North Sea
Wind Power Hub
Programme

Regulatory & Market Design

Economic and Financial Framework for Electrical infrastructure

Discussion paper

#1

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About this paper

Why read this report

For a hub-and-spoke project, the economic and financial framework should be determined before the final investment decision and provide clarity on all financial streams and economic corner stones of support, cost recovery and financing mechanisms. The analyses provided in this document aims to empower policymakers in their decision-making by facilitating a balanced and structured discussion. This paper addresses the suitability of existing frameworks for electricity and gas infrastructure by identifying gaps for hub-and-spoke projects. Furthermore, European funding schemes are described and their impact on the frameworks is assessed. Also, several aspects to opening up of the regulation congestion income is discussed in light of the expected proposal of the European Commission. Finally, recommendations of next steps are provided.

Highlights

It seems possible to cover the financing and cost recovery of a hub-and-spoke project on a national level due to the assumed configuration and governance model of the project. Only the hub-to-hub or hub-to-shore interconnectors are cross-border and international.

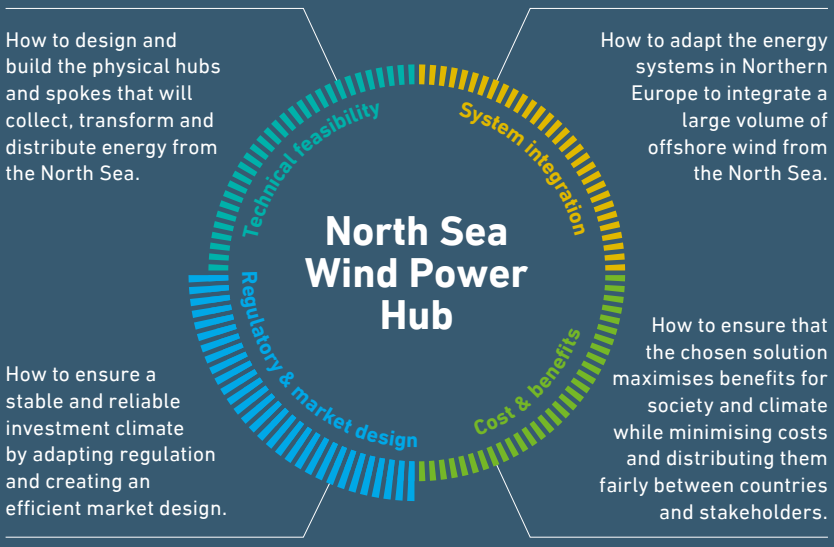
Financing and cost recovery of the hub-and-spoke project may be possible at a national level but leveraging European funding schemes may help reduce the burden on the tariff and tax payers.

The implications of alternative usage of congestion income are far reaching. Other mechanisms might be more suitable to ensure sufficient OWF income and more research is required to examine this.

The big picture

The North Sea is a powerhouse of wind energy. Harnessing this power requires us to cooperate across countries and borders to build an efficient network. To show that a solution can be achieved in a cost-effective and secure manner, the North Sea Wind Power Hub is working within four key areas.

This discussion paper explores key topics within regulatory & market design.



Executive summary

The increasing demand for renewable energy has driven ambitious goals for offshore wind power in Europe.[1] Meeting this demand requires innovative solutions and a new, novel approach including both electricity and (offshore) hydrogen. The North Sea Wind Power Hub (NSWPH) is a consortium formed by TenneT Netherlands, TenneT Germany, Energinet and Gasunie to develop the energy infrastructure for integrating large-scale offshore wind energy from the North Sea into the European energy system. This paper discusses the economic and financial frameworks that are required for the realisation of such a project to provide clarity on the regulatory framework ahead of the necessary investment decisions for project developers. The peculiarities of both electricity and hydrogen require, however, a separate in depth look. The analyses provided in this document therefore aims to empower policymakers in their decision-making by facilitating a balanced and structured discussion, focusing on electricity. Due to the major recent developments on hydrogen on both EU and national level, an additional paper (to be published by NSWPH) will describe how hydrogen can play a role in the overall offshore hub-and-spoke concept.

The economic and financial framework refers to all financial streams and economic corner stones of support, cost recovery and financing mechanisms during three building blocks of a project: planning, ownership and system operation. The choice of a suitable economic and financial framework is highly dependent on the governance model of the infrastructure. The governance model defines how ownerships and legal tasks for assets and activities are allocated across different actors and the economic and financial framework defines how costs in hub-and-spoke projects can be financed and recovered.

Existing economic and financial frameworks

This paper describes the current national frameworks for electricity in the Netherlands, Germany and Denmark and analyses how suitable they are for hub-and-spoke projects. Using existing frameworks without requiring many adjustments, facilitates the implementation process and increases the chance that the framework is implemented early enough to avoid delay of investment decisions. The national frameworks in the three countries cover the following assets: offshore wind connection, electricity transmission, interconnection, storage and the hub foundation. There are many similarities between the frameworks: electricity transmission, interconnection and OWF connection are regulated third party. All regulated assets need to be included in the investment plans of the TSOs, which in some cases need to be checked and/or approved by the NRAs and ministries. There are also many differences between the frameworks when the details are considered in depth. Most significantly, Denmark only has one framework for all electrical transmission assets whereas Germany and the Netherlands have separate frameworks for the offshore grid and some interconnectors.

The implications of these frameworks are discussed in detail and suggested suitable combinations are outlined. It is generally possible to cover the financing and cost recovery of a hub-and-spoke project on a national level due to the configuration and governance model of the project. Only the hub-to-hub and hub-to-shore interconnectors are international and cross-border whereas all other assets can be seen as national assets. There are a few aspects which require further consideration: i) hub foundation framework in Germany and the Netherlands, ii) possibility of anticipatory investments, and iii) the legal definition of the Dutch offshore grid.

[1] For example the Esbjerg declaration.

European funding and impact on economic and financial frameworks

Financing and cost recovery of the hub-and-spoke project may be possible at a national level but leveraging European funding schemes may help reduce the burden on the tariff and tax payers. This paper discusses possible European funding frameworks and the most promising are presented in detail. The five European funding schemes that were considered in detail are: The Connecting Europe Facility (CEF), Horizon Europe, EU renewable financing, Recovery and resilience facility, Invest EU and the Innovation Fund. These five were selected as the most relevant and applicable to the NSWPH. The analysis shows that in all countries an European fund can be part of the national economic and financial frameworks. It is, perhaps, surprising that the funds do not have a very large positive impact for the TSO. However they can benefit the public acceptance of large infrastructure projects and the reputation of the developer. However, applying for grants is very time and resource intensive and may not be attractive from a business perspective and may slow down the development of such an innovative project.

Opening up the usage of congestion income and impact on economic and financial frameworks

Finally, the use of congestion income is discussed in light of a EC proposal to be published in 2022 on the alternative uses of congestion income. The European Commission is considering opening the European regulation on usage of congestion income to mitigate the negative impact of an offshore bidding zone on offshore wind farm investment certainty. Differing regulation between the countries causes differences in how congestion income is spent. The implications of the EC proposals are far reaching and are discussed in detail:

- Impact of advanced hybrid coupling on the correlation between congestion income and OWF revenues;
- Furthermore, opening up congestion income regulation can have a negative impact on the compliance with European regulation which stipulates that network charges shall be cost reflective and shall not include unrelated costs supporting unrelated policy objectives;
- The resulting mix up of levies and tariffs when opening congestion income regulation. Especially, the interference of member states in NRA power should be further considered; and
- Finally, other mechanisms might be more suitable to ensure sufficient OWF income than the redistribution of congestion income approach. More research is required to examine this.

1 Introduction

The increasing need for renewable energy and ambitious goals for offshore wind power in Europe demands a novel approach. TenneT Netherlands, TenneT Germany, Energinet and Gasunie joined forces in the North Sea Wind Power Hub (NSWPH) consortium to develop the energy infrastructure for the integration of large-scale offshore wind from the North Sea into the North West European energy system. Hybrid projects combine infrastructure with interconnector functionality with offshore wind grid connection. The hub-and-spoke project also couples energy sectors at scale by offshore or onshore electrolysis and offshore hydrogen transmission. In this way, a hybrid project benefits the European energy system by maximising the efficiency of the usage of infrastructure, connecting energy supply centres from one country to demand centres in another, and optimising the utilisation of resources. In this paper, emphasis is being put on electricity related matters regarding the development of the hub-and-spoke project. The role of a hub-and-spoke concept with hydrogen included will be addressed in an additional paper (to be published by NSWPH).

The role of economic and financial frameworks

Clarity on the regulatory framework can help reducing investment uncertainty. Investment uncertainty can hamper project development and project milestones. For any major investment project, and thus also for a hub-and-spoke project, the economic and financial framework should be determined before the final investment decision. This investment decision for the North Sea Wind Power Hub will need to be made in the relatively near future, owing to the long lead time of a hub-and-spoke project[2]. The economic and financial framework[3] refers to all financial streams and economic corner stones of support, cost recovery and financing mechanisms during three building blocks of a project:

- **The planning** building block covers system planning, including scenarios on future energy production and usage, and implications for further infrastructure investments.
- **Asset ownership** covers pre-development, development, and construction.
- **System operation** relates to coordination of the system once it is operational, including operational planning, system and markets operations, and post operational tasks.

The framework provides clarity on the tender design, financing and cost recovery of (anticipatory) investments and develops long term outlooks of the energy market and infrastructure development.

Current economic and financial frameworks in the Netherlands, Germany and Denmark were developed for radial wind connection, gas transmission, electricity transmission, interconnection, natural gas transmission and gas storage. These frameworks might not satisfy the support, cost recovery and financing needs of new hybrid projects due to their complexity. For example, a hub-and-

Highligt

The economic and financial framework should be determined before the ultimate investment decision.

[2] Depending on the type of asset, construction of a hub-and-spoke project is expected to take between 4 – 10 years, whereas offshore wind farms require tendering up to 5 years before go-live

[3] In the context of this scope of works the economic and financial framework refers to all financial streams and economic corner stones of support, cost recovery and financing mechanisms for all hub-and-spokes projects related assets.

spoke project is a multinational project connecting two or more countries, costs related to the planning, ownership and operation phase of hub-and-spoke assets can be recovered and financed differently depending on in which country they are located. Using existing frameworks without requiring many adjustments, facilitates the implementation process and increases the chance that the framework is implemented early enough to avoid delay of investment decisions. As such, a key remaining question is how hub-and-spoke projects fit into existing national and European economic and financial frameworks for electrical and gas infrastructure and what adjustments are required. National and international discussions are needed to empower decision-making by policymakers to ultimately develop an economic and financial framework that serves and enables hub-and-spoke projects.

Highligt

Using (parts of) existing frameworks benefits the implementation process of hub-and-spoke projects.

Aim of the paper

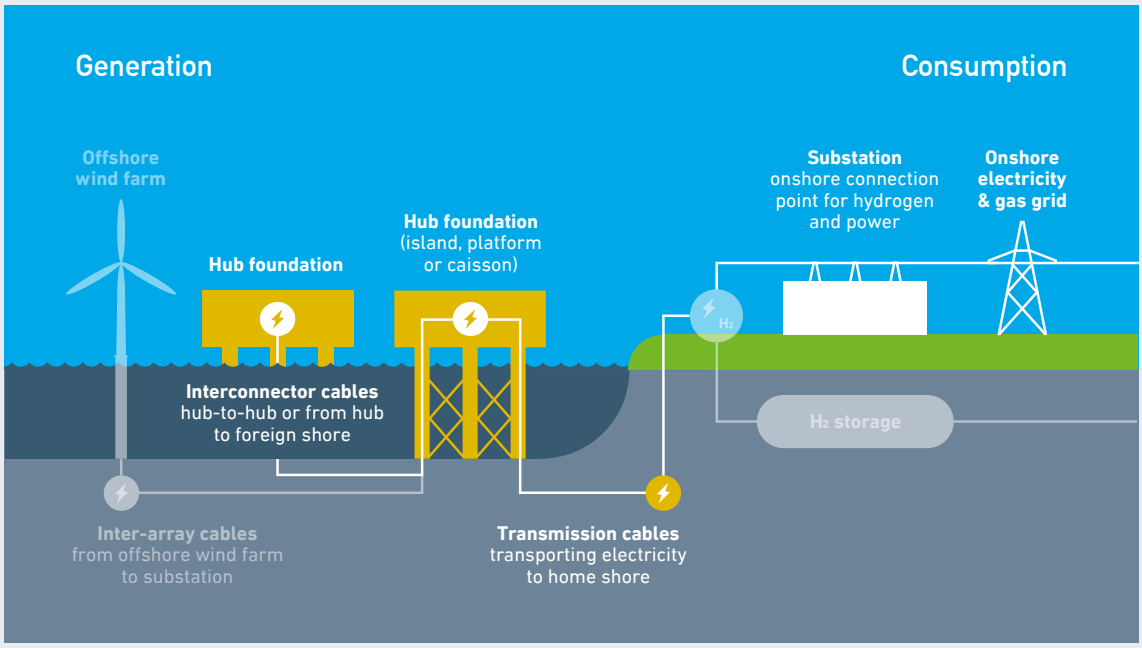
The purpose of this paper is to enable discussions around the economic and financial framework, focused on the electrical domain and to provide guidance to policymakers to ultimately identify required adjustments to existing economic and financial frameworks for hub-and-spoke projects for electricity. This paper focuses on the electrical infrastructure since these assets have longer development and construction lead times than offshore wind farms (OWF) and power-to-gas converters. OWFs, electrolysis assets and hydrogen transport infrastructure are, therefore, out of scope. Text box 1 provides an overview of all assets in scope of this paper.

Text box 1: Assets in scope

A hub-and-spoke project combines aspects of offshore wind, hydrogen, and interconnection infrastructure. Although this includes power production, conversion into hydrogen and transmission of two energy carriers (electricity and hydrogen), the focus is on electricity. Furthermore, the hub-and-spoke concept allows for a modular approach where anticipatory investments in infrastructure facilitate phased build out of multiple offshore wind farms.

The hub-and-spoke configuration that is considered in this paper, using electricity cables to shore, onshore electrolysers and H2 infrastructure, is shown in Figure 1.

Figure 1: Assets in scope of hub-and-spoke project



Germany, Denmark and the Netherlands all have one hub foundation in their respective Exclusive economic zones (EEZ) which is connected to the other hubs with hub-to-hub interconnection. The hub foundations are connected to the onshore converter and/or substation with hub-to-shore transmission cables. The hydrogen transmission infrastructure and storage are also assumed to be onshore. The OWFs and power-to-gas asset are out of scope of this paper.

The choice of a suitable economic and financial framework for a hub-and-spoke infrastructure for electricity is directly linked to governance models of such infrastructure – e.g. private, regulated, private public partnership or third party access. Where the governance model defines how ownerships and legal tasks for assets and activities are allocated across different actors and the economic and financial framework defines how costs in hub-and-spoke projects can be financed and recovered. This paper focuses on the governance model which is most similar to the current electrical and gas infrastructure governance models. Text box 2 provides an explanation of the governance model used in the governance models paper. Consequently, the application of a different governance model, will require additional analysis for the suitability of the current economic and financial frameworks.

This paper also discusses European funding options which could provide additional support to hub-and-spoke projects for electricity. Financing and cost recovery of new projects will be capital intensive due to the size of the required offshore grid infrastructure and offshore generation; Guidehouse[4] estimated that the capital costs for build out of offshore renewable energy technologies in the North Sea is almost 800 billion euros by 2050. The European Commission expects that this needs to be covered by, amongst others, private investments and EU funds. EU funding schemes can be relevant to the NSWPH due to their potential for funding by either grants or loans. Because of the complex nature of the NSWPH it is important to consider which funding schemes can be applied, which costs can be covered and how that affects existing frameworks.

On the interconnector assets, power-TSOs earn congestion income which is a part of the economic and financial frameworks of interconnectors. The European Commission is considering to allow part of this congestion income to go to OWF developers in an offshore bidding zone (OBZ) to mitigate the negative financial impact of the OBZ on the OWFs. Chapter 6 discusses the impact of the OBZ on the OWF, the current national and European regulation around congestion income and the impact on the economic and financial frameworks of a hub-and-spoke project.

Finally, the paper provides recommendations and next steps to ultimately develop a fitting economic and financial framework for hub-and-spoke projects.

[4] Guidehouse, Financing of offshore hybrid assets in the North Sea, November 2020, retrieved from: Link

Text box 2: Governance model used

The governance model shown below was applied to the analysis. The reference model is based on how electrical and hydrogen projects are currently governed and is extensively described in the corresponding NSWPH discussion paper, *Governance Models for Hub-and-Spoke Projects.*

Figure 2: Depiction of the used governance model

	Planning	Ownership					System operation
	System planning	**Hub foundation**	**Offshore transmission cables (hub to shore)**	**Interconnector cables (hub to hub or hub to foreign shore)**	**Hydrogen transmission Pipelines**	**Offshore storage or PtG assets**	**System operation**
Reference model	Consor-tium of TSOs	National electricity TSO and/ or gas TSO/ national state-owned entity	National electricity TSO	Consortium of electricity TSOs	National gas TSO(s) and/or gas network company	Privately owned (commercial developers and/ or gas network companies)	National TSOs

A hub-and-spoke project includes many interfaces between Hydrogen Network Operators (HNO) and electricity TSOs. Therefore, system planning can best be performed by a consortium of national TSOs and HNOs, each considering their respective national interests and targets while collectively working towards an optimum configuration.

Ownership of the respective parts is split between various parties. The hub foundation is the key component and is the centre of all activities. A suitable ownership structure for the hub foundation depends strongly on the functionality of the hub, for which there are several possibilities:

- Ownership of an all-electric hub and the power components is best assigned to the national electricity TSO.
- Ownership of a hub with only gas or hydrogen infrastructure components is best assigned to the national gas TSO or hydrogen HNO (see NSWPH, governance model discussion paper, 2022 for more information).
- For an energyhub such as the Danish energy islands, a national governing body may be expected to take ownership of the island.

The offshore transmission cables to the shore could be owned, developed, and constructed by the national electricity TSO. For onshore gas or hydrogen infrastructure, ownership is to be assigned to the gas TSO or hydrogen HNO. Ownership of interconnection cables between hubs can be split between the respective national electricity TSOs.

System operation of the hub-and-spoke project is the responsibility of the national TSOs. The national TSOs of the home country operate the transmission cables from the hub to shore. Interconnection cables are operated on a mutual basis between the respective national TSOs, similar to current operation of interconnectors.

2 Description of current frameworks

The aim of the chapter is to provide an overview of the existing national economic and financial frameworks in the Netherlands, Germany and Denmark for the following assets:

- **OWF connection |** Inter-array cables, offshore substation, offshore conversion station, transmission cables, onshore substation.
- **Electricity transmission |** All assets belonging to the electricity transmission system.
- **Interconnector |** Electrical AC or DC interconnector which can be either onshore or offshore. In case of a DC interconnector also two converter station on both sides of the cable belong to the interconnector.

As stated in the introduction, the economic and financial framework includes all financial streams and economic cornerstones of support, cost recovery and financing mechanisms for all hub-and-spokes project's related assets. These assets can have separate frameworks: e.g. the separate hub foundation or energy island framework in Denmark which exclusively covers the hub foundation. The costs related to the different phases of infrastructure projects can be categorised in a similar fashion as the governance building blocks:

- **Planning costs** refers to the system planning costs.
- **Ownership costs** relates to the pre-development, development, and construction including costs of capital and depreciation.
- **Operational costs** represents maintenance and operation costs including costs related to operational planning, system and markets operations, and post operational tasks.

This analysis provides insights on the areas of compatibility and areas of difference between the frameworks. The full description of the framework covers the following topics:

- **Ownership |** Who owns the infrastructure?
- **Funding |** How is the infrastructure financed?
- **Cost recovery |** Which costs can be recovered and how are the corresponding costs recovered? For example, this could be done by incentive based tariff or by means of subsidies.
- **Other infrastructure reimbursements |** Are there revenue streams in addition to the subsidies, levies and tariffs?
- **Anticipatory investments** | Does the regulation allow investments in infrastructure which facilitates anticipated future grid expansions?
- **Conditions for inclusion |** Which conditions must be met by the infrastructure to allow for coverage by the framework?

The appendix provides the full analysis and the technical details on the frameworks. The following sections will provide the most important take-aways from that analysis including the main objectives and principles, the similarities between the frameworks and the main differences.

2.1 Objectives and Principles

The economic and financial frameworks can be broadly distinguished by three types:

- Market based: other than general competition laws, there are no specific regulations.
- Negotiated Third party Access (nTPA)[5] in which the tariffs are negotiated between operator and customer in a transparent, non-discriminatory way. The National Regulatory Authority (NRA) will set guidelines related to for instance capacity allocation and congestion management.
- Regulated Third party access (rTPA) where tariffs are suggested by the TSOs and in combination with access conditions are (ex-post[6]) approved by the National regulatory authority (NRA). Tariffs are to be cost-reflective.

Figure 3: Economic and financial frameworks in Germany, the Netherlands and Denmark

Assets			
Interconnectors	rTPA - if built, owned and operated by TSOs with control power – refinanced via their onshore grid tariffs. If a stand-alone interconnector is built owned and operated, the stand alone interconnector has to be certified as TSO without control area. This entity can pass on their costs to the connecting TSO with control area who refinances the costs via its tariffs. CI is also passed on to the TSO with control area which uses it acc. to art. 19 of the regulation.	Market based for its only merchant connector. rTPA – Need to be included in investment plans. Paid from tariffs. Interconnectors are also paid from congestion income.	rTPA – Need to be included in investment plans. Paid from tariffs. Interconnectors are also paid from congestion income. OWF connection also needs to be included in wind development plans. Market based - Part of tender OWF.
Electricity transmission	rTPA – Need to be included in investment plans. Paid from tariffs.		
OWF connection	rTPA – Need to be included in wind development plans and investments plans. Paid from levy.	rTPA – Need to be included in wind development plans and investments plans. Paid from levy.	
Gas Transmission	rTPA – Need to be included in investment plans. Paid from tariffs.	rTPA – Need to be included in investment plans. Paid from tariffs.	rTPA – Need to be included in investment plans. Paid from tariffs.
Gas storage	nTPA - The asset owner is designated as Storage System Operator role (SSO) by the NRA. the tariffs are negotiated between operator and customer in an transparent, non-discriminatory way.	nTPA - The asset owner is designated as Storage System Operator role (SSO) by the NRA. the tariffs are negotiated between operator and customer in an transparent, non-discriminatory way.	nTPA - The asset owner is designated as Storage System Operator role (SSO) by the NRA. the tariffs are negotiated between operator and customer in an transparent, non-discriminatory way.

[5] Both rTPA and nTPA regulation is laid down in EU-legislation Regulation (EC) No 943/2019 for electricity forms the basis for national legislation.
[6] In Denmark, the tariffs are set by the TSO and ex post approved by the NRA.

Usually transmission infrastructure assets which are likely to evolve into natural monopolies are subject to rTPA regulation, see figure 3. In the three countries, the national TSOs finance costs of all three project phases – i.e. planning, ownership and operation - with either internal or external equity and debt, and then recover these costs when construction starts under an incentive-based regulation[7]. Typically, under this scheme the maximum revenues for the TSO are set based on a historical costs minus an efficiency factor. The idea behind the incentive-based regulation is that the efficiency factor incentivises the TSOs to cut costs and make the operation more efficient and effective. The costs for electricity transmission of the Danish, Dutch and German TSOs can either be recovered via the tariffs or via a levy[8], which are both part of the energy bill. Except for the tariffs, the TSOs also receive balancing settlements from market parties in case of a portfolio imbalance, and congestion income or auction revenues for sold capacity on the interconnectors.

Highligt
The national TSOs finance costs of all three project phases with either internal or external equity and then recover these costs via tariffs or levies.

In Denmark, a framework for an offshore energy island – from now on further referred to as hub foundation – has been agreed politically. This framework is based on a public-private partnership where the state owns a majority of at least 50.1% and private investors own the remaining part. Intention is that Denmark will use this framework to tender for a first hub foundation. It is still to be decided how the planning, ownership and operational costs will be recovered.

2.2 Similarities

As described in the section above, the characteristics of the frameworks in the three countries are quite similar. All regulated assets need to be included in the investment plans of the TSOs. In Germany and in Denmark, projects in the grid development plan require approval by respectively the NRA or government. Furthermore, the offshore wind connections in Germany and the Netherlands also need to be included in the national wind development plans or spatial development plans, which are developed by the governments. Once included in these plans, the asset naturally derives from the TSOs legal task and corresponding costs can be recovered.

Highligt
The characteristics of the frameworks in the three countries are quite similar.

Another similarity between the frameworks is that connected offshore wind farms do not contribute to the infrastructure costs since there is no separate offshore tariff as in Denmark nor in Germany and the Netherlands where the costs are subsidised by the government and recovered via a levy.

[7] All frameworks except for the German offshore framework applies incentive based regulation. Also the CAPEX of future onshore investments in Germany will not be subject to incentive based regulation.
[8] This is not true for the German offshore assets. All efficient CAPEX and OPEX can be recovered. What is efficient is determined in the annual cost assessment.

2.3 Differences

Even though the principles of the frameworks are quite similar between the three countries, there are various differences found in the details:

Separate offshore electricity grid framework

Germany and the Netherlands have a separate framework for their offshore grid[9]. In the Netherlands, offshore grid (except for system operation costs[10]) are subsidised by the government, who recovers this from a levy. It is currently being discussed in the Netherlands whether future offshore investments and/or operational costs should be subsidised or recovered via the onshore tariffs. A strict requirement of offshore assets is that assets must be used to facilitate transport of wind energy from connected wind farms. Other energy[11] than energy from the connected offshore wind farms cannot be transported. Currently, the same requirement exists in Germany. This requirement does not exist in Denmark.

Highligt
Germany and the Netherlands have a separate framework for the offshore grid and stand-alone interconnectors.

In Germany, the Energy Act[12] states that power-TSOs can recover costs for the offshore grid including i) compensation payments made to operators of offshore wind farms and ii) OWF connection costs. The power-TSOs can recover the costs from an offshore grid levy against end consumers. The German offshore framework does not apply incentive based regulation, but instead cost based. This means that no efficiency factor is deducted from the expected revenues, but during the annual cost assessment the German NRA BNetzA looks into the efficiency of the CAPEX and OPEX and only recognises efficient costs.

Separate interconnector framework

Germany and the Netherlands also have separate frameworks for certain interconnectors[13]. In Germany, this framework is called the stand-alone interconnector framework. The stand-alone interconnector annually charges a revenue cap to the responsible (onshore) TSO which includes this revenue cap in its own revenue cap as non-influenceable costs (without efficiency factor) leading to raising grid tariffs. Congestion rents of stand-alone interconnectors are given to the responsible onshore TSO which uses it according to European regulation to guarantee capacity or lower the grid tariffs.

The Netherlands have three DC interconnectors and one is a so-called "merchant interconnector". The Netherlands have a market-based framework in place for its only merchant interconnector. The cable is owned and operated by BritNed Development Limited, which received in 2007 an exemption from the regulated third party access as regulated in the Electricity Directive 2003/54 and Electricity Regulation 1228/03 allowing it to be merchant. BritNed was financed for 100% by stakeholders and all costs are being recovered via auction revenues. Additional income consists of explicit loss handling and imbalance settlement.

[9] All assets from inter-array cable up to onshore substation.
[10] The system operation costs are financed by the onshore TSO via the tariffs.
[11] OWFs with pilot projects likeas e.g. offshore solar are allowed to feed in this "other" energy.
[12] 17f Abs. 5 EnWG.
[13] Not all interconnectors are covered by this framework. The other interconnectors are covered by the framework as discussed in section '3.1'.

Separate hub foundation framework

As briefly touched upon in section '3.1', Denmark has a new, special framework for hub foundations. This framework was recently introduced after the announcement of the Danish plans to develop Energy islands. The energy island can be used for other activities than directly related to the transmission of gas and/or electricity. It is still to be decided how the CAPEX and OPEX will be recovered, an option here would be user payments to the hub foundation owners. Germany and the Netherlands have not introduced such a framework. Offshore platforms – which can also function as hub foundation – are part of their offshore frameworks and are thereby the responsibility of the TSOs. Such a structure suggests that the platform or foundation cannot be used for other activities than electricity transmission.

Highligt

Unlike Denmark, Germany and the Netherlands do not have a framework for multi-purpose hubs or energy islands.

Connections of offshore windfarms either radially connected or connected to an offshore energy hub is based on the same terms following Order No. 1063 on grid connection[14]. This means that the OWF is responsible for all infrastructure until the point of connection (POC) onshore or on the hub including the (sea) cable connecting the OWF to the grid.

Anticipatory investments

Anticipatory investments are possible for regulated electrical assets in the Netherlands under the current framework provided that the project is included in the investment plans and the necessity can be proven. Again, OWFs and their connections to shore also need to be included in the wind development plans which are developed by the government.

In Germany anticipatory investments are not driven by the frameworks. The need for the projects has to be proven in the German grid development plan and are dependent on a political approval.

Also in Denmark, anticipatory investments for electrical assets are dependent on a political decision. Projects need to be included in the investment plans, which require NRA and government approval.

[14] Link

3 The suitability of current frameworks for electrical infrastructure of hub-and-spoke projects

Arranging the economic and financial framework on a national level without requiring many adjustments, facilitates the implementation process and increases the chance that the framework is implemented early enough to avoid delay of investment decisions. In this chapter, the compatibility of the earlier described electricity frameworks with a hub-and-spoke project is assessed. Economic and financial framework possibilities for hub-and-spoke projects can be separately considered for the three countries in scope. The analysis indicates that it is possible to cover the financing and cost recovery of hub-and-spoke projects on a national level. This is mainly due to the configuration and the governance model of the hub-and-spoke project: placing infrastructure in one exclusive economic zone, allows the regular stakeholders to conduct their original roles and responsibilities and to recover the associated costs via the existing frameworks.

Only the hub-to-hub and hub-to-shore interconnectors are international and cross-border whereas all other assets can be seen as national assets. The consortium of TSOs is responsible for all hub-to-hub interconnection infrastructure. Depending on how the governance model 'Consortium of power TSOs' is organised, the financing and cost recovery can fit within the national economic and financial frameworks. The consortium of (power) TSOs should contractually agree between member states and TSOs on allocation of ownership, tasks and costs to the specific national TSOs. This is similar to how this is currently done for electricity interconnectors.

Highligt
In general, it seems possible to cover the financing and cost recovery of hub-and-spoke projects on a national level.

3.1 Possible Danish framework for electrical infrastructure of a hub-and-spoke project

Especially the Danish frameworks are considered relatively ready for hub-and-spoke projects considering that they have a political agreement for a framework for hub foundations. Furthermore, the Danish framework for electricity transmission and interconnection was developed for a broad range of assets, making it a relatively simple fit for the hybrid projects.

A possible Danish framework for hub-and-spoke project incorporates elements of all frameworks. Electrical transmission assets can be covered by the rTPA framework which currently covers onshore transmission, interconnections and offshore wind connections. For the interconnector, the cost could be shared by the involved TSOs. In order to incorporate a hub-and-spoke project in this framework, certain requirements must be met:

- Offshore assets are included in wind development plans;
- The assets are included in investment plans; and
- The plans are approved by the NRA and ministry.

The expected framework to be used for a hub foundation in Denmark is the framework that the Danish government is developing for an energy island, which is based on a public-private partnership.

3.2 Possible German framework for electrical infrastructure of a hub-and-spoke project

Highligt
The national frameworks for hub-and-spoke projects could incorporate elements of all existing national frameworks.

In Germany, a combination of the existing frameworks is able to cover most of the hub-and-spoke project for the electrical domain. The activity system planning, system operations and the onshore substation can be covered by the onshore framework if it is included and confirmed in the investment plan. The the hub electrical transmission assets, offshore shore-to-hub transmission assets and parts of the onshore converter station can be covered by the offshore framework if it is included and confirmed in investment plans and wind development plans. This approach is similar to the framework for existing assets, and hence, no difficulties are expected when including them. However, there are a few aspects that need further consideration:

Highligt
There are a few aspects which require further consideration to make a German frameworks fit for a hub-and-spoke project.

- **The hub-to-hub or hub-to-shore interconnector |** It remains uncertain which framework can cover this category even though no showstoppers are foreseen. This is due to the fact, that until today, interconnectors between onshore points are regulated as onshore assets. This may change, if offshore points will be connected via interconnectors.
- **The hub foundation |** Depending on the type of hub and the activities that will be conducted on the hub and whether these fit in the legal tasks of either the gas or electricity TSO, the hub foundation can be covered by the existing offshore framework, or in case of a multi-purpose hub, a new framework should be timely developed.
- **Anticipatory investments |** From the analysis it seems that the German frameworks do not allow anticipatory investments. Anticipatory investments are especially relevant for hub-and-spoke projects due to its modular character. To increase the chance that infrastructure is fit for future expansions and to minimise the risk on recovery payments[15], anticipatory investments are required. Adjustments of the economic and financial framework can help driving anticipatory investments and minimise the risk on recovery investments. It should be noted that anticipatory investments are not expected to be a problem for hydrogen assets. For hydrogen assets, it is expected that the need for justification of market demand will be lower, because the hydrogen market - unlike the market for natural gas - has yet to be developed.

3.3 Possible Dutch framework for electrical infrastructure of a hub-and-spoke project

Also for the Netherlands, it is found that using a combination of frameworks is most suitable to ensure financing and cost recovery of the assets in a hub-and-spoke project. transmission. The onshore electricity framework can cover the onshore substation and the activity system operation.

[15] With recovery payments is meant: payments with which you pay for infrastructure repairs, because you did not take e.g. future expansion of the network into account when building the infrastructure.

The offshore framework can cover the:

- offshore converter station,
- offshore transmission line,
- offshore hub foundation if the hub does not host other activities than directly related to the legal task of the TSO,
- hub electrical transmission assets, and
- activity system planning.

Under the condition that the assets and activities are part of the legal task of the TSO and are included in wind development plans and investment plans. However, there are a few aspects which require more attention:

- **Legal offshore grid definition |** It is suggested to cover most of the offshore assets by the offshore framework as the specific offshore risks can better be managed under the offshore framework. This is since the offshore framework considers i) a different cost of capital, ii) other asset classes with specific depreciation terms, and iii) other estimations methods for future investments and/or operational costs. This is only possible if the legal definition of the offshore grid is adjusted. At this moment, the offshore grid can only be used to transport energy from the directly connected offshore wind farms to the onshore transmission grid[16][17]. Adjustments of i) the legal definition of the offshore grid by making it a transmission system or ii) the definition of these new assets in combination with that the offshore grid can connect these assets could solve this.
- **Hub-to-hub or hub-to-shore interconnector |** For the interconnector assets it remains uncertain by which framework they can be covered. This is due to the fact, that that interconnectors are part of the Dutch onshore transmission system[18]. According to European law, a cross-border interconnector couples the transmission systems of two member states. The Dutch offshore grid needs to become part of this transmission grid to connect the hub-to-hub interconnector is connected to the offshore grid. Another possibility would be to make the interconnector part of the Dutch offshore grid, but this would not allow co-ownership of the interconnector by foreign TSOs.
- **Hub foundation |** Similar to Germany, depending on the type of hub foundation and the activities that will be conducted on the hub, the hub foundation can be covered by the existing offshore framework, or in case of a multi-purpose hub, a new framework should be developed which allows the responsible parties to recover the planning, ownership and operation costs.

Highligt

The Dutch offshore framework would be suitable to cover most of the hub-and-spoke assets.

[16] Ministerie van Economische Zaken en Klimaat, Elektriciteitswet June 2020, Article 15a.
[17] Ministerie van Economische Zaken en Klimaat, Ontwikkelkader windenergie op Zee – versie voorjaar 2020, May 2020, paragraph 3.9.
[18] Ministerie van Economische Zaken en Klimaat, Elektriciteitswet June 2020, Article 10(1).

4 European funding frameworks

Financing and cost recovery of the hub-and-spoke project may be possible at a national level, but this may burden the tariff and tax payers extensively considering the size of the required offshore grid infrastructure and offshore generation while also putting pressure on equity requirements. Considering that the North Sea hub-and-spoke projects is an enabler in a broader European carbon reduction strategy, European funding schemes can be relevant to the NSWPH due to their potential to reduce the costs related to planning, ownership and operation phases of the project. This can reduce the burden on the tariffs or levies and increase the public acceptance.

Because of the complex nature of the NSWPH it is important to consider which funding schemes can be applied, which costs can be covered and what the potential risks are. Five European funding schemes were considered in detail: The Connecting Europe Facility (CEF), Horizon Europe, EU renewable financing, Recovery and resilience facility, Invest EU and the Innovation Fund. These five were selected as the most relevant and applicable to the NSWPH. Other EU funds and grants were considered but were deemed less suitable and are included in appendix B. A comparison of the five most relevant schemes is presented in Figure 4 followed by summaries of each individual scheme and the impact on the considered national frameworks.

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European funds can reduce infrastructure projects costs and thereby minimise tariff or levy increase.

Figure 4: Comparison of the selected European support measures

Scheme (Grant or loan)	Assets and costs covered	Maximum amount	Conditions	Level of required coordination
CEF (Grant)	Covers all electrical infrastructure assets. The costs covered are development costs and capital costs.	50-75% of the eligible costs.	Only applicable to Project of Common Interests	Proposals shall be submitted by one or more Member States or, with the agreement of the Member States concerned, by international organisations,
Horizon (Grant)	Covers electrical infrastructure. Development costs, capital costs and operational costs are covered.	70-100% of eligible costs.	It should fit within EU research and innovation program for 1) open science; 2) global challenges; 3) open innovation.	Collaboration with other member states required in case of financing of cross-border infrastructure.
EU renewable financing mechanism - REFM (Grant)	A wide range of projects, from small-scale installations and innovative technologies (such as floating offshore wind parks) to large-scale, cross-border and hybrid projects. Can be used to cover development, capital and operational costs	Dependent on call	Dependent on call	No coordination between project member states required since it is a settlement between hosting and contributing member state.
InvestEU (Loan/ Guarantee)	Covers the capital costs of large scale generation projects for renewable energy, storage, improving interconnection levels.	Is determined on a project-by-project base	Expansion of RES, interconnection capacity or cricital infrastructure	In case cross-border infrastructure is funded with the innovation fund, coordination between project developers and relevant member states is required.
Innovation Fund (Grant)	The fund supports up to 60% of the additional ownership and operational costs linked to innovation related to the reduction or avoidance of the greenhouse gas emissions.	Max. 60% of eligible costs	TRL of 6-9 and Innovation related meaning that only the additional costs for the innovation on a hub-and-spoke will be covered	In case cross-border infrastructure is funded with the innovation fund, coordination between project developers and relevant member states is required.

Connecting Europe Facility[19] (CEF)

The CEF Energy Grant supports feasibility studies as well as works for Projects of Common interest (PCIs) in the energy sector. Studies are defined as preparatory activities needed for project implementation such as: preparatory, mapping, feasibility, evaluation, testing and validation studies, including in the form of software, and any other technical support measures, including prior action to define and develop a project and decide on its financing, such as reconnaissance of the sites concerned and preparation of the financial package. Works are defined as the purchase, supply and deployment of components, systems and services including software, the carrying out of development and construction and installation activities relating to a project, the acceptance of installations and the launching of a project. Therefore, both CEF programmes seems to be suitable for different phases of a hub-and-spoke project.

[19] European Parliament and Council, Regulation (EU) 1316/2013 establishing the Connecting Europe Facility, 2013, source: Link

The maximum amount that can be awarded depends on the size of the project and covers studies and works up to a maximum of 50% of eligible development and capital costs for 3-4 years. Operational costs cannot be covered by this funding option. For actions which provide a high degree of regional or EU-wide security of supply, strengthen the solidarity of the EU or comprise highly innovative solutions, the funding rate may be increased to a maximum of 75%.

Highligt
CEF studies and works can be used for different phases of a hub-and-spoke project.

Proposals shall be submitted by one or more Member States or, with the agreement of the Member States concerned, by international organisations, joint undertakings, or public or private undertakings or bodies established in Member States. (CEF regulation). Hence, coordination between the project developing member states is required.

Horizon Europe[20]

Horizon Europe is the EU Research and Innovation program for the period 2021-2027. The program is built around three pillars:

- Open science,
- Global challenges and European industrial competitiveness,
- Open Innovation.

Horizon Europe supports, amongst others, the development and testing of new and innovative offshore renewable energy technologies, components and solutions. Hydrogen Europe can be used to finance planning, ownership and operation costs, but aims at projects which run for 3-4 years. Therefore, it seems unlikely that this option can be used to also cover the operational phase of a hub-and-spoke project. The maximum amount that will be awarded is €95.5 billion but the specific amount for each call differs. Calls are opened from 25 February 2021 onwards.

Highligt
Horizon Europe can be used for innovative offshore renewable energy technologies and components.

In case Horizon Europe will be used to finance cross-border infrastructure, also coordination between project developers and member states is required.

EU renewable financing mechanism[21]

The renewable energy financing mechanism is the somewhat special option from the list of European funding. This mechanism offers a way of sharing the benefits of offshore energy projects with Member States that do not have a coastline. Therefore, this mechanism can be interesting for member states who do not require all RES credits to reach their renewable energy targets.

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The EU renewable financing mechanism is a way of sharing RES credits between EU Member States.

All Member States, including landlocked Member States, can make financial contributions to the mechanism, setting out their preference for the type of projects and technology they would like to support, including offshore projects. In turn these member states can get a part of the renewable energy credits. The mechanism covers a range of projects from small-scale installations and innovative technologies to large-scale, cross-border and hybrid projects regarding renewable energy. It can include grants for the renewable generation component of projects focused on generating renewable fuel from 'Power-to-gas', pro-

[20] European Parliament and Council, Regulation (EU) 2021/695 Establishing Horizon Europe, 2021, source: Link
[21] European Commission, Regulation (EU) 2020/1294 on Union renewable energy financing mechanism, 2020, source: Link

jects on energy production and storage, and projects that receive other forms of support for infrastructure or grid connection.

The scheme supports projects generating renewable energy (e.g. offshore wind farms), as well as projects focusing on (energy) infrastructure and grid connection with grants, especially in case of large additional system costs to connect the renewable energy. A large amount of financial support can be expected from this instrument although the amount that will be awarded is currently unknown and depends on the hosting and contributing member states' preference. The amount of support is expected to be large because the available budget from the European Commission is complemented with financial support from private investors and EU Member States. Since this mechanism is a financial settlement between the hosting and contributing member states, it is expected that less coordination between project developers and member states is required than for the other European funds.

Every year, the Commission shall call on Member States to express their interest in participating as contributing and/or host Member State.

InvestEU[22]

The investEU fund provides a loan or guarantee for the capital costs of eligible projects. These projects could amongst others be focused on the development, smartening and modernisation of sustainable energy infrastructure, in particular storage technologies and electricity interconnections between Member States. Whether a project is eligible is decided based on the criteria listed below. The fund is a combination of the previous European Fund for strategic Investments (EFSI) and thirteen other EU financial instruments. There are no quotas by sector or by country and financing is purely demand driven. The programme will mobilise public and private investment in the EU and address market failures and investment gaps that hamper growth. Hence, this option is desirable for project developers in case external funding is required to finance the hub-and-spoke project. This option can provide funding against potentially very low costs.

Highligt
InvestEU mobilises public and private investments in the EU to address investment gaps.

Here as well applies, that in case cross-border infrastructure is financed coordination between project developers and member states is required.

The general eligibility criteria stipulate that InvestEU projects must comprise sustainable investment in the areas of amongst others sustainable infrastructure in the areas of:

- "the expansion of the generation, supply or use of clean and sustainable renewable and safe and sustainable other zero and low-emission energy sources and solutions;
- the development, smartening and modernisation of sustainable energy infrastructure, in particular storage technologies, electricity interconnections between Member States and smart grids, both at the transmission and distribution level;
- critical infrastructure, whether physical or virtual, including infrastructure elements identified as critical as well as land and real estate crucial for the

[22] European Parliament and Council, Regulation (EU) 2021/523 establishing the InvestEU programme, 2021, source: Link

use of such critical infrastructure and the provision of goods and services instrumental to the operation and maintenance of the critical infrastructure[23]".

The criteria established by Regulation (EU) 2020/852 are important for determining whether an economic activity is environmentally sustainable.

Innovation Fund[24]

The Innovation Fund is a grant that aims to finance sufficiently mature projects (in terms of planning, business model and financial and legal structure), that are projects with a technology readiness level of 6-9[25]. In case a hub-and-spoke project wants to apply for this grant, maturing of the project is required. The projects should focus on the following innovative technologies:

Highligt
The Innovation Fund aims at financing innovative technologies.

- Highly innovative low-carbon technologies and processes, and flagship projects in energy intensive industries, including products substituting carbon intensive ones;
- Carbon capture and utilisation (CCU);
- Construction and operation of carbon capture and storage (CCS);
- Innovative renewable energy generation and Energy storage and how to drive these first of a kind technologies to the market.

According to the Offshore renewable energy strategy[26], the Innovation fund can support the demonstration of innovative clean technologies at commercial scale like new floating offshore wind technologies or projects to couple offshore wind parks with hydrogen production. Therefore, it may be questionable if all parts of hub-and-spoke projects can be financed with this fund. It may fund up to 60% of the additional capital and operational costs linked to innovation and up to 40% of the grant can be given based on pre-defined milestones before the whole project is fully up and running. In case of pre-funding, the project milestones and targets must be reached or otherwise funds might need to be paid back.

In case cross-border infrastructure is funded with the innovation fund, coordination between project developers and relevant member states is required. There will be regular calls for proposals in the lifetime of the Innovation Fund which is from 2020-2030.

[23] European Commission, Regulation (EU) 2021/523 of the European Parliament and the council of 24 March 2021 establishing InvestEU Programme and amending Regulation (EU) 2015/1017, Annex II Areas eligible for financing and investment operations: Link
[24] European Commission, Regulation (EU) 2019/856 supplementing Directive 2003/87/EC of the European Parliament and of the Council with regard to the operation of the Innovation Fund, 2019, source: Link
[25] Technology readiness level of 6-9 refers to projects which are in a stage between full-scale demonstration project in relevant environment up to 'filed proven' through successful operation.
[26] European Commission, COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS - An EU Strategy to harness the potential of offshore renewable energy for a climate neutral future, 2020, source: Link

4.1 Compatibility of European funds and national economic and financial frameworks

The analysis shows that in all countries an European fund can be part of the national economic and financial frameworks. All funds allow the remaining costs (i.e. costs that cannot be covered by the funding option) to be financed and recovered via the general approach. What the exact impact is of the renewable energy financing mechanism on the financing and cost recovery of the remaining costs is unclear and will be further discussed at the end of this section.

Highligt
All funds allow the remaining costs to be financed and recovered via the normal approach.

The funds can benefit the public acceptance of large infrastructure projects and the reputation of the project developer. Other than that, it is indifferent for the power TSOs whether they use the European funds or if they finance it on a national level. The TSOs in Denmark, Germany and the Netherlands have experience with the application process and being successful in obtaining the grant. Applying for grants is very time and resource intensive and might not be worth it from a business perspective. At this moment, there is no financial incentive for power TSOs to apply for public grants for their projects. This is due to the fact that in case that a capex fund is granted, operational cost recovery remains the same. The ownership cost recovery is even negatively affected as the fund needs to be used to lower the equity base, leading to lower received interest rate on equity.

Even if a project applies for funding, the fund might not be granted. This may be due to that the project doesn't meet the funding requirements and conditions or due to application mistakes and misinterpretations. Investing time in applications for funds which are not granted for specific (innovation) projects can hamper and slow down project development. Delaying such infrastructure projects due to funding bureaucracy can be a big risk for reaching climate targets.

Highligt
There is no financial incentive for TSOs to apply for public grants.

If a hub-and-spoke project is to be developed the initital costs will be very substantial. This could pose a risk for project development and its public acceptance. If there is a financially positive effect of applying for grants this would incentivise TSOs to apply for them and put resources into the application.

The impact of renewable energy financing mechanism on the national frameworks seems unclear. The renewable energy financing mechanism is a financial settlement between member states and not project developers. This makes it unclear how this mechanism impacts the developer's ability to finance and recover all project costs. The EU regulation on the Union renewable energy financing mechanism[27] does not provide clarity on how it should be organised within a country between government and project developer. Direction from the European Commission would be helpful to further assess the value and suitability of the renewable energy financing mechanism.

[27] European Commission, Regulation (EU) 2020/1294 on Union renewable energy financing mechanism, 2020, source: Link

5 Alternative usage of congestion income

Congestion income is derived from the price difference between bidding zones that power-TSOs receive when cross-border interconnection capacity is auctioned and allocated. The available transmission capacity on some AC and DC interconnectors is auctioned in the intraday, day-ahead and forward market. The auctions only generate income if there is congestion on the interconnector; this is congestion income. On other interconnectors, congestion income arises when connecting an (offshore) bidding zone to other bidding zones through market coupling and in case of congestion. It is therefore a big part of the economic and financial frameworks of interconnectors and thus also of hub-and-spoke projects.

In previous papers we have shown that there is a correlation between the revenues that OWF capture in an OBZ and the congestion income that results from the day-ahead market coupling. This could be seen as a redistribution of income from the OWF to the tariff payer or vice versa. The NSPWH calculations were based on net transfer capacity (NTC) calculations. More recent calculations based on advanced hybrid coupling (AHC) show another relation between OWF income and congestion income in OBZ. However, the European Commission[28] believes - based on these NTC results – that this redistribution effect should be addressed to ensure attractiveness of hybrid projects to renewable energy investors by opening up how congestion income can be used. This will be further discussed in section 6.1. Section 6.2 describes current European and national regulation on the usage of congestion income. Section 6.3 describes the impact of AHC calculations and the different implications of alternative usage of congestion income on the economic and financial frameworks.

5.1 Proposal of European Commission on alternative usage of congestion income

A way to address the impact of OBZ on OWFs is to amend the rules on the use of congestion income and to e.g. allow member states and NRAs to redistribute congestion income to OWF developers in an OBZ. The European Commission stated three advantages to this approach:

- it could reduce the level of subsidies needed through support schemes,
- it could enable a transition for producers to market participation once the support scheme ends,
- and it could limit the need for support schemes entirely by enabling projects to come forward in a market-based way[29],

Highligt

The EC is considering opening up the regulation on usage of congestion income.

[28] European Commission, Commission Staff working document accompanying the COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMIITTEE OF THE REGIONS - An EU strategy to harness the potential of offshore renewable energy for a climate neutral future, 2020, source: Link

[29] Idem, section III a, page18.

The EC will publish a proposal on the alternative uses of congestion income in 2022 to e.g. stabilise OWF income in OBZs. The proposals will include:

- Market-based options to address the redistribution effect of revenues in relation to hybrid projects,
- Considerations of the extent to which existing market arrangements and auctions could be used and how to ensure that developers have a choice of how and whether to use this option to hedge their risks (some may not wish to access the congestion income). In particular, how robust these options are over time and how resilient they are to changing network topology.

5.2 Congestion income usage according to regulation

According to article 19 of the clean energy package[30], there are two priority objectives to allocate congestion income resulting from cross-zonal capacity:

- "guaranteeing the actual availability of the allocated capacity including firmness compensation;
- or maintaining or increasing cross-zonal capacities through optimisation of the usage of existing interconnectors by means of coordinated remedial actions, where applicable, or covering costs resulting from network investments that are relevant to reduce interconnector congestion."[31]

Highligt
At this moment, there are two priority objectives for congestion income.

Only when these two objectives are met, the remaining congestion income may be used to lower the tariffs or must be stored in a separate account to be used for the above mentioned priority objectives at a later moment in time.

Within Germany and the Netherlands national regulation exist that further elaborates on the application of CI.

In Denmark, there is no national regulation related to the usage of congestion income.

In Germany, congestion income is used according to § 15 Abs. 3 Satz 1 StromNZV to (1) guarantee the actual availability of the allocated capacity or (2) invest in the grid. If invested in the grid, the congestion income is directly assigned to concrete investment measures as passive position such as “construction cost grants”. This reduces the need for income from tariffs. According to the new stand-alone interconnector regulation in § 28h EnWG the underlying stand-alone interconnector TSO has to give its congestion income to the responsible connection TSO with control area who uses this income according to the above named priorities. As it is foreign congestion income the law states that it may not have adverse effects on the connecting TSO.

[30] European Parliament and the council, Regulation (EU) 2019/943 on the internal market for electricity, 2019, source: Link
[31] Idem, article 19.2b.

In the Netherlands, TenneT saves the congestion income at Stichting Beheer Doelgelden Landelijk Hoogspanningsnet and uses congestion income for[32]:

I. If planned non-availability of a critical branch is required to enable the increase of capacity of the critical branch.
II. If the critical branch is temporarily not available.
III. If there is an unplanned outage of a critical branch.
IV. If the scheduled transport on the critical branch exceeds security limits.

Up till 2015 the funds from Stichting Doelgelden were used to invest in new interconnectors. However, in 2015 ACM and TenneT agreed[33] to finance new interconnectors from the grid fees (like other capacity expensions) and to gradually reduce the funds of Stichting Doelgelden by lowering the grid fees. Hence, congestion income is used to the benefit of tariff payers in all cases, be it directly by lowering tariffs, or indirectly by using it for costs that would otherwise be in tariffs.

5.3 Impacts of proposal European Commission

The European Commission is considering to open up the European regulation on usage of congestion income to mitigate the assumed negative impact of an OBZ on OWF investment certainty[34]. There are several effects which should be considered:

Highligt
Opening up the regulation on CI would have several effects.

- Primarily, in earlier NSWPH work we indicated that, depending on the project topology and the reference electricity price of the onshore bidding zone, an OBZ may result in lower capture prices. However, an OBZ may also result in higher prices in the case that the OWFs would have otherwise belong to a low-price home market. At the same time, the non-dispatch risk and balancing risk that the OWF developer may be exposed to should also be considered. In an OBZ, there may be a risk that the OWFs cannot fully dispatch due to interconnector capacity reduction and congestion income generated may be insufficient to compensate the OWFs. An OBZ may result in a balancing risk if there is no load on the hub and the OWF produces less energy than expected. In that case, the OWF will not be able to self-balance after the intraday gate closure.
- The proposed way forward is AHC instead of NTC on which the modelling work of the EC and NSWPH was based. AHC is coupling HVDC infrastructure with a flow-based approach to the AC grid. Preliminary calculations show that AHC reduces the correlation between OBZ congestion income and OWF income. Therefore, it makes congestion income less predictable and potentially less suitable as financing source to stabilise OWF income. It is necessary to further consider the details and working particulars of AHC and the corresponding decorrelation of OWF revenues with congestion income.

Highligt
AHC reduces the correlation between CI and OWF income and thereby makes it less suitable as financing source.

[32] Autoriteit Consument en Markt, Verslag congestie-ontvangsten TenneT 2020, case number: ACM/20/049441, June 2021.
[33] ACM, Competence Agreement, reference: ACM/DE/2015/206388_OV, December, 2015.
[34] During the publication of this paper, ENGIE Impact - a consultant hired by the EC to further investigate this issue and recommended a Transmission Access Guarantee as a potential solution, see Text box 3 for more information.

- The longevity of the EC proposal should also be examined. The increasing interconnector capacity that will be developed when working towards a meshed offshore grid could result in less congestion income making it difficult to use as financing source to stabilise OWF income. Instead of increasing the captured electricity prices with subsidy schemes, the electricity prices may also be increased by adding (flexible) demand. NSWPH calculations show that adding local demand such as electrolysis can improve OWF business cases and help increasing the rate of further OWF deployment. This shows, that further research to other mechanisms to stabilise OWF income should be investigated in addition to the redistribution of congestion income approach.
- Redistributing congestion income may not be in line with the non-discriminatory principle of the internal energy market, because onshore generators are not compensated with a reallocation of congestion income in case of newly developed bidding zones. It is also important to consider compliance with Article 18(1) of the CEP which stipulates that network charges shall be cost reflective and shall not include unrelated costs supporting unrelated policy objectives. Whereas the support schemes are not directly paid from the tariffs, they are paid from the congestion income that is generated with the tariffs. This seems contradicting with the regulation.
- Finally, there are implications for the individual countries. So far, the possible support to OWFs rests indirectly with taxpayers (through Member States). With the proposal of the EC, this would be with the tariff payers. In Germany and the Netherlands, under the assumption that a large part of the hub-and-spoke infrastructure can be covered by their offshore frameworks, redistribution of congestion income would mix up the use of tariffs and levies. Offshore investments are financed via the offshore grid levy, while susbsidisation via congestion income and thus via tariffs would result in increasing tariffs. In case the hub-and-spoke project will be paid from the tariffs, the tariffs will rise since congestion income cannot be used to mitigate this tariff increase. More importantly, this could result in interference of the Ministries (responsible for taxes and OWF support) with the responsibilities of NRAs (responsible for tariffs) in all three countries.

Highligt

Other mechanisms to stabilise OWF income should be investigated.

Text box 3: Transmission Access Guarantee

During the publication of this paper, ENGIE Impact - a consultant hired by the EC to further investigate this issue – organised a workshop on the reallocation of surplus. The European Commission intends to publish a proposal on the redistribution of congestion income in 2022. ENGIE Impact stated that reallocation of surplus from the OWF to congestion income alone cannot be justification to implement specific support measures. However, ENGIE Impact has a clear preference for a new proposal called "Transmission Access Guarantee" (TAG), which is a monetary compensation paid by the TSO to mitigate what they call "the preventive congestion management issue". The preventive congestion management issue is when internal grid constraints lead to limited interconnection capacity being provided to the market, which might negatively affect OWFs in OBZs. However, there are some issues to the TAG that have not been addressed and need to be further analysed:

- ENGIE Impact did not consider AHC when developing TAG. When designing mitigation schemes for OWF in hybrid projects AHC should be considered. At the time hybrid projects with an OBZ setup will go live, AHC will be implemented.
- The TAG only accounts for the preventive congestion management issue (resulting in limited interconnection capacity) that OWFs face in an OBZ. Other risks are not considered.
- The cross-subsidisation issue still exists in the TAG as market parties in OBZs would receive a financial compensation from TSOs – ultimately paid via tariffs – and market parties in onshore bidding zones are not compensated when cross-zonal interconnection capacity is reduced.

Source: ENGIE Impact, Support on the use of congestion revenues for offshore renewable energy projects connected to more than one market, 2nd workshop, 29 March 2022.

5.4 Alternative usage of congestion revenues in REPowerEU

In REPowerEU published by the European Comission[35], the commission proposes an alternative usage of congestion revenues where the revenues could be used to finance emergency measures for vulnerable consumers and businesses following the extreme price volatility. The proposal is given under the exceptional circumstances and must be implemented by the induvial member states. The respective member states therefore must consider the implications of such a solution and consider alternative support options targeting vulnerable consumers both considering present and future circumstances. The NSWPH is also aiming to further analyse this proposal, but has not done so when writing this paper.

[35] Link

7 Overall conclusion and recommendations

Financing and cost recovery of the hub-and-spoke projects within the electrical domain appears to be possible within the current frameworks at a national level. Arranging the financing and cost recovery of a hub-and-spoke project within the existing frameworks, might ease the implementation and development of these projects. This is due to the hub-and-spoke configuration where only the hub-to-hub interconnectors are international and cross-border whereas all other assets can be seen as national assets. Furthermore, one other key assumption is the reference governance model. In case other governance models are preferred, this analysis should be extended.

There are some aspects which require more attention such as:

- **The hub foundation in Germany and the Netherlands |** In case the hub will be a multi-purpose energy island, existing offshore frameworks do not seem to be a good fit and a new framework should be developed.
- **The suitability of the Dutch offshore framework for a hub-and-spoke project within the electrical domain |** The offshore grid is not allowed to transport other electricity than from the directly connected OWFs. Furthermore, the offshore grid is not part of the Dutch transmission system, which is required according to EU law to cover interconnectors. In case, it is preferred to cover most Dutch assets by the offshore framework and connect the interconnectors to the Dutch offshore grid, this frameworks requires adjustments.
- **Anticipatory investments |** Anticipatory investments are necessary when considering the modular build out of hub-and-spoke projects. At this moment, the electricity framework in Germany does not allow this, and in Denmark political approval is required. Not anticipating on future grid expansions can result in substantial recovery payments. This should be considered when pursuing a hub-and-spoke project.
- An issue with the financing and recovering the costs of hub-and-spoke projects via the national frameworks is that it may burden the tariffs and the levies due to substantial investment requirements while also putting pressure on equity requirements. However, this is not different for other large-scale infrastructure projects. The tariffs and levies (in the Netherlands and Germany) are already under pressure due to extensive investment requirements in the onshore grid resulting from increasing electrical demand. This may harm the project development and the public acceptability of a hub-and-spoke project. In case it is required that offshore wind farm developers contribute to TSO investments in export capacity from the island, this will probably require a change to current regulation in all three countries. Further impact analysis is required to analyse how this could fit in the current economic and financial frameworks.

European funds

There are several European funding schemes that could be relevant to the NSWPH due to their potential to reduce the costs related to planning, ownership and operation phases of the project. This can reduce the burden on the tariffs or levies and increase the public acceptance. The CEF works, Horizon Europe and Innovation fund in particular appear to be promising grants which can be used to cover an extensive part of hub-and-spoke project costs. The InvestEU fund can be beneficial due to its access to low-cost European loans/guarantees. The EU renewable financing mechanism presents an interesting opportunity in the case that RES credits can be shared and not required for national targets. Remaining costs can still be recovered via the existing national gas and electricity frameworks. In case cross-border infrastructure is funded with the innovation fund, coordination between project developers and relevant member states is required.

However, applying for grants is very time and resource intensive and may not be an attractive use of resources from a business perspective. Grants may even have an adverse effect from a business perspective. Even if a project applies for funding, the fund might not be granted. Not getting funds granted for specific (innovation) projects can hamper and slow down project developments. Slowing down a project due to funding bureaucracy is a significant risk when it is considered that hub-and-spoke projects may be required to deploy large quantities of offshore wind farms and reaching climate targets. An incentive to apply for grants would further incentivise TSOs to apply for them and put resources into the application. Therefore, NRAs and member states could consider such an incentive for project developers.

Redistribution of congestion income and impact on economic and financial frameworks

An OBZ may result in risks related to revenue, congestion and balancing. These are all risks that should be taken into account when developing policies to ensure sufficient OWF income. The European Commission is considering opening up the European regulation on usage of congestion income to mitigate the negative impact of an OBZ on OWF investment certainty. Before a decision should be made, there are several effects which should be considered including:

- Impact of AHC on the correlation between congestion income and OWF revenues;
- Furthermore, opening up congestion income regulation can have a negative impact on the compliance with Article 18(1) of the CEP which stipulates that network charges shall be cost reflective and shall not include unrelated costs supporting unrelated policy objectives;
- The resulting mix up of levies and tariffs when opening up congestion income regulation. Especially, the interference of member states in NRA power should be further considered; and
- Finally, other mechanisms might be more suitable to stabilise OWF income than the redistribution of congestion income approach. More research is required to examine this.

Appendix A

Here the frameworks are described which cover hub foundation, electrical interconnectors, OWF connection and onshore transmission following five framework subtopics:

- Ownership
- Funding
- Regulation and Cost recovery
- Other infrastructure reimbursements
- Anticipatory investments

In Denmark four frameworks exist: i) a framework which covers the electrical interconnectors, OWF connection and onshore transmission, ii) a framework which covers the hub foundation[1], iii) a gas transmission framework and iv) a gas storage framework. In Germany and the Netherlands, similar frameworks exist. Both countries do not have a separate framework for hub foundation assets, but do have a framework for offshore transmission, stand-alone interconnectors, and onshore transmission and TSO-owned interconnectors. Similar to Denmark, both Germany and the Netherlands have a transmission and storage framework for natural gas.

Electricity – Ownership

Which party is responsible for ownership of the assets in the electrical system. Covering onshore and offshore transmission, interconnectors and the offshore energy hub.

			
Offshore Transmission	Offshore TSO ACM, Besluit certificering TenneT TSO B.V. als netbeheerder van het net op zee, Link	TSOs § 17d EnWG	TSO
Electricity Transmission and regulated Interconnectors	TSO Electriciteitswet 1998, Artikel 10(3)	TSOs EnWG § 12	
Stand-alone Interconnector	DC interconnector owned by a merchant TSO Electriciteitswet 1998, Artikel 10Aa(1), juncto article 10(3); ACM, Besluit certificering BritNed Development LTD., 2014, Link	Standalone TSO EnWG § 28d-I	Law on Energinet § 2, The electricity supply act § 19 a, § 20, § 51 (2).
Offshore Energy Hub	Non existent N/A	Non existent N/A	Public-private partnership Law on an Energy-island in the North Sea (still in draft)

[1] There is a political agreement to develop this framework.

Electricity – Funding and regulatory refinancing

The funding types, for example loans from international funding institutions, internal equity, government subsidies, EU grants.

			
Offshore Transmission	Funding is by SDE subsidy. Future investments (2023- 2030) could either be funded by SDE subsidy or included in onshore grid tariffs. Decision is to be made by policy makers. Electriciteitswet 1998, Article 42a, (1) and (3)	Funding is by TSO investments. Various internal and external capital market funding types possible. N/A	Funding is by TSO investment covered by congestion rents and feed-in tariffs.Funding for a TSO-owned interconnector is by joint TSO investment and potential EU funding options such as CEF
Electricity Transmission and regulated Interconnectors	Funding is by TSO investments directly financed from the onshore grid tariff (only for 50% in case of an interconnector). Congestion income is used to expand or maintain interconnection capacity and/or reduce tariffs. Electriciteitswet 1998, article 10Aa (5); Electriciteitswet 1998, article 41-43,	Various internal and external capital market funding types possible.	Electricity supply act § 71
Stand-alone Interconnector	Funded completely by stakeholders (50% TenneT in case of BritNed). ACM, Besluit certificering BritNed Development LTD., 2014, Link	Various internal and external capital market funding types possible. EnWG § 28f-I	Non existent N/A
Offshore Energy Hub	Non existent N/A	Non existent N/A	State funding, private funding (For example pension funds). N/A

Electricity – Regulation and Cost Recovery

The costs covered by each framework and how they can be recovered in the different frameworks. This includes methods such as incentive based tariff or by means of subsidies, for example.

			
Offshore Transmission	rTPA regulation and capital pricing model to determine revenue cap for assets covered by the offshore transmission framework. Revenue cap translates into subsidies for current projects (until 2023). Compensation for the offshore grid covers depreciation, cost of capital (WACC) and operational costs. Balancing capacity costs are covered by the onshore TSO.	Refinancing via the Offshore Grid Levy.Costs are recovered by annual cost assessment of OPEX and CAPEX. OPEX pass-throughof efficient costs. The following CAPEX elements are reimbursed based on actuals: Depreciation, RoE, Calculated trade tax, Interest on debt.	rTPA regulation. Tariffs will be onshore tariff, offshore tariff, incentive based tariffs. Costs recovered include: Capital costs, Operational and maintenance costs.
	ACM, Methodebesluit TenneT Net op zee 2022-2026	EnWG § 17f	
Electricity Transmission and regulated Interconnectors	rTPA regulation and capital pricing model to determine revenue cap. Revenue cap translates into tariffs to which quality requirements and incentive based regulation applies. The duration of regulatory periods is between 3 -5 (usually 5) years. All capital costs are recovered through grid tariffs, consisting of depreciations (Cobra deprecation period 40 years) and cost of capital. Capital costs of interconnectors are already reimbursed during construction phase (T-0). OPEX costs are recovered based on a historic average. Costs for energy losses, balancing energy, balancing capacity and auction costs were paid from congestion income.	Regulated asset base model. Onshore tariff (revenue cap regulation incl. efficiency factor on influenceable costs). Regulatory period of 5 years. Capital-cost-pass-through (without OPEX-lump sum) from 2024 onwards. CAPEX of new investment is directly passed-through to the revenue cap without delay. Reduced CAPEX based on reduced residual book values are also passed-through without delay. OPEX refund via snapshot year every 5 years.	
	Elektriciteitswet 1998, Article 41d(1); International Financial Reporting Standards	§ 10 a ARegV i.V.m. § 35 AregV	Electricity supply act § 71
Stand-alone Interconnector	Regulated by commercial regulation for which an exemption from the European tariff regulation is required. All costs are recovered via auction revenues and congestion income in the case of BritNed.	Regulated asset base model. Tariff recovered indirectly via onshore tariff of onshore TSO. Stand-alone interconnector annually charges revenue cap to responsible (onshore) TSO. Congestion rents of stand-alone interconnectors are given to the responsible onshore TSO which uses it according to European regulation. (to guarantee capacity or lower the grid fees)	Non existent
	ACM, Besluit certificering BritNed Development LTD., 2014, Link; BritNed, BritNed Access Rules Non-Internal Energy Market Access Rules January 2021, Link	§ 28i-f EnWG	N/A
Offshore Energy Hub	Non existent	Non existent	Tender for Danish energy island to be published in 2022, for a public-private partnership. Cost recovery is to be decided for capital costs. Operational and maintenance costs to be covered by, for example, investment contributions. This would require change of current regulation.
	N/A	N/A	N/A

Electricity – Other infrastructure reimbursements

This table describes other potential revenue streams on top of the previously described tariffs, levies and subsidies.

Offshore Transmission	None N/A	None N/A	Congestion rents from interconnectors and balancing settlements
Electricity Transmission and regulated Interconnectors	Congestion rents from interconnectors and balancing settlements. Elektriciteitswet 1998 artikel 27 and Regulation (EU) 2019/943 article 19	Congestion rents from interconnectors and balancing settlements VO (EU) 714/2009; in combination with StromNZV § 15 (3) Satz 1	Electricity supply act § 71
Stand-alone Interconnector	Congestion income or auction revenues from selling interconnection capacity and reimbursements for cable losses. ACM, Besluit certificering BritNed Development LTD., 2014, Link; BritNed, BritNed Access Rules Non-Internal Energy Market Access Rules January 2021, Link	Congestion rents from interconnectors, but these are passed on to the connecting TSO. Regulation (EU) 714/2009	Non existent
Offshore Energy Hub	N/A N/A	N/A N/A	Still undecided N/A

Electricity – Anticipatory investments

The possibility, risks and conditions of anticipatory investments related to future grid expansions.

Offshore Transmission	Anticipatory investments can be included in the development framework. Examples are additional costs to modify the platform. Ontwikkelkader windenergie op zee, ministerie van Economische Zaken en Klimaat, Link	Not existent. N/A	Anticipatory investments are not possible as status quo, depending on political decision.
Electricity Transmission and regulated Interconnectors	Anticipatory investments are included in the investment plan. This may need discussions with NRA/Ministry. Link	Not existent N/A	N/A
Stand-alone Interconnector	Not permitted N/A	Non existent N/A	Non existent N/A
Offshore Energy Hub	Non existent N/A	Non existent N/A	Not possible as status-quo. Depending on political decision N/A

Electricity – Conditions for inclusion

The conditions which must be met by the infrastructure to allow for coverage by the framework.

			
Offshore Transmission	Project is part of legal tasks of the TSO. To be included in wind energy development plan by Government; To be Included in investment plan by TSO; Investment plan to be approved by NRA and ministry . Asset must be used to facilitate transport of wind energy from connected wind farms	Project included in: Netzentwicklungsplan (NEP - grid development plan). This is approved by the NRA; Flächenentwicklungsplan (FEP - spatial development plan)	Offshore plans need to be included in national wind plans. All plans need to be Included in investment plan by TSO; Investment plan to be approved by NRA and ministry
	Ontwikkelkader windenergie op zee, ministerie van Economische Zaken en Klimaat, Link; TenneT, Investeringsplannen (website), Link	§ 12b EnWG	
Electricity Transmission and regulated Interconnectors	Project is part of legal tasks of the TSO Included in investment plan by TSO Investment plan to be checked by NRA and ministry within 12 weeks	Project included in NEP, replacements, vertical point measures and other special non-NEP-projects	
	TenneT, Investeringsplannen (website), Link	§ 12b EnWG	
Stand-alone Interconnector	Requires a positive business case usually based on congestion income. Requires a derogation and needs to meet the following conditions of EU CEP: The investment enhances competition in electricity supply; The level of risk attached to the investment is such that the investment would not take place unless an exemption is granted. Requires a reserve price. Will probably not be possible, but could also be a cap-and-floor regime.	Non existent	
	Regulation (EU) No. 2019/943, Article 63, Link	N/A	Law on Energinet § 4
Offshore Energy Hub	Non existent	Non existent	To be included in national wind plans; To be tendered by government
	N/A	N/A	N/A

Gas

In this section the frameworks are described which cover onshore gas transmission and gas storage. In all countries similar frameworks consists: a framework that covers gas transmission and a framework that covers gas storage. These frameworks will be described below following the topics Ownership, Funding, Cost Recovery and Regulation, Other infrastructure reimbursements, Anticipatory investments and Conditions for inclusion. An explanation of these topics can be found above or below the header of corresponding paragraphs.

Gas – Ownership

This table covers the ownership of the infrastructure within each framework, i.e. which party is responsible for ownership and operation of assets.

The ownership of the TSOs is laid down in European legislation: Directive 2009/73/EC

			
Transmission	Owned and operated by ownership unbundled Gas Transmission System operator (TSO) Gaswet, paragraaf 1.2, Link	Owned and operated by unbundled Gas Transmission Sytem operator (TSO) EnergieirtschaftsGesetz (EnWG) Teil 2 Abschnitt 3, Link	Owned and operated by unbundled Gas Transmission System operator (TSO) Law on Energinet § 2, Gas supply act § 10, § 30
Storage	Owned by private party, but can also be owned by Energy network company (but activities are carried out independently of the TSO) Gaswet, paragraaf 1.3, Link	Owned by private party, but can also be owned by Energy network company EnergieWirtschaftsGesetz (EnWG) Teil 2 Abschnitt 2, Link	State owned SSO Law on Energinet § 2, Gas supply act § 10, § 30

Gas – Funding

How the infrastructure is financed, including funding by loans and grants.

			
Transmission	Funded by internal equity, private funding, potential subsidies Gasunie, Financial information, Link	Funded by internal equity, private funding, potential subsidies For instance financial reporting of Open Grid Europe, Link	Funding by state loan, external equity, EU grants (e.g. CEF), potential subsidies Gas supply act § 37 d
Storage	Funded by internal equity, private funding, potential subsidies. Gasunie, Financial information, Link	Funded by internal equity, private funding, potential subsidies. N/A	Funded by internal equity, private funding, potential subsidies. N/A

Gas – Regulation and Cost recovery

This section shows which costs can be recovered and how the corresponding costs can be recovered in the different frameworks. This could be by for example incentive based tariff or by means of subsidies.

Cost recovery mechanisms are laid down in REGULATION (EC) No 715/2009 which has a direct effect for all member states. Detailed tariff calculation mechanisms are derived from this regulation and are implemented on a national level.

			
Transmission	rTPA and Cost-plus regulated asset base model. Cost recovery for investments and operating expenses through allowed revenues. Fully decoupled Entry-exit model. Interruptible capacities available at a discount 5 years regulatory period.Detailed income calculation for the TSO in Method Decisions by National Regulatory Authority (NRA)	rTPA and Cost-plus regulated asset base model. Cost recovery for investments and operating expenses through allowed revenues Partially decoupled Entry-exit model. 5 years regulatory period. Detailed tariff mechanisms for the TSO in GasnetzEntgelt Verordnung (GasNEV) and) Detailed income calculation in AnreizregulierungsVerordnung (ARegV)	rTPA and Regulated asset base model. Cost recovery for investments and operating expenses through allowed revenues. Entry-exit model. Interruptible capacities available at a discount. Monthly factors to reflect utilisation of grid (winter more expensive then summer)
	REGULATION (EC) No 715/2009, Art. 13-14, Link; ACM, Methodebesluit GTS 2022–2026, Link	REGULATION (EC) No 715/2009, Art. 13-14, Link; Verordnung über die Entgelte für den Zugang zu Gasversorgungsnetzen, Link; Verordnung über die Anreizregulierung der Energieversorgungsnetze, Link	REGULATION (EC) No 715/2009, Art. 13-14, Link; Gas supply act § 37 d
Storage	Negotiated Third Party Access (nTPA): The tariffs are negotiated between operator and customer in a transparent, non-discriminatory way. The National Regulatory Authority (NRA) will set guidelines related to capacity allocation and congestion management, for instance. Negotiated tariffs with customers on a non-discriminatory basis. Costs are reimbursed at the owner's discretion.	Negotiated Third Party Access (nTPA): The tariffs are negotiated between operator and customer in a transparent, non-discriminatory way. The National Regulatory Authority (NRA) will set guidelines related to capacity allocation and congestion management, for instance. Negotiated tariffs with customers on a non-discriminatory basis. Costs are reimbursed at the owner's discretion.	Negotiated Third Party Access (nTPA): The tariffs are negotiated between operator and customer in a transparent, non-discriminatory way. The National Regulatory Authority (NRA) will set guidelines related to capacity allocation and congestion management, for instance.Negotiated tariffs with customers on a non-discriminatory basis. Costs are reimbursed at the owner's discretion.
	REGULATION (EC) No 715/2009, Art. 15, Link, Gaswet paragraph 2.4 Link	REGULATION (EC) No 715/2009, Art. 15, Link, § 28 EnergieWirtschaftsGesetz (ENWG), Link	REGULATION (EC) No 715/2009, Art. 15, Link

Gas – Other infrastructure reimbursements

This table describes other potential revenue streams on top of the previously described tariffs, levies and subsidies.

			
Transmission	None - Unbalance charges are to be settled with market (neutrality principle)	Limited - Unbalance charges are to be settled with market. Some additional income from accepting bio-gas.	None
	N/A	N/A	N/A
Storage	None	None	None
	N/A	N/A	N/A

Gas – Conditions for inclusion

The conditions for an asset to be included within a particular framework.

			
Transmission	Inclusion in investment plan by TSO; Investment plan is to be approved by NRA and Ministry of Economic affairs (art. 7a Gaswet). Assets are to be required for the legal task of the TSO	Inclusion in Network Development Plan (Netzentwicklungsplan (NEP)) to be approved by National Regulatory Authority (BNetzA)	Inclusion in national plans; Inclusion in investment plan by TSO; Investment plan to be approved by NRA and ministry (investments above 100 mio. DKK)
	Gaswet, paragraaf 1.2, Link, GTS, Investment plan 2022, Link	EnergieWirtschaftsgesetz (EnWG), Teil 3 Abschnitt 1, FNB Gas,Network Development Plans, Link; Bundesnetzagentur, Ausbau der Gasfernleitungsnetze, Link	Law on Energinet § 4
Storage	Operator must be assigned by Ministry of Economic affairs. Supervision by National Regulatory Authority (ACM). Activities of the SSO are independent of the TSO	N/A	Operator should be assigned by Ministry of Climate, Energy and Utilities (KEFM). Supervision by National Regulatory Authority (FSTS)
	Gaswet, paragraaf 1.2, Link	N/A	Law on Energinet § 2; Gas supply act § 10

Gas – Anticipatory investments

The possibility, risks and conditions of anticipatory investments related to future grid expansions.

			
Transmission	Expansion investments are allowed to enter the regulatory asset base at the start of commercial use. No-pre-financing of investment through tariffs allowed.	The current incentive scheme for expansion investments of "Investionsmaßnahmen" will be abandoned soon. New schemes will have to be implemented to include Hydrogen. These could be subsidies, guarantees, higher allowed returns etc.	Expansion investments are allowed to enter regulatory asset base during construction phase (not anticipatory). However, it is required that they are part of Grid Development Plan.
	ACM, Methodebesluit GTS, Link	Bundesnetzagentur, Investitionsmaßnahmen, Link	N/A
Storage	Anticipatory investments only at the expense and risk of shareholders.	Anticipatory investments only at the expense and risk of shareholders	Anticipatory investments are only at the expense and risk of shareholders
	N/A	N/A	N/A

Appendix B

Other EU Funds that were considered to be less suitable for a hub-and-spoke project are presented here. Each of these funds is described with the reasons why they were deemed less or unsuitable. It is important to note that this grant analysis only provides a snapshot with insights into the financing and grant opportunities for the project at that very moment. As the landscape of grants and financial instruments constantly changes, the analysis must be seen in that light. A regular update of grants and financing possibilities is therefore advisable.

Interreg North Sea region[2]

Interreg is an European subsidy scheme under which parties from various countries work together on projects in the field of spatial and regional development. Its aim is to jointly tackle common challenges and find shared solutions in fields such as health, environment, research, education, transport, sustainable energy such as hydrogen and more. Interreg is aimed at three different forms of cooperation:

- Cross-border cooperation: Europe;
- Transnational cooperation: North-West Europe (NWE), North Sea Region (NSR);
- Interregional cooperation: the Netherlands-Germany; Flanders- the Netherlands; Meuse-Rhine Euroregion; Interreg Two Seas.

Interreg North Sea Region is a grant that will invest in period 2020-2030. It support 'first of a kind' technologies that meet the following criteria:

- Effectiveness of GHG avoidance
- Degree of innovation
- Project maturity
- Scalability
- Cost efficiency.

The NSWPH project should become more mature to be eligible. Project maturity in terms of planning, business model, financial and legal structure as well as prospect of reaching the financial close within a pre-defined period of time not exceeding four years after the award decision. As Interreg provides financial support of typically a few million, this instrument is deemed interesting, but not extremely relevant for the NSWPH project.

[2] Link

European Energy Efficiency Fund[3]

The final beneficiaries of European Energy Efficiency Fund (EEEF) are municipal, local and regional authorities as well as public and private entities acting on behalf of those authorities. The EEEF invests at the city, region and community level in the EU Member States by financing technologies in energy efficiency, small-scale renewable energy and clean urban transport, with all projects to achieve annually a minimum of 20% primary energy savings or greenhouse gas savings compared to the baseline. The EEEF requires a TRL of 7-9 and the maximum loan amount is 25 MEUR.

As the NSWPH consortium consists of utilities and energy service companies this scheme could be interesting for their project. Especially, since the NSWPH project could match with the subtheme Renewable energy within this scheme. However, it is still unclear how this will be interpreted exactly, this should be verified with the partners of this financial instrument. Therefore, the fund was not included as one of the five most suitable EU funds.

European investment bank[4]

When a project is aligned with at least one of the priorities of the EIB, an (corporate) organisation can apply for loans or equity from the EIB. The priorities focus on the following areas:

- Climate and environmental sustainability
- Small and medium sized enterprises
- Innovation and skills
- Cohesion
- Infrastructure
- Development

All the projects the EIB finances must be bankable. But they also need to comply with high technical, environmental and social standards. As the NSWPH enables the integration of renewables on a large scale this project could qualify for a loan supplied by the EIB. Moreover, regional cooperation is also stated as one of the eligibility criteria of the EIB lending policy. This clearly fits with the scope of the NSWPH project. As is stressed in the Energy Lending Policy the EIB supports long-term development of energy networks among others, this will be done during the North Sea Wind Power Hub project. Nevertheless, the criteria stated in the EIB lending policy are relatively ambiguous, therefore the EIB needs to be consulted to determine if the NSWPH project is eligible for funding.

InnovFin Energy Demo Projects[5]

One specific project of the EIB is the InnovFin Energy Demo Projects. This project provides loans, loan guarantees or equity-type financing between EUR 7.5M and 75M to first-of-a-kind commercial-scale demonstration projects in the fields of energy system transformation, including but not limited to renewable energy technologies, smart energy systems, energy storage, carbon capture and storage or carbon capture and use. As a cross-border energy hub has not yet been demonstrated in the EU, the project can be considered as an innovative

[3] Link
[4] Link
[5] Link

application of existing technologies. In order to be eligible for this instrument the project should demonstrate the commercial viability of pre-commercial technologies. When the exact technical configuration of the offshore energy hub is known, the consortium should assess whether a successful application can be submitted for this instrument. Since it is still doubtful whether the NSPWH qualifies for this fund, the fund was not included as one of the five most suitable EU funds.

L'Instrument Financier pour l'Environment[6]

LIFE provides grants to pilot and demonstration projects contributing to increased resilience to climate change; particularly technologies and solutions ready to be implemented in close-to-market conditions. The aim is to mitigate the economic and social impact of the Covid-19 Pandemic by making societies more sustainable and resilient. In order to be compatible, a project should be included in national recovery and resilience plans of member states and have a TRL from 4-8. Maximum 55-75% of the eligible costs can be covered by this grant.

The NSWPH project has a good link with the scope of the Clean Energy Transition sub-programme, as this LIFE programme supports projects with high EU added-value, which are breaking market barriers. Nevertheless, the scope of this financial instrument is more focused on projects that facilitate the Energy transition than on the actual implementation of this. Despite the thematic fit, this scheme is thus deemed less relevant for the NSWPH project. One of the project components of the NSWPH project is focusing on Market and Regulation. If funding for this specific project element is needed, LIFE could be an interesting option since Market and Regulation could match with one of the sub-themes: building a policy framework supporting the clean energy transition.

Recovery and resilience facility[7]

The Recovery and Resilience Facility (the Facility) will make €672.5 billion in loans and grants available to support reforms and investments undertaken by Member States. The aim is to mitigate the economic and social impact of the coronavirus pandemic and make European economies and societies more sustainable, resilient and better prepared for the challenges and opportunities of the green and digital transitions.

The Facility funding supports offshore renewable energy in the upgrading of port infrastructures and grid connections. The maximum amount that can be awarded differs by member state.

Funding under the Recovery and Resilience Facility will need to be committed by the end of 2023 and, these investments should be implemented by 2026. This is not compatible with the NSWPH and so it is not considered in detail.

[6] Link
[7] Link

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