

Large Scale Integration of Off-shore Wind Power Plants in Turkey

Kamil Çağatay BAYINDIR

Professor, Electrical and Electronics Engineering Department, Ankara Yıldırım Beyazıt University.

Abstract

The use of renewable energy sources (RESs) is continuously increasing worldwide due to several factors, including the depletion of fossil fuels, energy security, and increasing environmental concerns. Wind and solar power plants are the prominent RESs with an installed capacity of 743 GW and 760 GW, respectively, as of 2021.

The cumulative installed wind power capacity in Turkey is 10976 MW and all these WPPs are onshore. Turkey has a large offshore wind power capacity which can contribute to reaching the renewable energy target of Turkey.

The studies presented in this tutorial are a part of the Offshore Wind Farm Large-Scale Integration project in Turkey (WindFlag). This project identified a potential of 1.8 GW OWPP in two phases at the Kiyiköy site located in the Black Sea region.

The whole Turkish grid and OWPP models are implemented using DigSILENT PowerFactory 2021. The operational performance of the power system is tested using actual data provided by TEIAS. The detailed grid code compliance analyses are presented to confirm that the designed large-scale OWPP meets grid code requirements.

The scenarios are carried out to analyze the static and dynamic characteristics of the power grid. The increase in the static stability limit of the power grid in presence of OWPPs is determined. Voltage stability limits of the Turkish power grid are estimated using the PV and QV curves.

The grid code published by the Energy Market Regulator Authority and the Ministry of Energy and Natural Resources in Turkey defines the grid connection criteria for wind and photovoltaic power plants. An elaborate assessment of the Turkish grid code reveals the technical requirements that need to be improved for further integration of onshore/offshore WPPs. Active power control & frequency regulation, reactive power control & voltage regulation, and requirements for voltage ride-through capabilities should be clarified in detail for the Turkish grid code. In this context, the key challenges and recommendations are clearly expressed by considering the dynamic conditions of Turkey's power system.