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Wind height distribution influence on offshore wind farm feasibility study

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The economic feasibility of offshore wind power utilization depends on the favourable wind conditions offshore as compared to sites on land. The higher wind speeds have to compensate the additional cost of offshore developments. However, not only the mean wind speed is different, but the whole flow regime, as can be seen in the vertical wind speed profile. The commonly used models to describe this profile have been developed mainly for land sites, so they have to be verified on the basis of field data.
Monin-Obukhov theory is often used for the description of the wind speed profile at a different height with respect to a measurement height. Starting from the former, , the profile is predicted using two parameters, Obukhov length and sea surface roughness.
For situations with near-neutral and stable atmospheric stratification and long (>30km) fetch, the wind speed increase with height is larger than what is predicted from Monin-Obukhov theory. It is also found that this deviation occurs at wind speeds important for wind power utilization, mainly at 5-9 ms-1.
In the present study the influence of these aspects on the potential site productivity of an offshore wind farm were investigated, namely the deviation from the theory of Monin-Obukhov due to atmospheric stability and the influence of the fetch length on the Charnock model. Both these physical effects were discussed and examined in view of a feasibility study of a site for offshore wind farm in Southern Italy.
Available data consisted of time histories of wind speeds and directions collected by National Tidegauge Network (Rete Mareografica Nazionale) at the height of 10m a.s.l. in ports. The theory of Monin-Obukhov was used to extrapolate the data to the height of the wind blades, while the Charnock model was used to extend the wind speed on the sea surface from the friction velocity on the ground. The models described were used to perform calculations for a feasibility study of an offshore wind farm in Southern Italy.
The potential site productivity was established on the basis of the wind speed distribution function for different heights (site specific) and the power law of the wind turbine considered, as a function of the wind speed at the nacelle height (machine specific).
The results of the optimization study for different sites and different wind turbines were compared with the power estimates of Italian Wind Atlas, which provided useful insights for further study.