



Wind Energy Tutorial

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Summary

Although the world relies heavily on fossil fuel (coal, oil, and natural gas) for its ever-growing appetite for energy, the negative environmental impact of burning fossil fuel have encouraged engineers and scientists to develop reliable alternative energy resources. The efforts were accelerated in the 1970s and many countries began investing in renewable energy, especially wind, through various programs that encourage the development and test of reliable systems. Tax credits, investments in research and development, subsidies, and developing favorable regulations are some of the various supports by governments to accelerate the development of wind energy technologies. These growths have led to a rapid change in the generation landscape because of the increasing penetration of wind energy systems and the emerging of several microgrids. These fundamental changes require the power grid to become more vibrant and interactive which will demand significant changes in the grid operation, protection and control. This tutorial covers the operation, control, and integration problems of wind energy systems from the utility point of view. The integration topics include the impacts of wind energy on power grid such as fault ride-through, reactive power, stability, voltage flickers, stochastic generation, uncertain production, dynamic performance and unit commitment.

The tutorial is divided into two parts: Part 1 covers the fundamentals of wind energy systems; and Part 2 covers the integration issues of high penetration wind energy system.

Agenda:

1. Aerodynamics of Wind Turbines
2. Wind Statistics
3. Overview of Wind Turbines
 - 3.1. Classification of Wind Turbines
 - 3.2. Alignment of Rotating Axis
 - 3.3. Generators
 - 3.4. Speed of Rotation
 - 3.5. Control Actions

Types of



4. Solid-State Converters
5. Type 1 Wind Turbine System
6. Type 2 Wind Turbine System
7. Type 3 Wind Turbine System
8. Type 4 Wind Turbine
9. System Stability
10. Fault Ride-Through, Low-Voltage Ride-Through
11. Variability of the Wind Power Production
12. Reactive Power

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