North Sea Energy
offshore system integration

Social embedding of North Sea energy system integration

A stakeholder analysis

November 2021

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Social embedding of North Sea energy system integration – a stakeholder analysis

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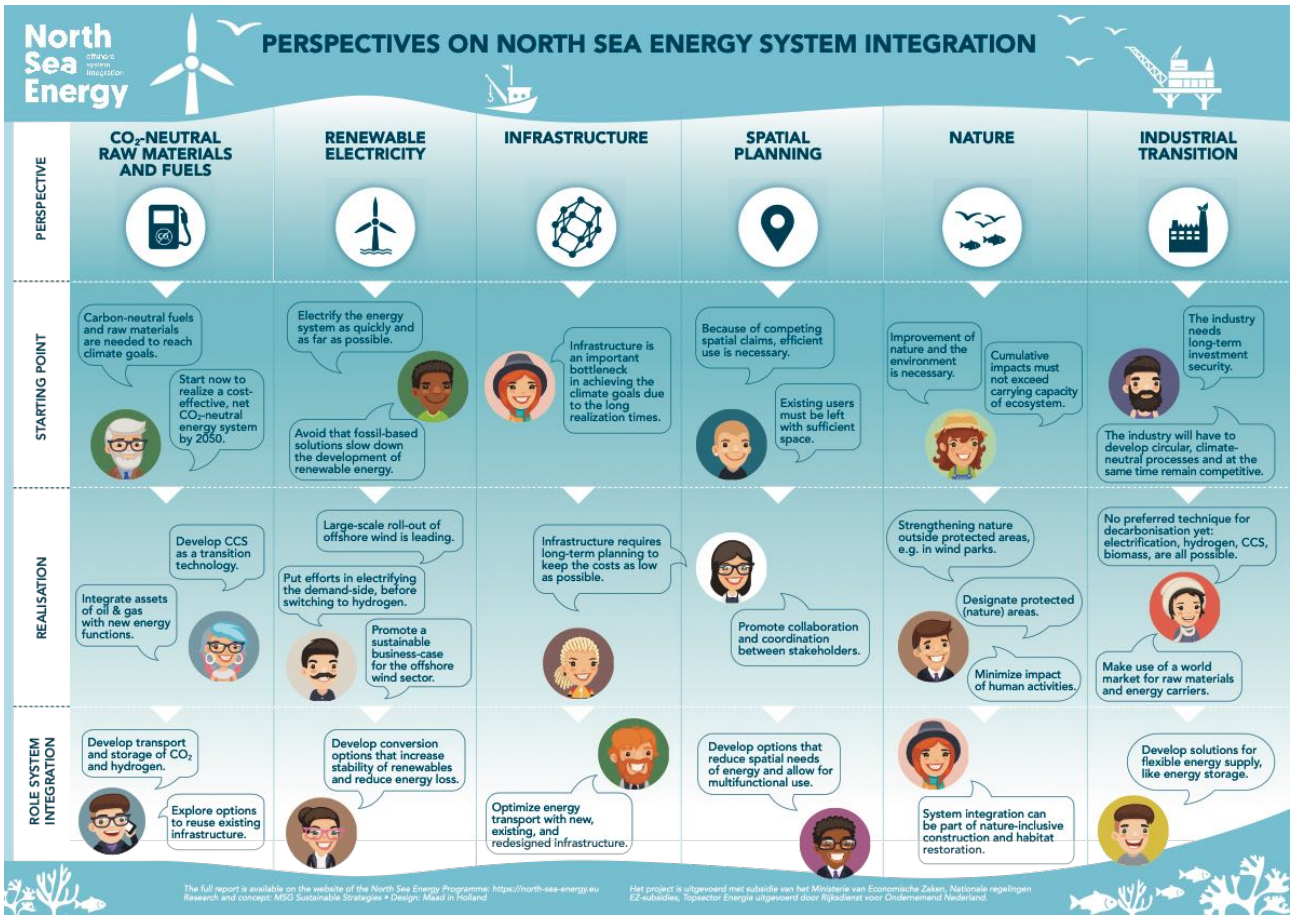
Executive summary

The North Sea has the potential to play a pivotal role in the energy transition of the surrounding countries. The North Sea Energy programme (NSE) researches how the North Sea's potential can be utilized for a climate-neutral energy system, using an integrated approach. The North Sea is a busy area with important ecological, societal, and economic functions to a wide range of stakeholders. The support or resistance of these stakeholders can be an important stimulus or barrier to system integration. As part of Work Package 2, this stakeholder analysis reports on views, concerns, needs and benefits of Dutch stakeholders related to North Sea system integration and specific integration options (reuse, CCS and hydrogen in particular).

Based on sessions with NSE partners, interviews with stakeholders and desk research, this study reports on North Sea stakeholders in three parts. First, it provides a fact sheet for each of the major stakeholder groups (see 3.1), detailing their key interests, needs and concerns, views on system integration options and information needs. Second, it provides an overview of six common perspectives on offshore energy system integration (see 3.2). This aids in understanding the background and motivation of stakeholders that lead to different positions on system integration. Finally, it provides stakeholder aspects that are relevant for the three hubs studied as part of NSE (see 3.3).

Overall, the stakeholder views show common ground regarding the need for large-scale offshore wind, the need to reduce spatial pressure and the importance of common knowledge base. Disputed topics are the need for national self-sufficiency, the importance of (especially blue) hydrogen, the societal value of reuse and the relevance of CCS to system integration.

Engaging the relevant stakeholders will be key to unlocking the energy potential of the North Sea. We recommend first to incorporate the research needs that were expressed by the stakeholders into current and future research programmes (see 5.1). Secondly, we recommend that a vision-based roadmap for energy system integration – which is part of WP7 - should seek to incorporate the different perspectives on North Sea energy.



Managementsamenvatting

De Noordzee heeft het potentieel om een cruciale rol te spelen in de energietransitie van de aangrenzende landen. Het North Sea Energy-programma (NSE) onderzoekt hoe het potentieel van de Noordzee benut kan worden voor een klimaatneutraal energiesysteem, met behulp van een geïntegreerde aanpak. De Noordzee is een druk gebied met belangrijke ecologische, maatschappelijke en economische functies voor veel verschillende stakeholders. De steun of weerstand van deze stakeholders kan een belangrijke stimulans of barrière zijn voor systeemintegratie. Als onderdeel van Werkpakket 2 beschrijft deze stakeholderanalyse de perspectieven, zorgen, behoeften en voordelen van en voor Nederlandse stakeholders gerelateerd aan systeemintegratie op de Noordzee en specifieke integratieopties (met nadruk op hergebruik, CCS en waterstof).

Op basis van sessies met NSE-partners, interviews met stakeholders en literatuuronderzoek bespreekt dit rapport de stakeholders op de Noordzee in drie delen. Als eerste beschrijft het de belangrijkste stakeholdergroepen in fact sheets die hun belangen, behoeften en zorgen, hun blik op systeemintegratieopties en hun informatiebehoeften beschrijven (zie 3.1). Ten tweede geeft het een overzicht van zes veel voorkomende perspectieven op energiesysteemintegratie op zee (zie 3.2). Dit helpt om de achtergrond en motivaties van stakeholders te begrijpen, die op hun beurt tot verschillende standpunten over systeemintegratie leiden. Tot slot beschrijft het de specifieke stakeholderaspecten die relevant zijn voor de drie hubs die als onderdeel van NSE bestudeerd worden (zie 3.3).

De opvattingen van de stakeholders overlappen als het gaat om de behoefte aan grootschalige ontwikkeling van wind op zee, de noodzaak om ruimtelijke druk te verminderen en het belang van een gedeelde kennisbasis. De meningen verschillen over de noodzaak van nationale zelfvoorzienendheid, het belang van (met name blauwe) waterstof, de maatschappelijke waarde van hergebruik en het belang van CCS voor systeemintegratie.

Het betrekken van de relevante stakeholders is cruciaal voor het ontsluiten van het energiepotentieel van de Noordzee. We adviseren allereerst om de onderzoeksvragen en -behoeften die de stakeholders naar voren brachten een plek te geven in huidige en toekomstige onderzoeksprogramma's (zie 5.1). Daarnaast adviseren we dat een visiegebaseerde routekaart voor energiesysteemintegratie – die onderdeel is van Werkpakket 7 – de verschillende perspectieven energie van op Noordzee zou moeten integreren.

1 Introduction

1.1 Background

The North Sea Energy programme researches how the North Sea's potential can be utilized for a climate-neutral energy system, using an integrated approach. The programme is investigating the benefits of smart linkages between the various energy functions in the North Sea. These benefits will save society money and time, enable us to use space effectively and considerably reduce carbon emissions.

Implementation of new technologies for a climate-neutral energy system in the North Sea – such as, offshore wind energy; CO_2 transport and storage; offshore hydrogen production, transport, and storage; and energy hubs or islands – requires insight into the socio-technical framework that exists for these technologies. This report presents the results of a stakeholder analysis that will aid in understanding the societal aspects of energy system integration on the North Sea.

1.2 Objectives

- Improve understanding of stakeholders' views on North Sea system integration and specific integration options.
- Identify various stakeholders' concerns and needs for information and further research with respect to system integration.
- Identify potential benefits of system integration that might drive support from key stakeholders.
- Outline a strategy and action plan for stakeholder engagement around Hubs (WP1) and Roadmap (WP7).

1.3 Scope

Geographical	The Netherlands with some consideration of wider North Sea area. Special considerations for three specific hub locations are also provided. These hub locations (West, East, and North) are described in WP1.
Technology	Focus will be on the following offshore energy system integration options: CCS, Hydrogen, and Reuse. These integration options are described in WP7. For the stakeholder analysis, we have used the following descriptions of these system integration options: **Reuse.** The reuse of existing offshore structures and assets that are now used by oil & gas (platforms, pipelines, empty fields) for new purposes for energy system integration (CO_2 transport/storage, hydrogen- production/transport/storage). **CCS.** The development of CO_2 storage infrastructure on the North Sea in empty gas fields, including the use of CCS as a precondition for the production of carbon-neutral hydrogen from natural gas (blue hydrogen). **Hydrogen.** Developing Dutch North Sea hydrogen production capacity (offshore or on the coast) and the infrastructure needed for transporting North Sea hydrogen to customers (hydrogen backbone). This integration option focuses on hydrogen produced from wind power via electrolysis (green hydrogen). The production of blue hydrogen is part of the CCS integration option.
Stakeholders	The analysis is performed at the level of Dutch stakeholder groups, not at the level of individuals or individual organisations. These groups are sectors or subsectors. Where relevant, these groups have been further subdivided.

1.4 Research questions

Box 1.1 Definitions used in this report

A **stakeholder** is any group or individual who can affect or is affected by an organisation, strategy or project. They can be internal or external.

Technically, **system integration** is defined as the linking of various energy functions, so that they behave as a single energy system. From an organisational viewpoint, system integration is defined as an integral process of coordination and cooperation between all actors involved in energy value chains.

We use the term **perspective** to identify different, but each consistent reasonings, which can be used as a means to understand where positions in a societal debate come from.

Within the context of a stakeholder analysis, we use the term **influence** to mean that a stakeholder can influence a decision-making process either directly or indirectly.

Within the context of a stakeholder analysis, we use the term **interest** to signify that a stakeholder has an interest in establishing or realizing a specific outcome.

Research questions

1. What are the relevant stakeholder groups and stakeholder organisations in The Netherlands for the North Sea system integration options: CCS, hydrogen, and reuse?
2. For each stakeholder group:
    - What are the main needs and concerns regarding North Sea energy system integration?
    - What are their views on integration options hydrogen, reuse, and CCS?
    - What are the main knowledge and information needs related to the North Sea Energy programme
3. What are the dominant perspectives in the social debate on North Sea energy system integration?
4. What are the points of attention regarding stakeholder engagement for specific hub locations: West, East, North?
5. What are the current topics of debate regarding North Sea energy system integration? Where are stakeholders aligned, and on what topics are there differences of opinion?
6. Based on the stakeholder analysis, what are recommendations for stakeholder engagement for North Sea energy system integration in general, and the NSE research programme?

1.5 Reading guide

After explaining the methodology (Chapter 2), the research results are provided in Chapter 3. The stakeholder fact sheets (3.1) provide information at the level of stakeholder groups and answer research question 1 and 2. An overview of stakeholder perspectives (3.2) answers research question 3. The next part of the results (3.3) contains points of attention for three potential hub locations, answering research question 4. Finally, a power analysis is included separately in Appendix C of this report.

A synthesis of the insights is presented in chapter 4, where general observations regarding the stakeholder positions are made (research question 5). In the last chapter (5) we give recommendations (answering research question 6). The first part addresses the stakeholders research needs (5.1) The second part (5.2) explains the need to integrate different perspectives to increase public acceptance for future developments.

2 Methodology

We have taken a stepwise approach to stakeholder analysis, working from stakeholder identification to developing a plan for stakeholder engagement.

1. Desk research and group brainstorm

Stakeholder groups relevant to North Sea energy system integration were identified through desk research and from the researchers' own knowledge and experience. On that basis, stakeholder groups were preliminarily prioritized and described in an interactive session with NSE industrial partners. This session also provided the technological scoping. For each group, key interests, potential benefits from system integration and potential issues concerning system integration were discussed in sub-groups.

2. Draft Stakeholder Fact Sheets and Perspectives

Based on the results of step 1, a preliminary fact sheet per stakeholder group was written. In addition, a description of the different perspectives on the North Sea energy system integration was written to aid further understanding of the stakeholders' positions. Based on desk research, we investigate stakeholder positions (position papers, websites, etc.) and distil the underlying storylines. These perspectives have been chosen primarily because they show sufficiently characteristic mutual differences in accents and reasoning methods. We have opted for a pragmatic classification that leads to the greatest possible recognisability among the parties involved in this debate. By testing the perspectives with the stakeholders, they are improved in a number of steps.

3. Open interviews with selected stakeholders

See also appendix A

Based on the analysis in steps 1 and 2, stakeholders were selected for interviews. As a basis for qualitative data analysis, the researchers conducted open interviews. In advance of each interview, an interview guideline was shared with the interviewee, introducing the NSE Programme, the Perspectives draft and a range of questions, which could be discussed. During the interview, interviewees were free to bring in other topics that they deemed important. In some cases, interviews took the form of a mini-workshop, where a presentation on NSE was combined with a group interview. From each interview, a report was made, which was sent back to the interviewee(s) for corrections. The interview reports are confidential and have only been shared within the research team.

4. Literature study

See also appendix B

To supplement the interviews, a literature study was conducted. Literature was obtained through the interviews, by searching the websites of key stakeholders and through a keyword search focusing on the stakeholder groups and key technologies. The literature was used to enrich and substantiate the findings of the interviews.

5. General analysis

Information gathered in steps 1 to 4 was combined into this stakeholder analysis report. The various sub-products form the basis for the recommendations for stakeholder engagement.

6. Review

The report was reviewed by the NSE consortium partners and sounding board. The stakeholder fact sheets were also shared with the interviewees, who were asked to provide feedback on their contents.

3 Results

3.1 Stakeholder fact sheets: Interests, perspectives, needs and concerns of stakeholder groups

The factsheets below provide an overview of each of the main stakeholder groups related to system integration on the North Sea:

- Oil and gas operators
- Offshore wind
- Infrastructure owners
- Logistics and service
- Demand-side industry
- Dutch policy makers
- Green NGOs
- Other North Sea users

One important stakeholder group that is not covered by a fact sheet are the ports. Ports service the various stakeholders active on the North Sea and the interests and perspectives of a specific port are intertwined with the stakeholders active there. For this reason, the fact sheets mention when a stakeholder group is particularly relevant to a specific port.

3.1.1 Oil and gas operators

Organisations

NOGEPA[a)]	Total	ONE-Dyas	Discover Exploration
EBN[b)]	Wintershall	Petrogas	Rockrose Energy
Neptune	Equinor (Northern Lights)	Spirit Energy	
Shell[c)]	TAQA	Tulip Oil	
NAM	Dana petroleum	Vermillion	

a) NOGEPA is the Dutch branch organisation; b) EBN is involved as a non-operating partner in nearly all oil and gas projects in the Netherlands; c) In the Dutch North Sea all oil and gas operations are carried by NAM, not Shell.

Ports. The Port of Den Helder is an important landfall site for offshore oil and gas. The Port of Amsterdam is a large gasoline port and player in the oil energy market. The Port of Rotterdam is a location for storage and throughput of oil and oil products and houses an industrial cluster with refineries and chemical companies.

Dominant perspectives

See 3.2 for a description of all perspectives.

Carbon neutral resources and fuels. Oil & gas operators have assets and expertise most suitable for contributing to carbon neutral rather than renewable energy. They argue that solutions such as CCS and blue hydrogen play an important role for the goal of emission reductions, especially in the short term as transition technologies. Part of the operators are exploring new business models for their assets and expertise more widely.

Key interests

- Continued business model.
- Production and sale of oil and gas.
- Extended license to operate with a continued role in the energy transition.
- Reuse of existing infrastructure for hydrogen and CCS.
- The continued availability of current assets and infrastructure for future development of oil or gas fields (or for new purposes such as CCS and offshore hydrogen production, storage and transport).

Needs

- Measures to (cost-effectively) reduce the environmental impact of oil and gas production.[1]
- Investment climate and public support for continued exploration and production of natural gas in the North Sea.
- Public/government support for reuse of infrastructure for CCS and hydrogen, incl. measures to allow for 'bridging the gap' between the end of gas production and new activities.

Concerns

- Industry reputation – lack of trust & loss of license to operate
- The business case for CCS & blue hydrogen – dependent on government policy (subsidies, taxes, ETS CO_2-price).
- Existing offshore infrastructure reduces the costs of developing new fields. Removal of this infrastructure increases these costs, thus decreasing the feasibility of new developments.
- Mismatch of the timing of reuse-developments and decommissioning
- Room for reuse of assets within the current legal framework
- Challenges and costs of decommissioning.[2]

Views on key technologies

Hydrogen	Blue hydrogen is an important steppingstone towards green hydrogen, as it helps to develop hydrogen demand.
CCS	CCS can play an important role as a transition technology, reducing industrial CO2 emissions that are otherwise difficult to abate in the short and medium-term.[3]
	Carbon storage in offshore gas fields can create opportunities for reuse.
	Offshore fields can also provide carbon storage potential internationally – e.g. for the industry in Germany, where storage potential is more limited.
Reuse	Reuse for hydrogen and CCS can generate additional value out of existing platforms and infrastructure.[4]
	Platform electrification can reduce the environmental impact of oil and gas production.[5]

Knowledge/information needs related to the NSE programme

- Solutions to legal challenges for reuse and hydrogen.[6]
- Additional insight into what infrastructure is crucial for what purposes in the future energy system (incl. CO_2 storage), what other infrastructure could beneficially be reused (costs of repurposing lower than costs of new infrastructure) and what infrastructure should be removed.
- Additional insights into the timing of decommissioning in relation to potential reuse.
- (Societal) value propositions for reuse of assets, making it attractive to other parties in the energy transition such as offshore wind.
- Improved insight into synergies between green and blue hydrogen developments.

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1 Rob Koster, 'Industrie, Visserij En Natuurorganisaties Verdelen Noordzee', NOS, 2019 https://nos.nl/artikel/2307905-industrie-visserij-en-natuurorganisaties-verdelen-noordzee.html [accessed 17 March 2021].

2 (a) Nexstep, Re-use & Decommissioning report 2020, 2020 https://www.nexstep.nl/re-use-decommissioning-report-2020 ; (b) Lorenzo Fränkel, 'Overheid Draalt Met Aanpak Opruimen Afgedankte Boorplatforms Noordzee', Follow the Money, 2016 https://www.ftm.nl/artikelen/overheid-draalt-met-aanpak-opruimen-afgedankte-boordplatforms-noordzee?share=QOq7plsN4JC8G9xBIPjm7%2BLMWBTmgdPfWpBgtKCB%2F7nFCYKvtpB1h1PW3g%3D%3D [accessed 17 March 2021]; (c) Lorenzo Fränkel, 'Wie Ruimt de Schroothoop van de Olie- En Gasbedrijven in de Noordzee Op?', Follow the Money, 2016 https://www.ftm.nl/artikelen/wie-ruimt-de-schroothoop-in-de-noordzee-op?share=6ZMb8v%2F8z8dwaDI%2F8wcpIpTpdHgTFIybaSp0qvgV%2FKUWHdJt2mbRsbdQFQ%3D%3D [accessed 19 April 2021]. (d) Rob Koster, 'Miljarden Nodig Voor Opruimen Olie- En Gasplatforms Noordzee', NOS, 2019 https://nos.nl/nieuwsuur/artikel/2291601-miljarden-nodig-voor-opruimen-olie-en-gasplatforms-noordzee.html [accessed 17 March 2021].

3 Shell Nederland, 'Onmisbaar Instrument', 2016 https://www.shell.nl/media/venster/eerder-verschenen/onmisbaar-instrument.html [accessed 17 March 2021].

4 Nexstep, *ibid.*

5 North Sea Energy, Klimaatwinst Door Systeemintegratie Op de Noordzee, 2018 https://www.north-sea-energy.eu/results-nse1.html.

6 North Sea Energy, Unlocking potential of the North Sea. Interim Program Findings June 2020, 2020

3.1.2 Offshore wind operators

Organisations

NWEA[a)]	Shell Renewables		
WindEurope[b)]	Ørsted		
Eneco	Equinor		
Vattenfall	Gemini Wind Park		

a) Dutch branch organisation; b) European branch organisation

Ports. Ports are the (future) landfall sites of choice for the energy produced by offshore wind.

Dominant perspectives

See 3.2 for a description of all perspectives.

Renewable electricity. Renewable electricity is the primary product of the wind sector. In their view, proper integration of renewable sources and as much direct electrification as possible, supplemented by green hydrogen, offers the most effective way forward and the only long-term solution.

Key interests

- Favourable long-term investment climate.
- Designation of sufficient and favourable areas for wind farm development (weather and seabed conditions, distance to shore, connection with users).[7]
- Efficient use of infrastructure for the effective integration of large-scale offshore wind
- Government incentivization of (flexible) electrification of industrial energy demand.[8]
- Interconnectivity between countries.
- Development of technologies for storing excess wind power (*e.g.*, hydrogen, Power2X and battery storage).

Needs

- Stable and predictable electricity demand at good and stable prices.[9]
  - E.g., through increasing demand for electricity through onshore electrification (direct or indirect);[10] through flexible (industrial) electricity demand that can match the production patterns of offshore wind or energy storage; through synchronized investment decisions and long-term contracts for electrification and wind;[11] through interconnectivity between countries; or through opportunities for transforming (excess) wind power into green hydrogen.
- Clear government policy about future wind areas and conditions.
- Timely availability of energy infrastructure.[12]
- Research into and development of improved regulations for combined use, incl. nature restoration, in wind farms.[13]

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7 Wind Europe, Our Energy, Our Future. How Offshore Wind Will Help Europe Go Carbon-Neutral, 2019 https://windeurope.org/wp-content/uploads/files/about-wind/reports/WindEurope-Our-Energy-Our-Future.pdf.

8 NWEA, 'Nieuw Onderzoek Toont Interesse Financiers Wind Op Zee, Maar Onder Voorwaarden', 2 October 2020 https://www.nwea.nl/nieuw-onderzoek-toont-interesse-financiers-wind-op-zee-maar-onder-voorwaarden/.

9 (a) NWEA, 'Reactie NWEA Wijziging Wet Wind Op Zee; Meer Overheidsregie Op de Vraag Is Noodzakelijk', 2020 https://www.nwea.nl/reactie-nwea-wijziging-wet-wind-op-zee-meer-overheidsregie-op-de-vraag-is-noodzakelijk/ [accessed 24 March 2021]; (b) Wind meets industry, Actieagenda, 2020 https://www.windmeetsindustry.nl/publicaties/. Gerard Reijn, 'Windparken Op Zee Kosten (Te) Veel En Leveren Steeds Minder Op', De Volkskrant, 2020 https://www.volkskrant.nl/nieuws-achtergrond/windparken-op-zee-kosten-te-veel-en-leveren-steeds-minder-op~b19371e5/ [accessed 18 March 2021]; (c) NWEA, 'Windsector Vecht Voor Blijvend Subsidieloze Sterke Windparken Op Zee in Het Noordzeeakkoord', 2020 https://www.nwea.nl/windsector-vecht-voor-blijvend-subsidieloze-sterke-windparken-op-zee-in-het-noordzeeakkoord/ [accessed 24 March 2021]; (d) Stuurgroep Extra Opgave, *Complementair Ontwikkelen. In Balans Naar Groeiende Elektrificatie van de Industrie En Extra Aanbod van Hernieuwbare Elektriciteit*, 2021.

10 (a) Reijn, *ibid*.; (b) Windenergie Nieuws, 'Noordzee Energie Outlook Geeft Inzicht Mogelijkheden Offshore Wind Na 2030', 2020 https://windenergie-nieuws.nl/08/noordzee-energie-outlook-geeft-inzicht-mogelijkheden-offshore-wind-na-2030/ [accessed 18 March 2021].

11 (a) Wind meets industry. (b) Eneco Groep, 'Elektrificeren Als de Bliksem: Is de Industrie Er Klaar Voor?', Het Financieele Dagblad https://fd.nl/advertorial/enecogroep/1275488/elektrificeren-als-de-bliksem-is-de-industrie-er-klaar-voor [accessed 18 March 2021].

12 (a) NWEA, 'Wind Meets Industry Legt Het Missende Puzzelstukje', 1 July 2020 https://www.nwea.nl/wind-meets-industry-legt-het-missende-puzzelstukje/; (b) Windenergie Nieuws.

13 NWEA, 'In 2050 60 GW Aan Windenergie Op de Nederlandse Noordzee', 2019 https://www.nwea.nl/in-2050-60-gw-aan-windenergie-op-de-nederlandse-noordzee/ [accessed 24 March 2021].

Concerns

- The limited business case for future offshore wind development.[14]
- Investment risks due to future electricity prices and government policy.[15]
- Locations further offshore will raise costs, unless they are developed over time with nearer to shore 'stepping stones' and/or offshore transformation into molecules.
- Additional demands raising the costs of offshore wind.[16]
- The need for cost reduction of up to 40%.
- Limitations of the current legal framework, and the pace at which these can be overcome.
- Negative cumulative ecological impacts of offshore wind, which may undermine public support and (over time) create legal barriers for further expansion.[17]

Views on key technologies

Hydrogen	Direct electrification is the primary solution for increasing renewable energy use. Indirect electrification through green hydrogen may supplement this for uses that cannot be directly electrified, but the conversion losses are a concern. Offshore wind operators differ in their views on the necessity of hydrogen for a successful roll-out of offshore wind in the medium and long term.
CCS	CCS requires large investments while being a temporary solution. It may divert money and effort better spent on renewable energy and creates a risk of lock-ins. The need for blue hydrogen as a transition fuel and stepping-stone towards green hydrogen is questioned. Many consider this an unnecessary intermediate step.
Reuse	Reuse may be attractive to infrastructure owners but is relevant to other stakeholders only when it provides wider benefits such as reduced costs. There is a risk of lock-ins. Platform electrification can create additional demand for the electricity of offshore wind farms. In some places this may be attractive, in other places it may be cheaper to transport all electricity directly to shore.

Knowledge/information needs related to the NSE programme

- Analyses of how system integration (incl. reuse of existing infrastructure) can help speed up the transition to renewables, reduce costs and generally improve offshore wind business case.
- Long-term masterplan/roadmap focused on conversion and landfall options and locations.

3.1.3 Infrastructure owners

Organisations

TenneT: TSO responsible for the offshore electricity grid and connections to new offshore wind parks.[18]

Gasunie: TSO responsible for the onshore (natural) gas transport infrastructure and (expected to be) responsible for future hydrogen infrastructure.[19] Gasunie contributes to the development of CO_2 tranport for CC(U)S.

Pipeline owners: owners of trunk lines: WGT, NGT, LOCAL, NOGAT.

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14 AFRY, 'The Business Case and Supporting Interventions for Dutch Offshore Wind', March, 2020 https://www.klimaatakkoord.nl/documenten/publicaties/2020/03/05/rapport-afry_the-business-case-and-supporting-interventions-for-dutch-offshore-wind_march-2020.

15 NWEA, 'Reactie NWEA Wijziging Wet Wind Op Zee; Meer Overheidsregie Op de Vraag Is Noodzakelijk'; (b) Eneco Groep.

16 NWEA, 'Windsector Vecht Voor Blijvend Subsidieloze Sterke Windparken Op Zee in Het Noordzeeakkoord'.

17 Wind Europe

18 (a) H.G.J. Kamp, Energierapport. Kamerstuk 31 510, Nr. 49., 2014; (b) Ministerie van Economische Zaken en Klimaat, Ontwikkelkader Windenergie Op Zee, 2020.

19 Rijksoverheid, 'Staatssecretaris Yeşilgöz-Zegerius zet eerste stap voor ontwikkeling landelijk waterstofnet', 2021 https://www.rijksoverheid.nl/actueel/nieuws/2021/06/30/staatssecretaris-yesilgoz-zegerius-zet-eerste-stap-voor-ontwikkeling-landelijk-waterstofnet [accessed 13 September 2021].

Note that the trunk lines are privately owned and operated. They are included here, as their interests partially overlap with the TSOs. Their (legal) possibilities however differ. The activities of the Dutch TSO's are described in the Energy Law. The Autoriteit Consument en Markt (ACM) oversees the TSO activities.

Dominant perspectives

See 3.2 for a description of all perspectives.

Infrastructure. The TSOs are responsible for the infrastructure needed for the energy system. Given the large investments and long periods needed to develop new infrastructure, they stress its pivotal role in the transition and its potential to become a bottleneck.

Carbon neutral resources and fuels. As the transition to renewable energy and increasing electrification pose significant infrastructural challenges, the TSOs tend to stress the role of intermediate solutions. Especially the assets and expertise of Gasunie lend themselves to these.

Renewable electricity. To electricity TSO TenneT, the challenges of the energy transition revolve primarily about building an infrastructure system around large amounts of (variable) renewable electricity generation.

Key interests

- Stable, secure and affordable energy supply.
- Timely and cost-effective infrastructure investments.
- Decarbonization of the energy system in line with obligations from the national Climate Agreement and EU climate and renewables targets.

Needs

- Efficient use and planning of infrastructure (e.g., through integrated planning,[20] combined use for generation and international connectivity[21] and use of hubs[22]).
- TenneT: integrating the offshore and onshore grid (including the match between offshore production and onshore demand).
- Long-term planning and certainty to take timely, justifiable investment decisions.
- Identification of 'no-regret infrastructure'.
- The steady development of infrastructure over time (avoiding bottlenecks).
- Acceleration of political decision making regarding offshore wind, power-to-gas/hydrogen investments and other decarbonization options, incl. related spatial decisions.
- Standardisation of infrastructure.[23]
- International coordination and interconnectivity.[24]
- Evaluating the potential for reuse of existing gas infrastructure as a means of reducing costs and speeding up the transition.

Concerns

- Limitations of the legal role of TSOs, including high dependence on policy decisions.
- Long periods needed for developing infrastructure, especially due to permit procedures.
- Slow, undecided decision-making posing a barrier to timely investment decisions.
- Uncertainty about the future choices of industrial users between (direct) electrification, hydrogen use and CCS and the corresponding infrastructure needs.
- The unclear weighting of ecological impacts, techno-economic impacts and achievement of climate goals.
- The shifting importance of energy carriers: increasing electrification, phase-out of natural gas.
- TenneT: the temporal match between power generation and use.

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20 Gasunie and TenneT, Infrastructure Outlook 2050. A Joint Study by Gasunie and TenneT on Integrated Energy Infrastructure in the Netherlands and Germany, 2019.

21 Gerald Schut, '"Energie-Eilanden Voor Systeemintegratie"', Technisch Weekblad, 2019 https://www.technischweekblad.nl/nieuws/energie-eilanden-voor-systeemintegratie [accessed 17 March 2021].

22 Frank Straver, 'Tien Eilandjes Moeten de Windenergie Tussen Noordzeelanden Gaan Verdelen', Trouw, 2019 https://www.trouw.nl/nieuws/tien-eilandjes-moeten-de-windenergie-tussen-noordzeelanden-gaan-verdelen~bfaafcd4/ [accessed 18 March 2021].

23 Schut, *ibid*.

24 (a) Rob Koster, 'Nederland En Verenigd Koninkrijk Koppelen Windparken Op de Noordzee', NOS, 2020 https://nos.nl/artikel/2349368-nederland-en-verenigd-koninkrijk-koppelen-windparken-op-de-noordzee.html [accessed 17 March 2021]; (b) Gasunie, 'Nederland En Denemarken Verkennen Samen Mogelijkheden Voor Offshore Energiehub', 2020 https://www.gasunie.nl/nieuws/nederland-en-denemarken-verkennen-samen-mogelijkheden-voor-offshore-energiehub [accessed 17 March 2021]; (c) Koster, 'Noordzee Wordt Elektriciteits-Snelweg Met Nieuw Eiland Als Knooppunt', NOS, 2017 https://nos.nl/artikel/2161927-noordzee-wordt-elektriciteits-snelweg-met-nieuw-eiland-als-knooppunt.html [accessed 18 March 2021].

- Spatial limitations of infrastructure for renewable energy supply (renewable energy production, electricity grid, electrolysers, etc.).

Views on key technologies

Hydrogen	Conversion of (excess) power can contribute to balancing energy supply and demand. Alignment of planned P2G installations to electricity and gas transport infrastructure is crucial for avoiding bottlenecks.[25] Ultimately, the role of hydrogen will depend on demand.
CCS	Viable and economical means of reducing CO_2 emissions in the short term.[26]
Reuse	Reuse of infrastructure is valuable if it can reduce the need for new investments. Reuse of current oil and gas installations can save costs for CCS.[27]

Knowledge/information needs related to the NSE programme

- Integrated analysis of the potential of electrons *vs*. molecules plus combination, considering not just transport ('pipe versus cable') but the whole system from generation to use.
- Timing of the energy transition and associated infrastructure needs.
- Coordination of spatial planning of offshore wind farms in relation to existing infrastructure and (onshore) users.
- Potential, benefits and risks of reuse of existing infrastructure *vs*. new developments.
- Potential, benefits and risks of different variants of hubs *vs*. 'one-by-one wind farms'.
- Insight into bandwidths for 'no-regret infrastructure', which can justify investment decisions despite uncertainties.

3.1.4 Logistics and Service Industry

Organisations

IRO	Van Oord	Paragon Offshore	Vroon Offshore
Maritiem Nederland	Peterson	SBM Offshore	Allseas Engineering
Boskalis	DEME Group	Fugro	Huisman

Ports. Logistics and service activities related to energy are especially relevant for the Port of Den Helder.

Dominant perspectives

See 3.2 for a description of all perspectives.

Perspectives vary among organisations. In general, they do not hold strong views on system integration of their own. Instead, they work for a variety of stakeholders and are often capable of serving as a bridge between these stakeholders and their perspectives.

Key interests

- New business opportunities: offshore wind construction, maintenance and decommissioning
- International competitiveness
- Clarity on decommissioning task and timing
- Safe working conditions in all weather
- Costs

Maritime logistics and services are an important sector to the Netherlands, which have a strong international position in this field.

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25 Gasunie and TenneT, *ibid*.

26 (a) EBN and Gasunie, Transport En Opslag van CO_2 in Nederland, 2017; (b) Gasunie, 'CO_2-Opslag Onder Noordzee Technisch Haalbaar En Kosteneffectief', 2018 https://www.gasunie.nl/nieuws/co2-opslag-onder-noordzee-technisch-haalbaar-en-kosteneffectief [accessed 17 March 2021]. (c) Gasunie, 'Noordzeekanaalgebied Biedt Potentieel Voor CO_2-Infrastructuur', 2019 https://www.gasunie.nl/nieuws/noordzeekanaalgebied-biedt-potentieel-voor-co2-infrastructuur [accessed 17 March 2021].

27 EBN and Gasunie, *ibid*

Needs

- The steady development of wind over time, to ensure a continuous workflow and income.

Concerns

- Uncertainty about the characteristics (*e.g.* size) of future wind turbines and the accompanying requirements ships and installation technologies.[28]

Views on key technologies

Views on different technologies differ between logistics and service companies. Their preferences for technologies depend on their expertise and target markets.

Knowledge/information needs related to the NSE programme

- Timeline for decommissioning/reuse of platforms.
- Characteristics of future offshore installations (windfarms, platforms, hubs, etc.) and the required assets and expertise for developing these.

3.1.5 Demand-side Industry

Organisations

All these organisations are energy users and (large) CO_2-emitters. Some are hydrogen producers. The overview of individual companies is non-exhaustive; the listed companies are some prominent examples.

VNO-NCW[a)]	Tata Steel	Air Liquide
VNCI[a)]	OCI	Dow
FME[a)]	Yara	AkzoNobel/Nouryon
VEMW[a)]	SABIC	DSM

a) Branche organisations; b) only with regards to CCS

Ports. The Port of Rotterdam, Port of Amsterdam, Groningen Seaports and North Sea Port (Zeeland) contain and service important industrial clusters bordering the North Sea. These clusters are highly inter-connected on large-scale industrial sites, exchanging materials, energy streams, common use of infrastructure for power, gas, heat, and logistics.

Dominant perspectives

See 3.2 for a description of all perspectives.

Industrial transition. For energy-intensive process industries, complying with climate transition targets means a transition towards sustainable processes. This involves both an energy transition and a resource transition. In both transitions, they need to mind their competitiveness and limit long-term investment risks.

These transitions are driving short term CCS and mid-term electrification and alternative energy sourcing, together with shifting from fossil to renewable feedstocks, for which renewable energy and Hydrogen are key.

Key interests

- (International) competitiveness - attractive investment climate
- Investment security in relation to the availability and costs of energy carriers.
- Continued license to operate.

Needs

- Low and predictable prices for energy and resources.[29]
- Sufficient, predictable and secure supplies of (carbon neutral) energy and resources.[30]

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28 Gerald Schut, '"Energie-Eilanden Voor Systeemintegratie"', Technisch Weekblad, 2019 https://www.technischweekblad.nl/nieuws/energie-eilanden-voor-systeemintegratie [accessed 17 March 2021].
29 Institute for Sustainable Process Technology, 'Electrification in Industry', 2020 https://ispt.eu/news/electrification-in-industry/ [accessed 24 March 2021].
30 Wind meets industry, Actieagenda, 2020 https://www.windmeetsindustry.nl/publicaties/

- Cost-effective decarbonization options.
- Availability of sufficient and diverse infrastructure for decarbonization: electricity, hydrogen, CO_2, heat.[31]

Concerns

- Regulations creating an internationally unlevel playing field, resulting in declining competitiveness and carbon leakage to other countries and companies.[32]
- High costs of decarbonization.[33]
- Future variation in (renewable) energy supply and prices.[34]
- Uncertainty about future carbon prices.
- Connection fees and timely access to infrastructure.
- Public support for transition technologies (e.g., CCS, blue hydrogen, biomass).
- Slow, undecided and fickle policy decisions posing a barrier to timely investment decisions.
- Uncertainty about the future availability of infrastructure for and relative costs of different decarbonization options (direct electrification, hydrogen, CCS).[35]
- The costs, reliability and availability of flexible production technologies.[36]

Views on key technologies

Note: the relevance and applicability of specific technologies and energy carriers vary between industries.

Hydrogen	As a feedstock and an energy carrier, hydrogen will deliver an important contribution to a circular and decarbonized industry.[37] For most parts of the industry, the 'colour' of hydrogen doesn't matter; a stable, low-cost supply is much more important. For industries with a need for very pure hydrogen, green hydrogen is preferred. Hydrogen does not have to be produced locally; like for other fuels and resources, the market is global.[38]
CCS	Can provide transitional decarbonization options, especially for industries with no or highly cost-intensive alternatives.[39] Not having access to CO_2 storage is currently a major barrier, as the infrastructure for CCS is insufficiently developed.
Reuse	Not of specific interest.

Knowledge/information needs related to the NSE programme

- Insights contributing to investment plans with a clear strategy and long-term perspective on energy transition and decarbonization path.
- Understanding of the interdependencies and synergies of offshore and onshore developments, including (investment) timelines.
- Potential, benefits and risks of electrons vs molecules.
- Potential, benefits and risks of hydrogen production onshore vs offshore vs import.
- The expected ratio between future Dutch hydrogen demand and demand from further inland.
- Options, costs and timeline for CCS.
- Availability and market readiness of technical solutions

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31 Werkgroep Industriecluster Rotterdam-Moerdijk, In drie stappen naar een duurzaam industriecluster. Rotterdam-Moerdijk in 2050, 2018.
32 Werkgroep Industriecluster Rotterdam-Moerdijk, *ibid*.
33 Wind meets industry, *ibid.*
34 Wind meets industry, *ibid*.
35 Stuurgroep Extra Opgave, 'Complementair Ontwikkelen. In Balans Naar Groeiende Elektrificatie van de Industrie En Extra Aanbod van Hernieuwbare Elektriciteit', 2021.
36 Wind meets industry, *ibid*.
37 a) Stuurgroep Extra Opgave, ibid.; b) Gehrels, C, Grünfeld, H, Hamer, M, & Weiffenbach, D, *De industrie-en energietop met een Aanbod aan Nederland*, 2021 https://www.netbeheernederland.nl/_upload/Files/Industrie-_en_Energietop__aanbod_aan_Nederland_191.pdf .
38 Port of Rotterdam, Haven van Rotterdam wordt internationale waterstofhub. Visie Havenbedrijf Rotterdam N.V., 2020.
39 Gehrels, et al., ibid.

3.1.6 Dutch policy makers

Please note that while this section discusses Dutch energy and North Sea policies, its focus is on the involved stakeholders. A comprehensive policy analysis is part of work package 7.

Organisations

- Ministry of Infrastructure and Water Management (I&W) with executive body Rijkswaterstaat (RWS)
- Ministry of Economic Affairs & Climate Policy (EZK) with executive body Netherlands Enterprise Agency (RVO)
- Ministry of Agriculture, Nature and Food Quality (LNV)
- Ministry of Defence; Coastguard
- Ministry of Finance
- Ministry of Education, Culture and Science (OCW)

Apart from these national organisations, Regional Economic Development programs are key regional vehicles for further investment in high voltage infrastructure in areas that are well situated for landing offshore electricity.

Box 3.1 Government responsibilities related to North Sea system integration

The various governmental bodies fulfil a range of tasks relation to North Sea system integration. Some of their main responsibilities are:

- I&W: coordinating ministry for the North Sea. Chair of the Interdepartmental Directors North Sea Consultative Body (IDON). Spatial planning, environmental quality, shipping (safety) and sand mining. Within the national Climate Agreement, responsible for mobility.
- Rijkswaterstaat: management of North Sea activities, permits.
- EZK: responsible for climate and energy policies. Within the Climate Agreement, responsible for electricity and industry. Key ministry concerning policy for the energy system, including offshore wind, gas production, hydrogen and CCS. Coordinates the Program Energy System.
- RVO: Subsidies for renewable energy projects: SDE+ (renewables) and SDE++ (renewables and other CO_2-reducing technologies such as CCS, energy-saving innovations, electrification and hydrogen). Organises tenders for offshore wind and offers policy support for the roll-out of additional offshore wind.
- BZK: together with I&W and EZK responsible for spatial planning of big energy projects, including offshore wind.
- LNV: fisheries, nature protection (Natura2000, Birds and Habitat Directives) and nature restoration.
- Defence: national safety. For military practice areas, see 3.1.8.
- Coastguard: safety, surveillance, and services at sea.
- Finance: customs, government budgets and taxes.
- OCW: science policy, archaeological sites and heritage.

Dominant perspectives

See 3.2 for a description of all perspectives.

Spatial. For I&W, balancing the interests and spatial claims of stakeholders within the environmental and ecological carrying capacity of the North Sea is a key task.

Nature. Protecting and improving the environmental and ecological status of the increasingly busy North Sea is an important challenge, especially due to international obligations.

Renewable electricity/carbon-neutral fuels. EZK focuses on advancing the energy transition with technology-agnostic instruments and incentives.

Interests

- A clean, affordable, and reliable energy system.
- General social and economic welfare.
- Achievement of policy goals and meeting (international) obligations.
- The politically acceptable weighting of different stakeholder interests.
- Public and stakeholder support for policies.

- Protecting and facilitating activities of national interest.
- Integration of stakeholder perspectives into a collective knowledge base.

Box 3.2 Dutch Policy goals related to North Sea system integration

- Climate Act: GHG reductions of 49% in 2030, 95% in 2050 (compared to 1990). Likely to be increased as a result of the EU agreement on 55% GHG reductions in 2030.
- 2030 Roadmap for Offshore Wind Energy: 11,5 GW worth of offshore wind farms by 2030.[40] 2030 Target likely to be increased by an additional 5-9 GW in line with 55% GHG reduction target.[41]
- North Sea Agreement: development of human activities within ecological carrying capacity. Additional measures to be taken to protect and restore nature and ecosystems, multifunctional use of wind farm areas, gas extraction in line with the Paris agreement.
- Dutch Maritime Strategy: an international sustainable top position for the Netherlands.[42]
- Meeting the obligations set out by the judgement in the Urgenda case.
- Draft North Sea Programme 2022-2027: integrated policy framework, incl. spatial plan and environmental protection measures, for nature protection and all human activities on the North Sea.
- Activities of national interest:[43] Oil and gas production; Carbon storage; Shipping; Sand production; Renewable energy generation; Defence; Sustainable fisheries.

Box 3.3 International agreements and obligations[44]

- Sustainable Development Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
- OSPAR Convention: aims "to prevent and eliminate pollution and shall take the necessary measures to protect the maritime area against the adverse effects of human activities to safeguard human health and to conserve marine ecosystems and, when practicable, restore marine areas which have been adversely affected."[45]
- United Nations Law of the SEA (UNCLOS).
- International Convention for the Prevention of Pollution from Ships (MARPOL) of the International Maritime Organization (IMO).
- European Marine Strategy Framework Directive: protection, preservation, and restoration of the marine environment to achieve good environmental status.[46]
- European Maritime Spatial Planning Directive
- European Water Framework Directive
- European Bird and Habitat Directives
- European Common Fisheries Policy
- European Climate Policy, including the European Green Deal and Fir-for-55
- North Seas Energy Cooperation

40 Ministerie van Economische Zaken en Klimaat, *Kamerbrief Routekaart Windenergie Op Zee 2030,* 2018.
41 Ministerie van Infrastructuur en Waterstaat and others, *Ontwerp Programma Noordzee 2022-2027*, 2021.
42 Ministerie van Infrastructuur en Milieu, De Nederlandse Maritieme Strategie 2015-2025, 2015 https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2015/01/16/de-nederlandse-maritieme-strategie-2015-2025/150604-maritieme-strategie-lr-2.pdf.
43 Ministerie van Infrastructuur en Milieu and Ministerie van Economische Zaken, *Beleidsnota Noordzee 2016-2021*, 2015.
44 Ministerie van Infrastructuur en Waterstaat and others., *ibid.*
45 OSPAR, 'Convention tekst' https://www.ospar.org/convention/text [accessed 19 May 2021]
46 Noordzeeloket, 'European Marine Strategy Framework Directive' https://www.noordzeeloket.nl/en/policy/europese/ [accessed 22 April 2021].

Views on key technologies

Hydrogen Hydrogen is a key energy carrier for the transition and system integration. It will need government support in the early stage to kickstart the (low-carbon) hydrogen market. A National Hydrogen Programme for 2022-2025 is currently in development.

CCS CCS is a necessary measure to achieve climate goals and will need government support in the early stage. The policy position on the application of CCS beyond 2035 is uncertain.

CCS will be subsidized until 2035, but only for emitters for which there is no cost-efficient alternative. A cap has been set on subsidies of 7,2 Mton CO_2 for industry and 3 Mton for the electricity sector (specifically connected to Tata Steel).

CO_2 storage is allowed under the seabed only. Securing space and infrastructure for CO_2 storage is a key priority.[47]

Reuse The potential for avoiding the environmental impacts of constructing new infrastructure would be valuable.

When reuse contributes to cost reduction, it is valuable. The government is exploring ways to bridge the gap between the end-of-life of gas production and the timing of potential reuses.

Knowledge/information needs related to the NSE programme

- Clear connections to existing studies to promote a consistent, common knowledge base.
- Insights into developments in initiatives facilitating system integration.
- Contribution of system integration and specific technologies to policy goals, e.g. preventing, mitigating and reducing environmental and ecological impacts and positive contributions to ecological development.
- Insights into perceived policy barriers to system integration.
- Insights into potential lock-ins and no-regrets, taking into account societal and economic aspects.
- Insights into preferred locations and framework conditions for energy hubs.
- Pathways and requirements for upscaling (offshore) hydrogen production.
- Insights into the potential for offshore hydrogen storage.
- The potential of offshore hydrogen production for cost reduction for wind farms further offshore.
- Insight into the role of blue hydrogen in developing the hydrogen market.

3.1.7 Green NGOs

Organisations

Natuur & Milieu	Vogelbescherming NL	Urgenda	
Stichting De Noordzee	Natuurmonumenten	Waddenvereniging	
Greenpeace	Milieudefensie	De Rijke Noordzee[b)]	
WWF-NL	NMFG[a)]		

a) Provincial Environmental Federacies, in particular: Zuid-Holland, Noord-Holland, Zeeland & Groningen; b) A programme for nature development in wind farms.

Dominant perspectives

See 3.2 for a description of all perspectives.

Nature. The natural system of the North Sea is under increasing pressure from human activities. To the green NGOs, protecting and restoring the natural system should have priority over other uses. Balancing local environmental impacts with climate change mitigation is a key challenge.

Renewable electricity. A 100 percent renewable energy system based on wind and solar and with much higher energy efficiency is the end goal. Decarbonized fossil fuel solutions (CCS) could slow down the energy transition.

Key interests

- Rapid reduction of greenhouse gas emissions and rapid transition to 100 percent renewable energy system.

47 Ministerie van Infrastructuur en Waterstaat and others, *ibid*.

- Conservation and restoration of biodiversity and ecosystems – minimized negative impact of human activities, thriving ecosystems.
- Reduced environmental footprint: limiting (energy) consumption and promoting circularity are key measures in transition.
- Public support and local support for their initiatives and actions. For NGOs with members, their approval is also important.

Needs

- Monitoring the environmental state of the North Sea.
- Societal support for nature and the energy transition, amongst others by limiting (social) costs and spatial impact.
- Increasing the amount and size of protected nature areas.[48]
- Clarity about ecological impacts and clear weighting of these impacts in decision-making.
- Innovative approaches to limiting the negative environmental impacts of offshore wind and combining it with nature restoration.[49]

Concerns

- The pace of the energy transition and climate change measures (too slow).[50]
- Achieving (or surpassing) the ambitions of the Climate Agreement.[51]
- The location of offshore wind farms in relation to protected areas and key ecosystem functions.[52]
- The cumulative impact of large-scale offshore wind developments on marine ecosystems, birds & bats.[53]
- Lock-in of continued fossil fuel use & production (CCS, platform electrification, reuse).
- An unfair transition, with taxpayers paying for the industry transition.
- Irreversible ecological impacts, e.g., due to the construction of an artificial island.
- Reuse being used as an excuse for leaving abandoned infrastructure offshore.

Views on key technologies

Views differ between NGOs.

48 a) Stichting de Noordzee, 'Natuur- En Milieuorganisaties Steunen Noordzeeakkoord', 2020 https://www.noordzee.nl/natuur-en-milieuorganisaties-steunen-noordzeeakkoord/ [accessed 24 March 2021]; b) Wereld Natuur Fonds, 'Windenergie Op de Noordzee' https://www.wwf.nl/wat-we-doen/waar-zijn-we-actief/nederland/noordzee/windenergie-op-de-noordzee [accessed 18 March 2021].

49 a) Natuur & Milieu, 'Dit Is Zeekracht' https://www.natuurenmilieu.nl/themas/energie/projecten-energie/zeekracht/dit-is-zeekracht/ [accessed 24 March 2021]; b) Stichting de Noordzee, 'Ingrijpende Veranderingen Op de Noordzee Door de Groei van Windparken Vragen Om Meer Onderzoek', 2019 https://www.noordzee.nl/ingrijpende-veranderingen-op-de-noordzee-door-de-groei-van-windparken-vragen-om-meer-onderzoek/ [accessed 17 March 2021]; c) Natuur & Milieu, 'De Rijke Noordzee' https://www.natuurenmilieu.nl/themas/energie/projecten-energie/de-rijke-noordzee/ [accessed 17 March 2021].

50 Greenpeace Nederland and others, *Input Aan Tweede Kamerfracties over de Routekaart Wind Op Zee Voor Algemeen Overleg Klimaat En Energie 28 Juni 2018*, 2018.

51 Natuur & Milieu, 'Klimaatakkoord: Genoeg Gepraat, Nu Aan de Slag' https://www.natuurenmilieu.nl/themas/energie/projecten-energie/het-klimaatakkoord/ [accessed 26 April 2021].

52 a) Natuurmonumenten, 'Windenergie' https://www.natuurmonumenten.nl/standpunten/windenergie [accessed 18 March 2021]; b)Greenpeace Nederland and others, *ibid*.

53 a) Stichting de Noordzee, 'Ingrijpende Veranderingen Op de Noordzee Door de Groei van Windparken Vragen Om Meer Onderzoek'; b) J. Vrooman and others, Windparken Op de Noordzee: Kansen En Risico's Voor de Natuur (Utrecht, 2018) https://drive.google.com/file/d/14SY561QSHxhUWRuj2jZhZtwY9TZ8e7o7/view [accessed 18 March 2021]; c) Greenpeace Nederland and others, *ibid*.

Hydrogen	(Green) hydrogen is important for a successful energy transition. The position on blue hydrogen is ambiguous. Natuur & Milieu sees it as a possible transition technology,[54] whereas Greenpeace is consistently negative about it and wants the government to invest only in green hydrogen.[55] Hydrogen should only be used when direct electrification is not an option.[56]
CCS	Natuur & Milieu: CCS can be one of the few options for some industries to achieve the necessary emission reductions in the coming 10 years. It is key to clearly identify which industries need CCS and which ones can do without.[57] Greenpeace: CCS is an attractive option to existing industries, but its costs, complexities and environmental risks are being underestimated.[58]
Reuse	The potential for avoiding the environmental impacts of constructing new infrastructure would be valuable. There is a risk of reuse becoming a long-term liability, due to the unwillingness of operators to remove installations at the end of life. This might undermine international agreements (in particular OSPAR 98/3)

Knowledge/information needs related to the NSE programme

- Information on marine ecosystems in potential locations for wind farms and other activities (baseline information).
- Knowledge of marine ecosystems and biodiversity on and around offshore installations (platforms & turbines).
- Knowledge of the cumulative impacts of various offshore activities.
- Ecological and environmental benefits of reuse vs. decommissioning and new construction
- Potential benefits of system integration in reducing transition costs and ecological impact and in speeding up the transition to a fully renewable system (avoiding lock-in).

3.1.8 Other North Sea users

Users included here are fisheries, military, shipping, sand and shell extraction, tourism and recreational activities and telecommunications

Sectors

- Fisheries, represented by VisNed and Vissersbond
- Military and Coastguard, which fall under the Ministry of Defence
- Sand extraction. Various companies, including Belgian companies
- Owners and users of pleasure craft: sailing, sports fishing, diving
- Sports fisheries, represented by Sportvisserij Nederland
- Tourism, residing in coastal municipalities
- Shipping, represented by the Royal Association of Netherlands Shipowners (KVNR)
- Telecommunications, represented by *Brancheverenigingen ICT en Telecommunicatie Grootgebruikers* (BTG).

Ports. International shipping is especially relevant to the Port of Rotterdam and the Port of Amsterdam.

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54 Natuur & Milieu, 'Transitievisie CCS: Van blauwe naar groene waterstof', 2021 https://www.natuurenmilieu.nl/wp-content/uploads/2021/05/Transitievisie-CCS-NatuurMilieu-DEF.pdf [accessed 13 September 2021].

55 Redactie Duurzaam Bedrijfsleven, 'Nederland dreigt achterop te raken met groene waterstof', *Change Inc*, 2020 https://www.change.inc/energie/waterstof-nederland-34447 [accessed 18 May 2021].

56 Natuur & Milieu, 'Wanneer waterstof? Afwegingskader', 2020 https://www.natuurenmilieu.nl/themas/energie/projecten-energie/waterstof/wanneer-waterstof/ [accessed 18 May 2021] .

57 Natuur & Milieu, 'Opinie: Uitsluiten van ondergrondse CO2-opslag is een luxe die we niet meer hebben', 2020 https://www.natuurenmilieu.nl/nieuwsberichten/opinie-uitsluiten-van-ondergrondse-co2-opslag-is-een-luxe-die-we-niet-meer-hebben/ [accessed 18 May 2021].

58 a) Greenpeace Nederland, 'Gevaren Grootschalige CO2 Opslag in Bodem van Noordzee', 2018 https://www.greenpeace.org/nl/klimaatverandering/6286/gevaren-grootschalige-co2-opslag-in-bodem-van-noordzee/ [accessed 17 March 2021]; b) Greenpeace Nederland, 'Notitie Carbon Capture and Storage', 2018 https://www.greenpeace.org/nl/artikelen/6414/notitie-ccs-aanbevelingen-succesvolle-en-kosteneffectieve-implementatie-ccs-in-nederland/ [accessed 17 March 2021].

Dominant perspectives

See 3.2 for a description of all perspectives.

Spatial. The North Sea is increasingly busy, with users potentially competing for space. The increasing spatial claims for energy are understandable, but enough space should be left to existing users.

Key interests

- Continuation of existing practices, business models and livelihoods.
- Protection of future income (fisheries, sand extraction), which needs the presence of sufficient natural resources.
- Direct routes with safe and unhindered access to areas of activity.[59]
- **Telecommunications.** Space for new cables, access to existing ones for maintenance.[60]
- **Shipping and fishery.** Clean and renewable propulsion technologies (e.g., through hydrogen, electrification or synthetic fuels).[61]
- **Military.** Space for the execution of constitutional tasks.

Needs

- Access to areas of value for the sector.[62] Possibly through multi-functional use or more efficient use of space, but in practice, this often turns out to be difficult.
- Compensation in case of limitations to access economically valuable areas.[63]
- Continued permits for activities.
- **Shipping.** Investments needed for retrofitting ships for new fuels/electrification.[64]
- **Shipping.** Fast, safe and direct (access to) shipping lanes and anchor areas.[65]
- **Military.** Suitable and sufficiently large practice grounds (free of obstacles for naval practice grounds, free of people during actual use, close enough to bases).[66]
- **Military.** (Energy) innovations providing operational improvements.

Concerns

- The increasing safety risks due to more intensive use of the North Sea (e.g., risks of collisions, snagging of nets and disturbance of helicopter routes).
- **Fishery.** The increasing spatial claim of offshore wind as well as nature protection, especially on rich fishing grounds (which are often shallow areas also valued for wind parks).[67]
- **Fishery.** The cumulative impacts of wider developments like the Brexit and the ban on pulse fishing.[68]
- **Fishery.** Effects of energy systems on the continued availability of commercially important fish, such as due to sound impacts and electromagnetic fields.[69]

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59 a) Ilse van de Velde, Alexander Oei, and Twan de Korte, *Kansen, Risico's En Kosten Voor de Visserij Bij Toestaan Sleepnetvisserij in Windenergiegebieden*, 2019; b) Waterrecreatie Nederland, 'Update Doorvaart Windmolenparken Noordzee', 2017 https://waterrecreatienederland.nl/2017/09/update-doorvaart-windmolenparken-noordzee/ [accessed 18 March 2021].

60 Wind op zee, 'Het Effect van Wind Op Zee Op Telecom' https://windopzee.nl/onderwerpen-0/effect-op/activiteiten/telecom/ [accessed 31 March 2021].

61 a) Marnix Krikke, 'Elektrificatie in Scheepvaart Is Onoverkomelijk', *Maritiem Nederland*, 2018 https://www.maritiemnederland.com/artikelen/techniek-innovatie/elektrificatie-in-scheepvaart-is-onoverkomelijk [accessed 18 March 2021]; b) Teun Schröder, 'De Toekomst van de Scheepvaart: Nieuwe Brandstoffen Vragen Om Transitie in de Haven', *Change.Inc*, 2020 https://www.change.inc/mobiliteit/schone-scheepvaart-35033 [accessed 18 March 2021].

62 a) VisNed, *Ruimte Voor Visserij in de Noordzee Vol Windmolens. Gezamenlijke Visie*, 2019; b) Maritiem Nederland, 'Visserij Staat Voor Transitie in Noordzee Vol Windmolens', 2019 https://www.maritiemnederland.com/nieuws/visserij-staat-voor-transitie-in-noordzee-vol-windmolens [accessed 17 March 2021]; Noordzeeloket, 'Oppervlaktedelfstoffenwinning' https://www.noordzeeloket.nl/functies-gebruik/artikel-baseline/ [accessed 17 May 2021].

63 Rob Koster, 'Industrie, Visserij En Natuurorganisaties Verdelen Noordzee', NOS, 2019 https://nos.nl/artikel/2307905-industrie-visserij-en-natuurorganisaties-verdelen-noordzee.html [accessed 17 March 2021].

64 Teun Schröder, *ibid.*

65 KNVR, 'Prioriteit KVNR: De Veilige Navigatie Op de Noordzee Zekerstellen', 2021 https://www.kvnr.nl/noordzeeinfra [accessed 17 March 2021].

66 Ministerie van Infrastructuur en Milieu and Ministerie van Economische Zaken, *Beleidsnota Noordzee 2016-2021*, 2015.

67 a) VisNed, *Ruimte Voor Visserij in de Noordzee Vol Windmolens. Gezamenlijke Visie*; b) Arie Mol, Hans Van Oostenbrugge, and Niels Hintzen, *Wind Op Zee. Bepaling van de Waarde van Geplande Windparkgebieden Voor de Visserij*, 2019 https://doi.org/10.18174/469809; c) Vist ik het maar, 'De Ruimte Op Zee Wordt Krap – of: Vissen Op Een Postzegel', 2021 https://vistikhetmaar.nl/dossiers/ruimte-op-zee-wordt-krap/ [accessed 18 March 2021]; d) Rob Koster, *ibid.*; e) Vanessa Stelzenmüller and others, *Impact of the Use of Offshore Wind and Other Marine Renewables on European Fisheries*, 2020.

68 A. Mol and others, Vissen Bij Wisselend Tij, 2019 https://doi.org/10.18174/477776 .

69 a) VisNed, 'Belangenbehartiging: Wind Op Zee' https://www.visned.nl/thema/ruimtelijke-ordening/wind-op-zee [accessed 24 March 2021]; b) Omroep Zeeland, 'Actiegroep EMK Start Petitie Tegen Windmolenparken Op Zee -', 2019 https://www.omroepzeeland.nl/nieuws/114191/Actiegroep-EMK-start-petitie-tegen-windmolenparken-op-zee [accessed 17 March 2021].

- **Fishery.** Hindrance of bottom trawling by electric cables on the seabed (due to risk of damage to cables).[70]
- **Fishery.** The changing distribution of fish (both in terms of species and spatial distribution) due to climate change. This complicates predictions about the locations of future important fishing grounds.
- **Shipping.** Consideration of the growth of shipping through the North Sea and future shipping routes to the Pacific Ocean through the northeast (arctic) passage.[71]
- **Coastal municipalities.** Impact of wind parks on views.[72]
- **Military.** Security dimension of energy (security of supply, strategic reserves, vulnerabilities).

Views on key technologies

Hydrogen	The use of hydrogen involves conversion losses and may thus ultimately lead to a larger spatial claim by offshore wind. Fishery. Unlike electricity cables, pipelines are no obstacle to bottom trawling as they are located deeper underground.
CCS	None of the other users seem to have a clear view of this technology. A likely explanation is the relatively small spatial footprint of CO_2 storage.
Reuse	Fishery: Platform electrification increases the number of cables in the North Sea, affecting bottom trawling.

Knowledge/information needs related to the NSE programme

- Dialogue and joint research about technologies such as platform electrification.
- Spatial (and environmental) effects of technologies/assets, including the spatial costs or benefits of system integration.
- Knowledge about nature and biodiversity and possible effects on commercially relevant species.
- Options for multi-functional use of *e.g.* hubs (islands).
- Policies/law: need to know which areas are available and which technologies are going to be used.

3.2 Perspectives on Offshore Energy System Integration

Perspectives are different, but consistent reasoning, which can be used as a means to understand where positions in a social debate come from. Such perspectives also can be used in the development of an integrated vision. A perspective is a consistent "storyline" that:

- includes a (social) main objective,
- has a substantiation based on scientific and/or "grey" literature,
- has an ideal image of what the future could look like, and often does
- comprises a "theory of change": an image of how the change process (transition) from the current situation to a final image can or should proceed and which measures are possible and desirable.

Perspectives do not have to be mutually exclusive: stakeholders who reason from one perspective can also use arguments from another perspective.

We have identified the following perspectives from interviews and literature. The perspectives are detailed in table 3.1, and graphically summarised in figure 5.1. The perspectives that are expressed by stakeholder groups can be found in chapter 3.1. All perspectives assume that achieving the Paris goals is necessary. For each perspective, the general starting point for a position is provided. This can be seen as an overall vision for the future. Next, the preferred realisation of this vision is provided. How should the desired change come about? Finally, this is translated to the topic of system integration. Given a specific starting point and a realisation, what are the concerns and needs regarding system integration?

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70 a) Velde, Oei, and Korte, ibid; b) Compendium voor de Leefomgeving, 'Gebruiksfuncties van de Noordzee, 2019', 2019 https://www.clo.nl/indicatoren/nl0064-gebruiksfuncties-van-de-noordzee [accessed 17 March 2021].

71 KNVR, *ibid.*

72 Wind op zee, 'De zichtbaarheid van windparken' https://windopzee.nl/onderwerpen-0/effect-op/omgeving/zichtbaarheid/ [accessed 18 May 2021].

Table 3.1 Six distinctive perspectives on offshore energy system integration

Perspective	Starting point	Realisation	Role system integration
CO_2-neutral raw materials and fuels	Production of CO_2-neutral raw materials and fuels must start now to be able to realize a cost-effective, net CO_2-neutral energy system by 2050. Intermediate solutions are necessary to accelerate the transition.	There is an opportunity to integrate the assets of the current fossil industry with new energy functions. Develop transition technologies to expand markets: CO_2 storage (CCS) in combination with blue hydrogen. Remove barriers to reuse. Establishing a business case for CO_2 neutral fuels through carbon pricing (ETS).	Develop new options for reuse. Development of a new business to store CO_2 and to produce, transport and store hydrogen (first blue, and then green).
Renewable electricity	Electrifying the energy system as quickly and as far as possible offers the greatest chance of a 100% sustainable energy system. There are sufficient alternatives to fossil fuels and therefore it must be avoided that the fossil business model obstructs the development of renewable energy.	The large-scale roll-out of offshore wind is leading. Conversion to hydrogen comes second after all efforts have been made to use electricity for the demand side. Promote a sustainable earnings model for the wind sector. Intermediate solutions such as blue hydrogen and CCS should not draw attention and subsidies away from the final solutions.	Develop conversion options that increase the value of offshore wind energy. Both conversion of electricity to hydrogen or other gases and vice versa.
Infrastructure	The costs for the energy infrastructure form a substantial part of the costs of the energy transition. The costs for infrastructure are eventually socialized and must therefore be kept as low as possible. Infrastructure is an important bottleneck in achieving the climate goals due to the long realization times and lack of roll-out capacity.	Long-term planning and direction aimed at an optimal mix of electrons and molecules. Adjustment of legal frameworks in line with new energy system design. Need for a long-term master plan, technology roadmap, taking into account the timeline for the phasing out of existing infrastructure.	Optimize energy transport with new, existing or redesigned infrastructure
Spatial planning	Different users are increasingly making claims to the same space in the North Sea. Effective use of space is necessary. Existing users must be left with sufficient space.	Long-term policy: marine spatial planning. Promote collaboration and coordination between stakeholders. Integration through multifunctional use of space. Enable far-offshore use through hubs. Keep existing use or compensate users for their loss.	Develop options for temporary and/or multifunctional use of space. System integration is also a process of cooperation between different energy chains.

Perspective	Starting point	Realisation	Role system integration
Nature	The ecology of the North Sea is under increasing pressure. Improvement of the current nature and environmental status is necessary. It is important to guard against cumulative and irreversible effects in new developments.	Designation of protected (nature) areas. Strengthening nature also outside protected areas - integration with wind. When designating locations and design of energy areas, carefully weigh the effects on climate and ecological effects.	Develop knowledge about nature and possible environmental effects (cumulative and long term) System integration can be part of nature-inclusive construction, habitat restoration, protein transition.
Industrial transition	The current industry is important for the economy of the Netherlands but is still largely fossil. The industry will have to transform into circular, climate-neutral processes and at the same time remain competitive. The industry needs long-term investment security.	Low energy prices and risk management determine investment decisions in an international market. No clear preferred technique for decarbonisation yet: electrification, hydrogen, CCS, biomass. New favourable business locations are access to CO_2-neutral electricity, fuels and raw materials. System integration is a means in this regard. Self-sufficiency is not necessary. There is a world market for raw materials and energy carriers.	Develop climate-neutral, circular industrial processes (including electrification), dealing with flexible energy supply, energy storage, CCS. Make considerations between the production of energy and raw material close to the sustainable source vs import of sustainable raw materials and energy (carriers).

3.3 Hubs: relevant aspects for stakeholder engagement

In 'Ontwerp Programma Noordzee' a range of potential areas for wind farms have been defined,[73] of which a selection still has to be made to meet the climate goals for 2030 and 2040. These potential wind energy areas form the starting point for any discussion about hub locations. Here we discuss relevant aspects of stakeholder engagement for the three hubs that have been detailed and assessed in WP1.

73 Ontwerp Programma Noordzee 2022-2027, p. 98

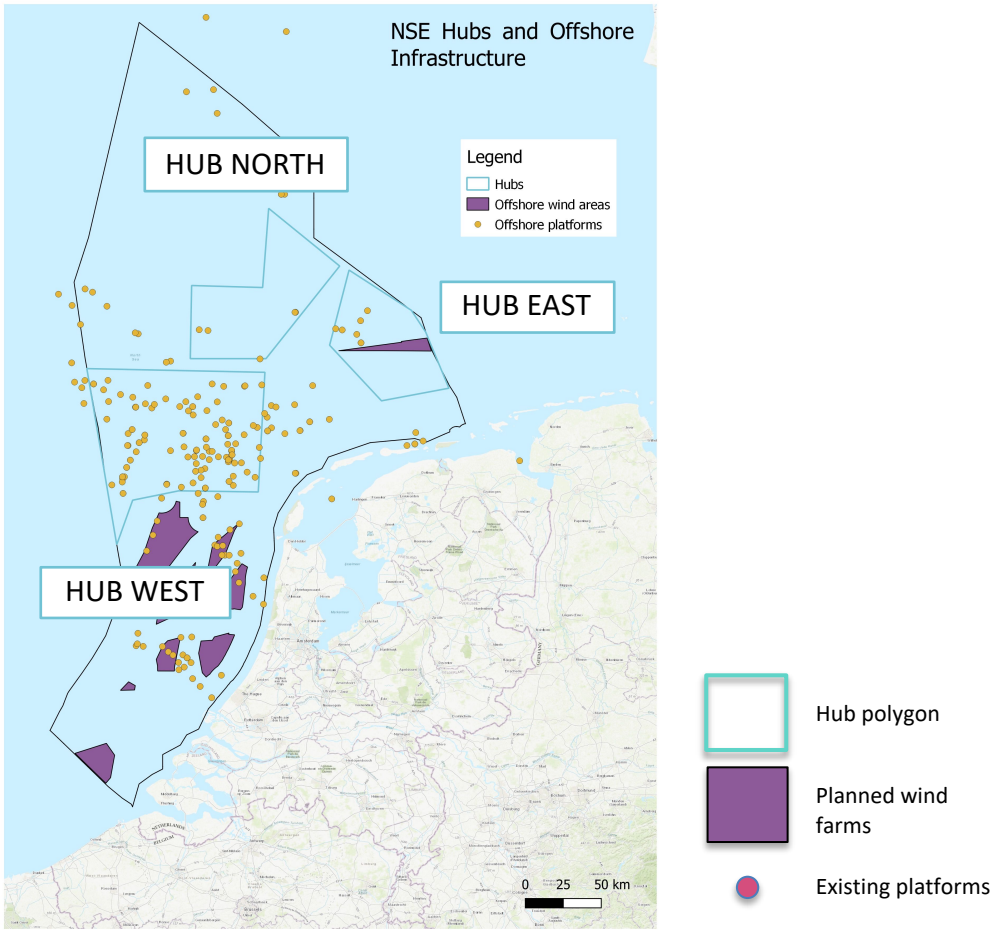


Figure 3.1 Three energy hubs defined and assessed in WP1.

3.3.1 Hub West

This hub is explicitly mentioned as a potential hub in Ontwerp Programma Noordzee, but seemingly dependent on the development of wind area 2, which is hindered by issues with defence areas and continued oil & gas production.

It is an intensively used area, where other users ((sole)fisheries, shipping, defence) will be crucial stakeholders. Also, UK stakeholders are key, as interconnection with UK wind farms could be part of system integration.

Special emphasis will be needed to show the added value of Power2Gas in this area, as the distance to the coast is relatively short and the projected costs of landfall via cables (electricity) limited. Also, the fact that wind farms in this area are likely to be developed already before 2030 will make many stakeholders (green NGOs, TenneT, NWEA) tend to focus on landfall as electricity rather than molecules.

When considering an island, special emphasis needs to be put on societal benefits such as nature compensation for birds impacted by wind farms in the area, added values for logistics (shipping and offshore maintenance) and maybe even coastal protection.

3.3.2 Hub East

The Borkum Reef area (Borkumse Stenen) has been dedicated as a protected nature area in the Dutch North Sea Agreement and been chosen for experiments with the restoration of flat oyster reefs by WWF-NL and German NGOs and researchers across the border. That makes the further oil and gas development in this area, highly controversial among green NGOs (in May 2021 a group of green NGOs, including WWF-NL, Greenpeace and Natuurmonumenten have filed a formal objection against ONE-Dyas' exploration and

production plans in this area[74]) and probably also with certain ministries. Also, the development of wind energy in this area is controversial, due to the interaction with defence activities and potential impacts on the neighbouring nature area Frisian Front (Friese Front).

Landfall of electricity from this area is likely to be an issue, as cables may have to be drawn through the Waddensea area or over a much longer distance through the Frisian Front area. Hence, stakeholder engagement for this hub will need to pay special attention to the potential impact on ecology – in particular on neighbouring nature areas Wadden Sea, Frisian Front and Borkum Reef – of various hub options.

Key stakeholders to engage with are green NGOs (see 3.1.7), complemented with Waddenvereniging, local communities in the Wadden Sea area, fisheries, defence and a range of German stakeholders, in particular concerning interconnection with German wind farms and potential impacts on the Borkum Reef and Wadden Sea.

3.3.3 Hub North

A hub in the North is generally seen as the most logical location by most stakeholder groups, as the distance to shore makes landfall as electricity and offshore maintenance from shore very expensive. Moreover, a hub in the North could play a major role in the interconnection of wind farms among a wide group of North Sea countries (NL, UK, D, DK). Considering the estimated negative societal costs of the development of wind in this area, policymakers as well as the offshore wind sector are unlikely to want to develop this area in the short term and certainly not without a hub. Here, offshore Power2Gas is seen as an opportunity.

The major issue in the North is the potential impact on the Doggersbank Natura2000 area, which is currently seen as insufficiently protected by (international) green NGOs. At the same time, the Doggersbank area is a key fishing spot, which means that also fisheries are a key stakeholder. An earlier NSWPH proposal for an island/hub on the Doggersbank was met by serious protests from green NGOs and fisheries.

Other potential issues could be the difficulties of policing and maintaining safety and security on a far offshore location and potential conflicts with shipping (clearway to Kattegat and connection to a Northern (Arctic) Route).

Potential benefits for non-energy stakeholders could be created by adding functions to the hub, such as harbour facilities for offshore maintenance/logistics, fishermen and others, but this is likely to increase issues with policing/safety and ecological impacts at the same time.

4 Conclusions - Integrated analysis

4.1 Common ground

Large-scale offshore wind will be essential

The need for large-scale offshore wind is commonly accepted as is the need for interconnectivity between offshore wind farms and grids in different North Sea countries. Interconnectivity is seen as a precondition for the stable and efficient use of offshore wind power.

Reduce spatial pressure

The North Sea is getting busy (high spatial pressure). Stakeholders stress the importance of increased coordination within and between sectors. Many stakeholders observe a tendency towards moving activities with low public acceptance onshore into the North Sea. Terms as ‘sea blindness’ and ‘new frontier’ are being used to describe this trend and the blindness for the fact that the North Sea is not just an empty space, but already heavily used. Especially fisheries and green NGOs are deeply concerned about the growing spatial pressure and the risk of industrialisation of the North Sea.

Improve common knowledge base for timely decisions

Stakeholders stress the importance of creating a common knowledge base and the role the NSE programme can play in this. This common knowledge base can then inform (governmental) visions for the future of the

[74] See e.g. https://www.rtvnoord.nl/nieuws/823928/natuurorganisaties-over-gaswinning-bij-schier-gekkenwerk

North Sea. Coordination with parallel efforts like the North Sea Energy Outlook, the Berenschot scenarios and the North Sea Wind Power Hub work is key.

The timelines of spatial procedures are a key factor in the speed of processes to guarantee future infrastructure. Delay of decisions about e.g. wind farm locations and infrastructure needed to get the energy produced onshore will lead to potential clogging of construction activities towards 2030 or a failure to achieve climate goals. On the other hand, the speed of decision making is often delayed by a lack of knowledge, e.g. about environmental impacts.

4.2 Differences of opinion

National self-sufficiency

Opinions differ widely on the extent to which national self-sufficiency is seen as a key priority, especially when it comes to (green) hydrogen production or whether self-sufficiency is unrealistic considering the limited space available in the Netherlands. Also concerning the desirability of opening up Dutch CO_2 storage locations to emitters from other countries, opinions differ. To the extent that hydrogen production and storage competes with CO_2 storage, the Dutch government (EZK) seems to consider hydrogen more important than CO_2 storage.

Hydrogen

The need for green hydrogen in the future energy system is commonly accepted, but there is disagreement about the size, importance and timing of this need: some stakeholders see electrification and demand-response as more important elements in the future energy system. From this perspective, green hydrogen is only needed for a small group of industries, e.g. steel production, for which electrification is unfeasible. Others see hydrogen as the key energy carrier in the future energy system.

There is disagreement about the need for blue hydrogen as a steppingstone for the hydrogen economy. Some parties would rather 'leapfrog' to green hydrogen. There is concern that investing in blue hydrogen may create a lock-in with (imported) gas.

Reuse

The importance of reusing assets is contested by some stakeholders. They question the cost advantages and suggest that reuse is probably relevant/cost-efficient in a very small number of cases. Other societal benefits, e.g. environmental and spatial benefits, too are being questioned. NSE can make a major contribution to this discussion by providing (more) solid data on where and when reuse provides societal benefits and what benefits can be expected.

CCS

Hardly any stakeholders mention CCS as a part of system integration. They seem to see this as a separate issue/technology. NSE will need to clarify the relationship.

4.3 General observations

General insights obtained from interviews

The government seems divided in their perspective on what is needed and realistic with respect to North Sea Energy; ministries are leaning to the perspective of 'their' primary stakeholder groups rather than towards a common government vision. Where EZK has a strong focus on climate targets, costs, reliability, self-sufficiency and economic opportunities in the energy system, I&W focuses on spatial limitations, safety, climate goals and impact on the North Sea ecosystem. Where EZK sees e.g. the development of substantial green hydrogen production (onshore and on the longer-term offshore) as a necessity, I&W points to the need to let go of axiom's regarding necessity and speed of offshore energy/wind development.

Stakeholders do not see a role for CCS in hubs. Most stakeholder groups see offshore hubs as a means to gather offshore wind energy and either convert (part of) it into hydrogen/molecules or redirect it towards other North Sea countries when supply exceeds demand. Except for the oil and gas industry, none of the stakeholders interviewed mention CO_2 storage as part of a hub. In their view the preferred location of energy hubs is determined by considerations concerning interconnectivity and potential benefits of offshore conversion of electricity into hydrogen, whereas the location of CO_2 storage depends on the suitability of a gas field, aquifer or cavern for the safe storage of CO_2. The benefits of combining the two is not understood.

Several stakeholders point to the risk of overestimating the economic opportunities and potential synergies of artificial islands/hubs: policing and guaranteeing public order and security offshore is much more difficult than onshore and currently the governance system is not suited for such tasks. As more vital infrastructure is located offshore, policing and emergency capacity will need to be significantly expanded. With additional economic activity on artificial islands, this need will be even larger.

More insight into the integrated costs of the energy system is desirable. Various stakeholders emphasise that cost comparison of e.g. transport of electrons versus molecules and onshore versus offshore hydrogen production need to take into account not only the difference in costs of cables versus pipelines, but also costs of constructing additional offshore wind farms to produce the same amount of energy (power-to-gas entails an energy loss) and other indirect costs, such as additional policing and emergency capacity associated with offshore energy islands/hubs with vital infrastructure.

CCS is generally seen as a transition technology that is primarily needed to achieve large CO_2 emission reductions in the short term, i.e. to achieve the 2030 climate goals. It is unclear how most stakeholders see the role of CCS after 2030. To some extent, this will depend on whether the Netherlands decides to also import CO_2 from neighbouring countries.

Industry's primary interest is to stay competitive through the energy transition, i.e. to choose the cheapest option for decarbonization: electrification, CCS and/or replacement of fossil fuels with carbon-neutral (green or blue) hydrogen. So far, the industry has an interest in keeping all options open until it becomes clear, which option will be the most attractive one. From a societal perspective, however, it might be cheaper to make clear choices between electrification, CCS and hydrogen, in order to limit investments in infrastructure that may rapidly become redundant. Policymakers need to make clear choices to help the industry making choices and investments.

Ports are searching for comparative advantages in a new energy system. In the long term, oil-and-gas is losing importance for the Dutch harbours, which may imply that also their role as logistic hubs may decrease. Consequently, they are looking for alternative opportunities/new activities. Hydrogen transport is seen as an important future activity by several ports (hydrogen backbone). Ports are competing for a role as a strategic energy hub, connecting offshore energy production with onshore energy demand.

Benefits of system integration for offshore wind. Non-wind stakeholders presume that system integration and conversion of offshore electricity into hydrogen will improve returns for the wind sector. This seems to be confirmed by the fact that major offshore wind operators increasingly show interest in green hydrogen. Notably Ørsted is taking initiative in this area with their promotion of energy islands in Denmark and more recently of green hydrogen production from a dedicated, new offshore wind farm off the coast of Zeeland as a means of decarbonising the Terneuzen – Antwerpen industry cluster[75].

Consideration of neighbouring seas. Several stakeholders emphasize the need to also consider impacts on the Wadden Sea, when looking at North Sea Energy development and transport to shore.

[75] https://en.wikipedia.org/wiki/Energy_islands_of_Denmark and https://orsted.com/en/media/newsroom/news/2020/10/143404185982536

5 Recommendations for Stakeholder Engagement

We make two types of recommendations. First, we summarize the needs and expectations of stakeholders regarding (further) research on offshore energy system integration. This set of recommendations can be used by the NSE programme itself, other researchers or by government agencies wishing to draft new knowledge and innovation programmes.

Next, based on stakeholder fact sheets (3.1) we provide general recommendations for engaging stakeholders with various system integration options. This serves as a general framework for more detailed stakeholder engagement plans at the time when concrete activities are planned. Also, it provides input for communication plans for NSE or other consortia that seeks to develop activities in this field.

Finally, we make a few closing remarks regarding the integration of different perspectives on offshore system integration.

5.1 What research do stakeholders expect and need?

During this research, stakeholders expressed a range of expectations and needs for (further) research. The following is a list of topics into which the stakeholders would value new insights. The list is provided *as-is*, without further analysis of what types of research is currently being done or underway, nor have we attempted to link the questions to specific NSE work packages.

General expectations

- Insights into the contribution of system integration and specific technologies to policy goals such as transition to renewables, climate targets, reduced costs and reduced ecological impacts (Good Environmental Status North Sea).
- Clear connections to existing studies to promote a consistent, common knowledge base.
- Dialogue and joint research about technologies affecting other users.

Roadmap

- Analysis of the benefits (and risks) of system integration in reducing costs and increasing the pace of decarbonisation and the energy transition.
- Insights into potential lock-ins and no-regrets.
- Knowledge of the cumulative impacts of various offshore activities on spatial demands and North Sea ecosystems.
- Particular focus on pros and cons of specific conversion and landfall options and locations (relation to hubs).
- Timing of infrastructure needs, including bandwidths for ‘no-regret infrastructure’ and windows of opportunity for reuse.
- Insights contributing to investment plans with a clear strategy and long-term perspective on industrial energy transition and decarbonization pathways.

Hydrogen

- Integrated analysis of the potential of electrons vs. molecules (not limited to hydrogen) and combinations considering the whole system from generation to use.
- The potential of offshore hydrogen production for cost reduction for wind farms further offshore.
- Improved insight into the relationship between green and blue hydrogen developments: synergies, risk of lock-ins and the potential role of blue hydrogen in developing the hydrogen market.
- Relative potential, benefits and risks of onshore production versus offshore production and import of hydrogen.
- Pathways and requirements for upscaling (offshore) hydrogen production.
- Solutions to legal challenges for hydrogen.

CCS

- Options, costs and timeline for CCS.
- Contribution to decarbonisation path
- Interactions with reuse: timelines, reuse platforms, pipelines, …
- Insight into the potential role of blue hydrogen in developing the hydrogen market (benefits and risks).

Reuse

- Value propositions for reuse of assets, including value to non-O&G actors and to society.
- Solutions to legal challenges for reuse.
- Additional insight into what infrastructure is crucial for what purposes in the future energy system, what other infrastructure could beneficially be reused and what infrastructure should be removed.
- Additional insights into the timelines of decommissioning and potential reuse and how these (mis)match.
- Ecological and environmental benefits of reuse versus decommissioning and new construction.

Hubs

- Potential, benefits and risks of different variants of hubs vs. 'one-by-one wind farms'.
- Insights into preferred locations and framework conditions for energy hubs.
- Coordination of spatial planning of offshore wind farms i.r.t. existing infrastructure and (onshore) users.
- Value propositions for multi-functional use of hubs.
- NSE will need to pay special attention to the role of CO_2-storage as part of a hub and to potential synergies and (spatial) conflicts between CO_2 storage and other hub activities.

Cross-cutting

- Insights into perceived policy barriers to system integration.
- Information on the ecological costs and benefits of North Sea system integration options, including effects on commercially relevant species for fisheries.
- Linking of findings on system integration to information on marine ecosystems in potential locations for wind farms and other activities (ecological baseline information).
- Knowledge of marine ecosystems and biodiversity on and around offshore installations.
- Spatial effects of technologies/assets, including the spatial costs or benefits of system integration and what types of (co-)use will be possible.
- Characteristics of future offshore installations (windfarms, platforms, hubs, etc.) and the required assets and expertise for developing these.
- Dissemination of insights and developments in current initiatives facilitating system integration.

5.2 Integrate perspectives

North Sea energy system integration encompasses and integrates many technologies, requires collaboration between many actors along the energy value chain, involves far-reaching investment decisions on long time scales, and will take place in an area where other sectors are competing for space and resources. For such an endeavour, societal support is crucial.

When the energy transition is considered in isolation, often the main objective will be formulated as: to reduce as much CO_2 emissions as possible for the lowest cost. System integration then simply becomes an optimization tool to reach that objective. While cost-effectiveness, in and of itself, is an important parameter for societal support, it is by no means the only one. Many energy technologies that have claimed to deliver the most "bang for the buck" (nuclear, CCS on land) have had to deal with strong opposition. While public acceptance is elusive and opposition to new developments can certainly not be avoided entirely, an approach that aims to maximize benefits for all the stakeholders involved – a win-win – is generally more successful.

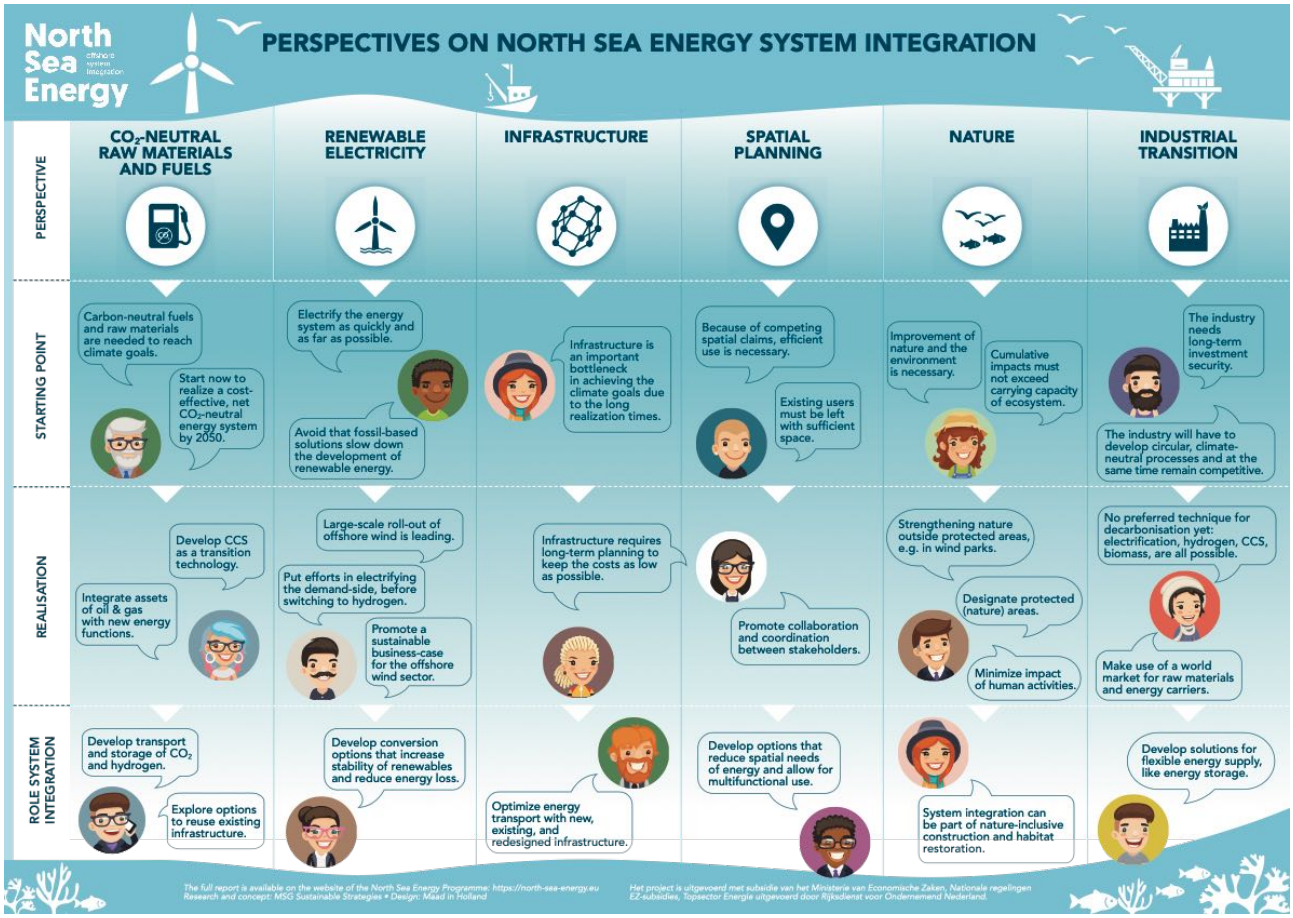


Figure 5.1. Perspectives on North Sea energy system integration

For specific projects this would require a dedicated stakeholder process to see how a choice of technical options, location, research and timing might contribute to the needs and concerns of other stakeholders. For system integration as a concept, it will help to integrate the values and perspectives of other stakeholders into a joint vision, roadmap or agenda. Especially the nature and spatial perspectives often tend to be overlooked in discussions about the energy transition, whereas these may eventually provide the most rigid barriers. The spatial impact of renewable energy as compared to fossil energy sources is one of the major challenges, continuously leading to conflicts with other users and ecosystem services, while regulations concerning nature conservation have, with the NOx-crisis, shown to form potential show-stoppers for new economic activities if these are not accompanies with reduction of other damaging activities and/or active efforts to restore ecosystem quality and resilience. Figure 5.3 shows this schematically. Table 3.1 provides concrete topics that can be used to find overlaps.

Appendix A Stakeholder interviews

A.1 Stakeholders

As part of this stakeholder analysis, we conducted sixteen interviews with stakeholders relevant to system integration on the North Sea. Table A.1.1 lists the interviewed stakeholders. When multiple people from a single organisation are listed, they were interviewed collectively. The green NGOs (Stichting De Noordzee and Stichting Natuur & Milieu) were consulted in a (simple) joint workshop rather than an interview.

Table A.1.1. Interviewed stakeholders along with their organisation and stakeholder groups.

Name	Organisation	Stakeholder group
Sjaco Pas	Coastguard	Policy makers/other users
Wouter van der Hilst	Coastguard	Policy makers/other users
Andreas ten Cate	Institute for Sustainable Process Technology	Demand-side industry
Marcelien Bos- De Koning	Burgemeester van Jouw Noordzee	Overarching perspective on various stakeholder groups
Egbert Kwast	Ministry of Defence	Policy makers, other users (military)
Tülay Berk	Ministry of Defence	Policy makers, other users (military)
Carla Robledo	Ministry of Economic Affairs and Climate Policy (EZK)	Policy makers
Karin Heijmen	Ministry of Economic Affairs and Climate Policy (EZK)	Policy makers
Liz van Duin	Ministry of Infrastructure and Water Management (I&W)	Policy makers
Wim van Urk	Ministry of Infrastructure and Water Management (I&W)	Policy makers
Huygen van Steen	Netherlands Enterprise Agency (RVO)	Policy Makers
Arendo Schreurs	NOGEPA	Oil and gas operators
Michiel Müller	North Sea Wind Power Hub	Infrastructure owners, offshore wind operators
Bastiaan Vader	NWEA	Offshore wind operators
Katja Naber - van der Aa	Port of Den Helder	Ports (incorporating various stakeholders)
Kees Turnhout	Port of Den Helder	Ports (incorporating various stakeholders)
Anne Geurts	Port of Rotterdam	Ports (incorporating various stakeholders)
Ruud Melieste	Port of Rotterdam	Ports (incorporating various stakeholders)
Heleen Vollers	Stichting De Noordzee	Green NGOs

Renate Olie	Stichting De Noordzee	Green NGOs
Michelle Prins	Stichting Natuur & Milieu	Green NGOs
Peter de Jong	Stichting Natuur & Milieu	Green NGOs
Thomas Donders	TenneT	Infrastructure Owners
Bob Meijer	TKI Wind op Zee	Policy makers, offshore wind operators
Pim Visser	VisNed	Other users (fishery)

A.2 Interview questions

In Dutch

Dit document dient als een leidraad voor de interviews en informeert u over de onderwerpen en de vragen die wij graag met u bespreken.

VERZOEK: In het kader van voorbereiding op het interview willen we u graag vragen om figuur 2, 'Perspectievenkaart' in dit document te bekijken.

Agenda voor gesprek

1. Introductie NSE programma
2. Introductie interview
3. Reflectie op de 'perspectievenkaart'
4. Vragen over systeemintegratie
5. Afsluiting

Introductie NSE programma

Europa is op weg naar een klimaatneutraal energiesysteem dat betrouwbaar én betaalbaar is. De Noordzee speelt hierin een sleutelrol. Eerst met olie- en gasproductie en nu in toenemende mate met hernieuwbare energie. De Noordzee biedt kansen voor grootschalige productie van windenergie en waterstof en ondergrondse CO2-opslag.

Het North Sea Energy programma (NSE) onderzoekt met ruim 30 (inter)nationale partijen hoe het potentieel van de Noordzee met een integrale aanpak benut kan worden voor een klimaatneutraal energiesysteem. Het programma onderzoekt de voordelen van slimme koppelingen tussen de verschillende energiefuncties op de Noordzee met de verwachting dat deze koppelingen de samenleving besparingen oplevert in geld, tijd, ruimtegebruik en versnelde reductie van de CO2-uitstoot.

In de afgelopen jaren heeft het NSE ondermeer het North Sea Energy Atlas ontwikkeld en onderzoek gedaan naar het potentieel voor waterstofproductie, CO2-opslag, energieeilanden/hubs, en de (on)mogelijkheden voor hergebruik van bestaande energie-infrastructuur. Ook is er gekeken naar de juridische aspecten van systeemintegratie. Zie hier een overzicht van de resultaten van het NSE in 2019.

Het doel van deze fase is eind 2022 een routekaart voor offshore systeemintegratie op de Noordzee richting 2050 op te leveren. Aan de hand van voorbeelden waarin de verschillende energiefuncties eenvoudig gecombineerd kunnen worden, doet het programma een haalbaarheidsstudie voor drie offshore locaties in de Noordzee die kunnen fungeren als energiehubs. MSG is partner in het consortium voor het NSE-programma en onderzoekt het maatschappelijke draagvlak voor verschillende aspecten van systeemintegratie op de Noordzee in het algemeen en voor specifieke energiehubs. Aan de hand van de resultaten van dit onderzoek kan het NSE-programma de verschillende stakeholders bij haar werk betrekken, op een manier, die past bij de behoeften van de betreffende stakeholder.

Gespreksleidraad en vervolg

Ten behoeve van ons gesprek hebben we onderstaande leidraad opgesteld, die wellicht behulpzaam kan zijn bij de voorbereiding. Het gaat nadrukkelijk om een losse leidraad voor het gesprek; wellicht zijn niet alle onderwerpen even relevant voor uw organisatie of zijn er andere onderwerpen, die hier niet zijn genoemd, maar die volgens u wel belangrijk zijn.

Na het interview maken wij een samenvattend verslag, die we terugsturen voor check en goedkeuring. Dit verslag wordt alleen met het onderzoeksteam gedeeld en verder verwerkt in een algemeen analyserapport, waarin informatie niet meer herleidbaar is tot individuele organisaties.

Introductie

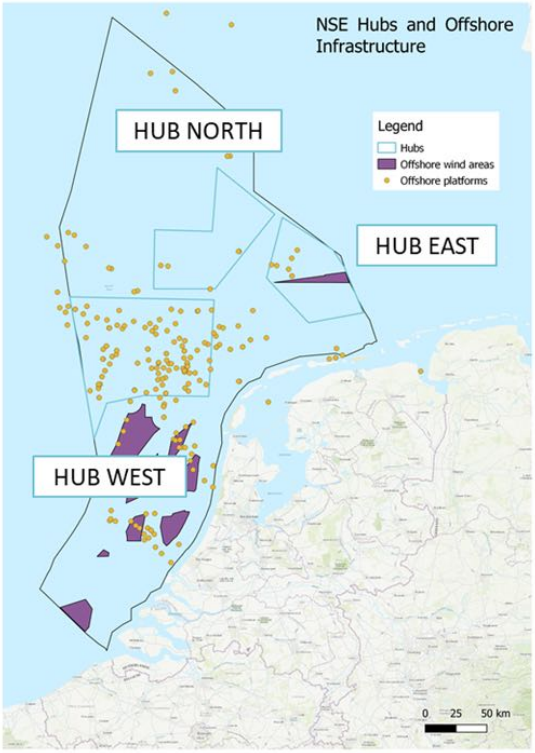
- Inleidende ronde gesprekspartner en MSG
- Op welke manieren is uw organisatie betrokken bij energie op de Noordzee?
- Hoe kijkt uw organisatie aan tegen systeemintegratie? Is dit een concept waar jullie veel mee bezig zijn? Op welke manier en met welk doel?

Reflectie op de 'perspectievenkaart'

- Korte uitleg doel perspectievenkaart
- Herkent u het perspectief (of perspectieven) van uw organisatie in dit overzicht?
- Bent u het eens met de algemene verklaringen in dit overzicht?
- Is er overige input die u wilt voordragen voor dit overzicht?

Vragen over systeemintegratie

- Wat ziet u als de belangrijkste ontwikkelingen op energiegebied, die in de komende decennia moeten plaatsvinden op de Noordzee?
- Voor 2030?
- Voor 2050?
- Hoe kijkt u tegen deze ontwikkelingen aan? Met enthousiasme, met zorg, met twijfels, …?
- Hoe ziet u de rol van uw eigen organisatie in deze ontwikkelingen? Op welke manieren wordt/is uw organisatie impacted hierdoor? En betrokken bij de besluitvorming? Op welke manieren zouden jullie in de toekomst graag een rol spelen?
- Voor welke klimaatneutrale technologieën is de Noordzee vooral van belang? Hoe zijn die technologieen onderling met elkaar verbonden – waar zitten afhankelijkheden en mogelijke synergieen? Waar zitten potentiele conflicten? En zijn er technologieen, die u vooral niet zou willen toepassen op de Noordzee of die elkaar uitsluiten?
- Hoe kijkt u aan tegen de kansen voor hergebruik van bestaande infrastructuur op de Noordzee (pijpleidingen, kabels, platforms, funderingen voor windturbines, …)? Wat kunnen daar de potentiele voor- en nadelen van zijn?
- Hoe kijkt u aan tegen energieontwikkelingen in verschillende delen van de Noordzee (zie kaart op de volgende blz) – waar zouden energiehubs kunnen ontstaan? Zijn er locaties die ongeschikt zijn (no-go areas)?
- Hoe kijkt u aan tegen de relatie tussen het gebruik van de Noordzee voor klimaatneutrale energieopwekking en de draagkracht van het ecosysteem van de Noordzee? Zijn er specifieke gebieden en/of soorten waar u bijzondere risico’s of kansen ziet?
- Welke kennis/informatie hebt u nodig, die wellicht in het NSE zou kunnen worden ontwikkeld en die voor u zou helpen om u beter voor te bereiden op de energietransitie op de Noordzee? Heeft een geredschap als de North Sea Energy Atlas voor uw organisatie toegevoegde waarde en zo ja op welke manier? Welke informatie zou er kunnen/moeten worden toegevoegd aan de atlas, die voor u nuttig zou kunnen zijn?
- Op welke manier zou u eventueel betrokken willen worden bij activiteiten van het NSE-programma? Zou u bijvoorbeeld feedback willen leveren op de routekaart of anderszins hierover willen meedenken? Of liever gewoon op de hoogte willen worden gehouden van de eindresultaten?



Figuur 2: Hubs & offshore infrastructure NSE

https://nse.projectatlas.app/atlas/introduction?map=52.84052,2.29924,5.68,0,0

Afsluiting

- Zijn er zorgen of wensen die we niet hebben besproken?
- Wat zijn belangrijke organisaties om mee te spreken in ronde 2 van de interviews?
- Welke deskundige belanghebbenden kunnen ons helpen om de betrokken stakeholders verder te analyseren?
- U ontvangt een verslag over de hoofdlijnen van dit interview. Wilt u hier naar kijken en aangeven of wij u goed hebben begrepen?
- We gebruiken het rapport voor een geanonimiseerde analyse. Kunnen we het rapport delen met ... ?
- De resultaten van onze analyse zullen worden opgenomen in onze uitgebreide analyse van de perspectieven van belanghebbenden.

Appendix B Desk research

In Dutch

B.1 Key word search

We hebben de zoekopdrachten uitgevoerd in het Nederlands, aangezien de focus van het onderzoek op Nederlandse stakeholders ligt. Wanneer relevante documenten in andere talen gevonden werden, zijn deze wel meegenomen.

Zoekopdrachten via Google zijn niet volledig reproduceerbaar, omdat Google de resultaten afstemt op de zoeker en op de relevantie die ze zouden hebben, bijvoorbeeld op basis van (veranderlijke) bezoekersaantallen. Om de key word search zo zuiver en reproduceerbaar mogelijk te maken, hebben we de zoekopdrachten uitgevoerd via Startpage. Dat gebruikt de resultaten van Google, maar presenteert deze anoniem.

Per zoekopdracht hebben we gekeken naar de eerste tien resultaten (zonder advertenties mee te rekenen). Relevante documenten en webpagina's daaruit zijn opgeslagen voor nadere analyse. De voorkeur ging daarbij uit naar onafhankelijk onderzoek, maar ook grijze literatuur, nieuws en stakeholderdocumenten zoals visies, position papers en persberichten zijn meegenomen.

Zoekopdrachten

De gebruikte zoekopdrachten bestaan uit de combinatie van 'Noordzee', een thema van het NSE-programma en een potentiële stakeholder. De zoekopdrachten zijn uitgevoerd op 17 maart 2021 en bevatten dus alleen resultaten tot die dag.

De thema's volgen uit de inhoud van de work packages van het vierde NSE-programma. Het zijn allemaal (deel)onderwerpen van systeemintegratie op de Noordzee. De thema's zijn:

- systeemintegratie
- energiesysteemintegratie
- CO_2-opslag
- CCS
- boorplatforms
- gasleidingen
- elektriciteitskabels
- elektrificatie
- waterstof
- aanlanding
- energiehubs
- kunstmatige eilanden
- windparken
- wind op zee

Voor de stakeholders onderscheiden we sleutelstakeholders en andere stakeholders. Voor sleutelstakeholders is op alle thema's gezocht, voor andere stakeholders alleen op de thema's 'systeemintegratie' en 'energiesysteemintegratie'. Op alle thema's is ook gezocht zonder een stakeholder te noemen.

De sleutelstakeholders zijn:

- industrie
- natuurgebieden
- windparken
- gassector
- overheid
- scheepvaart
- Gasunie
- TenneT

- visserij

De andere stakeholders zijn:

- Kustwacht
- Marine

Om zo relevant mogelijke zoekresultaten te vinden hebben we zoekwoorden gecombineerd met AND's en hebben we zoektermen die uit meerdere woorden bestaan verbonden met aanhalingstekens. De zoekopdracht naar scheepvaart en kunstmatige eilanden was dus bijvoorbeeld: *Noordzee AND scheepvaart AND "kunstmatige eilanden"*.

B.2 Additional sources

Om een completer beeld te krijgen zijn de resultaten van de key word search aangevuld met andere bronnen. Deze bronnen kwamen uit bestaande kennis en documenten van het NSE-programma, uit de interviews die gevoerd zijn met stakeholders en van de websites van belangrijke stakeholders en onderzoeksinstituten. Deze websites zijn kort doorzocht op documenten rondom systeemintegratie of voor de specifieke stakeholder relevante thema's. De websites van de volgende partijen zijn doorzocht:

- NWEA
- TKI Wind op Zee
- North Sea Windpower Hub
- TenneT
- Gasunie
- EBN
- NOGEPA
- VisNed
- Vissersbond
- ISPT
- Port of Rotterdam
- Port of Den Helder
- Kustwacht
- Defensie
- Waterstofcoalitie
- Stichting De Noordzee
- Natuur & Milieu
- Greenpeace
- Noordzeeloket
- NIOZ
- Deltares
- Wageningen Marine Research
- Netherlands Maritime Technology

North Sea Energy

offshore system integration