GE
Energy

Wind Energy Highlights

South Carolina Wind Energy Production Farms Feasibility Study Committee

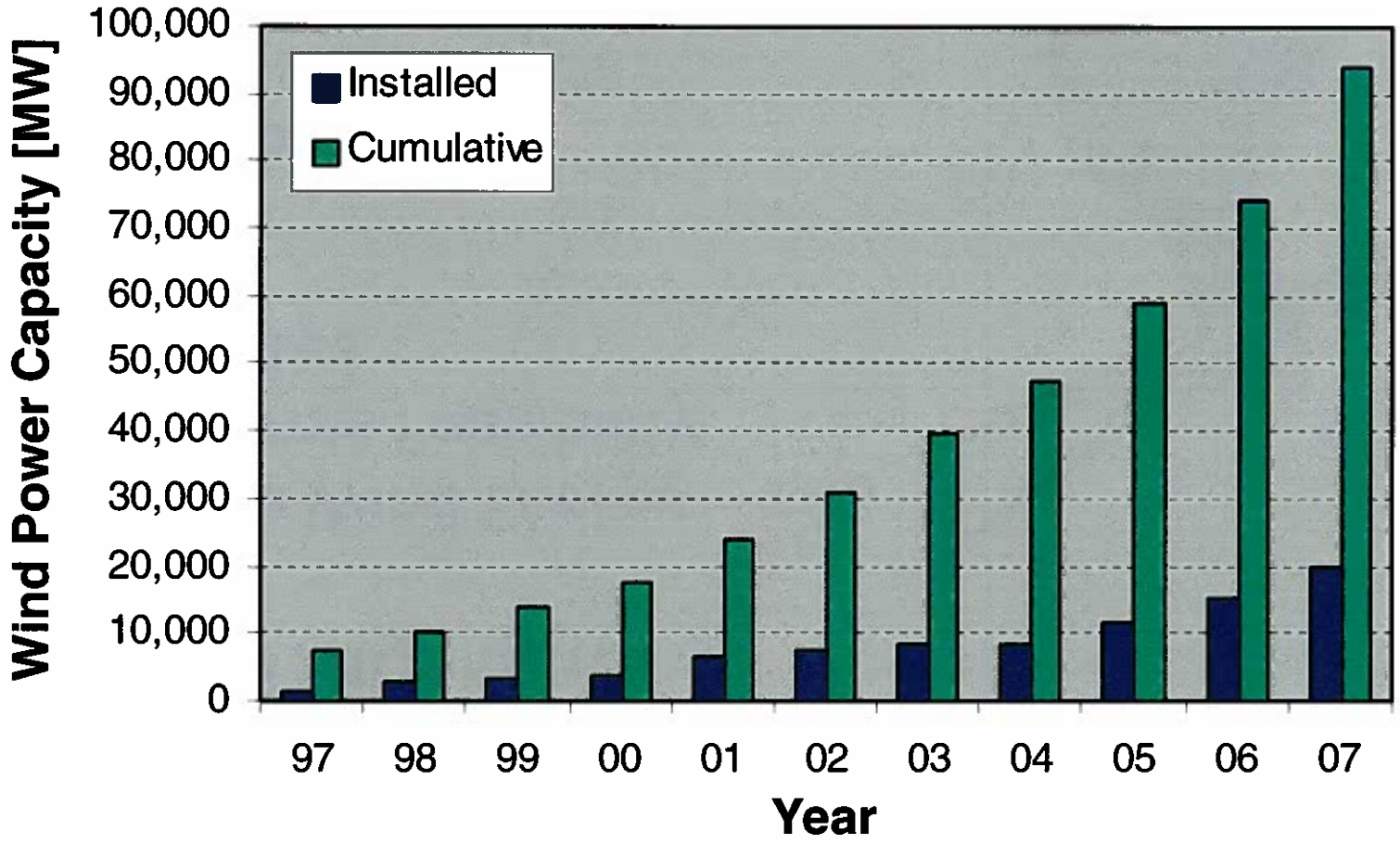
20 April 2009

Roger Schonewald
Mgr, Technology External Programs

imagination at work

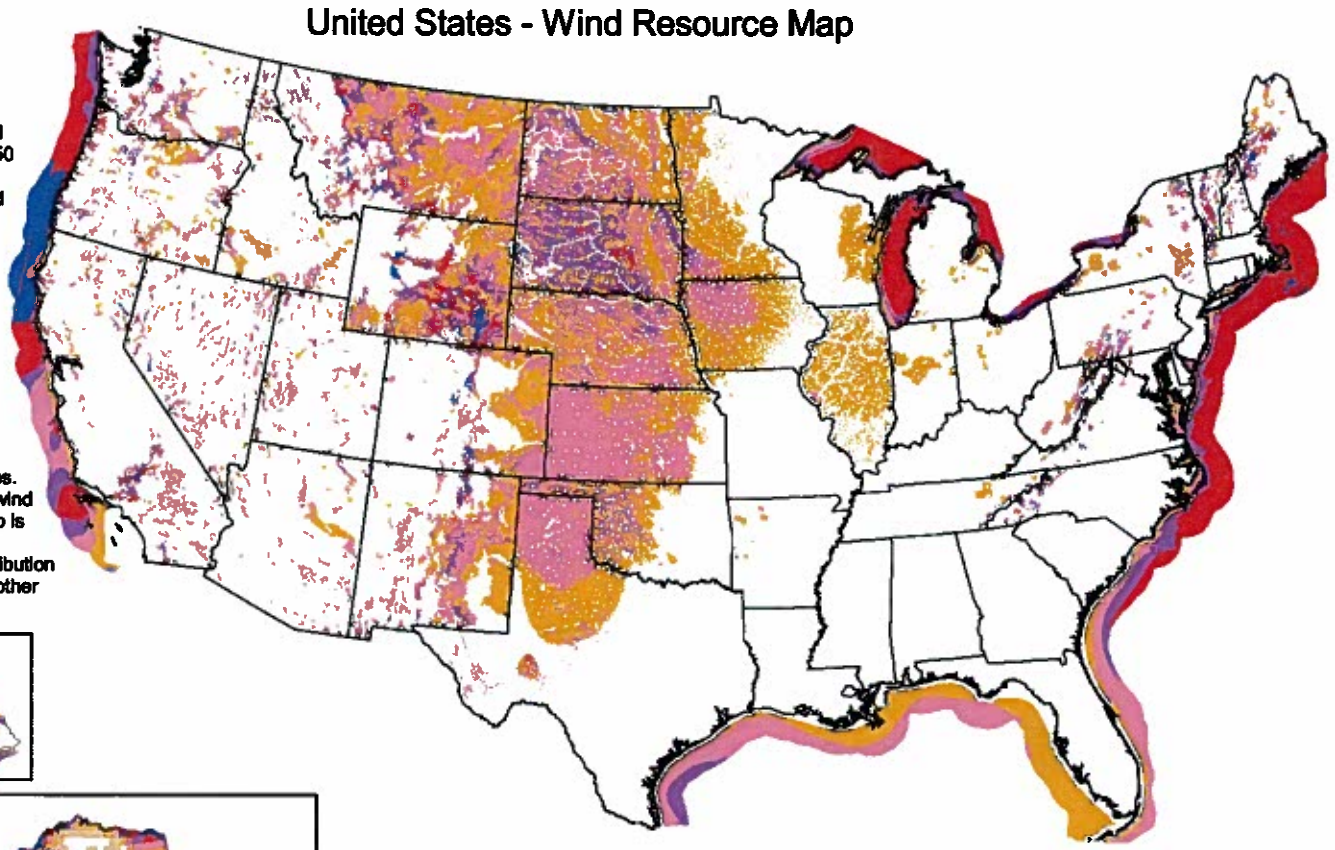
Wind Power Capacity Worldwide

- 30% avg. growth over last 10 yrs
- Source: Global Wind Energy Council (www.gwec.net)

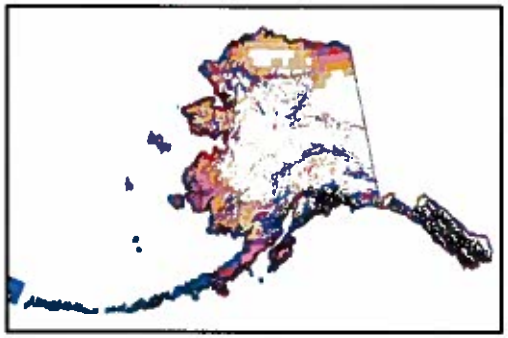


imagination at work

Wind Resource in U.S.



This map shows the annual average wind power estimates at 50 meters above the surface of the United States. It is a combination of high resolution and low resolution datasets produced by NREL and other organizations. The data was screened to eliminate areas unlikely to be developed onshore due to land use or environmental issues. In many states, the wind resource on this map is visually enhanced to better show the distribution on ridge crests and other features.



Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed [a] at 50 m m/s	Wind Speed [a] at 50 m mph
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	800 - 1600	8.8 - 11.1	19.7 - 24.8

[a] Wind speeds are based on a Weibull k value of 2.0

U.S. Department of Energy
National Renewable Energy Laboratory

imagination at work

US 20% by 2030

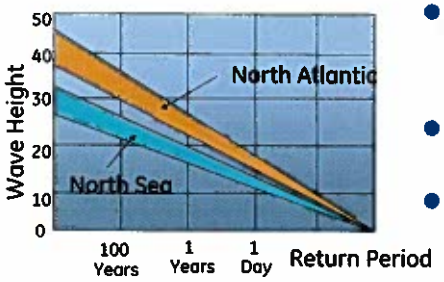
- Next decade: manufacturing growth rates of 20-25% necessary to reach annual installations of ~ 20 GW in the U.S.
- Maintaining this rate through 2030 results in 20% Wind generation
- Annual WTG installations starting at ~2000 to ~7,000+ by 2017
- 10%-20% ↑ in capacity factor and 10% ↓ in capital costs by 2030
- Availability of raw material, investment, and qualified labor is achievable

imagination at work

GE Company Proprietary

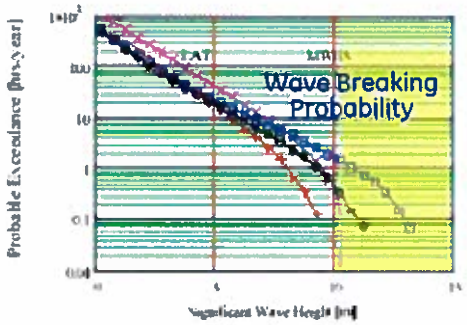
Offshore Wind Market Drivers / Constraints

Market Drivers:

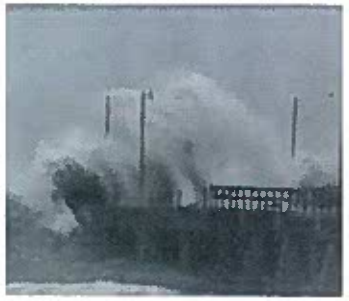


Wave Heights Larger than European Experience

- High interest - Green, Renewable Energy close to major Load Centers
- PR and Gov'mt support critical
- Great wind conditions
  - capacity factors to 0.5
  - Low turbulence & wind shear
- Favorable Sites: US East Coast, Irish Sea, North Sea, Baltic …
  - Water depths to 30 m, 10-20 km offshore



Fuse site data & physics-based models



Storm Conditions

Constraints:

- Risks/Costs: Technology; Construction; Operational; Maintenance
- Accessibility: Difficult service environment
- Exposure: hurricane; waves; sea bed stability
- Economics - Cost of Energy

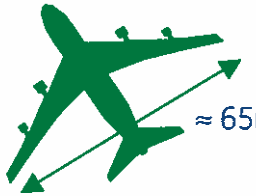
GE Wind At Arklow

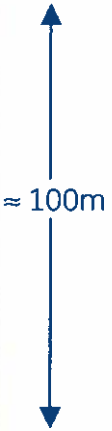
imagination at work

Wind Turbine Giant Example

- GE 3.6-MW, 104-meter (341 ft) rotor

Boeing 747-400





imagination at work

Wind Turbine Example - GE 1.5sle

Rotor
39 tons
253 ft diameter

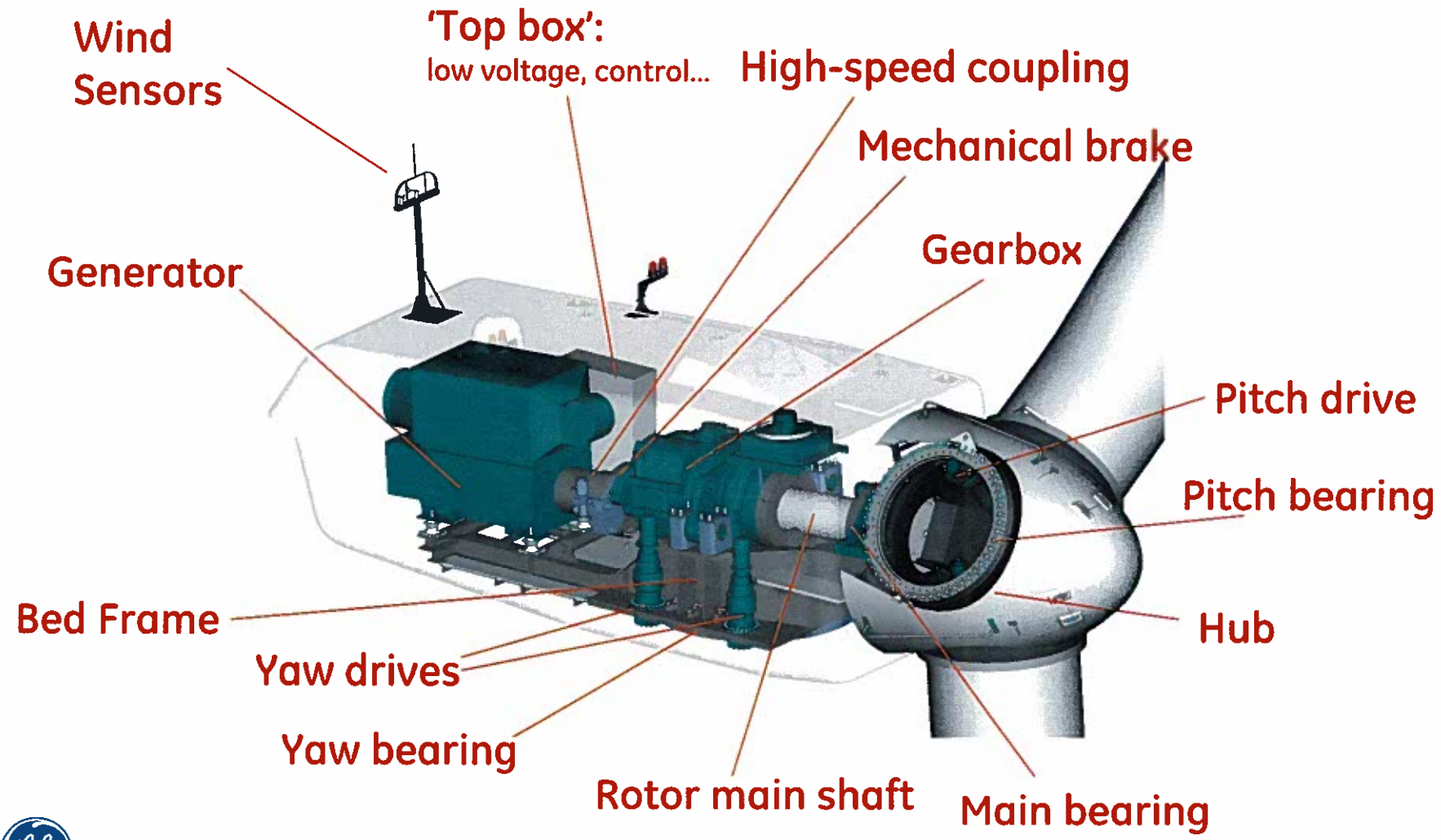
Nacelle
57 tons

Tower
130+ tons
200 to 325 ft hub height

Car (for scale)

imagination at work

Nacelle Components GE 1.5 Turbine Series



imagination at work

GE in Greenville

- **Gas turbines**
  - Heavy duty (40–500MW)
  - Combined cycle

- **Wind turbines**
  - Land based (1.5MW, 2.5MW)

Two main product lines …

3000+ employees … Split between Engineering & GSCM

Engineering

- Wind systems
- Blades, Nacelles & Towers COE
- Drive Systems COE
- Controls & Power Electronics
- Materials & Processes
- Wind Advanced Technology Ops
- Aerodynamics
- Test & Validation
- Six Sigma Quality
- Safety

Supply Chain

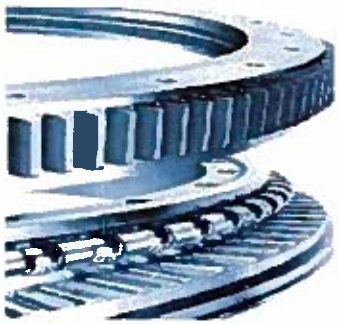
- Fulfillment Mgr
- Sourcing Quality Ldr
- Global Commodity Leaders:
  - Castings
  - Forgings
  - Composites
  - Gearbox
  - Bearings
  - Electrical
  - Fabrications
  - Parts & Svcs

imagination at work

Sourced in the US

Already produced in the US:

Blades, Tower, Gearbox, Controls, Casting, Forging, Main Bearings, P&Y Bearings, B&C parts . . .



Start in 2010:

Pitch & Yaw bearings

Greer, SC

Since 2004:

Hub & MH assy

Pensacola, FL

In discussion:

Pitch & Yaw Drives

NC

Current Needs:

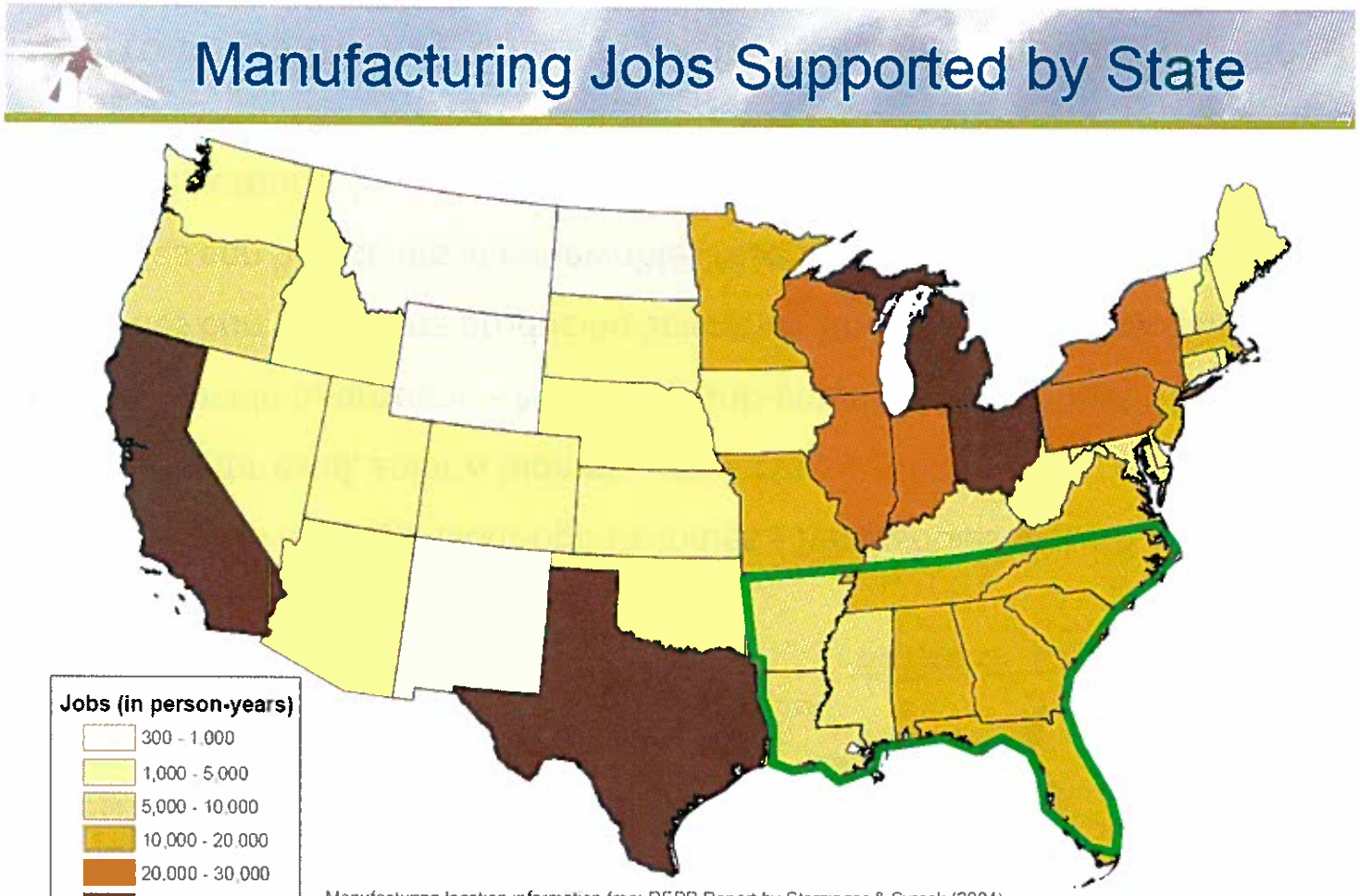
Wire harnesses, Ring rolling, Foundry

imagination at work

Opportunity to attract others. . .

GE Company Proprietary

20% wind ... green collar jobs by state



Manufacturing location information from REPP Report by Sterzinger & Svrcek (2004)

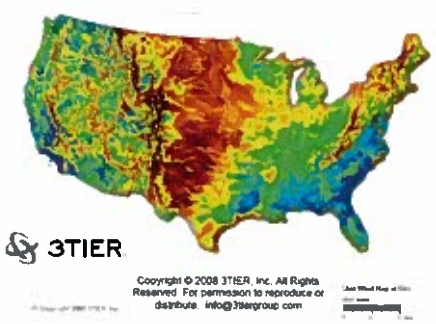
Major component assumptions: 50% of blades are manufactured in U.S. in 2007 increasing to 80% by 2030, 26% of towers are from the U.S. in 2007 increasing to 50% by 2030 and 20% of turbines are made in the U.S. increasing to 42% by 2030.

imagination at work

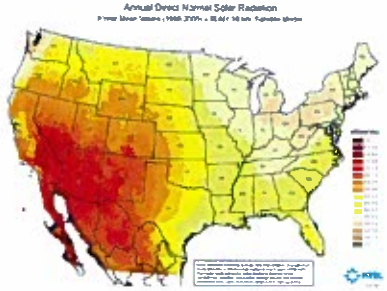
Recent hearing before Subcommittee on Energy & Environment of the House Energy & Commerce Committee entitled "Renewable Energy: Complementary Policies for Climate Legislation"

"Designing a federal standard that is acceptable to the Southeast has clearly emerged as the major challenge to passage of a bill"

Wind



Solar



Response:

- Solar PV & biomass are significant opportunities – Renewables growth . . . Jobs
- Lower cost mfg for wind, solar & biomass products . . . Jobs
- GE GVL & Pensacola operations – Numerous sub-suppliers throughout the region . . . Jobs
- SE Universities can be leaders producing Scientists, Engineers & Technicians . . . Jobs
- SE Universities can be leaders in Renewables research . . . Technology
- Offshore wind getting a look . . . SC preparing for the possibilities [1]

Policy certainty is the key enabler for Renewables supplier base expansion

[1] https://www.santeecooper.com/portal/page/portal/SanteeCooper/Press/windEvent_poster.pdf

Offshore Project Resource Challenges

- **Transportation**
  - Cables
  - Towers
  - Foundations
  - Nacelles
- **Heavy Duty Equipment Availability**
  - Specialized Equipment Required:
    - Heavy-lift jack-up barges & cranes
    - Large pile-driving hammers & eqpt
    - Marine cable-laying equipment
- **Specialized Manufacturers & Suppliers Required:**
  - Heavy steel rolling/welding
  - Submarine cable production
  - Foundries for cast hubs & frames

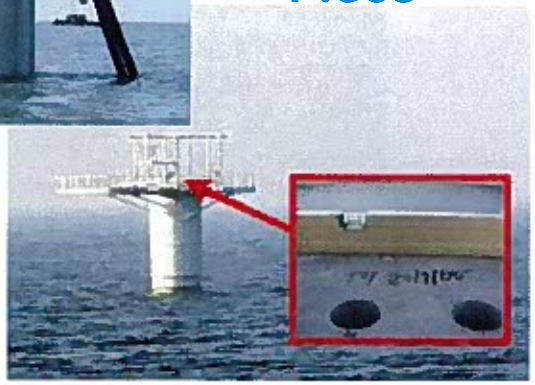
Sea Cable Installation

Offshore Wind Turbine Installation

Pile Transport

Pile Placement

Transition Piece



Nacelle Loading

Nacelle Lift

Tower and Nacelle

imagination at work