Report 2023

Netherlands

Opening ceremony of offshore wind farm Hollandse Kust Zuid by King Willem-Alexander 29-9-2023. *Source: Vattenfall.*

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The installed capacity offshore is 4.0 GW and will grow steadily according to the tender policy towards 21 GW by 2032. In 2050, about 70 GW of wind power should be offshore and the industry should be largely electrified.

Onshore, 6.8 GW is installed, which is projected to grow to 7.2 GW in the coming years. The policy concerning onshore wind development has shifted from a national to a regional level. In the coming years, the regions must decide whether renewable energy generation onshore should be done by wind or other sources.

Research, development and design are important to speed up the development and rollout of wind energy and other renewable energy sources. For that reason, several subsidy schemes are in place to support RD&D. The Netherlands also participates in 18 Tasks of the TCP wind.

Highlight(s)

- The share of national electricity demand met by renewables rose from 43% in 2022 to 52% in 2023. Wind leaped from a 20% to 27%

Table 1. Key National Statistics 2023: The Netherlands

Total (net) installed wind power capacity	10.8 GW
Total offshore capacity	4 GW
New wind power capacity installed	2 GW
Decommissioned capacity (in 2023)	
Total electrical energy output from wind	29.164 TWh
Wind-generated electricity as percent of national electricity demand	27%
Average national capacity factor	31%
Target	In 2030 Offshore 21 GW and 49 TWh Onshore 35 TWh
National wind energy RD&D budget	

share - and solar 19%.

- In 2023, the offshore wind farms HKZ and HKW were commissioned with 2.3 GW.
- About 6.8 GW of onshore wind power was operational at the end of 2023. This was realised due to a growth of 770 MW.

Market Development

Targets and Policy

- The national policy to support offshore wind development is still in place. Site investigations providing the necessary data for development are progressing steadily and tenders for permits are scheduled regularly. However, another 17 GW has to be built offshore to achieve the 21 GW objective by 2032. The challenges for offshore wind farm developers to accomplish this objective include the shortage of qualified people, materials, equipment and rising costs, in combination with speeding up the installation process for offshore wind.
- Currently, the offshore wind farm Hollandse Kust West 1.4 GW is under development and will be operational in 2026. Two sites of 2 GW each in the IJmuiden Ver area were tendered in Q1 2024 and will probably be operational in 2028.
- A comparative test is used for the latest and upcoming offshore wind tenders. Criteria like ecology, grid criteria, combinations of storage and solar are used to compare applicants for the tender. Also, the combination of hydrogen production and offshore wind will be actively investigated in offshore demonstrations.
- The development of offshore energy systems beyond 2030 until 2050 is a continuous process. Each year, the ten-year programme is updated and elaborated in more detail. The goal is to have a sustainable society, and for that, 50 GW of offshore wind power in the Dutch part of the North Sea has to be realised by 2040 and total 70 GW by 2050. The expectation is that much of the generated energy is converted into hydrogen at energy hubs. The North Sea energy system development programme will ensure that new techniques and a policy framework are available in time.
- The policy concerning onshore wind development has shifted from a national to a regional level. The Netherlands is now divided into 30 regions. In these regions, water boards, municipalities and organisations jointly draw up a Regional Energy Strategy in which they make choices for the sustainable generation of electricity (solar and wind) and heat. It therefore depends on the region whether the electricity will be generated by wind or other sources like solar.
- The contours of the future energy system are outlined, among other things, in the National Energy System Plan (NPE). This shows that growth in onshore wind is expected even after 2030.
- The national subsidy instrument to support the generation of renewable energy (SDE++) will change in the future. Instead of only subsidising the unprofitable top, the possible extra profits must be paid to the government. This is the so-called Contract for Difference (CfD). The reason for this is that as the costs of renewable energy technologies fall, the justification

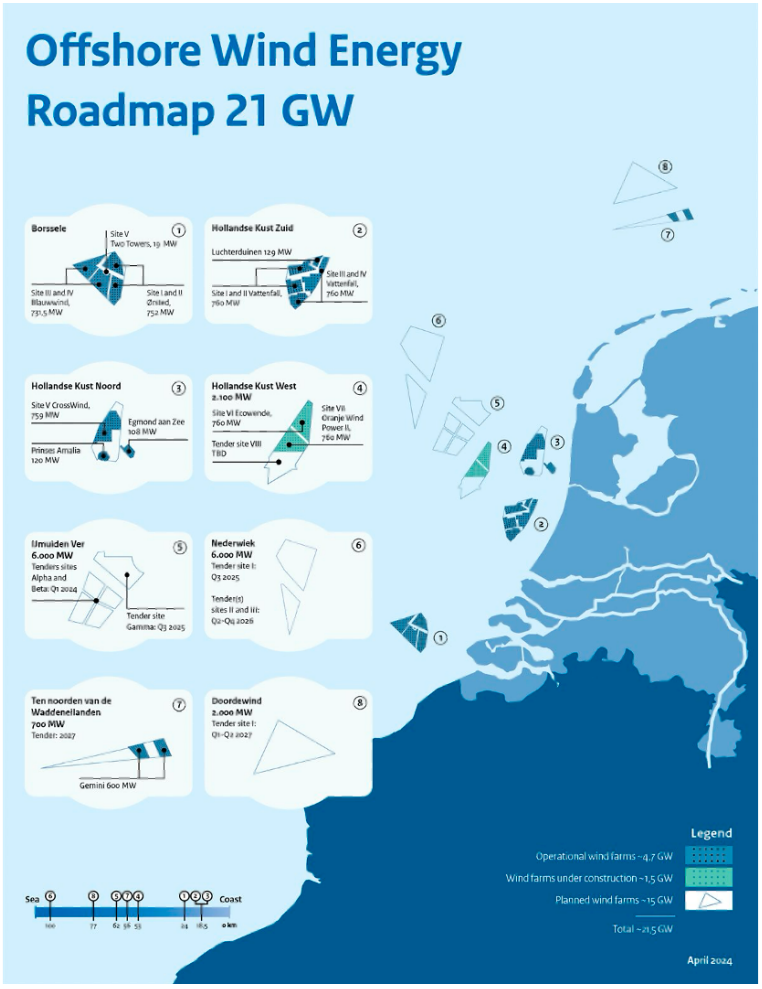

Image 1: Offshore Wind Energy Roadmap 21 GW. *Source: RVO, Netherlands Enterprise Agency.*

for subsidising renewable electricity becomes increasingly questionable.

Progress and Operational Details

- In 2023, 52% of the yearly electricity demand was generated by renewables. Wind is responsible for 27%.
- Last year, the installed wind power increased by 2 GW to 10.7 GW, of which 0.6 GW was installed onshore and 1.4 GW was installed offshore.
- The average capacity factor for wind in 2023 is 31%, whereof 30% is and 33% is offshore. The low capacity factor in offshore is because many wind turbines were installed during 2023 and started producing electricity in the second half of the year.
- The newest wind farms, HKZ and HKN, comprise 11 MW Siemens turbines with a 200 m rotor and 126 m hub height. For HKN, the consortium CrossWind will implement several innovations: intelligent turbines for quick response to changing circumstances, wake-steering to reduce wake losses, a combination of floating solar and wind, battery and H2 storage, and integration of these innovations.
- In Q4 2022, the consortium Ecowende received a permit for HKW 1.4 GW. In this tender, ecology was a distinguishing criterion. Therefore, ecological innovations and measures will be implemented like location-specific curtailment for migratory birds and bats by using radars, deterrence of bats, habitat recovery at the sea bottom, monitoring a research of harbour porpoises, creating corridors for birds and bats.
- In the 4 GW tender for IJmuiden Ver the minimum turbine size is 15 MW and the deployment of even larger turbines will be awarded with extra points on the ecology criterion. It is expected that there will be fewer bird strikes.
- In 2023, about 6.8 GW of wind power will be operational onshore, which means that the target of the 2020 road map has been achieved. There is still 1.3 GW of onshore wind power in the

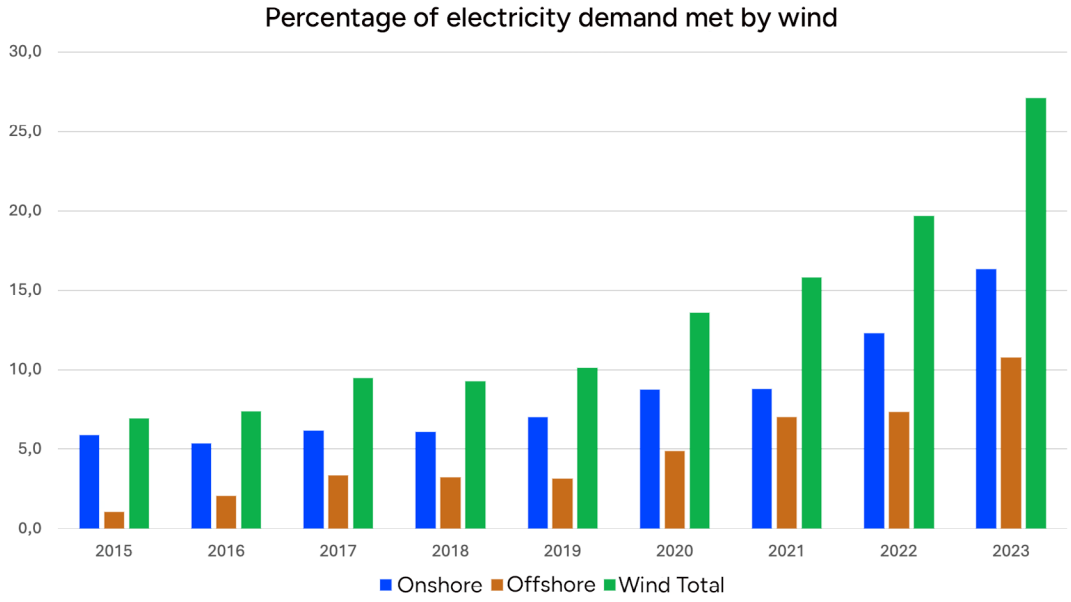

Figure 1: Percentage of electricity demand met by wind.

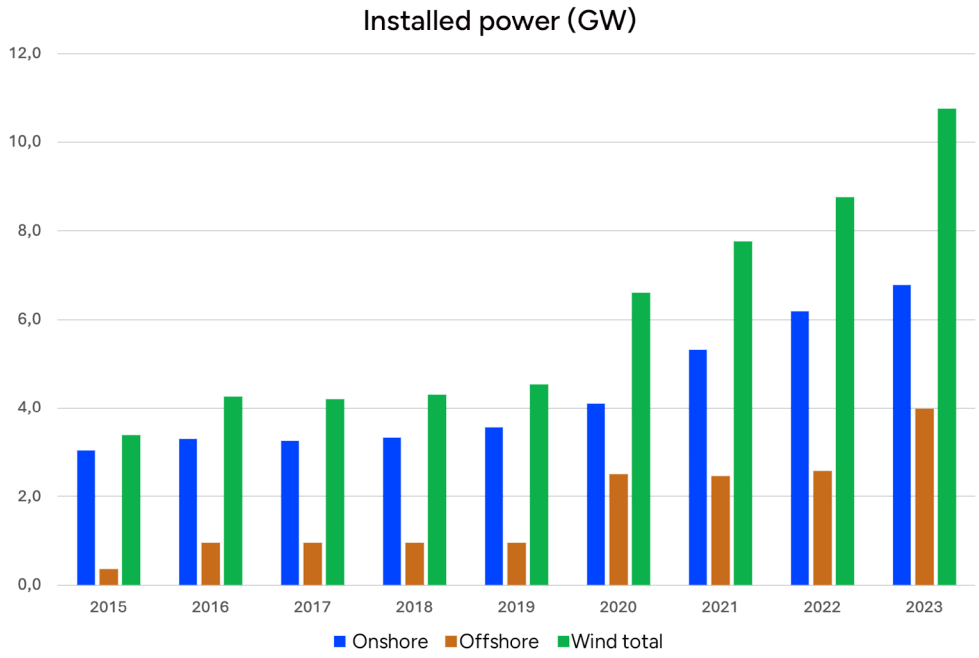

Figure 2: Installed power (GW). *Source: Statistical data CBS.*

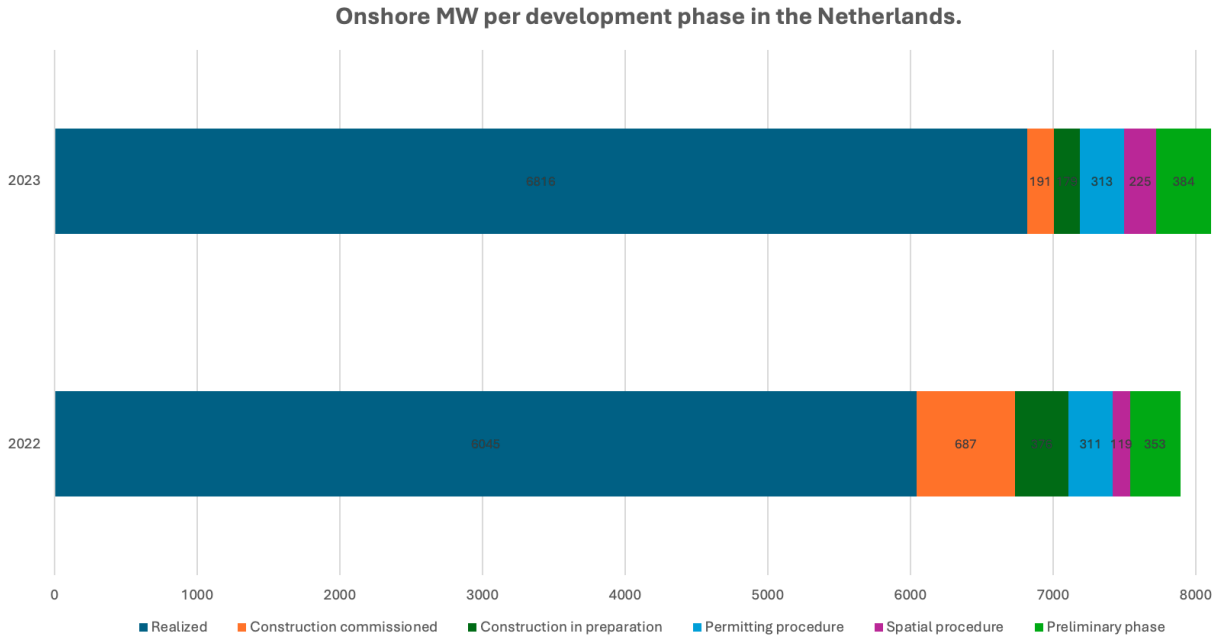

Figure 3: Onshore MW per development phase in the Netherlands. *Source: Onshore wind monitor, Netherlands Enterprise Agency (RVO).*

pipeline, of which 311 MW has an irrevocable permit. Not all projects in the pipeline will be realised, but 7.2 GW onshore seems to be an achievable goal.

Matters Affecting Growth and Work to Remove Barriers

- The progress of onshore wind development is severely hampered as the Council of State has made national environmental standards for new wind farms inoperative. New projects are now waiting for new standards. Additionally, the very long lead times concerning objection and appeal cases with the Council of State cause severe delays.
- Costs to realise wind farms are increasing because of long lead times, financing, prices for raw materials and transport costs. Some projects have been cancelled for that reason.
- Red obstacle lighting on wind turbines at nighttime is experienced as a nuisance for people living in those areas. One of the solutions is approach detection, which switches the light on when an aircraft is near a wind turbine. The transponder-based system is cheaper than the radar-based and will probably become the preferred solution.
- Wind farms can disturb the military defence radar coverage. Therefore, newly planned wind farms must request a certificate of no objection. Also, the Ministry of Defence is considering the option of a wind turbine-free circle with a radius of 15 km around military airfields and low flying zones.
- For wind farms, the grid connection is mostly not a problem because a grid connection must be requested well in advance, and it is mandatory to obtain a subsidy.
- To increase participation and support, the aim is that local communities engage for 50% of the ownership of new wind projects. Because of the long lead times of wind projects, participation is still limited. More participation is expected for the new projects.

RD&D Activities

National RD&D Priorities and Budget

- The Integral Knowledge and Innovation Agenda (IKIA, November 2023) states that innovation and RD&D are essential to achieving climate goals. Five climate and energy missions have been defined: CO2-free electricity system, CO2-free build environment , a climate-neutral industry with reuse of raw materials and products, zero-emission and future-proof mobility for people and goods and the system of agriculture and nature will be net climate neutral. Thirteen Multiyear Mission Innovation Programs (MMIP) were defined for these five missions. The National Energy System Plan (NPE), in combination with the Main Energy Structure Program (PEH), will provide guidance for these innovation programmes.

- The National Energy System Plan (NPE) is the government's vision for the energy system until 2050. The Main Energy Structure Program (PEH) is about the spatial planning of the main energy infrastructure, transport as well as production. The 13 IKIA programmes have to follow the NPE and PEH.

- For wind energy, the innovation projects in 2023 had to fit in the MMIPs for a CO2-free electricity system and CO2-free build environment to obtain financial support from, amongst others, the MOOI scheme, the DEI+, the HER+ and the VEKI. Together, these funding instruments had a budget of 246 million euros. The subsidy schemes are evaluated and updated each year, or new ones are developed and old ones are discarded.

National Research Initiatives and Results

- In 2022, eight offshore wind-related R&D projects received a 24 million euro grant from the HER+ subsidy scheme. Five granted projects will be described below.

- **POWER - Positive wake effects of wind turbines with tilted rotors by TouchWind.**

  This project aims to lower the costs of offshore wind energy production by drastically decreasing the wake effects of offshore wind farms. This reduction is possible due to the tilted rotor concept of the TouchWind floating wind turbine. To reach this goal, the consortium will conduct research to better understand the wake effect's behaviour in a wind farm with tilted rotors. This will make it possible to optimise the potential wake reduction in wind farms with turbines with tilted rotors. The findings can be adapted to other wind turbines with tilted rotors, including fixed offshore wind turbines. The future commercialisation and deployment of the POWER concept will result in significant cost reductions for offshore wind by the higher power output and more compact wind farm, theoretically resulting in a 4x higher power density [1].

- **Gentle Driving of Piles 2.0 (GDP 2.0) by DOT.**

  The conventional and proven hammering has several drawbacks like underwater noise, fatigue loads, limited pile size, limited number of suppliers and long lead times. Instead, shaking has become an important technology for driving monopiles into the seabed. GDP2.0 is one of several innovation projects maturing the shaking technology to become competitive for hammering. GDP not only applies vertical vibrations but also circumferential vibrations to reduce friction when driving a pile into the seabed. In previous projects the principle has been proven on a laboratory scale. In GDP2.0, an industrial clamping system and vibration system are developed to independently control the frequency and amplitudes of the vertical and circumferential vibrations.

- **AIRTuB Resident Offshore wind turbine blade Monitoring & Inspection (AIRTuB-ROMI).**

  AIRTuB-ROMI is the successor of the Automated Inspection and Repair of Turbine Blades (AIRTuB) project. AIRTuB technologies for inspecting leading edge erosion (LEE) and internal blade damage have been developed. Also, a drone autopilot for operations under harsh wind conditions has been developed, as well as a crawler to move over the blade and do the internal inspections. Some specific results are sensor-in-blade monitoring solutions, a drone- and crawler inspection platform resident in the wind farm, data communication technology for drone operation, and a digital twin technology to assess urgency of the repair based on the collected data. In this project, 17 companies, research institutes, and educational institutes participate, ensuring good knowledge dissemination [2].

Image 2: Disc experiments in the wind tunnel at the TU Delft, pulling air downwards (TouchWind).

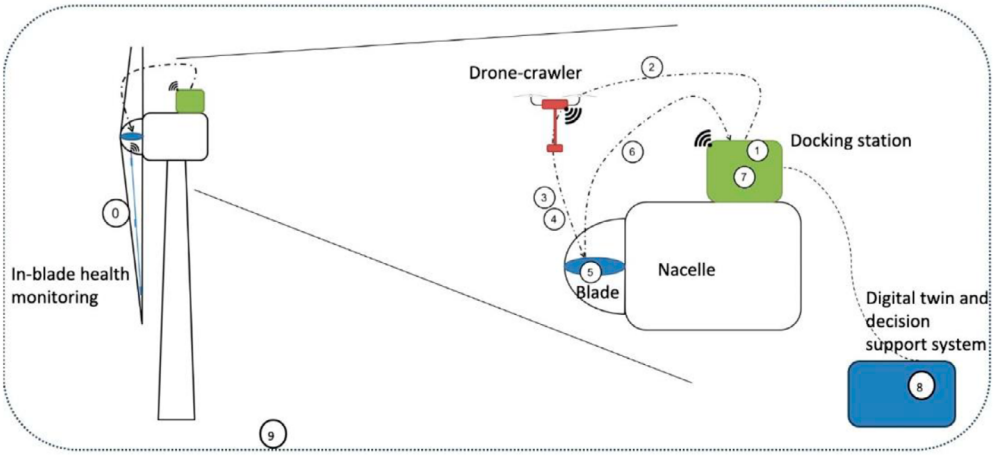

Image 3: Schematic representation of inspection, monitoring and modelling (AIRTuB-ROMI).

- **Site-specific Conditions for wind ENergy rIsk reduction (SCENIC) by TNO, Whiffle, GE and Eneco**.

  This R&D project aims to reduce the uncertainties of the operation and increase the reliability of the offshore wind farm performance. The main result is a methodology built around the Large Eddy Simulation (LES) tool, GRASP, developed by Whiffle and complemented by supporting tools like an aero-elastic design code. Furthermore, with weather models with which a complete map of meteorological conditions and turbine response is generated for the assessment of performance, and environmental and aero-elastic risks at the precise location of the wind energy project (and turbines). The methodology is demonstrated through case studies and where possible results are compared with measurements. The project leads to a service based on this methodology, available as a toolbox that consists of the extended GRASP tool (offered by Whiffle) for the prediction of environmental parameters linked to the in-house aero-elastic tools of TNO and GE.

- **GeoWin: Geophysical wind farm surveys to reduce cost by Fugro and TU Delft.**

  For the development of an offshore wind farm, it is mandatory to assess the location's geotechnical feasibility. This is conventionally done with classical geotechnical approaches like cone penetration tests, borehole investigations, as well as high-resolution seismic surveys to image the near subsurface structurally. These surveys are done using large, crewed and expensive ships. This project aims to develop and build a non-invasive, compact, environmentally friendly, autonomy-ready geophysical system to map topography, structure and properties of the ocean floor up to geotechnically relevant depths below the seafloor. Two techniques are developed, Synthetic Aperture Sonar on an Autonomous Surface Vessel (SASV) and Silent Seismic operated from an unmanned underwater vessel. GeoWin will produce more accurate, higher resolution and faster to acquire three-dimensional subsurface models in a more cost effective way.

Some other funded RD&D developments:

- About 21 GW has to be installed offshore and 50 to 70 GW in the Dutch North Sea in 2030. In order

Image 4: Fugro developed the underwater vehicle BlueAmp, deployed from a remotely controlled surface vehicle (Fugro).

to speed up the installation process, several innovations are and have been supported. For instance, Barge Master and Seaqualize have developed tooling to use barges as suppliers for wind turbine components instead of transporting with the installation of jack-up vessels. C1 Connections is successfully developing a wedge connection to replace the bolted connection for masts and monopiles. SIF, the monopile manufacturer, is developing a new type of monopile platform, which can be installed much quicker without needing a transition piece.

- Underwater noise from using a hammer to install monopiles is a severe problem that can delay the installation of future offshore wind farms. Therefore, several research projects are being undertaken in the Netherlands to tackle this problem. Most of them focus on more silent vibration techniques eventually in combination with water jetting at the inside of the monopiles.

Test Facilities and Demonstration Projects

- No new facilities in 2023.

Collaborative Research

- Dutch companies and research institutes are actively involved in 18 IEA Wind TCP Tasks 11, 25, 34, 37, 39, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 55, 56 and 57.

Impact of Wind Energy

Environmental Impact

- In 2022, about 11 million tons of CO2 emissions were avoided by wind energy. This corresponds to a reduction of 6%. Together with solar energy, a total of 31 million tons of CO2 emissions were avoided, corresponding to a 16% reduction. The total reduction of greenhouse gasses compared to 1990 is 31%. (source CBS).

- Due to objection and appeal of interested parties, the Council of State has made national environmental standards for new wind farms inoperative. New standards must be implemented before new onshore wind farms can be developed.

- The effects of wind turbine noise and drop shadow on the health of people near wind farms have been investigated. No significant relation has been found between health complaints reported by the general practitioner and the sound levels.

- The State, the provinces, NWEA, the TSO TenneT, and various nature preservation organisations are working together on the nature-inclusive energy transition on land. Agreements have been made about mitigating measures, population strengthening measures, financing, research and monitoring.

- Bird collisions with wind turbines can be a problem in areas with many or rare birds. An investigation has been started in the province of Groningen to see if bird collisions can be avoided by painting wind turbine blades black.

- The ecological impact of offshore wind is increasing as the number of wind turbines will grow rapidly in the coming decades. Therefore, ecological requirements are implemented in the Dutch offshore wind tenders. This also includes research assignments into the ecological effects of offshore wind, ways to mitigate the adverse effects or even nature-enhancing measures.

Economic Benefits and Industry Development

- Dutch companies already have a market share of approximately 25 percent of the total European offshore wind market. Several foreign offshore wind companies are also located in the Netherlands due to the potential of the Dutch part of the North Sea.

- The Dutch offshore wind industry is operational in areas like monopile development, site investigation, and installation of cables and foundations. Also, Dutch companies play an essential role in installing wind turbines.

- About 6,000 jobs were involved in the offshore sector until 2023 (4.7 GW). To realise the offshore goals for 2030 (21 GW) and 2050 (50 to 70 GW), many more people are needed, which will be a huge challenge. Estimating employment development on a longer time scale and regional level is difficult. On a regional level, ports can especially benefit from offshore wind growth because they serve as a marshalling port or as a base for maintenance.

Next Term

In November 2023, parliament elections were held in the Netherlands and a new right-wing coalition government is in power. However, the policy regarding the energy transition is expected to stay the same. The focus is on greater energy independence and sustainable energy production. In addition to the existing Borssele nuclear power plant, the government wants to build four new nuclear power plants.

Onshore, a 1.3 GW pipeline of permitted projects will bring at least 0.5 GW of new onshore wind during the next years. The offshore wind farm Hollandse Kust West (1.4 GW) is under development and will be operational in 2026, and a steady flow of tenders for offshore projects is proceeding well.

References

[1] TouchWind B.V. – One-piece rotors.
https://touchwind.org/

[2] AIRTuB-ROMI (Resident Offshore Monitoring & Inspection) – World Class Maintenance.
https://www.worldclassmaintenance.com/sub-project/air-tub-romi/