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Curtailment vs. Low-Capacity Credit –The Two Faces of Variable Renewable Energy Sources

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Poland is among the countries experiencing the highest growth dynamics in variable renewable energy sources (VRES). A country that not long ago relied almost entirely on coal-based energy is undergoing a profound transformation, with solar power plants and onshore wind farms playing a key role. Between 2020 and 2025, the installed capacity of wind power increased from 5.9 GW to more than 10 GW, while solar power grew from 1.6 GW to more than 21 GW. The peak demand in polish power system in 2024 exceeded 28 GW. By 2030 approx. 6 GW of offshore wind farms are planned for development, and after 2035, nuclear reactors are expected to be commissioned, with a total capacity reaching 6–9 GW by 2045. The current storage capacity, mainly in pumped storage power plants, amounts to 7.1 GW of discharge power. The total contracted capacity of new energy storage under the capacity market amounts to 4.4 GW, primarily consisting of storage systems based on electrochemical battery technology. The increasing share of VRES in energy systems leads to a growing number of hours with overproduction and negative residual load. On the other hand, VRES capacities are weather-dependent and characterized by low-capacity credits. Capacity credits quantify the contribution of a resource to overall system adequacy.

The ongoing process of electricity market coupling and the associated regulatory changes have led to the adoption of 15-minute settlement intervals. As a result, operational system data is now collected at this time resolution. Based on the gathered data, this study presents results on the occurrence of non-economic VRES redispatch from July 2024 onwards (frequency and magnitude). In the second part, historical data were used to calculate capacity credits for wind and solar power plants in the polish conditions. Two primary methods for calculating the capacity credit for renewable energy technologies were employed: the deterministic method and the probabilistic method. Additionally, periods when VRES operate with very low-capacity factors are identified.

The results indicate that due to low values of VRES capacity credit, in addition to energy storage solutions, flexible generation units must also be present in the system. These units must be capable of supplying electricity when unfavorable meteorological conditions persist for several days, preventing RES from charging depleted energy storage systems. Capacity credits for solar PV and onshore wind power plants for the years 2021–2023, ranged from 9.19% to 9.58% for onshore wind and from 2.12% to 4.10% for solar PV.

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