

WIND ENERGY AND ENERGY CONVERSION FACILITY SITING

North Dakota Public Service Commission

www.psc.nd.gov

701-328-2400

Annette Bendish

Commissioners



Kevin Cramer



Tony Clark
Chairman

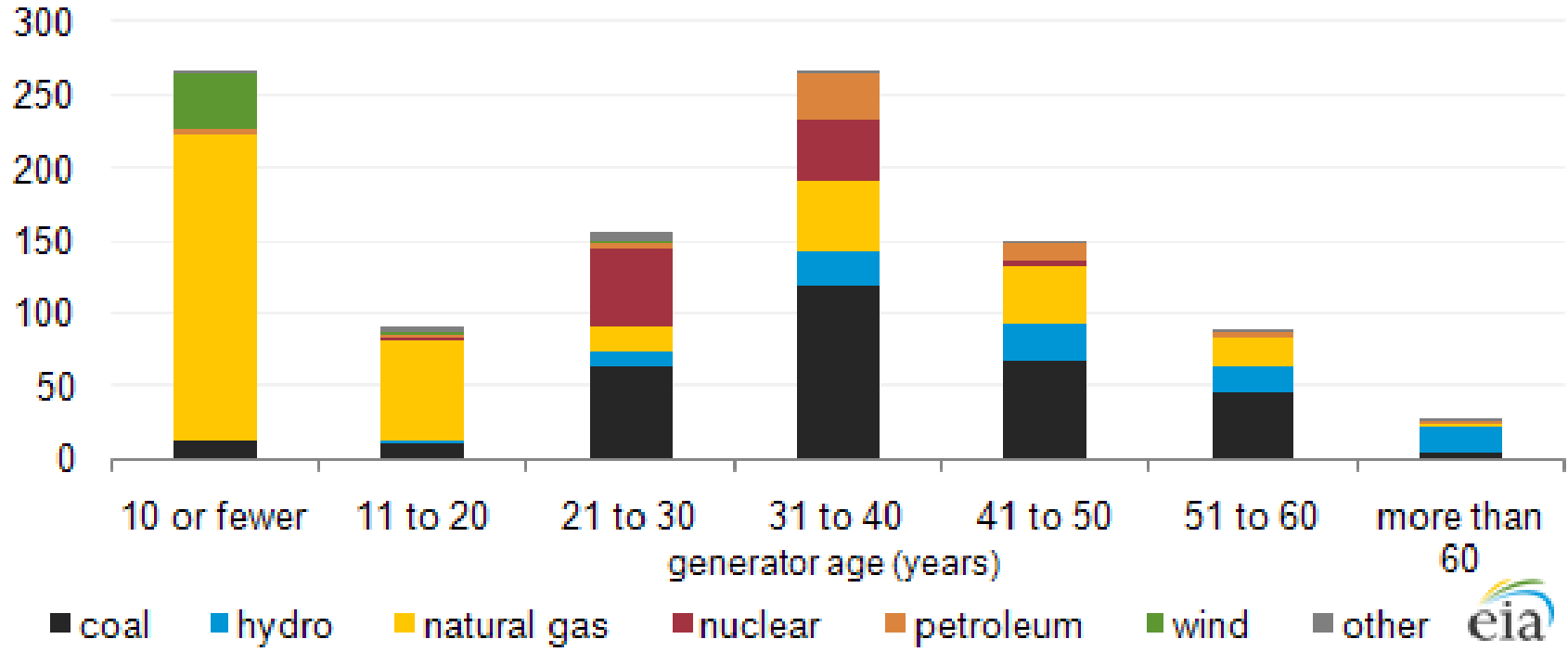


Brian P. Kalk



HOW OLD ARE US POWER PLANTS?

Age and capacity of existing electric generators by fuel type, as of year-end 2010
gigawatts

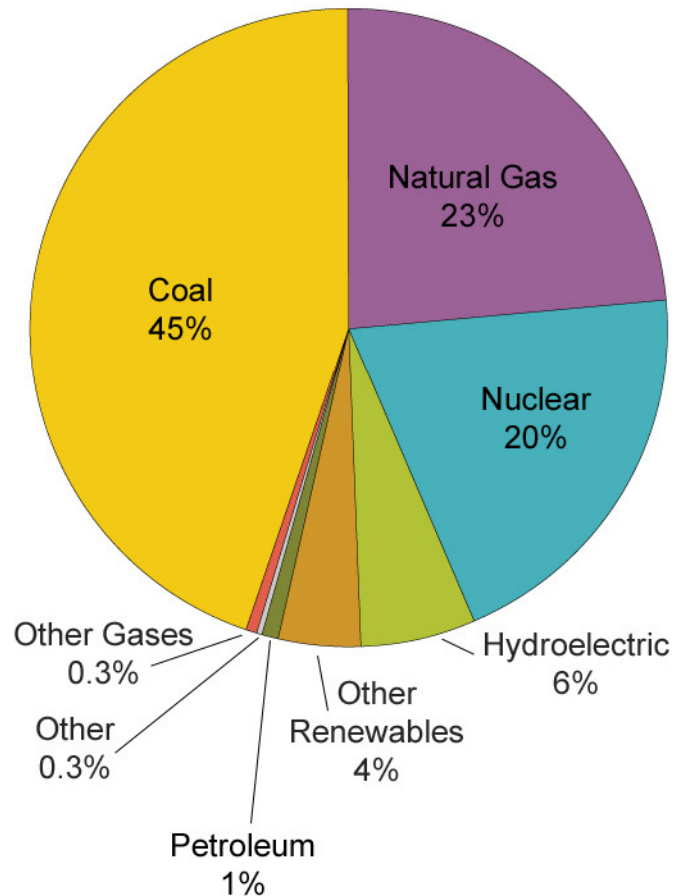


Source: http://www.eia.gov/todayinenergy/images/2011.06.16/vintage_cap_bar.png



FOSSIL FUELS GENERATE MOST US POWER

U.S. Net Electricity Generation by Fuel, 2010



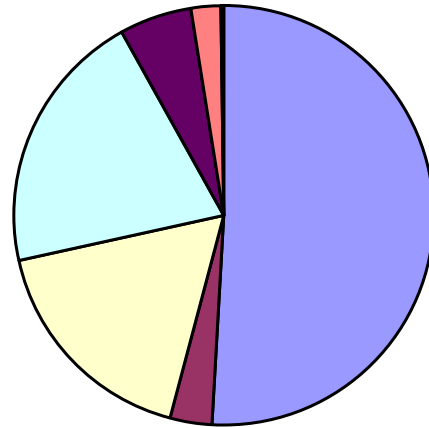
Source: U.S. Energy Information Administration, *Electric Power Monthly*, Table 1.1 (March 2011), preliminary data.

Source:
http://www.eia.gov/energyexplained/index.cfm?page=electricity_in_the_united_states

ANCIENT RESOURCE MEETS 21ST CENTURY



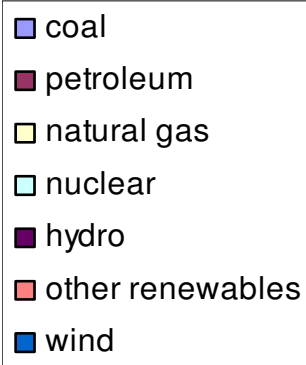
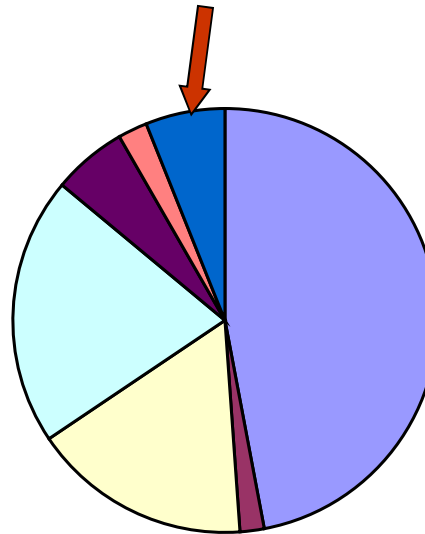
INCREASINGLY SIGNIFICANT POWER SOURCE



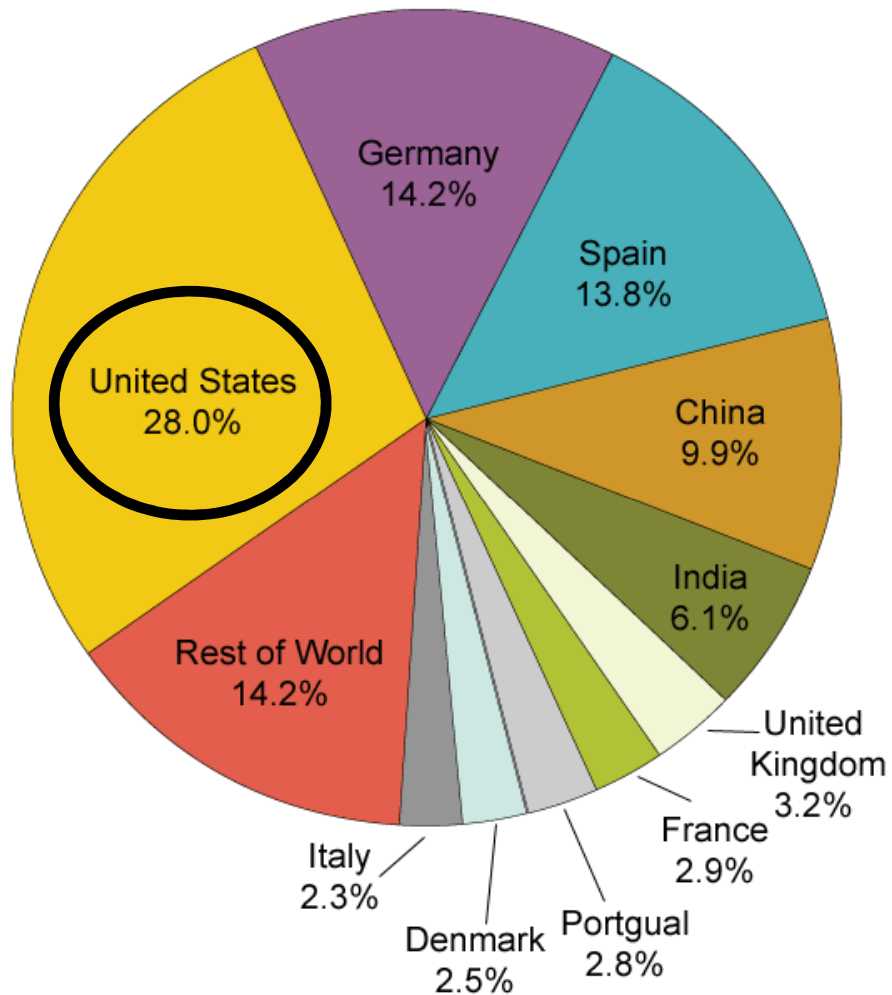
Wind currently produces less than 2% of the nation's power.

Source: Energy Information Agency

Wind could generate 6% of nation's electricity by 2020.



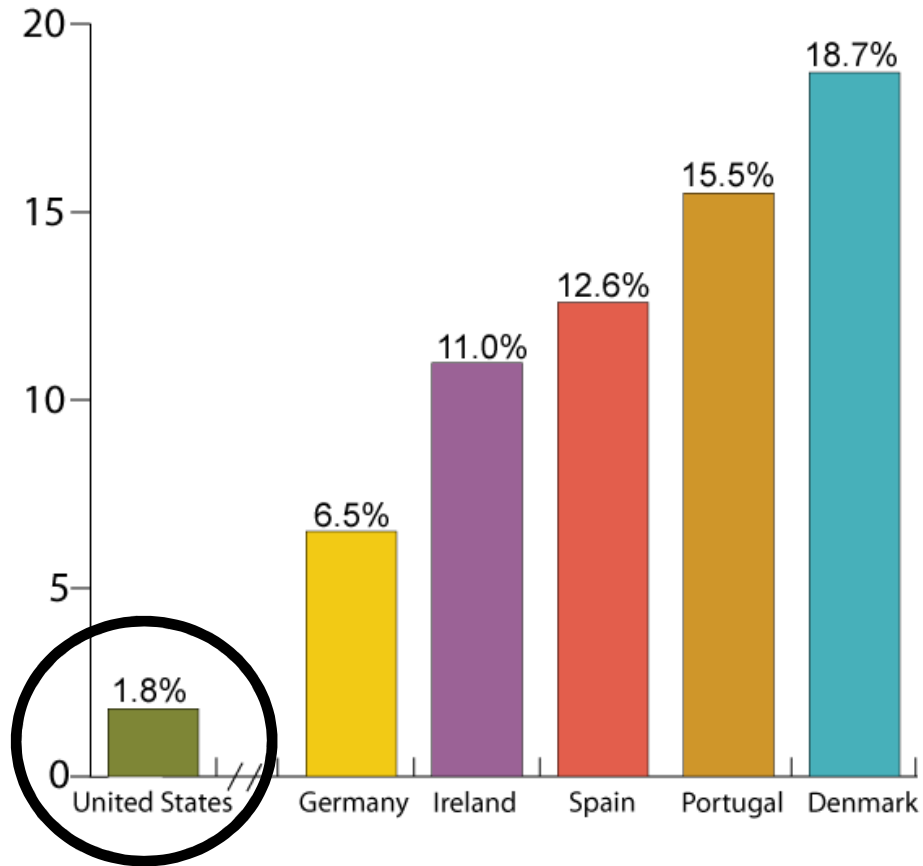
Contribution to Global Wind Generation in 2009



Source: U.S. Energy Information Administration, *International Energy Statistics*.

Share of Total Electricity Generation from Wind in 2009

Percentage of Total Electricity Generation



Source: U.S. Energy Information Administration, *International Energy Statistics*.

Note: The United States is shown for comparison purposes only. It does not have the 6th highest level of wind penetration.

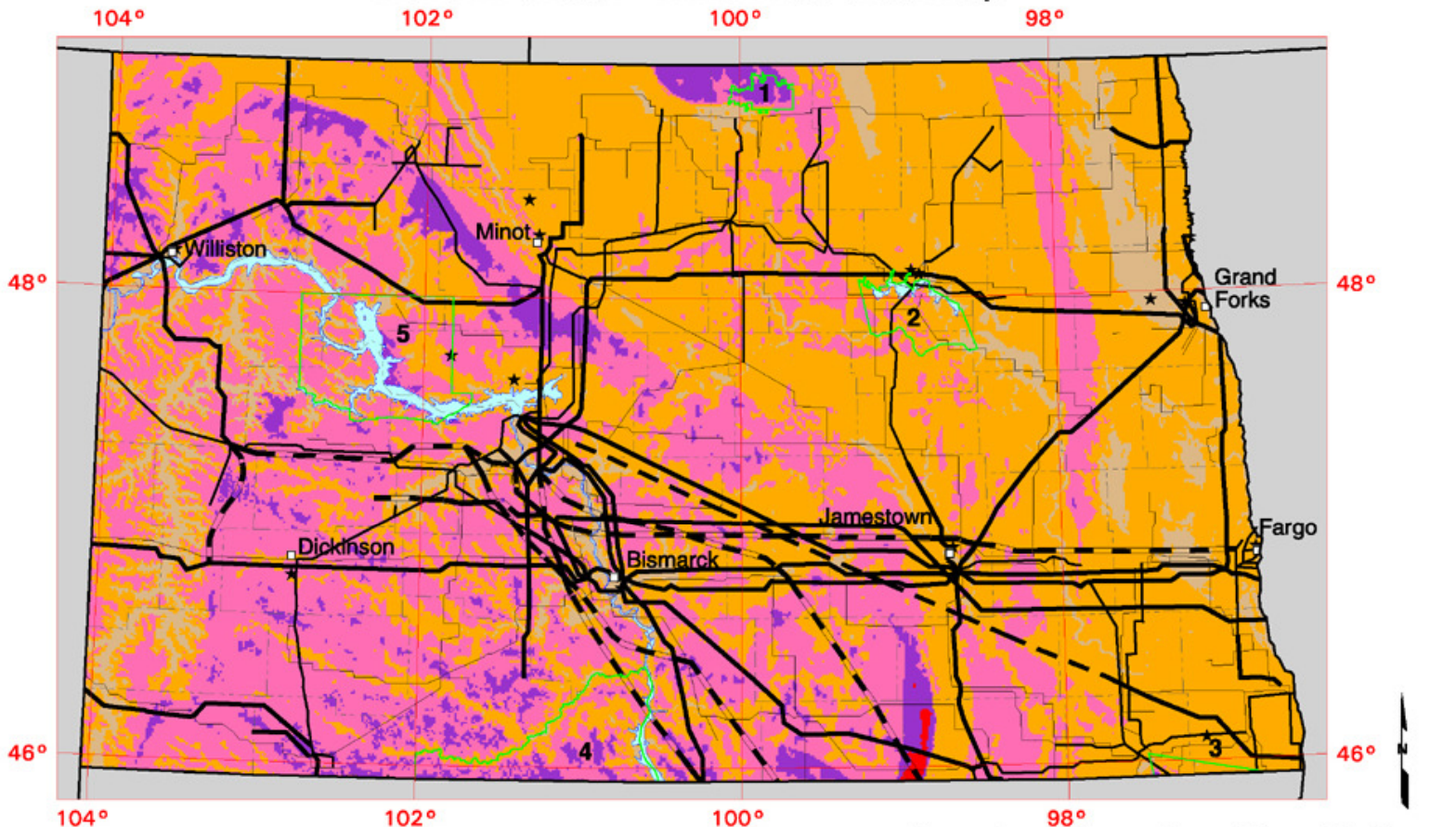
SITE SELECTION

- ⊙ Wind resource – minimum annual average wind speed of approximately 11 mph to 13 mph
- ⊙ Economics
 - ⊙ Available power purchaser or market
 - ⊙ Transmission availability
 - ⊙ Tax incentives
 - ⊙ Financing
- ⊙ Environmental



WHY NORTH DAKOTA?

North Dakota - Wind Resource Map



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
2	Marginal	200 - 300	5.6 - 6.4	12.5 - 14.3
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

^a Wind speeds are based on a Weibull k value of 2.0

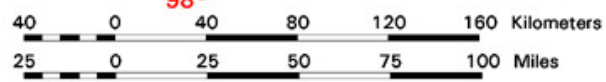
★ Meteorological Station with Wind Data
 □ City or Town

Transmission Line Voltage

- ~ 69 Kilovolts
- ~ 115 Kilovolts
- ~ 230 Kilovolts
- ~ 345 Kilovolts
- ~ Under Construction

Indian Reservations

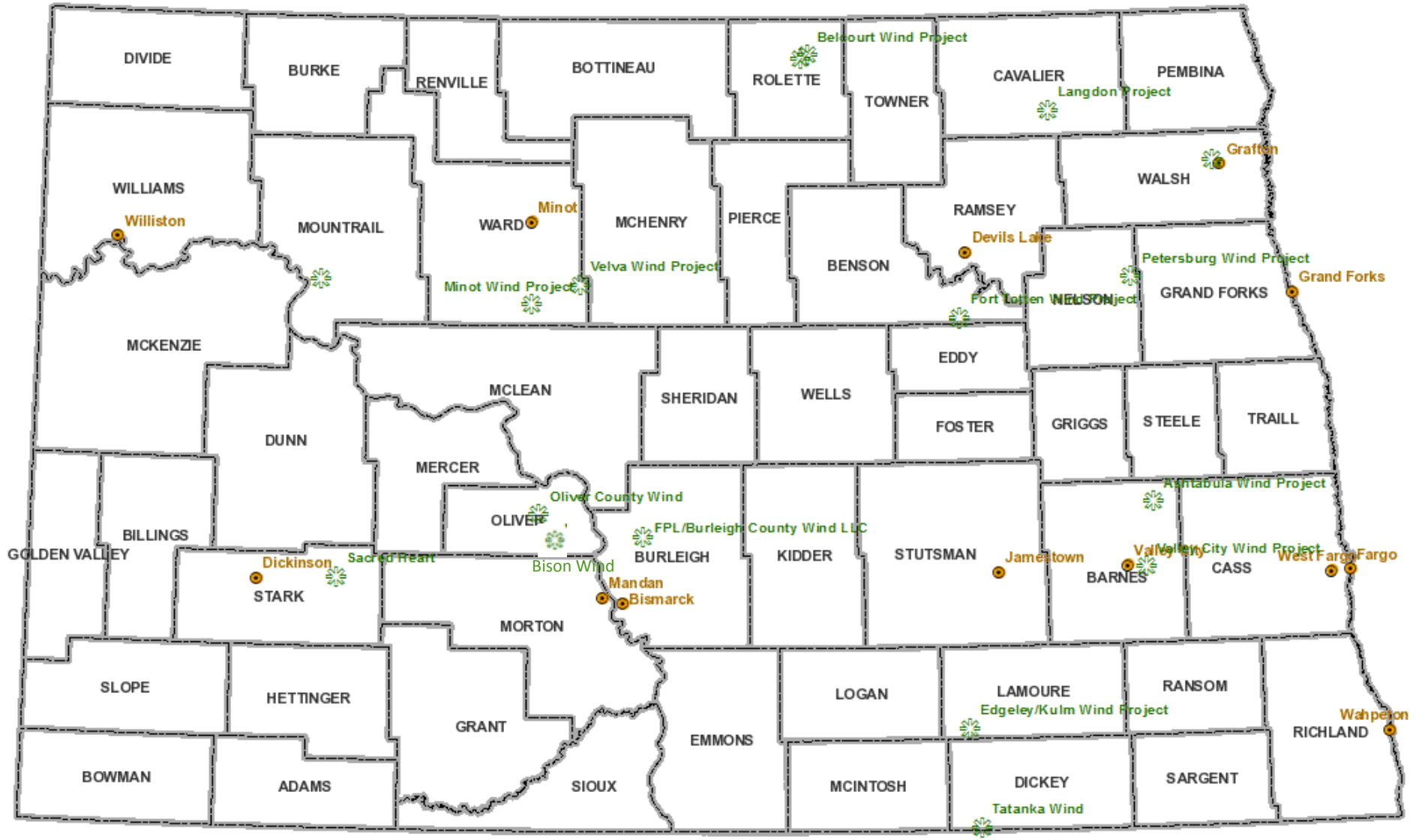
- 1 Turtle Mountain
- 2 Devil's Lake Sioux
- 3 Lake Traverse
- 4 Standing Rock
- 5 Fort Berthold



U.S. Department of Energy
 National Renewable Energy Laboratory



NORTH DAKOTA WIND FARMS CONSTRUCTED



WIND FARM LOCATIONS BY COUNTY

Letter of Intent or Application received by the PSC

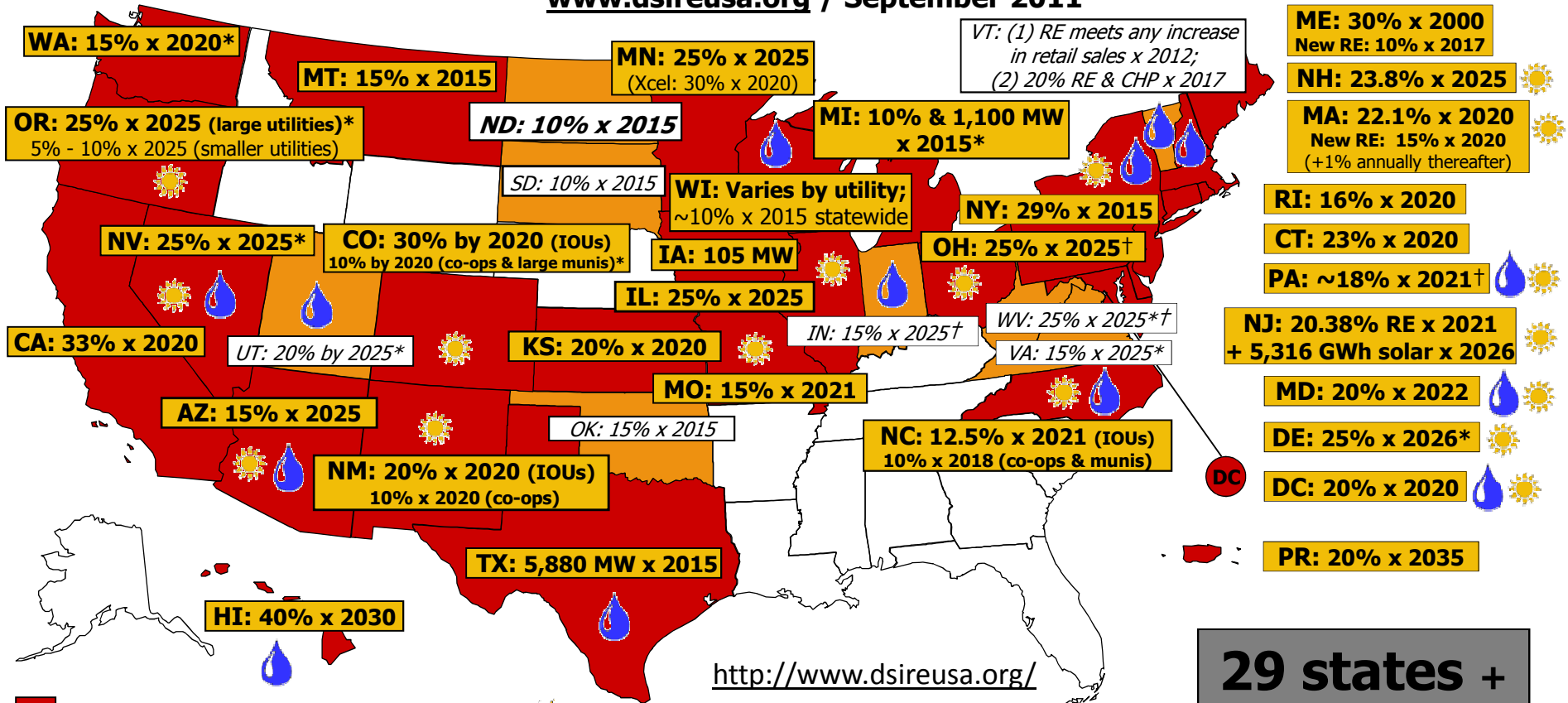
- ⊙ Adams and Bowman Counties 1
- ⊙ Adams County 1
- ⊙ Barnes County 2
- ⊙ Burleigh County 1
- ⊙ Cavalier County 2
- ⊙ Dickey County 1
- ⊙ Emmons County 1
- ⊙ Logan County 1
- ⊙ McIntosh and Dickey Counties 1
- ⊙ McIntosh County 1
- ⊙ Oliver and Morton Counties 3
- ⊙ Oliver County 1
- ⊙ Pierce County 1
- ⊙ Rolette and Towner Counties 1
- ⊙ Steele County 1
- ⊙ Ward County 1
- ⊙ Ward, Burke, and Mountrail Counties 1

VARIABLES IMPACTING DEVELOPMENT

- ⊙ Political
 - ⊙ Renewable mandates
 - ⊙ Regulatory restrictions
- ⊙ Economic
 - ⊙ Tax incentives

Renewable Portfolio Standard Policies

www.dsireusa.org / September 2011



<http://www.dsireusa.org/>

- Renewable portfolio standard
- Renewable portfolio goal
- 💧 Solar water heating eligible

- ☀️ Minimum solar or customer-sited requirement
- ✳️ Extra credit for solar or customer-sited renewables
- † Includes non-renewable alternative resources

29 states + DC and PR have an RPS
(8 states have goals)

DSIRE™

Database of State Incentives for Renewables & Efficiency

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

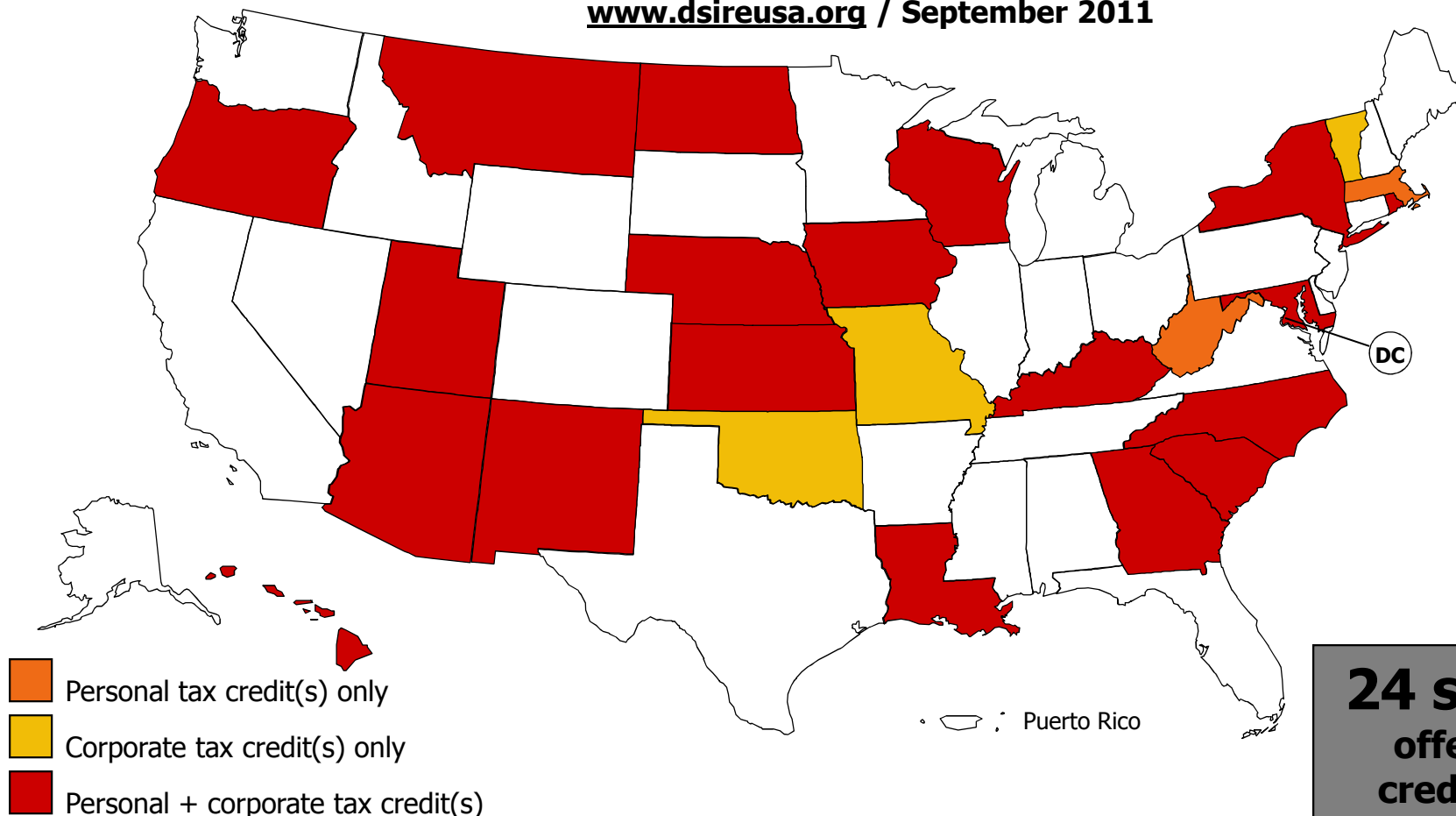
IREC
INTERSTATE RENEWABLE ENERGY COUNCIL



Tax Credits for Renewables

<http://www.dsireusa.org/>

www.dsireusa.org / September 2011



**24 states
offer tax
credits for
renewables**

Notes: This map does not include corporate or personal tax deductions or exemptions; or tax incentives for geothermal heat pumps.

DSIRE™

Database of State Incentives for Renewables & Efficiency

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

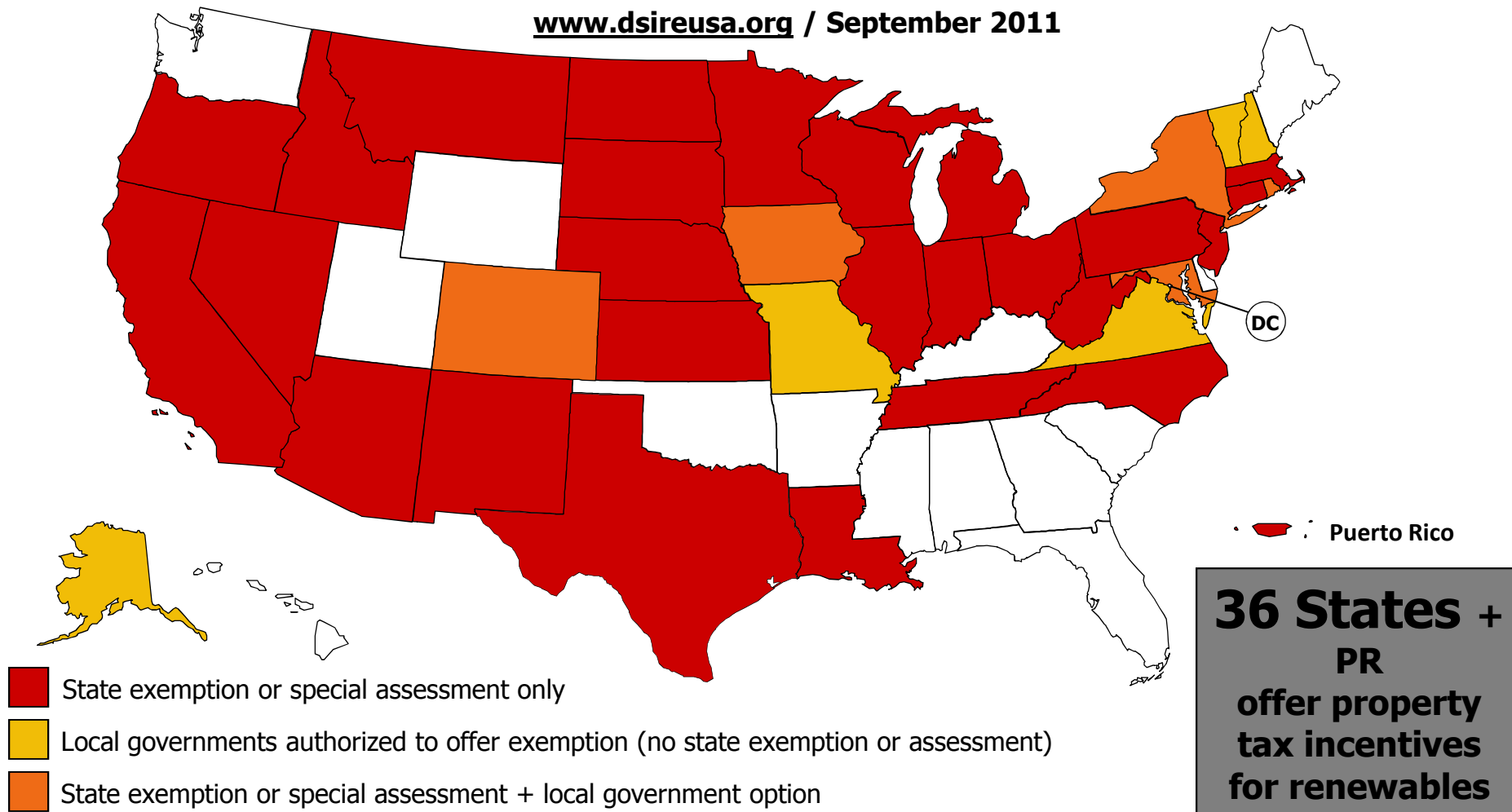
IREC
INTERSTATE RENEWABLE ENERGY COUNCIL



<http://www.dsireusa.org/>

Property Tax Incentives for Renewables

www.dsireusa.org / September 2011



DSIRE™

Database of State Incentives for Renewables & Efficiency

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

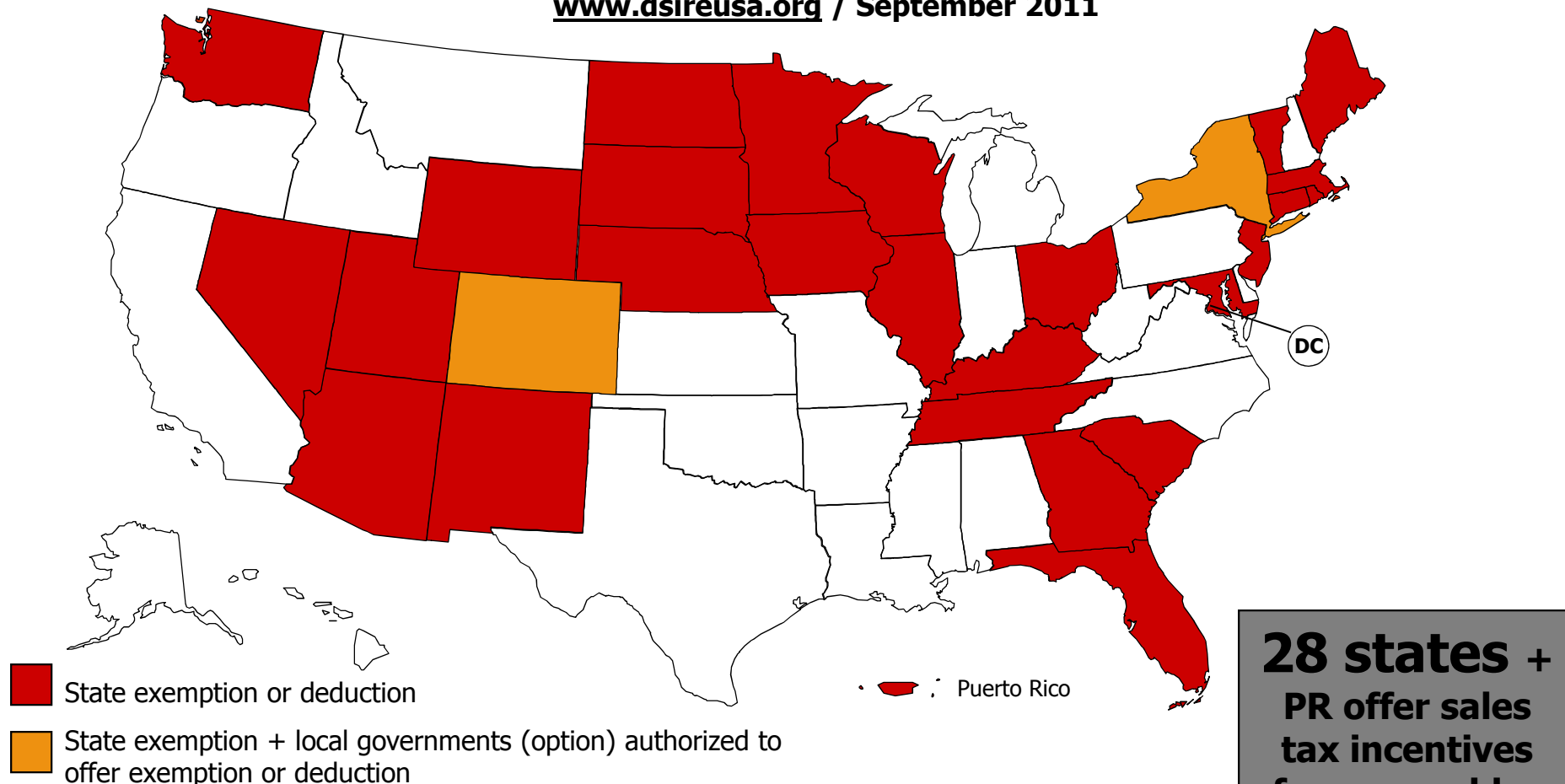
IREC
INTERSTATE RENEWABLE ENERGY COUNCIL



<http://www.dsireusa.org/>

Sales Tax Incentives for Renewables

www.dsireusa.org / September 2011



Notes: This map does not include sales tax incentives that apply only to geothermal heat pumps or other energy efficiency technologies.

REGULATORY ISSUES

- ⊙ State level – Public Service Commission
 - ⊙ Wind farm is an energy conversion facility
 - ⊙ PSC has jurisdiction over wind energy conversion facilities of .5 MW or greater
 - ⊙ PSC jurisdiction does not preempt local land use and zoning rules

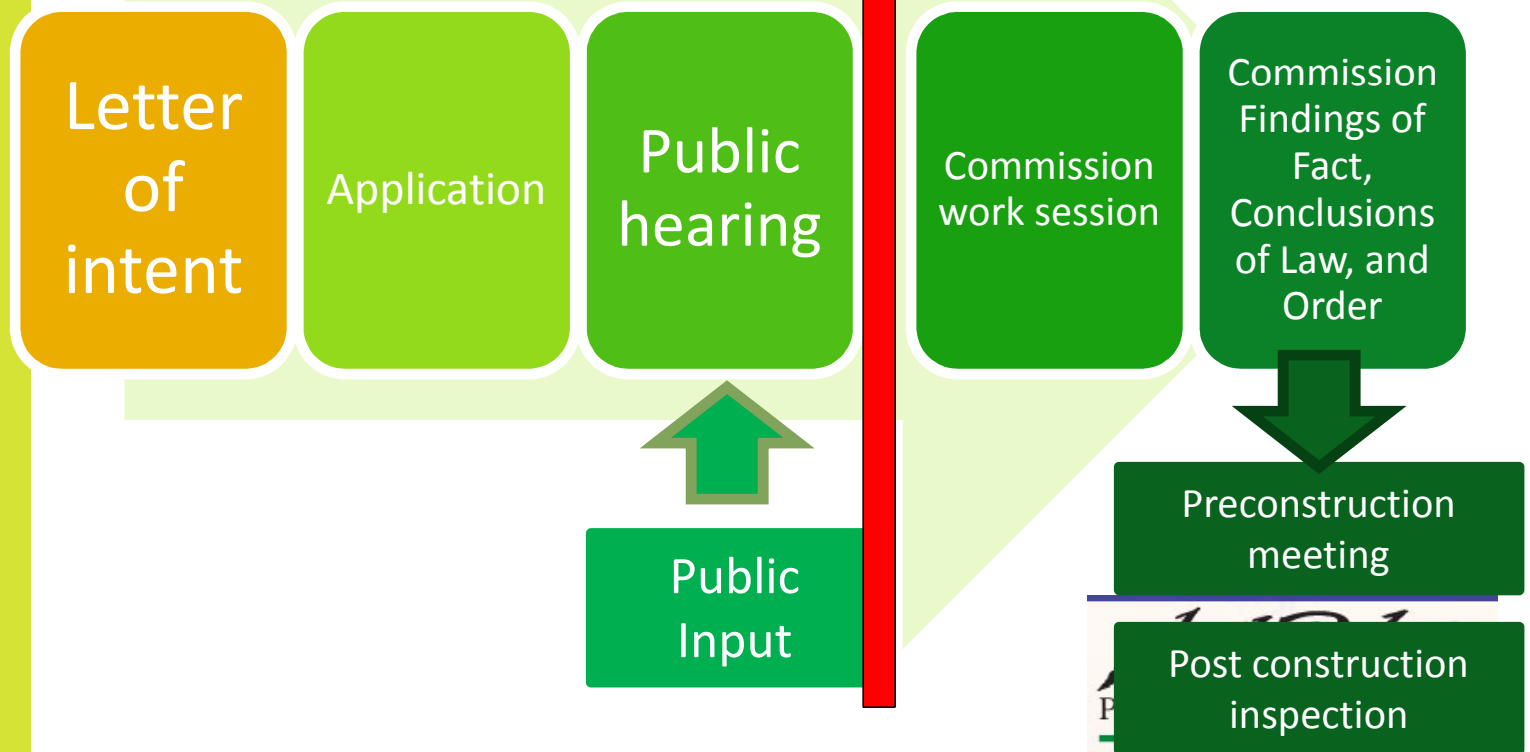
WHAT DOES THE PUBLIC SERVICE COMMISSION DO?

- ⊙ Authority – Energy Conversion and Transmission Facility Siting Act – North Dakota Century Code chapter 49-22
- ⊙ Rules – North Dakota Administrative Code Chapter 69-06

WHAT DOESN'T THE PUBLIC SERVICE COMMISSION DO?

- ⊙ Leasing
- ⊙ Costs
- ⊙ Wind rights
- ⊙ Site Meteorological (MET) Towers
- ⊙ Legal advice

STATE REGULATORY PROCESS FOR SITING

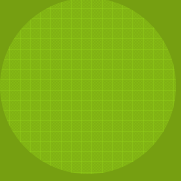


AVERAGE TIME FOR PROCESSING APPLICATIONS

- ⊙ From date application is deemed complete to date order is issued:
 - ⊙ Wind – 110 days
 - Gas plants – 57 days
 - Pipelines – 78 days
 - Transmission – 83 days

ADDITIONAL ISSUES ADDRESSED BY THE COMMISSION AT HEARING AND IN ITS ORDERS

- ⊙ Setbacks
 - ⊙ Occupied residences and other buildings
 - ⊙ Roads
 - ⊙ Existing transmission lines
 - ⊙ Railroads
 - ⊙ Property boundaries
 - ⊙ Others
- ⊙ Aviation issues
 - ⊙ Radar
 - ⊙ Crop spraying
- ⊙ Noise
- ⊙ Shadow Flicker



MAJOR FEDERAL LAWS APPLICABLE TO WIND PROJECTS

- ⊙ Endangered Species Act
- ⊙ Migratory Bird Treaty Act
- ⊙ Bald and Golden Eagle Protection Act
- ⊙ Clean Water Act
- ⊙ National Wildlife Refuge System Improvement Act
- ⊙ National Environmental Policy Act
- ⊙ National Historic Preservation Act

MANY OF THESE ARE TRIGGERED BY FEDERAL NEXUS...

- ⦿ Examples:
 - ⦿ Federal funding or loans
 - ⦿ Interconnection to Federal transmission system
 - ⦿ Use of Federal lands

FEDERAL REGULATORY REQUIREMENTS

- ⊙ National Environmental Policy Act Environmental Assessment
- ⊙ United States Fish and Wildlife Service – Biological opinion
- ⊙ Federal Aviation Administration – notice of proposed construction and approval
- ⊙ Other Federal agency input
 - ⊙ National Park Service, Natural Resource Conservation Service, EPA, US Army Corps of Engineers

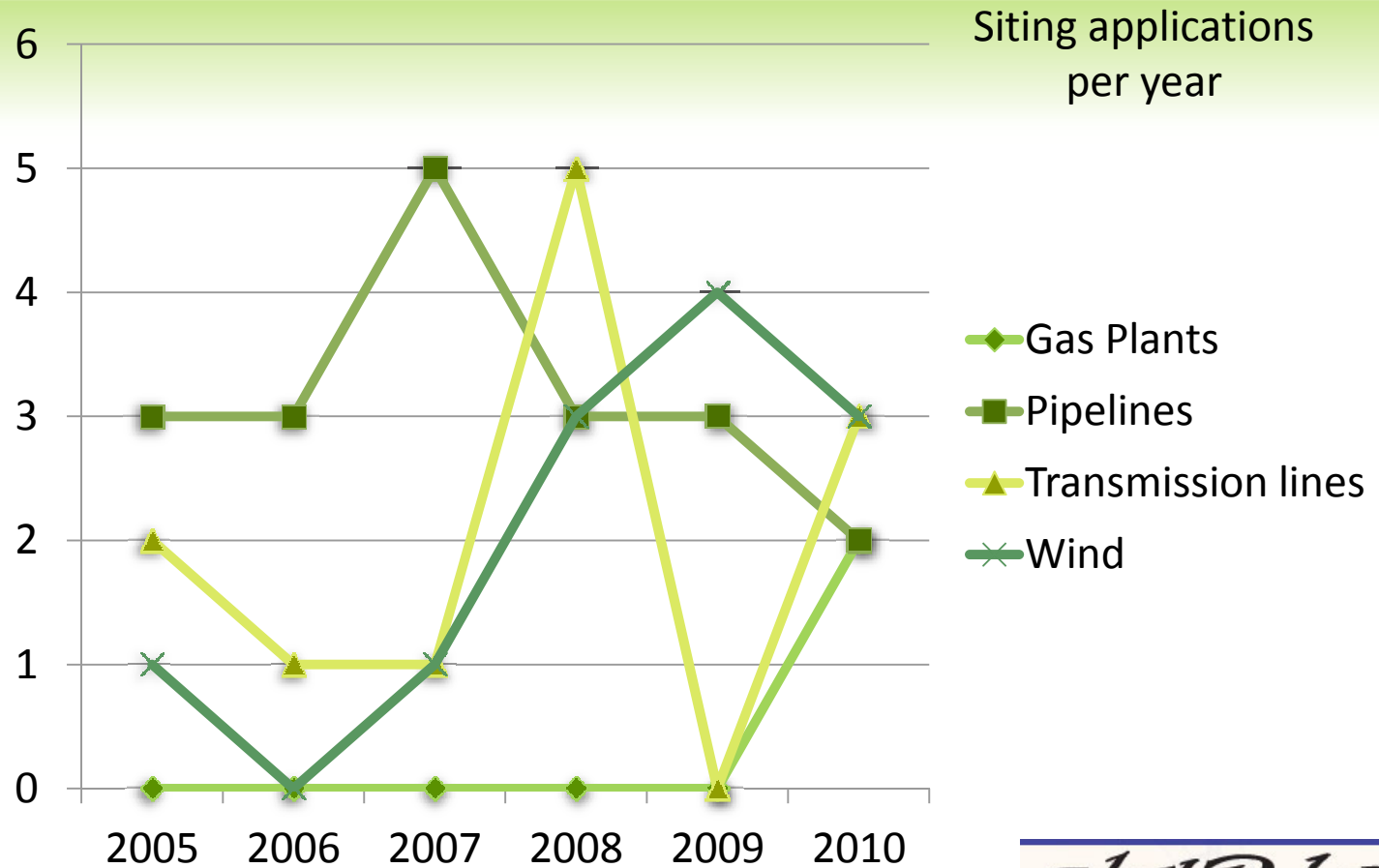
LOCAL REGULATORY REQUIREMENTS . . .

- ⊙ Zoning restrictions
- ⊙ Use permits
- ⊙ Building permits

ADDITIONAL STATE REGULATORY REQUIREMENTS AND PERMITS

- ⊙ Department of Transportation – road and utility permits
(construction phase)
- ⊙ Highway Patrol – height and weight permits (construction phase)
- ⊙ Department of Health – storm water pollution prevention plan
- ⊙ Game and Fish
- ⊙ Historical Society
- ⊙ Geological Survey
- ⊙ Parks and Recreation
- ⊙ Department of Agriculture
- ⊙ Land Department
- ⊙ Others

HOW HAS THE PSC BEEN IMPACTED BY THE SURGE IN ENERGY DEVELOPMENT?



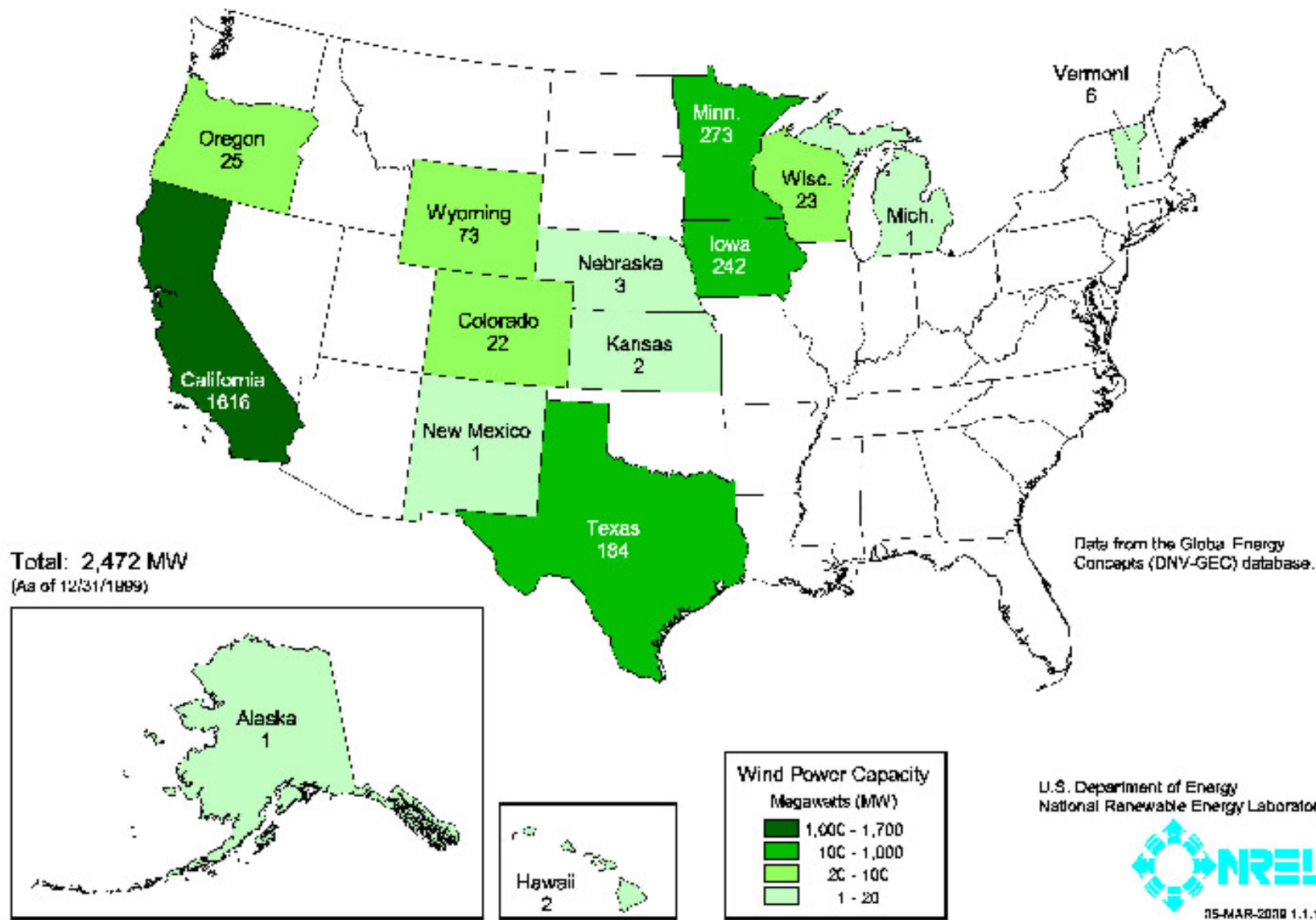
WIND IN NORTH DAKOTA

- ⊙ The first wind farm was sited by the Commission in October 2005 near Rugby
 - ⊙ Construction began in 2008, completed 2009
 - ⊙ PPM Energy, Inc (now Iberdrola Renewables, Inc.)
 - ⊙ 71 Suzlon 2.1-MW S88 turbines, totaling 149.1 MW (originally 100 GE 1.5 MW turbines totaling 150 MW)

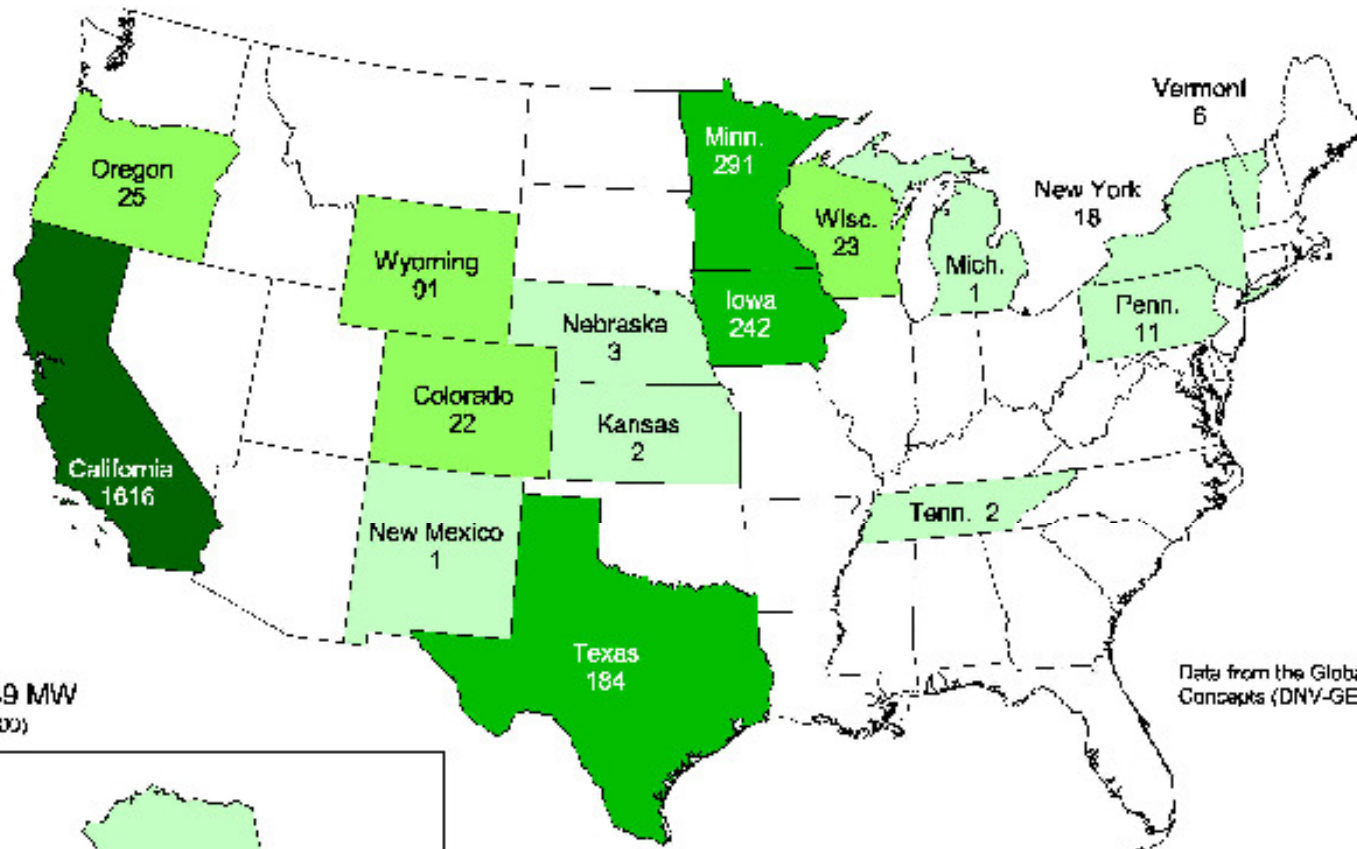
WIND IN NORTH DAKOTA

- ⊙ As of October 17, the Commission has letters of intent or has granted certificates for 7268.5 MW of wind
- ⊙ Total estimated investment of \$13,179,250,000
- ⊙ Total estimated investment of completed projects \$5,860,931,000

1999 Year End Wind Power Capacity (MW)

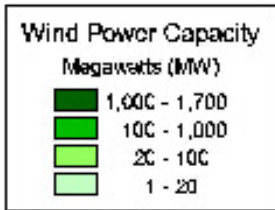
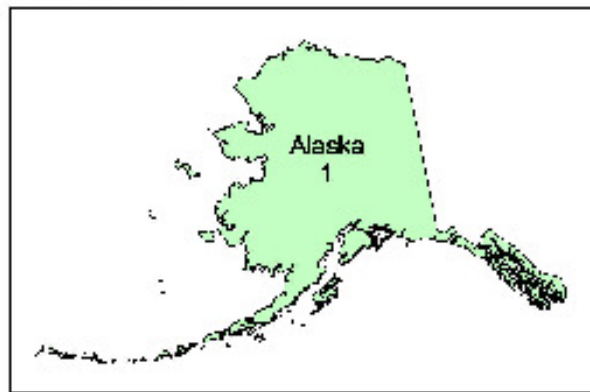


2000 Year End Wind Power Capacity (MW)



Total: 2,539 MW
(As of 12/31/2000)

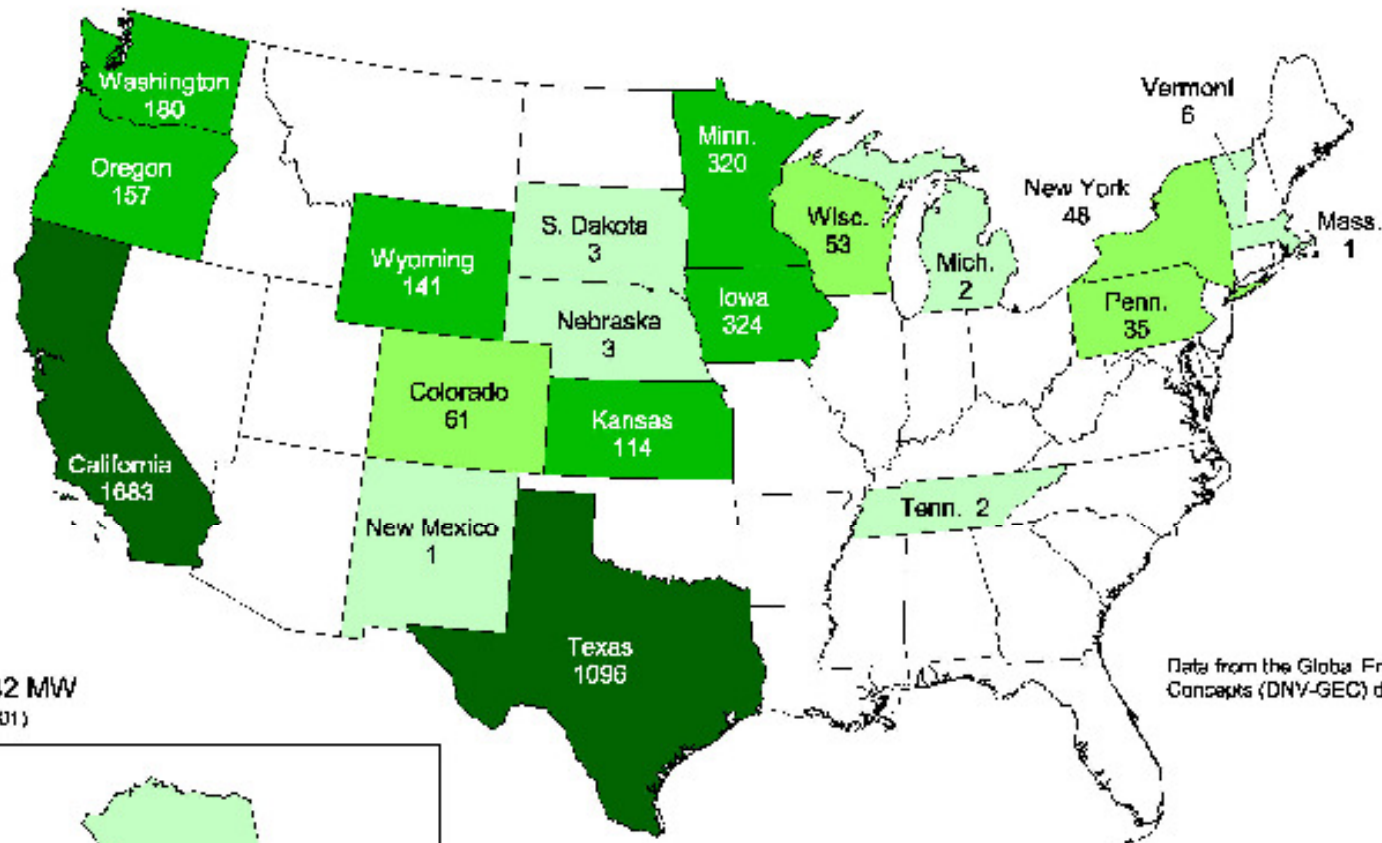
Data from the Global Energy Concepts (DNY-GEC) database.



U.S. Department of Energy
National Renewable Energy Laboratory

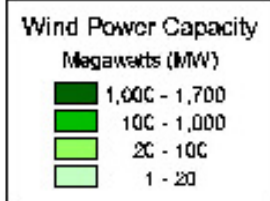
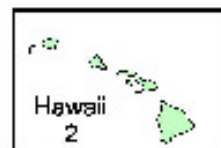


2001 Year End Wind Power Capacity (MW)



Total: 4,232 MW
(As of 12/31/2001)

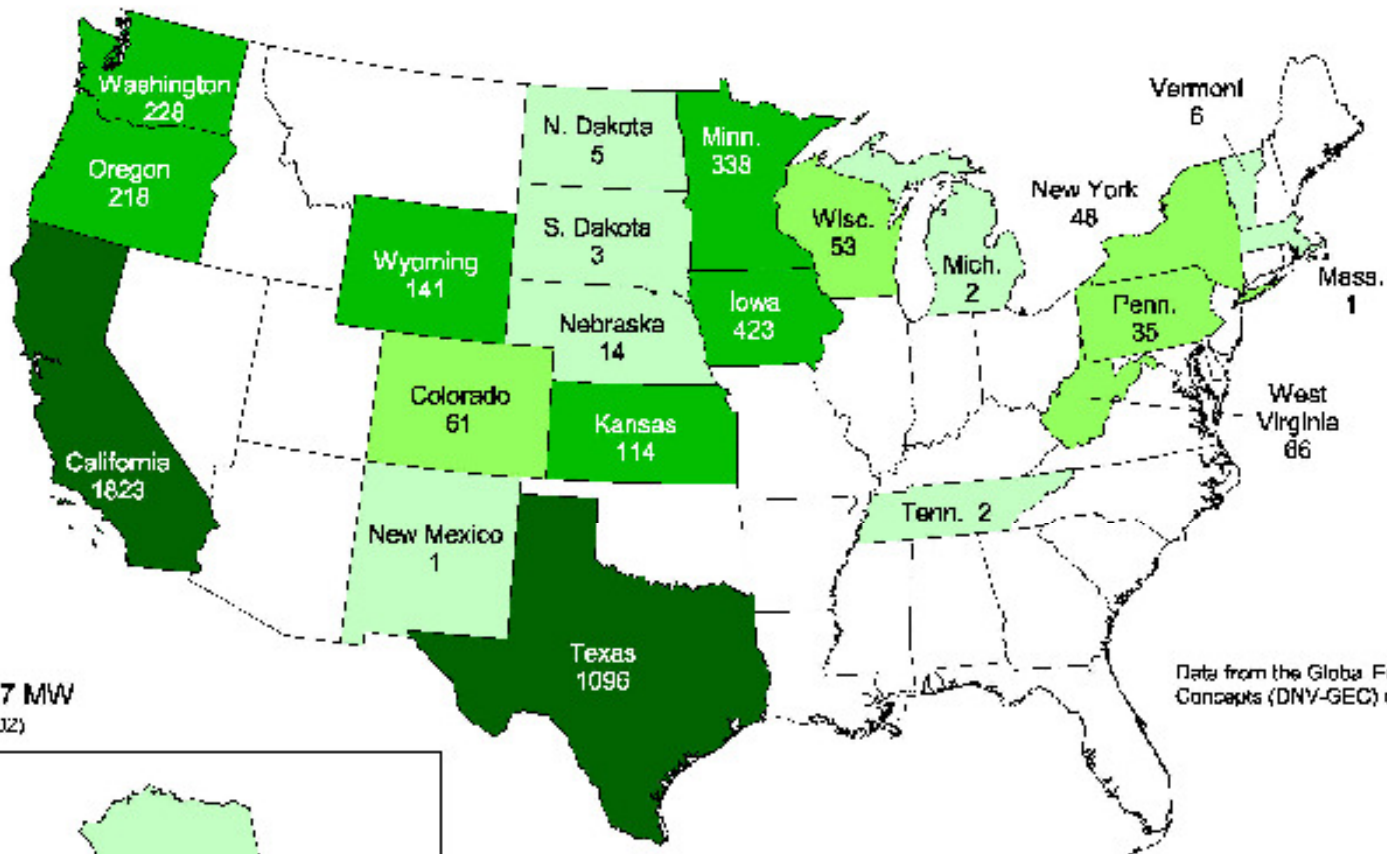
Data from the Global Energy Concepts (DNY-GEC) database.



U.S. Department of Energy
National Renewable Energy Laboratory



2002 Year End Wind Power Capacity (MW)



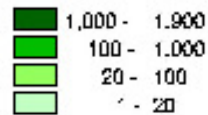
Total: 4,687 MW
(As of 12/31/2002)

Data from the Global Energy Concepts (DNY-GEC) database.



Wind Power Capacity

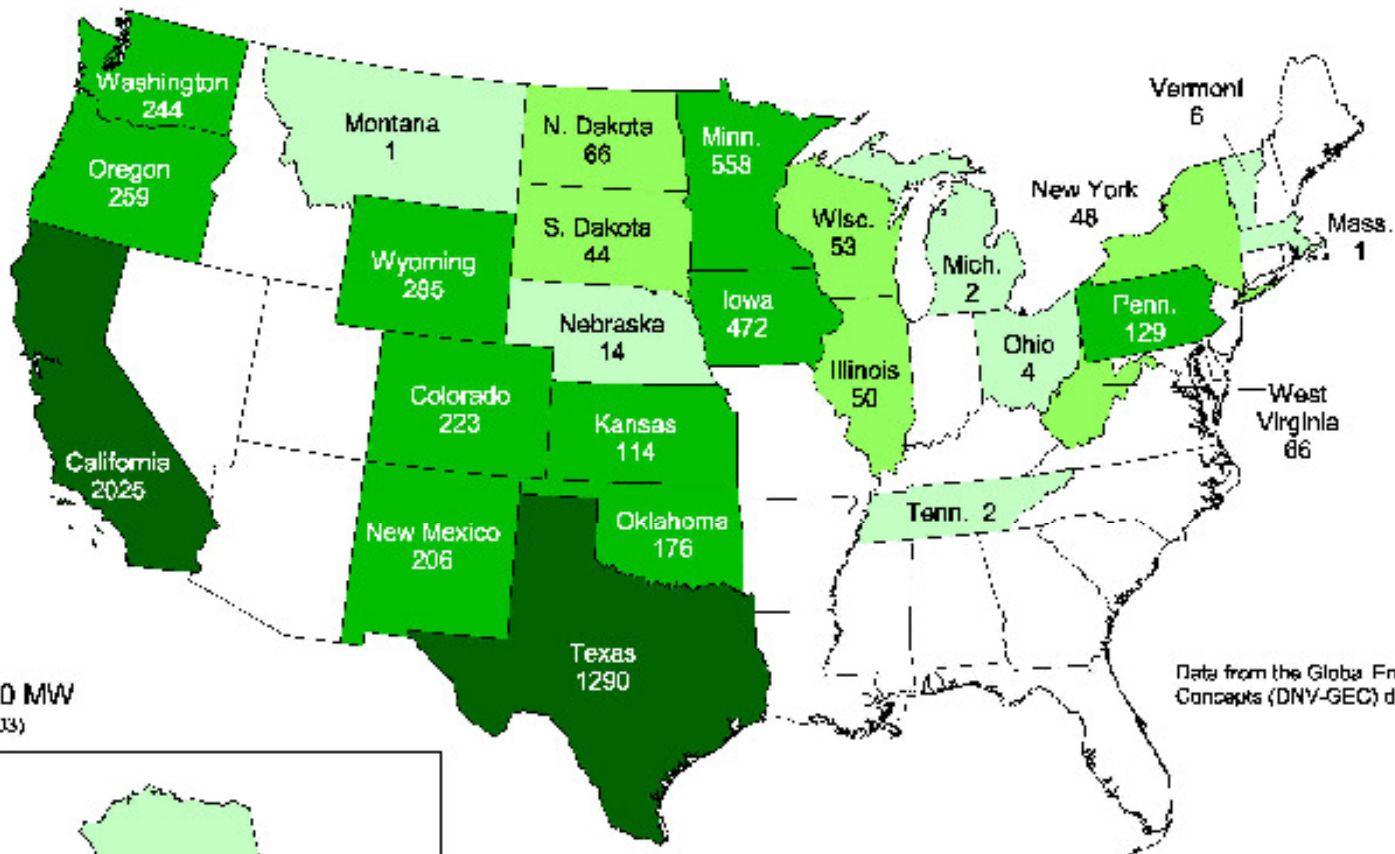
Megawatts (MW)



U.S. Department of Energy
National Renewable Energy Laboratory

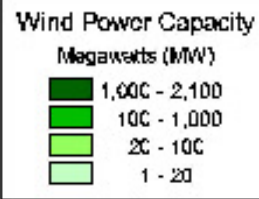


2003 Year End Wind Power Capacity (MW)



Total: 6,350 MW
(As of 12/31/2003)

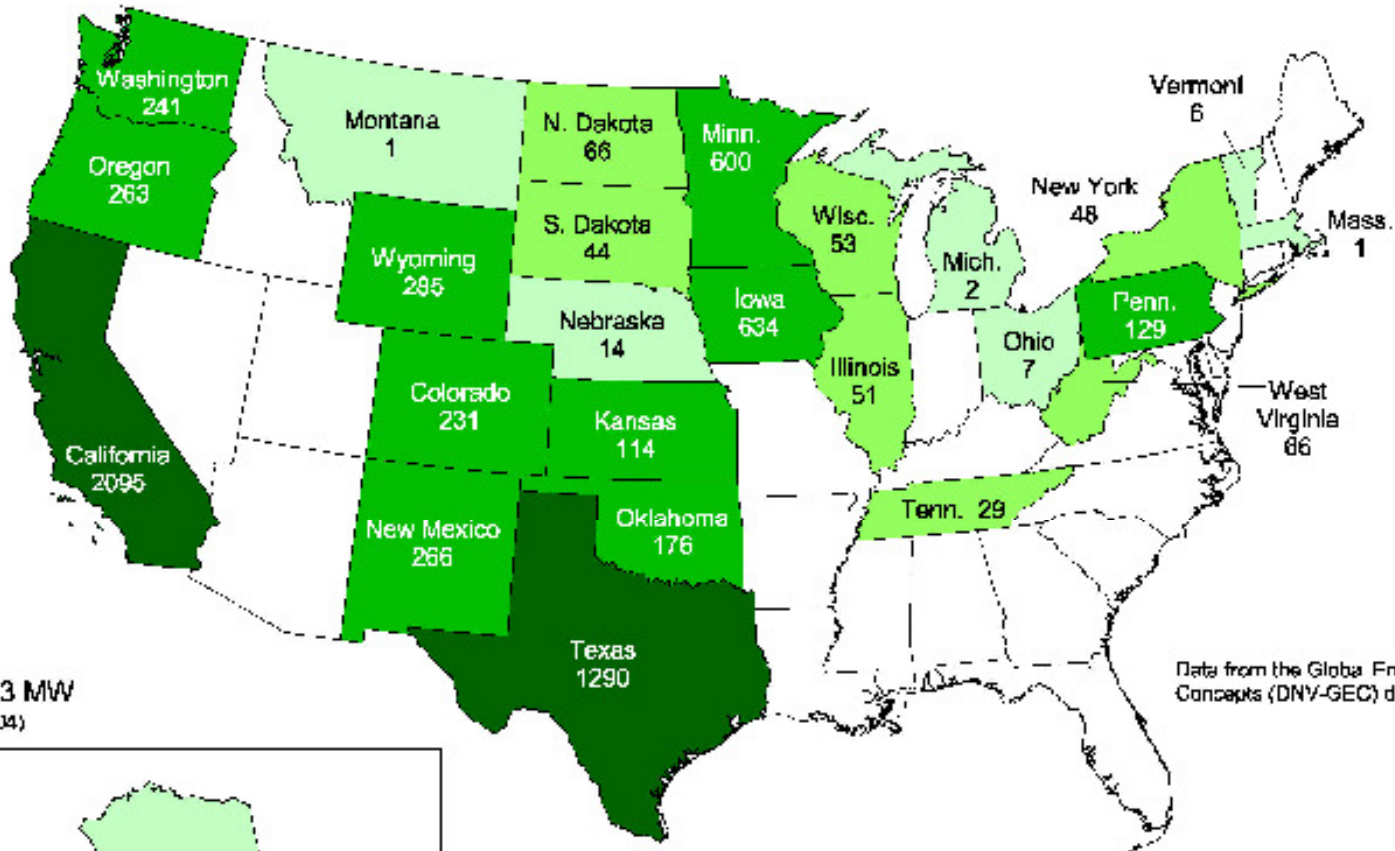
Data from the Global Energy Concepts (DNY-GEC) database.



U.S. Department of Energy
National Renewable Energy Laboratory

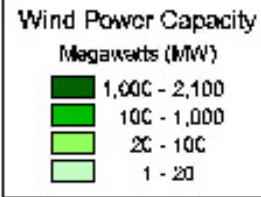


2004 Year End Wind Power Capacity (MW)



Total: 6,723 MW
(As of 12/31/2004)

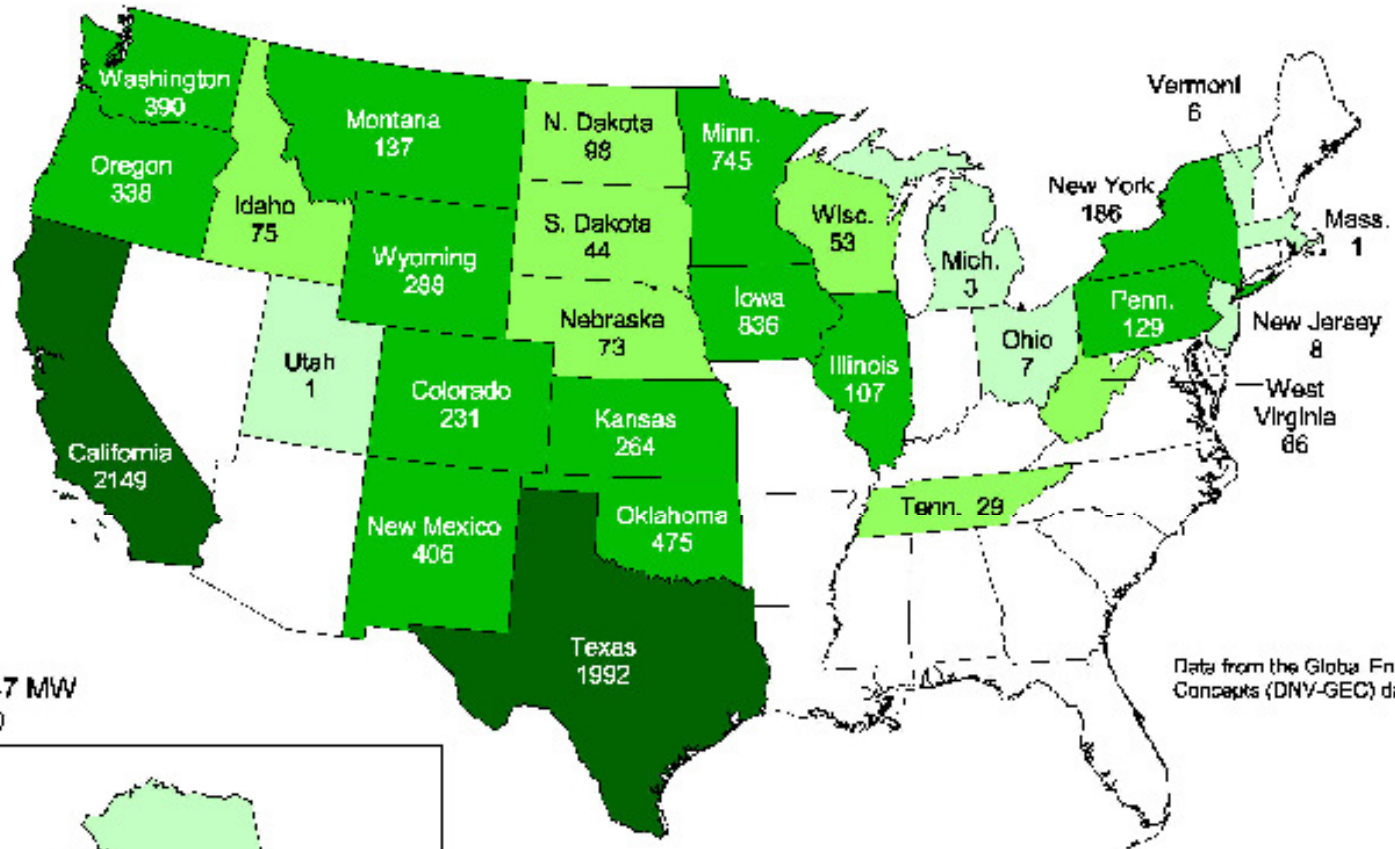
Data from the Global Energy Concepts (DNY-GEC) database.



U.S. Department of Energy
National Renewable Energy Laboratory

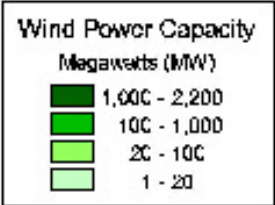


2005 Year End Wind Power Capacity (MW)



Total: 9,147 MW
(As of 12/31/05)

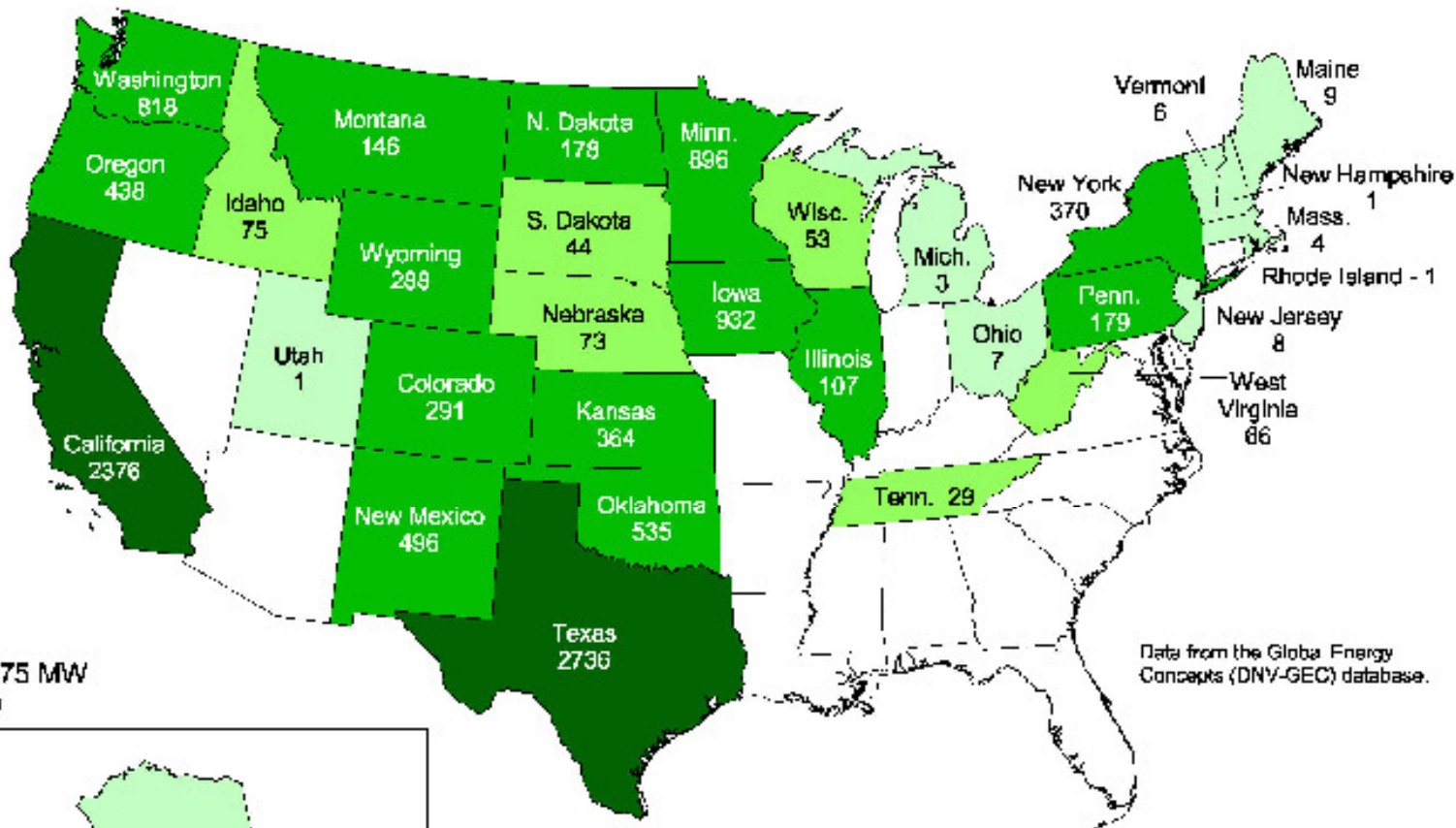
Data from the Global Energy Concepts (DNY-GEC) database.



U.S. Department of Energy
National Renewable Energy Laboratory

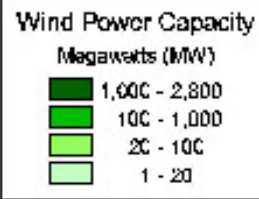
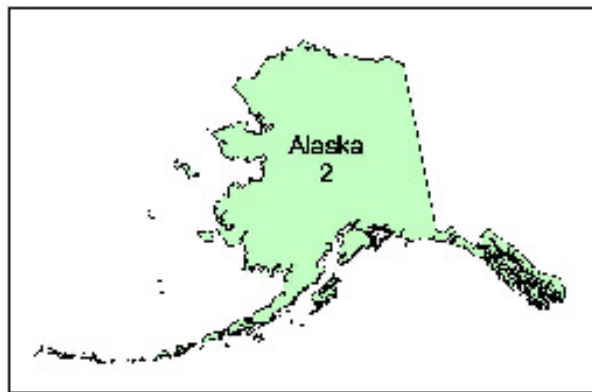


2006 Year End Wind Power Capacity (MW)



Total: 11,575 MW
(As of 12/31/06)

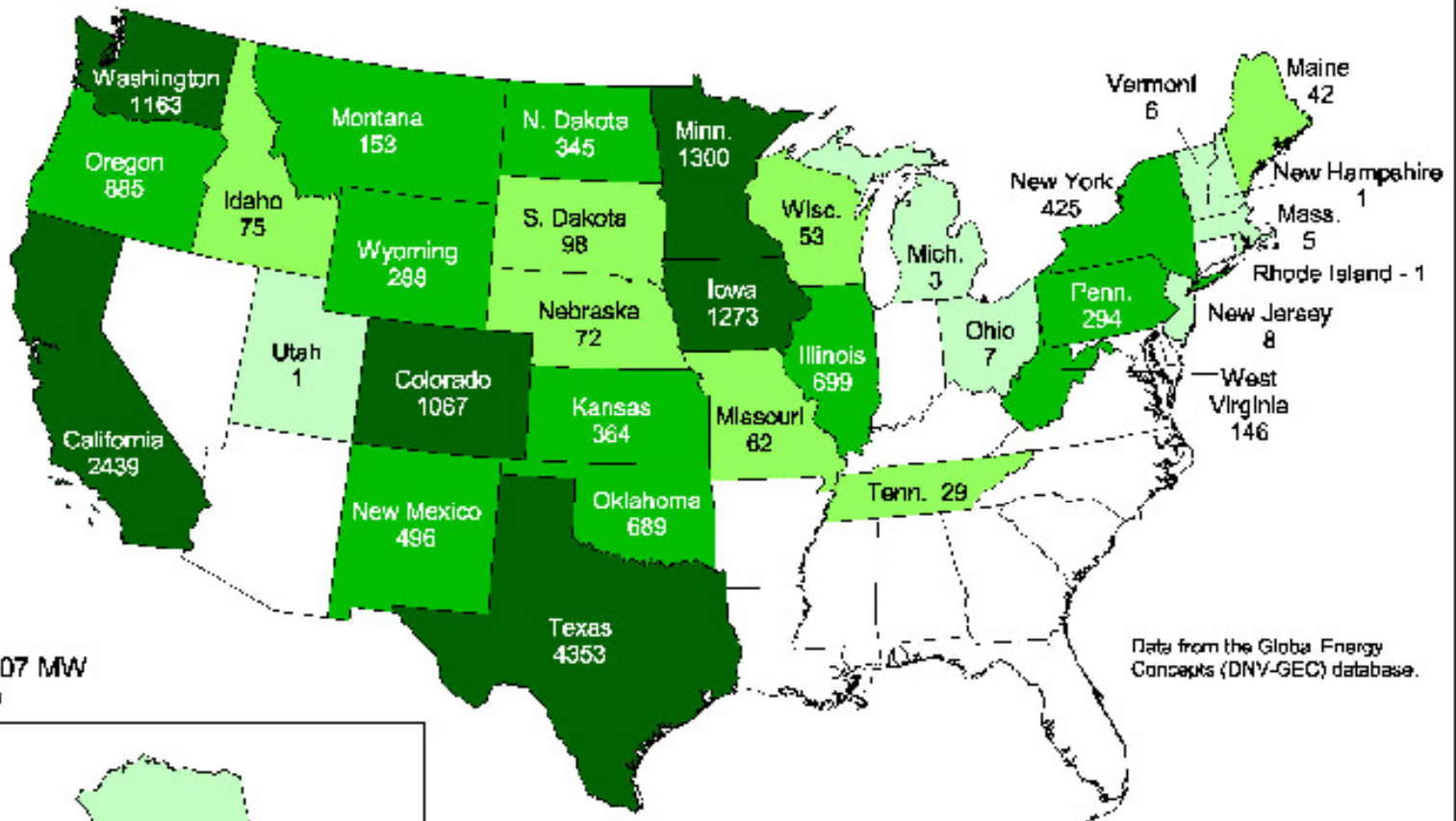
Data from the Global Energy Concepts (DNY-GEC) database.



U.S. Department of Energy
National Renewable Energy Laboratory

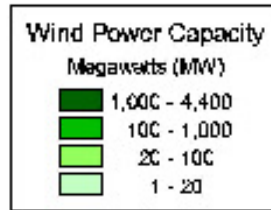


2007 Year End Wind Power Capacity (MW)



Total: 16,907 MW
(As of 12/31/07)

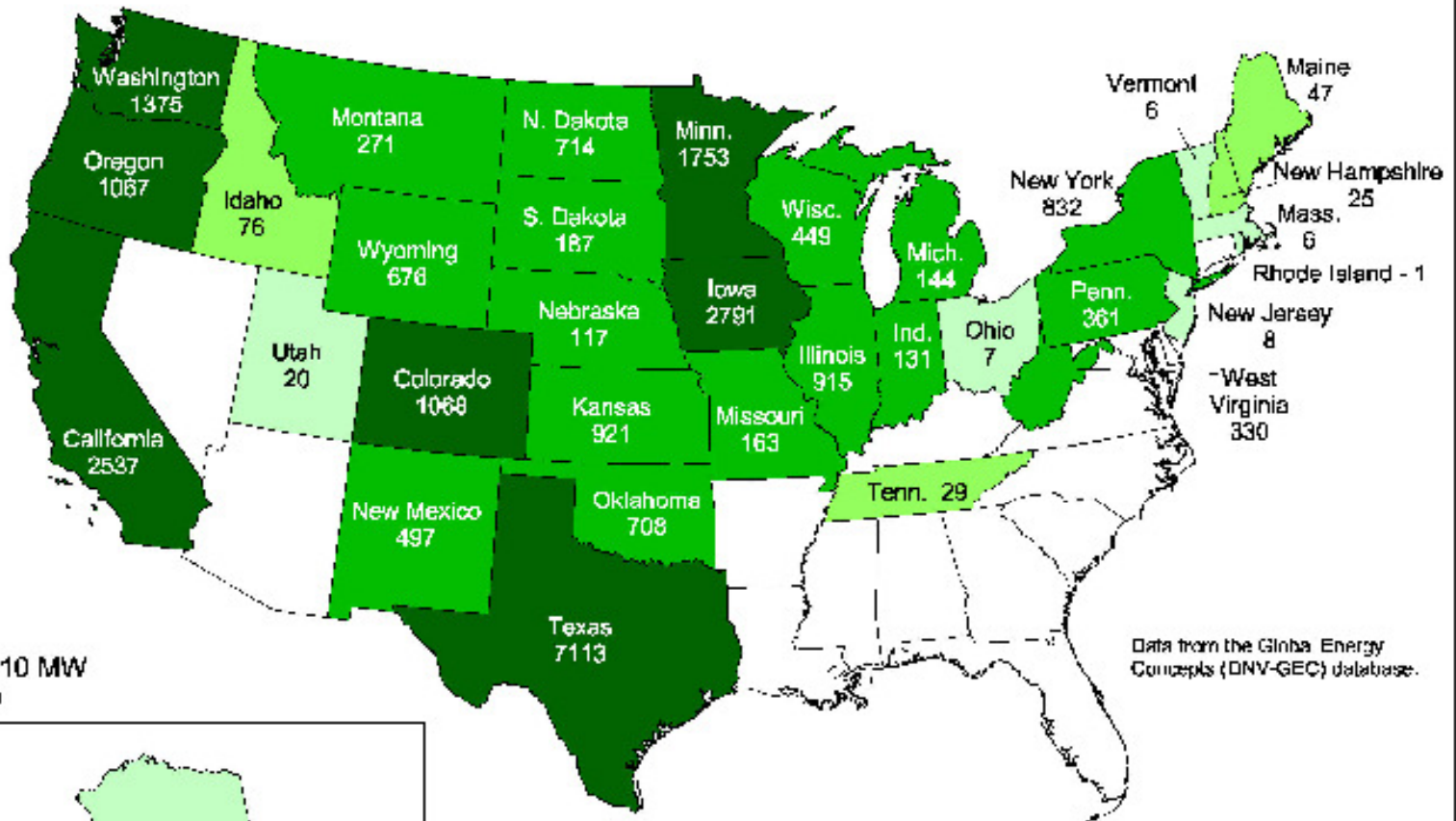
Data from the Global Energy Concepts (DNY-GEC) database.



U.S. Department of Energy
National Renewable Energy Laboratory

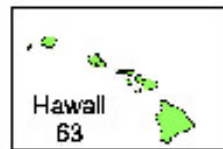


2008 Year End Wind Power Capacity (MW)



Total: 25,410 MW
(As of 12/31/08)

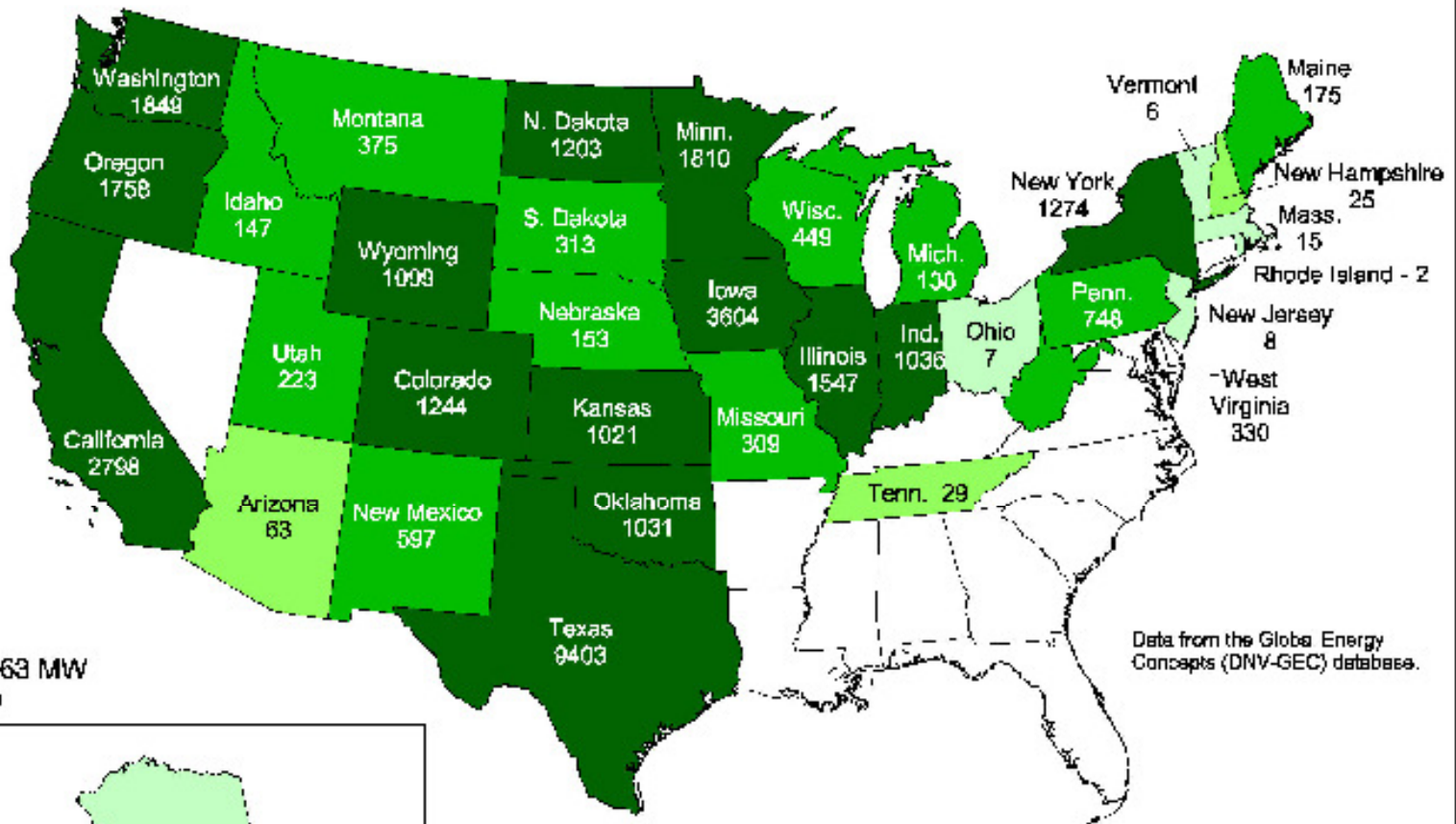
Data from the Global Energy Concepts (DNV-GEC) database.



U.S. Department of Energy
National Renewable Energy Laboratory

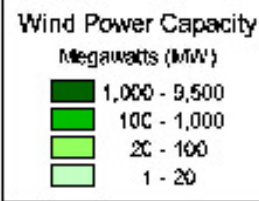
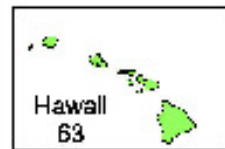


2009 Year End Wind Power Capacity (MW)



Total: 34,863 MW
(As of 12/31/09)

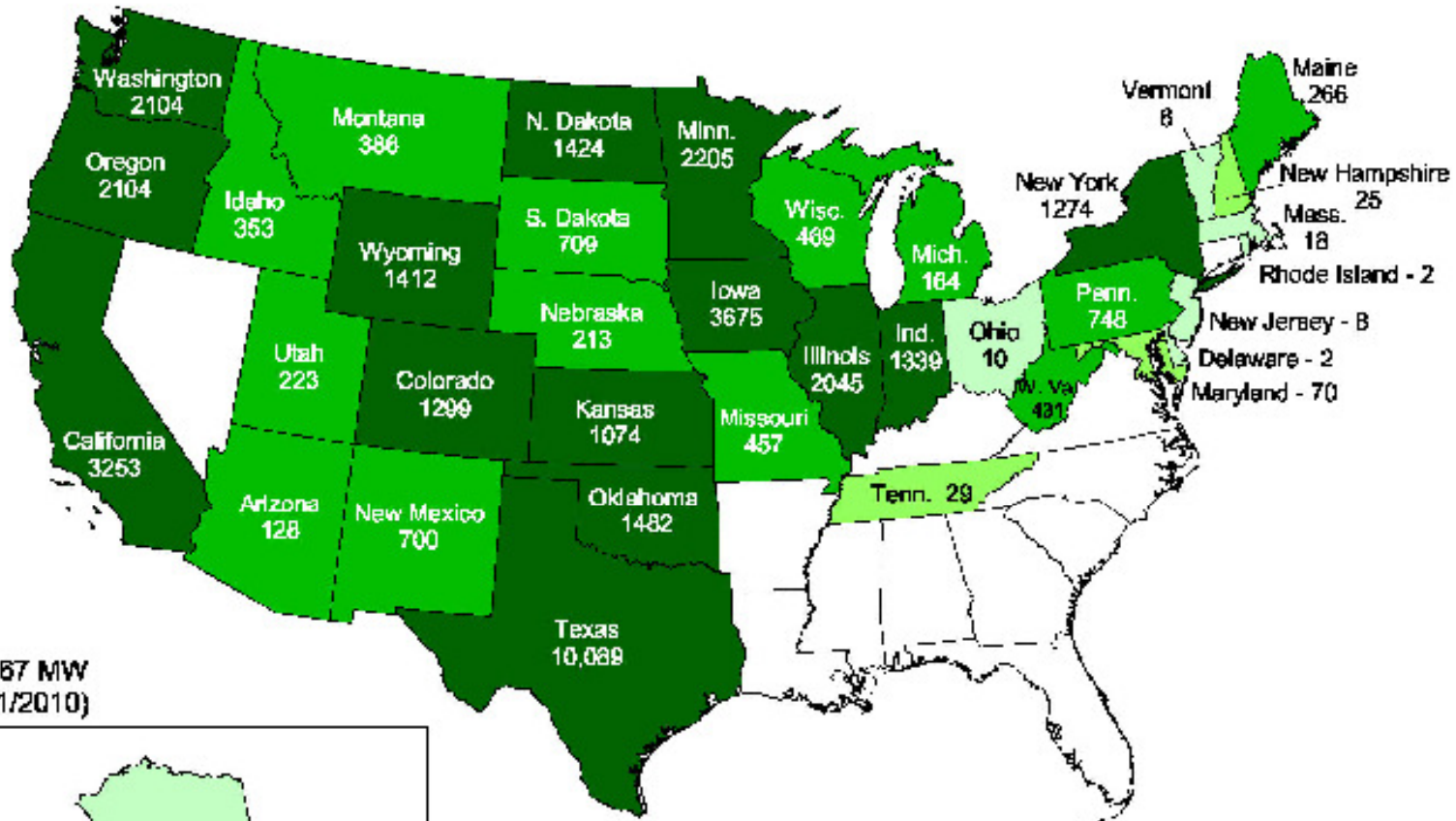
Data from the Global Energy Concepts (DNV-GEC) database.



U.S. Department of Energy
National Renewable Energy Laboratory



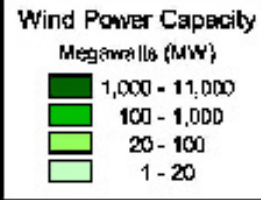
2010 Year End Wind Power Capacity (MW)



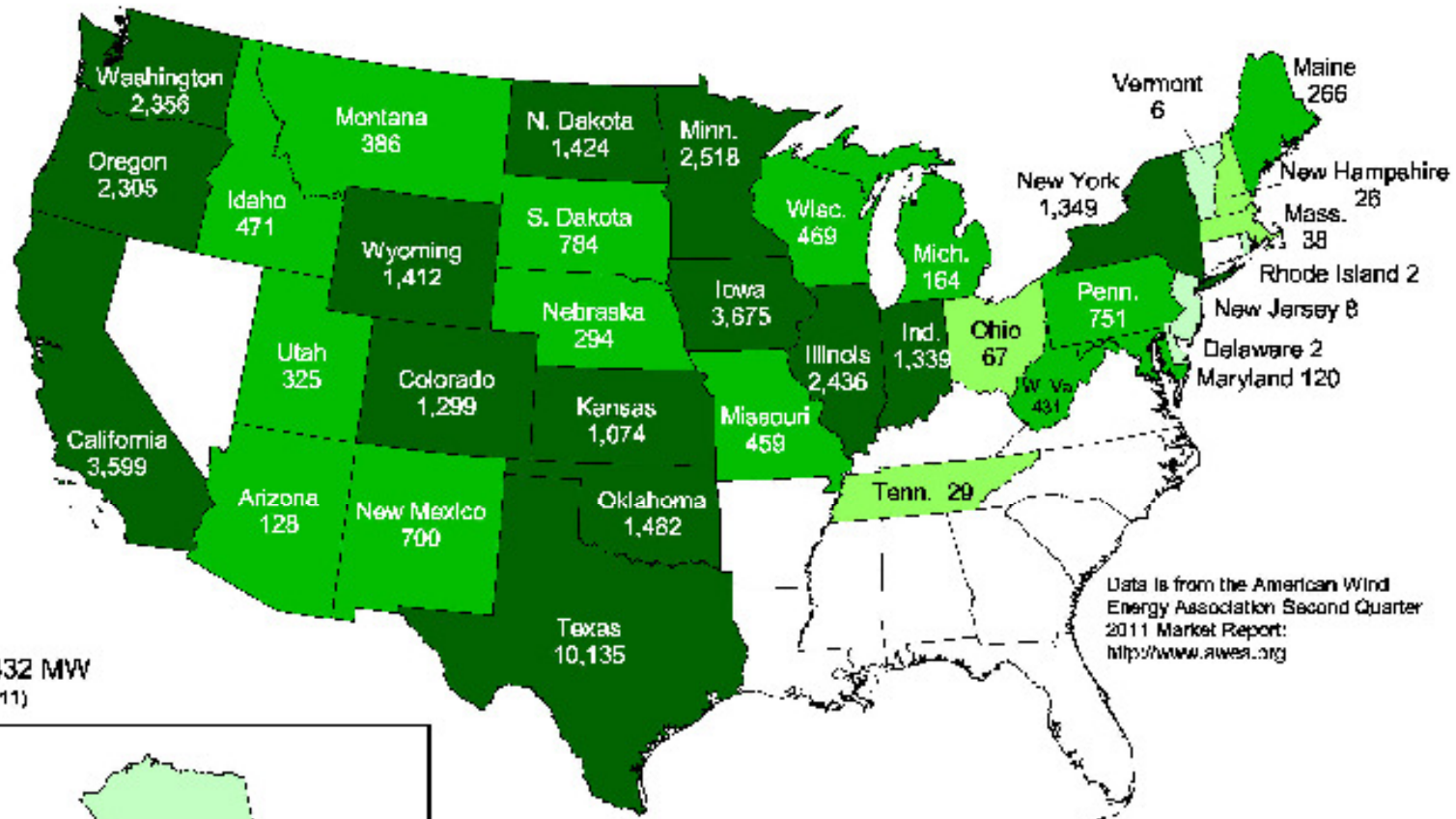
Total: 40,267 MW
(As of 12/31/2010)



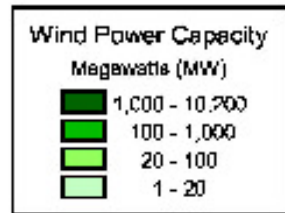
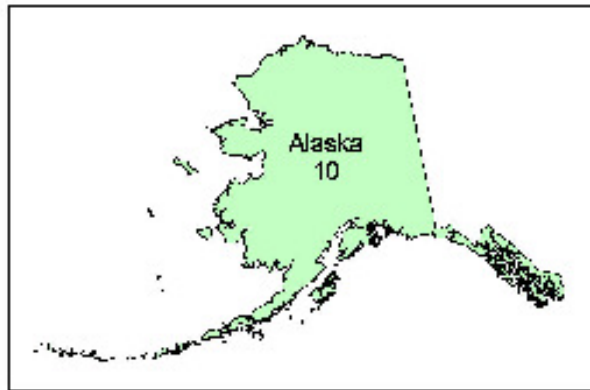
U.S. Department of Energy, "2010 Wind Technologies Market Report." (June 2011)



Current Installed Wind Power Capacity (MW)



Total: 42,432 MW
(As of 06/30/2011)



Data is from the American Wind Energy Association Second Quarter 2011 Market Report:
<http://www.awea.org>

U.S. Department of Energy

NREL
NATIONAL RENEWABLE ENERGY LABORATORY
V1-SEP-2011 1 1 23

TYPICAL TURBINE LAYOUT

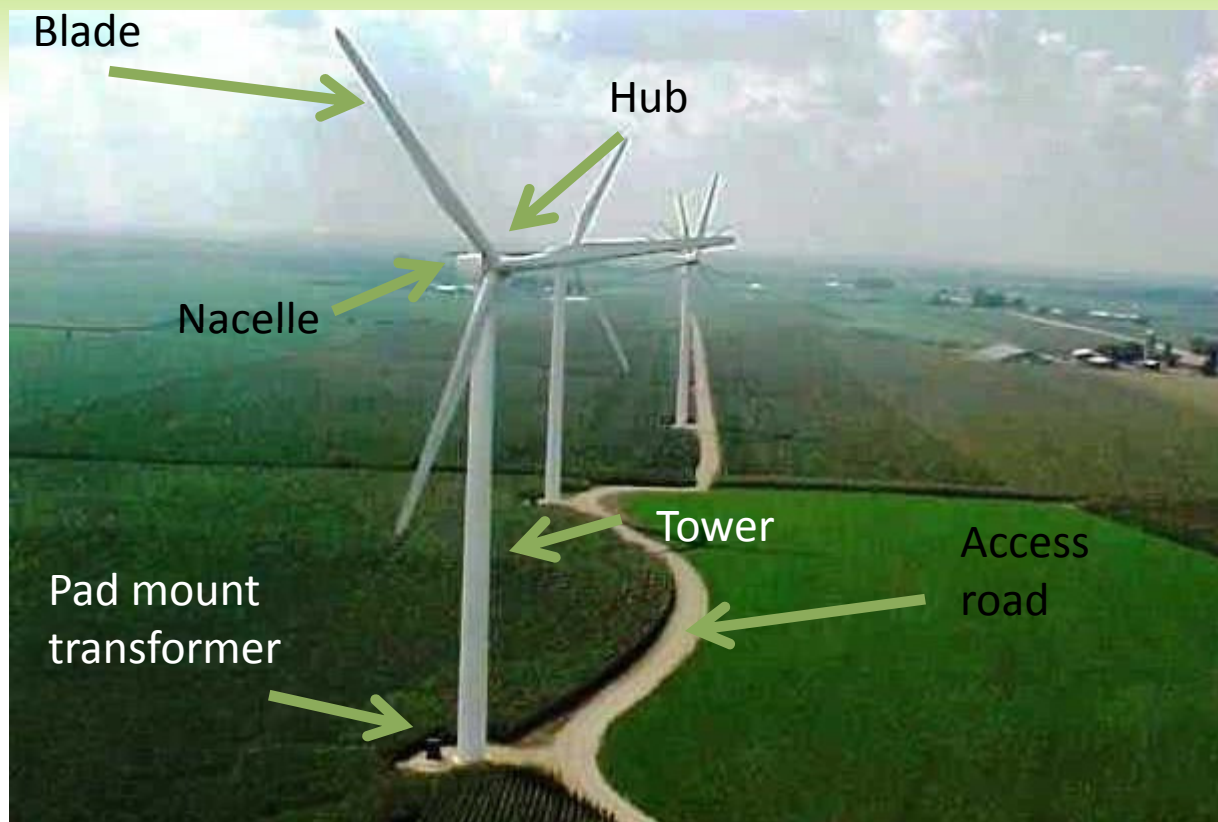
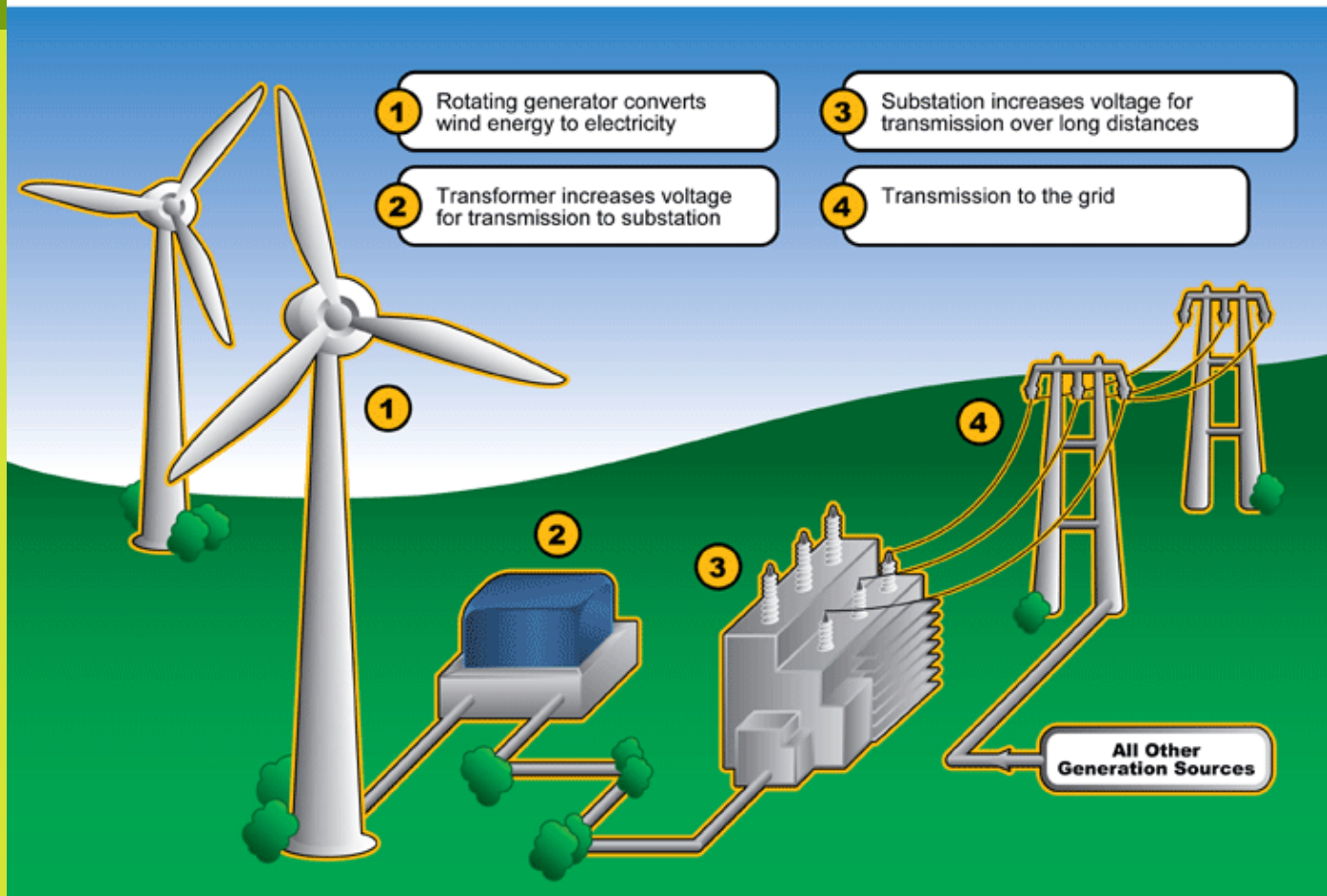


Photo Source: Langdon Wind Energy Center PSC Application, Figure 8 by Tetra Tech EC, Inc.

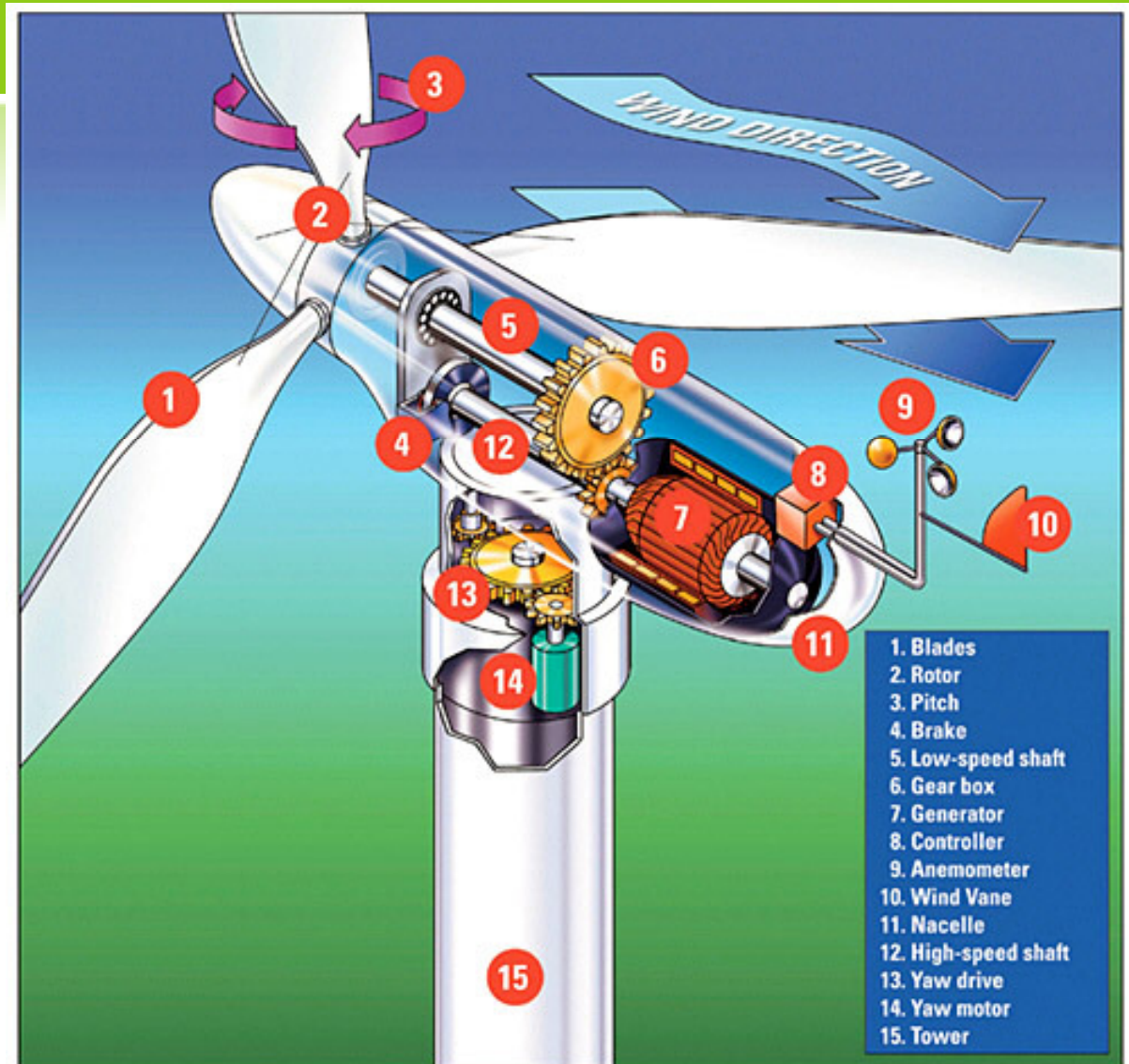
HOW DO WIND TURBINES WORK?

WIND



Source: [www. http://greenpoweroregon.com/Images/WindDiagram_Lg.gif](http://greenpoweroregon.com/Images/WindDiagram_Lg.gif)

WHAT'S INSIDE

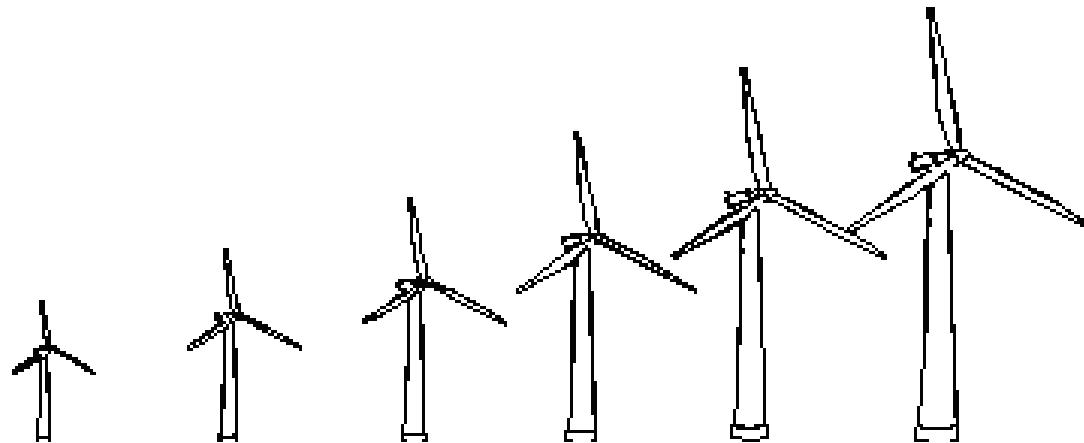


TURBINES CONSTANTLY IMPROVING

- ⊙ Larger turbines
- ⊙ Specialized blade design
- ⊙ Power electronics
- ⊙ Computer modeling
 - ⊙ produces more efficient design
- ⊙ Manufacturing improvements



Wind turbines vary in size. This chart depicts a variety of historical turbine sizes and the amount of electricity they are each capable of generating (the turbine's capacity, or power rating).



	1981	1985	1990	1996	1999	2000
Rotor (meters)	10	17	27	40	50	71
Rating (KW)	25	100	225	550	750	1,650
Annual MWh	45	220	550	1,480	2,200	5,600

The electricity generated by a utility-scale wind turbine is normally collected and fed into utility power lines, where it is mixed with electricity from other power plants and delivered to utility customers. Today (August 2005), turbines with capacities as large as 5,000 kW (5 MW) are being tested.

Source: http://archive.awea.org/faq/wwt_basics.html

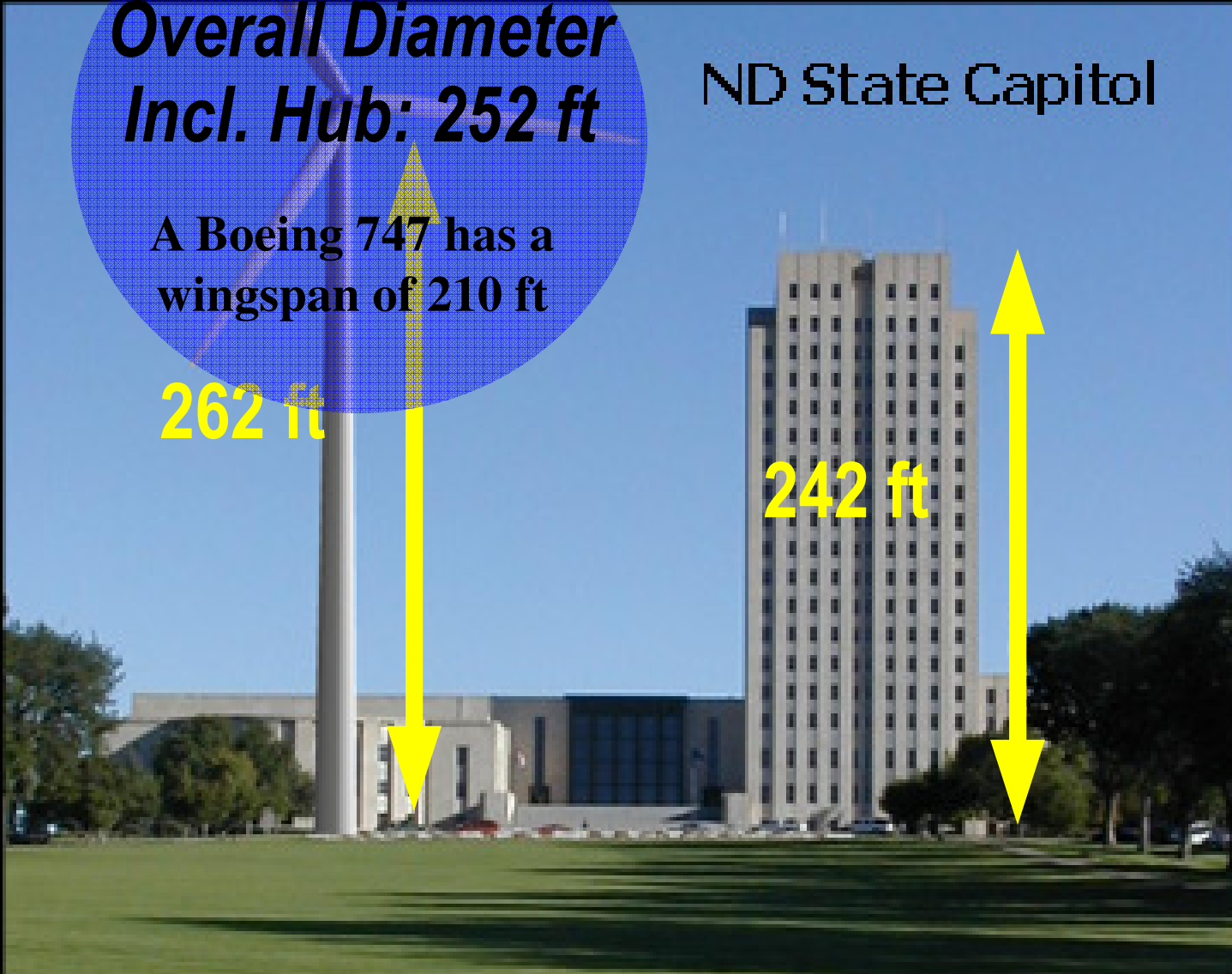
**Overall Diameter
Incl. Hub: 252 ft**

A Boeing 747 has a
wingspan of 210 ft

262 ft

ND State Capitol

242 ft



HOW MANY HOMES CAN ONE MEGAWATT OF WIND ENERGY SUPPLY?

- ⊙ An average U.S. household uses about 10,655 kilowatt-hours (kWh) of electricity each year.
- ⊙ One megawatt of wind energy can generate from 2.4 to more than 3 million kWh annually.
- ⊙ A megawatt of wind generates about as much electricity as 225 to 300 households use.
- ⊙ ... but...wind does not blow all of the time, it cannot be the only power source for that many households without some form of storage system.

Source: http://archive.awea.org/faq/wwt_basics.html#How many homes can one megawatt of wind energy supply

HOW MUCH DO WIND TURBINES COST?

- ⊙ Total costs vary depending on:
 - ⊙ the cost of financing
 - ⊙ when the turbine purchase agreement was executed
 - ⊙ construction contracts
 - ⊙ the type of machine
 - ⊙ the location of the project
 - ⊙ other factors

Source: <http://www.windustry.org/how-much-do-wind-turbines-cost>

HOW MUCH DO WIND TURBINES COST?

- ⊙ Cost components for wind projects include:
 - ⊙ wind resource assessment and site analysis expenses;
 - ⊙ the price and freight of the turbine and tower;
 - ⊙ construction expenses;
 - ⊙ permitting and interconnection studies;
 - ⊙ utility system upgrades, transformers, protection, and metering equipment;
 - ⊙ insurance;
 - ⊙ operations, warranty, maintenance, and repair;
 - ⊙ legal and consultation fees.

Source: <http://www.windustry.org/how-much-do-wind-turbines-cost>

HOW MUCH DO WIND TURBINES COST?

- ⊙ The costs for a commercial scale wind turbine in 2007 ranged from \$1.2 million to \$2.6 million, per MW of nameplate capacity installed.
- ⊙ Most of the commercial-scale turbines installed today are 2 MW in size and cost roughly \$3.5 Million installed.
- ⊙ Wind turbines have significant economies of scale. Smaller farm or residential scale turbines cost less overall, but are more expensive per kilowatt of energy producing capacity. Wind turbines under 100 kilowatts cost roughly \$3,000 to \$5,000 per kilowatt of capacity. That means a 10 kilowatt machine (the size needed to power an average home) might cost \$35,000-\$50,000.

Source: <http://www.windustry.org/how-much-do-wind-turbines-cost>



POTENTIAL LEGISLATIVE ISSUES

- ⊙ Allocation of wind rights
- ⊙ Setbacks
- ⊙ Bonding
- ⊙ Decommissioning
- ⊙ Leasing requirements

WIND LEASES

- ⊙ North Dakota has statutory requirements – North Dakota Century Code chapter 17-04
 - ⊙ Severance of wind rights precluded
 - ⊙ Five year development period to maintain lease
 - ⊙ Statutory lease provisions

QUESTIONS?

North Dakota Public Service Commission

Tony Clark, Commissioner

Brian P. Kalk, Commissioner

Kevin Cramer, Commissioner

www.psc.nd.gov

701-328-2400

