

Wind Farm Modeling for Steady State and Dynamic Analysis

G.Kabashi, K.Kadriu, A.Gashi, S.Kabashi, G.Pula, V.Komori

Abstract—This paper focuses on PSS/E modeling of wind farms of Doubly-fed Induction Generator (DFIG) type and their impact on issues of power systems operation. Since Wind Turbine Generators (WTG) don't have the same characteristics as synchronous generators, the appropriate modeling of wind farms is essential for transmission system operators to analyze the best options of transmission grid reinforcements as well as to evaluate the wind power impact on reliability and security of supply. With the high expected penetration of wind power into the power system a simultaneous loss of Wind Farm generation will put at risk power system security and reliability. Therefore, the main wind grid code requirements concern the fault ride through capability and frequency operation range of wind turbines. In case of grid faults wind turbines have to supply a definite reactive power depending on the instantaneous voltage and to return quickly to normal operation.

Keywords—Power System Transients, PSS/E dynamic simulation Double-fed Induction Generator.

I. INTRODUCTION

The proper modeling of wind farm projects in systems studies is becoming increasingly important to system operators. In the past decade, wind power has evolved into a significant renewable energy source which continues to grow rapidly. Wind farms are growing in size and complexity and they consist of many units with significant power output. The increased size of wind power projects and the development of large wind parks bring about a number of opportunities and challenges [1]. The location of wind farms installation is based on good wind conditions and favorable economic and environmental condition of selected site. However these good wind conditions often coincide with relatively remote parts of power systems. In a power system there are always limitations as to how much power can be transmitted from one point to another point. The limitations depend on thermal limits, angle stability limits or voltage stability limits. Because of the limited extension of the Kosovo power system this process is particularly challenging. In view of the increasing interest in connecting wind farms to the Kosovo transmission grid, KOSTT (Kosovo Transmission System and Market Operator)

G.Kabashi is with the Kosovo Transmission System and Market Operator, at "Bor Koder" s.a.s. Pristina, Kosovo, (corresponding author, phone: +37744297928; e-mail: gkabashi@kto.net.kos).

K.Kadriu is with the Kosovo Transmission System and Market Operator, at "Bor Koder" s.a.s. Pristina, Kosovo.

S.Kabashi is with Faculty of Mathematical and Natural Sciences University of Pristina, Kosovo.

A.Gashi, G.Pula and V.Komori are with Electrical and Computer Engineering Department of University of Pristina, Kosovo.

has undertaken an initiative to modify or extend own Grid Code to accommodate the particular capabilities and requirements of wind turbine generators (WTG-s). The main issue here is the obligation the Wind Code places on the Generator/developer to provide a computer model of the WTG suitable for power systems studies [2]. Some TSO-s prefer to develop such a model themselves directly from a detailed mathematical description of the WTG. This however places the burden of responsibility onto the TSO to get the model right – which is impractical given the present state of modeling knowledge as well as because of having non-power-intensive requirements. Therefore KOSTT follows the practice of many other TSO-s and places the obligation on the developer. In practice, we cannot expect wind farm developers to have the knowledge or skills to produce such a model – it will probably be provided by the wind turbine manufacturer (which in turn opens up confidentiality issues). In cases where the wind farm developer can not provide WTG model, KOSTT will use generic user model provided by the PSS/E (PTI).

The objective of this paper is to present the most significant characteristic and specific aspects of detailed wind farm modelling containing variable speed wind turbine units. A specific case study is analysed in order to identify the main requirements for wind farm connection to the Kosovo transmission grid. This paper will not address the detailed mathematics of PSS/E WTG user models which have been covered in many publications.

II. WIND FARM MODELING APPROACH

A. Overview

The modelling approach of wind farms is based on Wind Grid Code Requirements. The aim of Wind Grid Code is to provide a self-contained description of the technical and operational requirements that are to be met by the developers and operators of Wind-Powered Generating Stations (WPGS) that wish to connect to the Kosovo electricity grid and participate in the Kosovo electricity market. The Wind Code applies to all WPGS that are or have applied to be connected to the transmission grid, with installed capacity of more than 10 MW. Developers of WPGSs intending to apply for connection to the transmission grid should be aware that they are required to provide Project Planning data at this level of detail at the time of filing the application in order for the TSO to carry out the relevant connection design and impact studies.

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Wind Farm Modeling For Steady State And Dynamic Analysis:

Modeling and Stability Analysis of Inverter-Based Resources Lingling Fan,Zhixin Miao,2023-11-29 Renewable energy sources interface with the ac grids via inverters are termed inverter based resources IBRs They are replacing traditional fossil fuel based synchronous generators at a dazzling speed In turn unprecedented dynamic events have occurred threatening power grid reliability Modeling and Stability Analysis of Inverter Based Resources provides a fundamental understanding of IBR dynamics Developing reliability solutions requires a thorough understanding of challenges and in this case IBR associated dynamics Modeling and stability analysis play an indispensable role in revealing a mechanism of dynamics This book covers the essential techniques of dynamic model building for IBRs including type 3 wind farms type 4 wind farms and solar photovoltaics Besides modeling this book offers readers the techniques of stability analysis The text includes three parts Part 1 concentrates on tools including electromagnetic transient simulation analysis and measurement based modeling Part 2 focuses on IBR modeling and analysis details Part 3 highlights generalized dynamic circuit representation a unified modeling framework for dynamic and harmonic analysis This topic of IBR dynamic modeling and stability analysis is interesting challenging and intriguing The authors have led the effort of publishing the 2020 IEEE Power and Energy Society's TR 80 taskforce report Wind Energy Systems Subsynchronous Oscillations Modeling and Events and the two taskforce papers on investigation of real world IBR dynamic events In this book the authors share with readers many insights into modeling and analysis for real world IBR dynamic events investigation *Energy Engineering and Environmental Engineering* Tony Sun,2013-04-10 Selected peer reviewed papers from the 2013 International Conference on Energy Engineering and Environmental Engineering ICEEE 2013 January 18 19 2013 Hangzhou China **Modeling and Control of Power Electronics for Renewables** Chen Zhang,Dao Zhou,Yongheng Yang,Wenping Zhang,2025-09-26 Modern power electronics converters are used in a wide range of applications including switched mode power supplies electrical machine motion control active power filters and distributed power generation Power electronics an important interface between renewables and the grid has advanced rapidly in recent years As the percentage of renewables integration increases new challenges emerge such as weak grid issues high frequency circulation suppression active grid support function arc detection and so on These new issues create new challenges for modeling and controlling power electronics As a result in depth discussions on these issues are required in order to provide technical support for the global energy transition The purpose of this research topic is to investigate the modeling and control of power electronics converters as well as to provide the reader with how to analyze and model converter behavior in order to improve their design and operation Furthermore a set of algorithms designed specifically for use with power converters to address emerging challenges such as weak grid issues high frequency circulation suppression active grid support function arc detection and so on We hope that this Research Topic will provide an overview of the state of the art in modeling and controlling power electronics for renewable

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