



Advancing Wind Power in Illinois Conference 2011

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Wind Energy 101 Pre-Session

Thursday, July 21, 2011, 8:00 AM

Introduction to Wind Energy

Matt Aldeman

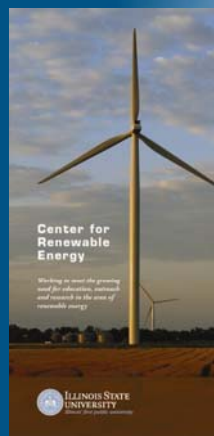
Senior Energy Analyst
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July 21, 2011



Center for Renewable Energy

- ...works to meet the growing need for education, outreach and research in the area of renewable energy.
- Three major functional areas:
 - to enhance the renewable energy major at Illinois State University;
 - to serve the Illinois renewable energy community by providing information to the public;
 - to encourage applied research concerning renewable energy at Illinois State University and through collaborations with other universities.



Wind Energy Overview

- Terminology
- Wind Turbine Evolution
- Current State of Wind Energy



Foundation



Foundation



Blades



Hub



Nacelle



Tower: Base Section

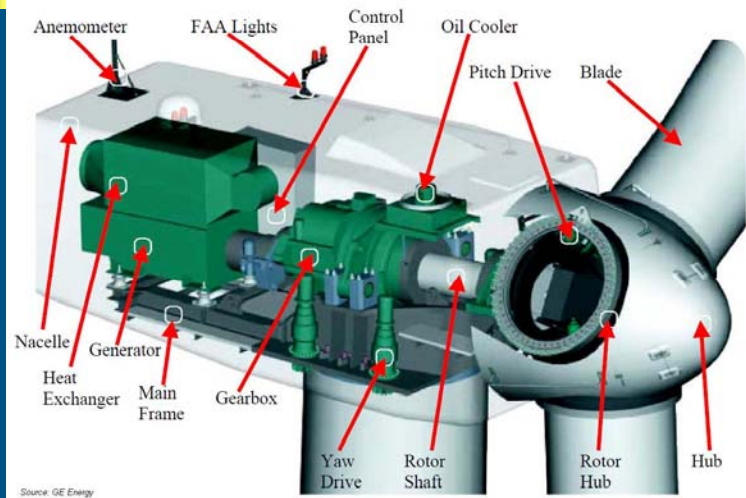
Foundation



Rotor assembly



Nacelle components



Turbine exterior



Down-tower controls



Climbing the tower



Inside the nacelle



Hub



Blade



Variations

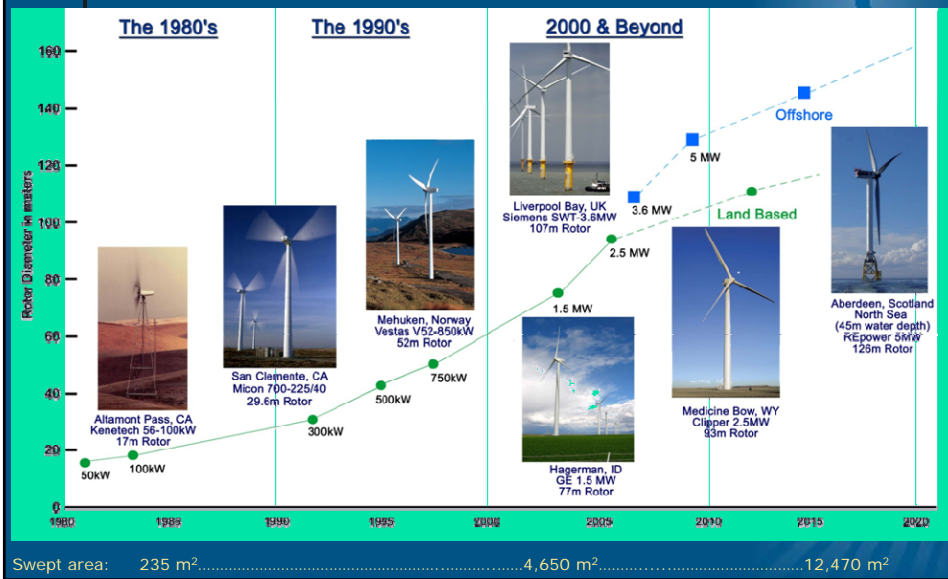
- Tower Height & Material
- Blade Length
- Generator Design:
 - Doubly Fed Induction
 - Permanent Magnet
 - Direct Drive (may be PM)

Variations

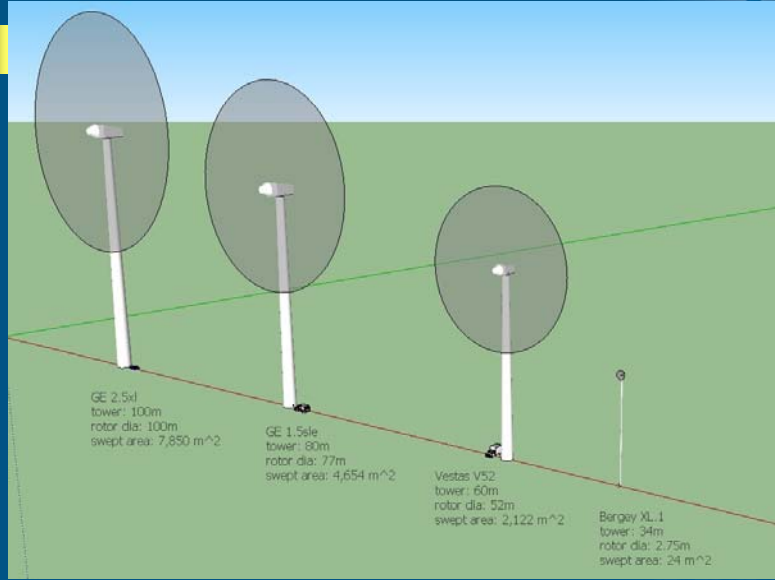
- Gearbox
 - Conventional
 - Direct Drive (no gearbox)
 - Hybrid
- Converter
 - Partial Converter
 - Full Converter



Recent History of Wind Technology



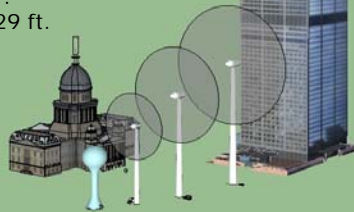
Wind Turbine Scale



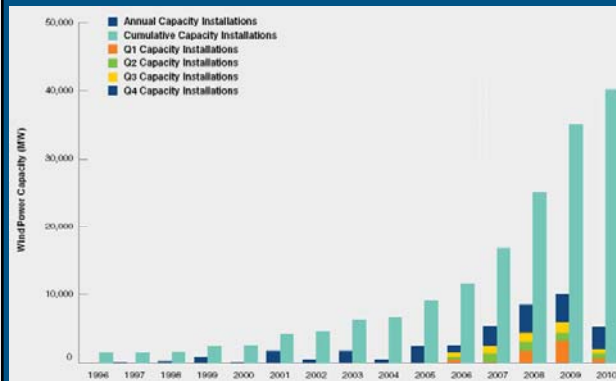
Wind Turbine Scale

Height:

- Avg. Water Tower: 130 ft
- V52, max blade arc: 280 ft
- Illinois capitol: 361 ft
- GE 1.5sle, max blade arc: 388 ft.
- GE 2.5xl, max blade arc: 492 ft.
- Willis Tower: 1,729 ft.



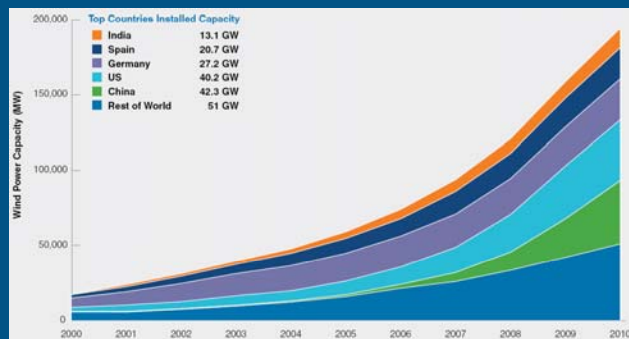
U.S. Annual and Cumulative Wind Power Capacity Growth (Utility-Scale Wind)



Source: AWEA U.S. Wind Industry Annual Market Report Year Ending 2010

- The wind industry installed 5,116 MW in the U.S. in 2010
- 15% growth in 2010
- Total U.S. wind installations stand at 40,181 MW
- Average annual growth for the past five years was 35%
- U.S. wind installations represent over 21% of global wind capacity

Global Wind Power Capacity Growth



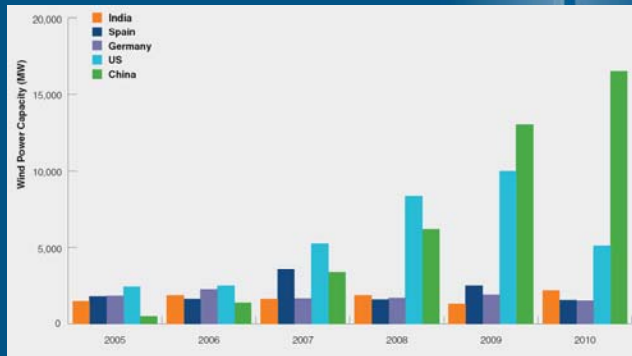
Source: AWEA U.S. Wind Industry Annual Market Report Year Ending 2010

- 35,800 MW installed globally in 2010, for a growth rate of 22.5%.
- Total Global Installations stand at 194,390 MW globally.
- China was the largest market for new installations with 16,500 MW installed in 2010; posting 20% growth.
- The European Union market remained roughly stable with 9,300 MW of new wind power installed in 2010.
- U.S. wind installations represent over 21% of global wind capacity.

Global Wind Power Capacity Installations for Top Countries

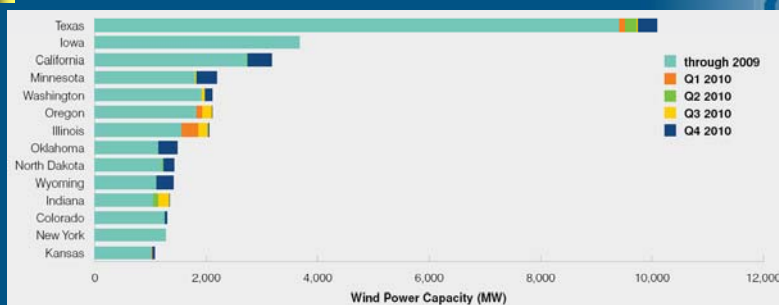
- The top 5 annual markets for new wind power capacity additions around the world in 2010, by country, were:

1. China: 16,500 MW
2. U.S.: 5,116 MW
3. India: 2,139 MW
4. Spain: 1,516 MW
5. Germany: 1,493 MW



Source: AWEA U.S. Wind Industry Annual Market Report Year Ending 2010

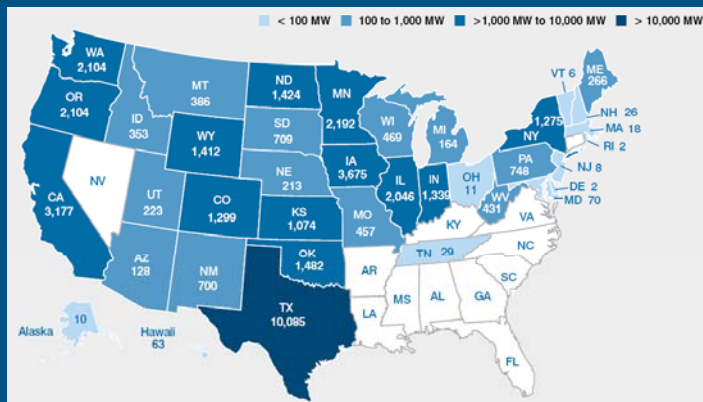
U.S. Wind Power Capacity Installations, Top States



Most Capacity Additions in 2010		Fastest Growing in 2010	
State	Capacity (MW)	State	Growth
Texas	680	Delaware & Maryland	First utility-scale project
Illinois	498	Idaho	140%
California	455	South Dakota	126%
South Dakota	396	Arizona	103%
Minnesota	396	Maine	52%

Source: AWEA U.S. Wind Industry Annual Market Report Year Ending 2010

U.S. Wind Power Capacity Installations by State in 2010 (MW)



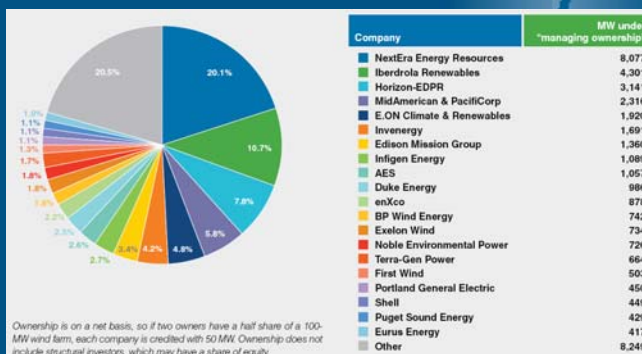
Source: AWEA U.S. Wind Industry Annual Market Report Year Ending 2010

- 38 states have utility-scale wind installations.

- 14 states have more than 1,000 MW installed.

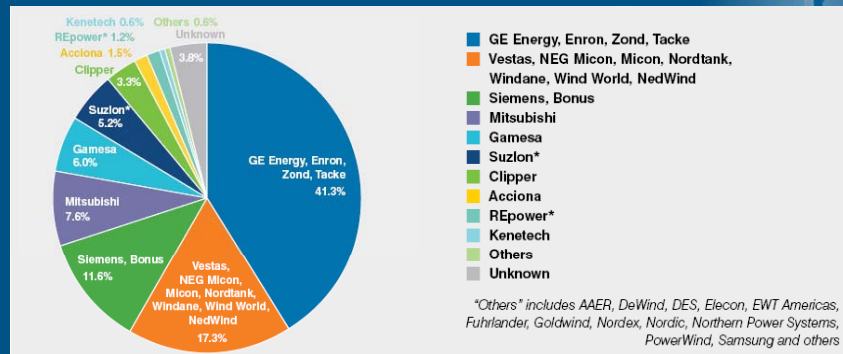
U.S. Top 20 Wind Power Capacity Owners in 2010

- The top 20 owners of U.S. wind project assets captured just over 49% of the 2010 capacity installations, consistent with 2009.
- 85% of 2010 project capacity was owned by Independent Power Producers (IPPs), and 15% was owned by utilities.
- Community wind, which has a component of local ownership, can be IPP, utility or other owners, and represented 5.6% of capacity installed in 2010.



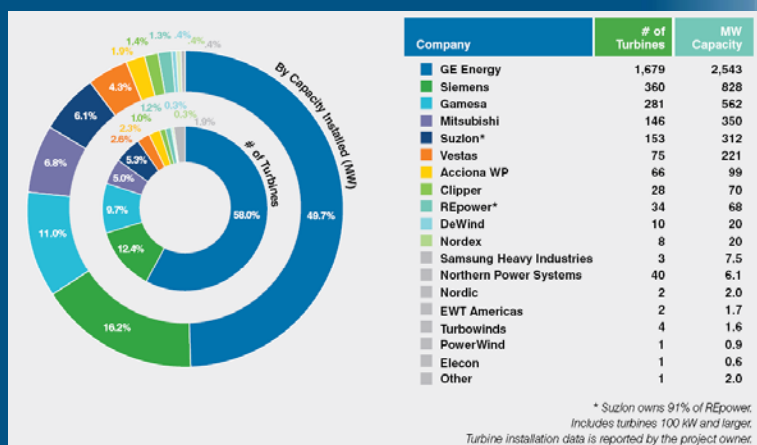
Source: AWEA U.S. Wind Industry Annual Market Report Year Ending 2010

Wind Turbine Manufacturers' Share of Total U.S. Wind Power Fleet



Source: AWEA U.S. Wind Industry Annual Market Report Year Ending 2010

Wind Turbine Manufacturers' Share of 2010 U.S. Wind Power Installations



Source: AWEA U.S. Wind Industry Annual Market Report Year Ending 2010

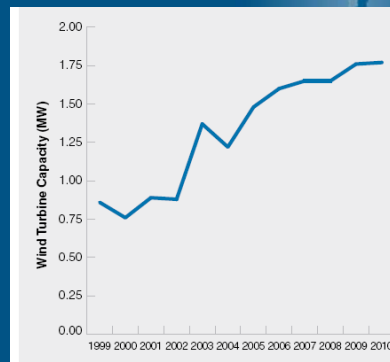
Wind Turbines Installed Each Year by Wind Turbine Manufacturer

2005	2006	2007	2008	2009	2010
GE Energy	GE Energy	GE Energy	GE Energy	GE Energy	GE Energy
Vestas	Siemens	Vestas	Vestas	Vestas	Siemens
Mitsubishi	Vestas	Siemens	Siemens	Siemens	Gamesa
Gamesa	Mitsubishi	Gamesa	Suzlon	Mitsubishi	Mitsubishi
Suzlon	Suzlon	Mitsubishi	Gamesa	Suzlon	Suzlon
	Gamesa	Suzlon	Mitsubishi	Clipper	Vestas
		Clipper	Clipper	Gamesa	Acciona WP
		Nordex	Acciona WP	REpower	Clipper
			REpower	Acciona WP	REpower
			Fuhrlander	Nordex	DeWind
			DeWind	DeWind	Nordex
			AWE	AAER	Samsung
			DES	Goldwind	Northern Power
			Northern Power	Northern Power	Nordic
				Fuhrlander	EWT Americas
					Turbowinds
					PowerWind
					Elecon

Source: AWEA U.S. Wind Industry Annual Market Report Year Ending 2010

U.S. Average Capacity of Installed Wind Turbines

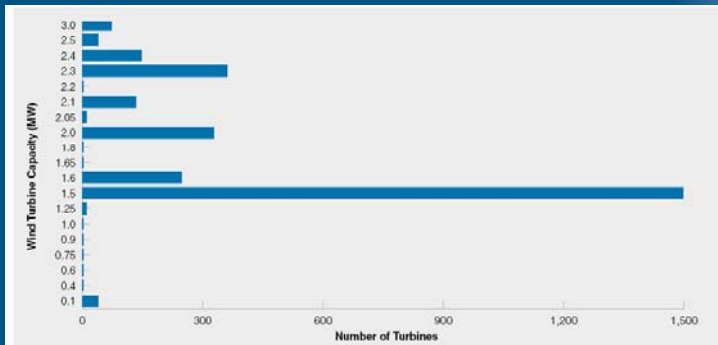
- In 2010, nearly 2,900 new turbines were installed bringing the total U.S. installation to over 35,600 wind turbines.
- The average size of turbines installed in 2010 was **1.77 MW**, up slightly from 1.75-MW in 2009.



Source: AWEA U.S. Wind Industry Annual Market Report Year Ending 2010

Distribution of Wind Turbines Installed in 2010 by Capacity

- In 2010, nearly 2,900 new turbine turbines were installed bringing the total U.S. installation to over 35,600 wind turbines.
- Turbines installed ranged from 100-kW to 3.0-MW, with the 1.5-MW platform remaining the most installed turbine size.



Source: AWEA U.S. Wind Industry Annual Market Report Year Ending 2010

Sizes and Material Use for Utility-Scale Wind Turbines Installed in 2010

- A typical turbine is roughly 90% steel and can weigh anywhere from 200 to 400 tons.
- Higher tower heights and larger rotor diameters have increased output of turbines.

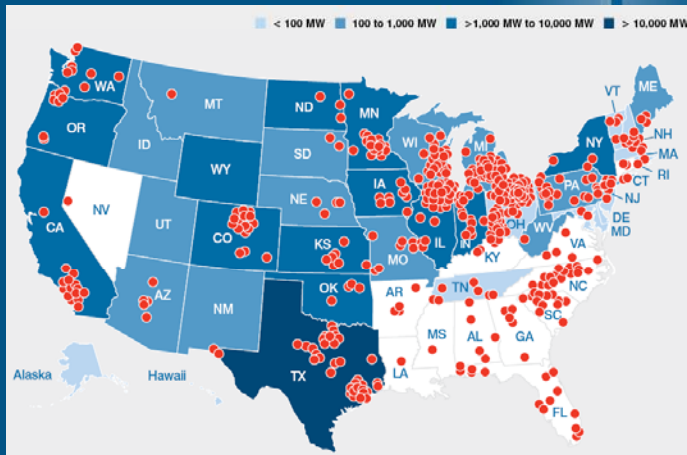
Component	% Weight	% Steel
Rotor		
Hub	6.0%	100%
Blades	7.2%	2%
Nacelle		
Gearbox	10.1%	96%
Generator	3.4%	65%
Frame	6.6%	85%
Tower	66.7%	98%

Capacity Range	1-3 MW
Tower height range	45 – 105 meters
Rotor diameter range	57 – 101 meters
Blade length range	26.8 – 49 meters

Source: AWEA U.S. Wind Industry Annual Market Report Year Ending 2010

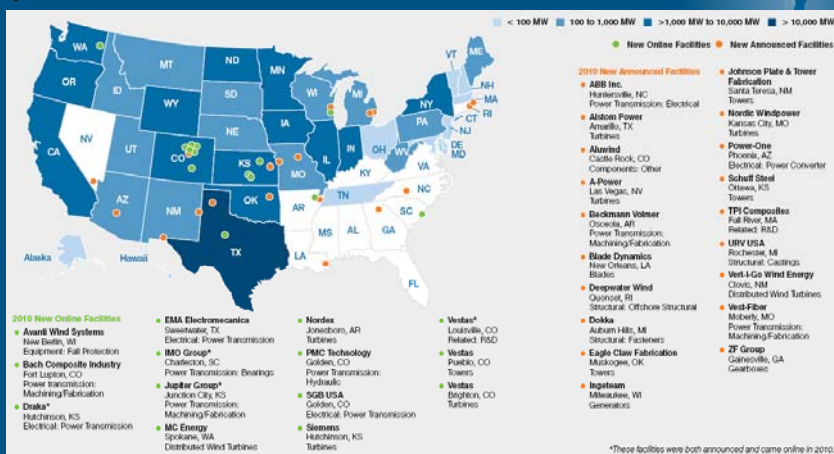
All Online Wind-Related Manufacturing Facilities

- At the end of 2010, there were over 400 manufacturing facilities online making wind-related products.
- The online facilities span 42 states



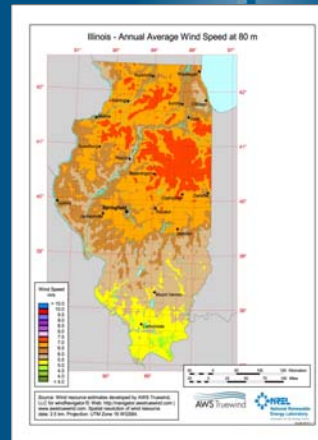
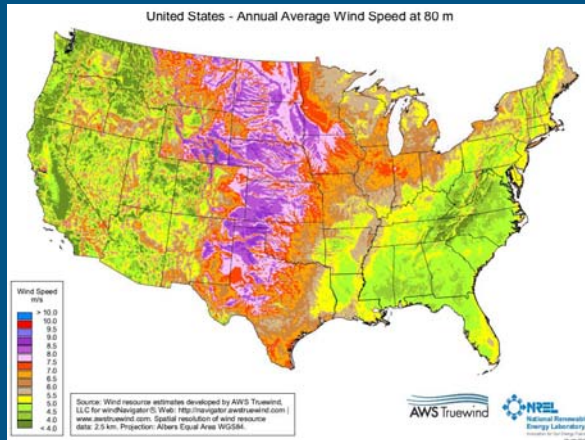
Source: AWEA U.S. Wind Industry Annual Market Report Year Ending 2010

Online & Announced Wind-Related Manufacturing Facilities in 2010



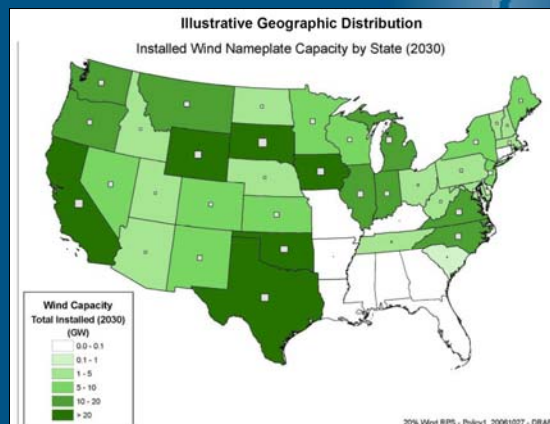
Source: AWEA U.S. Wind Industry Annual Market Report Year Ending 2010

Wind Resource Maps National Renewable Energy Laboratory

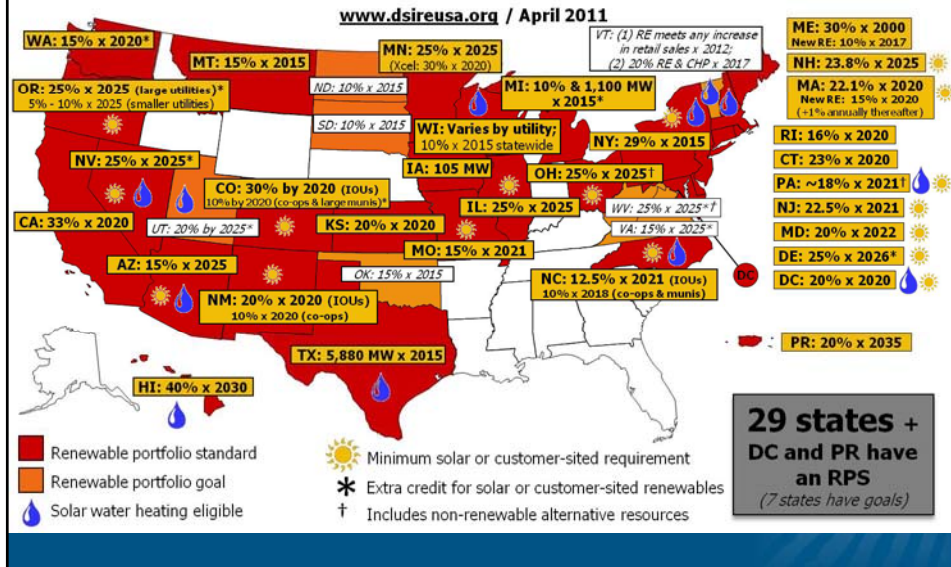


Wind Energy Potential 20% Plan from the U.S. DOE

- 20% of the nation's electrical needs can be provided by wind!



Renewable Portfolio Standards



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