iea wind

IEA Wind
Technology Collaboration Programme

2017
Annual Report

Portugal

Table 1. Key Statistics 2017, Portugal	
Total (net) installed wind power capacity	5.3 GW
Total offshore capacity	0 GW
New wind power capacity installed	0 GW
Decommissioned capacity (in 2017)	0 GW
Total electrical energy output from wind	12.3 TWh
Wind-generated electricity as percent of national electricity demand	24.0%
Average national capacity factor	26.3%
Target	Land-based: 5.3 GW; Offshore: 0.027 GW by 2020

OVERVIEW

The wind energy sector achieved a maturity status within the Portuguese power system. In 2017, Portuguese wind farms produced 12.3 TWh, meeting 24.0% of the nation's electricity demand with wind energy [1-4]. For the third consecutive year, wind energy covered more than 100% of the electricity demand during certain hours, without any technical problems reported by the Portuguese Transmission System Operator (TSO). The instantaneous and daily electricity demand met by wind energy achieved new records during the year as well: 110% and 82%, respectively.

For the first year since wind energy capacity was deployed in Portugal, no additional wind power capacity was deployed, although repowering of some wind farms has occurred to maintain the installed capacity.

The total installed wind power capacity at end of 2017 was 5,313 MW, which represents 38.6% of the total renewable operational capacity in the country [1]. A new paradigm is emerging in Portugal, with the first licensing requirements to deploy wind farm projects without feed-in tariff.

Within the scope of the ERA-NET+ NEWA collaborative project, an important experimental wind campaign in complex terrain at Perdigão site started in 2017 with European and North-American partners. Forty meteorological masts, several LiDAR systems and a radio-sounding system were used to measure wind speed and direction from near surface up to 10 km in height. This information is crucial to validate the new European Wind Atlas [5].

MARKET DEVELOPMENT

National Targets & Policies Supporting Development

In April 2013, the government established the national renewable energy targets through the National Renewable Energy Action Plan (NREAP) 2013-2020 [6]. This action plan aims for wind power to reach an installed capacity of 5,300 MW by 2020, of which 27 MW are reserved for offshore wind. The total land-based installed wind capacity is 5,313 MW—exceeding the estimation by 271 MW. In fact, total installed capacity is already above the targets planned for 2020.

The NREAP renewable targets have not been adjusted since 2013. Therefore, the renewable targets previously set to 2020 are active and established as a 10.0% contribution for the transportation sector, 35.9% in the heating and cooling sectors, and 59.6% for electricity [6]. In 2017, Portugal also took an important step toward the NREAP offshore wind targets. The Portuguese government approved an industrial strategy designed to accelerate development in the ocean renewable energy sector, along with the corresponding action plan: Industrial Strategy for Ocean Renewable Energies (EI-ERO) [7]. The EI-ERO plan provides guidelines for using renewable energy with a special focus on floating offshore technology, due to its higher potential compared to fixed technology (40 GW versus 1.4-3.5 GW, respectively).

The Decree Law 153/2014 maintains and regulates the national incentives for micro- and mini-generation [8]. According to Ordinance 20/2017 issued in January 2017, the feed-in tariffs from 2015 will remain valid for existing installations during the statutory period [9]. In August 2017, Ordinance no. 7087/2017 was published requiring an analysis of the fixed tariff for wind energy produced by additional capacity to be installed in existing wind farms (overcapacity).

Figure 1. Installed and cumulative wind power capacities and share of electricity demand met by wind (Source: DGEG, REN, LNEG)

The current tariff is 60 EUR/MWh (72 USD/MWh). To apply this tariff, the National Regulatory Entity for Energy Services (ESRE) has to ensure any energy produced by additional capacity will not exacerbate the overall cost of the electricity [10].

Progress & Operational Details

In 2017, no additional wind power capacity was installed in Portugal (Figure 1). By the end of the year, the cumulative installed capacity was distributed over 257 wind farms, with 2,743 wind turbines operating across the country [1]. The Portuguese wind power fleet generated 12.3 TWh—24% of electricity demand—for a second consecutive year.

The wind share of the total renewable production increased 13.4% from the previous year to 50.8%. This substantial increase is due in part to the third driest year since 1931, leading to a strong decrease in the hydropower production (only 31.1% of the total renewable production during 2017) [1]. The average production at full capacity stood at 2,399 hours, indicating a 0.8% decrease since 2016 (2,419 hours).

The Portuguese TSO indicated an annual wind generation index of 0.97. This represents a 3% decrease in the index compared to 2016, which is explained by Portugal's atypical winter [2]. Figure 2 depicts the wind generation profiles on:

- The maximum demand day and the respective wind power contribution: The maximum instantaneous demand value (8,763 MW) occurred at 19:45 on 19 January 2017, but wind generation was only 2,009 MW.
- Maximum daily penetration from the wind and the daily wind: On 12 March 2017, 92.5 GWh of wind-generated electricity were supplied, accounting for 82% of the daily demand—the highest in 2017 [2].
- Instantaneous peak wind penetration: On 30 April 2017, wind power penetration was above the national consumption from 04:15 until 07:45, with the highest instantaneous penetration value (110%) at 06:15.

Both the peak wind contribution and the maximum daily penetration represent new records. The TSO did not report any technical problems during these high wind penetration events.

Matters Affecting Growth & Work to Remove Barriers

The lack of government support by suspending new grid connection capacity in 2012, combined with the low competitiveness of wind in the Iberian electricity market compared to other technologies (e.g., solar photovoltaic) has resulted in a strong divestment in the wind sector, which will likely continue in the upcoming years [11]. Nevertheless, recent governmental decisions indicate that over 123 MW of new capacity will be built in the near future [12]. This capacity is related to the 2008/2009 wind power capacity tendering procedures, which benefits from feed-in tariffs.

In 2017, the government also approved the construction of the first wind farm (with a nominal capacity of 4 MW) without feed-in tariffs or other public support. There are already 80 MW of license applications for proposed capacity without subsidies paid by consumers [13].

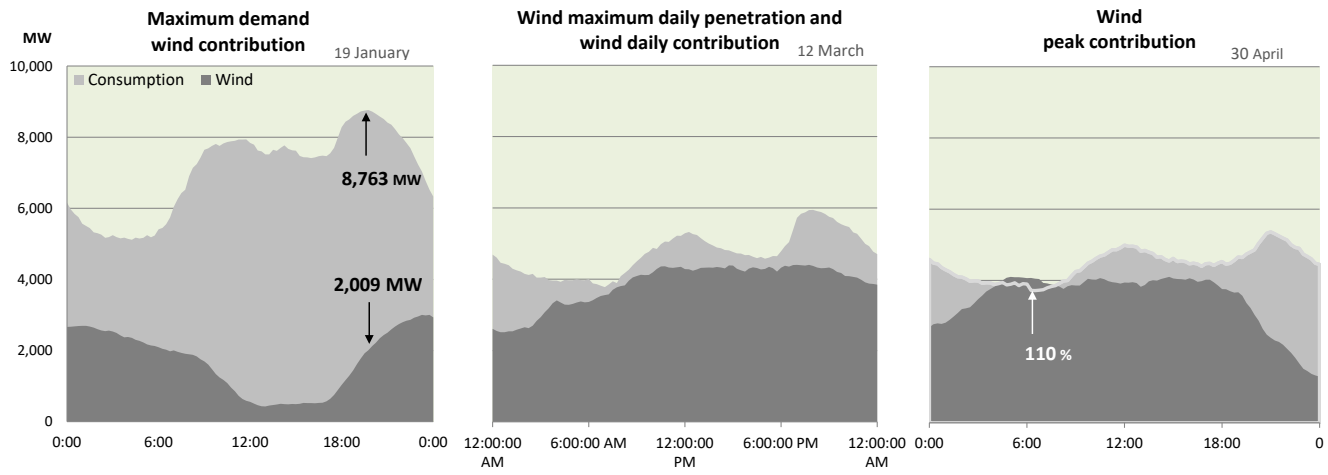

Figure 2. Wind power penetration and energy generation records during 2017 [2]

National R,D&D Priorities & Budget

National R&D efforts during 2017 focused on offshore wind energy, structural safe inspections, and the development of tools and methodologies to maximize the penetration of renewable energy from a grid security operation point-of-view as well as a market perspective. Most R&D activities are taking place at the main Portuguese institutes and universities being funded through national and/or European programs.

The Portuguese Foundation of Science and Technology (FCT), invested nearly 512 million EUR (614 million USD) in science and technology in 2017. Approximately 103 million EUR (123.6 million USD) was for R,D&D and innovation projects, while 55 million EUR (66 million USD) went towards scientific jobs [14]. These numbers represent a 2% increase since 2016 for both total investment and investment in R,D&D. However, the investment in scientific jobs increased 16% since 2016 [15].

National Research Initiatives & Results

A nationally-funded project, designated "Offshore Plan" (FCT program POSEUR), began in 2017. This project aims to provide optimized scenarios for planning offshore renewable energies considering the economic impacts.

Other initiatives are being developed to implement five different smart-grid facility types in Portugal, Slovakia, and Sweden to test energy delivery according to consumption, forecasting, and energy storage under the newly-launched project InteGrid [16].

The gravity foundations to support offshore wind turbines and geophysical survey campaigns are ongoing within the DEMOGRAVI3 project [17]. The first floating offshore wind park projected to be installed in 2017 is still in the pre-commercial phase, and the commission processes are expected to occur during 2018 [18].

Test Facilities & Demonstration Projects

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

- **InteGrid:** an H2020 demonstration project aiming to implement and test five smart-grid facility types in three countries: Portugal, Slovakia, and Sweden
- **DemoWind:** an H2020-ERA-NET collaborative demonstration and collaborative project to join offshore wind technology demonstration through 2019 under Horizon 2020
- **DEMOGRAVI3:** an H2020-funded project to demonstrate the GRAVI3 technology, an innovative gravity foundation for offshore wind turbines
- **Research Infrastructure (RI) WindScanner.PT:** constitutes the Portuguese node for the European Research Infrastructure WindScanner.EU. This project will use high precision remote sensing technology to measure the 3D wind for scientific, industrial and meteorological purposes. The RI will also include an open access platform and advanced training actions.

Collaborative Research

Portugal participates in the following IEA Wind TCP Tasks:

- Task 25 Design and Operation of Power Systems with Large Amounts of Wind Power
- Task 30 Offshore Code Comparison Collaboration, Continued, with Correlation (OC5) (through WavEC, IST/Centec with a participation co-sponsored by EDP-Inovação)
- Task 36 Forecasting for Wind Energy (through INESC TEC, LNEG, Prewind and Smartwatt)

In addition to the IEA Wind TCP activities, Laboratório Nacional de Energia e Geologia (LNEG) is the Portuguese representative in the European Energy Research Alliance Wind Program (EERA-Wind). During 2017, LNEG also joined EERA in Energy Systems Integration (EERA – ESI). In Portugal, LNEG and other Portuguese R&D entities are active partners in international research efforts:

- **IRPWind**: an FP7 project combining wind energy research projects and activities to foster innovation, collaboration, and knowledge transfer between European researchers and leading R&D entities, with the participation of EERA Joint Programme on Wind Energy partners
- **ETIPWind**: an H2020 project to create a virtual and physical platform through which the wind energy community can communicate, coordinate, and collaborate on work and activities related to R&I&T to reach the RES targets for 2020. The Portuguese contribution to this project focuses on facilitates the sustainable integration of wind energy into the EU grids. Portuguese partner is EDP Renewables
- **AEOLUS4FUTURE**: an H2020 project that aims to develop sustainable and efficient wind energy systems for a variety of EU needs
- **NEWA**: an ERA-NET+ project concerning the development of the new wind atlas for land-based and offshore wind in European countries
- **OceanNET**: an FP7 project to educate a new generation of engineers and scientists on floating offshore wind and wave renewable energies, which will support the emerging offshore renewable energy sector
- **LEANWIND**: an FP7 project aiming to develop innovative technical solutions to optimize offshore wind farm deployment, operation and maintenance, and decommissioning procedures.
- **FORESEE**: the IEE training project for renewables and energy efficiency in the building sector, which puts into practice the priorities identified in the Roadmap 2014–2020 under the Build Up Skills—Portugal.
- **MEDOW**: an FP7-PEOPLE project developing a new DC-grid-based, multi-terminal voltage-source converter suitable for the connection of offshore wind farms
- **SWARMs**: an H2020 project to create underwater robots in cooperation meshes to inspect offshore foundations
- **Wind-DRONE**: an H2020 project to develop a powerful UAV-based (Unmanned Aerial Vehicle) information and communication technology solution to enable safe, reliable and effective inspections of wind turbines

IMPACT OF WIND ENERGY

Environmental Impact

In 2017, wind-generated electricity generated 1.124 million EUR (1.349 million USD) for wind power plant developers. This represents a decrease of 0.5% from the previous year and a savings of 5.3 million tons of CO_2 emissions (considering a factor of 430 g/kWh) [19]. Based on data from the yearly contribution of each technology in the Portuguese energy mix, imports, and the consumption index, Portugal's dependence on fossil fuels generation was calculated at nearly 57.9%—a significant increase compared to 2016 (Figure 3).

Coal is the cheapest fossil fuel for generating electricity; as such, it predominately fulfils Portugal's fossil fuel dependency. Despite this, the tendency towards natural gas penetration in the power system continues to increase. Contributions from natural gas and coal resources raised the 2017 CO_2 emissions to nearly 17 million tons (MT) in mainland Portugal—a 9% increase compared to 2016 [3]. Madeira Island also observed an almost 5% increase in CO_2 emissions, reaching 0.4 MT. For the second year, Portugal's exports exceeded imports by nearly 2,684 GWh [2]. This result is particularly relevant, as the country also observed an increase in the electricity consumption to 49.6 TWh (Portugal mainland).

Economic Benefits & Industry Development

The wind industry and deployment activities in Portugal supported approximately 3,250 jobs during 2017. The mean tariff paid to the wind power plants in 2017 increased from the 2016 rate of 1.81 EUR/MWh (2.17 USD/ MWh) to 95.02 EUR/ MWh (114.02 USD/ MWh) [19]. German company Enercon continues to lead in wind power capacity deployment in Portugal, with 53.6% of the country's installed capacity. Vestas is in second place with 12.9%, followed by Gamesa (9.3%), Senvion (8.5%), Nordex (7.7%), GEWE (2.0%), Alstom (2.0%), Suzlon (1.9%), and Bonus (1.4%). Other manufacturers make up the remaining 0.6% [20].

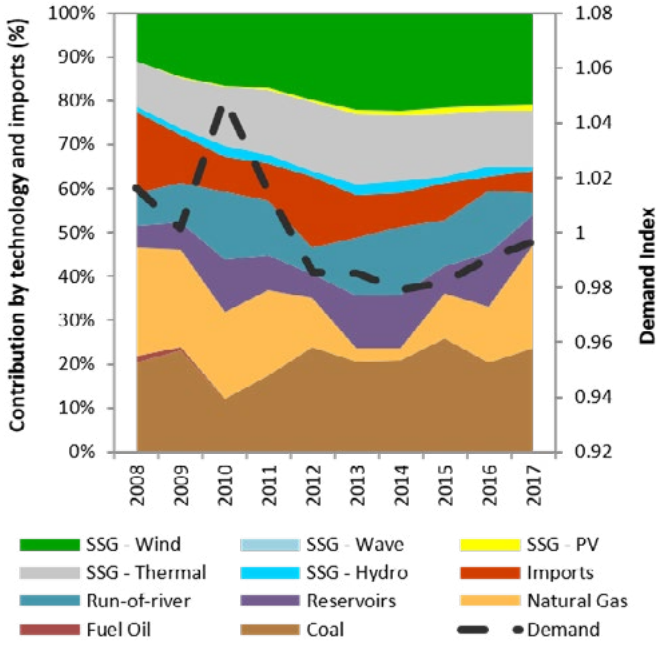

Figure 3. Yearly contribution from each technology and imports to the energy consumption and demand index from 2008-2017 in mainland Portugal (Source: REN and LNEG) [1]

NEXT TERM

With the government's commitment to support economically competitive technologies within the electricity market environment without public support, new land-based wind energy installations are expected to stagnate in the upcoming years. Thus, the first wind farm projects commissioned without feed-in tariffs will be decisive for the future of Portugal's wind energy sector. It is also expected that in the coming years, repowering will be more expressive in Portugal.

The first floating offshore wind park on the Portuguese coast (25 MW) will start implementation during 2018 with the government's support, as well as the NER300 and InnovFin programs (with support from the European Commission and the European Investment Bank, respectively).

References

Opening photo: Tudo o Vento Levou (Gone with the Wind), 2016, Wind turbine, clipping vinyl, 1,450 x 900 x 136.8 cm, Parque Eólico do Douro Sul, S.A. (Douro Sul Wind Farm), Serra de Leomil, Moimenta da Beira, Portugal (Photo credits: TAKEMEDIA – Digital Motion). Artist: Joana Vasconcelos

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