D7.6 Financing framework for meshed offshore grid investments

PROMOTioN – Progress on Meshed HVDC Offshore Transmission Networks
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LIST OF ABBREVIATIONS

Abbreviations	Description
CAPEX	Capital Expenditures
CATO	Competitively Appointed Transmission Owner
CEF	Connected Europe Facility
CIP	Copenhagen Infrastructure Partners
CoD	Cost of Debt
EC	European Commission
EEPR	European Energy Programme for Recovery
EIB	European Investment Bank
EU	European Union
GHG	Greenhouse Gas
HVDC	High Voltage Direct Current
Hybrid assets or hybrid solutions	Offshore infrastructure that combines OWF connections and interconnection
IDC	Interest During Construction
MOG	Meshed Offshore Grid
National TSOs	Transmsission System Operators of the countries surrounding the North Sea
NETSO	National Electricity Transmission System Operator
North Sea region or North Sea or Northern Seas	It includes the countries surrounding the North Sea and are involved in the development of a meshed offshore grid
NRA	National Regulatory Authority
NSG	North Sea Grid; a meshed offshore grid and interconnectors in the North Sea
NSG ISO	Independent System Operator of the North Sea Grid
NSG TSO	Tranmsission System Operator for the North Sea Grid
OFTO	Offshore transmission owner
O-GDP	Offshore Grid Development Plan
OPEX	Operational Expenditures
OSS	Offshore Substation
OSY	Offshore Switch Yard
OWF	Offshore Wind Farm

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Abbreviations	Description
PCI	Project of Common Interest
RAB	Regulatory Asset Base
RE	Renewable Energy
RES	Renewable Energy Sources
RoE	Return on Equity
SPV	Special Purpose Vehicle
TO	Transmission Owner
TSO	Transmission System Operator
WACC	Weighted Average Cost of Capital

Table 1: List of abbreviations

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EXECUTIVE SUMMARY

Large scale deployment of offshore wind will be needed to help Europe meet its Paris climate commitments. A meshed offshore grid (MOG) in the North Sea is key infrastructure to ensure the safe, reliable and cost effective transmission of offshore wind generated electricity to shore. Combining offshore wind generation links with offshore interconnectors for cross-border electricity transmission (hybrid projects) could offer great socio-economic benefits for the North Sea region, but the extent to which these benefits can be fully captured remain a matter of great uncertainty. This is mainly due to the lack of coordinated roll-out of offshore wind and the lack of a common, forward-looking approach for the development of the electricity network in the North Sea. The development of a MOG in the North Sea is an international challenge that requires cross-border cooperation and international alignment to coordinate the expansion of transmission links into a meshed offshore grid, supported by appropriate legal and regulatory frameworks that facilitate efficient investments in a MOG.

Currently there is a great interest in the market for offshore electricity transmission infrastructure; TSOs, industry and the financial sector are willing to invest in hybrid projects but the lack of an adequate legal and regulatory framework is the main barrier for investing in a MOG.

This report focuses on the financing challenges and particularly the parameters that have an impact on financing and provides solutions to address them as well as recommendations on appropriate financing structures that could attract investors and facilitate efficient investmets in a MOG. The parameters that affect financing are:

- The specifics of the MOG investment i.e. the timeframe (grid planning), the grid design (central or bottom-up), the owners of the grid assets (one or multiple asset owners) and the investment volume. The grid planning and design determine the investment volume and thus, the financing needs while the ownership models (and how they are regulated) will influence the design of the mechanism by which investors in the MOG are repaid.

- Investor income: the regulatory framework determines the investor income and plays the most important role in attracting investment in electricity transmission infrastructure. The regulatory regime for a MOG should be long-term, stable and predictable. It should provide a regulated revenue for agreed anticipatory investments, and should clearly define and allocate roles and responsibilities between parties involved in the MOG, whilst continuing to ensure good value for consumers.

- Financing strategies: the development of a MOG is capital intensive and needs appropriate financing structures and financial sources which can facilitate the necessary investments. There are international experiences and examples from the European Transmission System Operators (TSOs) and Transmission Owners (TOs) who have developed financial strategies to cope with the capital intensive offshore transmission investments, including attracting private investment and developing novel financial instruments (e.g.green bonds, ect.). These ideas could be applied for the financing of a MOG.

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- Grid ownership: there are central approaches, where one entity owns and operates the MOG, or asset-based approaches (nationally or market driven), where there is (independent from grid operation) ownership of specific assets. Which ownership model will best fit in a MOG depends on the regulatory framework and political will for changing the national laws in order to facilitate cross-border investments involving several countries. In order to capture the full scale of the potential benefits associated with a MOG in the North Sea, the political decision should be taken on the basis of a common forward-looking electricity strategy for the North Sea region.

In the following table a summary of recommendations on the most crucial elements and structures that need to be in place in order to eliminate the risks for investors and thus, unlock MOG investments are presented. A detailed synthesis of the recommendations is given in chapter 6.

No.	Obstacle for financing	Recommendations	Actions
1	Lack of coordination of infrastructure development is holding investors back from investing in a MOG	Increase the coordination of the national development plans for cross-border (anticipatory) grid investments	- A common plan (central approach) or stronger co-ordination of the national grid development plans (timing and location) between countries - Binding grid development plans for all countries involved - Develop a North Sea regional authority for coordinated and strategic planning
2	Lack of clarity on allocation of responsibilities and liabilities between multiple transmission owners (across borders) and between transmission owners and offshore wind farm developers prevents investment in the MOG	Increase the clarity on responsibilities and liabilities of investors in a MOG	- Split liabilities regarding operation and maintainance of MOG among TSOs and third parties - Define and allocate liabilities regarding OWF compensation - Establishment of an offshore liability regime as part of the regulatory regime for the MOG
3	Lack of stable and predictable regulatory regime for hybrid/ meshed assets perceived as key barrier for investors	Set up a long – term, stable and predictable regulatory framework for investments in a MOG	Develop a revenue model with a long-term fixed revenue stream
4	If investor income is market-based (electricity prices differencials between countries) higher risks for investors	Provide regulated income for investments in a MOG	- Under TSO regime: investments included in the TSO's regulated asset base - Under a tender model: fixed revenue subject to availability, asset performance and market indicators (e.g. OFTO regime)
5	Development and construction most risky phase of investment cycle with possible negative financial impact	Provide regulatory remuneration during the construction phase of the MOG	- Remuneration during the construction phases similar to Germany and the Netherlands regulatory TSO regime - Cap and Floor regime uses interest during construction which includes development and construction risks

No.	Obstacle for financing	Recommendations	Actions
6	TSO legal ownership restrictions hinder private equity provision	Facilitate private equity provision for the required MOG investment volumes	Flexibility regarding access to private equity - through possible financing structures: - TSO sub-structure: equity partnerships with investors - TSO maintains majority of voting rights (similar to TenneT's example in Germany) - Tenders of transmission assets to third parties under a SPV structure (similar to OFTOs, international practices, etc.) for construction, ownership and asset operation. This could be applied in the early phase of the development of the MOG for rapid initial growth. - One entity responsible for construction of the MOG - then tenders the assets after commissioning to third parties for ownership and asset operation; the 'builder' of the MOG could be national TSOs and investors (pension funds, infrastructure funds, ect.) forming a dedicated equity investment fund for the early phase of the MOG supported by EU
7	No national regulatory incentives for cross-border anticipatory investments regarding grid assets with multiple use	Allow remuneration for cross-border anticipatory investments through EU funding	Early phase of the MOG: EU financial support (CEF/ EEPR funding) to - eliminate the risk for investors, - bridge the financing gap due to inadequate cost allocation mechanisms and unlock the necessary crosss-border anticipatory grid investments that the national governments alone cannot deliver Later phase of the MOG: anticipatory cross-border investments included in the TSOs' regulated asset base and allow for regulatory remuneration.
8	No national regulatory incentives for deployment of innovative technology for the MOG	Support technological innovation through EU funding at the early stage of the MOG development	EU financial support (CEF/ EEPR funding): - for innovative technology - to kick-start the industry and - reduce the financial risk for the companies deploying innovative technologies

Table 2: Summary of recommendations for a financing framework for a MOG in the North Sea

The investigation of the international experiences and examples from the European TSOs and TOs showed that appropriate financial strategies to cope with the capital intensive offshore transmission investments have been developed and have succeeded in attracting private investors and securing alternative innovative funding. These strategies could be applied for the financing of a MOG. The analysis also showed that the driver of successful realisation of massive infrastructure investments is a long-term, stable, reliable and predictable legal and regulatory framework which assigns clear roles and responsibilities among the relevant actors and incetivises the required cross-border anticipatory investments. Therefore, the financing of a MOG in the North Sea is not seen as a challenge as long as an appropriate legal and regulatory framework is in place. For this, political commitment, collaboration and coordination are needed to realise the benefits of a MOG in the North Sea. To this end, the EU should support and co-ordinate regional initiatives and approaches, ensuring that the

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different national policies are aligned towards a common vision for the North Sea region. The aforementioned set of recommendations and best practices could be the first step to this direction.

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1 INTRODUCTION

Offshore wind power is expected to play a key role towards the decarbonisation of the European energy system and its key enabler, a strong and secure offshore grid, is a widely recognised prerequisite to reach the European energy and climate policy targets for a competitive, secure and sustainable energy system. A meshed offshore grid (MOG) in the Northern Seas, in particular, has been recognised by the European Commission (EC) as one of the priority electricity corridors to ensure an integrated European energy market (Directorate General for Energy, 2010). The current situation in the North Sea, however, includes radial connections of offshore wind farms to shore and point-to-point offshore interconnectors with three main parties investing in offshore electricity transmission lines: the national Transmission System Operators (TSOs), private investors in juristrictions that allow private Offshore Transmission Owners (OFTOs) (exclusively in UK) and the offshore wind farm (OWF) generators. Little progress has been made so far towards a fully integrated offshore grid in the North Sea mainly due to the lack of agreed objectives and forward-looking approaches for the development of the electrictity network in the North Sea region.

In the following sections, the main challenges of investing in a MOG are presented. Also, the aim and the structure of the report are outlined.

1.1 CHALLENGES OF INVESTING IN A MESHED OFFSHORE GRID

Given that a high (>60 GW) penetration of offshore wind (200 GW till 2050 scenario of PROMOTioN project)[1] is envisaged, a fully interconnected offshore electricity grid in the Northern Seas[2] represents a high investment value for Europe, as it contributes to the higher integration of renewable energy (RE), the increase of the cross-border power trading and thus, the energy security and the decrease of energy imports outside the EU (Gaventa, 2014). Additionally, the development of a common integrated offshore grid in the Northern Seas could reduce the capital costs for individual Member States through economies of scale and contribute to the stabilization of the consumer prices (Directorate General for Energy, 2010). Several studies have been conducted and have shown that multiple benefits occurring from coordinated offshore grid developments in the North Sea region[3]. Due to all aforementioned potential benefits, EC has identified the development of a MOG in the Northern Seas as one of the main electricity priority corridors to achieve the EU energy policy goals and economic strategies (Directorate General for Energy, 2010).

[1] Deliverable D12.2

[2] Northern Seas offshore grid (NSOG): “Integrated offshore electricity grid development and interconnectors in the North Sea, Irish Sea, English Channel, Baltic Sea and neighbouring waters to transport electricity from offshore RES to centres of consumption and storage and to increase cross-border electricity exchange” (European Parliament, 2017).

[3] Pöyry, 2017, WindConnector

3E, Deutsche WindGuard, CEPS, DNV GL, ECN, Imperial College, 2015 NorthSeaGrid
Tractebel Engineering, GDF Suez; Ecofys; PWC, 2014, Study of the benefits of a meshed offshore grid in the Northern Seas region.

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However, the current situation in the North Sea region includes only radial connections to shore and point-to-point offshore interconnectors with very limited steps taken towards offshore integrated grid infrastructure projects. TSOs, industry and the financial sector are willing to invest in hybrid projects (combined solutions), which incorporate transfer of offshore wind with interconnection but so far such projects remain rare; the only hybrid project is Kriegers Flak Combined Grid Solution (CGS) and is currently under construction (Energinet.dk, 2019). This is due to the lack of adequate legal and regulatory regimes; the current legal and regulatory frameworks treat offshore wind transport and interconnection separately hindering the development of multi-purpose offshore infrastructure, like a MOG (Nieuwenhout, 2019). From an investors' and financiers' perspective, an adequate legislative framework which increases investor understanding and thus, reduces risk, is a prerequisite to invest in a MOG; both debt side and private equity diligent risk management requires a legal and regulatory framework (European or supra-national) whichl defines clearly and allocates the liabilities related to operating and maintaining the MOG among the involved parties. This reduces the uncertainties around investing in a novel concept, such as a MOG (interviews).

Moreover, some stakeholders expressed concerns related to the lack of regulatory clarity and consistency in setting and maintaining tariffs over the lifecycle of transmission projects. They also perceive cross-border transmission projects to be very complex due to the different national regulatory frameworks involved and the lack of adequate compensation mechanisms; despite the proven overall net benefit, a cross-border transmission project will be approved and realised only if there is a direct socio-economic benefit for the countries involved (EWEA, 2014). In addition, the divergent national offshore wind ambitions and the lack of a common forward-looking approach for the development of the electricity network creates uncertainty and hampers the investments in integrated offshore grid projects in the North Sea.

There are also certain financial challenges. A MOG in the North Sea is capital intensive; the investment volumes are estimated by some stakeholders in the range of EUR 100-200 billion by 2050 (interviews). Of course this amount depends on the exact grid configuration. However, investments of this scale cannot be covered only by debt from TSOs due to their balance sheet constraints. Equity is needed but equity provision is very often hindered; state-owned TSOs often face government budget constraints which do not allow them to increase the capital of their company (DG ENER, 2015). On the other hand, state-owned TSOs might be reluctant to dilute their ownership share by allowing private shareholders. Therefore, diversified sources of financing should be attracted from both the public and private sector and more complex financing structures, such as a consortium structure, may be needed. Taking into account the multinational nature of the projects against the national nature of the TSOs, alternative ownership structures for owning and operating the hybrid assets may be needed. The ownership structures should tackle some of the financial challenges, facilitating (anticipatory) investments in a MOG in the North Sea.

Based on interviews with TSOs and private investors there are certain concerns regarding permitting and public acceptance issues which are perceived as major challenges leading to delays of cross-border transmission projects. Different permitting procedures in different countries is a major barrier for delivering cross-border projects on time and obtaining financing; complex and lengthy permitting makes lenders and investors reluctant to provide the required funds or they increase the financing costs to fit the risk profile of the project (Berger, 2011). Moreover, insufficient public acceptance due to environmental concerns hinders the development of cross-border transmission investments.

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Finally, there are concerns referring to the uncertainty that comes from the non-realisation of planned OWFs that can lead to higher risk of stranded grid assets. For instance, should in the future the OWFs depend greatly on the market prices for electricity and given that currently, in some countries, the TSOs are obliged to build the OWF grid connections before the Final Investment Decision (FID) of the OWFs, the risk for stranded transmission assets could be increased in case the OWFs are not going to be built.

Given the importance of developing a Northern Seas offshore grid, it is essential to remove the above barriers and to find solutions for the legal, regulatory and financing challenges in order to realise investments in an integrated offshore grid.

1.2 AIM AND REPORT STRUCTURE

A financing framework is needed to kick-start, encourage and accelerate investments in a MOG, provided that an adequate legal and regulatory framework is in place. The purpose of a financial framework should be to mobilise capital for investments in a MOG and to be flexible to respond to unforeseen events, such as financial crisis, to reduce their impact on money available for offshore transmission investments. To this end, the financing framework should first consider the key parameters that impact financing for a MOG. These parameters are the general infrastructure policy frameworks for the development of a MOG in the North Sea and the legal and regulatory frameworks for the respective investments.

The grid planning including timing, location and anticipatory investments and the grid design of the MOG will determine the investment volume and consequently, the financing needs. In addition, the legal and regulatory framework for grid investments has a profound impact on the feasibility of the financing of electricity infrastructure projects. Particularly, the allocation of grid responsibilities and risks, the stability of the regulatory regime and the related remuneration are important issues for the investors who plan the investment and the financing institutions that provide the financing.

Moreover, the financing framework should outline ways in which additional financial resources and tools can be utilised to maximise the chances of raising the 100+ billion Euros to pay for the MOG. In order to achieve this aim, the financing framework draws on inspiration from best practices used regarding financing structures, sources and ownership models in order mobilise the necessary capital needed and facilitate efficient investments in a MOG.

Summarising, the aim of the financing framework for the kick-start of a MOG is to consider the parameters that have an impact on financing and provide solutions to address them as well as provide appropriate structures that could attract investors and facilitate investmets in a MOG. To this end, the following elements are investigated:

- Specifics of the MOG investment:
    - Timeframe
    - Design
    - Ownership
    - Investment volume
- Investor income:
    - European framework for investments
    - National regulatory frameworks
    - Investor perception of risk
- Financial strategies:

  - Financing of European electricity transmission networks
  - Practical examples
  - International experiences
- Grid ownership
  - Ownership models for a MOG
  - Evaluation of the ownership models

The aim of task 7.3 is to identify barriers that prevent the financing of a MOG and provide recommendations on the appropriate financing structures and ownership models that could tackle these barriers facilitating private capital provision and delivering efficient investments in a MOG in the North Sea. Based on research on the current financing of onshore and offshore electricity transmission grids in Europe, the investigation and comparison with international practices as well as multi-stakeholder consultation regarding the main risks for financing and the possible ownership models for a MOG, a set of recommendations is developed to overcome the challenges and enable the necessary financing needed for investing in a MOG.

The final report of task 7.3 is structured as follows:

- Chapter 2 presents the investment specifics, i.e. the features of the MOG investments that need to be financed (timing, grid design, investment volume).
- Chapter 3 describes the characteristics of the national regulatory frameworks for electricity transmission investments onshore and offshore. An overview of the EU investment framework developed to support key energy infrastructure investments is provided. The investor perception of risk is presented.
- Chapter 4 focuses on the financing structures and financial sources used by the TSOs and private investors. Examples of investments in OWF grid connections and offshore interconnectors in Europe as well as key learnings from international experiences in tendering electricity transmission assets that can be relevant to a MOG in the North Sea are presented.
- Chapter 5 investigates possible ownership models for a MOG and evaluates these models against a set of assessment criteria.
- Chapter 6 presents the conclusion of the analysis and provides recommendations on the most essential parameters that from financing perspective need to be in place in order to facilitate investments in a MOG.

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2 SPECIFICS OF THE MOG INVESTMENT

A MOG in the North Sea is a critical infrastructure project which can deliver great benefits for the consumers. However, the extent to which these benefits can be fully captured remain a matter of great uncertainty mainly due to the current incremental national policies and approaches to the deployment of offshore wind and thus, the network planning. If each country continues developing its own renewable power supply and network infrastructure independently from their neighbours, it will not be possible to capture the full scale of the potential benefits of a MOG in the North Sea. In order to move towards an integrated solution, however, decisions need to be taken on fundamental topics regarding *when to start*, *how to build* and *who owns* the MOG.
The time horizon, the possible design of a MOG and the anticipatory cross-border investments will determine the volume of the integrated network investments and consequently, the financing volume. At the same time, clarity is required on who is going to own and operate such infrastructure. This will influence the design of the mechanism by which investors in the MOG are repaid. The investment volume and the ownership remuneration mechanism need to be defined in order to determine the finance of the MOG. Figure 1 illustrates the specifics of the investment to be financed, the MOG.

Figure 1:Specifics of the MOG investment

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2.1 TIMEFRAME

Governments in the region of the North Sea are currently failing to deliver the required meshed offshore grid investments due to the divergent national ambitions for the deployment of offshore wind and a lack of forward-looking regional electricity strategy for the North Sea's region (Gaventa, Bergamaschi, & Ryan, 2015). More specifically, the pragmatic conditions reveal a fragmented landscape of national approaches; there are different national ambitions and plans for the offshore wind generation (different volumes, timing and location). Some countries estimate already high offshore wind capacities till 2030, as depicted in Figure 2, while it is uncertain the development of offshore wind capacities after 2030.

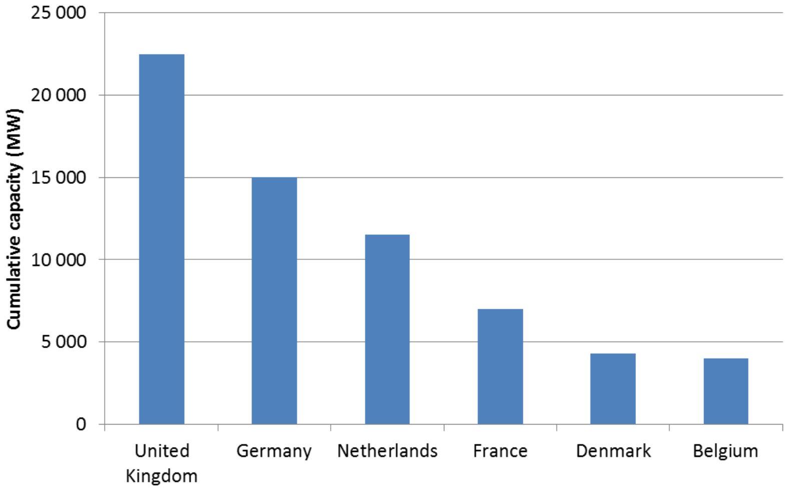

Figure 2: Offshore wind power cumulative capacity to 2030 (Source:WindEurope)

The timing and pace of development of offshore wind depends a lot on political will and therefore, the network planning connecting several countries should be done against a background of uncertainty. Nevertheless, in order to move towards an integrated solution, decisions need to be taken on the time horizon considering at the same time the technological challenge; should the MOG planning start now, multi-terminal and innovative technology is needed to connect existing point-to-point infrastructure to the future HVDC grids. However, this technology is not yet developed enough and thus, the national TSOs would continue using mature technologies that are confident with. Should the MOG planning start after 2030, technological standardisation for future cross-border OWF connections is needed today if the national grid developments till 2030 are to be integrated to the MOG. If not, it is uncertain what the additional offshore generation capacity and possible benefits from meshing after 2030 will be.

In general, the time for planing the MOG has an impact on financing; it is unlikely that the current national grid plans (to 2030) are going to utilise complex or new technologies extensively. Instead, they will be most probably simpler than later topology improvements which may give the opportunity to test new technology. However, this is an added risk which might make finance options more costly and therefore, prevent TSO investments in projects that rely on new technologies.

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2.2 POTENTIAL DESIGN OF THE MOG

The grid technologies (AC, DC, voltage levels, etc.) and network design vary considerably between countries. Most wind farms are connected radially to shore via point-to-point links while others are via offshore hubs (clustering approach). At present, the Kriegers Flak CGS is the first hybrid project combining offshore wind power transmission and electricity interconnection between different countries due to the challenges associated with the different national regulatory regimes, support structures and inconsistencies related to priority dispatch for renewables and open access to interconnection capacity. Figure 3 illustrates the current business-as-usual offshore grid development approach, which is based on national policy driven investments in the form of radially connected wind parks.

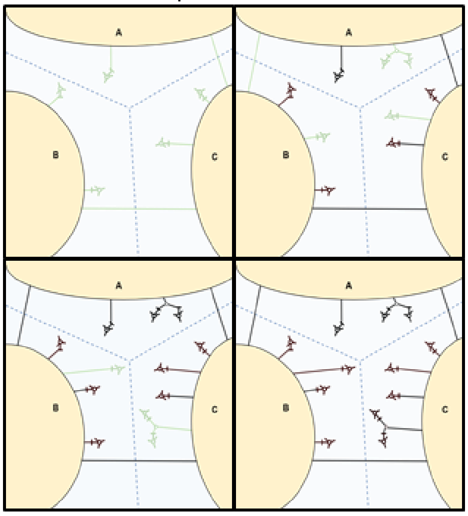

Figure 3: Business-as-usual approach (Source: D12.2)

There are several approaches for the design and development of a MOG. Some of these concepts have been investigated by WP12 and illustrated in Figure 4, Figure 5 and Figure 6. The grid configuration i.e. the number of hybrid connections vs. European centralised wind power hubs determines the investment volume and thus, the financing volume.

These grid concepts could be grouped into two categories; the central (top down) approaches, implying a common grid planning for the North Sea, and the bottom-up which are based on the national grid developments and plans of each country within their EEZ.

Both approaches involve challenges; the central grid design, which could co-optimise the location of offshore wind with the grid infrastructure, would require strong political will to facilitate cooperation and adequate distribution of costs and benefits amongst countries and actors.

If a bottom-up approach for grid designs based on national developments is to be followed, there is a risk of incremental narrow offshore grid investments. Therefore, to create an efficient grid, strong cross-border coordination is needed to eliminate the risk of fragmented grid development, avoid mixed technological standards which are hard to mesh and to ensure that the necessary anticipatory investments will be allowed to meet the future long term needs of the grid as a whole, as more wind generation is connected into power networks.

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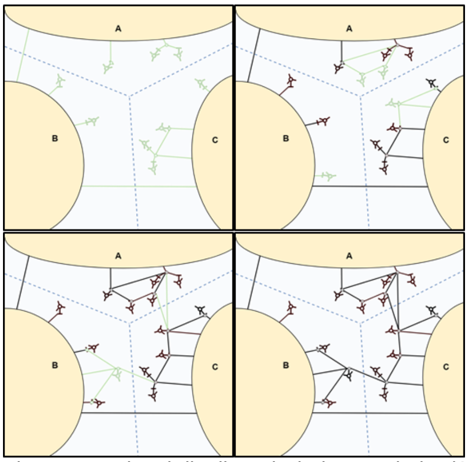
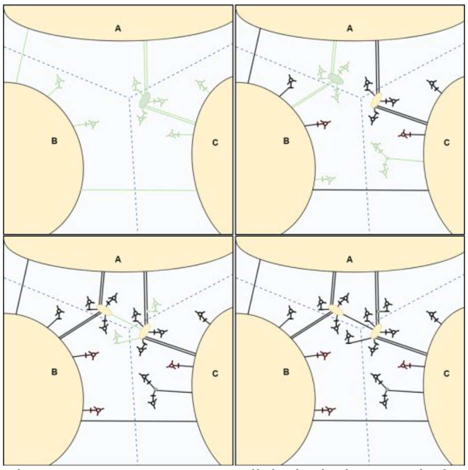
In general, the various grid designs are related to different regulatory frameworks that in turn lead to different timeframes for the development of the MOG, impacting its financing.



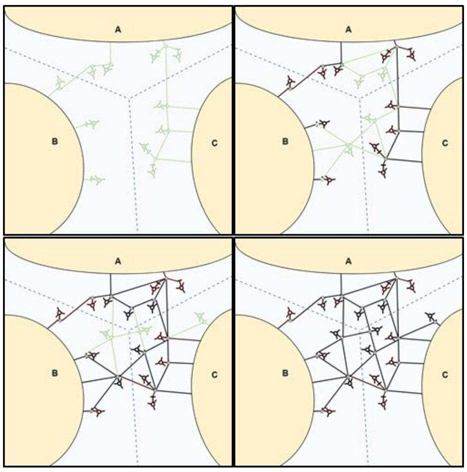
Creation of small HVDC hubs meshed at national level but loosely interconnected amongst countries

Figure 4: National distributed wind power hubs (Source: D12.2)



OWFs connected to large centralised connection points and the power evacuated to North Sea countries through dedicated HVDC corridors

Figure 5: European centralisied wind power hubs (Source: D12.2)



Stronger interconnection between decentralised hubs up to a level where the overall infrastructure forms a fully meshed international offshore grid

Figure 6: European distributed wind power hubs (Source: D12.2)

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2.3 OWNERSHIP

There are two fundamental approaches to grid ownership which may be applied: central approaches, where one entity owns and operates the MOG, or asset-based approaches (nationally or market driven), where there is (independent from grid operation) ownership of specific assets. Under nationally driven, asset-based approaches, the responsible parties under each national regime (in most cases national TSOs and in the UK third parties) are responsible for the grid assets within their EEZ. In a nationally driven scenario, the ownership follows the EEZ borders where the multiple owners own complete grids (or single assets in the UK's case) within their EEZ. On the other hand, under a market driven, asset-based approach, there are multiple owners, each owning individual assets/ parts of the MOG within the North Sea region (potentially across multiple EEZs). In order to build more complex meshed grids, ownership structures that could facilitate the required anticipatory cross-border investments must be explored.

Currently there are three investor models in Europe for connecting OWFs to the onshore grid (these are each national driven, asset-based approaches); the TSO model, the OWF generator model and the OFTO model (exclusively in UK). In case of offshore interconnectors the investor can be the national TSOs of the interconnected countries or private investors. Hereafter, a short description of the type of investors for OWF grid connections and interconnectors are given. Additionally, the investor appetite and the impact of the financial markets on the investments in electricity transmission infrastructure are presented.

Investor model for OWF grid connections

The TSO model is currently dominant in several European countries including Germany, the Netherlands, Denmark and Belgium, where the responsibility for the connection of the OWF to the onshore grid is with the national TSOs. In the UK, offshore transmission operates under a third party model – the Offshore Transmission Owner (OFTO) regime. The OFTO transmission systems have separate owners from the onshore transmission network, though they are still operated and paid by the National Electricity System Operator (NETSO), which in the case of England and Wales is National Grid, and are regulated by the same entity (Ofgem). In the current regime (the Enduring Regime), there is the possibility to have tenders for a generator-build or an OFTO-build option and the generator can decide on the preferred option (see 3.4.2).

Despite the third liberalisation package for electricity, which requires the unbundling of TSOs from the OWF generators, in some countries and under certain conditions, the generator model is still used for OWF grid connections. For instance, in Denmark the generator finances the grid connection to the shore for near to shore wind farms and in Belgium the OWFs have been, until now, individually connected to the onshore grid. In Sweden the generators are responsible for the design and development of the grid connection to shore and they also finance their grid connection. However, for the connection of the OWFs to the onshore grid, most countries with offshore wind, including Germany, the Netherlands, Denmark and Belgium have extended the TSO model from onshore to offshore, with the UK's OFTO model being the exception. There are several practical reasons for this choice; the OWF grid connection can add a substantial cost to the total capital expenditure (CAPEX) of an offshore wind project (15%-30% of the CAPEX) (IRENA, 2016). Additionally, on offshore, unlike onshore, it is often the case that several generators ask to be connected in the same area at the same time. Under the

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regimes, where the TSO is responsible for the grid connection (and rather not the OWF generator) an advanced and economic connection planning can be achieved by coordinating the requests for grid connection and capturing economies of scale (Meeus, 2014) (PwC, Tractebel Engineering, ECOFYS, 2016). A MOG, comprising hybrid grid solutions (combination of OWF grid connections and cross-border interconnections) would require a significant financing effort as well as coordination hence, the OWF generator model is not expected to be the preferred model for financing a MOG.

Investor model for offshore interconnectors

Traditionally, the interconnector investment is on a fully regulated basis by a TSO in order to secure the long-term ability of the system to meet electricity demand. In Norway, in the period 2013 to 2016 it was regulated by law that only the Norwegian TSO was allowed to own and operate interconnectors. Since 1 January 2017, however, private investors are also allowed to own and operate interconnectors, following an amendment to the Energy Act (The Ministry of Petroleum and Energy, 2016).

In the European legal context, the owners of merchant interconnectors should be separated (unbundled) from the TSOs in whose system will be built (Regulation (EC) No 1228/2003, 2003). In many cases the owners of merchant interconnectors are financed by holding companies that also own TSOs. For example, BritNed is a joint venture between National Grid International Ltd., a subsidiary of National Grid Holding and NLink International B.V., a subsidiary of TenneT Holding B.V. (see 4.3).

Since 2014, a new regulatory regime for interconnectors was developed in the UK, the "Cap and Floor" regime. The Cap and Floor results form a compromise between a more market-based (merchant) approach for interconnectors, raised by Ofgem, and the common EC policies (see 3.4.3). In Nemo interconnector project, where the Cap and Floor regime will be applied, the investors and owners are National Grid and Elia, the national TSOs of Great Britain and Belgium respectively.

Investor appetite

The investor appetite in terms of liquidity available and willingness to invest in the offshore electricity transmission infrastructure in Europe plays a key role on the financing of these investments. In 2016, TenneTHolding B.V. issued their second EUR 1 billion green bond for investments in the connection of OWFs to the onshore grid in Germany which was four times oversubscribed. This demonstrates that there is a keen market interest for offshore grid investments.

According to a study carried out by DG ENER (DG ENER, 2015) which is partly focused on the assessment of the investor appetite in the electricity transmission infrastructure projects, it was found that this type of assets are attractive due to the long term drivers for investments, the regulated and stable rate of return and the low risk nature of these assets. Moreover, within the current market, long-term stable investments are increasingly attractive propositions to investors against wider market uncertainty. However, it needs to be highlighted that hybrid assets that combine OWF grid connections and interconnection, are more complex and entail higher risks. Being able to reflect this in the regulatory framework by providing the right incentives for investors would ensure that the market for equity investment in hybrid assets is more competitive leading ultimately to lower costs for consumers.

There is a diversity of investors active in the offshore electricity transmission sector in Europe. Primarily, transmission system operators invest in OWF grid connection projects, since the electricity transmission grid is

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a regulated sector and in most countries with installed wind capacities, the national TSOs have the responsibility for financing and operation of the offshore grid.

Infrastructure funds (funded by pension funds, insurance companies and private funds) are interested in these investments, since they are regulated and thus, characterised by long-term, low risk and stable yields. They are passive investors and they prefer to form partnerships with experienced operators, such as the TSO (e.g. partnership of CIP with TenneT in DolWin3 project) (Global Capital Finance, 2014).

Institutional investors, such as pension funds and insurance companies, have expanded their investment activities in the offshore electricity transmission infrastructure. Pension funds in particular typically seek to invest a minimum of EUR 100-250 million per deal (Global Capital Finance, 2014), a transaction size which is offered by offshore transmission assets. Moreover, they prefer to co-invest alongside experienced financial partners and consequently make minority investments. Institutional investors invest equity or debt in projects although the majority prefers equity as it generates higher returns (Global Capital Finance, 2014). They benefit from the long-term predictable and stable cash flows of the offshore electricity infrastructure assets. Furthermore, other reasons which have made pension funds to consider offshore electricity transmission projects as a better investment are the cost parity with conventional power generation sources and the increasing regulatory risk of fossil fuel-based generation assets (Mittal , 2015).

Corporate investors, like Japanese investors, invest in European offshore electricity transmission assets driven by financial and strategic reasons (Global Capital Finance, 2014). The negative interest rates in Japan have pushed the largest Japanese banks to add more project finance loans for, primarily European, renewable infrastructure projects. For instance, in 2016, Sumitomo Mitsui Financial Group provided debt for the purchase, operation and maintenance of the Humber Gateway offshore transmission system in UK (offshorewWIND.biz, 2016). Additionally, Japanese trading houses like Mitsubishi Corporation, invest in European offshore electricity transmission assets in order to gain experience which will apply later to their domestic markets. Therefore, they tend to form partnerships with experienced players such as TSOs. (Global Capital Finance, 2014). Table 3 presents the diversity of investors who are active in the offshore electricity transmission grids in Europe as well as the factors which make these assets attractive to the investors.

Type of investors	Examples investors	Investment focus
TSOs	TenneT owner offshore transmission assets in the Netherlands and Germany	Obliged by national laws to connect the OWFs to the grid
Institutional investors	PensionDenmark owns shares in DolWin3	-Interested in large scale long-term investments with stable rate of return -Transmission infrastructure is a better investment avenue compared with investments in conventional power generation sources
Infrastructure funds	Copenhagen Infrastructure Partners (CIP) Transmission Capital Partners owns the TC Barrow OFTO Limited	Long-term infrastructure investments with stable cash flows and low correlation to the ordinary business cycles.

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Type of investors	Examples investors	Investment focus
Corporate investors	Mitsubishi Corporation (BorWin1,2 HelWin2,)	-Long-term price stability positive impact on brand and PR -Gain experience that can be applied to developing projects in Japan's deep waters

Table 3: Investor landscape in the European offshore electricity transmission infrastructure

2.4 INVESTMENT VOLUME

EU's climate and energy objectives and targets have a major impact on the electricity transmission networks. The Energy Union Package has set the targets, by 2030, of reducing the domestic greenhouse gas (GHG) emissions by 40% compared to 1990 levels, increase the RE penetration by at least 27% and reaching at least 27% energy savings (European Commission, 2017a). EC has proposed to increase the interconnection target to 15% by 2030 (European Commission, 2017b). In order to facilitate higher levels of RE into the electricity system, while contributing to the decrease of CO_2 emissions, the transmission grid has to be adapted accordingly. Significant transmission investments, related to the upgrade and extension of the grid are needed to secure the connection of the RES to the load centres. To this end, offshore electricity grid infrastructure can play a key role. Offshore wind energy is one of Europe's largest domestic energy resources and its key enabler, an offshore grid in the Northern Seas, is a critical infrastructure project for the achievement of the 2030 objectives of the Energy Union Package. This development would enable access to the large scale offshore wind, contribute to the reduction of GHGs emissions and increase energy security (Gaventa, Bergamaschi, & Ryan, 2015).

A meshed offshore grid in the North Sea which would support the integration of 200 GW offshore wind is a capital intensive infrastructure but at the moment there are no clear estimations of the investment volume. For the integration of 200 GW offshore wind, some stakeholders estimate investments in the range of EUR 100-200 billion by 2050. However, given the national investment plans regarding the offshore transmission infrastructure, it is unlikely that by 2030 investments in hybrid projects will be extensively carried out and thus, the financing required for a MOG is uncertain.

ENTSO-E addresses in their TYNDP the development of electricity grid infrastructure in the North Sea region based on the national investment plans for OWF grid connections and interconnectors. Apart from investments in the offshore grid TSOs are obliged to meet the domestic investment plans, as set by the national governments. Hereafter, the investment needs for a Northern Seas Offshore Grid determined by ENTSO-E TYNDP 2018 as well as the the national investment plans for the OWF grid connections and point-to-point interconnectors are described. Also, the estimations of stakeholders regarding the investment volume for a MOG by 2050 are presented.

Investment needs in Northern Seas Offshore Grid

The Northern Seas Offshore Grid represents an investment of high importance for Europe and it has been identified as a priority area under the EU regulation No 347/2013 on guidelines for trans-European energy

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infrastructure[4]. The North Sea region presents a strong project pipeline including OWF grid connections and offshore interconnectors. TYNDP 2018 estimates 60 GW offshore wind capacity by 2030 in the North Sea region and total infrastructure costs between EUR 14 billion and EUR 27 billion, including mainly offshore interconnectors (and not hybrid assets) (ENTSO-E, 2018). Based on interviews with TSOs, investments in meshed solutions (in a MOG), i.e. hybrid assets which combine OWF grid connections and interconnection, to evacuate 200 GW offshore wind are estimated in the range of EUR 100-200 billion by 2050. However, there are hardly any investments in meshed solutions including hybrid assets and connections of OWFs of one country to the shore of a neighbouring country. EC addresses that many energy infrastructure projects which have an added value to the EU's energy objectives (e.g. security of supply) are not commercially viable mainly due to the fact that not all the investment costs can be recovered throught tariffs (European Commission, 2012). Especially for cross-border interconnection projects the cost allocation mechanisms are very often not sufficient, leading to significant delays of the projects or even cancellation.

Annual investments in interconnectors currently represent about EUR 0.9 to 1.5 billion but in a high RES scenario are expected to rise substantially to an average of EUR 3.6 billion annually (Directorate General for Internal Policies, 2017). Table 4 presents the annual average estimates for onshore and offshore electricity investments in interconnectors and transmission grids based on different scenarios and studies.

Grid investments	Estimates 2011-2020	Estimates 2021-2050
Interconnectors	EUR 0.9-1.5 billion annually	EUR 0.5-3.6 billion annually
Transmission	EUR 4.6-5.3 billion annually	EUR 6-12.3 billion annually
Sum	EUR 5.5-6.8 billion annually	EUR 6.5-15.9 billion annually

Table 4: Annual average estimates of electricity investment levels in interconnectors and transmission grids. Source: Figures taken from (Directorate General for Internal Policies, 2017)

National investment plans

Hereafter an overview of selected national investment plans for grid connections of OWFs and offshore interconnectors is presented.

Table 5 presents a summary of the national investment plans for the connection of OWFs to the onshore grid that are expected to be delivered within a certain time horizon. Only Germany has set longer term investment plans, till 2030. It is apparent that the North Sea countries apply short term energy policies and lack a common European vision for the future energy system, which puts at stake the development of a MOG in the North Sea.

It is noted that in Belgium the OWFs are so far connected to the oshore grid by the generator but in the future Elia, the national TSO, plans to create the Belgian Offshore Grid, where the offshore wind farms will be connected to a high-voltage substation located on an offshore platform, which will, in turn, be connected to the onshore grid (Elia, 2017). In Norway, there are no OWFs (only a floating wind turbine) at the moment and consequently no investment plans for grid connections.

[4] The Northern Seas Offshore Grid is defined by EC as integrated offshore electricity grid development and interconnectors in the North Sea, Irish Sea, English Channel, Baltic Sea and neighbouring waters to transport electricity from offshore RES to centres of consumption and storage and to increase cross-border electricity exchange (European Commission, 2012).

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Country	Time horizon	Investment Volume
Germany	2019-2030	EUR 18-24 billion[5]
Netherlands	2017-2023	EUR 2 billion[6]
Denmark	2017-2020	EUR 1.2 billion[7]
Belgium	-	-
Norway	-	-
UK	Round 4	GBP 0.230 billion
	Round 5	GBP 2.067 billion
	Round 6	GBP 2.708 billion

Table 5: National investment plans for OWF grid connections

TSOs provide at specific time intervals the national development plans for electricity grids, which are based on their national scenarios that are not always consistent with the ones from the Community-wide TYNDP-E. TYNDP-E includes only the projects which are of pan-European significance.

In Table 6, the mid-term national investment plans (projects to be commissioned by 2022 and have received intergovernmental approval (ENTSO-E, 2018)) for offshore interconnectors in several countries surrounding the North Sea, are presented.

Interconnector projects	Countries	Time horizon	Investment Volume
NordLink	Germany-Norway	2016-2020	EUR 2.1 billion
Kriegers Flak - CGS	Denmark-Germany	2014-2019	EUR 3.5 billion
COBRAcable	Denmark-Netherlands	2015-2019	DKK 4.7 billion
Viking Link	Denmark-UK	2014-2023	EUR 2 billion
Nemo	Belgium-UK	2015-2019	EUR 0.69 billion
NSN	Norway-UK	2016-2021	EUR 2 billion
Eleclink	France-UK	2016-2020	GBP 0.49 billion
Fab Link	France-UK	2015-2022	EUR 1.2 billion
IFA2	France-UK	2015-2020	EUR 0.69 billion
Green Link	Ireland-UK	2018-2023	EUR 0.4 billion
North Connect	Norway-UK	2018-2024	GBP 1.3 billion

Table 6: National invetment plans for offshore interconnectors[8]

[5] https://www.netzentwicklungsplan.de/sites/default/files/paragraphsfiles/NEP_2030_V2019_1_Entwurf_Teil1.pdf
[6] http://www.tennet.eu/fileadmin/user_upload/Company/Publications/Technical_Publications/Dutch/TP_KCD2016_net_op_zee.pdf
[7] Information delivered by Energinet.dk
[8] https://www.4coffshore.com/transmission/interconnectors.aspx

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2.5 SUMMARY

There are currently hardly any meshed offshore grid projects combining OWFs connections and interconnectors and given the national grid investment plans, it seems unlikely that by 2030 hybrid projects would be extensively developed. Most North Sea countries apply short term energy policies and lack a common vision for a MOG in the North Sea. If each country continues developing its own renewable power supply and electricity network infrastructure independently from their neighbours, it will not be possible to capture the full scale of the potential benefits of a MOG in the North Sea. To this end, it is crucial that the countries involved in the MOG in the North Sea first ensure that sufficient consistency exists between the various approaches adopted regarding offshore wind deployment and grid planning.

From a financing perspective, adequate legal, regulatory and infrastructure policy frameworks and conditions need to be in place before developing a financing framework for a MOG. At the moment there is a great interest in the market for offshore transmission infrastructure but the lack of an adequate legal and regulatory framework hinders investments in hybrid/ meshed assets. The financing framework recognises that the infrastructure policy framework regarding the timing and design approaches for the development of a MOG influences its financing. The time horizon and the planning process for a MOG will determine the volume of the (cross-border) network investments and hence, the financing need for the transmission owners and operators in the North Sea. ENTSO-E has estimated for the North Sea region a total investment of EUR 14-26 billion by 2030 which includes mainly offshore point-to-point interconnectors and no hybrid projects (ENTSO-E, 2018) while for a MOG some stakeholders estimate investments in the range of EUR 100-200 billion by 2050, depending on the grid design and configuration (interviews). The investment requirements for a MOG is set against a background of uncertainty since, there are hardly any meshed offshore grid plans including several countries. However, the development of a MOG in the North Sea is expected to be capital intensive. In order to overcome the financing challenge and encourage the investment in more complex assets crossing international borders, financing structures and ownership models are needed, such that investors can anticipate and fund the required cross-border investments.

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3 INVESTOR INCOME

In all EU Member States operation and ownership of the electricity transmission network is a regulated activity, undertaken by licensed TSOs. The grid investments are supervised and approved by the National Regulatory Authorities (NRAs) while the investor income is determined by the regulatory framework for grid investments. The regulatory framework has a profound impact on the feasibility of the financing of the TSOs and TOs. The regulatory framework should allow a sufficient rate of return which covers the Capital Expenditures (CAPEX), efficient Operational Expenditures (OPEX) of the investments and include efficient financing costs. Merchant interconnectors are an exception to the regulation where the investor income depends on the difference in market prices, i.e. congestion rent. However, by increasing interconnectivity the income (congestion rent) of merchant interconnectors decreases, increasing the risk for investors. Hence, a purely market-driven revenue scheme would not be a viable solution for a MOG where high interconnectivity is envisaged. Therefore, and considering the great societal value that a MOG creates, it is recommended that such investments should be funded on a regulatory basis, i.e. the investor income should be regulated (Nieuwenhout, 2019).

Moreover, for projects which are highly desired by EC, such as combined solutions of OWF connections and interconnection or connection of an OWF in one country to the shore of another country, the national regulatory frameworks should give appropriate incentives for prioritising these investments which exhibit higher complexity and risks compared to the average (ENTSO-E, 2014a). In addition, financial support from EC is also needed at least at the early stage of the development of the MOG and especially for HVDC projects which use innovative technology in order to eliminate the risk for investors and kick-start the industry.

The sope of this chapter is to provide recommendations on the regulatory elements that from financing perspective need to be in place in order to incentivise investments in a MOG. To this end, an overview of the current EU policies and funding mechanisms developed to support cross-border offshore electricity transmission investments is given. Moreover, the most important regulatory elements which impact investor income and thus, financing, as well as the particular characteristics of the TSOs' national regulatory regimes for onshore and offshore grid investments are presented. A description of the OFTO regime for OWF grid connections as well as the 'Cap and Floor' regime for offshore interconnectors in the UK is also provided. Finally, based on interviews with TSOs, corporate investors and financial institutions, the investor perception of regulatory risk and the suitability of the existing regulatory frameworks for a MOG are presented.

3.1 EU FRAMEWORK FOR INVESTMENTS

Since the economic and financial crisis the investment levels across the EU have been reduced dramatically. Specifically, the investment levels have been dropped to approximately 15% since its peak in 2007 (Official Journal of the European Union, 2015). The investment gap indicates a market failure and reluctance of private investors to take risks, mainly due to the uncertainty regarding the future of the economy and the regulatory hurdles (S&P Global ratings, 2017). The money is available but the investors have adopted a "wait and see" attitude; instead of investing they save their money until uncertainty dissipates (CEPS, 2014). This poses a threat to the EU's long-term growth, its global competitiveness and thus, its energy and climate objectives. In order to reduce the investment gap, restore the investors' confidence and strengthen its competitiveness, the EC has developed several financial strategies and instruments. Especially, in the field of cross-border energy infrastructure, a number of policy tools, funding programmes and lending schemes are provided by the EU to stimulate strategic investments which have a clear contribution to the objectives of security of supply, integrated energy markets and the reduction of CO_2 emissions. These tools are described in this section.

Projects of common interest (PCI)

The concept of PCIs was developed to aid the completion of an integrated European energy market and to meet the EU's energy policy objectives for affordable, secure and sustainable energy (European Commission, 2017a). PCIs are governed under Regulation (EU) No 347/2013 on guidelines for trans-European energy networks (TEN-E). The main benefits of the PCI label are:

- accelerated planning and permitting procedures (3.5 years for granting a permit)
- a single national authority for providing permits ("one-stop-shop")
- streamlining of environmental assessment procedures
- increased public participation through consultations
- increased visibility to investors
- access to financial support by the Connecting Europe Facility (CEF)

Funding instruments

There are several funding mechanisms developed by the EU to stimulate investments in the field of electricity transmission infrastructure. Table 7 gives an overview of the characteristics of these mechanisms, whose aim is to fill the financing gap for strategic investments in the EU by mitigating certain risks for the projects and thus, the cost of capital for investors and facilitating access to finance. The financial support from these programmes can take different forms; there are financial instruments, such as debts, equity capital and grants or guarantees to energy infrastructure investments.

The European Fund for Strategic Investments (EFSI) is an EU initiative launched jointly by the EIB Group and the EC to help overcome the current investment gap in the EU by mobilising private financing for strategic investments such as investmenst in transport, energy, digital infrastructure, etc. (EFSI, 2019). Since its implementation in 2015, EFSI has mobilised in total EUR 375.5 billion investments and it has been extended to mobilse additional investment of at least EUR 500 billion by 2020 (EFSI, 2019).

Connected Europe Facility (CEF) is a programme which focuses on PCIs and thus, plays a crucial role in supporting the electricity transmission projects of supra-national interest (ENTSO-E, 2014a). As part of the next long-term EU budget 2021-2027, the European Commission has proposed to renew the CEF, with EUR 8.7 billion to support investments in the European infrastructure networks for energy (European Commission, 2019). Assuming that the total investment for the period 2020-2050 is approximately EUR 200 billion (interviews), the CEF support of EUR 8.7 billion represents 21.75% of the required investment.

The European Energy Programme for Recovery (EEPR) is another funding programme that EC uses to promote energy transition. To this end, the EERP has provided financial support to two wind-grid integration projects, Kriegers Flak CGS and the Cobra Cable. Especially, in the case of Kriegers Flak CGS the funding of EUR 150 million from EEPR was perceived by the project developers as essential support for the development of the project (Windpower Monthly, 2017).

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It is noted that the scope of these mechanisms is much broader than covering only the investment needs in electricity transmission and interconnection in the EU.

Funding programme	Applied period	Total budget available	Types of financing
European Fund for Strategic Investments (EFSI)	2018-2020	EUR 26 billion EU guarantee & EUR 7.5 billion EIB's own capital	Financial instruments
Connecting Europe Facility (CEF)	2021-2027	EUR 8.7 billion for infrastructure energy networks (proposal)	90% Grants 9% financial instruments 1% project support actions
European Energy Programme for Recovery (EEPR)	2009 - Ongoing	EUR 910 million for electricity infrastructure[9]	Grants & financial instruments
European Investment Bank (EIB)	Ongoing	EUR 7.5 billion in energy (as per 2014[10])	Financial instruments (subsidised/guaranteed loans)

Table 7: EU funding mechnanisms for electricity infrastructure

3.2 INTRODUCTION TO REGULATORY ELEMENTS

The electricity network is characterized as "natural monopoly", which means that the competition is limited or does not exist at all. Therefore, in order to foster transparency of costs and improve efficiency of transmission, the electricity network is regulated. This legal task is fulfilled by many national regulators through "incentive regulation". The economic principle of incentive regulation is based on the simulation of competition and on motivating a network operator to manage its operations more cost efficiently than comparable network operators in other regions or in other countries. From financing perspective it is important to investigate which regulatory elements impact the investor income and thus, the financing of the grid. Therefore, the scope of this chapter is to give an introduction to the common regulatory terms. A detailed analysis of the principles of the regulatory frameworks is presented in D7.4 (Bhagwat, Schittekatte, Lind, Keyaerts , & Meeus, 2019). Hereafter, the main principles and common elements of the current European regulatory frameworks for grid investments are presented.

Regulated Asset Base (RAB)

The current dominating regulatory model around the European countries is based on the Regulated Asset Base (RAB) of the transmission operators. RAB is defined as the amount of money a company has invested and they are paid a return for this investment (EY, 2013).

Allowed revenue

The incentive regulation model and revenue cap are based on the RAB structure. In these regulatory models the allowed revenue is estimated as depicted in the following simplified equation:

$$Allowed\ revenue\ =\ Efficient\ OPEX + Asset\ remuneration + Depreciation\ ,$$

Equation 1: Allowed revenue Source: (EY, 2013)

The terms used in Equation 1 are described below:

[9] (European Commission, 2009)

[10] (EIB, 2015)

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- Efficient OPEX (Operational Expenditure) are the costs of an efficient system operator, defined by the national regulator.
- The Asset remuneration is based on an assessment of the RAB, using the accounting value of fixed assets or a standard or inflation-linked value, and an applied rate of return that may by pre- or post-tax, nominal or real (EY, 2013).
- The depreciation is related to the RAB.

Weighted Average Cost of Capital (WACC)

The WACC formula is a commonly used method for determining a rate of return on an asset base (Glachant et al, 2013). It is set equal to the sum of each component of the capital structure weighted by its share as shown in Equation 2.

$$WACC = CoD \times gearing + RoE \times (1 - gearing)$$

Equation 2: WACC methodology

The terms used in Equation 2 are described below:

- *CoD* is the cost of debt set by the national regulators and reflects the national financing and tax conditions.
- The *gearing* describes the relation of debt to equity in the TSOs' balance sheet and is set by the regulator typically in the range of 60%-70% (debt/ (debt+equity)) (Berger, 2011).
- *RoE* is the allowed rate of return which the national regulator allows the TSOs to earn on the equity component of their capital structure.

Return on Equity (RoE)

The allowed return on equity (RoE) represents the return on the investor's capital. The RoE is set by the national regulators using the Capital Asset Pricing Model (CAPM) and is determined as follows:

$$RoE = R_f + \beta \times (R_m - R_f)$$

Equation 3: CAPM method for determining the RoE

The terms included in Equation 3 are described below:

- R_f is the risk-free rate which is typically a 10-year government bond yield (DG ENER, 2015).
- R_m is the market return.
- $R_m - R_f$ represents the equity market risk premium that the equity investors demand to compensate them for the extra risk they accept (Investopedia, 2017b).
- β is the beta equity and in finance is a measure of risk. It shows how much a company's share price reacts in relation to the market; if β=1 the company moves in line with the market, if β<1 the company's shares are more stable than the market and if β>1 the share is more volatile in relation to the market. The electricity transmission grids which are regulated assets are considered less risky and thus, benefit from a relatively low beta (EY, 2013).

It is noted that the last years a decrease in RoE, set by the national regulators, has been observed. This trend is due to the lower interest rates in the countries which have not been badly affected by the financial crisis (EY, 2013). This also reflects a decrease in the risk-free rate and the intention of the regulators to keep up with the broader economic and financing conditions. The general downward trend is evident on the rates of return in

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Germany as presented in Table 8. It is importnant to mention that the TSOs would not worry for the reduction of the RoE as long as the regulatory framework keeps the risk for the TSOs at acceptable levels (interview).

Regulatory periods	1st regulatory period (01.01.2009 - 31.12.2013)	2nd regulatory period (01.01.2014 - 31.12.2018)	3rd regulatory period (01.01.2019-31.12.2023)
Risk-free rate	4.23%	3.80%	2.49%
Market premium	4.55%	4.55%	3.80%
β equity	0.79	0.79	0.83
Rate of return on equity before taxes (for new facilities)	9.29%	9.05%	6.91%
Rate of return on equity after taxes (for new facilities)	7.82%	7.39%	5.64%

Table 8: Decrease of the rate of return on equity in the German regulatory framework Source: (BNetzA, 2008), (BNetzA, 2011), (BNetzA, 2016)

Revenue cap and cost elements

A revenue cap is set by the regulator to limit the amount of the total revenue received by the TSO, which holds a monopoly status in the industry. Depending on its design, the revenue cap can include all the total expenditure (TOTEX) of the TSO or may include only one part of the operating costs (e.g. controllable OPEX) while the other costs are remunerated through a cost-plus[11] or pass-through mechanism (costs that are pass directly to the consumers without applying efficiency targets). The aim of the TOTEX approach is to give more incentives for cost reduction. However, there are cost items which are not fully under the TSO's control, such as the network losses in an interconnected transmission system, which depends on the non-controllable cross-border flows (Glachant et al, 2013). The costs, on which the TSO has little or no control, should not be included in the revenue cap but rather be compensated though other mechanisms (cost-plus or pass-through) (Glachant et al, 2013). Furthermore, it is noted that it is difficult to correlate the CAPEX with the network performance, thus, to quantify the cost of under-investment that might be generated by the incentive regulation. Therefore, it is better to exclude the investment costs partially or completely from the incentive mechanism (Glachant et al, 2013).

Efficiency targets

Another common element of the regulatory regimes for electricity transmission investments are the efficiency targets, set each regulatory period, to guarantee a cost efficient performance from the TSOs. There are several methodologies for determining the efficiency targets with benchmarking being the most popular. Benchmarking is based usually on determining the efficiency frontier from a sample of companies with comparable characteristics (Glachant et al, 2013). Depending on the design of the incentivised revenue cap, the efficiency targets can be applied at different cost elements (e.g. in TOTEX or only OPEX).

3.3 NATIONAL REGULATORY FRAMEWORKS FOR TRANSMISSION INVESTMENTS

The regulatory framework for electricity transmission grid investments, especially the regulated remuneration, is one of the most important factors in financing grid infrastructure projects. The current regulatory frameworks are

[11] An analysis of the cost-plus mechanism is presented in D7.4 (Bhagwat, Schittekatte, Lind, Keyaerts , & Meeus, 2019)

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mainly focused on reflecting past costs supplemented with cost efficiency incentives. There are formal similarities but also substantive differences among the national regulatory regimes for electricity grid investments. Hereafter, an overview of the key characteristics of the current regulatory regimes for onshore investments in Germany, Denmark, Norway, UK, the Netherlands and Belgium is given.

Table 9 presents the national regulatory authorities and the legal ownership of the national TSOs. In most countries the national TSOs are state-owned, with Great Britain to have three privately owned transmission system owners and a separate, privately owner, system operator (National Grid) and Germany three privately-owned and one state-owned. It is noted that TenneT TSO B.V. is the state-owened TSO in the Netherlands, while TenneT TSO GmbH is the privately owned TSO in Germany.

Key elements	Germany	Denmark	Norway	Great Britain	Netherlands	Belgium
Regulatory authority	BNetzA	DEA	NVE	Ofgem	ACM	CREG
Legal ownership	- 3 privately-owned TSOs: 50Hertz, TenneT TSO GmbH, Amprion - 1 state-owned TSO: TransnetBW GmbH	State-owned enterprise: Energinet.dk	State-owned enterprise: Stattnet	Privately-owned enterprises: National Grid, SPTL and SHETL.	State-owned enterprise: TenneT TSO B.V.	State-owned enterprise (>45%): Elia System Operator

Table 9: Characteristics of the national TSOs

Characteristics of national regulatory regimes

Table 10 gives an overview of the key characteristics of the European regulatory frameworks for transmission grid investments. It is noted that the Danish regulatory regime differs significantly from the other national regimes for grid investments. Energinet.dk is a state-owned, not-for-profit enterprise, which is not allowed to build up equity or pay dividends to its owner, the Danish Ministry of Energy, Climate and Building (CEER, 2015). Therefore, it is allowed to include in the tariffs only the necessary costs of efficient operations plus the necessary return on the equity. Necessary costs are operating costs, depreciation, financial and administrative costs. No efficiency requirements for Energinet.dk are facilitated by regulation.

It is observed that the duration of the regulatory period varies among the different countries, while in the Norwegian regulatory regime there is no periodic review of the allowed revenue but it is estimated on a yearly basis.

The efficiency targets are determined based on different methodologies and benchmarking by the national regulators. The efficiency targets are applied to the total controllable costs (TOTEX) while uncontrollable costs are passed-through to the consumers. Finally, the current regulatory regimes do not offer significant incentives for innovation apart from the RIIO regime in the UK which is based on the premise that stakeholder engagement and investment in innovation should be encouraged.

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Key elements	Germany	Denmark	Norway	Great Britain	The Netherlands	Belgium
Regulatory period	5 years 2019-2023	No regulatory period	No regulatory period, it rolls forward with updated parameters each year	8 years 2013-2021	5 years 2017-2021	4 years 2016-2019
Revenue cap	-non-controllable costs -controllable costs of the reference year -CPI inflation correction -X general	Not relevevant	-base level costs: 40% actual values & 60% norminative values -60% expected level of cost of energy not supplied (CENS) -system responsibility costs: 40% actual values & 60% norminative values	RIIO model: -Base revenue -Efficiency incentives, rewards and penalties -Uncertainty mechanisms	-efficient costs & rate of return on investments -yearly revenues based on the consumer price index CPI-X formula	-non-controllable costs (pass-through elements) -controllable costs (subject to efficiency targets) -influnceable costs (eligible for an incentive mechanism within predefined limits)
Estimation of the efficiency target	-International benchmarking Efficiency target: 3% over regulatory period -Productivity factor: 1.50%/a	Not relevevant	NVE applies a DEA result of 100% which means that the cost norm equals the cost base for the transmission grid	TOTEX + Outputs defined by TOs and accepted by the regulatory entity (Ofgem)	-International benchmarking -Productivity analysis -efficiency target 0.42%/a -productivity factor 0.8%/a year	NA

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Key elements	Germany	Denmark	Norway	Great Britain	The Netherlands	Belgium
Application of the efficiency target	Controllable costs (CAPEX+ OPEX)	Not relevevant	-100% cost recovery -cost base: t-2	TOTEX + adjustment mechanisms for costs and revenues allowances	-TOTEX approach (also incentives on costs for ancillary services) -cost base: t-2 capex and t-2/t-4 opex -efficiency score 97.9%	Controllable costs & Infuenceable costs
Innovation incentives	No lump-sum recognition, except for officially approved R & D projects. Indirect promotion of innovation as part of the costs for approved investment measures.	Not relevevant	R&D (max 0.3% of the capital assets) can be approved as pass-through item.	Innovation stimulus package: - rewards for successful innovations - no penalties for unsuccessful innovations -partial financing for innovations	No	R&D 50% of subsidies is attributable to the net profit with a minimum of EUR 0 and maximum EUR 1 million

Table 10: Characteristic elements of national regulatory regimes

Capital remuneration

Table 11 presents the components of WACC for each country under investigation. There are some differences among the national regulatory approaches. The variation of the beta equity values show that the regulators have different perceptions about the relative risk profile of the regulated companies in their local environment. The gearing is in the range of 60%-70% in most countries, with the Netherlands the only exemption, with 50% gearing set by ACM.

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Key elements	Germany	Denmark	Norway	Great Britain	The Netherlands	Belgium
Risk free rate	2.49%	Not relevant	2.50%	2.00%	1.28%	Interest rate for Belgian 10-year linear bonds for the year in question
Market risk premium	3.80%	Not relevant	5%	5.25%	5.05%	3.50%
β_equity	0.83	Not relevant	0.875	0.95 (for National Grid)	0.74	Based on a historical 3-year period minimum value 0.53
Gearing	60%	Not relevant	60%	60%	50%	67%
Return on Equity (RoE) pre-tax	6.91% for new assets	Not relevant	11.89% (nominal, for 2016)	7% real	5.02%	NA
Cost of Debt (CoD)	CoD is considered in the revenue cap as pass-through item	Not relevant	2.10% Nominal, pre-tax(2016)	Pre-tax real: 2.55% (2015/16) 2.38% (2016/17)	2.19%	NA
WACC	NA	Not relevant	WACC pre-tax for 2016: 6.25%	4.55%	Real WACC pre tax: 3.0%	NA

Table 11: WACC components in the national regulatory regimes for transmission grid investments

3.4 NATIONAL REGULATORY FRAMEWORKS FOR OFFSHORE TRANSMISSION INVESTMENTS

A Northern Seas offshore grid is an investment which requires massive debt and equity financing (Berger, 2011). Therefore, it is also required that the TSOs receive a sufficient rate of return that covers the CAPEX of the investments, the payment to shareholders and debt holders. To this end, the regulatory framework for transmission investments should allow enough revenue and ensure the long term financial viability of the TSOs. Moreover, for projects which are highly desired by EC, such as OWF grid connections and interconnectors, the national electricity transmission regulatory frameworks should give appropriate incentives for prioritising these investments which exhibit higher complexity and risks compared to the average (ENTSO-E, 2014b).

Hereafter, a description of the current national TSO regulatory regimes for offshore grid investments is given. The OFTO regime, for investments in OWF grid connections as well as the Cap and Floor regime for offshore interconnectors, both developed in the UK, are also presented.

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3.4.1 TSO REGIME

The regulatory issues are considered by the TSOs and many investors as the main barrier to investing; especially the insufficient regulated return on equity, the duration of the regulatory period and the lack of incentives for specific projects (DG ENER, 2015) (Berger, 2011) (European Parliament, 2017). Especially, when it comes to the offshore grid investments, which require a significant financing effort the following questions arise: is the current regulatory framework sufficient to facilitate the significant investment volume of the offshore grid projects in the long run? Do the existing regulatory regimes provide the necessary incentives to fostering investments? In order to answer these questions, it is important first to investigate what the current regulatory frameworks for offshore grid investments are. In this section the characteristics of the national regulatory frameworks for investments related to the connection of OWFs to the onshore grid and the regulated offshore interconnectors are described. The countries investigated are the Netherlands, Germany, Denmark and Belgium and Norway. In Norway, there are almost no OWFs (except for one floating offshore wind turbine) and thus, no regulatory regime for offshore grid connection investments is in place.

Table 12 presents the characteristics of national TSO regulatory frameworks for investments in OWF grid connections and regulated offshore interconnectors:

- Denmark's regulatory regime for onshore investments applies also to offshore grid investments without any adjustment.
- In Belgium the OWF generator model has been applied so far for the connection of OWFs to the shore and therefore, there is no relevant TSO regulatory regime for these investments. However, interconnectors are treated as strategic investment projects and as such a mark-up is introduced for selected progects (Elia, 2016).
- In Germany and the Netherlands the regulatory frameworks include adjustments when it comes to offshore transmission investments. In both countries the costs of these investments are covered already during the regulatory period (construction and commissioning phase, t-0) and there is no uplift in the rate of return (RoE) (which is the same for the onshore and offshore grid investments). In Germany, until 2018 the OPEX lump sum included in the investment measures amounted to 3.4% of the acqusitilon and production costs while since 2019 (third regulatory period), offshore costs will not be part of the grid fees anymore but part of the offshore levy (Offshore Netzumlage), i.e. new investments do not underly the incentive regulation but will be considered as pass through costs (CAPEX and OPEX) during the construction phase and the instrument of the investment measure will not apply anymore. In the Netherlands, the OPEX lump sum amount to 1% of the investment value.
- Finally, in Norway the regulatory framework for offshore interconnectors are the same as for Statnett's onshore investments.

It is noted that none of the investigated countries where the TSO owns both onshore and offshore assets, have separate regulatory frameworks for offshore electricity transmission investments. The national regulators either offer the same return for all types of investment or a premium on certain types. According to some stakeholders, as long as the risks for the TSOs are kept at acceptable levels, there is no reason for a higher return on equity for offshore investments (interviews). Moreover, the offshore investments are treated as special cases/exemptions among the overall portfolio of the TSOs' regulated investments and as such specific

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adjustments of the existing remuneration mechanisms are applied either by recognising the investment costs upfront (like in Germany and the Netherlands) and thus, eliminating the risk for the TSOs, or increasing the revenue (like in Belgium). The application of these adjustments can be considered sufficient to incentivise investments in offshore electricity transmission networks. However, in the case of investments in a MOG the regulatory complexity could increase, especially in terms of information asymmetry and transparency (Bhagwat, Schittekatte, Lind, Keyaerts , & Meeus, 2019).

Key elements	Germany	Denmark	Norway	Netherlands	Belgium
Regulatory period	5 years: 2014-2018	Not relevant	Not relevant	5 years: 2017-2021	4 years: 2016-2019
Revenue cap	For OWF connections and interconnectors: -permanently non-influenceable costs without delay (CAPEX & OPEX costs for OWF connections)	Not relevant	The same as onshore	The same as onshore: -efficient costs & rate of return on investments -yearly revenues based on the consumer price index CPI-X formula	The same as onshore plus a mark-up for strategic investment projects (interconnectors)
Adjustment mechanisms	Pass through CAPEX & OPEX during the construction phase	All the necessary costs incidental to Energinet.dk's activities are covered by the tariffs. There is no special treatment for offshore investments.	No adjustments	Offshore grid investments are considered investments of national interest. t-0 remuneration is applicable. -CAPEX remuneration during construction phase -OPEX remuneration directly after commissioning. For OPEX, an estimation of 1% over the efficient investment value is used.	A mark-up for strategic investment projects

Table 12: National TSO regulatory frameworks for offshore electricity transmission investments

3.4.2 OFTO REGIME

The OFTO model, unlike TSO model, has its unique regulatory framework for investments in OWF grid connections. The key driver for the current framework is to lower the costs incurred by the consumer and not in fostering innovation. The model contains penalties/awards for poor/outstanding operational performance.

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Regulatory regime

According to the current OFTO regime, the OWF generators have the flexibility to choose whether they, or an OFTO, design and construct transmission assets ('OFTO build' versus 'Generator build'). Whichever option is chosen, the assets are always transferred to (or remain with) the OFTO during the time of its operation. The OFTO Build option was introduced to Round 3 and available in all subsequent tenders. So far all the projects have used the 'generator-build' option, which is perceived by generators as the one with the lowest risk to their own operations.

Financial model

The OFTOs are provided with a fixed 20-year revenue stream (subject to performance delivery and other adjustments) in return for operating, maintaining and decommissioning the transmission assets. The revenue stream is unrelated to the performance of the generating assets. In this sense the generator is responsible for generation of electricity and the OFTO for its transmission to shore. The payment of this revenue is made by the NETSO and stream is funded through the provision of transmission charges that the wind farm and the supplier have to pay to the NETSO (which, for the UK is the National Grid Electricity Transmission) – see Figure 7 below.

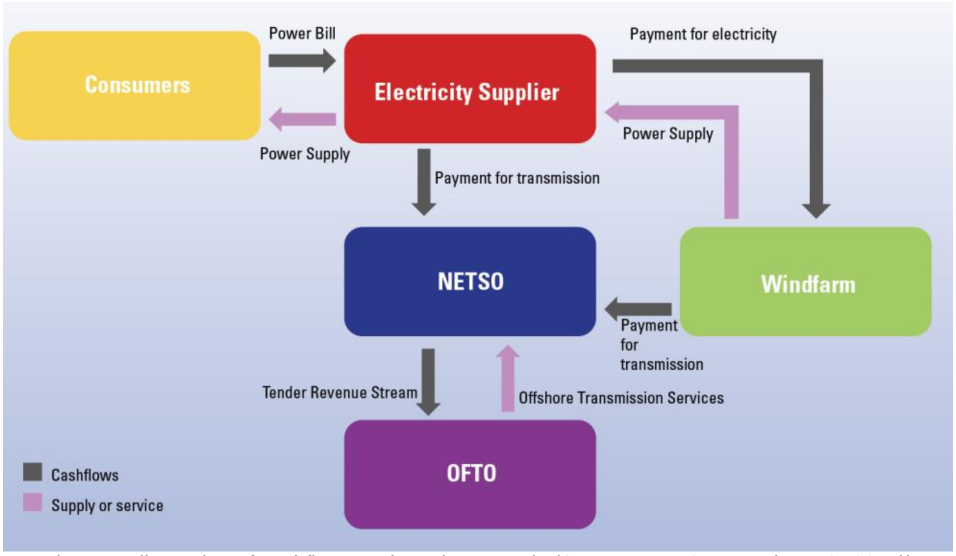

Figure 7. Illustration of cashflows and services supply (Source: KPMG report (KPMG, 2014))

Annual revenue stream

The payment of OFTOs takes place annually across a 20-year fixed period from the time the license is granted (for new tenders will be extended to 25 years). An OFTO's annual revenue is based on the Tender Revenue Stream (TRS) but is subject to various adjustments moderated by Ofgem during the tendering process (KPMG, 2014) (Ofgem, 2016). The exact calculation of each year's revenue starts with the TRS and includes adjustments in relation to various factors such as market rate revenue, inflation, pass through items and performance.

Cost of capital

With projects the size of OFTO investments, an important proportion of the costs come from financing the project itself. In the calculation of the Transfer Value that is agreed with Ofgem, the financing costs incurred by the generators are included as the Interest During Construction (IDC). Within the cost reports published by

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Ofgem when the licenses are attributed to each OFTO, the IDC is one of the categories discriminated and its contribution to the Final Transfer Value can range from 8%-15%. Ofgem calculates the IDC rate each year in accordance to certain parameters linked with risk and the cost of capital; this rate acts as a cap rather than a fixed rate. The IDC rate is fixed for each project at the Final Investment Decision (FID) up to the end of the eligible construction period (Ofgem, 2013). The figures presented in Table 13 present estimates of the WACC (or IDC) components by using the CAPM.

Parameter	2017-18	2018-19
Cost of debt (nominal and pre-tax)	3.86%	3.41%
Risk-free rate (nominal)	3.12%	2.76%
Market free premium	4.40%	4.40%
β equity	0.93	0.84
Cost of equity (nominal and post-tax)[12]	7.21%	6.46%
Gearing	41.22%	24.5%
Tax Rate	19.00%	19.00%
IDC or Pre-tax WACC (nominal)[13]	6.83%	6.85%

Table 13: Indicative values for input parameters of IDC rates Source: (CEPA, 2018)

The OFTO regime is favoured by private investors due to its long and stable revenue stream; a fixed 20-year revenue stream provides long term security to investors (interviews). This means that there is no risk for the revenue coming from changes in the regulatory regime. The risks are only due to asset failures or cost volatility. It is also noted, that the ‘Generator Build’ model is particularly favoured by the investors because of the low risk incurred to them; the construction and planning risk which is the highest risk of the investment cycle is borne by the generator while the OFTO in this case bears only the asset operation and commercial risk.

3.4.3 CAP AND FLOOR REGIME

In the UK, the national regulator imposes limitations on the TSO, National Grid, to recover interconnector costs from customer tariffs, which makes the regulated approach (in which the investment and operation is carried out by the TSO) an impossible option. Because of this, merchant interconnectors were initially the only feasible option as a financing model (Cigre, 2017) (Stennett, 2013). However, the perceived risk by the interconnector developers was too large to generate the level of investment the regulator perceived to be of the best interest to the UK consumers. This was the case even with the application of the exemption from the EU law[14] about regulated interconnectors. In 2014, a new regime was created to regulate electricity interconnectors; this regime is called the “Cap and Floor regime”. By ensuring a minimum level of revenue to developers (floor), the Cap and Floor regime, greatly reduces the risk for investors making it a more attractive option. The main characteristics of this regime are summarised on Table 14 and described in detail the following paragraphs.

[12] These values have been calculated.
[13] These values have been calculated.
[14] Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity

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Characteristics	Description
Expected rates of return	Interest During Construction (IDC) defined in line with the OFTO regime. Differences: IDC based on the Vanilla post-tax WACC & it includes additional risk premiums. Current IDC rate of 5.10%
Regime period	25 years with 5-years evaluations cycles of the cap and floor levels applied.
Efficiency targets	Floor level only available if 80% of availability is reached. +/-2% of the cap depending on availability targets/incentives

Table 14: Main characteristics of the Cap and Floor regime for offshore interconnectors in the UK

Definition of the “cap” and “floor”

The most important characteristic of the Cap and Floor regime is the limitation of the risk both for consumers and for developers. By introducing a “cap” and a “floor” to the revenue earned by interconnectors, developers limit the risk of revenues not covering their existing costs and the system benefits from limiting the maximum profit they can earn. The definition of both the cap and floor levels is built over similar parameters used for the regulations applied to transmission operators: capital costs, operational and maintenance costs, decommissioning costs, tax and a parcel for allowed levels of return. Figure 8 is illustrates the Cap and Floor regime principles.

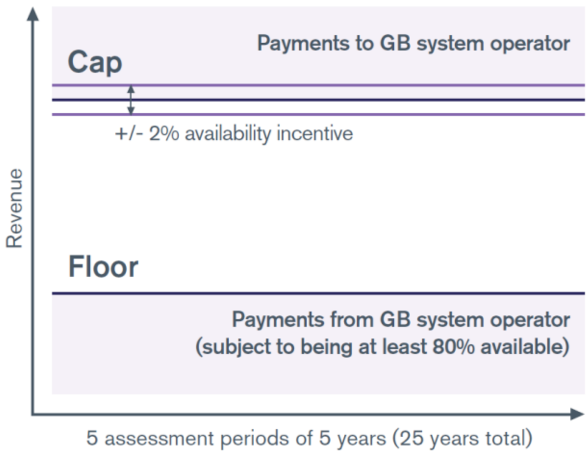

Figure 8: Scheme of the Cap and Floor regime principles Source: (Ofgem, 2016a)

The floor is defined as the minimum revenue earned by the interconnector, which is set up at a level that guarantees that the operating and that debt commitments are covered. In case the interconnector annual revenues fall short of this value, the system operator (National Grid) provides the remaining value so that the floor level is reached. This expense by the system operator is then transferred to the users of the electrical system through an adjustment of the transmission charges.

The cap is defined as the maximum revenue the interconnector is allowed to make, which includes a certain return on the investment for the developers. When the annual revenue exceeds this amount, the surplus is transferred to National Grid. This would lead to a reduction of the transmission charges paid by consumers.

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Efficiency targets

To ensure that the interconnector provides a service at a satisfactory level, the validity of the floor level is only applicable if the availability rate is, at least, 80%. If the performance falls below this value, the floor payment does not apply, as depicted in Figure 8. There are also performance incentives that can move the cap level by +/- 2%, depending on the levels of availability shown (Figure 8).

Regime period

The duration of the Cap and Floor regime is of 25 years with 5-year review periods where the set cap and floor levels are reviewed. This is in line with the duration of the exemption from the regulatory requirements granted by Ofgem, the UK regulator, which also runs for 25 years. If interconnectors wish to do so, they can request an interim review or adjustment for financing reasons or as anticipation to a large adjustment that will need to take place at a 5-year review.

Expected rates of return

For regulatory purposes, the cost of capital for developers is represented as the IDC. The framework for its application and calculation is similar to the one previously described for OFTOs. However, while the IDC for OFTOs was used to calculate the Tender Revenue Stream, for interconnectors it is used to define the floor and cap levels. Differences also exist in the specific rate used to calculate the IDC. In the case of OFTOs investments, IDC is set in pre-tax, nominal terms (pre-tax nominal WACC) and under the Cap and Floor regime, IDC is set in vanilla, real term (vanilla real WACC)[15]. In addition, there are specific risk premia which are linked with the development and the construction risks. A summary of the most relevant rates is presented in Table 15**.**

Parameter	2017-18
Pre-tax nominal cost of debt	3.86%
Nominal risk-free rate	3.12%
Market risk premium	4.40%
Equity beta	0.93
OFTO's IDC	6.83%
Nominal, vanilla WACC	6.53%
Real, vanilla WACC	3.65%
Interconnectors' IDC	5.10%

Table 15: Input parameters of IDC rate Source: (Ofgem, 2016a)

Ofgem has recently proposed to make the update of the IDC rate an annual process, in line with what currently happens in the OFTOs' regulatory system. The main reason for this would be to increase flexibility and improve the speed of response to any market movements (Ofgem, 2016e).

The Cap and Floor regime was introduced as a viable solution, against the merchant model which perceived as very risky by the investors, for promoting investments in offshore interconnectors. By introducing the Cap and Floor regime, a minimum level of revenue to developers (floor) is ensured and reduces greatly the risk for investors. However, it is questionable whether the "floor" level would be sufficient to compensate the investors/project promoters in the future under conditions of markets' prices convergence.

[15] The weighted average cost of capital using a pretax cost of debt and a post tax cost of equity.

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3.5 INVESTOR PERCEPTION OF RISK

Risk perception plays a central role in investors' decision. Based on interviews with TSOs, corporate investors and financial institutions, the regulatory risk, i.e. the stability and predictability of the regulatory regime as well as the security of returns is considered as their main concern. Moreover, the existing regulatory frameworks focus on short term reduction of costs and thus, cross-border anticipatory investments face close scrutiny from the NRAs which regulate each TSO to ensure costs are minimised. Hereafter, the risk perception of stakeholders regarding the MOG investments as well as their opinion on the suitability of the existing regulatory frameworks for a MOG is presented.

Confidence in long-term stability and predictability of the regulatory regime

The stability and predictability of the regulatory regime is considered as one of the main drivers of risk perception by TSOs, their investors and financiers. The TSOs are regulated entities obliged to invest in electricity transmission infrastructure and at the same time they need to attract financing from the capital markets. However, investors with a long-term vision requiring stability (e.g. pension funds) may opt for alternative sectors if the TSO regulatory framework does not provide enough stability. The electricity transmission investments are long-term assets (with an economic life of up to several decades) therefore, it is necessary that the regulatory framework, or at least those aspects, methods and parameters that impact on long-term investment decisions and their financing, remain stable with predictable results (ENTSO-E, 2014b).

Incentives for MOG investments

MOG investments are particularly challenging due to their increased complexity mainly from a technological and regulatory perspective. The technological risks for a MOG and the related uncertainty regarding the cost recovery are perceived by the investors as very high. In addition, the lack of adequate regulatory frameworks and mechanisms for cost benefit allocation do not create incentives for investments in hybrid projects, which combine the connection of OWFs with interconnection. In particular:

- A MOG involves innovative technology, such as the DC circuit breakers (DC-CB), which is associated with uncertain infrastructure costs due to lack of accurate data and experience. Therefore, it is hard for the financiers to carry out a reliable due diligence and thus, they perceive the investment as risky. Consequently, the lenders might be reluctant to grant loans or they might grant loans with higher interest rates reflecting the higher risk of the investment. In conclusion, the uncertainty in estimating the capital expenditure could lead to higher cost of investment capital raised by the investors of the MOG.
- The use of innovative technology means also higher cost uncertainty for operation and maintenance of the technological equipment compared to mature technology. For instance, in the case of a MOG which uses technology that has not been proven in large scale projects, unforeseen higher OPEX could occur due to uncertainties associated with equipment replacement, frequency of maintenance work, etc. Should the OPEX be assessed and included in the controllable costs of the revenue cap ex-ante, the investor's regulated remuneration would be affected negatively if the additional operational

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costs are not reimbursed. In other words, if the TSO has to bear all the costs, the perception of risk will be high and they may refrain from carrying out the investments, at the expense of the society.

- Investments in hybrid projects come with additional uncertainty and thus, costs, due to their forward-looking nature; the TSOs need to consider upfront higher capacity for the interconnectors in order to enable the integration of greater wind power in the future. However, this implies risk of stranded investments and therefore, higher costs for investors. Moreover, hybrid projects present specific challenges related to coordination problems among those entities participating in the cost and benefit allocation decisions i.e. TSOs, national regulatory and governmental bodies, OWFs. In these cases the cost/benefit assessment could be complex and the lengthy coordination processes can delay investments.
- The current regulatory frameworks contain requirements which limit the connection of OWFs only to their national market, preventing their remuneration if they connect to another country's EEZ, and restrict the multi-use of different types of transmission assets. There is also lack of clear responsibilities regarding the connection of an OWF to an interconnector. A good example is the WindConnector study which proved that there are several socio-economic benefits from meshed network options but the current regulations prevent their realisation (Pöyry, 2018).

Currently, in many countries which have a TSO regime NRAs regulate each TSO to ensure costs are minimised and do not encourage long term investments interconnecting several countries. Therefore, the regulatory frameworks do not allow the recovery of extra costs (CAPEX and OPEX) resulting from the innovative technology and do not support hybrid projects needed for a MOG. This makes TSOs and investors reluctant to take up the investment challenge.

Liabilities and compensation payments

The clear definition and allocation of liabilities is perceived as a prerequisite to investing in a MOG. In case where multiple asset owners co-exist in the future, the liabilities related to delays in commissioning and non-availability of the grid need to be clearly defined and allocated among the involved actors. In Germany under the § 17e EnWG[16], OWFs can receive compensation payments from the TSO due to delays, interruptions of OWF connections or maintenance work. Under § 17f EnWG[17], the compensation payments can be passed through to the four German TSOs who are entitled to refinance their share of the compensation payments by charging a liability levy to the end consumers (offshore liability balancing regime). However, the right of the TSO to put the compensation payments into the levy is limited if the TSO acted negligently. If delays or interruptions are caused by any degree of negligence of the TSO, the compensation amount that the TSO can put into the levy has to be reduced by a deductible amount and the rest of the compensation is paid by the TSO itself. This deductible amount is limited in the event of delayed connection or unavailability during operations to EUR 17.5 million per connection per (damaging) event in case of simple negligence and to EUR 110 million per year in total, irrespective of whether (several) delays or interruptions have been caused by simple or gross negligence (TenneT, 2017d). In the Netherlands, based on the Dutch Electricity Act 1998, any liability of TenneT TSO B.V. as offshore system operator to electricity producers can be recouped through future tariffs, including any liability

[16] https://www.gesetze-im-internet.de/enwg_2005/__17e.html

[17] https://www.gesetze-im-internet.de/enwg_2005/__17f.html

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for simple negligence, and liability for gross negligence exceeding EUR 10 million a year (TenneT, 2017d). A liability framework which balances the risk between transmission owners of the MOG and transmission owners and OWFs should be developed as part of the MOG regulatory regime.

Time lag in cost recognition for offshore grid investments

The development phase of the transmission projects is considered to be the most risky part of the investment cycle. The time between the investment and the payout is long and is characterised by high uncertainty due to technological risks and delays from permitting issues and public opposition. The issue of time lags between the incurred investment costs for new offshore grid assets and their remuneration as part of the RAB could lead to liquidity problems when the allowed revenues are not aligned in time with expenditures. It is recommended that investments in a MOG which use new and innovative technology and therefore are riskier should be remunerated during the construction phase similar to the regulatory frameworks in Germany, the Netherlands and the UK under the Cap and Floor regime.

3.6 SUMMARY

The regulatory framework determines the investor income and thus, plays a key role in the development of a MOG. The analysis (from a financing perspective) showed that, in order to attract the necessary capital and facilitate the required cross-border (anticipatory) investments the following parameters need to be in place for the development of an appropriate regulatory regime for meshed offshore grid investments:

- **Regulated income:** the European transmission grids are regulated investments, i.e. with regulated returns. The only exception is the merchant interconnectors whose income depends solely on the price differentials between two markets. However, the development phase of the interconnector till commissioning is long and the electricity prices are hard to predict. In addition, the development of a MOG implies a higher interconnectivity which would lead to an insufficient remaining price difference, deteriorating the profitability of the merchant interconnector and raising the risks for investors. That was the case in the UK where the perceived risk by the interconnector developers was too large to generate the level of investment (under the merchant model) the regulator perceived to be of the best interest to the UK consumers. The risk was reduced significantly by introducing the Cap and Floor regime under which a minimum level of revenue to developers (floor) is ensured. The Cap and Floor regime also addresses the concerns of investors that the creation of additional interconnectors will lead to a convergence of the prices at the different markets and hence, to a sharp decrease in revenues. Therefore, it is recommended that meshed offshore grid investments should receive a regulated income.
- **Long-term, stable and predictable regulatory framework:** offshore transmission infrastructure has a lifetime of several decades and the type of investors that are interested in these assets expect from them a low risk profile with a regulated, long-term and stable rate of return. Given the enormous investment volumes that are anticipated for the development of more complex and riskier hybrid projects, with combination of OWF connections and interconnectors, the regulatory regime should guarantee sufficient remuneration with a long-term perspective. The experience from the OFTO regulatory regime shows that a fixed 20-year revenue stream with no periodic reset of the price control

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builds investor confidence and attracts the required capital. Under the OFTO regime, there is no risk for the revenue coming from changes in the regulatory regime. The risks are only due to asset failures or cost volatility. In the case of the TSOs, the regulatory framework should take into account that the TSOs are regulated entities which are obliged to invest in transmission infrastructure while at the same time they need to aquire the necessary capital to finance the investments according to the rules and conditions of the market. A decrease of the regulated return on equity might mean a reduction of the equity available in the future. Therefore, the regulated rates of return should be set in a forward-looking way taking into account the higher risk of new technology and the tariff revenue should allow a sufficient cash flow stream, ensuring that the TSOs can maintain the financial ratios and attract investors whilst continuing to ensure good value for consumers.

- **Cost recovery for innovative technology:** the use of new and innovative technologies, such as DC-CB, for meshed offshore grid designs come along with high risks. However, the existing regulatory frameworks for onshore grid investments apply also to the offshore investments, the same or with some adjustments without incentivising cross-border investments which use new and innovative technology. This may imply that suboptimal standard solutions are preferred to innovative technological options. Since a MOG creates a great value for the society, the national regulators should take the risks of new innovative technologies and reflect them in adjusted returns on investment for the TSOs or socialise the costs through the grid tariffs. To this end, financial support from EC at the early stage of the MOG development is needed. CEF funding could be used to support grid investments which use innovative technology reducing the risks for investors and thus keep the financing costs at acceptable levels.
- **Remuneration for anticipatory cross-border investments:** the current TSO incentives for cross-border investments are based on the NRA's approval of these investments. Usually, NRAs approve the cross-border offshore transmission investments only if there are domestic socio-economic benefits. Moreover, an agreement on the CBCA when more than two countries are involved is harder to reach making the project promoters refrain from investing. Such approaches prevent TSOs from taking decisions for future cross-border investments which would be otherwise beneficial from a wider socio-economical and regional perspective. In this case financial support from the EU could be provided for anticipatory cross-border grid investments of European interest that improve the wider economic grid efficiency which would be otherwise stalled due to the lack of regionally oriented policy decisions and the inadequate cost allocation mechanisms among the parties involved. To this end, CEF funding could be used at the early phase of the MOG development to eliminate the risk and bridge the gap of what the involved countries are willing to pay in order to unlock the anticipatory cross-border grid investments with a net benefit for the society that the national governments alone cannot deliver. At a later stage, the anticipatory cross-border investments should be included in the TSOs' RAB and the national regulator should allow their regulatory remuneration.
- **No time lag in cost recognition:** the development period of offshore transmission assets is long and is characterised by high uncertainty due to technological risks and delays from permitting issues and public opposition. During the construction phase the debt level of the TSOs (under a TSO regime) normally increases, and, as the new projects do not yet generate revenue, the investment can

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endanger the credit rating of the TSOs by increasing their gearing above acceptable regulatory levels (> 70%). As a result, the TSOs are forced to limit the number of new projects they can implement at the same time. In order to eliminate this risk and allow for anticipatory grid investments, the regulated rates of return should be set in a forward-looking way taking into account the higher risk of new technology and the tariff revenue should allow a sufficient cash flow stream, ensuring that the TSOs can maintain the financial ratios and attract investors. In addition, the recognition of investment costs already during the construction phase as implemented in Germany, the Netherlands and under the Cap and Floor regime in the UK are good practices that should be extended and applied to investments in a MOG.

- **Clear allocation of liabilities:** the multinational nature of hybrid offshore projects, combining the OWF connections with interconnections requires clear definition and allocation of liabilities among the parties involved regarding delays in commissioning and non-availability of the grid. For example, the establishment of the offshore liability balancing regime in Germany built investor confidence and thus, secured finances for the German offshore transmission grid. Such legal arrangements should be applied to investments in a MOG.

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4 FINANCIAL STRATEGIES

Given the significant investment volumes estimated for the development of a North Sea grid by 2030 as well as the national network development plans, it should be investigated whether the European offshore grid operators and owners (TSOs and OFTOs) within their current financing structures and their financial sources will be able to realise the required investments. Therefore, it is important to understand how the TSOs and OFTOs perform their financing operations, what the financial sources they use are and how factors like ownership and leverage influence their ability to attract private capital. Especially, in the case of the TSOs, which are regulated entities, obliged in most countries to connect the OWFs to the grid and invest in offshore interconnector projects, it is also essential to investigate the drivers which affect their balance sheet and force them to adapt their financing strategies in order to be able to realise the required investments. To this end, the example of TenneT, the TSO with the largest offshore connection facilities in the Netherlands and Germany, can serve as an interesting example where balance sheet financing, under different business models, is used to finance the OWF grid connections in Germany. Furthermore, the case of OFTOs in UK is another interesting example where project finance is used for OWF grid connections. Emphasis is given also on the financing of offshore interconnectors, both regulated and merchant, as well as the different financial sources existing in the market and the public mechanisms which are available for cross-border investments. To this end, the examples of COBRAcable and BritNed are examined. Finally, international experiences of tendering electricity transmission assets to third parties inspired by the case of Brazil, Peru and the CATO model in the UK are investigated as potential models which could facilitate the private sector participation in the transmission networks and deliver the optimum required investments.

4.1 FINANCING OF EUROPEAN ELECTRICITY TRANSMISSION NETWORKS

In this section, the existing balance sheet and project finance as well as the financing sources, used by the TSOs and OFTOs to finance the offshore grid projects and interconnectors, are presented. An overview of the factors which influence the TSOs' investment and financing capabilities such as the legal ownership, gearing and credit rating is given.

4.1.1 FINANCING STRUCTURES

There are two types of financing structures for energy infrastructure projects; the corporate finance and the project finance. The corporate finance is the prevailing approach used by TSOs to finance electricity infrastructure projects. In this case, the projects are handled as part of the TSO asset base, the TSO debts are covered by its overall balance-sheet and loan repayment is guaranteed through the revenue which is created by a broader set of projects. Additionally, large volumes of funds can be acquired under better financing conditions, since the risk involved, is spread by TSO's entire portfolio of investments.

Project finance, on the other hand, is a financial structure that involves the establishment of a separate legal and economic venture in order to finance, develop and operate an infrastructure project (DG ENER, 2015). Project finance is more complex, as in this case separate processes for acquiring and managing funds on a

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specific-project basis are required. This implies that the project finance approach might be more expensive than the corporate finance, since the lenders and equity providers face a higher risk when financing a stand-alone project than when financing the portfolio of TSO's projects (DG ENER, 2015). Moreover, in project finance the debt is covered only by the revenues that the project generates and not by the company's balance sheet. Table 16 below summarises the difference between the two approaches.

Financing structure	Corporate Finance	Project Finance
Characteristics	Financing on a portfolio basis and not on a specific project level Projects part of TSO asset base	Financing on a project-specific level
Debt coverage	Debt is covered by TSO balance sheet.	The debt is covered by the revenues of the project.
Financing costs and risks	Company-specific financing conditions provided by the lenders Risk is spread through the overall portfolio of investments	Generally higher financing costs Higher risk for investors/lenders related to individual projects Lower risk for the TSO
Application	Domestic projects and many interconnectors are corporate-financed	Merchant interconnectors Specific regulated interconnectors as a joint venture by related TSOs

Table 16: Differences between the corporate finance and project finance approaches Source: (Berger, 2011)

4.1.2 FINANCIAL SOURCES

There are mainly three approaches which TSOs follow in order to finance their grid infrastructure investments; loans from commercial banks or institutions, funding from internal equity or funding from external investors. Table 17 presents the main sources of financing offshore electricity transmission investments.

- Taking loans from International Financial Institutions (IFIs) is the most common approach the European TSOs follow to raise funding for their grid infrastructure projects. Especially EIB loans with long maturities (up to 15 years) and low interest rates covering up to 50% of the cost of a specific project (EIB, 2017d) have become a very popular financial source for TSOs and private investors.
- Loans from commercial banks are a conventional instrument of financing but less attractive, since they have higher interest rates and shorter maturities (5 to 10 years) (Berger, 2011).
- Furthermore, large TSOs such as TenneT and Elia, use corporate bonds to finance their activities. It is noted that TenneT TSO in May 2015 issued a new form of corporate fundraising, the Green Bonds. The aim of the green bond issuance is to finance projects with an environmental added value.
- Apart from debt, TSOs use also the cash flows of their own operations to finance their activities. However, when the debt needs to be kept under a certain level and additional capital is needed, raising external equity is the preferable solution.

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- Finally, grants from the EU, which constitute non-reimbursable investments, is an alternative source of funding provided to the TSOs and project promoters to support the development of projects, which, due to financing challenges, e.g. financial crisis, could not be realised.

Financial sources	Description
Loans from IFIs	EIB: loans with low interest rates & long maturities can cover up to 50% of the investment cost equity financing, guarantees & project bonds Other IFIs: EBRD, World Bank, KfW
Commercial bank loans	Higher interest rates than IFIs and shorter maturities
Corporate Bonds	Debt securities with long maturities and low interest rates Green bonds to finance projects with environmental added value
Internal equity	TSOs use the cash flows of their own operations to finance their activities.
External equity	From pension funds, infrastructure funds of investment banks and insurance companies interested in investing on projects/activities with low risk profile and stable return on equity
EU grants	Non-reimbursable investments from the EU budget provided by EEPR & CEF

Table 17: Financial sources used for offshore electricity transmission investments

The current low interest rate environment and the sufficient banking liquidity make debt financing the most favourable way for the TSOs to fund offshore grid connection projects. This statement is projected in Figure 9 which comes from WindEurope's report on offshore wind statistics 2016 (WindEurope, 2017). Figure 9 presents investments in transmission assets in Germany, the Netherlands and UK from 2011 till 2016. The total investment requirement represents the total cost of the investment and the transaction value represents the commercial debt and public funds which were raised for the investments. The difference between the total investment requirement and the transaction value is the equity used for the investments (information provided by WindEurope via call). According to (WindEurope, 2017), the investments in transmission assets in 2016 account for EUR 2 billion including refinancing. From this amount, EUR 1.8 billion was raised through commercial debt, out of which EUR 1.5 billion was raised through green bond issuance from TenneT to finance the OWF grid connections in Germany (see 4.2). This means that only EUR 200 million of equity was raised to finance the offshore transmission investments in 2016. This shows that debt instruments have taken the lion's share of all instruments, since the interest rates are at their historically lowest level, as well-stated in (DG ENER, 2015) and therefore, the TSOs can raise low cost of capital (mainly debt) to fund their offshore grid investments. However, it should be pointed out that in case the current situation changes, this will affect the capital structure of the TSOs.

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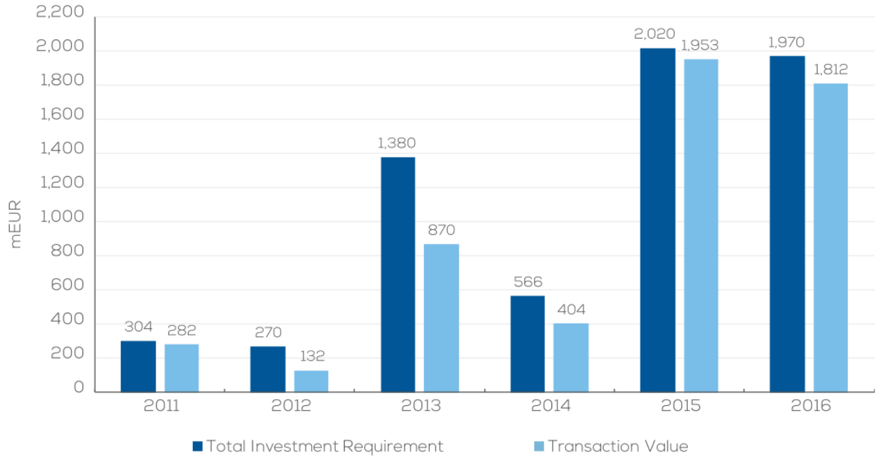

Figure 9: Investments in transmission assets in the period 2011-2016 Source: WindEurope

4.1.3 FACTORS IMPACTING FINANCING

Most TSOs in the North Sea countries use balance sheet financing also for the offshore grid investments, meaning that they finance the offshore projects as part of their overall business portfolio. The ownership, the relation of debt to equity (leverage/gearing) on their balance sheet and the credit ratings are some of the factors which highly affect the financial strategies of the TSOs and mainly their ability to raise debt and equity to meet the investment needs. Hereafter, the impact of the owenship, the leverage and the credit ratings of the TSOs on the financing are described.

Ownership

The national TSOs are privately or state owned. This has a major impact on the financing framework and financing conditions which are available for the TSOs. State owned TSOs are often not flexible in raising additional equity. This is due to the fact that the government, who is the shareholder in this case, is reluctant to increase the capital of their company due to their own budget constraints (DG ENER, 2015). Another reason is that the government might be reluctant to dilute their ownership share of essential public goods like the electricity transmission network (Henriot, 2013). On the other hand, state-owned TSOs can more easily raise loans under sovereign guarantees. The increasing debt financing however, leads to a high leverage which in turn results in a lower credit rating and consequently higher funding costs. Privately owned TSOs are more flexible in raising additional private equity, when needed, but they may not raise debt under the same conditions (higher interest rates) compared to a state owned TSO which is able to secure sovereign guarantees. TenneT, the TSO with the largest onshore and offshore connection facilities in the Netherlands and Germany, serves as a good example where it can be seen that the ownership affects the TSO financing conditions and their ability to access external equity; TenneT TSO B.V. is fully owned by the Dutch State and cannot attract private equity for investments in the Netherlands. TenneT TSO GmbH, on the other hand, the German privately owned TSO, can attract private equity for funding the offshore grid connection projects.

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Financial Leverage

According to (Investopedia, 2017), financial leverage is the degree to which a company uses fixed-income securities such as debt and equity, in order to increase the potential return on investment. A firm which uses significantly higher debt financing than equity is considered to be high leveraged. The term *gearing* refers to the financial leverage. At a fundamental level, gearing is sometimes differentiated from leverage. Leverage refers to the amount of debt incurred for the purpose of investing and obtaining a higher return, while gearing is a type of leverage analysis which refers to debt along with total equity expressed as a ratio. According to (BusinessDictionary, 2017), the financial leverage is measured as the ratio of total debt to total assets. The leverage/gearing of TSOs reflects the relation of debt to equity on their balance sheet. The gearing of the TSO is set by the national regulatory authority, typically in the range of 60%-70%, and is influenced by the TSO's commitment to keep a certain credit rating and thus certain leverage (Berger, 2011). Unlike TSOs, OFTOs have not such constraints and can be highly geared (90% +) (see 4.2).

Credit ratings

TSO's credit rating indicates its ability to meet its financial commitments and thus, expresses its creditworthiness. Given the significant investment volumes that are required to meet the EU energy objectives, it is important that the TSOs have access to debt and equity under market conditions (Berger, 2011). High credit ratings can ensure this. Furthermore, high credit ratings are precondition for the TSOs for issuing corporate bonds.

4.2 OWF GRID CONNECTIONS – CURRENT EXAMPLES

In this section the practical examples of TenneT for the conncection of OWFs to the German grid as well as the OFTO as an alternative example for financing investments in OWF grid connections are analysed.

TenneT example

TenneT is the TSO with the largest offshore connection facilities in the Netherlands and Germany and their structure and business strategies to finance the OWF grid connection investments serve as an interesting example of lessons learnt. TenneT Holding. B.V. is the parent company, while TenneT TSO B.V. and TenneT TSO GmbH are its subsidiary companies in the Netherlands and Germany respectively. TenneT TSO B.V. is appointed as the offshore grid operator in the Netherlands and is obliged to connect OWFs to the onshore grid. According to the law, TenneT TSO B.V. must be directly or indirectly owned by the Dutch state. Therefore, they cannot attract private equity by selling (part of) their shares. Such legal requirement, related to the 100% state-ownership, is not applicable for TenneT TSO GmbH, the German TSO, within the TenneT group. TenneT TSO GmbH is responsible for the connection of OWFs, which are located in the German part of the North Sea, to the grid.

When the Dutch TSO TenneT purchased the German TSO transpower from E.ON in 2010, inherited also an extensive pipeline of offshore wind transmission projects which accounted for EUR 5 billion (for the period 2005-2014 according to (DG ENER, 2015)). The German Government, in response to the nuclear disaster in Japan in 2011, decided to move away from the nuclear power by 2022 and to increase the support for the development of renewable energy. Due to the German energy transition, the OWFs in Germany have been built in a fast pace, more quicly than original planned. The fast pace of offshore wind development in the country raised

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financial and technical challenges. TenneT had to build offshore grid connections of high capacity very quickly. Back then, there was limited offshore experience among the parties involved (TenneT and suppliers) and the offshore field was a new business territory. Furthermore, the tight state financing and the legal requirement of 100% state-owneship, which prevents stake sales of TenneT, posed a challenge to raising equity for financing the German offshore grid connections. At the same time, the company would not increase its debt for fear of harming its A- grade investment rating.

In order for TenneT to finance the offshore grid expansion in Germany, while keeping the financial ratios at a level that conciliates with the required A-/A3 rating levels, TenneT had to raise new equity in Germany through an innovative equity structure; separate project companies, special purpose vehicles (SPV), were incorporated to sell minority voting interest (voting rights) of the offshore connection projects to private parties. In order to balance risk and reward in these projects, separate “mini TSOs” were incorporated in order to have a separate revenue cap for each specific project.

In parallel, TenneT Holding B.V. raises, only at holding level, new debt financing. TenneT has several sources of debt funding, such as public (green) bonds, financing by the European Investment Bank (EIB), the German Schuldschein and recently the hybrid green bond. All this debt financing is raised at TenneT Holding level in order to benefit from its A-/A3 rating and to avoid any subordination. The proceeds from this external debt are injected either as a loan or as equity into the offshore projects. This financing structure is illustrated in Figure 10.

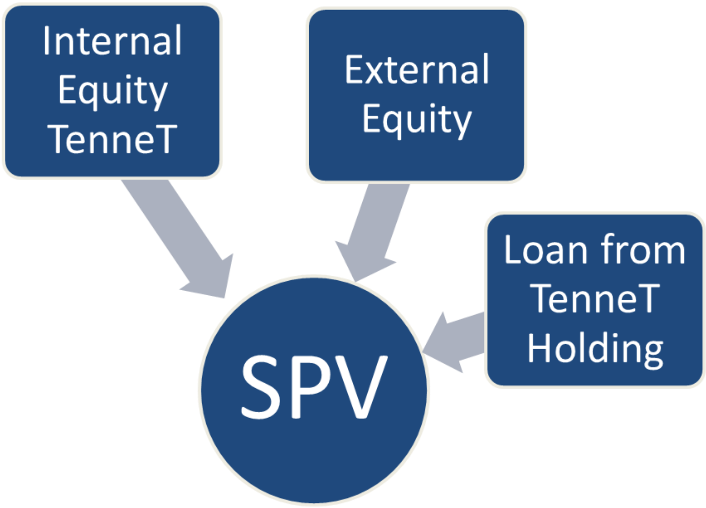

Figure 10: Financing structure of SPV for the German OWF grid connection projects

Table 18 gives an overview of the characteristics (year of issuance, size, tranches, coupons and maturities) of the green financing instruments used by TenneT to finance their green project portfolio.

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<table>
<tr><th>No.</th><th>Year of issuance</th><th>Size</th><th>Tranches</th><th>Coupons</th><th>Maturities</th></tr>
<tr><td>1</td><td>2015</td><td>EUR 1 billion</td><td>2 x EUR 500 million</td><td>0.875% & 1.750%</td><td>6 & 12 years</td></tr>
<tr><td>2</td><td>2016</td><td>EUR 1 billion</td><td>2 x EUR 500 million</td><td>1% & 1.875%</td><td>10 & 20 years</td></tr>
<tr><td>3</td><td>2016</td><td>EUR 500 million</td><td>-</td><td>1.25%</td><td>17 years</td></tr>
<tr><td rowspan="6">4</td><td rowspan="6">2016</td><td rowspan="6">EUR 500 million green Schuldschein</td><td>1 x EUR 77 million</td><td>0.646%</td><td>6 years</td></tr>
<tr><td>1 x EUR 100 million</td><td>0.989%</td><td>8 years</td></tr>
<tr><td>1 x EUR 55 million</td><td>1.310%</td><td>10 years</td></tr>
<tr><td>1 x EUR 50 million</td><td>1.500%</td><td>12 years</td></tr>
<tr><td>1 x EUR 138 million</td><td>1.750%</td><td>15 years</td></tr>
<tr><td>1 x EUR 80 million</td><td>2.000%</td><td>20 years</td></tr>
<tr><td>5</td><td>2017</td><td>EUR 1 billion green hybrid bond</td><td>-</td><td>2.995%</td><td>7 years</td></tr>
</table>

Table 18: Green bonds, green Schulschein and green hybrid bond issued by TenneT Holding B.V. Source: figures from TenneT's website

OFTO example

OFTOs, unlike TSOs, are exclusively privately owned by entities created for the project's tender process and operate independently from the onshore transmission system, though they are still regulated by the same entity (Ofgem) and are paid by National Grid. The entities which own the OFTOs are linked to consortia constituted by companies that are either specialised/infrastructure managing or investment companies.

In the case of OFTO, both on balance sheet financing and project financing are possible. So far, only project financing has been used, which is done through SPVs (KPMG, 2014). Unlike the state owned TSOs which are not able to attract external equity, OFTOs have not such constraints. However, to date, OFTO projects have generally adopted highly leveraged project finance with the gearing ratios falling between 81% and 91%. These gearing ratios are high compared with the range of gearing ratios of offshore wind projects Europe-wide (between 60% and 70%) (European Wind Energy Association, 2013), based mostly on long term loans (DG ENER, 2015). Figure 11 illustrates the financing structure of a high leveraged OFTO SPV.

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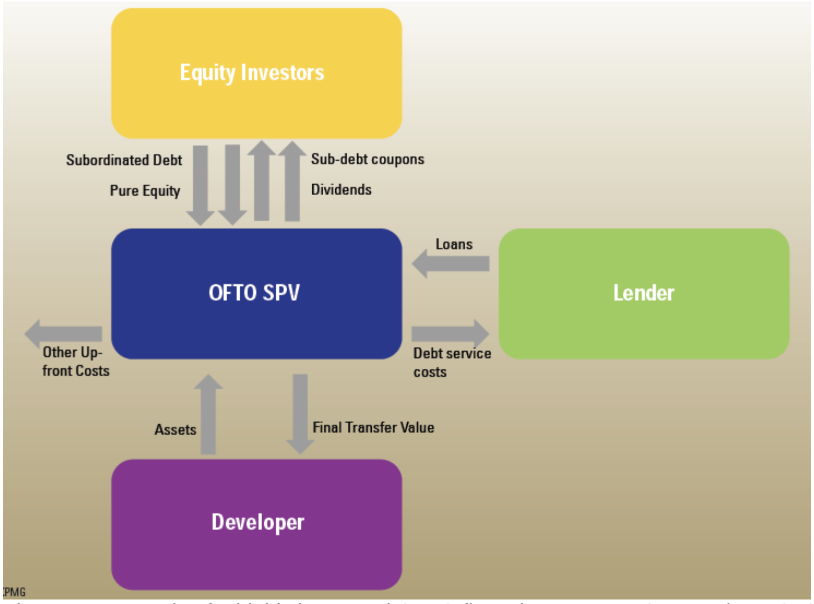

Figure 11: Example of a highly leveraged OFTO financing structure Source: (KPMG, 2014)

Table 19 provides a summary of the main financing and debt structure characteristics of most of the OFTO projects already licensed. The structure of the debts of the projects already licensed has been varied and solutions found for each projects are often composed of more than one type of debt. The use of bonds as a financing mechanism was first used by the Greater Gabbard project OFTO. This project was also the first recipient of the EIB's Project Bond Credit Enhancement. At this time, Moody's classified the credit rating of these bonds as (P)A3 (A-) (KPMG, 2014). In 2015, the licence attributed to the Gwynt y Môr project also used bond financing, which became the largest OFTO project to use this option (Ofgem, 2015).

It is noted that the OFTO regime has resulted in significant cost savings compared to merchant and regulated price control-based approaches. Ofgem has evaluated the three rounds of offshore transmission tender competitions, Tender Round 1 (TR1), Tender Round 2 (TR2) and Tender Round 3 (TR3) and the results are presented below:

- For TR1 the savings are estimated to be in the range of £200m and £400m (Ofgem, 2019a)
- For TR2 the savings are estimated to be in the range of £326m-£595m (Ofgem, 2019c).
- For TR3 the savings are estimated to be in the range of £102m-£154m (Ofgem, 2019c).

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Round	Project	Debt (£m)	Debt type	Gearing	Margin
1	Greater Gabbard	304	Bond issuance + EIB credit enhancement	87%	4.137% coupon (125 bps spread)
1	Sheringham Shoal	191	Term loan + £6m liquid facility	91%	LIBOR + 220 bps
1	Walney 2	109	Term loan + £5m liquid facility	87%	LIBOR + 240 bps
1	Robin Rigg	67	Term loan	84%	LIBOR + 200 bps
1	Gunfleet Sands 1 & 2	50	Term loan	84%	LIBOR + 195 bps
1	Walney 1	105	Term loan	85%	Not available
1	Barrow	35	Term loan	81%	LIBOR + 220 bps
2	Lincs	168	Not available	50%	LIBOR + less than 150 bps
2	London Array	419	Term loan + £3m liquid facility	85%	LIBOR + 220 bps (+ 240 bps by end of tenor)
2	West of Duddon Sands	255	Not available	85%	3.446% coupon (2027 gilts + 145bps)
2	Gwynt y Mor	339	Bond issuance + other mechanisms	87%	2.778% coupon (2025 gilts + 110bps)
3	Westermost Rough	155	Not available	83%	Not available

Table 19: OFTO debt financing terms for projects in Rounds 1, 2 and 3 (Source: (KPMG, 2014) (Cambridge Economic Policy Associates Ltd and BDO LLP, 2014))

4.3 OFFSHORE INTERCONNECTORS – CURRENT EXAMPLES

When the interconnector project is the fully regulated model the financing structure is balance sheet financing and the developers of the project are the national TSOs meaning that the project is financed through the balance sheets of the national TSOs. There are also cases where apart from the TSOs other parties can also invest. This is the case of NordLink interconnector which is a joint investment of the Norwegian TSO Statnett and TenneT TSO GmbH and the German promotional bank KfW who are both responsible for the construction of the German part of the project, including permits (TenneT, 2017). In the case of merchant interconnectors separate companies invest and not the national TSOs of the interconnected countries. Hereafter, the example of the regulated interconnector COBRAcable, a cross-border project of European significance which has designated as PCI is presented and the challenges encountered are investigated.

BritNed is a merchant interconnector between the UK and the Netherlands and has been in operation since 2011. The interconnector represented a significant link in furthering the development of the European transmission grid and played a critical role in EU's strategy to achieve a single European energy market. Thus, it serves as an interesting example to investigate the financial challenges experienced and lessons learnt.

COBRAcable

COBRAcable is an approximately 325 km long high voltage direct current (HVDC) subsea cable of around 700 MW capacity which will connect the Dutch and Danish electricity markets, as depicted in Figure 12. The purpose of COBRAcable is to improve cohesion in the European transmission grid by increasing the exchange of surplus wind power with neighbouring countries and strengthen the infrastructure, security of supply and the market (Energinet.dk, 2015) . Furthermore, the connection will also be designed in such a way as to enable the connection of an offshore wind farm at a later stage. This will contribute to the realisation of a sustainable international energy landscape, a key aim of the European Union (TenneT, 2017a).

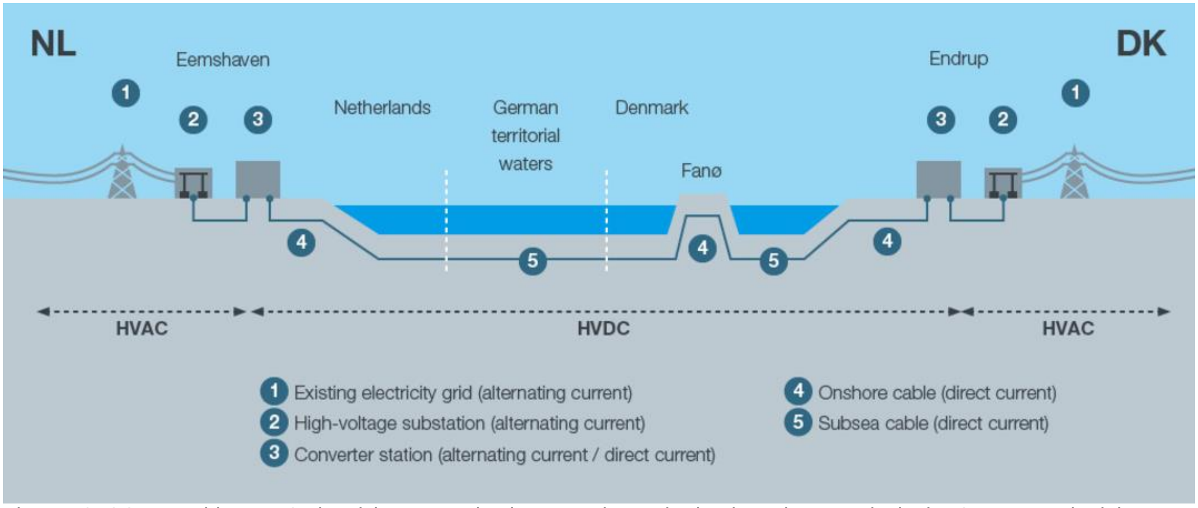

Figure 12: COBRAcable-HVDC electricity connection between the Netherlands and Denmark via the German territorial waters. Source: TenneT's website

TenneT TSO B.V. and Energinet.dk are the owners and operators of the COBRAcable whose operational lifetime is estimated 40 years. The total investment cost for the entire project is EUR 621 million of which EUR 86.5 million is subsidy granted by the EEPR. The rest of the investment costs are shared 50/50 between TenneT and Energinet.dk (TenneT, 2013).

Table 20 shows the economic figures of COBRAcable. It is noted that EEPR supports the construction, laying and connection of the cable, and the research and development activities on the new technologies which are necessary for the connection of wind farms to the cable (European Commission, 2013). The motivation for granting the subsidy to COBRAcable is that the design of the interconnector considers the future connection of an OWF to the cable and thus, contributes to the development of a meshed North Sea grid (TenneT, 2013).

COBRAcable interconnector	**Investment costs**
Total required budget	EUR 621 million
EEPR grant	EUR 86.5 million
Project promoters' contribution, 50/50 split	EUR 267 million, TenneT
	EUR 267 million, Energinet.dk

Table 20: Investment cost of COBRAcable

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The economic interest as well as the voting interest of each partner in COBRAcable is 50%. In case of TenneT, COBRAcable is financed through balance sheet financing. Liable for the interconnector project are the two TSOs.

The duration of the permitting phase was six years. The preparation for the permit application in all countries involved (the Netherlands, Denmark and Germany) started in 2010 and all permits were granted in 2016. The same year started the construction of COBRAcable which is scheduled to be commissioned in the first quarter of 2019. During the permitting phase certain challenges were encoutered; extensive discussions with relevant authorities regarding the shipping and nature interests took place. Difficulties with the German shipping authority regarding the route settlement at crossing Westereems was, partly, the cause of on-hold period 2012-2013. Difficulties were also encountered regarding cross-border coordination; the settlement on permit requirements with authorities in different jurisdictional borders was challenging, in particular the case of crossing of the Treaty area and Disputed area between the Netherlands and Germany. According to the developers of COBRAcable the permit requirements for all jurisdictions are comprehensive and compliance with these requirements needs appropriate technical and managerial involvement. In particular the German permit requirements are extensive and strict. All of these issues led to substantial delays. Even though the interconnector holds the status of PCI and thus, benefits from favourable permitting conditions, the stakeholder managers of COBRAcable perceived the coordination with the relevant authorities as very challenging; in some cases it was necessary to mobilise political powers to speed up the permitting procedure (information from TenneT).

BritNed

BritNed is a HVDC interconnector which is situated between the Isle of Grain in Kent, in the UK, and Maasvlakte in Rotterdam, in the Netherlands, as depicted in Figure 13. The interconnector has a 260 km cable length with 1000 MW cable capacity.

Figure 13: High voltage interconnector BritNed location Source: (Cigre, 2017b)

BritNed is a joint venture between the National Grid International Ltd and NLink International B.V. , a subsidiary of TenneT Holding B.V. . Both parties are 50% shareholder of Britned. The total cost of the development of this interconnector was EUR 600 million which was split as a 50/50 venture between the two companies. BritNed is a separate legal entity from the owners of the two national transmission systems that it connects, National Grid and TenneT, and thus, has full financial separation from them. It is assumed that the financial structure used behind BritNed is project finance, as the company produces a separate financial report each year and because it faces full liability should the interconnector fail (BritNed, 2015).

The revenue of the interconnector is based primarily on the cost spread between the two member states, UK and Netherlands.

BritNed is exclusively paid for by its users (i.e. participants of implicit and explicit auctions). All of BritNed's costs, including capital investment and operational expenditures, need to be covered by the auctioning of cable capacity. None of these costs are underwritten through regulated transmission charges.

BritNed began its first development works in 2001 where the planning phase began. A total of 10 years was taken from planning to commissioning phase. A permitting phase took place from 2001 to 2007 in which BritNed applied for regulation exemption.

BritNed requested an exemption from regulated third-party access to ensure a risk/reward balance for their investors. Under a regulated framework, both UK's and Netherlands's tariff regulation would limit the amount of revenue available to BritNed without covering the risk it was exposed to. Therefore, it was in BritNed's best interest to apply for an exemption from this regulation to attract more investment. Additionally, with the exemption, the interconnector's future capacity expansion would be at BritNed's discretion rather than being directed by the regulator. In all other respects the access arrangements would resemble that of a Regulated Third-Party Access (RTPA) regime.

In 2007, the European Commission granted a 25-year exemption, for the full capacity of the interconnector, from regulated third-party access. The European Commission raised the concern that BritNed might have undersized the capacity of the interconnector to artificially inflate congestion revenues. As a result, the commission requested that the NRAs amend their exemption decisions with the addition of a financial review after 10 years of operation. This review consists of BritNed providing total costs, total revenues and the rate of return using 2007 as a base year. In the case of the revenue exceeding that which was estimated at the time the exemption was put in place, BritNed has two options going forward; to increase capacity or cap any profits it has made. This is referred to as a 'de facto cap' regulating the amount of revenue the interconnector can have.

Complying with the three conditions for exemption from the regulatory requirements, as presented in Table 21, was a challenge for BritNed which consequently led to the agreement of the financial review every 10 years since development. The first financial review of BritNed will take place over 2017/18. Since the exemption being granted, there has been some reluctance in new projects which follow the steps of BritNed and instead have followed a cap and floor mechanism, such as Nemo interconnector. Investors have been deterred by a regulatory structure which threatens that they may be obliged to pay the entire costs and recoup a fraction of returns.

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Conditions for regulatory exemption	Description
The interconnector must enhance competition.	A general competition analysis is conducted - the interconnector must show a positive effect on competition.
The risk level must necessitate an exemption.	The risks must rise to a level that rules out development of the interconnector as regulated investment.
Granting an exemption must leave competition unharmed.	Focus is on whether exempting the project from regulation would harm competition conditions.

Table 21: Three conditions for approval of an EU financial exemption for interconnectors Source: (Cuomo & Glachant, 2012)

4.4 INTERNATIONAL EXPERIENCES

Electricity transmission networks are capital intensive and thus, require resources from both the public and private sectors (ESMAP, 2015). Over recent decades, several countries have allowed private sector participation in the electricity networks which have been traditionally in public hands. The motivations for these reforms are the governments' aim to improve the operating and financial performance of the electricity networks and to attract private capital for investments in network expansion.

In this section, the facilitation of private sector participation in the transmission networks, inspired by international experiences in tendering electricity transmission assets to third parties, are explored.

Hereafter, international practices of tenders of transmission assets in three countries, Brazil, Peru and the UK, are presented and key learnings, useful for developing investment and ownership models for a MOG in the North Sea, are identified. The description of the three international examples is based on information provided by investors experienced in investing in transmission assets in some of these countries as well as literature review.

4.4.1 EXPERIENCE OF BRAZIL

Brazil is the fifth largest country in the world by area, having a surface of 8.5 million square kilometres (km^2). This poses a great challenge for the transmission and distribution of electricity, especially when the country's generation is sited far away from the load centres. Sistema Interligado Nacional (SIN) is the national grid of Brazil. SIN is an interconnected transmission system which functions at voltage levels of 230 kV to 750 kV and is operated by Operador Nacional do Sistema Elétrico (ONS), the national independent transmission system operator, which is also responsible for the dispatching of the system (Salcedo & Porter, 2013).

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Roles and responsibilities

Since 1999, the government has given concessions, through tenders, to third parties to build and operate parts of the SIN. The government launched a concession programme with the intention of accelerating private investment and increasing competition in the electricity transmission sector. The structure of the concession programme includes the following institutions, each with certain functions:

- Energy Research Office (Empresa de Pesquisa Energética - EPE): EPE is in charge of the long-term planning of the Brazilian energy sector (generation and transmission) and is responsible for the technical specifications of the transmission auctions (EPE, 2018).
- Brazilian Electricity Regulatory Agency (Agencia Nacional de Energia Eletrica - ANEEL): ANEEL regulates the energy industry in Brazil including generation, transmission, distribution and commerce (Salcedo & Porter, 2013). ANEEL manages the transmission tender processes (auctions) through a long-term regulatory framework.
- National Electricity System Operator (Operador Nacional do Sistema Elétrico-ONS): ONS is the Brazilian independent transmission system operator and is responsible for the coordination and control of the power generation and transmission (Salcedo & Porter, 2013). ONS ensures the payments to the concessionaires.
- Brazilian development bank (Banco Nacional do Desenvolvimento - BNDES): brings reliable and subsidized financing to the scheme.

Tender process and design parameters

The tender process and concession contracts are described below:

- EPE defines the general project requirements for the transmission lines to be tendered.
- ANEEL carries out an international public auction, offering transmission lines to investors.
- The tender process is open to any entity with technical and financial capacity; public, private, national, international, consortium and individual firms are eligible to participate in the auction (Serrato, 2008).
- ANEEL determines a maximum price for the value of each project taking into consideration the total investment in transmission lines and the investors' profit.
- The bidders submit a price that they are willing to receive for each project. This price is called the Allowed Annual Revenue (Receita Anual Permitida-RAP) and is the total annual revenue the winner of the auction will receive in return for the construction, operation and maintenance of the transmission line as well as an allowance for the return on their capital over the concession contract period (Martins da Silva & Candido, 2017). The equity share of the capital of the bidder should be at least 10% of the total value of the project. It is noted that the individual RAP is periodically (every four or five years) revised pursuant to the terms included in the concession contract and is adjusted annually to inflation factors by ANEEL (Salcedo & Porter, 2013). There is also the possibility of RAP adjustment in cases of significant imbalance between costs and revenue (Salcedo & Porter, 2013).
- The bidders must provide ANEEL with a Bid Bond or Proposal Guarantee. This is 1% of the investment sum envisaged by ANEEL and can be provided as security deposit, insurance guarantee, bank guarantee or public debt certificates (Salcedo & Porter, 2013). The Proposal Guarantee is returned to the auction losers. For the successful bidder, the Proposal Guarantee is replaced by the Performance Bond, representing 5% of the investment foreseen by ANEEL. The Performance Bond is paid to

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ANEEL in order to cover penalties imposed for total or partial non-compliance with the obligations under the tender document and the concession contract and shall remain in force for a term of not less than 270 days after the start of commercial operation of the power transmission facilities (ANEEL, 2017).

- The auction winner is the one who offers the lowest accepted RAP, below the maximum RAP determined by ANEEL, and is responsible for the construction, operation and maintenance of the transmission line during the concession period which is typically 30 years. It is noted that when the concessionaires are requested, they should connect any producer, distributor, other transmission firm or major consumer to their lines. In this case, they are paid by providing connection to others through bilateral contracts (Serrato, 2008).
- The auction winner has to provide a set of qualification documents in order to prove the legal, technical and financial viability and feasibility of their business plan to fulfill the requirements of the tender.

Since 1999, approximately 90,000 km of transmission lines have been built by concessionaires representing a total investment volume of 6,000 billion R$ per annum (EUR 1,425 billion). This amount reflects a discount of 24% compared to the estimated investment volume forseen by ANEEL (ANEEL, 2018).

Lessons learnt

The Brazilian tender model for investments in the electricity transmission sector managed successfully to mobilise significant private capital for the grid expansion (ESMAP, 2015) (ANEEL, 2018). Investor confidence is achieved and the necessary capital is attracted by implementing a long term stable regulatory framework which provides fixed revenue for the entire concession period, subject to periodical revisions and adjusted to inflation variations or gross imbalances between costs and revenues.

Moreover, the concession contracts, delivered through tenders, strike the balance between the investors' and consumers' interests; the concessionaires receive an annual guaranteed revenue over the whole concession period and at the same time, the competitive auctions ensures the lowest transmission tariff for the consumers by selecting the concessionaire offering the highest discount to the initial Allowed Annual Revenue (ESMAP, 2015).

4.4.2 EXPERIENCE OF PERU

In Peru the private sector participation in the transmission sector was driven by the need to attract a large amount of capital in order to raise efficiency and tackle transmission shortages and bottlenecks without placing an excessive burden on public finance (ESMAP, 2012). Today in Peru, 100% of the high voltage transmission system is in private hands.

After a significant decline in transmission investments during the period 2004-2006, the Electricity Concessions Law (Ley de Concesiones Eléctricas-LCE) of 1992 was modified in 2006 to provide the necessary incentives for investments in the transmission sector. This legislation introduced a set of measures which included among others:

- The formalisation of a centralised binding transmission planning regime aimed at identifying the system's expansion needs (ESMAP, 2012).
- The transmission planning is the responsibility of the national system and market operator, Comité de Operación Económica del Sistema Interconectado (COES).

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- A 30-year Build, Own, Operate, Transfer (BOOT) concession contract for the construction and operation of transmission assets through competitive bidding procedures.

Roles and responsibilities

The main roles and responsibilities of the key actors under the Peruvian legislation for grid investments are presented below:

- The Ministry of Energy and Mines (MEM) is in charge of setting electricity policies and regulations regarding environmental matters applicable to the energy sector. It also oversees the granting, supervision, maturity and termination of licenses, authorizations and concessions (Enel, 2017).
- The Energy and Mining Investment Supervisory Body (Organismo Supervisor de la Inversión en Energía y Minería - OSINERGMIN), is an autonomous regulatory entity that enforces compliance with legal and technical regulations related to electrical, hydrocarbon and mining activities (Enel, 2017). It is also in charge of enforcing compliance with the obligations stated in the concession contracts. OSINERGMIN is also in charge of fixing generation, transmission and distribution tariffs and the tariff adjustment conditions for the end consumers.
- The System Economic Operation Committee (COES) is the national system and market operator and is responsible for the grid planning and determines the Transmission Expansion Plan which is binding on all parties. COES determines also which transmission lines should be paid by the all consumers and which should not (ESMAP, 2012).

Tender process and design parameters

The BOOT investment model for transmission in Peru is structured as follows:

- The national system and market operator, COES, determines the Transmission Expansion Plan which is binding to all parties.
- The regulator, OSINERGMIN, has to approve the Transmission Expansion Plan.
- The transmission projects, which are included in the Transmission Expansion Plan, are tendered through an international bidding process.
- The winning bid is the one that offers the lowest Guaranteed Annual Return. The Guaranteed Annual Return is the annual return required by the bidders to cover their investment, the operation and maintenance costs (ESMAP, 2012). It is noted that, unlike the old tariff system which was based on estimated and not actual investment costs, the new approach for determining the revenues for transmission investments recognises the sunk costs of existing assets and captures the actual expansion costs resulting from a competitive bidding process.
- The BOOT contract is for 30 years and guarantees the annual revenue for the winning bid.
- The revenue of the transmission projects is paid by generators, big consumers and distribution utilities in proportion to their energy consumption and maximum demand (ESMAP, 2012).
- The transmission owners are responsible for the technical design, construction, operation and maintenance as well as the environmental and social licences of the transmission assets (ESMAP, 2012).

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Lessons learnt

The Peruvian experience highlights that a well-organised transmission planning and the establishment of a separate system operator that identifies the national expansion needs builds investor confidence and attracts the required capital for the transmission investments.

The long-term (30 years) concession contracts and a predictable tariff system based on competitively driven costs made the BOOT investment model very attractive to private investors. Also the establishment of a tariff system which recognises the actual costs linked to the transmission expansion investments reduces considerably project risks for the investors (albeit they have to bear the environmental and social licences).

4.4.3 EXPERIENCE OF THE UK – CATO

Currently the electricity transmission system in Great Britain is owned and maintained by three Transmission Owners (TO), the National Grid Electricity Transmission plc (NGET) for England and Wales, Scottish Power Transmission Limited for southern Scotland and Scottish Hydro Electric Transmission plc for northern Scotland and the Scottish islands groups. The system as a whole is operated by a single System Operator (SO). This role is performed by National Grid Electricity Transmission plc (NGET) - it is responsible for ensuring the stable and secure operation of the whole transmission system (Ofgem, 2019b).

The national regulator, Ofgem, and other stakeholders decided recently, under the Integrated Transmission Planning and Regulation project, to introduce competition into the onshore provision of transmission infrastructure in order to deliver new onshore transmission assets at lower costs and increase innovation. The system is focused on maximising value for consumers by reducing the costs of delivering large (£100 million +) transmission infrastructure that otherwise would have been procured directly by the TOs and pass to the consumers through the grid charges (FTI Consulting, 2017).

Under the proposed regime, which builds on the OFTO regime, a Competitively Appointed Transmission Owner (CATO) will be granted a licence, though competitive tendering, to own and operate onshore transmission assets. Depending on at which point along the lifecycle of the transmission project the tender process is initiated, Ofgem has identified two broad CATO models; the “Early Model” and the “Late Model”. For projects that are already planned to be constructed during the RIIO-T1, the CATOs will be appointed after the projects have secured planning consent. This is the “Late CATO” model. Under the “Early CATO” model, the tender takes place at an earlier stage, so that the successful bidder is also responsible for the initial design and obtaining the all the required consents for the project. Figure 14 illustrates the starting point of the tender process under each CATO model.

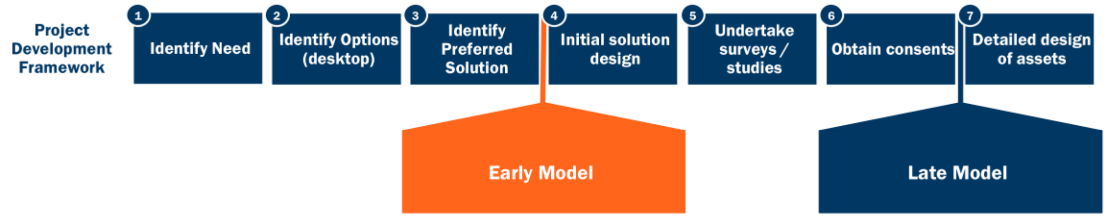

Figure 14: Early and Late CATO Model. Source: (FTI Consulting, 2017)

Roles and responsibilities

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The key roles and responsibilities of the main actors/parties involved in the CATO model are illustrated in Figure 15 and summarised below:

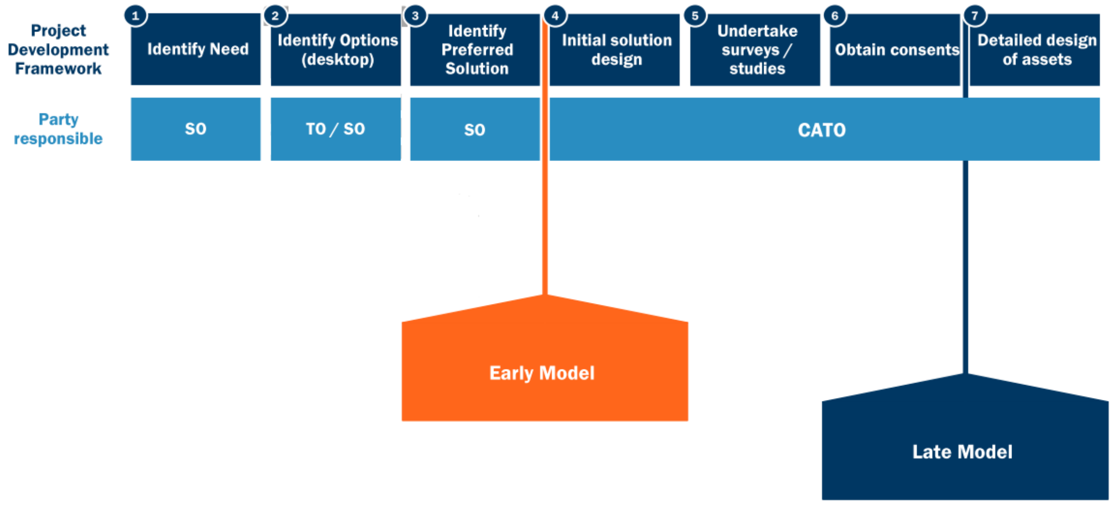

Figure 15: Key roles and responsibilities under the CATO model. Source: figure from (FTI Consulting, 2017) edited

- The System Operator (SO) identifies a specific need within the transmission system (Stage 1).
- The Transmission Owner (TO) propose a set of options/solutions against the system need (Stage 2).
- The SO selects a preferred solution and defines a reference design for this solution (Stage 3 and 4). The reference design refers to the geographical start and end point of the asset, the required capacity, etc.
- Under the "Early Model", the successful bidder will be responsible for developing the initial design of the transmission asset (e.g. AC underground cable or HVDC, etc.) and will carry out all the required surveys and consenting. Under the "Late Model", the SO undertakes all the preliminary work. The winning CATO will be responsible for the ownership, construction, operation and maintenance of the transmission asset (Stage 4-7).
- The CATO should comply with all industry codes and standards as TOs also do.
- Ofgem conducts the tender, evaluates the bids and selects the winning bidder. Ofgem also allows funding for preliminary works and defines the CATO's revenue stream. Figure 16 summarises the key revenue arrangements that has been proposed by Ofgem for the CATO.

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Proposed Revenue Arrangements
Revenue to be paid through an annual Tender Revenue stream (TRS) bid during the tender process.
25 year revenue term, usually commencing from completion of construction.
Revenue stream should be largely fixed, with a limited number of reopeners.
Asset depreciation period aligned with the revenue term.
Assets would remain the property of the CATO at the end of the revenue term and will most likely be subject to ongoing price control.
Gains made by CATO through debt refinancing should be subject to some sharing mechanism with consumers.
The proportion of annual revenue indexed to inflation should be proposed by bidders.

Figure 16: Revenue arrangements proposed for the CATO model Source: (Ofgem, 2016)

Tender process and design parameters

The criteria to select the winning bid may include several parameters (e.g. timeline for delivery of the project, innovation, security of supply impact, availability, costs for preliminary works, construction and operation and risk-sharing mechanisms between CATOs and consumers). The key design parameters of the tender process are described below:

- The tender process includes a pre-qualification process according to which the potential bidder should submit information regarding qualitative features, cost profiles, financing etc. in order to determine a sensible number of bidders with appropriate financing capabilities and thus, ensure that competition is facilitated. The incumbent TOs can bid, as long as there are no conflicts of interest.
- The bidders should submit a fixed bid for preliminary works, under the “Early Model”. The CATO is paid during the preliminary works for their costs on an annual basis (FTI Consulting, 2017).
- The bidders should submit an indicative bid for construction and operation of the transmission asset including the cost of capital (this implies RoE or profit). The CATO is paid for the construction and operation upon completion of the project and the payment would include the costs incurred (also profit) plus Interest During Construction (IDC) (FTI Consulting, 2017). The initial view is that a fixed revenue stream of 25 years should be applied.
- Due to the cost uncertainty inherent in the “Early Model” resulting from unexpected changes of project needs or planning consent etc., CATOs may be allowed to bid a range of costs, between a cap and floor, both for CAPEX and OPEX. In such a way, the commercial risk is partially shared between the CATOs and the customers.
- An alternative option would be that CATOs bid their costs on “sharing factors”. In this case, the costs would be shared with consumers either partially or fully. Figure 17 illustrates an example of potential combination of sharing factors for different categories of costs and different levels of cost pass-through. In the “Early Model” is possible that the cap and floor sharing mechanism could be combined with the “sharing factors”.

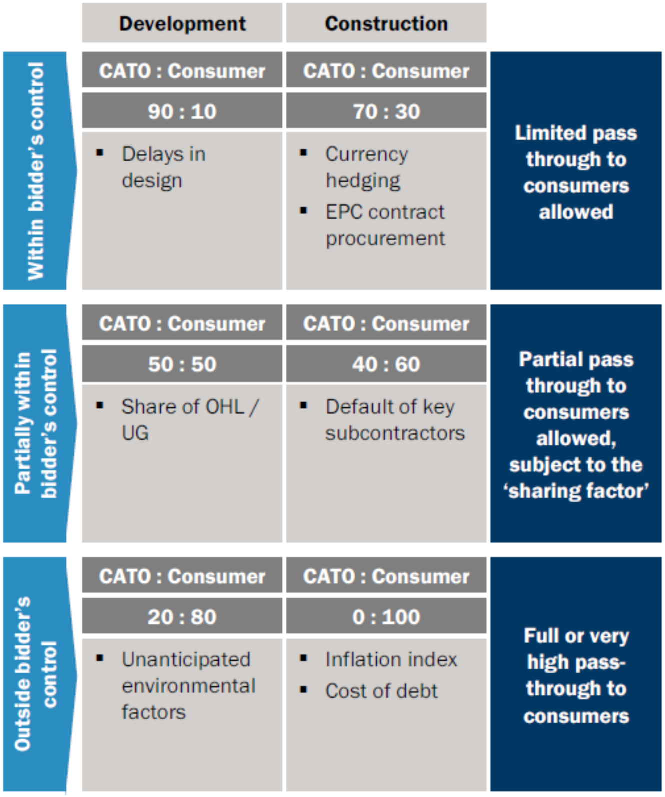

Figure 17: Illustration of sharing factors. Source: (FTI Consulting, 2017)

- The CATO model includes penalties for late delivery of the asset and guaranteed compensation for costs incurred in case of project cancellation.

Lessons learnt

The (Early) CATO model introduces competition in the construction and design of onshore transmission assets and presents opportunities for innovation and efficiency in their design. This model allows competing bidders greater scope for innovation in the design solution (e.g. in deciding on the technical solution to meet a specified transmission requirement) thus, benefiting consumers with potential reduced costs or a more secure transmission system (FTI Consulting, 2017). Apart from cost savings, it could provide with cost benchmarks that may be helpful for the regulation of monopoly delivered networks (Ofgem, 2016).

Separating the revenue stream for preliminary works from the revenue stream for construction and operation provides confidence to investors due to the high uncertainty during preliminary works for consenting and planning permission and due to the risk that there might be no need for the project. CATOs are remunerated annually for the costs incurred during the project development period.

Moreover, the proposed long-term (25 years) fixed revenue stream is very attractive for the investors. This is indicated by the great interest from a range of entities such as the UK's biggest construction contractors, asset operators and investors on the onshore transmission assets (Ashfords, 2018).

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4.5 SUMMARY

The enormous investment volume for the development of a MOG poses a serious financing challenge. Due to the current low interest rates, debt financing is the most favourable funding instrument at the moment, something which is also reflected in the high gearings of the offshore projects. However, an increase in the interest rates might have a negative effect on the TSOs' balance sheet by increasing the cost of debt. In this case, an internal or/and external equity injection would be the most viable solution in the long run. To this end, there are international experiences and examples from the European TSOs and TOs that have developed financial strategies to cope with the capital intensive offshore transmission investments, attracting private investor and securing alternative innovative funding, and could be applied for the financing of a MOG:

- TenneT, the TSO with the largest offshore connection facilities in the Netherlands and Germany, managed to secure financing for the offshore grid projects in Germany through equity partnerships with private investors, while maintaining the majority of voting rights and leaving a certain part of the economic interest with the external investors. In parallel, TenneT managed to secure alternative funding by EIB and through the green bonds and recently the hybrid green bond with significantly low interest rates and long maturities.
- The OFTOs in the UK are privately owned and use a project finance structure. Typically, their gearings are high, between 80%-90%, and historically mostly on long term loans. Bond financing is becoming a more common option. The Gwynt y Môr project used bond financing and became the largest OFTO project to use this option. In addition, the OFTO regime has succeeded in bringing the costs down compared to merchant and regulated price control-based approaches (see 4.2).
- International experiences in introducing competition to the electricity transmission sector show that multiple benefits could be created for the consumers by allowing private sector participation to the sector though competitive tenders. In Brazil, the competitive selection of concessionaires resulted in a cost reduction of 24% for the period 1999-2017 (ANEEL, 2018). In the UK, Ofgem decided, following the successful example of the OFTO model, to introduce competition also to onshore high voltage transmission assets through the CATO regime. This is expected not only to bring the costs down for consumers but also to provide cost benchmarks for improving the regulation of the monopoly delivered networks and increase innovation across the project development (Ofgem, 2016). Tenders of offshore transmission assets to third parties could be considered (at least at the early stage of the MOG) in order to mobilise the significant amounts of capital required and deliver efficient cross-border investments at a reasonable cost.

All these experiences demostrate that the driver of successful realisation of massive infrastructure investments is a long-term, stable, reliable and predictable legal and regulatory framework which assigns clear roles and responsibilities among the relevant actors. Such a regime could build investor confidence and thus, attract the required capital. Another example which demonstrates the importance of stable and predictable regulatory framework is BritNed. BritNed is an interesting example of an interconnector that opted for a transmission capacity financial mechanism which would maximise the revenue under exemption. However, the fact that a regulated cap was developed to keep the revenue under certain limits made investors reluctant to invest in new merchant interconnectors and instead they have followed a cap and floor mechanism. BritNed published a

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response to the Cap and Floor regime during its consultation phase[18]. This response highlighted the initial challenges of structuring investment in interconnector infrastructure between the UK and the Netherlands. The Netherlands have a different regulatory approach, with the interconnector forming part of the regulated asset base and being primarily owned by the TSO. From the response it is clear that BritNed is encouraged by the new attempts to ensure the merchant interconnector model is catered for across interconnector regulation of different countries through the new cap and floor mechanism. BritNed addresses that the new regulatory regime should be stable and predictable creating the right investment incentives at the outset and during the lifetime of existing and new interconnector infrastructure. In hindsight, this new interconnector regulation could have worked well in the case of BritNed and would ensure correct balance of rewards and risks for their investors.

It is also noted that within the current market, long-term stable investments are increasingly attractive propositions to investors against wider market uncertainty. This makes the market for equity investment in transmission assets more competitive, which ultimately leads to lower project WACC. Being able to reflect this in the regulatory model would ensure that this leads to savings for consumers.

Finally, permitting procedures pose significant challenges for delivering cross-border projects on time. The example of COBRAcable showed that despite the PCI status, which allow the investor to benefit from accelerating permitting procedures (including a binding time limit of 3.5 years for granting a permit (Regulation (EU) No 347/2013)), the administrative and regulatory complexity of multi-national projects can lead to significant delays in realising the investment. In task 7.1 it is suggested that the one-stop-shop needs to be implemented in practice and not only be adopted in law, in order for developers to reap the benefits in the permitting procedure (Nieuwenhout, 2019). For further recommendations regarding mitigation of permitting risk refer to (Nieuwenhout, 2019).

[18] https://www.ofgem.gov.uk/ofgem-publications/59320/britned-response-8611.pdf

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5 OWNERSHIP MODELS FOR A MOG

Several studies have reported the potential for significant benefits from a meshed offshore grid in the North Sea as already mentioned in 1.1. However, to date there has been minimal investment in a MOG. Although, the EU has launched policies and mechanisms to improve the regulatory environment and incentives for cross-border investments, there are still many steps to be achieved to reach more integrated grid solutions which will be beneficial for the North Sea and the entire EU. To this end, the EU should support and co-ordinate regional initiatives and approaches, ensuring that the different national policies are aligned towards a common European vision.

Hereafter, possible ownership models for a MOG in the North Sea are presented. Traditionally, electricity transmission investments have been carried out by national TSOs. However, the need for an integrated offshore grid, which has a dual function, the offshore wind evacuation and electricity trading, requires massive volumes of investment which might not be possible to be delivered by the existing structures alone (at least at the early stages of the development). The aim of task 7.3 is to explore the possible options for ownership of a MOG and present the perceptions of multiple stakeholders on the ownership models. Therefore, alternative investment models and structures which can facilitate different options of private equity provision and enable investments in a MOG in the North Sea are proposed. The development and the evaluation of the proposed ownership models is based on information provided during interviews with TSOs, corporate investors, infrastructure funds and banks as well as a literature review on best practices and lessons learnt from international experiences in electricity transmission investments (see Chapter 4).

5.1 DEFINITIONS

The definitions of grid activities and entities involved in the context of national regulatory frameworks as well as in the context of a MOG are presented in this section. It is noted that, the governance models are analysed based on a financing perspective. The regulatory governance of a MOG is analysed in task 7.1 (Nieuwenhout, 2019).

It is highlighted that the ownership of the MOG is closely related to financing and therefore, emphasis is given on the description and analysis of the ownership models without considering the system operation.

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Grid activities

In the context of the financial framework for a MOG, the transmission grid activities that are considered are defined and presented below:

- Construction: it refers to the responsibility for building the MOG.
- Ownership: it refers to the economic ownership and includes the responsibility for investments and asset operation.
- Asset operation: it refers to the responsibility for the technical operation and maintainance (O&M) i.e. repair and maintenance of the physical assets.
- System operation: it refers to the responsibility for balancing of the entire system, managing of the flows and system safety and stability. It is noted that the definition of system operation is included for completence but is out of scope of task 7.3.

Figure 18 gives an overview of the grid activities.

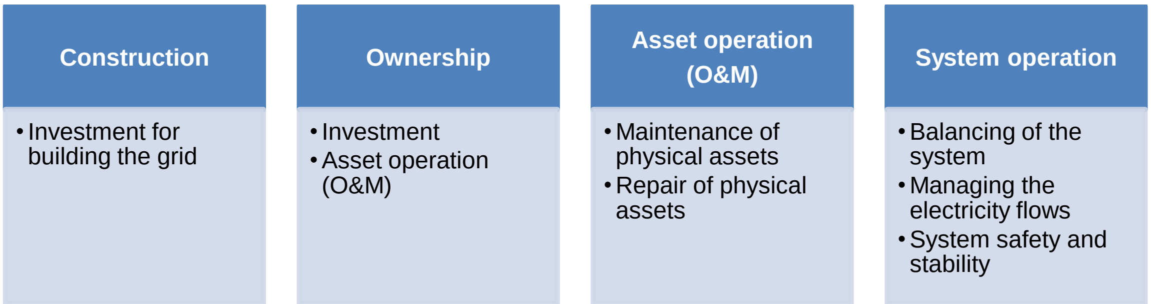

Figure 18: Definitions of grid activities under the financing framework for a MOG

Entities in the context of national regulatory frameworks

The responsibilities, regarding the grid activities, of the actors involved in offshore transmission networks in the context of the current regulatory frameworks are:

- Transmission System Operators (TSO): are the prevailing entities involved in the current national regulatory frameworks (except the UK) and are responsible for the system operation, asset operation, ownership and construction of the grid.
- Transmission Owners (TO): In the UK the TOs are responsible for the asset operation, ownership and construction of the onshore grid assets.
- Offshore Transmission Owner (OFTO): In the UK offshore, the Generator Build approach is used. Under Generator Build, the wind farm owner is responsible for constructing the radial link to shore for its windfarm. Post-construction, the asset is then transferred to an OFTO (following a tender process) who is responsible for the technical operation of the asset over 20 years. Ofgem has also proposed the OFTO Build approach as an alternative to the current, Generator Build process, used to date. Under OFTO Build, the OFTO is also responsible for the construction of the assets. The OFTO Build approach has not been taken up by new wind farm generators, in part because of the perceived risk of stranded wind farm assets if the OFTO doesn't build the transmission asset on time.
- System Operator (SO): In the UK, responslible for the operation of the entire system is the SO.

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5.2 POSSIBLE OWNERSHIP MODELS FOR A MOG THROUGH THE PRISM OF FINANCING

Unlike the onshore transmission grids, a Meshed Offshore Grid (MOG) in the North Sea is a new concept which has not been yet developed. A MOG is expected to combine the evacuation of wind energy with electricity interconnection and energy trading among (several) countries. The creation of this market should drive down price differences, remove congestion and thus, create benefits for the society. To this end, responsibilities regarding the system operation, asset operation, ownership and construction of the MOG should be clearly defined and allocated. The prevailing approach in Europe is that the offshore transmission networks are in the hands of a single entity, the (national) TSO, who is owner of the grid and the system operator. There is a limited number of exceptions, where transmission assets are owned by third parties while the system operation is the responsibility of a separate entity. From financing perspective the ownership of the grid assets is of particular interest; for a MOG, where enormous investment volumes are needed, the development of an appropriate regulatory framework and ownership structures which will attract diverse financing sources at reasonable cost is fundamental. This implies that different ownership models could be developed and applied for a MOG, where a TSO-model and third parties could co-exist under different structures.

The five ownership models identified are illustrated in Figure 19. Some of the models are central and others asset-based approaches (see 2.3). The ownership of the offshore transmission assets with cross-border impact is closely related to the financing of the investments. Therefore, the responsibilities and possible shareholders and business structures of the onwerhip models are described.

It is noted that the scope of task 7.3 is to explore the possible options for ownership structures that could facilitate investments in a MOG based on a financing perspective. However, for a detailed analysis of the possible business and shareholder structures, there is a requirement for specifics of the legal and regulatory framework, which could be applied to a MOG.

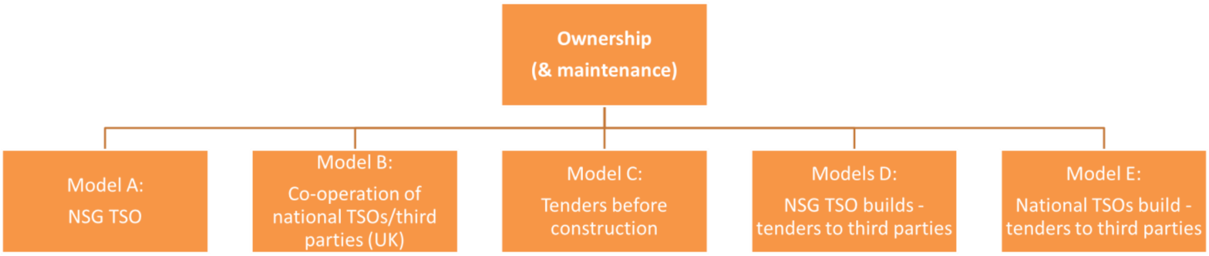

Figure 19: Possible ownership models for a MOG

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5.2.1 MODEL A: NSG TSO

The North Sea Grid Transmission System Operator (NSG TSO) is an ownership model that was inspired by central approaches for the integration of the EU power market that exist in the literature and have been often expressed by some stakeholders. According to this approach, a European HVDC network could be built and operated by a cooperative company owned by the national TSOs and jointly controlled by the respective governments (Rusting, Dik, & Hoonhout, 2015). Hereafter and based on the aforementioned approach, the structure and role of the NSG TSO in a MOG are described.

Responsibilities

Under the NSG TSO model, one entity invests, owns and is responsible for the construction and technical operation and maintenance of the transmission assets. The NSG TSO is also the system operator of the entire MOG (see Figure 18).

Shareholders & business structure

Shareholders of the NSG TSO could be the national TSOs of the countries surrounding the North Sea or a consortium of the national TSOs and private investors or just private investors. It is assumed that a NSG TSO would use balance sheet (corporate) financing (instead of project financing) and their income would be regulated.

5.2.2 MODEL B: CO-OPERATION OF NATIONAL TSOS/THIRD PARTIES

Unlike model A, model B is an asset-based ownership model, where the responsible entities, under each national regime of the countries surrounding the North Sea, own the grid assets within their EEZ. Model B is an extension of the current stuctures and practices.

Responsibilities

Under model B, the establishment of a co-operation among the national TSOs and third parties (considering the UK) in order to construct, own and maintain the MOG is assumed (see Figure 18), where each involved party will apply its existing approach within its own EEZ. In the UK's case this would be continuing with some variant of its OFTO regime, adapted as needed for inclusion of hybrid assets.

Shareholders & business structure

The existing legal ownership and business structures of the national TSOs and third parties (in the UK's case) are applied (see Chapter 4).

5.2.3 MODEL C: TENDERS BEFORE CONSTRUCTION

Tenders before construction is an ownership model that was inspired by the OFTO Build approach (see 5.1). Under model C, the ownership and asset operation are separated from the system operation.

Responsibilities

Under Model C, parts of the MOG could be tendered directly to third parties who would be responsible for the construction, technical operation and maintenance and ownership of the grid assets. This approach requires an overall 'system planner' to identify the assets needed and run the tender process. However, this definition of a 'system planner' and their responsibilities is out of task 7.3 scope. The third parties are also obliged to keep the availability of the offshore assets at required availability and performance levels and comply with the technical

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requirements and standards set by the 'system planner'. However, they have flexibility regarding the technical design of the asset.

Shareholders & business structure

The third parties could be private or public investors, national or international investors, public-private consortia. It could also be possible for the national TSOs to participate in the tenders. The third party tender winner could be formed as a Special Purpose Vehicle (SPV), which owns the transmission assets and is remunerated for keeping a certain level of availability of the assets. The SPV would face penalties if the availability is not kept at the required levels.

5.2.4 MODEL D: NSG ISO BUILDS - TENDERS TO THIRD PARTIES

The model of the NSG ISO who builds the transmission assets and then tenders parts of the grid to third parties resembles the current Generator Build approach in the UK (see 5.1) with the difference that in model D the entity who builds the transmission assets is the system operator. Also under model D, the ownership and asset operation are separated from the system operation.

Responsibilities

Under Model D, a NSG ISO could build the grid and after the commissioning of the assets transfer them to third parties through competitive tenders. The third parties could own the offshore transmission assets/parts of the grid and be responsible for their technical operation and maintenance. In this case the role of the NSG ISO is more of a 'system planner' and 'builder' who identifies the grid needs, builds the transmission assets and runs the tender process.

Shareholders & business structure

Under model D, the NSG ISO, as 'builder' of the MOG, could be formed by the national TSOs of the countries surrounding the North Sea, but also allow for private investor participation with long term horizon such as pension funds, infrastructure funds, etc. Such a structure should be supported by the EU and private or public investment banks.

The shareholders and business structure of the third parties have been already presented in 5.2.3.

5.2.5 MODEL E: NATIONAL TSOS BUILD - TENDERS TO THIRD PARTIES

Under Model E, multiple entities co-operatively construct the MOG and then tender parts of it to third parties to own and operate the assets. Model E also implies the separation of ownership and asset operation from system operation.

Responsibilities

Under Model E, the national TSOs of the countries surrounding the North Sea jointly build the MOG and then tender parts of it to third parties who could own the grid and be responsible for the O&M of the transmission assets. The national TSOs and SOs could jointly operate the system or a NSG ISO could be set up for the system operation. This model assumes a bottom-up approach where the MOG is jointly constructed by the national TSOs of the countries surrounding the North Sea.

Shareholders & business structure

The shareholders and business structure of the entities involved in model E have been already presented in the previous paragraphs.

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5.3 EVALUATION OF OWNERSHIP MODELS

As presented already in 5.2, there are several options for ownership models for a MOG. In order to come up with recommendations on appropriate ownership structures which will facilitate investments in a MOG in the North Sea, the different options need to be compared in a logical and consistent way. To this end, the various models were evaluated against a set of criteria which can allow the identification of the features that contribute the most to meeting the financing objectives and would facilitate efficient cross-border (anticipatory) investments in a MOG. The evaluaton of the ownership models is based on stakeholder consultation. Several bilateral interviews with TSOs, OWF developers, national and European financial institutions, infrastructure funds and corporate investors were carried out (see list of interviewees in Table 22). Also, during workshops and stakeholder meetings with North Seas Energy Forum valuable input was provided.

It is noted that the evaluation of the ownership models is a qualitative analysis based on the main assumption that an adequate legislative framework for the MOG is in place. For a detailed analysis and quantitative evaluation of the ownership structures/models, the specifics of the regulatory environment should be known and taken into account. In the following sections the methodology that was followed, the assessment criteria and the evaluation of the ownership models are presented.

5.3.1 METHODOLOGY AND ASSESSMENT CRITERIA

A set of assessment criteria was used to perform an objective and systematic evaluation of the investigated ownership models. From financing perspective, it is important to investigate the ownership structures that could facilitate efficient investments in a MOG by attracting the necessary financing sources from capital markets. Therefore, the assessment criteria that were used are related to the net economic benefits and the provision of private capital. Hereby, the methodology and assessment criteria used for the comparison of the various ownership models are described.

Assumptions

In order to evaluate the ownership models it is assumed that an appropriate legal and regulatory framework is in place since, both debt and private equity diligent risk management requires an adequate legislative framework, mainly due to the novelty introduced with MOG.

A number of additional and more specific assumptions were made for the comparison of the different ownership models:

- A regulated income for all models; it is assumed that the investors' remuneration is regulated.
- Security of supply for all models; the security of supply (n-1 criteria) should be guaranteed independently from the owner of the grid.
- Low entry barriers for participation in the market in a competitive environment; it is assumed that in those cases where third-party asset ownership is allowed, there is a sufficient number of interested parties in the market and they also have the financing and operating capabilities that are required for the development, operation and ownership of the transmission assets.
- Central planning in case of Model C (tenders before construction); in the case where the entire MOG is tendered for ownership and asset operation to third parties, a central grid planning is assumed to be in place.

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- Regulator allows for anticipatory investments in the central approaches (e.g. Model A, D); where one entity is responsible for the development of the MOG, it is assumed that the regulatory framework enforces the necessary cross-border anticipatory investments.
- The investor risk is evaluated given that an appropriate regulatory framework is in place.

In order to perform an objective and consistent evaluation of the investigated ownership models the following assessment criteria has been defined:

Net economic benefits

The objective is to deliver solutions at least cost and maximum benefit for the society. The benefit is assumed to be the transmission of wind energy to the shore. A number of sub-criteria have been used to judge the economic benefit of different ownership models:

- Standardisation - how easy would it be to deliver a common approach to building and operating the MOG. Currently, different grid technologies (AC, DC, voltage levels, etc.), grid designs and configurations for the connection of OWFs to the shore (radial, clustering, etc.) are used in the different countries. For the development of a MOG technical standardisation is required for the future cross-border connections.
- Learning rate – given that in all approaches there is a learning curve in constructing the grid, the criterion needs to assess the extent to which the approach allows to share the knowledge that has been gained from earlier projects with other project developers.
- Competition for ownership - Given that all approaches will involve competitive tenders for construction contracts, this criterion needs to assess the extent to which competition benefits consumers (e.g. by bringing the costs down).
- Regulatory complexity - does the proposed approach apply a disproportionate regulatory burden
- Scope of cross-border anticipatory investments - does the proposed approach allow and incentivise anticipatory investments for the development of the MOG in the North Sea

Provision of private capital

The objective is to facilitate the provision of private capital to maximise the chances of raising the 100 billion + Euros to pay for the MOG. A number of sub-criteria have been used to judge the provision of private capital of different ownership models:

- Private equity provision – does the proposed approach allow the access of private investors/third parties as shareholders of transmission assets in a MOG/ attract additional equity financing into the business
- Debt level constraints – does the proposed approach pose certain debt level constraints (see 4.1.3)
- Investor risk & financing costs (CoE, CoD) – how the assessment of the investor risk under each proposed approach influences the cost of financing (Cost of Debt (CoD) and Cost of Equity (CoE))

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5.3.2 EVALUATION OF OWNERSHIP MODELS

The evaluation of the governance models is the result of multi-stakeholder consultation. Several bilateral interviews with TSOs, OWF developers, national and European financial institutions, infrastructure funds, corporate investors and ministerial bodies were carried out. Also, during workshops and stakeholder meetings with North Seas Energy Forum valuable input was provided. The multi-perspective feedback that was received indicates the divergent objectives and interests of key stakeholders regarding investments in a MOG. However, a common aspect across all the interviewed parties regarding the success of financing the MOG is the development of an adequate legal and regulatory framework which could attract the necessary capital and facilitate the required cross-border anticipatory investments.

The analysis of the ownership models, described in 5.2, showed that some of them present similar characteristics. Therefore, the investigated ownership models have been grouped into three categories; the central approach, the co-operative approach and the competitive approach.

5.3.2.1 CENTRAL APPROACH

This category relates to the ownership of the MOG and responsibility for construction and asset operation by a single entity. Model A, the NSG TSO, and under model D, the construction phase by one entity, belong to this category. Figure 20 illustrates the responsibilities of a NSG TSO.

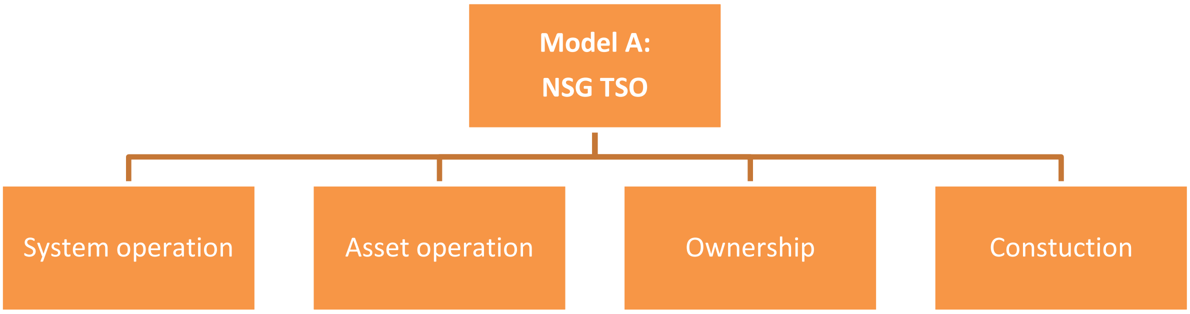

Figure 20: Grid responsibilities of the NSG TSO

Net economic benefits

Central approaches, where one entity is responsible for all grid activities, could facilitate higher levels of consistency for construction and operation of the MOG, since they follow a unique set of technical standards and a single grid design. Therefore, model A, the NSG TSO, could achieve a high level of standardisation. According to some financial institutions however, under the model of a single owner for the entire MOG the element of competition is reduced and this might not give the incentive for improving the learning curve, leading to less innovation and ultimately higher costs for consumers. Central approaches do not allow knowledge exchange with other actors in the market which ultimately could lead to a slow learning curve and thus, higher learning costs. From TSOs' perspective though, under a TSO-model where incentive regulation, which is the current approach in most countries for regulating the electricity networks, is applied, the regulator simulates competition and motivates the TSO to manage its operations more cost efficiently than comparable network operators in other regions or in other countries. However, offshore there is not yet much experience and thus, limited international benchmarks are available. Therefore, it is assumed that central approaches like model A

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and model D could introduce very limited competition at least in the early stages of the development of a MOG compared to competitive approaches.

Moreover, in the case where only one entity needs to be regulated, such as Model A, the interfaces with other entities are eliminated and thus, low regulatory complexity is assumed. However, according to several stakeholders, in this case there is higher information asymmetry, since the NRA, which often lacks technical knowledge, receives information only from one entity, the NSG TSO, and thus, cannot compare with information from other actors.

Finally, it is assumed that under central approaches, where the ownership of the MOG is in the hands of one entity, cross-border anticipatory investments could be enforced.

Provision of private capital

Given that private investors can also be shareholders of a NSG TSO, model A facilitates private equity provision. However, under model A there are balance sheet constraints, since the NSG TSO should keep the financial ratios at a level that conciliates with the required rating levels. Under model A, the NSG TSO bears the whole risk; the risk of construction, O&M, system operation and commercial risk. However, given that a balance sheet financing is used, the risk is diversified in a portfolio of projects and hence, the cost of financing could be reasonable.

5.3.2.2 CO-OPERATIVE APPROACH

This category concerns the co-operation of the national TSOs and third parties, in the UK's case, for jointly constructing, owning and operating the MOG. This is an extension of the current practices and is illustrated in Figure 21.

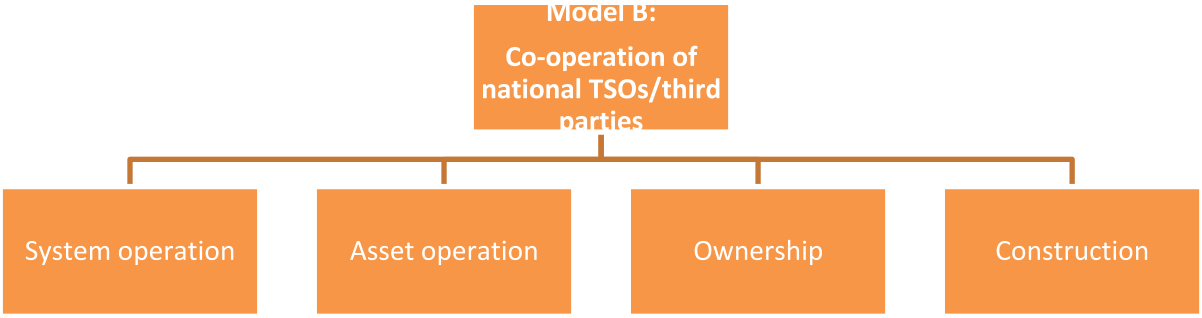

Figure 21: Grid responsibilities under the co-operatve approach

Net economic benefits

According to some representatives from national ministries, for these models, where the national TSOs and third parties (in the UK) jointly construct the grid, there is the risk of not achieving a high level of consistency, since each country has its own grid design and potentially uses different grid technologies (see 5.3.1). On the other hand, TSOs claim that there are other measures for reaching the high level of standardisation, though for example the requirements of the HVDC Network Code that need to be fulfilled by all TSOs. Moreover, project developers often make their standards together when they engage in a joint project. However, it should be ensured that for a MOG the selected approach could be extended into a more complex structure like the MOG otherwise there is the risk of fragmented development which is likely to have a negative impact on the social welfare.

TSOs are positive that knowledge can be shared, through TSO co-operation, improving the learning curve. As already mentioned in 5.3.2.1, TSOs' opinion is that competition can be good simulated by applying incentive regulation but from financial institutions' and private investors' perspective real competition is introduced when there are low entry barriers in the market for grid asset ownership by third parties. Therefore, it is concluded that under model B competition is partially introduced.

Regarding the regulatory complexity, in the model where several TSOs and private asset owners with different regulatory backgrounds co-exist, higher coordination effort regarding the construction, operation and maintainance of the assets would be required leading to higher regulatory complexity compared to the regulation of one entity.

Additionally, the opinion of some ministerial bodies and TSOs is that it would be hard to enforce cross-border anticipatory investments under a co-operative approach due to the different national grid plans and incentive schemes for cross-border investments, leading to a situation in which investments that would increase the societal welfare in the North Sea are not forthcoming due to insufficient incentives. Therefore, they suggest that a binding framework that combines a top-down supra-national approach with a bottom-up one, so that the specifics of the national networks are taken into account, should be in place. Hence, the most beneficial cross-border transmission investments could be identified on time and efficient development of the MOG could be ensured.

Provision of private capital

Some financial institutions and TSOs doubt whether the full investment needs of 100+ Billion Euros could be covered only by the national TSOs. As already mentioned in 4.1.2, the national TSOs around North Sea have used the last years mainly debt financing to fund their regulated investments. This reflects the favorable for TSOs financing conditions due to low interest rates but it creates also concerns whether in the long term the TSOs will be able to continue raising debt under good conditions (low financing costs) due to high (≥ 70%) gearing ratios. In case of TSO budget constraints and given that the debt needs to be kept under a certain level, raising external equity would be the preferable solution. Moreover, some financial institutions state that diversified financing sources, including capital markets outside Europe, need to be attracted. However, this depends on the political will to allow within a monopolistic environment international investors as sharehorders in a TSO structure. This is not always possible especially in the case of state owned TSOs where the government, who is the shareholder, is not willing to dilute their rights and allow equity injection from private investors (see 4.1.3). Thus, only partly a co-operative approach with the majority of grid owners the TSOs (such as model B) facilitates the private equity provision.

The risks under a co-operative approach are split among several actors through contractual agreements. Also, since most of the actors are national TSOs who use balance sheet financing, it is assumed that the investor risk and consequently the cost of financing will be low compared to a project finance structure, such as under model C.

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5.3.2.3 COMPETITIVE APPROACH

The competitive approach refers to the ownership models where competitive tenders are run in order to determine who will be in charge of construction, operation and ownership of the offshore transmission assets. Model C and its variables, model D and E, fall into this category. The responsibilities regarding the grid activities under these models are presented in Figure 22 and Figure 23.

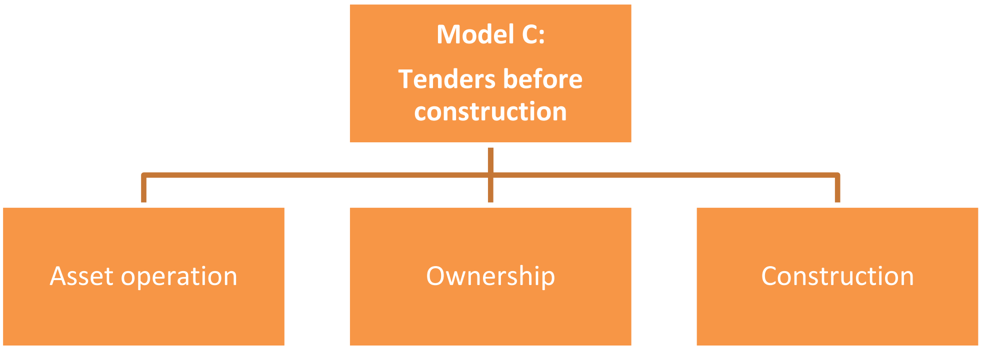

Figure 22: Grid responsibilities under tenders before construction

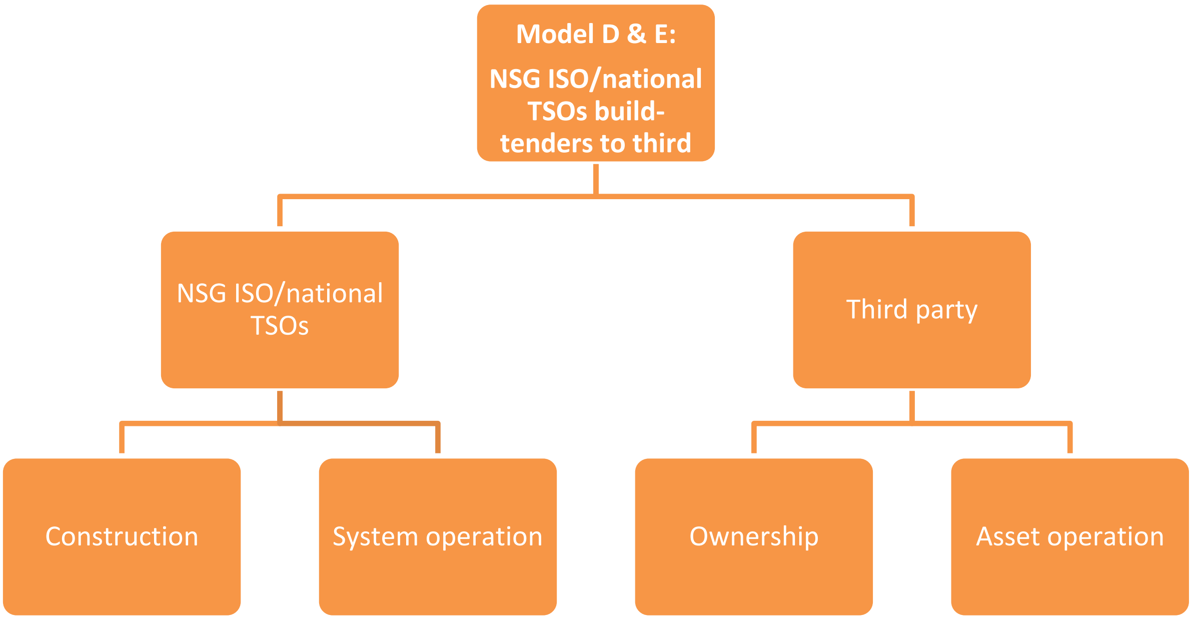

Figure 23: Grid responsibilities under TSO Build - third party model

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Net economic benefits

In model C, tenders before construction, as already mentioned in 5.3.1, it is assumed that a central ‘planner’ sets the technical requirements by giving to the third parties some flexibility in the technical design. Under this model, a medium level of standardisation could be achieved compared to a central approach where one entity builds and operates the grid (see 5.3.2.1).

Under a competitive environment the sharing of knowledge is very limited, since the parties who are bidding for the ownership of the grid assets are competitors.

Given that entry barriers are low, it is assumed that models C, D and E could introduce real competition through tenders for ownership and operation of the transmission assets, bringing the costs down for consumers. Some stakeholders, however, express concerns about model D, since it excludes competition during the construction phase reducing the incentive for innovation.

Under the competitive approach, where third-party asset ownership were to be considered for a MOG, transaction and coordination costs might arise from potential separation of asset-related activities, such as maintainance, that is the owner’s responsibility, from system operation, increasing the regulatory complexity (e-HIGHWAY 2050, 2015). This separation is perceived by some stakeholders (including TSOs) as complex and not cost-efficient for the management of the network. Also, allowing asset ownership to multiple parties the interface risks between the owners and the operator(s) of the MOG increase.

Under model C and D, given that a central planning is in place, cross-border anticipatory investments could be enforced. Under model E on the contrary, the multiple national TSOs have divergent investment and operation interests and objectives, reflecting the different national policies for the grid extension, which might hinder the required cross-border anticipatory investments which are crucial for the development of a MOG (see also 5.3.2.2).

Provision of private capital

Under a competitive approach, such as model C, where it is assumed a diversified source of financing for the grid investments, i.e. third-party ownership is allowed, enables private equity provision. Also, under an SPV structure with high participation of private investors, high debt levels are allowed unlike under the TSO-model with a balance sheet finance structure, where the gearing ratios need to be retained at certain levels (≤ 60%-70%). However, model C entails higher risk for the investors, since the third parties apart from the O&M and commercial risk, will have to bear the most risky part of the project, the construction of the assets. Of course, it depends on the regulatory framework to strike the right balance between the risk and return so that it makes the investement an attractive business case.

In model D, which could be seen as a combination of model A and C, it is assumed that shareholders of the NSG ISO who builds the grid could be also private investors so that also under this model the private equity provision is facilitated. Unlike model D, under model E, which could be seen as a combination of model B and C, there are often legal ownership constraints for equity injection from private investors to the state-owned TSOs (see 5.3.2.2).

Moreover, under both model D and E, the entity who builds the grid (NSG ISO or national TSOs) needs to raise high level of debt up-front for the construction of the MOG meaning that for the most risky part of the investment cycle (construction phase), the entity who builds will have to bear the financing burden in their balance sheets. However, this debt could be in the form of short term loans, since after the commissioning of the assets they

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could be relieved from the financing burden by transferring the assets to third parties for ownership and operation. Therefore, the conditions for raising debt could be reasonable under model D. On the other hand, for the third parties the risk is lower compared to model C, since they have to bear only the O&M and commercial risk but not the construction risk. Hence, attracting low risk and low remuneration investors could be possible under model D or E. It is noted that model D in particular was considered by financial institutions and infrastructure funds as a feasible onwerhsip model for a MOG, provided that an adequate legal and regulatory framework is in place.

5.4 SUMMARY

The development of a MOG is capital intensive and requires financing structures and ownership models that can deliver the optimal investments required. To this end, possible ownership models which could facilitate cross-border investments in a MOG have been identified. There are many options for ownership structures; central approaches such as a NSG TSO being the owner and system operator of the entire grid allowing also private investors as shareholders or nationally driven approaches, where each involved party will apply its existing approach within its own EEZ. Additionally, more market driven approaches have been presented; parts of the MOG are transferred through competitive tenders to third parties for ownership and asset operation while the system operation is considered separately. The third parties could be institutional or other type of investors, national or international and public-private consortia. Finally, another option could be the combination of the aforementioned approaches, where one entity, e.g. a NSG ISO, or multiple national TSOs build the grid and after commissioning of the assets tender parts of the grid to third parties for ownership and asset operation. Figure 24 presents a summary of the main entities that could be involved in a MOG along with their responsibilities.

NSG TSO	Co-operation of national TSOs/third parties	Third parties	NSG ISO
• System operation, asset operation (O&M), ownership, construction • National TSOs or national TSOs & private investors or private investors	• Extension of the current national structures • Each actor applies their current approach within its own EEZ	• Asset operation (O&M), ownership and/or construction • Private or public investors/ national or international/ public-private consortia	• Constrcuction • National TSOs and/or national authorities • If "builder" of the MOG, consortium of TSOs and other investors

Figure 24: Entities and their responsibilities in the context of a MOG

The aim of task 7.3, apart from exploring the possible options for ownership, is also to present the stakeholder views and perspectives on the ownership models. To this end, the ownership models have been grouped into three categories, the central, co-operative and competitive approach, and evaluated against a set of assessment criteria based on stakeholder consultation.

Central approaches are considered to deliver investments with high standardisation and relatively low regulatory complexity since, only one entitiy is responsible for the whole grid but on the other hand, they lack competition

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which could ultimately slow down the learning curve leading to higher costs for consumers. On the contrary, competitive approaches, where ownership of the gird assets is assigned to third parties through competitive tenders (assuming low entry barriers), competition is introduced with positive effects for the consumers. However, under competitive and co-operative approaches where several owners co-exist, higher coordination efforts are needed, increasing the regulatory complexity. Under co-operative approaches, in particular, where each involved party will apply its existing approach within their EEZ, stronger cooperation and coordination is required in order to mitigate the risk of lacking consistency due to the different national grid plans and technological standards which might be difficult to mesh in the future, limiting the value for the consumers. This requires the enforcement of cross-border anticipatory investments which currently depends on the national grid development plans.

Regarding the provision of private capital, a common concern among the stakeholders is that under the current ownership structures and framework conditions (TSO balance sheet constraints and the legal ownership restrictions) would be difficult to carry out the enormous investments required for the MOG. Additional funding is needed. Some financial institutions stated that diversified financing sources, including capital markets outside Europe, need to be attracted. However, this depends on the political will to allow international investors as shareholders in a TSO structure or to accept private investments in the national grid under a third party asset ownership. Finally, the model, where one entity builds the grid and after the commissioning of the assets transfers parts of the grid to third parties through competitive tenders, was considered by the interviewed financial institutions and infrastructure funds as a feasible onwerhsip model for a MOG, provided that an adequate legal and regulatory framework is in place.

It is concluded, that each ownership model has strengths and weaknesses, depending on the stakeholder perspective. In any case effort is needed to mitigate the risks, maximising the societal benefits. The opinion of stakeholders about the ownership models varies reflecting the different grid policies driven by the national expectations, targets and ambitions. It is a political decision which model to apply for a MOG but in order to capture the full scale of the potential benefits the decision should be taken on the basis of a common forward-looking electricity strategy for the North Sea's region. To this end, the EU should take into consideration the opinion and concerns of the different stakeholders and should have a central role, as co-ordinator and moderator of the various approaches, ensuring the alignment of the different national policy pathways towards a common vision for the North Sea's region.

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6 CONCLUSION AND RECOMMENDATIONS

A fully interconnected offshore electricity grid in the Northern Seas represents a high investment value for Europe and therefore, it has been recognised as one of the main electricity infrastructure priority corridors to achieve the EU energy policy goals and economic strategies (Directorate General for Energy, 2010). However, the extent to which these benefits can be fully captured remains a matter of great uncertainty, mainly due to the divergent national offshore wind ambitions and the lack of a common forward-looking approach for the development of the electricity network which creates uncertainty and hampers investments in integrated offshore grid projects. Currently there is great interest in the market for offshore electricity transmission infrastructure; TSOs, industry and the financial sector are willing to invest in hybrid projects but the lack of an adequate legal and regulatory framework is the main barrier for investing in a MOG. Hybrid assets that combine OWF grid connections and interconnection are more complex and entail higher risks. Being able to reflect this in the regulatory framework by providing the right incentives for investors would ensure that the market for equity investment in hybrid assets is more competitive leading ultimately to lower costs for consumers. Under these conditions, a financing framework is needed to kick-start, encourage and accelerate investments in a MOG, provided that an adequate legal and regulatory framework is in place. To this end, the financing framework should consider the parameters that have an impact on financing and provide solutions to address them as well as provide appropriate structures that could attract investors and facilitate investmets in a MOG. These parameters are:

- **The specifics of the MOG investment**: the timeframe (grid planning), the grid design (central or bottom-up), the ownership (one or multiple owners) and the investment volume characterise the investment to be financed. Specifically, the time horizon and the planning process for a MOG will determine the volume of the (cross-border) network investments and hence, the financing need. Investment needs in the range of EUR 100 billion for offshore electricity grids by 2030 (ENTSO-E, 2014a) or EUR 200 billion by 2050 (interviews) highlight the financing challenge. In order to overcome this challenge and encourage investments in more complex assets crossing international borders, financing structures and ownership models are needed, such that they can anticipate and fund the required cross-border investments. However, independent of the financing structures and ownership models, a coordinated approach for grid planning is required to capture the full scale of the potential benefits of a MOG.
- **Investor income:** the regulatory framework determines the investor income and plays the most important role in attracting investment in electricity transmission infrastructure. In particular, for a MOG, the return on investment should be regulated as this is the case for all European electricity transmission networks. A long-term, stable and predictable regulatory regime which provides sufficient remuneration to transmission owners, taking into account technology innovation risk, and providing revenue during construction where appropriate is important to build investor confidence. In addition, provision to remunerate agreed anticipatory investements may be important, depending on MOG design. .

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In a multinational investment environment, like the MOG, clear allocation of liabilities between onshore an offshore TSOs/TOs and OWFs, regarding delays in commissioning of transmission assets and non-availability of the grid is a prerequisite to unlock the necessary capital and secure financing for the hybrid offshore projects.

- **Financing strategies:** the development of a MOG requires enormous capital to be raised and thus, needs appropriate financing structures and financial sources which can facilitate the necessary investments. To this end, there are international experiences and examples from the European TSOs and TOs that have developed financial strategies for the capital intensive offshore transmission investments, attracting private investor and securing alternative innovative funding (eg. Through the green binds), and this could be applied to the financing of a MOG. An example is a TSO substructure, where equity partnerships with private investors are formed, where the TSO maintains the majority of voting rights and leaves a certain part of the economic interest with the external investors (see 4.2). Another example is the highly leveraged project finance structures by third parties which are appointed transmission asset owners through competitive tenders (see 4.2 and 4.4 experiences in the UK, Brazil and Peru). Tenders of offshore transmission assets to third parties could be considered at the early stage of the MOG in order to mobilise the significant amounts of capital required and deliver efficient cross-border investments at a reasonable cost. Regarding debt financing, there are several alternative funding options that could be used to finance a MOG such as funding from EIB, bond financing, including green and hybrid bonds. In all cases, the driver of successful realisation of massive infrastructure investments is a stable, reliable and predictable legal and regulatory framework which assigns clear roles and responsibilities among the relevant actors and provides sufficient revenue over the lifetime of the asset.
- **Grid ownership:** there are many options for ownership models; central approaches where one entity is the owner and system operator of the entire grid allowing also private investors as shareholders, national driven approaches, where each involved party will apply its existing approach within its own EEZ. Additionally, more market driven approaches where parts of the MOG are transferred through competitive tenders to third parties for ownership and asset operation. Another option could be the combination of the aforementioned approaches, where one entity builds the grid and, after commissioning of the assets, tenders parts of the grid to third parties for ownership and asset operation. Each ownership model has strengths and weaknesses and the opinion of the stakeholder varies due to the different interests and goals. Which ownership model will best fit in a MOG depends on the regulatory framework and political will for changing the national laws in order to facilitate cross-border investments involving several countries. In order to capture the full scale of the potential benefits associated with a MOG in the North Sea, the political decision should be taken on the basis of a common forward-looking electricity strategy for the North Sea's region.

Appropriate regulatory frameworks will be required to facilitate investmets in a MOG. The key parameters required for financing a meshed offshore grid are: (i) a coordinated approach for grid planning in the North Sea that allows for anticipatory cross-border investments, (ii) clear allocation of responsibilities and liabilities among

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the actors involved and (iii) a stable long term regulatory framework that allows remuneration of anticipatory investments and the facilitation of private capital provision.

Following the interviews with multiple stakeholders, recommendations are made on the most crucial elements and structures that need to be in place in order to eliminate the risks for investors and thus, unlock MOG investments. For each recommendation:

- first, the obstacle for financing that needs to be tackled is described,
- then, suggestions on how to overcome the obstacle are made and
- finally, the benefits for financing from implementing the recommendations are presented.

6.1 RECOMMENDATION 1: INCREASE THE COORDINATION OF THE NATIONAL DEVELOPMENT PLANS FOR CROSS-BORDER (ANTICIPATORY) GRID INVESTMENTS

Obstacle for financing

The current lack of coordination of infrastructure development is holding investors back from investing in a MOG in the North Sea (Gaventa, Bergamaschi, & Ryan, 2015). Therefore, agreed objectives are required for the offshore wind planning and development of the electricity infrastructure in the North Sea.

Recommendation

There is a need for either a common plan (central approach) or stronger co-ordination of the national grid development plans (timing and location) for future network investments with cross-border impact driven by regional needs and goals. The grid development investments in the North Sea should be binding for all actors involved. Coordinated and strategic planning for the MOG should require a legal framework for the establishment of a North Sea regional authority that can decide on the optimal locations for OWFs and cable trajectories in the entire area (Nieuwenhout, 2019). The long term vision of the North Sea regional authority could be similar to the TYNDP as developed by ENTSO-E [19].

Benefits for financing

Coordinated grid planning that identifies anticipatory investments for the long term needs in the North Sea could allow for a better estimation of the investment volumes needed, improving the investor visibility and increasing certainty regarding the expected future network investment needs. Therefore, public and private investments could be attracted at low cost and the international capital could be efficiently allocated to the desired investments.

6.2 RECOMMENDATION 2: INCREASE THE CLARITY ON RESPONSIBILITIES AND LIABILITIES OF INVESTORS IN A MOG

Obstacle for financing

Lack of clarity on allocation of responsibilities and liabilities between multiple transmission owners (across borders) and between transmission owners and offshore wind farm developers prevents investments in the MOG in the North Sea.

Recommendation

[19] (Nieuwenhout, 2019), chapter 4.2, p.38

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An adequate legislative framework is required by both the debt and private equity due diligence risk management, mainly due to the novelty introduced with the MOG. This framework should clearly define and allocate the various grid responsibilities and hence, the right amount of liabilities to the involved actors. The investment in establishing the MOG should be directly linked to the liabilities related to operating and maintaining the MOG, especially when these responsibilities could be split between various transmission owners e.g. TSOs and third parties (SPV). Also liabilities regarding compensation of OWFs due to delays in commissioning or non-availability of the grid should be clearly defined and allocated. For example, Germany has established the offshore liability balancing regime, for compensation payments to OWFs in case of delays or interruptions caused by any degree of negligence of the TSO.

Benefits for financing

A legal framework which clearly assigns responsibilities and liabilities among the relevant actors that are involved in the MOG investments builds investor confidence and can unlock private capital. An interesting example is that of TenneT Offshore GmbH; TenneT secured finances for the German offshore transmission grid with the participation of Mitsubishi and Danish pension fund, PensionDenmark, only after liabilities for the investors were secured by law (offshoreWIND.biz, 2015). Also, the investigation of international practices in Brazil, Peru and the UK showed that particularly under regimes where system operation is separated from asset related activities (e.g.maintenace, etc), private investor participation is secured when the responsibilities are clearly defined and appointed to the relevant parties hence, relieving investor uncertainty due to liability issues.

6.3 RECOMMENDATION 3: SET UP A LONG – TERM, STABLE AND PREDICTABLE REGULATORY FRAMEWORK FOR INVESTMENTS IN A MOG

Obstacle for financing

The regulatory risks are considered by investors and financiers as the main barriers to investing in a MOG and especially the duration of the regulatory period, the stability and predictability of the regulatory regime. The TSOs are regulated entities obliged to invest in electricity transmission infrastructure and at the same time they need to attract financing from the capital markets. However, investors with a long-term vision requiring stability (e.g. pension funds) may opt for alternative sectors if the TSO regulatory framework does not provide enough stability.

Recommendation

Offshore transmission infrastructure has a lifetime of several decades and the type of investors that are interested in these assets expect from them a low risk profile with a regulated, long-term and stable rate of return. A long-term and stable regulatory regime with regulatory periods longer than five years is favoured by several investors. Such an approach has been applied in the UK. The OFTOs in the UK have a fixed 20-year revenue stream and there is no risk for the revenue coming from changes in the regulatory regime. The risks are only due to asset failures or cost volatility. In addition, the duration of the Cap and Floor regime is of 25 years with 5-year review periods where the cap and floor levels are reviewed. It is recommended that under a tender model for investments in a MOG, a similar regime that provides long term security for the investors with clearly defined exit possibilities (this is often investors' requirement) should be applied.

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In the case of the TSOs, the regulatory framework should take into account that the TSOs are regulated entities which are obliged to invest in transmission infrastructure while at the same time they need to aquire the necessary capital to finance the investments according to the rules and conditions of the market. A decrease of the regulated return on equity might mean a reduction in the equity available in the future. Therefore, it is important to ensure that the regulatory framework allows TSOs to attract capital from the market at a fair rate, enabling TSOs to overcome the financial challenge.

Benefits for financing

A long term and stable regulatory framework creates trust and provides investors with long term visibility thus, increasing investor confidence in remuneration level. Such a regime could attract investors with long investment horizon, such as pension funds and secure the necessary capital.

6.4 RECOMMENDATION 4: PROVIDE REGULATED INCOME FOR INVESTMENTS IN A MOG

Obstacle for financing

Merchant investments such as merchant interconnectors whose income is market-based entail higher risks for investors due to the high uncertainty when predicting the electricity prices for the lifetime of the asset (more than 10 years). In addition, the development of a MOG implies a higher interconnectivity which would lead to an insufficient remaining price difference, deteriorating the profitability of the merchant interconnector and raising the risks for investors.

Recommendation

It is recommended that the income for investments in a MOG should be regulated as this is the case with current European transmission grids. Depending on the regulatory framework, these investments should be included in the RAB of the TSOs (TSO-regime) or they should receive fixed revenue subject to the availability and performance of the assets as well as market indicators (e.g. OFTO-regime).

Benefits for financing

A regulated income creates certainty to investors by securing future returns and protects them against the price volatility of the electricity markets.

6.5 RECOMMENDATION 5: PROVIDE REGULATORY REMUNERATION DURING THE CONSTRUCTION PHASE OF THE MOG

Obstacle for financing

The development and construction phase of a MOG is capital intensive and at the same time represents the most risky phase due to technical risks, delays arising from permitting and public opposition and also high uncertainty of the development of interest rates till the commissioning of the assets. All of these factors can have a negative financial impact due to possible cost overruns. Considering that the cash flows are generated as soon as the assets are in operation, the time lag between the construction and operational phase increases the uncertainty due to non-timely recognition of costs leading to liquidity problems for the investors.

Recommendation

The regulatory framework should allow for timely recognition of investment costs by providing regulatory remuneration of the offshore transmission investments during the construction phase. In Germany and the

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Netherlands the regulatory frameworks include adjustments when it comes to offshore transmission investments. In both countries the costs of offshore investments are covered already during the regulatory period (construction and commissioning phase, t-0). Also, the Cap and Floor regime uses the IDC to define the levels of cap and floor and includes specific risk premiums which are linked with the development and the construction risks (see 3.4.3).

Benefits for financing

Regulatory remuneration during construction phase creates certainty for TSOs and especially investors who use project finance e.g. under third-party asset onwnership. This improves the availability of financing during the riskier phases of development and construction of the assets.

6.6 RECOMMENDATION 6: FACILITATE PRIVATE EQUITY PROVISION FOR THE REQUIRED MOG INVESTMENT VOLUMES

Obstacle for financing

The investment challenge of 100+ billion Euros (some stakeholders mention 200 bilion Euros by 2050) for the MOG implies a significant financing challenge particularly for the TSOs and raises questions whether the TSOs will be able in the long run to carry out the enormous investment volumes required for a MOG. In cases where the TSO is state-owned and the government is reluctant to inject further equity, alternative ways should be found to enable private equity participation in a TSO sub-structure in order to avoid increasing requirements for debt financing, which would lead to higher gearing, a lower TSO credit rating and thus, higher financing costs.

Recommendation

There should be flexibility regarding access to private equity in order to optimise allocation of capital available from global investors (European Union, Bearing Point, Microeconomix, 2015). Possible financing structures which could allow injection of external equity could be the following:

- a TSO sub-structure; TenneT managed to secure financing for the offshore grid projects in Germany through equity partnerships with private investors, while maintaining the majority of voting rights and leaving a certain part of the economic interest with the external investors. Thus, TenneT could retain the gearing at acceptable levels and consequently, the good credit rating.
- Tenders of transmission assets to third parties under a SPV structure to be responsible for the construction, operation and maintenance of the assets. Such a structure is foreseen in the UK under the OFTO Build regime for the connection of OWFs to the shore while so far the Generator (OWF) Build model has been implemented under which the OFTOs are responsible for the operation and maintenance of the assets while the construction is the responsibility of the OWF. The OFTOs are privetly owned entities, typically with a high leveraged project finance structures and they have a low risk profile due to the fixed 20-year revenue stream. In the case of a MOG, such a structure should be adapted to allow the ownership and operation of hybrid assets from third parties. Due to the success of the OFTO regime which has resulted in significant cost savings compared to merchant and regulated counterfactuals (see 3.4.2), Ofgem considers applying this approach to the onshore grid through the CATO model to introduce competition, and thus, deliver new onshore transmission assets at lower costs and increase innovation. There are also, international practices e.g. in Brazil and Peru, where the

privatisation of onshore transmission assets through competitive tenders mobilised significant amounts of capital for new transmission assets without putting an excessive burden on public finances. It is recommended that tenders of transmission assets for construction, ownership and asset operation is an approach that could be applied at the early phase of the development of the MOG to deliver rapid initial growth. However, such an approach needs strong coordination to lead to meshing and thus, maximise the social benefit.

- One entity is responsible for the construction of the MOG and after commissioning of the assets transfers them to third parties through competitive tenders for ownership and asset operation. Under such an approach, it is recommended that the 'builder' of the MOG should be formed by the national TSOs of the countries surrounding the North Sea but also allow for private investor participation (e.g.pension funds, infrastructure funds, etc). Such a structure could be seen as a dedicated equity investment fund for the early development of the MOG in the North Sea supported by public and private investors and also the EU. After commissioning of the assets, parts of the grid could be tendered to third parties to own, operate and maintain them.

Benefits for financing

By facilitating private equity provision the enormous financing needs for the development of the MOG could be tackled and the TSOs' balance sheet constraints could be overcome. There are several ownership and financing structures that could be applied. Most interviewees (investors and financiers) favoured a structure where the construction of the MOG would remain responsibility of one entity that bears the development risk while the asset operation and commercial risk stays with the third parties. This approach removes any restriction to accessing private equity from global investors during the construction phase and relieves the 'builder' from the financing burden after the commissioning of the assets. Also, the development risk could be born by the governments creating higher certainty for the private investors during the construction phase. Moreover, private investments could be attracted at the operational phase, since then the risk for the investors is lower. Such an approach could accelerate network infrastructure implementation.

Some of the interviewees stated that a dedicated equity investment fund for at least the early phase of the MOG with high public economic support but also support from private investors could reduce the risks for investors and hence, unlock private investments in a greenfield project like a MOG in the North Sea.

6.7 RECOMMENDATION 7: ALLOW REMUNERATION FOR CROSS-BORDER ANTICIPATORY INVESTMENTS THROUGH EU FUNDING

Obstacle for financing

A MOG in the North Sea is expected to be developed gradually based on individual projects and thus, certain anticipatory investments will have to be made in the expectation of future long term needs. However, cross-border anticipatory grid investments which are related to the connection of OWFs with offshore interconnectors or connections between OWFs across borders entail higher risk mainly due to the lack of coordinated grid planning for the North Sea, the regulatory complications and lack of adequate cost allocation mechanisms among the parties involved. Therefore, the NRAs approve only cross-border grid investments that have a

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domestic socio-economic benefit. Hence, TSOs refrain from taking decisions for future cross-border investments which would be otherwise beneficial from a wider socio-economical perspective.

Recommendation

Given the importance of creating the MOG, it is essential to ensure public financial support by the EU for the remuneration of the necessary cross-border anticipatory investments. To this end, the CEF or EEPR funding could be used to support crosss-border anticipatory grid investments of European interest that improve the security of supply and the economic efficiency of the grid. A North Sea regional authority could be responsible for the grid planning and decide on the required grid investments that need to be anticipated (Nieuwenhout, 2019). The EU financial intervention could eliminate the risk, bridge the financing gap due to inadequate cost allocation mechanisms and unlock the necessary investments that the national governments alone cannot deliver. This is short-term financing that is required to foster anticipatory cross-border grid investments. At a later stage, the anticipatory cross-border investments should be included in the TSOs' RAB and the national regulator should allow their regulatory remuneration.

Benefits for financing

EU funding e.g. CEF funding to support cross-border anticipatory grid investments could mitigate the risks for investors, increase certainty for the TSOs and mobilise the required capital from institutional investors and the industry. Moreover, financial support from EU could reduce the risks and costs in the eyes of the national regulators enabling, at a later stage, the inclusion of the cross-border anticipatory investments directly in the TSO RAB and allow for a regulatory remuneration. Such a measure strengthens the regulatory framework for investments and creates the right incentives for the TSOs to take up the investment challenge.

6.8 RECOMMENDATION 8: SUPPORT TECHNOLOGICAL INNOVATION THROUGH EU FUNDING AT THE EARLY STAGE OF THE MOG

Obstacle for financing

Hybrid projects which combine OWF connections and interconnections leading to meshed offshore grid designs are more complex and riskier due to the new and innovative technology that is required. The innovative technological solutions are fundamental to the development and eventual functioning of a MOG in the North Sea. However, the deployment of innovative technologies for the MOG at national regulatory level is limited; most national regulatory frameworks do not incentivise cross-border grid investments which require new and innovative technology. This poses a high risk for investors (due to higher CAPEX, OPEX, lack of operational experience and uncertainty regarding expected revenue) making finance options more costly and therefore, they prefer to invest in projects based on suboptimal standard solutions instead of more efficient options using new technologies.

Recommendation

Given the importnance of creating a MOG in the North Sea it is essential to ensure public financial support by the EU for grid investments that require technological innovation. This is short-term financing that is required to kick-start the industry when the national governments alone cannot deliver these investments. To this end, CEF or EEPR funding could be used at the early stage of the MOG development to support grid investments which use new and innovative technological solutions. For the Kriegers Flak CGS the EEPR grant of EUR 150 million

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was an essential financial support for the development of the "back-to-back" AC/DC/AC converter to synchronise the eastern Danish with the German electricity system. Energinet.dk, the Danish TSO, claimed that without the grant, the business case of the project would not be positive (Windpower Monthly, 2017).

Benefits for financing

Financial support through EU funding mechanisms, e.g. CEF, EEPR, could reduce the financial risk for the companies deploying innovative technologies, increase certainty for the TSOs and mobilise the required capital from institutional investors and the industry. Thus, public funding by the EU for innovative technological solutions could kick-start the industry and accelerate grid investments that are fundamental to the integration of higher levels of offshore wind in the electricity system and the increase of interconnection between the countries.

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8 ANNEX

Name	Category
ACS, Servicios Comunicaciones y Energia	International EPC contractor and concessions developer
BMWi	Germany Economic Ministry
EIB	Financial institution
KfW	Financial institution
Macquarie Group Limited	Financial Services
TenneT TSO B.V.	TSO
TenneT TSO GmbH	TSO

Table 22: List of interviewed stakeholders

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