Integration of Wind Power

Technology Based Balancing of Fluctuating Power Production

The Wind Turbines Technical Ability to Deliver Ancillary Services and Support the Grid
Business Card

Michael Nørtoft Frydensbjerg
Team Leader Grid Connection,
M.Sc.E.E.

Education

M.Sc., Electrical Engineering,
Aalborg University, 1997

B.Sc., Electrical Engineering,
The Engineering College of Odense, 1995

Wind Power Experience

Wind Power Business, July 2000
Siemens Wind Power, August 2005
Agenda

- System Services in General
- Fault Ride Through
- Reactive Power
- Wind Power Plant Control
System Services in General

- Grid Support
  - Technology
Grid Support from a Wind Power Plant

Diagram showing connections between various components such as Wind Turbine Generators, Converter, Busbar, and PCC, with voltage levels such as 0.69/33 kV, 33 kV, 132 kV, and connections to Power Station and Consumer.
System Services in General

- Grid Support
  - Technology

- New System Services
  - Technology
  - Development Time

- Services Costs
Fault Ride Through

- Low Voltage Ride Through
Low Voltage Ride Through

-1.00 1.00 3.00 5.00 7.00 9.00 11.00 13.00 15.00 17.00 19.00

Voltage

Time

-0.2 0 0.2 0.4 0.6 0.8 1 1.2

Nationa Grid, UK
ESB, IRL
E.ON, D
Energinet.dk
Svenska Kraftnät, S
RED Eléctrica, E
FERC, USA
Statnet, N

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Low Voltage Ride Through

![Graph showing voltage over time for different grid operators](image-url)
Fault Ride Through

- Low Voltage Ride Through
  - Voltage Support
  - Power Recovery

High Voltage Ride Through
Reactive Power

- Wind Power Plant
Reactive Power

- Wind Power Plant
  - Transformer incl. Tap Changer
  - Cables
  - Capacitors
  - Wind Turbines
  - Etc.

- New Possibilities
  - Reactive Power at No Wind
Wind Power Plant Control

- **Active Power Control**
  - MW Control
  - Frequency Control
  - Synthetic Inertia (Another Frequency Control)

- **Reactive Power Control**
  - kvar Control
  - Power Factor Control
  - Voltage Control
Thank your for your attention!
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