GE Energy Infrastructure

# Renewable Energy

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April 3, 2009

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# GE Energy Infrastructure

**Employees:** 65,000 • **'08 revenue:** ~$40B • Operating in 140 countries

## Power & Water
## $23B

- Power generation
- Renewable Energy
- Gas Engines
- Nuclear
- Gasification
- Wastewater treatment
- Process chemicals

## Energy Services
## $10B

- Contractual agreements
- Smart Grid
- Field services
- Parts & repairs
- Optimization technologies
- Plant management

## Oil & Gas
## $7B

- Onshore & offshore natural gas
- Transportation
- Processing
- Pipeline inspection
- Subsea
- Extraction

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# GE Power & Water … Broadest product portfolio




**Wind** | **Solar** | **Water Technologies** | **Biomass**




**Gas** | **Nuclear** | **Cleaner Coal** | **Smart Grid**

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**100+ years of technology leadership**

# A world leader in renewable energy solutions

## *$5B investment …*

### Wind

- Leading N. American wind turbine supplier
- 6x unit growth since '02
- 12,000+ 1.5MW installed globally

### Solar

- Residential, commercial and utility applications
- PrimeStar Solar thin film technology investment
- Large utility projects in Europe

### Biogas

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

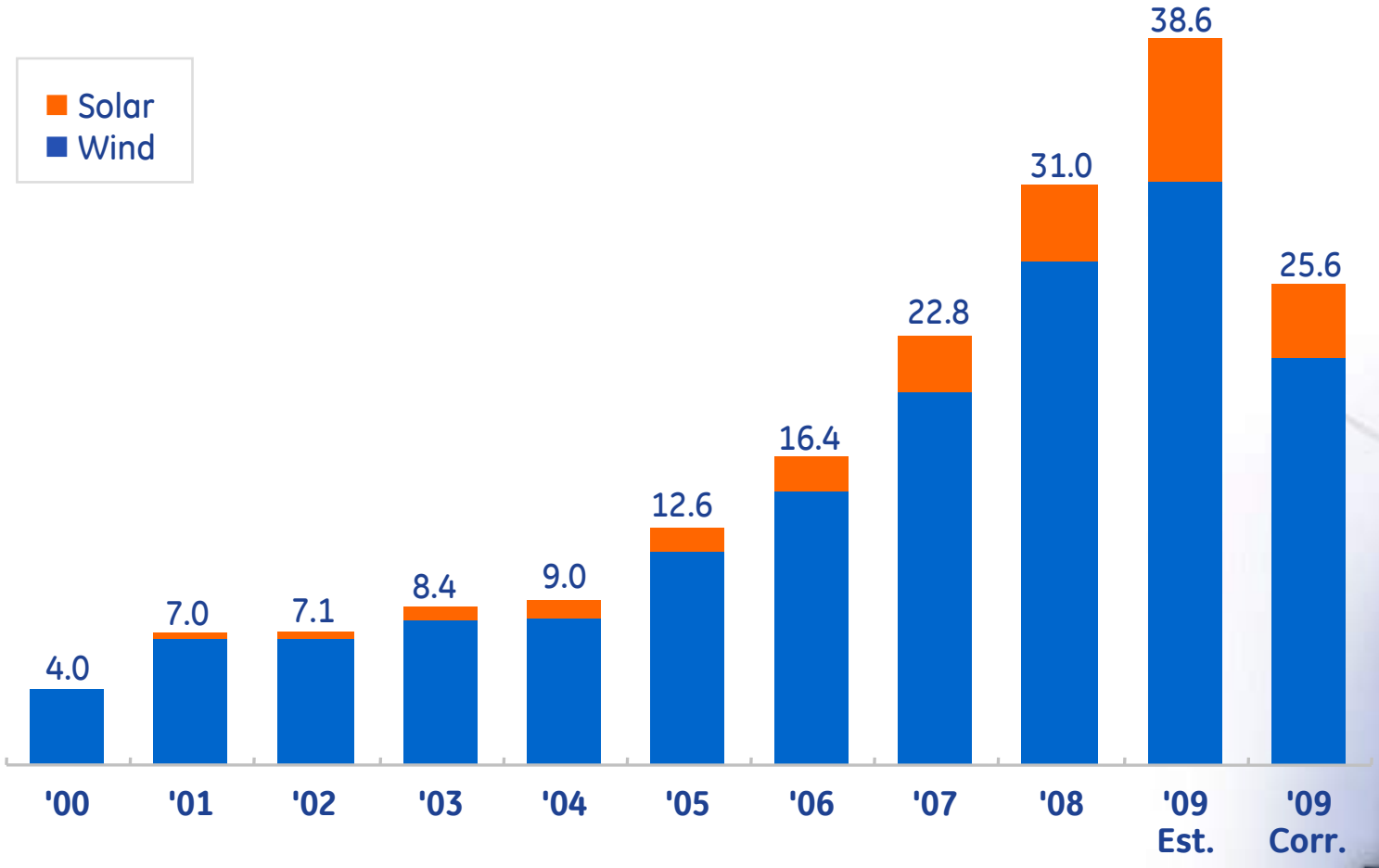
### Energy Financial Services

- Developing creative financial solutions
- 25+ years in Energy Finance
- $19B assets

- 10 manufacturing/assembly sites
- 4,700 global employees
- Installed base: 25GW
- Projects in 65+ countries
- $200M invested in supply chain
- 10,000 sub-supplier jobs created

# Global renewable annual installations

(GW)




**Financial crisis causing 1st slowdown in a decade**

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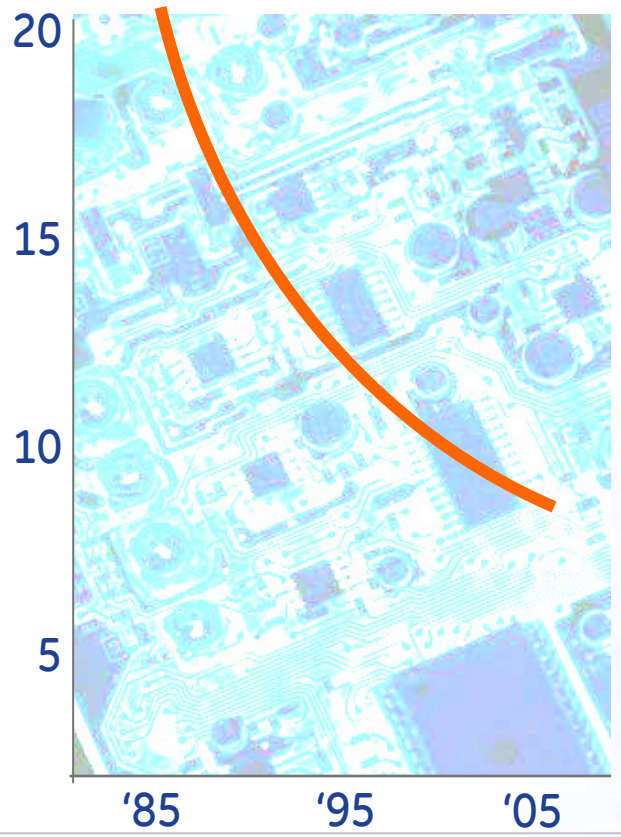
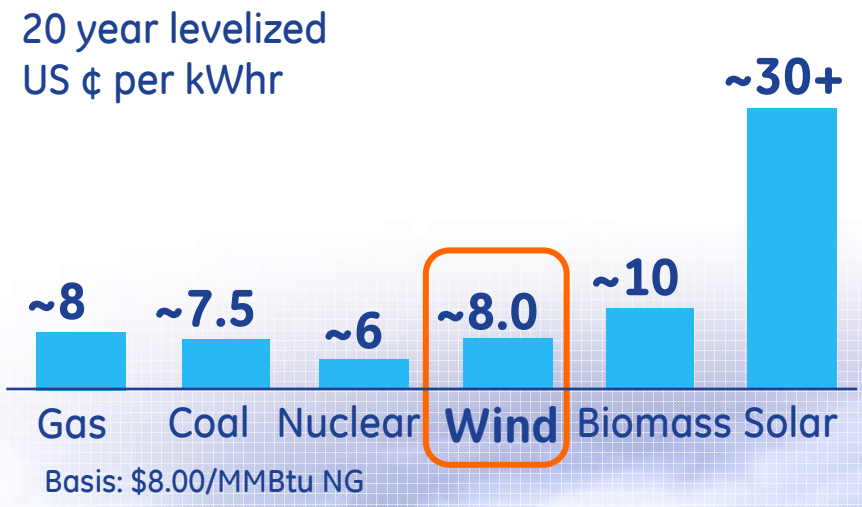
# Wind ... most economic large scale renewable

## Cost of Electricity (¢/kWh)




## Cost of Electricity nearing mainstream




Basis: $8.00/MMBtu NG

- Fixed cost of electricity
- Energy security
- Zero air emissions

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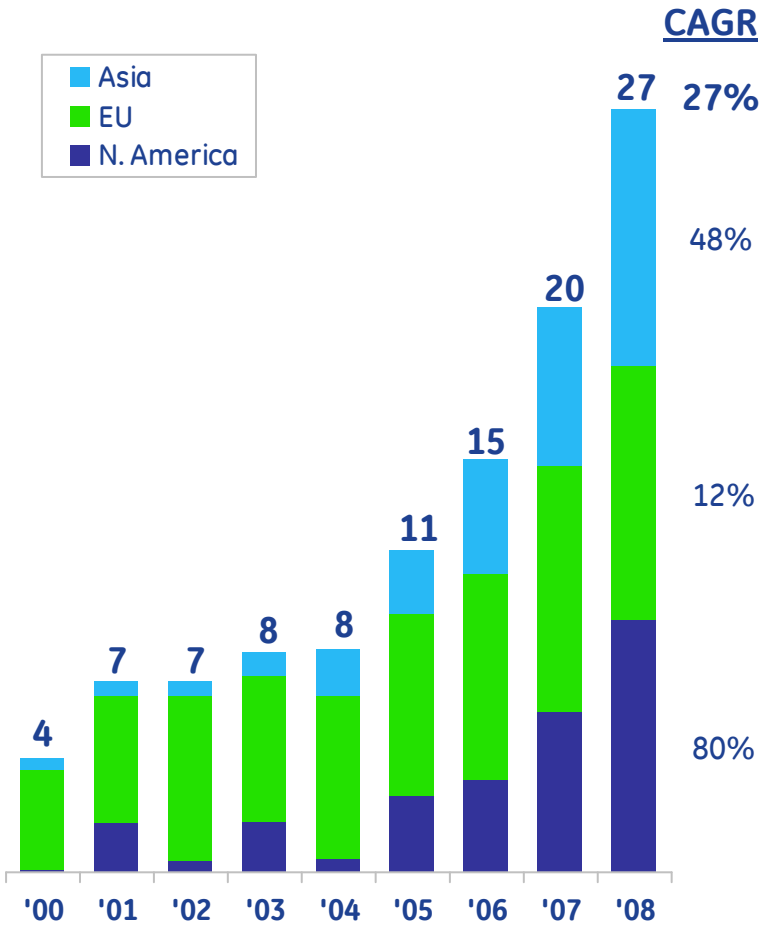
# Global wind installs … 7X growth since 2000

(GW)




## An amazing decade …

- US installs #1 … ~45% wind ('08)
- US largest wind generator
- 1 out of 2 US wind turbines are GE

## A bright future

- Today ~4% renewable kW
- For each additional point …
  - ~40,000 wind turbines
  - ~500,000,000 solar panels

**Wind has become a mainstream power generation technology**

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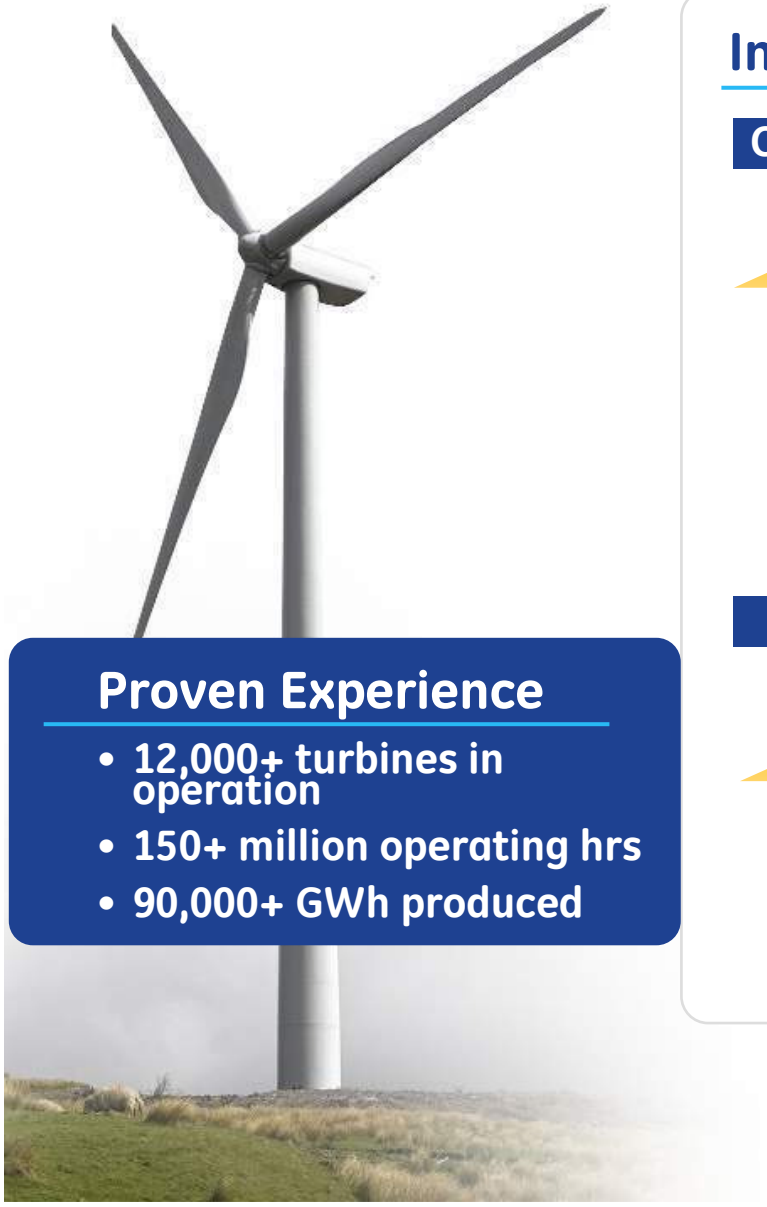
# GE 1.5MW … The Industry Workhorse



## Proven Experience

- 12,000+ turbines in operation
- 150+ million operating hrs
- 90,000+ GWh produced

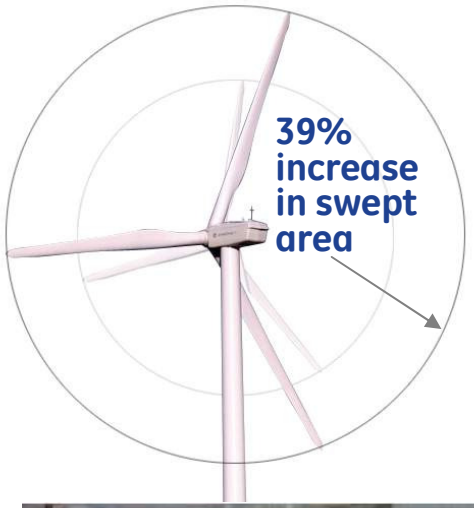
## Increasing Customer Value ('02-'08)

**Capacity Factor**

**$450MM/GW***

**+9pts**

- Increased rotor size … XLE
- Increasing output … WindBOOST




**Reliability**

**$200MM/GW***

**+12pts**

- GE Design for key components
- Improved diagnostics … Mark VIe, CBM

*20yr NPV estimate

# The European Workhorse … GE 2.5xl

## Product Evolution

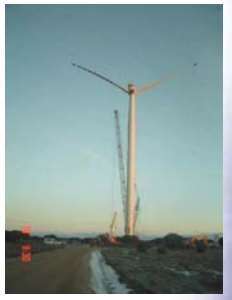
| | | |
|---|---|---|
| 1st | 2.5s installed | May '04 |
| 1st | 2.5xl tech demo installed | July '06 |
| 1st | Unit COD | Sept '08 |
| | 8 countries … 1GW of commitments | |
| | 60hz Certification | Mid '09 |

## Advancing Technology

55m AT Blade

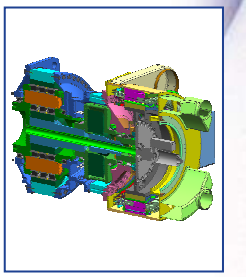
DEWI Germany

Cerros de Radona Spain



Froidchapelle Belgium

Compact Drive-train



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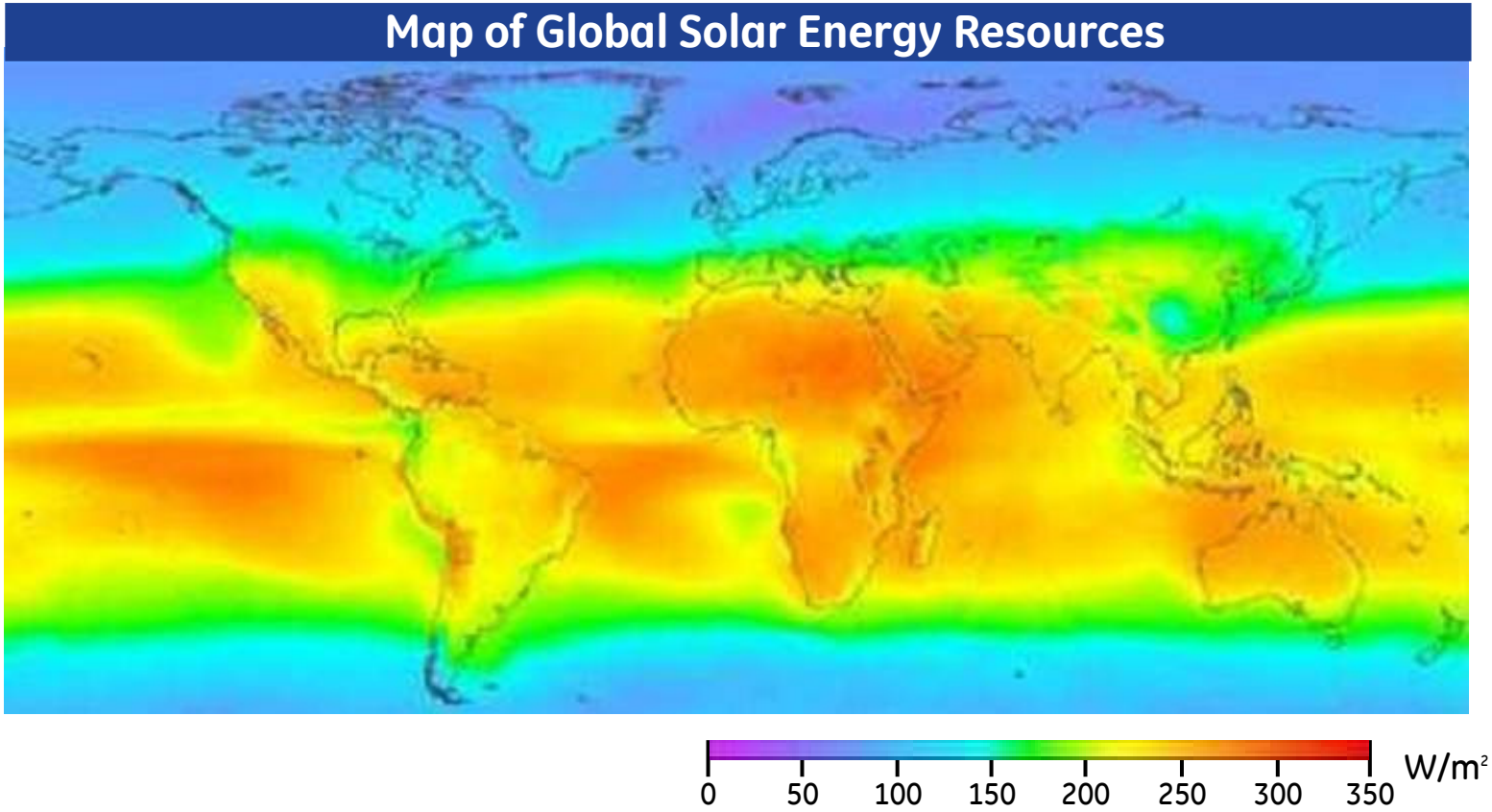
# Solar … a bright future

*120,000 TW (600 TW "feasible")*




**1 hour of sunlight = 1 year of energy demand**

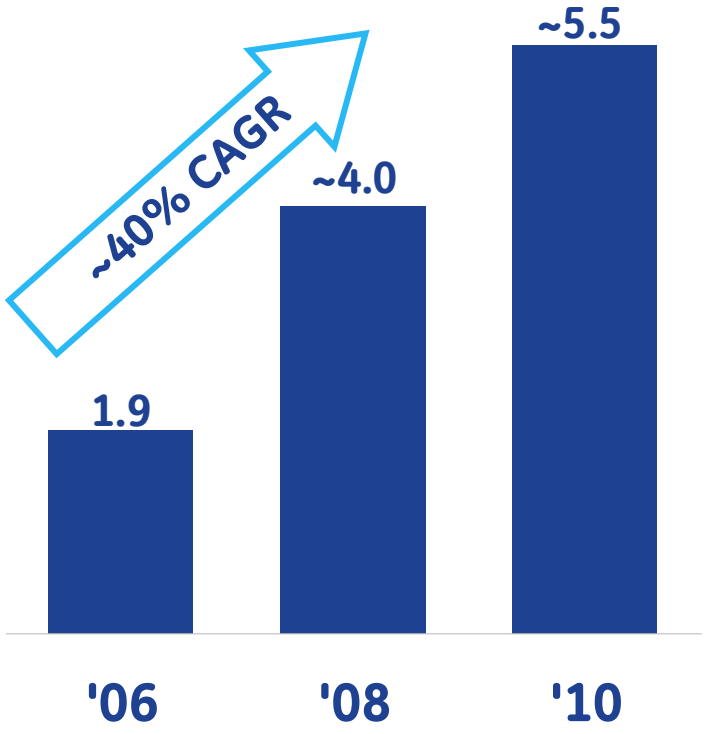


http://en.wikipedia.org/wiki/Solar_energy

# Solar … fastest growing renewable

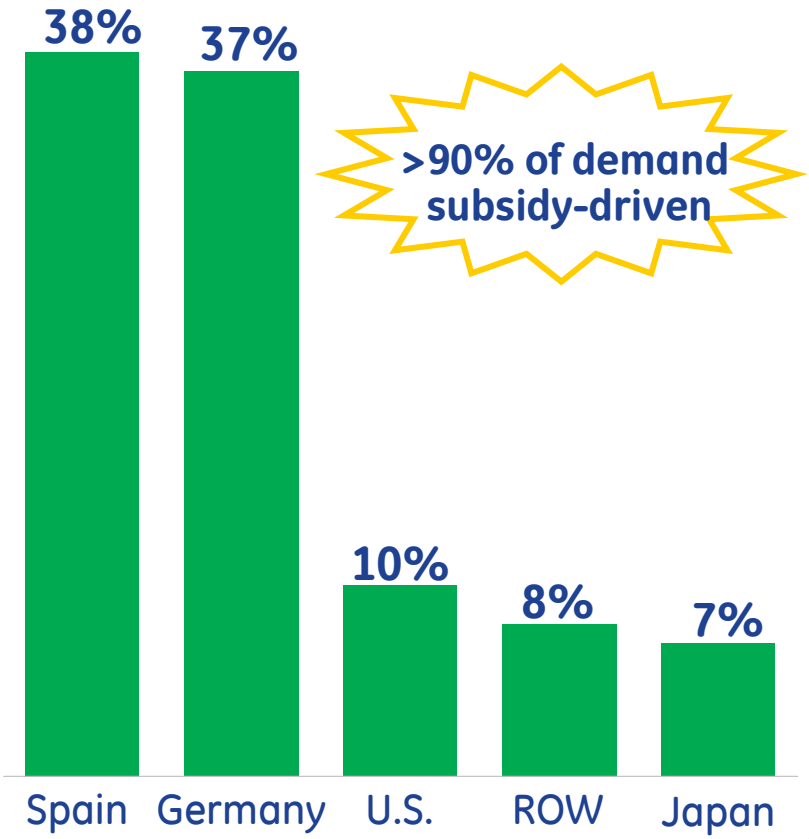
## Industry installation forecast

(GWs)




Source: GE Estimates

## 2008 regional installs




Source: EPIA & GE Estimates

**Growing segment … incentive driven**

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# Investing across growth platforms

## Modules

### ThinFilm Leadership

- Develop line in place
- PrimeStar ramp
- Deliver best-in-class TF module

## Inverters

### Power conversion

- GE 250-500 kW Inverter
- Utilizing Wind Controls Tech & Volume
- Grid Friendly Differentiation

## Solar Systems

### Utility Scale Power Plant

- Standardized & scalable
- Integrated grid controls
- Modular design … cost ↓

**Differentiating through best in class module & grid capabilities**

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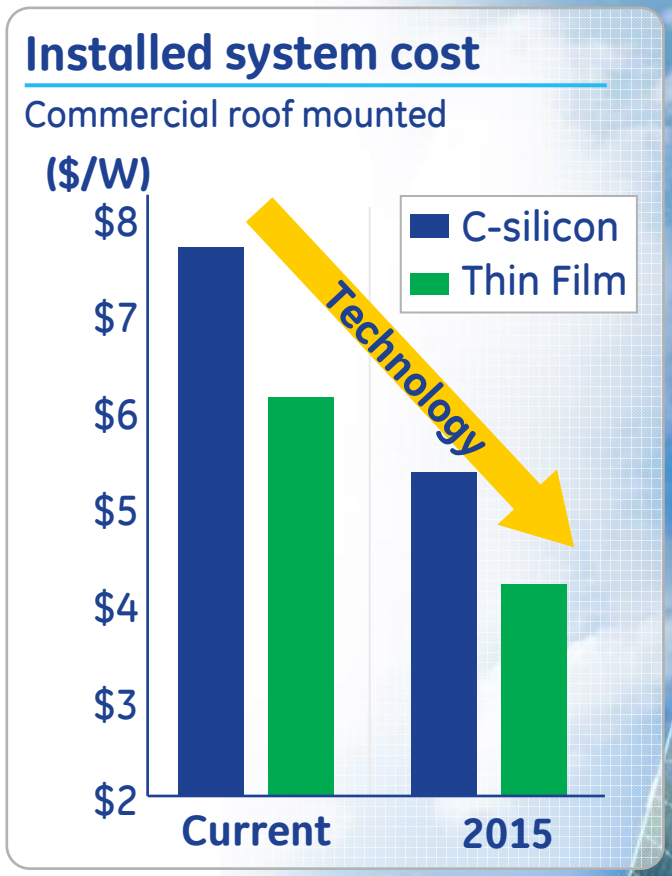
# PrimeStar – making solar cost competitive

## GE a majority owner of PrimeStar Solar, Inc.

PrimeStar

- Focused on large scale, cleaner, renewable, cost competitive solar electric power a reality
- Developing high performance thin film photovoltaic (PV) modules for large scale applications
- Scaling up patented thin film PV technology that was developed at the U.S. Department of Energy's National Renewable Energy Laboratory (NREL)
- Advantaged in high humidity diffused light installations




**1st product – targeted for 2009**

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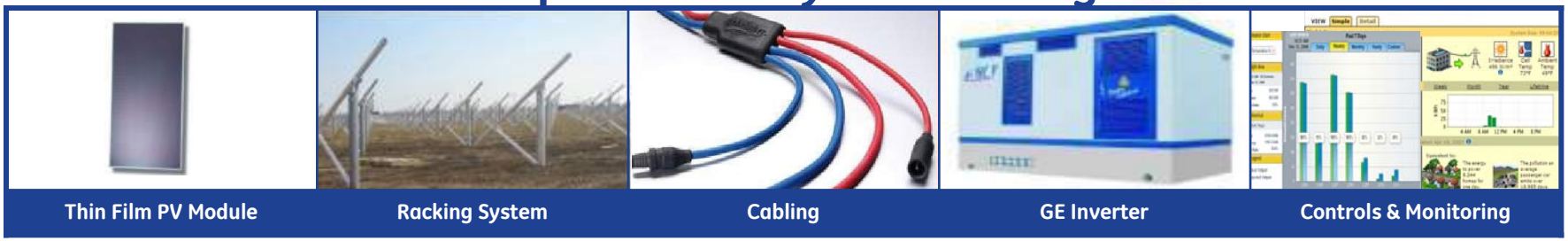
# Delivering a utility-scale thin film solution

## Complete Solar System Package




| System Specs | 1.2MW |
|---|---|
| Area | 8 Acres |
| Efficiency | 9 ->12+ %CE |
| Steel Posts | 1,500 |
| Modules | 10,000 |
| Production | 2,500 MWh/yr |

### "Plug & Play" Advantages

- GE Reliability & Execution
- Grid Friendly & GE Controls
- Simplified & Scalable
- Cost Competitive

## Building on GE Power Generation expertise

# GE biogas applications

## Landfill Gas

Best in class emissions

## Waste Water Treatment Plants

Dual-Fuel switching capability

## Animal / Industrial Bio

World's largest biogas installation

Type 3

Type 4

Type 6

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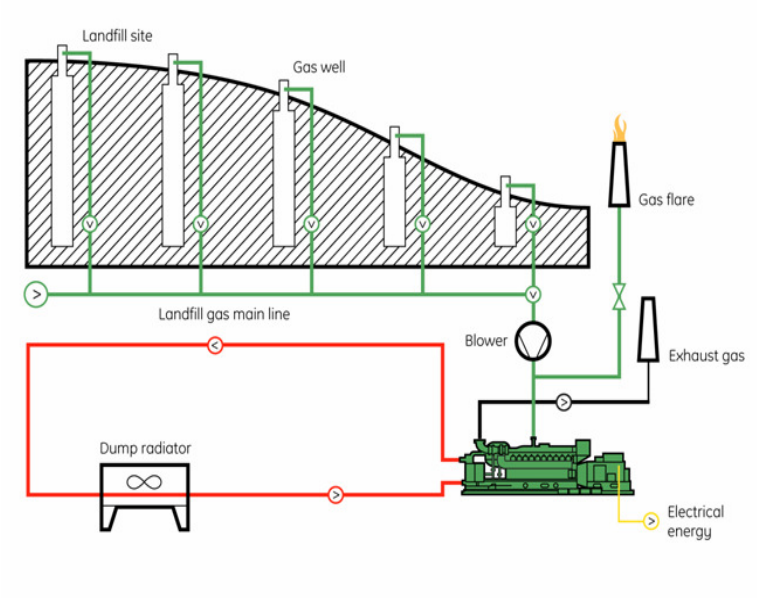
# Landfill gas solutions

- More than 25 years of experience in the combustion of landfill gas
- 1,200+ landfill gas systems with a total electrical output of over 1,200 MW
- Best in class emissions with TSA & CLAIRE systems

**Landfill gas plant in Texas**

| | |
|---|---|
| No. of units and engine type: | 3 x JMS 616 GS-L.L |
| Emissions: | TSA 3 x 2 units |
| Fuel: | Landfill gas |
| Electrical output: | 5,000 kW |

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# Biomass solutions for North America

## Drivers

- RPS expanding … biomass being defined distinctly
- Climate change … regional greenhouse gas policies
- Increasing power prices … increasing biogas project viablility
- Legislation around organic waste disposal
- Baseload renewable generation source
- Increasing energy efficiency … cogeneration

## Potential

1,300 MW

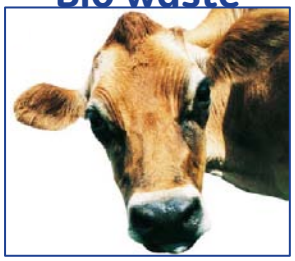
300+ MW

2,700 MW

**Landfill Gas**

**Waste Water Treatment Plants**

**Animal / Industrial Bio waste**



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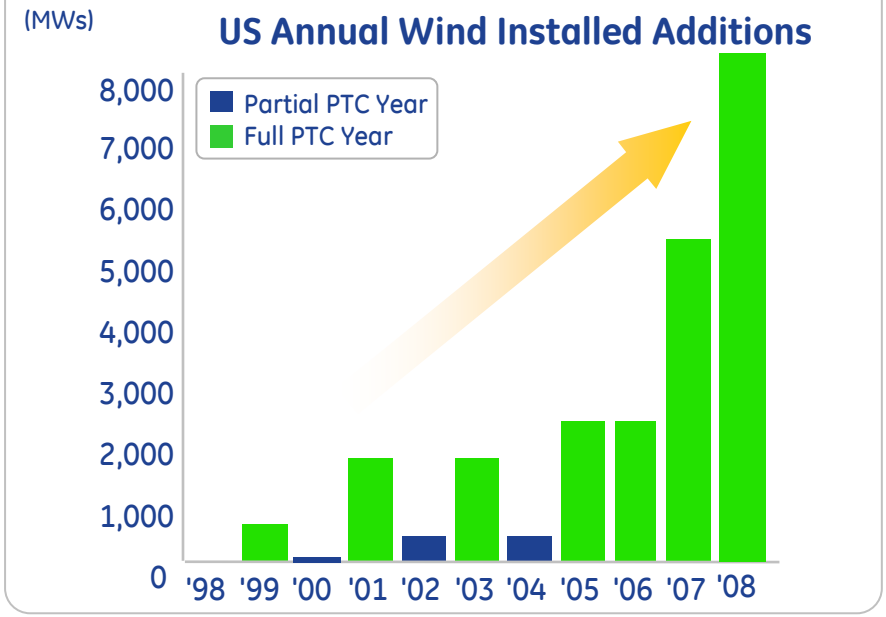
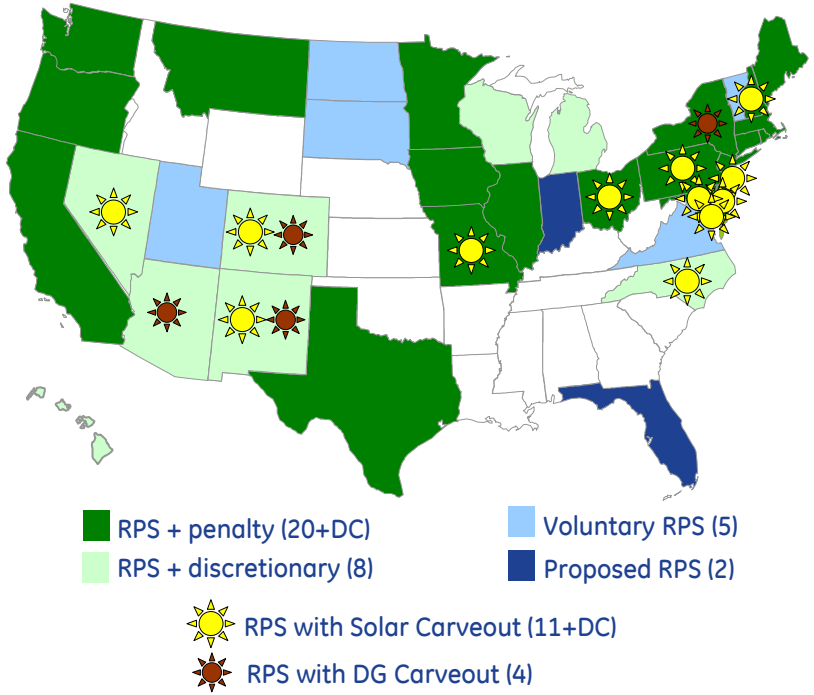
# Successful policy has driven U.S. growth

## Federal production tax credit




## Renewable portfolio standards




## Growth drivers

- National: PTC … 2.1c/kWh, 10y
- State: RPS
  - Jan 07: 22 states … ~44 GW wind
  - Jan 09: 33 states … ~55 GW wind

**But PTC ineffective in current crisis**

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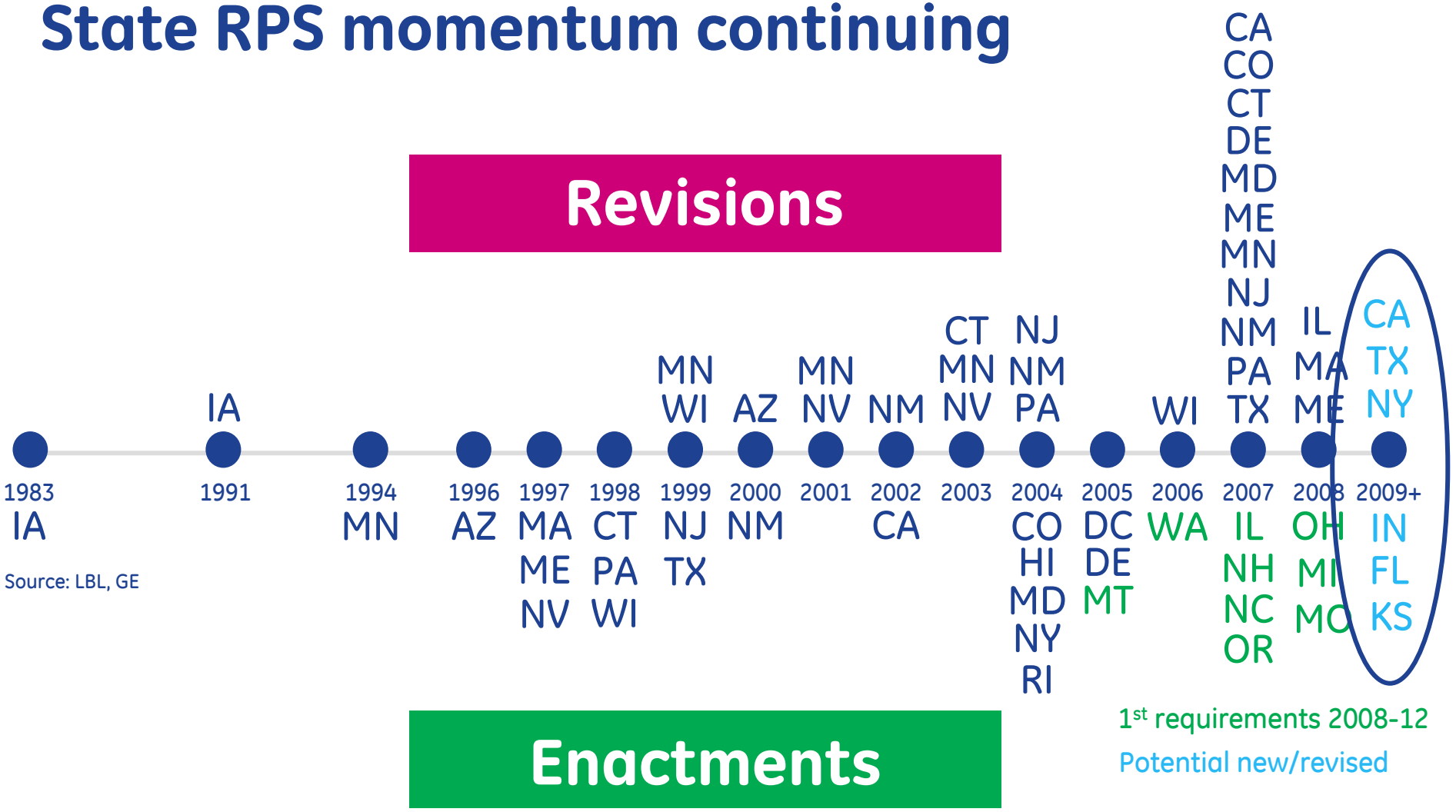
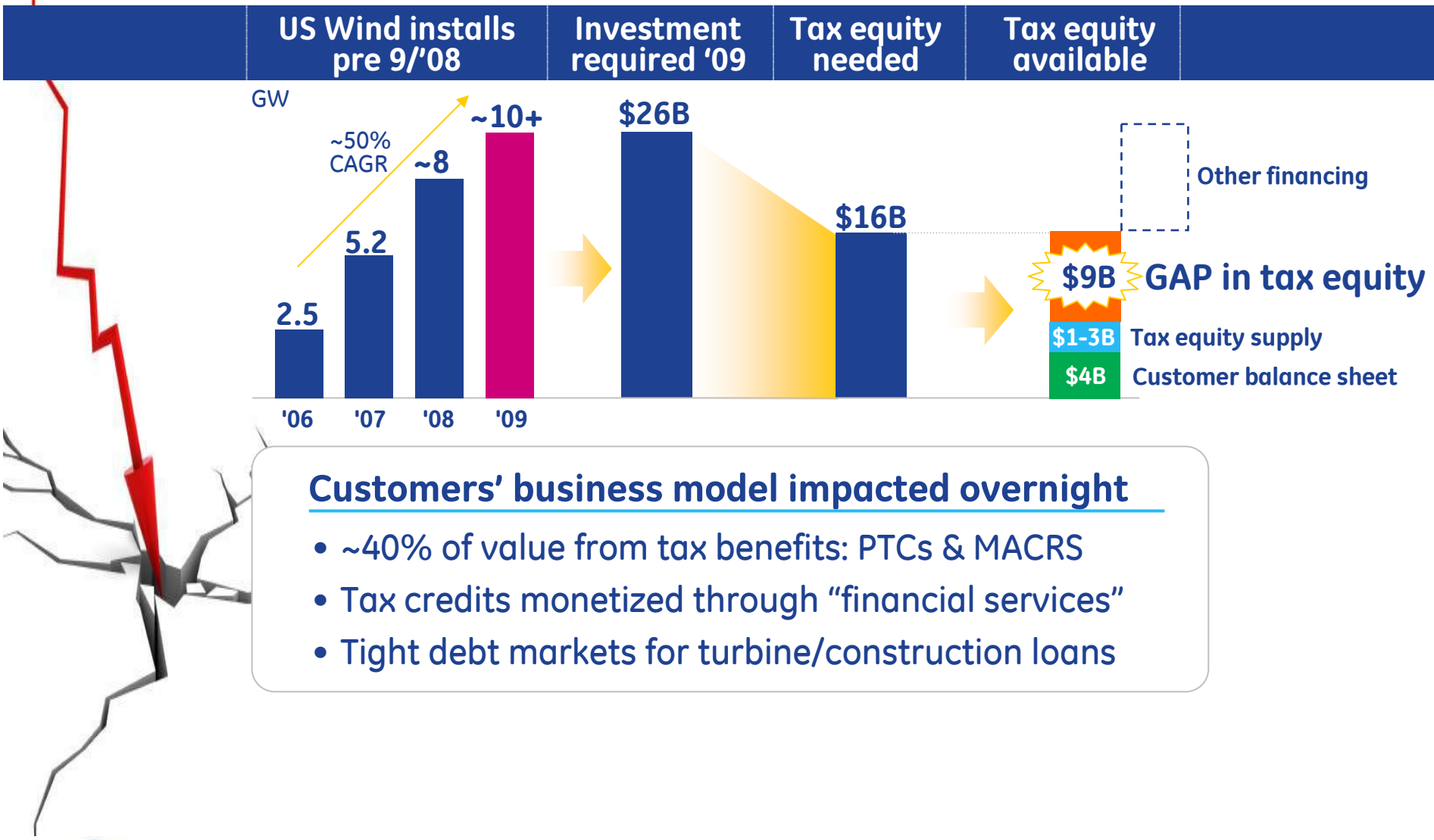
# State RPS momentum continuing




Source: LBL, GE

# Financial crisis … impact on renewables




## Customers' business model impacted overnight

- ~40% of value from tax benefits: PTCs & MACRS
- Tax credits monetized through "financial services"
- Tight debt markets for turbine/construction loans

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# GE Advocacy to "re-start" US renewable energy

| Steps to drive demand | Stimulus | Energy bill |
|---|---|---|
| 1 **Refundable PTC**<br>Extend 3 years<br>30% ITC Option<br>ITC refund (Treasury grant) | ✓<br>✓<br>✓ | |
| 2 **Gov't loan guarantee** | ✓ | |
| 3 **Sustainable policy**<br>RES 25% by '25 | ✗ | ✓ |

**PTC "fix" included in stimulus**

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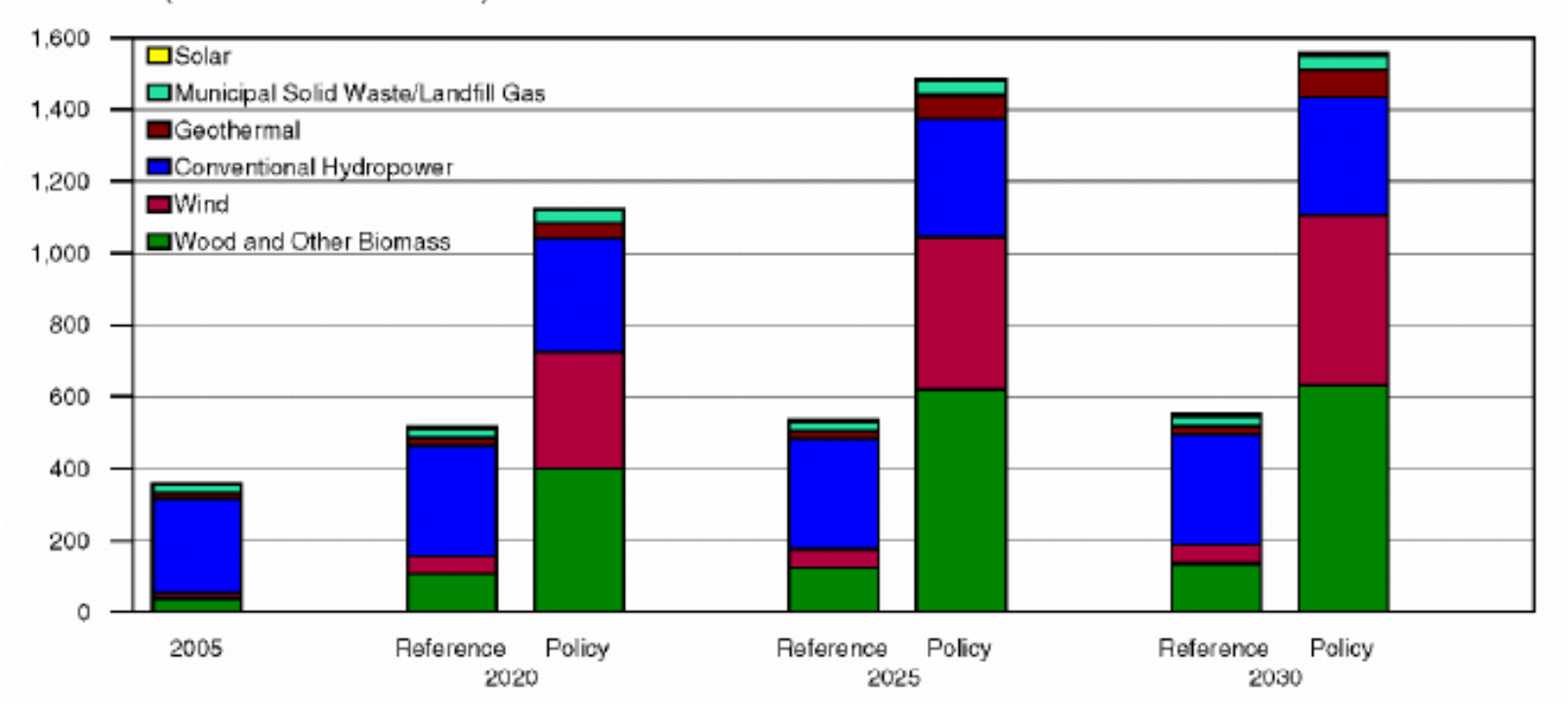
# US Federal RES – '09 proposals

| Key Provisions | Bingaman | Markey |
|---|---|---|
| Near-term target | 4% by 2012 | 6% by 2012 |
| Long-term target | 20% by 2021 | 25% by 2025 |
| Compliance payment | $.03/kWh | $.05/kWh |
| Distributed generation REC multipliers | 3x (<1 MW) | 3x (<2 MW) |
| Energy efficiency provisions | Up to 25% of RES | Energy Efficiency Resource Standard (25%*/'20) |

*15% electricity, 10% natural gas

# Scenarios for Federal RES compliance

**Figure 4. Renewable Generation, Reference and Policy Cases**
(billion kilowatthours)

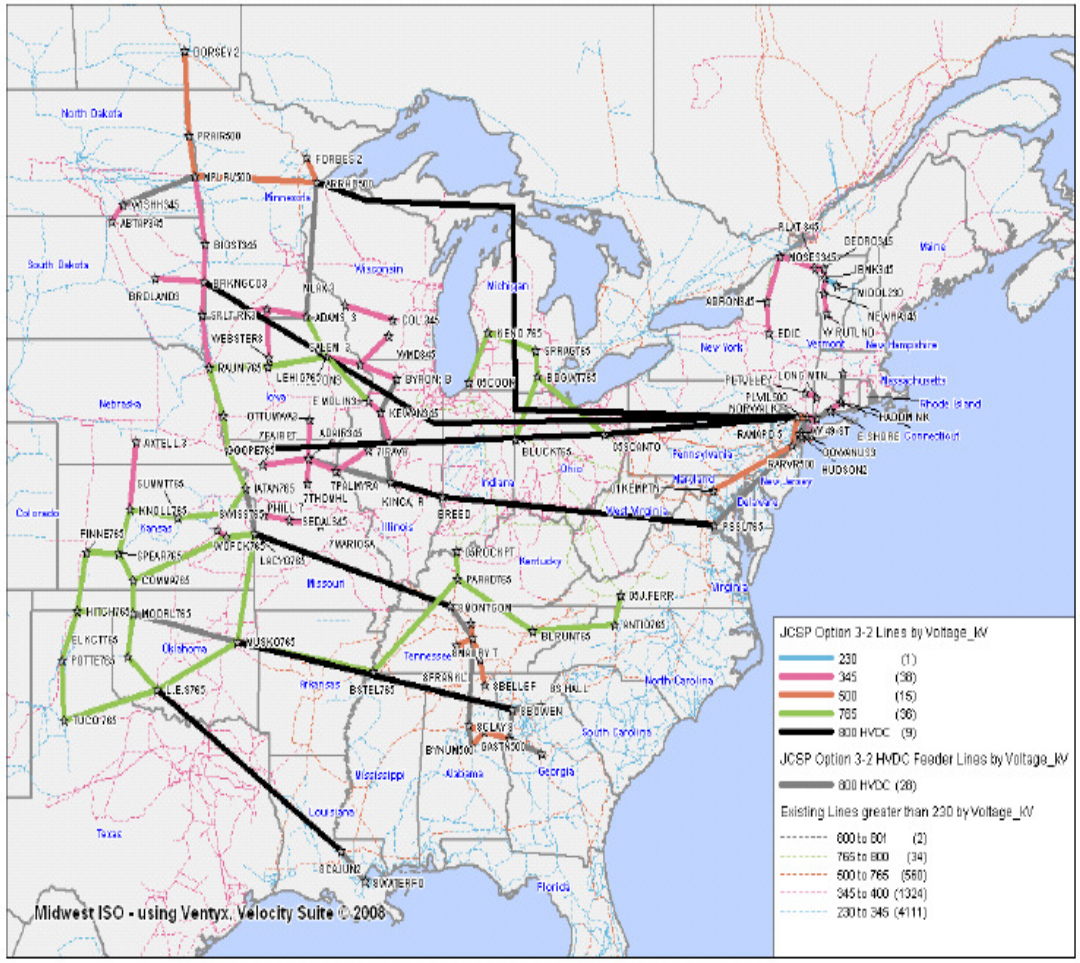



Source: National Energy Modeling System, runs IBASE.D060607A and IRES2525.D060607A.

**2007 Energy Information Administration analysis of 25% by 2025**

- Biomass is leading contributor to RES, esp. cofiring in coal plants
- EIA revisiting solar assumptions in analysis of current proposals

# Significant wind transmission potential to SE




Source: JCSP

## Eastern Interconnect study

"Joint Coordinated System Plan" (JCSP) … conceptual plan to achieve 20% wind in Eastern Interconnect

All major operators … MISO, SPP, PJM, TVA, MAPP, SERC

15,000 miles of new EHV (75% 765+ kV) lines

230 GW wind + 37 GW baseload steam + 75 GW gas

$85B investment but net $20B cost savings due to low-cost wind + avoided nat gas costs

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# Technology for the next decade

## Wind

### Blades
- Sweep area
- Logistics
- Carbon fiber

### Controls
- Mark VI
- Load management
- Model driven

### Drives
- Compact
- High reliability
- Light-weight

### Reliability
- Remote monitoring
- Return to service
- Upgrades

## Solar

### Breakthrough technology
- Thin film
- Nano scale materials
- Concentrators

**Technology that drives lower COE & higher reliability**

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