Report 2023

Finland

Wind turbines rising above the forest canopy in the municipality of Kalajoki. *Credit: Ville Suorsa.*

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After a record year in deployment in 2022, Finland's wind power growth decreased slightly. Despite the slowdown, the actual wind power capacity increased by 23% by the end of 2023.

By the end of the year, wind power capacity in Finland closed in on 7 GW. Wind power in Finland continues to be built in a market-driven way, without subsidies.

Practically all wind power in Finland is onshore. Most of this capacity is concentrated in the western part of the country. There is an increased interest in offshore wind in Finland, but most offshore projects are still in the planning stage.

The focus in research in Finland last year was on developing energy system modelling tools, developing solutions for cold climate issues and the effects of atmospheric icing on wind turbines and sea ice on offshore wind. On the other hand, local acceptance of wind power is becoming more and more relevant in Finland due to the increasing

Table 1. Key National Statistics 2023: Finland

Total (net) installed wind power capacity	6.946 GW
Total offshore capacity	0.04 GW
New wind power capacity installed	1.278 GW
Decommissioned capacity (in 2023)	0.012 GW
Total electrical energy output from wind	14.467 TWh
Wind-generated electricity as percent of national electricity demand	18.1%
Average national capacity factor	28.9%
Target	
National wind energy R&D budget	4.835 M€

number of wind turbines. Research into the social acceptance of wind power in Finland and how to develop projects in collaboration with other local interests were also prominent themes in 2023.

Highlight(s)

- New onshore wind turbines are large: average rated capacity of 6 MW, hub height of over 150 metres and rotor diameter of over 160 metres.
- Wind power capacity increased by 1.3 GW, a 23% increase in total capacity to 7 GW, and a share of wind from 14% to 18% of demand.

Market Development

Targets and Policy

The new government of Finland published its programme in June 2023 [1]. It includes several policy initiatives related to wind power development. The main goals are to streamline permitting procedures by eliminating overlapping appeals and to increase wind energy construction in eastern Finland. In addition, the legislation regarding offshore wind development in Finland is still unclear or lacking in certain cases. The regulations regarding wind turbine construction in the Finnish exclusive economic zone must be set as soon as possible.

In addition, goals are set to ensure that the increase of wind power can be done without compromising the social acceptability of wind, including revamping the compensation mechanism towards landowners regarding transmission lines and clarifying the requirements for environmental impact assessment. There will also be new requirements related to end-of-life activities, such as dismantling the turbines.

The policy scenario in the previous national climate and energy strategy envisioned an annual wind power production of 23 TWh in 2030 and 30 TWh in 2035, corresponding to shares of 24% and 29% of annual electricity consumption, respectively [2]. However, the previous strategy and its calculations were made before the Russian invasion of Ukraine. Since then, the Finnish energy system has made substantial changes. A new energy and climate strategy is in the making. It will have significantly more wind power to replace imports from Russia, the Russia-backed nuclear power plant project has been abandoned, and initiatives are being made to cover the growing electricity demand.

Progress and Operational Details

Onshore wind in Finland is being built without any active public support system. Following the record year of 2022 in terms of deployment of new projects, the pace slowed down in 2023, but there was still a 22.5% growth in wind power capacity, see Figure 1 [3].

The year 2023 was a below-average wind year. The wind index was 93%, but due to a substantial increase in wind power capacity and new turbines being more efficient, the share of electricity produced by wind increased by 28% to 18.1% of total electricity consumption in Finland [4].

Wind turbines built in Finland are large and have relatively tall hub heights. Last year, the average new turbine in Finland had a rated capacity of 6 MW and a hub height of over 150 metres. The average rotor diameter was over 160 metres [3].

42% of Finnish wind power capacity is owned by domestic corporations (domestic here means that more

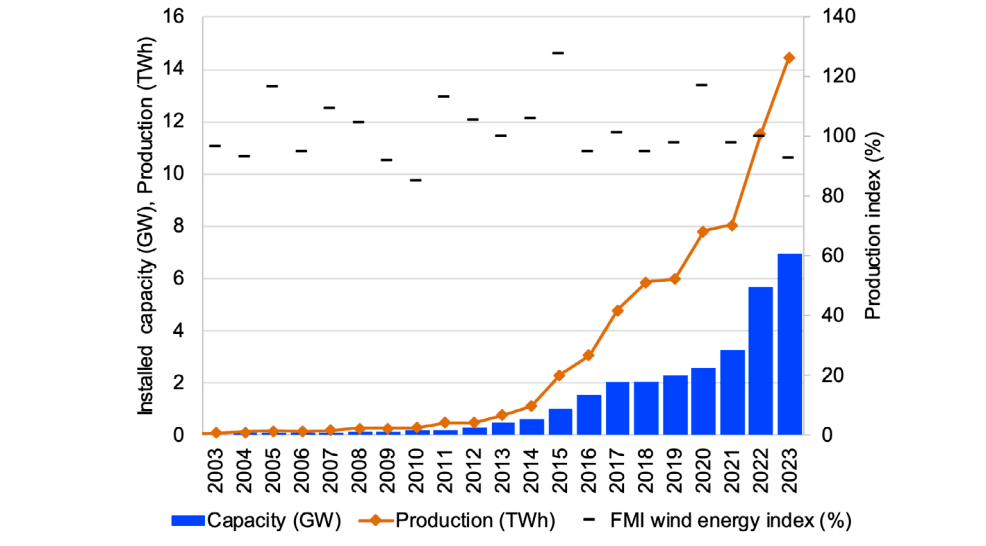

Figure 1. Development of wind power capacity and production in Finland. The wind power index shows the yearly generation compared to the long-term average (100%) provided by the Finnish Meteorological Institute (FMI).

than 50% of corporate ownership is Finnish). The ownership is quite widely distributed. The largest market share held by a single company is 10%. The newly added capacity came from three suppliers: 55% Nordex-Acciona, 44% Vestas and 1% Enercon.

Matters Affecting Growth and Work to Remove Barriers

Wind power in Finland is concentrated in the western part of the country, partially for wind resource and national security reasons.

To ensure the system's and power plants' security, the transmission system operator started limiting the grid connection of new inverter-connected generation units on the west coast of Finland in 2023. Solving these issues requires changes in the power plant control systems and investments in the transmission grid. New grid investments in the area will be completed in 2027 and 2028 [5].

In 2023, the Finnish government commissioned a study to reduce the barriers to wind power development in eastern parts of the country. The

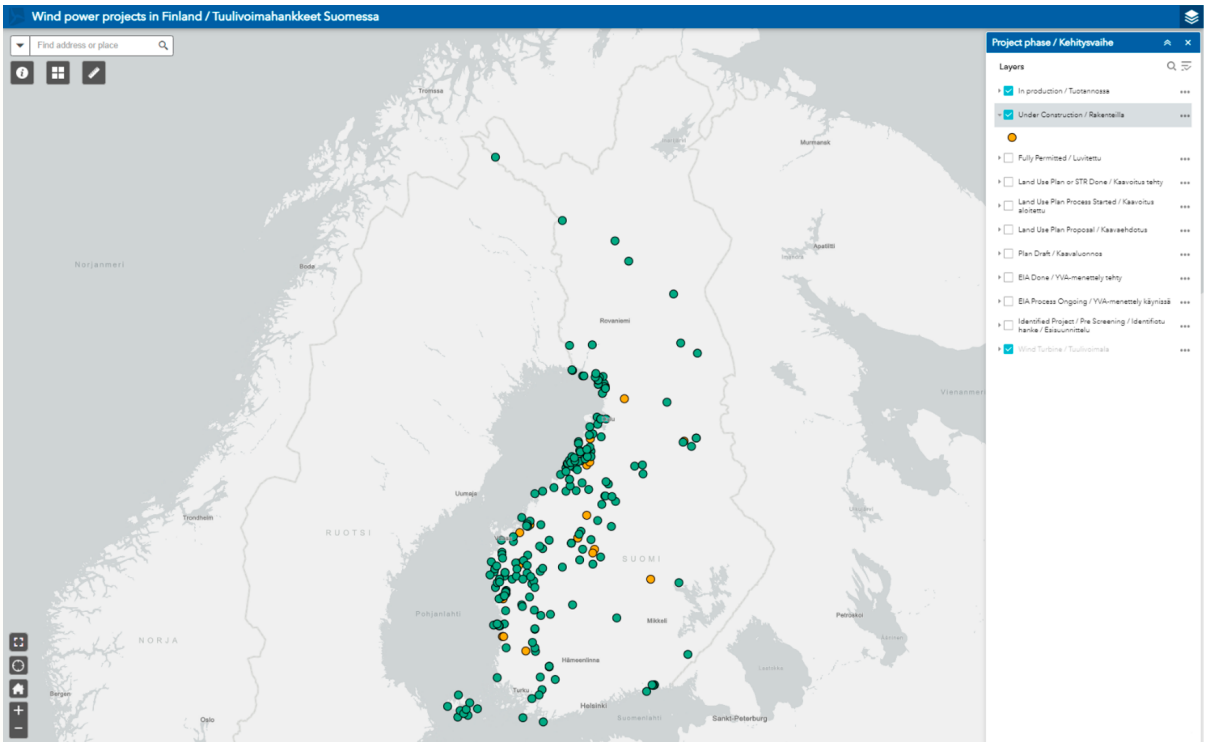

Figure 2. Wind power projects in Finland. *Source: Finnish Wind Power Association / AFRY.*

report included several suggestions to increase wind power deployment in eastern Finland and the government has set up a committee to implement the suggested policies.

The average electricity spot price decreased to 56 EUR/MWh from last year's record-high average price of 154 EUR/MWh. The number of negative price hours was 467. Compared to other European countries, the electricity spot price is relatively low in Finland (58% of the average 97 EUR/MWh in Europe). The market value of wind power was 40 EUR/MWh, that is, 72% of the average spot price in Finland.

The transmission system operator aims to promote wind power in the market for automatic reserve products. The system operator published a guide for participating in weather-dependent energy production in automatic reserves as part of a pilot project. It specifies requirements for baseline power, calculation of available active power, and the maintained reserve [6].

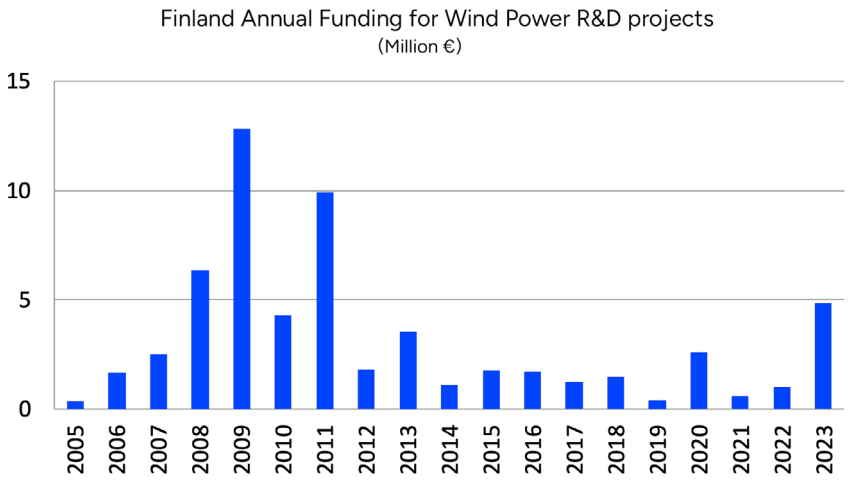

Figure 3. Public R&D funding in Finland has averaged EUR 1.7 million annually during the past decade. *Source: Business Finland.*

RD&D Activities

National RD&D Priorities and Budget

The Finnish Funding Agency for Technology and Innovation, Business Finland (BF), continues to fund research and innovation in the country. Wind power is aligned with the key aspects of sustainability and economic growth, which define the Business Finland (BF) strategy for 2025. Public R&D funding from BF for wind power was EUR 4,835 million in 2023 (Figure 3).

National Research Initiatives and Results

An operational ensemble wind power prediction system has been established at FMI as a result of R&D work conducted as a part of the HOPE project (Highly Optimised Energy Systems) funded by Business Finland and BC-DC (Bright Clouds – Dark Clouds) Energy project funded by the Strategic Research Council at the Academy of Finland. Deterministic forecasts of Finland's aggregated wind power generation are available for the public on FMI's web page.

The Project LandUseZero, funded by the Ministry of Agriculture and Forestry, looked at different land use and land management options in Finland, wind power construction being one of them. The project partners studied the acceptance and perception of wind power, its impact on wildlife and people and land value, and how the siting of wind farms and management of land and forests around wind farms can affect the acceptance of wind power in the area.

There is a growing interest in offshore wind in the Baltic Sea, but the local conditions, especially sea ice, cause unique challenges for these projects. Two example projects looking into these issues are currently active: The WindySea project, funded by the Research Council of Finland and led by Aalto University, aims to build design and simulation tools to simulate icing conditions and wind turbine structures that allow operations in areas where sea ice can form. Project IceWind, led by VTT, focuses on sea ice's impact on the foundations of bottom fixed structures. The project will conduct experiments at the Aalto University ice tank and field measurement campaigns on sea ice loads on structures and atmospheric icing on wind turbine blades.

Collaborative Research

FMI and researchers from Chalmers and Copenhagen universities developed a model for calculating the lifetime revenues for wind power investments, accounting for the cannibalisation effect due to growing wind power market penetration [7].

Within the 3-year EU Horizon project, RISKADAPT, FMI will execute a task related to the effect of icing on energy infrastructure, including wind turbines, especially on the transmission grid. During the project, FMI will analyse the projected changes in icing conditions in Scandinavia, which will be of interest in all fields affected by icing.

VTT is active in collaborative research projects, such as 1) TradeRES, analysing electricity market designs for nearly 100% renewable systems in Europe, 2) OASES, developing an energy system modelling ecosystem to facilitate wind and solar integration in Africa, 3) Mopo, developing modelling tools for planning of 100% sustainable and resilient energy systems, and 4) AIRE, developing tools for blade erosion modelling and

a toolbox to mitigate the impact of erosion at the blade level. The AIRE project relies on field measurements and more theoretical models.

Within the IEA Wind TCP, Finland takes part in:

- **Task 11.** Base Technology Information Exchange, which produces valuable information for identifying issues important for wind R&D in Finland.
- **Task 25.** Design and Operation of Energy Systems with Large Amounts of Variable Generation (Finnish organisations VTT and Recognis serve as Co-Operating Agents).
- **Task 44**. Farm flow control. VTT as a participant.
- **Task 46**. Erosion of wind turbine blades. VTT as a participant.
- **Task 54.** Cold Climate wind power (VTT serves as the Operating Agent). Finland has a national interest in addressing the challenges of adapting wind energy to cold climates. The Task has been instrumental in deploying wind energy in harsh environments.

Impact of Wind Energy

Environmental Impact

In 2023, CO2 emissions from electricity production were 2.5 Mt in Finland (decreasing 38%, 65% and 87% from 2022, 2018 and 2010, respectively). Specific CO2 emissions of electricity production have decreased from 227 g CO2 / kWh(e) to 33 g CO2 / kWh(e) between 2010 and 2023. At the same time, the share of wind power in annual electricity production has increased from less than 1% to 18.5%. The share of renewables was 52% and the share of CO2 neutral production was 94% of the total electricity production in 2023 [4].

Suomen Hyötytuuli actively monitors birdlife in the Tahkoluoto offshore wind farm area with the help of a bird radar. Breeding bird surveys have shown that the Tahkoluoto wind farm has no significant impact in one way or another [8].

A multi-year study on how to improve the collaboration between the wind industry and reindeer owners in Finnish Lapland was concluded in 2023. The project developed a framework for communication and cooperation between wind power developers and reindeer owners. The main result of this work has been the opening of a communication channel between the wind power industry in Finland and the reindeer owners, which will hopefully lead to an increase in the local acceptability of wind power in Finnish Lapland [9].

Economic Benefits and Industry Development

The majority of wind power-related employment in Finland is in the construction and operations of wind power. The growth of wind power in Finland is expected to remain relatively high, meaning that the wind power industry will continue to grow as well. According to a study conducted by MDI, the lack of an expert workforce will be a growing issue for the wind power industry in the country in the future; many companies see recruitment issues already and do not expect the situation to improve in the immediate future [10].

Offshore wind is also a potentially growing segment in Finland. Gaia Consulting looked at the potential impact on Finland's planned and published offshore projects. Depending on the scenario and completion rate of the scheduled projects, offshore wind can create between 73.000 and 224.000 person-years of work for Finns [11].

Next Term

The growth of wind power in Finland is expected to continue at a level comparable to 2023. According to statistics collected by the Finnish Wind Power Association, there are currently 2.6 GW of onshore capacity under construction and a further 3.5 GW of fully permitted projects in the pipeline.

The government plans to set an ambitious goal for offshore wind in Finland, but the exact numbers are not public yet. Wind onshore and offshore are considered an integral part of the plans for carbon neutrality by 2035.

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