

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 wind 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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