

WIND RESOURCE AND VARIABILITY ASSESSMENT IN SOUTHERN LUZON USING THE WRF MODEL: A COMPARATIVE REVIEW OF ERA5, GFS, AND CFS REANALYSIS DATA

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ABSTRACT

The Philippines, with its vast coastline and strategic location within the monsoonal tropics, holds substantial potential for wind energy, yet much of this resource remains untapped, particularly in Southern Luzon. This study aims to provide an in-depth assessment of the region's wind resources, focusing on both onshore and offshore potential through high-resolution simulations using the Weather Research and Forecasting (WRF) model. Driven by three reanalysis datasets—ERA5, GFS, and CFS—the WRF model will capture detailed wind dynamics across a 2-way nested domain setup, with the high-resolution inner domain focused on Southern Luzon. By analyzing wind parameters such as speed, direction, and power density over a 3-year period, the study will evaluate seasonal and spatial variability of wind-derived power. Special attention will be given to the impact of intraseasonal variability due to monsoonal cycles, as the northeast and southwest monsoons are expected to significantly influence wind and energy reliability. Additionally, the interaction of monsoonal, regional, and local mesoscale winds with the region's varied topography will be investigated. Particularly, the wind gap effect between Batangas and Mindoro, which is expected to create areas of accelerated wind flow, further enhancing the region's wind energy potential. To ensure accuracy, the WRF model outputs will be validated against observational data from various PAGASA stations (i.e. Calapan, Ambulong, and Tayabas stations) providing essential benchmarks for both coastal and inland wind conditions. By identifying areas with high wind power density and favorable seasonal patterns, this study will produce detailed description of regional wind resource of the area, guiding potential sites for offshore wind farm development. These findings are expected to provide data-driven insights that will support energy developers, policymakers, and investors in their decision-making, aligning with the Philippine government's goal to expand renewable energy capacity by 2030. Ultimately, this research contributes to the country's renewable energy sector by focusing on the offshore wind potential in Southern Luzon, paving the way for a more sustainable and resilient energy infrastructure that will reduce dependence on fossil fuels and bolster energy security.

Keywords: wind energy, wind resource, WRF, reanalysis dataset, renewable energy