



EMS Annual Meeting Abstracts

Vol. 20, EMS2023-92, 2023, updated on 20 May 2024

<https://doi.org/10.5194/ems2023-92>

EMS Annual Meeting 2023

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Climate change impacts on wind energy production for the Italian peninsula

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Wind energy is one of the key aspects for renewable resources that contributes to climate change mitigation policies in national and international energy transition strategies. The availability of wind resources itself is also affected by climate change, due to possible expected changes in large-scale circulation patterns, with consequent impacts on wind regimes on the Italian territory. This study focuses on understanding whether, how and to what extent climate change can affect wind producibility in Italy, using the Euro-CORDEX regional climate models. Because wind turbines work within a defined wind speed range (within the cut-in and cut-off wind speed), a better estimate of wind speed values is able to significantly impact the estimation of wind producibility. For this reason, a bias correction is performed using the MERIDA meteorological reanalysis, for the 10 m wind speed variable of the climate models. The calculation of the producibility was obtained assuming a reference wind turbine that is widely used in the Italian wind farms (VESTAS V112 - 3000 kW). The study also analyzes the changes in the wind energy production compared to the reference period 1986-2005 for the short (2021-2050), medium (2051-2080) and long-term (2071-2100) scenarios, according to the RCP 4.5 and RCP 8.5 scenarios. Together with the variation of the climate signal of the ensemble mean, an uncertainty analysis is also performed to evaluate the reliability of the climate signal itself. If, on one hand, the results show a prevalently weak and not statistically significant climate signal for the RCP 4.5 scenario, on the other hand, a more pronounced and significant signal is highlighted for the RCP 8.5 scenario in the medium and long term, indicating a decrease in wind producibility. More specifically, the conclusions suggest that the future planning of wind producibility should mainly be targeted toward some specific areas of the eastern Italian coast and in the south-east Italian regions, mostly in the off-shore areas. In these regions, indeed, the RCP 8.5 scenario shows the lowest decrease in the overall annual producibility with respect to other Italian regions, while, for the RCP 4.5 scenario, the medium and the long term foresee a slight increase in wind producibility at the annual level.