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Polycentric marine governance for the offshore renewable energy transition

Evaluating the ability of North Sea Wind Power Hub consortium to address barriers and drivers to the energy transition on the North Sea

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Robin Verheij, 941006875120
Master International Development Studies (MID)
Specialisation Politics & Governance - Sustainable Development Diplomacy

Supervisor: dr. Tamara Metze
Second readers: dr. Judith van Leeuwen, prof. dr. ir. Katrien Termeer
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Abstract

The shallow and wind-rich North Sea offers potential for large-scale offshore wind energy generation and contribute significantly to the European Union renewable energy goals. Yet, the energy transition on the North Sea faces technical, political, economic, legal, spatial and institutional barriers. According to the North Sea Wind Power Hub consortium, the main barrier is the limited and fragmented nature of international cooperation for offshore wind. This thesis considers the consortium as an embodiment of an alternative, more polycentric approach to offshore wind governance that emphasises multi-actor and multi-level cooperation. It evaluates the ability of the consortium to address existing barriers and drivers to the energy transition on the North Sea. This thesis argues that the consortium effectively addresses technical and legal barriers; moderately addresses political and economic barriers; and insufficiently addresses institutional barriers. With its techno-economic focus, the consortium risks to overlook disputes that may arise between stakeholders because of knowledge lacunas on the environmental impact of large-scale offshore wind. Furthermore, the nature of stakeholder involvement remains unclear. This thesis provides a framework for further research into polycentric governance of offshore wind energy, which analytically separates offshore wind from other renewable energy sources due to its situation in the marine space. Besides, this thesis combines the descriptive use of polycentric governance literature with its prescriptive purposes, allowing for (future) evaluations and recommendations to improve existing polyentric governance arrangements such as the North Sea Wind Power Hub.

Contents

Acknowledgements

The relationship between natural resources and politics fascinated me throughout my student career. In my bachelor thesis, I researched the existence of a subnational 'resource curse' in Russia's oil- and gas rich regions quantitatively. In this master thesis, I analyse international cooperation on offshore wind energy on the North Sea in a qualitative manner. Interestingly, not only my research topics transitioned from fossil fuels to renewable energy: the global momentum did so as well.

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Chapter 1: Introduction

In 2015, 195 countries negotiated the 'Paris Agreement' that stimulates a novel approach to reduce Greenhouse Gas (GHG) emissions and keep the global temperature rise 'well below' two degrees Celsius above pre-industrial levels (United Nations, 2015). Reducing GHG emissions requires an energy transition from fossil fuels to renewable energy sources (RES). Renewable energy entails different sources, including solar, thermal, hydro, tidal, wind, wave and geothermal (Boyle, 2004). In an effort to reach the goals of the Paris Agreement, the European Union (EU) promotes the energy transition through its 'Renewable energy directive' with binding targets of at least 20% renewable energy by 2020 and 32% by 2030. Offshore wind energy plays a crucial role in the energy transition of countries bordering the shallow and wind-rich North Sea, which provides great potential for the generation of large-scale offshore wind energy.

EU Member states draft 'National Energy & Climate Plans', based upon their 'starting point and overall potential for renewables' (''Renewable energy directive'', n.d.). The Netherlands for instance, formulated a 'Climate Agreement' with the target to generate 70% of its energy demand from renewable sources by 2030. The Climate Agreement highlights the 'tremendous potential' for large-scale offshore wind energy to realising this 2030 target (Klimaatberaad, 2019: 167). These offshore wind ambitions necessitate a revised spatial planning on the North Sea, where various sea uses such as energy generation, food production and nature protection are at play. For this reason, various stakeholders active on the North Sea, together with the Dutch government, negotiate the spatial distribution of the Dutch Exclusive Economic Zone (EEZ) in an effort to produce a 'North Sea Agreement' (Overlegorgaan Fysieke leefomgeving, 2019).

As this example of the Netherlands shows, the current approach creates a situation where EU member states individually draft and implement energy policies to reach national targets that are derived from the overarching EU targets. Currently, the 'North Sea countries', which include France, Belgium, the Netherlands, Germany, Ireland, the United Kingdom, Sweden, Norway and Denmark, individually develop offshore wind farms in the North Sea and the generated electricity feeds into one country. There is little institutionalised cooperation between countries and the little internationally coordinated decision-making that exists takes place in fragmented areas of the process such as marine spatial planning and grid connection. Since the North Sea countries' energy priorities vary in approach and speed, this situation impacts the business case for renewable energy as well as the space for energy policy implementation in neighbouring countries (Franza et al., 2018: 8). Hence, a large part of the offshore wind potential of the North Sea remains to be harnessed in the light of the targets of the EU renewable energy directive and the Paris Agreement.

Apart from the limited and non-integrated institutionalised cooperation between North Sea countries, the energy transition on the North Sea encounters other factors that hamper or accelerate the process. These 'barriers and drivers' include technical barriers such as intermittency of supply; political drivers such as the Paris Agreement; economic barriers concerning market insecurities; and legal and spatial barriers concerning marine spatial planning. Hybrid offshore wind projects aim to overcome these barriers by linking (existing and new) offshore wind farms to a transboundary, interconnected, grid on the North Sea. The idea is that jointly developing offshore wind farms and interconnectors creates 'a platform for coordination' between countries

(Weichenhain et al., 2019). The North Sea Wind Power Hub consortium (hereafter: 'NSWPH' or 'the consortium'), consisting of TenneT Netherlands and Germany, the Port of Rotterdam, Gasunie and Energinet, is an example of a party that stimulates large-scale offshore wind on the North Sea through hybrid offshore wind projects. The consortium informs policymakers on the techno-economic costs of offshore wind-related processes and aims to foster international cooperation and offshore grid interconnection, for instance by creating a platform for dialogue between various stakeholders.

This thesis considers the consortium as an effort to increase the degree of polycentric offshore wind governance in order to address existing barriers and drivers to the energy transition. A polycentric governance system is characterised by multiple centres of decision-making on multiple scales, from local to global, involving a diversity of actors from public, private and non-governmental spheres interacting with each other (Nagendra & Ostrom, 2012: 116). Although the current European renewable energy system is polycentric since various issue areas (technical, political, economic, legal, spatial) reflect various centres of decision-making, its degree of polycentric governance is limited due to the little amount of cooperation between governments and stakeholders on an international scale. Increasing the degree of polycentric governance could help to address existing barriers and drivers in an efficient and effective manner. A principal advantage of high degrees of polycentric governance is that it allows for experimentation and learning at different levels of governance, which offers opportunities to test new and potentially preferable institutional arrangements (Ostrom, 2009; Galaz et al., 2011: 8-9). This way, knowledge on the efficiency and effectiveness of policies will increase through trial and error (Ostrom, 2009: 31; Aligica & Tarko, 2012: 242). Ultimately, polycentric governance has the potential to reconfigure existing regimes (Hodson & Marvin, 2010: 482). This thesis approaches the NSWPH as an example of a potentially preferable institutional arrangement. It identifies barriers and drivers to the energy transition on the North Sea and evaluates the ability of the polycentric governance arrangement proposed by the NSWPH to address them.

The hybrid character of the proposed offshore wind arrangement adds extra complexity to its governance given its transboundary nature and its situation in the marine space. Existing research on polycentric renewable energy governance is not sufficient to identify barriers and drivers as it overlooks spatial issues specific to the marine context. Therefore, this thesis separates offshore wind analytically from other RES and takes into account the marine governance literature. Marine governance is defined as: 'the sharing of policy making competencies in a system of negotiation between nested governmental institutions at several levels (international, (supra)national, regional and local) on the one hand and governmental actors, market parties and civil society organizations on the other in order to govern activities at sea and their consequences' (Van Tatenhove, 2011: 87). With its emphasis on the diversity of actors at play on different levels of governance, marine governance research clearly contains polycentric elements.

The polycentric governance perspective appears in existing marine governance literature, addressing different actors and sea uses ranging from shipping (Van Leeuwen, 2015; Gritsenko, 2014), ecosystem-based marine resource management (Raakjaer et al., 2014; Gruby & Basurto, 2014; Morrison, 2017; Österblom & Folke, 2013; Soma et al., 2015), fisheries (Gelcich, 2014), marine litter (Kerber, 2017), marine spatial planning (Greenhill & Tett, 2018) and recently also in global

ocean governance (Mahon & Fanning, 2019). However, literature specifically on the polycentric governance of offshore wind energy is still scarce. This thesis provides a conceptual framework for future research into polycentric governance for offshore wind energy. It suggests that research takes into account the growing role of information in stakeholder interactions as well as various forms of stakeholder involvement.

A particular strength of polycentric governance research is that it allows for ex-ante hypotheses on polycentric indicators and their importance for specific institutional designs (Andersson & Ostrom, 2008: 79). We are able to ex-ante evaluate the effectiveness of the NSWPH consortium because it concerns a proposed governance arrangement with concrete measures formulated to address existing barriers and drivers. Thus, the evaluation entails the goals and preferred cooperation of the consortium. Before we can ex-ante evaluate this polycentric governance arrangement it is important to identify the existing barriers and drivers to the energy transition on the North Sea. This raises the following research question: *''what hinders and accelerates the transition to large-scale offshore wind energy on the North Sea?''*, which consists of the following two sub-questions:

- What barriers and drivers influence the transition to large-scale offshore wind energy on the North Sea?
- To what extent are hybrid offshore wind projects able to address the barriers and drivers to this offshore wind energy transition?

While the first question is descriptive, the second question evaluates the effectiveness of a newly proposed governance arrangement and is therefore prescriptive. In an effort to answer these two questions, this thesis provides a conceptual framework of barriers and drivers to offshore renewable energy transitions emerging in several issue areas: technical, political, economic, legal - spatial and institutional. This framework of issue areas enables us to analyse empirically the case-specific barriers and drivers emerging from documents and interviews. For some barriers and drivers, the situation in the Netherlands serves as an illustration.

The institutional issue area plays a dual role in this research. On the one hand, it *describes* institutional barriers to the offshore wind energy transition such as the low degree of international cooperation. On the other hand, it provides a list of overarching drivers for cooperation in a polycentric governance construct, including for example 'diversity of stakeholders', 'information sharing' and 'mechanisms for monitoring'. We call these overarching drivers 'polycentric indicators': the more indicators a governance arrangement displays, the more effectively the arrangement addresses barriers and drivers. These indicators *prescribe* what effective cooperation ought to look like and enable us to evaluate the ability of the NSWPH governance arrangement to address the case-specific barriers and drivers. One of the strengths of this thesis is that it combines the descriptive as well as the prescriptive use of polycentric governance literature into one framework.

Eventually, this thesis argues that a couple of polycentric indicators are present in the consortiums proposed governance arrangement, especially 'data on costs and benefits'. This enables the consortium to efficiently address the barriers apparent in the technical and economic issue area. On the other side, some important indicators including 'transparency and trustworthiness' and 'mechanisms for monitoring' remain unaddressed and are therefore not sufficient to mitigate the

barriers and drivers in the institutional and spatial issue areas. The conclusion of this thesis provides recommendations on how to approach the remaining issue areas from a polycentric perspective: it suggests that the NSWPH is more susceptible to the role of information in various offshore wind-related processes and that it closely considers its preferred nature of stakeholder implementation and environmental protection. As the hybrid project of the NSWPH consortium is still on-going, these recommendations create an intermediate feedback moment.

Chapter 2: Conceptual framework

Throughout the literature, the polycentric governance perspective may play multiple roles, serving different aims: from descriptions of existing governance arrangements, to more normative approaches of how such arrangements should be organised. These are different, yet not mutually exclusive components of the same perspective. According to Thiel (2016, 3), the understanding of polycentric governance as a descriptive concept developed over time into additional understandings, including polycentricity as normative theory. In the first place, polycentric governance can be used to describe 'structural features of static governance arrangements', taking into account the different actors at play and the relationships between them (Thiel, 2016: 6). This approach can be considered as an analytical model that highlights components of existing policy networks (Van Tatenhove, 1993; Van Tatenhove & Leroy, 1995). In an additional understanding of the theory, the normative application of polycentric governance refers to 'the interrelations between a set of variables and their effect upon a specific, desirable outcome' (Thiel, 2016: 6; see also Hajer, Van Tatenhove & Laurent, 2004: 17). In this approach, policy networks can be considered as a guiding model, prescribing how to arrange policy networks in such a way that political and societal problems are solved most effectively (Van Tatenhove, 1993; Van Tatenhove & Leroy, 1995).

This thesis unites two different uses of polycentric governance theory: on the hand, it describes the barriers and drivers that exist in the current polycentric context. On the other hand, it evaluates the ambition of the NSWPH consortium, which is a more normative statement as polycentric indicators hint towards what polycentric governance ought to look like. This reveals the underlying normative assumption that higher degrees polycentric governance arrangements are more efficient and effective than governance arrangements with low degrees of polycentric governance. These two applications come together in the conceptual framework described in this section, which provides one of the strengths of this thesis.

Polycentric governance research is particularly prominent in the domain of natural resources, where the management of a 'common pool resource' is approached as a collective action problem. A common pool resource is characterised by both a high subtractability of use and and the difficulty of excluding potential beneficiaries, which creates possibilities for free-riding behaviour of certain stakeholders (Ostrom, 2010: 5). The governance of common pool resources involves making complex decisions under uncertainty, biophysical constraints and conflicting values and interests (Dietz, Ostrom & Stern, 2003: 1907). Examples of work polycentric governance theories applied to natural resources include articles on irrigation systems, fisheries, land (degradation) and forests (Ostrom, 2005; Nagendra & Ostrom, 2012; Galaz et al., 2011).

This section looks into polycentric governance applied in the literature on renewable energy governance and marine governance in order to describe barriers and drivers to offshore renewable energy transitions. These barriers and drivers emerge in different issue areas: technical; political;

economic; and legal-spatial. Combining two strands of literature allows us to identify a broader spectrum of issue areas than considering only one: marine governance literature largely informs the legal - spatial issue area. Combining different issue areas into a framework allows us to identify empirically the barriers and drivers specific to our case in the analysis of this thesis. Thus, the framework serves to analyse all included documents and interviews.

After discussing the technical, political, economic and legal-spatial issue area, which will serve to describe the current governance arrangement and is thus the descriptive application of polycentric governance theory, this section proceeds to the institutional issue area. This particular issue area includes barriers and drivers as described in the renewable energy and marine governance literature, as well as drivers to effective cooperation in polycentric governance constructs derived from general polycentric governance literature. These overarching drivers, which we call polycentric indicators, enable us to analyse to what extent these indicators are apparent in the documents published by the NSWPH – reflecting the normative use of polycentric governance literature. Table 1 merges the drivers and barriers per issue area and the polycentric indicators into a conceptual framework.

Issue area: technical

Since energy systems consist of complex infrastructure such as large power utilities and grid connections (Koster & Anderies, 2013: 34), energy transitions require structural changes to broader socio-technical systems (Smith & Stirling, 2010). As scaling up renewable energy technology increases the complexity of energy systems, with different energy sources across different scales increasingly integrated into one grid, the grid infrastructure should be able to support its transmission (Goldthau, 2014: 138; Koster & Anderies, 2013: 40). In other words, being able to use large-scale renewable energy necessitates appropriate infrastructure.

Translating this insight to the marine context, we see that the energy transition to offshore wind involves both the development of technology that generates offshore wind (such as the turbine), as well as the integration of this energy into a grid that transmits the energy to land. The offshore grid in the North Sea combines power from renewable sources (mostly wind) with transmission lines of other technologies such as oil and gas (Dedecca et al., 2019: 56).

Technical barriers include ensuring the reliability and resilience of devices, for instance in the case of extreme waves or little wind. Currently, the offshore grid in the North Sea is expanding. Important challenges and opportunities relate to the way in which energy is transmitted from for example an offshore wind farm to land. Conventionally, a wind farm is connected to one country and from there can be transmitted to another country, resulting into a ‘non-integrated grid’. Recently however, new developments have paved the way for an ‘interconnected grid’, where the planning for both energy generation and transmission occurs simultaneously (Dedecca et al, 2019: 56). Concretely, this means that already off the shore, grids are interconnected and energy can flow directly from the wind farm to multiple countries. Such ‘hybrid projects’ (of which the North Sea Wind Power Hub is considered an example), could produce more socio-economic and environmental advantages than the traditional, non-integrated approach. However, hybrid projects also encounter barriers and drivers due to their transboundary character. Some of the following issue areas will touch upon such barriers and drivers

Issue area: political

The main political driver for energy transitions emerging from the literature is government commitment, which includes the need for governments to deliberately intervene and shift current technologies and practices (Shove and Walker, 2007: 763; Koster & Anderies, 2013). Concretely, this entails a willingness to 'levy taxes, implement regulations, and invest in innovation' (Sovacool, 2011: 3842). In their interventions however, governments must also be willing to share power with other stakeholders Sovacool (2011: 3842). According to Goldthau (2014: 138), this can pose a barrier in the sense that regulation by a government becomes more complex, as 'the more the liberal paradigm informs national or regional energy policy, the more the number of involved actors is likely to increase'

The marine governance literature also highlights the importance of government commitment. Yet, Johnson, Kerr & Side (2013: 497) highlight the difficulty that government interventions such as economic measures and infrastructure planning make marine renewables a very politicised topic. What helps in this regard is the backing of the EU governance framework that helps to shape the evolution of offshore wind, for example with its 'Energy Union' as a holistic approach to address several energy and climate goals (Dedecca et al, 2019: 55-56).

Issue area: economic

Economic incentives may drive the achievement of energy targets. Examples of economic support schemes are tenders, fiscal measures (Kitzing, Mitchell & Morthorst, 2012), subsidies, loans and feed-in tariffs. Feed-in-tariffs ensure that a grid operator pays a set price for renewable energy, so the costs of the renewable energy generator are covered (Koster & Anderies, 2013: 43). Promoting only one financial incentive will not increase renewable energy use in a system that is as complex as the energy system. Therefore, governments need to promote a diverse range of measures. The eventual aim is that sustainable financial schemes can replace state support with market-based support (Koster & Anderies, 2013: 54).

Investment in renewable energy technologies is steadily increasing (Koster & Anderies, 2013: 34) as decreases. As a consequence, renewable energy has become competitive with fossil fuels. Economic competitiveness is a necessity for a (renewable) energy technology to develop. Being competitive as a country requires such high levels of installed power that it could be too ambitious for one country to deploy, which highlights the need for transnational cooperation (Guerra, 2016: 531).

According to the marine governance literature, accurate planning and stability are vital since offshore wind projects are developed over long timescales (Guerra, 2016: 533). However, forward-planning of offshore wind is largely non-existent, which increases risk and therewith costs. Here, the 'ad hoc' nature of the sectoral marine management approach creates uncertainty, for example about the spaces that will be dedicated to wind farms (Young, 2015: 157).

Issue area: legal - spatial

The literature on the polycentric governance of renewable energy addresses legal barriers to a limited extent. It states that cince polycentric governance spans over different scales, it encounters

various laws and regulations. A variation in rules at the national and international level can lead to unclarity for actors and foster inefficiency (Sovacool, 2011: 3833).

In the context of offshore wind and therewith in the marine governance literature, the legal aspect in combination with space becomes salient. This has to do with the increasing amount of ocean stakeholders and interests, which makes seas more and more crowded, combined with declining ocean health (Wright et al., 2016: 115).

The United Nations Convention on the Law of the Sea (UNCLOS) of 1982 outlines how the world's oceans are divided between countries and sea uses. This convention for example divides the North Sea into different Exclusive Economic Zones (EEZ) of surrounding countries. Even though the UNCLOS regulates sea uses, it does not cover marine renewable energy completely: regulation of this sector is scattered over various national and international regulations without a coherent institutional framework (Castelos, 2014: 228; Wright et al., 2016: 128). Different countries pursue different regulations for planning and siting of offshore wind (Guerra, 2016: 533), which constitutes barriers for the construction of wind farms as well as for offshore cable infrastructure. Improved international coordination and cooperation could reduce inefficient levels of fragmentation, but this process can be time-consuming (Wright et al., 2016: 128).

According to Young (2015), marine spatial planning provides a way to overcome the above described barrier as it is 'an integrated planning framework that informs the spatial distribution of activities in an on the ocean in order to support current and future uses of ocean ecosystems and maintain the delivery of valuable ecosystem services for future generations in a way that meets ecological, economic and social objectives' (Young, 2015: 154-155). MSP is an instrument to coordinate the fragmented management of different sea uses in a rational way while also ensuring environmental responsibility. MSP has the potential to harmonise legal frameworks, different government departments and different sectoral interests (Wright et al., 2016: 131). Depending on the way in which priorities are assigned and implemented, MSP can facilitate the offshore wind industry. Concrete factors that drive implementation are for example the degree of stakeholder engagement and commitment to prioritise offshore wind in the allocation of marine space (Young, 2015: 173).

Even though MSP on paper addresses many barriers, its significance for the development of offshore wind is also contested. Guerra argues for example that MSP is an example of a 'mono-instrumental approach', which does not recognise the broader constellation of various actors, contexts and existing policies at play (2016: 530). Wright et al. (2016: 131) note that early experience with MSP suggests that it can undermine environmental protection, depending on the prioritisation of uses and whether it focuses on opportunities or rather limitations.

Issue area: Institutional

The barriers and drivers below reflect institutional barriers to the current energy system. They reveal the ways in which cooperation within and between the previous issue areas is organised among various actors on various levels, which will enable us to describe and analyse the current polycentric context. This section subsequently describes the polycentric indicators that serve as evaluation criteria for governance arrangements, which will enable us to formulate a normative statement on the governance arrangement proposed by the NSWPH.

Undeniably, for polycentric governance theorists, the level of centralisation of energy governance shapes outcomes. A monocentric and thus centralised approach to energy transitions minimises the options for effective solutions to appear at different levels in society, let alone to engage in sub- or international feedback loops (Goldthau, 2014: 138). An example of a monocentric governance arrangement unable to address the various scales at which energy governance takes place is the German 'Energiewende', where the low degree of international coordination resulted in grid stability problems in surrounding provinces in Poland, the Czech Republic and the Netherlands (Buchan, 2012).

Transitions are path-dependent (Verbong & Geels, 2007: 1026), case-specific (Smith & Stirling, 2010) and never ending (Kemp et al., 2007). System change requires coordinating multiple actors and resources: only when developments connect institutions, networks and actors at different levels, they can transform an existing socio-technical system (Smith et al., 2005: 1492). Often, the diffusion of a certain energy technology is hampered by the stable nature of existing regimes: vested interests in a socio-technical regime can for example prevent the adoption of a new energy source (Smith et al., 2005: 1491).

The marine governance literature also highlights the level of centralisation of energy governance as a factor to take into account: the governance of marine renewable energy should be sensitive for the existence of various stakeholders on multiple levels and the networks between them. Problems may arise if no coordination exists between too many institutions and issue areas (Guerra, 2018: 28; Zürn & Faude, 2013). Regarding these multiple issue areas, creating an enabling institutional context for offshore wind further may involve 'addressing the possible interactions of a given policy instrument with other energy or non-energy policies' (Guerra, 2016: 534). Concretely, this implies that different goals and different policy domains should interact with each other (Van Leeuwen & Van Tatenhove, 2010) in order to promote offshore wind. Examples of such institutional synergies exist in the domains of energy security, economic development, international cooperation and environmental protection (Guerra, 2018: 26).

Another barrier to the acceleration of renewable energy identified by Guerra (2016: 529) is the underdeveloped state of environmental impact assessments. This has to do with existing knowledge gaps on the environmental impacts of offshore wind farms and transmission expansion, given the difficulty of studying the marine environment (Wright et al., 2016: 128; Young, 2015; Smith, 2008). These issues relate to a broader concern in energy governance, namely the question how polycentric systems should deal with the increasing dominance of information in governance, which Soma et al. (2016) call the 'Information Age'. This concept touches upon how information technologies, information networks and social media influence environmental governance outcomes. The authors argue that on one side, this creates opportunities for, among others, information exchange, feedback, debate, learning and innovation, while on the other side it blurs 'the power of classic public and private institutions as nobody is in control of information' (Soma et al., 2016: 89). Consequently, various actors deploy the transformative power that the uncontrolled flows of information provides (Mol, 2008).

Polycentric indicators

Now that we discussed the barriers and drivers to (offshore) renewable energy transitions, we will zoom out to broader polycentric governance literature and derive normative indicators for effective cooperation in polycentric energy governance constructs. Governance of common pool resources involves making complex decisions under uncertainty, biophysical constraints and conflicting values and interests (Dietz, Ostrom & Stern, 2003: 1907). Therefore, as individual actors do usually not have access to perfect information, environmental decisions inherently entail trade-offs (Dietz, Ostrom & Stern, 2003: 1909). Yet, certain settings are more conducive to learning about each other's interests and values than other settings (Ostrom, 2009: 11). The polycentric governance perspective provides an analytical lens for examining what factors drive cooperation and decision-making in complex governance constructs surrounding common-pool resources. More specifically, it can elucidate what institutional arrangements actors develop to become effective partners, unfolding effective performance on the long term (Nagendra & Ostrom, 2012: 127). Concerning these institutional arrangements, there are several indicators that enable cooperation in polycentric governance constructs, which we will discuss below.

The introduction of this thesis pointed out that polycentric governance entails governance between various stakeholders at various levels of governance (Nagendra & Ostrom, 2012: 116). Information plays a central role in polycentric governance constructs: it should be trustworthy, verifiable and understood at relatively low cost (Dietz, Ostrom & Stern, 2003: 1908). Furthermore, it should be shared frequently and consider the short- and long-term costs and benefits of actions (Ostrom, 2009: 12). As science is never exhaustive, decision-makers also need information on existing uncertainties (Dietz, Ostrom & Stern, 2003: 1908).

This information should be monitored at all levels, even though this can be challenging (Dietz, Ostrom & Stern, 2003: 1908), because monitoring through a set of agreed-upon rules allows for feedback and learning (Ostrom, 2009: 11). In order to create consensus on governance rules, various actors should be actively involved in a structured dialogue (Dietz, Ostrom & Stern, 2003: 1908). The larger the natural resource, the more difficult monitoring will be. For this reason, monitoring should happen in a transparent way and be open for the possibility of challenge by stakeholders (Nagendra & Ostrom, 2012: 125). In order to further encourage adaptivity of institutions to unanticipated events, rules should not be too fixed on the status quo as optimal scales of organisation can shift, as well as biophysical and social systems (Dietz, Ostrom & Stern, 2003: 1909).

Monitoring should ideally induce compliance. Another factor that induces compliance is when actors trust each other and feel that their actions and willingness to cooperate are reciprocal. This also builds commitment and can motivate actors to take responsibility for their own achievements, on both the short and the long term (Ostrom, 2009: 12).

Inherently to cooperation between various environmental actors with diverging powers and values, conflicts will arise. If a polycentric system manages to deal with conflict effectively, it can evoke learning and change (Dietz, Ostrom & Stern, 2003: 1909). Mechanisms to resolve conflict at low cost are therefore vital (Ostrom, 2002: 1331). Thus, formal and informal sanctions that are considered legitimate and enforced equitably on all are in place (Ostrom, 2009: 12).

If we understand polycentrism in terms of degrees, we could argue that low levels of polycentricism can pose in itself a barrier to effective energy governance. In the case of low degrees of polycentricism, decisions with environmental consequences such as level of energy use, type of investments and new technology for energy production, are made by independent actors in fragmented policy areas without communication between them (see Kemp et al., 2007: 78). This could lead to policy inconsistency, contradicting actions and inefficiency (Ostrom, 2009: 9), which in turn may hamper effective energy governance. In other words, increased sensitivity of the polycentric indicators present at the described levels might contribute to our understanding of what influences transitions to renewable energy.

In sum, this chapter provided a conceptual framework of several issue areas with barriers and drivers to energy transitions and, more specifically, offshore wind energy transitions. These issue areas contain technical, political, economic, legal - spatial and institutional barriers and drivers and enable us to analyse the case-specific barriers and drivers as they appear in the analysed documents and interviews. Besides serving as an issue area for applied polycentric governance, the institutional issue area provides general indicators for effective polycentric governance: polycentric indicators. These indicators are based upon broader polycentric governance literature and are considered drivers to overcome the barriers in different issue areas. The indicators are: governance on multiple scales; interaction between scales; diversity of actors; information sharing; transparency and trustworthiness of information; data on costs & benefits; and mechanisms for: monitoring; feedback; inducing compliance; conflict resolution; sanctioning; and encouraging adaptivity. The polycentric indicators enable us to analyse documents published by the consortium to evaluate if their proposed governance arrangement is indeed able to overcome the case-specific barriers.

	Technical	Political	Economic	Legal - spatial	Institutional
Governance of renewable energy transitions (descriptive)	Driver: - Ability of energy infrastructure to support scaling up of RES	Driver: - Government commitment	Driver: - Existence of diverse economic support schemes - Competitiveness with fossil fuels, e.g. through transnational cooperation	Barrier: - Variety of rules on national and international level	Barriers: - Centralised (monocentric) approach to energy transitions - Divergent interests - Vested interests
Marine governance (descriptive)	Barrier: - Reliability and resilience of offshore grid Driver: - Energy transmission through interconnected grid	Barrier: - Government intervention politicises marine renewables Driver: - Backing of EU Energy Union	Barrier: - Little forward-planning of offshore wind, creating uncertainties for investors	Barrier: - Crowded seas - Variety of regulations for planning and siting of offshore wind Driver: - marine spatial planning (but is contested) - Improved international cooperation	Barrier: - No coordination between actors and issue areas - Knowledge gaps on environmental impact of offshore wind; influence of information on governance outcomes
Polycentric governance (prescriptive)					*Polycentric indicators (drivers):* - Governance on multiple scales; interaction between scales; diversity of actors. - Information sharing: transparency & trustworthiness; data on costs & benefits. - Mechanisms for: monitoring; feedback; inducing compliance; conflict resolution; sanctioning; encouraging adaptivity.

TABLE 1: CONCEPTUAL FRAMEWORK OF ISSUE AREAS WITH BARRIERS AND DRIVERS.

Chapter 3: Contextual background

The potential for generating offshore wind energy in a specific water basin is determined by the average performance of the wind speed over the course of a year; the deepness of the basin; and the distance of a wind farm from shore. With its high quality wind, relatively shallow water and proximity to shore, the North Sea provides good conditions for generating offshore wind energy on a large scale (Offshore Wind Outlook, 2019: 49-51). Besides these geographical factors that determine the technical potential for offshore wind, there are many factors that influence its implementation. This chapter discusses the broader context of offshore wind developments before it zooms in on hybrid offshore wind projects.

Cooperation on the North Sea

The countries surrounding the North Sea, individually organise their maritime affairs regarding their Exclusive Economic Zones (EEZ). Concerning marine spatial planning for example, the Netherlands is in the process of drafting a 'North Sea Agreement', which should facilitate the energy transition and therewith reach the goals of the Paris Agreement. Consequently, the current spatial division of the Dutch part of the North Sea needs to be revised, which requires taking a new look on the division between energy, nature and food provision (fisheries) (Adviesrapport Noordzee, 2019). During 'North Sea consultations', various stakeholders that have a claim on the North Sea participate in discussions on what the new spatial planning will look like.

These national affairs are situated in a broader, European context. In 2016, ten European countries signed the 'Political Declaration on energy cooperation between the North Seas Countries' to follow up on the Paris Agreement. These countries include France, Belgium, Luxembourg, the Netherlands, Germany, Ireland, the United Kingdom, Sweden, Norway and Denmark. The aim of this cooperation is firstly to facilitate the cost-effective deployment of offshore renewable energy and secondly, to promote grid interconnection between the countries in the region. This energy cooperation involves four work areas: maritime spatial planning; development and regulation of offshore grids; finance for offshore wind projects; and a support framework for technical rules and regulations. The Political Declaration suggests that countries voluntarily move to a bottom-up approach, including 'strong political commitment at the national level' (Political Declaration on energy cooperation between the North Seas Countries, 2016: 2). According to the declaration, regional cooperation is an important instrument to progress towards an internal energy market including further market integration and grid interconnection. Cooperation is cost-effective since it can reduce transaction costs and has the potential to exploit benefits of scale. The European Commission, as 'an important source of knowledge, analysis and capacity', should stimulate this cooperation process (Ibid.). There are different platforms and support groups in place where member states can liaise, such as the European Maritime Spatial Planning Platform or ENTSO-E where Transmission System Operators (TSOs) cooperate on the transmission system. Besides cooperation between national governments, the report underlines that it is important to ensure an open dialogue with key stakeholders such as system operators, regulatory authorities, business, civil society and institutional investors (Ibid.).

In 2019, three years after the initial Political Declaration, the North Seas countries published a 'Joint Statement on the deliverables of the energy cooperation between the North Seas Countries'. This Statement mentions that the costs for offshore wind farms have dropped faster than expected and that the need for regional or international cooperation 'may also come sooner than expected' (p. 2). The Statement further identifies concretised targets for the four work areas defined in 2016. Examples of these targets are increasing knowledge on the cumulative impact assessment of wind farms and the need to work towards a common environmental impact assessment methodology. Another insight gained since the Political Declaration of 2016 is that regional coordination in the development of 'hybrid offshore wind projects' linking offshore wind farms internationally with interconnectors could provide cost reductions in comparison to isolated developments (North Seas Energy Cooperation, 2019: 1).

The North Sea Wind Power Hub

The North Sea Wind Power Hub consortium is a concrete hybrid project that the North Seas Energy Cooperation points out. The consortium consists of four Transmission System Operators (TSOs): TenneT Netherlands and Germany, Gasunie and Energinet; and the Port of Rotterdam. Regardless of the above described EU-wide efforts for international cooperation on offshore wind, the consortium states that currently there is no institutionalised process within the European Union regarding an interconnected trans-European grid (Interviewee 2). The consortium embodies an alternative approach to this 'short term and fragmented' energy system, by emphasising concerted international and multi-stakeholder cooperation (North Sea Wind Power Hub(1), 2019: 3).

Traditionally on the North Sea, electricity generated on a wind farm is transported to one country as the power feeds into one national grid. On shore, electricity can travel for example from the Netherlands to Germany or the other way around. In other words, the generation of wind power on wind farms and the transmission of this power to land through a grid are developed and operated as two separate elements of offshore wind. This means that conventionally, there is limited to no coordination between the planning and construction of wind farms, the grid they feed into and where this grid leads. To be able to make use of the large potential for offshore wind on the North Sea, future wind farms have to be built further out in the sea, which complicates its development. Hybrid offshore wind projects aim to combine the development of offshore wind (the construction of the turbines) with its operation (transmission of generated energy). With a 'modular Hub-and-Spoke concept', wind farms will be connected to a (couple of) hub(s) on the North Sea, connecting energy markets of the countries bordering the North Sea and integrating them into the onshore energy networks. Concretely, this could be implemented by at least two countries that jointly develop an offshore wind farm and an interconnector, with grids leading to both countries. This allows for more transboundary energy coordination, is economically attractive and uses less overall sea space than conventional projects, leaving more space for other sea uses (Weichenhain et al., 2019). Additionally, the Hub-and-Spoke concept can potentially serve as a source for other forms of energy, for example by using hydrogen for energy storage (North Sea Wind Power Hub(1), 2019).

According to one of its concept papers, one of the primary benefits of the Hub-and-Spoke concept 'concept in an internationally coordinated approach is the higher likelihood of delivering on the Paris Agreement, through lower costs, higher value for society, lower risk of delay and stranded

assets, stable long-term market conditions and minimised environmental impact' (North Sea Wind Power Hub(4), 2019: 4). Besides implementing this hybrid concept, the consortium aims to inform the broader discussion on the energy transition and large-scale offshore wind developments. It intends to facilitate decision-making of governments by bringing in expertise of the various consortium partners, mainly concerning the techno-economic implications of different policy decisions (Interviewee 2). An example of a policy decision that the consortium tries to be involved in is the designation of space for offshore wind farms and cables on the North Sea: if only fragmented areas remain for offshore wind, for the benefit of for example nature reserves, this could hinder the potential for economies of scale (Interviewee 2). Other activities of the Hub comprise finance, rule-making, information sharing and networking (North Sea Wind Power Hub Consortium presents achievable solution to meet climate goals, n.d.). The consortium cooperates with the governments of Denmark, Germany and the Netherlands, the European Commission and other stakeholders such as policymakers, offshore wind farm developers and non-governmental organisations. The consortium furthermore invites other North Sea countries to also participate in the discussion, such as the network operators of Norway and the United Kingdom (North Sea Wind Power Hub Consortium presents achievable solution to meet climate goals, n.d.).

Hybrid projects are complex because they integrate 'multiple assets in one project across maritime boundaries' (Weichenhain et al., 2019: 29). The first project could be operational in the 2030s, as it takes over ten years of development- and construction time in order to realise the Hub. For this reason, it is important that the involved countries soon decide on the crucial elements of the project. This thesis shows that the implementation of hybrid offshore wind projects is not straightforward due to existing barriers and drivers to the energy transition on the North Sea as well as hybrid-specific barriers and drivers. It evaluates the ability of the proposed hybrid approach to offshore wind to address these barriers and drivers. The following chapter describes the methods used for researching this.

Chapter 4: Methodology

This thesis describes the barriers and drivers to the energy transition on the North Sea and evaluates the ability of the hybrid offshore wind approach by the NSWPH consortium to address them. This chapter discusses the research design and methods used for data collection and qualitative content analysis.

Research design

Polycentric governance research inherently entails multi-level and multi-actor cooperation. It suggests that the way in which this collective action is shaped, produces certain outcomes. Cooperation on multiple levels can for example produce a more efficient way to approach polycentric challenges. That is to say, actors construct the social world (see Ritchie et al., 2013: 13). This constructionist character dictates the qualitative research design of this thesis.

The research strategy of this thesis is to conduct a case study, which fits the nature of the research question since it concerns a 'what'-question. Case studies can provide a detailed and contextualised understanding of processes underlying a phenomenon (Bhattacherjee, 2012: 107). They also allow for an investigation into the perspectives of various actors at multiple levels of analysis (Bhattacherjee, 2012: 93), which is relevant for this research on multi-actor and multi-level governance. The selected case is that of the North Sea Wind Power Hub consortium because it aims to address existing barriers and drivers to the energy transition on the North Sea. With their hybrid offshore wind project, which stimulates international and integrated coordination between multiple stakeholders, the NSWPH provides a polycentric answer to the currently low degree of polycentric offshore wind energy governance. The NSWPH consortium is a constellation of actors with a clear aim, which tailors multi-level and multi cooperation accordingly. Because this governance arrangement is designed for addressing specific barriers and drivers, it makes sense to evaluate its effectiveness in doing so. The subsequent chapter provides a description of the broader context in which the NSWPH emerges. Since three out of the five businesses that make up the consortium are Dutch, this thesis zooms in on the Dutch perspective. This enables us to provide concrete national-level illustrations of the international barriers and drivers that emerge in the analysis.

Case studies on polycentric governance have additional benefits, including their ability to 'inspire conceptual refinements' (Poteete, Janssen & Ostrom, 2010: 77). This thesis provides a conceptual framework for further research, including some conceptual refinements. An example of such a refinement is the distinction the framework makes between informational and institutional factors that influence offshore energy transitions. Some degree of information is inherent to institutional arrangements. However, this thesis argues that considering the two factors apart does more justice to the important role that information plays in offshore wind governance. This relates to another benefit of case studies on polycentric governance: their ability to 'tease apart distinct elements of tightly interwoven factors' (Poteete, Janssen & Ostrom, 2010: 77). Another benefit of case studies entails their potential for agenda-setting (Poteete, Janssen & Ostrom, 2010: 77). Given the timeliness of our case, we are able to provide recommendations for the consortium while their project is still on-going. This provides an intermediate feedback moment for the consortium.

Data collection

A particular strength of this thesis' case study approach is its ability to deal with various sources of evidence, including document and interview analysis (Kohlbacher, 2005). The period of data collection is from November 2019 until January 2020. The unit of analysis is the polycentric arrangement for governing offshore wind on the North Sea, as proposed by the NSWPH consortium. Given the multi-stakeholder and multi-level nature of polycentric governance arrangements, this arrangement consists of a diverse group of stakeholders: national governments, the EU, non-governmental organisations (NGOs) and businesses. The contextual chapter described the various interests regarding nature, energy and food provision that are at play on the North Sea. The collected data includes seventeen documents and four interviews, which reflect the various stakeholders in the governance arrangement as well as the various interests. The interests of nature are represented by a document of Greenpeace and an interview with the WWF and the interests of food production are reflected in the Visned document. All selected documents touch upon the interests of renewable energy to some extent. Since the case study particularly focuses on the Dutch perspective, three documents highlight the efforts of the Dutch government regarding offshore wind. The selection of documents provide a sound context of barriers and drivers to the energy transition on the North Sea, including information on some barriers and drivers specific to hybrid offshore wind projects. The other documents include concept papers published by the NSWPH consortium; a report specifically on hybrid projects; and two documents of the European Commission on cooperation between North Seas countries.

In this research, document analysis plays a primary role whereas the interviews, adding more detail to this analysis, play a secondary role. While documents serve to specify the case-specific barriers and drivers to the renewable energy transition on the North Sea and inform the case study chapter and the interview questions, the interviews provide additional information on the barriers and drivers identified in the documents. The aim to balance between different types of actors also determined the selection of respondents. Even though not exhaustive, the selection of interviewees includes one member of the consortium, one representative of the Dutch government, one representative of the offshore wind industry and one non-governmental organisation. With their specific knowledge, the respondents provided insights on specific issue areas. For the sake of confidentiality, this thesis does not provide the names of interviewees. The interviews were conducted in a semi-structured manner, conducted semi-structured interviews, questions are prepared in advance. At the same time, this approach enables the researcher to ask follow-up questions when interviewees raised issues that were of particular relevance to this research (see Longhurst, 2003: 103). The interviewees knew that they were participating in a research on 'the factors that accelerate and hamper the energy transition on the North Sea'. Every interview started with the question if the interviewee could introduce her/himself and her/his responsibilities regarding offshore wind. The interview would then proceed to the barriers and drivers that the respondent highlighted. The barriers and drivers were not always mentioned straightforward: often, this approach produced general responses. In such cases, the questions were directed towards issue areas. Since all four interviews were conducted in Dutch, they were also transcribed in Dutch. The quotes used to support conclusions in the analysis chapter are translated into English. The implications of this will be discussed in the limitations.

Institution	Document name	Reference in analysis
North Sea Wind Power Hub	Concept paper 1 - The Challenge: Urgent action is needed to reach a low-carbon society in time (2019)	NSWPH-CP1
North Sea Wind Power Hub	Concept paper - The Vision: The Hub-and-Spoke concept as modular infrastructure block to scale up fast (2019)	NSWPH-CP2
North Sea Wind Power Hub	Concept paper 3 - Modular Hub-and-Spoke: Specific Solution Options (2019)	NSWPH-CP3
North Sea Wind Power Hub	Concept paper 4 - The Benefits (2019)	NSWPH-CP4
North Sea Wind Power Hub	Concept paper 5 - Requirement to Develop (2019)	NSWPH-CP5
North Sea Wind Power Hub	Concept paper 6 - Requirements to Build (2019)	NSWPH-CP6
North Sea Wind Power Hub	Web page 1 from News Update December 2019 #6: North Sea Wind Power Hub Programme and Port of Rotterdam: towards a long-term view (2019)	NSWPH-W1
North Sea Wind Power Hub	Web page 2 from News Update December 2019 #6: NSWPH: From Project to Programme (2019)	NSWPH-W2
North Sea Wind Power Hub	Web page 3 from News Update December 2019 #6: A Brief Introduction: NSWPH's Workstream Leads	NSWPH-W3
Roland Berger for the European Commission	Hybrid projects: How to reduce costs and space of offshore developments. North Seas Offshore Energy Clusters study (2019)	RB
European Commission	Political Declaration on energy cooperation between the North Seas Countries (2016)	EU-PD
European Commission	Joint Statement on the deliverables of the energy cooperation between the North Seas Countries (2019)	EU-JS
Overlegorgaan Fysieke Leefomgeving	Onderhandelaarsakkoord voor de Noordzee (2019)	OFL
Greenpeace	A North Sea electricity grid [r]evolution: electricity output of interconnected offshore wind power - a vision of offshore wind power integration (2008)	GP
Consortium of various fisheries active on the North Sea, formulated by VisNed	Ruimte voor Visserij in de Noordzee vol windmolens - Gezamenlijke Visie (2018)	VIS
Tweede Kamer der Staten-Generaal (Dutch Government)	Wijziging van de wet windenergie op zee: nota naar aanleiding van het verslag (35092-6) (2019)	Nota1
Tweede Kamer der Staten-Generaal (Dutch Government)	Wijziging van de wet windenergie op zee: nota naar aanleiding van het nader verslag (35092-8) (2019)	Nota2

TABLE 2: ANALYSED DOCUMENTS

#	Affiliation	Date	Type of interview	Reference in analysis
1	Dutch Ministry of Infrastructure and Water Management	21 November 2019	Face-to-face	Int-1
2	TenneT Netherlands	26 November 2019	Face-to-face	Int-2
3	Van Oord	9 December 2019	Face-to-face	Int-3
4	World Wide Fund for Nature (WWF)	21 January 2020	Phone call	Int-4

TABLE 3: LIST OF INTERVIEWEES

Data analysis

This thesis describes the barriers and drivers to the energy transition on the North Sea and formulates a statement on the ability of the consortium to address them. Let us first go deeper into how this thesis approaches the analysis of barriers and drivers. The conceptual chapter sketches a conceptual framework consisting of issue areas, based on barriers and drivers from the applied polycentric governance literature on renewable energy transitions. Due to the transboundary nature of large-scale offshore wind energy and its situation in the marine space, the literature on renewable energy is not sufficient to identify all issue areas. Therefore, the literature on marine governance is included as well, which informs the legal-spatial issue area. Thus, barriers and drivers to (offshore) renewable energy transitions from the literature serve to identify issue areas. The technical issue area concerns grid-related factors. The political issue area touches upon those issues that require political decision-making. The economic issue area includes barriers and drivers that affect the business case of offshore wind energy. The legal-spatial issue area includes barriers and drivers relating to rules and regulations and the interplay between actors with a spatial claim on the North Sea. The institutional issue area concerns cooperation between various actors on various levels. In this sense, it reflects a certain degree of polycentric order. The institutional issue area plays a dual role in the conceptual framework and data analysis. We will first discuss how the case-specific barriers and drivers were identified and then proceed to the second, evaluative, role of the institutional issue area.

The issue areas are merged into a coding scheme that serves to empirically identify and categorise barriers and drivers appearing in the analysed documents and interview transcriptions. These barriers and drivers thus reflect a certain degree of polycentric order, resulting from the descriptive use of polycentric governance theory. The quotes referring to barriers and drivers were grouped under the most appropriate issue area in Excel. Here, the category where the effects are most salient gets priority. The matter of subsidies for instance, involves a political debate but ultimately affects the business case of offshore wind. Therefore, this was grouped under the economic issue area instead of the political one; the evaluation chapter will reflect upon such overlaps. The documents and interviews were coded partially, as only some quotes were relevant for this research. For deciding if a quote concerns a barrier or a driver, it mattered if a factor is currently a reality or not. Take for example the barrier ‘lack of international cooperation on marine spatial planning and grid interconnection’. Some documents highlight the need for more international cooperation as a driver, but this was coded as a barrier since this situation is currently not the case. Factors that (directly or indirectly) contribute to overcoming a barrier were coded a driver. An example of this is ‘the increasing amount of political agreements and declarations highlighting the

importance of international cooperation'. It is important to note here that this distinction between barriers and drivers in the analysis is different from the distinction used in conceptual framework. In the literature, barriers and drivers are often hypothetical, so when something is described as a driver by an author, it is included in the conceptual framework as a driver independent of whether this is currently the case or not.

We pointed out before that the institutional issue area plays a dual role in this research. On the one hand, it serves to identify institutional barriers to the offshore wind energy transition. On the other hand, it provides a list of overarching drivers for effective cooperation in a polycentric governance construct derived from general polycentric governance literature: governance on multiple scales; interaction between scales; diversity of actors; information sharing; transparency and trustworthiness of information; data on costs & benefits; and mechanisms for: monitoring; feedback; inducing compliance; conflict resolution; sanctioning; and encouraging adaptivity. We call these overarching drivers 'polycentric indicators'. The more polycentric indicators a governance arrangement displays, the more effectively the arrangement addresses barriers and drivers. The polycentric indicators are prescriptive, as they suggest that they are conducive towards effective and efficient cooperation in a polycentric arrangement, based upon the normative use of polycentric governance theory. The polycentric indicators are used to categorise quotes from documents published by the NSWPH consortium and the interview transcription with TenneT, a consortium member. The quotes explicitly mention 'the consortium' and how it aims to work, both internally between consortium partners as well as externally, with outside actors.

The qualitative and interpretive nature of this research implies an inductive data analysis process. This means that the analysed data shows patterns that help to answer the research question (Ritchie et al., 2013: 6). The analysis chapter presents some preliminary conclusions that emerge from these patterns, with supporting quotes per statement. It firstly presents the case-specific barriers and drivers per issue area and then discusses the polycentric attributes as they did or did not appear in the NSWPH data. The evaluation chapter connects the two parts of the analysis by evaluating the ability of the proposed governance arrangement to address the identified barriers and drivers. Despite the limited generalisability of this Western-European oriented case study research, this thesis suggests a conceptual framework for further research based upon the outcomes of this research. This 'analytic generalisation' (Yin, 2003a), of the framework that can be applied to future research, provides one of the strengths of this thesis.

	Technical	Political	Economic	Legal - spatial	Institutional
All documents & interviews (descriptive)	*Barriers* *Drivers*	*Barriers* *Drivers*	*Barriers* *Drivers*	*Barriers* *Drivers*	*Drivers* *Barriers*
NSWPH consortium data only (prescriptive)					*Polycentric indicators (drivers):* - Governance on multiple scales; interaction between scales; diversity of actors. - Information sharing: transparency & trustworthiness; data on costs & benefits. - Mechanisms for: monitoring; feedback; inducing compliance; conflict resolution; sanctioning; encouraging adaptivity.

TABLE 4: CODING SCHEME

Limitations

As this thesis does not aim to sketch an exhaustive overview of the existent barriers and drivers to the renewable energy transition on the North Sea, this thesis should be considered a primary investigation. For this reason, inevitably, limitations arise. This part shortly discusses some limitations of this methodology. The evaluation chapter touches addresses the limitations of this thesis.

Due to the time scope and reach of this thesis, it is not able to provide a complete overview of the universe of factors that influence offshore wind development. This is for instance reflected in the number of interviews. In an effort to mitigate this drawback, the analysis includes documents and interviews from the most relevant actors in the governance arrangement. However, this thesis does provide a rich interpretation of the case-specific barriers and drivers. The barriers and drivers that emerge from the analysis are roughly similar to those identified in the literature review; we might consider this as an indication that the analysis does not overlook the most fundamental barriers and drivers. Furthermore, the main barriers and drivers emerge in multiple data sources, which suggests that a certain degree of saturation is reached.

Additionally, as the decision-making process regarding for example the spatial division of the North Sea and the precise location of the Hub-and-Spoke concept is still ongoing, some information is confidential. For this reason, certain interviewees had to generalise some statements touching upon confidential affairs. Concretely, this means that there might be factors that hamper the

implementation of offshore wind on the North Sea that the public is not supposed to know about. Over time, the results of negotiations become public, which highlights the importance of consecutive research.

The constructionist character of this research means that the researcher interprets the literature, documents and interviews that ultimately leads to an answer to the research question. One could argue that this affects the internal validity of the research. In order to ensure that the research question is answered in the best possible manner, the conceptual framework and coding scheme were crosschecked multiple times using various sources throughout the research process (triangulation). Something that relates to this is the translation of the interviews held in Dutch and some of the analysed documents in Dutch. The analysis presents quotes from Dutch interviews and documents, translated into English, which could potentially alter the way there are interpreted by the reader. Yet, the translation of interview quotes is as close as possible to any colloquial language used during the interview in order to keep the original nuances.

Chapter 5: Analysis

The analytical framework of the technical, political, economic, legal-spatial and institutional issue areas enables us to describe and analyse the existing barriers and drivers specific to the transition to large-scale offshore wind energy on the North Sea. These are the barriers and drivers the NSWPH consortium, our case, encounters. We identify the case-specific barriers and drivers through analysing all selected documents and interview transcriptions. For some issue areas, specific examples from the Netherlands illustrate what the barriers and drivers may look like on the national level. Among the analysed documents are the documents published by the NSWPH consortium. We notice that the consortium highlights certain barriers in their concepts papers, while positioning itself as a driver to overcome these barriers. For the second part of the analysis, we use data from only NSWPH documents to analyse how the consortium shapes their transnational and multi-stakeholder cooperation. The prescriptive polycentric indicators from the analytical framework serve as a tool for this.

Issue area: technical

The main technical barrier to offshore wind energy is the issue of intermittency, meaning that wind supply and therewith energy production is variable (NSWPH-CP1, 4), which has implications for the security of supply. This barrier applies to many types of renewable energy, according to interviewee 3 who states that 'renewable is almost always intermittent, and you have to do something about that' (Int-3).

Even though the precise increase of offshore wind in the future energy system is still unknown, two interviewees seem to agree that further growth is inevitable (Int-1; Int-3). This raises the challenge of integrating renewable energy into the existing (offshore and onshore) grids. Currently, grids connect offshore wind farms to the nearest onshore point. According to the NSWPH however, this does not leverage synergies (NSWPH-CP4, 5). What would leverage synergies, according to the analysed documents, is an interconnected grid on the North Sea that connects surrounding countries to offshore wind farms. The following quote further explains why this is the case: 'Although wind is a variable energy source, this is less the case over a large area like the North Sea. Variations in production at one wind park can be partly balanced by that of another park several hundreds of kilometres away' (GP, 3). This quote shows how an interconnected grid could provide more flexibility regarding intermittency. Also, such a grid could facilitate increasing shares of renewable energy in the energy system (NSWPH-CP1, 6). Besides grid interconnections, also 'sector coupling' is mentioned as providing more flexibility to the energy system. With this, the NSWPH means 'power-to-gas' options, in their case predominantly by converting power into hydrogen, which can be stored (NSWPH-CP2, 5-6). This might help to 'avoid onshore grid congestion and supply risks' (RB, x). As the Hub further explains: 'Using power-to-gas conversion in coastal regions connected to transmission to demand centres located deep inland may relieve congestions in the electricity transmission grid. Therefore, it can reduce curtailment due to transmission bottlenecks of variable renewable energy and support system adequacy' (NSWPH-CP4, 8).

We can consider the constitution of the NSWPH a driving force behind overcoming the barrier of intermittency because the consortium actively promotes an interconnected grid between

North Seas countries. Besides, the consortium aims to facilitate sector coupling, which might help to overcome the barrier of renewable energy integration. With this hybrid approach, the NSWPH attempts to deploy a more holistic approach to the energy system than traditional, national-oriented processes. Even though the interconnected grid is currently not implemented as it has only recently moved out of the assessment phase (NSWPH-W2), the consortium is considered a driver because it raises attention for hybrid projects and aims to bring different parties together. What helps in this regard is that the Hub-and-Spoke concept is technically feasible, according to desktop studies commissioned by the consortium (NSWPH-CP3, 3). The following quote also support this: 'After several critical studies and animated conversations with specialists, developers and stakeholders, the answer was clear. Yes, a network of hubs that connect far offshore wind farms to North Sea Countries' energy markets is possible' (NSWPH-W2).

Issue area: political

This part draws some preliminary conclusions on political drivers and barriers for the energy transition on the North Sea, followed by quotes that support these conclusions.

An important barrier highlighted by the NSWPH is the current lack of clarity on long-term goals for renewable energy. As the NSWPH consortium states in their concept papers, the current offshore wind plans run until 2030. There is a need for a post-2030 spatial and grid planning (NSWPH-CP6, 7) because 'the North Sea countries' combined maritime spatial plans cannot yet accommodate the envisaged offshore wind capacity addition' (NSWPH-CP1, 6). The reason why a lack of long-term planning can pose a barrier is that 'these type of projects (e.g. combined transmission assets and interconnectors, or development of large scale P2X conversion capacity) typically have lead times of more than 10 years, while the full energy transition must be accomplished within 30 years' (NSWPH-CP1, 6). This need is highlighted in other NSWPH documents as well, stressing for example the need for specific renewables targets beyond 2030, 'to allow for timely grid planning and spatial planning of offshore wind farms' (NSWPH-CP6, 4). Interviewee 2 formulates this issue as follows: 'the plans of a transmission system operator have a longer time horizon than the plans of a government. There are studies that look at how to integrate offshore wind developments, but there is a mismatch here since the government only makes plans until 2030. A long term vision can further facilitate an integrated rollout of offshore wind' (Int-2).

Data from the analysed documents and interviews suggest that this lack of clarity on long-term goals relates to insufficient political will and governments not taking their responsibilities in formulating such goals. According to Int-3, 'the business case of the Hub-and-Spoke concept is determined by countries' political will: without political backing, the TSOs in my perception will not be able to realise this, this is not going to happen'. The interviewee elaborates that 'if the government does not want these energy islands, I am not going to build them. So the business case has to be there, which is not the case because the government needs to make long-term policies and they also need to say what is needed to implement them. The business case is partly determined by politics, but there is nobody that governs all aspects of it. So who takes the lead? In this kind of complicated cases, this can only be the government' (Int-3). Interviewee 4 also touches upon the need for governments to take their responsibility in leading the realisation of offshore wind, in this case in relation to biodiversity: 'currently there is no proactive government policy on where to

situate offshore wind farms because there is not a very obvious demand for this. I think that the government does not feel the pressure to do something, as there is not a very loud scream from the administration to act regarding the biodiversity crisis' (Int-4). These quotes suggest that at least in the Netherlands, the government currently does not take a leading role in formulating long-term goals and stable policies. Another issue relates to the day-to-day reality of politics. In the Netherlands: 'within the Council of Ministers, multiple dossiers occur at the same time, so ministers keep track of who gives what on which dossier, and how money is divided. Especially now, with PAS1, where millions are distributed. Everybody in the coalition wants to have a piece of the cake' (Int-1).

One factor that could play a role in this is the amount of different interests that a (liberal democratic) government represents. Interviewee 3 notes for example that 'In politics, there are always contradicting wishes, that are all defended simultaneously, with a similar intensity. This creates a difficult balance for a government' (Int-3). Thus, the ability of government(s) to provide long-term clarity on renewable energy goals and policy is dependent upon political prioritisation in a political landscape that represents many different interests. The Greenpeace document formulates this as follows: 'The topology of an offshore grid will result from these drivers (connectivity between countries and economically efficient connection of OW farms) and will therefore heavily depend on the relative importance assigned to each in political and economic decision making' (GP, 20).

Some stakeholders are represented in politics more than others, with more opportunities for defending their interests. In the Netherlands for example, there appears to be an connection between the fisheries sector and some parties in the government. During the debates preceding a North Sea Agreement, the fisheries sector makes an appeal to the coalition agreement, which states that 'no more fishing areas will be closed than necessary following from European regulations. The Netherlands will argue in an EU context that the location of wind turbines at sea takes into account the interest of fishing and will, wherever possible, allow multifunctional use' (VIS, 7). Interviewee 1 states, regarding the North Sea debate and international cooperation on spatial planning, that 'the annoying thing is, that you can try to get to international optimisation, but at the same time you see that important fishing grounds are situated in British waters. This means on the one hand that you try to optimise for offshore wind internationally, and on the other hand you see that the Dutch government aims to let the fishers keep their good fishing areas. And you see that at that moment, politically it is often more important that our fishers are served in their political needs' (Int-1). We further see this representation of the fisheries sector in a question asked during a government debate regarding the amendment of a law on offshore wind energy, where: 'The members of the VVD note that by expanding the licensing procedures in order to deal with the situation that offshore wind energy requires less or no subsidy, more companies from the wind sector will apply for a permit for offshore wind farms. As a result, the share of offshore wind farms will increase, with the result that fishing grounds will be restricted. The members of the VVD ask how to ensure that the economic position of the fishing sector is protected. - In view of this, the economic position of

[1] PAS refers to a programme of the Dutch government to protect 'Natura 2000' sites from nitrogen surpluses, which negatively affect biodiversity. In 2019, a 'nitrogen crisis' emerged in the Netherlands when the construction of many big infrastructural projects was suspended because it was ruled that the PAS was not able to accurately protect the natura 2000 sites.

the fishing sector in relation to the development of offshore wind energy is currently being protected' (Nota2, 2-3).

We will now go deeper into the political drivers for international cooperation on offshore wind on the North Sea. An important driver is the growing amount of political agreements that increase attention and political pressure for reducing CO2-emissions and global warming, such as the Paris Agreement, which aims 'to limit global warming well below 2 degrees and pursuing efforts to limit it to 1,5 degrees' (EU-PD, 1). According to Int-1, the 'Paris Agreement created a political momentum for the energy transition'. Apart from the Paris Agreement, which aims to unite countries globally, there is a growing amount of regional and national agreements, 'driven by society's desire to decarbonise' (RB, iv). According to the NSWPH, 'In each of these North Sea countries, as well as in the UK, renewable energy is high on the agenda. The ambitions for offshore wind energy are strong in all of the North Sea countries' (NSWPH-W2). In Europe, particularly offshore wind is considered a promising source of renewable energy, as the EU wants to become 'a Silicon Valley of offshore wind and become the place for developing new and cost-efficient solutions' (EU-JS, 6). An example of a 'crucial development' in this regard was a Dutch-German climate summit, where 'The two countries declared their ambition to work together more closely on sustainable energy – offshore wind farms being one of the more promising potential sources' (NSWPH-W2). Hence, in 2016, 'Countries in the North Seas region (Ireland, the United Kingdom, France, Belgium, the Netherlands, Luxembourg, Germany, Denmark, Norway and Sweden) signed the North Seas Energy Cooperation declaration. It aims to strengthen cooperation on energy and improve conditions for the development of offshore wind energy, ensuring a sustainable, secure and affordable energy supply in the region. As part of this, it encourages transmission system operators and offshore wind developers to become early movers in hybrid projects. Such initiatives are helping hybrid projects to gain momentum' (RB, v-vi). More recently, in 2019, the countries participating in the Political Declaration released a 'Joint Statement on the deliverables of the energy cooperation between the North Seas Countries', which claims that 'Since then considerable results have been achieved. Governments have directed significant resources to the implementation of the Political Declaration and are taking forward the actions as identified through a series of Support Group meetings with experts' (EU-JS, 2). More specifically, 'The cooperating countries are preparing a common chapter on the cooperation of offshore wind within the North Seas Energy Cooperation to be included in the National Energy and Climate Plans of the North Seas countries' (EU-JS, 5). The above quotes show that the EU acknowledges the potential of offshore wind in its energy transition and the importance of international cooperation therein. This constitutes a driver for the offshore energy transition on the North Sea.

A part of this European collaboration refers specifically to hybrid projects: 'Several initiatives such as the North Seas Energy Cooperation and long-term strategies and plans have hinted at integrated North Sea infrastructure development' (NSWPH-CP3, 4). The notion that 'the construction of the Kriegers Flak hybrid project in the Baltic Sea, the one hybrid project nearing commissioning, shows that these barriers are surmountable if stakeholders make a concerted effort' (RB). In other words, 'Kriegers Flak provides an example for other parties, as it illustrates the feasibility and benefits of hybrid projects in a European context where there is little experience with hybrid projects' (Int-2).

As discussed before, not only regions but also countries make use of the momentum for climate agreements. The Netherlands, as a 'maritime nation', wants to play a leading role in developing new perspectives through innovation on the North Sea (OFL, 9). According to the OFL document, there is broad support for winning a considerable amount of energy from the sea (OFL, 6, 7). Two interviewees state that it is inevitable that offshore wind will grow (Int-1; Int-3): 'even if the business case worsens, the government will still proceed its roll-out' (Int-3).

Issue area: economic

The most salient economic barrier emerging from the analysis of documents and interviews is the existence of uncertainties, which impacts the business case for (hybrid) offshore wind as it creates financial risks for investors. The political issue area pointed out that there is currently no clear long-term market perspective for offshore wind. According to the NSWPH, 'Present business cases for hybrid projects (combining interconnection and wind farm transmission asset infrastructure) are already under pressure due to uncertainty, short-term focus and lack of coordination in optimising use of the infrastructure for maximum social economic benefits' (NSWPH, CP1-5). One contextual factor that adds to the uncertainty is Brexit and its possible economic consequences. If we look at the Roland Berger report, it mentions 'Uncertainty regarding the British market' (RB, vii) as a barrier to hybrid offshore wind projects.

Another factor that creates uncertainty specifically for hybrid projects is the 'Disproportionate allocation of costs and benefits across involved stakeholders' (RB, vii). This means that investing in a hybrid project does not necessarily equal the benefits that a country gets from this, which could influence countries' willingness to participate in such projects. Interviewee 2 further explains this as follows: 'It could be that Germany for example carries 50% of the costs, even though they only get 30% of the benefits. It could also be that the Netherlands, Denmark and Germany carry the costs for grid infrastructure, but that other countries also significantly benefit from this, even though they do not pay for this directly' (Int-2). Interviewee 3 adds, regarding the NSWPH, 'Imagine that all countries surrounding us subsidise the production of renewable energy, you know that the price will drop. If the Hub would be realised, the subsidised energy enters our country and I will not build any more wind farms here' (Int-3).

Following the Roland Berger report, another potential barrier is 'The lack of an applicable, transnational subsidy scheme for renewable energy sources' (RB, ix). The Dutch government is currently discussing the amendment of the law on offshore wind, where the consideration between providing subsidies or pursuing zero-subsidy tenders is an important point of discussion. According to the government, 'it is in the interest of both developers and society to make sure that the business case for offshore wind is profitable, also for the long term and in principle without subsidies' (Nota1, 6). On the other side, interviewee 3 claims that 'The world has changed completely since we moved into the zero-subsidy era' and later adds: 'The issue here is the price of electricity: if this drops below a certain point, who bears the costs? And if it rises, who gets the money?' (Int-3). The Roland Berger report recommends using public money to mitigate risks for the development of hybrid projects. The report explains that: 'Hybrid projects are riskier than conventional offshore developments. They are largely untested, require collaboration between multiple parties and integrate several projects into one. Developers therefore need incentives to

switch from a conventional offshore project to a hybrid one during its early stages; the best time as changes naturally become more difficult and costly in later stages. Public financial support is key to this, helping developers and investors to de-risk pilot hybrid projects and allowing for early-stage alignment across assets and countries' (RB, x). This points our attention to the use of public money. In the United Kingdom and Denmark, the 'contract for difference' subsidy system prevails. In this system, the government subsidises the difference when the price of electricity drops below a certain level, taking away a risk for the investor. As interviewee 3 puts it 'this creates security because you know that you are going to get the money' (Int-3). However, the government states that 'with contract for difference, we would increase the supply of electricity at the expense of citizens, which will further lower the market prices and increase the problem. The solution is on the demand side. We must make sure that there is sufficient demand and an accurate price for electricity from offshore wind. Price risks have always been for the market parties. This is nothing new for the market' (Nota1, 6-7). In other words, the government is hesitant to use public money for subsidising renewable energy. The last two tenders were zero-subsidy tenders and 'I deduce from that that it is attractive for multiple parties to develop wind farms on the North sea without subsidy' (Nota1, 6). An alternative to the contract for difference subsidy scheme is 'SDE+', which is considered 'a reverse auction, with the lowest costs for society. Here, the energy producer shows its subsidy demand in an offer and the producer that bidded the lowest gets the permit. In the SDE+ tender the producer itself has to take varying revenues into account' (Nota1, 11). In short, there seems to be an inconsistency between the industry that demands public funds and the government promoting zero-subsidy tenders. Currently, the Dutch government is engaged in a debate on how to shape the situation wherein offshore wind needs less, or no subsidy at all. The outcome of this debate also influences the speed of decision-making regarding permitting for offshore wind. Th 'legal - spatial' issue area will go deeper into this.

An important factor in this discussion is who determines the price of electricity. This is pertinent because rising electricity prices foster investment in renewable energy. Conversely, lower electricity prices make investment less attractive, especially when they fall below the price of fossil fuels. There seems to be an incongruence between what the Dutch government states and what interviewee 3 says on this topic. In the context of the law on offshore wind, the Dutch government states that 'The price that producers receive for trading electricity is to a large extent determined by supply and demand on the market; that market is a Northern-European market where an individual producer cannot influence the price' (Nota1, 2). Interviewee 3 on the other hand, states that: 'We need an expectation that the price of electricity will rise. But who determines the price of electricity? The government denies this, they say that the market determines this, and the market says that the government determines it to a large extent. The daily price is probably based upon supply and demand, but who determines the bigger trends? This creates a huge insecurity. This is the reason why there is no construction security for wind farms' (Int-3).

The price of electricity partly depends on the demand for it. Multiple documents and interviewees highlight the (future) demand for electricity as a crucial driver for energy transitions. Decarbonisation of the industry and transport sector plays a large role in this. According to the NSWPH, 'Decarbonising the power sector is generally considered to be a first step, as it is cost effective, has significant impact on CO2 emission reduction and is considered possible well before

2050' and 'In parallel, options need to be developed to decarbonise non-electric final energy demand e.g. for industry and mobility' (NSWPH-CP1, 4). However, we consider 'demand for electricity' as a barrier here since the data suggests that the current demand for electricity should increase in order to facilitate the energy transition. As interviewee 1 puts it 'the demand has to develop towards sustainable forms of energy. One can put many wind turbines on a sea, but the energy has to be bought. We see that the industry still needs to make this transition. If this doesn't happen soon enough, the price of energy will decrease, which worsens the business case for offshore wind' (Int-1). Interviewee 2 states that 'the government can play an important role in this' (Int-2). However, there seem to be different views on the role that the government should play in stimulating demand. According to interviewee 3: 'One of the biggest obstacles is that the production of renewable energy is subsidised, which lowers the market price. And subsidising everything on the production side, that is a dead system. The demand for renewable energy needs to be stimulated, this can happen in different ways such as a CO2-tax. if you do not punish CO2, you get a race to the bottom or nobody will invest in clean energy but then we will not reach a transition' (Int-3). While interviewee 2 and 3 plead for a proactive government, the Dutch government does not actively push for stimulating electricity demand. Even though the government 'endorses the necessity of adequate demand for electricity from offshore wind for the further growth thereof' (Nota1, 4), the following quote shows that it decided not to (further) stimulate electricity demand directly because the precise increase of demand is still unsure: 'The energy transition should lead to an increased use of electricity in the built environment, the industry and in mobility. The demand for electricity from renewable sources will therefore increase, but in what tempo and with what amount is not predictable in advance. The government therefore does not pursue policy to increase the demand of electricity. It does pursue policy to limit the CO2-emission of the built environment, industry and mobility, which possibly leads to more use of electricity in those sectors' (Nota2, 11).

An economic driver for the business case of offshore wind is that, even though the Netherlands pursues zero-subsidy tenders, the European Commission supports hybrid projects financially. The following quote supports this: 'Ministers and the European Commission underline the relevance and opportunities of new financing instruments such as the future Connecting Europe Facility (CEF) as well as the European Union renewable energy financing mechanism under the Governance Regulation with the aim of supporting the development of first joint offshore projects in the North Seas' (EU-JS, 4). In their Political Declaration, the North Seas countries mention that they will also cooperate on 'Concepts for concrete joint (pilot) projects, and exploring opportunities for the opening of support schemes and joint tenders, ensuring win-win situations for all participating countries' and 'The further mobilisation of investment capital for joint (pilot) projects, for instance through EU funds such as EFSI and CEF, and institutional investors' (EU-PD, 4). Another factor that might contribute to the development of hybrid projects specifically is that recently, the NSWPH was appointed as a 'European Project of Common Interest', which means that 'there will be more attention and funding for hybrid projects' (Int-2).

Comparable to the technical section, the existence of the NSWPH is also considered a driver within the economic issue area because it promotes an international coordinated approach to offshore wind, which 'can ensure a steady offshore wind deployment throughout the North Sea region, securing market stability to further reduce cost for offshore wind and realise the required

upscaling of the entire supply chain and introduce the necessary innovations' (NSWPH-CP2, 5). Creating market stability through international cooperation also helps developers to anticipate the zero-subsidy era, which the following quote from the NSWPH shows: 'The frameworks should provide the appropriate incentives to offshore wind developers to enable offshore wind developments in a "post subsidy" environment. A stable market outlook on offshore wind developments is essential for a significant build-up of supply chain capacity in the industry' (NSWPH-CP1, 6).

Issue area: legal - spatial

In this issue area, the legal barriers apply particularly to transnational (hybrid) offshore wind projects as part of the offshore energy transition on the North Sea. One way in which such offshore wind projects discern themselves compared to 'conventional' offshore wind is the transnational grid that interconnects wind farms on the North Sea to surrounding countries. This specific feature produces a legal barrier because countries have different rules and regulations regarding grids. The NSWPH describes this issue as follows: 'Whilst Europe is on a long-term trajectory towards becoming a single energy market, coordinated jurisdictional planning of the energy system is not currently a reality' (NSWPH-CP5, 6). Even though the EU Joint Statement highlights the possible cost reductions that might come with aligning rules between countries, 'Today the existing rules, regulation and standards differ to a certain extend among the North Seas countries' (EU-JS, 5). Interviewee 3 also touches upon the need for government involvement in international coordination since they are the ones who need to align regulations: 'TSOs develop the Hub-and-Spoke concepts. But without support of underlying governments, this will never happen because they decide if the business case is right or not, since there are a lot of rules and regulations that need to be aligned' (Int-3). On the other hand, increased international coordination might delay the development of offshore wind, due to the 'Required permitting and commissioning timelines of the Hub-and-Spoke project' (NSWPH-CP3, 4).

A spatial barrier for the offshore energy transition is 'the limited available area in the North Sea' (NSWPH-CP1, 3). The available space on the North Sea is not only limited in size, but also limited by other sea uses such as oil and gas platforms, protected areas, fisheries and shipping routes. Both nationally and internationally, countries engage in marine spatial planning efforts to divide the sea over these different users. From the perspective of the NSWPH, it is crucial that MSP leaves enough space for large-scale offshore wind, preferably in adjoining areas on the sea. As the NSWPH describes, the currently available area for offshore wind on the North Sea is 'relatively scattered, when considering water depths up to 55m and assuming full exclusion of current use areas (shipping, military, operational and planned wind farms up to 2030, etc.). This would allow for up to 50-90 GW, depending on wind farm capacity density. Therefore, an exclusion strategy of offshore areas will likely not allow for a full deployment of any conceivable future energy system including offshore wind capacity, green hydrogen facilities, hubs and grid connections (NSWPH-CP6, 4). In other words, a spatial planning that prioritises other sea uses over offshore wind would pose a significant barrier to the development of hybrid projects because it would not leave sufficient space for offshore wind farms and interconnected grids.

Thus, it remains yet to be seen what the exact space for offshore wind on the North Sea will be, since 'The combination of today's national maritime spatial plans have not caught up with the projected offshore wind capacity increase, mainly by the lack of appointed offshore wind farm areas after 2030' (NSWPH-CP5, 4). In the Netherlands for example, there is currently no common framework for spatial planning on the North Sea (OFL, 11; VIS, 7). The North Sea debate should lead to a North Sea Agreement that arranges the spatial planning of the Dutch EEZ. According to interviewee 3, 'At this moment, the legislation on how we can build and where is not clear. The North Sea Agreement is a potential danger because it may grant too much space for others in comparison to the space for offshore wind' (Int-3). This concern reflects the following barrier from the Roland Berger report: 'Uncertainty about responsibility and rules to provide access to maritime space for offshore wind farms (location selection, site pre-investigation and tender execution)' (RB. vii).

The consortium tries to influence marine spatial planning processes, which interviewee 2 explains as follows: 'One of the aims of the NSWPH consortium is to accurately inform the broader discussion regarding the energy transition and large-scale offshore wind. What are for example the socio-economic costs when only areas x and y remain left for wind farms? Taking into account nature protected areas and fragmented designation of offshore wind areas can hamper the possibilities for economies of scale. It is the intention of the consortium to facilitate well-balanced decision making of policymakers by bringing in expertise from the consortium partners, mostly focused on the techno-economic impacts of different policy decisions' (Int-2). Following this aim, the consortium investigated four locations 'to understand the main differences in environmental and techno-economic impact. These locations do not represent a preference for a location for a first project – but have been used to assess different locations specific impacts on Hub-and-Spoke design' (NSWPH-CP3, 9). Besides this techno-economic perspective to spatial planning of wind farms, the consortium states in one of their concept papers that 'Not all impacts of offshore area use are straightforward to monetise (especially long-term environmental effects) and all carry substantial uncertainty. These aspects need to be addressed in a spatial planning debate which clearly goes beyond a techno-economic analysis.' (NSWPH-CP6, 6). This introduces an issue relating to the potential location of the Hub-and-Spoke concept. The following quotes illustrate the tradeoff between economic and environmental concerns in spatial planning for large-scale offshore wind energy. Interviewee 4 from the WWF highlights this tension by stating that ''The reality is that the industry often develops faster than research and regulations. This is why currently, wind farms are built on the basis of: where do we have space left and where is it cheap' (Int-4). Building further upon this, interviewee 4 provides an example of the NSWPH: 'A couple of years ago, when TenneT announced the idea to build wind farms on the Dogger bank[2], which would happen on top of a bad fisheries management plan, we raised our alarm. You cannot just put offshore wind farms in protected areas. We had high-level talks and the media showed interest. We spent a lot of time to persuade the consortium that this was not acceptable, that constructing and operating such wind farms has ecological effects. There has been an impact assessment on what would happen if the Hub were to be on the Dogger bank, and this was of a very bad level, so we again had talks about this.

[2] The Dogger Bank is a Natura 2000 site in the North Sea of approximately 300 kilometers long.

Ultimately, they realised that they would encounter resistance if they would move on with their plans. We kept on repeating that this area should finally be protected. They went looking for alternative locations, and currently we are still discussing this' (Int-4). From the consortium side, this event is shortly touched upon in a concept paper: 'To address the feedback from NGOs the consortium has introduced an additional "investigative location" to its techno-economic analysis of main drivers for the design of a Hub-and-Spoke project' (NSWPH-CP6, 6). All in all, the active involvement of the WWF and other nature organisations is considered a barrier for the NSWPH because they probably will not be able to develop their Hub-and-Spoke concept in the area that was suitable according to their own socio-technical analysis.

Another issue relating to the spatial tension between nature, fisheries and energy on the North Sea concerns the different takes on the desirability of multi-use areas (see OFL, 9; VIS, 23; Nota2, 14&33). The WWF and Greenpeace want single-use for protected areas (natura 2000), which means that these areas cannot be used for wind farms nor fishing (VIS, 23). The Dutch government is not of the opinion that (future) wind farms should be closed for all forms of fisheries (Nota2, 33); these areas can also be used for 'nature development projects' (Nota2, 14). Single-use is not an option for the fisheries, as they claim this would entail a 'cumulative constraint' of their fishing area (VIS, 23). According to the NSWPH however, 'Given the current and planned use of space in the North Sea, a co-utilisation approach is necessary in the future to reach the required installed capacity of offshore wind. A recent study concluded that if all the currently utilised areas are excluded, only 14,000 km2 or 3% of the suitable space in the North Sea remains available for OWFs which is only sufficient to host 50-90 GW, depending on the power density. In addition, this space is highly fragmented limiting the potential to benefit from scale effects' (NSWPH-CP5, 6). The NSWPH pleads for 'clarity on co-utilisation', which 'will have different impacts on the costs of the offshore wind roll-out' (NSWPH-CP6, 5). This issue creates another uncertainty regarding spatial planning of the North Sea and therewith the large-scale rollout of offshore wind.

In one of its concept papers, the NSWPH observes that 'Currently several processes are ongoing on a national level regarding spatial planning of offshore wind farms, such as the Crown Estates market engagement for Round 4 in the UK and the Flächenentwicklungsplan 2019 in Germany; but they are not integrated. It is essential in these processes to consider all aspects, including synergies for connection infrastructure, on an international level' (NSWPH-CP6, 5). In the technical and economic issue area we noticed that the NSWPH promotes the integration of several, currently separated, offshore-wind related processes. The above quote suggests that marine spatial planning is one of these processes. Therefore, we could also consider the consortium as a driver in this issue area. Additionally, the North Seas Energy Cooperation provides a platform, which supports the goals of the NSWPH. Within the work area Maritime Spatial Planning, the North Seas countries namely agree to cooperate on 'Coordinating the planning and development of offshore wind and grid projects beyond national borders including area mapping' (EU-PD, 4).

A legal driver is that in the 2016 EU Political Declaration, participating countries pledge to work towards harmonisation on different standards, technical rules and regulations regarding offshore wind, for example of 'health and safety requirements'; 'certification standards for components in offshore wind projects'; and 'a common approach to rules applicable to offshore turbines in territorial waters and exclusive zones' (EU-PD, 4-5). This shows that the North Seas

countries already acknowledged the legal barriers at the time. Three years later, in a Joint Statement, the countries mention their commitment to 'reducing unnecessary regulation and thereby costs for the industry (EU-JS, 5). Greenpeace also mentions this need: 'Authorisation and licensing procedures for offshore wind farms across Europe should be streamlined, transparent and efficient' (GP, 4). This EU-level attention for the need to harmonise rules might diminish the perceived legal barriers, according to the Roland Berger report: 'At the same time, progress in harmonising EU energy policies and regulation has changed perceptions of the challenges developers face in realising them' (RB, vi).

Issue area: institutional

This issue area firstly presents institutional barriers and drivers that relate to the ways in which offshore wind cooperation between various actors on different levels is currently organised, drawing upon all analysed documents and interviews. Subsequently, this part discusses the polycentric indicators as they appear in documents published by the NSWPH consortium. These indicators are connected to quotes wherein the consortium touches upon their proposed cooperation.

A barrier that relates to the broader context of the energy transition encompasses the vested interests of existing, non-renewable energy industries, which hampers the transition to renewable energy in favour of the status quo. This barrier is apparent in the Greenpeace document, which states that 'Despite the healthy growth of the wind industry, the EU power system today is still dominated by large coal and nuclear plants. These large-scale power plants are not designed to be switched on and off according the rise and fall of electricity demand; they are inflexible when it comes to our needs' (GP2, 4). Furthermore, 'European electricity companies such as EDF, E.ON, RWE or Suez are fiercely opposing the closure of their ageing nuclear power and coal plants and are pushing for new ones to be created. These inflexible, inefficient plants are incompatible with the large-scale integration of renewable energy sources. Every new, large fossil fuel or nuclear power plant installed will operate for forty years or more, locking us in to massive environmental problems and blocking the transition to an efficient, flexible and renewable electricity system' (GP, 4). One interviewee adds to this by stating that 'What hampers us? Just vested interests, it is not more complicated than that: everything that relates to fossil fuels. There is a lot of money in oil and gas and this will just keep on going' (Int-3). The interviewee later adds that 'Shell is investing in green energy, but at the same time a member in interest groups that maintain fossil fuels. The earth will keep on spinning' (Int-3). These quotes suggest that the world is still largely dominated by non-renewable energy interests and there is a high probability that this status quo will remain as it is in the (near) future.

The main barrier for the development of hybrid offshore wind projects that the NSWPH stresses in their concept papers is that currently, there is no institutionalised international coordination for offshore wind in terms of space and grid interconnection as this is treated as a national affair. This has to do with political prioritisation by governments and their current emphasis on national goals and policies. Differences in governance cultures could also negatively influence the ease of international cooperation.

The following quote provides an example of how this barrier is formulated by the consortium: 'Offshore wind projects are planned and developed on a national level without intensive

international coordination in terms of spatial planning' (NSWPH-CP1, 4). According to Int-2: 'the current institutional framework does not cater for hybrid projects, since institutions do not manage the coordination between national governments and different international Transmission System Operators (TSOs). There is international cooperation, but only on different parts of one or the other process, such as spatial planning or the cooperation on interconnection between TSOs in an EU context. However, it is not the case that plans are jointly made and implemented'. Possible consequences of this separation become clear in the following quotes: 'the current national oriented approach to offshore wind development and system integration, and its separation from interconnection development is expensive and insufficient to meet the long-term climate goals' (NSWPH-CP4, 4). Generally, 'this hinders the implementation of transnational projects, such as the hybrid projects considered in this study' (RB, x). One reason for this 'failure of developers to align planning across assets and countries' (RB, vii) is that 'although the European Union is planning an internal energy market, most countries still place more emphasis on their own energy policies and rules' (RB, x). No other documents touch upon why exactly this is the case, only two interviewees do. Interviewee 2 states that 'energy policy has a high political sensitivity: countries and governments want to maintain their national autonomy. Different countries have different national contexts. Recently, the Netherlands and Germany pleaded to cooperate more closely on the North Sea and offshore wind; this pledge only does not concretise what such cooperation entails. Denmark for example has formulated different targets for its share of renewables/offshore wind than the Netherlands' (Int-2). This prioritisation of national policies over international cooperation also becomes clear in the following quote: 'there is always the political reality of a country that wants to keep its own reality and wants to make its own policy. So you can coordinate internationally, but national politics, here as well as in other countries, remains dominant. You also encounter different governance cultures. The Netherlands is very much focused on cooperation with stakeholders, while the Germans first make a plan and then show it to other actors' (Int-1). The interviewee later adds that 'not all countries make their plans simultaneously, so there are always differences in the phase that they are in. Sweden is now taking the initiative to see if we can get to structural cooperation and common policy formulation on the North Sea level. This is often difficult because you have to give and take something internationally and this is not as easy for certain countries' (Int-1).

If we go deeper into the topic of governance cultures, we observe some national-level issues that might influence international cooperation. One of them relates to internal cohesion within governments. In the Netherlands, 'even though the government speaks with one voice', 'it has become very clear that the different policy domains and government departments are not aligned', and differences exist between but also sometimes within departments (OFL, 10-11). According to interviewee 1 however, 'the Netherlands is quite unique in its degree of internal alignment, this is definitely not the case in other countries: in Germany, first the shipping routes are drawn and only then the spatial planning starts. So you encounter some internal obstructions as well' (Int-1). This could lead to the conclusion that internal alignment within governments happens to different extents, dependent upon the respective country. Since internal coordination takes time, such differences in governance cultures can become apparent when countries aim to work internationally.

Another factor that may relate to the low degree of international coordination is the non-binding nature of the current Political Declaration between North Seas countries. Even though the amount of climate-related agreements and therewith international cooperation is growing (the 'drivers' section below will further touch upon this), the nature of the Political Declaration of North Seas countries reflects 'a political intent alone' (EU-PD, 3). This means that there is no sanctioning mechanism to induce compliance, so cooperation happens on a voluntary basis which could influence the intensity of their cooperation. The following disclaimer from the 2019 Joint Statement shows the non-legally binding character of the cooperation: 'This document does not create any rights or obligations under national or international law and does not intend to replace or modify any existing legal obligations, nor is it meant to prejudge in any way an outcome of discussions on the governance system for the Energy Union' (EU-JS, 6). One interviewee reflects on this non-binding nature by stating that 'we need a leap forward: it is not the case that we plan together. You see that TenneTs project emerges in this context, and it is not the case that countries immediately say 'let's do it'. This has to do with 'is it obligatory': coordinating spatial planning is desirable, but it is not a binding European obligation to work together' (Int-1).

A lack of knowledge on the precise impact of large-scale offshore wind generation on the North sea constitutes another institutional barrier because it influences the way in which stakeholders cooperate regarding the transition to large-scale offshore wind. According to the NSWPH, 'In general, there still are many environmental data gaps and potential environmental impacts and opportunities should be jointly investigated further with relevant stakeholders' (NSWPH-CP3, 9). Multiple documents highlight that the precise effects of large-scale offshore wind development on the marine environment, birds and bats are existent, yet unclear: 'Installation of large wind farms and hubs will most likely have a permanent impact on the local habitat, which will have a knock-on effect on the species abundance and biodiversity' (NSWPH-CP3, 9, see also OFL, 15; VIS, 10). Therefore, there is a need to fill up lacunas in current knowledge with scientific research (OFL, 15; VIS, 30). This influences stakeholder cooperation because various stakeholders have various, often conflicting, takes on existing information. The role that information plays in stakeholder cooperation on the North Sea became apparent in the analysed interviews, which mainly mention marine spatial planning as an issue area where informational tensions arise. We will present some examples below.

Usually, environmental impact assessments are considered as a way to increase knowledge on environmental consequences of offshore wind. In the North Seas countries' Joint Statement, the European Commission recognises 'the possible ecological limits of large scale wind development at sea and acknowledge the necessity of increasing knowledge in the field of maritime spatial planning, environmental research and cumulative impact assessment of wind farms' (EU-JS, 3). It also reaffirms 'to continue to work towards a common environmental impact assessment methodology, which requires an integrated approach and close cooperation between responsible authorities for energy, maritime spatial planning and environment' (EU-JS, 3). Relating to this 'cumulative impact assessment of wind farms', interviewee 4 states that to date, there has not been an adequate cumulative impact study. 'It is important to measure cumulative impact, because if everybody only measures its own use in an isolated manner without looking at the effects in combination with existing farms and preferably also with fisheries, shipping, dredging, cables and pipes, it may look

like one wind farm might not have such a big effect on the ecosystem. There are cumulative impacts, but so far no one has looked at the system as a whole' (Int-4). Interviewee 4 furthermore mentions that the WWF will keep on challenging the people working at the NSWPH to take a broader perspective, but the interviewee does not know yet if this will be the case; 'This will become clear from their research questions, how they set up their impact assessments and what potential locations they look at' (Int-4). This stance suggests that the stakeholders that the NSWPH engages with remain critical on the ways in which the consortium acquires its information.

It becomes clear from the data that interpretations of existing knowledge on environmental consequences differ. Interviewee 3 states that offshore wind 'farms are healthy for the marine environment since fishers are not allowed too close to the turbines' (Int-3). Interviewee 4 on the other hand, states: 'Do not sell wind farms as new nature areas, because they just are not' (Int-4). The interviewee elaborates that 'what you can do, is to make sure that for the time that you have wind farms, you try to do this with as little harm to nature as possible. But do not pretend that wind farms are amazing nature reserves, because they are not meant and designed to be that. Be honest about the true impact it has, and look at how to compensate this, especially with large-scale nature protection' (Int-4).

In the Netherlands, science also plays a role in the discussions regarding the North Sea agreement (OFL, 15). The following quotes show the delays that might occur in stakeholder cooperation due to informational disputes. The debate preceding a North Sea Agreement happens on the basis of Joint Fact Finding (JFF), with the intention to establish shared facts and work further from there (OFL). According to Int-1, 'JFF goes well as long as it does not touch upon an actor's own interest; from that point, it is impossible to look at the facts without attaching value to it' (Int-1). And: 'When it comes to balancing interests and when it is going to cost money, parties become more and more critical on the information and increasingly try to refute it: established knowledge is questioned over and over by certain parties. There is also distrust between parties' (Int-1). The interviewee adds: 'What would not surprise me is that when we finish the North Sea Agreement and the next step is to adopt this to certain wind energy areas for reserving space and sand extraction, that this discussion will come back again, that the joint facts that we have gathered will again become subject to discussions' (Int-1). An example of a point of discussion that might re-emerge relates to fishing areas. The fisheries document states that 'the current method of using value maps that determine the most valuable fishing areas on the North Sea is too abstract to truly assess the those areas. Such maps should not illustrate the financial impact of wind farms on fisheries because fish can move between areas over time, so this ecosystem cannot be captured in several restricted areas' (VIS, 23). Referring to the preferences of the fisheries sector, Int-1 states that 'the annoying thing is, if you cannot ground something on the North Sea scientifically, you will run into the fisheries sector who will use this to block nature protection, and they always have a majority for this in the parliament' (Int-1). This quote also reminds of the likely interwovenness between the fisheries sector and the Dutch government that the political issue area pointed out.

Involving a variety of actors in the process concerning offshore wind seems to be a driver for both governments and stakeholders. The EU Political Declaration highlights for example 'The importance of maintaining an open dialogue with all stakeholders including system operators, regulatory authorities, business, civil society, institutional investors, governments and politicians,

when drawing up and implementing a work programme and further shaping North Seas regional cooperation' (EU-PD, 2). In this quote, we also see that these stakeholders will be involved in creating and implementing a work programme. However, in the Joint Statement released three years after this Declaration, the industry is stressed as an important stakeholder and the involvement of stakeholders seems to be limited to 'preparing a new work programme': 'Ministers and the European Commission recognize the importance of maintaining an open dialogue with all stakeholders, especially the industry, when preparing a new work programme and acknowledge the role of the industry in exploring the potential of the North Seas and the window of opportunities this offers for the industry; therefore welcomes the recommendations delivered by the industry as a valuable input for future key headlines for the next phase of the North Seas Energy Cooperation' (EU-JS, 6).

In the Netherlands, stakeholder involvement is deemed crucial for reaching a North Sea Agreement. During the North Sea debate, where TenneT (a consortium member) is included, 'stakeholders are involved in the development of an agenda in many ways. Sometimes more intensively, for example regarding spatial use, the knowledge agenda or nature. Sometimes more informal and open-ended in 'catch up sessions' with a broader group' (OFL, 9). This quote suggests that there are multiple ways to involve stakeholders.

This institutionalised cooperation between government and stakeholders did not always look the way it does today: the decision-making process changed from a 'consultative to a participative' process, from responding to official government concepts to together creating a North Sea Agreement' (OFL, 11). The traditional consultative process was perceived as a 'black box' by stakeholders because they did not get insight into what exactly happened with their input. Besides, this consultation often took place per sector or per issue, instead of looking at the North Sea integrally. For these reasons, 'according to stakeholders essential choices were not made. And when they were made, the stakeholders did not feel as if they were a part in this. This did not surprise the OFL: the process of consultation is characterised by definition as the consultation that the owner of the process has with interest groups, with whom a serious conversation is held, but who are not members of the decision-making. It is, put simply, not a model that leads to a common deliberation' (OFL, 9).

Currently, the North Sea debate is moving towards a more participative process, where due to the setting stakeholders and the government sit at the table as equal partners, which creates mutual trust and goodwill. This is supported by the following quotes: 'The fact that we had an independent and heavy-weight chairman, which made that we were sitting at the table with them (the stakeholders), created a situation of fair hearing, so people felt as if they were more equal partners. So we did get closer, in that sense. Also the fact that we acted upon the stakeholders' wish to get to a North Sea Agreement created goodwill' (Int-1). The following quote underlines how stakeholder participation can lead to more trust: 'In the opinion of the OFL, a conscious transition from a consultative to participative decision-making helps to do something against the growing distrust that stakeholders have against the government. This will come naturally. But true collaboration creates a new basis for trust' (OFL, 11). In this sense, more and meaningful stakeholder participation in the Netherlands seemed to increase the likelihood of stakeholder support for decisions regarding the North Sea.

In order to overcome the above-discussed informational challenges between stakeholders during the North Sea debate, the government sometimes lets parties come up with reports together (Int-1). Another way is to introduce a scientific committee, which can validate the information that is used (Int-1). A driver that mitigates the absence of cumulative environmental impact assessments relates to the North Seas Energy Cooperation, which provides a platform for cooperation on 'Developing a common environmental assessment framework' (EU-PD, 4).

Polycentric indicators

The NSWPH consortium proposes an alternative approach to the current European energy system, promoting international multi-stakeholder cooperation and integration of multiple processes including grid interconnection and marine spatial planning. This section draws upon data from the NSWPH to enlighten the polycentric governance construct that the consortium proposes to achieve this alternative approach. It is structured by the polycentric indicators described in the conceptual chapter. Most of the analysed data revolves around the ways in which the consortium wants to organise cooperation for offshore wind energy on the North Sea. In the cases that it was available, data on the internal organisation between consortium partners is included as well. We note here that, in the analysed documents, the consortium does not touch upon all polycentric indicators and only concisely on some others. For this reason, for some indicators it remains unclear how the consortium conceives them. The evaluation chapter goes deeper into what this means for the research outcomes. With the consortiums aim to increase international cooperation between countries that traditionally approach the energy system individually, it inherently pleads for 'governance on multiple scales' and more interaction between these scales. The interaction that the consortium promotes takes place mainly between the national and the European scale, more specifically between the countries that surround the North Sea. The two quotes below are examples that show the efforts of the consortium to increase governance on multiple scales. "With our programme, we're not only aiming to facilitate a major energy transition – we're also breaking the national perspective. We're working on a large scale, from a long-term point of view' (NSWPH-W3); 'The consortium and industry invite the Dutch, Danish and German governments to consider setting up a cross-governmental consultation to find solutions for the issues highlighted in this report in order to enable the offshore wind potential of the North Sea to contribute to achieve the ambitions of the Paris Agreement. We are also keen to open up the discussion for participation from other North Sea countries such as the United Kingdom and Norway' (NSWPH-CP5, 7).

The next polycentric indicator is 'diversity of actors', which includes the diversity of the consortium members as well as the variety of actors with whom the consortium liaises. The consortium consists of four Transmission System Operators and the Port of Rotterdam, which suggests that the diversity of actors inside the consortium is quite low. As the consortium puts it: 'The consortium members are all players in large energy infrastructure and are committed to realise long term climate goals by developing the energy infrastructure of tomorrow' (NSWPH-CP2, 7). Concerning the outside actors with whom the consortium works, the consortium brings forward its commitment to increase cooperation between 'all North Sea stakeholders', which suggests a big variety of actors. See for example the following quote : 'Therefore, a concerted action and cooperation across all North Sea stakeholders is required now to enable this internationally coordinated roll-out and integration of offshore wind, which is pivotal in reaching the Paris

Agreement' (NSWPH-CP1, 6). In other quotes however, the consortium seems to stress specific types of actors. The following quote particularly mentions 'industry, NGOs and TSOs': 'It also requires proper alignment with national and European grid planning processes. Such decisions require vision and direction from policy makers which takes into account feedback from industry, NGOs and TSOs to ensure realisation at lowest cost and highest value for society while minimising environmental impact' (NSWPH-CP3, 11). The following two quotes also show that there might be a focus on actors from the industry instead of 'all North Sea stakeholders': 'In early 2019, the consortium has engaged with more than 10 leading and influential OWF[3] developers to get feedback and input on a successful business model for a first-of-a-kind project, combining grid connection of offshore wind power with interconnectors. During the discussions with industry, a number of principles regarding a viable business model of the Hub-and-Spoke concept were commonly agreed upon' (NSWPH-CP5, 5); 'After several critical studies and animated conversations with specialists, developers and stakeholders, the answer was clear. Yes, a network of hubs that connect far offshore wind farms to North Sea Countries' energy markets is possible' (NSWPH-W2).

Another polycentric indicator that emerged from the conceptual chapter is 'information sharing'. According to interviewee 2, the actors that make up the consortium collaborate in a 'stable and open' manner. They 'share information regarding the project' under the condition that 'sensitive information stays between the consortium partners' (Int-2). This suggests that in any case inside the consortium, information is shared. If we look at how the consortium perceives the importance of information sharing in its contact with outside actors, we see that one of the goals of the consortium is to 'adequately inform the broader discussion, regarding the energy transition and specifically the large-scale offshore wind development' (Int-2). Even though the consortium aims to intensify engagement with all North Sea stakeholders, it also aims to 'facilitate deliberative decision-making from policy makers by bringing in the expertise of the different consortium partners' (Int-2). What remains unclear here is if it is only the expertise of the consortium that is shared with policy makers, or if the expertise from all North Sea stakeholders is included in the NSWPH's efforts to facilitate political decision-making. Another question that remains here is whether actors also share information with the consortium, or if it is primarily the consortium that provides it.

The (perceived) degree of transparency and trustworthiness of information that is shared in a polycentric governance construct is a component of 'information sharing'. The analysed documents and interview do not particularly touch upon the transparency and trustworthiness of the shared information. Conversely, the other component of information sharing is 'data on costs and benefits' and appears in four out of six NSWPH concept papers. Based upon these documents, it is clear that the consortium specifically brings a 'techno-economic perspective' to the discussions with policy makers (NSWPH-CP1, 7; NSWPH-CP2, 7; NSWPH-CP3, 9, NSWPH-CP6, 7). This techno-economic view stresses the feasibility of different technical approaches to the Hub-and-Spoke concept and the costs and benefits that they would bring. For example, the consortium wants to 'quantify the costs and benefits associated with further sector coupling between the electricity and the gas (Hydrogen) grid in relation to the integration of large scale North Sea offshore wind' (NSWPH-CP4, 8).

[3] OWF stands for 'Offshore Wind Farm'

Other polycentric indicators include mechanisms for monitoring; feedback; inducing compliance; conflict resolution; sanctioning and encouraging adaptivity. None of the NSWPH documents clearly reveals a commitment to monitoring, conflict resolution or sanctioning. Some documents however, touch upon the need for feedback from stakeholders. The perceived preference for input from industry stakeholders versus stakeholders from non-governmental organisations that is highlighted above under 'diversity of actors', seems to be apparent in the consortiums feedback mechanisms as well. Multiple quotes, including the following, highlight the input from industry actors that the consortium deems important: 'Decisions are required on how revenue models for generators and transmission infrastructure operators should be structured. First discussions with the offshore wind farm (OWF) industry have started on which models could potentially work best; this however requires careful consideration and further interaction with industry' (NSWPH-CP5, 5). And: 'The business model of the Hub-and-Spoke projects will strive to support the business case for OWF developers through minimised costs, access to an interconnected energy market and enhanced long term revenue stability. To achieve this ambition, early input from OWF developers has been a key priority for the consortium as it is essential to create a successful business model and advance the first Hub-and-Spoke project' (NSWPH-CP5, 5).

Drawing upon the analysed data, we might conclude that feedback from non-industry stakeholders is desirable in other aspects apart from the techno-economic: 'Next to environmental and techno-economic studies, the consortium has specifically engaged with NGOs over the past year to consider their input on the Hub and-Spoke concept. In addition to specific workshops, feedback was gathered through direct interaction. To address the feedback from NGOs the consortium has introduced an additional "investigative location" to its techno-economic analysis of main drivers for the design of a Hub-and-Spoke project' (NSWPH-CP6, 6). What these aspects exactly are does not become clear, but this quote suggests that the input from NGOs was used for the issue where to locate the Hub-and-Spoke concept. The following quote suggests that input from NGOs is also used for the topic of grid planning: 'It also requires proper alignment with national and European grid planning processes. Such decisions require vision and direction from policy makers which takes into account feedback from industry, NGOs and TSOs to ensure realisation at lowest cost and highest value for society while minimising environmental impact' (NSWPH-CP3, 11).

According to the polycentric governance literature, ideally there is a mechanism for 'inducing compliance' in polycentric governance constructs. Between the consortium partners, 'There are conditions under which the cooperation takes place, also with a legal component. There are arrangements regarding the content and the way in which strategic decisions are made', according to interviewee 2. The legal component might create conformity in the interaction of the consortium. Concerning the compliance of outside partners, the consortium mentions that 'For the long term, it (the consortium) aims to ensure that proper and robust incentives across all stakeholders throughout the roll-out and energy transition are in place' (NSWPH-CP2, 7). This quote does not completely clarify what such incentives may look like. The following quote might give a clarification, however this quote stresses only the potential compliance from offshore wind farm developers vis-à-vis the Hub: 'Agreed principle from discussion with OWF developers: Roles and responsibilities have to be defined early and clearly, for example who is operating the grid infrastructure, who is responsible for balancing the power, etc.' (NSWPH-CP5, 5).

Polycentric governance arrangements have the benefit of fostering experimentation. This suggests that in theory, if the consortium effectively organizes cooperation, it could promote experimentation with different energy system approaches. The conceptual chapter showed that being able to adapt and preferably even 'encourage adaptivity' plays an important role here. The NSWPH touches upon this in the following quotes: 'Facilitating a step-by-step roll-out of projects through its modular design to find an optimal balance between scale and development times and investment phasing. Each specific project can adapt to its specific physical environment' (NSWPH-CP3, 4). And: 'The modular Hub-and-Spoke concept provides flexibility to adapt each project to location specific needs. Scale and design can be adapted to location specific needs – wide range of design options available across scale, foundation type, and configuration, optimisation to leverage synergies with end-use sectors' (NSWPH-CP4, 5). Regarding the foundation type, interviewee 2 states that 'the NSWPH consortium is not only focused on creating an island, also other foundation types are possible. This is why the term interconnected 'hub' was chosen; this can encompass all types' (Int-2). We might derive from these quotes that 'adaptivity' in the context of the NSWPH relates primarily to the physical environment of the Hub-and-Spoke concept and its ability to adapt to location-specific needs.

However, two more recent quotes from the NSWPH newsletter suggest that 'adaptivity' is also (to a certain extent) understood in a broader sense, including sensitivity for country-specific political contexts: 'The upcoming stages of the NSWPH Programme require constant flexibility: not just by responding quickly to recent political developments and the latest insights in the field, but also by closely reviewing the roles of all the partners involved. During the latter process, the Port of Rotterdam recently suggested to take up a new role in the Programme. By getting a better perspective on the entire process, it also became clear that the Port of Rotterdam wouldn't be able to play the role it had initially in mind – at least not in the near future' (NSWPH-W1). And: 'Now that the green light has been given, it's time for the next stage: from project to programme. 'A programme this ambitious and widespread requires so much preparation that it has to be divided into smaller steps', Michiel explains. 'Instead of trying to develop a blueprint for the years to come, we take a programme approach to facilitate the energy transition, focusing on crucial questions like: what can we do to make the energy transition as smooth as possible? Which challenges do we foresee in the near future? What are the demands for the individual hubs? And how can we start getting everything in place to be able to realise the first hub in the early 2030s?' The programme-oriented view offers the consortium the possibility to be more flexible: 'Instead of working with fixed long-term goals, we can adjust our plans according to the different stages of the programme and the latest developments in the countries involved' (NSWPH-W2).

In conclusion, the following polycentric elements are not clearly apparent in the analysis of NSWPH data: transparency and trustworthiness of information; mechanisms for monitoring, conflict resolution and sanctioning. According to the analysis of polycentric indicators, the primary focus of the NSWPH seems to be on providing data on the costs and benefits of hybrid projects to policy-makers. The Hub mentions to include all stakeholders, yet some quotes suggest that the consortium receives more feedback from industry actors than from NGOs.

Chapter 6: Evaluation

Empirical evaluation

Although the current European renewable energy system is polycentric, with the various issue areas reflecting various centres of decision-making, its degree of polycentric governance is limited due to the little and fragmented cooperation between governments and stakeholders on an international scale. As a result, this may hamper the large-scale rollout of offshore wind and the possibility of North Sea countries to reach the EU renewable energy targets. This thesis considers the hybrid offshore wind approach of the NSWPH consortium as a proposed polycentric governance arrangement that addresses this problem. This chapter first shortly describes case-specific barriers and drivers per issue area and subsequently evaluates the consortiums proposed governance arrangement using polycentric indicators. It argues that the governance arrangement effectively addresses the technical and legal issue area, moderately addresses the political and economic issue area and insufficiently addresses the institutional issue area.

Barriers and drivers

Let us first discuss the main barriers and drivers per issue area that emerged from the qualitative content analysis. Table 5 synthesises the outcomes of the analysis. The upper row of the table involves the barriers and drivers that occur at the international level, between the North Seas countries. The lower row entails the barriers and drivers as they appear in the Netherlands, which serve as an illustration for how some barriers and drivers may play out on the national level.

	Technical	Political	Economic	Legal - spatial	Institutional
International / EU	Barriers: -Intermittency of renewable energy sources - Integrating RE in existing grids Driver: - Hybrid approach to offshore wind, promoted by NSWPH	Barrier: - lack of clarity on long-term renewable energy goals Driver: - Climate agreements; North Seas Energy cooperation	Barriers: - Uncertainties due to lack of clear market perspective; potentially unequal division of costs and benefits - Need for increased electricity demand Drivers: - The NSWPH promotes market stability - Financial EU support for joint offshore projects	Barriers: - Grid interconnection between countries with different rules and regulations - Size of North Sea with multiple sea uses; unclarity on space for offshore wind and possibility for multi-use areas - Opposition from stakeholders against potential Hub location Drivers: - EU Political Declaration supports harmonisation of standards - The NSWPH promotes integrated spatial planning - North Seas Energy Cooperation	Barriers: - Vested interests - No significant international coordination on offshore wind, due to political prioritisation of national policies, different governance cultures and no binding mechanism for cooperation - Energy system operates in silos - Lack of knowledge on environmental impact Driver: - North Seas Energy Cooperation: developing common environmental assessment framework
National/ Netherlands		Barriers: - Government does not sufficiently take the lead in formulating long-term goals - Political backing for the fisheries sector	Barriers: - Uncertainty on subsidy design: pursuing zero-subsidy tenders - Government does not directly pursue policy to stimulate electricity demand	Barrier: - Inexistence of common framework for spatial planning on the North Sea	Barriers: - Internal alignment within government is time-consuming - Joint Facts continuously disputed by stakeholders, especially by fisheries sector Driver: - From a consultative to a participative process: broader stakeholder involvement (OFL)

TABLE 5: THE BARRIERS AND DRIVERS THAT EMERGED FROM THE ANALYSIS

The main barriers in the technical issue area include the intermittency of energy supply and the integration of renewable energy in existing grids. Hybrid offshore wind projects could address this challenge, since interconnected grids mitigate potential fluctuations in energy generation and facilitate the integration of renewable energy into the current energy system. The NSWPH is considered a driver in this issue area because the consortium actively invents and promotes their hybrid solution to address these technical barriers. This leads us to conclude that the technical barriers relatively have a lower priority for evaluating the consortiums governance arrangements as we did not identify any other barriers besides the ones that the consortium already addresses.

A political barrier that the NSWPH highlights is the current lack of clarity on long-term goals for renewable energy, which hampers the integrated rollout of large-scale offshore wind. Current plans run until 2030, while the consortium pleads for plans until 2050 because of the long lead times of hybrid projects. In the Netherlands, interviewees mention the lack of political will and the acknowledgement of a government that it should take the lead in overarching societal challenges such as the energy transition. This could have to do with the daily reality of politics as 'quid pro quo', where politicians keep track of who gives and takes on what dossiers. This plays out in a political landscape where politicians have to balance between the many different interests they represent, which could result in policies that contradict each other. Here, some interest groups have more political backing than others. In the Netherlands, the fisheries sector is one of those groups that relatively have a lot of political backing from multiple parties. Concretely, this can clash with the interests of the NSWPH since the Dutch government wants to protect the economic position of 'our

fishers'. A political driver is the emergence of various climate agreement that create political attention and momentum for the energy transition. In Europe, the North Seas Energy Cooperation Declaration endorses the potential for large-scale offshore wind, specifically mentioning the aim to work towards hybrid projects. Kriegers Flak, the first hybrid project connecting Danish and German wind farms on the Baltic Sea shows that it is possible to overcome existing barriers. All in all, there seems to be a consensus that offshore wind on the North Sea will grow.

Economically, the existence of uncertainties impacts the business case of offshore wind as it creates financial risks. Examples of such uncertainties are the impacts of Brexit on the market and the potentially unequal division between costs and benefits among interconnected countries. Another important economic factor concerns subsidies for renewable energy. In the Netherlands, politicians are debating the amendment of the law on offshore wind, where different subsidy schemes are discussed. The last two Dutch tenders were subsidy-free and the government want to pursue this line. However, the analysis suggests that the absence of subsidies creates uncertainties when the price of electricity drops below a certain point and either the business or the government has to compensate the difference. There seems to be a disagreement between the government and the industry on whether to use public money for subsidies or not. The need for a higher demand of electricity also poses a barrier. Here, another divergence between government and industry arises: the Dutch government does not directly pursue policy to increase demand, only to limit CO2-emissions, which 'possibly' creates more electricity use. The industry on the other hand, highlights the crucial role of the government in stimulating demand, which would positively affect the business case for (hybrid) offshore wind. We consider the NSWPH a driver in this issue area, as it actively promotes measures that increase market stability. Another driver is the financial support from the European Union for joint offshore projects and the 'Project of Common Interest' status that the NSWPH received, which may ease funding and permitting processes.

For the legal and spatial issue area, we found that hybrid projects inherently encounter legal barriers since they integrate grids of countries with different rules and regulations. Government support is also crucial in this regard. Yet, both the consortium and the North Seas Energy cooperation raise awareness and aim to overcome this barrier. A driver is the aim of North Seas countries to harmonise their rules and regulations, which shows that this barrier is acknowledged by the European Union. This important step takes time, but there is work in progress.

Spatially, the main barrier is the limited available area on the North Sea for offshore wind, including many different and often competing sea uses. An uncertainty is the possibility that only a scattered area is left for the Hub-and-Spoke concept, which makes it difficult for the Hub to create the synergies it could provide. In the Netherlands, there is currently no framework for spatial planning in the Dutch EEZ. A barrier that emerges in this context is the opposition from stakeholders regarding the precise location of the Hub; especially the Dogger bank as a nature protected area is controversial. We can consider the NSWPH as a driver in this issue area because it promotes integrated spatial planning between countries. The North Seas Energy Cooperation also shows efforts to further integrate European-level spatial planning.

Concerning the institutional issue area, we observe that vested interests of existing, non-renewable energy industries hamper the transition to renewable energy in favour of the status quo.

The main barrier described by the NSWPH is the lack of significant international cooperation for offshore wind. The cooperation that does exist takes place in separated parts of the process. The reasons for this are the prioritisation of (often sensitive) national energy policy and the will of governments to maintain national autonomy over this. Differences in governance cultures on for example the degree of stakeholder cooperation and planning timelines also pose difficulties for international cooperation. In the Netherlands for example, alignment within the government between several departments that work on offshore-wind is often difficult and time-consuming. The degree of internal alignment varies between the North Seas countries, which may further delay coordination processes. Furthermore, there is international cooperation between the North Seas countries, but this is based upon political intent alone as there is no binding sanctioning mechanism for not complying to the agreements made under this cooperation.

The institutional issue area furthermore highlighted the knowledge gaps concerning the impact of large-scale offshore wind on the North Sea ecosystem. The NSWPH wants to conduct more scientific research (with relevant stakeholders). The analysis suggests that stakeholders make different research choices, which produces different results and generates different conclusions. This happens for example regarding environmental impact assessments, where NGOs such as the WWF promote cumulative environmental impact assessments versus non-cumulative options. Furthermore, existing knowledge is interpreted in various ways and NGOs remain critical on the methods that the Hub uses. In this opacity on environmental impacts, uncertainty for the Hub emerges about where to locate their Hub-and-Spoke concept. In the Netherlands, 'Joint Fact Finding' encounters similar problems. The situation is that there is disagreement on these facts between the variety of stakeholders involved in the discussion, which delays the process. Information is questioned again and again, illustrating the distrust that exists between stakeholders on this topic. Especially the fisheries sector seems to hamper the process in an effort to block nature protection as they might rekindle old discussions again when the North Sea debate enters the next phase.

A way to overcome the barrier of limited international cooperation is to engage in a dialogue with various stakeholders. Interestingly, the input from industry stakeholders is often particularly mentioned, which highlights a preference for industry actors in comparison to other actors such as NGOs. The nature of stakeholder involvement may vary, but seems to be mostly present in the preparation phase of a programme instead of during the implementation phase. In the Netherlands, the institutionalised cooperation between government and stakeholders morphed from a consultative into a participative process. Before, stakeholders could give input on separate issues but did not see what happened with it, so they were not truly involved in decision-making. With the move towards a more participative process, government and stakeholders deliberate together as equal partners. This builds trust and goodwill because stakeholders are involved in many processes, ranging from creating a common agenda to spatial use. Even though the process takes more time, the likelihood of stakeholder support for eventual decisions will increase, which is a driver on the long term.

Altogether, we see that some barriers and drivers interrelate as they are not always bound to one issue area. Building upon the analysis, we attach a relatively high weight to the political issue area for we observe that (the absence of) political decision-making ripples through to other issue areas, mainly the economic: political decisions on longer-term targets for renewables and

stimulating electricity demand could provide more market stability. The economic issue area also shows some incongruencies between what the market needs and what the (Dutch) government says it will provide. In line with this, the government does not seem to fully acknowledge its (small yet significant) contribution to the bigger trends in electricity prices. Take for example the various subsidy systems of North Seas countries. With an interconnected grid, subsidised and unsubsidised energy will flow between those countries. This might negatively influence the competitiveness and therewith the business case for offshore wind in countries that do not, or to a lesser extent, provide subsidies for renewable energy. It is important to note here that some political barriers might be harder to address by the consortium since they are subject to political decision-making. The consortium does inform policy makers, but it does have the mandate to make the final decisions. The current debate on subsidy schemes in the Netherlands illustrates this: the consortium can inform policy makers with techno-economic information, but not make the final decisions. One can therefore argue that some barriers remain largely outside of the consortiums scope. For this reason, some of the recommendations presented in the conclusion address the Dutch government. Yet, in the following section where we discuss the polycentric indicators that the consortium touches upon, we do notice that there is still room for improvement on the indicator of 'information sharing'.

In general, the barriers and drivers identified in the analysis overlap with those previously identified in the conceptual framework. Comparing the barriers and drivers emerging in the analysis to the barriers and drivers described in the conceptual chapter, we see primarily that the spatial component of the legal-spatial issue area is indeed relevant for large-scale offshore wind, which confirms the relevance of connecting the literature on polycentric governance of renewables to the literature on polycentric marine governance. In fact, the spatial issue area proved to be so important that we suggest to decouple it from its legal component. We will go deeper into this later in this chapter. For the technical issue area, we see for example that intermittency of energy supply and grid interconnection between multiple countries remain the most important barriers. The fragmented nature of global energy governance that we described in the literature review comes back as the need for increased international coordination and integration that the NSWPH stresses. Concerning the political issue area, the need for government commitment is shortly mentioned in the conceptual framework. The analysis provided more insights into this as it touched upon the day-to-day reality of politics and the representation of certain stakeholders in the government. In the Netherlands for example, the interest of the fisheries sector is represented to such an extent that it is able to block decisions that co-determine the available space for offshore wind on the North Sea. Economically, the lack of forward-planning and the need for increased electricity demand also overlap. Interestingly, a driver in the conceptual framework is the 'diverse range of economic incentives', which has become barrier in the Netherlands where, according to the analysis, the government only plays a limited role to provide economic incentives. The latter part of this chapter will go deeper into the institutional issue area relate the research outcomes to the initial conceptual framework.

Polycentric indicators

Now that we sketched the barriers and drivers specific to the energy transition on the North Sea, we will evaluate the governance arrangement that the NSWPH proposes to address them. This governance arrangement concerns the way in which the consortium shapes international and multi-

stakeholder cooperation. The polycentric indicators serve to evaluate this arrangement, reflecting the normative use of polycentric governance theory. Since the polycentric governance literature does not clearly add more weight to one polycentric indicator over the other, we do not necessarily discuss the indicators in the order in which they happen to be presented in the conceptual framework. The polycentric indicators that appear in the NSWPH documents are 'governance on multiple scales'; 'diversity of actors'; 'data on costs and benefits'; 'feedback'; 'inducing compliance' and 'encouraging adaptivity'. The extent to which these indicators emerge in the documents varies. The indicators that are not explicitly mentioned in the analysed documents are 'transparency and trustworthiness'; mechanisms for monitoring; and 'mechanisms for conflict resolution and sanctioning'. Table 6 displays the polycentric indicators from the conceptual framework and the way in which they appear in the analysed NSWPH data.

Polycentric indicator	**Governance on multiple scales**	**Diversity of actors**	**Information sharing:**	**Transparency & trustworthiness**	**Data on costs and benefits**	**Mechanisms for: monitoring**	**Feedback**	**Inducing compliance**	**Conflict resolution & sanctioning**	**Encouraging adaptivity**
Analysis of NSWPH data	Yes: aim to increase international cooperation and interaction between national government and EU-level.	Internally: low, as the consortium consists of 4 TSOs and one port. Externally: aim to engage with all North Sea stakeholders, but potentially prioritising industry actors.	Internally: consortium partners share (sensitive) information with each other. Externally: informing policy makers with expertise of consortium	The analysed documents do not explicitly mention this.	Prominent in the documents, that mainly highlight the 'techno-economic perspective.	The analysed documents do not explicitly mention this.	Consortium mentions the need for feedback from stakeholders. There might be a slight preference for input from industry actors.	Internally: cooperation between consortium partners on the basis of a legal agreement. Externally: defined roles and responsibilities between OWF developers	The analysed documents do not explicitly mention this.	Mentioned a couple of times, mostly meaning the ability of the Hub-and-Spoke concept to adapt to its physical environment. Also understood more broadly as sensitivity for national (political) contexts: no blueprint, but programme approach.

TABLE 6: POLYCENTRIC GOVERNANCE INDICATORS AND HOW THEY APPEAR IN THE ANALYSED NSWPH DATA.

One of the polycentric indicators most prominent in the NSWPH documents is 'governance on multiple scales': the consortium clearly highlights its dedication to cooperate internationally, therewith showing its support for multi-level governance. We do note here that these scales only include the national and the EU-level, not the subnational level. With this indicator, the consortium addresses the main institutional barrier of limited international cooperation for offshore wind. The analysis pointed out that this limited international cooperation has to do with an emphasis on national policies, different governance cultures and the lack of a binding sanctioning mechanism for non-cooperation. Concerning the latter, we do not consider imposing sanctions as a mandate of the consortium: rather, this is a concern for public actors. On the other hand, stimulating effective cooperation between self-interested actors from different (governance) cultures is something that the consortium can address in a polycentric manner. Besides 'governance on multiple scales', its ability to do so depends on the presence of other polycentric indicators such as 'inducing compliance' and 'mechanisms for conflict resolution'. We will come back to the ability of the

consortium to address the barriers behind the lack of international cooperation in the conclusion of this section.

Concerning 'data on costs and benefits', which makes up one part of 'information sharing', the consortium sees itself as an important knowledge broker regarding the techno-economic aspects of large-scale and hybrid offshore wind on the North Sea. We notice this in the analysis of barriers and drivers as well, where the Hub is mainly a driver that addresses barriers in the technical and economic issue areas. While the consortium efficiently addresses the technical barriers with its hybrid concept, some economic uncertainties remain such as the need for increased electricity demand. In the case of the Netherlands, it is a political decision to not directly stimulate this demand so addressing this barrier largely remains outside of the scope of the consortium. What the consortium can do to address the interrelated political and economic issue areas, is sharing data on the costs and benefits of political decisions and underline the need for clarity on long-term renewable energy goals. Here, is not entirely clear if the information is shared reciprocally between the consortium, stakeholders and policymakers. What we do know is that some sensitive information stays inside the consortium and is thus not shared externally. In the analysed documents, it seems like the consortium mostly provides information to policymakers instead of also receiving and using information from other stakeholders. We do notice that the consortium receives information in the form of feedback. However, there seems to be a predilection for input from industry actors regarding techno-economic affairs. Other affairs, such as environmental, social or spatial, may include input from other stakeholders, but the documents do not explicitly mention what this stakeholder involvement looks like and whether or not is differs from the desired industry involvement.

Even though the consortium shares information, we argue that this aspect does not cover the full breadth of the polycentric indicator as described in the conceptual chapter. A reason for this is that the shared information is predominantly techno-economic, while other types of information are also important. We see for instance in the institutional issue area that there are many knowledge gaps on the impact of large-scale offshore wind on the North Sea ecosystem and the interpretation of available knowledge may create disputes between stakeholders. Even though the consortium highlights the need to address the current knowledge gaps, it does not mention the polycentric indicator of 'transparency and trustworthiness' of information. It would however be relevant for the consortium to acknowledge the varying takes on the transparency and trustworthiness of information, since choices made in their research produce certain outcomes, which will in turn be interpreted differently between stakeholders. Being transparent about decisions made during research and being sensitive towards different takes on the trustworthiness of specific data, can therefore increase the ability of the consortium to cooperate effectively with stakeholders with diverging interests. This is relevant given the example of research on potential Hub-and-Spoke locations where NGOs remain critical on the data shared by the consortium.

Taking into account the informational disputes that may emerge between various stakeholders, the polycentric indicator of 'mechanisms for conflict resolution' is also relevant for the consortium. We do not have sufficient information to draw definitive conclusions on this: neither about the internal cooperation in the consortium, nor about the way in which the consortium engages with other stakeholders. What we do know from the analysis is that the limited amount of

information on environmental impacts of offshore wind influences stakeholder cooperation. It can create dissent between stakeholders, for example on the possibility of multi-use versus single-use of wind farm areas. In the Netherlands, we see that conflicts emerge mostly around the different values attached to information on environmental impacts. Taking into account the lacunas in knowledge and the various interpretations of existing knowledge, it is likely that disputes will (re-) emerge in the future and delay the decision-making process. Therefore, we deem it important for the consortium to have a basic mechanism for conflict resolution in place.

One domain where there is more need for data on costs and benefits concerns potential free-riding, which polycentric governance literature describes as inherent to collective action problems. The analysis touched upon the potentially unequal allocation of costs and benefits between North Seas countries as an economic barrier to invest in hybrid offshore wind projects. Following the conceptual framework, knowledge on the efficiency and effectiveness of policies will increase through trial and error (see Ostrom, 2009: 31; Aligica & Tarko, 2012: 242). In line with this, it would make sense to closely monitor if and to what extent this potential free-riding takes place. In other words, a mechanism for monitoring could provide data on the costs and benefits for North Seas countries. However, based upon the analysis, the consortium currently does not deploy such a monitoring mechanism.

We do not have sufficient data to assess the compliance mechanisms inside the consortium since we only know that cooperation happens on a legal basis. Their documents also do not provide much information on how they aim to induce compliance, only that from a discussion with OWF developers emerged that 'roles and responsibilities have to be defined early and clearly' (NSWPH-CP5, 5). This does not include compliance mechanisms between the consortium and other types of stakeholders besides offshore wind developers. Taking into account the aim of the consortium to increase voluntary international cooperation, it would seem reasonable to address this polycentric indicator. According to the conceptual chapter, compliance increases when actors trust each other and feel that their willingness to cooperate is reciprocated by others (Ostrom, 2009: 12). In the Netherlands for instance, the switch from a consultative to a participative process for stakeholder involvement created mutual trust and goodwill.

This brings us to another polycentric indicator that the consortium mentions in some documents: 'diversity of actors'. The analysis showed that the internal diversity within the consortium is quite low, since four out of five members are TSOs and one is a port. Given the aim of the consortium to integrate currently separated offshore wind-related processes, it is remarkable that the consortium consists of significant players in energy infrastructure. From the other side, the members of the consortium are Danish, German and Dutch, so they do reflect a part of the North Seas countries. Involving a variety of actors is a crucial characteristic of polycentric governance. It is therefore not surprising that the consortium mentions this in the context of their external partners. Interestingly, the analysis of barriers in the legal-spatial issue area shows that that actors promoting the interests of biodiversity pursue efforts to convince the consortium not to develop the Hub-and-Spoke concept in a nature protected area. This constitutes a barrier to the swift implementation of the Hub-and-Spoke concept. Moreover, this could explain why the consortium prioritises input and feedback from industry actors, whose interests are most likely comparable to that of the consortium.

Being able to facilitate experimentation requires governance arrangements to be adaptive. The consortium clearly mentions the need for flexibility. This is mostly referred to as the ability of the Hub-and-Spoke concept to adapt to different physical contexts, including different foundation types for wind farms. This flexibility will probably be of use in the context of unclarity of information on environmental impacts, where future developments in for example cumulative environmental impact assessments might alter the preferred Hub-and-Spoke design. Besides being able to adapt to biophysical contexts, the conceptual chapter also mentions the ability of polycentric governance to adapt to varying social contexts. In their recent newsletters, the consortium mentions its ability to respond to political developments and insights in the field as important parts of being flexible. The reason for this might be the new stage that the consortium recently entered: 'From project to programme'. With the programme approach (as opposed to a more rigid blueprint approach), the consortium is able to be more adaptive because it can alter its plans according to the stage and country-specific developments. Connecting this to the different governance cultures of countries and the uneven developments of offshore wind-related processes that emerged within the institutional issue area, we can argue that this broader interpretation of flexibility may prove to be useful. Monitoring of the biophysical and social context might enable the consortium to better adapt to potential changes in this context.

Altogether, a couple of elements of the governance arrangement that the NSWPH proposes contribute to its degree of polycentric governance, mainly because of its flexibility and its provision of data on costs and benefits, but some important indicators, including 'transparency and trustworthiness', and 'mechanisms for inducing compliance' remain unaddressed. As a consequence, there are certainly opportunities for the consortium to address some barriers more efficiently. Also, given the limited data that the consortium provides on its proposed governance arrangement, we conclude that there is certainly room for improvement in the amount of information that the consortium shares on its desired international cooperation with various stakeholders.

The evaluation of barriers and drivers points out that the consortium is considered an effective driver in the technical issue area and the legal component of the legal-spatial issue area because it addresses all identified barriers. The consortium also aims to be a driver within the economic issue area, given the techno-economic information it provides to policymakers. Since economic barriers are partly dependent upon political decisions, regarding the stimulation of electricity demand for example, some barriers in the economic and political issue areas are outside of the reach of the consortium. For this reason, the conclusion of this thesis provides recommendations for both the consortium and the Dutch government.

The remaining issue areas are the spatial component of the legal-spatial issue area and the institutional issue area. Interestingly, these are the areas where potential clashes between stakeholders may emerge as a result of the lack of knowledge on the environmental impact of large-scale offshore wind. Given the absence of the polycentric indicator 'trustworthiness and transparency' of information, the consortium risks to overlook the influence of informational disputes in multi-stakeholder cooperation. Furthermore, there consortium does not describe a 'mechanism for conflict resolution' to settle such potential conflicts.

Concerning the institutional dimension, even though the consortium aims for 'governance on multiple scales' the limited mention of other crucial polycentric indicators makes it difficult to overcome the reasons behind the current lack of international cooperation, which include countries' emphasis on national policies and the different governance cultures. For instance, the concise mention of 'inducing compliance' does not clarify how the consortium induces countries' and stakeholders' willingness to cooperate voluntarily. Yet, the analysis showed that the nature of stakeholder involvement influences compliance because some types of stakeholder involvement create more mutual trust and willingness to cooperate than others (e.g. consultative versus participative). In this sense, it could be interesting for the consortium to monitor how other polycentric governance constructs approach stakeholder involvement and experiment with this in its own proposed arrangement. It is not possible for the consortium to overcome all identified barriers in the institutional issue area directly: especially vested interests of the oil and gas industry are more encompassing than the offshore wind energy transition on the North Sea. Yet, the consortium does address this barrier indirectly because makes use of the broader momentum for energy transitions.

Academic evaluation

The methodology chapter already touched upon the limited empirical generalisability of this Western-European oriented case study research. Since this thesis aims to pave the way for future marine governance research on offshore wind energy, it is better suited for analytic generalisation instead than empirical generalisation. This section uses the research outcomes to reflect on the initial conceptual framework. It argues that the following categories should receive further attention in future research: the informational issue area; the spatial issue area; and the nature of stakeholder cooperation in polycentric attributes.

The framework in the conceptual chapter consists of issue areas that emerged from barriers and drivers described in literature on renewable energy governance and marine governance. Initially, we included barriers relating to information, such as the lack of knowledge on environmental impacts, in the institutional issue area because information sharing is an important factor in multi-actor and multi-level cooperation. Soma et al. (2016) argue for example that information creates opportunities for feedback, debate, innovation and more. However, a lack of environmental information and the increasing amount of actors that claim to possess information, alters the transformative power of information (see Mol, 2008). In the literature review, we saw that for example Guerra (2026: 529) highlighted the underdeveloped state of environmental impact assessments. The analysis pointed out that in the Netherlands, informational disputes regarding for instance the outcomes of environmental impact assessments and the way in which these outcomes are interpreted by diverse stakeholders, may significantly delay the rollout of offshore wind as disputes over 'Joint Facts' revive. Even though the institutional issue area touches upon environmental information, the dominance of information shaped cooperation so significantly that creating a separate issue area for environmental information would do more justice to the concept. We therefore strongly suggest that future research addresses the role of information and knowledge gaps in cooperation. This amendment enables future research to be more susceptible for the impacts of uncertainties or contradictory information. It would be especially interesting in this regard to consider presence of the polycentric indicators 'transparency and trustworthiness' and 'mechanism for conflict resolution' to address this issue area.

Building upon this, the next suggested amendment to the initial conceptual framework is to decouple the legal and spatial issue area into two separate areas, one legal and one spatial. Initially, marine spatial planning was conceptualised as a driver addressing the legal barrier of crowded seas and varying coastal state jurisdictions. The analysis pointed out that there are significant legal to hybrid offshore wind projects, but the consortium already addresses them effectively. The spatial barriers on the other hand, emerged more prominently in the analysis because they generate much more discussion between stakeholders than the legal barriers. In this sense, the degree of polycentric multi-level and multi-stakeholder governance are more relevant when addressing the spatial issue area than the legal issue are. Therefore, we argue that decoupling this issue area allows for more awareness of barriers and drivers in future research, which is especially salient for the spatial issue area.

Another proposed alteration to the conceptual framework addresses the polycentric indicators used in this research to evaluate the proposed governance arrangement. Even though these indicators clearly touch upon the importance involving a diversity of stakeholders, they fail to concretise the nature of stakeholder inclusion. It is relevant to take this into account in future research because the analysis pointed out that there are various ways in which stakeholders can be included and that some stakeholders are involved in different ways than others, which influences the effectiveness of multi-actor and multi-level cooperation. We saw for example that stakeholders may be consulted, participate or give feedback and that is affects outcomes. Adding another polycentric indicator on 'stakeholder participation' enables researchers to evaluate the nature of stakeholder involvement in polycentric governance arrangements. This addition to the initial polycentric attributes brings us to a final remark: besides paving the way for further research on polycentric offshore wind governance, this thesis also encourages further research into polycentric energy governance in general. Even though the issue areas of the proposed conceptual framework are tailored for researching offshore wind-specific barriers and drivers, the polycentric indicators are applicable to other polycentric governance arrangements as well. That is to say, the indicators can be used to evaluate other polycentric arrangements, for example on other renewable energy sources.

	Technical	Political	Economic	Legal	Spatial	Informational	Institutional
Describing barriers & drivers (descriptive)	*Barriers* *Drivers*	*Barriers* *Drivers*	*Barriers* *Drivers*	*Barriers* *Drivers*	*Barriers* *Drivers*	*Barriers* *Drivers*	*Barriers* *Drivers*
Evaluation of polycentric governance arrangement (prescriptive)							*Polycentric indicators (drivers):* - Governance on multiple scales; interaction between scales; diversity of actors; stakeholder participation. - Information sharing: transparency & trustworthiness; data on costs & benefits. - Mechanisms for: monitoring; feedback; inducing compliance; conflict resolution; sanctioning; encouraging adaptivity.

TABLE 7: THE CONCEPTUAL FRAMEWORK FOR FUTURE RESEARCH

Strengths and limitations

The introduction and the methods chapter already touched upon the ex-ante nature of this research, which is one of its strengths as the recommendations that the conclusion presents apply to a process that is currently still in motion rather than set in stone. This provides an intermediate feedback moment for the consortium, grounded in academic research. By combining two uses of polycentric governance literature into one framework, we are able to first describe the existing context and subsequently formulate a normative ex-ante statement on the potential effectiveness of a proposed governance arrangement. Yet, the timely nature of the selected case underlines the need for consecutive research. We saw for example in the analysed newsletter that the consortium addresses the polycentric indicator of 'flexibility' more comprehensively than in the concept papers published before. The aim of the consortium to be adaptive also suggests that their proposed governance arrangement may undergo changes, which shows the possibility for future evaluations. The proposed conceptual framework paves the way for such future research.

Another strength of this research is its integral perspective to offshore wind development. Where authors often highlight only one or several issue areas of the barriers and drivers for large-scale offshore wind, this thesis brings forward barriers and drivers from multiple issue areas and shows that they interact. This approach allowed us to reveal rough explanations for barriers that are often considered in isolation. For instance, the analysis provided insight into what informational aspects affect marine spatial planning and showed that governance cultures may hamper smooth international cooperation.

A limitation that we previously touched upon in the methods chapter encompasses the limited amount of information on some confidential topics, which prevents us from drawing conclusions on those topics. For instance, we saw in the analysis of that the NSWPH documents do not touch upon all identified polycentric indicators. This does not necessarily mean that the consortium does not want to pursue these indicators, but it does mean that we cannot draw definitive conclusions based upon this limited data. This potentially affects the research outcomes because on the one hand, we risk to overlook polycentric indicators that the consortium wishes to stimulate and on the other hand, we risk to understate the true degree of polycentric governance that the consortium aims to reach.

Additionally, interviewing multiple stakeholders that engage with the consortium could provide more clarity on its proposed governance arrangement, given the limited amount of information that the consortium provides in its concept papers. This could enlighten for example the desired nature of stakeholder involvement. It could have provided more clarity on the consortiums seeming predilection for input from industry rather than from NGOs. This practical drawback affected the conclusions most because it creates the possibility of overlooking important polycentric attributes for addressing barriers and drivers.

This thesis mainly addresses the national and international scale, even though polycentric governance literature also highlights the subnational scale. Increasingly, subnational initiatives regarding the energy transition emerge, with for example cities setting their own renewable energy targets. The municipality of Amsterdam for example also has a 'Climate Agreement for Amsterdam' with the target of 80% renewable energy generation (by offshore wind and solar energy) by 2030 ('Het Amsterdams Klimaatakkoord', n.d.), which is 10% higher than the renewable energy target in the Dutch Climate Agreement. This shows that on all levels, energy policies interact, also within countries. This thesis did not take into account the subnational level because the NSWPH consortium promotes cooperation between the national and international scale and thus does not address subnational actors. One could argue that this inherently produces flawed polycentric governance construct because multiple scales are inherent to polycentric governance. On the other hand, the consortium aims to fulfil national and EU climate targets that are derived from the Paris Agreement. In this sense, the climate agreements that the consortium adheres to reflect three levels: national, EU and global. Yet, future research into how the subnational, national and international scales interact would be insightful. Energy transitions in cities could for example be treated as polycentric experiments that may inspire broader institutional change.

In conclusion, a remaining strength of this thesis is that it is able to provide an additional insight for further research, based upon the analysis instead of only on the research outcomes. This gives us the opportunity to suggest that future research looks deeper into the connection between the fisheries sector and the government. The analysis showed that in the Netherlands, the fisheries sector is well represented by the government, who speaks of 'our fishers' in its documents. The sector is also vocal in the marine spatial planning debate regarding a North Sea Agreement. Polycentric governance entails cooperation between various stakeholders. If some stakeholders are represented relatively more than others, they may have political decision-making on their side, which affects other stakeholders' interests. This could mean for example a prioritisation of fishing grounds over space for offshore wind farms. Research on this potential interwovenness could

provide insights on barriers and drivers in the political issue area. One interviewee suggested that the fisheries sector is also strongly represented in Denmark, which highlights the relevance to discover what political pressure the fisheries sector can create in other North Seas countries.

Chapter 7: Conclusion

This thesis described the barriers and drives to the energy transition on the North Sea and evaluated the ability of the NSWPH consortium to address these. It draws the following conclusions. The barriers and drivers for the energy transition on the North Sea emerge in the following issue areas: technical, political, economic, legal, spatial, informational and institutional. The consortium effectively addresses the technical and legal issue area and moderately addresses the political and economic issue are. The scant appearance of certain polycentric attributes decreases the ability of the consortium to address barriers and drivers in particularly the institutional, spatial and informational issue area. The main institutional barrier that the consortium identifies is the limited degree of international cooperation and the non-integrated way in which offshore wind-related processes are approached in this cooperation. Even though the consortium promotes governance on multiple scales, the limited mention of for example 'inducing compliance' makes it difficult to drive international cooperation. Furthermore, there seems to be a predilection for feedback from industry stakeholders. The consortium could more effectively integrate fragmented offshore wind-related processes if it (re)considers its desired stakeholder involvement. This could for example range from rather consultative to more participatory. This thesis argues that participatory stakeholder involvement creates mutual trust and willingness to cooperate.

Furthermore, this thesis states that the spatial and informational issue area remain largely unaddressed. Interestingly, these are the areas where the lack of knowledge on the environmental impact of large-scale offshore wind is most salient as a barrier. Given its focus on techno-economic information and the absence of the polycentric indicator 'trustworthiness and transparency' of information, the consortium risks to overlook potential informational disputes between stakeholders, which may influence the efficiency of cooperation.

This thesis analytically separates offshore wind energy from the broader concept of 'renewable energy sources' as it looks into barriers and drivers specific to the offshore wind energy transition. This approach allows us to provide a conceptual framework for further marine governance research on offshore wind energy. The main suggestions for further research are to create a separate issue area to scrutinise the role that information plays in polycentric governance constructs, which includes distinguishing between the legal and the spatial issue area; and to be susceptible for the nature of stakeholder involvement when conducting evaluations using polycentric indicators.

Discussion

This thesis describes barriers and drivers to the energy transition on the North Sea from the perspective of the selected case, the NSWPH consortium. This means that some factors were coded as a barrier because they interfere with the swift roll-out of the consortiums hybrid project. We saw for example that stakeholders protecting the interests of nature posed a barrier for the consortium because they challenged the initial plan to locate the Hub-and-Spoke concept on the Dogger bank, which is a protected area. This raises questions about whether the identified barriers and drivers would be experienced similarly for other actors that also aim to reach the goals of the Paris Agreement. I will shortly discuss my view on the energy transition as a way to reach climate goals.

There are many paths that lead to a reduction of CO2-emissions. By its nature, the Paris Agreement encourages countries to create their own pathways, according to natural endowments and national potential. Novel environmental policies usually do not immediately spark change; experimentation, which is inherent to polycentric governance, also entails failure. An important thing to keep in mind however, is that the ultimate goal of reducing CO2-emissions does not only entail the transition to an emission-free society, but also necessitates maintaining the quality of natural resources to sequestrate carbon. In other words, if we truly want to decrease the amount of CO2 in the air, environmental measures should not be deployed at the expense of nature.

Take the example of biomass. Biomass is not considered a renewable energy source by some authors because it has opposite effects for the environment as it substantially increases the levels of carbon dioxide in the atmosphere (see Norton et al., 2019). In my view, this will have counterproductive effects on the long run as it diminishes the ability of forests to capture carbon. The same counts for large-scale offshore wind development. If this happens without sufficiently taking into account the marine ecosystem, notwithstanding the current knowledge gaps, chances are that the ability of the sea so capture CO2 diminishes over time and the net CO2 emissions will remain roughly the same. This balance between rapid action and accurate climate policy requires polycentric governance and inclusive stakeholder involvement.

This idea of growth within ecological limits is captured compellingly by Kate Raworth in her book Doughnut Economics (2017). This novel approach to economics that considers, among others, climate change and ocean acidification as consequences of trespassing the earth's ecological ceiling. Raworth (2017) argues that the traditional approach to economics, with its emphasis on economic growth, increases inequalities and is not sustainable on the long term. I would like to accentuate this thought-provoking approach to balancing growth with sustainability as we move to the final recommendations of this thesis.

Recommendations

Higher degrees of polycentric governance may increase the ability of the NSWPH consortium to address existing barriers and drivers effectively. Taking into account the mainly the barriers in issue areas that the consortium fails to address with its current polycentric attributes, we provide the following recommendations for the North Sea Wind Power Hub consortium:

- Aim to be more sensitive for the role of information in offshore wind developments. Consciously increasing the degree of polycentric governance in the proposed arrangement might help to mitigate potential issues. This includes, but is not limited to: besides sharing techno-economic data, promote cumulative environmental impacts and share this data as well; be transparent about the research methods used; be aware that the trustworthiness of data may be experienced differently across stakeholders; increase monitoring, in any case on potential free-riding behaviour of countries.
- Closely consider the different natures of stakeholder involvement and the type you choose, while taking into account the importance of stakeholder support and mutual trust; value feedback from a wide range of stakeholders equally. Include stakeholders not only in the preparation phase, but also during the potential implementation, since the context might alter in terms of environmental knowledge, or socially or politically. It will 'pay off' to do so, since at the end of the day, stakeholders represent a larger public. Also, provide more information on how aim to organise multi-actor and multi-level cooperation.
- Pursue a long-term vision, just like you ask from governments. This includes explicitly taking into account the environmental aspects of large-scale offshore wind, even though they remain largely unknown: on the long term, resilient natural resources capture carbon as well.

Some barriers in the political and economic issue areas remain partly outside of the scope of the consortium to address. We therefore also formulate a recommendation for the Dutch government:

- Even though ultimately it might be desirable to create zero-subsidy tenders, reconsider if the current zero-subsidy era did not come too early. Engage with surrounding countries on what such national decisions imply if in the future wind farms are interconnected. Especially consider here that the current percentage of renewable energy in the country is relatively low and that this could negatively affect the position of the Netherlands if surrounding countries do give subsidies. Otherwise, consider stimulating electricity demand. Acknowledge that the government has to take the lead in transitions as big and encompassing as the energy transition.

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