Netherlands Enterprise Agency

# Hollandse Kust (zuid) Wind Farm Zone

## *Wind Farm Sites I & II*

### Project and Site Description

October 2017

>> *Sustainable. Agricultural. Innovative. International.*

# Contents

# Foreword

**In 2016, the Netherlands embarked on its journey towards fulfilling its goal of adding 3,500 MW of new offshore wind power capacity by end 2023 to take the country's cumulative offshore total to 4,500 MW. Two tender rounds have so far been conducted, seeking bids from companies to win grants and project permits for developments with a combined capacity of 1,380 MW in the Borssele Wind Farm Zone.**

With this Project and Site Description (PSD) for Wind Farm Sites I and II of the Hollandse Kust (zuid) Wind Farm Zone (HKZWFZ), the country is implementing the lessons learned from the 2016 Borssele tenders and taking the next step in its five-year offshore wind tender programme. After the five-year offshore wind tender programme the Dutch Government has planned an additional seven-year programme of 1,000 MW of extra offshore wind power capacity each year. This has been formulated in the Energy Agenda of December 2016.

The first Borssele tender offered a combined total of 700 MW at Borssele Wind Farm Sites I and II (BWFS I and II), while the second offered 680 MW across BWFS III and IV. Now, as this PSD shows, work for the first request for tenders for projects in the HKZWFZ is firmly underway. As with the first Borssele tender, the first one for HKZWFZ will offer two 350 MW projects for development: one at Site I of the zone, the other at Site II.

This next tender round is scheduled for opening and closing in December 2017. The Government has published the Ministerial Order for Offshore Wind Energy 2017 in October 2017. This order sets out the final requirements for applications in the HKZWFZ tender and provides the legal framework to ensure companies can fully prepare a successful tender submission this year.

The aim of our offshore wind programme is not simply to add new capacity, but also to reduce the cost of electricity from offshore wind in a sustainable and socially responsible way. Our belief this can be achieved has been reinforced with the winning bids of DONG Energy Borssele I B.V. and Blauwwind II C.V. for the Borssele Wind Farm Sites. Our proactive strategy of reducing risk and costs for developers and operators by providing a stable market framework, taking on more of the pre-construction work ourselves, and appointing TSO TenneT to take on all the grid-connection infrastructure responsibilities, was clearly shown to work in those rounds.

Nonetheless, there can be no room for complacency. We have learned valuable lessons from the previous tenders and adapted our approach accordingly to help in our joint efforts with industry to maintain the downward cost curve.

Whilst a permit without any subsidy is in place for the HKZWFS I and II tender, The Netherlands Enterprise Agency, in Dutch known as RVO.nl, has increased its emphasis on providing more complete and high-quality site data compared to the process for the Borssele tenders.

In fact, with our new approach, RVO.nl has set a new global standard that acts as benchmark for governments worldwide. We followed a thorough quality assurance procedure for the HKZ site investigations, including verification against applicable standards by accredited certification bodies. DNV GL verified the metocean study, the soil investigations and the morphodynamic study. The metocean campaign was verified by ECN. The archaeology study was verified by RCE whilst the UXO report was verified by the Ministry of Defense.

We then also asked DNV GL to assess the overall package of site studies conducted with a view to awarding an overarching certificate confirming that the work has been conducted in line with industry best practice. The objective of this final procedure was to validate the quality of all the site studies and to ensure overall high quality, completeness and consistency between them and ensure the whole package forms a suitable basis for the preliminary design of offshore wind farms.

DNV GL's overarching certification report confirms that RVO.nl receives a statement of compliance regarding meeting the requirements of DNVGL-SE-0190:2015-12 (Project certification of wind power plants) with regards to its metocean investigations, geotechnical investigations and geological ground model, morphological investigations and wind investigation and that, in doing so, it has also fulfilled the Site Assessment Requirements listed in IEC

61400-22:2010-05 (Wind turbines – Part 22: Conformity Testing and Certification). It concludes "the site-conditions have been established correctly and that risks and uncertainties have been minimised according to state-of-the-art methods."

In summary, the results of the HKZWFZ site studies indicate conditions are perhaps even more favourable than at Borssele. HKZWFZ Site I and II are closer to shore than the Borssele sites (reducing transport distances and times for offshore wind installation vessels and maintenance crews), water depth is shallower whilst soil conditions (mostly sand) should allow for the use of simple foundation methods (eg monopiles). Furthermore, the extreme wave height is lower, as is the level of seabed dynamics. The combination of these favourable parameters and the more comprehensive data compiled by RVO.nl for developers to help in the preparation of their bids means we are optimistic that the downward cost curve for offshore wind can be maintained.

We have also expanded the coverage of this PSD, incorporating additional useful background information that should also further assist companies when they come to prepare their project bids. This includes an overview of the Hollandse Kust region and key stakeholders, plus an overview of our Dutch ports, which will prove instrumental in helping bidders reduce cost and increase efficiency.

The overall aim of our increased efforts is to further reduce risks for developers and stimulate design optimisation in the tender stage. With that in mind, we very much look forward to receiving cost-effective and innovative bid submissions that ensure economic, social and environmental benefits can be maximised for both the local communities of the Hollandse Kust region and for the Netherlands generally. We have no doubt that once again the wind industry will rise to the challenge and make 2017 another exciting year for offshore wind power in the Netherlands.

DNV·GL

# STATEMENT OF COMPLIANCE

Statement No.:
SC-DNVGL-SE-0190-02664-0

Issued
2017-03-21

Issued for:

**Site Conditions Assessment**

of

**Wind Farm Zone Hollandse Kust (zuid) (WFS I and WFS II)**

Comprising:

**Wind Turbines, Substation and Power Cables**

Specified in Annex 1

Issued to:

**Netherlands Enterprise Agency**

Croeselaan 15
3521 BJ Utrecht
The Netherlands

According to:

**DNVGL-SE-0190:2015-12**
**Project certification of wind power plants**

Based on the documents:

CR-SC-DNVGL-SE-0190-02664-2 Certification Report, dated 2017-03-21

Changes of the site conditions are to be approved by DNV GL.

**Hamburg, 2017-03-21**

**For DNV GL Renewables Certification**

**i.V. Fabio Pollicino**
Service Line Leader Project Certification

DAkkS Deutsche Akkreditierungsstelle D-ZE-11053-01-00

By DAkkS according DIN EN IEC/ISO 17065 accredited Certification Body for products. The accreditation is valid for the fields of certification listed in the certificate.

**Hellerup, 2017-03-21**

**For DNV GL Renewables Certification**

**Erik Asp**
Project Manager

The accredited certification body is Germanischer Lloyd Industrial Services GmbH, Brooktorkai 18, 20457 Hamburg.
DNV GL Renewables Certification is the trading name of DNV GL's certification business in the renewable energy industry.

# 1. Objectives and reading guide

## 1.1 Objectives

This Project and Site Description (PSD) is designed to help any party with an interest in participating in the planned permit tender for Hollandse Kust (zuid) Wind Farm Sites I and II (HKZWFS I and II) in the Hollandse Kust (zuid) Wind Farm Zone (HKZWFZ) in the Netherlands. This is the final version of the PSD and includes updated data (including maps and tables), site investigation results, and legislative decisions.

This document summarises:

A description of the site, surroundings and characteristics of HKZWFS I and II.

- All data collected by the Netherlands Enterprise Agency (RVO.nl) regarding the physical environment of the Hollandse Kust (zuid) area.
- A selection of constraints, technical requirements and grant related issues that are deemed to be most relevant for development of the Hollandse Kust (zuid) area.
- The process for the permit and the legal framework.

This document has been produced for information purposes only and is not intended to replace any legal or formally communicated rules, regulations or requirements. More information on the site studies, including all reports and other deliverables mentioned in this PSD, can be found at offshorewind.rvo.nl. When the tender is officially opened in December 2017, the application forms and related bid documents will be available to download at ***www.mijnrvo.nl***

## 1.2 Reading guide

This is the final version of the PSD for HKZWFS I and II. It presents an updated overview of all relevant information for parties interested in preparing a bid for a permit to build and operate wind farms at these sites. This PSD covers the following aspects in the different chapters:

Chapter 1: **Objectives and reading guide**

Chapter 2: **Hollandse Kust (zuid) - The region and the opportunities** - some background information on the region generally, including wind power development to date and what you need to know about doing business in this region.

Chapter 3: **Hollandse Kust (zuid) - Site I and II - site description** - general information on the HKZWFZ, the location, surroundings, its bathymetry (submarine topography), existing cable and pipeline infrastructure, nearby wind farms and TenneT grid connection system.

Chapter 4: **Site Studies** - an updated overview of all the studies and measuring campaigns performed to date on the HKZWFZ, covering the following:
- Obstructions: Archaeological desk study, Archaeological assessment of geophysical survey results, UXO risk assessment desk study
- Soil: Geological desk study, Geophysical survey, Geotechnical survey, Morphodynamical desk study and a technical note on scour
- Wind and Water: Wind Resource Assessment, Metocean assessment, Metocean measurement campaign.

Chapter 5: **Legal framework and specific requirements of the HKZWFS I and II permit tender** - an overview of the legal framework that is and will be implemented to facilitate the Dutch offshore wind programme rollout.

Chapter 6: **Specific requirements and relevant information from the legal framework** - an overview of the most relevant design parameters, coordinates, permit requirements found in the various acts, decrees, ministerial orders and Wind Farm Site Decisions (WFSD), described in chapters 3 and 5. It also provides an overview of the status of the framework. This overview does not replace any legal documents, but it aims to provide information that is relevant to prepare a tender bid submission in December 2017.

Chapter 7: **Next steps preparing a bid** - an overview of the process for receiving a permit, including key dates, useful links for further information or help (including those relating to the Dutch offshore wind programme, incentives and finance, and national and regional stakeholders), background information on Dutch energy policy and the State's role in reducing the cost of offshore wind, and an overview of Dutch ports.

Chapter 8: **Applicable documents** - this PSD contains three appendices, all updated as well, and a map of the Netherlands with the existing port and manufacturing infrastructure base which can be found as separate documents:

Appendix A: **Applicable Law**

Appendix B: **Summary of Environmental Impact Assessment HKZWFS I and HKZWFS II**

Appendix C: **Boundaries and Coordinates HKZWFS I and II**

Map: **Existing port and manufacturing infrastructure base**

# 2.
# Hollandse Kust (zuid) The region and the opportunities

**The Hollandse Kust (zuid) Wind Farm Zone (HKZWFZ) lies to the west of the Netherlands, offshore from the provinces of Zuid-Holland (South Holland) and Noord-Holland (North Holland). For companies involved in the development, construction and operation of the projects planned across the HKZWFZ, both Zuid-Holland and Noord-Holland will play key roles. This PSD therefore discusses both provinces.**

## 2.1 Regional overview

Zuid-Holland and Noord-Holland are the two most densely populated provinces of the Netherlands. Zuid-Holland includes the cities of The Hague, Rotterdam, Delft, Leiden and Dordrecht and is home to a population of 3.5 million people (and a labour force of 1.6 million people). Meanwhile, 2.8 million people live in Noord-Holland, with around 50% of those making up its labour force. The province of Noord-Holland is home to Amsterdam, the capital of the Netherlands, which alone attracts approximately 5 of the 6 million annual tourists that visit the province. Other cities are Haarlem, IJmuiden, Den Helder, Alkmaar.

Both provinces have proactive local and regional governments and flourishing economies thanks to a strong business base, attracting companies and people from all over the world. The Amsterdam Metropolitan Area alone counts 2,200 international companies and is home to 170 nationalities, for example. The gross domestic product (GDP) of Zuid-Holland alone, meanwhile, makes up 20.9% of the total GDP for the Netherlands.

Both Zuid-Holland and Noord-Holland are very well connected to the rest of the world with direct train connections to major European cities, two international airports and the key ports of Rotterdam in Zuid-Holland (Europe's largest port) and Amsterdam, IJmuiden, and Den Helder in Noord-Holland (see chapter 7 for more information on Dutch ports).

Both provinces are a hotspot for the maritime and offshore industry and energy R&D. Zuid-Holland, in particular, hosts one of the most diversified maritime clusters in the world, with 4,375 companies located there and some 70,000 employees (45% of the Dutch total). The cluster consists of companies active in design, shipbuilding, maintenance, asset owners, suppliers, maritime service suppliers and the world renowned university, Delft University of Technology (TU Delft), which is ranked among the top technological universities worldwide. Similarly the north of Noord-Holland has a significant industrial focus on maritime and offshore, along with energy (there have been over €6 billion of investments in offshore energy and maritime in the region over the last decade). The city of Den Helder, for instance, is known for being a centre of the offshore oil and gas industry while the northern Noord-Holland region is already a leader in the Dutch wind energy sector, with the port of IJmuiden in the North Sea Canal area being the base for the installation and maintenance of the Netherland's first three offshore wind farms, for example.

## 2.2 Wind power development in the Hollandse Kust region

In the province of Zuid-Holland there are currently 167 turbines installed with a combined capacity of 360 MW. Offshore there is the 129 MW Luchterduinen Wind Farm near Noordwijk (23 km offshore). The province has set an onshore wind goal of 735.5 MW installed by end 2020, as part of the Dutch national plan targeting 6,000 MW of installed onshore wind power within the same timeframe. Based on projects currently planned or under construction, however, Zuid-Holland is expected to exceed its goal, instead achieving an installed onshore total of 811 MW in 2020, rising to 833 MW in 2023.

In the province of Noord-Holland, there is currently 578 MW of wind power installed, 228 MW of that offshore at the OWEZ Wind Farm (10-18 km offshore , 108 MW) and the Prinses Amalia Wind Farm (23 km offshore, 120 MW). Onshore, the provincial goal is to increase capacity from the 350 MW currently operating (from 332 turbines) to 685 MW. This is being achieved via repowering projects, whereby older turbines are dismantled and replaced by a fewer number of quieter, larger capacity, modern models. Provincial regulations require that for each new onshore turbine installed, at least two older turbines should be dismantled. In this way, visual and noise intrusion can be minimised for the local community while energy sourced from wind power can be increased and produced more efficiently.

Around 450-500 MW of onshore turbines are currently being installed or planned onshore in the Wieringermeer polder to achieve the 685 MW target. This includes the 350 MW Wieringermeer wind farm repowering project. Located 60 km north of Amsterdam, comprising 100 turbines, it will be one of the largest onshore wind farms in the Netherlands - almost three times bigger than the Prinses Alexia Wind Farm inaugurated in 2013. Meanwhile, the Port of Amsterdam area will also contribute to the goal with an ambition to increase its onshore wind capacity to over 100 MW, up from 69 MW currently. Eneco and the Port of Amsterdam jointly operate the Afrikahaven onshore wind farm in the Western port area.

The projects planned under the Dutch Government's current offshore wind programme will boost the wind capacity in the two provinces of Zuid-Holland and Noord-Holland by 2,100 MW - 1,400 MW is planned in the HKZWFZ (700 MW at sites I and II which are the subject of this PSD and 700 MW at sites III and IV planned for tendering in 2018) and 700 MW off the coast in the Hollandse Kust (noord) Wind Farm Zone (due to be offered up for tenders in 2019).

Over the past decade, a complete value chain has been developed in both Zuid-Holland and Noord-Holland to install, operate and maintain offshore wind farms thanks to the growing cooperation between the onshore wind industry and the traditional offshore energy industry. For example, some well-known Dutch offshore dredging contractors and manufacturers which have their headquarters in Zuid-Holland, also lead market offshore installation of turbines and foundations globally.

Today, the onshore and offshore wind and offshore oil and gas sectors work very closely. Potential for further cooperation still exists, for example in the management of the complex construction/installation of projects, and in integrated design of masts and foundations. In Zuid-Holland and Noord-Holland there is a strong commitment amongst local business communities and regional authorities to strengthen that cooperation and drive the offshore wind sector forward. For example, recently a number of Rotterdam offshore companies signed a manifesto with the aim of strengthening the Rotterdam cluster and to indicate the commitment to the development of offshore wind energy, not only in construction but also in exploitation, maintenance and services. The port further aims to create an "Offshore Center Maasvlakte II", which will provide room for companies involved in offshore wind, offshore oil and gas and decommissioning. Similarly, in the North Sea Canal area, government agencies and local administrations, educational establishments, two seaports (Port of IJmuiden and Port of Amsterdam) and over 70 companies cooperate as part of the Amsterdam IJmuiden Offshore Ports (AYOP) initiative. AYOP facilitates offshore wind installation, operation and maintenance as well as services relating to electrical infra-structure. It has also recently launched a vocational education programme for wind technicians.

## 2.3 Support and opportunities in the Hollandse Kust region

The provincial administrations of Zuid-Holland and Noord-Holland value investments in offshore wind given the goals of the energy transition. The strengthening of this sector and the need for further innovation can be assisted by the knowledge clusters present in the West Holland region, while opportunities for growth exist and are welcome in the maritime clusters.

As the projects planned in the HKZWFZ are relatively close to shore (see Chapter 3), a good, open, working relationship between project developers and local stakeholders in the Hollandse Kust region is seen as paramount to ensuring success. The overall aim is to ensure any concerns by local community groups, such as those involved in tourism or fishing, are addressed while the potential benefits to the region resulting from the construction and operation of the wind farms are fully maximised.

This is, to some extent, legislated for in the Wind Farm Site Decisions for the zone (see Chapters 5 and 6), which contain regulations about how the region should benefit from the wind farm site developments. Regulation 2.16, for example, states that the developer must show how the design, construction and exploitation of the wind farm actively contributes to the regional and local economy. This might involve the use of harbours and its facilities, suppliers, supply of electricity directly to locals or local companies, collaborations with companies in the recreational and leisure sector, sponsoring, contribution to the local communities, the use of hotel rooms for employees etcetera.

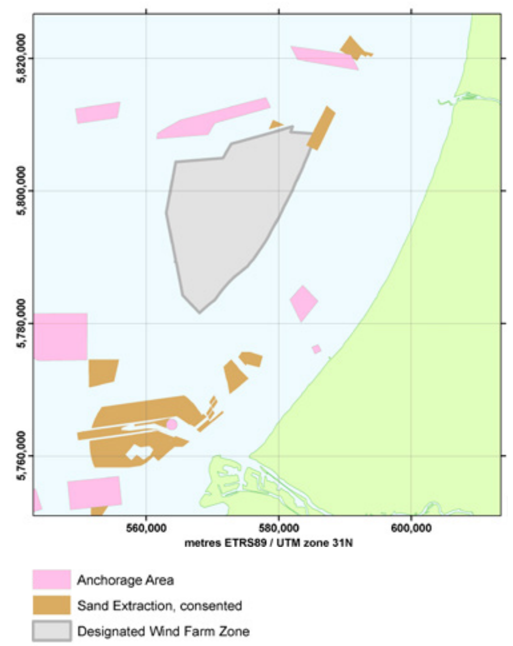
*For further background information about the Hollandse Kust region and wind power development in the Netherlands generally, including a list of key authorities and organisations, see Chapter 7.*

# 3. Hollandse Kust (zuid) Site I and II - site description

## 3.1 General description of the Hollandse Kust (zuid) Wind Farm Zone

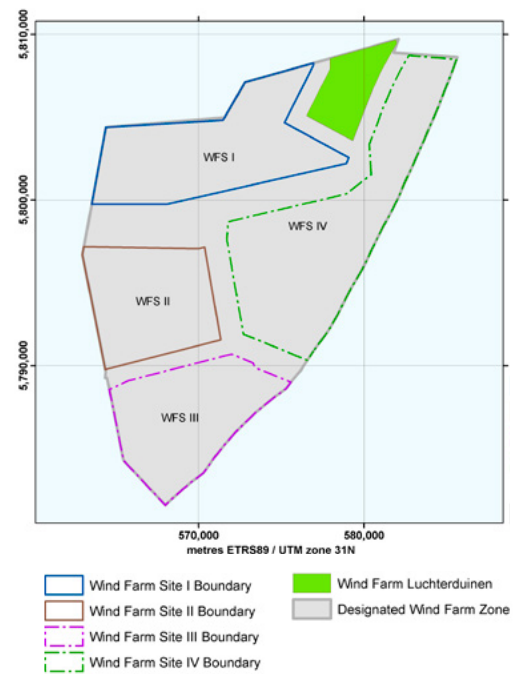
Covering an area of 235.8 km², the Hollandse Kust (zuid) Wind Farm Zone (HKZWFZ) shown below in Figure 3a is a designated wind farm zone located off the province of Zuid-Holland (South Holland). It is enclosed by the main shipping routes of IJmuiden and Rotterdam and the coastline. There is one sand extraction area bordering the north of the HKZWFZ, while others are in the vicinity of the HKZWFZ. In addition anchorage areas lie to the north and south. The HKZWFZ encloses the Luchterduinen Wind Farm, operational since late 2015, in the north eastern part of the zone (see section 3.3.2 for more information on the Luchterduinen Wind Farm).

**Figure 3a** *The Hollandse Kust (zuid) Wind Farm Zone and surrounding areas*




Four wind farms are planned for the HKZWFZ in total. This PSD relates to the two projects planned at Wind Farm Sites I and II (HKZWFS I and II). The two additional wind farms planned, HKZWFS III and IV, will be offered to tender in 2018 and, while they are shown in some of the illustrative figures, they are not the subject of this PSD. They are therefore not discussed further in this PSD.

**Figure 3b** *The Hollandse Kust (zuid) Wind Farm Sites I, II, III and IV*

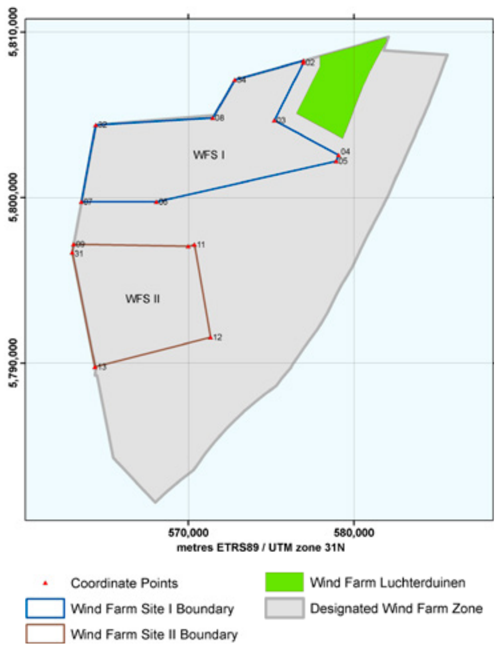



## 3.2 Layout and coordinates of HKZWFS I and II

The HKZWFS I covers an area of 67.2 km². The area includes the maintenance zones of infrastructure (active cables crossing the site and one planned telecom cable forming the northern border of site II and the south of site I). This reduces the effective area available for new wind farm construction. On this basis, the effective area available for HKZWFS I is 56.5 km².

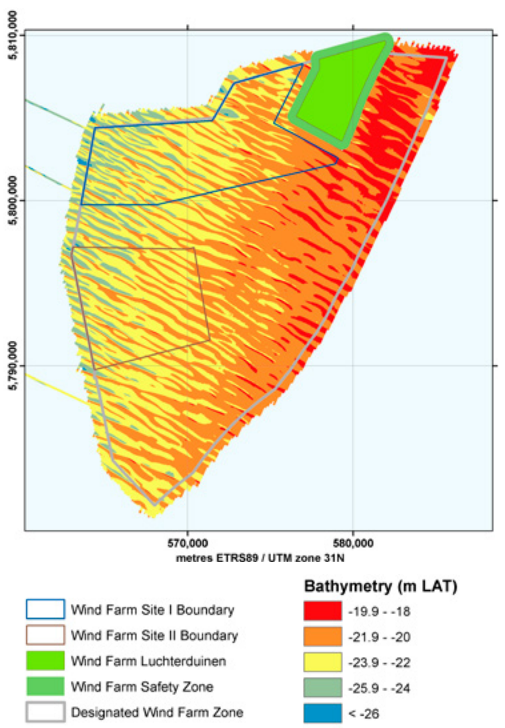
There is no existing or planned infrastructure crossing HKZWFS II - the effective area of HKZWFS II is 47.7 km². The maintenance zone for a planned telecom cable forms the northern border of site II. Figure 3c shows the boundaries of HKZWFS I and II and the Luchterduinen Wind Farm. All coordinates tables for boundaries, maintenance zones, infield cable corridors and safety zones are published in the Memo Boundaries and Coordinates. This memo, published in April 2017, can be found in Appendix C. The memo and related GIS files can also be found on ***offshorewind.rvo.nl***. All figures in this document are based on this reference.

**Figure 3c** *The Hollandse Kust (zuid) Wind Farm Zone and the corner coordinates of Wind Farm Sites I and II*




The water depth ranges from 18.1 m to 27.8 m with respect to Lowest Astronomical Tide (LAT) across HKZWFS I and 18.8 m to 26.6 m LAT across HKZWFS II. The bathymetry of HKZWFS I and II is shown in Figure 3d.

**Figure 3d** *Bathymetry of Hollandse Kust (zuid) Wind Farm Zone. Seabed levels are given in metres relative to Lowest Astronomical Tide (LAT)*

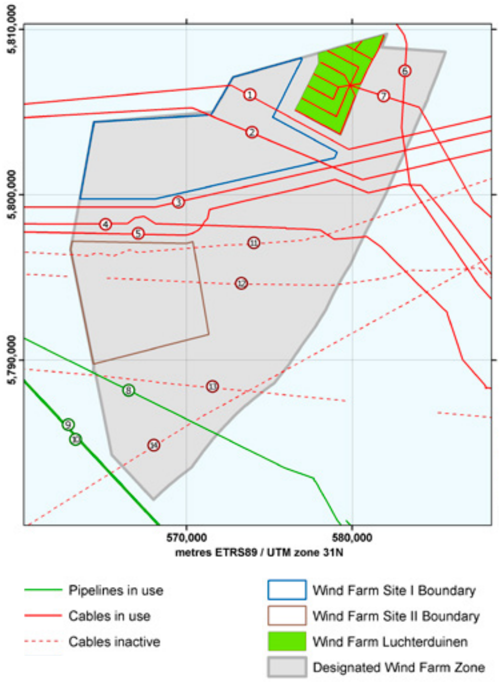



# 3.3 Existing infrastructure

## 3.3.1 Cables and pipelines

There are several existing and planned cables and pipelines (both active and inactive) crossing the wind farm zone. These can be seen in Figure 3e, while the characteristics of the different cables and pipelines are described in Table 3a.

**Figure 3e** *Existing infrastructure in the Hollandse Kust (zuid) Wind Farm Zone*




Two inactive cables (11 and 12) cross HKZWFS II. As they are no longer in use, they do not require maintenance zones and they are assumed not to affect the effective area. An overview of all the existing infrastructure can be found in the GIS files at: ***offshorewind.rvo.nl***.

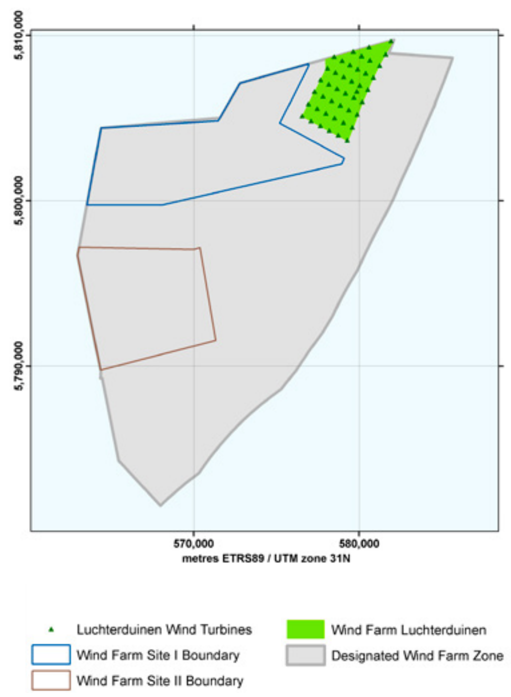
## 3.3.2 The nearby Luchterduinen Wind Farm

The Luchterduinen Wind Farm, commissioned late 2015 and operated by Dutch energy company Eneco, is located within the HKZWFZ. The 129 MW wind farm consists of 43 Vestas 3 MW V112 turbines which each have a tip height of 137 m. Figure 3f shows the lay-out of the Luchterduinen Wind Farm's turbines.

**Table 3a** *Description of pipelines and cables in the HKZWFZ*

| Cables in use | Name | Route | Material | Type | Status |
|---|---|---|---|---|---|
| 1 | Concerto 1 Segment 1 North | Zandvoort (NL) to Sizewell (GB) | Fibre Optic | Telecom | In use |
| 2 | Circe 1 North | Zandvoort (NL) to Lowesoft (GB) | Fibre Optic | Telecom | In use |
| 3 | Ulysses 2 | IJmuiden (NL) to Lowesoft (GB) | Fibre Optic | Telecom | In use |
| 4 | TAT14 Segment I | Katwijk (NL) to Saint Valery en Caux (F) | Fibre Optic | Telecom | In use |
| 5 | COAM | Cork (IR) to Katwijk (NL) | Fibre Optic | Telecom | Planned |
| 6 | TAT14 Segment J | Katwijk (NL) to Norden (D) | Fibre Optic | Telecom | In use |
| 7 | Luchterduinen | Noordwijk (NL) to Luchterduinen (NL) | Copper | Electricity | In use |
| Pipelines in use | | | | | |
| 8 | PL0228_PR | Q13a-A to P15-C | Pipeline | Oil | In use |
| 9 | PL0039_PR | P15-C to Hoek van Holland (NL) | Pipeline | Oil | In use |
| 10 | PL0099_PR | P15-D to Maasvlakte (NL) | Pipeline | Gas | In use |
| Cables inactive | | | | | |
| 11 | Hermes 1 | Zandvoort (NL) to Aldeburgh (GB) | Fibre Optic | Telecom | Inactive |
| 12 | UK - NL 6 | Katwijk (NL) to Covehithe (GB) | Coaxial | Telecom | Inactive |
| 13 | UK - NL 7 | Katwijk (NL) to Covehithe (GB) | Coaxial | Telecom | Inactive |
| 14 | Concerto 1 Segment 1 East | Zandvoort (NL) to Zeebrugge (B) | Fibre Optic | Telecom | Inactive |

**Figure 3f** *Location of the 43 turbines of the Luchterduinen Wind Farm*

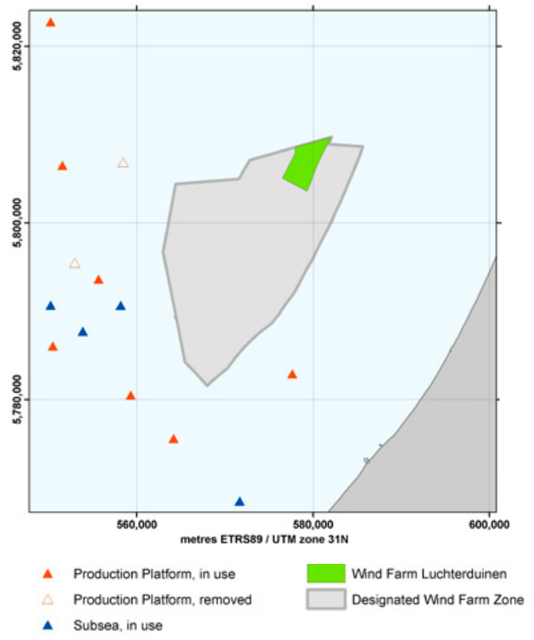



Wake effects from the Luchterduinen Wind Farm will have an impact on the energy yield of the wind farms that will be developed in the HKZWFZ and vice versa. This has been the subject of a study by ECN in August 2016 MHI called *Scoping analysis of the potential yield of the Hollandse Kust (zuid) wind farm sites and the influence on the existing wind farms in the proximity* (see ***www.ecn.nl/publicaties/ECN-E--16-021***). The OWEZ (Offshore Windpark Egmond aan Zee) and Prinses Amalia Wind Farm, located further away from the HKZWFZ, will have negligible impact on the energy production of wind farms in the zone. The wake effects of Luchterduinen on HKZWFS I and II will be taken into account in the wind resource assessment for the HKZWFZ (see Chapter 4). Appendix C includes detailed information about these wind farms.

## 3.3.3 Offshore oil and gas platforms

Several offshore oil and gas production platforms are located in the vicinity of the HKZWFZ, see Figure 3g. Terminal Manoeuvring Areas (TMAs) around Amsterdam Airport (TMA 1 and 2) and Rotterdam Airport (TMA 1 and 3) are also located above the HKZWFZ. These are approach control areas surrounding military and civil airports where traffic approaching the airport is controlled. These TMAs do not impose any building restrictions on the planned wind farms.

**Figure 3g** *Oil and gas production platforms in the vicinity of the Hollandse Kust (zuid) Wind Farm Zone*



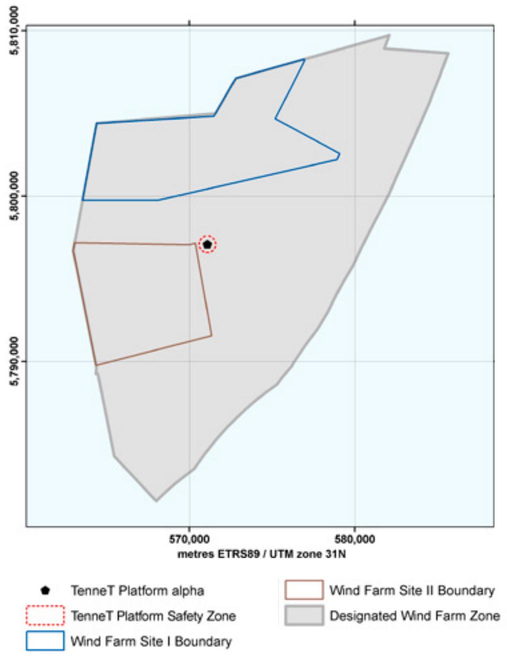

### 3.3.4 Exclusion zones

A 500 m safety zone is defined around the Luchterduinen Wind Farm and the HKZWFZ (see Appendix C). No construction ships or building activities are allowed in this safety zone. Pipelines and cables, including their maintenance zones (500 m on both sides of the pipelines/cables), are also excluded from the different sites (see Appendix C). The turbines need to be constructed and located in such a way that their blade tips are within the site boundaries. There are not any shipping corridors within the HKZWFZ. However, under the National Water Plan 2016-2021, vessels up to 24 m are allowed to cross the entire area.

## 3.4 TenneT offshore grid connection system

The planned Hollandse Kust (zuid) alpha platform is shown in Figure 3h, while Table 3b shows its coordinates. Infield cables from the wind farm will connect directly to this station. Cable entry zones are designated as the area to place infield cables connecting the wind farms at HKZWFS I and II to the Hollandse Kust (zuid) alpha platform. These zones are confirmed for HKZWFS I and II in the Wind Farm Site Decisions. The Hollandse Kust (zuid) alpha platform will transform the power of HKZWFS I and II from 66 kV to 220 kV and transport the electricity to shore through two export cables. The preferred route has been decided; the export cables will connect to the to be built onshore substation Maasvlakte-Noord. A table in Appendix C shows the border coordinates of the export cable corridor.

**Figure 3h** *The location of HKZWFZ TenneT alpha platform*

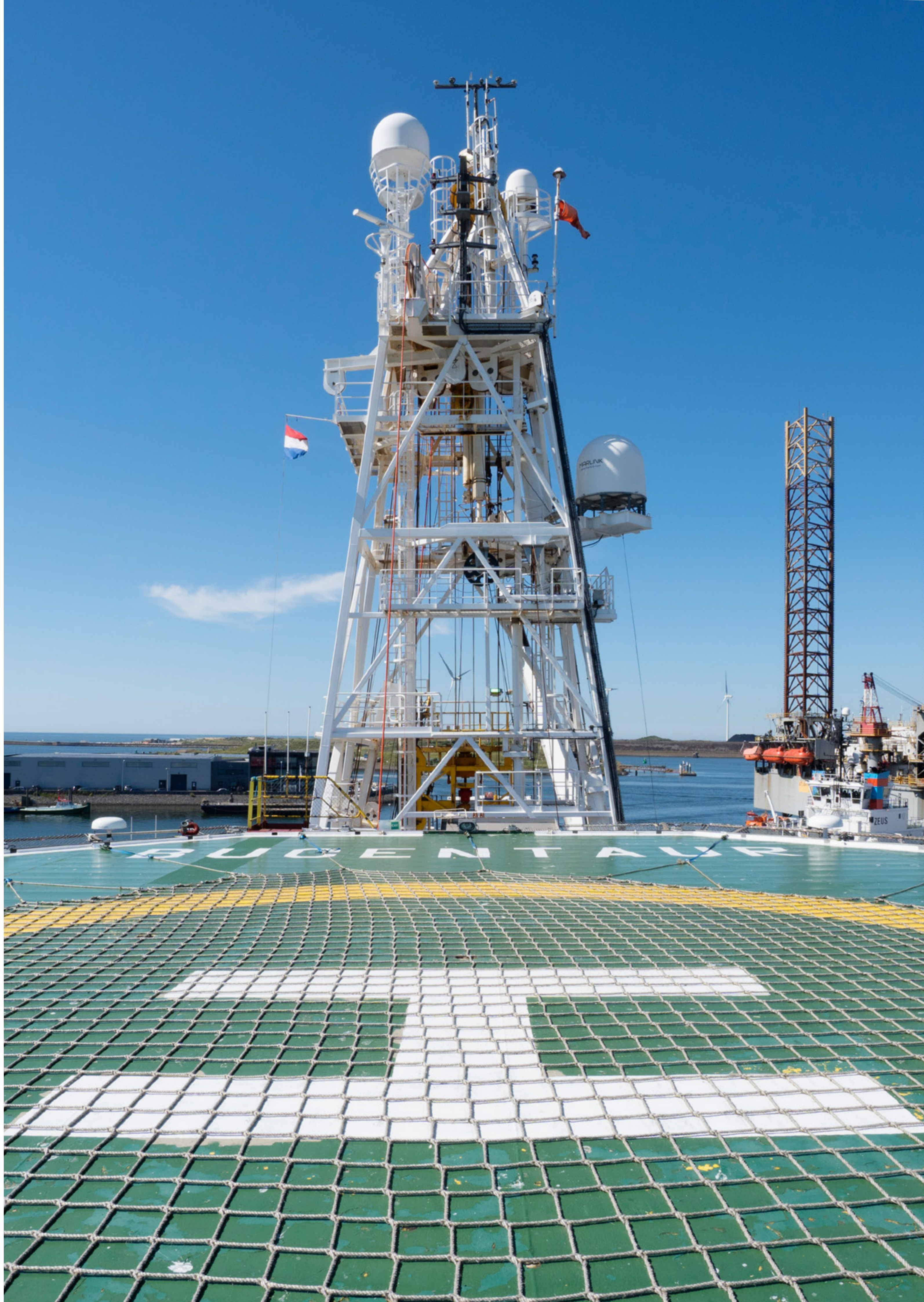



The first part of the Environmental Impact Assessment documents and other documents related to spatial planning and licensing for grid connection system Hollandse Kust (zuid) have been published in 2017 under the 'Rijkscoördinatieregeling'. Regular updates regarding the project status can be found at: ***netopzee.eu/hollandsekustzuid***

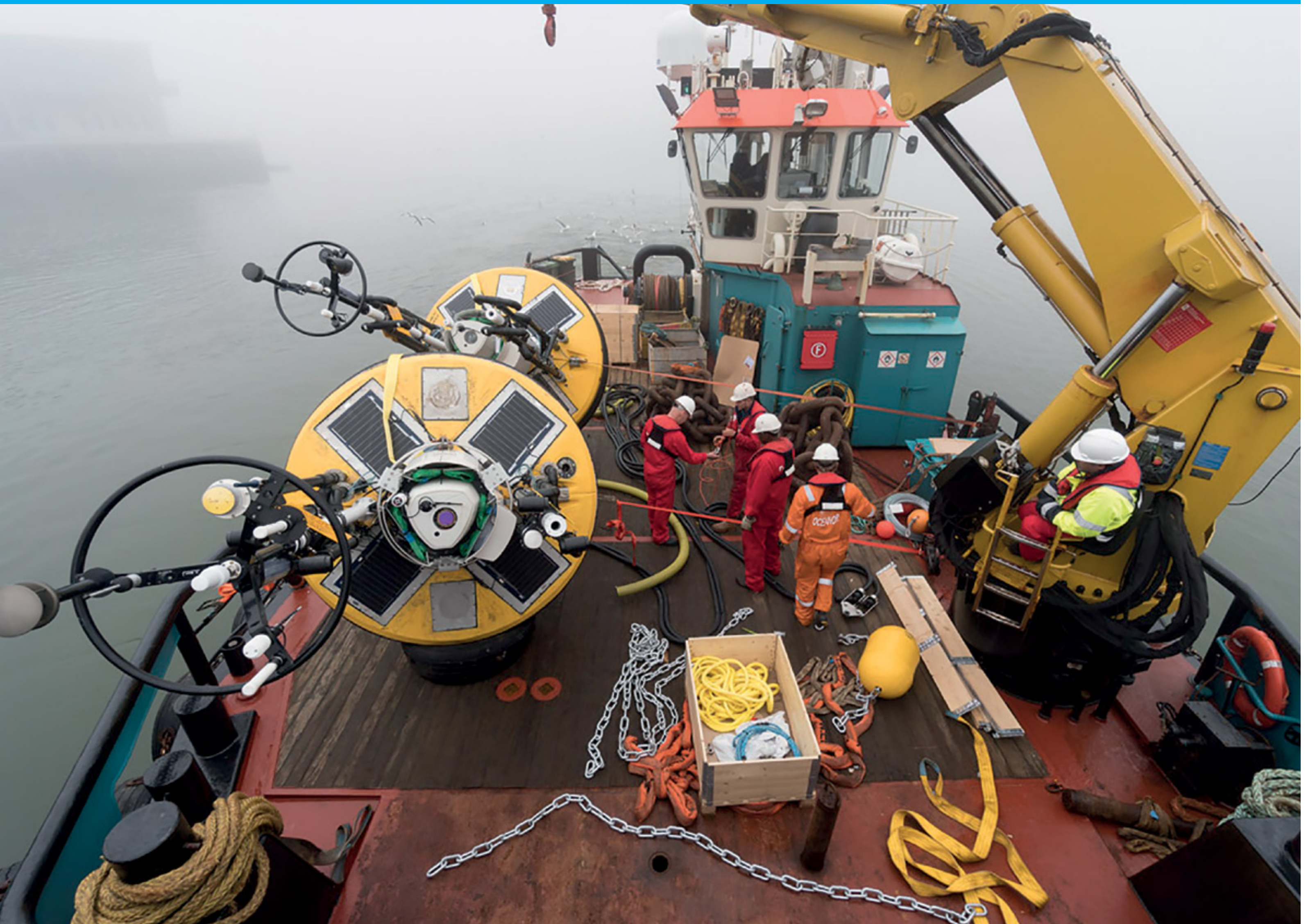
**Table 3b** *Coordinates HKZWFZ alpha platform by TenneT*

UTM (ETRS89, zone 31)

| TenneT platform | Easting | Northing |
|---|---|---|
| Alpha | 5,71100.0 | 5,797,090.0 |



# 4. Site Studies



**The Netherlands Enterprise Agency (RVO.nl) is responsible for publishing the site information companies require to prepare bids for the permit tenders for the HKZWFZ. The site information package should be of sufficient detail and quality to be used as input for preliminary engineering design studies.**

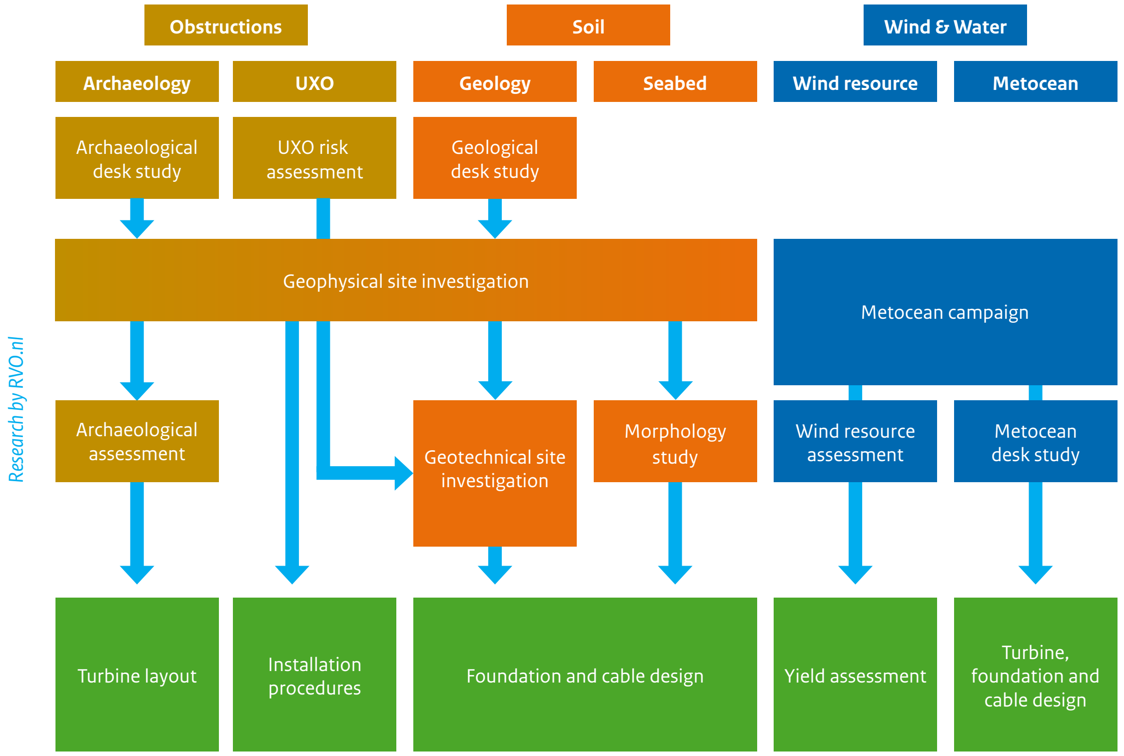
Results from previous tenders show that this approach will provide the basis for an optimal tender result. In providing a more comprehensive data package, risk is significantly reduced for the developer, as is the need for conservatism in the assumptions of the tender design, while the business case for the project and the overall planning can be optimised. In this chapter, the scope of work and results of the individual studies and investigations are summarised, covering the following:

- Obstructions: Archaeological desk study, Archaeological assessment of geophysical survey results, UXO risk assessment desk study
- Soil: Geological desk study, Geophysical survey, Geotechnical survey, Morphodynamical desk study and a technical note on scour and scour mitigation
- Wind and Water: Wind Resource Assessment, Metocean measurement campaign, Metocean desk study

Figure 4a shows how the various studies and investigations relate to each other as well to which element of the wind farm design they feed into.

The findings of the archaeological, UXO and geological desk study were used to define the scope of work and basis of the geophysical site investigation. The results of this more detailed geophysical site investigation refine and partly supersede those of the three earlier desk studies and further feeds into the main archaeological assessment (now completed), the geotechnical site investigation and the morphodynamical study. Meanwhile, the wind resource assessment takes into account the findings of the metocean measurement campaign. Please note that this version of the PSD for HKZWFS I and II includes a summary of the results of all final studies and site investigations.

**Figure 4a** *Site studies and investigations for the Hollandse Kust (zuid) Wind Farm Zone*



In the remainder of this Chapter, we provide an overview of the site studies and investigations. In sections 4.1 - 4.8 we discuss the studies and investigations regarding obstructions and soil conditions, while in sections 4.9 - 4.11, the studies and investigations relating to wind and water conditions (metocean campaign, metocean desk study and Wind Resource Assessment) are discussed. Lastly, a detailed overview of the approach, the procurement of the studies and quality assurance follows in section 4.12 (site investigations quality and certification).

## 4.1 Archaeological desk study

### 4.1.1 Overview - aims, objectives and approach

The purpose of this study was to provide insight into any archaeological aspects that may have an impact on the development of the HKZWFZ using existing data and information gathered from previous research in the area. The main objectives of the study were to:

1. Assess whether archaeological remains (e.g. plane and ship wrecks or prehistoric life) are (or likely to be) present at the HKZWFZ;
2. If present, present the known information (location, size and dating) of these remains;
3. Assess possible risks of offshore wind farm installation on these remains;
4. Assess options to mitigate disturbance on these remains;
5. Determine whether further archaeological assessments should be carried out and make a recommendation on the scope of future investigations;
6. Specify obligations and requirements for any activity carried out in the wind farm zone (including site investigations or monitoring activities, installation activities and operational activities) that may affect the archaeological aspects.

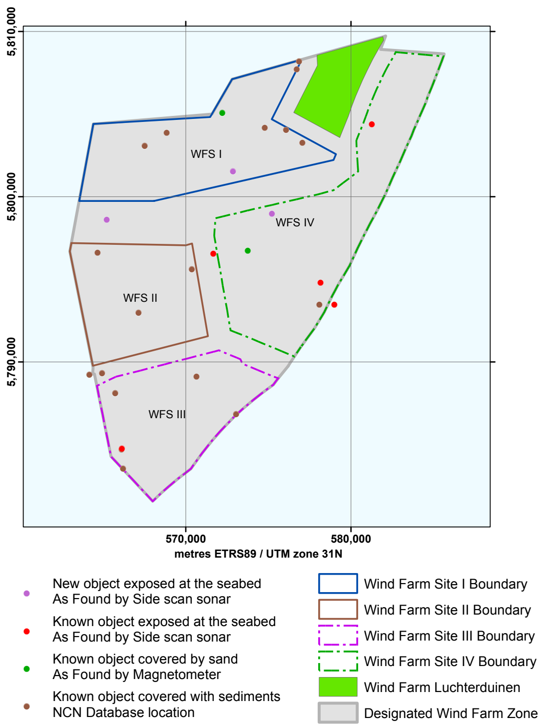
### 4.1.2 Supplier

Periplus Archeomare was assigned by RVO.nl to conduct a maritime archaeological assessment of the HKZWFZ. This company has a track record in maritime archaeological preparatory research, most notably the archaeological desk study and assessment of geophysical data for the Luchterduinen Wind Farm and a desk study for a fibre optic subsea cable to be installed later, both of which are located within HKZWFZ. Moreover, Periplus Archeomare conducted similar desk studies for the site of Borssele, Tromp-Binnen and Q4 (permit does not exist anymore).

### 4.1.3 Results

The results of this desk study indicated that, within the HKZWFZ as a whole, the presence of ship and plane wrecks (mostly resulting from WWII) is likely. For example, 19 shipwrecks are known to be in the area, although details like names, types and date of sinking are not known, nor are the exact locations. The desk study also concluded that locally, in situ remains of prehistoric sites may also be present. Meantime, Periplus Archeomare found two previous geophysical surveys of the area - one covering 5% of the area for the Luchterduinen Wind Farm and the other for Delta Hydrocarbons (2% of survey area). Just three objects were classified as of possible archaeological value, all identified in the Luchterduinen survey. Over 90% of the surface of the HKZWFZ has not previously been investigated by detailed geophysical surveys.

**Figure 4b** *The maritime archaeological desk study of the Hollandse Kust (zuid) Wind Farm Zone suggested that 19 known shipwrecks could be present in the area. However none of these were detected in the geophysical survey*



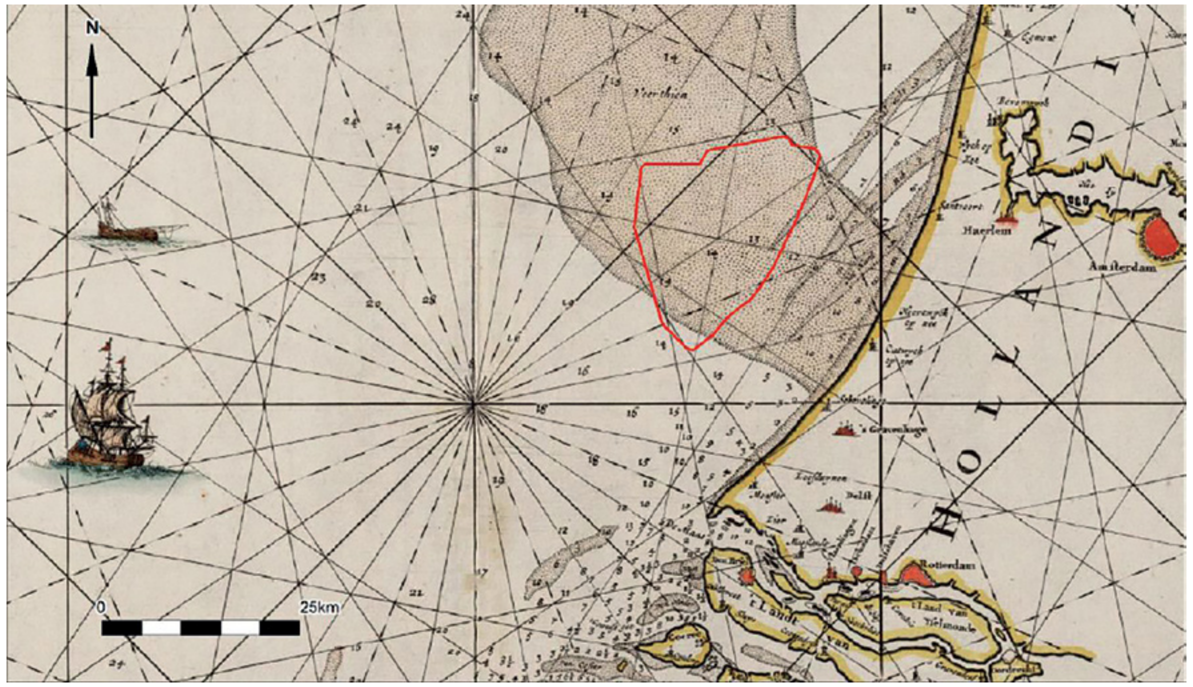

### 4.1.4 Conclusions and recommendations

Within the investigated area of the wind farm zone there is a high probability for the presence of (remains of) ship and plane wrecks, mostly resulting from WWII. During the geophysical survey no wrecks have been detected in HKZWFS I and II, see 4.4.3b. No early prehistoric sites have been identified but these might be present. Periplus Archeomare recommended that further exploratory field investigation should be conducted in order to:

- Map the locations of known and unknown wreck sites in detail to be able to assess their archaeological value; and
- Create an inventory of the parts of the HKZWFZ which have not been investigated in previous surveys.



**Figure 4c** *Historic chart of the Hollandse Kust (zuid) Wind Farm Zone and its surroundings*




The findings of this desk study have served as a starting point for subsequent investigation, most notably the geophysical site investigation (section 4.4) and, following that, an archaeological assessment of the geophysical site investigation (section 4.5). The results of this desk study are now to large extent superseded by the findings of these reports.

## 4.2 Unexploded ordnance (UXO) risk assessment desk study

### 4.2.1 Overview - aims, objectives and approach

The UXO desk study provided the initial insight into the risk of encountering unexploded ordnances (UXOs). The main objectives of this study were to:

1. Identify risks and/or constraints for offshore wind farm related activities in the HKZWFZ as a result of the presence of UXOs;
2. Identify areas within the HKZWFZ where wind farm construction or cable installation should be avoided;
3. Identify requirements from a UXO perspective that should be taken into account for:
   - Determining the different sites in the wind farm zone;
   - Carrying out safe geophysical and geotechnical investigations;
   - Safe installation of wind turbine foundations;
   - Safe installation of cables.

The UXO desk study was performed in Q4 of 2015. In Q1 of 2017 the study was extended with an additional report containing newly available information from historical archives of the Bundesarchiv-Militärarchiv in Germany and The National Archives in the United Kingdom. The new information provides more details regarding the type of ordnances (mines) to be expected in the area and recommendations for UXO detection operations that follow from this new information.

### 4.2.2 Supplier

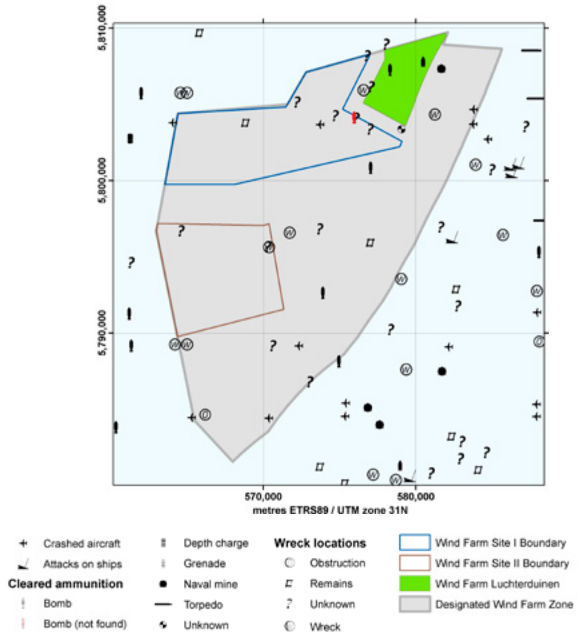
REASeuro performed the UXO desk study including the additional report. The company is specialised in (offshore) UXO desk studies, risk assessments and UXO clearance operations. Since 2012, REASeuro has been involved with several offshore projects in the North Sea and Persian Gulf, performing data analysis, project risk assessment and coordination of UXO clearance activities. Moreover, the company has performed the UXO desk study for the Borssele Wind Farm Zone, the previous tender location of the Dutch offshore wind rollout.

### 4.2.3 Results

The HKZWFZ and surrounding areas were the scene of many war-related activities during World War I and World War II. Additional historical research has shown that intense mining operations took place in and near the HKZWFZ in World War I and in World War II, but the mines were only partially recovered after the war. In addition, the HKZWFZ is located slightly north of the main flight path of allied bomber raids - many bombs were dropped and a large number of aircraft have crashed in the North Sea. As a result many bombs, wrecks and crashed aircraft are likely to be found in the HKZWFZ. a few types of mines that may be present in the HKZWFZ, according to the consulted historical sources, are German moored mines, German LMB ground mines, British Mark XIX contact mines and British Mark XVII moored mines.

It must be taken into account that this overview is based on the minefields actually present in (the vicinity of) the area of investigation. Since the war, some ordnances are likely to

**Figure 4d** *An overview of all known wreck locations and cleared ammunition in the vicinity of HKZWFZ*




have moved as a result of fishing, wave and current loads and seabed dynamics. The entire wind farm zone is considered a UXO risk area. This conclusion is supported by the fact that since 2005 fishermen have found eight UXOs within the HKZWFZ. However the types of mines mentioned in the additional research are considered the most plausible types of mines to be present. An overview of all known wreck locations and cleared ammunition in the vicinity of HKZWFZ can be found in figure 4d. Note that locations of crashed aircraft are only indicative.

A UXO can be sensitive to hard jolts, change in water pressure and accelerations with an amplitude >1m/s². Detonation can lead to serious damage to equipment and injuries to crew members. The possible presence of UXOs in the area, however, is no constraint for offshore wind farm related activities. With proper UXO risk management strategies, risks can be reduced to a level that is as low as reasonably practicable (ALARP).

A main challenge in UXO risk management at HKZWFZ is the dynamic character of the seabed (see section 4.7, morpho-dynamical desk study). This may cause UXOs that were buried during preliminary scanning to resurface and become subject to migration. Also sand dune migration may have led to burial of UXOs. Furthermore, migration of UXOs may occur as a result of waves and currents or fishing activities. The possibility of UXO migration and burial needs to be considered in all development phases and closely integrated into the UXO risk management strategy.
The report provides a number of recommendations to manage UXO risks in each development phase:

1. Preparation phase
   a. A geophysical survey should be conducted to assess geomorphology and identify objects, consisting of at least a high-resolution multibeam and side scan sonar. This has now been completed, with the results now superseding those of this UXO desk study - see section 4.4.
   b. In case of any soil intrusive operations (e.g. anchoring, CPTs or boreholes), a UXO search of the area of planned activity should be conducted and any discovered UXOs should be cleared or avoided. The clearance operation should be conducted by a certified UXO clearance company (see 4.2.5).
2. Execution Phase
   a. A UXO-related risk assessment should be prepared based on the first draft of the wind farm design and optimisation of the design may be performed based on the outcomes.
   b. A UXO risk mitigation strategy should be prepared, which includes a search for and safe removal of UXOs within the areas of planned activity. Because the validity of the collected data is time-limited, it is recommended that the period between the survey and installation work is minimised.
3. Operational phase
   a. After completion of construction activities, it is still important for developers to remain vigilant and remember that UXOs can migrate as a result of loads from tidal currents and waves, mobility of sand waves and seabed usage.
   b. Produce a UXO maintenance and monitoring plan.

### 4.2.4 Conclusion and recommendations

UXOs from both world wars are likely to be present at the site, which is therefore considered a UXO risk area. Due to the types and sizes of UXO likely to be present there is no 'silver bullet solution' for the UXO geophysical survey. Especially the possible presence of non-ferrous ground mines (LMB) might necessitate a combination of geophysical survey methodologies to mitigate UXO related risks to a level that is considered ALARP. The provisional thresholds in the geophysical survey needed to mitigate the risk to a level that is considered ALARP are set.

Due to the highly dynamic soil morphology and possible associated migration and burial of UXOs, it is recommended companies conduct UXO search (and removal) operations immediately prior to construction activities at the intended construction locations. The limited temporal validity of the collected survey data should be taken into account when planning survey and construction operations. Due to the time-limited nature of findings and the required survey demands (dense grid spacing), a dense magnetometer survey to detect UXOs was not part of the geophysical survey performed by RVO.nl. However, the survey does include a magnetometer survey on a grid spacing of 100 m.

### 4.2.5 UXO removal procedure

If a wind farm developer identifies a UXO at a location where activities are planned, it needs to be removed. This should be reported to the Dutch Coastguard. The Royal Netherlands Navy will dispose of the UXO. No disposal costs will be charged to the wind farm developer.

## 4.3 Geological desk study

This study was the starting point for several other studies. However, more in-depth geophysical and geotechnical site investigations have since been conducted hence the desk study is not described further in this PSD.

## 4.4 Geophysical survey

### 4.4.1 Overview - aims, objectives and approach

Following up on the findings of the geological desk study and the archaeological desk studies (discussed earlier in this chapter), the objective of the geophysical survey is to provide more detailed, accurate soil information for developers planning to submit tenders for HKZWFS I and II.

The geophysical survey is designed to improve the bathymetrical, morphological and geological understanding of HKZWFS I and II. Furthermore the geophysical results were used for the planning of the geotechnical campaign, which was integrated with the geophysical data to create a ground model. The ground model will serve as the base for the design and installation of support structures and cables.

Specifically, the aim of the geophysical survey is to:

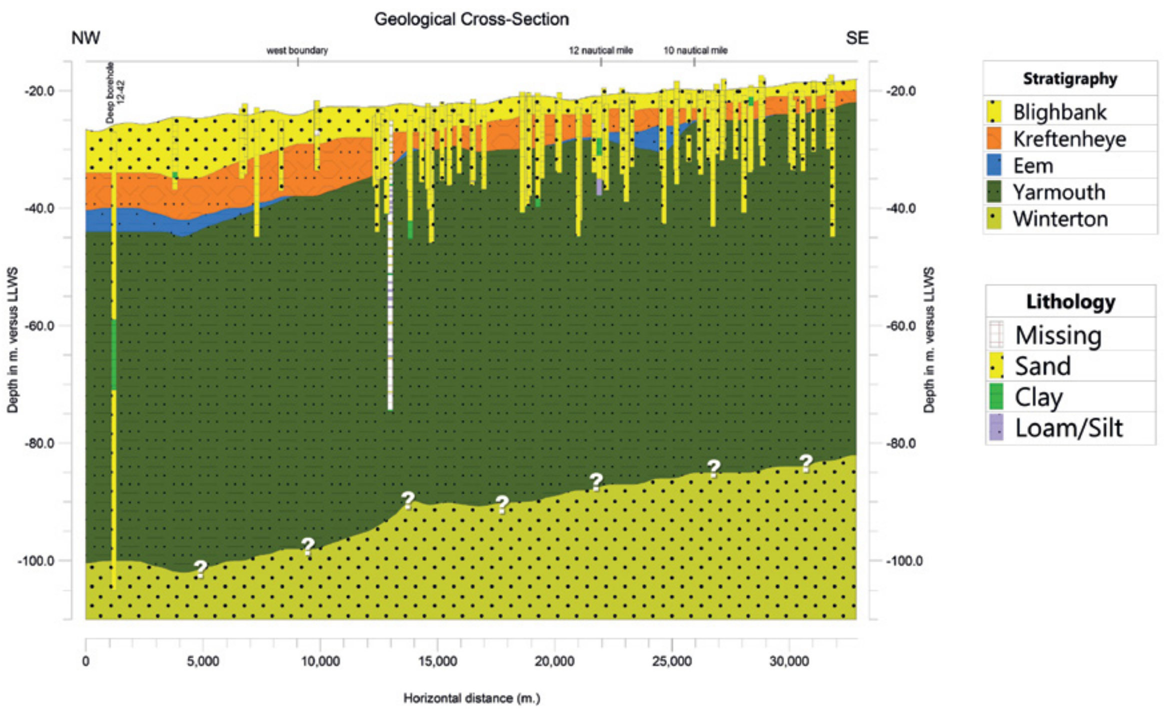
1. Obtain an accurate bathymetric chart of the development areas HKZWFS I and II;
2. Identify or confirm the position of wrecks, pipelines, possible electrical cables, and natural objects;
3. Produce isopach charts showing the thickness of the main geological formations including any mobile sediments and any other significant reflector levels which might impact on the engineering design;
4. Locate and identify any structural complexities or geohazards within the shallow geological succession such as faulting, accumulations of shallow gas, buried cables, etc;
5. Provide detailed geological interpretation showing facies variations and structural feature changes via appropriate maps and sections;
6. List the exact position of existing (active & inactive) cables and pipelines;
7. Provide proposed positions for a geotechnical sampling and testing programme following the completion of the geophysical survey;
8. Prepare a comprehensive interpretative report on the survey results in order to assist design of the offshore foundations/structures and cable burial and assist in the preparation of the geotechnical investigation (discussed in section 4.6).

The survey itself was carried out from 7 March to 18 April 2016, using the survey vessels MV Fugro Pioneer and MV Victor Hensen with Scheveningen used as the main reference port. The equipment used in this campaign was state-of-the-art and included sidescan sonar (SSS), single beam echo sounder (SBES), multibeam echo sounder (MBES), pinger (SBP), ultra high resolution (UHR) multichannel and single channel seismic (SCS) and magnetometer (MAG). The approach towards the geophysical survey for the HKZWFZ was therefore similar to the one adopted for the Borssele Wind Farm Zone.
An important distinction, however, is the application of UHR MCS with a mix of two seismic sources: this improves the resolution in the shallow subsurface.

### 4.4.2 Supplier

Fugro Survey B.V. was contracted by RVO.nl to conduct the geophysical survey for HKZWFZ. Fugro is an integrator of geotechnical, survey, subsea and geosciences services.

**Figure 4e** *Geological Cross Section of the HKZWFZ*




Services are designed to support engineering design and large structure building projects. The company has previously performed investigations for offshore wind farm projects in The Netherlands, Belgium, United Kingdom, Denmark and Germany. The company is familiar with the local conditions and technical requirements for a geophysical survey of the HKZWFZ. DNV GL was contracted to review the study results and provide a Verification Report.

### 4.4.3 Results

*4.4.3a Bathymetry and seabed features*

The bathymetry data from the geophysical survey shows water depth ranging from 18.1 m to 27.9 m bLAT across HKZWFS I and 18.8 m to 26.6 m bLAT across HKZWFS II, whilst the seabed for both sites is characterised by very large sand dunes. These dunes were observed throughout both areas with NW to SE trending crests with wavelengths ranging from 250 - 1050 m for HKZWFS I and 300 - 900 m for HKZWFS II, and height ranging from 2 - 6 m for HKZWFS I and 2 - 5 m for HKZWFS II. At both sites, medium sized dunes are superimposed on the very large dunes and have the same crest orientations. They have 4 - 20 m wavelengths and are typically 0.2 - 0.4 m in height.
The very large sand dunes are expected to migrate at a rate of 2 - 4 m/year in a north-easterly direction.

The shallow sub-surface geological conditions within the survey areas for HKZWFS I and II were interpreted based on single channel and multichannel UHR sparker data and information from BGS standard geological maps. The limit of interpretation of the UHR data to achieve satisfactory results was set at a depth of 100 m below seabed. Four lithological units were identified in each area with generally similar results identified across the two sites: sediments found within the two top units/layers at both HKZWFS I and II mostly consist of medium to coarse sand with shells and shell fragments, silt, clay and gravel. These were all also found in the lower two units although generally they tend to be of a finer consistency (material) here. Thin layers of peat were also detected in these lower level units at both sites.

*4.4.3b Wrecks, cables and pipelines*

In order to confirm and/or identify the presence of wrecks, cables and pipelines at HKZWFS I and II, Fugro was provided with a database listing those believed to be in the vicinity. Fugro was also provided with the desk studies previously mentioned in this chapter. Key results of its geophysical survey were:

- No wrecks detected at either site
- No pipelines at HKZWFS I

One pipeline lies adjacent to HKZWFS II, the survey confirmed. This is the ENGIE Q13a-A to P15-C 8 inch oil pipeline, identified by magnetometer data in the location cited in the database provided. Four active telecom cables were also confirmed in or adjacent to the HKZWFS I area, along with one active and two inactive telecom cables in the HKZWFS II area. Again these had been listed in the database provided.

The survey reports for both sites note the reason why the known wrecks were not detected may be due to the strong currents and sediment movements (i.e. sand dune migration) in the area that can bury or relocate possible objects on the seabed. Moreover, wreck locations are seldom reliable as often their final positions are 'last known' or 'mayday' positions instead of the actual sinking location. These positions are also often derived from less accurate positioning systems.

The geophysical survey identified several seabed and sub-seabed geohazards at both sites. For example, at both sites, high seabed gradients up to 20° are found on the lee side of the very large dunes. Meantime, in HKZWFS I survey area 132 SSS contacts and 546 magnetometer contacts were detected. Similarly, in the HKZWFS II area 101 SSS contacts and 403 magnetometer contacts were found. The SSS contacts were observed scattered across the survey areas and were interpreted as debris items except for eleven (11) high backscatter patches that might have originated from local reworking of sediments.

Meantime, in terms of the magnetometer contacts, at HKZWFS I the magnetic anomalies ranged from 2 nT to 1845 nT, whilst at HKZWFS II they ranged from 3 nT to 2761 nT. Most of the strongest anomalies are associated with the buried cables or pipelines, the survey report says. It adds that unknown, high amplitude magnetic anomalies were observed across both sites.

At sub seabed level, when assessing Palaeochannel infills, numerous buried channels were also detected in seismic Unit B (Kreftenheye Fm - Upper Pleistocene) at both wind farm sites. In this regard, the survey notes that fluvio-glacial /delta front channel infills are expected to be highly heterogeneous and can pose an engineering hazard due to lateral changes in mechanical resistance. Coarser sediments or gravel layers were also identified within seismic Unit C (Brown Bank Member/ Eem Fm - Upper Pleistocene) in the HKZWFS I survey area, showing high amplitude reflections. In Unit C of the HKZWFS II, meanwhile, some localised, high amplitude, reversed polarity reflectors were observed, possibly related to the presence of shallow gas and/or peat layers.

As mentioned earlier in this section, the geophysical results are used for planning a geotechnical campaign (see section 4.6). The geological interpretation from the geophysical survey was integrated with the results of the geotechnical campaign to produce a ground model for the wind farm site. The presence of gravel layers and their thickness were confirmed by the geotechnical campaign. Meanwhile, an archaeological assessment of the geophysical data reported in the geophysical survey has been performed (section 4.5).

## 4.5 Archaeological assessment of geophysical survey results

### 4.5.1 Overview - aims, objectives and approach

Periplus Archeomare was asked to conduct an archaeological assessment of the geophysical survey results to further investigate the presence of archaeological remains in the HKZWFZ.

The goals set for this assessment were:

1. To determine the historical or archaeological value of contacts found in the geophysical survey;
2. To validate the locations of known wrecks; and
3. Assess the prehistoric landscape based on the seismic data.

### 4.5.2 Supplier

Periplus Archeomare was contracted by Fugro Survey B.V., on behalf of RVO.nl, to conduct an archaeological assessment of the geophysical survey.

### 4.5.3 Results

Periplus Archeomare's analysis of the geophysical survey concluded that at HKZWFS I there are possibly two unknown objects (detected by SSS) and one known object beneath the seabed surface (found with MAG). Meanwhile, seven known objects expected to be in the area of HKZWFS I and four known objects expected in the HKZWFS II area were not found. Periplus Archeomare suggests these could simply be covered with sediments however.

The company's report suggests a buffer zone of 100 m should be applied around the few objects found which have yet to be determined to have no archaeological value. This also applies to cable trenching and anchorages of work vessels. The buffer zone may be reduced if it can be substantiated that the applied activity and disturbance has no effect on the archaeological object. For example, when no anchoring is used during cable lay operations the buffer zone can be decreased. Reduction of the distance may be obtained after consultation with Rijkswaterstaat on behalf of the Ministry of EZ and their advisor the Cultural Heritage Agency.

Meanwhile, a number of magnetic anomalies have also been observed that cannot conclusively be related to known pipelines and cables, or visible objects at the seabed surface. They are related to unknown ferrous objects buried in the seabed, covered by sediments and some have an amplitude of 50 nT and more. Whilst installing wind turbines and the various inner field and export cables, the report advises developers to avoid areas where these buried ferrous objects have been identified, again by implementing a 100 m buffer zone.

If it is not feasible to avoid the reported magnetometer locations with such a buffer zone, additional research should be conducted to determine the actual archaeological value of the reported locations, the report says. It also suggests that any UXO research conducted within 100 m of those magnetometer anomalies with an amplitude of 50 nT or more are carried out under onboard archaeological supervision. Depending on the outcome of the UXO research it can be decided if additional research (for instance by means of ROV or dive investigations) is needed. If the UXO research indicates that the object has no UXO risk, the location can be omitted.

*Pre-historic remains*

The report confirms that no in situ remains of prehistoric settlements are expected to be located or found in the HKZWFS I and II. So there are no restrictions on the wind farm development regarding remains. While earlier desk studies by both Periplus Archeomare and Deltares had suggested that prehistoric remains could be expected within specific archaeological layers at both HKZWFS I and II, these layers were not identified in the seismic data. Additional research for prehistoric remains within both sites is therefore not considered necessary.

Finally, the report notes that during the installation of the wind turbines and cable lay operations, archaeological objects may be discovered which were completely buried or not recognised as an archaeological object during the geophysical survey. Periplus Archeomare recommends passive archaeological supervision based on an approved Program of Requirements. Passive archaeological supervision means that an archaeologist is not present during the execution of the work but always available on call. Following this recommendation would prevent delays during the work when unexpected archaeological remains are found. In accordance with the law on cultural heritage (Erfgoedwet), those findings must be reported to the competent authority. This notification must also be included in the scope of work.

## 4.6 Geotechnical survey

### 4.6.1 Overview - aims, objectives and approach

The primary aim of the geotechnical campaign is to validate the geological model resulting from the geophysical investigation and to confirm the soil engineering properties at HKZWFS I and II required by developers to progress with their geotechnical foundation designs and other general design and installation requirements for the wind farm, as well as those relating to cable installation.

As with the Borssele wind farm sites, the geotechnical survey for HKZWFS I and II used intrusive techniques to gain an insight into the characteristics of the subsoil. Two general types of measurements were performed: cone penetration tests (CPT) and boreholes.
The field investigations and laboratory tests have been completed. The results of the survey will be used to:

- Further develop and confirm the geological and geophysical model for HKZWFS I and II;
- Determine the vertical and lateral variation in seabed conditions;
- Provide the relevant geotechnical data for design of the wind farms, including (but not limited to) foundations and cable installation; and
- Update the geological desk study and provide a geological model.

### 4.6.2 Key changes to improve data quality

There are some key differences in the approach taken to defining the site investigation for Hollandse Kust (zuid) when compared to the procedures adopted for Borssele. This follows feedback from developers after the tenders for the Borssele Wind Farm Zone projects. The aim is to provide more detailed higher-quality information, cut risks further, and save time by limiting the need for the developers who win contracts to conduct too many further geotechnical site investigations in the post-tender phase.

For example, the amount and type of boreholes were selected with the specific aim of avoiding the need for additional boreholes in the post-tender phase when the company awarded with the contract and subsidy for the project is in the detailed design stage. For Borssele, developers indicated that in the post-tender phase (after winning the tender) additional geotechnical investigations for detailed design purposes were on the critical path towards reaching financial close of the project.

Following this feedback, for the HKZWFZ geotechnical survey RVO.nl has increased the number of boreholes required and optimised their locations. This means that in the post-tender detailed design stage, likely, only CPTs will need to be performed at the turbine locations. Eliminating the need for sample boreholes and advanced laboratory testing at this stage will save developers significant time and costs and gives them the best opportunity to truly optimise their planning.

A three-step procedure was adopted as follows to define measurement locations:

1. The preliminary CPT and borehole locations were initially defined based on the results of the geophysical study.
2. Those locations were then reviewed by geotechnical experts and designers hired by RVO.nl and Fugro Engineers BV to make sure the right information would be obtained for the design.
3. Finally, contrary to Borssele, the CPTs were performed prior to the boreholes, which gave the opportunity to further optimise the borehole locations based on the preliminary CPT data.

In taking this approach the selection of the borehole locations was significantly improved when compared to Borssele.

In the meantime, the laboratory test programme was reviewed and adapted to provide a better basis for advanced design methods. Tests added were:

- Microbial Influenced Corrosion (MIC) tests (assess risk of microbiological induced corrosion),
- Age dating (for a better understanding of the geology),
- Thermal conductivity (needed to calculate heat transmission of cable design); and
- Resonant column tests (soil damping).

The cyclic test programme was also extended to include drained cyclic tests, asymmetrical loading conditions and cyclic triaxial tests. After the laboratory testing programme all remaining samples will be stored and handed over to the winner(s) of the grant and permit tender. Please note, MIC tests were only performed for HKZWFZ III and IV and will be issued as a separate report.

The total number of measurement locations for HKZWFS I and II was as follows:

- CPTs 26 (HKZWFS I) and 23 (HKZWFS II),
- continuous sampling boreholes 8 (HKZWFS I) and 8 (HKZWFS II),
- seismic CPT boreholes 3 (HKZWFS I) and 4 (HKZWFS II).

An overview of the basic laboratory test programme can be found in Table 4a, whilst the types of tests which were part of the advanced laboratory test programme performed across the different formations are presented in Table 4b.

**Table 4a** *Overview Basic Laboratory Test Programme*

| Index tests | HKZWFS I | HKZWFS II | Total |
|---|---|---|---|
| Density of Solid Particles (Small Pycnometer) | 57 | 42 | 99 |
| Particle Size Analysis (Sieving and Pipette) | 141 | 121 | 262 |
| Minimum and Maximum Index Dry Unit Weight | 16 | 35 | 51 |
| Atterberg Limits | 55 | 44 | 99 |
| Carbonate Content | 28 | 31 | 59 |
| Organic Content (dichromate oxidation) | 30 | 26 | 56 |
| **Triaxial tests** | | | |
| Unconsolidated Undrained Triaxial compression -Undisturbed (UU) | 24 | 14 | 38 |
| Unconsolidated Undrained Triaxial compression - Remoulded (UUr) | 24 | 14 | 38 |
| Isotropically Consolidated Undrained Triaxial in compression (CIUc) | 12 | 5 | 17 |
| Isotropically Consolidated Undrained Triaxial in compression (CIUc) with bender element testing | 8 | 9 | 17 |
| Isotropically Consolidated Drained Triaxial in compression (CIDc) | 18 | 13 | 31 |
| Isotropically Consolidated Drained Triaxial in compression (CIDc) with bender element testing | 10 | 11 | 21 |
| **Ring Shear Tests** | | | |
| Ring Shear (Soil-Soil Interface) | 11 | 8 | 19 |
| Ring Shear (Soil-Steel Interface) | 18 | 15 | 33 |
| **Compressibility Tests** | | | |
| Incremental Loading (IL) Oedometer | 7 | 6 | 13 |
| Constant Rate of Strain (CRS) | 13 | 10 | 23 |
| **Other Tests** | | | |
| Thermal Conductivity | 10 | 12 | 22 |
| Microscopic Photography | 20 | 29 | 49 |

*Note water content, unit weight, torvane and pocket penetrometer tests were also performed as part of other test types, e.g. a CIUc triaxial tests includes determination of unit weight and water content, but are not presented in Table 4a.*

**Table 4b** *Overview Advanced Laboratory Test Programme per Formation*

| Unit | Formation | Test type(s) |
|---|---|---|
| A | Southern Bight (-) | Geotechnical index, (cyclic) strength, and dynamic |
| B1 | Kreftenheye (sand member) | Geotechnical index, (cyclic) strength, and dynamic |
| B2 | Kreftenheye (clay member) | (Cyclic) strength and dynamic |
| C1 | Eem (Brown Bank) | (Cyclic) strength and dynamic |
| C2 | Eem (alternating sand/clay member) | Geotechnical index, (cyclic) strength, and dynamic |
| D | Yarmouth Roads (-) | Geotechnical index, (cyclic) strength, and dynamic |

As Table 4c shows, the advanced laboratory test programme included the following tests.

**Table 4c** *Overview Advanced Laboratory Test Programme*

| Geotechnical Index | HKZWFS I | HKZWFS II | Total |
|---|---|---|---|
| Particle Size Analysis (Sieving and Pipette) | 3 | 4 | 7 |
| **Strength (Static)** | | | |
| Direct Simple Shear (DSS) | 4 | 3 | 7 |
| Isotropically Consolidated Undrained Triaxial compression (CIUc) | 2 | 2 | 4 |
| Isotropically Consolidated Undrained Triaxial extension (CIUe) | 1 | - | 1 |
| Anisotropically Consolidated Undrained Triaxial compression (CAUc) | 1 | 2 | 3 |
| Isotropically Consolidated Drained Triaxial compression (CIDc) | - | 2 | 2 |
| **Strength (Cyclic)** | | | |
| Stress-controlled Cyclic Simple Shear (CSS) | 14 | 9 | 23 |
| Stress-controlled Isotropically Consolidated Undrained Cyclic Triaxial (CTX) | 9 | 9 | 18 |
| Stress-controlled Isotropically Consolidated Drained Cyclic Triaxial (CTX) | - | 8 | 8 |
| **Dynamic** | | | |
| Bender Element (BE) | 4 | 2 | 6 |
| Resonant Column (RC) | 3 | 6 | 9 |

In addition, the geological age dating programme included 30 samples at HKZWFS I taken from 7 boreholes and 33 samples at HKZWFS II taken from 8 boreholes. The results are presented in the geological ground model report .

### 4.6.3 Supplier

Fugro Engineers B.V. was contracted to perform this survey. The company is a member of the Fugro global group of companies and is responsible for offshore geotechnical surveys. The survey has been performed according to ISO 19901-8 (2014) Marine Soil Investigations.

The investigation was conducted in two successive campaigns with the geotechnical drilling vessel Bucentaur between 18 June 2016 and 17 July 2016 (see Figure 4f). A 20-ton double block-drive unit was used for the seafloor in situ testing in combination with piezo-cone penetrometers. The geotechnical boreholes were performed with rotary drilling with direct circulation and use of a seabed frame.

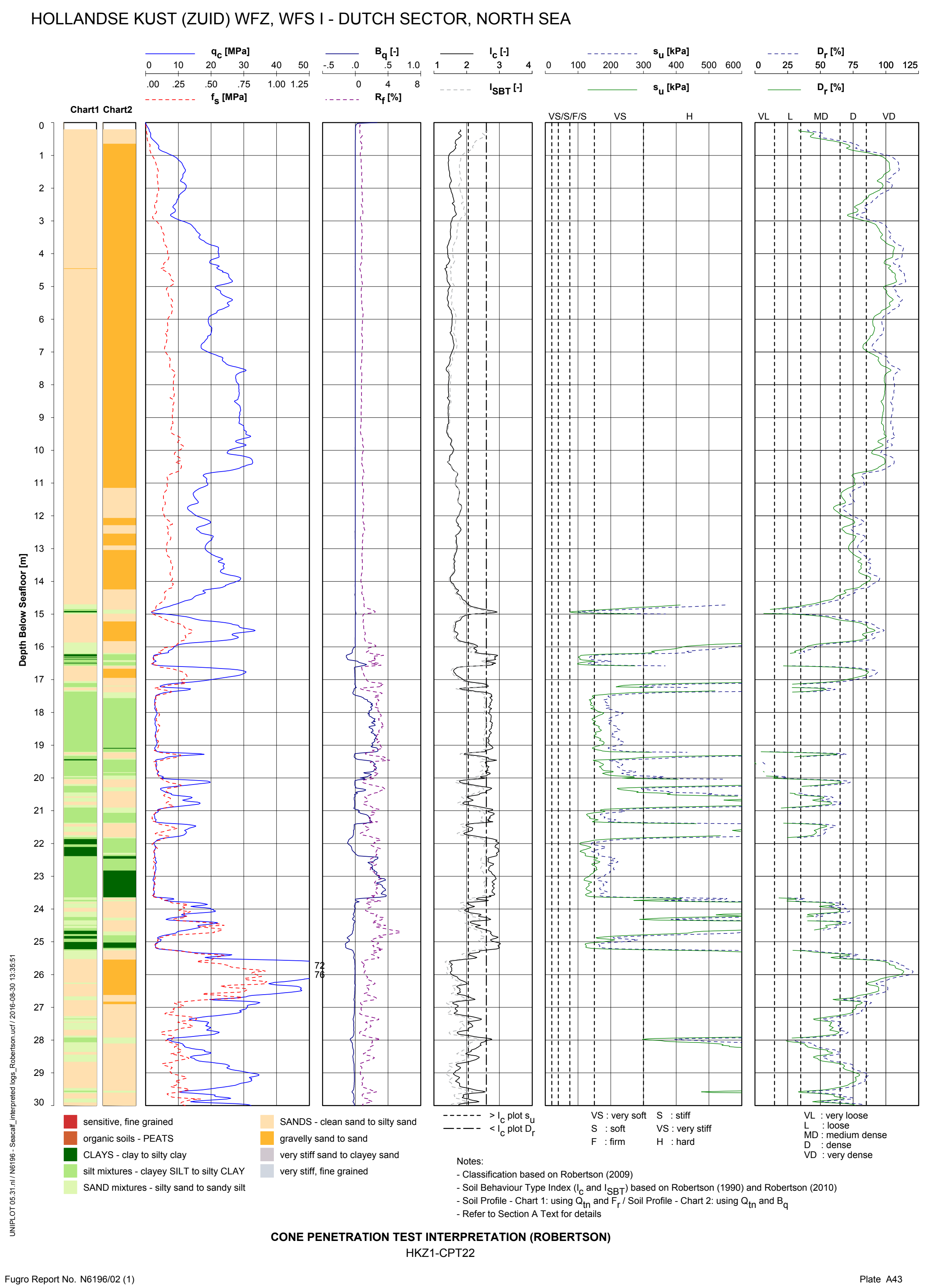
### 4.6.4 Results

The results of the geotechnical investigation and the basic laboratory test programme can be found in three reports for each individual site:

1. A geotechnical report containing interpreted CPT logs and results from in situ testing, including:
   - Interpretation of soil profile, strata description and PCPT-derived relative density and undrained shear strength.
   - Cone resistance (net/total), sleeve friction, pore pressure, friction ratio and pore pressure ratio.
   - Results of pore pressure dissipation tests, i.e. cone resistance and pore pressure versus time.
2. A geotechnical report containing geotechnical logs and results from in situ testing and laboratory testing, including:
   - Interpretation of soil profile, strata description and PCPT-derived relative density and undrained shear strength.
   - Cone resistance (net/total), sleeve friction, pore pressure, friction ratio and pore pressure ratio.
   - Recorded shear waves (X and Y) and derived shear wave velocity.
   - Selected results of laboratory tests.

**Figure 4f** *Aerial photograph of Bucentaur during the campaign*

**Figure 4g** *Example of CPT data interpretation*




3. A geological ground model report containing a geological ground model, including:
   - Geological setting, stratigraphy, lateral variability;
   - Isopachs, depth to top of unit maps and contours and thickness of unit maps and contours;
   - Geotechnical parameter values per borehole location and unit;
   - Geohazards and assessment of suitability of selected types of structures;
   - Age dating results.

In addition, the results of the advanced static and cyclic laboratory programme for HKZWFS I and II are issued in a further report combining the results from both sites as follows:

- Results of static and cyclic direct simple shear and triaxial tests;
- Results of dynamic tests;
- S-N degradation curves with results of static and cyclic tests;
- Drammen Clay Model graphs with results of static and cyclic tests.

In addition to the geotechnical reports, the following deliverables have also been issued:

A. Digital Data Packages – Geological Ground Model (IHS Kingdom® format) – HKZWFS I & II.

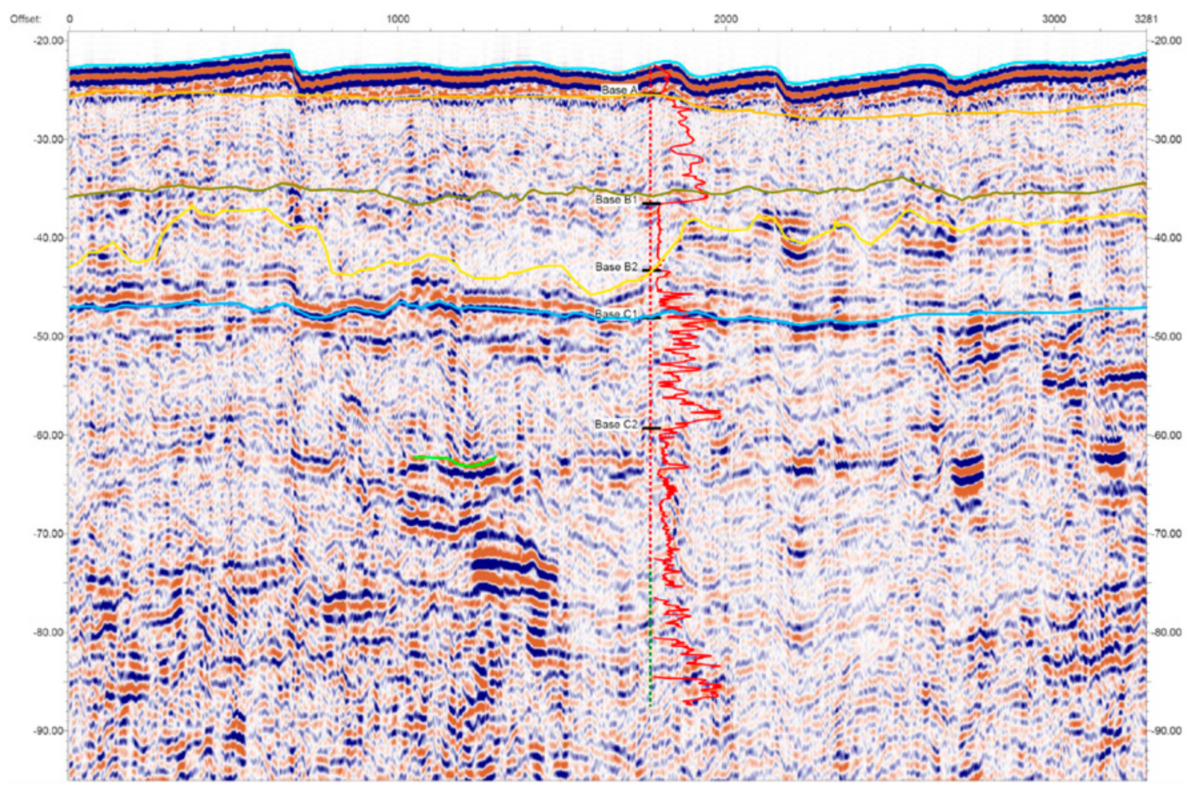
In February 2017, a Digital Data Package was released which consisted of interpreted horizons used for the Geological Ground Model from sub-bottom profiler and multi-channel seismic data together. Data is presented in the IHS Kingdom® format. The provided digital data packages contain information for HKZWFS I & II.

B. Technical Note – MIC; Technical Note Laboratory Test Data Microbial Influenced Corrosion (MIC) at HKZWFS III & IV.

Selected tests were performed to provide information to assess the likelihood for Microbial Influenced Corrosion (MIC). Since these tests were added to the scope in a later stage they were only performed for HKZWFS III & IV. The resulting interpretative report will be issued in Q2 2017.

An example of CPT data interpretation provided in the reports is shown in Figure 4g. An example of a seismic line at HKZWFS I with a projected seafloor CPT is shown in Figure 4h.

**Figure 4h** *Seismic UHR MCS cross section with CPT cone resistance data projected in red*



### 4.6.5 Conclusion

Significant effort was taken to maximise the data quality and suitability of the geotechnical data for HKZWFS I and II. The reports were certified by DNVGL. The data was used to ground truth the geological ground model resulting from the geophysical campaign. The results are anticipated to form a solid basis for geotechnical designs at HKZWFS I and II.

It is anticipated that, thanks to the enhanced programme followed, additional sampling boreholes may not be needed in further stages of the development, if a reliable correlation between CPT data and laboratory test data can be made. However, this remains the final responsibility of the developers. The samples remaining after the laboratory testing phase will be available to the winning developers, e.g. to perform additional testing.

### 4.6.6. Webinar

The results of the investigation was presented and discussed at a webinar in January 2017. The webinar can be found on ***offshorewind.rvo.nl/presentationshk***.

## 4.7 Morphodynamical desk study

### 4.7.1 Overview - aims, objectives and approach

The morphodynamical study assesses the seabed dynamics at the HKZWFZ. It is based on existing historical bathymetrical data and the survey results obtained in the geophysical campaign.

The aim of the study is to:

1. Characterise the seabed features at the HKZWFZ ;
2. Assess the morphodynamics at the HKZWFZ;
3. Predict the change in seabed levels at the HKZWFZ over the lifetime of a wind farm to support the design, installation and maintenance of wind turbines, inter array cables, platforms and their support structures.
4. As for Borssele, the study determines minimum and maximum seabed levels at the site for a total duration of 40 years, but for the HKZWFZ, it also provides a minimum, maximum and best-estimate seabed levels at five-year intervals over a 40-year period. The best-estimate seabed levels are useful to define the monitoring or maintenance requirements for the infield cables and the scour protections.


Overall, the information gathered in this desk study should provide detailed information to help developers with the design, installation and maintenance of wind turbines, inter array cables, substations and their support structures. e.g. by choosing smart locations for the wind farm infrastructure. The results of this study were also used for UXO burial/migration assessments and were relevant for the metocean study.

Compared to Borssele, the morphodynamic study of HKZ was extended with a geological analysis of the top layers, hydrodynamic modelling to assess and validate the migration directions of the bed features, an analysis of the morphodynamic changes during a storm, and best-estimate seabed levels.

In addition, a separate note has been performed into the scour conditions at the side. The purpose of this note is:

1. To describe the scour conditions to be expected at Hollandse Kust (zuid) for typical structure types, and
2. To provide a state-of-the-art overview of scour mitigation measures and their applicability at HKZ at these structures.

The results of this scour note are presented in Chapter 4.8.

### 4.7.2 Supplier

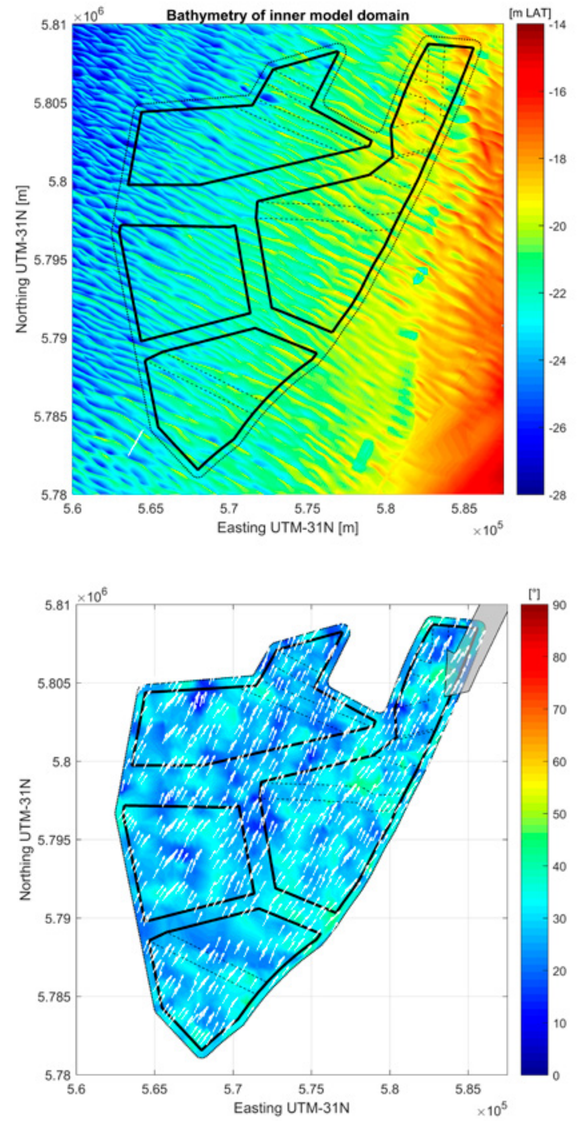
Research institute Deltares was awarded the contract to conduct the morphodynamical desk study and the scour note for HKZWFZ. Deltares has previously conducted similar studies for other offshore wind farms, including Borssele, Prinses Amalia, Luchterduinen, Nordergründe, Vesterhav Nord and Syd and Belwind.

The approach followed by Deltares was to start with a literature study, followed by an analysis of available seabed surveys and the shallow geology and supported by numerical modelling, to assess the morphodynamics and predict the future seabed levels at the site. The data analysis included available historical seabed surveys and the survey performed during the geophysical campaign.

### 4.7.3 Results

The morphology is classified as dynamic with significant sand wave migration in the top layer. The sand waves are in general oriented perpendicular to the shore and are migrating to the north-northeast (see Figure 4i). The underlying bathymetry is considered static over the lifetime of the wind farm.

**Figure 4i** *Map view of the bathymetry (top) and estimated sand wave migration directions (bottom)*



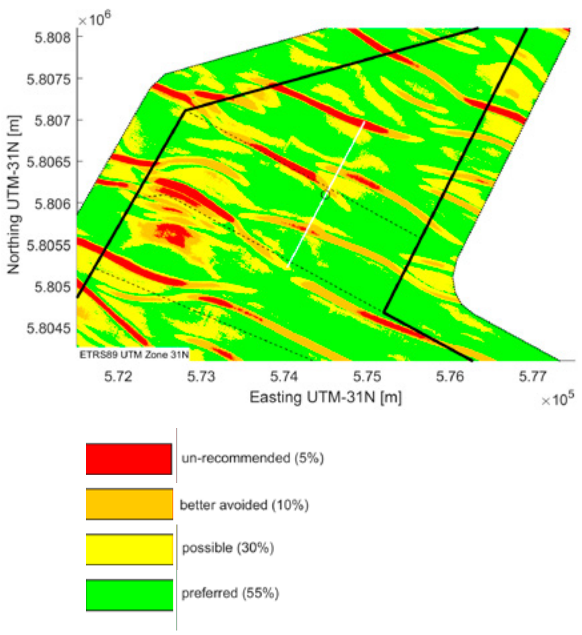

A review of available geological and geophysical data indicates that non-erodible layers exist, but that they are located too deep to influence the sand wave migration. A numerical analysis of the hydrodynamics and sediment transport in the area indicates that the net sediment transport is aligned with the residual tidal flow and towards the north-northeast.

A Fourier frequency analysis was carried out to determine the spatial characteristics of the sand waves. Wavelengths between 200 and 1000 m and wave heights between 1.1 and 4.0 m are observed. Sand waves are higher and shorter in the western part of the wind farm zone which is characterised by a deeper water depth.

A detailed analysis of the sand wave field is presented for the entire HKZWFZ, as well as for the individual wind farm sites. In total 3904 transects distributed over the wind farm zone were analysed. The sand wave migration speeds were determined by a 1D cross-correlation technique and average migration speeds of 0.7 m/year to 3.0 m/year were observed. In general sand waves in the northern part migrate faster than in the southern part and locally migration speeds as high as 5.2 m/year are observed.

Based on the morphodynamic analysis a best estimate bathymetry (BEB), a lowest seabed level (LSBL) and a highest seabed level (HSBL) were determined. The LSBL and HSBL indicate the lowest and highest seabed levels that are expected during the lifetime of the wind farm (2016-2051). Locally, the maximum seabed lowering that was found for the entire area is -3.6 m and the maximum seabed rising is 7.2 m (the 99% non-exceedance values for lowering and rising are -1.5 m and +4.1 m respectively). Furthermore, the LSBL is compared against both the base of the Holocene formation and identified non-erodible layers. The predicted seabed level changes presented in this study follow from the applied morphological analysis techniques, describing the physics and the natural variability of the analysed morphological system. No additional safety margins for design purposes have been applied. Finally, classification zones were provided to assist developers in determining the locations of their cables and foundations (see Figure 4j).

**Figure 4j** *Overview map of classification zones including classification for both highest and lowest seabed levels*




### 4.7.4. Deliverables

The results of the morphodynamic analysis are summarised in a desk study report. This report includes:

- General background information regarding sand waves;
- Geological and geophysical characterisation of the site and other offshore morphodynamic seabed features present in the HKZWFZ;
- Summary of performed numerical modelling for tides and sediment transport;
- Analysis regarding bed form migration speed and direction, including storm effects;
- Predicted future seabed levels (LSBL, HSBL, BEB).
- Classification zones and considerations for cables and foundations.

The resulting minimum, maximum and best-estimate seabed levels are provided as GIS files.

The results of the scour note are presented in Chapter 4.8 and are published on ***offshorewind.rvo.nl/soilzh***.

### 4.7.5. Webinar

The study was presented and discussed at a webinar in January 2017. The webinar can be found on ***offshorewind.rvo.nl/presentationshk***.

## 4.8 Technical note on scour and scour mitigation

### 4.8.1 Overview- aims, objectives and approach

The technical note on scour and scour mitigation provides general considerations on how to deal with scour development and scour mitigation in the HKZWFZ taking into account the morphodynamic character of the area (the presence of migrating sand waves) and a range of potential types of foundations. Also general considerations for cable routing in a morphodynamic environment are provided.

The aim of the technical note is to:

1. Describe scour conditions to be expected at HKZWFZ for typical wind farm-related structures;
2. Provide a state-of-the-art overview of scour mitigation measures and their applicability for structures within the HKZWFZ;
3. Provide guidance on how the morphodynamics should be taken into account for the selection of locations for structures and cables as well as for a scour mitigation strategy.

### 4.8.2 Supplier

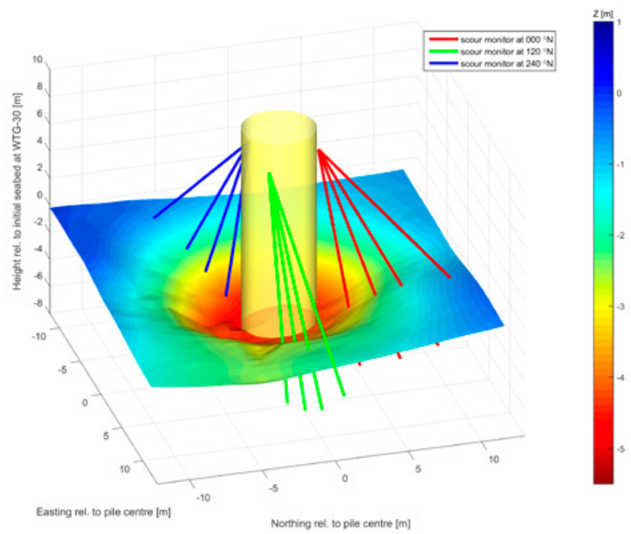
Research institute Deltares provided the technical note. Deltares has previously conducted many scour assessments, designed scour mitigation strategies and physical model testing for other offshore wind farms, including Borssele, Egmond aan Zee, GEMINI, Luchterduinen, Nordergründe, Butendiek, DanTysk and Norther offshore wind farms.

### 4.8.3 Results

Offshore structures can either be protected against scour or be designed such that scour development can be allowed. To decide which strategy can best be adopted for a certain foundation type and specific location, information was presented on how to predict the scour depth (when not protected) and how to protect against scour, both taking into account the morphodynamic scenarios of stable, lowering and rising seabeds.

It can be concluded that for monopiles, an easy-applicable, well-proven solution is to place the monopiles just north-east of the sand wave crests in the HKZWFZ or even on top of the sand wave crests and to apply a scour protection to maintain a more or less fixed seabed level around the foundation. In the first case a slightly longer pile is needed, while in the second case, a longer extent of the scour protection is recommended to cater for the lowering seabed. Gravity-Based-Structures will typically need a scour protection due to too severe scour development in the mobile seabeds in HKZWFZ and the low tolerance for scour due to undermining risks; locations with a significantly lowering seabed are best to be avoided for GBS. Jacket structures are expected to experience significant scour development as well. However, as long as they are not located in areas with lowering seabeds and cable free spanning risks are mitigated by proper cable protection measures, they can be designed for free scour development. This does not hold for Suction Bucket Jackets: due to the limited penetration depth of the suction cans, scour protection is in most cases recommended in HKZ. Self-installable systems look promising here.

**Figure 4k** *Measurement setup at an unprotected monopile in Luchterduinen used for field validation of Scour Prediction Model [source: flow-offshore.nl]*




Next to foundations, this technical note also discusses general considerations for cable routing in a morphodynamic area such as HKZWFZ. It is expected that cables can be buried sufficiently deep to avoid cable exposure, when smart cable routing techniques are adopted, which avoids the areas with largest morphodynamic seabed lowering or other 'expensive' areas.

### 4.8.4 Deliverables

The results are summarised in a technical note on scour and scour mitigation. The note includes:

- Recommendations regarding possible scour mitigation strategies for the HKZWFZ;
- Scour predictions for selected foundations, e.g. monopiles, jacket structures and Gravity Based Structures;
- Scour predictions for selected jack-up platforms (for installation purposes);
- Implications of edge scour around scour protections;
- Design requirements for a scour protection;
- Description of scour protection methods, e.g. rocks, mattresses, gabions, artificial vegetation, filter units etc.;
- Description of how to deal with cable routing in morphodynamic environments.

# 4.9 Wind Resource Assessment

### 4.9.1 Overview - aims, objectives and approach

The goal of this study is to provide a wind resource assessment (WRA) for the HKZWFZ.

The information can be used to feed into wind farm modelling, yield assessments and business case calculations for the offshore wind farms to be developed at HKZWFS I and II. The analysis is based on the best possible data and state-of-the-art methods and models and is designed to be in accordance with applicable offshore standards.

The study consists of two parts:

- One is an overview of the assessment issued in March 2017 based on off-site data, the WRA1.
- The second is a new assessment performed based on on-site metocean campaign data, the WRA2.

The study concludes with a discussion and the combined findings from both elements for a final wind climate assessment.

#### WRA1

Since there were no on-site measurements available at the time of this study, i.e. the measurement campaign had just started, Ecofys performed the study based on nearby offshore wind measurements and scale based on a validated mesoscale model. The analysis was performed for the entire HKZWFZ with the following approach:

- The data of five nearby wind measurement locations was subjected to a detailed analysis. The station with the highest quality was selected for the analysis;
- Several mesoscale models were compared and the one with best performance (lowest uncertainty) was selected for the analysis;
- The wind climate was calculated based on a combination of the best available data source and mesoscale model. The analysis included variations with height, time and distance, as well as a comprehensive uncertainty assessment;
- The resulting wind climate was compared with various other studies and wind atlases and aligned with the metocean study.

The Offshore Windpark Egmond aan Zee (OWEZ) 70 m met mast data formed the basis of the wind resource assessment, based on the proximity to the site and the overall low uncertainty of the wind measurements. The extrapolation was based on the EMD-ConWx mesoscale model, which was selected based on a validation using multiple offshore measured wind datasets. Detailed analyses of the calculated wind climate were carried out across the modelled heights, showing good comparisons of the analysed trends with measurements at other offshore sites in the Dutch North Sea.

#### WRA2

Wind measurement data from the metocean measurement campaign has become available and this data has been used as a second wind resource assessment study (WRA2). The contractors have made metocean measurement campaign data available, from June 2016 to May 2017, for two Fugro SeaWatch buoys (HKZA and HKZB) which both had a Zephir Z300 wind LiDAR installed. The wind speed measurements of the HKZB buoy (with some gaps filled based on the co-located HKZA buoy) were the primary source for this assessment. Wind measurements from the Lichteiland Goeree platform were selected as the long-term reference, based on a validation using multiple offshore measured wind datasets.  Based on this reference, a translation to the lon- term wind speed was performed, using the so-called MCP-method. Detailed analyses of the calculated wind climate were carried out across the modelled heights, showing good comparisons of the analysed trends with measurements at other offshore sites in the Dutch North Sea.

#### WRA and metocean desk study

Both WRA1 and WRA2 were carried out in parallel with the metocean desk study (section 4.11). Both the WRAs and the metocean study analyse the ambient wind climate at the HKZWFZ. However they do so for different reasons and with different outcomes in mind - the metocean study is to be used for wind farm design purposes whilst the WRAs are used to calculate energy yield. Thus the reporting criteria and calculation methods used can differ between these studies, which in turn can sometimes result in different results when compared.

RVO.nl and the contractors responsible for the WRAs and metocean desk study have ensured that the basic boundary conditions (e.g. wind speeds and directions, vertical/horizontal bins and assumed vertical wind profiles) were compared and aligned as much as possible in order to achieve consistency or a motivated deviation between both studies.

### 4.9.2 Supplier

Ecofys WTTS was contracted by RVO.nl to conduct the wind resource assessment. The company has ample experience in offshore wind resource assessments, having prepared bankable reports on multiple large offshore wind farms, often at sites where wind measurements were not available previously. Moreover, the company is skilled in the validation and application of mesoscale model data, including detailed uncertainty assessments.

### 4.9.3 Results

The results of the two wind resource assessments differ only slightly, with a 0.5% difference in the mean wind speeds at 100 m MSL. Also, the uncertainty of both assessments is comparable. Since the calculations are largely independent, the two results may be combined based on inverse-variance weighting, to result in long-term mean wind speed at 100 m MSL at the centre of the HKZWFZ of  9.44 ± 0.38 m/s (± standard deviation). The spatial variation from the zone's centre is about ±0.1m/s, as seen Figure 4l.The wind speeds found within the wind resource assessment are comparable with the wind speeds found within the metocean study.

Please note this final WRA is for reference only. Companies participating in the tenders for the permit relating to HKZWFS I and/or II are required to submit their own wind report with net P50 value of the yield. This report must be produced by an independent company and this WRA may be used as input for the required report.

### 4.9.4 Deliverables

The results of the WRA are summarised in a desk study report. The report includes the following results:

- Annual mean wind speeds at elevations of 10 to 200m;
- Annual mean wind speeds at various probability levels (P10 – P90);
- Wind roses (mean wind speed vs. direction) and wind shear  (vertical distribution);
- Omni and directional mean wind speed distributions including Weibull parameters;
- Diurnal, monthly, seasonal and year to year variations of mean wind speed;
- Anticipated wake losses due to the existing wind farms;
- A comprehensive uncertainty assessment.

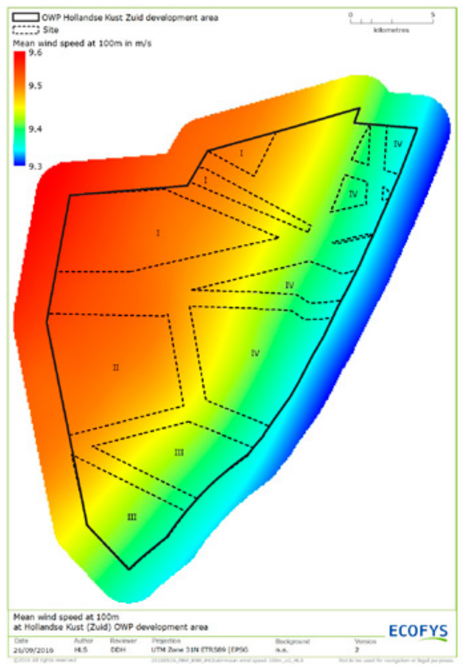
In addition, the spatial distribution of the mean wind speed from both WRAs is provided as a GIS file. Time series are provided at the five output locations of the current site (2000-2016).

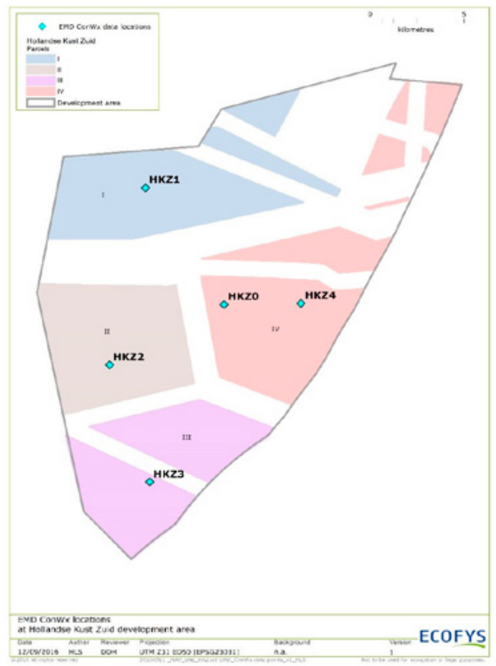
For information regarding wind turbulence, refer to the metocean report. Turbulence is considered applicable for design and was not considered as part of the wind resource assessment..

### 4.9.5 Webinar

The study was presented and discussed at a webinar in January (WRA1) and November 2017 (combined WRA). The webinars can be found on ***offshorewind.rvo.nl/presentationshk***.

**Figure 4l** *Long-term mean wind speed (WRA2) at a hub height of 100 m MSL at the Hollandse Kust (zuid) Wind Farm Zone (left) and output locations of the WRA1 and WRA2 (right)*



# 4.10 Metocean measurement campaign

### 4.10.1 Overview - aims, objectives and approach

In the belief that more accurate metocean data will lead to a lower risk surplus and therefore lower cost of capital (strengthening the business case) for an offshore wind farm, DNV GL and Ecofys were asked to perform an assessment of the different options for a metocean measurement campaign. The aim of the study was to investigate the possibility of improving the accuracy of wind resource data at HKZWFZ.

Based on their recommendation, in June 2016 two onsite Seawatch Wind LiDAR Buoys to measure wind properties and dedicated instrumentation to measure wave and current properties were deployed by Fugro (OCEANOR) to provide on-site metocean data for the HKZWFZ. The buoys were positioned centrally in the site and far enough from the existing Luchterduinen wind farm to avoid wake effects and ensure they measure a representative wind climate (see Figure 4n).

The Seawatch Wind Lidar buoys are equipped with an integrated system comprising instruments to measure wind, waves, currents, water levels, air pressure and air temperature simultaneously. The wave sensor and the Wavescan platform is validated for use by clients requiring high quality wave measurements. Raw data from all sensors are transmitted to shore in real time and triggers are present to notify in case the buoy leaves its position or in case instruments fail. The buoys are located close to each other (2 km distance) to create a redundant system, i.e. to make a second set of measurements available if any of the instruments fail. This was a key learning point after the measurement campaign at Borssele.

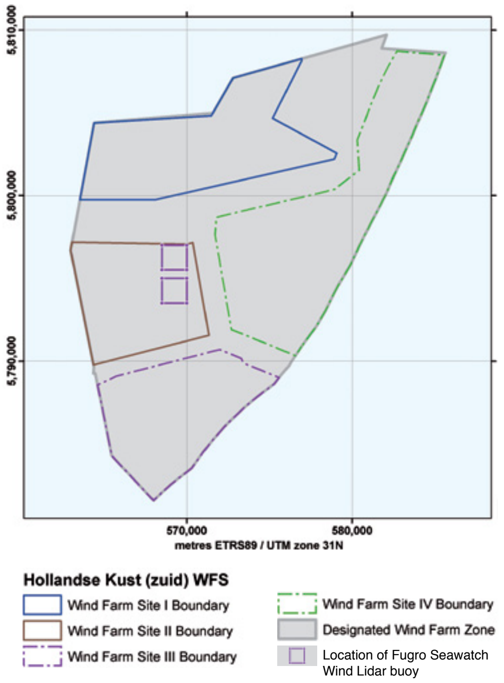
The objective of the measurement campaign is to reduce the uncertainty of the metocean data at the HKZWFZ. The aim has been to have at least 12 months of validated data measured at the HKZWFZ available a few months prior to the closing date of the permit tender for HKZWFS I and II. This goal has been achieved. However, based on input from Ecofys and actors preparing for the tender, RVO.nl has decided to extend the campaign until 31st January 2018.

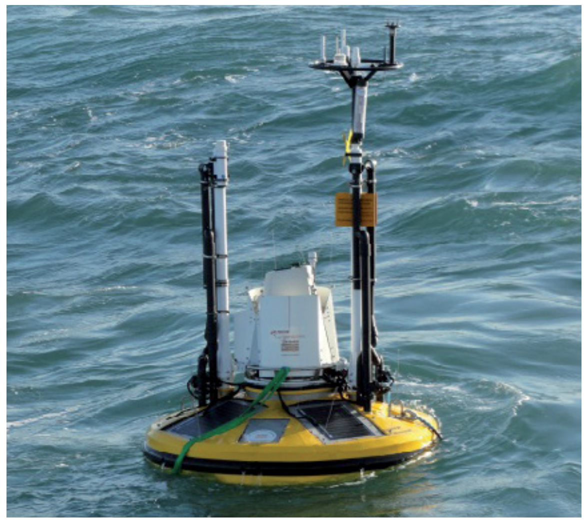
The dataset means the metocean models available for wind farm design can be calibrated and/or validated, enabling developers to carry out more accurate calculations of annual energy yield. Also the second Wind Resource Assessment (WRA2) is based upon the data of this metocean measurement campaign.

The meteorological data (or variables derived from it) include the following parameters, measured at 10-minute frequencies:

- Wind speed and direction in the range of 30 - 200 m above mean sea level (MSL), in steps of 20 m
  *Please note that Mean Sea Level (MSL) at Hollandse Kust (zuid) is equal to Lowest Astronomical Tide (LAT) + 0.95m.*
- Wind shear and wind veer
- Turbulence intensity
- Inflow angle
- Air temperature LiDAR level
- Air pressure LiDAR level

**Figure 4m** *Location (squares) of Fugro Seawatch Wind Lidar buoys (left) and picture of Seawatch Wind Lidar buoy (right)*





Similarly, the oceanographic data will also be provided and include at least the following:

- Significant wave height
- Peak wave period
- Mean wave period
- Mean wave direction
- Wave spectra
- Current speed at ≥ 10 evenly spread positions over the water depth
- Current direction at ≥ 10 evenly spread positions over the water depth
- Water level
- Sea water temperature

Compared to Borssele, the main differences are that the present metocean campaign started in an earlier phase and that the performed validation is more extensive and includes all measured parameters including water levels, currents and waves.

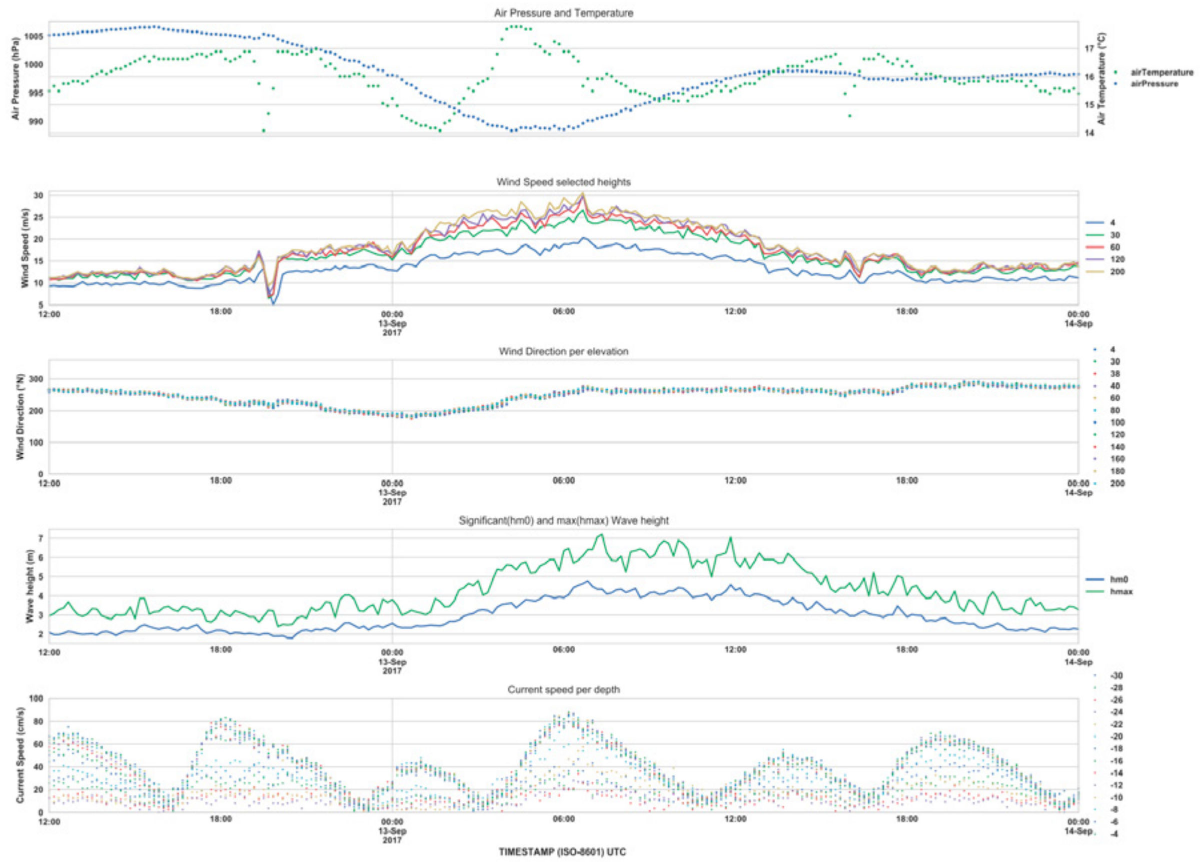
### 4.10.2 Supplier

The metocean measurement campaign is being conducted jointly by Fugro Norway AS (OCEANOR) and Fugro Survey B.V, subsidairies of Fugro B.V.. With more than 30 years experience, Fugro Norway is a global leader in design, manufacturing, installation and support services for environmental monitoring, metocean observation and forecasting systems.

### 4.10.3 Results

Monthly results from June 2016 are being made available on offshorewind.rvo.nl. Available data is validated by Deltares. This validation includes a comparison of the measured wind and waves between both buoys and with several surrounding measurement stations (Meetmast IJmuiden, Licht Eiland Goeree, Euro platform and K13 platform). The measured currents and water levels are checked by comparing with operational numerical model results of Rijkswaterstaat (DCSM). Each month, after completing the data validation, a data package is issued to RVO.nl, containing the raw data, a data report and a data validation report. This data package is subsequently reviewed and quality approved by ECN on

**Figure 4n** *2017 September storm with maximum wind speeds of 31 m/s at the 200m measurement elevation and 20 m/s at the 4m measurement elevation at September 13, 06:40 UTC*



behalf of RVO.nl, before finally being made available on the RVO.nl website. This strict quality assurance procedure assures that the results serve as a high-quality reference for wind climate and metocean studies.

The monthly reports made so far demonstrate that the required parameters are being measured with a high availability and accuracy. The winter of 2016/2017 included two storms (20 November 2016 and 14 January 2017) for which the data has been successfully recorded. Offshore operations are being performed to service the buoys and instruments at regular intervals.

One year of measurement data were available as of July 2017.

#### 4.10.4 Deliverables
The results of the metocean campaign are published on a monthly basis on offshorewind.rvo.nl/windwaterzh. The data package includes raw data, a data report and a data validation report. The packages become available about two months after completion of a month of measurements.

#### 4.10.5 Webinar
TThe setup of the metocean measurement campaign was presented and discussed at a webinar in January 2017. The webinar can be found on ***offshorewind.rvo.nl/presentationshk***.

## 4.11 Metocean desk study

#### 4.11.1 Overview - aims, objectives and approach
The metocean desk study provides information on the meteorological and oceanographic (metocean) conditions in the HKZWFZ to serve as input for the design, installation and maintenance of wind turbines, inter array cables, substations and their support structures for companies submitting bids to develop projects at Sites I and II. The study also provides information relevant for HKZWFS III and IV as well as for the sites in Hollandse Kust (noord), but these will not be discussed in any detail in this PSD.

The metocean desk study includes the following:
1. A general characterisation of the metocean climate at the sites (e.g. operational conditions, dominant tides, storm severity, spatial uniformity of conditions);
2. Analysis of normal and extreme metocean conditions for winds, waves, currents, water levels and their joint probability;
3. A combined report for Hollandse Kust (zuid) and (noord) for efficiency reasons;
4. A digital metocean database that will enable users (e.g. project developers) to obtain output (time series, tables and graphs for both normal and extreme conditions) at any requested location within the site boundaries of the HKZWFZ as well as the surrounding areas. The metocean conditions vary across the zone, mainly due to variations of the local bathymetry and tide. With the metocean database, developers will be able to optimise their designs - i.e. for wind turbines, inter array cables, substations and their support structures - based on the conditions at their actual location, rather than using a single conservatively chosen reference point in each zone. The database has been made available through offshorewind.rvo.nl, by an application that can be downloaded.

The development of the digital metocean database is one of the main improvements compared to the metocean desk study performed for Borssele Wind Farm Zone. This database will allow developers to further optimise their preliminary design when preparing the tender bid. The results can also be used for detailed design of the offshore wind farms.

#### 4.11.2 Supplier
RVO.nl assigned DHI to perform the metocean study. DHI is a renowned hydraulic institute with significant experience with the provision of metocean conditions and databases. DHI has contributed to most of the existing offshore wind farms in Europe.

#### 4.11.3 Results
Work started on the metocean desk study in August 2016. The metocean conditions were established using a dedicated high-resolution model covering the period from 1979 to 2016 (37 years). The modelling procedure comprised a wave model to simulate wave generation and propagation and a hydrodynamic model to simulate currents and water levels. Both featured an unstructured grid with respective grid resolutions of about 600m and 200m at the wind farm site. The atmospheric forcing for both wave and hydrodynamic model was taken from the wind and pressure field data from the Climate Forecast System Reanalysis (CFSR) dataset provided by the National Centers for Environmental Prediction (NCEP). The local hydrodynamic model was forced by a regional DHI model covering the North-Atlantic and optimised with data assimilation techniques. The local wave model was forced by DHI's regional North Sea wave model.



An extensive validation of the modelling results was conducted using available satellite and local measurements. The local measurements included met masts at IJmuiden and Egmond aan Zee, measurements at platforms K13, K14, Euro platform, Lichteiland Goeree and measurements performed by RVO.nl at Borssele and HKZWFZ. The (south) eastern CSFR wind speeds in the metocean study were increased to match the wind speeds of the wind resource assessment. All models were extended to cover until 2017-04-01 in order to validate the models against the latest HKZWFZ metocean campaign measurements. The resulting validation showed very good model performance and demonstrated accurate and high-quality metocean conditions at the wind farm areas (see e.g. Figure 4o and Figure 4p).

The metocean analysis covered winds, waves, currents and water levels, both under normal (ambient) conditions and extreme storm conditions. The analysis included persistence tables, scatter tables, rose plots, spatial variations, spectral analyses, joint occurrence tables, occurrence of individual wave heights and periods and misalignment of wind and waves.

Particular attention was brought to the extreme value analyses, since the resulting values are critical for design. Extreme conditions were established for winds, currents and water levels for return periods up to 100-years and for waves (significant wave height, maximum individual wave height and maximum crest heights) for return periods up to 10,000 years. Extreme conditions were provided on a directional and monthly basis. In addition, the joint probability of various parameters and the likelihood of breaking waves were assessed.
The report includes results of metocean analysis at one output location for Hollandse Kust (zuid) and one output location for Hollandse Kust (noord). These output locations were selected at locations with maximum extreme significant wave height for a 100-year return period. The output location of HKZ was located in the north-western part of HKZWFS I (see Figure 4q).

Typical design values with a 50-year return period at the output location of HKZ include an hourly wind speed (at 100m elevation relative to MSL) of 40.4m/s, a significant wave height of 7.0m, an associated peak wave period of 12.1s (to the 50-year significant wave height) and a depth-averaged total current velocity of 1.0m/s at a water depth of about 31m MSL (this includes storm surge).The extreme sea states show spatial variability, e.g. at HKZWFS II the 50-year significant wave height is a few decimetres smaller. Values at other locations can be accessed through the metocean database, which enables users to access the modelling data and the analysis results through a user-friendly interface.

**Figure 4o** *Scatter comparison plot of significant wave heights between the model and measurements at location Euro platform*

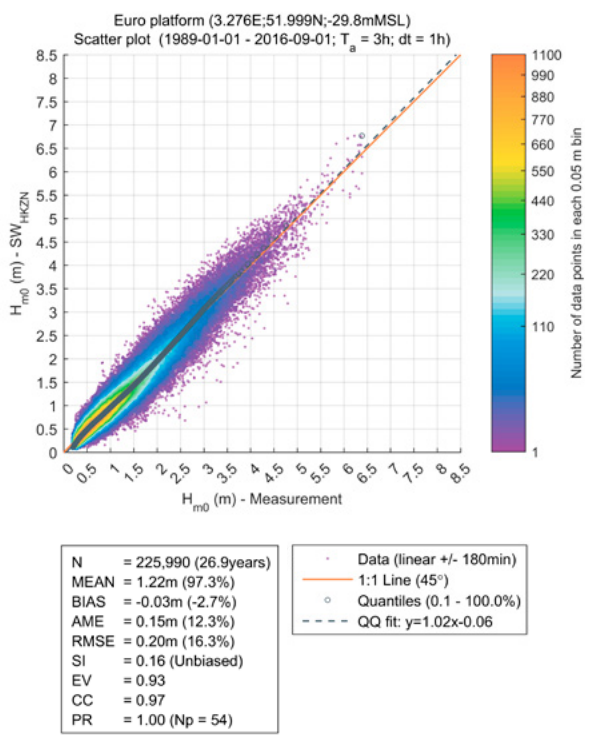



**Figure 4p** *Wave rose comparison between the model and measurements at HKZA*

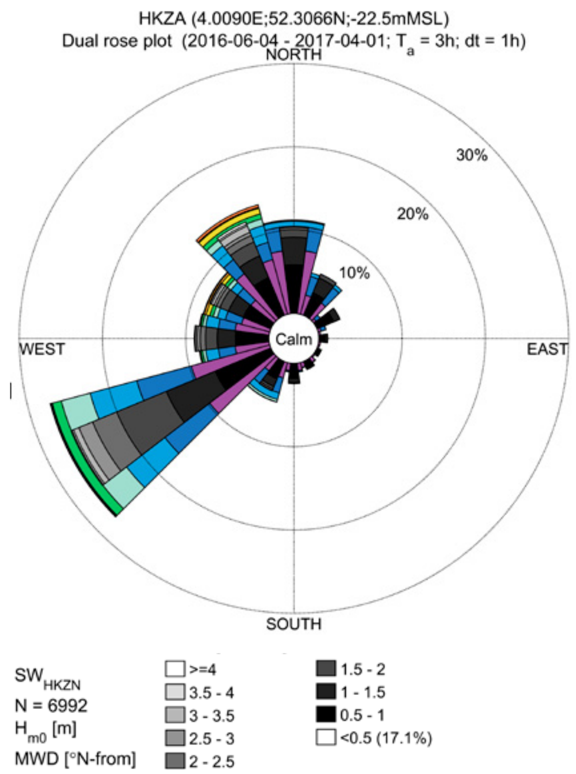
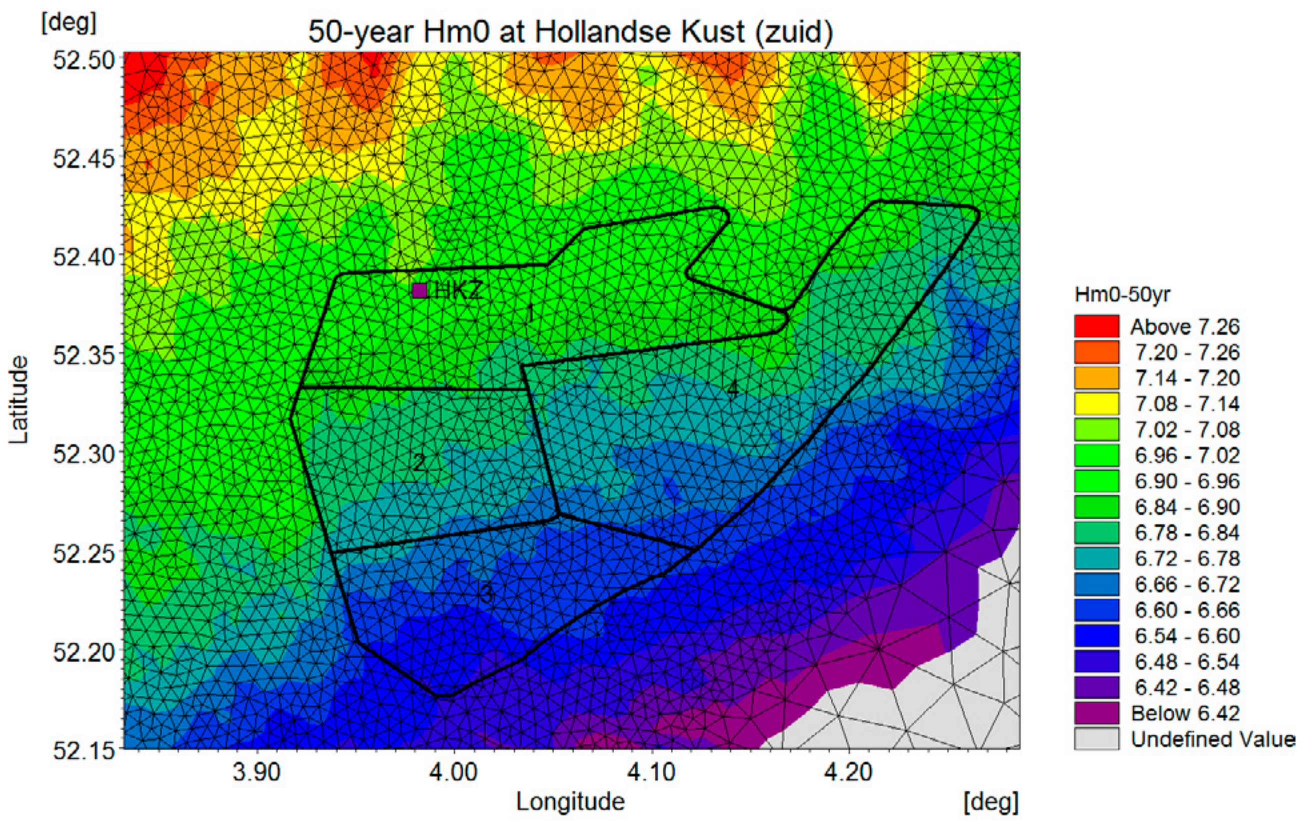


**Figure 4q** *Significant wave height with a 50-year return period at the Hollandse Kust (zuid) including the output location*




### 4.11.4 Deliverables

The results of the metocean study are summarised in a desk study report. The report includes the following results:

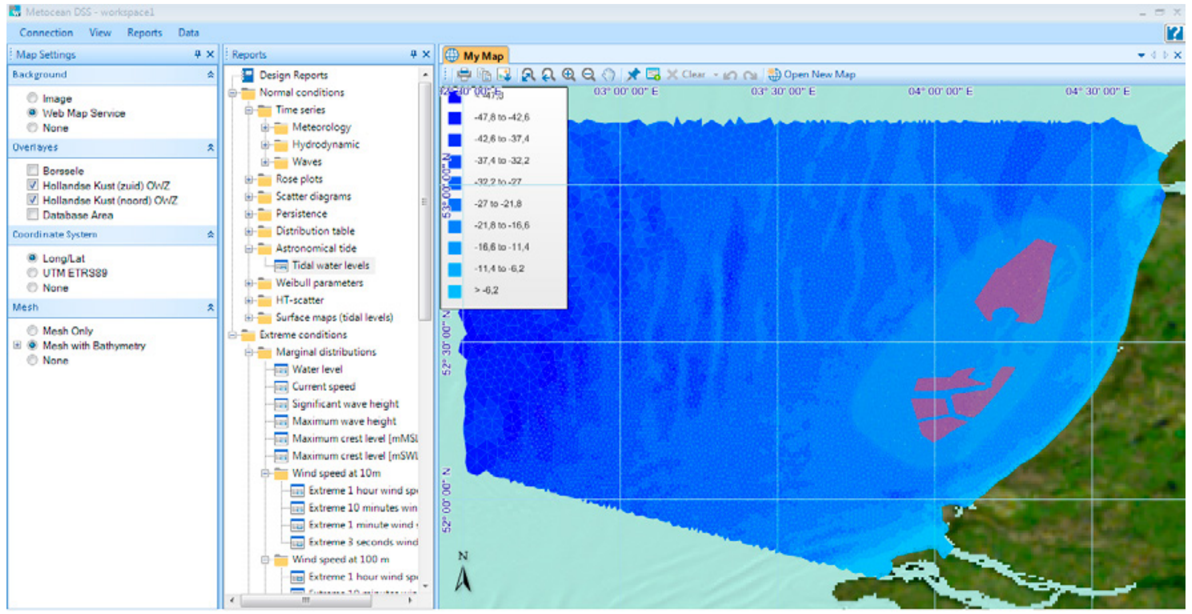
- Wind: wind velocity roses, joint occurrence tables, Weibull parameters, persistence of wind speed, extreme wind speeds, wind profiles, wind energy spectra, wind turbulence intensity and spatial variations;
- Wave: roses of significant wave height and peak wave period, joint occurrence tables, persistence of wave height, extreme wave conditions, partitioning wind sea and swell, assessment of sea level rise on the extreme sea states, mean storm durations, spatial variations, breaking wave effects, and normal sea states, according to DNV-GL-0437;
- Currents: current roses, velocity profiles, occurrence tables of current velocity and direction, extreme currents, separation tides and residual currents and spatial variations;
- Water levels: astronomical tide levels, extreme water levels, assessment of sea level rise and spatial variations of water levels;
- Joint probabilities: joint occurrence tables of wind and waves, current and waves, water levels and currents;
- Other metocean parameters: snow and ice accretion, seismicity, salinity, air and sea temperature, atmospheric and seawater density, marine growth, lightening and visibility.

The metocean database is a software application that can be downloaded from the RVO.nl website. It includes the following functionality:

- A graphical user interface with a map (see Figure 4p) allowing to select locations by clicking on a map, or by loading own coordinates;
- Access to modelling results (winds, waves, currents, water levels) at about 17,000 grid points within a large area covering both Hollandse Kust (zuid) and (noord) for the period from 1979 to 2016 (37 years) at high resolution;
- Functionality to perform analyses: plot time series, rose plots, scatter diagrams, persistence tables, distribution tables, fatigue tables, tide level tables, tables with extreme conditions and surface maps, all with user-defined settings;
- Functionality to export time series, data and plots at selected location(s), including an option to create various tables in one go, which can be customised;
- Functionality to download full directional-frequency spectrum on a 1km grid within the wind farm zones.



**Figure 4r** *Example of graphical user interface of metocean database*




The following options are available regarding support for using the database: user manual and a webinar. RVO.nl and DHI organised one day of training on 13 March 2017 . DHI will maintain the database for bug fixes for a period of five years. The metocean report and database are available on the website ***offshorewind.rvo.nl***

### 4.11.5 Webinar and database support

The study was presented and discussed at a webinar in January 2017. The approach towards the metocean study and the performed analyses were presented in the first part of the webinar. In the second part of the webinar, the metocean database was demonstrated. The webinar can be found on ***offshorewind.rvo.nl/presentationshk***.
The metocean report and database can be found on ***offshorewind.rvo.nl/windwaterzh***.

## 4.12 Site investigations quality and certification

### 4.12.1 Procedure

The Netherlands Enterprise Agency (RVO.nl), assisted by BLIX Consultancy, managed the process of site investigations for HKZWFS I and II. RVO.nl maintained a quality assurance procedure to provide accurate practical high-quality studies.

First, the scope of the different studies was determined using the following steps:

1. RVO.nl and BLIX determined the preliminary scope of the different studies. Lessons learned from the site investigations at the Borssele Wind Farm Zone were taken into account;
2. Where applicable, input was provided on these scope descriptions by internal experts, other governmental departments, agencies, external experts and the industry (Netherlands Wind Energy Association);
3. At market consultation sessions, the scope descriptions were discussed with market parties with input on completeness provided by the attendees at these workshops.
4. The study deliverables were reviewed by internal experts from other governmental departments, and external experts;
5. For studies with results becoming part of the design basis for the developer, the accredited certifying body DNV GL was contracted to confirm the completeness of the scope.

### 4.12.2 Procurement

The procurement of the different studies was carried out in compliance with the applicable procurement procedures within RVO.nl. The desk studies have been procured through a limited tender where, for each study, at least two expert parties were invited to submit their proposal.

The site investigations, were procured through a public European tender. All proposals have been assessed by internal experts, other governmental departments, agencies and external experts. Contractors were selected on the basis of determining the most economic advantageous offer, with safety, quality and track record as the primary award criteria.

#### 4.12.3 Quality assurance

After procurement, whilst work was being conducted by the specific contractor, quality assurance was performed as follows:

1. A project team from RVO.nl and external experts was assigned for each study. The project team monitored the execution of the scope was in compliance with the scope description;
2. Draft reports and other deliverables were reviewed by internal and independent external experts;
3. Where applicable, accredited certifying body DNV GL reviewed reports and other deliverables and provided a Verification Letter to assure the results were acquired in compliance with the DNVGL-SE-0190:2015-12 and other applicable industry standards. Verification Letters are added to the published reports where applicable;
4. An overall Statement of Compliance was issued for the complete set of site studies, allowing the studies to be used in the design basis of an offshore wind farm. The following scheme was applied: Document No. DNVGL-SE-0190:2015-12 Project certification of wind power plants. By fulfilling the requirements in DNVGL-SE-0190, the Site Assessment Requirements listed in IEC 61400-22:2010-05 Wind turbines – Part 22: Conformity Testing and Certification are also fulfilled.

#### 4.12.4 Experts

Experts that have provided input in the process include:

- BLIX Consultancy (Project management, experts)
- The Cultural Heritage Agency (Archaeological desk study)
- Rijkswaterstaat
- Windsupport Ltd (Geotechnical site investigations)
- Reynolds International Ltd (Geophysical site investigations)
- RPS Energy Ltd (Geophysical and geotechnical site investigations, Metocean campaign HSE)
- Rambøll (Geotechnical Site Investigations)
- ECN (Metocean measurements)
- Ecofys WTTS (Metocean measurements)
- Carbon Trust, Offshore Renewable Energy Catapult (Metocean measurements)
- Primo Marine (Metocean desk study)
- Periplus Group (GIS)
- DNV GL for Verification Letters
- Ministry of Defence (UXO risk assessment).

# 5. Legal framework and specific requirements of the HKZWFS I and II permit tender


## 5.1 Introduction - Offshore wind road map

**With offshore wind seen as a key technology for the Netherlands, the Dutch Government published a road map for offshore wind in September 2014. The road map outlines plans for new designated offshore wind areas, a new regulatory framework for permits and subsidies, and offshore grid expansion and operation by TSO TenneT.**

The road map sets out a schedule of tenders offering 700 MW of development each year in the period 2015 – 2019, under the condition that the cost of offshore wind power will decrease by 40% in 2020, compared to 2014.
The Government has streamlined the entire development process and taken on direct responsibility for key elements including spatial planning, site surveys and environmental impact assessments. This new approach alleviates much of the industry burden and costs traditionally associated with offshore wind development. After the five-year offshore wind tender programme the Dutch Government has planned an additional seven-year programme of 1,000 MW of extra offshore wind power capacity each year. This has been formulated in the Energy Agenda of December 2016.

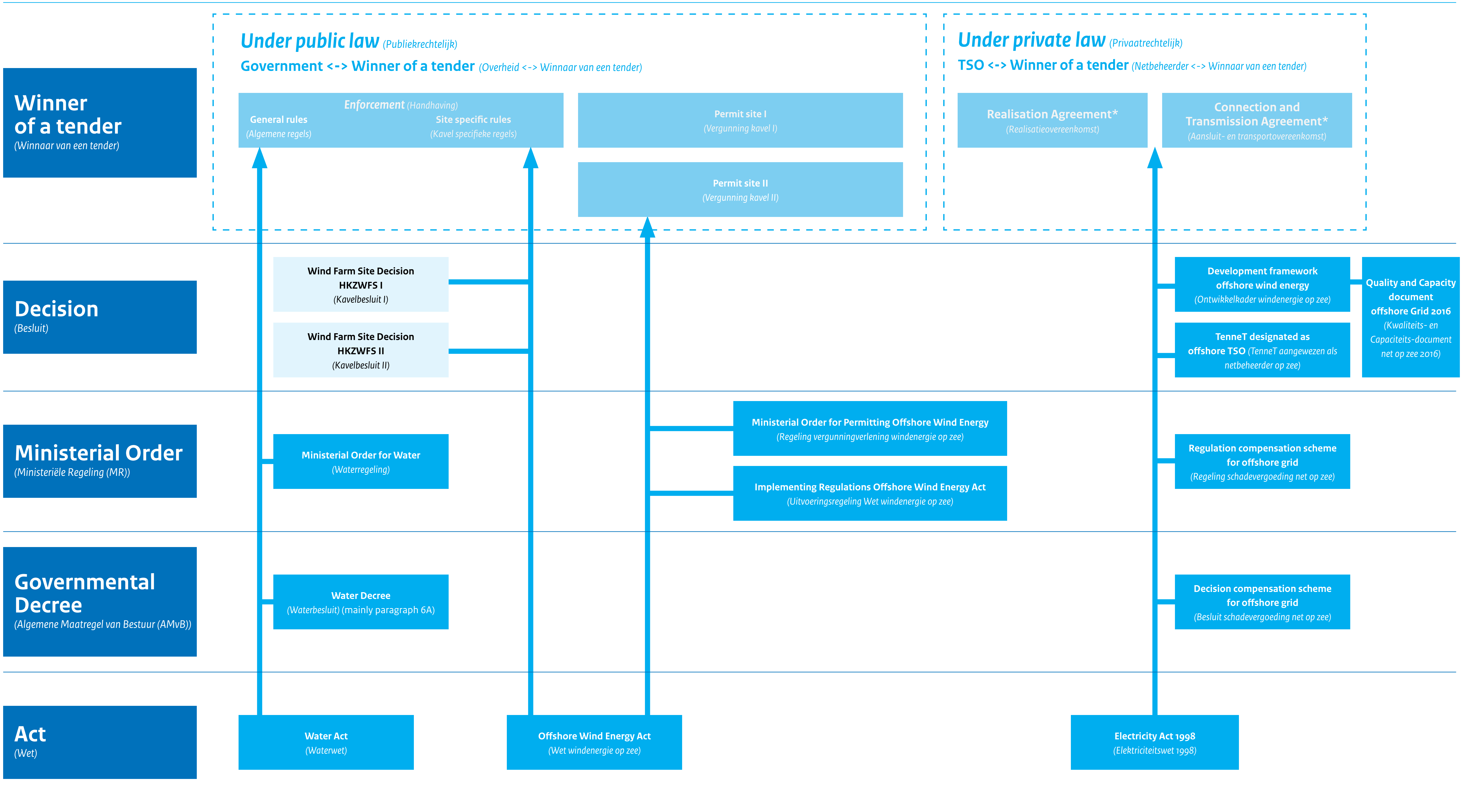
The remainder of this chapter provides a broader overview of the legal framework and the requirements for the HKZWFS I and II permit tender as follows:

- Legal framework - Offshore Wind Energy Act, Wind Farm Site Decisions, Water Decree, National Waterplan, tender process and brief overview of how it will work for HKZWFS I and II;
- Permit - overview of the process and permit terms for HKZWFS I and II, including the conditions that apply and who is responsible for enforcement;
- TenneT alpha platform - framework overview, permitting and planning process, Realisation Agreement and Connection and Transmission Agreement, applicable codes, and a summary of the step-by-step process to connection.

The legal framework can be found in Figure 5a. An unofficial translation of the relevant law in English can be found in Appendix A.

Published, not yet irrevocable
(Gepubliceerd, niet onherroepelijk)
Final, into force
(Finaal)

**Figure 5a** *Legal framework*




* TenneT has offshore model agreements available online.

## 5.2 Legal framework

To cement its plans, the Dutch Government introduced new legislation and a new bill on offshore wind energy, the Offshore Wind Energy Act (Wet windenergie op zee), which came into force in July 2015. The Act prohibits the construction, exploitation and removal of a wind farm in the Dutch territorial sea or Dutch Exclusive Economic Zone (EEZ) without a license, sets out the requirements for a license, and provides the legal framework for the designation of sites for the construction and exploitation of wind farms in the so-called Wind Farm Site Decision (WFSD, 'kavelbesluit').

The 'general rules' for offshore wind farms (Water Decree) also apply for all locations within the Dutch EEZ. Paragraph 6A of the Water Decree provides general requirements for the construction of offshore wind farms. These requirements are listed in chapter 6.2.

Together with these 'general rules' in the Water Decree, the WFSD contains the specific conditions for building and operating a wind farm on a designated site. The Dutch Government provides all relevant site data, via the Netherlands Enterprise Agency (RVO.nl), an agency of the Ministry of Economic Affairs. It should be noted that an Environmental Impact Assessment (EIA) is required. The Government has prepared the EIA. This means that no additional EIA will be required by companies bidding to develop projects. Appendix B contains a summary of the Environmental Impact Assessments for HKZWFS I and HKZWFS II.

Under the new legal framework, Dutch TSO TenneT is responsible for the electricity transmission infrastructure needed for the offshore wind farm. The Electricity Act 1998 was amended to formally designate TenneT as operator of the offshore grid, including the legal framework for the planning of the roll-out and the establishment of its statutory liabilities for delays and faults. The amended Electricity Act 1998 came into force in April 2016.

### 5.2.1 National Waterplan update

The National Waterplan (2009-2015 including amendments in 2014) had designated Borssele, Hollandse Kust (zuid and noord outside the 12 nautical mile zone), IJmuiden Ver and north of the Frisian islands as Wind Farm Zones (WFZs).
A new National Waterplan 2016-2021 was sent to Parliament in December 2015. This included the reconfirmation for all designated WFZs from the National Waterplan 2009-2015. It also reconfirmed the investigation of potential offshore wind development in the Hollandse Kust zone (zuid and noord), 10-12 nautical miles offshore (adjacent to the existing designated areas). Development in this area has now been approved.

The National Waterplan 2016-2021 also contains the framework for the assessment of shared use of the designated WFZs. This has been translated in the policy memorandum North Sea (Beleidsnota Noordzee). This includes the processes for distance between shipping routes and wind farms, the distance between mining operations and wind farms and rules for passage and shared use.

### 5.2.2 Tender process

Under the process, the Government first designates a WFZ. It then carries out the site investigations, determines the conditions for building and operating a wind farm, and issues request for tenders from industry for the project permits. Winners of the site development tenders will be granted a permit to construct a wind farm according to the Offshore Wind Energy Act (Wet Windenergie op zee) and offered a grid connection to the mainland. The Ministry of Economic Affairs (via RVO.nl) provides site data, which can be used for the preparation of bids for these tenders. This system is expected to contribute to cost savings.

In summary, the process for HKZWFS I and II is as follows:

- The Ministries of Economic Affairs and Infrastructure and the Environment issue a Wind Farm Site Decision (WFSD). The WFSD for HKZWFS I and II was published in December 2016. Seven parties have made an appeal against the final Wind Farm Site Decicions (WFSD) I and II Hollandse Kust (zuid) at the Council of State.
- The boundary and coordinates of HKZWFS I and II can be found in the Memo Boundaries and Coordinates. This memo has been fully updated since it was last published in November 2016. The updated memo is included in Appendix C.
- The Dutch TSO TenneT will develop and operate the offshore grid connections.
- The Government will issue the call for tenders for HKZWFS I and II in December 2017.
- The winner of a tender is allowed to build a wind farm on the specific site and therefore receives: a permit, based on the Offshore Wind Energy Act, allowing it to build, operate and decommission a wind farm;
- The winner and TenneT agree upon (respectively) a Realisation Agreement and a Connection and Transmission Agreement, required prior to realisation or operation of the connection (see 5.4.3).

The Arbo act (decree, regulations) and working hours (decree, regulations) apply to all work related to offshore wind farms and offers employers and employees a lot of space to self-fulfill healthy and safe work. The law only describes standards. How these standards are to be complied with is left to the companies themselves and can be recorded in a catalog of labor ('arbeidscatalogus').
A catalog of labor for wind farms has been made by NWEA (*http://windenergiebedrijven.dearbocatalogus.nl/nl/arbo/offshore/322*).

### 5.2.3 Enforcement

Rijkswaterstaat (Ministry of Infrastructure and the Environment) is appointed as the overseeing authority charged with enforcing the general rules that stem from the Water Act (mainly § 6A of the Water Decree) and specific rules that stem from the Wind Farm Site Decisions.

State Supervision of Mines (SSM) is appointed as the overseeing and enforcing authority for the arbo laws for all offshore activities. Because of this role SSM inspectors have been inspecting offshore wind farms prior to 2017. For efficiency reasons it was decided in 2017 to also appoint SSM for the Water Act and the specific rules from the WFSD.

## 5.3 Permit

### 5.3.1 Permit

The winner of the tender receives a permit to build, operate and decommission the relevant wind farm, valid for a 30-year period. According to the application the wind farm must be operational within four years after the permit is irrevocable, and can operate until the 29$^{th}$ year. Decommissioning can start latest end of year 25 and should be completed within two years maximum after the power generation operations have stopped, but at the latest in the 30$^{th}$ year.

## 5.4 TenneT offshore grid operator

### 5.4.1 Introduction and framework

The Authority for Consumers and Markets, ACM, (Regulator) decided to certify TenneT as the offshore grid operator in July 2016. This was a requirement for the Ministry of Economic Affairs to formally designate TenneT as offshore grid operator in the Netherlands on September 6, 2016.
The Electricity Act 1998 introduced a 'Development framework for the offshore grid', which provides a technical framework and outlines the future development of offshore wind energy in the Netherlands. The Development framework for the offshore grid was published by the Ministry of Economic Affairs and amended in June 2016.

### 5.4.2 Status Permitting process and planning

As prescribed in the Development framework and elaborated on in the offshore Quality and Capacity Document published in May 2016, TenneT will build grid connections for the planned 3,500 MW new offshore wind capacity.
To create economies of scale, TenneT will construct five standardised substation platforms, each with a capacity of 700 MW. These platforms will be connected to the national Extra High Voltage grid with two 220 kV export cables per platform. Two platforms, alpha and beta, will be connected via a 66 kV link. Output from HKZWFS I and II will be connected to a single platform (alpha). The 220 kV export cables will connect to the planned onshore substation Maasvlakte-Noord. The platform alpha is planned to be due in the second quarter of 2021.

### 5.4.3 Realisation Agreement and Connection and Transmission Agreement

In close consultation with the offshore wind industry, the Ministry of Economic Affairs, the regulator ACM, and representatives of the Dutch energy market, TenneT has developed an offshore legal framework consisting of so-called model agreements. Consultation sessions of these model agreements were open to all stakeholders of the offshore grid and this consultation was finalised ahead of the first subsidy tender process. The model agreements consist of a Realisation Agreement and a Connection and Transmission Agreement supported by Offshore General Terms and Conditions, in line with onshore practice. Model agreements are available for parties to be connected to the offshore grid (see ***www.tennet.eu/netopzee***).

The model for these agreements will basically be the same for all winners of the tenders (past, present and future). All agreements will be entered into force according to the model agreements published by TenneT. The agreements will be concluded on an equal basis with the parties concerned in accordance with the model which has been consulted. For the sake of completeness: the content of these agreements is non-negotiable.

The missing data in these agreements will be completed in close consultation with the parties with whom TenneT enters into agreements.

### 5.4.4 Applicable codes

The generic technical requirements for offshore wind farm connections are established as technical code requirements, and as such are based on public law. In December 2016, ACM concluded and published the offshore code. Further generic technical requirements by TenneT can be found in the annexes to the model agreements.

### 5.4.5 Step-by-step process to connection

RVO.nl will, when requested, organise an introduction for the winner(s) of the tender with RVO.nl, Ministry of Economic Affairs, Rijkswaterstaat and TenneT. After this introduction, TenneT will invite the winner(s) for bilateral meetings to start the connection process with the necessary steps for connecting a wind farm to the offshore grid:

- The winner(s) of the tender will provide TenneT with the missing data as indicated by TenneT in the Realisation Agreement and the Connection and Transmission Agreement;
- TenneT will process the data received in the agreements and provide fully completed agreements to the winner;
- After the agreements have been signed by both parties, the parties will consult on the joint planning, and further information exchange and coordination will take place in the project working group (as referred to in Article 6 of the Realisation Agreement);
- Timely conclusion of the agreements is vital to effecting the connection to the offshore transmission grid according to the planning;
- RVO.nl will hand over all remaining samples of the geotechnical survey.

# 6. Specific requirements and relevant information from the legal framework

**This chapter outlines the specific information that is relevant or needs to be adhered to when competing in the call for tender to design and build a wind farm at HKZWFS I and II. These requirements originate from the legal framework (an unofficial English translation of the legal framework can be found in Appendix A).**

## 6.1 Boundaries and coordinates

The boundaries of the HKZWFZ have been updated and published in the Memo Boundaries and Coordinates, Appendix C.

Appendix C contains the coordinates of:
- The Hollandse Kust (zuid) Wind Farm Zone;
- The Hollandse Kust (zuid) Wind Farm Sites;
- Infrastructure (pipelines, telecom and export cables, and infield cable entry zones);
- The existing wind farms.

## 6.2 Design and operation requirements

This section contains tables summarising the specific requirements that need to be adhered to when competing in the call for tender relating to the design and build of a wind farm in HKZWFS I and II. The requirements are grouped in line with the different wind farm development stages (design, finance, build, operate, and decommissioning).

While Netherlands Enterprise Agency (RVO.nl) has tried its best to provide a complete overview of all relevant requirements, this list may still be incomplete or may be superseded. In any case, the applicable law is leading.

### 6.2.1 Design bandwidths for the HKZWFZ

In order to be compliant with the permit, the design of a wind farm built in the HKZWFZ shall be compliant with the requirements listed in the Table 6a, which are an abstract of the applicable law (Appendix A).

Besides compliance to the permit, compliance to the Arbo act (decree, regulations) and working hours (decree, regulations) is required. English translations of these laws can be found on *https://www.arboineuropa.nl/en/legislation/wetgeving-in-het-engels*

As mentioned in chapter 5.2 the catalog of labor for wind farms made by NWEA can be found on: *http://windenergiebedrijven.dearbocatalogus.nl/nl/arbo/offshore/322*.

For offshore wind farms it is extremely important to take safe working conditions into account for the entire supply chain: installation, operation and decommissioning, while designing the wind farm.

**Table 6a** *Bandwidth of design characteristics for HKZWFS I and II*

| Requirement | Applicable Law |
|---|---|
| HKZWFS I and II are each appointed as locations for wind farms with a capacity of 350 MW: total minimum capacity allowed is 342 MW and total maximum capacity is 380 MW. | Wind Farm Site Decision (WFSD) I and II |
| The wind farms will be situated within the contours of the coordinates listed in Appendix C. | WFSD I and II Reg 2.1 |
| The route of the grid connection to the Hollandse Kust (zuid) alpha platform is within the coordinates listed in Appendix C. | WFSD I and II Reg. 2.2 |
| No wind turbines will be installed in maintenance zones. These zones are within the coordinates listed in Appendix C. | WFSD I Reg. 2.3 |

| Requirement | Applicable Law |
|---|---|
| The rotor blades of the wind turbines must remain completely within the contours cited of HKZWFS I and II in Appendix C of this PSD and completely outside of the maintenance zones regarding WFS I cited in Appendix C. | WFSD I and II Reg. 2.4 |
| The maximum number of wind turbines to be installed: 63. | WFSD I and II Reg. 2.5 |
| The maximum total swept area permitted: 1.461.542 $m^2$. | WFSD I and II Reg. 2.6 |
| Only wind turbines of minimal 6 MW capacity per wind turbine are to be installed in the wind farm. | WFSD I and II Reg. 2.7 |
| The minimum distance between wind turbines must be 4 times the rotor diameter expressed in metres. | WFSD I and II Reg. 2.8 |
| The minimum tip lowest level is 25 m above sea level (MSL). | WFSD I and II Reg. 2.9 |
| The maximum tip highest level is 251 m above sea level (MSL). | WFSD I and II Reg. 2.10 |
| The cables from the wind turbines must be connected to the Hollandse Kust (zuid) alpha platform. | WFSD I and II Reg. 2.11 |
| The permitted foundations for the wind turbines are: monopile, tripod, jacket, gravity based and suction bucket. If the permit holder wishes to deploy a type of foundation that is not cited in this paragraph, then the environmental impact of that must be determined and submitted to the Minister of Economic Affairs. The environmental impact must not exceed the limits set out in the Wind Farm Site Decision. | WFSD I and II Reg. 2.12 |
| If sacrificial anodes are used as cathodic protection for steel structures, then these alloys should consist of aluminium or magnesium. The alloys may contain small quantities (< 5 weight %) of other metals. | WFSD I and II Reg. 2.13 |
| The permit holder must make demonstrable efforts to design and build the wind farm in such a way that it actively enhances the sea's ecosystem, helping to foster conservation efforts and goals relating to sustainable use of species and habitats that occur naturally in the Netherlands. In this respect the permit holder is required to create an action plan, to be submitted to the Minister of Economic Affairs no later than eight weeks before the commencement of the construction. Construction work must adhere to this plan. | WFSD I and II Reg. 2.15 |
| The permit holder must make demonstrable efforts to design, build, and operate the wind farm, while taking into account the prevailing laws, in such a manner that the wind farm actively contributes to strengthening the local and regional economy. For that purpose, the permit holder is required to create an action plan, to be submitted to the Minister of Economic Affairs at least eight weeks before the commencement of the construction. The work will be performed in accordance with this action plan. | WFSD I and II Reg. 2.16 |
| The permit as referred to in Section 12 of the Offshore Wind Energy Act will be issued for a period of 30 years. | WFSD I and II Reg. 3 |
| If it is determined by the Water Decree that a measure must be taken for the protection of the North Sea, then another measure can be taken if Our Minister has decided that at least an equal level of protection of the North Sea will be achieved by means of that measure. The person or entity who intends to take another measure should submit an application to Our Minister for that purpose, containing details from which it can be demonstrated that at least an equal level of protection of the North Sea will be achieved by means of that other measure. Our Minister will make a decision within eight weeks regarding an application to take another measure (to protect the North Sea), determining whether or not it will ensure an equal or improved level of protection. Our Minister may extend this period once by six weeks at most. | Water Decree / Article 6.16b |
| The operator will report its intention to install and/or change a wind farm to Our Minister at least eight weeks before the start of the construction period and will provide the following data thereby: its location, the type of quality and security provisions. Within three months after installation an operator will provide Our Minister the position of foundations and export cables and related works. | Water Decree / Article 6.16d |



### 6.2.2 Financial and legal requirements

The final financial and legal requirements for HKZWFS I and II will be published in October 2017. Table 6b provides a summary of the expected requirements.

**Table 6b** *Financial and legal requirements for HKZWFS I and II*

| Requirement | Applicable Law |
|---|---|
| The deadline for tender submissions is planned 21 December 17.00 Dutch time. | MOPOW Art. 2.1 |
| The wind report must be drawn up by an independent organisation with expertise in the area of wind energy output or yield calculations. | MOPOW Art. 3.1a |
| When calculating the wake effect for the P50 value, only Luchterduinen Wind Farm and the site itself should be taken into account. | MOPOW Art. 3.2 |
| When calculating the P50 value for net electricity generation per annum of the wind farm, the following losses should be taken into account: availability, wake effects, electricity losses and curtailment losses. | MOPOW Art. 3.2 |
| The insight into equity will be offered by the provision of the most recent annual accounts of the applicant, its parent company and/or the participants in the alliance. | MOPOW Art. 3.10d |
| The Minister will reject an application if the level of applicants own assets is less than 20% of the total investment cost of the requested sites. | MOPOW Art. 4.2 |
| If the applicant or a participant in an alliance is a subsidiary company, the other own assets of the parent company has agreed to this in writing. | MOPOW Art. 4.3 |
| If the applicant will apply for two sites, 20 % own assets of the total sum of investments is required. | MOPOW Art. 4.4 |
| The permit will be provided for a period of 30 years. | |

### 6.2.3 Construction

**Table 6c** *Construction requirement parameters for HKZWFS I and II*

| Requirement | Applicable Law |
|---|---|
| The operator will report its intention to install and/or change a wind farm to Our Minister at least eight weeks before the start of the construction period and will provide all relevant issues related to safety and environment during the construction and operational phase. | Water Decree/§ 6.16d1 |
| Measures for the prevention of permanent physical harm and/or effects to porpoises and seals and the mortality of fish:<br>a. the permit holder must use one or more acoustic deterrent device(s) tuned to the relevant frequencies during piling work, including half an hour before piling work starts. In its piling plan, the permit holder will outline the type of deterrent it plans to use, including supporting evidence of its proven effectiveness;<br>b. piling work must adopt a soft start, ensuring that porpoises are given the opportunity to swim to a safe location. The piling plan should provide details outlining the duration and power of the soft start along with supporting evidence of effectiveness. | WFSD I and II Reg. 4.1 |

| Requirement | Applicable Law |
|---|---|
| Measures to prevent disturbance to porpoises, seals, and fish (sound emission standard):<br>a. The underwater sound level as a result of the construction of the wind farm must not exceed the sound levels cited in WFSD Regulation 4.2;<br>b. the permit holder may exceed the sound emission standard stated in the above table by a maximum of 2 dB re 1 μPa2s SEL1 for the first ten foundation pillars;<br>c. during the pile-driving work, the sound level must be continuously measured by or on behalf of the permit holder. The sound measurements for each foundation pillar driven must be sent to the Minister of Economic Affairs within 48 hours after completion of the pile driving of the foundation pillar concerned;<br>d. when consecutive sound measurements reveal that the underwater sound level during the pile driving of the foundation pillars does not exceed the sound emission standard stated in the table, the Minister of Economic Affairs can be asked to permit the lowering of the sound measurement frequency.<br>e. the permit holder prepares a piling plan and submits this to the Minister of Economic Affairs at least 8 weeks before the commencement of the construction;<br>f. the work must be performed in accordance with the piling plan as referred to in subparagraph e of this regulation;<br>g. the permit holder strives to produce as little underwater sound as possible;<br>h. the permit holder strives to produce underwater sound in a continuous period of time as short as possible. | WFSD I and II Reg. 4.2 |
| Measures to protect archaeology and cultural history:<br>a. Before laying cables or building the foundations of wind turbines in locations with verified or potential archaeological value as listed in the Periplus Archeomare report and in a buffer zone with a radius of 100 metres around such locations, it is necessary to do a further exploratory field study to the presence, nature and extent of archaeological monuments. This study must be performed in accordance with the Dutch Archaeology Quality Standard Aquatic Soils (version 3.2) (Kwaliteitsnorm Nederlandse Archeologie Waterbodems).<br>b. At the latest, three months prior to building a wind farm the results of the research mentioned in subparagraph a have to be handed over to the Minister of Economic Affairs.<br>c. Depending on the conclusions of the study:<br>· the work can proceed without changes;<br>· follow-up study is required;<br>· physical measures must be taken to protect archaeological sites;<br>· sites are to be excluded from interference taking into account a buffer zone;<br>· the work must be supervised archaeologically. | WFSD I and II Reg. 4.5 |
| Concerning the visible structures at the seabed surface, as long as the archaeological value of the remains is not determined, it is advised not to conduct disturbing activities on the locations including a buffer zone of 100 m around. This also applies to cable trenching and anchorages of work vessels. The buffer zone of 100 m is a standard that applies to the protection of cultural heritage, this distance may be reduced if it can be substantiated that the applied disturbance has no effect on the archaeological object.<br><br>If it is not feasible to avoid the reported magnetometer locations, additional research is required in order to determine the actual archaeological value of the reported locations.<br>It is advised that the UXO research within 100 m of the 65 magnetometer anomalies is carried out under on-board archaeological supervision. Depending on the outcome of the UXO research, it may be decided that additional research (for instance by means of ROV or dive investigations) is needed. If the UXO research indicates the object has no archaeological value, the location can be omitted. During the installation of the wind turbines and cable lay operations, archaeological objects may be discovered which were completely buried or not recognised as an archaeological object during the geophysical survey. Periplus Archeomare recommends passive archaeological supervision based on an approved programme of requirements.<br>In accordance with the Monuments Act 1988 (Revised 2007), those findings must be reported to the competent authority. | Archaeological Assessment |
| If, during the construction of a wind farm or during other work relating to wind turbines in the Dutch Exclusive Economic Zone, a monument is found, or what is possibly a monument, as defined in the Monuments and Historic Buildings Act 1988, then the first subsection of Sections 53, 56, 58, and 59 of that Act are equally applicable. | Water Decree 6.16f.1 |

| Requirement | Applicable Law |
|---|---|
| 1. A wind turbine and any other installation that forms part of a wind farm must be sufficiently strong to withstand the expected forces resulting from wind forces, waves, sea currents and use of the turbine itself.<br>2. At least four weeks before putting the wind farm into operation, the operator will provide Our Minister with a statement confirming that the construction/installation of the wind turbines and other balance of plant components forming part of the wind farm comply with the first subsection. | Water Decree 6.16g 1 and 2 |
| 1. In order to ensure the safety of air traffic and shipping traffic, a wind farm will be equipped with identification marks and beacons.<br>2. The identification marks and beacons referred to in the first subsection must comply with the IALA recommendation O-139 (the marking of manmade offshore structures) and with the guideline published by the British Civil Aviation Authority CAP 764 (policy and guidelines on wind turbines). | Water Decree 6.16h 1 and 2 |

### 6.2.4 Operation

**Table 6d** *Operational requirements for HKZWFS I and II*

| Requirement | Applicable Law |
|---|---|
| Vessels used by or on behalf of the permit holder must take into account during their actions the presence of seals in the shallows and designated resting areas and the presence of bird concentrations. The measures cited in the Voordelta Management Plan, the Delta Water Management Plan, the Management Plan Waddenzee, and the Management Plan Noordzeekustzone must be taken into account hereby. | WFSD I and II Reg. 2.14 |
| During repairs to and maintenance of telecommunication cables, the number of rotations per minute per wind turbine of those wind turbines that are situated within a radius of 1,000 m from the site of the repairs or maintenance must be reduced to less than 1. | WFSD I and II Reg. 2.17 |
| Measures to limit collision victims amongst birds at rotor height during mass bird migration:<br>a. at night (between sunset and sunrise), during the period in which mass bird migration effectively takes place, the number of rotations per minute per wind turbine will be reduced to less than 1;<br>b. the permit holder is required to participate in the placement of a system that observes actual bird migration at the location specified by the government for that purpose;<br>c. for the purpose of implementing this regulation, referred to in subparagraph a, the control system of the wind turbines will be linked to a system that effectively observes bird migration;<br>d. in a plan, the permit holder describes the system to which the wind turbines will be linked. The permit holder must submit this plan to the Minister of Economic Affairs at least eight weeks before the commencement of the construction;<br>e. the connection mentioned in part b of this regulation will be executed within the plan mentioned in part c;<br>f. January 1st and July 1st of each year the permit holder reports how and in what way the regulation rules have been executed. | WFSD I and II Reg. 4.3 |
| Measures to prevent victims of collision amongst bats at rotor level:<br>a. the cut-in wind speed of turbines will be 5.0 m/s at axis height during the period of 15 August to 30 September between 1 hour after sunset to 2 hours before sunrise;<br>b. in case of a wind speed of less than 5.0 m/s at axis height, during the period referred to in part a, the permit holder will reduce the number of rotations per minute per wind turbine to less than 1;<br>c. within two months after the end of the period referred to in part a, the permit holder will produce a report outlining how and in which way this regulation is implemented and submit it to the Minister of Economic Affairs. | WFSD I and II Reg. 4.4 |



| Requirement | Applicable Law |
|---|---|
| Measures to reduce nuisance from lighting of the wind farm:<br>a. Obstruction lights at the highest fixed point on wind turbines are steady-burning red lights.<br>b. If visibility during the twilight and/or night-lighting period is greater than 5 kilometres, the nominal light intensity of these obstruction lights during the twilight and/or night-lighting period will be reduced to 30%, and if visibility during the twilight and/or night-lighting period is greater than 10 kilometres, the intensity during the twilight and/or night-lighting period will be reduced to 10%. | WFSD I and II Reg. 4.6 |
| 1. The Minister of Economic Affairs has an environmental monitoring and evaluation programme.The permit holder will cooperate in the implementation of this programme to a reasonable extent, without financial compensation. In doing so, the safety regulations applicableon the wind farm will be taken into account.<br>2. The Minister of Economic Affairs will publish the data generated by the monitoring and evaluationprogramme.<br>3. The permit holder will cooperate in the implementation of the monitoring and evaluation-programme e.g. as follows:<br>• providing access to the wind farm for vessels conducting monitoring and evaluation work;<br>• enabling the attachment of equipment such as cameras and bat detectors to/on (parts of)<br>• the wind turbines;<br>• enabling the attachment of radar equipment to/on (parts of) the wind turbines;<br>• enabling the attachment of measurement equipment (for example measurement buoys,<br>• C-PODs, etc.) within the wind farm;<br>• making available bandwidth on the data cable. | WFSD I and II Reg. 5 |
| The operator is responsible for a good level of maintenance of the wind farm and for this purpose will periodically inspect the wind turbines and other provisions, as well as the security provisions. | Water Decree/Article 6.16i |

### 6.2.5 Decommission of the wind farm

**Table 6e** *Decommissioning requirements for HKZWFS I and II*

| Requirement | Applicable Law |
|---|---|
| After the power generation operations have stopped the permit holder will dismantle and remove all elements of the wind farm within two years at the latest, but always within the term of validity of the permit. | WFSD I and II Reg. 6 |
| 1. At the latest at the moment of given proof of produced electricity by the means of so-called Guarantees of Origin (Garanties van Oorsprong), the permit holder will guarantee the removal of the wind farm by means of a bank guarantee for the State in the amount of €120,000 per MW installed.<br>2. The permit holder will annually increase the amount referred to under 1 by 2% as a consequence of indexation during a period of 12 years after the issue of the bank guarantee.<br>3. After operating for a period of 12 years, operating for a period of 17 years, and 1 year before the date of removal, the permit holder will request the Minister of Economic Affairs to redetermine the amount referred to under 1 and its indexation. | WFSD I and II Reg. 7 |
| A wind farm that is no longer in use must be removed. This is equally applicable to scrap metal and other materials that are present on site or in the surrounding area as a result of the placement, maintenance, use or decommissioning of the wind farm. Our Minister can set a time limit, within which the obligation for decommissioning must be complied with. | Water Decree 6.16l |

### 6.2.6 Electrical Infrastructure

**Table 6f** *Electrical infrastructure requirements for HKZWFS I and II*

| Requirement | Applicable Law |
|---|---|
| A power producer is entitled to compensation from TenneT if the offshore grid commissioning is late or if there has been too much downtime during the year. | COMPS 2.1[1] |
| A downtime of five days per calendar year is allowed without compensation. | COMPS 2.3 |
| Compensation consists of consequential damages and damages resulting from lost or postponed revenue. | COMPS 3.1,3.2 |
| In case of late commissioning, the compensation is: postponed income from electricity price (E-E/3.87) + consequential damages (EACT/Article 16f.2). The rationale behind this factor is that this income is not lost, it is only postponed by 16-20 years. The factors are a compensation for the time value of money. | COMPS, 4.3 |
| In case of unavailability, the compensation is: Lost income from electricity sale + consequential damages. In formula: (E price) * (kWh missed-kWh transported_ in_5_days) + consequential damages. | COMPS, 4.2 |
| The connection voltage level of the inter-array systems to the TenneT platform will be standardised at 66 kV. | Development framework offshore wind energy 3.3.7 |
| Number of bays. With the 66 kV inter-array cables, six 66 kV bays will be available per PPM (Power Park Module). This results in four bays with "one string – one bay" and two bays with "two strings– one bay" on the platform. The "two strings – one bay" solution will be executed with two separate cable disconnectors. | Development framework offshore wind energy, 3.3.8 |
| Access to platform. Boat landing and walk-to-work (W2W) solutions are the standard access method to the offshore substation. The platform will have a helicopter hoisting facility for emergency response (if allowed by authorities) but no helicopter platform. | Development framework offshore wind energy, 3.3.4 |
| Organisation of metering. TenneT will centralise the organisation of the accountable metering requirements via one certified party, contracted by TenneT, responsible for the installation, commissioning and maintenance of the metering equipment. The metering responsibilities of the operator of the PPMs as the Connection Party will be dealt with in the Connection and Transmission Agreement. | Development framework offshore wind energy, 3.3.9 |
| Overcapacity. TenneT guarantees a transmission capacity of 350 MW per power park module. The power park module (PPM) is allowed to transmit to a maximum of 380 MW, with the requirement for output from the PPM to be curtailed in case the 220 kV export cables reach their maximum allowable temperature limits. Curtailment will be addressed in the Connection and Transmission Agreement. | Development framework offshore wind energy, 3.3.6 |
| Number of J-tubes and bays. Based on 66 kV inter-array cables and 60 - 70 MW per cable - a standard platform shall be equipped with 18 J-tubes for the inter array system:<br>- 2x 8 J-tubes for offshore PPMs; 1 J-tube installed for possible test purposes; 1 J-tube installed for the connection to the neighbouring platform. | Development framework offshore wind energy, 3.3.7 |
| Point of Common Coupling. The connection point (CP) between the offshore power park module (PPM) and TenneT is specified at the cable termination of the inter-array cables and the switchgear installation on the platform. | Development framework offshore wind energy, 3.3.8 |
| TenneT will provide a standardised protection system and will decide post award of bid, in consensus with the selected project developer, on details for this protection system and arrange this in the offshore agreements between TenneT and Connected Party. Customised wishes will be at cost of the Connected Party. | Development framework offshore wind energy, 3.3.8 |



| Requirement | Applicable Law |
|---|---|
| TenneT is inclined towards:<br>(i) not installing, nor make provisions for, a (diesel engine powered) back-up generator plant on the offshore platform to provide auxiliary power for the PPMs; and<br>(ii) installing a wireless communication interface (emergency facility) between the offshore platform and onshore substation, only in case of a firm and significant delay in realisation of such communication through the export cable fibres. | Development framework offshore wind energy, 3.3.5 (i)/ TenneT (ii) |
| Planning. The indicative date for delivery of Hollandse Kust (zuid) alpha is the third quarter of 2019. | Development framework offshore wind energy, 3.4.2 |

[1] *COMPS = Compensation Scheme for Offshore Grid*

*For further technical requirements please see TenneT's model agreements published at: http://www.tennet.eu/our-grid/offshore-projects-netherlands/programme-offshore-grid/*

# 7. Next steps preparing a bid

**Preparations by the Government for the first Hollandse Kust (zuid) tender are being finalised. This Project and Site Description, version October 2017, is the final version, which contains all available site data and requirements that are relevant to prepare a tender bid by December 2017 for HKZWFS I and/or II.**

In this Chapter, you will find the following information (and web links) to help you with the next steps in preparing your tender bid:

- Key dates you need to know to participate in the request for tender for HKZWFS I and/or II;
- Useful websites which provide the most up-to-date information on the tenders and status of all relevant studies, the legal framework and the application for a permit;
- Background information on Dutch energy policy, Dutch wind power development to date, and the State's role in reducing the cost of offshore wind power;
- General information on the Dutch wind power industry, opportunities for growth and R&D innovation (in both a local and European context), key industry authorities and contacts, and links to further information on incentive schemes and finance contacts that may be of interest;
- Information and contact details relating to key stake holders in the Hollandse Kust region;
- An overview of all the major Dutch ports that can service the offshore wind sector, both locally and in a European context.

## 7.1 Key dates

The key dates which participants in the tender for HKZWFS I and/or II need to know are:

- 17 October 2017: publication of the Ministerial Order for Permitting Offshore Wind Energy 2017;
- In November 2017: application forms can be downloaded from ***www.mijnrvo.nl*** (Dutch only: Please note all applications must be completed using the Dutch language);
- In December 2017: tender Offshore Wind Energy 2017 HKZWFS I and II.

## 7.2 Useful websites to help keep track

Several websites provide the most up-to-date information and status of all relevant studies, legal framework and the application process for a subsidy and permit. The most important of these are listed below:

- The most up-to-date information on site data, including the results of the HKZWFZ metocean campaign, can be found at ***offshorewind.rvo.nl***. The site also contains maps, minutes of workshops, and a Q&A and revision log;
- Application forms required to participate in the tenders for HKZWFS I and II can be downloaded from ***www.mijnrvo.nl***;
- More information on the permit and the FAQ can be found at ***www.rvo.nl/windenergie-op-zee*** and ***www.english.rvo.nl/offshore-wind-energy***;
- Wind Farm Site Decisions are published at ***www.rvo.nl/windenergie-op-zee*** and ***www.english.rvo.nl/offshore-wind-energy***;
- An overview of all relevant wind measurement locations in the North Sea: ***www.windopzee.net***;
- General information about offshore wind energy from the Dutch Government: ***www.rijksoverheid.nl/onderwerpen/duurzame-energie/windenergie***;
- Information from Holland Trade and Invest on opportunities in the Netherlands for offshore wind: ***www.hollandtradeandinvest.com/key-sectors/energy/publications/publications/why-explore-the-netherlands-for-offshore-wind-energy/06/06/why-explore-the-netherlands-for-offshore-wind-energy***;
- "Noordzeeloket" provides information on several spatial topics concerning the North Sea, including offshore wind ***www.windopzee.nl*** and ***www.noordzeeloket.nl/functies-en-gebruik/windenergie/***;
- Information on the permitting procedure for the grid connection: ***www.rvo.nl/windenergie-op-zee***;

- All information resulting from TenneT's consultation process with the offshore wind sector (technical, legal, planning and other topics):
  - *www.tennet.eu/nl/grid-projects/projects-in-the-netherlands/ grid-at-sea.html*
  - *www.tennet.eu/nl/nl/net-projecten/projecten-in- nederland/ net-op-zee/frequently-asked-questions.html*
  - *www.tennet.eu/nl/nl/over-tennet/nieuws-pers-publicaties/ publicaties/technische-publicaties.html*
- Draft spatial plan and draft licenses for Grid Connection System Hollandse Kust are published under the 'Rijkscoordinatie-regeling': ***www.rvo.nl/subsidies-regelingen/ bureau-energieprojecten/***;
- Scoping analysis of the potential yield of the Hollandse Kust (zuid) wind farm sites and the influence on the existing wind farms in the proximity, ECN, August 2016: ***www.ecn.nl/publicaties/ECN-E--16-021***.

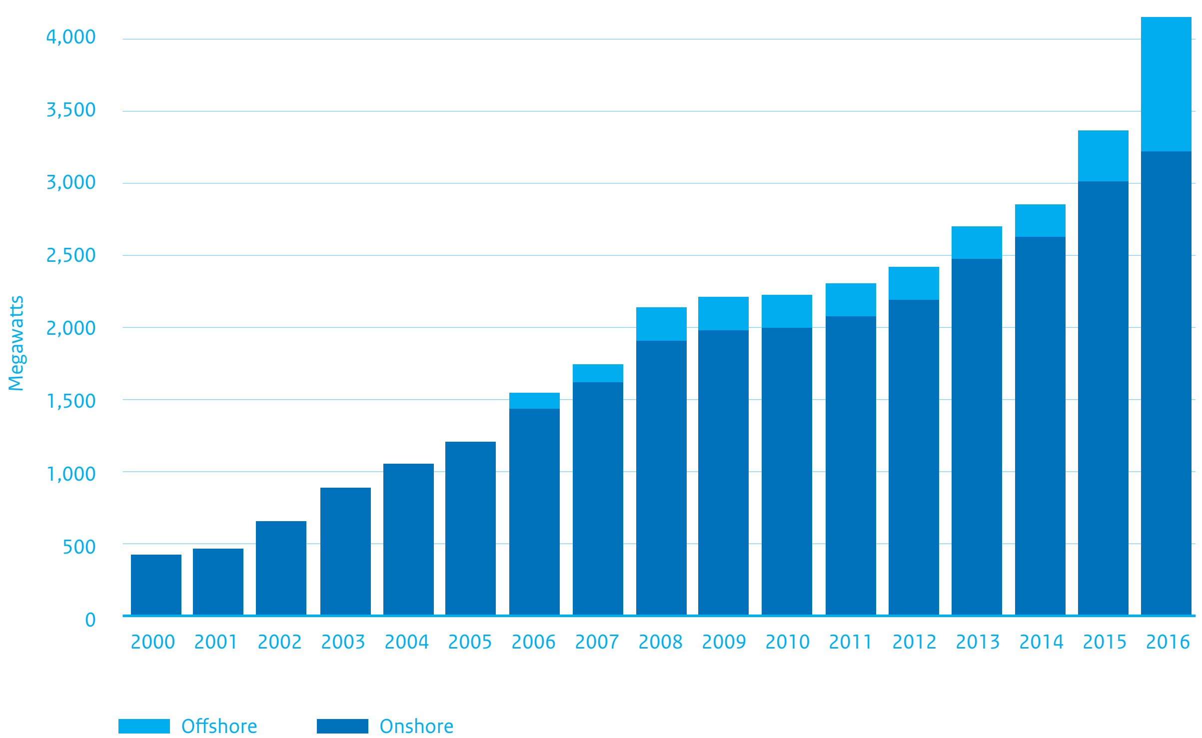
## 7.3 Dutch energy policy and the State's role in reducing the cost of offshore wind

The role of the Dutch State in driving forward development of renewable energy has, until recently, largely been based on general policy frameworks, traditional concession programmes and market incentive mechanisms. Wind power has long been at the heart of that.

The Netherlands started developing wind energy technology in the mid 1970's and has been a key player ever since, both onshore and offshore, along the whole supply chain.

In fact, the Netherlands was one of the first countries to install wind turbines offshore: in 1994 the Lely offshore wind farm was installed in the shallow waters of the 'IJsselmeer' and comprised four 0.5 MW NedWind 40/500 turbines which had a rotor diameter of 40 m.

**Figure 7a** *Wind power growth in the Netherlands 2000-2016 (source: CBS)*






Over the last two decades, with continued government support, the contribution of the wind industry to Dutch energy supply has grown steadily. In 1997, total installed (grid-connected) wind capacity in the Netherlands was just 319 MW. In 2015, 586 MW of new wind capacity was installed to take the country's cumulative total to 3,431 MW by end 2015, according to WindEurope. Of that, offshore wind accounted for 427 MW from 184 turbines installed at six projects. The 427 MW of offshore wind installed accounted for 3.9% of Europe's 5,060 MW total offshore capacity. That percentage share is set to grow significantly in coming years.

The 144 MW Westermeerwind wind farm was commissioned in the 'IJsselmeer' in June 2016, while the last turbine of the 600 MW Gemini project was installed August 2016. By end September 2016, there was 957 MW of offshore wind plant operating in the Dutch North Sea.

Note that European statistics for offshore wind include near shore wind farms, for example the Wind Farm Westermeerwind in the 'IJsselmeer'. Statistics Netherlands (CBS) accounts near shore wind farms to onshore wind.

CBS notes that renewables generated 13 billion kilowatthours of electricity in the country in 2015, equating to approximately 11% of total Dutch electricity consumption for the year. Wind power, it says, accounted for more than half of that, alone generating almost 7 billion kilowatthours, which is 20% more than in 2014.

Within Europe, the Netherlands is forecast to be the third biggest offshore wind market by 2022, behind only the UK and Germany (source: Roland Berger), while globally only China and the US currently have significant long term plans for offshore development (and they are still some way behind their European counterparts).

### 7.3.1 A new approach to energy policy and wind power development

Acknowledging that policy stability and predictability are fundamental to securing the investments required for the coming decades, especially in the energy sector, in 2013 key stakeholders from politics (central and local administrations) and civil society (industry, employers' associations and unions, environmental groups, NGOs, financial institutions etc.) in the Netherlands took a bold step towards providing it.

On 6 September 2013, after an eight-month negotiation process, 47 Dutch organisations laid the foundations for a robust, future-proof energy and climate policy for the Netherlands by signing the Energy Agreement for Sustainable Development (Energieakkoord voor Duurzame Groei, 6 September 2013). This agreement implements the country's climate and energy policy programme. Significantly, the Agreement's 'life span' is much longer than the four-year terms of government and parliament, because its objectives cannot be realised within four years. Parliament supports this rationale.

Designed for long-term sustainability, the Energy Agreement sets out 12 agreed aims, known as 'pillars', for the short to medium term (2014 - 2023) and aims to create at least 15,000 additional jobs by 2020. Each pillar consists of actions to be taken. The third pillar in the Agreement is to scale up renewable energy production, targeting an increase from 4.3% in 2013 to 14% by 2020, in line with the EU Renewable Energy Directive, and to 16% by 2023. Moreover, the Agreement also sets a target for the Netherlands to have a fully zero-carbon energy supply by 2050.

Find out more about the Energy Agreement for Sustainable Growth at ***www.energieakkoordser.nl/doen/engels.aspx*** and ***youtu.be/_mmzZ-JibkQ***

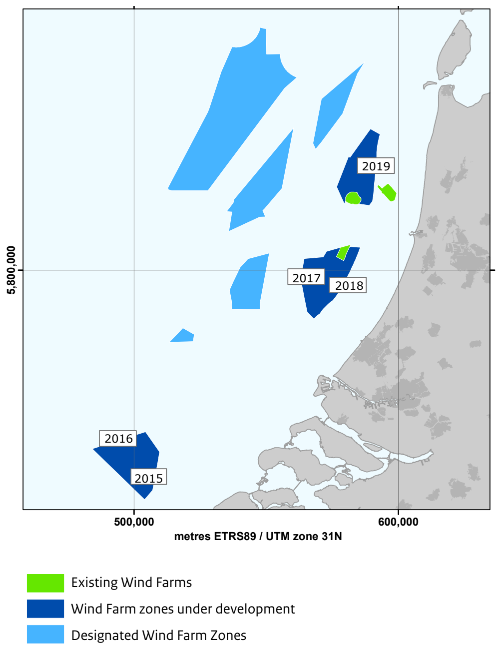
### 7.3.2 Wind Farm Zones 2015-2019
The Government decided that three offshore Wind Farm Zones should be used for the deployment of the 3,500 MW of new offshore wind power as agreed upon in the Energy Agreement: Borssele (1,400 MW) and Hollandse Kust (zuid: 1,400 MW and noord: 700 MW). The planned location of some projects, including HKZWFS III and IV, required approval from Parliament for development in the area between the 10 and 12 nautical mile zones. This has now been granted after a thorough consultation period. Figure 7b shows a schematic representation of these Wind Farm Zones and the planned timetable for related tenders to be issued.

### 7.3.3 Borssele tenders - results for sites I, II, III and IV
This Dutch system in which companies have to compete with each other while the Government regulates all conditions for building the wind farm has proved to be successful. The reduction of cost achieved represents a major breakthrough globally in the transition to more renewable energy.

The cost of building and operating the four sites of the BWFZ so far tendered is now much cheaper than previously estimated. Moreover, the 1,380 MW being installed across the four sites will generate more electricity than originally anticipated.

DONG Energy Borssele I B.V. (a subsidairy of Danish offshore wind developer DONG Energy) submitted the winning bid for 700 MW at BWFS I and II for €72.70 MWh. In the second tender round, for a further 680 MW at BWFS III and IV, a

**Figure 7b** *Tender timetable for the Dutch offshore wind rollout. Wind Farm Zones to be tendered are marked light blue, realised wind farms in dark blue, future Wind Farm Zones in yellow*




Dutch consortium called Blauwwind II c.v. (comprimising Shell, Van Oord, Eneco and Mitsubishi/DGE) submitted the winning bid of €54.5 per MWh. If the electricity price continues to develop as expected, this means the Blauwwind project will no longer require subsidies at all within 7.5 years.

DONG Energy Borssele I B.V. and Blauwwind II c.v. have both confirmed that the Government's design of its tender process and the direct role it has taken in doing much of the preconstruction development work and in having the transmission substations and grid infrastructure constructed is one of the key reasons they can build and operate the wind farms at these low prices. The favourable site conditions of the Borssele sites (relatively shallow waters, short distance to shore, good seabed conditions and wind speeds) also help drive down cost, for example by enabling the use of conventional monopile foundations. Additional cost savings due to efficiencies of scale are also achieved by building the two projects offered in each tender as if they were one larger project. The combined 700 MW wind farm for BWFS I and II is expected to be completed in 2019, whilst the 680 MW for BWFS III and IV is due for completion by 2020.



## 7.4 The right skills, the right location - the perfect base for a strong supply chain

The North Sea is the most important location in the world for offshore wind farms, thanks to the beneficial wind conditions and relatively shallow waters. Over 70% of existing and planned European offshore wind farms are located here, with an estimated long-term growth in capacity to 90 GW, according to WindEurope. The Netherlands has a strategically advantageous geographic location to capitalise on this. Its seaports border all offshore wind farms in operation, under construction, or under development in the United Kingdom, Belgium, Denmark, Germany and the Netherlands itself (see section 7.6 for an overview of Dutch ports). Meanwhile, the Dutch wind power industry features leading players across the offshore wind supply chain. Expertise spans wind farm design, turbine development, foundation and component design and manufacture, inter-array and export cables, transformer technology/sub-stations and transport, installation and logistics. It also has strong skills in R&D, offshore and environment consultancy, education and training, and more. In fact, the Netherlands Wind Energy Association (NWEA) has more than 450 members working in the wind sector (on- and offshore). Dutch export association Holland Home of Wind Energy (HHWE) is also active in connecting Dutch offshore wind companies to offshore wind developments outside Europe (i.e. in Asia).

Meanwhile, the Association of Dutch Suppliers in the Oil and Gas Industry (IRO) is also increasingly active in offshore wind installation. In terms of employees in direct full time employment (fte), the Dutch offshore wind industry recorded a growth of 12% in 2014, compared to 2013 (source: TKI Wind op Zee, 'Economische impact van het Nederlandse cluster Wind op Zee', published October 2014). For 2014, sector turnover was around €1 billion with approximately 2,150 people in direct fte (and 3,800 indirect employments). By 2020, the forecasts are that industry will have 12,500 people in fte. The construction side (transport, installation and logistics) accounts for the most people currently employed (just under 50% of the total in 2014), while component manufacturing is the next biggest employment sector of the industry, followed by policy and research. In fact, Dutch companies are involved in almost all of the offshore wind farms developed worldwide to date.

Looking to the future, the Dutch offshore wind industry has a significant role in driving forward Europe's market development, especially in the following areas:

- Development and project management of wind farms
- Wind turbine component supply
- Balance of plant (all the infrastructural components of a wind farm with the exception of the turbine and all its elements)
- Installation and commissioning
- Operations and maintenance
- Ship and crane building (O&M, cable ships, installation ships)
- Universities and knowledge institutes

*Some of the key companies and institutions involved across the supply chain in Dutch offshore industry can be found at: www.tki-windopzee.nl/page/offshore-wind-supply-chain-assessment.*

### 7.4.1 Offering new opportunities and driving innovation
While the Netherlands is home to some of the top industry players, the supply chain still needs to be strengthened to meet on-going and future ambitions for offshore wind. For example, there are opportunities for offshore cable manufacturing companies.
Particularly strong opportunities exist in the following sectors:

- Wind turbine design, production and/or assembly
- Design and production of blades
- Tools, vessels and monitoring equipment for O&M activities
- Design and production of high voltage electrical equipment

Meantime, continuous innovation is critical. Committed to strengthening its position in the global energy industry, the Netherlands therefore offers good incentive programmes that support and stimulate energy innovation (including tax exemptions for R&D activities), strategic public-private partnerships and world-class R&D facilities. These include the Top consortium for Knowledge and Innovation Offshore Wind (TKI Wind op Zee - ***www.tki-windopzee.nl***), the Energy Research Centre of the Netherlands ECN - ***www.ecn.nl***) and Delft University of Technology - one of the world's leading specialists in sustainable energy (see ***www.tudelft.nl*** and ***www.duwind.tudelft.nl***). The Knowledge Center WMC, TU/e, RUG, Deltares, NIOZ, IMARES, MARIN and NLR are other leading Dutch enablers and catalysts for manufacturers, project developers, owners, operators, investors, governments and NGOs.

There are several tax incentives to encourage innovation. For example, it stimulates R&D activities by providing for a reduction of wage tax due on the wages of employees engaged in R&D of technologically new products.

A company can reduce the costs of its R&D activities by making use of the WBSO (R&D Tax Credit Act) for reducing the payroll tax and national insurance contributions to be remitted.

The WBSO covers both salary costs and other costs and expenses related to R&D, thanks to the integration of the Research and Development Allowance (RDA) into the WBSO as of 2016. These other costs or expenses could, for example, relate to the cost of prototypes or research equipment.

#### 7.4.2 Key industry contacts, incentive schemes and finance contacts

There are several routes and key organisations that can help offshore wind companies investigate the potential for business in the Netherlands and find out more, for example, about getting involved with TKI Wind Op Zee, Top Sector Energy, and working within the offshore seaports.
This can include setting up preliminary meetings and providing up-to-date, personalised information about the Netherlands in general, relevant business locations, Dutch legislation and tax regulations, labour issues, permit procedures, govern- mental incentives and so on. Customised fact-finding trips can also be organised in close cooperation with regional economic development partners, local administrations, Dutch industry networks and service suppliers, and other relevant contacts in the investment process.

Two of the key government agencies are:
- Netherlands Enterprise Agency (RVO.nl): RVO.nl is an agency of the Ministry of Economic Affairs. The organisation is charged with implementing The Netherlands' offshore wind programme as well as other renewables development via the SDE+ framework. (***www.rvo.nl***)
- Netherlands Foreign Investment Agency (NFIA): As part of the Dutch Ministry of Economic Affairs, in 22 offices worldwide, the NFIA offers customized information, practical assistance via fact-finding trips and introductions to national and local administrations. (***www.nfia.nl*** and ***www.investinholland.com***)

Other useful industry contacts and sources for information are:
- Top Sector Energy: ***www.topsectorenergie.nl***
- Supply Chain Tool of TKI Wind op Zee (database for offshore wind companies in the Netherlands): ***sct.tki-windopzee.nl/sct***
- Dutch Wind Energy Association (NWEA): ***www.nwea.nl***
- Holland Home of Wind Energy (Dutch export association for wind energy, HHWE): ***www.hhwe.eu***
- The Association of Dutch Suppliers in the Oil and Gas Industry (increasingly active in offshore wind): ***iro.nl***

Some of the key incentive schemes and/or financing sources which may prove useful to those working in the Dutch wind industry are:

- The WBSO (R&D Tax Credit Act): Covering both salaries and other costs, the WBSO stimulates R&D activities by providing for a reduction of wage tax due on the wages of employees engaged in R&D of technologically new products. (***www.rvo.nl/wbso***)
- Energy Investment Allowance (Energie Investeringsaftrek, EIA): Tax advantages when investing in energy-saving systems and technologies and in renewable energy supplies. (***www.rvo.nl/EIA***)
- Environmental Investment Allowance (Milieu Investeringsaftrek, MIA) and Vamil: Tax advantages when investing in environmentally-friendly systems and technologies. (***www.rvo.nl/miavamil***)
- Innovation credit (Innovatiekrediet): Credit for the financing of highly promising and innovative projects. (***www.rvo.nl/innovatiekrediet***)
- Loans for SMEs (BMKB): Bank loans for small and medium-sized enterprises, with favourable conditions. (***www.rvo.nl/bmkb***)
- The MKB+ Innovation Fund (Innovatiefonds MKB+): Supports innovative entrepreneurs with three financing instruments - Innovation Credit, the SEED Capital Scheme, and the Fund-of-Funds. (***www.innovatie-fondsmkb.nl***)
- Other support for entrepreneurs: ***www.rvo.nl/ondernemingsfinanciering*** or ***www.rvo.nl/ondernemersfinanciering***



## 7.5 Key stakeholders in the Hollandse Kust region

In Chapter 2 of this PSD, an overview of the Hollandse Kust region has been provided. Below is a list of some of the key stakeholders and organisations based in the region which may prove of help for companies who win the tenders for HKZWFS I and/or II. (For information and weblinks for Dutch ports please see section 7.6).

- Provincial administration of Zuid-Holland: ***www.zuid-holland.nl***
- Provincial administration of Noord-Holland: ***www.noord-holland.nl***
- InnovationQuarter: InnovationQuarter is the regional economic development agency for Zuid-Holland. In close cooperation with major businesses, educational and research institutions and governmental organisations, it supports technological developments, encourages entrepreneurship and invests in start-up companies. InnovationQuarter uses dedicated business developers and a revolving fund to stimulate innovation in the region. It also actively promotes the West Holland region, attracts foreign companies and investors and facilitates them in finding the right locations and facilities for setting-up or expanding business. (***www.innovationquarter.eu/english***)
- Amsterdam In Business (AIB): AIB is the cooperation of municipalities in the greater Amsterdam Metropolitan Area. It provides a free service to assist foreign companies with establishing and expanding their operations in the Amsterdam Metropolitan Area and beyond. (***www.iamsterdam.com***)
- West Holland Foreign Investment Agency (WFIA): WFIA is a government funded organisation specialised in economic development, investment promotion and Foreign Direct Investment (FDI) within the West Holland region. WFIA attracts international companies and organisations and assists them in establishing, expanding or relocating their (foreign) operations to The Netherlands. (***www.westholland.nl***)
- The Development Agency Noord-Holland Noord (NHN): The NHN assists and supports anyone wishing to establish, invest or develop business in the greater Amsterdam area, north of Amsterdam. The shareholders of NHN are local and regional administrations. NHN can advise you in the site selection, organise site visits and introduce you to potential partners and authorities. (***nhn.nl*** and ***www.ofdutchorigin.com/invest/ development-agency-noord-holland-noord***)
- Rotterdam Partners: Rotterdam Partners has the objective of strengthening the economy of Rotterdam and the region. It works for businesses, visitors and residents who are already based in the city or those who plan to visit or establish themselves in Rotterdam in the future. (***en.rotterdampartners.nl***)
- NOM: NOM is the foreign direct investment agency for the Northern Netherlands. With the Ministry of Economic Affairs as their main shareholder, NOM's goal is to assist companies setting up their business in the best possible way. (***www.nvnom.com***)
- Northern Netherlands Offshore Wind (NNOW): NNOW is open to any company that is or wants to become active in offshore wind in the region. Besides networking, knowledge exchange and promotion and acquisition activities, NNOW also devotes attention to business development and training. (***www.nnow.nl***)
- Energy Valley: This acts as a networking organisation to stimulate information exchange and cooperation between public and private partners. (***www.energyvalley.nl***)

# 7.6 Overview of the Dutch Ports

Accounting for 20% of total construction costs, logistics is a major factor in wind farm construction. With poor logistics, costs increase exponentially. The set-up of Dutch ports avoids this, offering exceptional logistics for all offshore wind farm operations.

Dutch seaports have, in fact, a long proven-track record in being a high quality, safe, and cost-effective operational base for leading international offshore energy and maritime companies. Located for direct access to the North Sea, they are all deep-water ports that also have open access to inland areas and feature low tidal ranges. These characteristics are indispensable for the immense logistical operations necessary in the supply and assembly of turbine components and the installation, operation and maintenance of wind farms.

The increasing size of offshore wind turbines is no obstacle for the Dutch seaports. They offer manufacturers the space to assemble wind turbines as efficiently as possible and as close as possible to the ports themselves. In addition, they have first-rate infrastructure and facilities such as reinforced quays, heliports, heavy mobile cranes, and grid connections, along with excellent transport links generally. Significantly, Dutch ports are only a short distance from the Netherlands' current and planned offshore wind farms as well as Europe's other biggest wind farms. Overall, when it comes to meeting the logistical demands of today's offshore wind sector, Dutch ports regularly outperform many other North Sea ports because of the significantly lower in- and outbound logistical costs: on average, one third of the costs of other European sites. Below is an overview of each port, with links provided for further information.

**Port of Amsterdam (and Amsterdam IJmuiden Offshore Port):** *www.portofamsterdam.nl* and *www.ayop.com*
The Port of Amsterdam is the world's largest gasoline port and Europe's second largest coal port, making it a leading player in the fossil energy market already. It is also a rising star for renewable energy, particularly offshore wind - the port serves as a base for Westermeerwind nearshore wind farm. With an abundance of expertise and experience onsite amongst the local business community, the port has an extendable, state-of-the-art infrastructure for the shipment and storage of energy sources and equipment. Offering a leading industrial complex with numerous intermodal connections, the port has ample space to accommodate production-related investments and a good climate to do so.

It currently offers existing terminal space and infrastructure for intermediary storage and related logistics. A key strategy for the port is its participation in the Amsterdam IJmuiden Offshore Port (AYOP) - a public private partnership initiative in the North Sea Canal area. With a shared focus on offshore energy, it offers a unique network and plenty of space in a highly accessible and central location in Europe. The AYOP's ambition is to service the total life cycle of offshore wind: installation, O&M, renewal/refurbishment and decommissioning of offshore wind farms in a radius of 180 nautical miles from the coast in the North Sea. Significantly, key knowledge institutes are located within a 40km radius of the port. These include, ECN, TNO, Science park Watergraafsmeer, Deltares, Ecofys, and several universities.

**Port of Den Helder:** *www.northseaenergygateway.com*
As well as being home to the fleet of the Royal Netherlands Navy, the Port of Den Helder in Noord-Holland has set itself the goal of becoming the logistics knowledge and service hub for the southern North Sea. The port's owners describe it as a "real pit-stop port", saying "Speed is our lead, both to quay and at sea". It has plenty of space and room for development, with its favourable geographic location to the HKZWFZ as well as other offshore wind farms planned in Dutch, Danish, German and UK waters being an additional benefit, justifying its claim to be a key North Sea Energy Gateway. Moreover, open sea access, sheltered and no hindrances of locks or other maritime obstacles add to the value proposition. It is a port geared to maintain quick and easy turnaround times for its customers and is a well located construction, O&M, renewal and refurbishment base in Northwest Europe, which can contribute to lowering offshore wind costs.

It is also home to Europe's largest dedicated helicopter airport. Den Helder Airport facilitates 25,000 helicopter flights annually and is serving two offshore wind farms already - the Gemini Wind Farm in the Dutch EEZ and the Veja Mate Wind Farm, which is currently under construction in the German EEZ. As well as a variety of civil and maritime companies, knowledge and research organisations and training and education institutions are also located on site at the Port of Den Helder.

**Port of Eemshaven/Groningen Seaports:** *www.groningen-seaports.com*
Perfectly situated as an offshore hub, Groningen Seaports in the Province of Groningen is a commercial and industrial port complex (in an area reclaimed from the sea) which offers a wide range of opportunities for the offshore wind sector. There is direct access to the North Sea (the port has no locks) and distance to the wind farms being built and planned in the North Sea is short. Also, due to uncongested roads and ports and the efficient logistics in place, waiting times are minimal. All this boosts efficiency for project construction and lowers cost.

Over 100 hectares are available at Eemshaven, while competitive purchase and lease prices are available as well as tax advantages (tonnage tax regime for the operational vessel - ETR less than 5%).

The port has three main terminals and can accommodate ships with draughts of up to approximately 11 m. The entrance has a bottom width of 200 m. It offers roll-on/roll-off and bulk handling facilities, ample heavy cargo storage space and transhipment warehouses and links directly to the Dutch railways, inland waterways and motorway networks. The Eemshaven harbour area consists of a central channel, the Doekegatkanaal, and four basins: the Beatrixhaven, Julianahaven, Emmahaven and Wilhelminahaven. An additional benefit of this port is that in the Northern Netherlands many companies are active in offshore wind throughout the entire supply chain, ranging from blade production and hydrography to heavy logistics. With energy being a major theme for the Province of Groningen, there is a strong well-established network of government bodies, companies and knowledge institutes like: NOM, NNOW, Energy Valley, Rijksuniversiteit Groningen and several education institutions.

**Port of Harlingen:** *www.harlingenseaport.nl*
The Port of Harlingen is focused on the niche of offshore maintenance. While it is a relatively small port, Harlingen's combination of large amounts of quay space for storage and offshore wind energy specialist companies - and a relatively favourable price/performance ratio - provides a sound business case for maintenance activities. The port is also part of the NNOW regional network, guaranteeing sufficient, cost effective, labour resources. Key dedicated offshore companies based at Harlingen include windpowercentre, SeaZip Offshore Service - part of JR Shipping, Abis Shipping. Meantime, Harlingen also leads the way with the first bachelor degree programme in offshore wind offered by the NHL University of Applied Science.

Harlingen Seaport supports sustainability on a European Level in international projects such as CNSS (Clean North Sea Shipping). CNSS encompasses eigtheen partners from six countries and is committed to reducing exhaust gas emissions from ships in the North Sea Region by exploring the possibilities for using available technologies and by implementing cost efficient and cleaner energy supply infrastructure for ships in port and at sea.

**Port of IJmuiden (and Amsterdam IJmuiden Offshore Port):** *www.zeehaven.nl and www.ayop.com*
Like most other Dutch ports, the port of IJmuiden (owned by Zeehaven IJmuiden NV) is strategically located for direct access to the North Sea. It also has energy at its core, servicing the oil and gas supply chain as well as assembly, installation and maintenance for offshore wind farms for more than 10 years now. Port of IJmuiden was the first seaport involved in the installation and assembly of offshore wind parks, starting in 2006. This focus has led to investments in infrastructure and quay sides, aimed at maintaining flexibility for suppliers and turnaround times for work ships - critical to keeping costs down for companies. Over 10 hectares of land is available at IJmuiden for long term and short term offshore projects, adjacent to quays and 11 m of draughts. The port has direct access to the sea (no locks, no congestion) and is highly accessible by truck and inland barge too. It is also just 30 minutes from Amsterdam Schiphol Airport.

Wind farms OWEZ, Prinses Amalia and Luchterduinen are all maintained out of the port of IJmuiden. The port is flexible and client focussed. For example, the port installed dedicated boat landings and floating pontoons for berthing six Crew Transfer Vessels for maintenance of the three wind farms. These berths and boat landings further strengthen the offshore wind cluster in the port of IJmuiden with companies such as Breman Offshore, C-Ventus, MHI Vestas Offshore, Noordzeewind and Windcat Workboats located in IJmuiden.

As discussed earlier in this chapter, the port is a participant in the AYOP initiative, a public private partnership in the North Sea Canal servicing the total life cycle. Bow Terminal also has a terminal at IJmuiden. This acts as the company's full-service port for maintenance activities. As with the terminal at Vlissingen, the one at IJmuiden is also perfectly located for direct access to the North Sea and offers a full-service 24 hrs, 7 days a week. Meantime, key knowledge institutes - including ECN, TNO, Deltares, Ecofys, MCN and several universities - can be found with a radius of 40 km from the Port of IJmuiden.

**Port of Rotterdam:** *www.portofrotterdam.nl*
The Port of Rotterdam is the biggest port in Europe and offers a complete maritime cluster with a variety of shipyards, breakbulk terminals, specialised service providers and industrial companies. Rotterdam is a strong base for storage, production, conversion, assembly and shipment of offshore wind components and a good location for the coordination of offshore wind farm construction and maintenance.

With a prime position in the North Sea at the mouth of the river Rhine, the port has a truly unique location. Numerous shipping connections secure an efficient supply chain for all equipment from around the world.
In fact, over 300,000 sea-going vessels and more than 100,000 inland vessels call into Rotterdam each year, making it Europe's largest logistics hub and one of the biggest seaports in the world. Unhindered by tides and locks and with a maximum draft of almost 24 m even the largest offshore units and vessels can access the Port of Rotterdam 24/7. The port has state-of-the-art breakbulk terminals and offshore facilities plus an unmatched number of maritime service providers. In addition, an extensive network of rail, road and inland waterways connects the port to the rest of Europe.

Meantime, a new dedicated construction, storage and load-out terminal covering over 40 ha and with a deep water quay is being developed by BOW Terminal at the 2nd Maasvlakte in Rotterdam. Like some of the ports already discussed, nearby specialised educational institutions guarantee a constant flow of dedicated professionals for companies operating from Rotterdam. A world-renowned offshore safety-training specialist provides all necessary offshore training right in the port area. And by stimulating innovation, with an innovation campus and test site, the Port of Rotterdam ensures it stays on top of its game.

**Port of Schevingen:**
*www.denhaag.nl/en/general/port-authority-and-traffic-control-centre.htm*
The port of Scheveningen (also known as Scheveningen harbour) is the seaport of The Hague and surrounding areas. It lies directly on the North Sea and is centrally located on the Dutch coast, allowing for rapid movement of shipping in and out of the harbour. Amsterdam, Rotterdam, Utrecht and the ports of the Hook of Holland and Ijmuiden are accessible by cargo vessels in less than an hour.

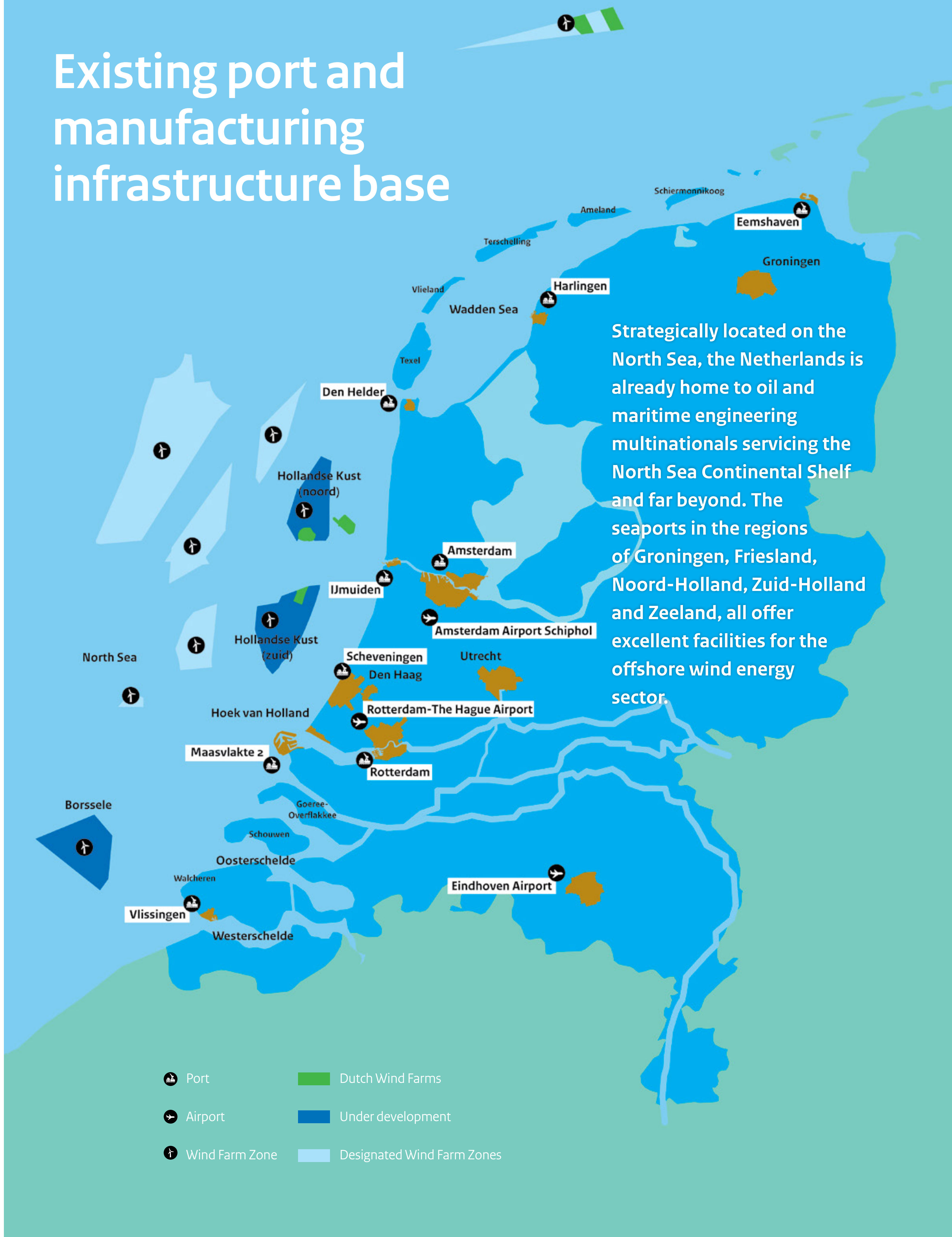
The wharfs are large enough for the shipping and storage of cargo. The small deepwater port is accessible to vessels up to 160 m in length with a draught of 7.5 m. Freighter and reefers up to 140 m are regular visitors. Most quays are 20 - 30 m wide and offer sufficient space for handling and storage in warehouses and cold stores. The harbour provides berths for more than 7,500 vessels each year. Apart from offshore, cargo and reefer vessels, a number of fishing vessels sail in and out of the harbour every day.

Activities in the seaport of Scheveningen are varied: as well as serving business sectors such as offshore wind and fishing, it hosts international sailing events, shopping and dining along the quays, fishing and sightseeing daytrips, and a variety of watersports facilities at the Nautic Center. Scheveningen beach, located next to the port, is very popular and the city of The Hague and its surrounding offers many attractions to visit. Amsterdam, Rotterdam and Utrecht are less than an hour away by road and train, and Scheveningen is just a short distance from Hoek van Holland and IJmuiden.

**Port of Vlissingen - Zeeland Seaports:**
*www.zeelandseaports.com*
Within the offshore wind market, Zeeland Seaports has been a market leader for many years now already. This is thanks to its strategic location for offshore oil and gas rigs and wind farms in the North Sea and its excellent nautical access for installation vessels (no locks and no congestion). Companies such as Bow Terminal and Verbrugge Terminals offer the space, facilities and equipment needed for all the operations involved in the final construction and maintenance of offshore wind farms. The 24/7 availability of heavy lift capacity makes this port a good location for heavy lift cargo and efficient transport to construction sites. For these reasons and more, the port was a key base for the developers of the 600 MW Gemini offshore wind farm, completed last year.

The strong offshore cluster that Zeeland Seaports has built up through the years offers numerous synergetic advantages and provides plenty of opportunities for new commercial activity that can further reinforce the offshore wind cluster. Companies such as Hoondert, VDS, GS Staalwerken and Damen Shipyards are specialised in the construction and maintenance of large steel structures, Heerema provides foundations for drilling platforms, Mammoet is a specialist in the future of heavy transport, Multra-ship can be deployed as a towage service.

# Existing port and manufacturing infrastructure base




**Strategically located on the North Sea, the Netherlands is already home to oil and maritime engineering multinationals servicing the North Sea Continental Shelf and far beyond. The seaports in the regions of Groningen, Friesland, Noord-Holland, Zuid-Holland and Zeeland, all offer excellent facilities for the offshore wind energy sector.**

# 8. Applicable documents

## 8.1 Bibliography


**Appendix A:**
Ministerial Order for Permitting Offshore Wind Energy,
Application form for permit for Hollandse Kust (zuid) Wind Farm Sites I and II,
Part I and III of the Wind Farm Site Decisions I and II,
Development Framework Offshore Wind Energy,
Offshore Wind Energy Act,
Offshore Grid Compensation Decision,
Regulation compensation scheme for offshore grid,
Policy rule concerning a change power generation facilities for offshore,
Definitions and Paragraph 6a of the Water Decree.

**Appendix B:**
Environmental Impact Assessments HKZWFS I and II

**Appendix C:**
Boundaries and Coordinates Hollandse Kust (zuid) WFS I and II, Luchterduinen Wind Farm:
Please use provided maps and coordinates

**Studies and Suppliers:**
Archaeological desk study, Periplus
UXO risk assessment, REASeuro
Geological desk study, Deltares
Geophysical site investigation, Fugro
Geotechnical site investigation, Fugro
Morphology study, Deltares
Wind resource assessment, Ecofys
Metocean study, DHI
Metocean campaign, Fugro

All the reports of these studies can be found at *www.offshorewind.rvo.nl*

Energy Agreement for Sustainable Growth,
*September 6 2013*

Energy Agenda,
*December 7 2016*

General Implementing Regulations for Stimulating Renewable Energy Production

Letter to Parliament rollout of offshore wind,
*September 26 2014*

Nationaal Water Plan 2016-2021,
*December 14 2015*

Act of 23 March 2016 for the amendment of the Electricity Act 1998

# Appendices

Appendix A: Applicable Law
Appendix B: Summary Environmental Impact Assessment
Appendix C: Boundaries and Coordinates HKZWFS I and II
Map: Existing port and manufacturing infrastructure base

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Netherlands Enterprise Agency (RVO.nl) is an agency of the Dutch Ministry of Economic Affairs. Netherlands Enterprise Agency implements policy for various ministries in the areas of sustainability, agricultural, innovation and international business and cooperation. Netherlands Enterprise Agency is the contact point for businesses, knowledge institutions and government bodies for information and advice, funding, networks and legislation and Regulations.