender design with strict pre-qualification requirements implies that extensive pre-qualification requirements are defined to ensure hybrid-specific and general capabilities to develop the DE OWF to NL hybrid project. The requirements are aligned among the Netherlands and Germany, including a jointly agreed set of financial requirements and a certain set of both Dutch and German rules related to the OWF site (e.g. environmental details) and a certain set of both Dutch and German rules related to the grid connection of the OWF (e.g. technical and operational details such as system integration or frequency control). Furthermore, all uncertainties arising from the hybrid character of the OWF development are clarified prior to the tender.

- Option 2 "Strict design with aligned requirements": A tender design with strict pre-qualification requirements implies that extensive pre-qualification requirements are defined to ensure hybrid-specific and general capabilities to develop the DE OWF to NL hybrid project. The requirements are aligned among the Netherlands and Germany, including a jointly agreed set of financial requirements and a certain set of both Dutch and German rules related to the OWF site (e.g. environmental details) and a certain set of both Dutch and German rules related to the grid connection of the OWF (e.g. technical and operational details such as system integration or frequency control).
- Option 3: "Strict design without hybrid-specific uncertainties": A tender design with strict pre-qualification requirements implies that extensive pre-qualification requirements are defined to ensure hybrid-specific and general capabilities to develop the DE OWF to NL hybrid project. Furthermore, all uncertainties arising from the hybrid character of the OWF development are clarified prior to the tender.
- Option 4 "Lenient design with aligned requirements and without hybrid-specific uncertainties": A tender design with lenient pre-qualification requirements is chosen, implying that only limited pre-qualification requirements are defined to ensure competition and low prices. The requirements are aligned among the Netherlands and Germany, including a jointly agreed set of financial requirements and a certain set of both Dutch and German rules related to the OWF site (e.g. environmental details) and a certain set of both Dutch and German rules related to the grid connection of the OWF (e.g. technical and operational details such as system integration or frequency control). Furthermore, all uncertainties arising from the hybrid character of the OWF development are clarified prior to the tender.

	Option 1: Strict design, aligned requirements and no uncertainties	**Option 2: Strict design and aligned requirements**	**Option 3: Strict design and no uncertainties**	**Option 4: Lenient design, aligned requirements and no uncertainties**
Legal / regulatory coverage	Not covered and potential amendments to national legislation and regulation necessary since multiple countries are involved in defining tender design	Not covered and potential amendments to national legislation and regulation necessary since multiple countries are involved in defining tender design	Covered and no amendments to national legislation and regulation necessary since only one country is involved in defining tender design	Not covered and potential amendments to national legislation and regulation necessary since multiple countries are involved in defining tender design
Alignment of requirements	Financial requirements aligned; technical and operational requirements defined by the NL; environmental requirements defined by DE	Financial requirements aligned; technical and operational requirements defined by the NL; environmental requirements defined by DE	No alignment of requirements	Financial requirements aligned; technical and operational requirements defined by the NL; environmental requirements defined by DE

	Option 1: Strict design, aligned requirements and no uncertainties	Option 2: Strict design and aligned requirements	Option 3: Strict design and no uncertainties	Option 4: Lenient design, aligned requirements and no uncertainties
Hybrid-specific un-certainties	All uncertainties arising from hybrid-specific setup are clarified, e.g. liability, applicable jurisdiction, grid connection responsibility, RES subsidy scheme	Uncertainties arising from hybrid character of development not entirely clarified such that uncertainty remains for OWF developers	All uncertainties arising from hybrid-specific setup are clarified, e.g. liability, applicable jurisdiction, grid connection responsibility, RES subsidy scheme	All uncertainties arising from hybrid-specific setup are clarified, e.g. liability, applicable jurisdiction, grid connection responsibility, RES subsidy scheme
Realisation probability	Applying OWF developers are aware of all specifications and requirements and can align planning and financing right from the beginning	Applying OWF developers are aware of all specifications and requirements and can align planning and financing right from the beginning	Applying OWF developers are aware of all specifications and requirements and can align planning and financing right from the beginning; however, it is questionable whether an OWF connected to foreign country can be tendered without alignment of tender requirements	Applying OWF developers are not aware of most specifications and requirements, which might result in significant cost overruns / delays after the tender process
Cost efficiency	Due to strict requirements and specifications, less developers expected to apply – cost efficiency of offers expected to decrease with fewer applicants	Due to strict requirements and specifications, less developers expected to apply – cost efficiency of offers expected to decrease with fewer applicants	Due to strict requirements and specifications, less developers expected to apply – cost efficiency of offers expected to decrease with fewer applicants	Due to lenient requirements and specifications, many developers expected to apply – cost efficiency of offers expected to increase with more applicants

	Option 1: Strict design, aligned requirements and no uncertainties	Option 2: Strict design and aligned requirements	Option 3: Strict design and no uncertainties	Option 4: Lenient design, aligned requirements and no uncertainties
Summary	Legal and regulatory coverage to be assessed and potentially decreases cost efficiency	Legal and regulatory coverage to be assessed and decreases cost efficiency, particularly due to remaining hybrid uncertainties	Legal and regulatory coverage given, but with limited chance of realisation due to non-consideration of one country's interest in defining tender requirements	Legal and regulatory coverage to be assessed and strongly decreases probability of project realisation

Table 42: DE OWF to NL – Assessment of options for tender design

In summary, the interaction with stakeholders shows that all four options – a strict or lenient tender design with aligned requirements and certainty about hybrid-specific characteristics of the OWF development (Option 1 and 4), a strict tender design with aligned requirements (Option 3) as well as a strict tender design with certainty about hybrid-specific characteristics of the OWF development (Option 2) – have advantages and disadvantages. While a tender design with strict requirements (Options 1, 2 and 3) increases the probability of successful project implementation, a tender design with lenient requirements (Option 4) decreases the cost of implementation through competition. Furthermore, certainty about hybrid-specific characteristics of the OWF development (Options 1, 3 and 4) increases the probability of successful project implementation and decreases the cost of implementation by reducing the risk premium otherwise demanded by OWF developers in terms of subsidies. Lastly, aligned requirements (Options 1, 2 and 4) aid in ensuring the interoperability of the OWF with the other assets of the hybrid project and thereby increase the probability of successful hybrid project implementation.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the DE OWF to NL hybrid project must also take into account the interdependencies between the individual barriers.

5.5.8 Discrepancies in responsibilities and requirements for balancing

In the context of the DE OWF to NL hybrid project, there is no discrepancy in the applicability of national balancing responsibility and requirements in the shorter term. Since each generator must always be part of only one bidding zone according to the existing CACM regulation and since the participation of one generator in different bidding zones at different times would be highly challenging for the operation of the entire energy system, an OWF physically connected to multiple bidding zones can only commercially feed its electricity into one bidding zone. Furthermore, the topic is addressed in the Clean Energy Package. It is likely that no further barrier mitigation regarding balancing responsibilities and requirements is needed for the implementation of the DE OWF to NL hybrid project. However, in the longer term the translation into Dutch and German law needs to be assessed in detail by the project-specific stakeholders.

5.5.9 Discrepancies in priority dispatch regulation

In the context of the DE OWF to NL hybrid project, there is no discrepancy in the applicability of national priority dispatch regulation in the shorter term. Since each generator must always be part of only one bidding zone according to the existing CACM regulation and since the participation of one generator in different bidding zones at different times would be highly challenging for the operation of the entire energy system, an OWF physically connected to multiple bidding zones can only commercially feed its electricity into one bidding zone. Furthermore, the topic is addressed in the Clean Energy Package. It is likely that no further barrier mitigation regarding priority dispatch regulation is needed for the implementation of the DE OWF to NL hybrid project. However, in the longer term the translation into Dutch and German law needs to be assessed in detail by the project-specific stakeholders.

5.5.10 Discrepancies in curtailment regulation and compensation

In the context of the DE OWF to NL hybrid project, there is no discrepancy in the applicability of national curtailment regulation and compensation in the shorter term. Since each generator must always be part of only one bidding zone according to the existing CACM regulation and since the participation of one generator in different bidding zones at different times would be highly challenging for the operation of the entire energy system, an OWF physically connected to multiple bidding zones can only commercially feed its electricity into one bidding zone. Furthermore, the topic is addressed in the forthcoming Clean Energy Package. It is likely that no further barrier mitigation regarding curtailment regulation and compensation is needed for the implementation of the DE OWF to NL hybrid project. However, in the longer term the translation into Dutch and German law needs to be assessed in detail by the project-specific stakeholders.

5.5.11 Lack of regulated revenues for anticipatory investments

This barrier is not relevant for the DE OWF to NL hybrid project.

In the context of the DE OWF to NL hybrid project, anticipatory investments are not required and therefore the barrier does not exist for this specific hybrid project.

5.5.12 Uncertainty about applicable RES subsidy scheme

This barrier is relevant for the DE OWF to NL hybrid project.

To address this barrier, four mitigation options are assessed with regard to their applicability (Table 43) – excluding the implications of interdependencies with other barriers.

- Option 1 "Dutch subsidy scheme": According to EU Directive 2009/28/EC, the Dutch government can fund the German OWF included in the hybrid project with a premium tariff through the SDE+ scheme (sliding feed-in premium), potentially with statistical transfers between the involved countries.
- Option 2 "German subsidy scheme": The German government awards the OWF included in the hybrid project a premium tariff (sliding feed-in premium), potentially with statistical transfers between the involved countries.
- Option 3 "Joint project between the Netherlands and Germany": According to EU Directive 2009/28/EC Member States may co-fund an energy project that relates to the production of electricity from renewable energy sources. In this context, a joint project implies that the Netherlands and Germany are financing parts of the hybrid project by applying their own national subsidy schemes.

- Option 4 "No subsidy scheme": The OWF included in the DE OWF to NL hybrid project is tendered without a subsidy scheme (i.e. comparable to zero-subsidy bids) and neither a subsidy scheme of the Netherlands and Germany nor a joint project is needed.

	Option 1: Dutch subsidy scheme	Option 2: German subsidy scheme	Option 3: Joint project between NL and DE	Option 4: No subsidy scheme
Legal / regulatory provisions	Not covered by NL legal and regulatory regime as OWF is located in DE	Potentially covered by DE legal and regulatory regime but clarification required with regard to need for statistical transfers due to and applicability despite onshore connection point in the NL	Covered by EU Directive 2009/28/EC on a European level but legally binding document between NL and DE needs to be formulated to establish joint project	Covered in national legal and regulatory regime
Costs	Costs borne only by the NL	Costs borne only by DE	Costs borne jointly by the NL and DE	No costs must be borne by the NL and DE
Mechanism	Sliding feed-in premium	Sliding feed-in premium	Sliding feed-in premium in the NL and DE	No mechanism necessary
Project bankability	Bankability ensured through subsidy scheme	Bankability ensured through subsidy scheme	Bankability ensured through joint project	Bankability of project depends on other offtake securities, such as long-term power purchase agreements
Public opinion	Dutch public opinion can be opposed to funding DE OWF with NL public funds	German public opinion can be opposed to funding DE OWF without DE connection with DE public funds	Public opinion in NL and DE can be opposed to funding RES generation potentially transmitted to other countries with public funds	Public opinion neutral since no public funds used

	Option 1: Dutch subsidy scheme	Option 2: German subsidy scheme	Option 3: Joint project between NL and DE	Option 4: No subsidy scheme
Timeline	Uncertain timeline as OWF inclusion into NL National Water Plan necessary but process not established	Uncertain timeline as OWF site is not foreseen in DE central plans but potentially included in a special tender and with unknown date	Uncertain timeline in DE as OWF site is not foreseen in DE central plans and joint project must be established	Uncertain timeline as OWF site is not foreseen in DE central plans but potentially included in a special tender and with unknown date
Summary	Not covered in NL legal and regulatory regime, bankability ensured but public opinion potentially opposed and uncertain timeline	Potentially covered in DE legal and regulatory regime, bankability ensured but public opinion potentially opposed and uncertain timeline	Covered in EU and national legal and regulatory regime with legal agreement required, bankability ensured but public opinion potentially opposed and uncertain timeline	Covered in national legal and regulatory regime but bankability only ensured with offtake securities and uncertain timeline

Table 43: DE OWF to NL – Assessment of options for RES subsidy schemes

In summary, the interaction with stakeholders shows that all four options – applying a Dutch (Option 1) or German (Option 2) subsidy scheme to the German OWF, establishing a joint project (Option 3) as well as tendering the OWF site without a subsidy scheme (i.e. comparable to zero-subsidy bids) (Option 4) – have advantages and disadvantages. While applying the Dutch subsidy scheme is not covered under Dutch legislation and regulation, applying the German subsidy scheme or no subsidy scheme are (potentially) covered. For the German subsidy scheme, it needs to be clarified whether statistical transfers between the Netherlands and Germany are required. While the bankability of the OWF supported under Options 1 to 3 is given, the bankability of an OWF tendered without a subsidy scheme (Option 4) largely depends on the ability of the OWF developer to obtain offtake securities like power purchase agreements. Establishing a joint project between the Netherlands and Germany is legally covered and provides the necessary bankability but might be problematic due to the extended timeline which is needed to agree the specifications of the scheme and to formulate a legally binding document between the Netherlands and Germany.

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the DE OWF to NL hybrid project must also take into account the interdependencies between the individual barriers.

5.5.13 Limited engagement of public stakeholders

The barrier "limited engagement of public stakeholders" is divided into two subtopics, formalised public support and financial support. The two subtopics are addressed individually in the following.

Formalisation of commitment from public stakeholders

This subtopic of the barrier is relevant for the DE OWF to NL hybrid project.

To address this barrier, two mitigation options are assessed with regard to their applicability (Table 44) – excluding the implications of interdependencies with other barriers.

- Option 1 "Memorandum of Understanding (MoU)": A Memorandum of Understanding is a formalisation of the goodwill of the involved parties in form of a non-binding agreement. An MoU addresses barriers by formalising the agreements of the involved parties with regard to the implementation of required actions to overcome the barriers. It can involve all project stakeholders, such as OWF developers, TSOs, national ministries and NRAs as well as the European Commission.
- Option 2 "Hybrid Asset Network Support Agreement (HANSA)": A project-specific Hybrid Asset Network Support Agreement is a legally-binding commitment to adapt national legislation and regulation in the future, and thus provides legal certainty to developers. European legislation and regulation can only be adapted via a project-specific HANSA if all Member States of the European Union sign the agreement. It only directly involves public stakeholders, such as national ministries.

	Option 1: Memorandum of Understanding (MoU)	Option 2: Hybrid Asset Network Support Agreement (HANSA)
Required effort	Some interaction and alignment required among project developers and stakeholders to facilitate signing of agreement	Significant interaction and alignment among political project stakeholders required to facilitate signing of agreement
Provided certainty	Intentional character of signed agreement sufficient for hybrid projects in early development stage	Legally binding commitment to topics covered by signed agreement directly facilitates project development, but is only required at a later development stage of hybrid projects
Summary	Reasonable effort to align agreement required prior to signing and non-legally binding commitment sufficient in early project development stages	Significant effort for alignment of agreement required prior to signing but provides legal certainty and therefore suitable in later development stages

Table 44: DE OWF to NL – Assessment of options for formalisation of commitment from public stakeholders

In summary, the interaction with stakeholders shows that both options – a project-specific Memorandum of Understanding (Option 1) and a project-specific Hybrid Asset Network Support Agreement (Option 2) – have advantages and disadvantages. While less effort is usually required to align and sign a project-specific MoU, an MoU is not legally binding, and thus the commitment of public stakeholders provides limited certainty, for example, about legal and regulatory changes for project developers (Option 1). However, while a project-specific HANSA provides legal certainty about the commitment of stakeholders to implement legal and regulatory changes, the alignment process requires more effort (Option 2).

Considering the results of the interaction with the stakeholders, the selection and / or implementation of the appropriate mitigation option for the DE OWF to NL hybrid project must also take into account the interdependencies between the individual barriers as well as the development stage of the hybrid project.

Financial support

This subtopic of the barrier is relevant for the DE OWF to NL hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of limited financial support, but rather that a portfolio of support programmes is available and their usage needs to be increased to facilitate the implementation of hybrid projects. In the past, hybrid project development and / or considerations, such as the Combined Grid Solution Kriegers Flak in the Baltic Sea and the Interconnector tie-in COBRA Cable in the North Sea, indicate that such support is required to de-risk and thereby allow for the realisation of pilot projects. In this context, financial support can come in various forms, such as co-financing for early-stage feasibility studies, scoping studies or R&D, co-financing of development and construction or guarantees for the operational phase. Generally, financial support programmes are available on national and European level and should be as specifically targeted at hybrid projects as possible. The target is to increase the awareness for and the usage of existing financial support programmes and thereby foster the development of hybrid projects.

Considering the results of the interaction with the stakeholders, the mitigation of this barrier for the DE OWF to NL hybrid project must also take into account the interdependencies between the individual barriers.

5.5.14 Uncertainty regarding the UK market

The barrier "uncertainty regarding the UK market" is divided into two subtopics, UK Capacity Market and UK Cap and Floor regime as well as EU internal energy market. The two subtopics are addressed individually in the following.

UK Capacity Market and Cap and Floor regime

This subtopic of the barrier is not relevant for the DE OWF to NL hybrid project.

In the context of the DE OWF to NL hybrid project, no commercial nor public UK stakeholders are involved. Thus, there is no uncertainty regarding the UK Capacity Market and Cap and Floor regime for the specific hybrid project idea.

EU internal energy market

This subtopic of the barrier is not relevant for the DE OWF to NL hybrid project.

In the context of the DE OWF to NL hybrid project, no commercial nor public UK stakeholders are involved. Thus, there is no uncertainty regarding the participation in the EU internal energy market for the specific hybrid project idea.

5.5.15 Disproportionate allocation of costs and benefits across involved stakeholders

This barrier is relevant for the DE OWF to NL hybrid project.

In summary, the interaction with stakeholders shows that there is no specific, tangible mitigation option to address the barrier of disproportionate allocation of costs and benefits across involved stakeholders, but rather that a process towards the mitigation of the barrier must be followed. Generally, the process consists of the identification and alignment of cost and benefit categories, the determination of the initial allocation of costs and benefits, the agreement on a re-allocation of costs and benefits as well as – if required and available – the usage of CEF funding to ensure the individual incentivisation of all stakeholders. This can build on the existing process for Cost Benefit Analyses (CBA) and Cross-Border Cost Allocations (CBCA) as defined by ENTSO-E for cross-border electricity interconnectors, which needs to be adjusted according to the specifications of each individual hybrid project. The process should allow for the incentivisation of all relevant stakeholders to implement the hybrid project.

Considering the results of the interaction with the stakeholders, the mitigation process to be followed for the DE OWF to NL hybrid project must also take into account the interdependencies between the individual barriers.

5.5.16 Uncertainty about legislative regime for power-to-gas and related infrastructure

This barrier is not relevant for the DE OWF to NL hybrid project.

In the context of the DE OWF to NL hybrid project, it is currently not planned to include power conversion to gas and / or gas transmission solutions. Thus, there is no need for and consequently no uncertainty regarding the legislative regime for power conversion to gas and gas transmission for the specific hybrid project idea.

Disclaimer

This study was prepared by Roland Berger within the scope of the project entitled "Development of the North Seas offshore energy potential – a cluster-based approach" under the Contract no. ENER/B1/2016-326, commissioned by the Directorate-General for Energy of the European Commission.

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Roland Berger acts as commercial advisor, no legal advice is provided.

MJ-01-19-503-EN-N

Publications Office

doi: 10.2833/416539