Report 2023

Italy

Vestas Italy - Taranto facility for XL offshore turbine blades manufacturing: IEA WIND Executive Committee members visit (May 2024).

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The new 2023 installed wind capacity was 0.45 GW, in line with the previous year's growth. New ambitious 2030 wind targets (28,4 GW of installed wind capacity, of which 2,1 GW will be offshore) were submitted to the European Commission.

The main issues affecting growth include the uncertainty around future regulation about incentives (mechanisms, quotas, tariffs, etc.) and the long and complex permitting process. Finally, the R&D outlook showed a significant increase in the number of national projects funded in 2023 mainly through the National Fund for Electric System Research (RdS), and the National Recovery and Resilience Plan (NRPP) that supports actions and of the Italian participation in European projects.

Highlight(s)

- The Newly installed wind capacity was around 0.5 GW, in line with previous year. The total installed capacity slightly surpassed 12 GW.

Table 1. Key National Statistics 2023: Italy

Total (net) installed wind power capacity	12.1 GW
Total offshore capacity	0.03 GW
New wind power capacity installed	0.45 GW
Decommissioned capacity (in 2023)	0 GW
Total electrical energy output from wind	23.4 TWh
Wind-generated electricity as percent of national electricity demand	7.6%
Average national capacity factor	23.2%
Target	28.4 GW (2.1 GW offshore) installed wind power capacity @2030 submitted to EC in 2023
National wind energy RD&D budget	-

- New ambitious 2030 wind targets submitted to the European Commission: 28,4 GW of installed wind capacity, of which 2,1 GW will be offshore.
- More than 90 GW of offshore wind capacity (134 wind farms, most with floating technology) have applied for grid connection permits.

Market Development

Targets and Policy

A revised version of the National Integrated Climate and Energy Plan (NIECAP) was submitted to the European Commission in June 2023 [1]. The proposed plan, now being examined by community bodies, will be the subject of discussion with parliament and the regions in the coming months, along with the Strategic Environmental Assessment procedure. The approval of the definitive text must be completed by June 2024. More ambitious targets are set for renewable production. Italy intends to pursue an objective of covering 40.5% of gross final energy consumption from renewable sources by 2030. For wind energy, the plan sets a target of installed capacity equal to 28.4 GW, of which 2.1 GW will be offshore. This is a significant increase compared to the 2019 wind energy target of 19.3 GW, of which 0.9 GW was planned for offshore.

The decree setting the renewable energy incentive mechanism (access, tenders, tariffs) rules, named the FER2 decree, was still not published by the end of 2023. In the current draft, a base tariff of 185 €/MWh is expected for offshore wind farms.

According to the expected increase in the offshore wind energy target, two measures are put in place in the so-called "DL Sicurezza Energetica" (Legislative Decree n181 – 9th of December 2023): the first one establishes that the Ministry of Environmental and Energy Security will adopt a "single procedure" for the authorisation of floating wind farms. According to the second measure, the same ministry will ask for expression of interest to identify at least two ports for offshore wind farm installation.

At the end of 2023, the Italian Maritime Spatial Planning, that should define (among others) the offshore areas suitable for offshore wind installations, was still in the Strategic Environmental Assessment phase, and it has not yet been published and adopted.

Progress and Operational Details

According to the National Wind Energy Association (ANEV), Italy installed a new net wind power capacity of 448 MW in 2023. The cumulative installed capacity at the end of 2023 reached 12.1 GW (of which 30 MW was offshore) including decommissioning and repowering. The trend of annual and cumulative capacity from 2010-2023 is shown in Figure 1. Around 300 MW of small wind plants (plant size lower than 200 kW) were added to the total installed capacity.

In 2023, 31 new wind farms were connected to the grid (14 were greater than 10 MW). The maximum plant size was 54,6 MW. 113 new turbines were installed with an average size of 4.0 MW (max 5.7 MW). The average size of all wind turbines installed in Italy is 1.6 MW.

New wind power capacity was mainly installed in Sicily (43%), followed by Campania (18%) and the Apulian Region (16%). 90% of the total installed capacity is concentrated in six southern regions: Apulian (25%), Sicily (19%), Campania (16%), Basilicata (12%), Calabria (10%), and Sardinia (9%).

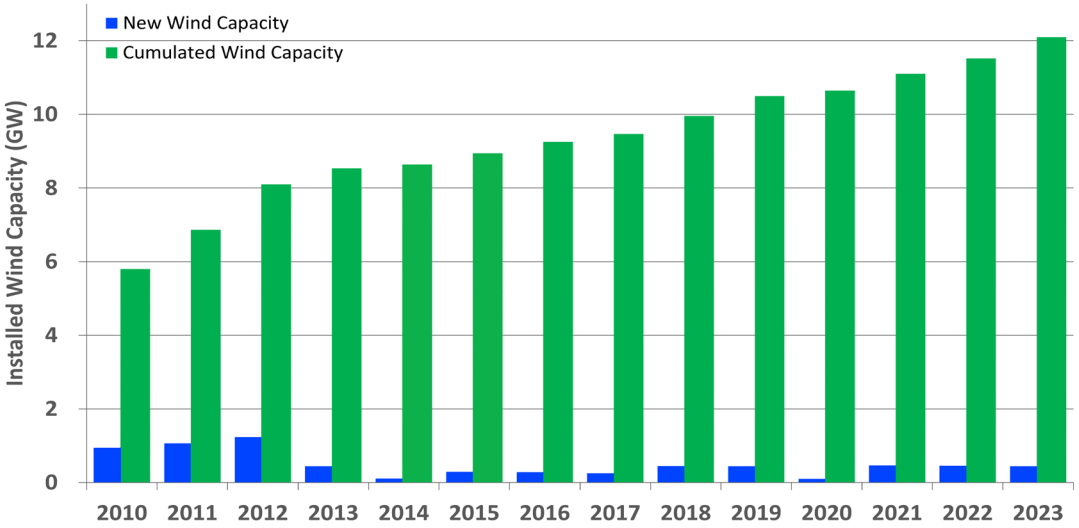

Figure 1: Trend of annual and cumulative wind capacity in the period 2010-2023.

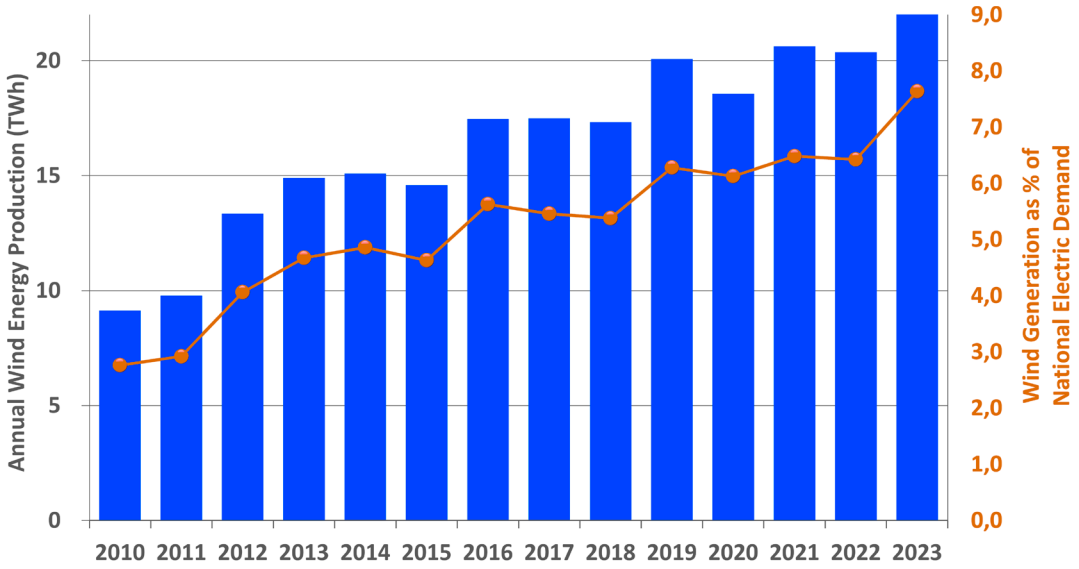

Figure 2: Trend of annual wind energy production and percentage of the electricity demand in the period 2010-2023.

According to the national Transmission Operator TERNA [2], the overall wind electricity production in 2023 was 23.4 TWh, corresponding to 7.6% of Italy's total electricity demand (total consumption plus grid losses). The trend of annual wind energy production and percentage of the electricity demand between 2010-2023 is shown in Figure 2. The curtailments reached 4.4% (preliminary data). The 2023 average national capacity factor was 23.2%.

Matters Affecting Growth and Work to Remove Barriers

According to the large wind energy operators, the main issues affecting growth are the uncertainty regarding the future regulation about incentives (mechanism, quota, tariffs, etc.) and the long and complex permitting process. For the offshore wind sector, the most significant matter affecting growth is the delay of the Maritime Spatial Planning adoption, the simplification of the specific authorisation process and the uncertainty of 2030 and medium-long term targets.

RD&D Activities

Italian Research Institutes and Universities in the field of wind energy are funded by national, European and international projects and consultancy activities, in addition to self-financing.

According to the present institutional organisation, the ministries mainly in charge of supporting R&D are the Ministry of Universities and Research (MUR) and Ministry of Environment and Energy Security (MASE).

National RD&D Priorities and Budget

It is difficult to give a representative value for the national wind energy R&D budget because most Italian research organisations set their own RD&D budgets on this topic and in many cases, the activities are funded under the wider umbrella of renewables.

A significant number of national projects on wind energy topics have been running (or begun) in 2023. The two major research supporting pillars for 2023 have been the National Recovery and Resilience Plan (NRPP, published in 2021) and the "National Fund for Electric System Research" (RdS).

Within the NRPP supporting action, the National Research Center on High Performance Computing (HPC), Big Data and Quantum Computing (CN1), established in 2022 and coordinated by the National Institute for Nuclear Physics (INFN), has overseen several activities in wind energy in 2023. As an example, "Sapienza" University of Rome (UniSapienza) has worked on HPC simulations to develop a multi-fidelity framework taking into account the atmospheric boundary layer and sea waves typically observed in the Mediterranean Sea. Moreover, (UniSapienza) has received an innovation grant (in collaboration with Eni S.p.A.) on lifetime monitoring, power forecasting and on the impact of rain/ice on the lifespan of blades for operating in onshore wind farms. In addition, the three-year project, NEST (Network 4 Energy Sustainable Transition), is coordinated by the Politecnico of Bari (PoliBA) and involves 11 universities, 5 research centres and 9 private companies. Within this project, research efforts aim to minimise of the LCoE of floating wind turbines suitable for the Mediterranean area and to their integration with wave energy converters. Furthermore, three two-year "projects of significant national interest" (PRIN) started in 2023. NETTUNO (overall budget of EUR 197 thousand; partners Università degli Studi di Firenze (UniFI) and Politecnico di Milano (PoliMI)) focuses on understanding the behaviour of floating offshore wind turbines wakes, and the resulting loading patterns they generate on a downstream rotor. NOSTRUM (overall budget of EUR 200 thousand; partners UniSapienza, UniFI and CNR-Institute of Marine Engineering (CNR-INM)) aims to develop of a new generation of floating wind turbines tailored for the Mediterranean Sea. DEEPAIRBORNE (overall budget EUR 240 thousand; partners Politecnico di Torino (PoliTO) and PoliMI focuses on the development of Airborne Wind Energy Systems (AWES) for deep offshore scenarios. This represents a growing research field in Italy, as also demonstrated by the research project, NEXTWIND (budget EUR 90 thousand), funded by the private philanthropic organisation, Fondazione Cariplo.

The RdS R&D support program is promoted by MASE. The current three-year term (2022-2024) includes wind-related research activities through different projects totalling a budget of around EUR 5 million. It involves CNR (numerical and experimental activities on FOWT) and RSE (wind atlas and offshore hybrid systems).

National Research Initiatives and Results

- A study on the dynamics of a deep offshore airborne wind energy system has been carried out at PoliMI and a novel control design approach has been proposed, which aims to avoid resonance effects of the floating platform due to the kite motion [3].

- PoliTO and RSE joined the Floating Offshore Wind Community, an initiative coordinated by The European House Ambrosetti, in collaboration with industrial partners (Acciaierie d'Italia, Renantis, BlueFloat, Fincantieri). PoliTO preliminarily estimated the Italian floating offshore wind potential of about 207 GW [4].

- UniRomaTre developed a controller for the reduction of floating offshore wind turbine vibratory loads which is based on Individual Pitch Cyclic control and resonant control. The combination of the two strategies has been effective in cumulative fatigue load reduction (figure 3) [5].

- PoliBA, in collaboration with CNR-INM, has developed an efficient numerical tool for the prediction of wind turbine noise. The permeable-surface Ffowcs Williams–Hawkings equation (FWH-P), combined with the post-processing of LES data on different acoustic surfaces, has demonstrated the importance of encompassing the quadrupole noise sources within the permeable surface [6].

- Within NEST, UniSapienza has developed a framework for the multi-objective layout optimisation for offshore wind farms to minimise LCoE in the Mediterranean Sea, considering heterogeneous factors (e.g. bathymetry, O&M cost, installation cost, turbine size). Figure 4 shows the optimised farm layout and the corresponding turbine power generation.

- The Danish Embassy in Italy, in collaboration with the OWEMES association and CNR-INM, has organised several workshops with representatives from R&D Agencies, ministries and industry to discuss challenges and potential solutions for the development of the (floating) offshore wind market in the Mediterranean Sea and promote offshore wind energy technology capabilities in Italy.

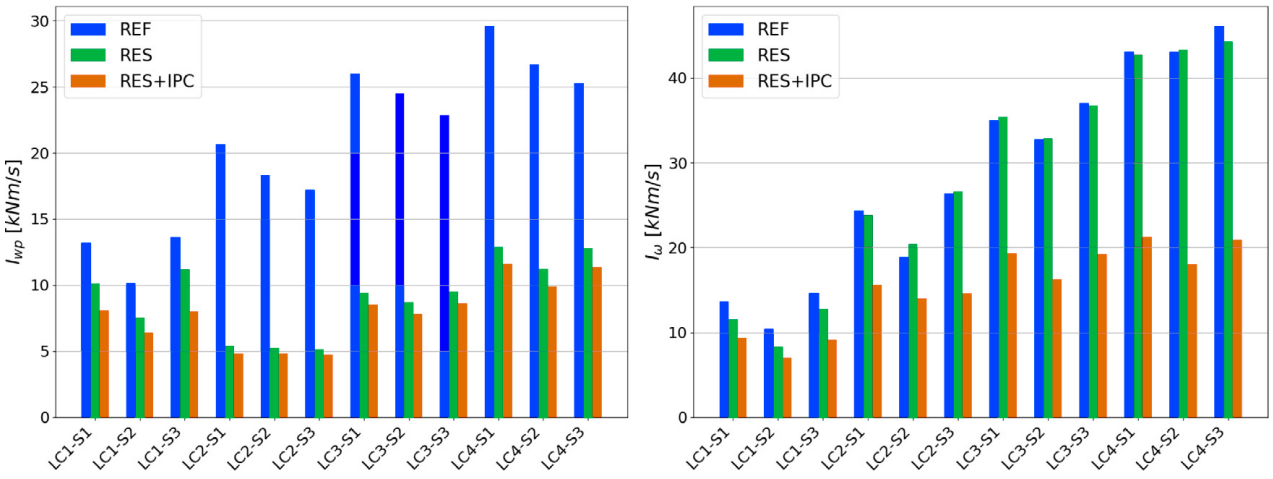

Figure 3: Blade root flapping moment spectrum for spar-buoy-supported FOWT in different LCs. Integral evaluated in the range ω=ω_sea+0.05 Hz (left) and ω=1P+0.05 Hz.

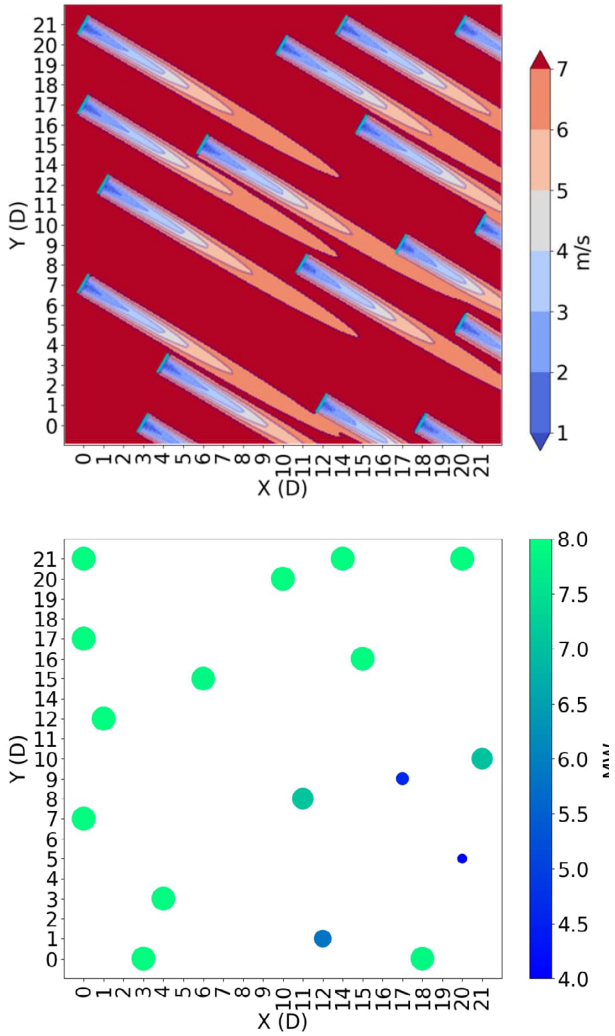

Figure 4: Multi-objective optimization for wind farm layout (top) and corresponding turbine generated power (bottom).

Collaborative Research

- APRE, RSE and CNR are the Italian partners in the MARINEWIND Horizon Europe project, a 36-month coordination and support action aiming at identifying bottlenecks and potential opportunities to strengthen the floating offshore wind technology FOWT role.
- UniFI, CNR-INM and SEAPOWER scrl are the Italian partners of the FLOATFARM, funded at the end of 2023. The goal of the four-year FLOATFARM project is to significantly advance the maturity of FOWT technology by increasing energy production, achieve important cost reductions, decrease the environmental impacts on marine life and enhance social acceptance.
- PoliMI is a partner in the EU collaborative project, SUDOCO, which is developing open-source technologies for offshore wind farm control and co-design.
- PoliMI is also a partner in the EU project, MERIDIONAL, which concerns advanced modelling of atmospheric wind and prediction of performance and loads for airborne wind energy systems.
- The University of Salerno is the Italian partner in the SURVIWEC project funded under the Spanish programme "Proyectos de I+D+i Retos Investigación" (budget EUR 180 thouusand) to develop the open-source high-fidelity CFD-based solver DualSPHysics [7]. This aims to capture wave–structure interactions of floating platforms for FOWT applications [8] [9].
- The number of Italian participants to the IEA WIND Tasks is significant: in 2023, Italy participated in Task 11, 25, 30, 34, 41, 47, 48, 49. In November 2023, the Italian ExCo members have organised the ITALIAN IEA WIND DAY, a workshop to facilitate the exchange of information among the Italian participants to the Tasks.

Impact of Wind Energy

Environmental Impact

According to the Italian Institute for Environmental Protection and Research (ISPRA), substituting one MWh produced by fossil fuels with one produced by wind energy avoids 386,3 kg of CO2 emissions [10]. In 2023, Italy's wind-generated electricity avoided around 9 million tons of CO2 emissions.

Economic Benefits and Industry Development

In 2023, the economic impact of wind energy in Italy was estimated at around EUR 4.8 billion (USD 5.1 billion). This value represents the overall contribution of three different business areas, estimated as follows: new installations (EUR 538 million; USD 567 million), operation and maintenance of the online plants (EUR 467 million EUR; USD 502 million), and energy production and commercialisation (EUR 3.7 billion; USD 4.0 billion) – the latter was calculated with an

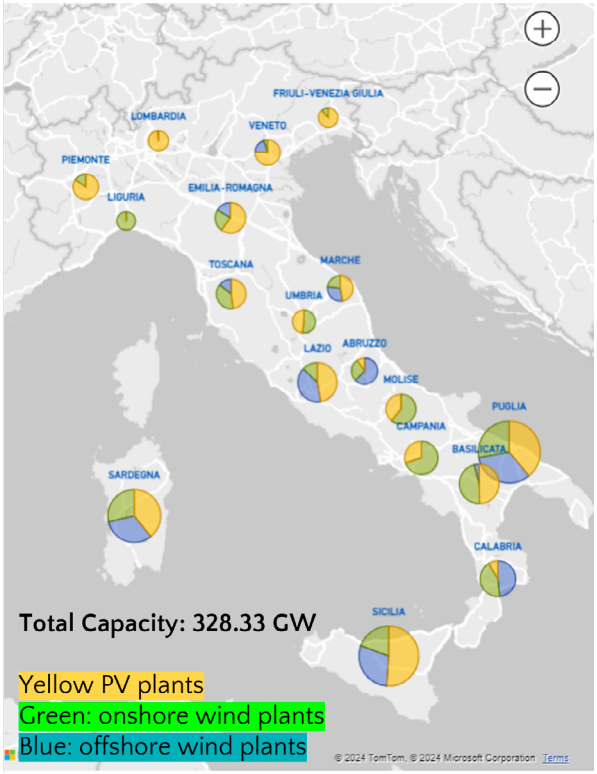

Figure 5: Renewable plants connection requests received by Italian TSO TERNA as of 31 december 2023. *Source TERNA.*

average wind energy selling tariff of 160 EUR/MWh, reflecting incentive tariffs belonging to different mechanisms for the overall installed wind farms.

Concerning owners/operators, the 2023 installations do not substantially modify the previous year's framework, in which three big operators (Gruppo ERG, Enel Green Power, and E2i Energie Speciali) manage around one fourth of the total installed capacity. The other 20 operators have a share greater than 1%.

Most of the new turbines are Vestas. The Italian wind turbine manufacturer, Leitwind, accounted for five single wind turbines. Vestas' facility in Taranto was renewed to build the mega blades for the V236-15.0 MW turbine, the largest in the world for offshore wind (see Opening Photo). Production started in the second half of 2023.

A huge interest for the offshore wind energy sector has grown in Italy. According to TERNA [11] The renewable farm grid connection requests totalled 328. 33 GW as of the 31st of December 2023. The request shares for technology include the following: photovoltaic plants 141.38 GW, onshore wind farms 95.03 GW, and offshore wind farms (mainly floating farms) 91.91 GW (see also Figure 3).

Next Term

A significant increase in the new yearly capacity within the next years is expected to reach the new ambitious National Integrated Climate and Energy Plan 2030 targets. The publication of the new renewable energy incentive mechanism decree (FER2) will speed-up further onshore development and the adoption of the Italian Maritime Spatial Plan strategy will facilitate the offshore wind plants' authorisation process. Current research activities on floating wind energy will produce a significant impact within the FOWT sector, specifically tailored for Mediterranean Sea conditions.

References

[1] Giugno, (2023), PIANO NAZIONALE INTEGRATO PER L'ENERGIA E IL CLIMA. https://www.mase.gov.it/sites/default/files/PNIEC_2023.pdf

[2] TERNA, Rapporto Mensile sul Sistema Elettrico, dicembre 2023. https://download.terna.it/terna/Rapporto_Mensile_Dicembre_23_8dc1752b3455abb.pdf

[3] S. Trombini, E. Pasta, L. Fagiano, "On the Kite-Platform Interactions in Offshore Airborne Wind Energy Systems: Frequency Analysis and Control Approach", European Journal of Control, to appear.

[4] Floating Offshore Wind Community. https://www.ambrosetti.eu/floating-offshore-wind-community/

[5] Pustina, L., et al. "A novel resonant controller for sea-induced rotor blade vibratory loads reduction on floating offshore wind turbines." *Renewable and Sustainable Energy Reviews* 173 (2023): 113073.

[6] Bernardi, C.; Porcacchia, F.; Testa, C.; De Palma, P.; Leonardi, S.; Cherubini, S. NREL-5MW Wind Turbine Noise Prediction by FWH-LES. Int. J. Turbomach. Propuls. Power 2023, 8, 54.

[7] Domínguez, J. M. et al. (2022). "DualSPHysics: from fluid dynamics to multiphysics problems." en. In: Computational Particle Mechanics 9.5, pp. 867–895. DOI: 10.1007/s40571-021-00404-2.

[8] Tagliafierro, B. et al. (2023a). "Numerical validations and investigation of a semi-submersible floating offshore wind turbine platform interacting with ocean waves using an SPH framework." In: Applied Ocean Research 141, p. 103757. DOI: https: //doi.org/10.1016/j.apor.2023.103757

[9] Tagliafierro, B. (2024). DeepCwind floating platform under extreme oceanic conditions. DOI: 10.5281/zenodo.10471117 [4] Ransley, E. et al. (2023).

[10] https://www.isprambiente.gov.it/files2023/pubblicazioni/rapporti/r386-2023.pdf

[11] TERNA, Econnextion: la mappa delle connessioni rinnovabili. https://www.terna.it/it/sistema-elettrico/rete/econnextion