Report 2023

Belgium

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By the end of 2023, Belgium's total land-based installed capacity reached 3.2 GW and offshore wind 2.3 GW. Only land-based capacity was increased by 215 MW in 2023.

The first offshore zone has been completed and in 2023, the 399 wind turbines, spread over nine offshore zones, produced approximately 8 TWh (10.2% of the total electricity demand in Belgium). The second offshore zone has entered the development phase. Additionally, it has been decided that the Princess Elisabeth Zone will be divided into three parcels, where a total capacity of 3.15 to 3.5 GW will be installed. The first tender for the first zone of 700 MW will start at the end of 2024 or the beginning of 2025.

Table 1. Key national statistics 2023: Belgium

Total (net) installed wind power capacity	5.5 GW
Total offshore capacity	2,262 GW
New wind power capacity installed	0.215 GW
Decommissioned capacity (in 2022)	0.114 GW
Total electrical energy output from wind	15,62 TWh
Wind-generated electricity as percent of national electricity demand	20.6%
Average national capacity factor	33.1% (estimated by average capacity)
Target	
National wind energy R&D budget	

Highlight(s)

- Wind generation share of demand exceeded 20%, with offshore wind providing a record of over 10%.
- The next offshore zone, the Princess Elisabeth Zone, will have its first tender of 700 MW at the end of 2024/ beginning of 2025.

Market Development

Targets and Policy

The federal government began planning the first Belgian offshore wind farm in the North Sea in 2003. In 2004, it created a 156km² area in the Belgian Exclusive Economic Zone (EEZ) in international waters for wind farms. The first wind turbines were installed in this area in 2009.

Regarding offshore wind power, the transmission system operator (TSO), Elia, is obligated to buy green certificates from generators at a minimum price set by federal legislation. This system was established in 2002 and amended multiple times over the years. The regulator, CREG, must approve purchase agreements.

Purchase obligations apply for 19 or 20 years, depending on various parameters and may not exceed the depreciation period.

Construction has now started on the Princess Elisabeth Island, which will connect the planned offshore wind farms in the western Princess Elisabeth Zone (Figure 1). In the federal grid development plan for the electricity transmission system 2024 – 2034, the installation of a hybrid interconnector with the United Kingdom is also projected. It will be linked to the third parcel, which will be developed last.

The Princess Elisabeth Zone will be divided into three parcels, where a total capacity of 3.15 to 3.5 GW will be installed. The first tender for the first zone of 700 MW is planned to start at the end of 2024, beginning of 2025. The tender criteria have already been published [1].

The two following parcels, each 1,225 – 1,400 MW, will be tendered between 2026 and 2028. The exact date depends on the permit for the necessary reinforcements of the transmission grid onshore.

To facilitate the development of the new offshore wind energy zone, the Belgian government has decided to carry out several preliminary studies and to publish them [2]. Development beyond the second offshore wind zone will be complex. Belgium is exploring the option of interconnection or developing new offshore wind capacity in the waters of other countries.

In February 2021, Belgium and Denmark signed a memorandum of understanding for developing an electricity interconnector from an energy island Denmark plans to build in the North Sea. The interconnector could connect Belgium to large offshore wind farms off the Danish coast and power from the wind farms would be transmitted to both countries.

Progress and Operational Details

Land-based wind capacity remained low until 2004, when the installed capacity and production started to double year after year, from 96 MW in 2004 to a total land-based capacity of 3,240 MW in 2023.

Offshore wind-generated electricity began in 2009 and progressed rapidly to a total of 2,262 MW in 2020,

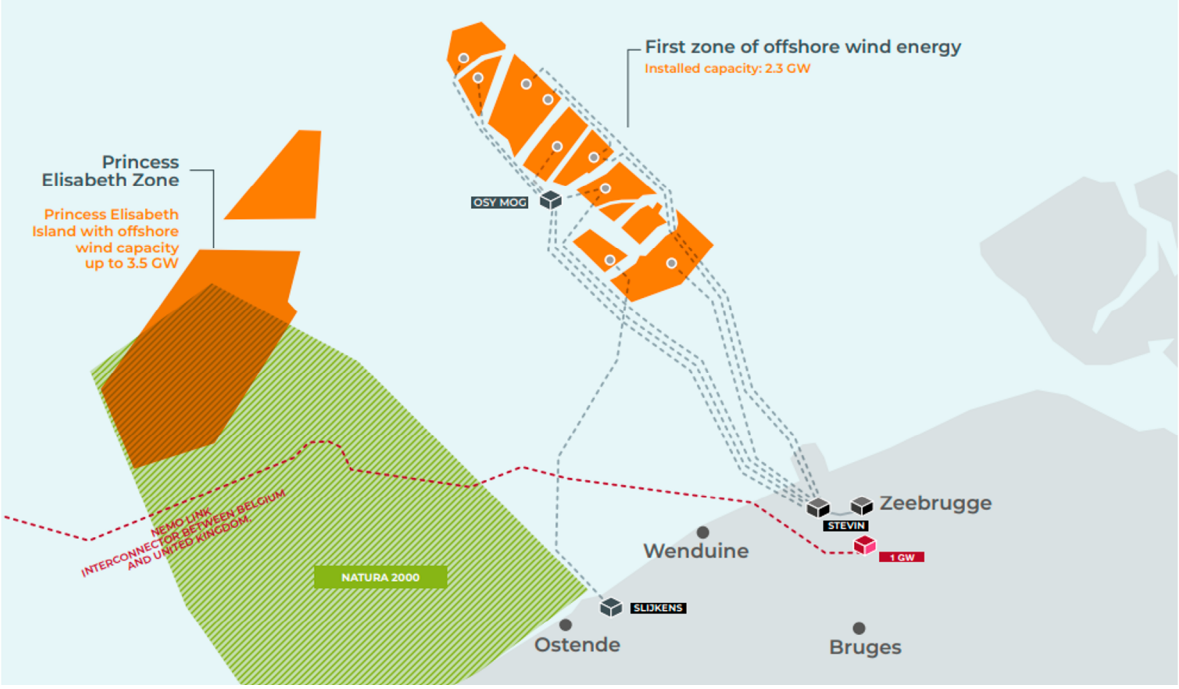

Figure 1: Location of the different phases of offshore development in the Belgian North Sea.

comparable to the capacity of the two largest nuclear reactors (Doel 4 and Tihange 3) combined.

All nine wind farms (399 wind turbines) in the Belgian North Sea have been fully operational since December 2020. This means 2023 is the third year with fully installed generation capacity for this major Belgian power plant. Over the first two years, the annual production of green electricity remained relatively constant, while 2023 produced significantly more. In 2022, a total production of 6.6 TWh was delivered to the Belgian power grid. In 2023, this increased to 8 TWh. This corresponds to the annual electricity needs of nearly 2.3 million households or about 10.2% of the total electricity demand in Belgium.

Matters Affecting Growth and Work to Remove Barriers

Work to remove barriers to new wind energy projects continues. Such barriers include spatial planning limitations (i.e., military, aeronautical, or traffic-related restrictions) and lengthy permitting procedures. The federal administration has created a 'one-stop-shop' to simplify and speed up the license procedures.

Lengthy legal procedures also affect the sector. For example, cases where local communities appealed against the construction of wind energy facilities have taken years to resolve. Such legal cases could potentially be avoided by involving the local communities more closely at the project planning stage and by offering them the opportunity to participate in investments through cooperatives.

The main issue affecting the growth of wind energy is the number of judicial appeals filed at the State Council, which has severely hindered the development of land-based wind farms in the Flemish and Wallonia regions. Belgium has limited space for wind energy compared to many other countries.

On the 18th of March 2022, the Belgian Council of Ministers decided to speed up the energy transition with the goal of developing greater energy independence going into 2023. Therefore, the federal government is accelerating its efforts to produce renewable energy and has decided to:

- Reduce barriers (distances to radars, height restrictions, surface area and location of exclusion zones, etc.) that prevent the rollout of renewable energy (a potential increase of 1.5 GW of renewable energy).
- Take the necessary initiatives to have the first wind turbines in the Princess Elisabeth zone operational by 2027.
- Investigate how offshore capacity in the North Sea can be optimised and further expanded to an installed capacity of up to 8 GW.
- Increase renewable electricity production in the first zone by conducting a study into repowering, in combination with the previous point. This concerns a potential increase of 2 GW. This study has been published on the 1st of March 2024 [3].
- Take the lead in setting up a fast-track task force together with neighbouring countries in the North Sea to accelerate the development of an offshore wind network.

- Accelerate investment in solar energy at sea (floating solar). This concerns a potential of 1 GW.

RD&D Activities

National RD&D Priorities and Budget

Belgium continues to prioritise onshore and offshore wind energy as a key component of its renewable energy strategy. The national research, development and demonstration (RD&D) priorities and budgets for wind energy innovation reflect a strong commitment to innovation and sustainability in all Belgian regions. In 2023, Belgium allocated significant resources towards advancing offshore wind technologies, optimising onshore wind farm performance, and integrating wind energy into the national grid via provincial and regional innovation subsidies and the federal Energy Transition Fund (ETF) framework. The latter explicitly focuses on the offshore wind and offshore grid infrastructure.

The RD&D programmes focus on improvements such as turbine production efficiency gains by using AI, enhancing predictive maintenance technologies, and minimising environmental impacts through, e.g., Nature Inclusive Design. The programmes encourage collaboration between government, academia and industry to advance new technologies and reduce costs. An example of such collaboration is described in the OWI-Lab collaboration framework. The budget for wind energy RD&D has increased to enable Belgium to achieve its renewable energy targets and contribute to the global energy transition. In 2023, the R&I expenditure in the Flemish region increased by more than 35% to 6.7 million euro (estimated). On the federal level (offshore wind), 7.662 million euros were allocated via the Energy Transition Fund.

National Research Initiatives and Results

OWI-Lab is a specialised research and expertise collaboration framework for advancing offshore wind energy technology. The initiative was already set up in 2010 by Sirris (Belgian Technology Centre) and two universities, VUB and UGent. The partners support the Belgian offshore wind industry through research, development and innovation services. Every year, the initiative submits locally and nationally funded RD&I projects based on the needs of the industry.

In 2023, a new HVDC and underground Cable Competence Center (HC3) was set up by EnergyVille/KU Leuven. HC3 is a specialised facility dedicated to the research, development, and testing of high-voltage direct current (HVDC) and underground cable systems.

Test Facilities and Demonstration Projects

- Several R&D measurement campaigns in the Belgian offshore wind farms, Northwester and Norther, continue as part of the SuperSized 4.0 project focusing on “Smart O&M for a fleet of SuperSized wind turbines in Industry 4.0 context”. New advanced SHM (structural health monitoring) and CM (condition monitoring) techniques using 5G IOT sensors are set up with this purpose.

- As part of the Rainbow project (Flemish Region), focusing on “optimised prediction and decision support for rain erosion and lightning-driven degradation of blades”, a microphone test set-up has been installed at the Rentel offshore wind farm which will be used in an experiment to ‘listen’ to blade erosion sound.

Figure 2: Microphone test set-up at the Rentel offshore wind farm.

- Wind turbine gearbox and drivetrain manufacturer, ZF Wind Power, located in Lommel, is investing in a new test and prototype centre, including a 30 MW validation test benchmark. It is proposed to be the most powerful in the world. The test benchmark will be used to test and validate the durability and lifetime of multi-MW prototypes that need to operate in extreme offshore conditions.

New projects to highlight (non-exhaustive list)

- ETF North-C-Blade: The North-C-Blade consortium will evaluate the use of gasification technology to recycle discarded turbine blades. This includes pre-treatment of the waste/feedstock, new electrified reactor technology and removing chlorine from the product so it can be valorised in new material applications. A feasibility study will assess the viability of a gasification plant capable of processing up to 200 KTA of waste, including decommissioned wind turbine blades from the North Sea area.

- ETF Bel-Float – Catalysing the Belgian industrial expertise in floating wind through academic innovation: To uphold the current competitiveness of the Belgian offshore wind industry, it needs to fully enter the emerging and promising market of

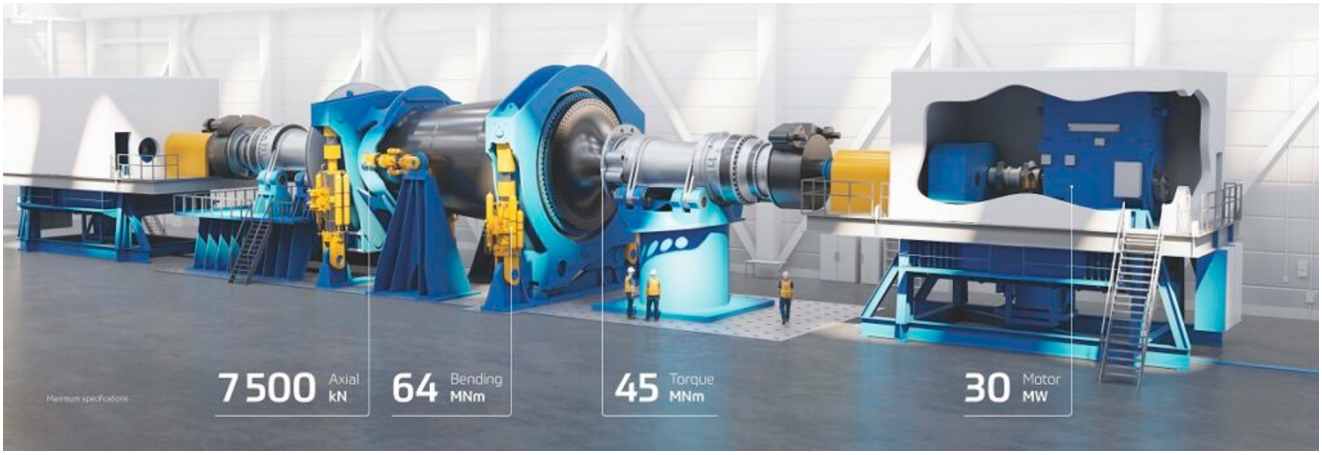

Figure 3: New test and prototype centre of ZF Wind Power.

floating wind. However, to do so, they require a competent and long-term academic base, which will be provided by BEL-Float: A select group of junior researchers and their surrounding ecosystems will acquire knowledge and skills in close collaboration with industry to face the most urgent challenges in floating wind. A unique bonus is our extensive cooperation with Norwegian universities to strengthen the Belgian-Norwegian energy alliance.

- ETF FlexWind - Fatigue Life Extension of offshore Wind foundations: Substructures of offshore wind turbines are designed for a lifespan of 20 to 30 years. After this period, a study is typically conducted to evaluate a lifespan extension. This study assesses whether the loads experienced were milder than those considered during the design phase. Such an analysis is only possible if the load history has been accurately recorded. The possibility that a structure has a higher (fatigue) resistance than assumed in the design rules is not considered. Within the FlexWind project, the possibility of extending the lifespan of offshore wind substructures will be investigated. To this end, the following innovative methods will be combined:

  *Inspection of aged welded 'node connections' (3D scans of the geometry of critical connections, evaluation of surface damage due to corrosion);

  *Numerical analysis of accumulated fatigue damage from the past and the future remaining lifespan;

  *Probabilistic methods to account for the variability of the different parameters that influence fatigue resistance;

  *Large-scale experimental tests on samples representative of offshore wind jacket substructures.

- ETF OWiDEX - Offshore Wind Decommissioning Expertise Centre: Belgium is among the world leaders in installing and maintaining offshore wind farms. The decommissioning of the first offshore wind turbines is imminent. The knowledge already acquired about the decommissioning value chain is fragmented, making a unified vision seem distant. This project brings all the individual elements together and is the kickstart of a long-term collaboration between knowledge institutions, government bodies, and companies. This way, experience, knowledge and research are consolidated, visualised and disseminated, providing an expertise platform for policy and industry.

- ETF Smartlife - Leveraging model and data-driven digital twins for smart asset management and lifetime optimisation of offshore windfarms: The Smartlife project aims to develop tools for further optimising the operation and maintenance of offshore wind farms, ensuring structural reliability and increasing the likelihood of extending the lifespan of offshore wind infrastructure in the Belgian North Sea. This project can directly contribute to federal policies regarding energy transition and energy supply security. To achieve this, the project will utilise advanced physics-based and data-driven "digital twins".

- ETF MP Multi-use - Multi-(re)-use scenarios for existing offshore infrastructure: a conceptual, economic, legal and structural reliability study: The project will study the feasibility of (re)using existing infrastructure for hybrid energy generation and/or repurposing it for wave/tidal energy or to accommodate storage technologies. It aims to improve yield and reduce the levelized cost of energy (LCOE) of the Belgian offshore zone. Furthermore, offering an alternative to the complete dismantling of existing infrastructure. In MP Multi-Use,

experienced consortium partners will conduct a conceptual, economic, legal, and structural reliability study on the multi-(re) use of existing infrastructure and the combined use of maritime space.

- ETF STERNA2050 - Industrial and fundamental research and scenario analysis of the potential contributions of superconducting offshore connection systems - aimed at long distance, high capacity, loss-free power transmission - to the decarbonisation and security of supply of Belgium by 2050: The project investigates the potential contribution of superconducting system technologies to supply security, the increased share of renewable energy for Belgium, and the associated socio-economic impact. A complementary academic-industrial consortium will examine the expected prospects of the North Sea power plant for 2030-2050 and the innovative technological scenarios for bringing power flows to Belgium. This will be combined with a comprehensive assessment of the environmental impact, material usage, and economic impact over the system's lifespan.

Collaborative Research

International collaboration is essential to accelerate investments in research and development in renewable energies, such as wind. To that end, the Federal Public Service of Economy joined the IEA Wind Technology Collaboration Program in 2015.

Belgium is active in several Tasks of IEA Wind: 11, 34, 41, 42, 34, 46, 48 and 50.

Impact of Wind Energy

Economic Benefits

The wind energy sector creates excellent economic opportunities. Being active in this industry has also created export opportunities. In addition to wind farm constructions, there is a need to expand grid infrastructure, grid connections, and connections with neighbouring countries.

The impact on employment is substantial, and jobs are created in the design, construction, maintenance, and replacement of wind farms, in addition to the permanent workforce, often in areas with few job opportunities. The offshore wind industry supports about 16,000 jobs in Belgium, including export activities, construction and operations, and maintenance. More specifically, the offshore wind industry will continue to provide significant direct and indirect contributions to the energy sector, which has about 50,000 direct jobs today.

Environmental Impact

In addition to adding sustainable energy capacity, offshore wind energy developments also increase biodiversity, specifically, for organisms such as sea corals and plants. Offshore wind turbine foundations form artificial reefs, where mussels and other sea life grow. The foundations also contribute to the growing fish population, providing many opportunities to further develop the marine culture in the Belgian North Sea.

Next Term

Belgium is preparing for the tender for the second offshore zone. It is anticipated that the tender will be launched in Q4 2024.

References

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