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Wind Plant
Collector Substation Protection

Mr. John J. Kumm, P.E.
POWER Engineers, Inc.

Introduction & Outline

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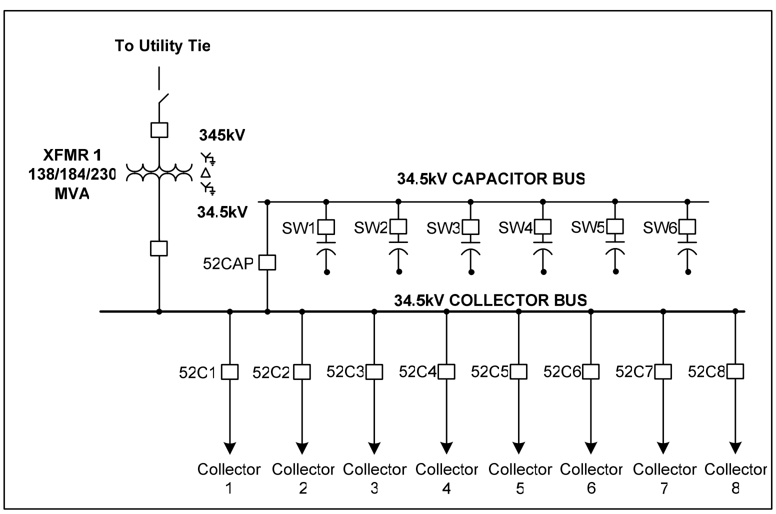
Background & Objectives

- Wind plants now have planned build-outs to 1,000 MW, intertie voltages to 345 kV
- Plants represent a large dollar investment and appreciable production resource
- Objectives of Dependability, Security, Selectivity, Speed, Simplicity, Economics all apply
- No single failure shall remove protection

Typical Collector Substation Topology



Utility Interface

- Utility requirements for protection & control vary with location, voltage level
- Determine protection scheme, communication, control, & data requirements as early as possible
- Consider protection signaling, breaker failure transfer trip, remote metering & control

Transmission Line Protection

- WTGs may not provide large or enduring currents for line faults
- Frequently, the wind park is served by a new OPGW-equipped line
- Dual, high-speed protection schemes are typical and increasingly likely with increasing line voltage and/or decreasing line length

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Transmission Line Protection

- In POTT schemes, use weak-infeed logic at the wind plant terminal
- DCB and line-current differential schemes are only impacted in sensitivity
- Many lines are initially—or are likely to become—three-terminal lines.
- In all cases, a time-stepped backup scheme should be provided for when communications are out

Transmission-Voltage Bus Protection

- Frequently not required as a result of station topology and placement of instrument transformers to protect the bus in the line or transformer zones
- When required, this protection needn't be exotic, high-impedance bus differential will typically serve

Collector Sub Transformer Protection

- Dual differential is typically desired and employed
- Consider restricted earth fault protection for improved sensitivity to low-winding ground faults
- Monitor non-electrical trips (sudden pressure, temperature) using the transformer relay for SOE & reporting

Collector-Voltage Bus Protection

- High-speed bus protection through high-impedance differential or zone-interlock protection is usually employed
- Particularly in switchgear applications, match the CT ratio and C-rating of CTs employed in high-impedance schemes. The C-rating should be at least C200
- Backup bus time-overcurrent should be employed in the bus main-breaker protection set or in the transformer relay

Collector Protection

- Coordinate with WTG step-up transformer fuses
- Cold-load pickup is not a concern, but transformer inrush may be
- Ground fault protection can be made more sensitive; no laterals and little natural unbalance
- Be aware of cable neutral I^2t rating

Capacitor Bank Protection

- Overcurrent-based protection for catastrophic faults
- Voltage-balance-based protection for capacitor fuse operations
- Alarm/Trip before voltage on remaining healthy capacitors exceeds 110% of rating
- Refer to IEEE C37.99 Guide for Shunt Capacitor Bank Protection

Key Points

- Negotiate transmission protection, signaling, and data exchange requirements early in the project
- Consider transmission relay selection and performance for three-terminal lines
- Analyze protection scheme for gaps due to single-point failures

Key Points

- Confirm transformer and collector-voltage bus protection speed and adequacy
- Don't forget cable neutral fault withstand capabilities when coordinating collector ground elements