

# GE Energy

## Wind Energy Applications Technology Symposium

**Katy Wilner**

May 22, 2008



# GE's portfolio

- 6 businesses operating in more than 100 countries ... 125+ years
- Over 300,000 employees worldwide
- 2007 revenue \$173B



Infrastructure



Industrial



NBC  
Universa  
|



Healthcare



Commercial  
Financial  
Services



Consumer  
Finance



# Global business ... aligned with customers

## Infrastructure



**Energy**



**Financial  
Services**



**Rail**



**Water**



**Aircraft  
Engines**



**Oil & Gas**

- >40,000 employees
- 700 locations ... over 100 countries
- 2007 revenue \$21.8B



# GE Energy Technology Portfolio



**Gas**



**Cleaner Coal**



**Nuclear**



**Wind**



**Hydro**



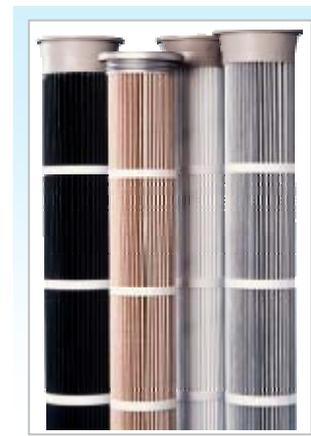
**Biomass**



**Solar**



**Network  
Reliability**



**Environmental  
Services**



**Asset  
Optimization**



# Technology...Leveraging the Breadth of GE



## GE Aviation

Aerodynamic and aero-acoustic modeling expertise



## GE Advanced Materials

Resins, Plastics, Metals...



## GE Global Research Centers

China, India, US and Europe



## GE Oil & Gas

Offshore Platforms/Experience



## GE Transportation

Gearbox and power converter technologies



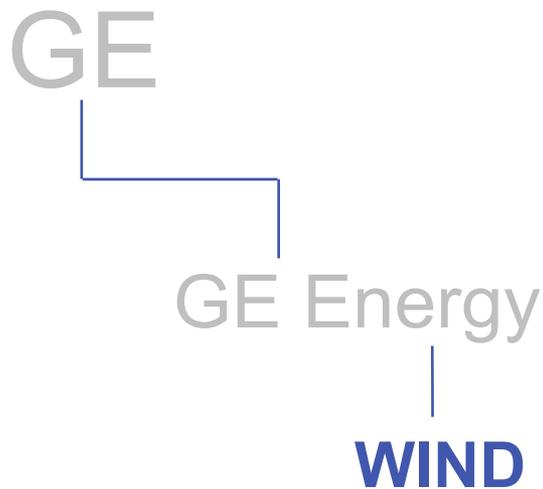
## GE Energy

Controls, Materials, Technology

Gas Turbine Bubble: Unprecedented execution...10x ramp in 3 years

**Advanced technology experience applied to wind**

# Wind...A Growing Part of GE



- Acquired in May 2002
- >\$4 B in Revenues in 2007
- \$10 MM+ Technology Investment
- 3 x Wind Engineering Staff
- Over 2,000 Employees Worldwide
- Global Manufacturing/Assembly



## GE Named #1 U.S. Provider of Wind Energy

HEADLINES

Source: Internal

11 April 2007

ATLANTA, GEORGIA - April 11, 2007 -Reaffirming its position as the leading supplier of technology and services for the U.S. wind industry, GE Energy provided wind turbines representing over 45% of the country's new wind capacity in 2006.

The American Wind Energy Association (AWEA) reported today that U.S. wind power generating capacity increased by 27% in 2006 and is expected to increase an additional 26% in 2007. The U.S. wind industry installed more than 2.4 gigawatts of new wind capacity during the year, with GE wind turbines accounting for nearly half of that total. GE supplied 764 of its 1.5-megawatt wind turbines for U.S. projects in 2006.

"This achievement reflects the tremendous strides wind power is making, as power producers are increasingly turning to renewable energy solutions to diversify and expand their generation portfolios," said Victor Abate, Vice President-Renewables for GE Energy. "Our continued investment in wind energy technology has positioned us well to compete in this growing industry. We are confident that wind power - an abundant, domestic and zero-carbon emissions resource - will be an integral part of the U.S. energy mix throughout the 21st century."

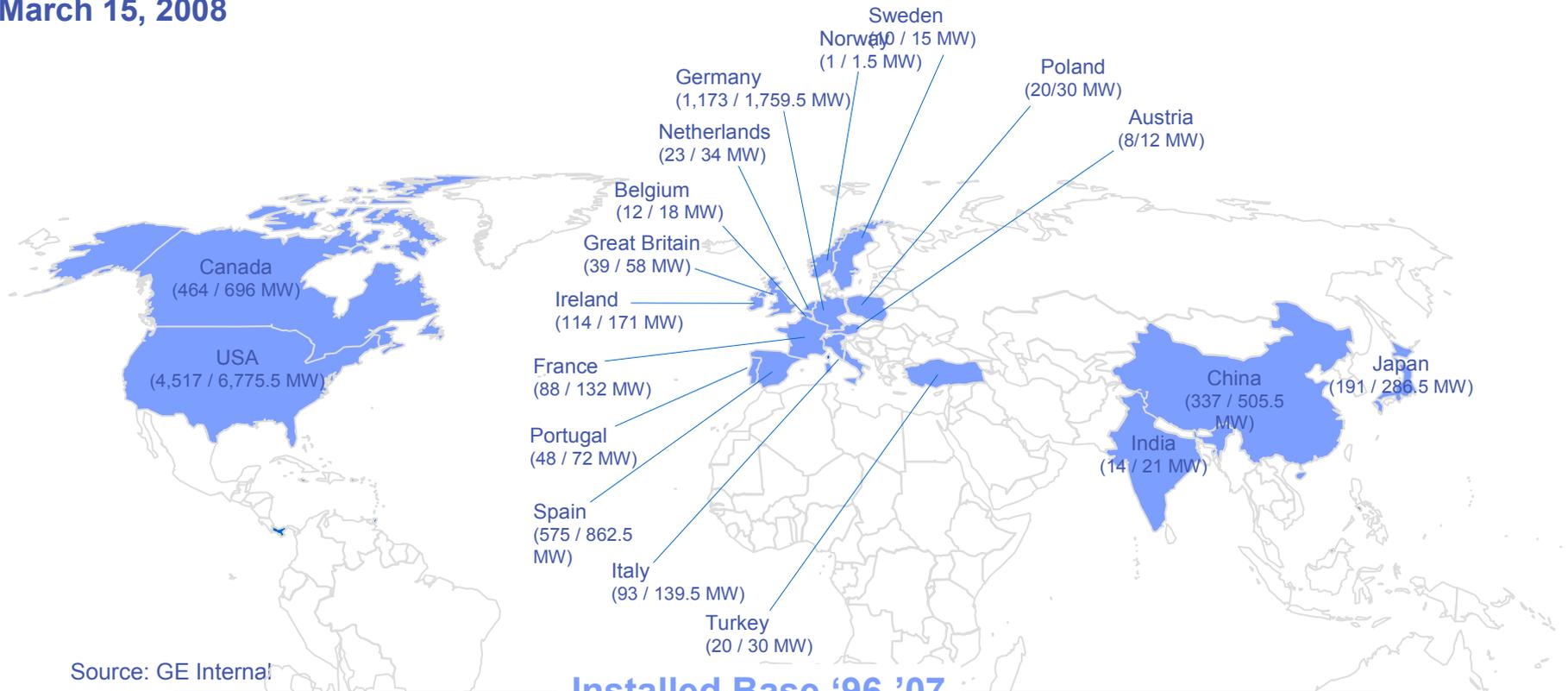
"With some of the world's best wind resources, the U.S. has the potential to greatly increase its wind energy output in the years ahead," Abate added.

Since entering the wind business in 2002, GE Energy has continued to expand its wind energy operations, increasing its wind engineering team threefold and applying experience and expertise from other GE business units to advance its wind turbine technology.

# GE 1.5MW WTG...The best selling wind turbine

7766 Turbines / 11,649 MW

March 15, 2008



Source: GE Internal

## Installed Base '96-'07

Turbine Type	1996-2002	2003	2004	2005	2006	2007	Total
1.5 l/p	24	0	0	0	0	0	24
1.5s	757	670	285	239	119	141	2,211
1.5sl	450	315	255	159	79	18	1,276
1.5se	0	0	41	2	20	14	77
1.5sle	0	0	35	935	1,237	1,988	4,195
1.5xle	0	0	0	1	0	6	7
<b>Total</b>	<b>1,231</b>	<b>985</b>	<b>616</b>	<b>1,336</b>	<b>1,455</b>	<b>2,167</b>	<b>7,766</b>



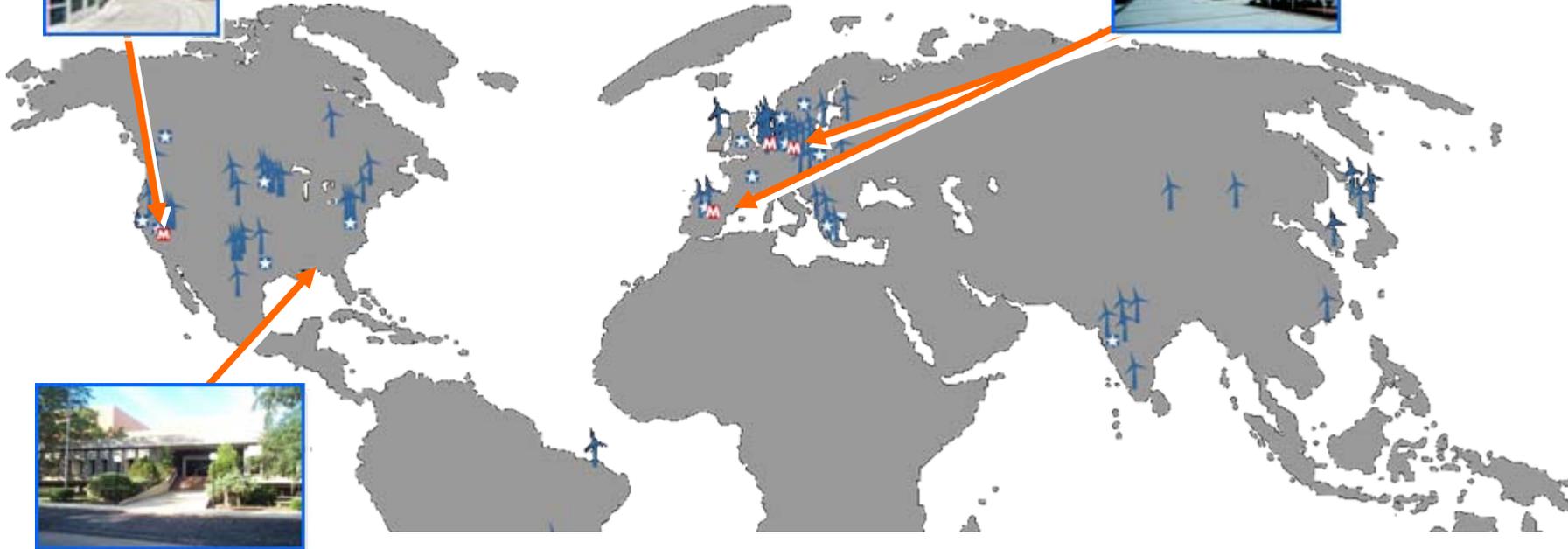
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# GE's Global "Wind" Presence - Manufacturing

US Manufacturing/Assembly  
Tehachapi, USA



European Manufacturing/Assembly  
Germany and Spain



Blade Manufacturing Facility  
Pensacola, Florida, USA



# Our Customer Offerings

- Wind Turbine Design and Manufacturing
- Customer Support Services Including:
  - › Operation and Management
  - › Maintenance and Repair
  - › Project Development Assistance
  - › Project Finance Assistance
  - › Land Acquisition and Permitting
  - › Wind Resource Assessment
  - › Community Education and Acceptance



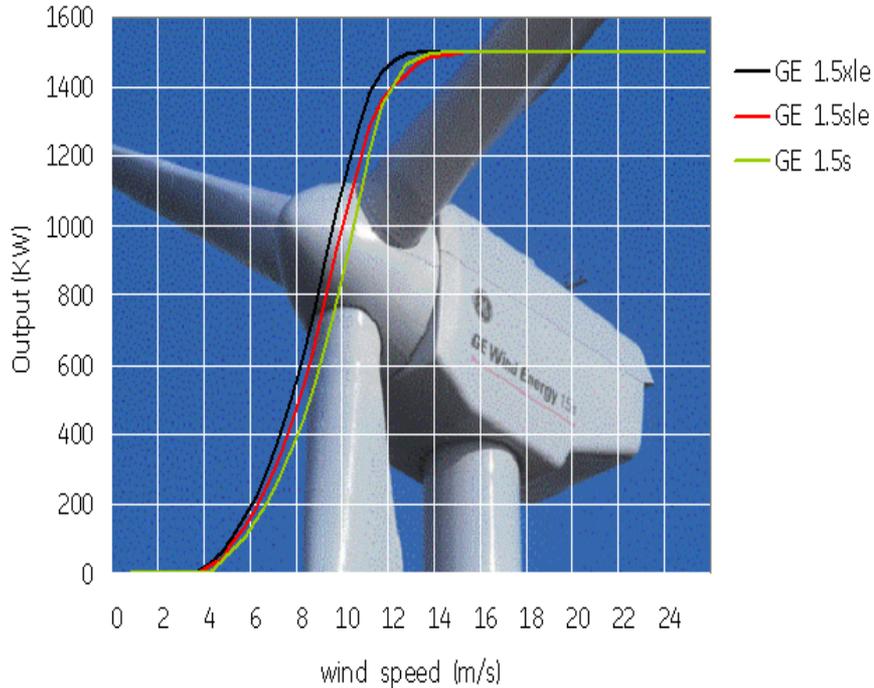
# Technology



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# GE 1.5MW wind turbine Product Line...

**GE 1.5MW turbine power curve**



Air density=1.225kg/m<sup>3</sup>  
10% <Turbulence intensities < 15%

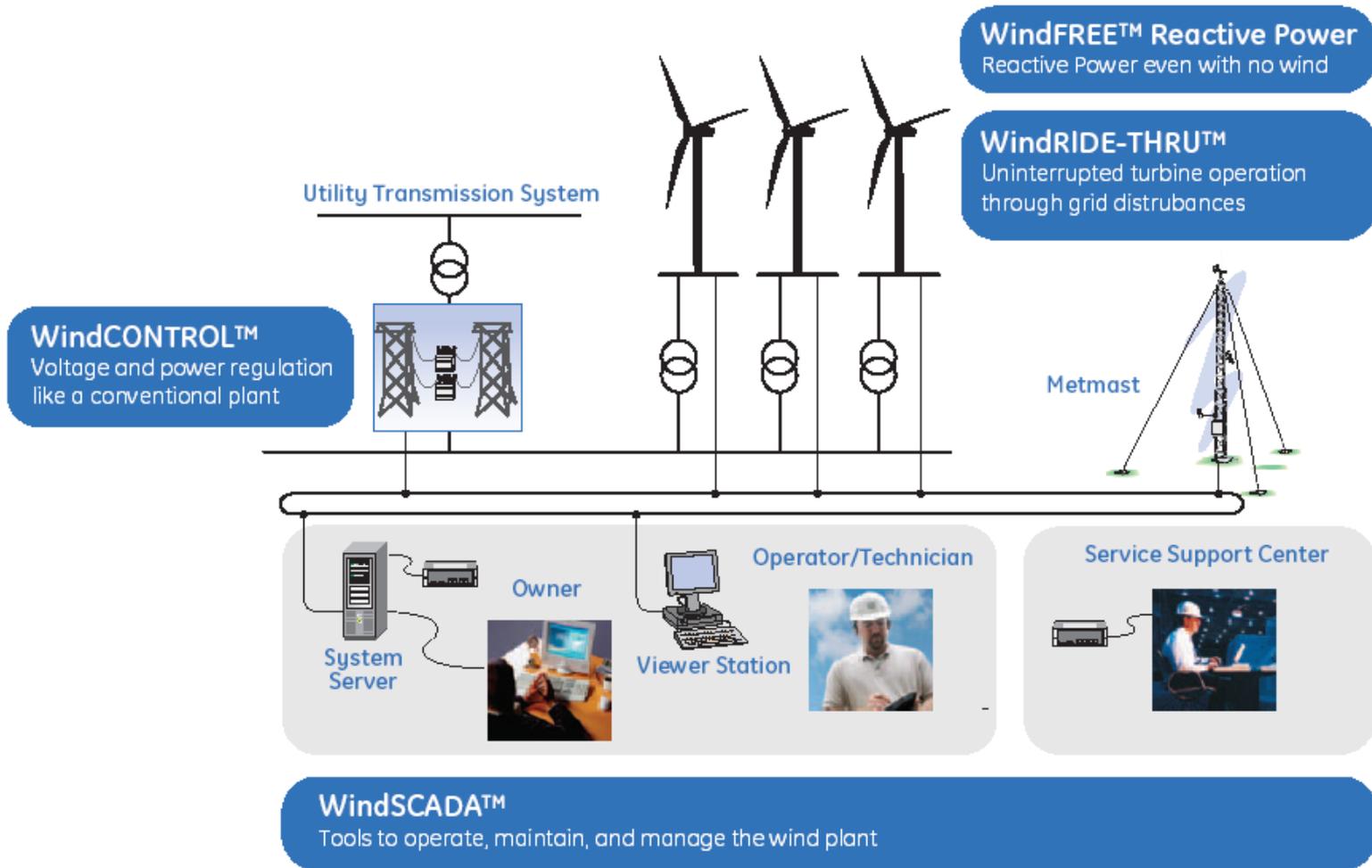
	1.5s	1.5sle	1.5xle
Rate power	1.5MW		
Wind regime	IEC IIa	IEC IIa	IEC IIIb
Rotor diameter	70.5m	77m	82.5m
Hub height	64.7m	61.4/80m	80m
Cut in wind speed	4m/s	3.5m/s	3.5m/s
Cut out wind speed	25m/s	25m/s	20m/s
Operating temperature	-15C to +40C -30C to +40C (CWE)		
Noise level	104 dB(A) +/- 2		

# 1.5 MW Wind Turbine...Industry Workhorse

- ✓ Technology leadership...high capacity factor in Class II and III, broad site suitability
- ✓ Global fleet...over 7,600 units operating in 20 countries
- ✓ Fulfillment excellence...leaders for on time delivery
- ✓ Logistics management...fixed price capability
- ✓ Reliability focus...realigned 130 person product service organization



# Grid Friendly Wind Power Plant



## Integrated Suite of Products for Seamless Grid Support

# Logistics



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# Advanced Logistics



## Logistics Friendly 1.5 Workhorse

- Rail capability
- Lowest site prep cost
- Reusable double blade fixtures



## Customer Benefits

- Firm price quote capabilities (cost & schedule)
- In-house GE coordination and management
- Strategic global sourcing & production locations
- Ability to support aggressive site schedules (>15/week)



# Transportation

H-frame Fixture







## Challenges:

- Urban delivery
- Building codes
- Small project coordination
- Salt water corrosion
- Proximity safety issues
- Winter construction

Jersey Wind, New Jersey

# Service



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# Service ...World class service Center

## Customer support center

- Service 24/7 365
- Remote trouble shooting& resetting capability.
- Part management service for service requests, curtailments, weather warnings etc.

## New wind capture center

- Centralized Staffing
- Services 24/7 365
- Dedicated Dispatch Teams for Troubleshooting, Repair and Maintenance
- Wind Capture Center Warehouse
- Wind Capture Center Resident

## Added value

- Availability – 1.5% Increase
- Time To Reset – 40% Decrease
- Consistent Operations



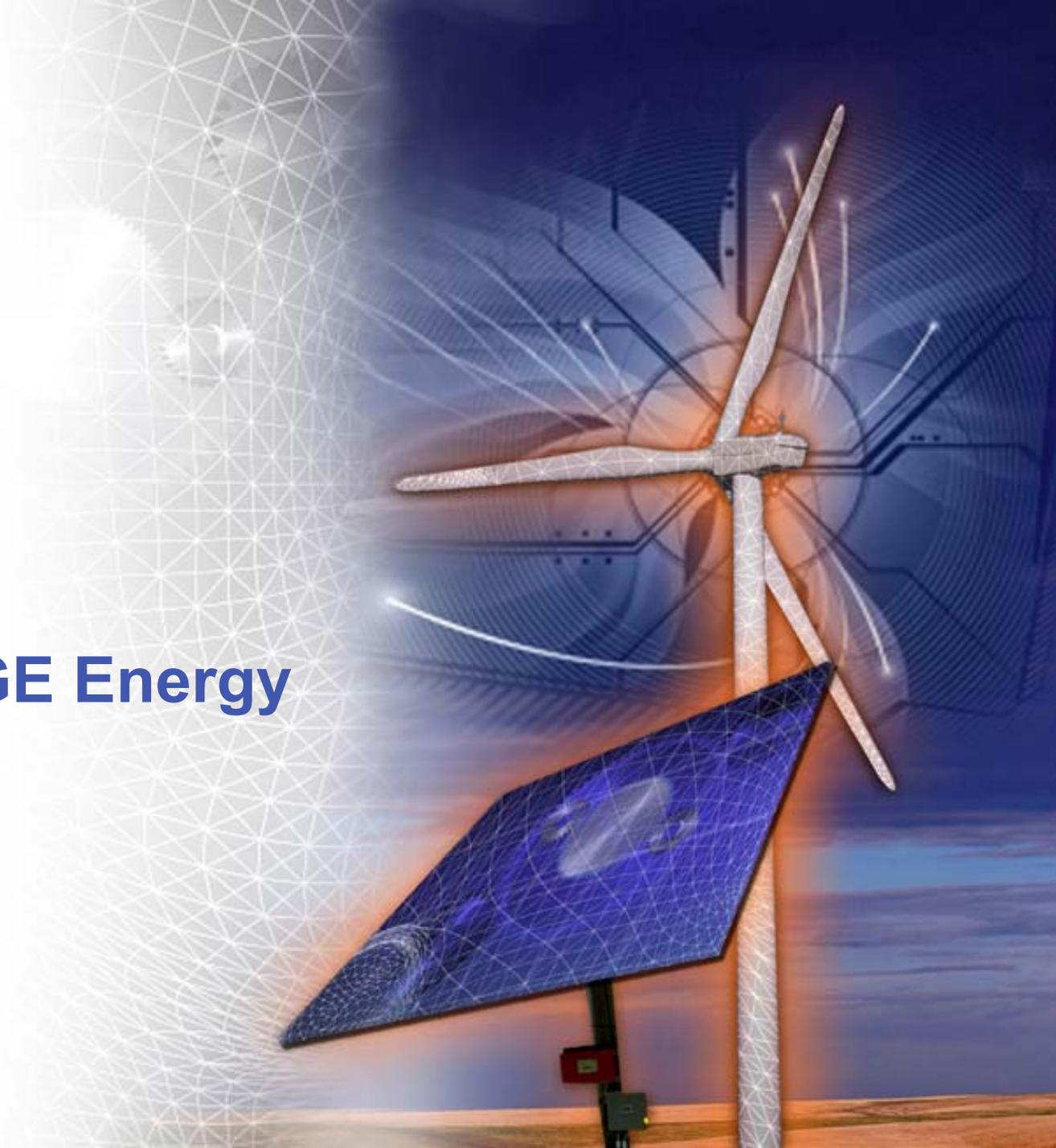
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**Thank you**

**Katy Wilner, GE Energy**



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# Back Up

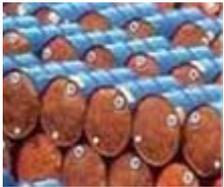


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# A Changing World ...



Growing population & energy density



Cost of energy ... fuel supply & demand



Increasing environmental requirements



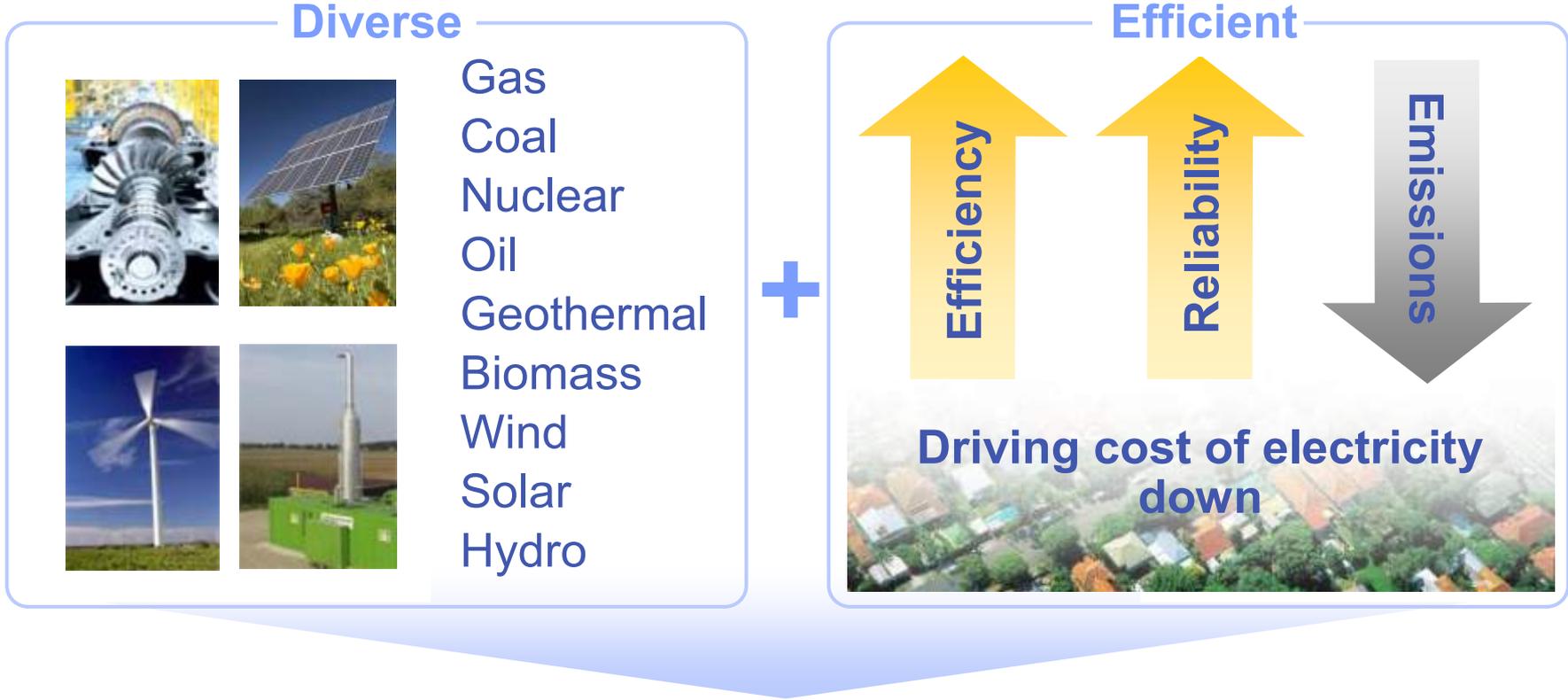
Escalating security concerns



Heightened investor demands

**Driving  
power  
generation  
technology**

# Fuel diversity critical



**Affordable, reliable & environmentally responsible**

# Renewable Energy ... Why Now?

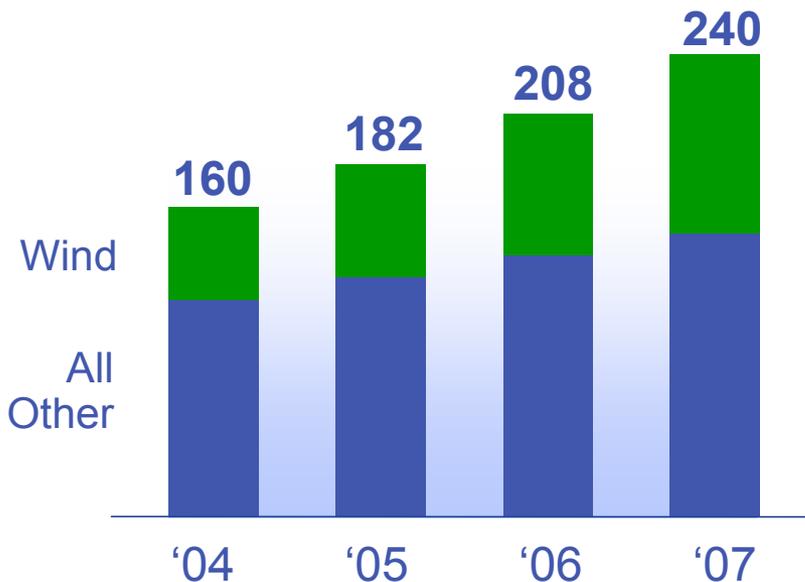


FUEL & CO<sub>2</sub>

Uncertainty driving diversification

# Growing renewables demand ...

## Global renewable installed capacity (GWs)



Source: REN21 2007 Preliminary + GWEC

- ✓ Significant growth ... 25% CAGR ('04-'07)
- ✓ 40% power capital spending
- ✓ Wind >50% of growth
- ✓ Domestic, abundant, carbon-free
- ✓ Countries & US states establishing renewable energy targets



**World requiring renewable energy solutions**

# Renewables global footprint

## Wind

- Leading N. American wind turbine supplier
- 6x unit growth since '02
- 8,000+ 1.5MW installed globally



## Solar

- Residential, commercial and utility applications
- Largest commercial solar project in Asia
- PrimeStar Solar thin film technology investment



## Biogas

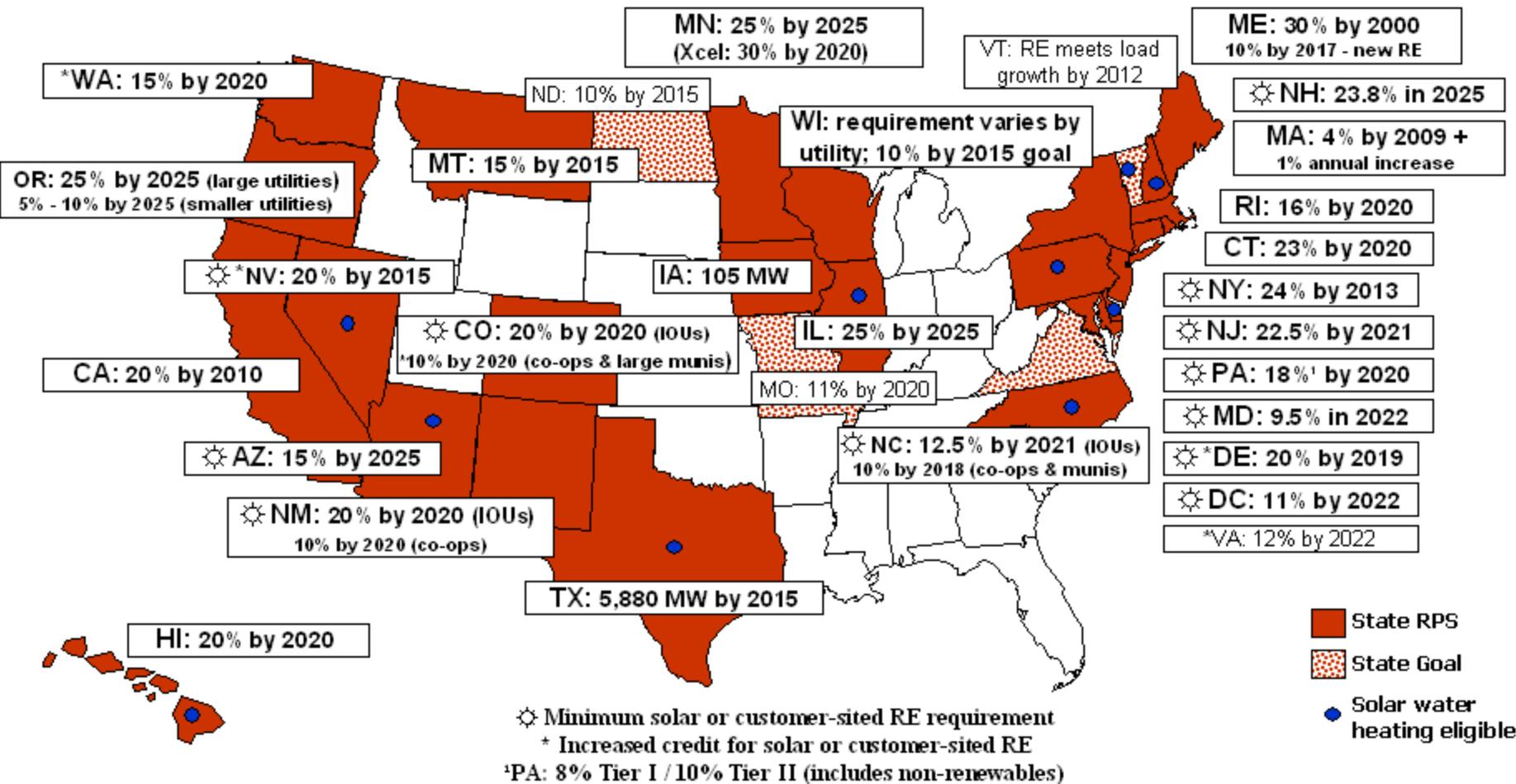
- Power range: 0.25 MW - 4 MW
- Fuel flexibility: Natural gas or a variety of renewable or alternative gases



- 10 manufacturing/assembly sites
- 4,000 global employees
- Installed base: 14GW

- Projects in 40+ countries
- \$200M invested in supply chain
- 10,000 sub-supplier jobs created

# Summary of state RPS

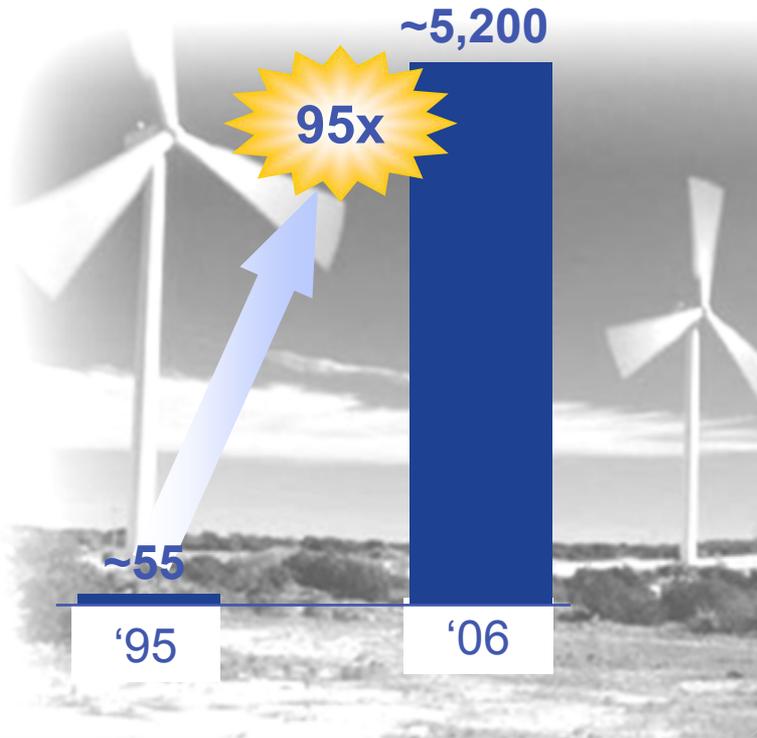


**RPS Compliance will require 18-40 GW of New Capacity**

# Industry build out ... U.S. example

## U.S. net annual install capacity

(MWs)



## GE since 2002:

\$700MM+ technology investment

...

- ✓ Unit production **6x**
- ✓ GE U.S. assembly **3x**
- ✓ Key suppliers **3x**
- ✓ Industry jobs **6x**

**Core business strategy ...**  
**ecomagination**

**“Green is Green”**

# Renewable industry growth levers

## Advancing Technology

- Efficiency
- Reliability
- Grid integration



## Growing Supply Chain

- Manufacturing growth needed
- Driving quality fulfillment
- Supplier opportunity



## Gov't/industry cooperation

- R&D programs
- Public/private partnerships
- Regulatory framework approach



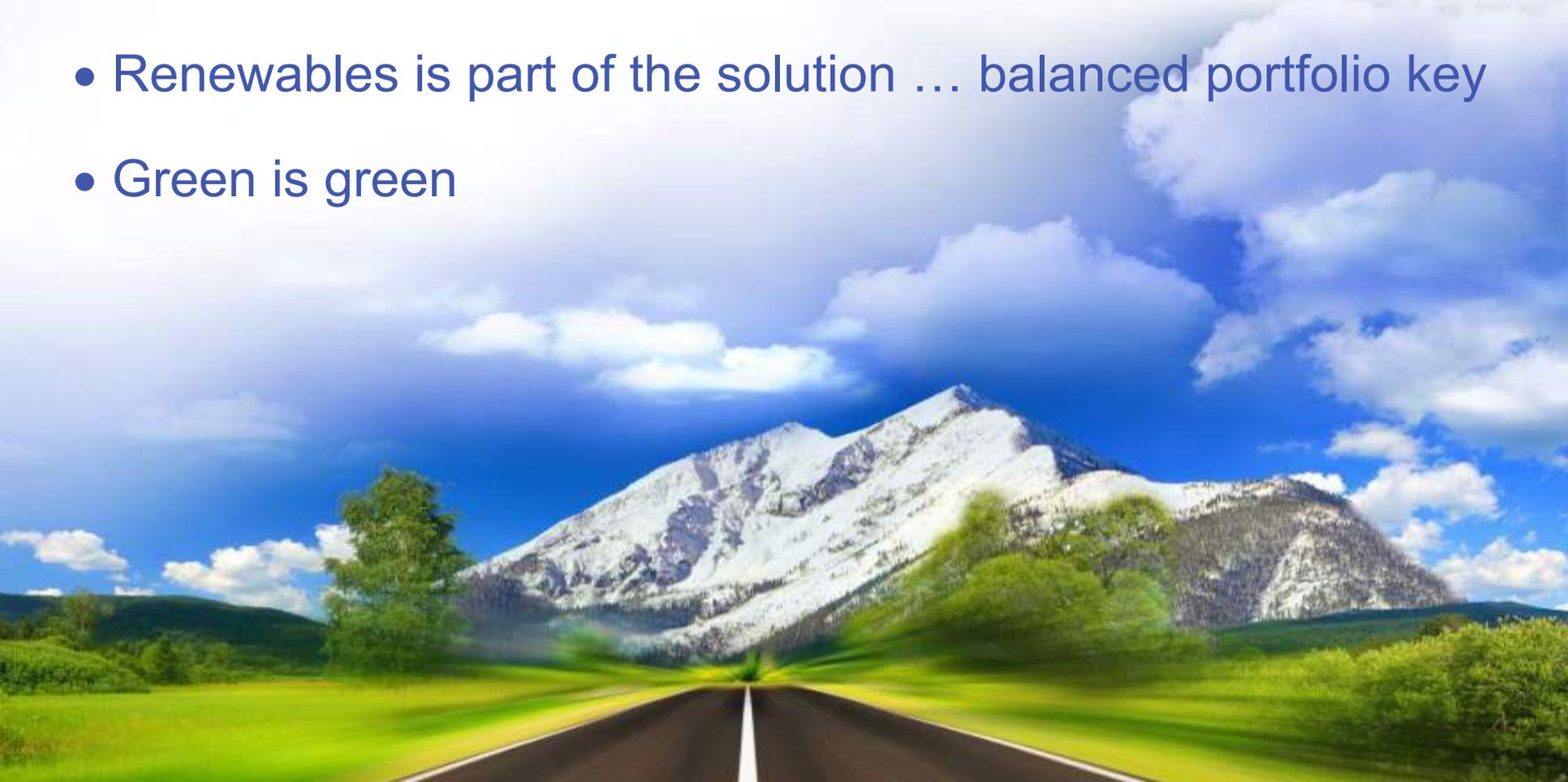
## Successful Policy

- Production Tax Credit
- Renewable Portfolio Standards
- EU 20% by 2020
- Cap and Trade for Carbon (i.e. USCAP)



# Looking Ahead ...

- Global energy demand expected to nearly double by 2030
- Increasing environmental requirements a global challenge
- Renewables is part of the solution ... balanced portfolio key
- Green is green



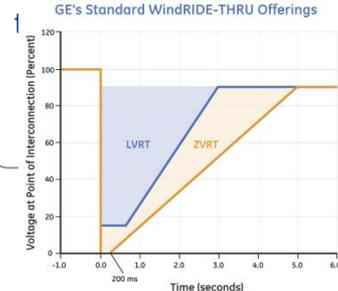
# Grid Friendly Technology

## WindFree Reactive Power(option)

- Wind Turbine converter can deliver reactive power without wind.
- Benefits weak grids and systems with high wind penetration.
- Voltage support continues without active power generation, even following trips.

## WindRIDE- THRU™ (Option)

- Remains on-line and feeds reactive power through system disturbances
- Meets present and emerging
- grid requirement with Low/Zero Voltage Ride through (LVRT/ZVRT) Capability.
- Meets transmission reliability standards similar

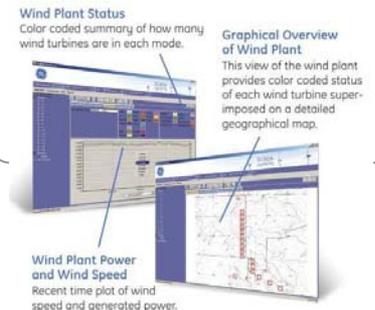


## WindCONTROL™ M

- (Option)
- Regulates Grid Voltage at point of Interconnection, minimizes Grid Voltage fluctuations Even Under varying Wind Conditions
  - Regulates Total Wind Plant Active & Reactive Power through Control of Individual turbines
  - Provides frequency droop and power ramp limiters to help stabilize power system frequency
  - Reduces BOP costs

## Wind SCADA (Option)

- Real-time operational control of each turbine &
- Complete Wind Plant historical database with comprehensive reporting system including production and Wind reports
- Secure User-Access, intuitive Operation & Maintenance tool



## Customer benefits

- Addresses reliability concerns of grid operators
- Improves grid operability and security
- Increases capability of grids to successfully achieve high levels of wind penetration