Wind farm controllers with grid support

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Project description

• Objectives
  - Develop wind farm controllers aiming at
    • Participation in power system control of power (frequency) and reactive power (voltage)
    • Maximisation of power production
    • Reduction of structural loads and life time consumption.
  - Use predictions to improve control
  - Compare different types of wind farms:
    • Double fed induction generators (as Horns Rev)
    • AC transmitted induction generators, combi/active stall (as Nysted)
    • HVDC transmitted induction generators, combi/active stall (virtual)

• Sponsor
  - Elkraft System, Public Service Obligation (PSO 2002, contract FU 2102)
Wind prediction to increase var speed power?

- Rotor speed not optimal at any time because wind changes and speed control is behind.
- US research claims 3% increase in power possible.
- Our results show perfect prediction + perfect control ⇒ <0.1% increase for typical wind conditions (Høvsøre), <0.6% for 20% turbulence!!
Wind farm controller function

Wind farm control level

Operators

Wind farm controller (power reference decision)

$P_{\text{meas}}^{PCC}$, $f_{\text{meas}}^{PCC}$

Power references

Available powers

Wind turbine control level

Wind turbine controllers

Wind turbines available power
Wind farm power control – wind turbines
Wind farm power control

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Wind farm controllers with grid support
Balance control

- Balance control provides
- Delta control already implemented in Horns Rev

Reserve can be utilised in frequency control (droop and deadband)
Delta control

- Delta control provides fixed reserve
- Delta control already implemented in Horns Rev

Reserve can be utilised in frequency control (droop and deadband)
Isolation of wind turbines in local grid

Diagram showing the connection of wind turbines (WT1_10kV, WT2_10kV, WT3_10kV) to the grid through a PCC point. Station 2 is connected to Station 1 through lines 1, 2, and 3. The diagram includes symbols for Static load, Motor load, and Local CHP. There is also a 2-winding transformer and an AC Voltage Source.

Key:
- WT: Wind Turbine
- PCC: Point of Common Coupling
- Disconnection point
- Static load
- Motor load
- Local CHP
- AC Voltage Source
- 2-winding transformer

Isolated system
Wind farm + static load
Wind farm + motor with $T_{ag} = 10$ sec

Figure 1: Case B - frequency and voltage control.
Conclusions

• Not possible to use predictions based on information in wind farm controller to increase production of var speed turbines

• Simulations confirm that the two concepts used in the two large offshore wind farms in Denmark can support grid control

• Combi stall / active stall wind turbines can also provide a relatively fast response to changes in active power demands

• Variable speed wind turbines can respond immediately to changes in active as well as reactive power demands

• Voltage control possible with power converters or with capacitors (dynamic phase compensation)!

• Even fixed speed wind turbines without power converters can control an isolated grid provided enough inertia!