

# Large Wind Plant Collector Design

IEEE PES T&D 2008

## Monitoring, Control, and Automation of Large Wind Plants

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## Plant Requirements

Function as a single  
coordinated power plant

- SCADA
  - Turbine Operation
  - Turbine/Plant Monitoring
  - Communications LAN
- Control Functions
  - Plant Power Regulation
  - Plant VAR Regulation
- Electrical Interfaces
  - Fixed VAR Banks
  - Utility control references
  - PT's and CT's



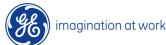
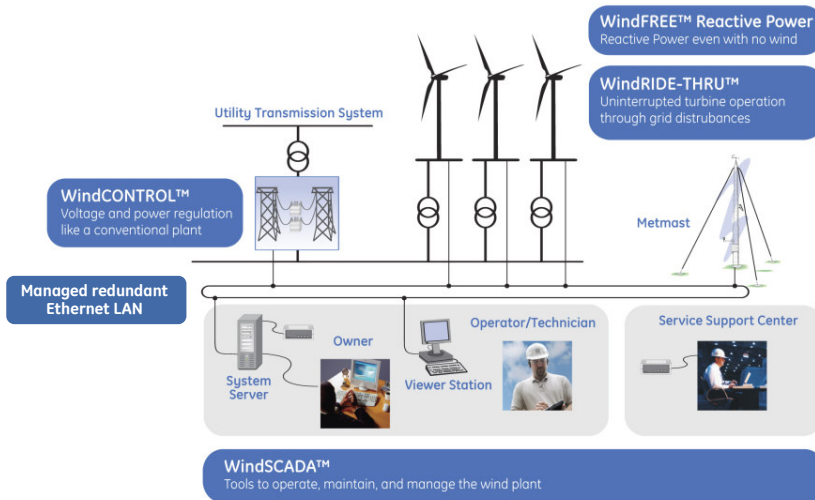
# Plant SCADA

## Integrated operation, monitoring and control system

- User HMI
- Communications LAN
- Real time Watt/VAR regulation
- Unit sequencing
- Historical and real time monitoring
- Reporting



## Power Plant SCADA and Control Architecture GE WindSCADA & WindCONTROL



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## Wind Plant SCADA System

- Real-time operational control of each turbine & complete Wind Plant
- Historical data base with reporting system including Production and Wind reports
- Secure User-Access, intuitive Operation & Maintenance tool

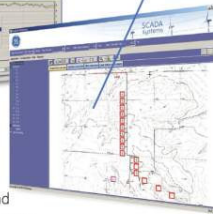
### Wind Plant Status

Color coded summary of how many wind turbines are in each mode.



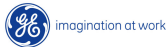
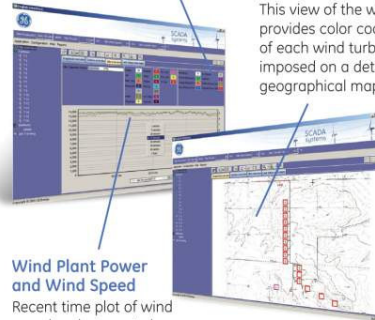
### Graphical Overview of Wind Plant

This view of the wind plant provides color coded status of each wind turbine superimposed on a detailed geographical map.



### Wind Plant Power and Wind Speed

Recent time plot of wind speed and generated power.



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## Control Functions

### Power control

- Curtailment
- Power-Frequency droop
- Ramp Rate
- Coordinated plant startup & shutdown

### VAR control

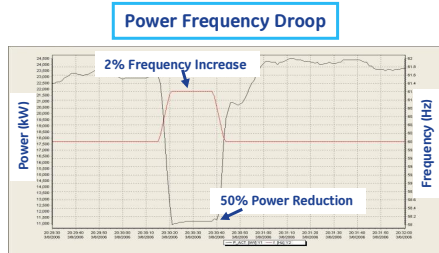
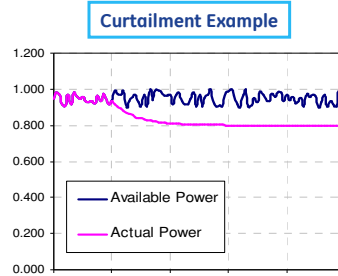
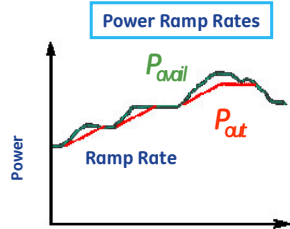
- Voltage (optional droop & line drop)
- Power Factor



# Power Controls

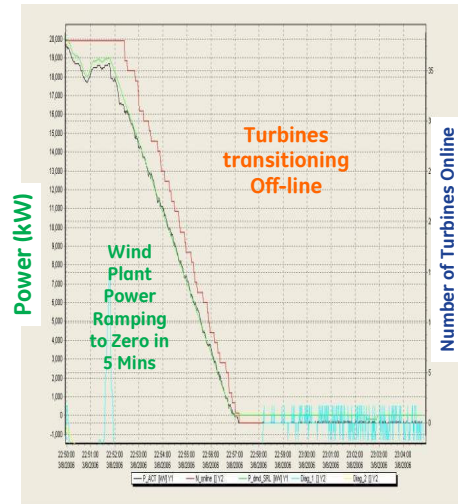
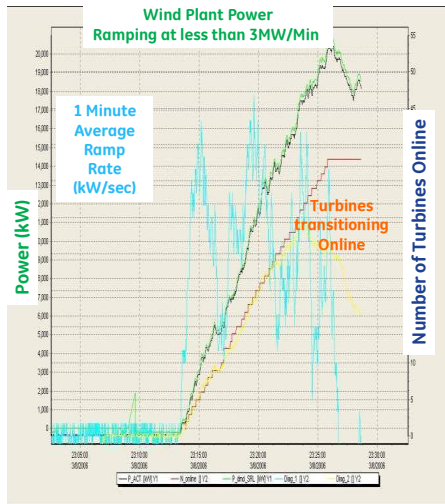
## Typical Grid Requirements

- Ramp rates
- Power curtailment
- Power droop w/ frequency



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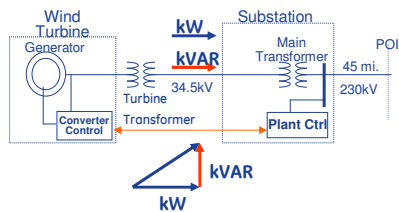
## Startup and Shutdown Control - Controls the Insertion and Removal of Large Power Blocks



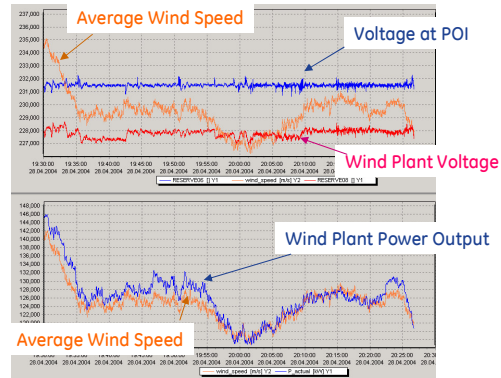
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## Voltage/Pf Regulation

- Regulates Grid Voltage at Point of Interconnection
- Minimizes Grid Voltage Fluctuations Even Under Varying Wind Conditions



Actual measurements from a 162MW wind plant with line drop compensation



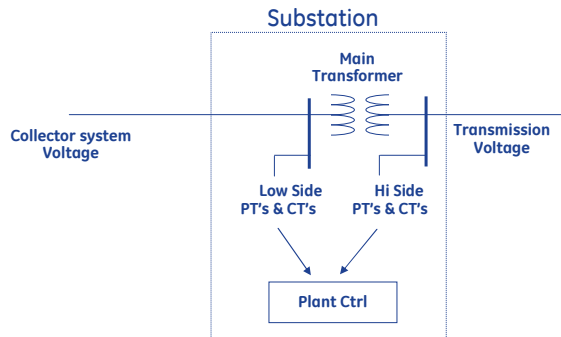
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## Wind Plant control application criteria

- Metering or Protection Grade CT
- PT & CT location
- Other control requirements  
Intra area coordination



# Plant Measurement Location Tradeoffs



## Low Side Measurement

- Regulates collector system voltage
- Conflict with OLTC operation
- XFMR droop & impedance buffering
- Neglects XFMR power losses

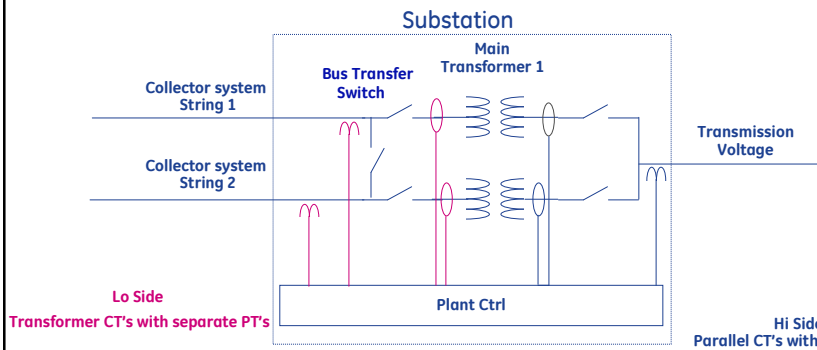
## Hi Side Measurement

- Regulates transmission voltage
- Coordinates with OLTC operation
- May require synthesized droop
- Includes XFMR power losses



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# Dual or Redundant Main Step Up Transformer Instrumentation Wiring



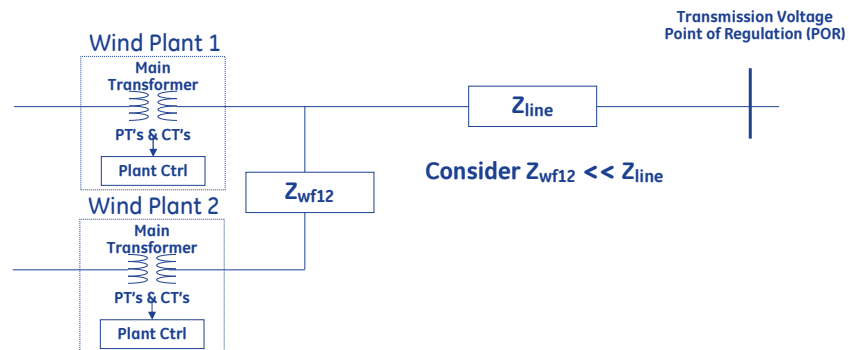
- Transfer switch closed - 2 separate control circuits
- Transfer switch open - Common control circuit

Single control circuit 1 or 2 transformers



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## Wind Plant Local Area Control Applications



### Voltage regulation with tightly coupled wind plants

Line Drop Compensation for POR is problematic  
Most often requires each wind plant to operate in voltage droop  
Power Factor control or 3<sup>rd</sup> party master control potential solution



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## Summary & Conclusion

### Wind Plant Controls

- Are available that allow wind plants to function as single power plant
- Integrated SCADA system architecture
- Control requirements are important when applying plant controls to wind plant electrical design

