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01 Jan 2006

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Recommended Citation

B. H. Chowdhury, "Operational Characteristics of Wind Plants and Windfarms," *Proceedings of the IEEE Power Engineering Society General Meeting, 2006*, Institute of Electrical and Electronics Engineers (IEEE), Jan 2006.
The definitive version is available at https://doi.org/10.1109/PES.2006.1709604

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Operational Characteristics of Wind Plants and Windfarms

Badrul H. Chowdhury [1], *Senior Member, IEEE*

Abstract: A wide range of power generation technologies exist today, whose characteristics can vary significantly. Additionally, a diverse range of wind turbines are available in the market. With experienced wind developers taking the charge in installing multi-megawatt-size windfarms at a rapid pace, the role of wind power in electricity generation is bound to grow in significance in the coming years. This panel takes a critical look at the operating characteristics of existing and planned wind power generation systems and their relationship to interconnection requirements and performance standards.

Keyword: Wind park, grid codes, interconnection, low voltage ride through.

I. Introduction

WIND power generation is the fastest growing source of energy worldwide [1]. The wind industry has experienced significant progress over the past decade not only in turbine technology, but also in the electrical interface. The cost of wind power generation has decreased so much in recent years that it is now competitive with conventional forms of power generation. In addition, since there is no fuel cost volatility, the long-term price of wind energy is stable.

However, operating large windfarms within an existing electric utility's system can bring about some uncertainties in both the windfarm behavior and the network behavior. Studies have proven that at certain penetration levels one may start to see problems with interconnection. Some suggest this level to be 15%, while some suggest 30%. However, whatever the penetration level is, it is clear that the wind variability will most likely have an impact on system operations, including voltage and frequency and, in general, power quality.

II. Uncertainties in Wind Power – Grid Codes

To counter some of these uncertainties, new grid codes are being devised in many parts of the world, particularly where wind power's presence is starting to be felt in system operations. Specific interconnection requirements as well as performance standards are driving the new codes. Among the issues at the forefront are:

- Low voltage ride through (LVRT) for wind machines
- Voltage control and reactive power capability
- Behavior under system fault conditions
- Protective system performance
- System reserve requirements to handle tripping of large wind farm output
- System monitoring
- Wind forecasting
- Modeling for system studies

Progress is being made on many of the issues. FERC in its Order 661 issued its LVRT requirement [2]. Many of the European countries are either introducing new requirements or revising inadequate grid codes [3], [4].

III. Panel Discussions

This panel looks at wind generation from different perspectives:

1. Researcher's perspective
2. Windfarm developer's perspective
3. Wind power user's perspective
4. Wind turbine manufacturer's perspective

Erlich et al [5], projects that by the year 2020 a total wind power capacity of nearly 50 GW is expected in Germany. This amount is more than 50% of the German peak load. As such, revision of the existing German grid code, introduced in 2003, is needed. The panelist suggests that the revised grid code requires wind turbines to provide voltage support during faults and also during normal operation. According to the new grid code, voltage support is required when the terminal voltage is outside 10% of the current operating point. Also, wind turbines are required to stay on the grid within the frequency range of 47.5 Hz and 51.5 Hz on the 50 Hz system.

Saylors [6] contends that the evolution of grid codes has been brought about by the desire to view windfarms simply as just another power plant from the vantage point of the grid operator. Turbine manufacturers are being challenged in the last three years to provide turbines that can behave in this fashion, but designs are constantly evolving.

Muljadi, et al [7] describes some aspects of power quality of the wind power plant. The authors contend that how one models the wind power generation – whether as individual

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1-4244-0493-2/06/$20.00 ©2006 IEEE.

turbines or as several groups of identical turbines will make a difference in simulations of wind farms. They also show that capacitor compensation used by induction generators in a wind power plant can lead to self-excitation and harmonics.

IV. Conclusion

The future of wind power appears to be bright. The momentum gathered over the past decade will almost certainly carry it forward to new heights. This technology holds the promise of significant green power production even at low to moderate wind speeds. Some of the prospects of the future hinges on how well wind farms can cope with new and evolving grid codes. At the same time, how well utilities are prepared to accept large percentages of wind power penetration can partly dictate the future course. Energy storage and reactive compensation will most likely play important roles in improving the value of wind power from the perspective of system reliability.

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VI. Biography

Badrul H. Chowdhury (M'1983, SM’1993) obtained his Ph.D. degree in Electrical Engineering from Virginia Tech, Blacksburg, VA in 1987. He is currently a Professor in the Electrical & Computer Engineering department of the University of Missouri-Rolla. From 1987 to 1998 he was with the University of Wyoming’s Electrical Engineering department. Dr. Chowdhury’s research interests are in power system modeling, analysis and control and distributed generation. He teaches courses in power systems, power quality and power electronics.