MSC THESIS SUSTAINABLE BUSINESS AND INNOVATION

Governance of the North Sea as a common pool resource: an empirical Dutch perspective

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Abstract

Transitioning to renewable energy sources, such as offshore wind energy, is crucial for mitigating global warming by reducing greenhouse gas emissions. The North Sea has a significant potential for offshore wind energy, making it key in the energy transition of its bordering countries. However, implementing this renewable energy presents challenges, particularly regarding required changes to marine spatial planning (MSP), which impacts both the ecological system and existing social structures, and the integration into the existing energy grid. The current governance of the area is complex and fragmented. A collective action approach might help prevent ecological resource depletion and realize a more efficient energy system. The Netherlands, positioned centrally in the North Sea with a substantial offshore area, serves as the focal point for this study, which aims to explore how conditions in the North Sea could facilitate collective action for energy resource governance from a Dutch perspective.

The research and data are structured using the institutional analysis and development (IAD) framework. The action situation shows different levels of governance: EU, North Sea, National, and Local. The governance is split between MSP and the energy system, both impacting the offshore wind farm development. The exogenous variables show the current environmental, technical, social, and rules context affecting the action situation. Evaluation criteria and current outcomes are also researched.

The research identified the following conditions that impact the opportunities for collective action on the North Sea energy resources: collaboration on a North Sea level, complex cost-benefit allocation, monitoring of resources, and a positive attitude towards collaboration. In this context, collaboration on the North Sea level, through NSEC and GNSBI, facilitates collective action; however, since both are relatively new platforms, the impact on collective action is still unknown. Complex cost-benefit allocation challenges collective action, as can be seen by the difficult involvement of fishers in the North Sea Accord. Complex monitoring of ecological resources complicates collective action since it challenges the total impact of offshore wind. Thus, adaptive rules should be in place to account for new emerging knowledge impacting the action situation. Lastly, a positive attitude towards collaboration provides an opportunity for collective action. The interviews show that stakeholders are willing to cooperate. However, to reach tangible results instead of merely a list of desires, stakeholders need to contribute to the collective goals instead of defending their own needs, and though decisions need to be made instead of just going over easy tasks.

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Abbreviations

Table 1 shows the list of abbreviations in alphabetical order.

Table 1: list of abbreviations

Abbreviation	**Meaning**
CoP	Community of practice
CPR	Common pool resource
EACP	Ministry of economic affairs and climate policy (Dutch: *EZK, Economische zaken en klimaat*)
EU	European Union
GNSBI	Greater North Sea Basin Initiative
IAD framework	Institutional analysis and development
I and W	Ministry of infrastructure and water management (Dutch; *I&W, Infrastructuur en waterstaat*)
MSP	Marine spatial planning, or Maritime spatial planning
NEA	Netherlands Enterprise agency (Dutch: *RVO, rijksdienst voor ondernemingen)*
NGO	Non-governmental organization
NSEC	North Seas Energy Cooperation
NWEA	Netherlands Wind Energy association
OWF	Offshore wind farm
TSO	Transmission system operator, Tennet in the Netherlands
UK	United Kingdom

1. Introduction

"Climate change is the defining issue of our age" (Guterres, 2022). Human-induced climate change and global warming are caused by increased greenhouse gasses in the atmosphere, mainly released by burning fossil fuels. According to the United Nations Environmental Programme (UNEP, n.d.), *"Energy production and use is the single biggest contributor to global warming."* To curb global warming and limit the global temperature increase to well below 2^{o}C preindustrial levels, as agreed upon in the Paris climate agreement (UNFCCC, n.d.), a transition to a renewables-based energy supply is required; this is commonly referred to as the energy transition. The energy transition is important from a global warming perspective, and acceleration away from fossil fuels is the key to stabilization, economic, geopolitical, and climate stabilization (Constantini et al., 2022). The added pressure on the energy market because of the invasion of Ukraine in 2022 and the subsequent interruption of the European gas supply underscores the urgency of the energy transition. The added pressure created a rise in energy prices right at the time when production started amping up again in a post-COVID-19 pandemic economy (Sturm, 2022).

The European Union (EU) is One of the primary global energy consumers; the twenty-seven countries together used around 9.7% of the total globally produced energy in 2019 (Planete Energies, 2022). The EU's energy transition goals target climate neutrality by 2050. By 2030, they aim to have 42,5% of their energy from renewable sources (European Commission Energy Directive, n.d.). One of the ways the EU is planning to achieve this goal is by the installation of offshore wind farms (OWF), aiming to expand their offshore wind capacity to 111 GW by 2030 and 317 GW by 2050 (Directorate-General for Energy, 2023a), from their current capacity of 16 GW, in 2022 (WindEurope, 2023). The majority of these OWFs will be installed on the North Sea. The EU North Sea countries aim to have 60GW of installed offshore wind energy capacity by 2030 and 190GW by 2050 (Directorate-General for Energy, 2023b)**.** The North Sea is a suitable location for these offshore wind farms due to good offshore conditions with shallow waters, favorable wind, and proximity to industry and ports (Ministerie van Algemene Zaken, n.d.). The North Sea will play a vital role in the energy transition. According to European Commission president von der Leyen (2022), the North Sea can be the green power plant of Europe, with opportunities reaching beyond offshore wind energy and infrastructure, with ambitions such as the production of green hydrogen.

The introduction of OWFs constitutes a change in the offshore environment and subsequently marine spatial planning (MSP). MSP is a spatial policy process widely regarded as the main concept for coordinating maritime activities (Spijkerboer et al., 2020). The restructuring of the offshore area is needed to create the necessary space for the installation of OWFs and related energy infrastructure, requiring a change in MSP. This change in spatial use affects the ecological system of the North Sea by introducing new structures influencing the biotic, living aspects such as algae, fish, and birds, and abiotic systems such as wind and water flows, creating the first challenge of integration into the ecological system. The literature review by Watson et al. (2024) created an overview of studies researching the ecological impact of offshore wind. The change in social structure due to the expansion of offshore wind is impacting the current users of this offshore space. Other maritime users suffer the implications of the installation of OWFs; the infrastructure stays in place for a long time after the installation of OWFs (Zaucha & Gee, 2019). Integration into the social structure is the second challenge. Skjølsvold et al. (2024) researched societal challenges on the North Sea due to offshore wind development; the research concludes that actor inclusion is one of the critical elements for a socially just energy transition. This coupling of social and environmental systems makes the North Sea a social-ecological system (Anderies et al., 2004).

Furthermore, the introduction of offshore wind energy not only affects ecological and social systems but also impacts the technical energy system. The significant increase in offshore wind energy leads to a change in the electricity mix, going from a fossil fuel-based electricity supply, which can be easily scaled up and down, to a renewables-based system with intermittent energy availability due to the energy supply depending on the wind availability. The intermittent nature of offshore wind energy and the large scale of the development, combined with an already congested on-shore electricity grid, create a complex integration in the energy system (Wiegner et al., 2024). This integration into the energy system is the third identified challenge. The literature review by Wiegner et al. (2024) emphasizes the need for interdisciplinary processes and the need for a coordinated approach for the technical integration of large amounts of offshore wind energy to improve the operational efficiency of the energy integration, to enhance economic and environmental performance by sharing infrastructure, knowledge human capital and products.

The governance of the North Sea area, which should address these challenges, is inherently complex. The North Sea falls under various policy levels, EU, North Sea, national, and regional, each level managed by different institutions and actors, leading to fragmented responsibilities and showing institutional fragmentation (Lubell, 2013). This fragmentation poses significant hurdles in coordinating efforts and implementing cohesive policies to manage the region effectively. Common pool resource (CPR) theory offers valuable insights into navigating this complexity by clarifying the interplay between preserving the ecological system and transforming the socio-technical system (Nogueira et al., 2021). By understanding the dynamics of resource management within the context of common pool resources, policymakers and stakeholders can develop more integrated and sustainable governance strategies for the North Sea, addressing both ecological conservation and energy transition goals.

"*The North Sea is a powerhouse of wind energy. Harnessing this power requires us to cooperate across countries and borders to build an efficient network.*" (North Sea Wind Power Hub, 2022, p4.).

A CPR refers to a shared resource available to use by multiple actors but is finite in nature and can be depleted or degraded if not appropriately managed (Ostrom, 1990). The ecological and technical resources on the North Sea can be seen as CPRs since both are finite and can be depleted. At the same time, access to resources cannot be blocked from the countries bordering the North Sea. CPR problems can be managed using collective action. Collective action refers to coordinated efforts and collaboration among stakeholders to collectively manage and sustainably use shared resources, improving resource efficiency and preventing over-exploitation or degradation for the benefit of all stakeholders. A collective action approach can prevent the depletion of ecological resources (Ostrom, 1990; Anderies et al., 2004; Dietz et al., 2003; and Bodin, 2017). The research on CPRs has long been applied to marine resources. There is also a large importance in institutionalizing stakeholder inclusion in offshore wind energy development in the MSP process for a nature-positive and people-centered offshore transition (Tafon et al., 2023). A collaborative approach might also improve the North Sea energy system's operational efficiency and economic and environmental performance by sharing resources such as infrastructure, products, human capital, and knowledge (Wiegner et al., 2024). The potential benefits of managing the North Sea energy as a collective action is why this research studies the potential for collective action. However, studying the whole North Sea does not fit within the scope of this research, which is why this research studies the Dutch stakeholder perspective on the status of collective action.

For this specific research, the Netherlands is a suitable case to research, with its central location in the North Sea area. The Netherlands is a part of the EU, thus falling within the EU legislation and ambitions. However, their location next to a non-EU country, The United Kingdom (UK), gives them a specific incentive to collaborate outside EU regulations. The Netherlands has many company actors in the offshore wind industry and a history of working offshore with their world-renowned dredging

companies. Furthermore, large harbors and industries are present, creating installation, production, and maintenance capacity, as well as a use for offshore energy. Lastly, they also have a considerable interest in offshore renewable energy production. The Netherlands' currently installed offshore wind capacity is 4.5GW (Macquart et al., 2023). The Netherlands aims to have 21GW installed by 2030 and between 38GW and 72GW installed by 2050 (RVO, 2023a). This capacity is around 26% of the EU's total aim for the EU North Sea. The Netherlands aims for 70% of its electricity use to be renewable by 2030. OWFs will produce over 50% of this renewable electricity (Ministerie van Economische Zaken en Klimaat, 2020**).** This introduction of large amounts of offshore wind energy leads to significant changes in the use of offshore space, as shown in Figure 1. Figure 1 shows the existing offshore wind areas in dark green, with enough space for 4.5GW, and the planned areas in bright blue, planned for the 21GW in 2030. As shown in Figure 1, the offshore wind farms will be installed further from the shore, requiring more expensive energy infrastructure; as the development continues, more areas further off the shore will have to be accessed (Bødal et al., 2024). With this large development upcoming, the governance of the offshore area has to adjust to the new situation.

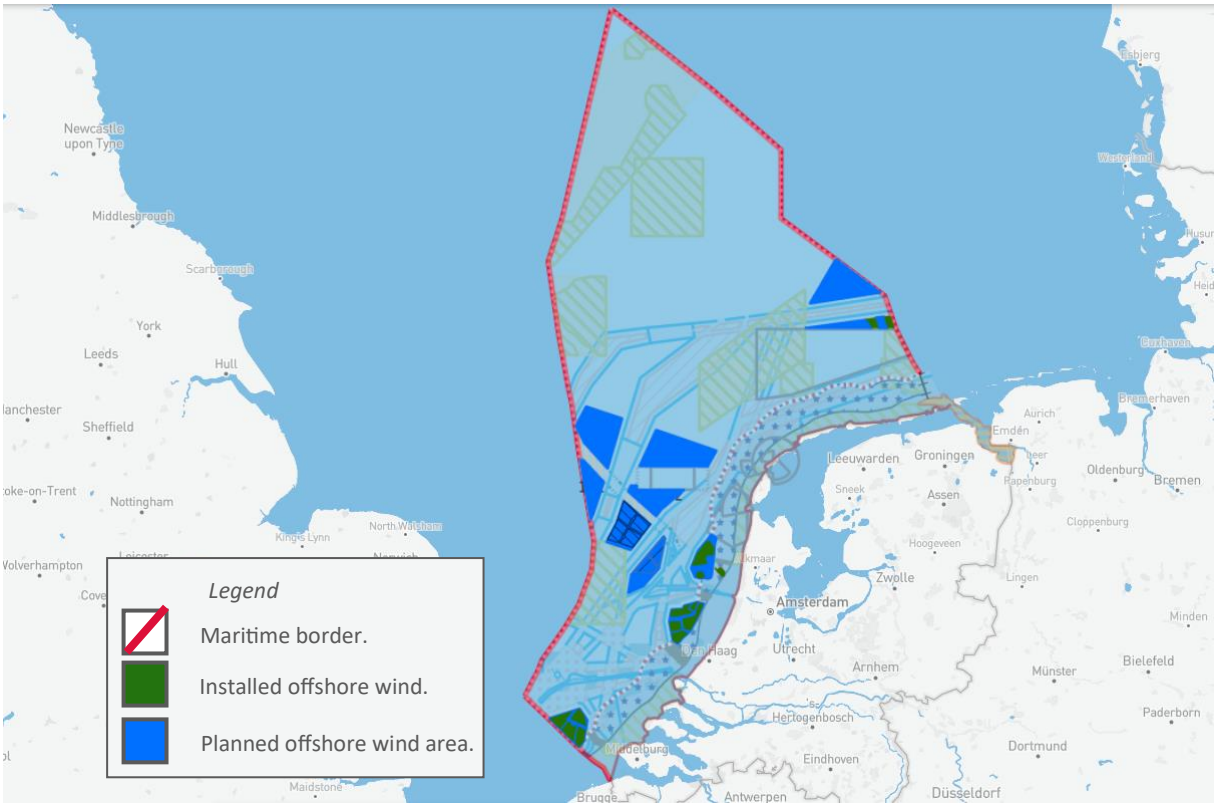


Figure 1: Planned Dutch North Sea offshore wind development, Image source: Noordzeeloket (2023)

The existing research on CPR exists on both the large, global, scale, the small, community, scale, and everything in between. When looking at energy as a CPR, the most prominent research is on a local or community scale, such as Eslamizadeh et al. (2020). The research focuses on the possibility of collaboration between large industrial parties in an energy community. Warbroek et al. (2022) focus on integrating societal issues in the energy transition through energy communities in rural and city areas in the Netherlands. Lestari et al. (2018) investigate energy communities in rural areas as a standalone system, assessing to what extend such systems are sustainable. Pavlowsky et al. (2023) assess the community impact on the failure of wind energy projects in the southern United States. Mohammadi's (2023) research focuses on the impact of institutional factors on business models surrounding energy communities. This research focuses on rural and urban areas in both the global north and the global south; however, their focus is limited to local and community scales. The lack of research on an

international scale is an important knowledge gap, as governance on an international level is different than on a community level, and there is added complexity with different stakeholders. The offshore environment also comes with very different social and ecological contexts, where there is less civil community involvement and a more considerable impact on the ecosystem, adding a new perspective to collective action in energy resources.

Research on the North Sea area from a community and collective action perspective has been done in the fishing industry, such as Steenbergen et al. (2017), focusing on brown shrimp fisheries and looking at the different countries' collaboration on fishing rules and strategies. They show that collective action between these countries and cultures is possible.

Much research has also been conducted on the governance of the North Sea area. From a Dutch perspective, the MSP has been researched (Spijkerboer et al., 2020), and specific governance initiatives the North Sea accord (Hatenboer et al., 2023) and the Community of Practice (Steins et al., 2021). On an international scale, there has been research on implementing specific European law (Kirkfeldt & Andersen, 2021). There have been multiple studies on transboundary MSP in the North Sea (Li & Jay, 2023; Moodie & Sielker, 2021; van Tatenhove, 2017; Jay et al., 2016). The research by Li and Jay (2023) combines the collective governance framework and the transboundary marine spatial planning framework, concluding that neither suffices for the long-term governance of transboundary cooperation. The research by Seltzenmüller et al. 2022 goes into the collaborations between fish and wind. Look at future trajectories of human activities in the German North Sea to inform cumulative effects assessments and marine spatial planning. None of these research studies take a collective action or CPR approach.

This research seeks to understand the potential for collective action in the governance of the North Sea's energy resources. Understanding the potential for collective action is done by examining the existing conditions in the North Sea from a Dutch actor perspective, providing context on the current mode of governance surrounding the ecological and social context and the technical transition happening on the North Sea. The study explores the potential role of collective action in the governance of North Sea's wind farms. The research answers the following research question:

How do the conditions in the North Sea potentially facilitate collective action for the governance of its energy resources from a Dutch perspective?

The findings can provide valuable insights into the possibility of collective action in the governance of the North Sea energy. Furthermore, it might help policymakers in their decision-making if the aim is to incorporate a collective action approach. The findings of this research might be helpful for research in other large-scale energy communities comparable to the North Sea, for example, the Southeast Asian countries (IEA,2023) and the different islands in the Caribbean (The Caribbean Climate-Smart Accelerator, 2022). Therefore, the research will look at wind farms in the North Sea as a CPR through a collective action lens and explore the conditions for facilitating such governance approaches. This is to contribute to the energy transition policies and better implementation of renewable energy sources, limit the planet's exploitation, and meet national and international energy transition goals.

From a scientific perspective, the research will add to the theory of CPR. Specifically, it will add to energy as a CPR on a larger international scale, a research field lacking so far. With the lack of research in this area, certain findings from the conditions that facilitate or hinder collective action in an international energy context might help strengthen the theory.

2. Theory

This theory chapter goes into the main theoretical concepts used in this research, starting with the types of goods. After which, the core of the research will be discussed: common pool resources and collective action. Lastly, the IAD framework will be introduced. The framework's components are the research's building blocks, and every component is discussed.

2.1 Types of goods

In order to understand CPRs, there must be a distinction made with what type of good it is; there are four different types of goods: common pool resources, public goods, private goods, and club goods. The different types of goods differ in whether access to the resource can be blocked off and whether the resource can be depleted.

A CPR is a good where the access to the good cannot be blocked off, and the resource can be depleted. As discussed in the introduction, the North Sea energy resources can be seen as a CPR.

Other types of goods are public goods, where access to the resource cannot be blocked off, like in a CPR. However, unlike a CPR, a public good cannot be depleted. There is no rivalry over the resource, and this rivalry is present in a CPR (Apesteguia & Maier-Rigaud, 2006). A public good can be owned by a central government and managed accordingly.

A private good**,** is where certain users can be blocked from accessing the resource. This differs from a CPR. Private goods are similar to a CPR, in the way they can be depleted when used (Ostrom, 2010). Private goods match a liberal market approach, where the market and money are supposed to manage the resource, with an essential feature: private ownership can take over a resource, and all parties follow their interests. Private goods rely on supply and demand to balance out the resources (Jahan & Mahmud, 2018).

Lastly, there are club goods, where access to the resources can be blocked off. However, they do not deplete when used (Ostrom, 2010).

2.2 common pool resources and collective action.

The basis of the theory used is Ostrom's theory on common pool resources and collective action (1990). Ostrom (1990) explores the conditions under which groups of actors can collectively organize and manage shared resources and achieve a shared vision. The theory poses that the tragedy of the commons is avoidable; not all free access to depletable resources will eventually be exhausted and unusable. The tragedy of the commons, as explained in the research by Hardin (1968), explains that when there is open access to a depletable resource, the individual actors will act in their own self-interest and not in the interest of the common good, the common good is destined to fail. If actors fail to contribute to the collective goal adequately, there is a risk of prioritizing easy tasks over tough decisions. This results in minimal progress toward collaborative objectives, with stakeholders primarily focused on defending their interests and advocating for personal gain. As a result, efforts may result in a mere compilation of desires rather than tangible results, perpetuating unresolved conflicts of interest and yielding only symbolic outcomes (Bodin, 2017). Ostrom’s theory gives the boundaries and rules under which the tragedy of the commons can be avoided without externally enforced rules, such as a government (Ostrom, 1999). This results in 8 rules created by Ostrom (2000):

1. Clear boundary rules should be in place, including what actor is in the agreement and which is not. Create rules on the extraction of the resource.
2. Create rules on how the cost and benefits will be separated. Consider the local conditions, tailor the rules to fit the community, and ensure the costs and benefits are separated fairly.

3. Resource users should be able to design their own rules. Everyone impacted by the rules should be involved in making them and have the power to amend them.
4. There must be monitoring in place of the resource, keeping an eye on the resource and user behavior.
5. Graduated sanctions should be getting progressively worse depending on the context and seriousness of the rule break. Either an independent body or a rotating position should be able to assign these sanctions.
6. The local problem-solving arena must always be available to resolve issues before they are out of hand.
7. The right to organize the national and international governments should allow for self-organization.
8. Multiple layers of nested enterprises due to the scale of the North Sea, there must be multiple layers of governance.

An important thing for the management of common pool resources is that the rules by Ostrom should be implemented in a reinforcing manner. The outcomes of the rules should build on each other toward the collective goal (Ostrom, 2000). Dietz et al. (2003) write the effective governance of large socio-ecological systems. The main difference with Ostrom (2000) is that Dietz et al. (2003) specifically goes into the collective action for large socio-ecological systems involving transboundary pollution, tropical deforestation, and climate change. Since the North Sea is a large ecological system, the rules by Dietz et al. (2003) will contribute to this research. There are two main things less addressed by Ostrom that are important for a large socio-ecological system, namely:

- Dealing with conflict: Conflict is inherent in environmental choices due to the differences in power and values. This conflict must be dealt with, focusing on learning and change due to the conflict.
- Be prepared for change; the current understanding might be wrong. Adaptive rules guard against low probability and high consequence possibilities for adaptive management.

2.3 IAD framework

The main frameworks often used to research CPRs are the Institutional analysis and development (IAD) framework and the social-ecological systems (SES) framework, both developed by Ostrom and suitable for researching CPRs. The IAD framework was first developed to analyze institutional environments, highlighting interactions among individuals (McGinnis, 2011). The framework highlights the social-cultural, institutional, and biophysical situation where all decisions are made (McGinnis, 2010). The SES framework is specifically designed to analyze coupled social-ecological situations (Cole et al., 2019). While the SES framework provides a broader analytical framework to understand social-ecological systems, the IAD framework provides a more specific lens for analyzing the institutional dimensions within those systems (Schlager & Cox, 2018). Due to this focus on the institutional dimensions, the IAD framework was chosen to analyze the CPR in this research.
The IAD framework is an instrumental framework to analyze institutional environments structurally. Using a framework can help generate the questions that need to be addressed in the analysis (Ostrom, 2011). The IAD framework is used to analyze institutional arrangements, identify the universal elements present in a theory like collective action, and identify the general relationship among the elements (Ostrom, 2011). It is a way to structure the research consisting of basic elements and their general connection to one another in an institutional environment.

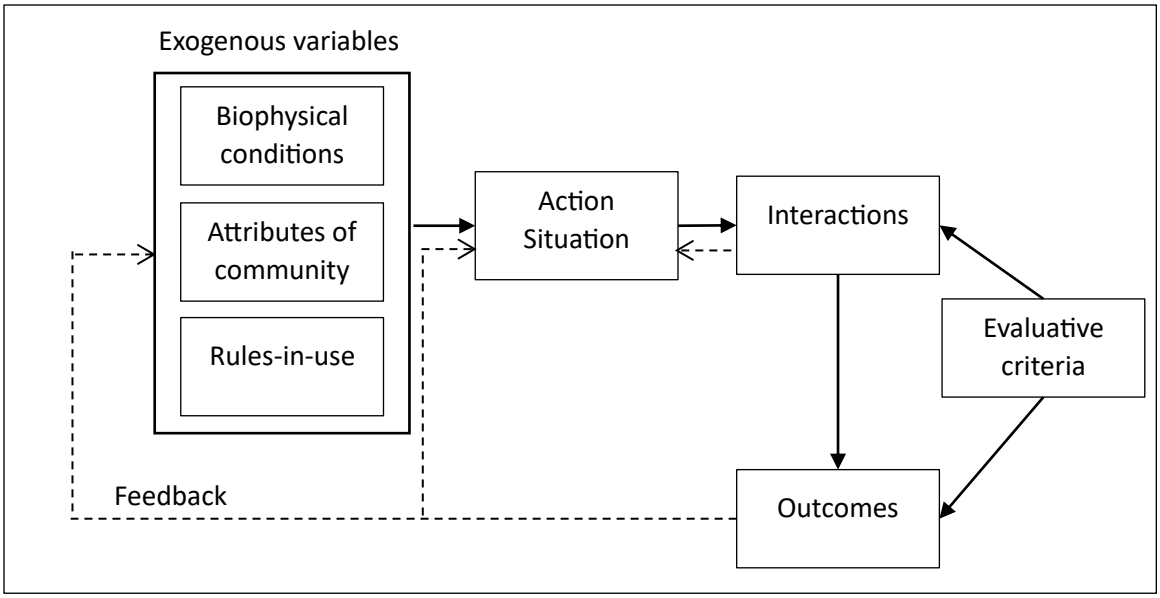


Figure 2: IAD Framework adapted from Ostrom (2005, p.15)

Figure 2 shows the IAD framework. "*The IAD Framework has its origins in a general systems approach to policy processes, in which inputs are processed by policymakers into outputs that have outcomes that are evaluated, with feedback effects."* (McGinnis, 2011, p.172). The IAD framework is based around an action situation, a conceptual unit describing, analyzing, and predicting behavior within an institutional arrangement (Ostrom, 2011). The action situation is the "Black box" where the policy decisions are being made (McGinnis, 2011). The action situation consists of different actors in different roles with differing impacts on the situation. Inputs impact the action situation, and the exogenous variables are also called contextual conditions or external variables (Cole et al., 2019). The exogenous variables are separated into three distinct categories based on their characteristics:

- Biophysical conditions are the physical resources, material resources, and capabilities available within the system (McGinnis, 2011). In the context of the North Sea, these are natural conditions, technical conditions, existing technical energy infrastructures, windmills, cables, transmission stations, and the investment capital and capabilities available for innovation.
- Attributes of the community are the social and cultural contexts commonly understood by the community (McGinnis, 2011); alternatively, the accepted values and behavior, the degree of heterogeneity in preference, the size and diversity in the community, and the equality or lack thereof, in the distribution of basic assets (Milchram et al., 2019). In the context of the North Sea, there will be a Dutch perspective on these various aspects between the local actors and their perspective of the other international aspects involved.
- Rules-in-use: The rules-in-use are all the relevant aspects of the institutional context (McGinnis, 2011). The existing structure of formal rules, laws, regulations, and informal rules, norms, and shared understandings might impact the deliberations of the actors (Cole et al., 2019). either between parties or being put on externally, for example, by the government.

Another part of the framework is the outcomes, which are shaped by both the interaction outputs and the exogenous variables' input (McGinnis, 2011). These outcomes can be assessed based on evaluation criteria (Ostrom, 2013). The evaluation happens by actors and assesses actions, outcomes, and outputs, which may impact all process stages (McGinnis, 2011). The focus of this research will be on the exogenous variables, the external factors limiting and shaping the action situation that is going on, and how the actors view and interact with these variables.

3. Methods

In the following chapter, the research design will be presented. First, going into the research design which will introduce the qualitative approach to answering the research question. Secondly, the data sample and sampling strategy will be discussed. The operationalization is the third part of the methods, and this will go into the different aspects of the IAD framework and explain how they were addressed in the interviews. The data analysis will be discussed, outlining how the interview data was processed to get concise results. Lastly, reliability, validity, and ethical considerations are presented.

3.1 Research Design

The research design used to answer the research question is an exploratory empirical qualitative approach, defined by Queiros (Queirós et al., 2017), focusing on semi-structured interviews with actors active in the Netherlands. These interviews will represent the Dutch perspective. Different studies show using a qualitative interview approach to study collective action using the IAD framework in an energy context (Warbroek et al., 2022; Eslamizadeh et al., 2020; Lestari et al., 2018;). The choice of an exploratory empirical qualitative approach is justified by the limited understanding of the institutional factors influencing the implementation of a collective action approach in governing North Sea energy development. This is the first research applying the collective action theory to an extensive energy system, such as the offshore wind development on the North Sea, which influences a social and environmental system with high complexity, the ecosystem of the North Sea. The nuanced and complex nature of the different parts of the IAD framework makes the qualitative approach appropriate. In this context, the IAD framework will structure the information on complex action situations involving many actors and the nuances in the different exogenous variables. The semi-structured interviews are conducted with Dutch offshore wind energy actors.

The data is collected through semi-structured interviews. They can provide a framework but also give the flexibility to ask more follow-up questions to analyze certain specific issues in an interview (Bryman, 2012). The Structure allows for interview comparison, creating a more structured data set. The Semi-structured interviews allow all the different assets of the IAD framework to be discussed in an interview while simultaneously allowing for personal input and further questions for clarification or relevant connections. Before the first interview, two test interviews were held to examine the completeness of the interview guide.

3.2 Sampling method

The sampling method applied was criterion sampling. Participant selection is based on their company's position in offshore energy development. The key was that they fit into a core part of offshore development. The four main categories identified by the Netherlands Enterprise Agency (2022) include:

- Government actors: Responsible for the tendering, permitting, and space allocation.
- Energy services: TSO: responsible for the offshore grid connection and development
- Industry responsible for the execution of offshore wind energy projects, including feasibility, design and development, construction and engineering, transport and installation, and Operations and Maintenance
- Knowledge and innovation actors: responsible for knowledge development for both industry and governmental actors

In addition to these four categories, a fifth one was added to represent the environmental perspective, namely, environmental NGOs.

Criterion sampling was applied. The interviewees were selected within the previously mentioned categories based on their position within the company. Due to the nature of the research and the large amount of context that must be taken into account, the interviews were selected based on their knowledge of collaboration. All interviews were held with people participating or involved in collaborating with different actors. Most interviewees were contacted through common connections or via Linked In. Some were selected through snowball sampling, where a previously interviewed expert recommended another expert for an interview.

The Actors that were interviewed are shown in Table 2. It is important to note that the order of actors in the list does not correspond to the interview numbers mentioned in this research's results section (chapter 4). The non corresponding number is to guarantee anonymity for the interviewees.

In total, 14 interviews were held, lasting an average of 50 minutes each. Most interviews were held online via Teams, and two were in person. Most interviews were held in Dutch to create a comfortable atmosphere, talking in the native language of both the researcher and interviewee.

Table 2: List of interviews.

Category	**actor**	**Number interviews**
Environmental NGO	NGO	1
Government	RVO	1
	EZK	1
TSO	TSO	1
Research	T2 institute	1
	Innovation actors (not for profit)	2
	Consultancy	1
	University	1
Industry	Industry Association	1
	Developers	2
	Installation actors	1
	Port	1
TOTAL		14

The different levels of involvement in decision making were included; five interviews were held with interviewees active in national and international decision making. The international decision-making includes the EU, NSEC, and GNSBI. Nine of the interviews were mainly involved in Dutch decision making, six interviews involved on a project tender level, and five with direct involvement in national policy-making; note that some interviewees are involved in multiple of these categories. All interviews were working on the development of offshore energy. Two actors were more indirectly involved, coming across its development and the development impacting them. The other 12 were directly involved in offshore energy development.

3.3 Operationalization

The research is done by having semi-structured interviews. The interviews are structured using an interview guide. The interview guide, including the interview questions, is added to Appendix A.

Starting with the core part of the IAD framework namely the **action situation**. The interview maps out the different aspects of the action situations. The key things that are being measured here are the different action situations, the different actors involved in these action situations, and lastly, the

position the actors hold in the action situations. These three aspects are being questioned in the interviews.

The exogenous variables are split into biophysical conditions, attributes of community, and rules in use. The Biophysical conditions are split into two main categories: the technical conditions and the natural conditions. The questions were deliberately kept broad and open to any input to prevent steering in a specific direction. The technical conditions included the limitations and opportunities to measure the most important technological opportunities and limitations. The Natural conditions include the biotic and abiotic factors. The attributes of community were researched, separating the national and international factors, and the attributes of community were interpreted as the social and cultural factors. Lastly, the rules in use were kept at all levels of government, national and international, and used to figure out the most influential and important rules perceived by the interviews.

The outcomes are a view into what has already been achieved by the different actors, including a small outlook on future achievements in the near future.

The evaluation is split into two parts: the goals that would be considered successful for the different interviews and the evaluation process, going into the level of evaluation, the actors involved in the evaluation process, and the changes to this process.

Lastly, the view on collective action will be asked to get an overview of the overall sentiment on a broader collaboration.

3.4 Data Analysis

The data analysis method is a thematic analysis. A thematic analysis is a method for identifying and encoding patterns (Braun & Clarke, 2006). The conceptual units in the IAD framework were used as a basis for the initial themes in the data analysis, this provided an initial structure to the data. These initial themes corresponded with the questions in the interview guide. These initial themes were analyzed using NVIVO, NVIVO is a data analysis software that helps in the structuring of the data. After the initial themes the data was separated into different sub themes/ codes, this was done by splitting up the data into different categories, as the patterns emerged from the data. This was an iterative process, a constant back and forth and re-structuring into whatever category best fit the data. The coding process was based on the process described by Fereday and Muir-Cocharane (2006) and Swain (2018), it is an iterative process with a constant back-and-forth between the different data analyzation steps. Using the various parts of the IAD framework as the initial themes. The open approach during the data analysis allows to stay close to the data.

3.5 Reliability validity and ethical considerations

External reliability, as defined by Bryman (2012), concerns the extent to which a study can be replicated. This aspect poses a significant challenge in qualitative research, as emphasized by LeCompte and Goetz (1982), due to the substantial influence of the social setting on the research process. To address this concern, ensuring external reliability involves providing a comprehensive description of the analysis and methodologies employed, as provided in this methods section. The utilization of a framework and semi-structured interviews enhances replicability, the semi-structured interview guide is also provided in the attachments of this research. Internal reliability, on the other hand, refers to inter-researcher reliability, in other words whether multiple researchers observe the same phenomenon in the data (Bryman, 2012). Given that the research is conducted by a single researcher, there is a risk of low internal reliability. However, close communication with the supervisor throughout the research process and maintaining transparency in the research methodology mitigate this risk.

Additionally, making the research data and transcripts available for further analysis post-research enhances internal reliability.

External validity concerns the generalizability of research findings across different social settings (Bryman, 2012). This poses a challenge for qualitative research due to the specificity of the researched situation. However, the nature of the framework going into the different exogenous variables that apply to the researched settings enables comparisons between social, physical, and governance settings. The research results provide insights into specific social and physical phenomena perceived by the interviewees, facilitating validation. Internal validity, the degree to which researchers' observations align with theoretical concepts developed in the research (Bryman, 2012), is considered a strength of qualitative research (LeCompte and Goetz, 1982), addressing context and research subjects, as well as staying close to the data in the results, this enhances internal validity.

Ethical considerations in the research process involve processing participant data anonymously and adhering to data protection regulations. Informed consent forms were signed by all participants, outlining their rights and expectations. Participants were allowed to review and amend their interview transcripts after transcription. Any information mentioned off the record during interviews was treated as such. Transparency regarding research goals and status was maintained throughout, and no deception was employed at any stage.

4. Results:

The result chapter presents the findings from the interviews. The results are organized within the components of the IAD framework, examining the results for each component. Starting with the framework's core, the action situation goes over the different actors and the different action situations. After which, the exogenous variables include the biophysical conditions, attributes of community, and the rules in use. Followed up by the evaluation and finished up with the outcomes. In addition to the components of the IAD framework, the results finish with the perspective on collective action.

4.1 Action situation

The action situation is the center of the IAD framework. The action situation goes over the different actors first, giving a description of some of the core actors and an overview of all the actors mentioned in the interviews. After this, the action situation discusses what decisions are made at what level of governance. The action situation will give an overview of the different levels of decision making.

4.1.1 Actors

Starting with the actors that were most described in the interviews, including a description of their roles on the North Sea. Ending with a complete actor overview.

- Research (interviews 1, 2, 3, 4, 6, 7, 9, 11, 12, 13, and 14) the role of research is gathering data and advising and informing government and business actors. This category includes university researchers, research institutes, innovation actors, and consultancies.
- The Ministry of Infrastructure and Water Management (I &W) (interviews 1, 4, 7, and 12) their role is to manage the spatial planning on the Dutch North Sea, including all the laws, rules and regulations surrounding what happens on the North Sea.
- The Ministry of Economic Affairs and Climate Policy (EACP) (interviews 1, 5, 4, 6, 8, and 9), this ministry oversees the climate policy and the energy transition policy, putting them in charge of offshore energy development, including the electricity grid and other energy infrastructure.
- Netherlands Enterprise Agency (NEA) (interviews 1, 2, 4, 6, 8, and 9) is the executive body of the Ministry of EACP. They manage everything from the tendering and permitting processes to subsidies and public information.
- Tennet (interviews 1, 2, 3, 4, 5, 6, and 14), the transmission system operator (TSO) of the Netherlands and a part of Germany, their main task is the managing of the high voltage grids, this includes the offshore grid infrastructure and connections to other countries. The Dutch state owns TenneT.
- The Netherlands Wind Energy Association (NWEA) (interviews 3, 4, 10, and 14) is the industry association representing over three hundred companies active in offshore wind. They represent the market actors as a collective in discussions and conversations with policymakers and researchers.
- Windfarm developers (interviews 1, 3, 4, 8, and 14). They are generally large investors and utility companies investing, owning, developing, and managing offshore wind farms.
- Environmental NGOs (interviews 1, 3, 4, 6, 10, 11, 13, and 14), environmental NGOs are the representatives coming up for the rights of nature and animals. Giving the environment a voice in policy consultations or collaborations with industry actors.

Throughout the interviews, a total of 37 actors were mentioned, all with different roles when it comes to the North Sea energy system. Their designated roles are briefly explained in Appendix B. Figure 3 shows the total number of actors mentioned in the interviews. The dot size corresponds with the number of interviews that mentioned them concerning their involvement in decision making. The figure is split into different actor categories:

- Research actors: the primary function of research actors is knowledge development and management.
- Government actors: these are the different Dutch ministries and responsible government agencies.
- Industry actors: this category contains commercial actors active in offshore wind/ energy development.
- NGO's containing the environmental NGO's.
- State-owned cooperations: responsible for the energy grid developments and investment in the energy business.
- International governments, the international government actors form other North Sea counties, the EU represents the European union as a governmental body, and the EU North Sea countries represent the individual member states, Norway, and the UK.
- Other: these actors are not directly involved in electricity development but are involved in the North Sea or dependent on the energy business.

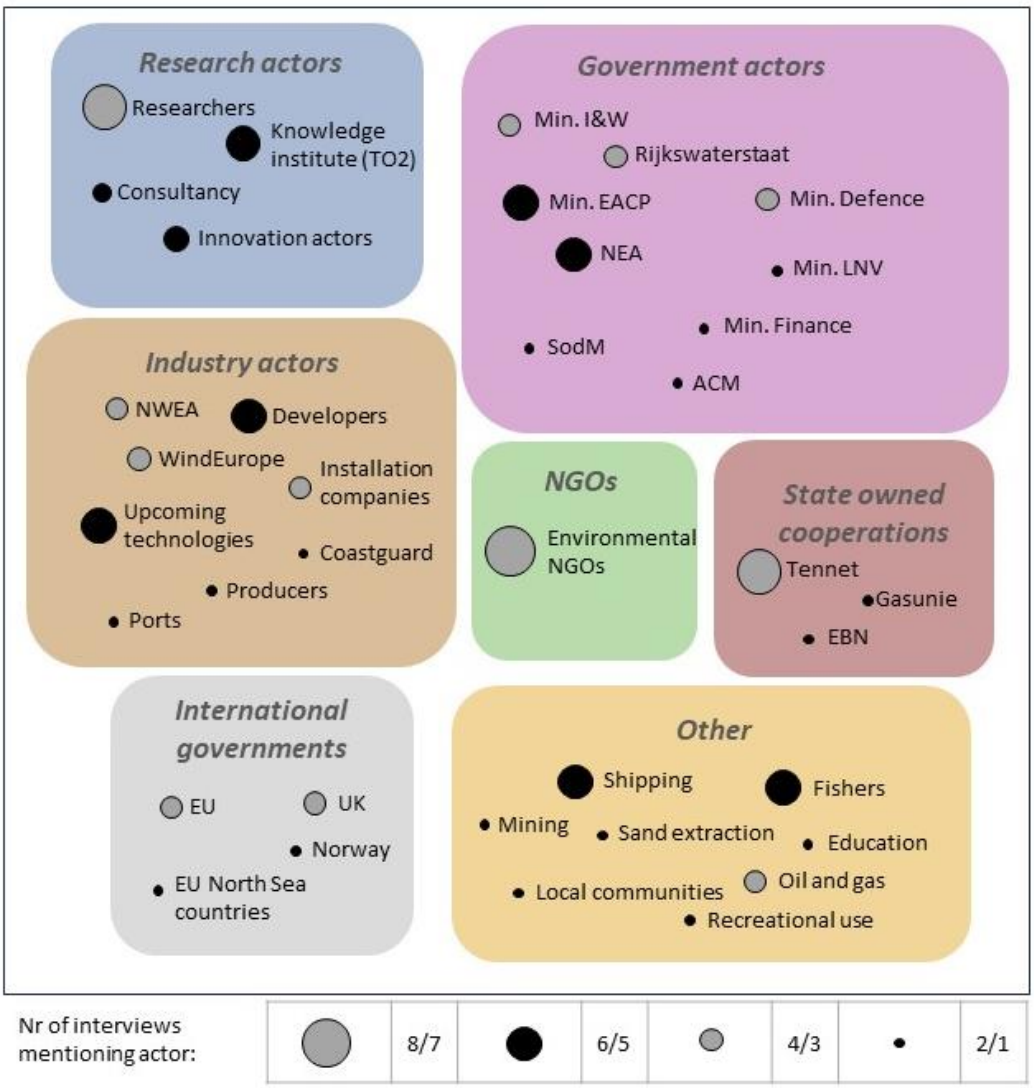


Figure 3: Actor overview.

4.1.2 Action situation

The action situation goes into the different levels of decision making, leading to the realization of the Dutch offshore wind energy system. This chapter will cover the various decision-making bodies that emerged from the interview data at each level.

Figure 4 explains the action situation with the different primary levels of decision making leading to the Dutch offshore energy system. The offshore energy system, depicted in green, operates within the intersection of two broader systems. Firstly, its physical presence lies within the offshore system, thus falling under marine spatial planning (MSP), represented by blue. Secondly, it plays a role in the transition of the energy system, marked by yellow. MSP and the energy system are responsible for making decisions and establishing rules and boundaries for the offshore energy system. Although they overlap, MSP specifically focuses on spatial use and regulations. It determines which actors can use specific areas, what activities are permitted, and what impact is permitted on the North Sea environment. The Ministry I&W is the primary authority in the Netherlands to make these decisions. Due to the diverse range of activities in the North Sea, MSP tends to be sector-based instead of overarching themes. *"At the moment, one of the biggest problems of the North Sea is that if you look at the spatial planning, it is all per sector"* (interview 12). The energy boundaries focus on offshore energy development, integration into the electricity grid, and achieving larger energy transition goals. The Ministry of EACP is the key decision-maker in the Netherlands.

Decision making occurs at three levels: European Union (EU), involving all EU countries; North Sea, involving all countries bordering the North Sea; and national, involving Dutch decision-makers and stakeholders. There are also specific rules per wind farm which are tender based.

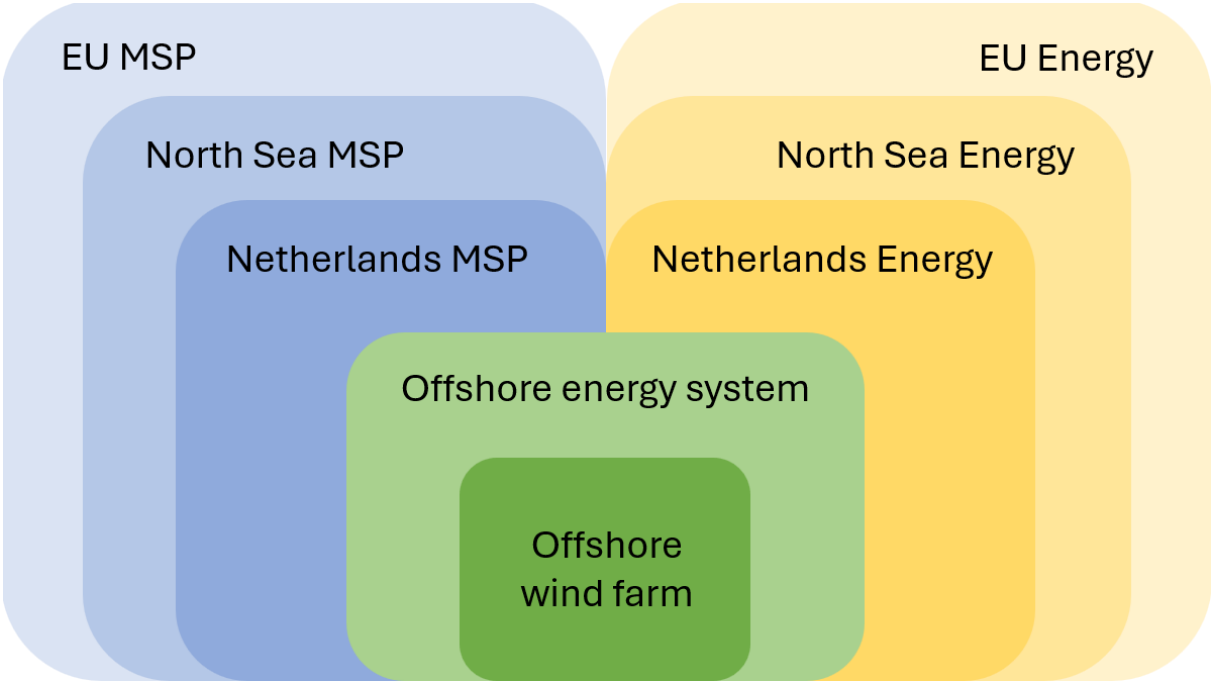


Figure 4: Different action situations.

The EU decision-making level was mentioned in 6 interviews (1, 5, 6, 8, 11, and 14). The EU aims at a collaborative approach on both MSP and energy, providing the guidelines for common planning. Regarding comments on EU decision-making, Interview 5 notes that non-EU countries within the North Sea, such as Norway and the UK, are underrepresented in the decision-making process. Three interviews specifically mentioned the offshore network development plan (Interviews 1, 5, and 6). The

offshore network development plan includes the required interconnections and the development of the offshore grid. The plan lays out where the interconnections need to be, how they will look, what cost would be associated with that (interview 5), and how the costs and benefits will be distributed (interview 1).

The North Sea level of decision making was mentioned in 10 interviews (interview 1, 3, 4, 5, 8, 10, 11, 12, and 13) referring to the decision making on North Sea basin level. There are two different significant platforms on the North Sea. The platform related to the MSP decision making is the Greater North Sea Basin Initiative (GNSBI) (interviews 3, 12, and 13). GNSBI is a relatively new decision-making platform, with a declaration signed in November 2023. All countries bordering the North Sea are involved in the GNSBI. This includes the non-EU countries of Norway and the UK. The signed declaration states a common vision will be created, and there will be collaboration in MSP, as well as GNSBI being a communication and knowledge-sharing platform (Greater North Sea Basin Initiative, 2023). The common vision will be on different overarching themes: nature conservation, long-term perspective fisheries, multi-use and co-use, cumulative effects, governance, and knowledge sharing. The GNSBI is working on overarching themes, moving away from sector-bound decision making and fragmentation. Representing the Netherlands is the Ministry of I and W and researchers. Researchers advise on knowledge exchange and provide a scientific basis for the conversations (interview 12). The second collaboration platform addresses the energy transition in the North Sea; this is handled by the North Seas Energy Cooperation (NSEC) (interviews 1, 4, and 5). NSEC is a collaboration between the EU North Sea countries (including Luxembourg) and Norway; due to Brexit, the UK is no longer a core member (European Commission, n.d.). The collaboration focuses on developing cross-border offshore wind and grid projects with the potential to reduce cost and space. Their agreed offshore ambitions will be delivered through eleven actions. They are separated into three categories: an integrated energy system in 2050, sustainable supply chain and financing in Europe, and the North Sea transitions: energy and nature (North Seas Energy Cooperation, 2023). The interview 11 stated they would like to be more involved in North Sea level decision making, and interview 4 stated they would like more involvement in NSEC. NSEC states they aim at a high standard of public engagement by clear stakeholder and citizen communication at an early stage in project development. NSEC, as well as GNSBI, recognize the importance of collaboration between NSEC and GNSBI for cooperation across sectors (North Seas Energy Cooperation, 2023) and establishing deeper collaboration between ministers and authorities (Greater North Sea Basin Initiative, 2023)

On a national level, The Ministry of I & W is leading the MSP. The decisions made concerning national MSP governance are described in the North Sea program (*Programma Noordzee*) (interviews 2, 3, 4, and 10). The North Sea program describes how a good environmental status will be achieved. One of the main policy frameworks forming the basis of the North Sea Program is the North Sea Accord (*Noordzeeakkoord*) (interviews 3, 10, 11, 12, and 13); the North Sea Accord is a consultative body consisting of different North Sea stakeholders, such as environmental NGO's, oil and gas companies, the trade association of the offshore wind, shipping actors, fishers, and government actors. The interview actors confirmed the good representation of actors in the North Sea accord (Interviews 10 and 12). The North Sea accord includes agreements on implementing three different transitions happening on the Dutch North Sea: energy, nature, and food, as well as the connections between them (Noordzeeoverleg, n.d.). The North Sea Accord has different working groups working on the different levels of agreement.

The Ministry of EACP manages the energy decisions in the Netherlands. The Offshore Wind Energy Roadmap (*routekaart windenergie op zee*) (interviews 2, 4, 8, and 14) shows the appointed location of the offshore wind areas on the North Sea; the roadmap looks around ten years ahead (RVO, 2023b).

The North Sea Energy Infrastructure Plan (*Energie Infrastructuur Programma Noordzee)* (interviews 2, 3, 10, and 14) looks at the further development of offshore wind projects after 2030, looking at what infrastructure and connections are required for the increasing amounts of offshore wind energy (RVO, 2023a). The inclusion of actors is limited, with comments such as a too-late involvement of offshore wind developers (interview 14), the government deciding on when they want market input, which is late in the process (interview 10), and no inclusion of environmental NGOs (interview 3). There is a platform started for multi-use within wind farms, the Community of Practice (CoP) (interviews 2, 10, 11, and 13). It is a discussion arena and connection point for all economic activities within wind farms. The interviews for this research were more distantly involved in this. There was a critical point on co-use with the main message that energy generation should remain the focus of the offshore wind farm, and to much focus on multi-use might cloud that message; clarity is also essential (interview 2).

Tendering and permitting (interviews 3, 4, 6, 8, 10, and 14) is the last category. The tendering process starts with a market consultation on what the market expects and needs for their next tender (interviews 10 and 14). After publication, the tender is open for comments from parties like environmental NGOs (interview 3). One of the main things about the tendering process is the inclusion of qualitative criteria, criteria that can set a tender bid apart from the other tenders, so that price is not the only winning factor in a tender, but there is more attention on qualitative criteria (interview 10 and 14). The importance of the qualitative criteria not only sets different actors apart but also sets the different projects apart, one focusing more on system integration and another focusing more on ecology. It also sets countries apart; the UK focuses more on involvement in local economies, and the tender bids follow the government's priorities (interview 14). These qualitative criteria are connected to the innovation potential of a project. This increase in innovation potential makes it more attractive to developers (interview 10). The main comment on the permitting process is the time it takes (interviews 3, 6, and 11) and the complexity of adding permit changes. These permit changes occur when multi-use projects are implemented in an offshore wind farm (interview 11).

4.2 Exogenous variables

The exogenous variables consist of three categories. First, the biophysical conditions are split into natural conditions and technical conditions. The second part addresses the attributes of the community going into the national and international societal context. Lastly, the rules in use, creating an overview of the most important.

4.2.1 Biophysical Conditions

The biophysical environment consists of two main categories: the natural environment and the technical environment. The first refers to both the biotic, the living environment, including animals, mammals, birds, fish, and algae, and abiotic aspects, all non-living aspects, such as wind, water, and soil. The technical environment addresses the technical context of the development of offshore wind farms in the North Sea. Lastly, the biophysical conditions are put in their corresponding impact layers, showing in what layer of governance most of the impact of these conditions can be found.

4.2.1.1 Natural conditions

If one underlying thing shapes the natural conditions, it is the lack of knowledge of the overall effects. The lack of knowledge of the biotic and abiotic aspects of the natural environment comes up in different interviews. The overall lack of knowledge on the effect the offshore wind installation has on the ecosystem (interviews 1, 4, 6, 10, 13, and 14), *"there is a lot of contrasting data on biotic life within offshore wind farms it is still unknown if the results are net positive or negative"* (interview 3), "*One thing is sure the ecosystem will change, some ecologist see every change as a bad thing"* (interview 11).

The effect of hard surfaces on the bottom of the North Sea affects the life on the bottom of the sea or the benthic habitat. This includes mollusks, plants, soil life, and consequently, the life higher up in the food chain. The impact of offshore wind farms on this benthic habitat was mentioned in interviews 1,3,4,7,10, 11, and 13. Most of these saw mainly a positive effect (interviews 1, 3, 4, 10, and 13), saying these extra reefs motivate soil life and are good places to adhere to and hide under. As well as interview 4 saying: "T*he North Sea used to have many more reefs until the fishing industry ruined them, offshore wind is bringing this seabed texture back*." There is also a more critical note saying the extra hard surfaces might be suitable for exotic, non-native species because of the introduction of hard surfaces where there are not supposed to be any (interviews 7, 11, and 13).

The second impact offshore wind farms have is changing the wind patterns due to the rotating blades, called wake effects (interviews 2, 3, 5, 6, 7, 8, 10, 12, and 13). This change in wind patterns does not just impact the ecosystem. There is also an impact from one windmill on another; this impact within wind farms is well understood. However, one windfarm on another windfarm is less understood, and the larger effect of the cumulative windfarms on other windfarms further down the wind in the North Sea is also under-studied (interview 6). This makes It a cross-boundary issue, "*when there is a common Southwest wind, well, then. Perhaps England is a bit ahead of us, but we are certainly in the way of the Danes and the Germans in that respect. So yes. And certainly, an international impact."* (interview 6). These macro wind effects can also impact revenues significantly (interview 10).

The rotating blades also impact birds and bats, migratory birds mentioned specifically (interviews 1, 4, 6, 9, 10, 13, and 14). Again, the main thing is the lack of knowledge about how many birds are killed in OWF collisions, what species it is (interview 4), and how much effect the windmill height has. *"The turbines become larger and higher and thus simply end up in areas where more birds migrate."* (interview 13). Moreover, the cumulative effect is also unknown; if there is one, wind farm birds can fly around OWFs, but if the whole sea is full, what impact would that have, "*Let's make sure that it doesn't become one big wall of meat grinders for birds, so to speak."* (interview 6). The Netherlands has implemented a start stop system for the moments there is a bird migration crossing a windfarm, the windmills can be turned off for that period of time (interviews 4, 13, and 14). To keep the downtime to a minimum models should be more accurate in predicting these migrations (interview 14). Since birds do not keep to country boundaries it is a cross boundary issue (interviews 4, 5, and 14).

The impact of the number of structures built in the North Sea, on the sea current and water movements is a concern (interviews 2, 3, 10, 12, and 13). "*Water movement is one of our biggest concerns. Every windmill has a tiny effect on this water movement, however, collectively it might create large wake effects and changes in the water system. The North Sea is largely stratified, the ecosystem is also adjusted to that.... The system has been functioning this way for over 8000 years. By placing windfarms, it could cause the sea to no longer be stratified, changing the whole system. This has an effect on algae growth, changing the availability and time of growth, affecting the food availability for fish, consequently affecting the food availability for seals and birds. Nowhere in the world will there be a sea as densely filled with infrastructure as the North Sea. It is essential we understand the abiotic effects and the effects on primary production.*" (interview 12). With densely packed wind farm development not just happening in the Netherlands but also in the rest of the North Sea, this is a cross-boundary issue.

The installation impact that the piling of the monopile has on sea mammals is another biotic effect wind farms have on their environment, as mentioned in interviews 4, 10, 14, and 13. However, there has already been much improvement in this area, and there are other ways of funding a windmill. However, these are more expensive.

The last impact is a positive one. The lack of fishing and other activities inside wind farms creates an animal rest area (interviews 3, 6, and 11*). "The lack of fishing in wind farm areas seems to have a positive effect on fish and seal populations within the wind farms. However, more research should be done."* (interview 3).

4.2.1.2 Technical conditions

This subchapter contains the technical opportunities and conditions. The innovations and opportunities only mentioned by one actor are excluded from this analysis.

Connecting to the natural conditions, there is the technology for data collection for environmental monitoring (interviews 2, 5, 11, 12, and 14). This was one of the technological innovation areas mentioned, to create a better understanding of what is happening offshore, both with biotic effects as abiotic effects. "F*or example, there would be measuring buoys at fixed locations over the entire depth and that they would also collect the data we need at high frequency, for example about water movement, to gain a better overview of the North Sea as a whole system."* (interview 12). Another environmental issue occurs with the installation of the foundations due to this impact there is a lot of innovation going on in the field of monopile installation to minimize the effects on the marine mammals (interviews 3, 4, 11, and 13). '

One of the ways the use of monopile foundations is completely bypassed is by utilizing floating foundations (interviews 1, 7, 13, and 14). Floating provides the opportunity to install offshore wind in deeper waters, mainly beneficial for different waters and in the North Sea parts of the coast of Scotland and Norway (interviews 1, 7, and 14). The possibility of moving wind farms due to using a floating foundation was also mentioned, however with doubts to the actual benefits (interview 7).

One of the main challenges of offshore wind is the intermittency of the supply, at the moment there is no wind there is no energy, and at the time there is a lot of wind there might be a surplus of energy. The innovations surrounding a better integration in the electricity grid are thus one of the main categories mentioned in the interviews (interviews 1, 2, 4, 5, 6, 7, 9, 10, 11, and 14). Most of these innovations had to do with the supply and storage side of the energy however one interview mentioned the need for industry to electrify and better follow the production patterns of offshore wind (interview 4). A way of transforming the energy is by turning it into hydrogen (interviews 2, 4, 6, 7, 9, 10, and 14). Interviews 7 and 6 were critical on the technology due to the large conversion losses, when going form electricity to hydrogen. Hydrogen is an expensive product, and it is required as a feedstock for the industry, this makes It a good business decision to invest in (interviews 2, 4, 9, and 10) "It *might be a good business opportunity to produce hydrogen at the time the energy costs are really low. To increase the value of the produced electricity. In the future projects will not be built anymore without the option for electrolysis to stabilize revenues, since you will no longer be able to build a profitable project*." (interview 10). However, the technology for large scale offshore hydrogen production does not yet exist and building it offshore comes with large challenges (interviews 2 and 10) this is why interview 10 proposes starting on land gaining experience with the technology before placing it offshore. Cable saving is one of the benefits of offshore hydrogen, since hydrogen can be transported on to land via gas pipes and does not require electricity cables all the way to the on shore (interviews 2 and 4).

By connecting different windfarms and being able to exchange energy without going back to the mainland, it adds to the security of supply in northwestern Europe. This is done by creating energy hubs or creating a meshed offshore grid (interviews 1, 2, and 5). "*It minimizes material use and environmental impact by using less cables and requiring fewer landing points*" (Interview 1) *"without this the system would be overly expensive"* (interview 2).

A part of this system integration is by smart cable use (interviews 2, 11, and 14). "C*urrently the cables are only used 40 percent of the time, increasing this will also help keeping the rising material costs in check"* (interview 11). A way to increase this cable use could be by installing offshore solar in the area of the wind farm, this would increase cable use due to its complementary production profile (interviews 2, 5, 11, and 14). However, one of the interviews had doubts when it comes to the added value of offshore solar, since it would increase the total installed energy capacity and increase the times the offshore wind would have to be turned off due to the maximum cable capacity (interview 10). Another technology that was named that could increase cable use is wave energy (interviews 2 and 11).

Another way to improve grid integration is by using battery systems (interviews 4, 11, and 14), 11 and 14 seeing it as a potential tool. However, it is not all positive when it comes to battery technology: "B*atteries take up a lot of space and provide only a little storage capacity"* (interview 4)

Standardization of the technology was mentioned for three main reasons, first of all by having standard lower wind mills there will be less bird collisions (interview 3), second of all standardization will lower the costs, by giving manufacturers security and allowing them to build less one off custom projects, have a lower stock of backup products, and allow for process innovation to make the cost go down further (interview 9). Standardization will also allow the cost to go down due to more clarity in the industry (interview 14). Lastly standardization can also pe perceived from another angle, namely the communication angle between the different technologies. The infrastructure of different windfarms and connection points needs to be able to communicate to each other if the offshore grid infrastructure will be integrated into a large offshore grid (interview 6).

Labor saving innovations, due to the lack of workforce certain tasks can be automated or taken over by robots (interviews 4 and 9). lastly there is material innovation (interviews 1 and 4), material innovation can increase the circularity of the offshore wind farm (Interview 4) and decrease the risk related to the dependence on chines materials such as rare earth metals used in the magnets (interview 1).

4.2.1.3 level of impact

Figure 5 shows the different impact levels of the natural and technological conditions. The purple dots show the natural conditions, and the orange dots correspond to the technical conditions. The natural conditions all impact the ecosystem level. Since these are ecosystem-level effects, birds, fish, and algae do not keep to the boundaries of a wind farm or a country. Except for the installation impact on sea mammals, this was not added to the ecosystem at the North Sea level due to the temporary scale of the impact. The technical innovations related to system integration are listed on the border of the North Sea and EU levels. This positioning was chosen due to the ambitions of creating an integrated offshore grid, making it a North Sea-level integration. However, this must also be implemented into the larger EU interconnected grid.

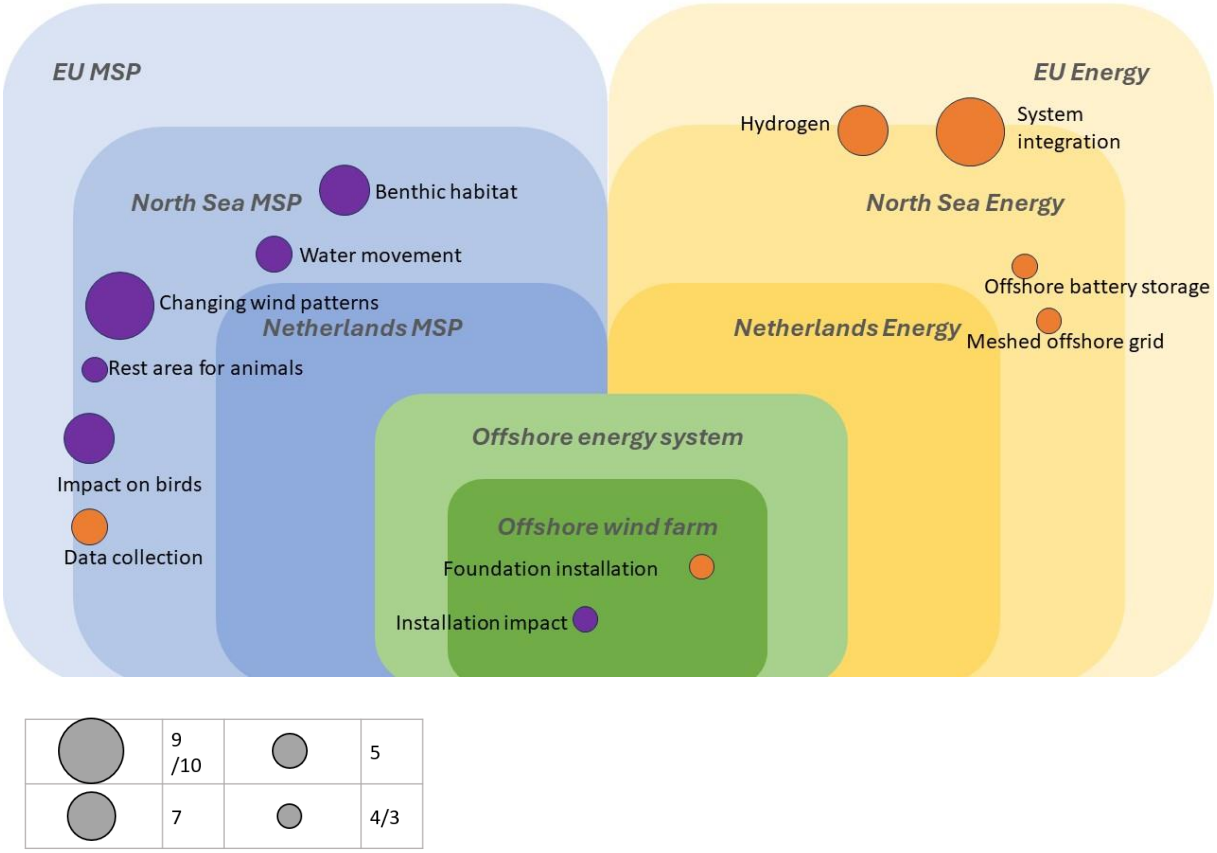


Figure 5: Impact levels of biophysical conditions.

4.2.2 Attributes of the Community

The first part of the attributes will be Dutch attributes or cultural phenomena seen in the Netherlands. The second part will be more of the European attributes. There might be some overlap in the attributes, for instance the cultural value of fishers, this is not a purely Dutch attribute since other countries might also struggle with this. The separation was just made to create some structure in the different phenomena.

4.2.2.1 National social context

the main thing mentioned by the most interviews is the changing role of fishers on the Dutch North Sea, the interviews mentioned the social impact offshore wind has on the fishers (interviews 1, 3, 7, 9, 12, and 13). The development of offshore wind limits their fishing area, at the same time there were comments of them not feeling heard and pushed down (Interviews 7 and 12). There were comments

on their larger social value, mentioning their cultural heritage and culture (interviews 3, 4, 5, and 12) and what the loss of this cultural heritage will do to these fishing communities. As well as *"Family businesses and the whole value chain of the fish industry is impacted. Many fishing communities and villages will be disrupted that are already vulnerable."* (interview 12). There was skepticism on the idea of retraining the fishers to work in the offshore wind (interviews 7, 9, and 12) "*Retraining of fishers does not seem to work, other job opportunities in offshore seem to be limited"* (Interview 7). Another view of the fishers is their stubborn nature and set in their ways (interviews 3 and 13), "T*hey themselves see it as a historic right, since they have been doing it a certain way for years."* (interview 3).

The consensus-based decision making engrained in Dutch governance is the so called *'polder model' (*interviews 4, 5, 6, 11, and 14), involving market actors and other representatives such as NGO's. This consensus-based process is a political process to get all actors on one line with something they can live with. *"There is no other country that I know of where there is such a consensus culture and that consensus culture, whatever is agreed, is also used and becomes leading in the roll-out of your policy and all kinds of programs and initiatives."* (interview 7). This process is applied in the North Sea accord (interviews 4, 1, and 14). The Netherlands is used to including businesses in a transparent dialogue (interviews 11 and 5). This inclusion of business and other actors in decision making is seen as a typical Dutch thing, with an emphasis the difference in inclusion of actors between the different countries (interviews 4, 5, 6, 11, and 14). One of the interviews praised the inclusion of all different actors by the government "I*nteraction between government, market, NGOs and research is good. Actors are involved from an early stage asking the right questions and doing research, coming to the best possible decisions, this is a part of the success of the North Sea development.*" (interview 4). However, when it comes to representation in the decision-making process in the Netherlands, interviews 12 and 14 mentioned the power and dominance of the offshore wind market. Interview 11 mentioned the lack of inclusion of Defense, education and oil and gas at the Dutch decision-making tables.

The societal acceptance was mentioned as a positive (interviews 5, 7, and 8). With the view pollution offshore not being seen as a problem (interviews 1 and 7), only the landing points getting some negative societal response (interview 5). The value of locally produced energy was also mentioned in 3 interviews (interviews 1, 3, and 5). The Netherlands has a history of working on water, and according to interviews 2 and 4 there is a certain pride in the Dutch offshore industry.

The view of protecting the offshore wind market to rising costs was brought up by 5 different interviews (interviews 1, 5, 7, 8, and 14), with their view being the government should provide the market with some protection to the rising costs, so that the government is able to reach their goals. One of the actors (interview 14) mentioned the use of a two-sided contract for difference, meaning there are agreements on profits and losses, protecting both parties from excessive gains and losses. in the contract between the government and the developer. When it comes to the economic aspect there were two interviews mentioning the free market and liberal market governance as a strong Dutch value (interviews 6 and 8). Lastly there was a mention of the Netherlands being a trading culture and used to doing business abroad (interviews 2, 4, 8, and 11).

4.2.2.2 International Social Context

In the European context, one of the main points is the value of a European supply chain over the Chinese competition (interviews 1, 4, 9, and 14). When it comes to international dependence on other countries, two interviews specifically mentioned the geopolitical aspect (interviews 3 and 5).

Interview 12 mentioned: "*You notice a split between countries that are a part of the EU and those that are not".* This was a more general statement referring to a country like Norway on the North Sea. The

other interviews mentioning a difference in treatment mentioned Brexit as a specific issue, making the collaboration more difficult (interviews 1, 5, 8, and 11).

Another sentiment was the giving up of national goals for a collective good, the countries in the EU want to do with their land what they want to do and not too much interference of the EU in their land use (interview 5). This sentiment is also perceived by interview 14. Interview 7 adds that thinking of the greater good might be getting more difficult due to the rise of populist movements throughout politics in Northwestern Europe, often paired with climate skepticism and anti-EU sentiment.

4.2.3 Rules-in-use

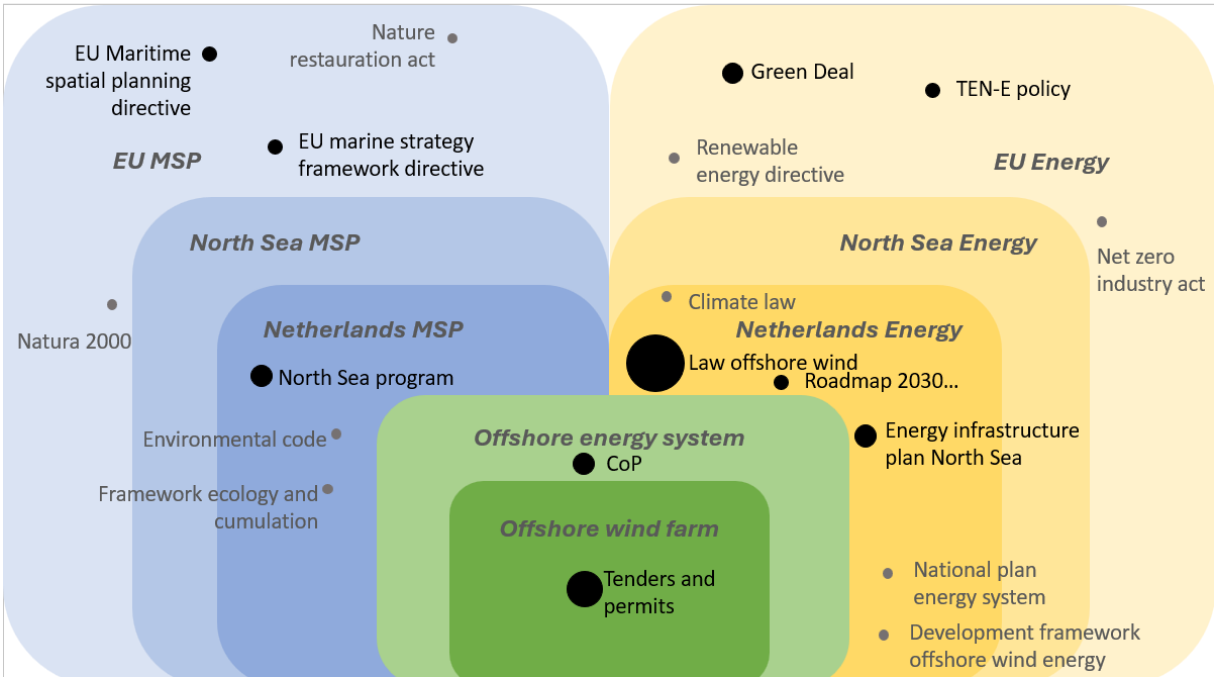
The rules are separated into two different parts: the MSP part and the Energy part. The MSP part goes into the different rules and regulations mentioned regarding the use of space and what is done within that offshore space. The energy rules go into the different infrastructure and ground rules laying out the different renewable energy ambitions.

Starting with the MSP Rules, the rules for the entire EU mentioned in the interviews are the EU Marine Strategy Framework Directive (MSFD) (interviews 1 and 12). This directive aims to protect the European Seas and the marine environment and, where necessary, restore it. The MSFD requires nations to write a marine strategy and collaborate, where necessary, with other EU countries in their marine region (Noordzeeloket, n.d.). One of the comments on their qualification system is that there is too much emphasis on the iconic higher species and not enough on the species lower in the food chain (interview 12). The EU Maritime Spatial Planning Directive (interviews 1 and 12) sets a common framework that should be applied within the EU. On the Dutch national level, the Program North Sea, with the underlying North Sea accord, gives the guidelines for what is and is not allowed in the offshore area and how the space is allocated between the different actors. An impartial chair chairs the North Sea Accord, a consensus-based process where all actors should agree.

The Energy rules, starting with the core rule on which the renewable energy targets are based, the EU Green deal (interviews 2, 5, and 8), means that if renewable energy targets are not reached, there are consequences for a country. This is a way of keeping countries accountable for their renewable energy development. The following EU regulation is the TEN-E regulation (Interviews 1 and 5). This regulation links the different energy infrastructures throughout Europe, including the North Sea offshore grid, and is a basis for offshore grid development in the Netherlands. However, the TEN-E regulation is the only regulation on international grid development. Every other collaboration is entirely voluntary (interviews 1, 5, and 7), such as the North Sea level decision making, NSEC, and GNSBI, "*The TEN-E regulation does not go further than the requirement to sit at the table and talk*" (Interview 1) there are no consequences when countries refuse to participate. *"EU only motivates member states to collaborate by facilitation and regulation. Member states themselves have to come to agreements, and this leads to opportunist behavior, avoiding the difficult problems, this does not lead to sustainable management of the oceans system"* (interview 7). However, according to interview 1, it is still too early to see the consequences: *"We still need to see if the recent changes work or not? Yeah so it's good, you know, to consider the policy cycle, right? So, implement, evaluate the current status, design new policy, implement, reassess, and start all over again.*" (interview 1). The primary national law on offshore energy development is the law on offshore wind energy (interviews 1, 2, 4, 5, 6, 8, 11, 13, and 14). The law includes guidelines on location designation, rules during construction and operation, and connection to the electricity grid (RVO, 2023a), it also describes the permitting and tendering process (interview 4). The main comments on the permitting process (interviews 2, 3, 6, 9, 11, and 13) was that there should be an aim of getting shorter permitting times (interviews 2, 3, and 11). There is a high complexity regarding the permitting process (interviews 6, 9, and 13). There were specific mentions (interviews 2 and 14) of the roadmaps developed or being developed for 2030, 2040, and 2050.

Roadmaps like these give the industry a clear picture of what projects will have to be realized by what time. The energy infrastructure plan for the North Sea (interviews 2, 4, and 14) is the long-term planning of all offshore energy infrastructure (RVO, 2023b). This long time span makes it a very guiding document for market actors to anticipate upcoming opportunities far into the future.

Figure 6 shows an overview of the mentioned rules and regulations, separated into the levels they impact. The dot size corresponds to the number of interviews mentioning it as an important regulation.



●	8	●	3	•	1
●	6	●	2		

Figure 6: Rules named in interviews.

4.3 Evaluative criteria

The Evaluative criteria describes the goals of the different interviews, after which the different aspects of the evaluation process are described.

4.3.1 goals

Regarding the goals described by the different actors, they align on various parts: The first one is contributing to the energy transition (interviews 2, 3, 4, 5, 6, 8, 10, 11, 13, and 14). These 10 interviewees mentioned in their **goals contributing to the energy transition**, by contributing to offshore wind. Second one is goals containing an **ecological priority** (interviews 3, 4, 8, 9, 10, and 14). This is either by standing up directly for the environment (interviews 3, 4, 9, and 10) or by lessening their company's environmental impact (interviews 8 and 14). The third goal is **knowledge development** explicitly said in their goals by interviews 1, 7, and 12. Goals in **contributing towards an integrated system** (interviews 9, 12, and 13). The last goals include **safety** (interviews 6 and 9), **keeping the costs down** for energy consumers and government (interviews 6 and 9).

4.3.2 Evaluation process

The evaluation process analyses the scale of evaluation and the evaluation process.

When looking at the evaluation scale, nine interviews (interviews 1, 2, 3, 5, 9, 11, 12, 13, and 14) mention evaluating on a project basis. Interviews 1, 3, and 13 mention evaluation based on their sector. Interviews 2 and 14 have mentioned a yearly cycle of evaluation. One thing that is lacking is the overall evaluation, "It *is not our role to monitor more widely the progress of offshore wind and transmission development. It is the role of the policymakers of the TSOs of the environmental NGOs and whatnot*." (interview 1). The system level of evaluation is not done or not sufficiently done according to the interviews; however, they do think it is going to increase in the future (interviews 3, 5, and 6). One of the reasons for it not happening now is that the development is not there yet, stating the large scaleup of offshore wind is still happening over the coming years and has not already happened (interviews 5 and 6). A second thing said about a system-level evaluation was the lack of time and speed of transition (interviews 3 and 5) *performing heart operations on the highway because we had to double our targets while we were still at the beginning of achieving those targets."* (interview 5).

The parties involved in the evaluation process also differ for different interviewees. An internal evaluation was mentioned by five interviews (interviews 1, 5, 6, 11, and 14) an evaluation including the clients was mentioned by six interviews (interviews 2, 3, 5, 11, 12, and 14). An evaluation including an external party was mentioned by three interviews (interviews 5, 6, and 12) and lastly there is the mention of making it public knowledge (interviews 2, and 12). One of the actors simply mentioned a lack of evaluation, saying it was not done enough (interview 8).

4.4 Outcomes

The outcomes named by the actors can be split into five categories: rules and regulation, knowledge development, collaboration, environment, and building.

The category of rules and regulation includes all changes that were made or upheld to rules and regulations, partially due to the effort of the actors interviewed. The rules include all government sanctions such as subsidies (interviews 10 and 4). The rules that were referred to are over different levels of government mainly referring to the national level of decision making (interviews 3, 4, 6, 10, 11, and 13), however also on the North Sea basin level referring to the NSEC collaboration (interviews 5 and 8), and the European level (interview 1). In total the outcomes mentioned their contribution to the rules in 9 different interviews.

Knowledge development was another category frequently mentioned when asked about the outcomes (interviews 1, 3, 7, 9, 11, 12, and 13). Interviews 3, 7, and 13 mentioned knowledge development regarding the ecological system. Regarding technical innovations, interviews 11 and 9 see their addition to the knowledge development as an outcome.

Collaboration is the category where they mention contributing to relationships between different actors (interviews 1, 3, 11, 12, and 13). This can be done through actors simply being involved in collaborations (interviews 3 and 11) or by actors helping to set up new collaborations (interviews 1 and 12).

Four interviews mentioned environmental achievements (interviews 3, 4, 8, 9, and 13). Interviews 3, 4, 9, and 13 all mentioned the larger environmental goals for the North Sea, such as: "*thus protecting the ecosystem if a project is related to that*" (interview 9) and *"giving a voice to nature"* (interview 3). Interview 8 mentioned their corporate role in the environment by being willing to phase out the fossil fuel business.

The last-mentioned category is that of building achievements on the North Sea (interviews 6, 8, 9, and 13). This concerns their contribution to the total installed capacity of 4.5 GW (interview 6). Their role in the finishing of different projects (interviews 8, 9, and 13)

4.5 Collective action

The last part of the results chapter is about collective action, analyzing the answers to what the interviewees think about collective action on the North Sea.

When asking the interviewees what their thoughts were on more collaboration and the creation of common goals and objectives, all respondents were optimistic about the idea of more collaboration on a national and international scale (Interviews 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14). When talking about an increase in collaboration and collective action, seven interviews used strong language: the words Essential (interviews 5 and 8), Necessary (interviews 4 and 14), inevitable (interview 11), It has to be done together (interview 13), and required and Crucial (interview 7) were mentioned concerning collective action. Two interviews were for extra collaboration, but they were more hesitant: "*I believe in collaboration, at least by communicating plans to the surrounding countries, and exploring how different ideas can reinforce each other that would be a good thing"* (interview 9), "*might be better off"* Referring to implementing a collective approach *(*interview 8).

Four actors emphasized that there has already been improvement and action regarding a collective North Sea approach. With interconnections (interview 1), The cooperation between stakeholders in NSEC (interviews 1, 5, 12, and 14), the better collaboration on an international scale surrounding MSP (interviews 1 and 12), this MSP collaboration through GNSBI (interview 12).

According to interviews 5, 6, and 7, the primary obstacle to collective action lies in the tension between national objectives and the broader interests of the North Sea region. By prioritizing their own national goals, countries are failing to advance the overarching goals of the North Sea effectively. Interview 7 puts it as "*Giving up some sovereignty."*

5. discussion

This research answers the research question: "*how do the conditions in the North Sea potentially facilitate collective action for the governance of its energy resources from a Dutch perspective?"* To figure out what the current mode of governance is and what aspects potentially lend themselves to collective action. The North Sea can be seen as a common pool resource, where it can be depleted, and access to it cannot be denied since bordering countries can manage their own offshore territories. The North Sea is an SES with a technical component. The resources identified are ecological, energy, and social resources. Collective action is a mode of governance that can create a more efficient way of governing resources and prevent depletion, involving all affected stakeholders. This is done by creating a common goal and collectively contributing to this goal. To answer the research question, the research included interviews with actors active on the Dutch North Sea involved in energy development.

5.1 IAD framework

This research used the IAD framework to research the status of governance. Figure 7 summarizes The research results.

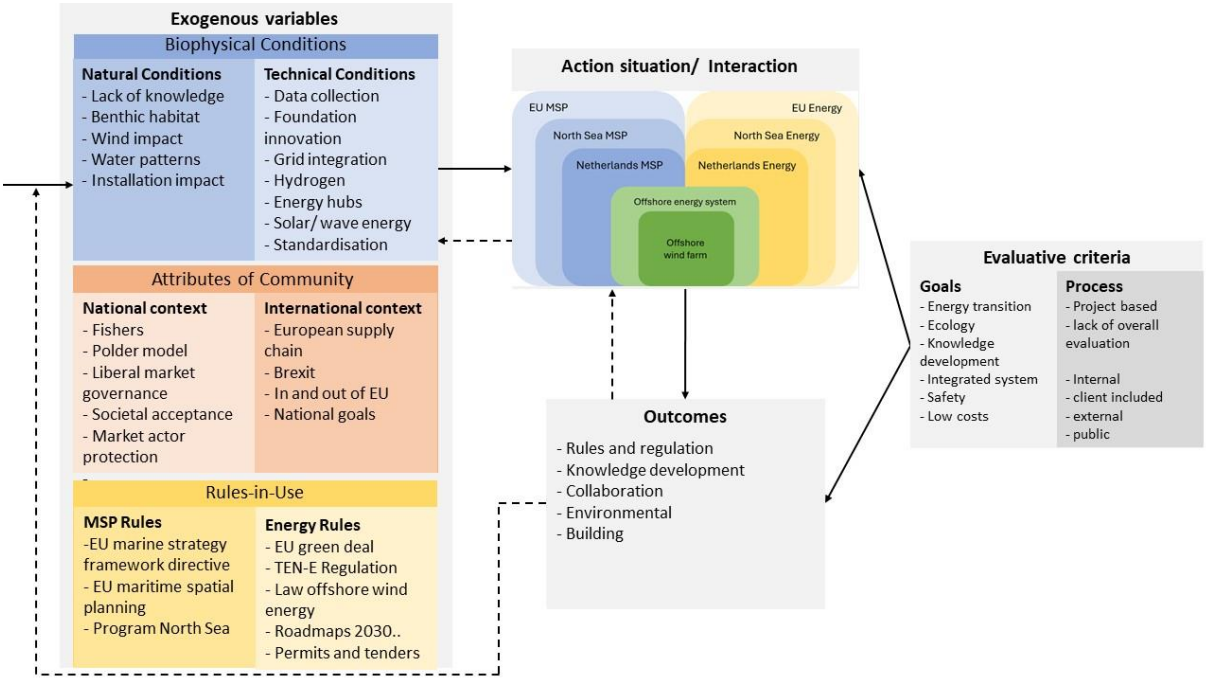


Figure 7: IAD framework of Dutch North Sea energy.

The different parts of Figure 7 are explained, starting with the action situation. The research shows many different action situations on different levels of governance. The MSP and energy decisions are made on the EU, North Sea, and National levels, with additional decisions being made per OWF. All the decisions cumulate into the total governance of the Dutch offshore renewable energy system. These decisions are made between many different actors, creating high complexity.

The exogenous variables shape the environment in which the action situations occur. The first part is on the biophysical conditions, starting with the natural conditions. The different activities and characteristics of offshore wind impact the ecosystem. The main takeaway from this impact is that a lot is still unknown. There is information on what is impacted and how; however, the total ecosystem effects are still unknown, including the effect on a local and ecosystem scale. Both the biotic, thus living aspects of the ecosystem, benthic animals, birds, algae, fishes, and mammals, are impacted, as well as

the abiotic, physical non-living ecosystem characteristics, such as wind and water flow. Most of these changes happen on a local scale within the wind farm. However, many of these changes impact the entire North Sea level ecosystem.

The technical conditions include the technologies for data collection about natural conditions. Then there are the foundation innovations to minimize installation impact, as well as to be able to build in deeper waters. The main category for the technical conditions surrounding the grid integration, including the different technologies that can be used to improve energy integration into the grid, the first solution is hydrogen, either onshore or offshore. The second category is offshore energy hubs, which are central distribution points for energy. Thirdly, added energy sources such as offshore solar and wave energy. Followed by battery technologies. The last technical condition is standardization and other incremental innovations.

The social context is split up into national and international contexts. The national context includes the fishers' impacted role and position due to offshore wind energy. The second national social context is cultural phenomena like the “Polder model” and the tendency to go to a liberal market economy and protect the market actors. The international context starts with the finding that actors perceive the European supply chain to be of importance to the independence of the EU. The second international context is Brexit and the differences between inside and outside the EU. The last is the importance of national goals and sovereignty over decision making.

The rules in use consist of different EU and National rules, separated into MSP rules and energy rules. The rules are not present on the North Sea level. All laws have been written on the EU and national level.

The outcomes of the actors’ actions are visible in their impact on rules and regulations, the knowledge they developed, the collaborations they have started, the goals they have realized surrounding their environmental impact, and the infrastructure they have built offshore.

The evaluation is split into the goals and the evaluation process. The goals include contributing to the energy transition, decreasing ecological impact, developing more knowledge, creating a better-integrated system, improving safety, and maintaining low costs for energy users. The evaluation process is often done on a project level, and the overall system-level evaluation is lacking. The actors included in the evaluation process are often internal or those that the project was created for or created with. In some cases, external actors were included, or the knowledge was made public for a less biased evaluation; however, this was the minority of the interviews.

5.2 comparison to theory

In order to answer the research question, the results are compared to the eight rules described in Ostrom (2000). Ostrom (2000) describes the rules that successful collective action initiatives tend to adhere to: 1. clear boundary rules, 2. rules on who can use what part of the resource when, where, and how, 3. all affected by the rules should be involved in the making or adjusting of the rules, 4. monitoring must be in place, 5. graduated sanctions, 6. local problem-solving arena, 7. the right to organize, 8. multiple layers of nested enterprises.

The rule that is not being met on any of the levels of governance is monitoring (rule 4). There is no sufficient overview, both because of the lack of knowledge on the total effects due to the lack of data on the natural biophysical conditions and a lack of general evaluation. The lack of precise data on the natural condition is while the OWFs can significantly affect the North Sea ecosystem. Knowledge and information sharing are, according to Van Tatenhove (2017), the backbone of transboundary collaboration. The research by Van Tatenhove (2017) suggests that to realize a legitimate and robust

knowledge base, the data and information system must be harmonized. This matches the research by Ansong et al. (2023), which suggests there should be better knowledge sharing on an international scale, both in formal and informal platforms, to facilitate collaborative learning. The GNSBI aims to exchange ecological knowledge across the North Sea. The research by De Vries et al. (2024) suggests that changes in the socio-ecological system are going faster than researchers can measure, causing uncertainty in the knowledge not to be complete. This uncertainty is not always added to the policy and should be. Dietz et al. (2003) suggest adaptive rules should be in place to handle uncertainty, specifically in the case of low probability and high consequence possibilities. One of these possibilities found in the results of this research is the cumulative impact of offshore wind farms on the water flows and stratification of the ocean with its consequential effects on the ecosystem. The rules in place to govern the resources should be adaptable to the possibility that the installation of offshore wind farms poses a threat to the North Sea ecosystem.

The lack of general evaluation also shows the lack of monitoring (Ostrom, 2000) rule 4. This research did not find any monitoring on the system level. Evaluation mainly happens on the project level. There might be better monitoring in place; however, this did not appear from the gathered data.

The rules that are currently not being met on the North Sea, referring to the GNSBI and NSEC, and EU level is mainly the graduated sanctions (rule 5), since there are no sanctions in place when rules are not being followed, all actors are voluntarily participating. The systems do not have the appropriate graduated sanctions in place to manage the North Sea with all its countries collectively. The inclusion of all countries, thus all affected (rule 3), is complex with Norway and the UK being affected by the EU decisions, despite not being a part of the EU. On the North Sea governance level, the GNSBI is involving all North Sea countries. The NSEC is including Norway, whilst UK involvement is still difficult, due to Brexit. Currently NSEC is just involving ministerial representatives from the different countries involved. There is a lacking involvement of industry actors, NGOs, and other involved parties. However their ambitions do state that stakeholder involvement will occur early on in the decision making, it is still to soon in the process to, the interview showed more involvement is wanted in NSEC. GNSBI at the moment is just involving government actors and research advisors from the different countries. However, GNSBI does state they will actively foster stakeholder engagement and they will set up an event for feedback collection from stakeholders (Greater North Sea Basin Initiative, 2023). How this involvement will look is unknown, it is too early in the development of the GNSBI to analyze. Both GNSBI and NSEC state they would like to foster collaboration between the two different platforms.

On the national level stake holder involvement is well represented by the North Sea Accord. When it comes to collective action the North Sea Accord has clear boundaries (1), set up rules for what is and is not allowed (2), all affected stakeholders are allowed to participate (3). However, the fishers have removed themselves certain times form the North Sea Accord, the results show that their involvement is not only important for them but also the complete social and cultural system connected to them. The research by Stelzenmüller et al. (2022) agrees with the importance of the inclusion of fisheries, linking it to the wider socioecological systems connected to the fishers. the research by Hatenboer et al. (2023) analyzed the difficulties in the North Sea Accord, it showed one of the main reasons a split occurred between the fishers, resulting in not all of them signing the North Sea Accord, was due to a large difference in socioeconomic context within the group of fishers, which contributed to their strategy preferences. The conclusion of Hatenboer et al. (2023) links to the second rule of Ostrom (2000), stating there should be a fair distribution of costs and benefits, these fishers left the North Sea accord, due to a difference in socioeconomic context. Leading to an according to them unfair distribution of costs and benefits. The inclusion of fishers is a difficult one with the clear clash between the use of offshore space for fishing or for the installation of offshore wind. This research also showed

the possible dominance of the offshore wind market in decision making, the research by Spijkerboer et al. (2020), confirms this this by concluding that the quick and efficient rollout of offshore wind is a priority over other sea users, stating that the Dutch MSP system is primarily there to provide legitimacy to implement renewable energy targets and external sustainability discourses.

Another result from this research shows the attributes of the Dutch society might be good for collective action, with their mentality and culture applied in the polder model and their inclination to do business abroad. Their compromising nature and experience with creating collective plans and including the different stakeholders. The trust between government and stakeholders is already there. The last positive finding of the national level of attributes of community is the positive outlook of the Dutch society towards the rollout of offshore wind. According to Watson et al. (2024) this general positive outlook towards the development of offshore wind, appears to be irrespective of the country region or experience with offshore wind farms. Despite this general positive view on the development of offshore wind Skjølsvold et al. (2024) still advocates for more debate spaces and engagement to enable legitimacy, leading to a more just transition. This cultivation of more communication areas aligns with Ostroms (2000) and Dietz et al. (2003) for communication arenas.

Bodin (2017) states that the risk of collective action is no clear common goal rather stakeholders are just there pushing their own agenda, not willing to contribute to the collective. This leads to the rules being a collective of things that want to be achieved that everyone can agree on without any of the decisions being made tackling the issue at hand and effectively managing the resource use. Thus, leading to a fake reality putting the resource in danger. The interviews show that there might be difficulty between the actors' own benefits and the collective benefits leading to inefficient management. The research shows actors are willing to increase collaboration, however it also states the importance of sovereignty. On the EU and North Sea level, every country will try to push for their own agenda, combined with the importance of sovereignty, to not be told what to do on their own land. This puts the collective action at risk for not producing tangible outcomes.

5.3 Limitations and recommended research

This subchapter discusses the research limitations and the recommended research. Starting with the research design, the framework used, the limitations of one country analysis, level of analysis, and sample

This research used a broad research design gathering qualitative data. When regarding the research design both the breadth and the depth of the gathered data are a limitation. Within this research a broad approach was taken, giving a broad overview of the different impacts in each category of the framework, this was a deliberate decision, to be as complete as possible and give the best possible overview. to prove the concept of collective action to govern the north seas energy resources. However, this broad approach did lead to the lack of some nuance and details in the data collection the intricate nuances of all the different interactions were lost. Due to the many different topics addressed in the interviews there was a lack of nuance in the specific answers. For instance, not being able to map out the total stakeholder networks and interactions. For future research a second round of interviews with might be able to provide more details, by asking follow-up questions on the topics highlighted in the first round of interviews.

The IAD framework is limited in its attention to the complexity and diversity of natural systems and processes (Cole et al., 2019). The Socio ecological systems framework by Ostrom and Cox (2010), was developed for this specific reason, and extends the number of contextual variables. For future research an analysis utilizing the SES framework might provide extended insights into the complexities of the contextual factors of the governance of North Sea energy resources according to collective action.

The research is limited in the knowledge on other North Sea countries, since this research only took them into account by proxy of the Dutch stakeholders. By taking a similar research approach and utilizing the IAD framework and a comparable interview guide the differences and similarities between the different countries can be identified, this broadens knowledge base of the collective action for the governance of energy resources on the North Sea. A similar approach can be taken in researching other sea basins, whereas this research solely focuses on the North Sea. Researching the collective action on the Mediterranean Sea or the Baltic Sea would broaden the knowledge base on collective action in European offshore energy.

This research takes an approach that includes all different levels of governance into one large action situation, this limits the research is specificity on the different levels of governance and the specific exogenous variables impacting it. By researching the different levels of action situations on their own by interviewing people within these different layers of governance specifically. This can be done by interviewing different stakeholders working on the European governance level, the North Sea governance level, and the National governance level. This also allows the results to reflect all het interactions in the action arena creating interaction networks, and seeing where the interactions are lacking. This also allows to compare within the layers, such as the representation on the North Sea level and the specifics of the NSEC and GNSBI and how the full decision-making process goes. Such research would also help validate this research.

The research is limited in the number of interviews conducted, when comparing the interviews to the actor overview in Figure 3, NGOs were mentioned by many interviews as an important actor, yet this research only conducted one interview with an NGO. This comparison also shows that the Installation companies and ports were mentioned only by a few actors, showing they are not involved in many action situations, for further research the recommendation is not to focus on these actors, but to put more of a focus on other sea users such as fishing and shipping actors.

6. Conclusion

This research focuses on North Sea energy as a common pool resource, providing insights into the interplay between preserving the ecological system and transforming the socio-technical system to account for the increase in OWFs. The data was gathered by conducting interviews with 14 stakeholders active in developing offshore wind in the Netherlands. The IAD framework helped structure the analysis and allowed for the inclusion of exogenous variables while taking the action situation as the core of the research,

the research identifies multiple cross-boundary challenges. The ecological effects of Dutch offshore windfarms have cross-boundary ecosystem-wide effects, such as bird collisions' impact on bird populations, OWF installation impact on large sea mammals, the impact on the water flows and ocean stratification resulting in the possible impact on the algae growth, the effects of increased benthic habitats, or the OWFs providing a rest area for animals. The wind movements caused by wind farms impact the productivity of other cross-boundary wind farms. For example, the wake effects of Dutch wind farms might influence the productivity of the German and Danish wind farms. The monitoring and data gathering of ecosystem data has to occur ecosystem-wide to get the complete picture of the different populations. The energy from the Dutch wind farms must fit within the European energy grid and the national energy grids, and the same goes for innovations such as hydrogen, offshore solar and wave energy, and battery systems. The international interconnection by installing energy hubs also requires cross-boundary collaboration. On a social level the importance of a European supply chain is a cross boundary challenge. The research answers the following question:

'How do the conditions in the North Sea potentially facilitate collective action for the governance of its energy resources from a Dutch perspective?'

The following conditions impact the opportunities for collective action on the North Sea energy resources: collaboration on a North Sea level, complex cost-benefit allocation, monitoring of resources, and a positive attitude towards collaboration. In this context, collaboration on the North Sea level, through NSEC and GNSBI, facilitates collective action, difficult cost-benefit allocation challenges collective action, the complex monitoring of ecological resources complicates collective action, and the positive attitude towards collaboration provides an opportunity for collective action.

The collaboration on a North Sea level through NSEC and GNSBI poses an opportunity for collective action by providing a platform to communicate and create a common goal and the rules to reach this common goal. Both state that stakeholder inclusion is required, and the NSEC also states that the connection between NSEC and GNSBI is important. However, NSEC and GNSBI are relatively new and have not yet established clear rules, stakeholder inclusion, or a good connection between the two platforms. There can not yet be a conclusion on their effectiveness in reaching collective action.

The North Sea Accord shows the complex cost-benefit allocation. Despite the efforts for good stakeholder involvement, according to the fishers, unjust cost-benefit allocation still provided difficulties in them signing the accord. In order to involve all stakeholders in collective action, a just allocation of costs and benefits is required. A just allocation involves considering the differences and nuances of stakeholder groups.

The research shows that monitoring natural resources is challenging due to the lack of data on the impact of OWFs on their environment and the unknown cumulative effects. This complex monitoring challenges collective action, and a lack of general evaluation further impacts this. A focus should be on gathering data to allow for better management of the common pool resource to prevent the depletion of ecological resources. Adaptive rules that can adapt to emerging knowledge should be in place to allow emerging information to adjust the rules.

The general positive attitude towards collaboration is an opportunity for collective action. All interviews showed a positive attitude towards an increase in collaboration. However, the research also shows that national goals and sovereignty are important. This emphasis on national goals, combined with the lack of tangible outcomes at this time, form the North Sea level collaborations, the large increase in offshore wind development happening over the coming years, the long planning tendering and permitting process required for offshore wind, might be too little too late. This might be the case if the actors fail to contribute to the collective goals by stakeholders merely defending their national or personal goals over the collective ambitions or by putting too little emphasis on the tough decisions and just going over the easy tasks. In that case, the results might not yield tangible results but rather just a list of desires.

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References

Anderies, J. M., Janssen, M. A., & Ostrom, E. (2004). A Framework to Analyze the Robustness of Social-ecological Systems from an Institutional Perspective. *Ecology and Society*, *9*(1). https://doi.org/10.5751/es-00610-090118

Ansong, J. O., Ritchie, H., Gee, K., McElduff, L., & Zaucha, J. (2022). Pathways towards integrated cross-border marine spatial planning (MSP): insights from Germany, Poland and the island of Ireland. *European Planning Studies*, *31*(12), 2446–2469. https://doi.org/10.1080/09654313.2022.2154597

Apesteguia, J., & Maier-Rigaud, F. P. (2006). The Role of Rivalry: Public Goods versus Common-Pool Resources on JSTOR. *The Journal of Conflict Resolution*, *50*(5), 646–663. http://www.jstor.org/stable/27638515

Bødal, E. F., Holm, S., Subramanian, A., Durakovic, G., Pinel, D., Hellemo, L., Ortiz, M. M., Knudsen, B. R., & Straus, J. (2024). Hydrogen for harvesting the potential of offshore wind: A North Sea case study. *Applied Energy*, *357*, 122484. https://doi.org/10.1016/j.apenergy.2023.122484

Bodin, Ö. (2017). Collaborative environmental governance: Achieving collective action in social-ecological systems. *Science*, *357*(6352). https://doi.org/10.1126/science.aan1114

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Bryman, A. (2012). Social Research Methods. Oxford University Press

Cole, D. H., Epstein, G., & McGinnis, M. R. (2019). The Utility of Combining the IAD and SES Frameworks. *The International Journal of the Commons*, *13*(1), 244. https://doi.org/10.18352/ijc.864

De Vries, J., Spijkerboer, R., & Zuidema, C. (2024). Making knowledge matter: Understanding and improving knowledge-integration in Dutch marine spatial planning policy. *Ocean & Coastal Management*, *248*, 106928. https://doi.org/10.1016/j.ocecoaman.2023.106928

Dietz, T., Ostrom, E., & Stern, P. C. (2003). The struggle to govern the Commons. *Science*, *302*(5652), 1907–1912. https://doi.org/10.1126/science.1091015

Directorate-General for Energy. (2023a, January 19). *Member States agree new ambition for expanding offshore renewable energy*. European Commission. Retrieved May 12, 2023, from https://energy.ec.europa.eu/news/member-states-agree-new-ambition-expanding-offshore-renewable-energy-2023-01-19_en

Directorate-General for Energy. (2023b, January 19). *Non-binding agreement on goals for offshore renewable generation in 2050 with intermediate steps in 2040 and 2030 for priority offshore grid corridor Northern Seas offshore grids (NSOG) pursuant to Article 14(1) of the TEN-E Regulation (EU) 2022/869* [Press release]. https://energy.ec.europa.eu/system/files/2023-01/NSOG_non-binding_offshore_goals_final.pdf

Eslamizadeh, S., Ghorbani, A., Künneke, R., & Weijnen, M. (2020). Can industries be parties in collective action? Community energy in an Iranian industrial zone. *Energy Research and Social Science*, *70*, 101763. https://doi.org/10.1016/j.erss.2020.101763

European Commission. (n.d.). *The North Seas Energy Cooperation*. European Commission. Retrieved January 29, 2024, from https://energy.ec.europa.eu/topics/infrastructure/high-level-groups/north-seas-energy-cooperation_en#nsec-members

European Commission Energy Directive. (n.d.). *Renewable energy targets*. European Commission. Retrieved May 11, 2023, from https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-targets_en#:~:text=The%20REPowerEU%20plan%20is%20based,directive%20to%2045%25%20by%202030.

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development. *International Journal of Qualitative Methods*, *5*(1), 80–92. https://doi.org/10.1177/160940690600500107

Greater North Sea Basin Initiative. (2023, November 21). Greater North Sea Basin Initiative Ministerial conclusions. *government.nl*. https://www.government.nl/binaries/government/documenten/discussion-documents/2023/11/21/greater-north-sea-basin-initiative---ministerial-conclusions/Greater+North+Sea+Basin+Initiative+-+Ministerial+conclusions.pdf

Guterres, A. (2022, November 7). *Secretary-General's remarks to High-Level opening of COP27*. United Nations Secretary General. Retrieved May 11, 2023, from https://www.un.org/sg/en/content/sg/speeches/2022-11-07/secretary-generals-remarks-high-level-opening-of-cop27#:~:text=Ant%C3%B3nio%20Guterres,crucial%20decade%20%E2%80%93%20on%20our%20watch.

Hardin, G. (1968). The Tragedy of the Commons. *Science*, *162*(3859), 1243–1248. https://doi.org/10.1126/science.162.3859.1243

Hatenboer, C., Van Den Berg, C. F., & Holzhacker, R. (2023). The Dutch fisheries sector and the North Sea Accord: Unpacking stakeholder participation in multi-levelled marine governance. *Marine Policy*, *147*, 105364. https://doi.org/10.1016/j.marpol.2022.105364

IEA. (2023, February). *ASEAN International collaborations*. Retrieved May 29, 2023, from https://www.iea.org/about/international-collaborations/asean

Jahan, S., & Mahmud, A. S. (2018, May 10). *What is capitalism?* IMF. https://www.imf.org/en/Publications/fandd/issues/Series/Back-to-Basics/Capitalism

Jay, S. J., Alves, F. L., O'Mahony, C., Gómez, M. J., Rooney, A., Almodovar, M., Gee, K., De Vivero, J. L. S., Gonçalves, J. M. S., Da Luz Fernandes, M., Tello, O., Twomey, S., Prado, I., Fonseca, C., Bentes, L., Henriques, G., & De Campos, A. S. (2016). Transboundary dimensions of marine spatial planning: Fostering inter-jurisdictional relations and governance. *Marine Policy*, *65*, 85–96. https://doi.org/10.1016/j.marpol.2015.12.025

Kirkfeldt, T. S., & Andersen, J. H. (2021). Assessment of collective pressure in marine spatial planning: The current approach of EU Member States. *Ocean & Coastal Management*, *203*, 105448. https://doi.org/10.1016/j.ocecoaman.2020.105448

LeCompte, M. D., & Goetz, J. P. (1982). Problems of Reliability and Validity in Ethnographic Research. Review of Educational Research, 52(1), 31–60. https://doi.org/10.3102/00346543052001031

Lestari, H., Arentsen, M. J., Bressers, H., Gunawan, B., Iskandar, J., & Parikesit. (2018). Sustainability of Renewable Off-Grid Technology for Rural Electrification: A Comparative Study Using the IAD Framework. *Sustainability*, *10*(12), 4512. https://doi.org/10.3390/su10124512

Li, S., & Jay, S. J. (2023). Addressing transboundary challenges: Exploring the interactive relations between collaborative governance and transboundary marine spatial planning in Europe. *Marine Policy*, *158*, 105880. https://doi.org/10.1016/j.marpol.2023.105880

Lubell, M. (2013). Governing Institutional Complexity: The Ecology of Games Framework. *Policy Studies Journal*, *41*(3), 537–559. https://doi.org/10.1111/psj.12028

Macquart, T., Kucukbahar, D., & Prinsen, B. (2023). Dutch Offshore Wind Market Report 2023. In *RVO.nl*. Netherlands Enterprise Agency. Retrieved July 7, 2023, from https://www.rvo.nl/sites/default/files/2023-04/Offshore-Wind-Market-Report.pdf

McGinnis, M. D. (2010). "Building A Program for Institutional Analysis of Social-Ecological Systems:A Review of Revisions to the SES Framework. *Working Paper, Workshop in Political Theory andPolicy Analysis, Indiana University.* Retrieved July 14, 2023, from https://mcginnis.pages.iu.edu/buildingpiases.pdf

McGinnis, M. R. (2011). An Introduction to IAD and the Language of the Ostrom Workshop: A Simple Guide to a Complex Framework. *Policy Studies Journal*, *39*(1), 169–183. https://doi.org/10.1111/j.1541-0072.2010.00401.x

Milchram, C., Märker, C., & Hake, J. (2019). The role of values in analyzing energy systems: Insights from moral philosophy, institutional economics, and sociology. *Energy Procedia*, *158*, 3741–3747. https://doi.org/10.1016/j.egypro.2019.01.882

Ministerie van Algemene Zaken. (n.d.). *Offshore wind energy*. Renewable Energy | Government.nl. Retrieved May 8, 2023, from https://www.government.nl/topics/renewable-energy/offshore-wind-energy

Ministerie van Economische Zaken en Klimaat. (2020, December 15). *North Sea Energy Outlook establishes framework conditions for future growth of offshore wind energy*. News Item | Government.nl. https://www.government.nl/latest/news/2020/12/04/north-sea-energy-outlook-establishes-framework-conditions-for-future-growth-of-offshore-wind-energy

Mohammadi, N. (2023). Investigation of Community Energy Business Models from an Institutional Perspective: Intermediaries and Policy Instruments in Selected Cases of Developing and Developed Countries. *Sustainability*, *15*(10), 8423. https://doi.org/10.3390/su15108423

Moodie, J., & Sielker, F. (2021). Transboundary Marine Spatial Planning in European Sea Basins: Experimenting with Collaborative Planning and Governance. *Planning Practice and Research*, *37*(3), 317–332. https://doi.org/10.1080/02697459.2021.2015855

Netherlands Enterprise Agency. (2022). Dutch Offshore Wind Guide: Your guide to Dutch offshore wind policy, technologies and innovations. In Windandwaterworks.nl. Retrieved February 15, 2024, from https://www.rvo.nl/sites/default/files/2021/10/Dutch%20Offshore%20Wind%20Guide%202022.pdf

Nogueira, L. A., Wigger, K. A., & Jolly, S. (2021). Common-pool resources and governance in sustainability transitions. *Environmental Innovation and Societal Transitions*, *41*, 35–38. https://doi.org/10.1016/j.eist.2021.10.004

Noordzeeloket. (n.d.). *Europese kaderrichtlijn mariene strategie*. Retrieved January 16, 2024, from https://www.noordzeeloket.nl/beleid/mariene-strategie-krm/

Noordzeeloket. (2023, February 23). *OpenEarth Viewer*. Informatie Huis Marien. Retrieved February 15, 2024, from https://viewer.openearth.nl/ihm-viewer/?layers=&layerNames=&folders=85223016%2C85223022%2C146612551

Noordzeeoverleg. (n.d.). *Noordzeeoverleg*. Retrieved December 22, 2023, from https://www.noordzeeoverleg.nl/default.aspx

North Sea Wind Power Hub. (2022). *Governance Models for Hub-and-Spoke Projects* (1.19-0001-NLDE-S-M–20). Retrieved June 28, 2023, from https://northseawindpowerhub.eu/files/media/document/NSWPH_Regulatory%20%26%20market%20design_Discussion%20paper%20%231_28.10.2022.pdf

North Seas Energy Cooperation. (2023, November 20). *North Seas Energy Cooperation Action Agenda 2023-2024* [Press release]. https://energy.ec.europa.eu/system/files/2023-11/Actie%20agenda%20DEF.pdf

Ostrom, E. (1990). Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press, Cambridge, 298 pp. https://doi.org/10.1017/CBO9780511807763

Ostrom, E. (1999). Design Principles and Threats to Sustainable Organizations that Manage Commons. *Workshop in Political Theory and Policy Analysis*. https://dlc.dlib.indiana.edu/dlc/handle/10535/5465

Ostrom, E. (2000). Collective action and the evolution of social norms. *Journal of Economic Perspectives*, *14*(3), 137–158. https://doi.org/10.1257/jep.14.3.137

Ostrom, E. (2005). *Understanding Institutional Diversity*. Princeton University Press.

Ostrom, E. (2010). Beyond Markets and States: Polycentric Governance of Complex Economic Systems on JSTOR. *The American Economic Review*, *100*(3), 641–672. https://www.jstor.org/stable/27871226?seq=5

Ostrom, E. (2011). Background on the Institutional Analysis and Development Framework. *Policy Studies Journal*, *39*(1), 7–27. https://doi.org/10.1111/j.1541-0072.2010.00394.x

Ostrom, E. (2013). Do institutions for collective action evolve? *Journal of Bioeconomics*, *16*(1), 3–30. https://doi.org/10.1007/s10818-013-9154-8

Ostrom, E., & Cox, M. (2010). Moving beyond panaceas: a multi-tiered diagnostic approach for social-ecological analysis. *Environmental Conservation*, *37*(4), 451–463. https://doi.org/10.1017/s0376892910000834

Pavlowsky, C., Koch, J., & Gliedt, T. (2023). Place attachment and social barriers to large-scale renewable energy development: a social–ecological systems analysis of a failed wind energy project in the south-central United States. *Socio-Ecological Practice Research*. https://doi.org/10.1007/s42532-023-00142-0

Planete Energies. (2022, April 25). *Energy Consumption and CO2 Emissions in Europe and Worldwide*. Retrieved July 4, 2023, from https://www.planete-energies.com/en/media/article/energy-consumption-and-co2-emissions-europe-and-worldwide#:~:text=The%2027%20countries%20of%20the,as%20much%20as%20the%20EU.

Queirós, A., Faria, D., & Almeida, F. (2017). STRENGTHS AND LIMITATIONS OF QUALITATIVE AND QUANTITATIVE RESEARCH METHODS. *European Journal of Education Studies*, *3*(9). https://10.5281/zenodo.887089

RVO. (2023a, May 22). *Plans 2030-2050*. Retrieved July 7, 2023, from https://english.rvo.nl/information/offshore-wind-energy/offshore-wind-energy-plans-2030-2050#:~:text=In%202022%2C%20the%20Government%20raised,of%20our%20current%20electricity%20consumption.

RVO. (2023b, September 20). *Wet- en regelgeving windenergie op zee*. RVO.nl. Retrieved January 16, 2024, from https://www.rvo.nl/onderwerpen/windenergie-op-zee/wet-en-regelgeving

Schlager, E., & Cox, M. (2018). *Theories of the Policy Process, The IAD Framework and the SES Framework: An Introduction and Assessment of the Ostrom Workshop Frameworks* (4th ed.). https://www.taylorfrancis.com/chapters/edit/10.4324/9780429494284-7/iad-framework-ses-framework-introduction-assessment-ostrom-workshop-frameworks-edella-schlager-michael-cox

Skjølsvold, T. M., Heidenreich, S., Henriksen, I. M., Oliveira, R. V., Dankel, D. J., Lahuerta, J., Linnerud, K., Moe, E., Nygaard, B., Richter, I., Skjærseth, J. B., Subotički, I., & Vasstrøm, M. (2024). Conditions for just offshore wind energy: Addressing the societal challenges of the North Sea wind industry. *Energy Research & Social Science*, *107*, 103334. https://doi.org/10.1016/j.erss.2023.103334

Spijkerboer, R., Zuidema, C., Busscher, T., & Arts, J. (2020). The performance of marine spatial planning in coordinating offshore wind energy with other sea-uses: The case of the Dutch North Sea. *Marine Policy*, *115*, 103860. https://doi.org/10.1016/j.marpol.2020.103860

Steenbergen, J., Trapman, B., Steins, N. A., & Poos, J. J. (2017). The commons tragedy in the North Sea brown shrimp fishery: how horizontal institutional interactions inhibit a self-governance structure. *Ices Journal of Marine Science*, *74*(7), 2004–2011. https://doi.org/10.1093/icesjms/fsx053

Steins, N. A., Veraart, J., Klostermann, J., & Poelman, M. (2021). Combining offshore wind farms, nature conservation and seafood: Lessons from a Dutch community of practice. *Marine Policy*, *126*, 104371. https://doi.org/10.1016/j.marpol.2020.104371

Stelzenmüller, V., Letschert, J., Gimpel, A., Kraan, C., Probst, W., Degraer, S., & Döring, R. (2022). From plate to plug: The impact of offshore renewables on European fisheries and the role of marine spatial planning. *Renewable & Sustainable Energy Reviews*, *158*, 112108. https://doi.org/10.1016/j.rser.2022.112108

Swain, J. (2018). A Hybrid Approach to Thematic Analysis in Qualitative Research: Using a Practical Example. Sage Research Methods. https://doi.org/10.4135/9781526435477

Tafon, R. V., Saunders, F., Pikner, T., & Gilek, M. (2023). Multispecies blue justice and energy transition conflict: examining challenges and possibilities for synergy between low-carbon energy and justice for humans and nonhuman nature. *Maritime Studies*, *22*(4). https://doi.org/10.1007/s40152-023-00336-y

The Caribbean Climate-Smart Accelerator. (2022). Caribbean Coalition to Benefit from International Energy Partnership. *Caribbean Climate-Smart Accelerator*. https://www.caribbeanaccelerator.org/caribbean-climate-smart-accelerator-joins-international-energy-partnership/

UNEP - UN Environment Programme. (n.d.). *Why does energy matter?* Retrieved May 11, 2023, from https://www.unep.org/explore-topics/energy/why-does-energy-matter#:~:text=Energy%20drives%20economies%20and%20sustains,emissions%20attributed%20to%20human%20activity.

UNFCCC - The United Nations Framework Convention on Climate Change. (n.d.). *The Paris Agreement*. United Nations Climate Change. Retrieved May 11, 2023, from https://unfccc.int/process-and-meetings/the-paris-agreement

Van Tatenhove, J. (2017). Transboundary marine spatial planning: a reflexive marine governance experiment? *Journal of Environmental Policy & Planning*, *19*(6), 783–794. https://doi.org/10.1080/1523908x.2017.1292120

Von Der Leyen, U. (2022, May 18). *Statement by President von der Leyen at the Leaders' Summit on offshore wind in the North Sea*. European Commission. Retrieved May 11, 2023, from https://ec.europa.eu/commission/presscorner/detail/en/statement_22_3162

Warbroek, B., Holmatov, B., Kruijf, J. V., Arentsen, M., Shakeri, M., De Boer, C., Flacke, J., & Dorée, A. (2022). From sectoral to integrative action situations: an institutional perspective on the energy transition implementation in the Netherlands. *Sustainability Science*, *18*(1), 97–114. https://doi.org/10.1007/s11625-022-01272-2

Watson, S. C., Somerfield, P. J., Lemasson, A. J., Knights, A. M., Edwards-Jones, A., Nunes, J., Pascoe, C., McNeill, C. L., Schratzberger, M., Thompson, M. S. A., Couce, E., Szostek, C. L., Baxter, H., & Beaumont, N. (2024). The global impact of offshore wind farms on ecosystem services. *Ocean & Coastal Management*, *249*, 107023. https://doi.org/10.1016/j.ocecoaman.2024.107023

Wiegner, J. F., Andreasson, L. M., Kusters, J., & Nienhuis, R. (2024). Interdisciplinary perspectives on offshore energy system integration in the North Sea: A systematic literature review. *Renewable & Sustainable Energy Reviews*, *189*, 113970. https://doi.org/10.1016/j.rser.2023.113970

WindEurope. (2023). *Wind energy in Europe 2022 Statistics and the outlook for 2023-2027*. Retrieved July 4, 2023, from https://windeurope.org/intelligence-platform/product/wind-energy-in-europe-2022-statistics-and-the-outlook-for-2023-2027/#:~:text=Findings,-1&text=In%202022%20new%20wind%20installations,onshore%20and%202.5%20GW%20offshore).

Zaucha, J., & Gee, K. (2019). *Maritime Spatial planning: past, present, future*. Palgrave Macmillan. https://library.oapen.org/bitstream/handle/20.500.12657/22921/1/1007240.pdf#page=227

Appendix A: Interview guide

The interview guide used during the interviews is listed in this appendix. First gaining some background information, going into the action situation, the different exogenous conditions, biophysical conditions, attributes of the community, and rules in use. Furthermore the outcomes and evaluation are discussed and lastly there are final questions.

Background data:

	Question aim	**Question**	**Follow-up**
1.1	Background information	Could you give a little background on yourself and the company you work at, and your position within your company?	
1.2	Company role on the North Sea	What is your companies/institute's role on the North Sea related to energy?	Wind energy specifically?
1.3	Personal role on the North Sea	What is your job within this?	How are you involved in offshore wind energy? (for reserachers what research in the past and current)

Action situation:

	Question aim	**Question**	**Follow-up**
2.1	Impacting outcomes	What decisions and decision-making processes are you involved in as a company in the Dutch North Sea offshore wind development?	Differently said what is decided upon in these action situations? What outcomes are impacted in what way? What is in your power to change?
2.2	Missing involvement	what decision making processes would you like to be involved in?	Focusing on general outcomes they would like to impact in the different phases of the decision-making processes?
2.3	Actors	Who is involved in these decision-making processes?	
2.4	Missing actors	Are there people missing from these decision-making processes?	Why what do you think could add?
2.5	Position	What position or role do you have in this decision-making process?	What is your company's role? Any patterns in what always occurs?
2.6	Position changes	What would you change, if anything, about the different roles in the decision-making processes?	Any one institution or company About your own role or someone else's role?
2.7	*offshore spatial planning*	*What do you think of the current offshore spatial planning process in the Netherlands?*	*Would you change anything? Think about shipping routes, nature reserves, offshore energy, both fossil and renewable.*

Biophysical conditions:

	Question aim	Question	Follow-up
3.1	Technological limitations and opportunities	What do you view as a T**echnological** limitation or opportunity for the development of offshore wind? Any specific technologies name two?	Any of these specific to the collaboration and international collaboration? any specific technologies, or innovations, capabilities, human and technological capacities? Or large differences in technologies that might limit it? Any technologies you would focus on or avoid for collaboration? EXAMPLES: Connecting cables, energy islands, digital innovations, base structure, windmills,
3.2	Natural limitations and opportunities	What do you view as the important Environmental factors impact the development of offshore wind energy?	Any specific opportunities or limitations? Examples of natural factors: abiotic: Seabed, wind factors, sea depth. Biotic: fish, birds, mollusks.
3.3	Changes to adapt to natural conditions	What would you change to better adapt to the natural conditions? Or make better use of them?	

Attributes of community:

	Question aim	Question	Follow-up
4.1	National Social/ cultural context	What Dutch Social/ cultural factors that are important when it comes the development of offshore wind? opportunities that allow for good national collaboration? or might inhibit this national collaboration?	Certain attitudes, communication styles, cultural value of fisheries that might inhibit expansion. Cultural differences between different actors and locations.
4.2	**internationa**l Social/ cultural context	What international Social/ cultural factors impact the collaboration? Or social aspects that inhibit this international collaboration	Do you experience more complexities with international collaborations? What would they be? Or do you think there is very close cultures and communication styles? Specifically: Brexit , the EU, Attitudes communication, distances, language problems, corruption, values
4.3	Industry wide adaptation to social cultural context	What would you change in the approach in dealing with the social and cultural context within the	Anything you or your company could change to better deal with this?

		interactions you have experienced?	

Rules-in-use:

	Question aim	Question	Follow-up
5.1	Rules	What are important regulations rules or policies in the development of offshore energy, could you name 3?	Also think about investments subsidies tender procedures etc. do not have to be specific laws. why these? any ones noteworthy but still missing from your 3 examples?
5.2	Changes to rules	What would you change to the current Regulations? And why?	

Outcomes:

	Question aim	Question	Follow-up
6.1	Current outcome	What have you achieved on the North Sea energy system so far?	Does this match the intended outcome why not or why does it?
6.2	Future ambitions	What do you predict your company will be doing in a couple of years on the North Sea?	

Evaluative criteria:

	Question aim	Question	Follow-up
7.1	goal	what is it your company is aiming for on the North Sea?	What is your goal
7.2	Project evaluation	How do you evaluate your projects on the North Sea wind energy?	Any specific KPI's? what do you evaluate on what level? Who is involved in the evaluation process? what is done with this evaluation within the project or after the projects?
7.3	Evaluation changes	What would you change to the evaluation?	Why and how?

Final questions :

	Question aim	Question	Follow-up
8.1	Collective action view	What do you think of collective action on the North Sea?	Pros and cons? do you see it happening? If not, what do you think is the correct governance system?
8.2	Final remarks	Do you have any final remarks? Things you want to say on the subject	
8.3	Interview improvement	Do you have anything that you thought was good or bad any specifics that you were missing?	
8.4	Other interviewees	Do you have any other people I might need to talk to?	
8.5	Transcript	Do you want to see the full transcript after it is finished?	
8.6	Extra questions	If during the research, I realize certain questions are missing is it okay to contact you for a short written answer?	
8.7	Receiving research	Would you like to receive the research afterwards?	

Appendix B: Overview of all actors

This appendix contains the total list of actors mentioned throughout the interviews as shown in Table 3, these are all the actors active on the North Sea active or impacted by offshore wind.

Table 3: Actor overview and their corresponding roles

A. Knowledge actors			
Nr.	Actor:	Interview Nr.	Role on North Sea
A.1	Researchers (universities) *	3, 7, 9, 11,12, 13, 14,	Fundamental and applied research
A.2	Knowledge institute TO2	3, 4, 9, 12,13	Researching for governments and industry, on issues with a high complexity.
A.3	Consultancy	1, 6, 12	Researching and consulting governments and industry,
A.4	Innovation actors	2, 4, 9, 11	Coordinating and researching different innovations, from a non-commercial point of view
B. National government actors			
Nr.	Actor:	Interview Nr.	Role on North Sea
B.1	Ministry of Infrastructure and Water Management	1, 4, 7, 12	Ministry responsible for the MSP and use of the offshore area
B.2	Rijkswaterstaat	2, 4, 7	Executive body of the ministry of I & W.
B.3	Ministry of Economic Affairs and Climate Policy	1, 5, 4, 6, 8, 9	In charge of the energy developments.
B.4	The Netherlands Enterprise Agency	1, 2, 4, 6, 8, 9	Executive body of the ministry of EACP, in charge of writing out tenders both to do the research as well as the building of the wind farms, providing public information, giving out subsidies, providing permits
B.5	Ministry of Defence	11, 13, 14	Defense practice areas and national safety
B.6	Ministry of Agriculture, Nature and Food Quality	4, 12	The food provision in the offshore area also through fishers and offshore farming
B.7	Ministry of Finance	4	Financing of projects
B.8	State Supervision of Mines	4	Safety regulations and checks
B.9	Authority for Consumers and Markets	14	Checking the financial status and workings of for instance Tennet, state owned corporations.
C. NGOs			
Nr.	Actor:	Interview Nr.	Role on North Sea
C.1	Environmental NGO's	1, 3, 4, 6, 10, 11, 13, 14	Representing the environment
D. State owned cooperations			
Nr.	Actor:	Interview Nr.	Role on North Sea
D.1	Tennet	1, 2, 3, 4, 5, 6, 14	Transmission system operator, responsible for Dutch, and part of Germany's, high voltage electricity grid, this includes the offshore grid.

D.2	Gasunie	6, 14	Gas transmission system operator, responsible for the Dutch gas supply. Might have a role in offshore hydrogen not clear yet though
D.3	EBN (energie beheer nederland)	2,3	Investment actor to speed up the energy transition
E. Industry actors			
Nr.	Actor:	Interview Nr.	Role on Northsea
E.1	NWEA (Dutch market Industry association)	3, 4, 10, 14	Dutch industry association, representing different actors from across the whole wind energy value chain in the Netherlands.
E.2	Wind Europe	4, 10, 14	European advocacy group, representing different actors from across the whole wind energy value chain in Europe.
E.3	Developers	1, 3, 4, 8, 14	Investing in the offshore wind, writing tenders and developing new offshore wind farms
E.4	Installation companies	4, 12, 13	Installation contractor, providing ships and installation plans.
E.5	Producers	4,8	Producing parts for the use in offshore wind farms, this can be turbines foundations, cables and others
E.6	Upcoming technologies	4, 5, 9, 11, 13	Including startups and other small innovative firms
E.7	Ports	8, 12	Landing ports for the installation and maintenance of offshore wind farms
E.8	Coastguard	4, 14	Monitoring vessels around the wind farms, preforming rescue missions.
F. Other			
Nr.	Actor:	Interview Nr.	Role on North Sea
F.1	Fishery	3, 8, 11, 13, 14,	Using the area for food production, either by underwater farming or open water fishing.
F.2	Local communities	6	
F.3	Shipping	3, 4, 8, 12, 13, 14	Utilizing shipping routes for transporting goods
F.4	Sand extraction	12,13	Extracting sand
F.5	Oil and gas	3, 4, 11	Pumping oil and gas on the North Sea
F.6	Recreational use	9	Human recreational use
F.7	Mining	13	Extracting minerals
	Education	11	Educating the workforce active in the development installation and maintenance of offshore wind
G. International governments			
Nr.	Actor:	Interview Nr.	Role on North Sea
G.1	European Union	1, 6, 12	Regulator on EU level
G.2	United Kingdom	3, 5,14	Regulator on UK level
G.3	Norway	5, 14	Norwegian regulator