



Report 2022

Portugal

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In 2022, wind generation constituted 25.5% of electricity demand, similar to the record year of 2019. Moreover, R&D Project PivotBuoy successfully installed their new X30 floating platform in the Canary Islands, and it is currently being monitored.

Introduction

In 2022, the new wind power capacity installed amounted to 28 MW. In an effort to support further onshore wind development, new legislation was published to facilitate the licensing procedures for repowering, overplanting and hybridisation of onshore power plants. Correspondingly, a ministerial working group was created by the Portuguese government to accelerate the offshore wind market,

expecting a total installed capacity of 10 GW. The initial procedures to develop this capacity are expected to start in 2023. In addition, a separate ministerial working group has been established to identify less environmentally sensitive areas available for RES installations.

The main R&D project tasks were ongoing as expected. Project Carbo4Power continues to develop new multi-materials to enhance the performance of its offshore turbine

Table 1. Key National Statistics 2022: Portugal

Total (net) installed wind power capacity*	5.671 GW
Total offshore capacity	0.025 GW
New wind power capacity installed	0.028 GW
Decommissioned capacity (in 2022)	N/A
Total electrical energy output from wind	13.27 TWh
Wind-generated electricity as percent of national electricity demand	25.5%
Average national capacity factor**	26.7%
Target	9.0 GW onshore and 0.3 GW offshore by 2030
National wind energy R&D budget	N/A

rotor blades. Meanwhile, project PivotBuoy successfully installed their new X30 floating platform at their test site, PLOCAN, in the Canary Islands. Project RealCoE remains in its development stage of engineering a 12+ MW wind turbine, while Project Atlantis continues performing scenario tests of their robotics to examine a turbine tower and blades at Viana do Castelo.

Highlight(s)

- R&D Project PivotBuoy successfully installed their new X30 floating platform in the Canary Islands and is being monitored.
- Wind generation constituted 25.5% of electricity demand, similar to the record year of 2019.
- Decline in new capacity installed in 2022, amounting to 28 MW. Proposals to accelerate this are planned from 2023.
- A new record in the 15-minutes instantaneous share of wind power of demand: 110%.
- Inter-ministerial working groups

were created for the definition of procedures for offshore development and identification of less environmentally sensitive areas for RES installation.

Market Development

Targets and Policy

The 2030 targets for renewable power capacity were published in the National Energy and Climate Plan (NECP) [1]. The ambitious targets aim for a wind power capacity of 9.3 GW, which is set to include overcapacity, repowering, and 300 MW dedicated to offshore wind energy systems, by the end of 2030. Furthermore, the vision for 2050 was developed and added to the Portuguese Roadmap for Carbon Neutrality 2050 (RCN2050) [2]. The wind power capacity scenarios expected by 2050 range between 12.0 to 13.0 GW onshore and 0.2 to 1.3 GW offshore. However, in lieu of the global energy crisis, the Portuguese Government has since 2022 revised the plans NCEP2030 and RNC2050. In order to reach the goals of 2030 and 2050, will naturally require the increase of RES contribution in the energy mix.

The target for the development of offshore wind was of special concern for the Portuguese Government. Therefore, a working group (WG) was created in the last trimester of 2022, to define development areas and capacity goals [3]. The WG creation certificate appointed a target of 10 GW exclusively for offshore wind projects, constituting a significant advance in wind energy capacity for Portugal.

The scope of this working group extends to developing guidelines for requesting tenders and defining areas to develop offshore renewable projects. The scope is expected to be launched in the first half of 2023.

During 2022, new legislation was published regarding the scope of renewable energies in Portugal. Its most relevant legal documents in relation to licensing procedures, have the objective of accelerating the RES installation, DL15/2022 [4]. The circumstances of this DL enabled, for the first time, significant measures which were defined to accelerate RES licensing procedures. The legislation intends to motivate further investment in the wind energy sector, specifically in overplanting, repowering, and hybrid power plants. This

additionally aims to allow the hybridisation of existing wind power plants with other renewable power sources and/or storage systems sharing a single interconnection busbar.

Progress and Operational Details

During 2022, the wind power cumulative capacity increased by 28 MW (See Figure 1). By the end of year, the cumulative installed capacity was 5,671 MW distributed over 267 wind parks, each with 2,836 wind turbines

[5]. The Portuguese wind power fleet generated 13.27 TWh, which accounts for approximately 26% of electricity demand [6-8].

The wind share of the total renewable energy production increased by 5% from 2021 to reach a total share of 45% in 2022 [5]. This slight increase is mainly due to the 30% decrease in hydropower production attributable to a dry year where the hydro generation index stood at 0.63. Furthermore, it was an average year regarding the wind regime. Solar power similarly increased by 5% from

2021, now standing at a 12% share.

The average wind power production at full capacity stood at 2,339 full load hours, indicating a slight decrease of 0.1% over 2021 [5]. The Portuguese transmission system operator (TSO) indicated an annual wind generation index of 0.99, comparable to a value of 1.01 in 2021 [6]. Figure 2 depicts the wind generation profiles on the following:

- The maximum demand day and the respective wind power contribution: The maximum

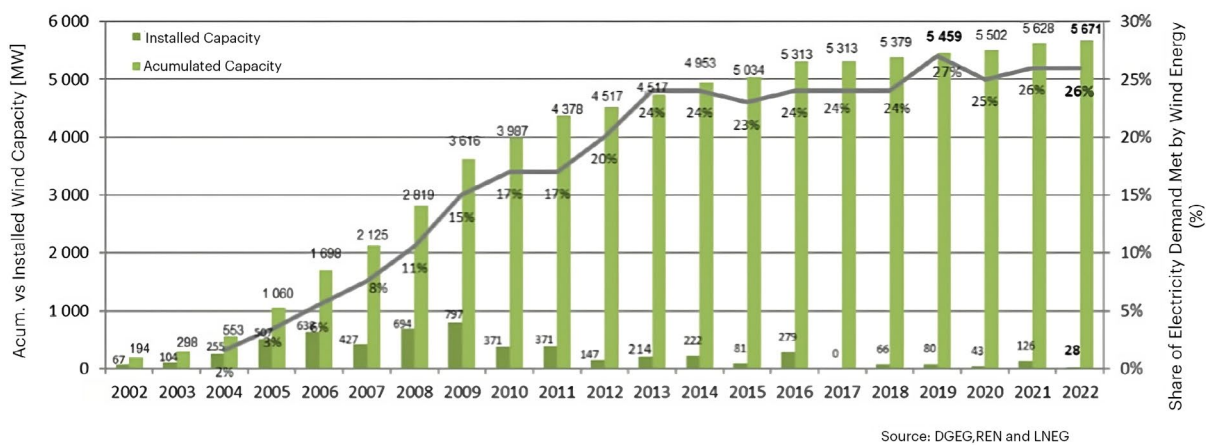


Figure 1. Installed and cumulative wind power capacities and share of electricity demand met by wind energy (line graph).

instantaneous demand value (8,595 MW) occurred at 19:30 on the 26th of January 2022, when wind generation was 2,019 MW (35% of the capacity installed).

- Maximum daily contribution from the wind: On the 19th of December 2022, wind power supplied Portugal with 101.4 GWh of electricity, setting a new record. This accounted for 68% of daily demand.
- Instantaneous peak wind contribution: A maximum of 110% of 15-minutes instantaneous penetration of wind power in the demand value occurred on the 23rd of October 2022. The daily wind contribution during this day was 76%.

Of the wind penetration values recorded in 2022, the TSO did not report any technical problems during these events. Moreover, the TSO also did not report wind energy curtailment occurrences.

Matters Affecting Growth and Work to Remove Barriers

Similar to previous years, the new grid connection capacity remained on hold for wind technology throughout 2022. However, following the current energy crisis, the Portuguese government has published legislation to accelerate the installation of renewable energy systems (Dec-law 15/2022) through the simplification of certain licensing procedures. Additionally, according

to the Portuguese NCEP 2030, large proportion of projects is expected to be focused on the exploitation of existing wind farms in regard to hybridisation. Hybridisation refers to power plants generating electricity using two or more renewable technologies, including energy storage systems and inject electricity into the same interconnection grid busbar. Furthermore, the new legislation concerns overplanting and repowering, as outlined in the current legislation. Studies are underway to define the available and sustainable capacity required in mainland Portugal. Nevertheless, approximately 10 GW of wind capacity is expected to be achieved by repowering existing wind power plants.

An additional activity conducted in

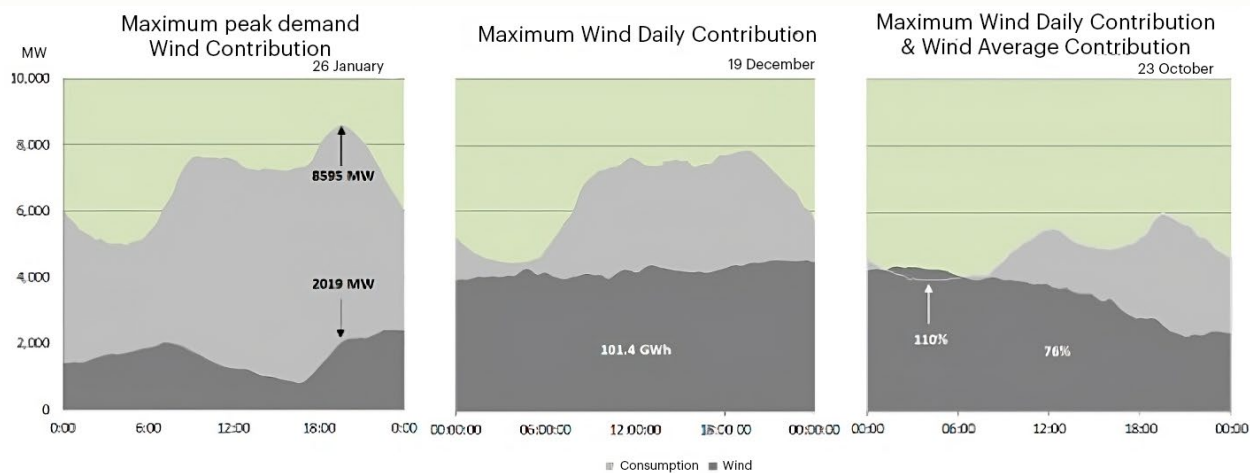


Figure 2. Demand, wind power penetration, and energy generation records during 2022 (Source: REN and LNEG).

2022 surrounds the initial phases of identifying the least environmentally sensitive areas suitable for RES installation. This is the first step in defining Portugal's "go-to" areas as intended by the REpower EU strategy. This work was conducted by a working group consisting of a number of entities directly involved in the licensing procedure, R&D institutes, and territorial management entities.

Furthermore, in the offshore sector, significant growth is expected in the coming years with the establishment of working groups tasked with defining areas and development procedures.

RD&D Activities

National R,D&D Priorities and Budget

National R&D priorities for 2022 remained focused on training facilities and the design of different services for offshore wind industry. This includes the creation of a wind forum [9] dedicated to all actors evolving the local, regional, national and EU wind energy governance entities. Additionally, a new pioneer project concerning the handling of reuse, remanufacture and recycling of wind energy materials was launched. Most R&D activities take place at the main

Portuguese institutes and universities and are funded through national and/or European programmes.

The Portuguese Foundation of Science and Technology (FCT) invested 636 million EUR (682 million USD) in science and technology in 2022. Approximately 152 million EUR (163 million USD) was for RD&D and innovation projects, while 131 million EUR (141 million USD) went towards scientific jobs [10]. These numbers represent a 12% increase in total investment, 13% increase in RD&D investment, and a 7% increase in scientific jobs compared to 2021 [10].

National Research Initiatives and Results

The demonstration project INFINITE [11] has commenced its activity. The project focuses on the development and demonstration of two technology innovations merged into a new TLP platform with a tendon mooring system utilising aluminium dynamic cables. Additionally, the following three new research projects launched as well: The EuReComp [12] is focused on providing strategies to reuse, refurbish and recycle materials in wind turbines. The JustWind4All [13] provides a wind forum with a platform to meet, network, discuss, and start dialogues with local, regional, national and EU wind energy governance actors. Lastly, MARINEWIND [14]

handles recommendation proposals for deploying offshore wind turbines.

Test Facilities and Demonstration Projects

Portugal's ongoing R&D activities are as follows:

- INFINITE: an H2020 demonstration project of a floating offshore wind system at 100 m water depths, equipped with a tension leg platform anchored with an innovative tendon-based mooring system.
- EU-SCORES: an H2020 demonstration project to display the benefits of continuous energy production based on the renewable energy sources: wind, sun and waves in Belgium and Portugal.
- ReaLCoE: an H2020 demonstration project created to accelerate a new generation of competitive and subsidy-free clean energy from offshore wind energy converters with a high-performance 12+ MW demonstration turbine.
- PivotBuoy: an H2020-funded project to demonstrate and validate the offshore PivotBuoy system for mooring, connection, installation and operation of

Floating Wind.

- ATLANTIS: an H2020-funded project for demonstration and developing a pilot infrastructure capable of enabling robotic technologies to conduct inspection and maintenance of offshore wind parks.
- MARINEWIND: an H2020-funded project for developing and demonstrating material solutions for cost reduction and the extension of service life of offshore wind facilities.
- Carbo4Power: An H2020-funded project for demonstrating a new generation of offshore turbine blades with intelligent architecture which increase operational performance and durability.

Collaborative Research

Portugal currently participates in various IEA Wind Tasks:

- Task 25 - Design and Operation of Power Systems with Large Amounts of Wind Power.
- Task 28 Social Acceptance of Wind Energy Projects.
- Task 34 - Working Together to Resolve the Environmental Effects of Wind Energy (WREN).
- Task 36 - Forecasting of Wind Energy.

The Portuguese participation in these tasks provided scientific and technical support to the Secretariat of State (Environment and Climate Action State Secretary) that leads the R&D activities in Portugal, and to the development of R&D projects.

In addition to the IEA Wind TCP activities, Portugal is represented in the European Energy Research Alliance Wind Programme (EERA-Wind), the Energy Systems Integration (EERA-ESI), the European Sustainable

Energy Innovation Alliance (ESEIA) and the International Renewable Energy Agency (IRENA).

Portugal continues to coordinate the COST Action, MODENERLANDS, which relates to sustainable energy islands covering offshore floating power systems, their regulation and grid integration, and their socio-economic and environment aspects. This action outlines the organisation of meetings, seminars, and training schools. In 2023, a training centre in Lisbon has been organised to discuss resource assessment and experimental procedures in the offshore area. In regard to the offshore area, although Portugal is not yet a full member, there has been a punctual collaboration in Task 49 relating to offshore wind and the definition of maritime spatial planning constraints. The work is in progress defining suitable areas for offshore RES development, where Portugal was of great importance for its contribution.

Concerning R&D in Portugal, the following list are some examples of Portuguese participation in national and international projects:

- EuReComp: An H2020 project aimed at developing strategies to reuse, repair, refurbish, remanufacture, recycling and repurpose composite materials from components used in wind energy [12].
- ADOreD: An H2020 project for training researchers in the area of transmission of offshore wind power to the AC grid using power electronics-based on AC/DC technologies [15].
- JustWind4All: An H2020 project to design a wind forum, meaning a platform developed to meet, network, discuss and collaborate with local, regional, national and EU wind energy governance actors [13].
- WIMBY: An H2020 project which provides tools for stakeholders

to assess the potential of the development of wind parks which help decision-making further wind energy deployment [16].

- Romain: An H2020 project developing a robotic inspection and repair solution system for wind turbine blades, both onshore and offshore [17].
- MARINEWIND: An H2020 project to propose recommendations and transfer specific knowledge for future deployment of offshore wind turbines in Greece, Italy, Portugal, Spain, and the United Kingdom [14].
- TWIND: An H2020 project that aims to create a network of specialised scientists and educators in offshore renewable energy, which will provide support to the rising offshore wind industry in Portugal [18].
- TradeRES: An H2020 project that aims to develop and test new market designs for the RES sector that are able to meet society's needs for a (near) 100% renewable power system [19].

Impact of Wind Energy

Environmental Impact

In November 2021 Portugal disconnected the coal-fired centrals and ceased the use of this source for electricity generation. 2022 therefore became the year of adjustment to the new situation. Based on data from the yearly contribution of each technology used in the Portuguese energy mix and imports, Portugal's dependence on fossil fuels was calculated at nearly 39%. This accounts for an additional 5% when compared with the value observed in 2021, as depicted in Figure 3. The wind-generated electricity allowed savings of approximately 5.5 million tons of CO₂ emissions, considering a factor of 430 g/kWh. Although, this estimate is expected to change when

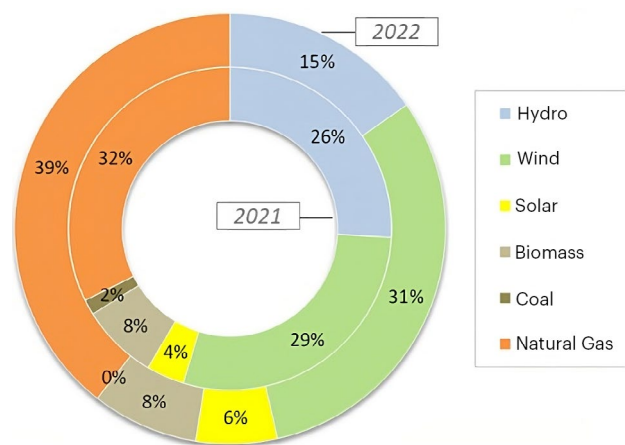


Figure 3. Generation shares in 2021 and 2022 (only in mainland Portugal) to meet the electricity consumption.

considering the reduction of reliance on coal for electricity generation.

Despite Portugal ceasing the use of coal for electricity production as of November of 2021, the share of natural gas contribution in the power system continues to increase. This situation resulted in a slight decrease of 0.1% in CO₂ emission compared to 2021. The 2022 CO₂ emissions totalled nearly 6.1 million tons (MT) in mainland Portugal [8]. Madeira Island observed an almost 13% increase in CO₂ emissions, reaching 0.44 MT. Additionally, Portugal relied on imports for nearly 18% of its energy [6] to meet the increasing electricity consumption, which reached 51.9 TWh in mainland Portugal mainland. This significant amount of imported energy further contributed to the observed reduction of CO₂ emissions.

The RES share in the electricity market is expected to continue increasing in the coming years, especially due to new targets for the NCEP2030, currently under revision.

Economy Benefits and Industry Deployment

The wind industry and deployment activities in Portugal supported approximately 3,250 jobs during 2022.

In the same year, wind-generated electricity generated 1.206 million EUR (1.294 million USD) for wind pow-

er plant developers [20]. The mean tariff paid to onshore wind power plants in 2022 increased by 6.56 EUR/MWh (7.04 USD/MWh) from the 2021 rate to 94.30 EUR/MWh (101.18 USD/MWh) [20]. Regarding offshore power plants, the average tariff paid was 149.92 EUR/MWh (160.86 USD/MWh) [20].

Enercon continues as the lead deployer of wind turbines in Portugal, with a share of 50.9% of wind turbines installed. Siemens-Gamesa is the second largest with 18.9%, followed by Vestas (15.2%), Nordex (7.5%), GEWE (1.9%), Alstom (1.9%), Suzlon (1.8%), and Bonus (1.3%). Other manufacturers make up the remaining 0.5% [21].

Next Term

The next year will be of particular relevance to Portugal since new targets are planned to be defined for 2030 in RES, under the revision of NCEP2030. These are expected to be published in the second half of 2023. The newly adopted legislation is expected to accelerate the permitting procedures for renewable energy projects, while the identification of priority areas, which represent an important measure in leveraging the installed capacity in the near future, is expected to commence during 2023. The first auctions (or similar schemes) are expected to be launched for offshore wind energy

systems before the end of 2023, as a result of the work being developed in the scope of the inter-ministerial Working Group established by the Portuguese Government.

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