GE’s Installed Wind Fleet

USA
(12,081 units/18,124 MW)
Canada
(936 units/1,411 MW)

Europe + Turkey –
16 Countries
(3,055 units/5,094 MW)

China
(747 units/1,121 MW)
Japan
(290 units/478 MW)

17,000+ WTGs, 27GW+ installed … 22 countries

As of 3Q, 2011
GE global research footprint
5 global research centers

Niskayuna, New York  
Munich, Germany  
Shanghai, China  
Bangalore, India  
Rio de Janeiro, Brazil

Highlights
- 2,600 research employees (nearly 1,000 PhDs)
- 27,000 GE technologists worldwide
- $5.7B technology spend
- 700+ renewable energy patents filed since 2002

Global research driving advanced technology solutions
Component Test Lab – Greenville, SC

- Test equipment utilizes real wind turbine field data
- Validates robust design
- Expertise from Thermal heritage

Gold standard lab test facility
Basic Physics of Wind Resource

Power = f (Air density * Velocity ^ 3 * Radius^2 )
Advanced Loads Control (ALC)

**ALC is a load mitigation strategy**

1) Optimizes turbine performance and energy capture by pitching each blade individually,... Measures and calculates the effects of the wind throughout the blade rotation.

2) Controls the tower movement through generator torque and blade pitch

**Customer Benefit**

- Increases energy capture to provide more revenue generation.
  - Higher capacity factor and AEP
  - Optimizes land utilization for turbine siting
  - Increases performance envelope by extending cutout speed from 20 m/s to 25 m/s

**How it works**

- Sensors enable improved machine control.
- Sensors allow the control system to adjust generator torque and speed more accurately for fatigue reduction.
- ALC allows individual blade pitching by sensing main shaft deflection

**Where Used**

- 2.75-100 & 103  •  1.6-82.5
- 2.5-100 & 103  •  1.5-77
Wind Farm Basic Layout

- Wind turbine generators
- Pad mounted transformers
- Power cables, control circuits, protection, and SCADA
- Substation transformer
- Point of interconnection
“Grid Friendly” wind power plant

Address reliability concerns
Industry leading ride-through technology
WindRIDE-THRU™ since 2005

Improve grid operability & security
200+ WindCONTROL™ installs, 8,500 turbines
Voltage and Megawatt control

Enable high levels of wind penetration
WindINERTIA™ – new grid feature by GE

Controls technology driving grid leadership
Benefits of GE grid integration technology

• Enabling wind farms to behave like conventional power plants

• GE Energy Consulting … recognized leader in grid integration studies and solutions

• Building on power electronics and controls technology utilized across thermal, nuclear, steam, IGCC, aero-derivatives, and renewable energy

• Integrated into turbine design and operation…not “bolt on” to meet grid requirements

• Continued investment to solve grid needs ... at turbine, at plant, across windplants

Building on a 100+ year history of power plant integration