LARGE WIND ENERGY WORKSHOP

MARINE INSURANCE DAY 2012

October 05, 2012

Risk Solutions

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Wind Turbine Overview

- Generation of electricity
  - Wind blows across aerodynamic blades
  - Creating pressure difference across blade
  - This causes the blades to rotate
  - The rotation turns a generator
  - Producing electricity
- Size is measured in output
  - Small wind is <100 kW
  - Large wind is >100 kW
  - Largest wind turbine is 6,000 kW
  - Typical wind turbine is 1,500 kW to 3,000 kW
  - Industry continues to develop larger sizes

How Are Wind Turbines Used?

- Provide power to a singe facility
  - Augment needs of a facility
  - Located on site
  - Owned by the facility
- Independent Power Producers & Public Utility Companies
  - Generate power for sale into the grid
  - Generally located in rural areas
  - Owned by private investors or public utility companies

Wind Energy – A Growth Industry

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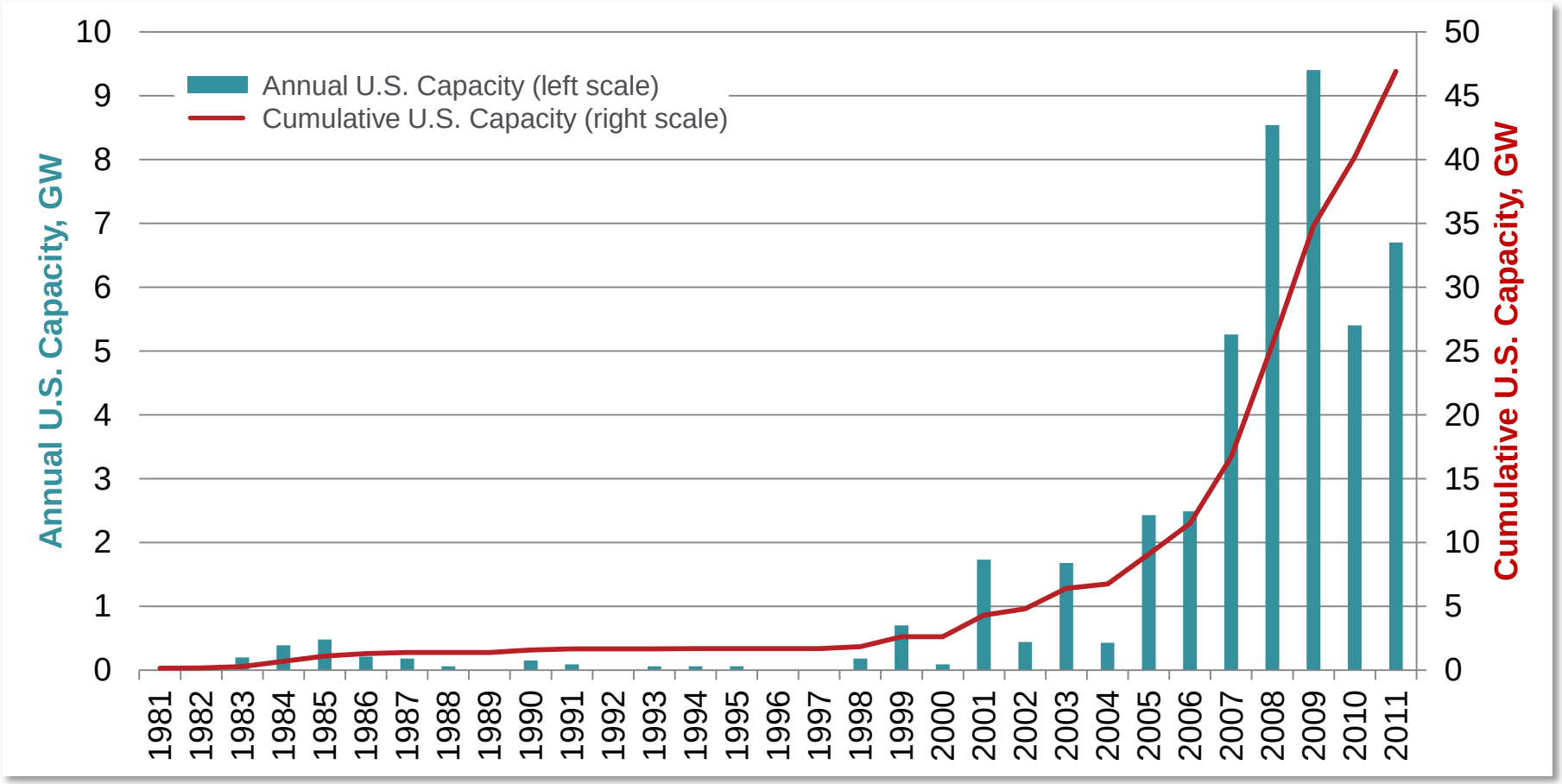
Annual and Cumulative Growth in U.S. Wind, GW



What's Driving the Growth?

- Independence from volatile fossil fuel prices
- Rising energy demand
- Improved power generation technology
- DOE has mandated that 5 percent of US energy needs to be generated from renewable sources by 2020
- 29 states and Washington DC have renewable portfolio standards (RPS), which mandate the fraction of energy supplied from renewable sources
- Production Tax Credit (PTC) has been renewed through 2012
- Investment Tax Credits (ITC) of 30%

What Issues Cause Growth to Flatten Out?

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- Production Tax Credit is not renewed
- Short-term drops in fossil fuel prices
- Global financial crisis (2007-2012)
- Electrical transmission system limitations
- Intermittency of power generated
  - Energy storage as a solution?
  - Back-up power generation?
- Reliance on state & local tax credits
- Local site issues

Wind Turbine Manufacturers

Photo Courtesy of DOE/NREL

Over 90%

of the US market is captured by the top 7 manufacturers

- GE Wind
- Vestas
- Siemens
- Suzlon
- Gamesa
- Clipper
- Mitsubishi

Who are the other companies?

Wind Turbine Market

Small Turbine Applications (<100 kW)

- Grid Integrated
- Off Grid (standalone)
  - Water pump operation (agriculture)
  - Off-the-grid rural power (battery storage)

Large Turbine (>100 kW)

- Utilities
- Wind energy companies
- Average wind turbine size rose from:
  - 710 kW in 1998/1999
  - 1,670 kW in 2009

A Quick Comment on Offshore Wind in the US

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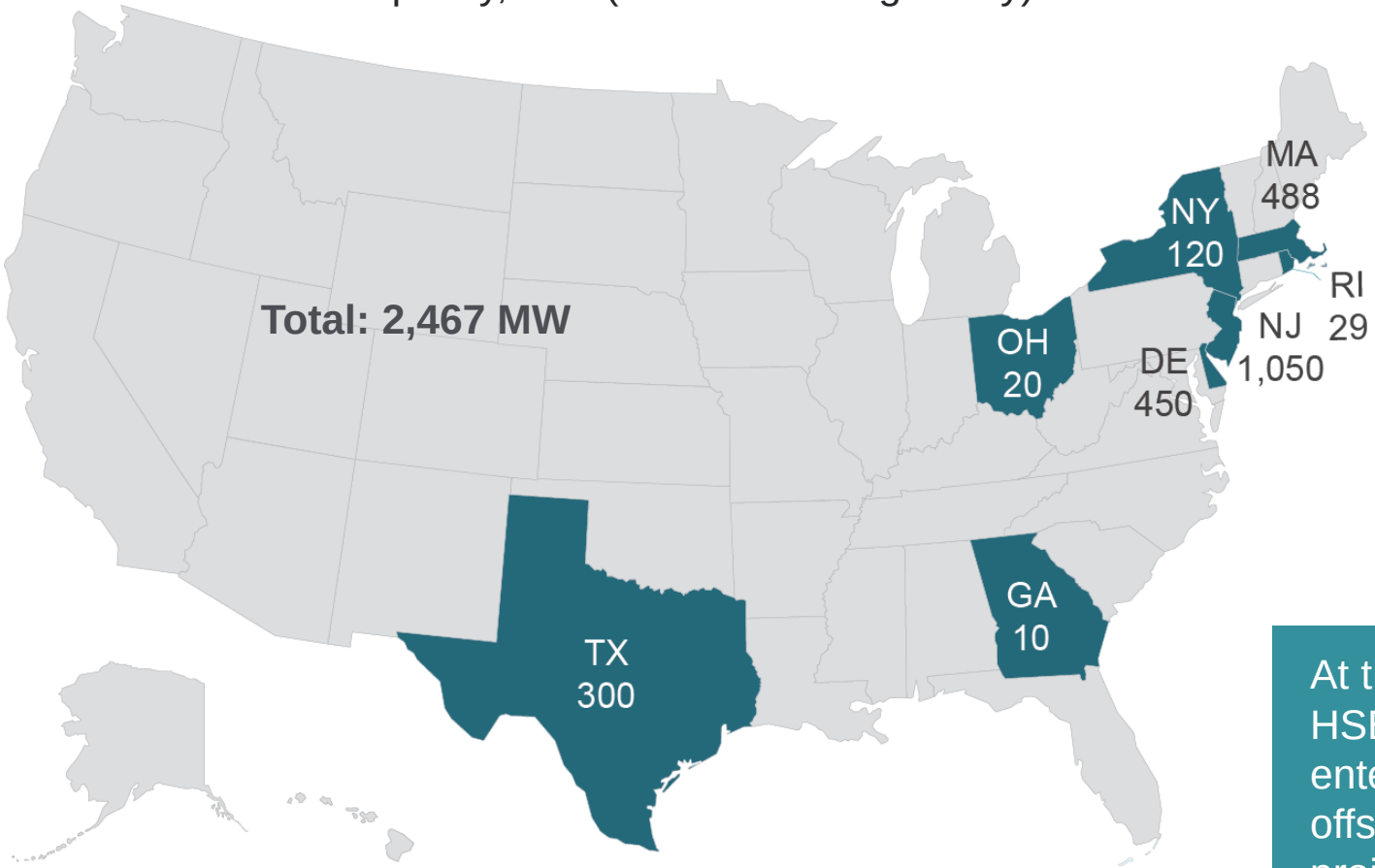
Proposed Offshore Wind Capacity, MW (Advanced-Stage Only)



At this time, HSB does not entertain offshore wind projects

Source: NREL

Small Wind vs Large Wind

70 ft, 1.8 kW Wind Turbine

224 ft, 1,000 kW Wind Turbine

Photo Courtesy of DOE/NREL

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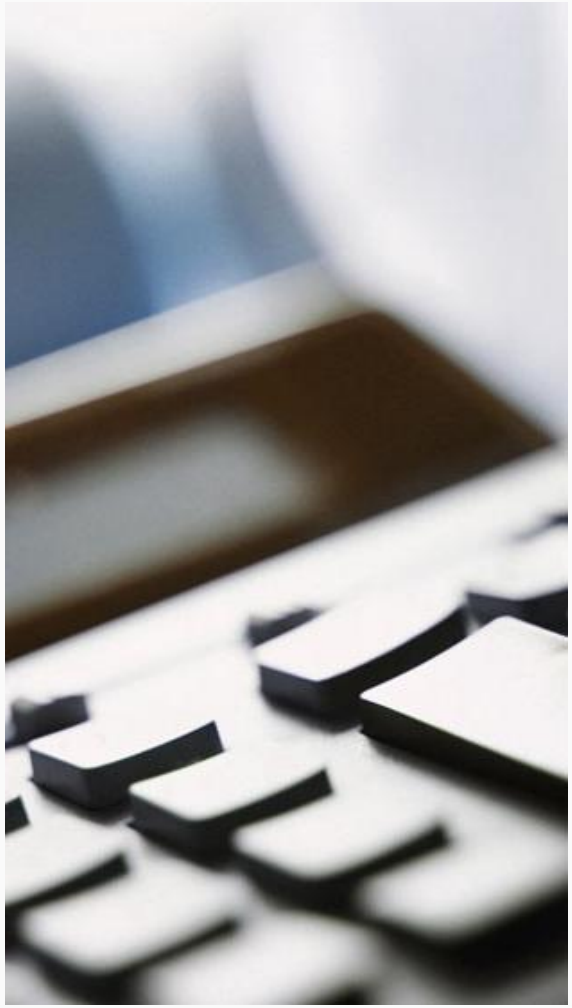
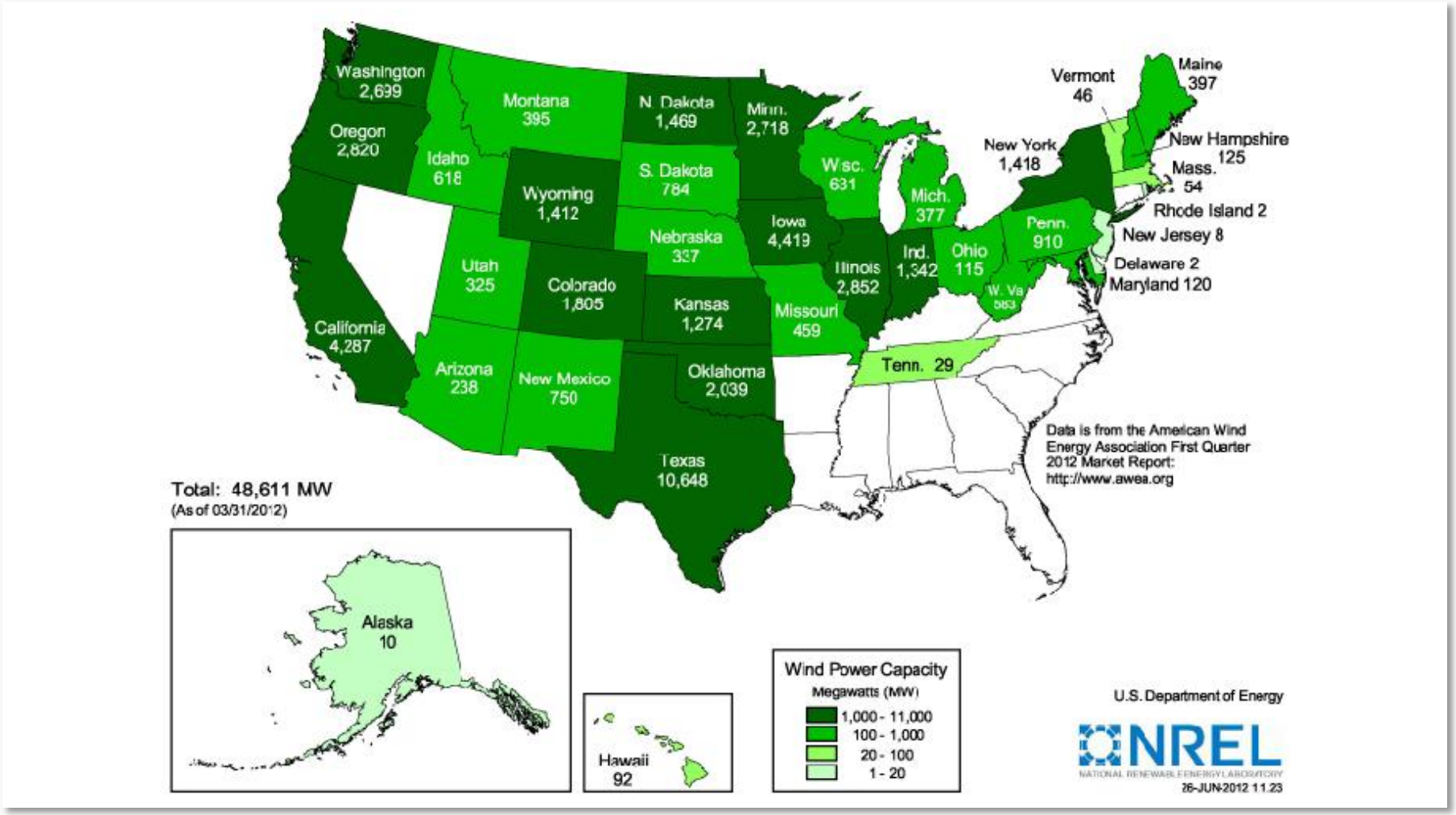
Wind Turbine Cost



- Small Wind
  - Generally between US $2,500/kW to US $4,500/kW
- Large Wind
  - Turbine Cost: US $1,350/kW
  - Project Cost: US $2,000/kW
- What influences the cost?
  - Size of order
  - Owners market share
  - Regional differences

Installed Wind Across the US in MW

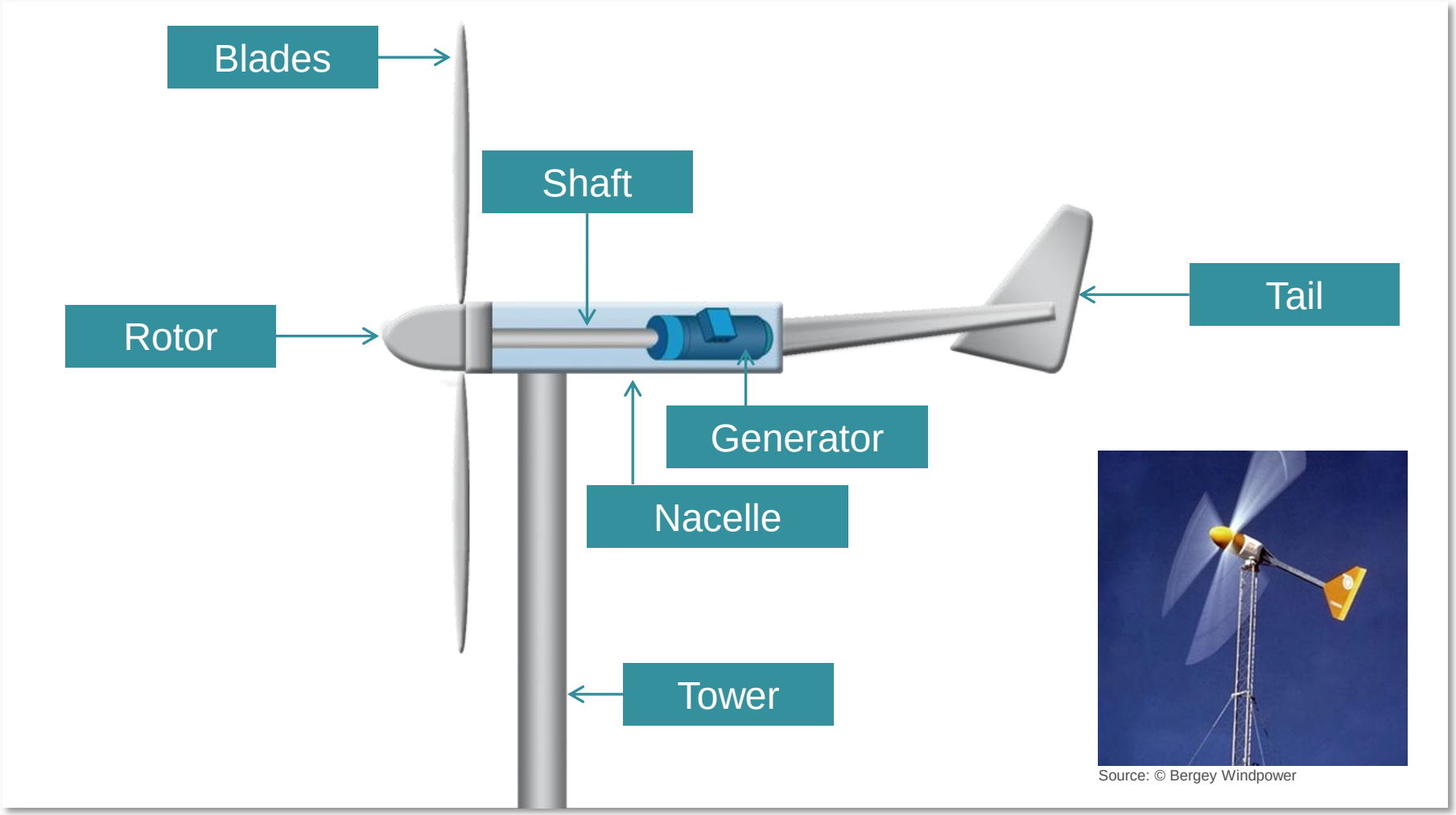


Wind Turbine System Components

Photo Courtesy of DOE/NREL

- Foundation
- Tower
- Blades
- Rotor
- Nacelle
  - Shaft
  - Gearbox
  - Generator
  - Power control
    - Blade pitch
    - Yaw (orientation to the wind)
- Transformer
- Power Electronics

Small Wind Turbines



Source: © Bergey Windpower

Wind Turbine Exposures

Shop Assembly of the Nacelle

http://www.geograph.org.uk/photo/824692

Shipment

Photos Courtesy of DOE/NREL

Site Construction

Photos Courtesy of DOE/NREL

Property Exposures

Photo Courtesy of DOE/NREL

Property Exposures – Fire

Lightning

Wind Turbine Risk Drivers

- Technology continually pushed to larger outputs
- Global Economy – Supply Chain – Lead Times
- Repair times impacted by remote locations, road conditions, & crane availability
- Manufacturers are no longer in business
- Parts for older models not available (obsolete)
- Repairs/replacement parts
- Losses can involve the entire nacelle
- High wind speeds
- Icing
- Fire
- Lightning
- Vandalism and theft

Wind Turbine Failure Mechanisms

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Component	Failure Mechanism	Cause(s)
Blade Failure	Foreign Object Damage Material or Design Defect Melting/Delamination Overspeed	Impact damage Poor quality, design, or workmanship Lightning strike or FOD damage Power regulator failure
Gearbox (Gears and Bearings)	Loss of Lube Oil or Inadequate Lubrication Overload	Oil supply to gear interrupted Operational failures/degradation Failure of power regulator or yaw system Intermittent wind loads
Generator	Winding Overheating Insufficient Cooling	Design issue Cooling system problem
Transformers (Including Distribution)	Winding Overheating	Design issue Application issue (undersized)

Insurance and Underwriting Considerations

- Manufacturer
- Size (kW output)
- Model
- Number of units
- Age (retrofit date?)
- Warranty
- Service and maintenance agreement
- Monitoring agreement
- Loss history (serial loss issues)

- TIV and value per unit
- Business income
  - Annual power production
  - Value per unit
- Transformers for each turbine
- Substation details
  - Owned or not owned
  - Manufacturer
  - Number and size
  - Age

Wind Turbine Experience Information

- Includes risks written in the U.K. and Europe
- Up until the end of 2007, HSB insured about 40% of the wind power generating capacity. Some of this business included U.S. locations of European companies.
- Claim detail includes the accumulation of both Property and EB exposures
- Loss experience analysis is based on a book of business that consisted of approximately 20 accounts and 7,000 wind turbines
- The European market is indicative of the wind industry

Wind Turbine

Loss Experience – Based on approximately 350 losses

- Accident years beginning in 2005 produced high-loss ratios, culminating with the still developing 2007 accident year LR of 216%
- Loss experience (frequency) was predominantly EB related (50%), with a lesser amount assigned to both Property (25%) and Blades (25%) – these can be assigned to either property or EB
- From a severity standpoint, large claims have generally been Property related (fire, lightning, collapse), while the frequency has been EB related
- Repair was able to be done on 31% of claims, Replacement required on 48% of claims

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Loss Experience

Cause of Loss, %

- Lightning 16
- Breakdown 13
- Wind Damage 5
- Unknown 25

By Component, %

- Gearbox 27
- Blade 22
- Generator 12
- MEA 5
- Transformer 4

Wind Turbine

Loss Experience

By Size, %

- 1,000 kW and < 72
- 1,300 kW 9
- 1,500 kW 9
- 1,650–1,800 kW 8
- >2,000 kW 1.5

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Loss Experience, US $

Direct Physical Damage Deductibles, %	
Less than 10,000	11
10,000–20,000	26
25,000–50,000	60
Greater than 50,000	3

Direct Physical Damage Losses Paid, %	
Less than 10,000	13
10,000–20,000	19
20,000–25,000	4
25,000–30,000	22
50,000–100,000	26
100,000–150,000	8
150,000–250,000	4
Greater than 250,000	3

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Loss Experience

Business Interruption Outage	
Less than 10 days	16%
Less than 20 days	37%
Less than 30 days	57%
Less than 45 days	69%
Less than 60 days	78%
Less than 90 days	85%
Greater than 90 days	14%

Deductible Applied at Time of Loss	
Less than 10 days	14%
10 days	80%
15 days	1%
20 days	1%
25 days	1%
30 days	1%
45 days	<1%

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Market Considerations

- Competitive pricing/terms as companies looked to increase market share
- Generating capacity growing at a rate of 4x in 6 years
- Manufacturing capacity and quality control are challenged with demand
- Series losses with blades and gear sets result from design, workmanship, and construction
- More units out of warranty as industry ages
- Older units now obsolete and out of production
- Many companies are entertaining cover – but how long will they last?

Wind Turbine

Rates

- Rates varied significantly by account
- Since 2007, HSB has lost approximately 70% of our wind business (premium) and approximately 50% of our accounts due to our adjustment in our pricing/terms due to experience. Previous rates considered inadequate.
- The current market rates for operational risks are 0.20–0.30/100 for all risk PD and 0.30–0.50/100 for all risk Loss of Profits/BI. EB is approximately 50% of those rates.

All Accounts are Referrals to HSB

If risk has any power generation other than emergency generation, account should be sent to HSB

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QUESTIONS?

THANK YOU VERY MUCH FOR YOUR ATTENTION

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10/05/2012

Michael S. Roy, P.E.

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