

Smart Wind for the Smart Grid

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imagination at work

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

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



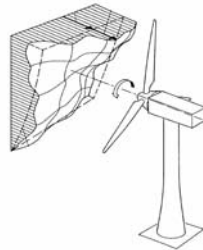
Basic Physics of Wind Resource

Power = f (Air density * Velocity ³ * Radius²)

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



Where Used

- 2.75-100 & 103 • 1.6-82.5
- 2.5-100 & 103 • 1.5-77

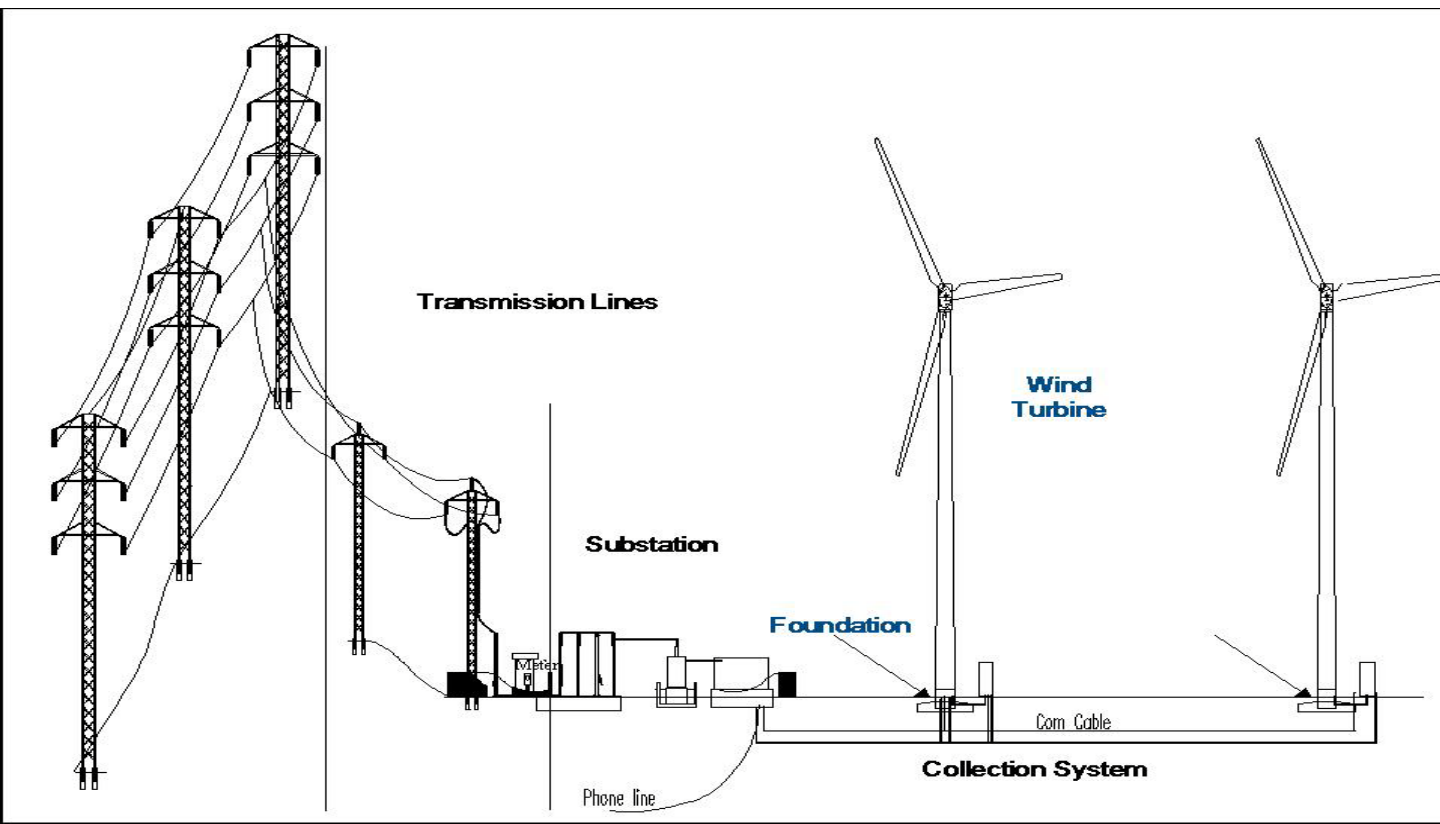


Customer Benefit

- 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 20m/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



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

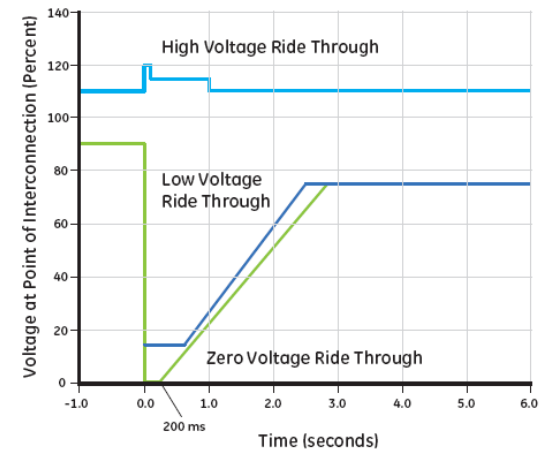
200+ WindCONTROL™ installs, 8,500
turbines

Voltage and Megawatt control

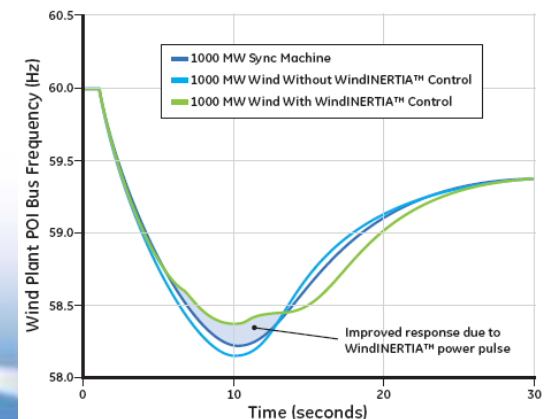
Enable high levels of wind penetration

WindINERTIA™ – new grid feature by GE

GE's Standard WindRIDE-THRU® Offerings



Simulated System Response Following a Trip of a Large Generator



**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