Report 2022

Netherlands

Photo: Brejeq / Getty Images-Canva.

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In 2022, the goal to reach 6 GW in onshore wind capacity was achieved, a deadline initially due in 2020. However, an acceleration process which allowed 866 MW to be installed in 2022 concluded the project.

Another 6.9 GW of onshore capacity is expected by the end of 2023, which will contribute 21 TWh and makes up 18% of total national electricity consumption. Approximately 800 MW in onshore wind projects are already spread throughout the permit, spatial, and preparatory stages. However, due to the numerous uncertainties associated with these phases, only some of them are expected to be achieved within the deadline.

In 2022, the installed offshore wind capacity level remained at 2.5 GW. However, the parties awarded permits for sites HKZ and HKN expect to finalise their windfarms in 2023, which will create an additional 2.3 GW. Several new offshore sites are being developed and will be tendered in the coming years to achieve the 21 GW goal in 2030.

Last year around 30 million EUR (33 million USD) in subsidies was awarded to fourteen innovative wind

energy RD&D projects, mainly offshore. The research and development of the rewarded projects concerned, amongst others: Offshore foundation developments, storage and flexibility of electricity production, inspection and maintenance, and innovative installation techniques for offshore wind turbines.

Highlight(s)

- Electricity production from renewable sources increased by 20% to 47 TWh, with a 17% increase in wind energy.
- The 2020 onshore wind capacity goal of 6 GW was achieved in 2022, with 0.8 GW newly installed.
- Offshore wind power plants of 2.3 GW are in construction, able to double the capacity in 2023.

Market Development

Targets and Policy

- The Netherlands is committed to fulfilling its role in limiting global warming to 1.5 degrees Celsius. For this purpose, a climate plan has been formulated, in which the reduction of greenhouse gasses is set to 55% in 2030 and 95% in 2050 compared to 1990 levels.
- An acceleration to meet these targets is needed as the current prognosis for 2030 is predicted at 39% instead of 55%. Therefore, the minister of climate and energy, Rob Jetten, announced in April 2023 an additional package of measures to close the gap to the 2030 climate target. The sectors of electricity, industry, building infrastructure, agriculture, mobility, and transport must all contribute. In addition, a climate and transition fund of 35 billion EUR (39 billion USD) has been allocated to support this acceleration.
- To speed up renewable energy production, the Dutch government announced new offshore wind sites last year, accommodating an additional 11 GW in 2030, resulting in a total capacity of 21 GW by 2030. Currently, the Dutch government, the National Enterprise Agency and RWS are developing offshore tenders so interested parties are aware of the conditions of the tenders and when to place their bids. Regarding these tenders, the non-price criteria ecology and integration in the Dutch energy system are essential in ranking the contestants. In addition to offshore wind, 3 GW of solar energy must contribute to electricity production by 2030.
- In 2050, offshore wind will be regarded as a significant renewable energy contributor in combination with offshore solar energy. Part of the electricity will be converted to hydrogen or other molecules, such as ammonia. Meanwhile, the electricity and offshore gas grid must be developed, and industry must transform into fossil-free

Table 1. Key National Statistics 2022: The Netherlands

Total (net) installed wind power capacity*	8.75 GW
Total offshore capacity	2.57 GW
New wind power capacity installed	1.11 GW
Decommissioned capacity (in 2022)	0.11 GW
Total electrical energy output from wind	21.36 TWh
Wind-generated electricity as percent of national electricity demand	18.1%
Average national capacity factor**	29.8%
Target	28 GW in 2030
National wind energy RD&D budget***	€120 million

production. The Dutch government furthermore expects to develop energy hubs in areas further out to sea. These will become key nodes (connection points) in an energy system using diverse energy carriers and power generation sources.

- Currently, the growth of onshore wind appears to be stagnating. In 2023, 7 GW is yet to be achieved, with the possibility of additional development to 8 GW. This is mainly due to limited space and complex permitting procedures.

- The information highlighted in this section is sourced from public government-related websites and CBS.

Progress and Operational Details

- Electricity production in 2022 has remained at a comparable level to the previous year. Electricity production from renewable sources increased by 20%, reaching 47 TWh. Output from solar energy increased by 54%, and 17% from wind. This is primarily due to the additional 4 GW solar and 1 GW wind capacity. In addition, favourable weather conditions have contributed to this increase, indicating a rendition of fossil fuels.

- In 2022, about 41% of the total electricity demand of 118 TWh was generated by renewable sources. Wind generated 18% in 2022, which is a slight increase, compared to 17 % in 2021. Solar is proliferating and is responsible for 15% of the electricity demand in 2022 compared to 10% in 2021. The remaining 8% is mainly generated by biomass, which is relatively constant.

- The increase in wind electricity production is mainly due to an extra 0.9 GW of onshore capacity (Figure 1)

- Capacity factors in 2022 registered 37% offshore and 24% onshore. In 2020, the combined wind capacity factor merely totalled 24% as the newly installed capacity was only operational for part of the year (Figure 2).

- Due to higher-rated capacity, the production per wind turbine offshore and onshore increased. Many offshore wind turbines with high-rated capacity became operational in 2021. Whereas in 2022, only 0,11 GW offshore capacity came into operation (Figure 3).

- In 2022, 2.6 GW of wind power was operational at sea, responsible for 8.4 TWh annually, accounting for about 7% of the yearly electricity demand.

- In 2023, the capacity of offshore wind energy is expected to surge. The offshore wind farms HKZ 1.5 GW and HKW 0.8 GW are expected to become operational, which will contribute an additional 7.4 TWh per year.

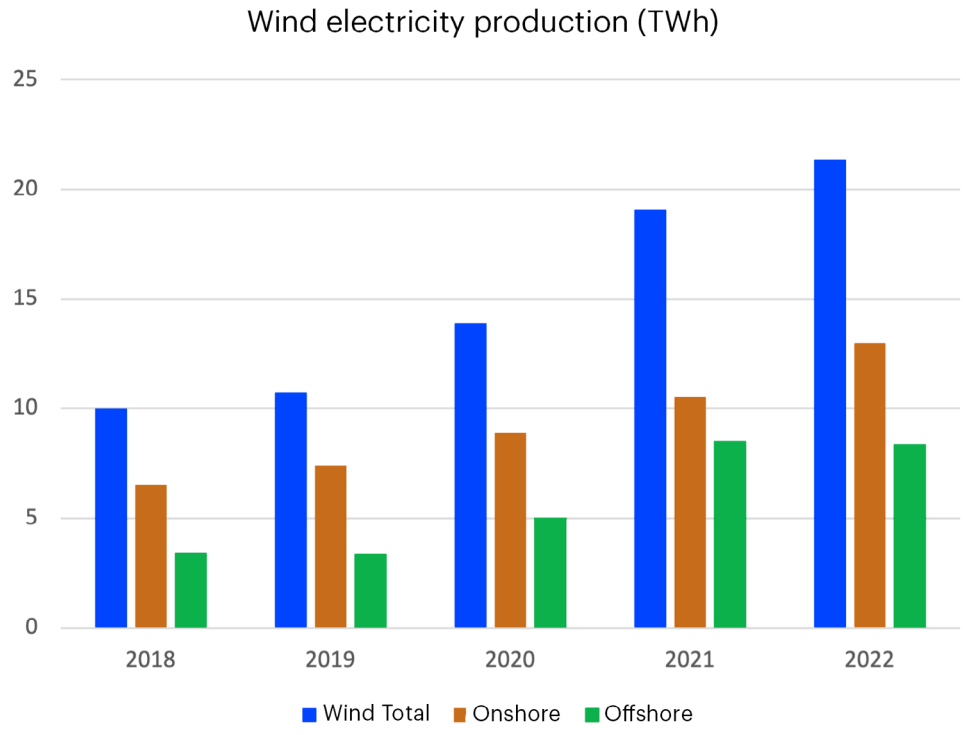

Figure 1.

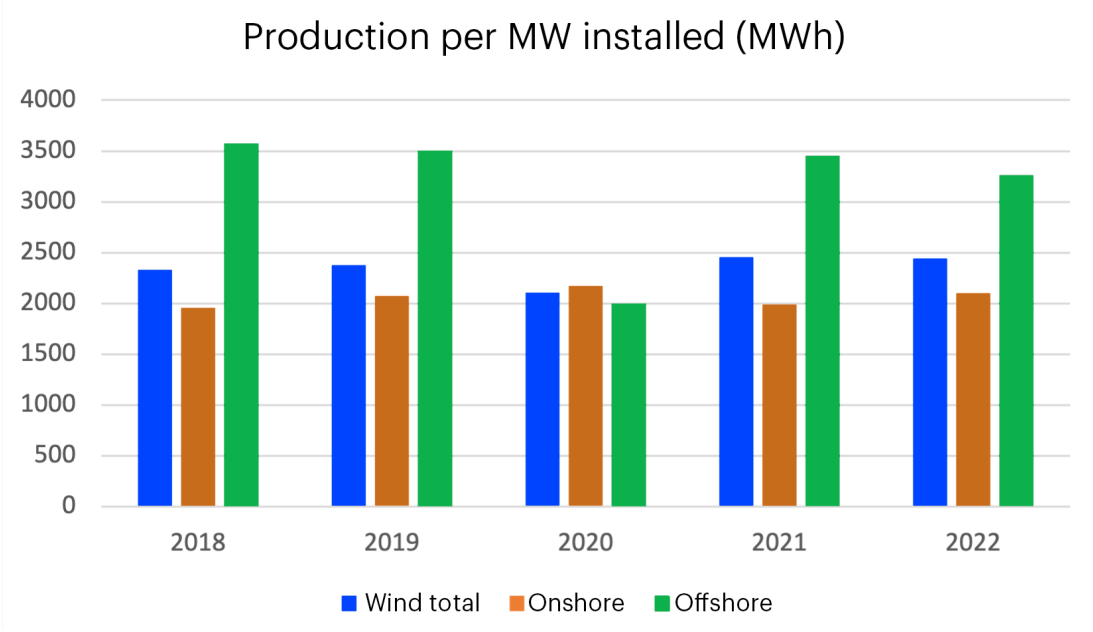

Figure 2.

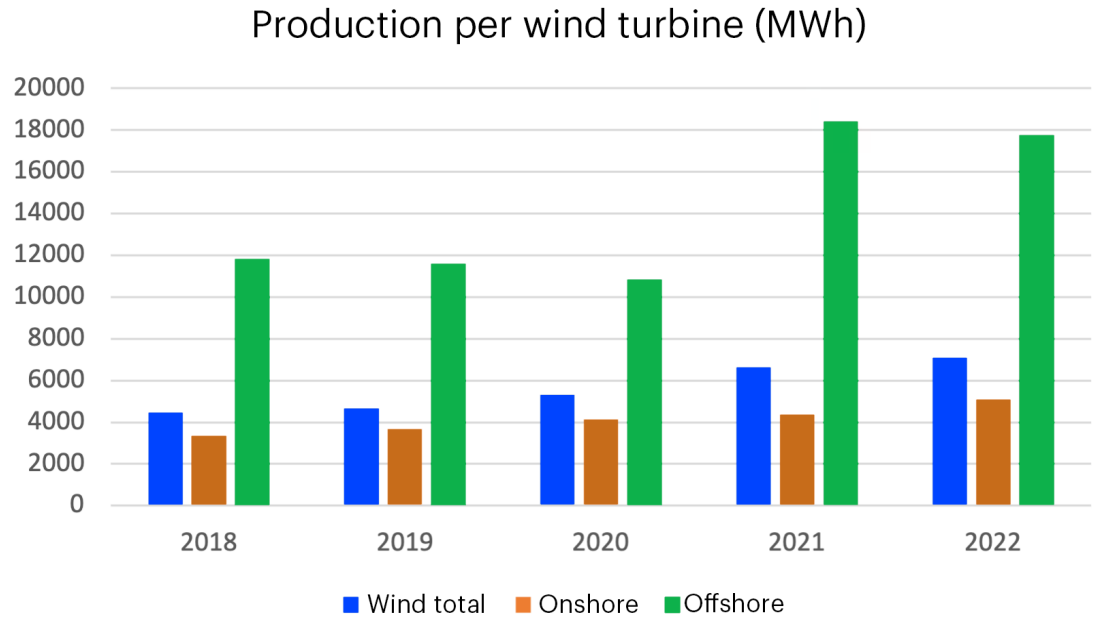

Figure 3. Forecasts for future tendencies depict increasing wind turbine size to 15+ MW, resulting in lower operational and maintenance costs.

- In Q4 2022, the permits for the offshore site HKW were awarded to a consortium of Eneco and Shell and Oranje Wind Power II. Within four years, another 1.4 GW will become operational.

- In Q4 2023, the two sites, Alpha and Beta, each with 2 GW within wind energy area IJver, will be tendered. Non-price criteria such as ecology and integration into the Dutch energy system are used as ranking criteria, as well as a financial offer the bidders must make. The points for all criteria add up to a total appreciation for a bid. 2025 the remaining 2 GW site, Gamma, will be tendered. All site studies are completed, and the data is available for those interested in developing wind farms. The site decisions for Alpha and Beta, which contain the conditions for the construction, operation and decommissioning of a wind farm, are under preparation. The national TSO, TenneT, will install the export cable as well as the two DC substations. The IJver sites are expected to be operational in 2028 and 2029.

- In 2026 and 2027, the sites Nederwiek, HKW (0.7 GW remaining), Ten Noorden van de Wadden and Doordewind will be tendered. Together, the sites have a combined capacity of 11.4 GW. The site studies are currently underway.

•The picture below (Figure 4) shows the roadmap for offshore wind energy until 2030.

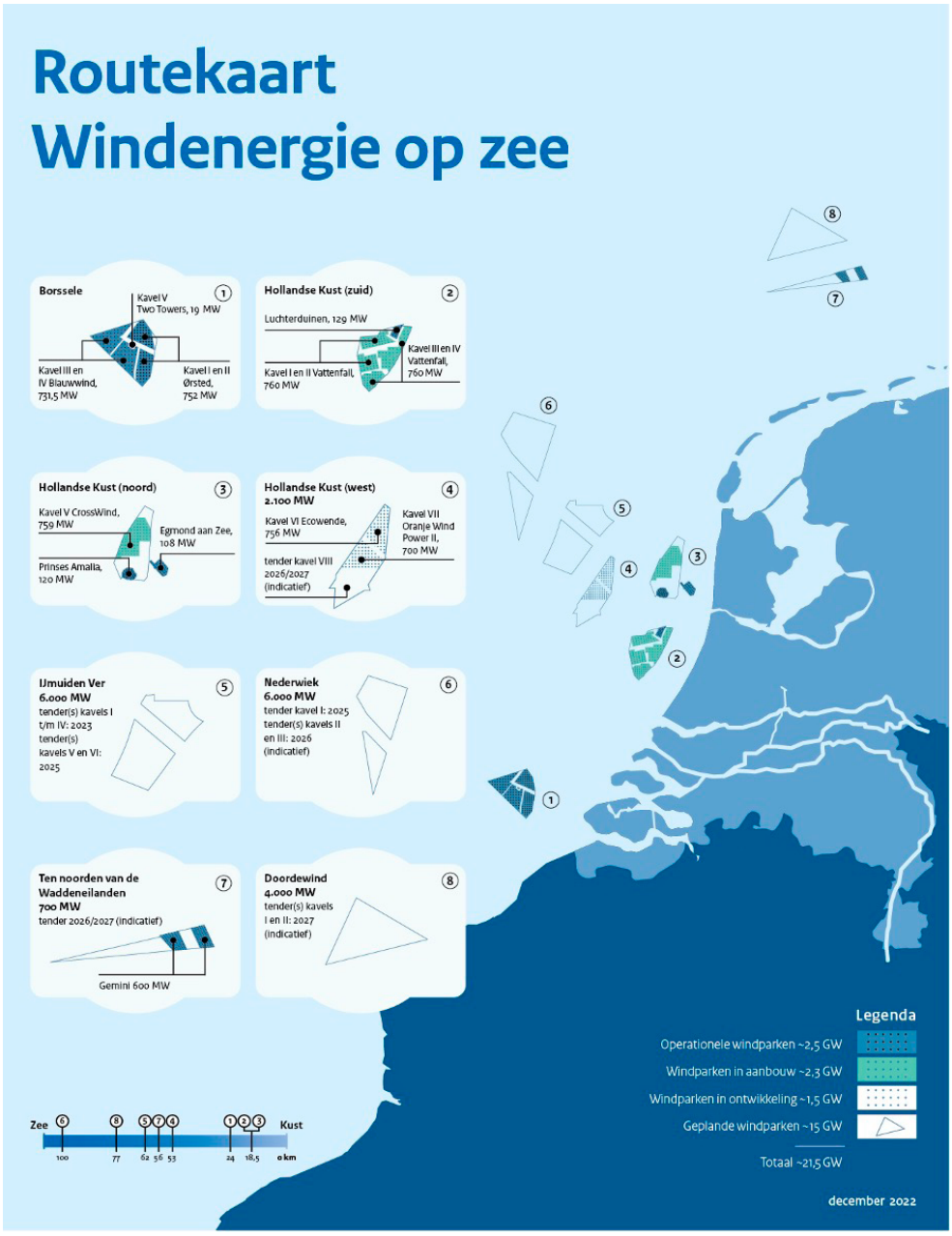

Figure 4. The dark blue areas are operational, the green areas depict sites under construction, the white dotted areas are under development, and the unfilled areas are planned wind farms.

- In 2022, the wind farm capacity was mainly expanded via onshore wind farms. The development added 866 MW and increased the total installed capacity in 2022 to 6 GW. Many new wind farms ranging from a few MW to a few hundred MW spread throughout the country contributed to this growth. In 2023, the installed capacity will reach an anticipated 7 GW. According to the onshore wind monitor, the land-based capacity may increase to 8 GW in the coming years. However, unlike offshore wind, onshore wind development is less streamlined, making it less predictable than offshore wind. Therefore, goals to increase beyond 8 GW remain on hold.

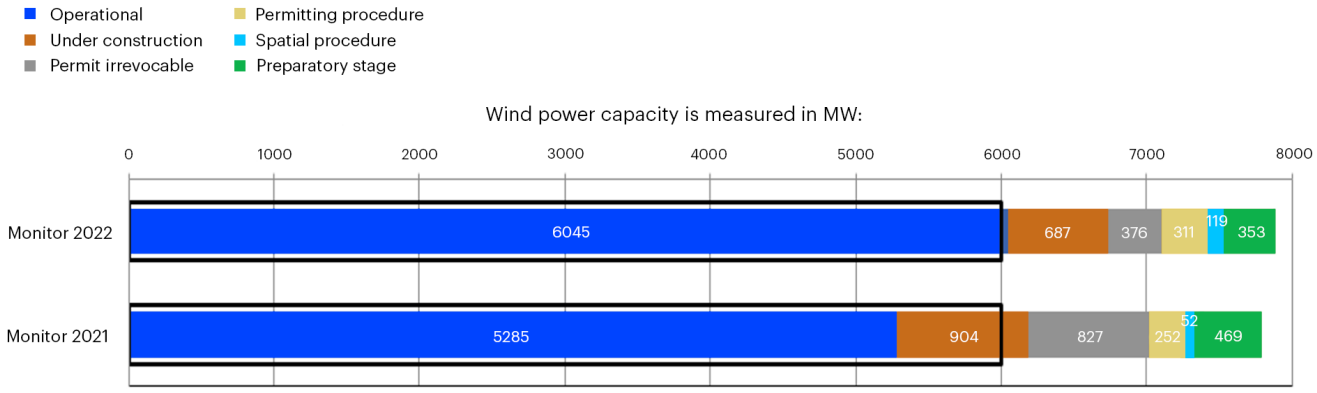

Figure 5. The information in this section is sourced from public government-related websites, the RVO website and CBS.

Matters Affecting Growth and Work to Remove Barriers

- The Netherlands is a small but densely populated country. This creates limitations on developing new onshore wind farms. Solar PV field developments are also encountering resistance as they become more numerous. This requires careful coordination amongst stakeholders and tenacious project managers to maintain the growth of renewable energy production, especially onshore. The stakeholders consist of developers of wind and solar farms, grid operators, energy consumers, residents, municipalities, provinces, and water authorities. Provinces and municipalities are furthermore responsible for the spatial planning of small to mid-size projects, while the national government oversees the large projects. They also issue permits. Project developers take the initiative for a project. They do so by requesting permits and environmental impact assessments. Once available, they take care of the realisation and operation of the wind farm. Nevertheless, lengthy and extensive objections and appeals can delay or even prevent a renewable energy project from being completed.
- The current grid was developed for large, centralised power plants rather than smaller, distributable renewable power generation. Therefore, the electricity grid needs to be strengthened, especially in rural areas where the grid is weak and where solar PV and wind energy will be installed. However, the grid in suburbs with rooftop solar PV is challenged to distribute the generated power. The network operators, TSO and DSOs, are currently engaged in solving the task, yet it proves to be a labour and material-intensive project. In addition to strengthening the grid, achieving a localised balance between supply and demand requires the implementation of local energy hubs with storage facilities.
- As renewable energy continues to increase as an energy source, sunny and windy days will more frequently result in negative electricity prices. The demand for renewable electricity, particularly from the industrial sector, must increase to enable this at a grander scale. This means that industry and other sectors have to make drastic changes in the type of energy consumption utilised, for instance, using electrical heating or heat pumps or switching to electrical mobility. Additionally, short- and long-term storage systems need development. Therefore, balancing the growth of supply and demand in the transition process to renewable energy poses a significant challenge.
- Finally, the transition to renewables requires a substantial and skilled workforce, which is not readily available.

RD&D Activities

National RD&D Priorities and Budget

- The Dutch innovation support system aims to achieve the ambitious goals defined in the Climate Agreement. To complete these goals, the focus of the available innovation instruments is on the other hand very concrete and projects requiring subsidy should therefore result in practical solutions within a few years. These instruments are open to innovations in reducing CO2 emissions and making them cheaper. Wind energy is one of them. The main subsidy instruments are the DEI+, HER+, and MOOI, which have a combined budget of 120 million EUR (133 million USD) per year. The DEI+ stimulates higher TRL demonstration projects, the HER+ supports mid-level TRL projects, and the MOOI is a two-year subsidy scheme focusing on the innovations' mission, cooperation, and market implementation. RVO (Netherlands Enterprise Agency) is responsible for the execution of these subsidy schemes.

National Research Initiatives and Results

In total, 18 innovative wind energy-related projects applied for subsidies totalling 50 million EUR (55 million USD). Five innovative projects supported by national subsidy schemes are discussed below. This project information came from public summaries, websites, or the projects themselves.

- Delta1100, developed by Seaqualize, is a logical continuation of the Delta600 project. It is an in-line heave compensation device on the hook of an offshore jack-up installation vessel. Its working principle is a mass-spring system using very little power to compensate for the heave when lifting a delicate nacelle, weighing up to 1100 tons, from a barge onto a jack-up. The cheaper barges are feeders for nacelles and blades, while expensive jack-up vessels stay on the wind farm and perform the installation work in the offshore wind farm. In essence, the installation of offshore wind farms is anticipated to become cheaper using the feeder principle. (www.seaqualize.com)

Photo 1: Heave Chief 1100 in the crane of a test vessel in the harbour. *(Source: Seaqualize)*

- Bargemaster is also developing a system where the feeder principle is used. In this system, a barge transports the mast, nacelle, and blades from the marshalling harbour to the wind farm. On the barge's deck, a platform is mounted with a wind turbine mast on top of it. When the barge aligns with the jack-up vessel, the platform is designed to counteract the effect of the waves, ensuring the mast remains vertical and prevents a swinging motion. The heave is compensated by in-line heave compensation techniques, which increases the stability of the operation. (www.barge-master.com)

Figure 6. Barge alongside jack-up vessel lifting a mast *(Source: Barge Master)*.

- MuTech BV is developing a new type of blade extension to further reduce wind turbine noise. Current serrations at the outer part of the turbine reduce noise by 3dB. The MuteSkin blade extension has the ability to reduce noise by 6 dB. The blade add-ons have an anisotropic permeability that reduces turbulent-boundary-layer trailing-edge noise. This extra noise reduction enables the possibility of installing wind turbines closer to housing areas. (https://muteskin.eu)

Photo 2. Part of a wind turbine blade with MuteSkin blade extension in wind tunnel test with microphone array.

- The Amphytrite project investigates and demonstrates offshore and off-grid hydrogen production at an offshore wind turbine. In the future, industrial demand for green hydrogen is expected to increase. Hydrogen is used to balance the grid and increase flexibility. For wind farms located further from the coast, converting electricity into hydrogen and transporting it through pipelines is assumed to be cheaper than laying thick high-power cables to shore over long distances. The project goals are to show that offshore and off-grid production is scalable and technically feasible. Additionally, the costs associated with the projects are manageable and provide a compelling business case. The demonstration will take place at the SIF site in Rotterdam using the Haliade X prototype wind turbine. Pondera Development is the project leader, and GE, SIF, KCI TNO Neste, and Shell are also involved.

- BeWild stands for Biodiversity Enhanced Wind Farm development, Integrated Monitoring & Inspection and Localised Design. Other stakeholders such as shipping, fishery and nature are often not welcome in offshore wind farms because of potential disturbance of the turbines. Therefore, this project aims to make sustainable ecological and economic expansion of offshore wind energy possible. This is done through an integral data collection and analysis approach during wind farm inspections, using robotic vehicles like USVs and ROVs and creating an eco-friendly environment. The project will result in a monitoring system for e-DNA samples, cable detection sensor, biodiversity enhancing low-cost scour protection and integrated sensing capabilities in USV/ROV.

Figure 7. Fugro is the project leader.

Test Facilities and Demostration Projects

- Demonstration Wrap Composite Joints are proposed for the next generation of offshore wind support structures. Wrapped composite will replace the welded joints in jacket foundations, making them lighter, more resistant to corrosion and drastically enhances fatigue life. In the first quarter of 2023, several full-scale ultimate load and fatigue load tests were conducted on a wrapped composite joint. These tests successfully validated initial expectations.

Photo 3.

Collaborative Research

- The Netherlands participates in 16 of the 23 active Tasks. These Tasks are 11, 25, 30, 31, 34, 37, 39, 44, 46, 47, 48, 49, 50, 51 and 53. For Task 52, TNO has shown interest in participating. More than 20 Dutch parties participate in these tasks, specifically Task 47 TURBINIA (TURBulent INflow Innovative Aerodynamics) which aims to cooperate in the field of detailed aerodynamic measurements on MW scale wind turbines. Dutch parties, therefore, play a leading and active role.

Impact of Wind Energy

Environmental Impact

- In 2022, around 48 TWh equating to 41% of the total electricity demand of 118 TWh was generated by renewable sources. By 2023, the target for total renewable electricity is 94 TWh. The expected generation at sea is 49 TWh, 35 TWh on land and 10 TWh from domestic housing. Concerning offshore wind electricity, a clear roadmap toward 2030 has been developed and is continuously adjusted and implemented. Furthermore, offshore solar PV will be stimulated. However, ecological studies are necessary. The renewables on land (wind, solar amongst others) are stimulated through so-called Regional Energy Strategies in which local stakeholders develop visions and plans to accommodate the renewable energy sources. Nevertheless, a serious challenge is projected towards 2030 and beyond as the demand for electricity continues to increase.

Economic Benefits and Industry Development

- Leading towards 2030, more than 18 GW offshore wind farms are projected to be installed. Hereby, the demand for maintenance is also expected to increase. Dutch stakeholders such as harbour facilities, installation companies, foundation factories, logistic companies, wind farm developers, maintenance companies and more will be involved in the growth of the industry. Most innovative developments in Dutch companies concern the installation of offshore wind farms, as well as operation and maintenance of those wind farms, and the development of foundation technology. This gives the Dutch industry a solid starting point for acquiring new projects locally and abroad.

- Onshore wind development is slowing down in the Netherlands. In 2022, the goal of reaching 6 GW installed capacity was reached. A modest goal of 7 GW is expected towards the end of 2023, and the possibility of reaching 8 GW beyond 2023 is being discussed. Therefore, the future for the majority of economic activities will be in the field of operations, maintenance, and replacement of older windfarms.

Next Term

Based on the current scheduled policy, the prognosis for 2030 predicts a 39-50% reduction in CO2 emissions. Therefore, the 2030 goal of a 55% decrease in emissions will not be met. Additional effort is needed to accelerate the reduction of CO2 emissions, as a new national target of 60% has been set for 2030. The following sectors, electricity, industry, building infrastructure, agriculture, and transport, must fulfil their share in this additional reduction. Furthermore, the establishment of a circular economy must be coordinated, which aims to help fulfil environmental targets. These additional goals have yet to be translated into concrete measures and policies.

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