Dutch Offshore Wind Guide

Your guide to Dutch offshore wind
policy, technologies and innovations

wind & water works

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windandwaterworks.nl

NL Netherlands

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The Netherlands Enterprise Agency (RVO.nl) developed this offshore wind policy and industry manual which was commissioned by the Ministry of Foreign Affairs and International Trade as a deliverable of the International Clean Energy Program (ICEP) on export promotion in the renewables energy sector.

Let’s make wind and water work

Thanks to a strong history in maritime operations, an innovative rollout policy and continuous innovation, the Dutch have become a renowned player in the offshore wind industry worldwide. As the international offshore wind industry is maturing and wind farm developers are increasingly looking for innovative solutions to further bring down costs, this sector is open to new business partners to stand out in an increasingly competitive market. The Netherlands is home to some of the most successful and innovative offshore wind policy initiatives, businesses, maritime companies, and research institutes in the world.

To strengthen the international awareness of the solutions and innovative competences of Dutch businesses within offshore wind energy, the wind industry and the Netherlands Enterprise Agency (RVO) have joined forces to operate under an official brand name, wind & water works. At the heart of the wind & water works campaign is an one-stop offshore wind information portal for international stakeholders: www.windandwaterworks.nl. Featuring the latest offshore wind news, project showcases and company profiles, the website shares Dutch expertise and provides practical information to help other countries successfully develop their offshore wind markets.

This guide offers a general overview for international stakeholders to learn more about the Dutch regulatory environment and industry offerings to offshore wind, while at the same time introducing the Dutch supply chain and showcasing some of their recent export successes in the international target markets.

We hope this guide will be helpful to identify new cost reducing technologies and services the Dutch supply chain can offer to help other countries successfully develop their offshore wind markets. We also invite you to check www.windandwaterworks.nl for the latest news, project showcases and – last but not least - vital business links in offshore wind.

Let’s work together to utilize the full potential of offshore wind energy and let’s show the world that wind & water works.

Merei Wagenaar
Deputy Director International Enterprise Department
Directorate-General for Foreign Economic Relations (DGBEB)
Ministry of Foreign Affairs

Netherlands Enterprise Agency

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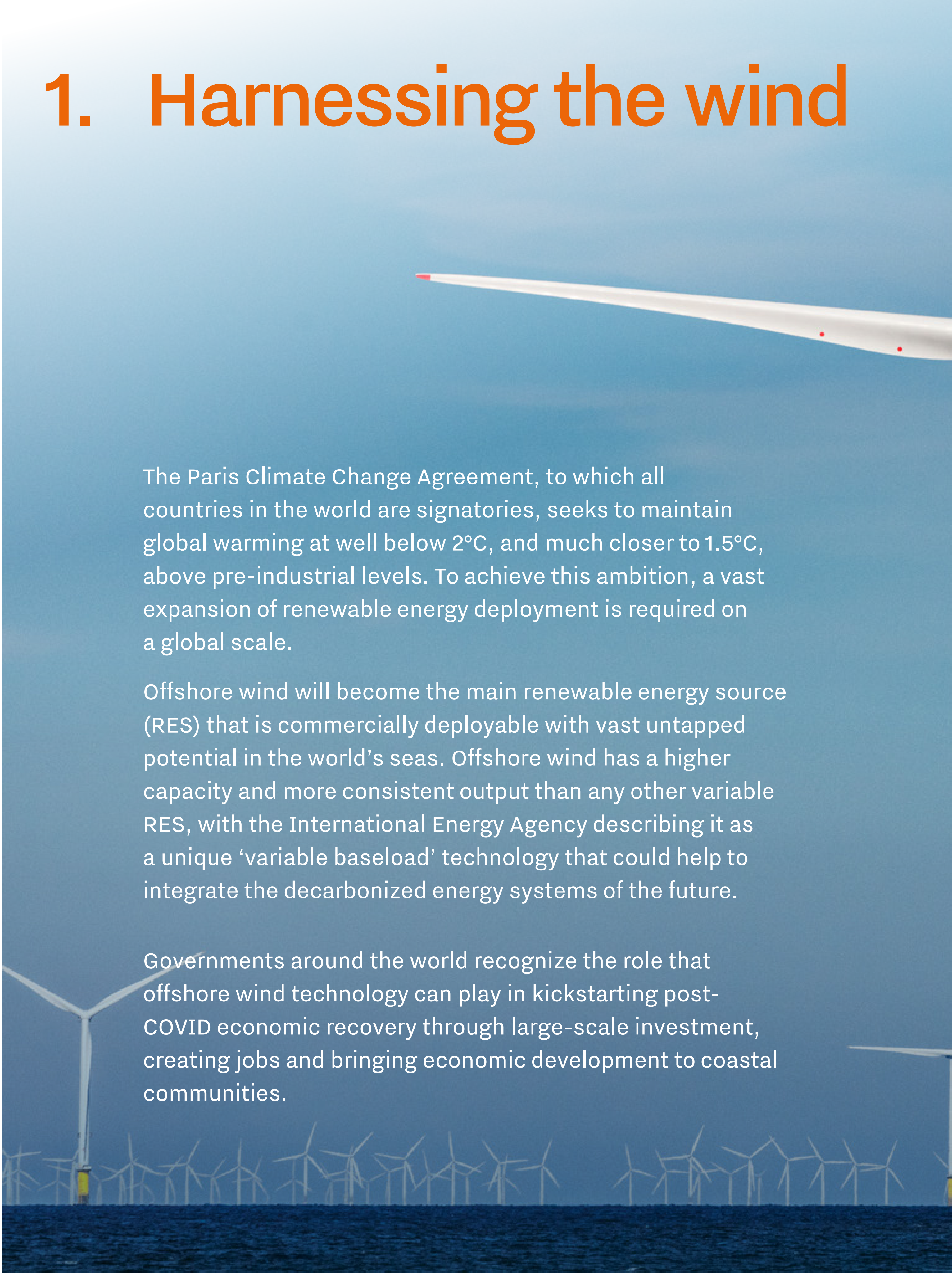


1. Harnessing the wind

The Paris Climate Change Agreement, to which all countries in the world are signatories, seeks to maintain global warming at well below 2°C, and much closer to 1.5°C, above pre-industrial levels. To achieve this ambition, a vast expansion of renewable energy deployment is required on a global scale.

Offshore wind will become the main renewable energy source (RES) that is commercially deployable with vast untapped potential in the world's seas. Offshore wind has a higher capacity and more consistent output than any other variable RES, with the International Energy Agency describing it as a unique 'variable baseload' technology that could help to integrate the decarbonized energy systems of the future.

Governments around the world recognize the role that offshore wind technology can play in kickstarting post-COVID economic recovery through large-scale investment, creating jobs and bringing economic development to coastal communities.

1.1 Global overview offshore wind development

As more countries in coastal regions plan to utilize their offshore wind potential, the Global Wind Energy Council (GWEC) forecasts 235 GW of new offshore wind capacity will be installed over the next decade under current policies.[1]

Today, Europe remains the largest market for offshore wind, making up more than half of total global installations. In the short-term, Europe will continue to be a leader in offshore wind, mainly driven by installations in Belgium, Denmark, France, Germany, the Netherlands, Poland and the UK. However, the Asia-Pacific region is primed to take over this position, led by China where record amounts of new offshore wind capacity are expected to be installed by 2030. Taiwan is set to become the second largest offshore wind market in Asia after mainland China. Other markets in the region such as Japan and South Korea are also beginning to scale-up their offshore wind ambitions, following net zero/carbon neutrality commitments.

The US has just 30 MW of offshore wind capacity in operation today, but deployment will accelerate in the coming years to 41 GW installed capacity by 2030, according to the Biden administration. The majority of this growth will come from the sector in the US and it is expected that the first utility-scale projects will come online by 2024.

1.2 Europe's policy on offshore wind

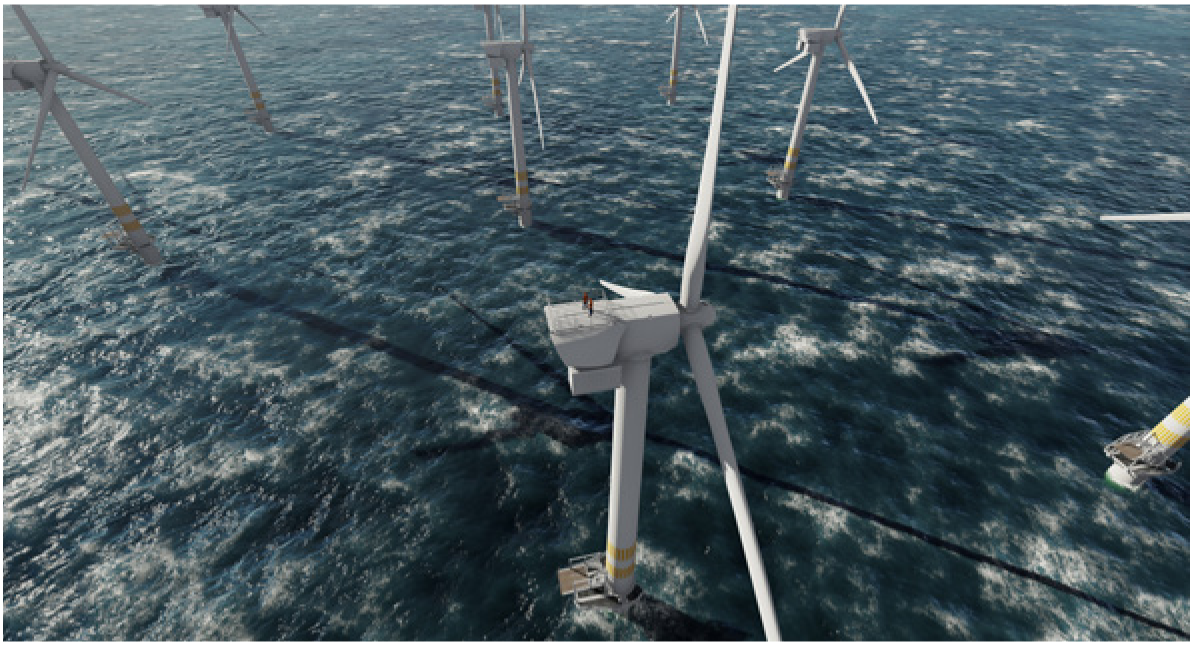
To keep pace with the ambitions of the Paris Climate Change Agreement, the EU's Fit for 55 package aims to reduce greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. Under this strategy, offshore wind will become the number one source of electricity in the EU, taking optimal advantage of the potential in Europe's seas – from the North Sea and Baltic to the Black Sea, and from the Atlantic to the Mediterranean.

The target of 300 GW by 2050, a 25-fold increase in offshore wind, implies a massive change of scale for the sector at an unprecedented speed. The current Offshore Wind installed capacity in the North Sea is just 12 GW and the supply chain produces only 3 GW of turbines to be added per year, a rate that is expected to reach 7 GW per year after 2030. To meet such ambitious targets, the EU and member states will also have to facilitate cross-border marine spatial planning, grid infrastructure development and research funding.

The EU strategy focuses not only on bottom-fixed installations but also on a further expansion of floating offshore wind, which will be needed for the deeper waters in the Atlantic, Mediterranean, and even the Black Sea. Today, Europe has just two small floating wind farms, but its aim is to have 300 MW of floating wind farms by 2022 and 7 GW by 2030. According to WindEurope, floating wind could be up to a third of all offshore capacity by 2050.

www.windeurope.org/intelligence-platform/product/floating-offshore-wind-energy

[1] Global Offshore Wind Report 2021, GWEC



1.3 Offshore wind policy development in the Netherlands

Today, the Netherlands is a front-runner in cost-efficient offshore wind development and installation. To reach this position, however, the Dutch had to overcome significant challenges. As with other countries, the potential offshore wind offers had long been recognized in the Netherlands. Even so, up to 2017 only a few offshore wind farms were actually built in the Dutch Economic Zone of the North Sea. Until then project developers were responsible for site selection and investigation, as well as having to go through the permitting process for projects with no guarantee projects would be approved. So they faced high costs and risks before they could even apply for a subsidy. Indeed, out of 80 initial applications, just four offshore wind farms with a combined capacity of less than 1 GW were actually built in the Dutch Economic Zone of the North Sea by that time.[2]

However, in 2013, the conditions for offshore wind development changed significantly when a broad coalition of Government, employers' associations, trade unions, environmental protection organizations and energy companies, accelerated climate ambitions and agreed to kick-off the Dutch energy transition. The resulting Energy Agreement for Sustainable Growth (Energy Agreement) included ambitious provisions on energy conservation and targets to raise renewable shares in the energy mix to 14% by 2020 and 16% by 2023. Regarding offshore wind, the Government committed to assign and develop three offshore wind zones - Borssele, Hollandse Kust zuid (Dutch Coast south) and Hollandse Kust noord (Dutch Coast north) - in the Dutch sector of the North Sea, potentially increasing the offshore wind capacity by 3.5 GW in 2023.

In 2019, the National Energy Agreement merged to form a more comprehensive Climate Agreement that is still in place today. The Climate Agreement aims to reduce CO2 emissions by 49% in 2030 (compared to 1990). With regard to electricity production in general, the current target is to achieve 70% of the electricity produced from renewable energy sources (wind and solar) by 2030 and 100% by 2050. The latter means that all coal plants in the Netherlands will be closed or converted into biomass plants in due course.

For offshore wind development in particular, today's Climate Agreement includes the commitment to install an additional 7 GW of offshore wind farm capacity in the Dutch sector of the North Sea between 2023 and 2030. The additional wind farm zones include Hollandse Kust west (Dutch Coast west), Ten Noorden van Wadden (North of the Wadden Sea Islands) and IJmuiden Ver (IJmuiden Far Offshore). Once completed, the total installed capacity will be 11.5 GW (49 TWh of electricity) in 2030, equal to approx. 40% of the Netherland's current electricity consumption.

[2] These wind farms are: Egmond aan Zee offshore wind farm (2007, 108 MW), Princess Amalia wind farm (2008, 120 MW), Luchterduinen wind farm (2015, 129 MW) and the Gemini wind farm (2017, 600 MW).

1.4 Update on the rollout of Dutch offshore wind farms

Under the 2013 Energy Agreement, the Government spurred the actual development of offshore wind farms by issuing a steady rollout plan - the 'Roadmap 2023'. This roadmap sets out the rollout sequence in which the Wind Farm zones and included sites will be developed, the projected generation capacity of the individual sites and the year of tendering for installation and operation. Under this Roadmap, there were successful tenders between 2016 and 2019 for five large-scale offshore wind farms and one small innovation farm - divided over three designated offshore wind zones.

Borssele WFZ 1 & 2 (752 MW)

In 2016, the first sites in the Borssele Wind Farm Zone were tendered. Fierce competition between companies in the public tender to secure the permit and associated subsidy to build and operate the wind farm (38 bids), resulted in achieving a far lower than anticipated price (max. 12.4 Euro cents per kilowatt hour), making the project at the time the cheapest worldwide. The permit and accompanying subsidy for the Borssele 1 & 2 offshore wind farm sites were won by Dong Energy (known today as Ørsted), based on a winning bid of 7.27 Euro cents per kilowatt hour. The offshore wind farm supplied power for the first time through TenneT's offshore grid in November 2020 and was officially opened in September 2021. Currently Norges Bank Investment Management (NBIM) is 50% co-owner of the Borssele 1 & 2 windfarm.

Borssele WFZ 3 & 4 (731,5 MW)

Towards the end of 2016, the Blauwwind consortium, comprising Partners Group (45%), Shell (20%), Diamond Generation Europe (full subsidiary of Mitsubishi Corporation, 15%), Eneco Group (10%) and Van Oord (10%, also being the BP contractor), won the second permit and subsidy to build and operate the Borssele 3 & 4 offshore wind farm sites, with a winning bid of 5.45 Euro cents per kilowatt hour. With Borssele III & IV, the subsidy savings were even higher than for the Borssele I & II projects which, at the time, was set to be the world's cheapest offshore wind farm. The second Borssele offshore wind farm is expected to be constructed and operated with a subsidy of just EUR 0.3 billion, meaning that it can potentially be operated without subsidy after 7.5 years. The originally anticipated subsidy was EUR 5 billion. The final wind turbine at the Borssele 3 & 4 offshore wind sites was installed in November 2020. Borssele III & IV are expected to produce around 3 TWh of electricity per year, enough to power the equivalent of 825,000 Dutch households, or to meet up to 2.3 per cent of total Dutch electricity demand.

Borssele WFZ 5 (19 MW)

The Borssele WFZ V site, designated as a small-scale demonstration site for offshore wind innovations, was won by the Two Towers consortium, comprising Van Oord, Investri Offshore and Green Giraffe in 2018. Situated within site III of the Borssele Wind Farm Zone, Borssele V features two Vestas 9.5-MW turbines and several innovations, one of which is a submerged Slip Joint. The design and manufacturing of the Slip Joint were certified by DNV GL in the autumn of 2019. Other innovations include Thermally Sprayed Aluminum (TSA), Impressed Current Cathodic Protection (ICCP) optimization, and oval cable entry holes. Finally, the seabed surrounding the two Borssele WFZ V wind turbines is fitted with eco-friendly scour protection.[3] This technology is used to explore how nature and renewable energy generation can be mutually enhancing. Oysters will be placed on the protective layer of rock on the seabed to improve erosion protection as well as biodiversity and the natural habitat for aquatic wildlife.

Hollandse Kust (zuid) 1 & 2 (760 MW) and 3 & 4 (760 MW)

In 2018 and 2019, Swedish Vattenfall won both tenders for building and operating the Hollandse Kust (zuid) wind farms, based on a zero-subsidy bid. These are the first non-subsidized offshore wind farms in the Netherlands. Moreover, as some parts of the wind farms will be located within territorial waters (12-mile zone, 22 km off the Dutch shore), Vattenfall pays an additional sum of approximately € 2 million per year for the right of superficies. Construction of the wind farms at Hollandse Kust (zuid), situated 18.5 km off the coast of The Hague, will start in 2022. Currently, BASF is 50% co-owner of the Hollandse Kust Zuid 1 & 2 windfarm.

Hollandse Kust (noord) (760 MW)

In 2020 the CrossWind consortium, a collaboration between Shell (80%) and Eneco (20%), won the tender to build and operate the fifth offshore wind farm in the Dutch sector of the North Sea. As with the wind farms in Hollandse Kust (zuid), the 760-MW Hollandse Kust (noord) wind farm was also tendered based on zero-subsidy conditions. Similarly to Hollandse Kust (zuid), approximately 25 percent of Hollandse Kust (noord) is located within the twelve-mile zone of the Dutch territories. This means a seabed lease, as well as a rental agreement for the infield cabling, will be established between the wind farm operator and The Central Government Real Estate Agency and TSO TenneT. The consortium plans to have the Hollandse Kust (noord) operational by 2023 with an installed capacity of 760 MW, generating at least 3.3 TWh per year. Apart from building and operating the wind farm, the CrossWind consortium also deploys a series of innovations (technology demonstrations), such as a floating solar farm, short-term battery storage, turbines that are 'tuned' to minimize the wake effect that turbines can have on one another, green hydrogen produced through electrolysis, and the combination of these individual measures to ensure a continuous power supply regardless of the wind.

[3] Scour protection: rocks placed on the seabed around the foundations to avoid seabed erosion.

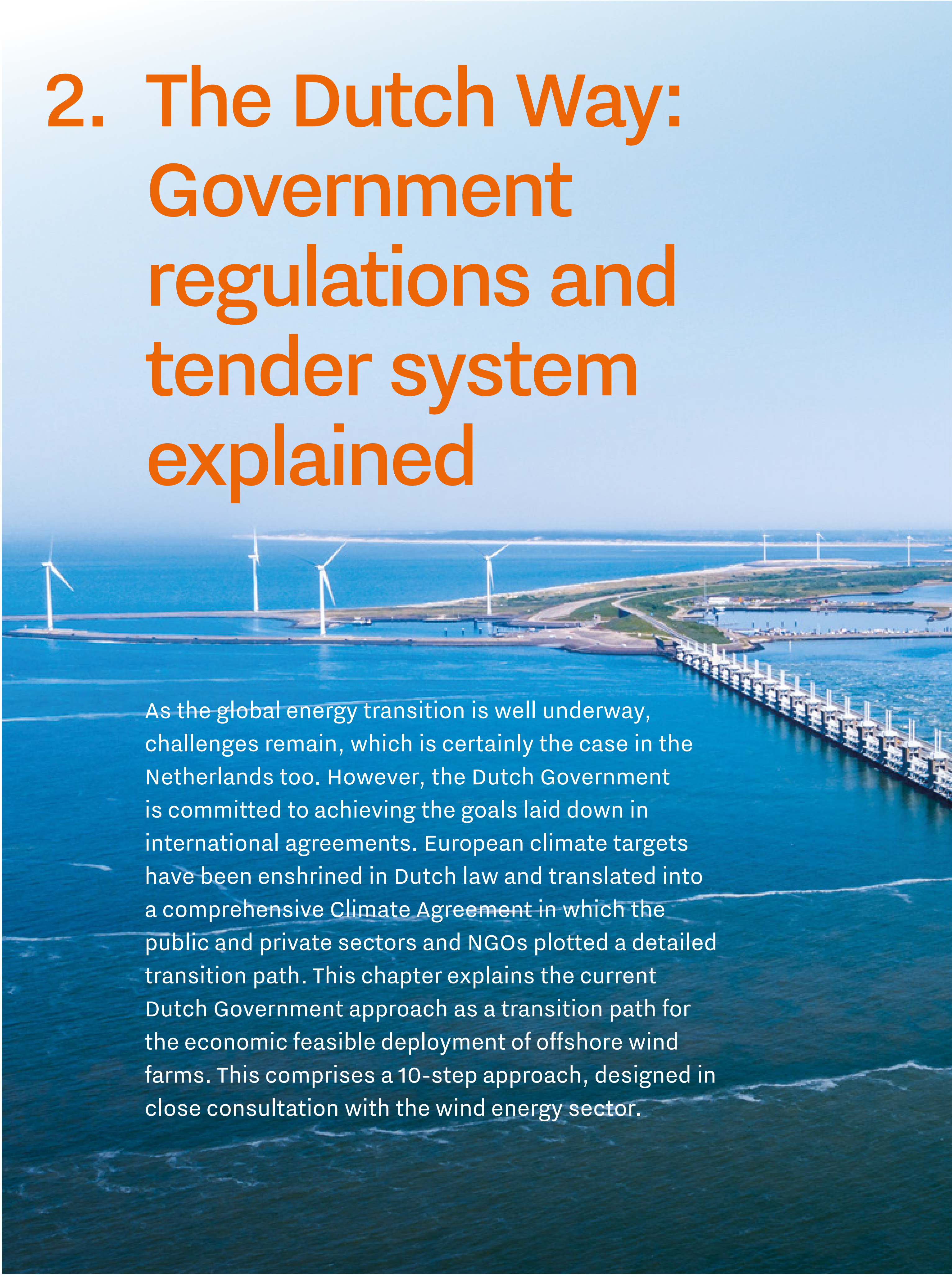
1.5 Energy Agreement: a kick-starter for energy transition

Looking back at the successful Roadmap 2023, it is safe to conclude that the Energy Agreement proved to be a 'game changer' for the development of offshore wind in the Netherlands. Under the old policy up to 2013, there was little activity in offshore wind, with just under 1 GW capacity installed in total. With the more proactive current policy approach, a legal framework was introduced and a total of 3.5 GW has been successfully tendered between 2016 and 2019, with an additional 7 GW now scheduled, which will result in a combined installed Dutch offshore wind capacity of just over 11 GW by end 2030.[4] The cost of wind energy has even gone down substantially faster than targeted. In the Energieakkoord 2013 the cost reduction was initially targeted at 40% by 2020 compared to price levels in 2010. The target price for 2020 was set to 100 €/ MWh. However, in 2016 the price level for Borssele I & II was already substantially lower than the target for 2020. The latest tenders for the Hollandse Kust Zuid and Noord resulted in prices even without subsidy, only grid connection cost are subsidised/publicly funded. In an evaluation of the Energieakkoord 2023, the independent Netherlands Court of Audit found that the costs for offshore have even dropped 80%. As a consequence also the expected subsidies have dropped substantially, from an expected maximum of 18 billion in 2015 to approximately 5 - 6 billion expected today.[5] It proves the importance of a strong public-private process guided by the Government, whilst setting parameters for the pace at which the proposed new capacity will be developed, the maximum capacity of the wind farms, planning and zoning, site investigations and, last but not least, the grid connection.[6] By regulating all conditions for the construction of the wind farms, the Dutch Government reduces project risk, financing and societal costs.

[4] The projected capacity may even be increased significantly in the near future to meet the targets for CO_2 reduction in 2030

[5] Bron: Pathways to potential cost reductions for offshore wind energy, TKI-WOZ, January 2021.

[6] Regarding the future offshore grid, the Dutch Government is already looking into the post-2030 era. For more information, see the North Sea Energy Outlook 2020. www.Government.nl/latest/news/2020/12/04/north-sea-energy-outlook-establishes-framework-conditions-for-future-growth-of-offshore-wind-energy



2. The Dutch Way: Government regulations and tender system explained

As the global energy transition is well underway, challenges remain, which is certainly the case in the Netherlands too. However, the Dutch Government is committed to achieving the goals laid down in international agreements. European climate targets have been enshrined in Dutch law and translated into a comprehensive Climate Agreement in which the public and private sectors and NGOs plotted a detailed transition path. This chapter explains the current Dutch Government approach as a transition path for the economic feasible deployment of offshore wind farms. This comprises a 10-step approach, designed in close consultation with the wind energy sector.

The Dutch Deltawerken.
One of the best-known examples of the way The Netherlands are able to ‘manage’ water.

2.1 Current Dutch offshore wind policy in 10 steps

Today’s regulatory and tender framework for offshore wind, tackles the disadvantages of the previous policy approach, in place until 2013, when wind farm developers were responsible for site selection and investigation, permitting process and grid connection. In contrast, the current policy approach is much more proactive: by regulating conditions for the construction of the wind farms - i.e. exact location, a long-term tender schedule, clear consenting procedures and the State being responsible for offshore grid connections, - the Dutch Government helps to reduce pre-bid investment risks, financing and societal costs. To ensure trusted site survey data and environmental impact information, fair tendering and timely permitting, the Netherlands Enterprise Agency (RVO.nl) acts as the coordinating administrator (one-stop shop) under the Ministry of Economic Affairs and Climate Policy.

The current policy approach can best be explained in 10 steps, demonstrating a leading role for the Government and favorable market and tender conditions for project developers.

2.1.1 Step 1. Designating the wind farm areas

The Dutch legislative offshore wind framework starts with early spatial planning. Through the National Water Plan, the legal base of which is encompassed in the Water Act, the Ministry of Economic Affairs and Climate Policy and the Ministry of Infrastructure and Environment allocated the areas for future offshore wind farm development in the Dutch territory of the North Sea. Each area can include one or more wind farm sites. The development of offshore wind farms will be restricted to these areas; permits will not be awarded for wind farms outside these areas.

2.1.2 Step 2. Drawing Up Offshore Wind Farm Tender Roadmaps (rollout plans)

‘In the Offshore Wind Energy Roadmap a schedule is provided for: the specific rollout sequence in which the Wind Farm areas and included sites will be developed, the projected installed generation capacity of the individual sites, and the year request of tendering for installation and operation. The law Wind Energy at Sea, on which the Roadmap is legally based, was introduced in 2015 in close consultation with the wind energy sector. The purpose of this law is to guarantee optimal efficiency in the use of marine space and provide a decade-long pipeline of tenders as an assurance for project developers.

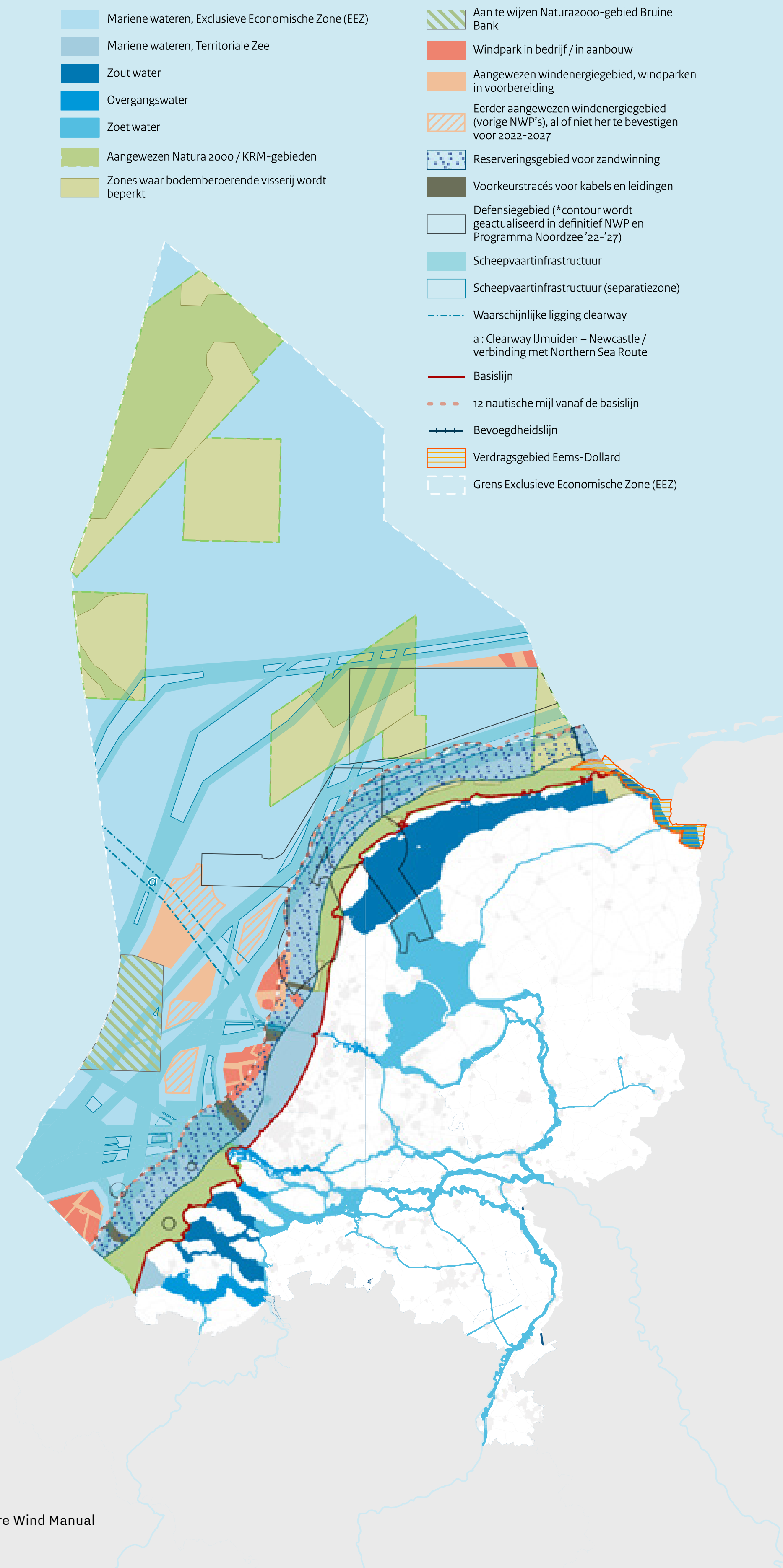
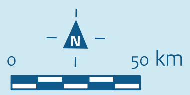


Figure 1. The areas for offshore wind development in the Dutch territorial waters (Economic Zone) of the North Sea are pictured in red



So far, two offshore wind farm Roadmaps have been issued by the Government:

- **Roadmap: 2015 - 2023**
  As planned under the National Energy Agreement (2013), in 2015, the Dutch Government published an initial Roadmap (2015 - 2023), aimed at adding a total of 3.5 GW of offshore wind power capacity by 2023. The Roadmap outlined plans for five offshore wind farms, all to be tendered between 2016 and 2019, with the last one expected to be in operation in 2023.
- **Roadmap: 2023 - 2030**
  Encouraged by the successful rollout of tenders in the first road map, the Government released another Roadmap in 2018, outlining an additional 7 GW of offshore wind development before the end of 2030. The second Roadmap schedules the release of wind farms, with tendering between 2021 and 2026, with the last one in operation in 2030. The second Roadmap includes the zones Hollandse Kust (west), Ten Noorden van de Waddeneilanden and IJmuiden Ver.

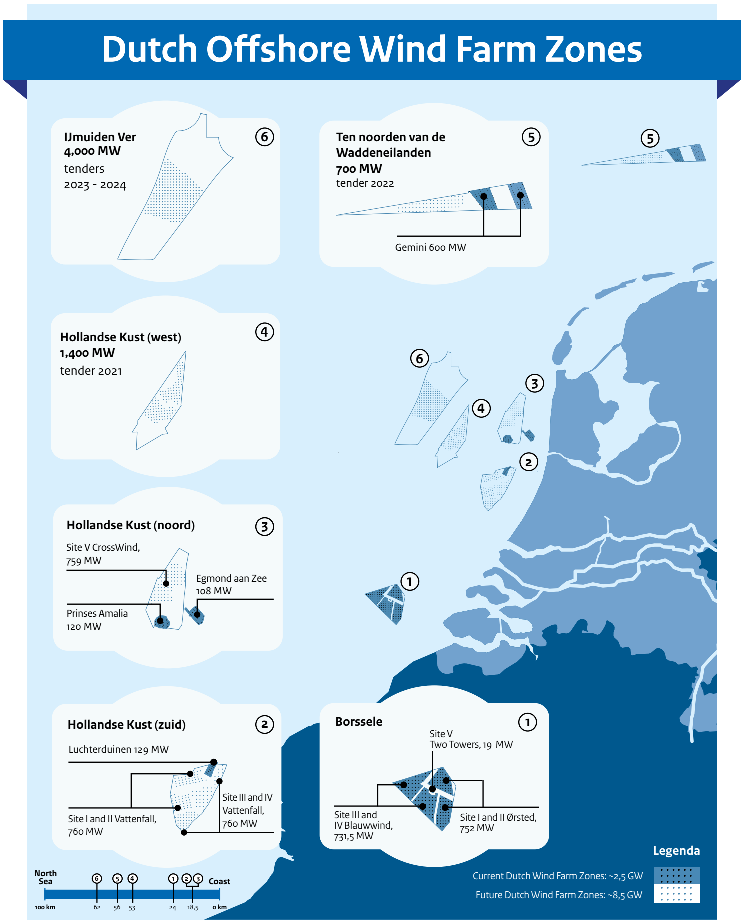


Figure 2 Offshore Wind Energy 2030 Roadmap

2.1.3 Step 3. Conducting studies

Following the parliamentary approval for the Roadmap, the foreseeable offshore wind farm sites are subject to a comprehensive environmental impact assessment, leading to a ministerial wind farm site decision (to be explained in step 5). Also, a series of geo-physical site studies are executed in step 3.

Environmental impact assessment
To analyze and - if necessary - deal with the economic, social, and ecological impacts of the wind farm(s), the site decisions are legally subject to an environmental impact assessment (EIA), commissioned by the Netherlands Enterprise Agency on behalf of the Ministry of Economic Affairs and Climate Policy and the Ministry of Infrastructure and Environment. The EIA results are published in the site decision (step 5), available for public inspection (and appeal), after which this becomes irrevocable.

Site studies
The Government also conducts a series of local site studies (investigating soil- wind- and water conditions). Examples are the meteorological and oceanographic survey, the soil survey, the ecological soil survey, the archaeological survey and UXO surveys. As with the EIA, the outcomes of these site data studies are made available for projectdevelopers to help with their FEED studies, enabling them to optimize project plans and submit competitive bids in the tendering (also see step 6). Project developers therefore do not have to conduct an EIA, nor perform their own site studies (or bear the associated costs for them) before deciding whether a project may be viable or not. The costs for these surveys is borne by the State and not the competing project developers. The Netherlands Enterprise Agency (RVO) will commission and publish the site data packages. All studies and investigations are officially and independently certified and quality approved.

For more information on offshore wind farm site assessment and selection, please refer to: www.windandwaterworks.nl/cases/offshore-wind-farm-site-assessment-selection).

For more information on minimising environmental impact of offshore wind farm (installations), please visit: www.windandwaterworks.nl/cases/minimising-environmental-impact

2.1.4 Step 4. Installing the grid connection

The Dutch national electricity Transmission System Operator (TSO) TenneT has legally been appointed to be responsible for the connection of the wind farms to the onshore electricity grid. As the planning and installation of this offshore grid network generally takes 8 to 10 years (depending on the distance, technique, and permit procedures and EIA), the grid installation decision is made as early as possible in the process. The permit for TenneT is made publicly available for inspection (and appeal) by all parties, after which it becomes irrevocable.

The choice of TenneT, as the offshore grid system operator, has clear advantages over individual grid connections installed by project developers. The advantages are mainly financial and relate to economies of scale following standardization in substation design, purchasing, maintenance and knowledge development. Grid operation by TenneT also simplifies compensating grid fluctuations, flow management, and balancing supply and demand, whilst integral grid operation also leads to a clear distribution of tasks and responsibilities in the electricity system.

To create the cost-saving economies of scale, standardized AC substations with an individual capacity of 700 MW, have been designed to connect the wind farms to the national grid, using two 220-kV export cables.[7] As soon as 380-kV subsea cables become available, these will be utilized to further reduce the number of cables required.

In the event that DC substations are required (such as for the wind farm zone IJmuiden Ver, scheduled in Roadmap 2030), the connected transmission capacity is approximately 2 GW and an onshore converter station via two 525-kilovolt cables will be part of the offshore grid.[8]

The inter-array (infield) cables, which connect the wind turbines to the substation, remain the responsibility of the project developer. The wind turbines will be connected to the TenneT platform through 66-kV infield cables, making the Dutch offshore wind farms the first in the world to be connected by a voltage level of 66 kV instead of 33 kV.

[7] Given the relatively short distance to the onshore connection sites and the relatively limited size of the capacity to be provided, the offshore grid for the Borssele, Hollandse Kust Wind Farm Zones and the North of the Frisian Islands Wind Farm Zone have been configured for alternating current (AC).

[8] In view of the relatively large distance (70 km) to the onshore connection sites and the large capacity to be connected (approximately 4 GW), the IJmuiden Ver Wind Farm Zone will be connected using direct current technology (HVDC).

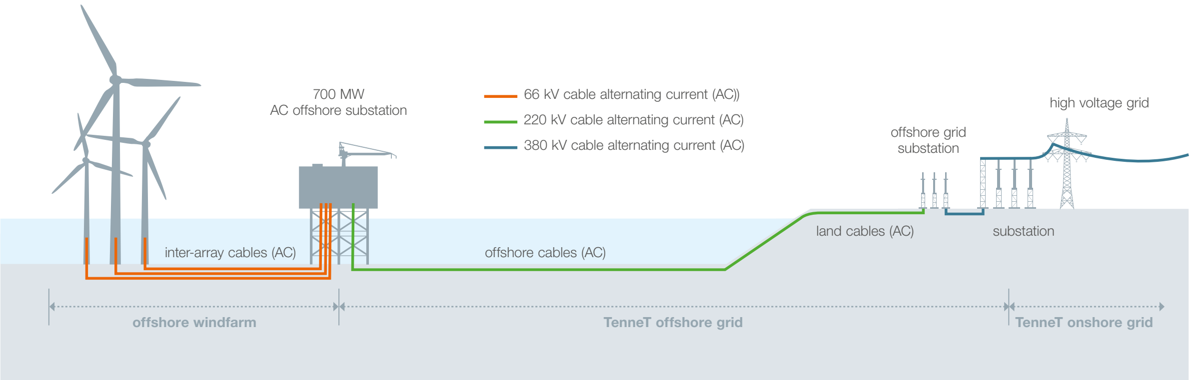


Figure 3 In case of relatively short distance to the onshore connection sites and the relatively limited size of the capacity to be provided, the offshore grid can be configured for alternating current (AC).

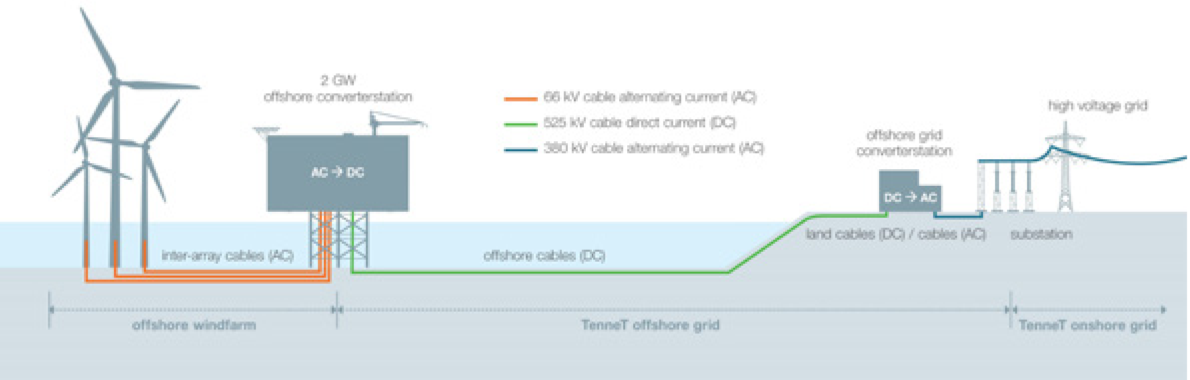


Figure 4 In view of the relatively large distance (70 km) to the onshore connection sites and the large capacity to be connected (approximately 4 GW), the IJmuiden Ver Wind Farm Zone will be connected using direct current technology (HVDC).

Offshore grid development framework
To plan the public investments in the offshore grid, the Government provides guidance through a development framework. This framework outlines the design and construction of the offshore grid and its main functional and technical requirements. It also stipulates the tasks of TenneT as offshore transmission system operator, provides the sequence of the development of the sites and sets the timetable for commissioning the connection for the sites. On the basis of the development framework, TenneT draws up an investment plan every two years, setting out the envisaged investments, performance targets, deadlines and plans for capacity expansion. The investment plan needs approval from the Dutch regulator, the Authority for Consumers & Markets.

Connection & Transmission Agreement
TenneT and the offshore wind farm operators sign a Realization Agreement as well as a Connection and Transmission Agreement. The agreements set out the terms and conditions regarding the development of the connection for the wind farm, addressing aspects such as the basic design and technical specifications of the connection and the substation, as well as operational arrangements and the exchange of information between TenneT and the wind farm developer. In the event of a delay or unavailability of the offshore grid, TenneT is legally committed to compensate the wind farm owner for postponed or missed (subsidy) revenues from electricity sales and consequential damages.

For more information on offshore grid connection, please visit: www.windandwaterworks.nl/cases/offshore-grid-connection

2.1.5 Step 5. Consenting: taking the wind farm site decision
After all the above steps have been taken, the Government is now ready to publish the Wind Farm Site Decision (WFSD). The WFSD is the cornerstone of the Dutch Law Wind Energy at Sea. This law, which received final parliamentary approval in June 2021, stipulates that offshore wind farms can only be built after a permit, based on the site decision, has been issued. A WFSD is, therefore, the necessary consent required to build a wind farm. It specifies the location for the wind farm and the conditions under which it may be constructed and operated, taking into consideration issues such as ecology and decommissioning of the wind farm. These conditions can be related to wind turbines (minimum power, maximum tip height, minimum tip height) and infield cables (prohibited outside wind farm site boundaries). The site decision, however, leaves some flexibility for the design of the wind farm. This means that project developers have the opportunity to choose the latest technical innovations – within the natural and environmental framework – to develop and operate the wind farm at the lowest possible cost.

The site decision is subject to public consultation and potentially an appeal. At the end of the consultation and appeal phase, the Wind Farm Site Decision becomes irrevocable, meaning it is final and no further appeals can be made.

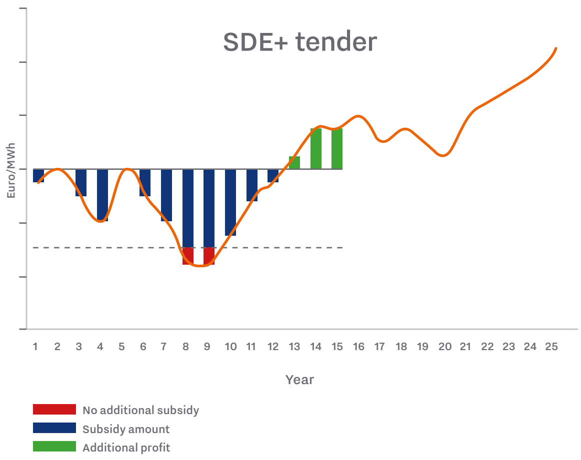
2.1.6 Step 6. Organizing the tender
Once the WFSD is irrevocable, the Government starts the tender process, coordinated by the Netherlands Enterprise Agency. All tenders kick off with a Ministerial Order, outlining the tender rules for the relevant offshore wind sites. Examples of tender rules are the timing of the tender, the deadline for full commissioning of the wind farm, the maximum tender amount and base electricity price, the minimum and maximum capacity of the wind farm and tender eligibility criteria, and criteria for ranking the bids. After the tender closes, the Minister of Economic Affairs and Climate Policy will appoint the winner within 13 weeks, a period which may be extended by another 13 weeks if required. The award decision is subject to objection and appeal proceedings by competing tender participants. Objections must be filed within six weeks of the date of the tender award. Subsequent appeals can be filed within six weeks of the date of the decision concerning the objection.

The current legislative tender framework distinguishes three optional tender models to select for future use: the tender based on lowest subsidy bid, best feasibility (+ financial) offer or highest auction price.[9]

[9] The The Wind Energy at Sea Act is currently subject to some legal changes with the following purpose 1) create more choice in (zero-subsidy) tender models, 2) include other sources of renewable energy, such as hydrogen and 3) extend the duration of the permit from 30 to 40 years. Parliamentary approval is expected in the course of 2021.

Model 1: Tender for lowest subsidy bid
In terms of this tender model with revenue support, used in 2016 for both Borssele WFZ tenders, the permit and associated subsidy are awarded to the party that tenders the lowest subsidy amount. The subsidy amount will be based on the so-called Stimulation of Sustainable Energy Production Scheme (SDE). The SDE offers an operating (premium feed-in-tariff) subsidy for renewable energy. Under this electricity price support scheme, producers receive financial compensation for the electricity they generate at times of low-cost prices for fossil energy, over a maximum period of 15 years. SDE compensates the difference between the production cost price of renewable energy (the "base amount") and the cost price for fossil energy (the "correction amount"). Accordingly, the SDE contribution depends on the correction amount and, therefore, on the evolution of the energy price. Eligible tender applications will be ranked on the basis of the tender amounts, with the subsidy awarded to the one with the lowest tender amount.[10]

As an example (also see the graph below): the Borssele WFZ 3 and 4 tender in 2016 was won by the Blauwwind consortium (Shell, Eneco Group and others) with a winning 'low' of 5.45 Euro cents per kilowatt hour ('auction price' in graph below). For a maximum period of 15 years, the consortium will receive electricity tariff support (subsidy) in times when the wholesale market price (also called 'correction price') is below 5.45 Euro cents per kilowatt hour (pictured as blue bars in the graph). If the wholesale or correction price falls below a pre-set minimum cost price (also called 'base electricity price', 3 Euro cents per kilowatt hour in 2016), no additional subsidy will be provided (pictured in red bars). In the times that the future market price rises above the winning auction price of 5.45 Euro cents per kilowatt hour (green bars), no subsidies will be provided either, as the developer now profits commercially from the offshore wind farm.[11]



Future use of the subsidy tender will only be considered as a 'backstop' in the event of insufficient developer interest in the subsidy-free tender. If future Dutch offshore wind projects remain viable in a merchant environment, meaning that Offshore wind production costs are likely to be reduced to (less than) 5 Euro cents per kWh in 2024 and 3 to 4 Euro cents per kWh in 2030, the Government plans to remove the subsidy backstop from 2025 onwards.

Model 2: Tender for best feasibility offer (comparative assessment)
Because of the strong interest and competition for the Borssele WFZ tenders, strike prices dropped rapidly. So much so that in 2018 and 2019, the Hollandse Kust (zuid) and Hollandse Kust (noord) tenders, permits could be granted subsidy free and based on a comparative feasibility assessment instead.[12]

In this tender model, applications will be subject to a differentiated feasibility assessment, potentially in combination with a financial offer. The most important feasibility criteria in this model are the assurance of the actual wind farm construction/operation and the contribution of the wind farm to the national energy mix. Depending on the local specifics of the wind farm, additional criteria may apply when deemed relevant. Such specific criteria may relate to nature, aquaculture, fishery, safety, or shipping issues. Depending on the expected commercial competition to secure the permit to build and operate the wind farm, a financial offer for the permit may also be considered. A team of independent experts - whose names will remain confidential to prevent potential interference by market parties – will be appointed to assess the quality criteria. The wind permit will be granted to the offer with the highest ranking.

[10] The maximum subsidy is based on the indicated capacity and the maximum number of full load hours of the offshore wind farm. The final subsidy payments are calculated per year, based on the actual amount of energy produced and the actual energy price. If the maximum production eligible for subsidy in a certain year has not been used, the remaining production capacity eligible for subsidy can be used in the following year. On top of the subsidy period of 15 years, another whole year can be taken to reach the remaining unused production eligible for subsidy, in effect stretching the subsidy period to a total of 16 years (forward banking). On the other hand, if production in a certain year exceeds the maximum production eligible for subsidy in that year, the excess production can be used in a following year if production is lower than expected in the later year, provided that this form of banking is restricted to no more than 25% of the annual production eligible for subsidy (backward banking).

[11] The Dutch SDE subsidy differs slightly from the popular Contract for Difference (CfD) mechanism, which many countries use to finance offshore wind development. CfDs provide both a guaranteed minimum price for the electricity generated to protect developers' project finance, as well as a financial reward (fee) if the wholesale price exceeds the strike price to compensate the Government. Project developers generally consider CfD to be the optimal system for revenue stabilization. However, the SDE model has the potential to be even more attractive for developer's project finance, as the Dutch subsidy system guarantees a minimum price, but demands no compensation fee when electricity prices are high. The SDE model is therefore sometimes also called a 'One Sided CfD'.

[12] The tenders for both Hollandse Kust (zuid) and Hollandse Kust (noord) in 2018 and 2019 were based on a previous version of this model, without the two-level criteria approach and financial offer option.

As no subsidy is involved, the winning developer will not have to sign an implementation agreement with the Dutch State or provide a bank guarantee. However, to ensure the timely development of the wind farm(s) in accordance with the wind permit, the Minister has the authority to impose a penalty for non-compliance. The amount of such penalty will be proportionate to the loss incurred by the Dutch State as a result of the non–compliance and is expected to equal the applicable penalties in the tender scheme with subsidy.

Model 3: Tender for highest auction price.
As from 2021, use of the auction model will also be a legal option for the Dutch Government. In this model, the winning auction bid is considered to be a 'negative subsidy' to cover (some of) the socialized costs of the grid infrastructure, the pre-development EIA and site studies and the costs of consenting. The specific procedure and timing of each auction will later be decided by the Government.

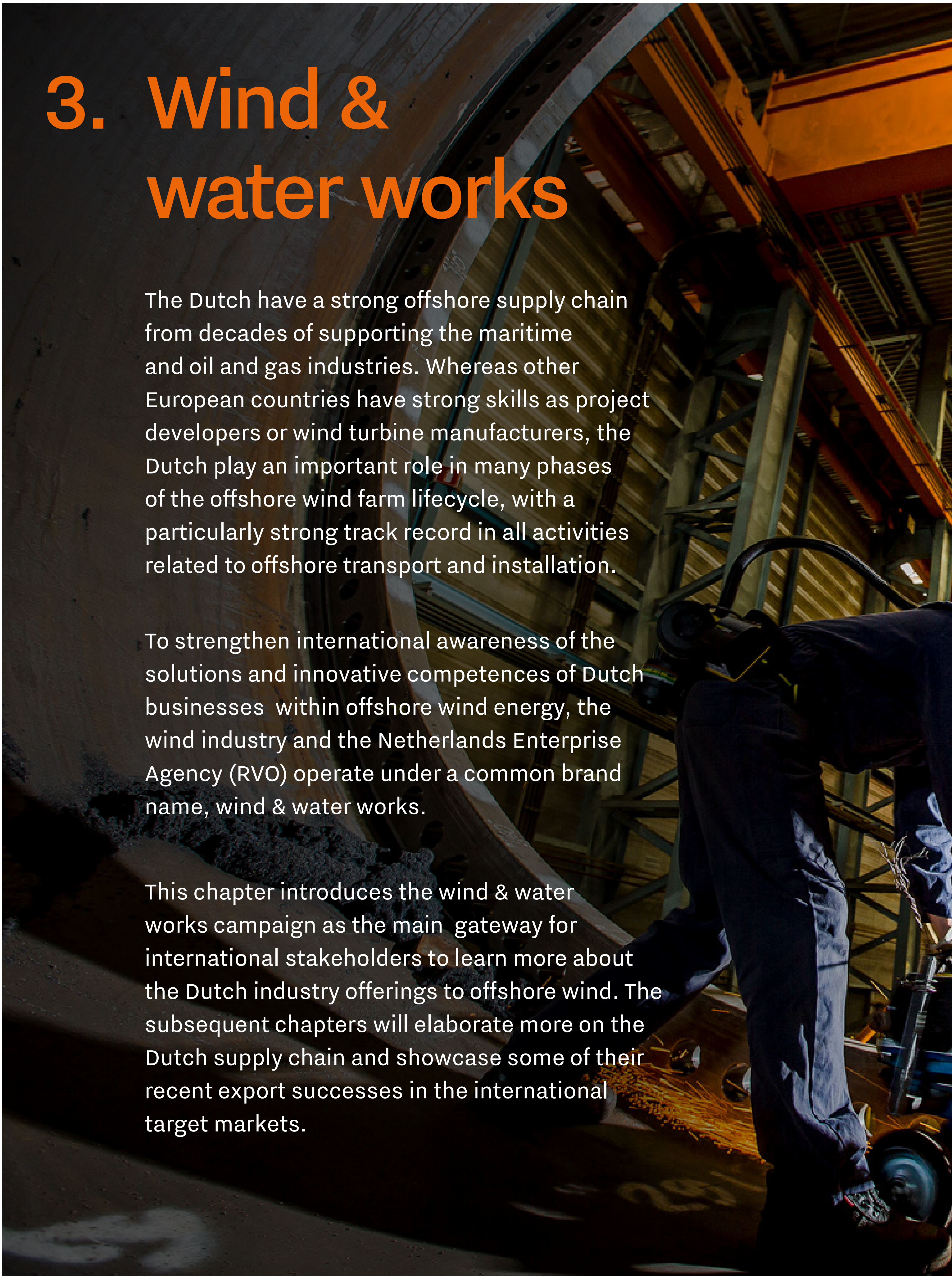
2.1.7 Step 7. Granting the permit
Immediately after winning the tender, the Government grants the permit for the construction, operation, and the removal of the wind farm. With this permit, the winning developer can immediately start constructing the wind farm. The permit states that the wind farm must be constructed within four (possibly five years) and is valid for a maximum of 40 years.

2.1.8 Step 8. Monitoring wind farm preparation
Once the wind farm developer is granted the permit, it must comply with its plan for the construction and operation of the wind farm as submitted in its tender bid. As stated in step 5, the permit remains flexible for innovation and therefore allows for certain permit changes in relation to the development or operation of the wind farm. This is to enable the use of the most up-to-date technology and pursue cost reductions through innovation. Examples of changes allowed to the production installations include the number of turbines of the production installation, the positioning of the turbines, the hub height, type of turbine and type of foundation. A request for an exemption must be accompanied by an explanation of the effect of the change on the aspects set out above, as well as by an amended wind energy yield calculation (if applicable). Any deviation from the original plan requires an exemption granted by the Minister of Economic Affairs and Climate Policy.

2.1.9 Step 9. Monitoring wind farm construction
The Directorate-General for Public Works and Water Management (Rijkswaterstaat) monitors the planning, construction, and operation of wind farms. The monitoring activities vary per phase. The planning phase mainly includes the assessment of the work plans drawn up by the permit holder. During the construction phase, inspections are performed via ships and aircraft of the Netherlands Coastguard and the State Supervision of Mines.

2.1.10 Step 10. Monitoring wind farm operation
The wind farm operation results in the generation of electricity. During the operational phase, the Directorate-General for Public Works and Water Management (Rijkswaterstaat) monitors the operations management and maintenance activities.[13] After a maximum of 40 years, the wind farm will be decommissioned and removed. The permit is no longer valid after that period.

[13] Rijkswaterstaat is part of the Dutch Ministry of Infrastructure and Water Management and responsible for the design, construction, management and maintenance of the main infrastructure facilities in the Netherlands.



3. Wind & water works

The Dutch have a strong offshore supply chain from decades of supporting the maritime and oil and gas industries. Whereas other European countries have strong skills as project developers or wind turbine manufacturers, the Dutch play an important role in many phases of the offshore wind farm lifecycle, with a particularly strong track record in all activities related to offshore transport and installation.

To strengthen international awareness of the solutions and innovative competences of Dutch businesses within offshore wind energy, the wind industry and the Netherlands Enterprise Agency (RVO) operate under a common brand name, wind & water works.

This chapter introduces the wind & water works campaign as the main gateway for international stakeholders to learn more about the Dutch industry offerings to offshore wind. The subsequent chapters will elaborate more on the Dutch supply chain and showcase some of their recent export successes in the international target markets.

3.1 An exerienced Dutch supply chain

For the Dutch, working at sea is in the blood. For centuries, our companies have worked offshore gaining a deep understanding of the specific conditions above and below sea level that can make or break a project. That experience means the Netherlands is home to some of most successful and innovative offshore wind businesses, maritime companies, and research institutes in the world. Our supply chain is a strong one with global reach and it's here to help you develop your own offshore wind industry with confidence.

In the Netherlands, the Government has taken on the task of developing offshore wind energy in the Dutch North Sea itself. It has introduced a stable policy environment with clear project pipelines. There are flexible rules and regulations in place. High quality site data is provided by the Netherlands Enterprise Agency to prospective developers of designated wind farm sites. Transmission system operator, TenneT, is responsible for all grid connection infrastructure. Meantime, Rijkswaterstaat grants consents for wind farm sites and monitors environmental impact. This approach provides greater certainty for developers, increases investor confidence, and has been proven to foster innovation and drive down overall costs for offshore wind projects. Combined, this array of Dutch private and public sector expertise can provide international neighbours with the right solutions for offshore wind in different site conditions around the world. We have proven experience working in the global wind industry to support its growth in a proactive, sustainable, and successful way and we are willing to share the lessons learned. Through the wind & water works gateway, our aim is to share this expertise and forge strong international partnerships to ensure the successful development of the offshore wind sector around the world. We are ready, willing, and able to work with you, so let's connect to maximise the full global potential of offshore wind.

3.2 One-stop information Portal

At the heart of the wind & water works campaign is the one-stop offshore wind information portal: www.windandwaterworks.nl and associated social media channels via #windandwaterworks. Featuring the latest offshore wind news, project showcases and company profiles, the website shares Dutch expertise and provides practical information to help other countries successfully develop their offshore wind markets.

Through the wind & water works gateway, Dutch businesses share their expertise and forge strong international partnerships to ensure the successful development of the offshore wind sector around the world.

Meanwhile, wind & water works also provides news and updates on export opportunities for Dutch companies hoping to increase their international activities. Dutch presence at international events and trade missions as well as public-private partnerships aimed at enhancing international trade are all featured. Company profiles and business links are also included under the Partners section of the website. More than 60 companies from across the Dutch wind industry have joined wind & water works as a partner already.

We will continue to welcome additional partners and add new insights and information across the website as the wind & water works campaign gathers momentum.

3.3 Founding fathers of wind & water works

Wind & water works is a public-private partnership between the Dutch government and leading business associations in offshore wind: Holland Home of Wind Energy (HHWE), the Association of Dutch Suppliers in the Offshore Energy Industry (IRO), Netherlands Maritime Technology (NMT) and the Netherlands Wind Energy Association (NWEA). The main goal is to inform and establish relations with stakeholders in the international offshore wind community. Through sharing of Dutch knowledge, experience and innovations, the wind & water works stakeholders aim at enhancing their international visibility and reinforcing their network as part of the international wind community.

HHWE: Holland Home of Wind Energy is an independent exporters association representing the interests of Dutch wind power companies abroad. HHWE's mission is to initiate and support marketing and promotional activities that will positively influence the image of the Dutch wind energy sector on emerging wind energy markets.

www.hhwe.eu

IRO: the Association of Dutch Suppliers in the Offshore Energy Industry is an independent non-profit organisation that supports and promotes the interests of Dutch suppliers within the offshore energy industry.

www.iro.nl

NMT: The Netherlands Maritime Technology trade association represents Dutch shipyards, maritime suppliers and maritime service providers in the fields of (inter)national trade, Innovation and Human Capital.

www.maritimetechnology.nl

NWEA: The Netherlands Wind Energy Association (NWEA) is the Dutch sector association working to increase sustainable wind energy on land and at sea. NWEA unites the wind sector in the Netherlands and accelerates the transition towards a renewable energy supply by spurring businesses and governments to invest in wind energy.

www.nwea.nl

3.4 Introduction to the next chapters

The next chapters will elaborate in more detail on the specific expertise the Dutch wind & water works partners can provide in the international offshore wind supply chain. The chapters follow the consecutive stages of the wind farm's lifecycle:

1. Feasibility, design and development
2. Construction and Engineering
3. Transport and Installation
4. Operations & Maintenance

To highlight the international track record of the Dutch expertise, a selection of recent export successes will also be presented. These showcases are derived from international media coverage through industry news outlets, such as offshore WIND.biz by Navingo.

4. Feasibility, design and development

In many international markets, especially those without any spatial planning for wind farm zones, the first step for project developers towards a new offshore wind farm is to find the right location. As potential offshore wind farm sites need detailed technical, financial, and environmental assessments, specialists are needed across all stages of the development process. And although only few international offshore wind farm developers, such as Shell, are headquartered in the Netherlands, Dutch companies and knowledge institutes are called upon throughout the world to assess the location and impact of potential offshore wind farms and the subsequent project development.


FUGRO
Intell

4.1 Development and project management

Although most wind farm utilities develop the initial offshore wind farm concept in-house during the pre-Front End Engineering Design stage (or pre-FEED), many consultancy and project management services are often subcontracted to third parties. Support includes legal advice, financial advice, planning, consenting, engineering consultancy, risk management and logistics.

Dutch consultants are internationally renowned at this early stage of project development in terms of consenting and development services and project management. A wide range of services are already provided by Dutch consultants to the development and project management area, such as legal and financial services.

The Dutch consultancy experience in wind farm development mostly lies in contract management support and project management. Renowned project investment consultants include:

- AMSCAP (investment, strategic consultancy);
- Green Giraffe (investment consultancy, tender support);
- Rebel (financial consultancy, co-developer)
- Voltiq (debt and equity, transactions and modelling).

Renowned Dutch consultants in feasibility, site selections and project management include:

- BLIX Consultancy (contract and project management, tender and survey consultancy);
- DNV-GL Arnhem (contractor selection for project developers, certifications);
- IX Wind (project development consultancy);
- Outsmart (production optimization, offtake agreements);
- Pondera Consult (project developer, consultancy);
- Royal Haskoning DHV (feasibility, consenting, permitting);
- Ventolines (development, contracting, installation supervision, asset management).

Ventolines Backs Massachusetts Offshore Wind Project

Source: OffshoreWIND.biz

The Netherlands-headquartered Ventolines has signed on as the offshore wind expertise partner for the Mayflower Wind project in Massachusetts.

Ventolines will provide transport and installation expertise on the substation, foundations, inter-array cables, and wind turbines.

The Dutch company has also opened its first U.S. office in Boston with the aim of exploring new opportunities in the local renewable energy market.

Ventolines worked on Block Island, the first U.S. offshore wind project, where it supervised the installation of turbines and advised on asset management.

“We are proud to be part of the team bringing more wind farms and sustainable energy to the U.S.,” said Thibaut de Groen, Ventolines’ Director of Contracting and Construction. “Our formal entry into the U.S. market is the next logical step in our company’s evolution.”

Mayflower Wind is being developed by a joint venture of Shell New Energies US and Ocean Winds some 40 km south of Nantucket.

The offshore wind project was chosen by the Commonwealth of Massachusetts in 2019 to supply 804 MW of capacity with the expected start-up in 2025.

The Massachusetts Department of Public Utilities (DPU) issued an order in November approving long-term contracts of Mayflower Wind with the Commonwealth’s Electric Distribution Companies.

Pondera Cracks Estonian Offshore Wind Market

Source: OffshoreWIND.biz

Pondera is assisting Saare Wind Energy with the environmental impact assessment (EIA) and the required research for the Saaremaa offshore wind project in Estonia.

The Saaremaa wind farm will comprise a maximum of 100 turbines at an area covering up to 200 km2 south-west of the Estonian island Saaremaa.

The location of the area, which could facilitate a capacity of over 1,000 MW, is said to offer a unique opportunity for the project to serve as an interconnector between the Estonian, Latvian, and Swedish grids.

Project development started in 2015. The Estonian government decided in May last year that Saare Wind Energy can proceed with the location permit procedure and the associated EIA.

Van Oord recently acquired a stake in the Estonian offshore wind developer, stating that the collaboration will allow Saare Wind Energy to intensify the development process, as financial support and knowledge are combined.

4.2 Environmental impact assessments

Offshore wind farm developers have to cross critical path items, such as environmental and social impacts that need to be assessed in terms of public scrutiny and comment, subject to legal challenges. Examples of environmental impact relate to birds, bats, fish, and marine mammals (noise mitigation) during the development process. Other topics relate to aesthetic considerations, decommissioning requirements, and the impact on tourism, fishing, navigation, and transportation that arise in the planning, construction, and operation of an offshore wind project.

Dutch suppliers are renowned for the execution of environmental impact assessments and include amongst others:

- Pondera Consult (EIA consultant);
- Royal Haskoning/DHV (EIA consultant).

4.3 Ecological surveys

Environmental surveys establish the distribution, density, diversity, and number of different species such as benthic, birds and marine mammals (acoustic impact during offshore piling). These studies take place early in the development process to provide information for the environmental impact assessment (EIA).

Current Dutch suppliers include:

- Imares (ecological impacts on marine life);
- Robin Radar Systems (bird-detection systems);
- Wageningen Marine Research (WUR) (ecological impact on marine life);
- Bureau Waardenburg (marine biologist subsea research).

4.4 Site investigations

During the site selection, developers also call upon specialists to carry out site investigations, including geotechnical and geophysical studies to identify suitable locations for the wind farm and cable routes. These investigations identify seabed topography and locate unexploded ordnance. Further geophysical surveys are often completed post-consent and pre-construction to determine turbine locations, foundation design and cable routes. Environmental studies such as wildlife impact assessments are sometimes combined with the geophysical surveys.

Site investigations are required at both the wind farm location and at the proposed onshore and offshore cable route and the onshore substation site. Depending on the survey type, the contract may involve both data collection and analysis, such as geotechnical surveys, or data collection only, where analysis is performed by the developer in-house, for example, meteorological and oceanographic (metocean) data. Geophysical surveys include bathymetric, cable route and unexploded ordnance surveys. These surveys plot the surface topography in support of the wind farm design and installation engineering.

The Dutch have a long-standing strength in offshore site surveying, resulting from the involvement in oil and gas and other marine operations. Examples of Dutch suppliers are:

- Bodac (UXO survey, clearance);
- Deep BV (subsea data collection);
- Deltares (characterization of waves);
- Fugro (seabed analysis);
- Geomil (soil studies, cone penetration testing);
- MARIN (behavior research of vessels and marine structures i.e. floating wind power);
- N-Sea (asset survey and inspection);
- Reaseuro (UXO survey, clearance) investigation);
- Royal Haskoning/DHV (wave, current and tidal installations, wind port design).

The multipurpose Fugro Enterprise is one of two Fugro vessels working on the Sunrise Wind project off the coast of New York - Credit: Fugro

Fugro Stays Offshore New Jersey

Source: OffshoreWIND.biz

Fugro has received a contract renewal from Atlantic Shores Offshore Wind for the provision of real-time wind and metocean measurements off the coast of New Jersey in the US over the next two years.

The award is the latest in a set of three contract renewals between Fugro and Atlantic Shores based on a successful 2020 work season.

Along with metocean services, Fugro's geophysical and geotechnical contracts have also previously been renewed, all three to support the safe design, permitting, and construction of future wind farm facilities within the 740 km2 lease area.

For the metocean contract, Fugro is utilising two SEAWATCH Wind Lidar Buoys. These systems provide cost-effective and reliable collection of wind, wave, current and meteorological data to optimise wind turbine design, installation, and operations and maintenance.

The geophysical and geotechnical contracts started earlier this spring and are focused on continued characterisation of the lease area, export cable routes, and inter-array cable modules.

The fieldwork will run until mid-July and is being performed from five vessels, including two third-party vessels local to New Jersey, equipped with advanced data acquisition and analysis capabilities for near-real-time data processing and geoconsulting.

With the potential to deliver more than 3 GW of wind power from late 2027, Atlantic Shores will play an important role in New Jersey's goal to reach 50 per cent of renewable power by 2030, Fugro said.

"Fugro is committed to ensuring a successful energy transition at the local, regional and global levels, so we are thrilled to continue our work with Atlantic Shores this year, building on past successes and applying innovative technologies that will help move this critical project forward," Edward Saade, President of Fugro in the US, said.

5. Construction and engineering

The absence of large wind turbine manufacturers does not mean that the Netherlands lacks expertise at this stage of the offshore wind project development. On the contrary, Dutch companies are often involved in producing and improving wind turbine components, such as rotor blades and drive trains, aimed at larger wind turbines and higher capacities. Dutch companies and organizations are known all over the world for their leading position in supply and development of technology to support wind turbine manufacturing.


KEEP CLEAR

5.1 Turbine component supply, engineering

Wind turbine manufacturers can best be seen as system integrators: designing the overall system and components such as nacelle, rotor, and the tower, then assembling the components (mostly at the offshore site), which it may manufacture in-house or source from suppliers externally.

Examples of suppliers from the Netherlands are:
- Bosch Rexroth (turbine drive and control technology);
- C1 Connections (wedge connections wind turbines);
- Hetraco (special fasteners);
- Huikeshoven (mold heating rotor blades);
- LM Windpower (supplier of wind turbine blades)[14];
- Pontis Engineering (rotor blade composite engineering);
- Sinus Jevi (electric heating system wind turbines);
- VDL Klima (turbine generator coolers);
- WE4CE (composite rotor blade design).

5.2 Turbine foundation supply

Turbine foundations are one of the main elements of any offshore wind farm, accounting for over one fourth of the total equipment cost. Developers select a foundation type depending on the water depth, seabed conditions, wave and tidal loading, and turbine loading, mass and rotor speed. The foundation types are listed and briefly summarized below:
- Monopiles;
- Jacket and tripod steel foundations;
- Suction piles/ buckets;
- Gravity base foundations;
- Floating foundations.

Monopiles

To date, most offshore wind farms have steel monopile foundations, being selected in more than 60% of the worldwide offshore wind installations. The main characteristics in favor of monopiles are simplicity (easily standardized design to be manufactured in series without the need for high-end 3D cutting and welding technology) and adaptability (more easily adaptable to different installation site characteristics, avoiding the need for a large amount of field data).

The most common design has been a cylindrical monopile that is first driven into the seabed, with cylindrical transition piece mounted over it and grouted into position. The purpose of the transition piece is to provide access arrangements (these welded appurtenances would not survive the piling activity) and levelling of the tower base interface. Increasingly large designs, with XL units up to 2.000t or more currently being deployed for deeper waters up to 60 – 70 meters.

Dutch monopile supplier Sif Offshore Foundations, already a major Tier 1 player in the European offshore wind market, has recently also won contracts in the US and Japan.

First Batch of Akita-Noshiro Monopiles Arrives in Japan

Source: OffshoreWIND.biz

The first nine monopiles for the Akita-Noshiro offshore wind project in Japan arrived in Akita on 12 January after being dispatched from Sif's terminal in Rotterdam, the Netherlands, on board SAL Heavy Lift's MV Lone vessel in December.

The Dutch foundation manufacturer started the production of 33 monopile foundations for the 139 MW Akita-Noshiro project in May. The transition pieces (TPs) are being manufactured by Smulders, which shipped off the first four TPs from its facility in Hoboken, Belgium, to Rotterdam in November 2020.

The foundation installation, to be carried out by Seajacks, will start this year.

Sif signed the final contract for the monopiles and transition pieces with Kajima Corporation, the project's EPCI contractor, in March 2020.

"Sif is evaluating the development of the Japanese offshore wind market for some years now. Sif recognises the ongoing development of offshore wind in Japan and therefore has decided to open a sales office in Tokyo in 2019 to study further expansion of Sif's business activities in Japan. This first delivery of Sif monopiles to Japan is an important milestone for us", said Fred van Beers, CEO of Sif Holding.

The Akita-Noshiro project comprises two sites off Akita Port and Noshiro Port. Thirteen Vestas V117-4.2 MW typhoon variant turbines will be installed at the Akita site, while the Noshiro site will comprise 20 turbines.

[14] Rotor blades are generally made in-house by the wind turbine manufacturers such as GE, MHI Vestas and Siemens-Gamesa. LM Wind Power, a GE Renewable Energy business, is the leading external supplier. The GE/LM Windpower rotors and blades are tested in the Netherlands at the WMC Technology Center facilities in Wieringerwerf, the biggest of its kind in the world.

Monopiles not always an option

Monopiles are used for almost all European developments because of their low cost (simplicity of fabrication and construction) and their ability to be hammered or vibrated deeply into the seabed, consisting of either sand, silt, medium to hard clays – or a mixture. But many of the most promising areas around the world do not have such competent seabed stratum. They are instead characterized by soft marine clays, hard volcanic and sedimentary rocks, deep faulting, seismic activity, and loose deposits with liquefaction potential. This means that certain situations may require alternative foundation systems – including piled jackets, suction buckets, or gravity-based structures.

Jacket and tripod steel foundations

There are several non-monopile steel foundation concepts for deeper water projects for which monopiles are not a feasible option:

- Jacket: structures typically used in O&G sector but optimized for the Offshore Wind Farms. It has a Transition Piece platform on top and the main structure is made of legs, braces, and pin piles to anchor the complete structure to the seabed. It can have four or three legs.
- Tripod: three-leg structure made of cylindrical steel tubes. The central steel shaft of the tripod makes the transition to the wind turbine tower. The base width and pile penetration depth can be adjusted to suit the actual environmental and soil conditions.

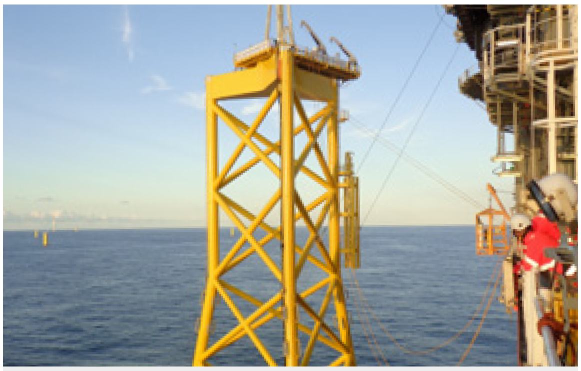
There are no current Dutch suppliers with international interests known in this field.

Suction piles/buckets

In 2017, SPT Offshore (now part of DEME) launched a new wind turbine suction pile foundation concept, as an alternative to jacket foundations. The foundation involves a star-shaped transition piece that is positioned in between the three (or potentially four) suction piles and the mono tubular. The suction bucket foundation creates a vacuum to secure the foundation to the sea floor. Pumping air back into the bucket reverses the suction process and aids the removal of the structure.

This foundation is potentially cost saving as the mono tubular is inexpensive to fabricate, being some 3 times less expensive than jackets. Furthermore, the suction piles have several advantages, including fast and noise-free installation. Also, suction piles do not cause any shocks to the foundation, so that single piece installation up to the work platform is possible.

There is significant interest in suction piles/buckets as seabed connections as a means of lowering installation costs and the impact of piling on wildlife.



First Suction Pile Jacket Installed at Changle Waihai OWF

Source: OffshoreWIND.biz

CCCC – First Harbor Engineering Company has installed the first suction pile jacket at the Fujian Changle Waihai offshore wind project in China.

CCCC installed the suction pile jacket on 21 February using SPT Offshore's SAPS007S suction spread.

The Netherlands-based SPT Offshore won a contract in August 2020 for the design and installation of suction pile jacket foundations at the project.

Dongfang Electric Corporation (DEC) will deliver the turbines.

The 300 MW Changle Area A will consist of 40 turbines, 15 of which mounted on suction pile jacket foundations, while the 496 MW Changle Area C will feature 62 turbines all set to be installed on suction pile jackets.

The wind farm is located in the east water area of Changle, Fuzhou City, 31–50 km from shore in water depths of 37 to 45 m, and is currently the farthest and deepest offshore wind farm in China.

Gravity-based foundations

Gravity-based structures (GBSs) are assembled onshore and installed without the need for piling. This avoids some of the noise restrictions faced by some projects to limit the impact on marine mammals and eliminates the need for expensive heavy-lift vessels. Large quayside or dry dock facilities are required with heavy lift capabilities for manufacture. These are made from concrete or are steel-concrete hybrids. Requiring no piles and no specialized installation vessels, gravity-based structures maximize the use of both local labor and materials. They have the potential to be an attractive option for many locations in i.e. Asia.

Examples of suppliers from the Netherlands are:
- BAM Group (self-floating gravity based foundation);
- Monobase wind (gravity base foundations).

5.3 Sealing, corrosion protection

Foundations for wind turbines and offshore substations require solid steel protection and bolting fixation, as bad sealings and corrosion can cause severe damage that is both expensive and difficult to repair.

Examples of current Dutch suppliers are:
- CORROSION & Water Control BV (cathodic corrosion protection and anti-fouling);
- MME Group (cathodic corrosion protection);
- Trelleborg (inflatable grout sealing TP-foundations).

5.4 Subsea cables

Subsea cables deliver the power from the turbines to the onshore grid. Array cables connect the turbines to an offshore substation from which the power is transmitted to an onshore substation via high-voltage (HV) export cables. The array cable technology is well established and has been extensively used in the power and oil and gas industries. To date, array cables have predominantly been medium voltage (MV) and rated at 33 kV. Dutch offshore wind farms will be connected through 66 kV cables, and this is expected to be a rapidly growing market elsewhere over the coming years. Export cables from substation to shore have a significantly higher capacity than array cables, ranging from 132 kV to 245 kV. Export cable installation takes place early in the construction schedule and there are potentially long lead times. It is therefore one of the first Tier 1 contracts placed.

Export cables can either be HV alternating current (HVAC) or HV direct current (HVDC). Most export cables have been alternating current (AC), but as future projects tend to be further from shore, it is likely to lead to greater use of direct current (DC) systems.

Current Dutch suppliers include:
- TKF (subsea cabling).

5.5 Substations and foundations

Modern commercial-scale offshore wind farms have at least one offshore substation, incorporating electrical components such as reactive compensation systems, switchgear, transformers, back-up generators and converters where required. HVAC electrical systems have been the most common solution to date. For projects that are built further offshore, however, there is cost benefit in using HVDC systems due to a reduction in electricity losses.

Offshore substation electrical systems are mounted on platforms (topsides). Offshore substation platforms are large complex steel structures. An HVAC offshore substation platform weighs up to 2,000 t and may include a helipad and emergency accommodation. HVDC substations are much larger, with masses of up to 15,000 t. Substation manufacturing is analogous to shipbuilding and offshore oil and gas platform fabrication. Both monopile and jacket foundations have been used to support these.

Substation supply can be divided into the supply of electrical systems and the supply of the structures. Electrical systems comprise transformers, reactors switchgear, power electronics, cables within the substation and control and auxiliary systems. Offshore substation structures include the offshore platform and associated structures for access and accommodation, and the substation foundation. Both monopile and jacket foundations have been used to support these.

Examples of current Dutch suppliers/engineers are:
- Hapam (high voltage equipment for substations);
- Heerema Fabrication (jacket structures);
- Heinen & Hopman (HVAC systems substations);
- HSM Offshore (construction substations);
- IV Offshore & Energy (substation engineering);
- KCI (foundation, substation design).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6. Transport & Installation

The Netherlands has a large and internationally renowned offshore services sector. Traditional Dutch offshore oil and gas contractors and dredging companies are now also world leaders in the installation of offshore turbines and foundations. With their strong market position and expanding track record, they offer either transport and installation or Balance of Plant packages, depending on the preference of the developer. In various partnerships and consortia, these companies also focus on faster development, higher efficiency and environmentally friendly installation methods for turbines and foundations.


Van Oord

6.1 Turbine and foundation installation

Turbine installation is undertaken by main contractors using jack-up vessels which transport wind farm components from port to site. Recent projects have mostly used vessels which are purpose built for offshore wind. It takes two to three days on average to install a turbine, including transit time, weather downtime and mobilization/demobilization time. The turbine installation is undertaken by the original equipment manufacturer (OEM) but the vessel is often contracted by the developer. Turbine installation may well be part of a full balance of plant contract.

For foundations, vessels may either transport the structures from port to site and undertake the installation or remain onsite with foundations transported to the site using feeder vessels. Some jack-up vessels are used for both turbine and foundation installation. Others are floating heavy lift vessels, which may be used for substations as in other maritime sectors. For jacket foundations, deck space is the limiting factor for vessel choice, whereas for monopile foundations it is increasingly the crane capacity. It takes about three days to install a monopile and five days on average to install a jacket foundation, including transit time, weather downtime and mobilization/demobilization time.

The oil and gas industry is the origin of the Dutch expertise in turbine installation. As the offshore wind industry has matured, the vessels used have become increasingly bespoke and many are exclusively used in offshore wind.

Today the Dutch have competitive contractors in the offshore wind turbine installation market. Examples of Dutch suppliers include:

- BigLift (heavy lift shipping);
- Boskalis (seabed preparation, installation of foundations & subsea cables, shipping);
- DEME (seabed preparation, installation of foundations & subsea cables);
- Heerema (installation of foundations & substations);
- Jack-up Barge (jack-up platforms);
- Jumbo Offshore (heavy lift shipping);
- Mammoet (lifting & transportation);
- Seafox (self-elevating jack-up vessels);
- Seaway 7 (installation of foundations & subsea cables);
- Van Oord ((seabed preparation, installation of foundations & subsea cables).

First Kincardine Floating Giant Heads to Scotland

Source: OffshoreWIND.biz

Boskalis has started towing the first Kincardine floating wind turbine from Rotterdam in the Netherlands to the installation site some 15 kilometres southeast of Aberdeen, Scotland.

The anchor handler Manta started towing the first of the five MHI Vestas 9.525 MW floating wind turbines from the Port of Rotterdam on Tuesday, 8 December.

At the installation site, the turbine will be hooked up to the already installed mooring spread by Boskalis' hook-up construction vessel Nicobar in a water depth of approximately 70 metres.

During the installation activities, the Nicobar will be supported by the anchor handlers Manta and Princess for station-keeping.

Once fully completed, Kincardine will comprise one 2 MW and five 9.525 MW MHI Vestas wind turbines, becoming the largest operating floating wind farm in the world.

The 2 MW unit has been operating offshore Aberdeen since October 2018. All six turbines will be installed on semi-submersible floating structures designed by Principle Power.

The wind farm is being developed by Spain's Cobra Grupo.

For more information on cable laying, please refer to: www.windandwaterworks.nl/cases/export-and-inter-array-cable-installation

Van Oord Clinches Sofia EPCI Contract

Source: OffshoreWIND.biz

RWE has awarded Van Oord with a contract to carry out the engineering, procurement, construction, and installation (EPCI) of the monopile foundations and the inter-array cables for the 1.4 GW Sofia offshore wind farm.

Sofia is sited on Dogger Bank in the central North Sea, 195 kilometres from the North East coast of the UK.

Through its UK branch MPI Offshore, Van Oord will create a logistics hub to deliver the scope of work.

Offshore installation vessel Aeolus will be deployed to install the 100 extended monopile foundations without transition pieces.

The 350 kilometres of array cables will be installed by cable-laying vessel Nexus. Van Oord will sub-contract the fabrication of the foundations and array cables.

”RWE and Van Oord know each other well having worked together on four UK projects prior to the signing of this most recent EPCI contract for foundations and array cables,” Sven Utermöhlen, Chief Operating Officer Wind Offshore Global of RWE Renewables.

”At 1.4GW, Sofia is our largest and most ambitious offshore wind development to date. We look forward to leveraging our vast experience and learnings as we progress into the construction of this flagship project, and to realising its potential in terms of contributing to the UK's net zero energy ambitions.”

The project will be executed by Van Oord Offshore Wind UK from their MPI Offshore office in Stokesley Teesside.

With the onshore converter station located near the village of Lackenby in Teesside and the recent announcement by the UK government of Freeport status for the Tees Valley, the area is expected to receive a boost. This will deliver opportunities for the local supply chain and create new jobs.

”Our project team is busy preparing for this great offshore wind project. Now that the contract is signed, the design phase will be started and the project team will commence its activities from our Stokesley office,” Arnoud Kuis, Managing Director Van Oord Offshore Wind.

”The recent announcement of Freeport status for the Tees Valley will further stimulate the regional development of the offshore wind sector in this area. In the coming period, we will be actively marketing our supply chain opportunities and vacancies with a focus on sourcing well-trained staff.”

RWE reached the final investment decision for the GBP 3 billion Sofia project last week.

The wind farm will feature 100 SG 14-222 DD wind turbines scheduled to be fully commissioned in 2026. Offshore construction is expected to start in 2023.

For more information on offshore wind farm installation, please refer to: www.windandwaterworks.nl/cases/balance-of-plant

6.2 Substation installation

Offshore substation electrical systems are mounted on platforms. These structures are often similar to offshore oil and gas platforms, as is the installation process, although substations are typically in shallower water. Most topsides have typically been installed with a single lift from a barge. Both sheerleg (two-legged lifting device) and heavy lift vessels can undertake the lift from the barge. Substation foundations may be either jackets or monopiles, and the installation of these may form part of the turbine foundation installation contract and use the same vessels.

Current Dutch suppliers are basically the same as those for the turbine and foundation installation.

6.3 Cable laying

Cable installation can be undertaken either in a single lay and burial process using a plough, or through a separate surface lay and subsequent burial approach using a jetting tool on a remotely operated vehicle (ROV). Installation of array cables is more challenging due to the large number of operations involved, with a pull-in at each foundation. For nearshore installations, shallow-draft barges are often used, whilst large-scale projects further from shore typically use dynamically positioned cable ships. Export cables are typically installed as a single length of cable and thus larger vessels are used with the necessary storage. Unlike turbine and foundation installation, success in the cable installation market is driven as much by technical capability and track record as it is by vessel capability.

Dutch suppliers have a good track record in undertaking cable installation and/ or associated services, include amongst others:
• Boskalis Subsea Cables (cable installation);
• Blue Offshore (deck equipment cable installation);
• CP/NL Engineering (cable protection solutions);
• DEME Offshore Services (cable installation);
• ECE Offshore (cable lay engineering);
• Gouda Holland (cable management systems);
• MOVE Renewable (cable engineering, cable protection);
• N-Sea (subsea services, inspections, repairs);
• Oceanteam Solutions (cable logistics);
• Primo marine (consulting engineer subsea, floating cables);
• Van Oord (cable-laying vessel Nexus);
• Visser & Smit Hanab (cable installation);
• VPI (Vos Prodect Innovations) (subsea cable protection);
• WIND Cable Service (cable equipment transport, storage, and rental services).

6.4 Installation tools

This sub-element covers the lower tier activities which are undertaken in support of the primary (Tier 1) installation contracts. Equipment used during installation includes:
• Cranes for loading components on the quayside;
• Sea fastenings and racks for securing components in transit;
• Foundation piling equipment such as templates, hammers, and handling equipment;
• Cable installation equipment such as carousels, tensioners, grapnels, trenching and burial tools, and cable retrieval tools;
• Turbine installation equipment, such as cranes and yokes.

Equipment such as cranes and cable-handling equipment may be bought by the installation contractor and permanently installed on the vessel or rented from a supplier.

There are some elements of the installation equipment that are designed and manufactured based on the needs of the specific projects, examples include sea fastening equipment, blade racks and pile-handling tools.

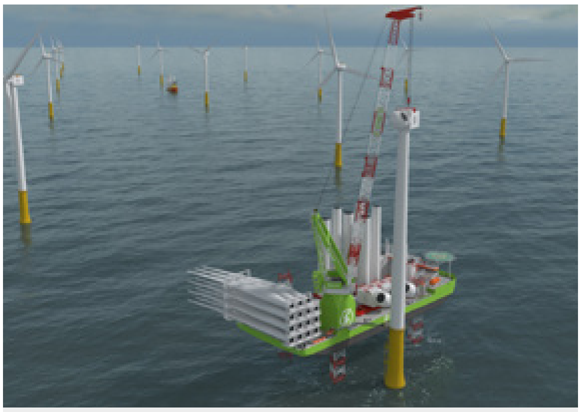
Dutch suppliers have a good track record in installation equipment, associated services and include amongst others:

Cranes:
• Huisman Equipment (leg encircling cranes);
• KenzFigee (cranes, lifting equipment);
• SMST (offshore cranes);
• Bosch Rexroth (crane systems).

Lifting equipment:
• Enduro (lifting gear, softslings);
• Enerpac (hydraulic bolting tools, lifting systems);
• FibreMax (lightweight synthetic cables);
• Franklin (synthetic and steel wire lifting ropes);
• Hendrik Veder (hoisting and lifting equipment);
• Polarttech (bearings, cradle and pile gripper linings).

Hammers:
• Cape Holland (lifting and vibro hammering tools);
• Dieseko Offshore/ ICE: vibro hammers);
• Dutch Drilling Consultants (solid rock drilling tools);
• IQIP (lifting, piling equipment).

Customized installation equipment:
• Breman Machinery (piling templates, precision machinery);
• Eager-One (design & construction of lifting and handling equipment);
• Hetraco (special fasteners offshore wind equipment);
• Holmatro (hydraulic TP levelling, sea-fastening);
• JB systems (installation automation);
• Muns Techniek (customized hydraulic lifting systems);
• Royal IHC (dynamic outrigger frames);
• Seatools (installation equipment design);
• Solidd Steel Structures (steel constructions);
• Temporary Works Design (design support equipment systems);
• TMS (design, supply mechanical installations).



Huisman Receives Order for 2,600-Tonne LEC Crane for Eneti’s Mega Jack-Up

Source: OffshoreWIND.biz

Daewoo Shipbuilding & Marine Engineering (DSME) has ordered a 2,600-tonne Leg Encircling Crane (LEC) from Huisman for Eneti’s new build Wind Turbine Installation Vessel (WTIV).

The crane has a 147-metre long boom, capable of reaching 170 metres above deck. With the lifting capacity of 2,600 tonnes, it will be able to install wind turbines of up to 20 MW, which are expected to come to the market in the near future and for which Eneti decided to build the vessel.

The scope of work for Huisman consists of the design, engineering and construction of the LEC and pedestal adapter at its production facility in Zhangzhou, China. Commissioning and testing of the LEC is scheduled for 2023 at the DSME shipyard, from where the vessel will be delivered to Eneti in 2024.

The Dutch company’s contract also includes an option for the delivery of a second crane, intended for an identical WTIV that Eneti has under shipbuilding option with DSME.

Eneti (formerly Scorpio Bulkers), decided to build the vessel(s) as the company is turning its focus from the dry bulk shipping sector to offshore wind. Last year, the NYSE-listed company announced it would sell its remaining dry bulk vessels and exit the sector during 2021 as it shifts its focus to owning and operating offshore wind installation vessels.

IQIP to Deliver Noise Mitigation System for He Dreiht OWF

Source: OffshoreWIND.biz

EnBW has awarded IQIP with a contract for the delivery of a noise mitigation system which will be used during the installation of monopiles at EnBW’s He Dreiht offshore wind farm in Germany.

The Dutch company will manufacture and deliver a double-walled noise protection system called NMS-10,000 which will reduce the noise induced by pile driving together with other components, so that the project could be in compliance with the relevant noise mitigation regulations.

While EnBW already pre-selected Vestas’s 15 MW wind turbine model in July, the foundation manufacturer(s) and installer(s) have not yet been chosen, according to the information currently available.

In February of this year, the developer contracted German company Jörss – Blunck – Ordemann to provide a detailed design of wind turbine substructures and foundations for the He Dreiht project, and issued a tender for the installation of foundations the same month.

EnBW secured rights to develop the 900 MW offshore wind farm in April 2017 by placing a zero-subsidy bid in the first competitive tender in Germany.

The start of offshore works is expected in the first quarter of 2024, with the wind farm expected to be fully commissioned in the fourth quarter of 2025.

6.5 Vessel design, ship building, deck equipment

Installation vessels

As already indicated above, there are basically two main vessel options for steel foundation installation: a jack-up vessel, mostly used for turbine installation; or a floating vessel, often with components fed using a separate floating vessel. Turbine installation on all existing commercial-scale projects to date has been undertaken by a jack-up vessel, to provide sufficient stability for the nacelle and rotor lifts.

Subsea cable installation can be undertaken using either a single lay and burial process with a plough or using a separate surface lay with subsequent burial, using a jetting tool operated from a remotely operated vehicle (ROV). Array cable laying is considered a more technically challenging process than export cable-laying due to the large number of operations that are involved and the cable pull-in interface at each foundation. Export cable-laying vessels tend to be larger with cable carousels with a higher capacity to enable a single length of cable to be laid from substation to shore, where possible.

Support vessels

The sort of support services required during installation includes cable route surveys and clearance, support vessels such as crew transfer and guard vessels, diving, ROV operations, grouting and several marine operations, including vessel modifications, logistics, certification, weather forecasting and planning. Many of these services are delivered by small and medium sized companies.

Dutch contractors have proven expertise in designing and delivering all types of vessels. Examples of current Dutch suppliers are:

- Bosch Rexroth (jacking systems);
- C-Job Naval Architects (ship design, engineering and construction supervision);
- Damen (ship building);
- DEKC (vessel design, engineering);
- GustoMSC (design & engineering offshore vessels, jack-up's, floating foundations);
- KENC (noise mitigation design);
- Nevesbu (vessel design, engineering);
- Royal IHC (ship building, cable lay equipment, jacking systems);
- SeaOwls (ship building);
- Ulstein Design & Solutions BV (ship design, engineering);
- Vuyk Engineering (vessel and equipment design).

For more information on vessel design and innovation, please refer to: www.windandwaterworks.nl/cases/vessel-design-and-innovation

GustoMSC Kit for Eneti's Next-Generation Jack-Up

Source: OffshoreWIND.biz

Houston-headquartered NOV has been awarded contracts for the design and the supply of equipment for Eneti Inc's first wind turbine installation jack-up vessel.

The vessel will be built by South Korea's Daewoo Shipbuilding and Marine Engineering (DSME) for scheduled delivery in the third quarter of 2024.

The jack-up is of the GustoMSC™ NG-16000X design by GustoMSC, a subsidiary of NOV.

The contract provides an option for an additional jack-up vessel.

Emanuele A. Lauro, Chairman and CEO of Eneti Inc., said: "Since August 2020, we have been unequivocal about our intention to enter the wind turbine installation sector. This vessel will have the advanced lifting capabilities and energy efficiency that offshore wind developers require, not just today, but well into the next decade."

The NG-16000X is an optimized, self-propelled turbine installation jack-up vessel design that features increased carrying capacity and lifting capacity, as well as a higher lifting height above the deck, NOV said.

The vessel is from the same series as the first US-built NG-16000X and is ready to carry multiple 20 MW turbines. The jack-up has been designed with the option to adapt the vessel in the future, allowing it to operate on alternate liquified natural gas or ammonia fuels.

The GustoMSC NG-16000X includes the GustoMSC Rack & Pinion jacking system with a variable speed drive. The jacking system will have a regenerative power option were the generated power is fed back into the vessel system, NOV said. The design further incorporates a 2,600-t leg encircling crane, ready to install the future size monopile foundations and wind turbines.

Eneti (formerly Scorpio Bulkers) is turning its focus from the dry bulk shipping sector to offshore wind. Last year, the NYSE-listed company announced it would sell its remaining dry bulk vessels and exit the sector during 2021 as it shifts its focus to owning and operating offshore wind installation vessels.

"We are impressed with Eneti's commitment and willingness to enter into this new market. In a short period of time, both companies worked hard to have this unique NG-16000X ready for construction. We are devoted to assisting our clients from the start until the delivery and beyond that, for many years with our operational support. The shortage of wind turbine installation jack-ups capable of installing heavier and higher turbines in deeper waters is foreseen. GustoMSC has invested and prepared for this change and is well positioned to support our client requirements," Jan-Mark Meeuwisse, Commercial Director, GustoMSC, said.

Green Shipping Line and DEKC to Design Jones Act Offshore Wind Vessels

Source: OffshoreWIND.biz

The US-based Green Shipping Line (GSL) has signed a Teaming Agreement with the Dutch marine vessel engineer DEKC Maritime to pursue Jones Act-compliant offshore wind vessel solutions in the United States.

This announcement follows a string of deals by GSL, including an agreement with Keystone Shipping Company to operate future shuttle vessels in the US offshore wind market and a Teaming Agreement with Moran Iron Works to construct future vessels.

"DEKC's extensive knowledge and capabilities provide GSL with an ideal partner to design our fleet of modern Jones Act feeder vessels, including our flagship Eleanor model," said Percy R. Pyne IV, founding partner of GSL.

"This agreement furthers our ability to provide efficient, proven, green solutions for offshore wind developers and component manufacturers in the U.S."

DEKC Maritime, headquartered in Groningen, Netherlands, has designed a multi-purpose vessel known as the 'swiss army knife' vessel of the offshore wind industry in Europe.

GSL's multi-purpose cargo vessel – the Eleanor model – will complement DEKC's European offshore wind vessel, the shipping company said. Green Shipping Line and DEKC to Design Jones Act Offshore Wind Vessels

With an approval in principle from the American Bureau of Shipping, GSL's Eleanor model is able to transport offshore wind components such as towers, nacelles, and blades from a port to installation sites in a two-day cycle, cutting down on costs and production time by over 40 per cent, GSL said. It will also be the first vessel of its kind in the US capable of transporting all of the components of a wind tower, according to GSL.

The 364-ft multipurpose vessel can also be configured to perform rock dumping, scour protection, and offshore accommodation.

Fully Jones Act-compliant, the Eleanor will be built in the US at the Moran Iron Works Shipyard in Onaway Michigan and operated by Keystone Shipping Company. It will be flagged American and manned by an American crew and can operate out of all the regional ports along the United States' East Coast due to its unique dimensions and draft. The Eleanor model will be available for delivery as soon as mid-2023.

"We look forward to sharing our knowledge and expertise with GSL and helping develop their fleet. Our aim is to take the experience we have gathered over the past decade in offshore wind and utilize it to provide the best vessels and solutions for the emerging U.S. offshore wind market," said Cor Lettenga, Managing Director of DEKC Maritime.

Following a study that included examining US and European ports, channels, and quays, and multiple visits to Europe to look at wind farm components, GSL identified an existing vessel design that would not require dredging to accommodate US ports or manufacturing needs, the New Jersey-based company said.

Ulstein Wins New Work on US Rock Installation Vessel

Source: OffshoreWIND.biz

Great Lakes Dredge & Dock (GLDD) has contracted Ulstein for the integration engineering for the first Jones Act compliant subsea rock installation vessel dedicated to the U.S. offshore wind market. The new contract follows the one for Basic Design, which GLDD awarded to Ulstein in December 2020.

The scope of work includes the selection of vessel main equipment with integration engineering plus the start of detail design. Awarding this contract is intended to advance the engineering work, ensuring the vessel is on schedule to meet its operational target, according to Ulstein.

The vessel will be built by a yet-to-be-selected U.S. shipyard and will initially serve the East Coast. GLDD believes the vessel will also be available as offshore wind projects develop along the Gulf and West Coasts.

Pending federal permitting and regulatory approvals, as well as a final investment decision, the rock installation vessel will be operational by Q2 2024, to coincide with major offshore wind project construction timelines.

"Given the priority the White House has placed on the offshore wind market, special-built vessels such as this will serve as the critical foundation for the advancement of this key industry", said Mike Greenwood, Sr. Project Sponsor at GLDD.

In March, the U.S. announced a national target of 30 GW of installed offshore wind capacity by 2030. The target is a centerpiece of a newly introduced plan by the Biden Administration to jumpstart offshore wind energy and create tens of thousands of jobs in the sector over the next decade.

To achieve the goal, the Department of Interior's (DOE) Bureau of Ocean Energy Management (BOEM) plans to advance new lease sales and complete review of at least 16 offshore wind Construction and Operations Plans (COPs) by 2025.

7. Operations & maintenance

Operations & Maintenance involves providing support during the lifetime of the wind farm to minimize downtime and ensure maximum energy production. Wind farms typically have an operating lifetime of 25 to 40 years. The Dutch have significant expertise across the operations, maintenance and services value chain, with a large variety of main component and equipment suppliers as well as service providers.

7.1 Operations

The day-to-day operation of a wind farm is managed from an onshore base. Activities include day-to-day workflow management and data gathering and analysis. This allows the owners to respond efficiently to failures when they occur and, where possible, to identify potential failures before they occur. The management of logistics (vessels, helicopters, personnel, specialist tooling and spare parts) is also an important part of the operations role.

For operations and maintenance, wind farm operators will typically look to use the nearest port that meets their specifications in order to minimize travel time and make the best use of weather windows. Vessels and equipment are therefore an essential component of this sub-element and an area where Dutch suppliers have significant expertise.

Crew transfer vessels (CTVs) typically provide transport for technicians and spares from the onshore base to offshore wind farms less than about 90 minutes transfer time from port. Some wind farms supplement CTVs with full-time helicopter support, for transporting technicians when the task in hand does not require heavy tools or spares, or when sea conditions are severe. Spare parts are stocked in onshore warehouses.

Service operations vessels (SOVs) are larger than CTVs with a greater capacity and are typically used for wind farms more than about 90 minutes transfer time from port. They are effectively a floating OMS base, accommodate between 60 and 90 passengers and contain workshops and storage for equipment, consumables, and spares.

Examples of current Dutch CTV and SOV suppliers are:
- Acta Marine (fleet owner O&M services, crew transfer, tugs, survey, walk to work, etc.);
- Glomar Offshore (offshore support vessels);
- SeaMar (offshore support vessels);
- SeaZip Offshore Service (fleet owner crew and support vessels);
- Windcat Workboats (fleet owner crew transfer vessels).

7.2 Maintenance

Maintenance and inspection services include both planned (and unplanned) visits to wind turbines and their foundations for the purposes of inspection maintenance and repair, performed by the wind farm's usual staff and equipment. Turbine maintenance typically involves a planned visit to each turbine once or twice a year.
During these visits, technicians carry out inspection and maintenance activities, including checks on oil and grease levels and a change of filters, checks on instruments, electrical terminations the tightness of bolts, and statutory safety inspections. Foundations for wind turbines and offshore substations require structural inspection and maintenance on a regular basis, as bad sealings and corrosion can cause severe damage that is both expensive and difficult to repair.

The oil and gas industry has developed a wide range of solutions for safe access to offshore structures. Inspection and repair activity is high within the North Sea sector with a high number of skilled and experienced technicians.

The Dutch have developed sophisticated logistics systems which can be applied to the specific challenge of offshore wind farms. Examples of Dutch suppliers are:

Walk to Work systems:
- Ampelmann (motion compensated walkways);
- BargeMaster (motion compensated feeders, gangways, cranes);
- Eagle -Access (electric crew and cargo access systems);
- KenzFigee (gangways, walk to work systems);
- Lift2Work (motion compensation platforms, gangways, cranes);
- Offshore Boarding (crew and cargo access systems)
- Safeway (motion compensated gangways);
- SMST (design and construction gangways);
- Zbridge (walk to work systems);.

Rope access:
- Rope Access Noord (rope access inspection/ maintenance);
- Sky-Access BV (rope access inspection/ maintenance).

Wave/tide monitoring & meteo:
- Mo4/ Mocean (wave, current forecasting);
- Radac (wave monitoring radar systems);
- Whiffle (meteo/forecasting).

Wind farm security, safety:
- Brady (identification, safety lables, signs);
- Boltlife (monitoring free bolted conncections);
- Intrepid Safety products (safety gates).

Ampelmann Scores Five Offshore Taiwan

Source: OffshoreWIND.biz

The Netherlands-based Ampelmann has secured contracts to provide its offshore access systems for five undisclosed offshore wind projects in Taiwan.

The contracts were signed in the first quarter of the year and include various Ampelmann systems to be used.

According to the Dutch company, one of the milestones is the first use of the Ampelmann E1000 system in the APAC region. The E1000 will provide offshore access for personnel and cargo in the construction phase of a Taiwanese wind farm.

The other four projects will all see the use of an A-type, operating in Taiwanese waters.

“Securing these projects in the renewables market marks a turning point for the APAC region, as operations in the region used to be solely in Oil & Gas,” said Ramesh Namasivayam, Business Developer at Ampelmann. “This move requires the effort of our whole team and inspires us to get involved in many more projects in the region.”

In September 2020, Ampelmann revealed it had signed a contract with Seaway 7 for an offshore wind project in Taiwan, representing the company’s first foray into the Taiwanese market.

Ampelmann’s Gangway for Chinese SOV Serving Guangdong Yangjiang OWF

Source: OffshoreWIND.biz

Ampelmann has signed its first contract for a motion-compensated gangway in China, where Guangdong Safety New Energy is set to fit the gangway onto its new Service Operations Vessel (SOV) which will be deployed on the Guangdong Yangjiang offshore wind farm, located some 74 kilometres off the coast of Guangdong province.

The company, which will deliver its A-type gangway to Guangdong Safety New Energy by the end of October, says that the 60-metre SOV, named MV Guang An Yun Wei 88, will be first the such vessel equipped with a motion compensated gangway in China.

Guangdong Safety New Energy is a wholly-owned subsidiary of Guangdong Yuean Shipping, with the project marking Yuean’s first step in the offshore wind operations and maintenance sector, according to Ampelmann, with whom the vessel operator will cooperate for a minimum of six months and could possibly extend the contract for another six months.

In addition, following its first project in China, the Dutch gangway provider is looking into the possibility of training local operators to support upcoming projects in the country.

7.3 Inspections, repairs

Unplanned service involves technician visits to a turbine in response to an alarm reported on the wind farm supervisory control. Large vessels are needed to undertake the removal and replacement of major components, such as turbine blades or gearboxes, during operation. This may occur following a failure or as part of a replacement program for components nearing the end of their lives.

The experience of the Netherlands is especially relevant when it comes to asset failures. Examples of Dutch suppliers in repair services are:
- Bluestream (topside and subsea inspection, maintenance)
- C-Ventus (topside and subsea inspections, repair and replacement);
- DroneQ (windturbine drone inspections);
- ECE Offshore (cable inspection, repair) engineering)
- MOVE Renewable (cable, inspection, repairs);
- N-Sea Offshore (subsea inspection, maintenance, repair);

Equipment such as ROVs and support vessels is often rented and, in many cases, operated by a third party.

7.4 Port development, logistics

The availability of waterside (port) infrastructure is a prerequisite for much of the necessary new coastal manufacturing, assembly, and installation infrastructure to deliver the anticipated offshore wind farms. Facilities may either be developed for manufacturing and installation activities, or as standalone installation facilities. Most Dutch ports are in public ownership and their investment decisions can consider the wider local economic benefits of a project, as well as the direct port revenue.[16]

Manufacturing and/or Installation

All larger NL ports have timely developed master plans that incorporate offshore wind installation facilities to contribute to the installation of commercial scale wind farms in the Dutch economic zone of the North Sea. Since the supply of finished wind farm components is relatively low, most ports in NL can be characterized as installation ports where the main wind farm components are stored and pre-assembly is completed before being loaded onto an installation vessel. Renowned installation ports in the Netherlands for offshore wind companies include Eemshaven, IJmuiden and Vlissingen. A notable exception is the port of Rotterdam where Sif has developed facilities for the manufacturing of monopile foundations.

GE Charters Acta Auriga for Wind Turbine Commissioning at Saint-Nazaire OWF

Source: OffshoreWIND.biz

GE Renewable Energy and Acta Marine have signed a charter contract for the Acta Auriga Service Operations Vessel (SOV), which will support the commissioning of 80 Haliade 6 MW turbines at the Saint-Nazaire offshore wind farm in France.

Operating out of the Port of Saint-Nazaire, the vessel will assist in the mechanical completion and commissioning of the 80 offshore wind turbines, and provide accommodation and transportation for the project's personnel, as well as for goods that are needed offshore.

Acta Auriga, which completed its three-year maintenance campaign at the Bard Offshore 1 wind farm in the German North Sea earlier this year, will start working on the Saint-Nazaire offshore wind farm in the second quarter of 2022, when the offshore wind turbine installation is set to begin.

Offshore construction at the project site is well underway with more than 20 foundations and the offshore substation already installed.

The installation of the offshore wind turbines will begin in Spring 2022, while the full wind farm completion and commissioning is scheduled for the end of 2022.

The 480 MW Saint-Nazaire project – developed by EDF Renouvelables and EIH, an indirect subsidiary of Enbridge., and CPP Investments – will be the first commercial wind farm in France.

The wind farm is being built at a site located between 12 and 20 kilometres off the coast of the Guérande peninsula.

For more information on the specifics of the Dutch offshore wind hubs, please check:

Port of Amsterdam:	www.portofamsterdam.nl
Port of Den Helder:	www.portofdenhelder.eu
Groningen Seaports:	www.groningen-seaports.com
Port of Harlingen:	www.portofharlingen.nl/en
Port of Rotterdam:	www.portofrotterdam.com/offshore
North Sea Port:	www.northseaport.com
Port of IJmuiden (Zeehaven IJmuiden):	www.zeehaven.nl/en
Port of Amsterdam:	www.portofamsterdam.com

[16] This is in contrast to most UK ports, which are operated privately and make investment decisions based purely on commercial factors.

[17] The reason for setting up an installation port (as opposed to transporting components directly from their manufacturing location to the offshore site) is to lower the logistics risks of a project by storing components closer to the wind farm site.

For more information on port logistics, please refer to: www.windandwaterworks.nl/cases/port-development-and-logistics


BLUE

8. Dutch offshore wind innovators

The main driver for growth in the offshore wind industry is the ongoing decrease in the so-called LCOE or Levelised Cost of Energy, partly driven by initial innovations in offshore-specific turbine designs and bespoke offshore wind installation vessels. These cost reductions have encouraged Government policy and financial support to the sector, in order to address the decarbonization of electricity production. Such efforts have, in turn, accelerated innovation, which has reduced costs, as well as boosted performance.

Dutch public and private parties have teamed up to design, develop, build, and maintain high-quality offshore wind farms in the North Sea. Together, they are proving that offshore wind is a powerful solution to achieve the Dutch climate goals in a cost-effective manner. Through such cooperation, the Dutch offshore wind sector is also exploring ways of making offshore wind energy more competitive, for example, by developing more efficient production methods and increasing the yield and lifespan of offshore wind technology. Throughout the entire offshore wind supply chain, Dutch companies, academics and independent knowledge institutes conduct research into better and smarter solutions that can be applied in any offshore wind project worldwide.

Empowering engineering and innovation excellence through energy education is also important in the highly multidisciplinary field of offshore wind. Dutch offshore energy education institute DOB-Academy trains national as well as international officials and industry professionals through lectures, classroom workshops, online modules and seminars. This enables people from different backgrounds to speak a common language, which is essential in a multidisciplinary field such as the offshore industry. Visit: www.dob-academy.nl/service

This chapter lists the main offshore wind innovation actors in the Netherlands and highlights the latest cost-cutting and (near) market-ready offshore wind innovations with Dutch origin across the supply chain.

8.1 Main innovation actors

TKI Wind at Sea (Wind op Zee)

The Dutch Government encourages product innovations through tax benefits, innovation credit and (EU) grants. The Government also works together with the private sector, universities, and research centers, in so-called Top Sector Alliances for Knowledge and Innovation (TKI) to support business sectors, such as the energy sector to get innovative products or services on the (inter)national market.

The Top Consortium Knowledge and Innovation (TKI) Wind at Sea plays an important role in Dutch innovations in offshore wind. TKI Wind at Sea (Wind op Zee) boosts and facilitates offshore wind innovation in collaboration with RVO through research, development, and demonstration. The aim is to allow offshore wind energy to make a major contribution to the energy transition. In addition, the Multi-annual Mission-driven Innovation Program (MMIP) focuses on three themes: cost reduction and optimization, integration into the energy system and integration within the environment. Visit: www.topsectorenergie.nl/en/tki-wind-op-zee

Technical University of Delft (TUD)

TU Delft is involved in research into new materials and structures for offshore wind turbines, applying newly developed insights in the fields of wind loads, fluid mechanics and control engineering. TUD focusses on new concepts designed to reduce the loads on the support structures, more reliable wind turbines and wind farm operations, and the optimization of the entire energy supply chain from wind to the grid, including the incorporation of the electricity from wind power plants within the European power grid.

Dutch innovation actors translate this knowledge into innovations for (amongst other things) wind turbine components and rotor blades and the so-called ‘balance of plant’ components such as foundations, substations, and cables.

Research Project on Sustainable Installation of XXL Monopiles (SIMOX) Launched

Source: OffshoreWIND.biz

A research project on sustainable installation and decommissioning of XXL monopiles for large next-generation offshore wind turbines has been launched in the Netherlands. The three-year project aims to have innovative technologies for the installation of large wind turbines commercially available within five years by testing multiple techniques to enable the installation and decommissioning of XXL monopiles in a sustainable, cost-effective, societally, and environmentally acceptable manner.

As the size of wind turbines is increasing, so is the size of the monopiles, enormous steel posts, mostly driven into the ground by hammering. This is a challenging process, not only in terms of time and costs, but also in terms of the impact on the monopile itself (fatigue damage) and the ecological impact on marine life.

Simox aims to test simultaneously a series of new, innovative driving concepts, to make the monopile installation faster, cheaper, more efficient than current methods and - last but not least - less disturbing for marine life. The Dutch innovations are: vibro hammering (Cape Holland), gentle driving of piles (TU-Delft), Blue Piling (IHC-IQIP) and jetting (GBM/ Deltares).

GDP

Gentle driving of piles (GDP) is based on simultaneous application of low-frequency and high-frequency vibrators exciting two different modes of motion on the monopiles, the so-called GDP shaker. By doing this, the monopile gets a little bit thinner (like the twisting of a cork). This makes it easier to drive the pile into the soil. Traditional impact methods lead to the opposite: monopiles expand a little when knocking or hammering on them, which of course make it harder to drive the piles. So, with the novel installation method, the pile installation process can be made as efficient as possible. The GDP method is called “gentle” for its envisaged ability to reduce the driving loads and the emitted installation noise, which is harmful for the environment, e.g. to mammals and fish.

Jetting

Jetting is complementary to other installation methods, such as vibration pile driving and greatly increases target depth and driving speed. When using a Water Jet-gun in combination with a vibratory hammer, the lateral bearing capacity of the foundation will be similar to normal vibratory driving. The water injected by the Jet-gun machine will only fluidize the soil on the inside of the pile, leaving the load carrying soil on the outside untouched. The Jet-gun is attached to the bottom of the monopile with clamps for installation in the cylinder. The Jet-gun function guarantees the fluidized state of the soil on the inside of the pile so that the Vibro-drill can be retrieved after installation.

Simox is a GROW project (Growth through Research, development & demonstration in Offshore Wind), a joint research program on offshore wind aimed at accelerating research and innovation. The project partners include Boskalis, Delft Offshore Turbine, Deltares, Royal IHC, RWE, Seaway 7, Shell, Sif Netherlands, TNO, TU Delft and Van Oord (all part of the GROW consortium), and CAPE Holland, GBM Works and Siemens Gamesa Renewable Energy. Deltares and TNO will take active part in the research and test campaign. The offshore contractors Van Oord, Boskalis and Seaway 7 will lead the onshore and nearshore tests, supported by DOT (Delft Offshore Turbine), whereas equipment manufacturers Sif, IHC IQIP, CAPE Holland and GBM Works will provide the monopiles and installation technologies. Operational aspects will be monitored and assessed by Shell, RWE and Siemens Gamesa Renewable Energy. Finally, the project will involve environmental and regional economic stakeholders at an early stage.

The project is also supported by the Topsector Energy Top consortium for Knowledge and Innovation Offshore Wind and has secured a grant from the Netherlands Enterprise Agency (MOOI).

TNO

TNO unit Energy Transition, Wind Energy Department - formerly known as ECN Wind Energy - has been active in wind energy for more than 40 years. It is the flagship of the Dutch Research & Development on Renewable Energy and is one of the global leading knowledge institutes in the field of wind energy. The Wind Energy Department focuses on research/B2B collaboration in:

- wind turbine and foundation design both bottom fixed and floating;
- wind farm design/wind turbine and wind farm control;
- energy system integration of large scale (wind) generated energy; power to X;
- installation and operations/maintenance strategy/ approach.

Dutch TNO builds huge wind turbine test facility together with General Electric

Source: Innovation original

Together with GE Renewable Energy and LM Wind Power, the Netherlands Organization for Applied Scientific Research (TNO) is building a gigantic test facility for rotor blades in Wieringerwerf, in the north of the province of North Holland. The facility will consist of a full-scale wind turbine where the largest rotor blades in the world are to be tested. The aim is to build even larger and more efficient rotor blades with a diameter of well over 200 meters which are also affordable for offshore wind energy. According to TNO, it will be the largest test facility ever built. The new test rig, which should be ready in November, is co-financed by the Dutch Ministry of Economic Affairs and Climate Policy

The following goal is to further scale up the rotor blade to a diameter of about 230-240 meters. This is still 220 meters in the case of GE's the Haliade-X. GE, which is American in origin and is one of the largest global manufacturers of wind turbines after Vestas, the Danish market leader. The others in the top 5 are the Spanish-German consortium SiemensGamesa and the Chinese companies Goldwind and Envision. In the field of offshore turbines, SiemensGamesa has the largest market share.

8.2 Foundation and installation innovators

Because of a strong history in maritime oil and gas operations, Dutch companies have built significant expertise in the global transportation and installation of offshore wind farms. This also translates into several innovations for 'balance of plant' components such as foundations, substations, and cables.

Foundation installations, in particular, are receiving a lot of R&D attention. The traditional installation method uses hydraulic impact hammers, which create underwater noise, potentially damaging nearby marine life and ecosystems. Dutch innovations are aimed at minimizing noise while retaining (and preferably improving upon) the speed and efficiency of the traditional method.

Low noise monopile installation 1: CAPE Holland's Vibro Lifting Tool (VLT)

The best way to reduce noise emissions is not to generate any noise in the first place, this is in brief the core concept of vibro driving as an alternative installation method. The Vibro Lifting Tool is a certified offshore lifting tool with the ability to upend and drive the piles quickly with reduced noise emissions. The tool is able to pick up a pile, upend it to vertical position, place it overboard and lift it to installation position. While driving down, it will automatically measure and adjust to the exact vertical position. All in one single operation, without the need to switch to another tool.

CAPE Holland's Vibro Lifting Tool (VLT) is used to install the monopile foundations at the Kaskasi offshore wind farm in Germany, making it the first wind farm in the world using the vibro driving technique to install all monopile foundations to target penetration. One of the advantages of the VLT is that there is no need for additional noise mitigation techniques.

Further development, to enlarge the workability and reduce costs are the installation with VLT-U from a floating vessel using Dynamic Positioning and combining vibration and drilling technology to tackle any seabed quietly.

Low noise monopile installation 2: AdBm Noise Mitigation System (Big Bubble Curtain)

Installing wind turbine foundations in the North Sea - and many other places worldwide - almost always requires pile driving. Without precautionary measures this methodology impacts underwater marine mammals near the construction site. To protect marine life, underwater noise emission limits will almost certainly become an important requirement for future wind farm constructions worldwide.

Supported by TKI Wind at Sea, the Dutch companies AdBm Technologies and Van Oord and Technical University Delft developed and extensively tested the so-called Noise Mitigation System (NMS). NMS reduces underwater noise resulting from offshore pile driving of wind turbine foundations, meaning less disturbance for marine

mammals. The NMS uses special acoustic resonators designed and produced by AdBm Technologies, which reduce the noise from pile driving. As a result of this technology, specific frequencies can be targeted which produce the most noise. In combination with a Big Bubble Curtain (air pockets that absorb the sound frequencies that produce the most noise during offshore pile driving) it works almost like window blinds, which can easily be raised and lowered. Another highlight of the Noise Mitigation System is the fact that waves and currents have virtually no influence on the system. This is due to the open yet robust design. The blinds simply go up and down.

The NMS meets the Dutch and Belgian standards (160 dB) - underwater noise limit for noise emissions at sea and turned out to be cheaper in the construction of offshore wind farms relative to existing systems.

Today, the NMS is in commercial use by Van Oord at the Borssele 3 – 4 wind farm site construction to serve approximately 850,000 households.

Low noise monopile installation 3: Hydropower instead of steel ram

IHC IQIP's Blue Piling Technology reduces underwater noise levels by creating a gentler blow, when compared to conventional impact hammers, to install offshore monopiles. This is done through the use of a large volume of water, which delivers a longer blow duration on the monopile. Combustion throws up this water column (large water tank) and under the force of gravity, it falls back on the pile, hereby delivering two blows. This cycle is repeated until the pile reaches its desired depth.

With the ever-increasing demands for larger wind turbines located at greater depths, alternative driving technologies such as Blue Piling will eventually become essential. Firstly, because it can provide a noise-mitigation solution where deep water and strong currents make Big Bubble Curtains unfeasible to protect marine life (mammals). Expensive noise reducing equipment is no longer needed. Secondly, because the gentle blow of a BLUE Hammer can significantly reduce pile driving fatigue (compared to the traditional steel impact hammering) and, thirdly, because it can, notably, install monopiles even larger than the current XXL monopiles.

Therefore, even very large concrete piles can be driven with the technology, due to the absence of tensile forces which are damaging for concrete piles. Considerable scalability will allow the largest piles in the world to be driven using this new technology.

The Blue Piling System is expected to be fully operational and ready for commercial offer in 2021. It will be compatible with existing installation vessels and interchangeable with conventional and hydraulic hammer technologies.

Cost efficient monopile installation: slip joint foundations

Another challenge is to optimize the process of connecting turbine towers to the foundations. Current methods use bolts or grout, both of which require regular inspections and maintenance. Several Dutch companies are working on more elegant and lower cost alternatives. One such innovation 'wedges' the tower into place, resulting in substantial savings in installation and maintenance costs.

One of the most outstanding examples of Dutch innovations in the field of offshore wind is the slip joint. This technology uses the tower's weight to 'slide' over cone-shaped monopiles, without having to use grout or bolts in a process which can save up to 20 million Euros in installation costs per wind farm. The Slip Joint therefore provides a rapid, simple, and safe installation solution. in combination with reduced maintenance for the duration of the project.

How it works
The Slip Joint connects a monopile and a transition piece by means of two conical sections placed on top of each other which can be produced using standard manufacturing methods. It is based on friction, with the weight ensuring firmness and stability. Installation takes place by sliding the wind turbine's foundation elements over the monopile, without having to use grout or bolts. The Slip Joint makes a submerged connection possible, allowing for a more balanced weight distribution between monopile and transition piece. As a result, the installation of larger foundations for the next generation of wind turbines is possible, using existing vessels.

The first ever offshore full-scale slip joint was installed at the Borssele V wind farm near the Dutch shore. It was the first time a submerged Slip Joint was used on a full-sized offshore wind turbine on a commercial basis.

8.3 Floating wind innovators

Today's offshore wind farms mostly depend on configurations in which shallow waters and sandy bottoms allow a well-mastered onshore technology: wind turbines on fixed foundations such as monopiles or jackets. However, space for bottom fixed offshore wind farms is limited and the offshore wind industry needs to move to new territories, further offshore and in harsher environments or seabed conditions. Floating offshore wind provides opportunities to move into deeper waters with high wind resource where fixed-bottom foundations cannot be deployed. The floating support structure consists of a floating platform and a platform anchoring system. The platform has a transition piece on top of which the tower is installed.
Currently, floating wind farms still have a higher (levelized) cost of energy than fixed, but there is growing confidence that they could be competitive by 2030. Advantages are the lower installation cost and the ability to standardize designs within and between wind farms. Floating offshore wind is set to become the next big development in the offshore wind industry and expected to reach commercialization by 2030.[18]

Floating wind turbine innovators
As there is (as yet) currently no clear path for a leading floating wind turbine or foundation technology to reach utility-scale commercial deployment and only a few international OEMs have publicly announced programs of in-house floating wind development, there is room for innovative SMEs. Several Dutch companies have already taken the challenge to further reduce the Levelized Costs of Energy while, at the same time, looking at farther offshore opportunities for floating wind. Some of them focus on developing integrated floating wind turbines, others focus on innovative floating foundation designs.[19]

Examples of innovative Dutch floating wind turbine suppliers are:
- 2BEnergy (integrated 2-bladed downwind turbine and foundation supplier);
- Ampyx Power (airborne wind energy systems);
- Seawind (integrated 2-bladed upwind turbine);
- Touchwind (floating one piece rotor turbines).

Floating wind foundation innovators
Although floating foundations are already a proven technology in the oil and gas sector, platform designs for offshore wind, however, require adaptation to accommodate different dynamic characteristics and a distinct loading pattern, as has already occurred to a great extent for fixed-bottom foundations, including monopiles, jackets and gravity based designs.

Several Dutch companies are already involved in moving floating foundation technologies from the early concept stage through to commercial deployment. Examples of current Dutch innovators are:
- Blue H Engineering (floating foundation design);
- Bluewater (floating wind systems);
- Damen (hulls floating platforms);
- FibreMax (deepwater mooring ropes);
- GustoMSC/NOV (tri-floater foundation);
- Lankhorst (deepwater mooring ropes);
- Iv offshore & Energy (floating substations);
- MonobaseWind (design floating foundations);
- Mooreast (mooring ropes, anchors);
- SBM offshore (floating EPCI contractor));
- Sif Group / KCI the Engineers (tubulars floating platforms); and foundation supplier);
- SPT Offshore (floating wind anchors and moorings);
- Vryhof mooring (anchoring and deep-sea mooring solutions).

[18] Demonstration and pre-commercial floating offshore projects are already operational in Scotland (Hywind), Portugal (Windfloat) and France (Floatgen) and more projects are underway in Ireland, Italy, Norway, Spain, Sweden and the UK. Other global early adopters of floating wind are expected to be the US, Japan, South Korea and Taiwan.

[19] Most SME's however do not have the resources to push new products all the way to market and need help to prove that their designs and business plans are sufficiently mature for the scale of investment needed, to prevent the risk of stranded technologies.

The Return of the Tripod – Foundation Specialists See an Opening

Source: OffshoreWIND.biz

Sif, KCI, and Smulders have teamed up to jointly develop a new product line called 'The revival of the Tripod'.

The Tripod foundation concept was last deployed offshore at Global Tech 1 wind farm in the German North Sea around eight years ago.

The concept on its own was abandoned as a 'live' foundation of choice since then, because it was not competitive against the monopile at the water depths used in that era.

According to Sif, times have changed since then and with bottom fixed foundations being deployed at ever greater water depths in the northern North Sea basin, monopiles are being selected up to 50-60 metres of water depth and jackets as the complementary foundation of choice from those or greater water depths.

The Tripod is said to have some specific advantages compared with the monopile and the jacket at water depths of 50 metres or greater as it is a sturdier construction than the monopile and easier to manufacture than a jacket.

It will have its own specific niche and application in addition to those of the jacket and the monopile respectively. With its robust history in the German market, bankability of the revived Tripod should be less of a challenge compared with floating wind or other completely new foundation concepts, Sif said.

The Tripod will be jointly marketed in JV by Smulders and Sif. Production will take place in Roermond (the central column) and at the Smulders Wallsend site for the final integration.

"We are very happy with the KCI developed Tripod design. It is the second innovation next to our Skybox design that we have developed since Sif's acquisition of KCI, the engineers. With ever larger diameters of monopiles, the balance is now shifting from our Roermond facility to our Rotterdam facility. The central column of the Tripod however, is a perfect match for the specifications of our Roermond facility and therefore perfectly complements our product range," Sif's Michel Kurstjens, said.

Bracings will be sourced from UK suppliers. Serial production is foreseen to start in 2024.

"We see the development and production of the Tripod as a perfect extension of our product portfolio and an excellent opportunity to further develop the Wallsend site in the UK. The development and production together with Sif is a continuity of utilizing our complementary strengths and capabilities in engineering and production of offshore wind foundations," Smulders' Jaap Jansen said.

Breakthrough SBM Floating Offshore Wind technology' to be tested in Mediterranean

Source: OffshoreWIND.biz

A final investment decision is expected shortly for a floating wind pilot project that will test a novel tension platform designed by SBM Offshore.

The construction contracts were awarded to Siemens Gamesa Renewable Energy, which will supply the 8.4-MW turbines for the project, SBM Offshore, which is responsible for the floater and for turbine installation, and Prysmian, for the inter array and export cables. RTE is responsible for the grid connection.

The SWP-8.0-154 turbines will be installed on SBM Offshore's inclined tension leg platform TLP) at a site approximately 40 km west of Marseille, which will act as the marshalling harbor for the project, in a water depth of approximately 100 m with a mean wind speed of circa 10 m/second. The specially designed mooring configuration adopted by SBM Offshore ensures it is well-adapted to loads imparted by the turbine. Tower base movements are reduced by the concept, ensuring the plane of the rotor is always realigned to vertical. Using three bundles of two lines, it uses conventional, proven mooring components – including the chains and wire ropes – thanks to the low level of tension in the design. It also uses field-proven accessories to limit out of plane bend fatigue in the mooring chains.

When the TLP structure is being towed, its waterplane area is limited, so it behaves well in waves. Its compact layout minimizes its environmental footprint and, unlike catenary mooring systems, some floaters are used, there is little risk of chain dragging or of any impact on fisheries in the areas in which it is installed. Development started in 2016 and a final investment decision is expected in Q3 2020. If all goes according to plan, the floating wind farm should be in production by mid to late 2022.

Appendix 1.

Overview of a selection of internationally operating Dutch offshore wind companies (Not exhaustive, regular updates are available via www.windandwaterworks.nl)

1. Wind farm development

Project developer
- Eneco (RE utility)
- Pondera Development (project developer)
- Shell New Energies (project developer)

Project, contract, finance support
- AMSCAP (finance, strategy, asset management)
- BLIX Consultancy (project, contract)
- DNV (certification, consultancy)
- Green Giraffe (contract, finance)
- IX Wind (project, contract, finance
- Liberty Mutual Systems (project, contract, finance)
- Pondera Consult (project, contract, finance)
- Tresios (project management)
- Ventolines (project, contract, finance)
- Voltiq (finance)

Project research support
- Antea-groep, previously Oranjewoud (engineering)
- ARC-SES (design, engineering, construction services)
- Deep BV (subsea survey)
- Deltares (wave, current, seabed research)
- DOB Academy (offshore education)
- Enersea (technical design reviews, due diligence)
- Fugro (seabed analysis)
- Geomil (geotechnical equipment)
- Marin (hydrodynamic and nautical research)
- Pondera Consult (EIA, site research)
- Royal Haskoning/DHV (EIA, consenting)
- Bureau Waardenburg (ecology research)
- Wageningen Marine Research (ecology consultant)
- Witteveen & Bos (EIA, permitting)

2. Wind Turbines

Original Equipment Manufacturers
- Ampyx Power (airborne wind energy systems)
- 2BEnergy (2-bladed downwind turbine supplier)
- Seawind (2-bladed upwind turbines supplier)

Component supply, engineering support
- Atlas Copco (supplier turbine testing power generators)
- Boltlife (blade to hub connections)
- Huikeshoven (heating system engineer)
- ECN/TNO (rotor blade and materials research)
- LM Windpower (rotor blade supplier)
- Mecal (turbine design)
- Orga Aviation (supplier turbine navigation lightings)
- Pontis (rotor blade composite engineering)
- Robin Radar (bird-detection systems)
- Tesucon (turbine evacuation systems)
- VDL Klima (cooling systems wind turbines)
- WE4CE (rotor blade design)

3. Foundations

Foundation supply Bottom fixed
- Monobase (gravity based foundations)
- Sif (monopile foundations)
- SPT Offshore (suction piles foundations)

Foundation supply Floating
- Blue H Engineering (offshore floating foundations)
- Blue water (floating wind tension leg platform)
- GustoMSC/NOV (tri-floater foundation)
- SBM-Offshore (tension leg floating foundations)
- Sif (tubulars floating wind constructions)

Component supply, engineering support
- Ancofer-Waldram (steelplates)
- Blue H Engineering (floating foundation design)
- Damen (hulls for floating platforms)
- GustoMSC/NOV (floating foundation design)
- IV-Offshore & Energy (foundation design fixed and floating)
- KCI, part of Sif (foundation design fixed and floating)
- Marin (testing floating wind structures)
- Mooreast (mooring systems)
- TNO Energy Transition (applied research fixed and floating)
- TU-Delft (applied research fixed and floating)
- Trelleborg (sealing connection foundation-TP)
- Vryhof (floating wind anchoring and mooring)

4. Substations, subsea cables

Substation/ cable supply
- Boskalis Subeas cables (cable supply)
- Heerema Fabrication (supplier jackets)
- HSM Offshore (supplier jackets)
- TKF (cable supply)

Component supply, engineering support
- Hapam (supplier electrical equipment substations)
- Heinen & Hopman (supplier of air-conditioning systems)
- IV-Offshore & Energy (substation design)
- KCI (substation design)
- Orga Aviation (helideck lighting systems)
- Siron (substation fire-protection systems)

5. Transport and Installation

Balance of Plant contractors
- Boskalis (lift, ship, install)
- DEME (B) / Tideway (lift, ship, install)
- Heerema Marine Contractors (lift, ship, install)
- Seafox (lift, ship, install)
- Seaway7 (lift, ship, install)
- Van Oord (lift, ship, install)

Lift, ship, install subcontractors
- Big Lift (heavy lift and transport)
- Blue Offshore (subsea cable barge vessel transport)
- Bonn & Mees (floating sheerleg transport)
- Enduro softslings (heavy lift slings)
- Hydrosun (grouting hose supplier)
- H2M (workspace cabins installation phase)
- Herman Sr (tug and workboat transport)
- Jack-up Barge (jack-up platform transport)
- Mammoet (heavy lift and transport)
- Jumbo Offshore (heavy lift and transport)
- MOVE Renewable (subsea cable installation)
- Seatools (subsea piling, cable installation support)
- Spliethoff (fleetowner multi-purpose vessels)
- WIND Cable Services (shipping subsea cables)

Installation equipment supply
- Bosch Rexroth (jacking systems)
- Breman (Offshore) Machinery (monopile gripper, piling templates)
- Cape Holland (vibro hammers)
- DDC (drilling tools)
- DHLC (lifting tools for TP)
- Dieseko Offshore (hammers)
- Eager.One (heavy lifting design)
- Holmatro (hydraulic TP levelling)
- Huisman (installation tools, cranes)
- IHC-IQIP (hammers, handling tools)
- ICE-Vibro (hammers)
- KenzFigee (cranes)
- SMST (cranes, drilling equipment)
- Solidd Steel (design, supply movable steel structures)
- TMS (design, supply mechanical installations)
- TWD (installation equipment)
- Vuyk (installation equipment)

Installation/ CTV/ SOV vessel design, supply
- C-Job Naval (installation, support vessel design)
- Damen (support vessel design, supply)
- GustoMSC/NOV (installation vessel design)
- Royal IHC (vessel design, supply)
- Ulstein Design & Solutions BV (installation vessel design, supply)
- Vuyk (vessel design)

CTV/ SOV deck equipment supply
- Ampelmann (gangways)
- BargeMaster (platforms, gangways, cranes)
- Eagle-Access (crew, goods lifting crane)
- Lift-2-Work (crew lifting systems)
- Praxis Automation Technology (ship automation, navigation)
- Safeway (gangways)
- SMST (gangways)
- Z-Bridge (walk-to-work systems)

6. Operations & Maintenance

Services Operations
- Acta Marine (fleet owner barges, CTVs, SOVs)
- Dutch Marine Contractors (fleet owner tugboats, crew and supply vessels)
- SeaZip Offshore Service (fleet owner SOVs)
- Vroon (fleetowner deep sea offshore vessels)
- VTN Veiligheidstechniek Nederland (safety equipment supplier)
- Windcat Workboats (fleetowner crew transfer vessels)

Maintenance
- Bluestream Offshore (inspection, repair and maintenance)
- CORROSION & Water Control BV (cathodic corrosion protection)
- C-Ventus (BoP inspection, repair and replacement)
- Demcon (drone navigation for turbine inspection and maintenance)
- DSPA (aerosol fire suppression systems)
- DUC marine Group (subsea inspection, work)
- Industrieel Klimmen (rope access)
- MEP (communication systems maintenance crew)
- MME Group (cathodic corrosion protection)
- N-Sea Offshore (subsea inspection, maintenance, repair)
- Primo Marine (subsea cable monitoring, repair)
- Riwal (crew lifting systems)
- Rope Access Noord (rope access inspection, maintenance)
- SDC verifier (fatigue inspection offshore steel structures)
- Sky-Access BV (rope access inspection/ maintenance)
- Trustlube (lubrication systems)
- Whiffle (weather forecasting)
- SeaZip (fleetowner service/ operation vessels)

Crew/ staffing services
- Atlas Professionals (crew)
- Bluestar (workforce services)
- iPS Powerful people (staffing, personnel, recruiting)
- Oak Offshore (crew staffing)
- Oceanwide (crew reqruitment, staffing services)
- Propakt (staffing)
- Searenergy (staffing services)
- TOS (maritime crew)

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Netherlands Enterprise Agency
Prinses Beatrixlaan 2
P.O. Box 93144
2509 AC The Hague
The Netherlands
T +31 (0) 88 042 42 42
E klantcontact@rvo.nl
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[20] Opportunities in offshore wind for the Norwegian supply chain (2019) commissioned by Norwegian Energy Partners

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