



## Connecting to the Wind Turbine Supply Chain

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# Connecting to the Wind Turbine Supply Chain

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- Wind energy markets
  - World
  - US
  - Ohio
- Wind turbine OEMs
- Wind turbine supply chains

# World Leader in New Installations

## Incremental Capacity (2008)

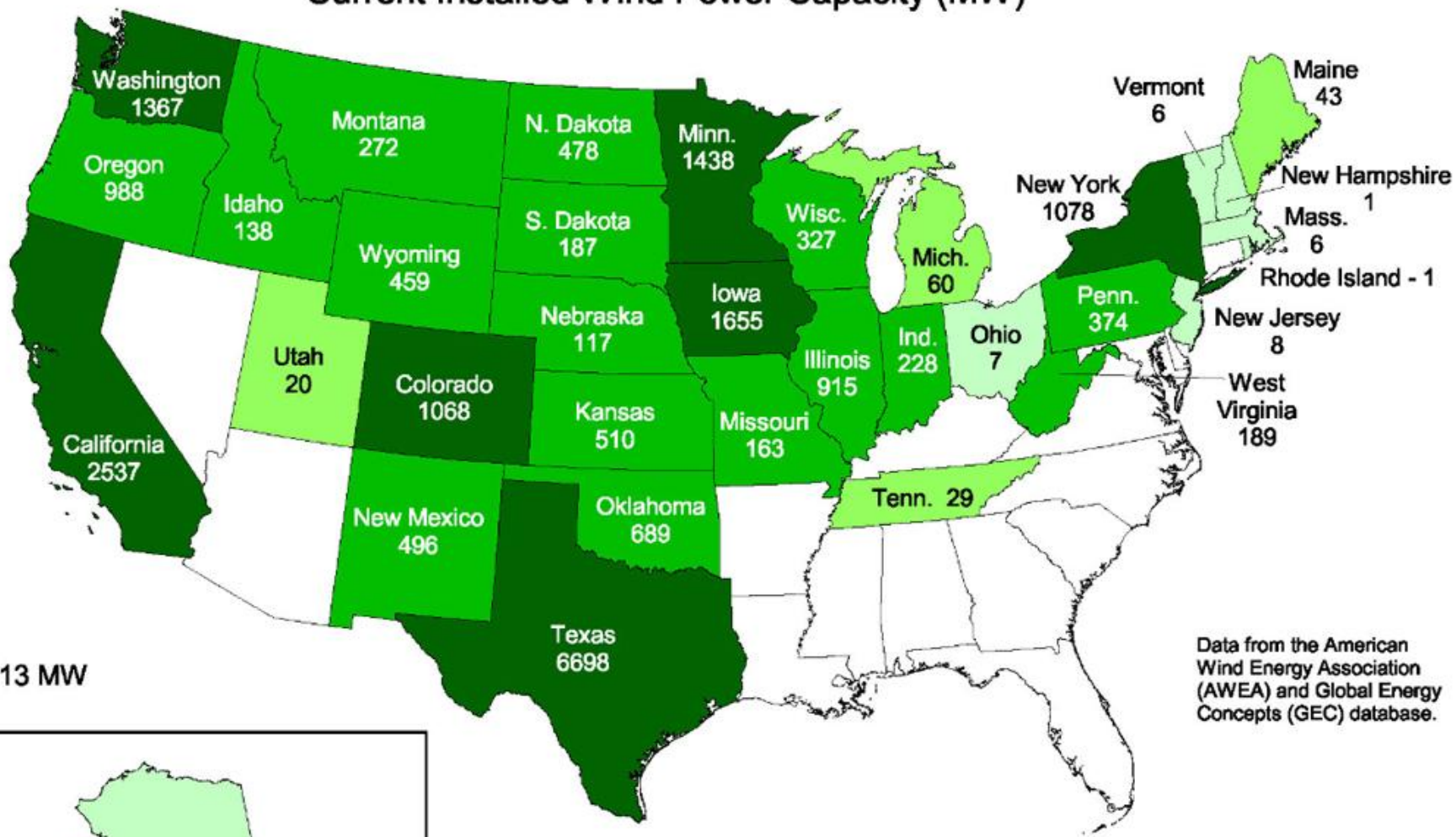
	MW	%
<b>U.S.</b>	<b>8,358</b>	<b>31</b>
China	6,300	23
India	1,800	7
Germany	1,665	6
Spain	1,609	6
Italy	1,010	4
France	950	4
U.K.	836	3
Portugal	712	3
Canada	523	2
Rest of the World	3,293	12
<b>World Total</b>	<b>27,056</b>	<b>100</b>

## Cumulative Capacity (2008)

	MW	%
<b>U.S.</b>	<b>25,170</b>	<b>20.8</b>
Germany	23,903	19.8
Spain	16,754	13.9
China	12,210	10.1
India	9,645	8.0
Italy	3,736	3.1
France	3,404	2.8
U.K.	3,241	2.7
Denmark	3,180	2.6
Portugal	2,862	2.4
Rest of the World	16,686	13.8
<b>World Total</b>	<b>120,791</b>	<b>100.0</b>

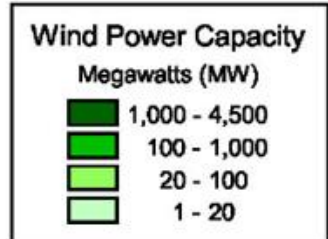
Source:GWEC

# Current Installed Wind Power Capacity (MW)



Data from the American Wind Energy Association (AWEA) and Global Energy Concepts (GEC) database.

Total: 22,613 MW  
(As of 9/30/08)

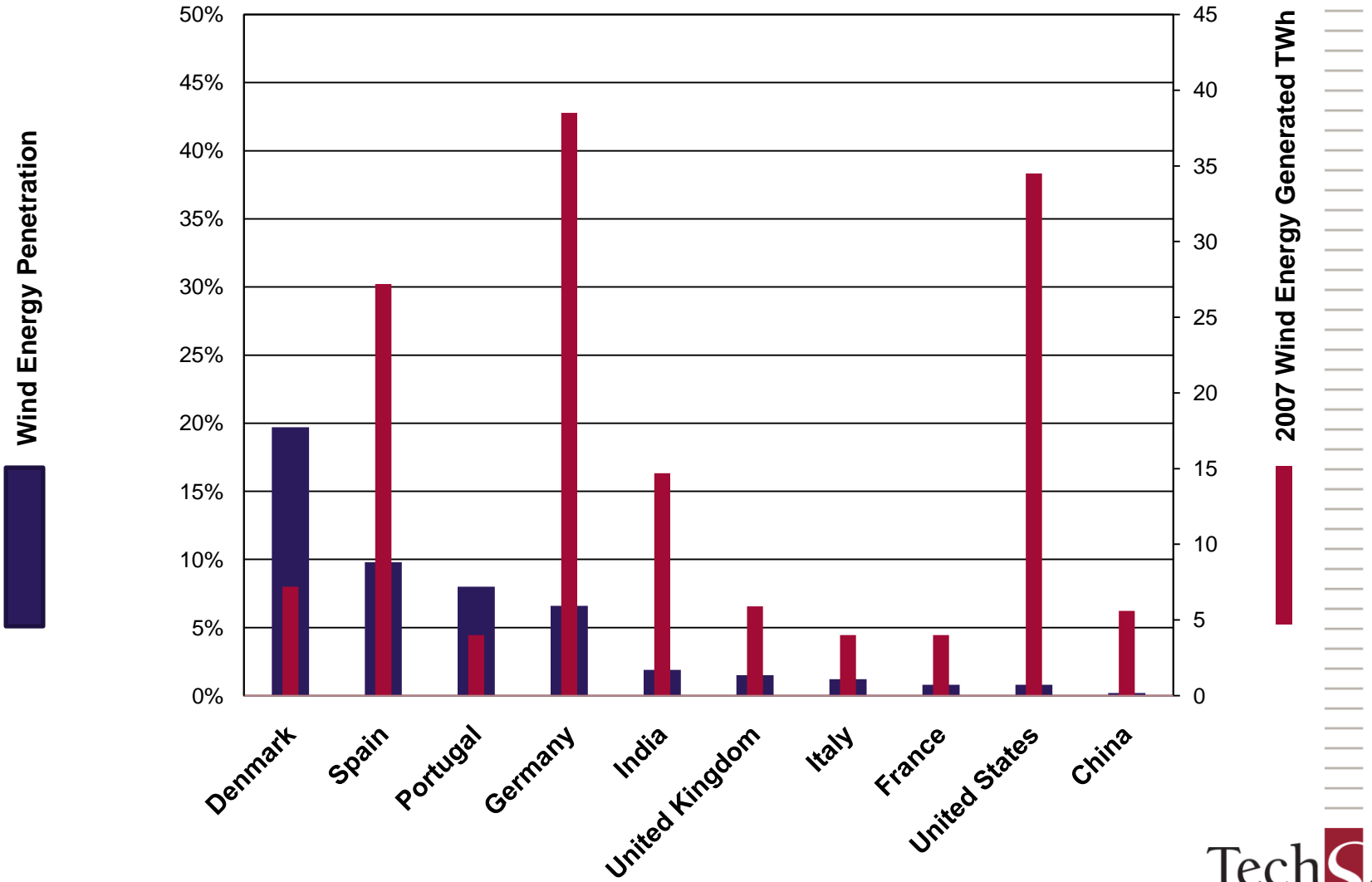


U.S. Department of Energy  
National Renewable Energy Laboratory



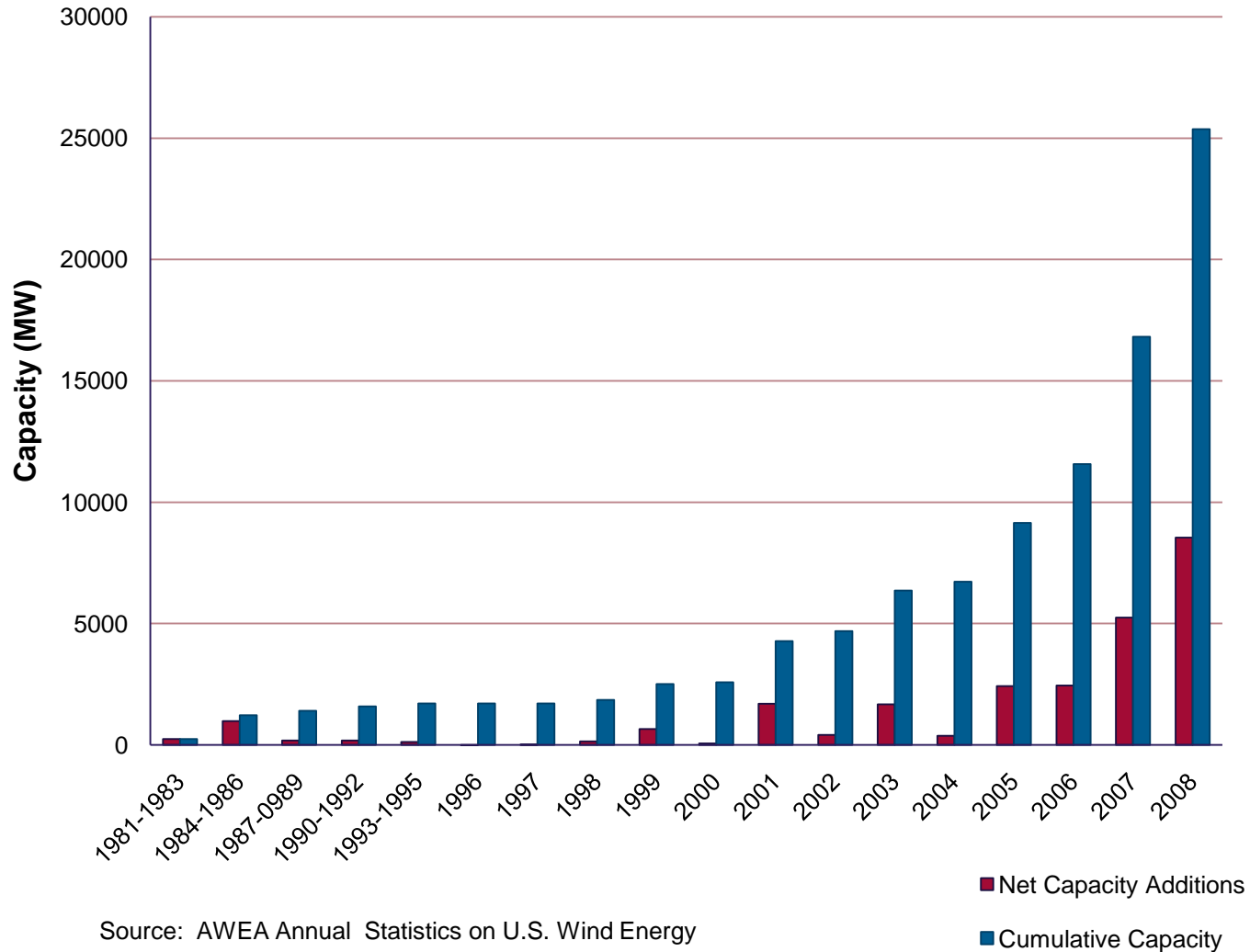


# Wind Energy Penetration and Generation: 2007





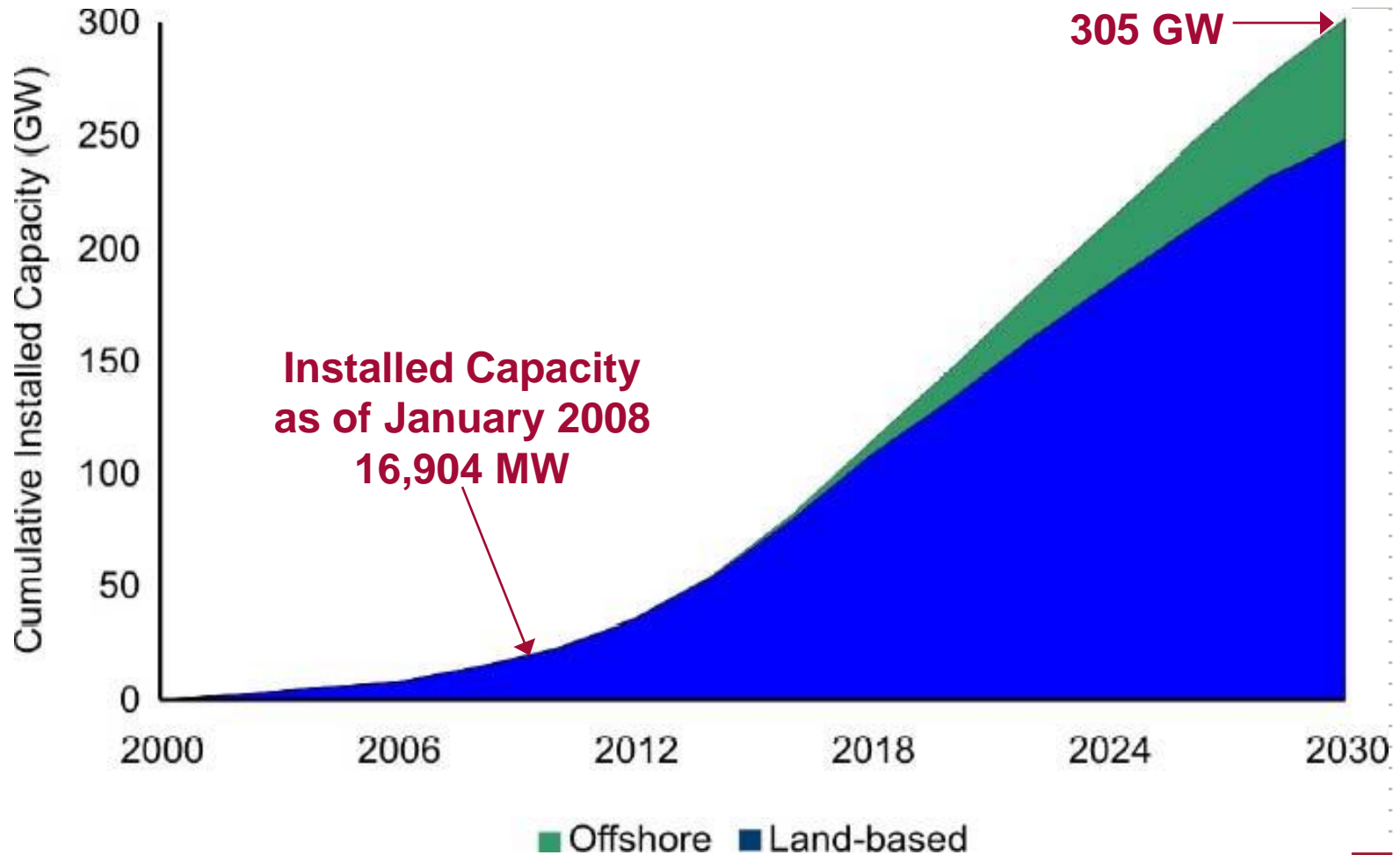
# U.S. Wind Energy Capacity



Source: AWEA Annual Statistics on U.S. Wind Energy



# U.S. 20% Wind Scenario



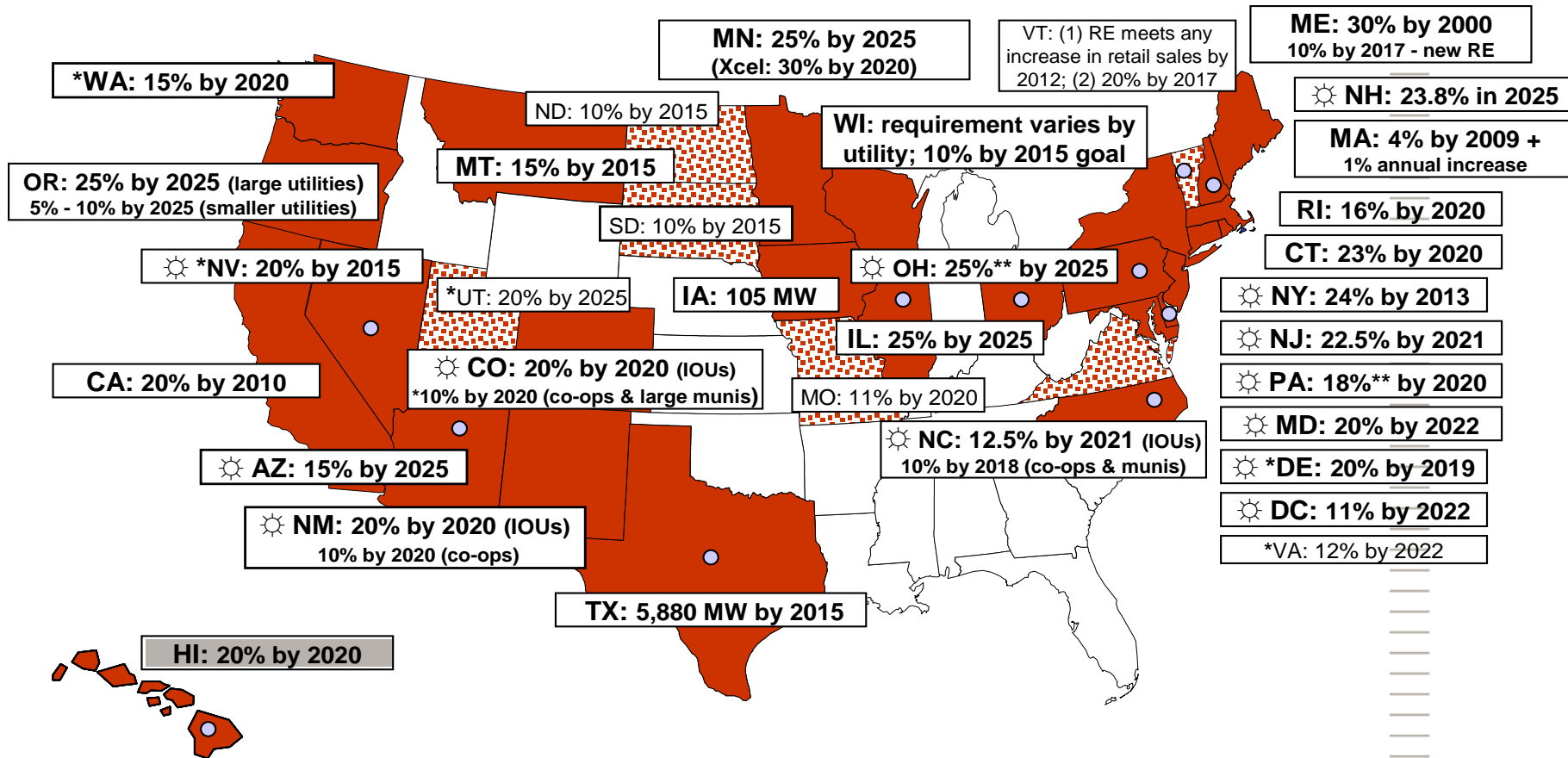
Source: US DOE: 20% by 2030

# Ohio Wind Energy Market

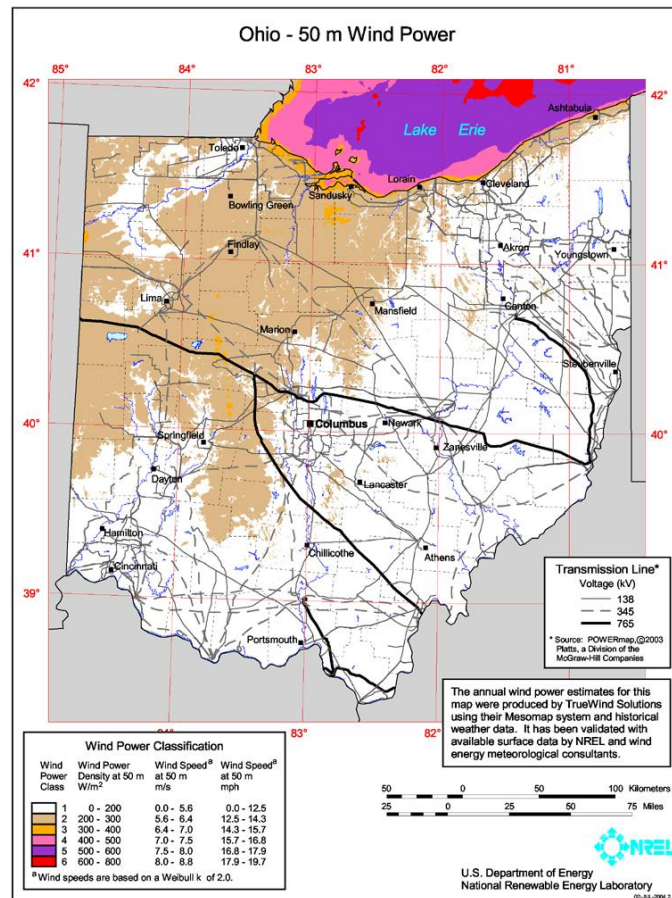
- For Ohio (Renewable Portfolio Standard May 2008)
- 7,000 MW by 2025
- 4000 new turbines/towers – \$14 billion total
- Market opportunity – \$10 billion in components
- Utility grade wind – generally 1 MW and above



# State Portfolio Standards



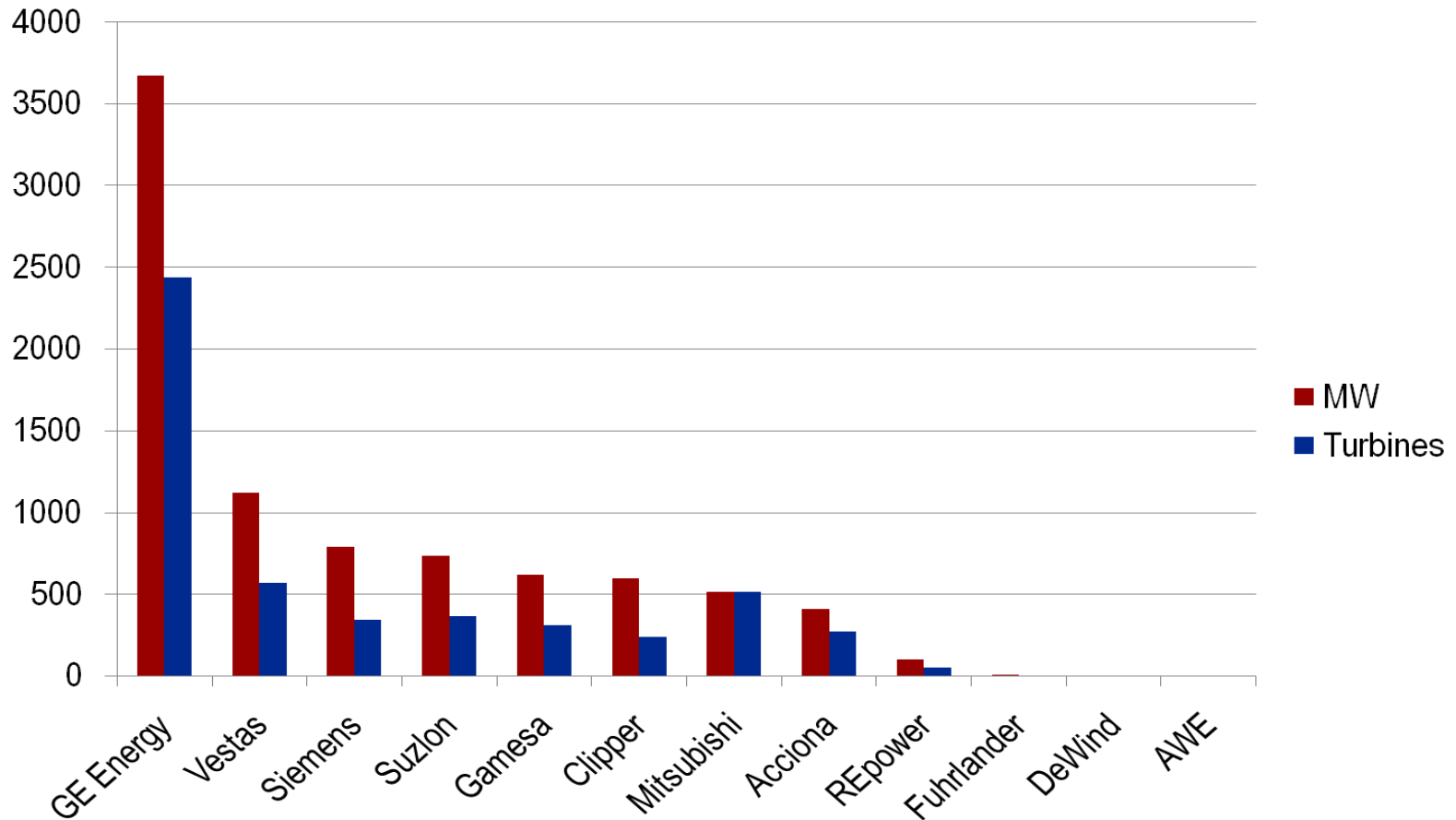
# Ohio Wind Potential



Source: USDOE office of Energy Efficiency and Renewable Energy

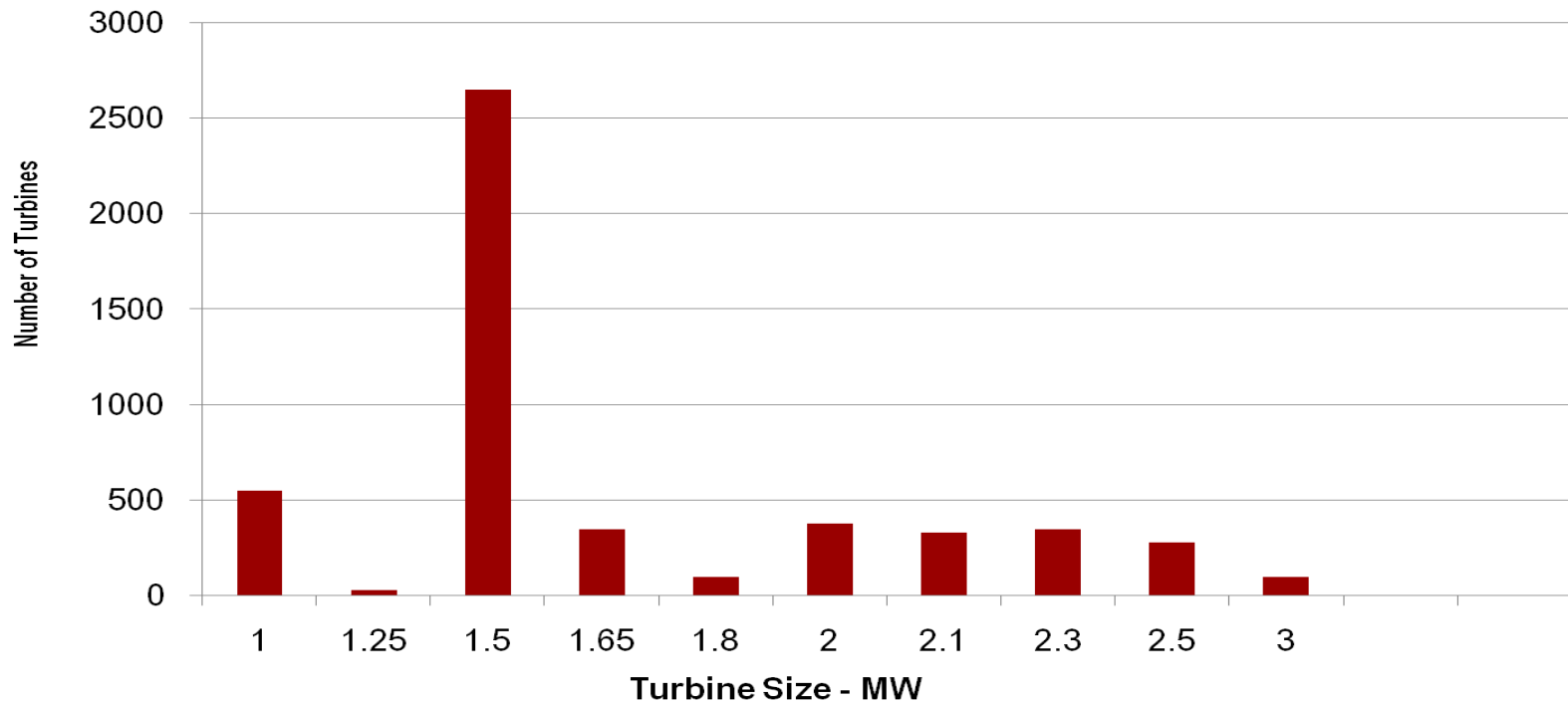


# 2008 Installations by OEM



Source: AWEA annual statistics on U.S. Wind Energy

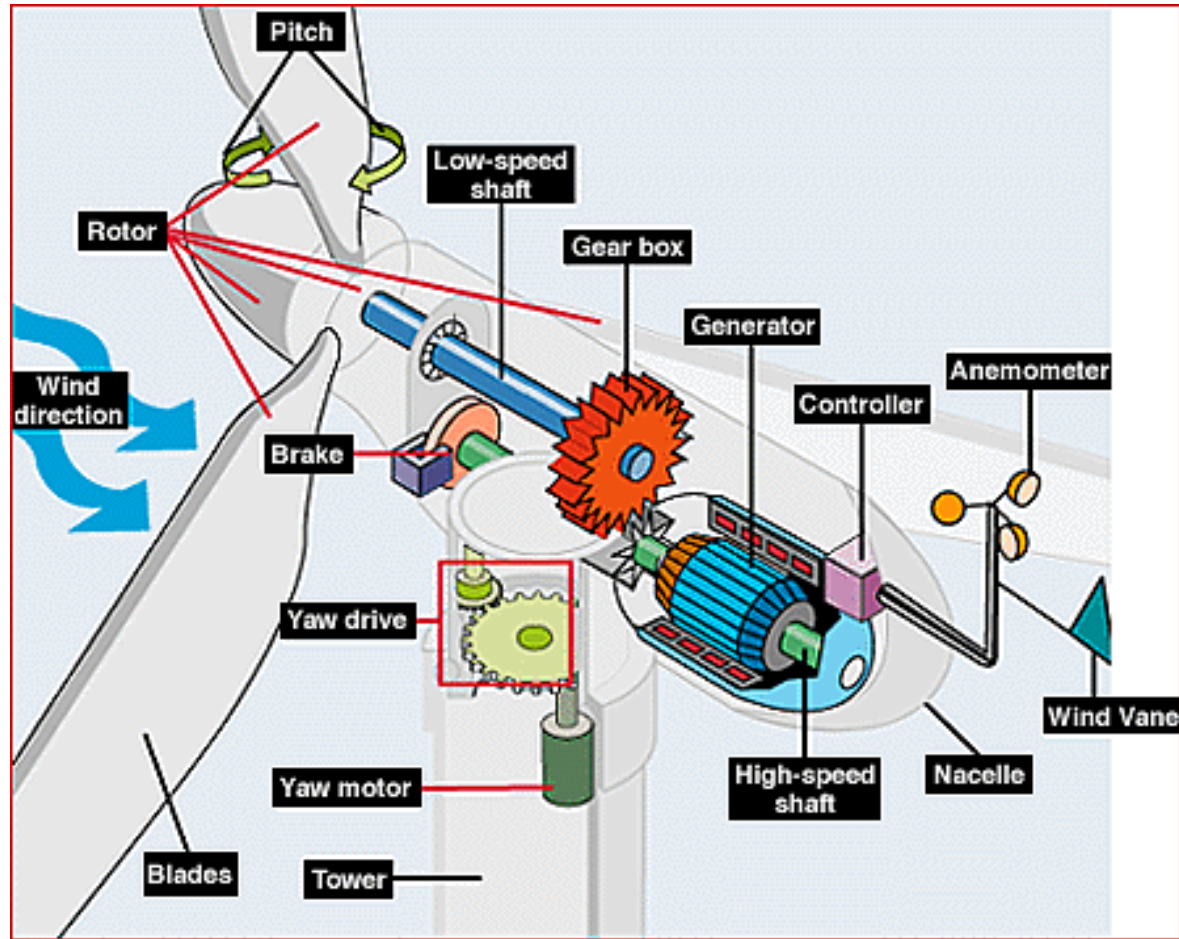
# 2008 Turbine Installations by Size



Tower Height Range: 45-105 meters  
Rotor Diameter Range: 57- 99 meters  
Blade Length Range: 26- 45 meters

Source: AWEA annual statistics on U.S. Wind Energy

# Wind Turbine Major Components



Source: USDOE office of Energy Efficiency and Renewable Energy



# Utility Grade Wind Opportunities

- OEM and Tier 1 Dominated
  - ISO9001 or equivalent
  - CNC and CMM
  - Internal certifications
- Domestic OEM supply base is relatively mature
- European OEM supply base is developing
  - Quality and facility strengths
  - Far down learning curve
- Transportation is key issue

# Assembly Plants

- GE (Greenville, SC and Pensacola, FL)
  - many Ohio suppliers
- Gamesa (Edensburg, PA)
  - nacelles, blades, and towers
- Clipper (Carpenteria, CA and Cedar Rapids, IA)
  - nacelles only
- Acciona (West Branch, IA)
  - mostly imported parts
- DeWind (Round Rock, TX)
  - shipped units in December 08

# OEMs on the Way



## Plants Announced

- **EWT (AK)**
- **Fuhrlander (MT)**
- **Nordic Windpower (ID)**
- **Nordex (AK)**
- **Vestas (CO)**

## Making Site Selections

- **Alstom (Ecotecnica)**
- **M. Torres**
- **Mitsubishi**
- **Northern Power**
- **REPower**
- **Siemens**
- **Suzlon**

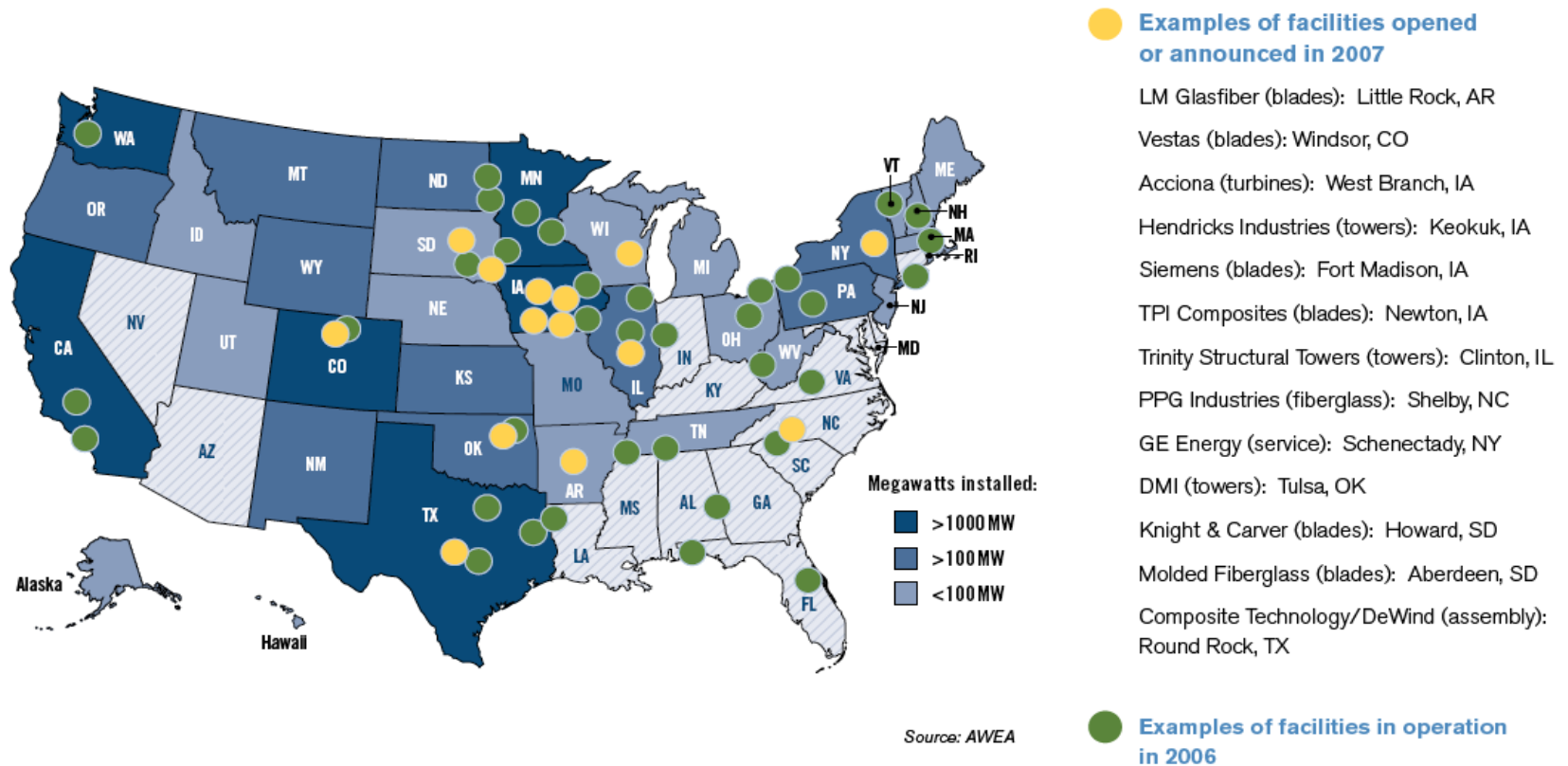
# Planned Assembly Plants

- Alstom Power (Spain)
- EWT (Netherlands)
- Nordex (Germany)
- Nordic (Denmark)
- REPower (Germany)
- Siemens (Germany)
- Suzlon (India)
- Vestas (Denmark)



# Utility Scale OEM and Supply Chain Plants

## Utility-Scale Wind Turbine Manufacturing: Investment in New Plants





# Tier Structure

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- Tier 1  
Manufacturers & fabricators of major components:  
Tower, blades, gearbox, hubs
- Tier 2  
Key supplier of subassemblies: control systems,  
hydraulics, power electronics, fasteners
- Tier 3  
Process/service providers: heat treatment,  
coatings, inspection, internals
- Tier 4  
Raw materials, consumables, support equipment,  
logistics

# ≡ Tower Fabricators

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- Trinity Structural Towers (Tulsa, OK, Clinton IL)
- Aerisyn (Chattanooga, TN)
- Thomas & Betts (Memphis, TN)
- Towers Tech (Manitowoc, WI)
- DMI Industries (West Fargo, ND)
- Hendricks Industries (Keokuk, IA)
- Northstar (Blair, NE)
- Great Lakes Towers (Monroe, MI) – Planned 2009

# ≡ Tower Fabrication Capabilities

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- Welding
  - Submerged Arc, FCAW, GMAW
  - CNC
  - Certifications
- NDT
- Coating
- Logistics
  - Cranes
  - Rail spurs, water routes

# Hybrid Tower Base



# ≡ Blade Manufacturers

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- Suzlon (Pipestone, MN)
- LM Glasfiber (Grand Forks, ND)
- Siemens (Fort Madison, IA)
- Knight and Carver (Howard, ND)
- Gamesa (Edensberg, PA)
- Vestas (Windsor, CO)
- Molded Fiber Glass (Aberdeen, SD)
- TPI Composites (Newton, IA)
- LM Glasfiber (Little Rock, AR)
- PPG Industries-fiberglass (Shelby, NC)

# ≡ Turbine Blade



# ≡ Blade Fabrication Capabilities

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- Blade Length Range: 26- 45 meters
- Large, complex composite structures
- Finishing capabilities
- Quality systems
- Lean

# ≡ Nacelle Components

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- Gearbox Operations
  - Winergy Drive Systems (Elgin, IL)
  - GE Transportation (Erie, PA)
  - Clipper Windpower (Cedar Rapids, IA)
  - *Moventas (MN or IA)*
  - *Bosch-Rexroth (TBD)*
- Shafts, generators, frames, hubs, sensors, motors

# Nacelle Capabilities

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- Very large machining centers
- Heavy cranes
- Quality systems
- Lean and Six Sigma practices
- CMM



# Specialty components

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- Electricals
  - Connectors
  - Sensors
  - Electronics



# Why Ohio manufacturers?

**Employment at Potential Active Companies, Investment and Job Creation Potential  
Top 20 States Ranked by Average Investment**

State	Employees at Potential Companies	Rotor	Nacelle and Controls	Gearbox & Drive Train	Generator & Power Electronics	Tower	Number of New FTE Jobs	Average Investment (\$ Billions)
California	<b>102,255</b>	25226	52490	1380	14889	8270	<b>12,717</b>	<b>4.24</b>
Ohio	<b>80,511</b>	30578	33367	6360	3372	6834	<b>11,688</b>	<b>3.90</b>
Texas	<b>60,229</b>	15191	28339	1678	3006	12015	<b>8,943</b>	<b>2.98</b>
Michigan	<b>66,550</b>	27719	30241	2466	926	5198	<b>8,549</b>	<b>2.85</b>
Illinois	<b>57,304</b>	20001	24193	5520	3143	4447	<b>8,530</b>	<b>2.84</b>
Indiana	<b>53,064</b>	18962	20359	4783	2633	6326	<b>8,317</b>	<b>2.77</b>
Pennsylvania	<b>50,304</b>	16647	20844	2565	1997	8251	<b>7,622</b>	<b>2.54</b>
Wisconsin	<b>48,164</b>	17795	21317	3796	567	4689	<b>6,956</b>	<b>2.32</b>
New York	<b>47,375</b>	10855	24188	4020	5966	2347	<b>6,549</b>	<b>2.18</b>
South Carolina	<b>20,532</b>	4398	4510	6780	1765	3079	<b>4,964</b>	<b>1.65</b>
North Carolina	<b>30,229</b>	9431	12814	3142	2036	2806	<b>4,661</b>	<b>1.55</b>
Tennessee	<b>28,407</b>	9761	12513	2128	381	3624	<b>4,233</b>	<b>1.41</b>
Alabama	<b>21,213</b>	6607	7686	927	620	5374	<b>3,571</b>	<b>1.19</b>
Georgia	<b>20,898</b>	6610	8245	2335	253	3456	<b>3,532</b>	<b>1.18</b>
Virginia	<b>20,201</b>	6692	7372	1549	567	4021	<b>3,386</b>	<b>1.13</b>
Florida	<b>24,008</b>	5138	12197	254	1923	4497	<b>3,371</b>	<b>1.12</b>
Missouri	<b>23,634</b>	8389	11031	1202	537	2475	<b>3,234</b>	<b>1.08</b>
Massachusetts	<b>27,955</b>	6956	15952	659	3331	1057	<b>3,210</b>	<b>1.07</b>
Minnesota	<b>26,131</b>	8364	14427	711	1142	1488	<b>3,064</b>	<b>1.02</b>
New Jersey	<b>22,535</b>	8552	10191	819	1299	1675	<b>2,920</b>	<b>0.97</b>

Source: Renewable Energy Policy Project, George Sterzinger and Matt Svrcek, Sept. 2004



# European OEMs

- Driven to U.S. manufacturing by cost of transportation
- Accustomed to European specs and manufacturing partners
  - Newer plants
  - Quality systems and safety
  - Turbine testing and certification
- Sourcing criteria
  - Cost
  - Quality
  - Delivery
- Relatively young sourcing organizations
  - Developed from scratch
- Many projects held up by financial collapse



# Voice of the Customer

- NARVAEZ: The approach to Quality by potential suppliers. The wind industry is different from other industries in that we do not produce items in the thousands. In wind, our needs are for a precious few, and each component has to be perfect. Wind Turbines are investment goods that need to operate reliably and continuously for more than 20 years. Nordex has narrow, defined, precise tolerances that need to be met, and failure to do that could be catastrophic.
- GLWN: This sounds like a critical area for supplier screening.
- NARVAEZ: It is. Sometimes I meet manufacturers with impressive capabilities, companies that can do wind. But if they don't have the processes in place to ensure that every single piece is made to the standards required, then they are missing a critical piece of the puzzle. They may have the right equipment but not the mentality required for producing a quality product.
- Part of my job involves helping to evaluate new suppliers, and I am sometimes surprised by the number who don't understand what it takes to become a supplier for wind. In a way, we find ourselves becoming teachers and facilitators for emerging companies as they learn our requirements.

Wigberto (Will) Narvaez, Purchasing Officer for German wind turbine manufacturer Nordex at the May AWEA conference.

# Other renewables

- Small wind (up to 100 kW)
  - Diverse niche market – 66 manufacturers in US
  - Installations up 78% in 2008 (10k + turbines)
  - 30x growth in small wind projected within 5 years
- Solar PV & solar thermal
- Biomass
- Micro hydro
- Conservation & geothermal
  - Smart grid



# Renewable Energy Storage

- Upper limit on solar and wind without energy storage
- Batteries on the grid
  - GE Sodium
  - A123
- Automotive PHEV
  - BYD
  - Chevy Volt
  - Prius
- EV
  - Better Place
  - Tesla
  - Zenn



# Resources

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- Industry Association
  - [www.awea.org](http://www.awea.org)
  - <http://www.windpowerexpo.org>
- Trade Publication
  - [www.nawindpower.com](http://www.nawindpower.com)
- Supply Chain Development
  - [www.glwn.org](http://www.glwn.org)
  - [www.techsolve.org](http://www.techsolve.org)