Report 2021

Netherlands

Photo: Viktor Hesse/Unsplash

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Compared to last year, the onshore wind capacity increased faster. Now 5.3 GW is installed, which is 1.2 GW more than last year, which means the Netherlands is 0.7 GW away from the 6 GW onshore target. For the Netherlands, 7 GW of onshore wind power seems to be the maximum onshore, mainly due to spatial and social issues.

HOWEVER, THIS MAY change because of the growing awareness concerning climate change, high energy prices, and dependency on fossil fuels originating from countries having autocratic regimes.

The rollout of the current offshore wind road map for 2030 is progressing steadily. In 2020 1.5 GW of offshore wind power was added, and 2.2 GW of wind power of this road map is under construction and is expected to be operational in 2023.

Last year around €12.5 million subsidy was awarded for nine innovative offshore R,D&D projects. The research and development of the rewarded projects concerned, amongst others: offshore foundations developments, storage, and flexibilization of electricity production, installation techniques, precipitation atlas, and improved installation of wind turbines.

Table 1. Key National Statistics 2021: Netherlands

Total (net) installed wind power capacity*	7.80 GW
Total offshore capacity	2.46 GW
New wind power capacity installed	1.28 GW
Decommissioned capacity (in 2021)	0.20 GW
Total electrical energy output from wind	19.058 TWh
Wind-generated electricity as percent of national electricity demand	15.6%
Average national capacity factor**	27%
Target	27 GW in 2030
National wind energy R&D budget***	€120 million

*Installed wind power capacity: Calculated using nameplate power ratings of the installed wind turbines

Highlight(s)

- three new areas for offshore wind farms, representing 10.7 GW, doubling the total planned capacity for offshore wind (21 GW by 2030).
- 1.2 GW new wind farm capacity onshore is the highest capacity increase in one year. The 6 GW onshore goal will be achieved in 2023.

Market Development

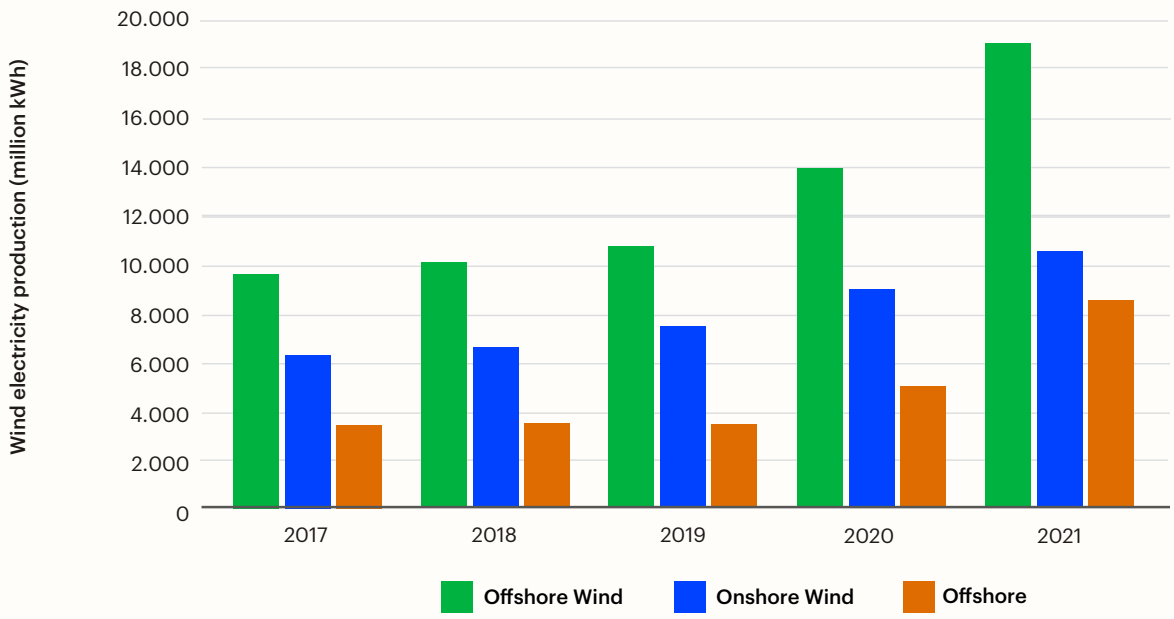
Targets and Policy

- The original goal of the climate agreement was to have 11 GW of offshore wind power installed in the Netherlands part of the North Sea in 2030. These wind farms can generate 49 TWh of electricity, which results in a 49% CO2 reduction compared to 1990. In Q1 2022, the government decided to realize 10.7 GW extra in three new areas: Nederwiek, Lagelander, and Doordewind. The reason for this is the ambition to reduce the CO2-emission even further in 2030 by 55%. Together these offshore wind farms can generate around 90 TWh of electricity. Compared to the original goal of 2030, now 125 TWh more electricity will be generated from renewable sources instead of 84 TWh. When designating the wind energy areas, careful consideration was given to the other interests in the North Sea, such as shipping, fisheries, nature, and defense. At the end of 2021, the minister of Economic Affairs and Climate initiated the exploration for bringing the extra electricity ashore. The local energy demand, environmental impact, costs, and social acceptance play a role in the choice of the routes.
- According to the Dutch climate agreement, the energy system must be completely CO2-free by 2050. All fossil electricity sources have to be replaced by renewable sources. The big challenge is to match the growing production of renewable energy and demand. For that reason, storage and conversion solutions for electricity will be developed, and the industry has to electrify.

Picture 1. Recently added offshore wind farms *(RVO)*

Progress and Operational Details

- High increase in generation in 2021, surpassing 19TWh and 15% share of demand
- Capacity factors in 2021 were 39% offshore and 23% onshore
- Vattenfall is now installing the offshore wind farm Hollandse Kust Zuid (1.5 GW). It is expected to be commissioned in 2023 and is the



Wind electricity production over the last five years (data CBS)

Picture 2. Wind farm Fryslân in the IJssel Lake. *(Wind farm Fryslân)*

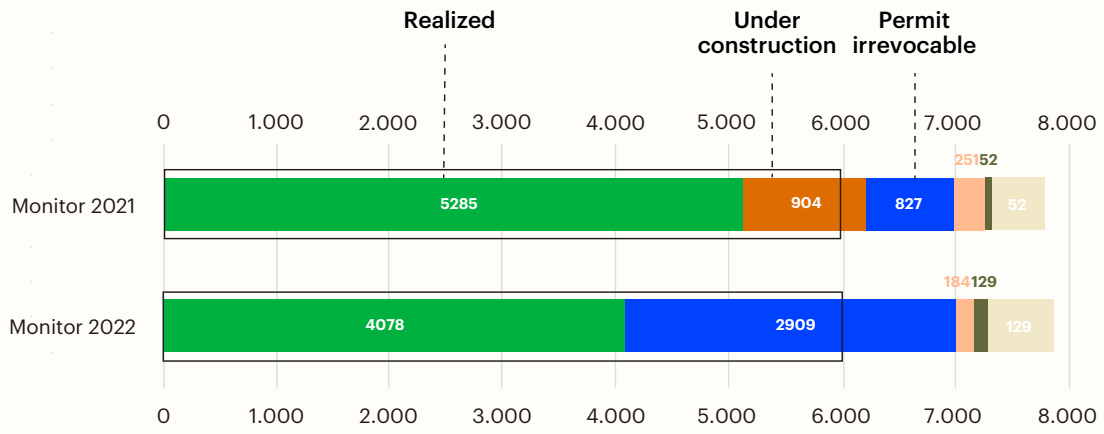
first offshore wind park without subsidy. HKZ will consist of 140 Siemens Gamesa wind turbines, each 11 MW.

- In 2020 the permit for Hollandse Kust Noord (HKN) offshore wind farm (759 MW) was awarded to Crosswind, a consortium of Shell, Eneco, Siemens Gamesa, and Van Oord. In the tender for HKN, innovations were required. The following innovations will be developed and tested in HKN: intelligent wind turbine control, steering the wake, floating solar, and energy storage. HKN is expected to be operational in 2023.

- After two years, there is a new tender for a new offshore wind farm, the Hollandse Kust West, under a new law. Next to the qualitative tender criteria, the Ministry of Economic Affairs and Climate asks for a financial offer from the tenderers. This tender will close on 17 May 2022, and a decision is expected in October 2022. The capacity is 1.5 GW

- In 2021 the wind farm capacity increase mainly took place on land and lake. On land ground in 2020 4.2 GW was installed, and in 2021, 5.3 GW. On the lake the installed power was 144 MW in 2020 and 527 MW in 2021. This increase is realized in wind farm Fryslân in the IJssel Lake. The onshore wind farms Drentse Monden and Zeewolde also play a major role in the onshore wind power increase. The rest was realized by smaller wind farms.

- Onshore, including lakes the target was 6 GW in 2020. Most projects for the 2020 goal are either under construction or have already their permits. Various agreements have been made to accelerate the process to achieve the 6 GW goal in 2023. All the remaining wind farms necessary to reach the 6 GW goal have an irrevocable permit or are under construction. It is therefore highly likely that 6.2 GW will be realized onshore in 2023.

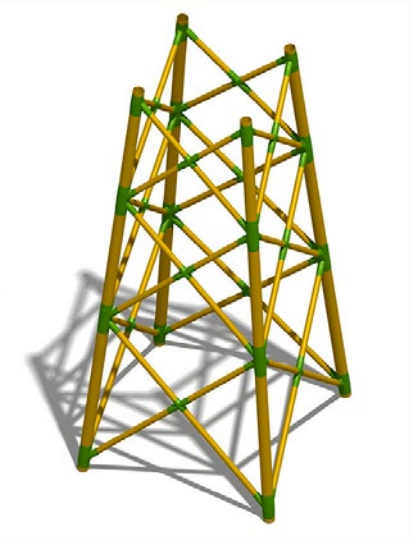


Onshore wind monitor 2020 and 2021. kW realized, under construction and permit irrevocable. (RVO)

Matters Affecting Growth and Work to Remove Barriers

- The Netherlands has been divided into energy regions. For each region, a Regional Energy Strategy (RES) had to be developed. Local authorities, communities, industry, farmers, and citizens had to come up with plans to achieve a fossil free energy system in 2050. Solar is the most favorable renewable energy source. But this is also about reduction of energy consumption and adding storage.

Picture 3. Gentle Driving of Piles *(GROW Offshore Wind)*



Picture 4. Jacket foundation with wrapped composite joints *(GROW Offshore Wind)*

R,D&D Activities

National R,D&D Priorities and Budget

- The Netherlands has several subsidy instruments to stimulate the practical development of innovation related to the energy transition toward implementation. These instruments are open to all kinds of innovations reducing CO2 emissions and making them cheaper. Wind energy is one of them. The main subsidy instruments are the DEI+, HER+, and MOOI, together with a budget of €120 million per year. The DEI+ stimulates higher TRL demonstration projects, the HER+ mid-level TRL projects, and the MOOI is a two yearly subsidy scheme in which the focus is on the mission, cooperation, and market implementation of the innovations. RVO (Netherlands Enterprise Agency) is responsible for the execution of these subsidy schemes.

National Research Initiatives and Results

- **Gentle Driving of Piles (GDP1.2).** GDP is a technique where vertical and torsional vibrations are induced in a monopile (offshore wind turbine foundation) to fluidize the seabed to install the monopile not using a hammer. The advantages of GDP are that the whole year monopiles can be installed because the GDP technique is much quieter, and monopiles can be constructed lighter because less fatigue loads are induced in the monopile. This project is an ongoing development to use vibrations in which effectiveness in clay, the power consumption, and the optimal frequencies and amplitudes are investigated. This project is executed by the Technical University of Delft and partners.

Photo: Tim Vanderhoydonck/Unsplash

- **Wrap Node.** Jacket foundations for offshore wind turbines need much less steel compared to monopiles. The drawback is that many complex welds must be made in the junctions of the steel tubes of the jacket. Monopile fabrication is quite simple and automated. To overcome the drawback, this R&D project develops pre-fabricated standardized composite joints. The production rate of jacket foundations can be increased, and the wall thickness of the steel tubes can be reduced, resulting in significantly lighter jackets. This project is executed by the Technical University of Delft and partners.

- **Cable JIP2:** The Cable JIP projects produce a fully comprehensive design life prediction methodology for the subsea electrical cables in which all relevant design aspects are taken into account in the prediction, including floater motions, wave induced loads, and current induced loads. This follow up project focuses on the electrical cable in a free span as applied in bottom fixed wind turbines as well as under floating wind turbines. The latter is the most challenging design case for dynamic inter-array cables. This project is executed by MARIN and cable manufacturer TKF and partners.

- **PRecipitation atlas for Offshore Wind blade Erosion Support System (PROWESS).** Precipitation is the major cause for leading edge erosion (LEE) of wind turbine blades at sea. LEE degrades the lifetime and performance of wind turbines. As a result, the levelized cost of energy increases, and more frequent blade repairs, inspections, and early replacements are necessary. In this project, a monitoring system for precipitation and LEE is developed. With these data, the correlation between LEE and precipitation can be determined. The correlation between LEE and precipitation is used to develop models for operation and maintenance costs and de energy production. This project is executed by TNO, Whiffle, KNMI, and various industrial partners.

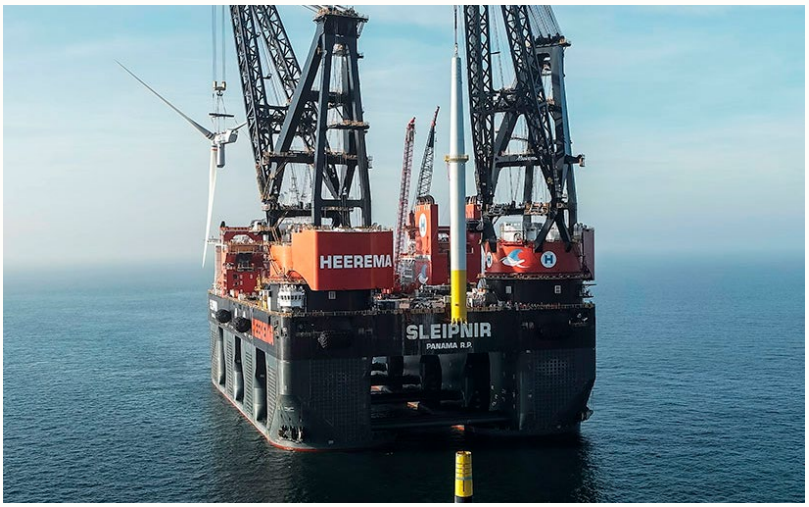
- **Flexible Offshore Wind Hydrogen Power Plant Module (Flex H2)**. Power to hydrogen is deemed a viable solution to tackle the energy balancing challenge arising from the intermittent nature of the renewable source, such as offshore wind. The goal is a flexible system by using the surplus of offshore generated electricity for H2-production onshore. The FlexH2 project wants to achieve this goal through innovation and optimization of a grid-forming offshore wind park, a multi-terminal hybrid HVDC system, and a high performance AC/DC solid state transformer. The wind farm doesn't have to follow the grid frequency and phase. As a consequence, such a concept can produce electricity when the wind is blowing independent of the demand side. This project is executed by SHELL, GE, ABB, TKF, TNO, TU Eindhoven, TU Delft, Van Oord, DNV and VONK.

- **Tri Suction Pile Caisson (TSPC).** The TSPC is a wind turbine foundation for offshore wind turbines. It has the benefits of monopile fabrication and the silent and cost reduced installation method of the Suction Pile foundation. This project aims to study the optimal sizes for different soil conditions, the optimal geometry for floating installation, and the optimal geometry for scour protection. This project is executed by SPT Offshore and other industrial and research partners.

Test Facilities and Demonstration Projects

- **Demonstration Delta600.** The Delta is an in-line heave compensation device in the hook of an offshore installation vessel. Its working principle is a mass-spring system using very little power to compensate for the heave. Last year the Delta600 from Seaqualize was demonstrated successfully at sea, lifting a 600 ton load from a feeder barge in a controlled way. Now a 1000 ton version is under development, able to install the wind turbine components of 1000 tons using floating vessels instead of jack-up vessels.

- **Inauguration TIADE.** Turbine Improvements for Additional Energy. Last year the TIADE test site was inaugurated in the Wieringermeer. It is a 3.8 MW GE wind turbine that is equipped with easy exchangeable and heavily instrumented outer blade parts. Various profiles, blade tips, vortex generators, and blade add-ons will be tested without the need to manufacture a completely



Picture 5. FOX, floating installation of XXL wind turbines *(DOT BV)*

new blade. TNO is in charge of this project.

- **Albatrozz oscillating wind turbine blades.** By oscillating the outer part of a wind turbine blade, a turbine can generate power at low wind speeds. This idea was inspired by the way large seabirds like the Albatross move their wings when landing. Wind tunnel tests have shown 200% more power at low wind speeds. Now a full size test facility is being built using an 850 kW Vestas V52 as a test bed. Instead of oscillating the whole outer part of the blade, lighter trailing edge flaps will be used. The Albatrozz project conceived at the University of Groningen.

- **FOX (Floating Offshore installation Offshore XXL wind turbines).** The current way of installing offshore wind turbines is a time consuming process. The various wind turbine parts (mast, nacelle, and blades) have to be connected very precisely, which requires calm weather. This limits the available installation time. To overcome this problem, the FOX project was developed. Last year in an offshore demonstration, larger components like a complete assembly of nacelle and rotor were installed successfully in one go using a slip joint. The installation time will decrease considerably, and cheaper heavy lift vessels can be used instead of jack-up vessels. This project is run by DOT, Heerema, and TU Delft. (picture 5. FOX, floating installation of XXL wind turbines (DOT BV))

Collaborative Research

The Netherlands participates in 15 of the 26 active Tasks. Three of them are new Tasks: 49 Integrated DEsign of floating wind Arrays (IDEA), 50 Hybrid Power Plants, 53 Wind Energy Economics.

Impact of Wind Energy

Economic Benefits and Industry Development

- The Netherlands industry is strong in the field of installation of offshore wind farms, operation, and maintenance of those wind farms, and the development of foundation technology. Industrial development in the Netherlands, therefore, mainly takes place in these fields, and the industry takes advantage of these developments. Some typical examples of recent developments are development of a silent installation of monopile foundations for offshore wind turbines using vibrator tools in combination with high pressure water jets, techniques using motion compensation for installing offshore wind turbine parts, development of new highly automated maintenance and inspection techniques and investigations into various causes of leading edge erosion of blades and what to about it.

Next Term

The Netherlands is in good speed to fulfill both onshore and offshore targets for wind power. However, the newly installed national government (March 2022) formulated more ambitious goals to become climate neutral in 2050. The target for 2030 was raised from 49% to 55% in 2030. After 2030, it is necessary to ambitiously continue to reduce CO2. The Netherlands is aiming for a reduction of 70% in 2035 and 80% in 2040. In order to achieve these goals, other measures besides renewable energy have to be implemented: e.g., paying per km driving motor vehicles in 2030, possible development of new nuclear power plants, reduction of fossil energy use in houses and industry, and make the energy networks future-proof. The new cabinet is developing a policy for this.
A special minister has been appointed for Climate and Energy who is in charge of the policy and the climate and transition fund of €35 billion. This climate fund is used to develop the required energy infrastructure (electricity, heat, H2, and CO2), make the built environment and mobility more sustainable, and helps to realize a more green industry.

A precondition for an ambitious climate policy is having sufficient professionals, now but also on the way to 2050. The national government intends to work with educational institutions, local governments, and social partners to train professionals and, where necessary, to retrain people.