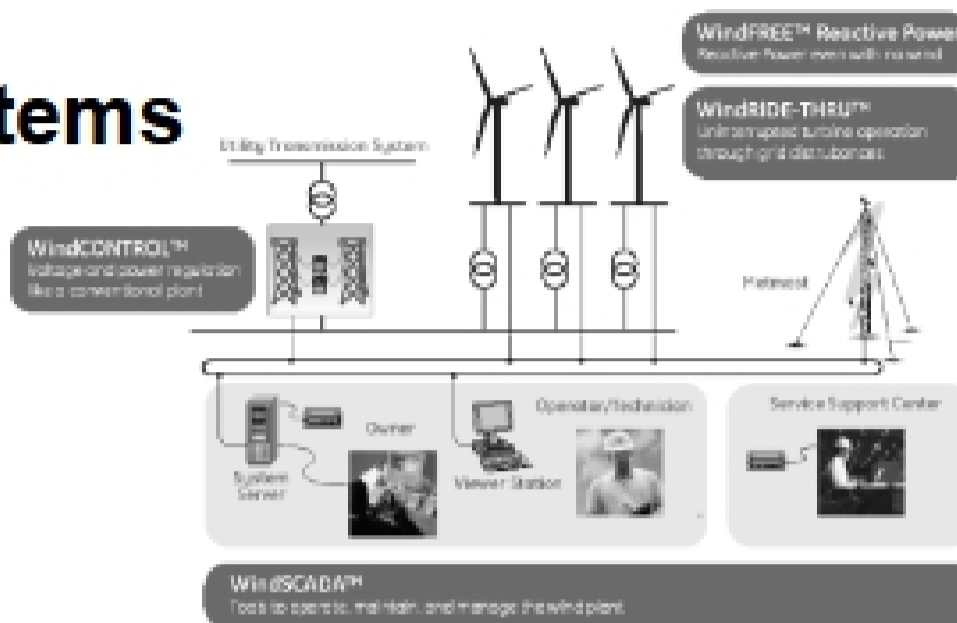


GE Energy

Wind Plant Systems

- **Grid Integration**
- **Plant and Turbine Controls**
- **SCADA**



Mahesh Morjaria
Manager, Wind Plant Systems Platform



imagination at work

Adopted for
Wind Power Management class
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Agenda

- ***Grid Friendly Wind Plant***
- ***Wind Plant Controls***
- ***SCADA System***

What makes a Wind Plant “Grid Friendly”?

- Does not trip during Faults and other System Disturbances ... *ride through capability*
- Regulates Plant Voltage and Power
- Limits the Rate of Change of Power from Variations in Wind Speed ... *Ramp Rate Control*
- Reacts to Changes in Grid Frequency ... *Frequency Droop*
- Controls the Insertion and Removal of Large Power Blocks ... *Startup and Shutdown Control*
- Provides Reactive Power When Needed ... *Wind Free Reactive Power*

Grid Fault Tolerance

Low Voltage Ride Through

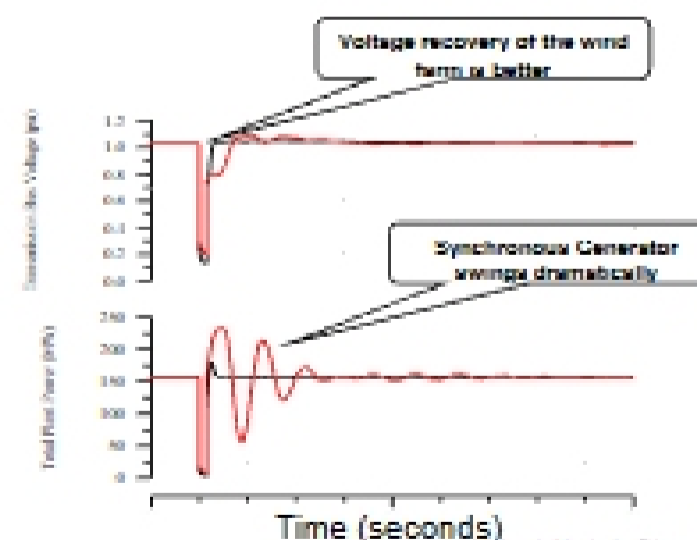
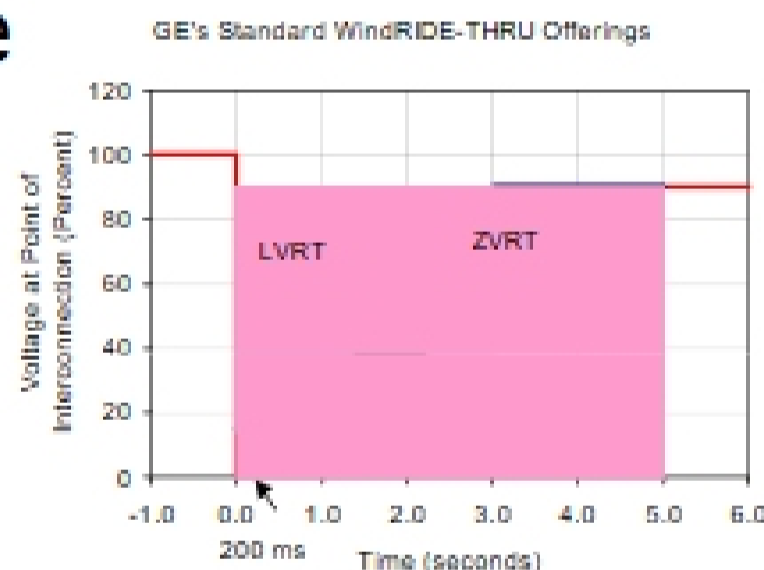
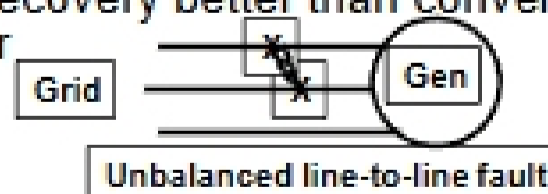
- > Required by grid codes
- > Improves gearbox life

Zero Voltage Ride Through

- > Required by FERC after 12/31/07
- > New controls for unbalanced faults
- > GE 1.5 and 2.5 will comply

Fault Recovery

- > Voltage recovery better than conventional generator



Low Voltage Ride Through Capability

Low voltage ride through (LVRT) is a turbine capability when the voltage in the grid drops due to a fault or load change in the grid.

The severity of the voltage dip is defined by the voltage level during the dip (may go down to zero) and the duration of the dip.

Depending on the application the device may, during and after the dip, be required to:

- ✓ Disconnect temporarily from the grid, but reconnect and continue operation after the dip
- ✓ Stay operational and not disconnect from the grid
- ✓ Stay connected and support the grid with reactive power



Mehesh Morjaria #5
March 3, 2009

Power Droop

- ✓ When circuit activity changes abruptly, it can cause a sudden drop or rise in power supply voltage.
- ✓ This change is known as power droop and is an instance of power supply noise.
- ✓ Power droop can cause an IC to fail.
- ✓ Such failures should be screened during testing
- ✓ Evaluation of the worst-case power drop by accumulating the high- and low-frequency effects.



Mehesh Morjaria #8
March 3, 2009