Wind Power Plant Collector System Design Considerations

IEEE PES Wind Plant Collector System Design Working Group

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***Abstract*—This paper presents a summary of the most important design considerations for wind power plants. Various considerations, including feeder topology, collector design, interconnect and NESC/NEC requirements, and design engineering studies are discussed.**

***Index Terms*— Wind turbine generator, turbine layout, transient analysis, harmonics analysis, wind power plants.**

I. Introduction

Considerations in Wind Power Plant (WPP) collector system design are driven by economics and reliability. While WPPs have many things in common with traditional utility electrical systems, they also have a number of unique characteristics that require special attention. This paper will discuss various important design considerations applicable to modern WPPs. The scope of the discussion includes design considerations associated with plant and equipment ranging from the point of interconnection (POI) to the switchgear or converter in the base of the wind turbine tower.

II. Feeder Topology

Feeder topology, also referred to as collection system layout, can range widely in function and features depending on several factors including, turbine placement, terrain, reliability, landowner requirements, economics, and expected climatic conditions for the location.

After site selection for the WPP has been determined, the tower specific locations are defined, based on wind resource, soil conditions, FAA restrictions, land agreements, and constructability considerations. The turbine locations and the POI will be the primary factors in the design and layout of the WPP feeder topology. A POI located far from the wind power plant may require a transmission line and interconnect switchyard in addition to the collector substation; otherwise, the collector substation can be connected directly to the POI. To optimize loss efficiencies within the collector system, the ideal collector substation location is within a central area of the wind power plant to minimize collector conductor lengths. However, this is not always possible due to land constraints and the actual utility POI location itself.

The majority of large wind power plants built in North America have a radial feeder configuration with a collection system voltage of 34.5 kV (Figure 1). In this configuration, turbines are connected together in a "daisy chain" style, moving outward from the project substation to the furthest located turbine. These feeder strings are commonly underground but may be of overhead construction as well. Each individual feeder string may also have branch strings, connected by sectionalizing cabinets that can make up several string paths within a feeder string. Sectionalizing cabinets, sometimes referred to as junction boxes, have separable connectors, or elbows, that can isolate a feeder string to allow the remaining connected turbines to operate while maintenance or repair work is being performed. The separable connectors can come in two forms: 200 A load-break or 600 A dead-break style. The load-break elbows allow removal and isolation of the feeder string while the connector is energized by use of a "hotstick" and properly trained electricians. For strings with full load current ratings above 200 A, 600 A dead-break elbows are required, which also requires the circuit to be de-energized before removing and isolating the connector, or a live-front cable termination (without use of elbows) which also must be de-energized for connection or disconnection. An alternative to the sectionalizing cabinet is padmounted switches, with or without interrupting devices, that can more easily isolate a feeder for maintenance or troubleshooting. However, the increased cost needs to be weighed against the expected frequency of operation.

The number of winds turbine generators (WTGs) placed on a feeder string is limited by the conductor ampacity. In addition, the total number of collector circuits is driven by the size of the substation transformer (ST) located in the collector substation. System reliability is also a consideration since any given collector circuit cable fault will typically result in an outage to all WTGs connected to that particular circuit. Underground feeders are generally limited to roughly 25 to 30 MW per string due to soil thermal conditions and practical cable sizes, although parallel conductors may be combined at the collector substation circuit breaker to increase the number of WTGs on the feeder.

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R Barnett

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Protection & Control Systems of Wind Farm Power Plants Maty Ghezelayagh,2020-03-05 There are a number of books in the market about wind energy turbine controllers modelling and different aspects of integration of Wind Farm Power Plants WPP to grids But none of these books meets the expectations of design and field engineers technicians to address directly the setting and design philosophy of different Intelligent Electronic Devices IED of WPP networks This book provides practical applications of numerical relays for protection and control of different parts of onshore offshore WPP network namely wind turbine generator collector feeder and EHV interconnection transmission line to grid In addition required changes to existing special protection system SPS and run back scheme by adding a new WPP are discussed The topology and characteristics of WPP networks are different from convectional one for both onshore and offshore WPP In addition the fault current contribution from wind farm generators are low 1 1 1 2 pu These causes significant challenge for setting and design of IEDs of WPP in order to meet the common industry practice requirement with respect to reliability sensitivity stability security and grading coordination The author believes that this book may be unique with respect to addressing these challenges and provision of the mitigation techniques to rectify the deficiencies of existing industry practice which otherwise have not been discussed for real systems in any other book The content of this book have been successfully applied in the field for various WPPs projects and consequently can be used as a practical guideline for implementation for future projects The content of the book covers Principal of Operation of WPP Modelling of different com ponents of WPP Short Circuit current and voltage characteristics of different type of wind turbine generators Setting and Design of Protection systems of WPP Network Design of Control systems of WPP Lightening and Overvoltage Protection of WPP and Analysis of Disturbance on the WPP networks **Control Applications in Modern Power Systems** Arvind Kumar Prajapati,Manoj Tripathy,Asheesh K. Singh,Vijay K. Sood,Om P. Malik,2025-03-24 The book titled Control Applications in Modern Power System select proceedings of EPREC 2024 delves into in depth discussions case studies and recent advancements within the burgeoning field of control systems It specifically focuses on areas such as load frequency control wide area monitoring control and instrumentation optimization intelligent control energy management systems and SCADA systems The development of effective control strategies plays a pivotal role in managing reactive power and upholding voltage profiles among other critical aspects Readers stand to gain valuable insights bolstering their knowledge and expertise in these domains Furthermore this book has the potential to inspire fresh and innovative ideas Whether a newcomer a researcher or a seasoned professional this book serves as an invaluable reference for all for staying abreast of the latest developments in control systems **The ^AChanging Energy Mix** Paul Meier,2020-09-21 The Changing Energy Mix compares twelve renewable and nonrenewable energy types using twelve common technical criteria After reading this book readers will be well informed enough to draw their own conclusions and make their own decisions about next steps in

the world of energy Advances in Energy Materials and Environment Engineering Pei Jiang Zhou,Aragona Patty,2014-12-11 Selected peer reviewed papers from the 2014 International Conference on Energy Materials and Environment Engineering ICEMEE 2014 October 25 26 2014 Guangzhou China **Wind Energy for Power Generation** K. R. Rao,2019-10-17 This far reaching resource covers a full spectrum of multi faceted considerations critical for energy generation decision makers considering the adoption or expansion of wind power facilities It contextualizes pivotal technical information within the real complexities of economic environmental practical and socio economic parameters This matrix of coverage includes case studies and analysis from developed and developing regions including North America and Europe Asia Latin America the Middle East and Africa Crucial issues to power generation professionals and utilities such as capacity credits fuel saving intermittency penetration limits relative cost of electricity by generation source growth and cost trends incentives and wind integration issues are addressed Other economic issues succinctly discussed inform financial commitment to a project including investment matrices strategies for economic evaluations econometrics of wind energy cost comparisons of various investment strategies and cost comparisons with other energy sources Due to its encompassing scope this reference will be of distinct interest to practicing engineers policy and decision makers project planners investors and students working in the area of wind energy for power generation *ELECTRIMACS 2024* Enrique Belenguer,Hector Beltran,2025-01-30 This book collects a selection of papers presented at ELECTRIMACS 2024 The conference papers deal with modelling simulation analysis control power management design optimization machine learning techniques and identification and diagnostics in electrical power engineering The main application fields include electric machines and electromagnetic devices power electronics transportation systems smart grids electric and hybrid vehicles renewable energy and energy storage systems batteries supercapacitors and fuel cells and wireless power transfer among others Contributions included in Volume 1 are particularly focused on electrical engineering simulation aspects and innovative applications

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