Wind Powering America
The Road Ahead

Jim Walker

June 2008

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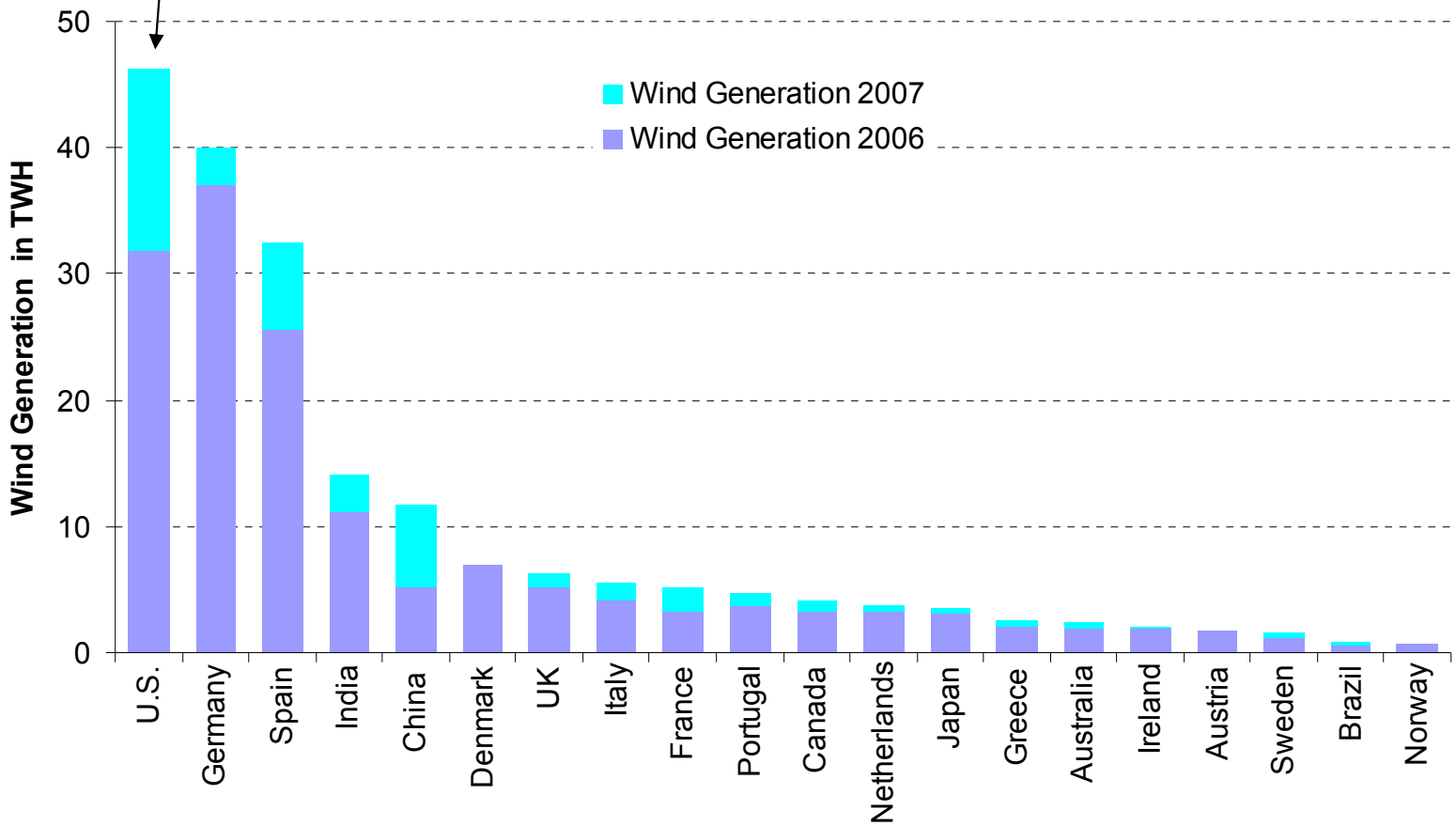
US Again #1 Wind Generator

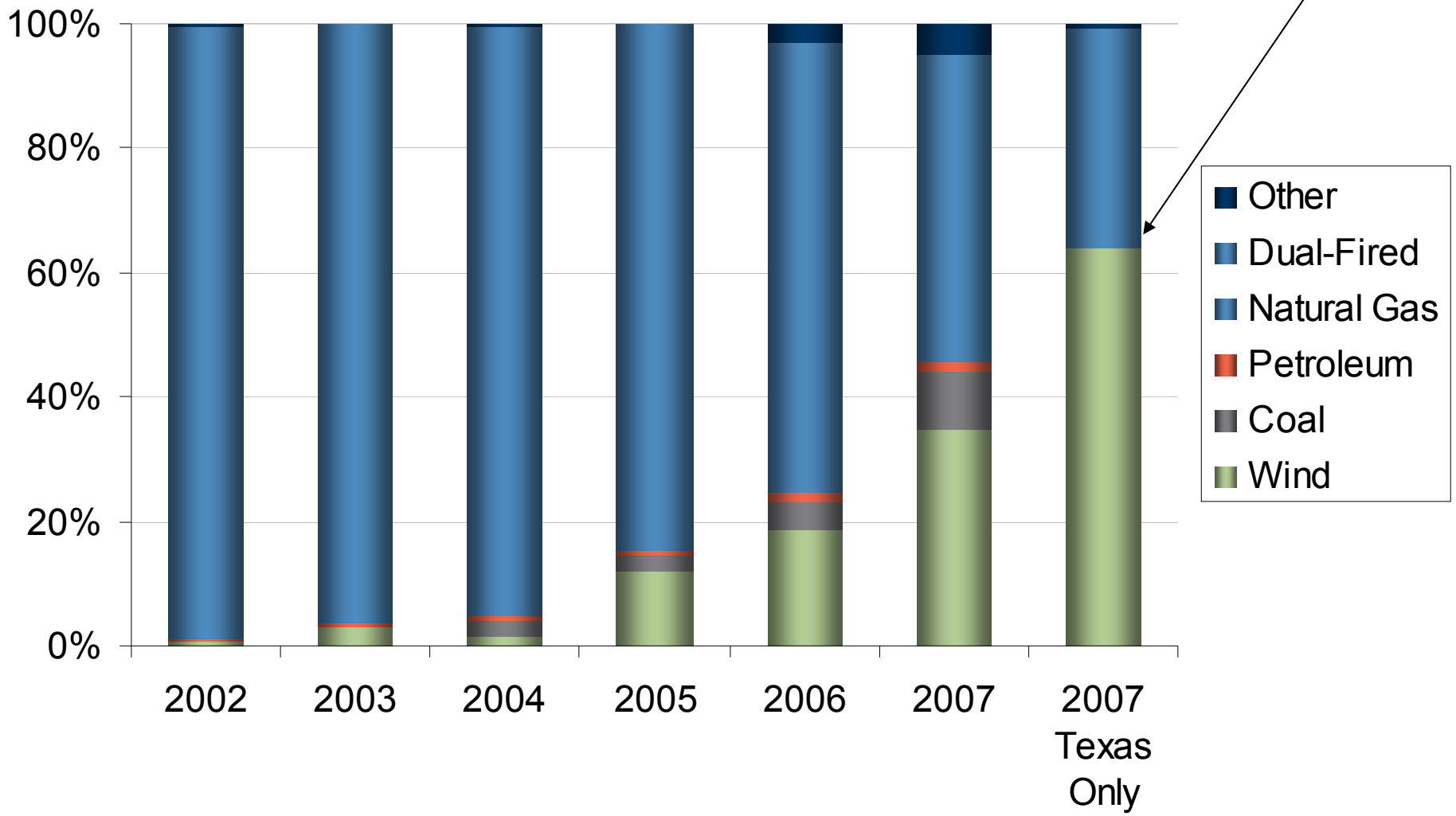
Germany has more MW, but US has higher capacity factors and produces more MWH



Source: Berkeley Lab estimates based on data from BTM Consult and elsewhere

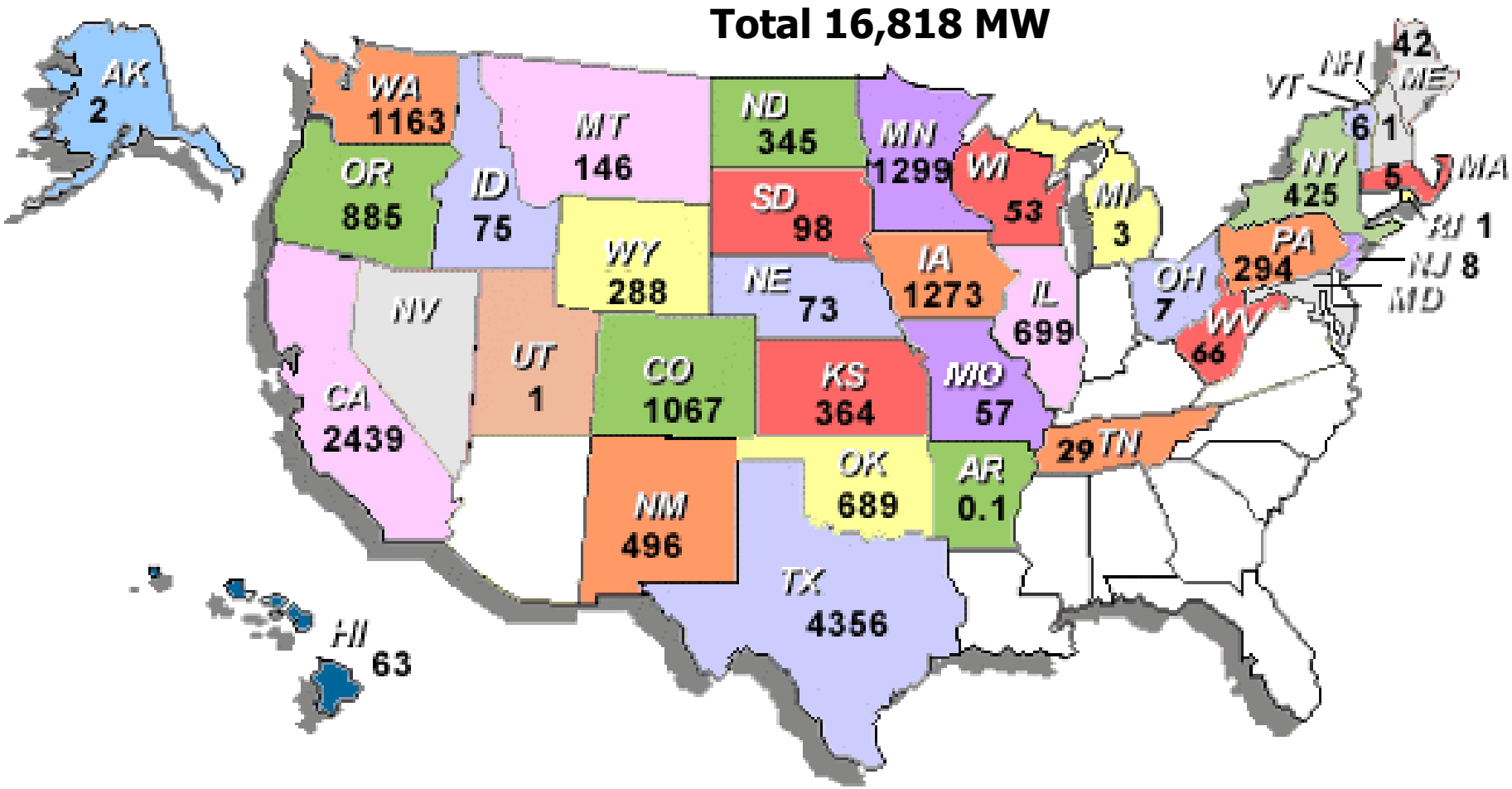
New Capacity in 2007 by Energy Source for the U.S. (and Texas)

In 2007, 64% of new MW in Texas were wind

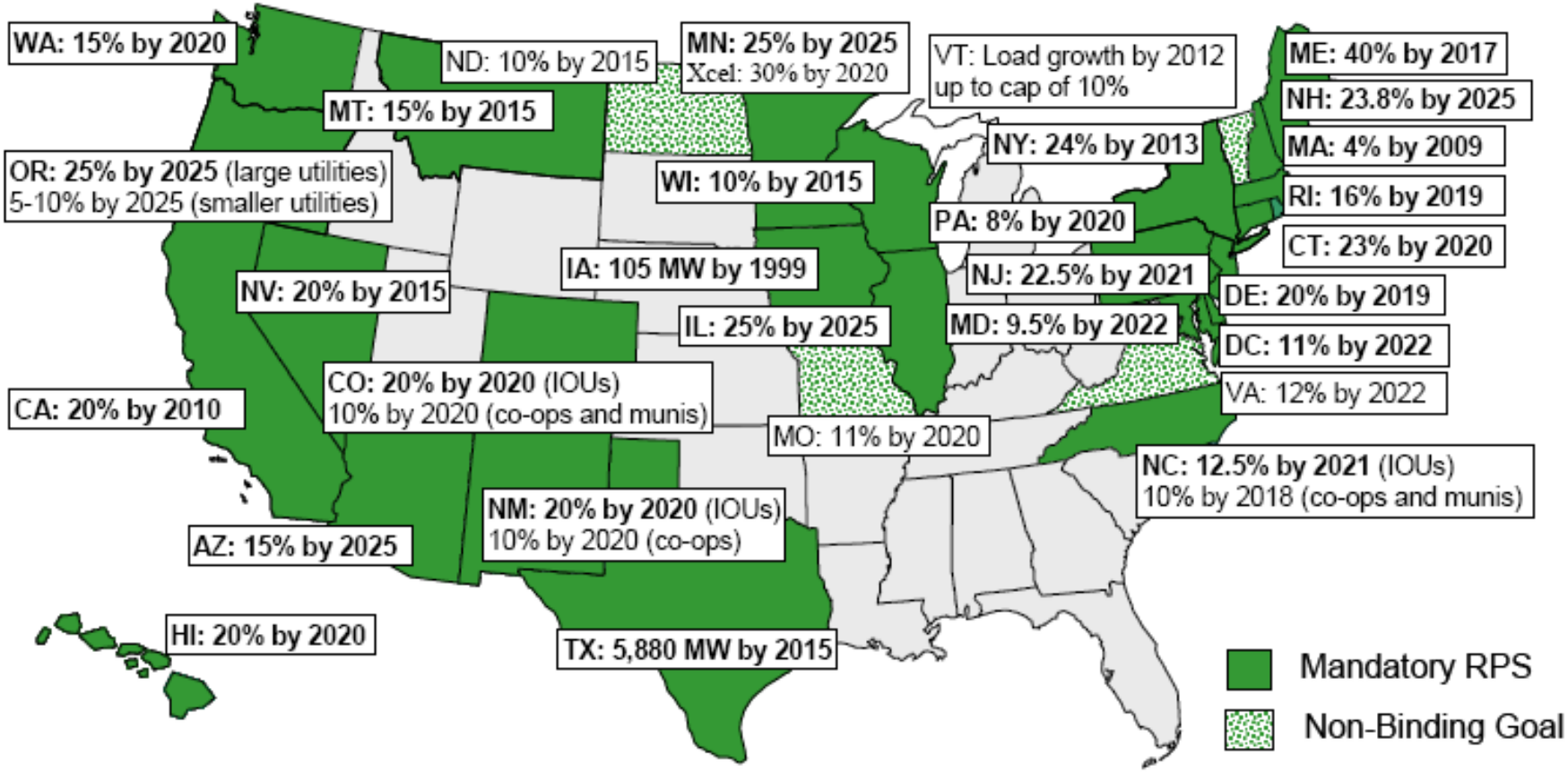


Wind Capacity by State (MW)

(per AWEA as of 12/31/07, http://www.awea.org/projects/)



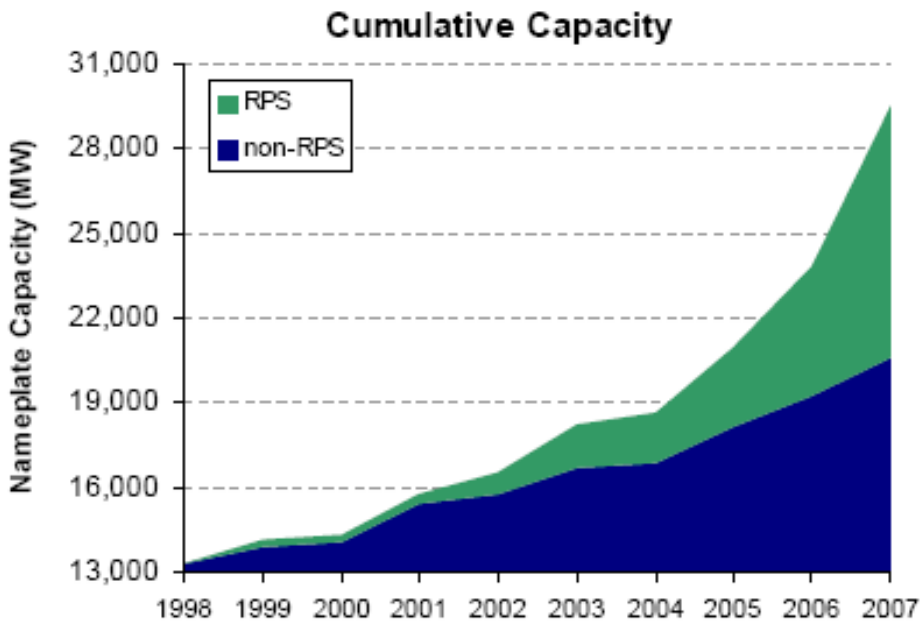
State RPS Policies Exist in 25 States and D.C.; Four States Have Non-Binding Goals

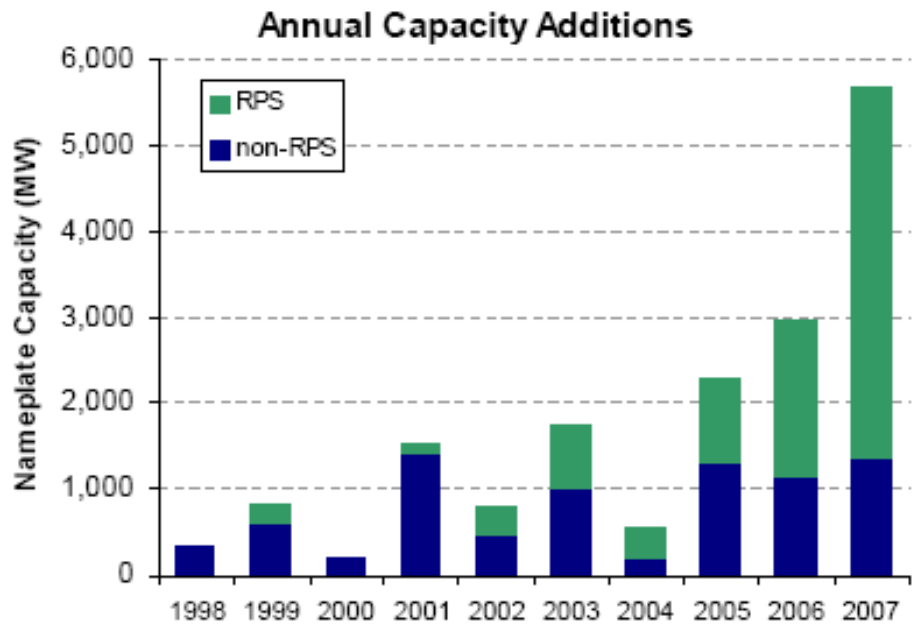


Most policies established through state legislation, but some through regulatory action (NY, AZ) or voter-approved initiatives (CO, WA)

State RPS' Are Increasingly Motivating Renewable Energy Development

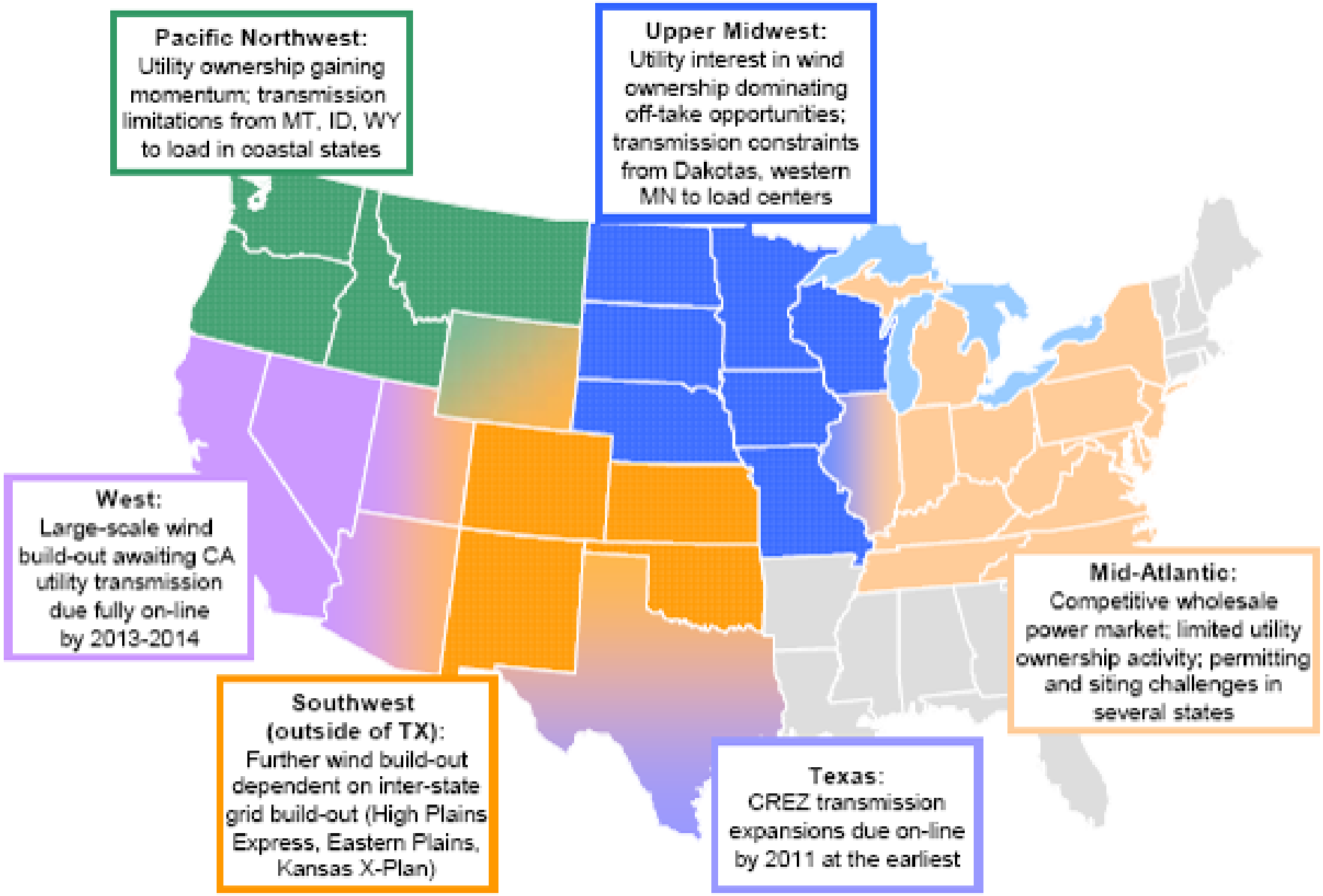
Cumulative and Annual Non-Hydro Renewable Energy Capacity in RPS and Non-RPS States





Though not an ideal metric for RPS-impact, over 50% of non-hydro renewable additions (8,900 MW) since the late 1990s have come from RPS states; metric increases to 76% in 2007 alone

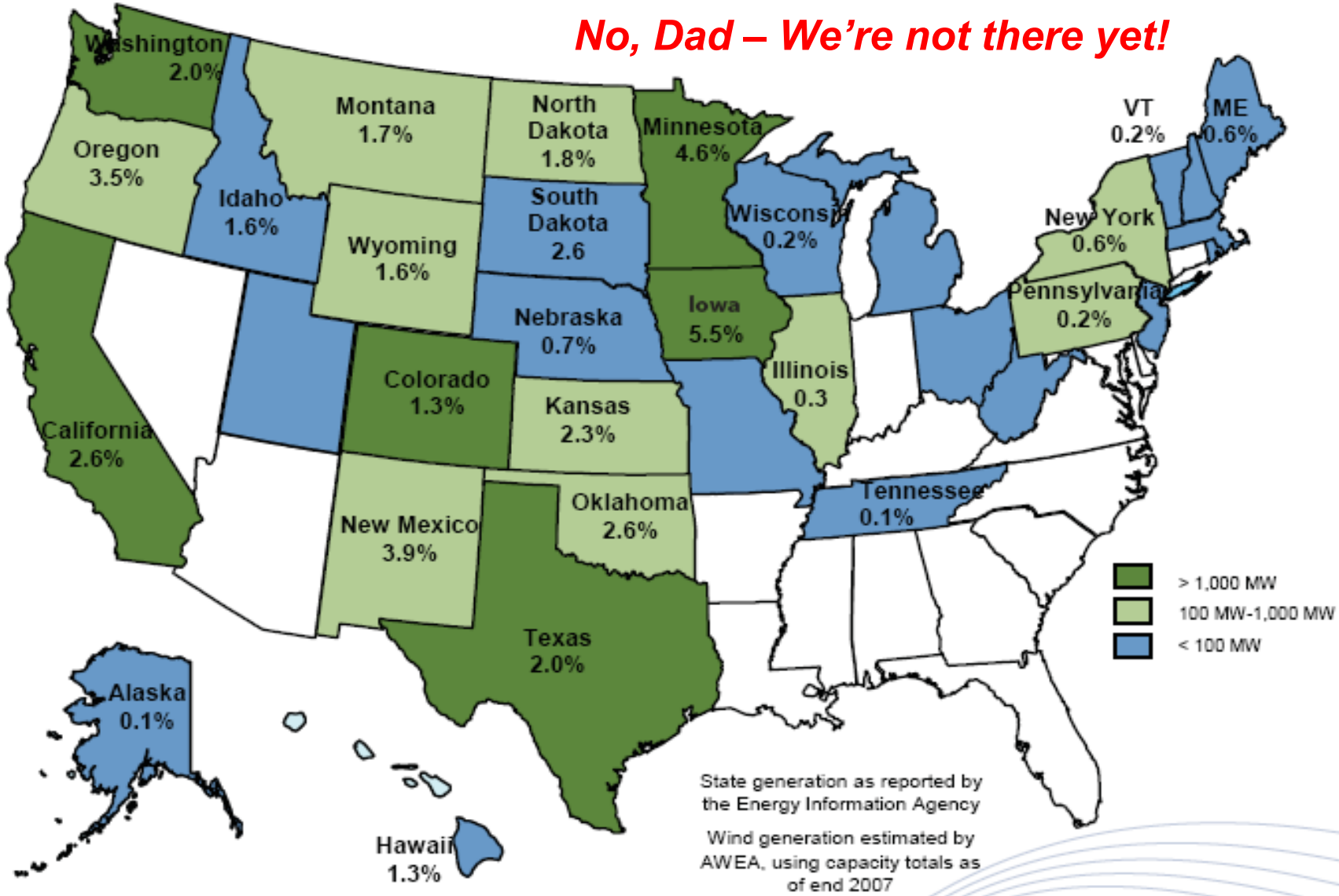
Near-term Challenges to Wind IPP Growth by US Region



Source: Emerging Energy Research

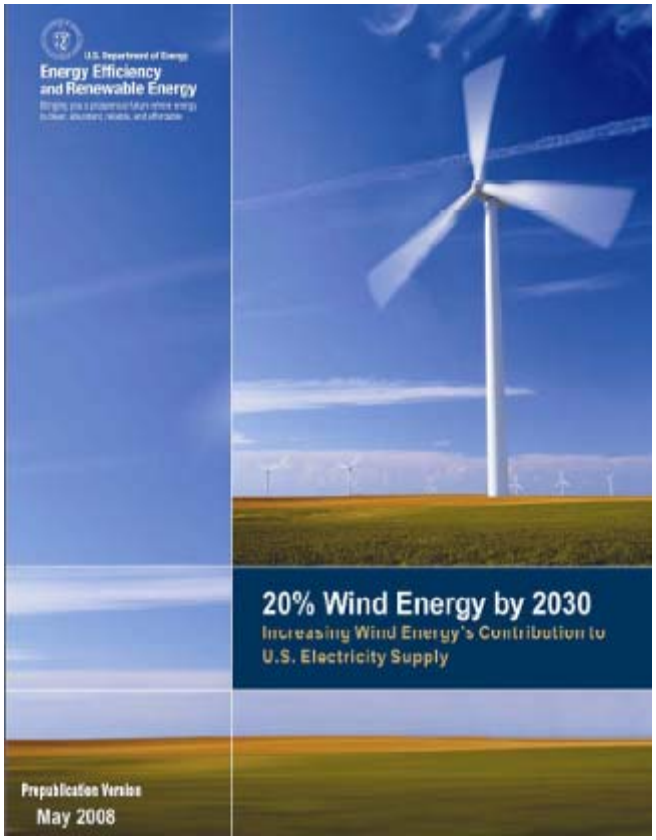
Percentage of State Electricity from Wind

No, Dad – We're not there yet!



In 2006, President Bush emphasized the nation's need for greater energy efficiency and a more diversified energy portfolio.

This led to a collaborative effort of government and industry to explore a modeled energy scenario in which wind provides 20% of U.S. electricity by 2030.

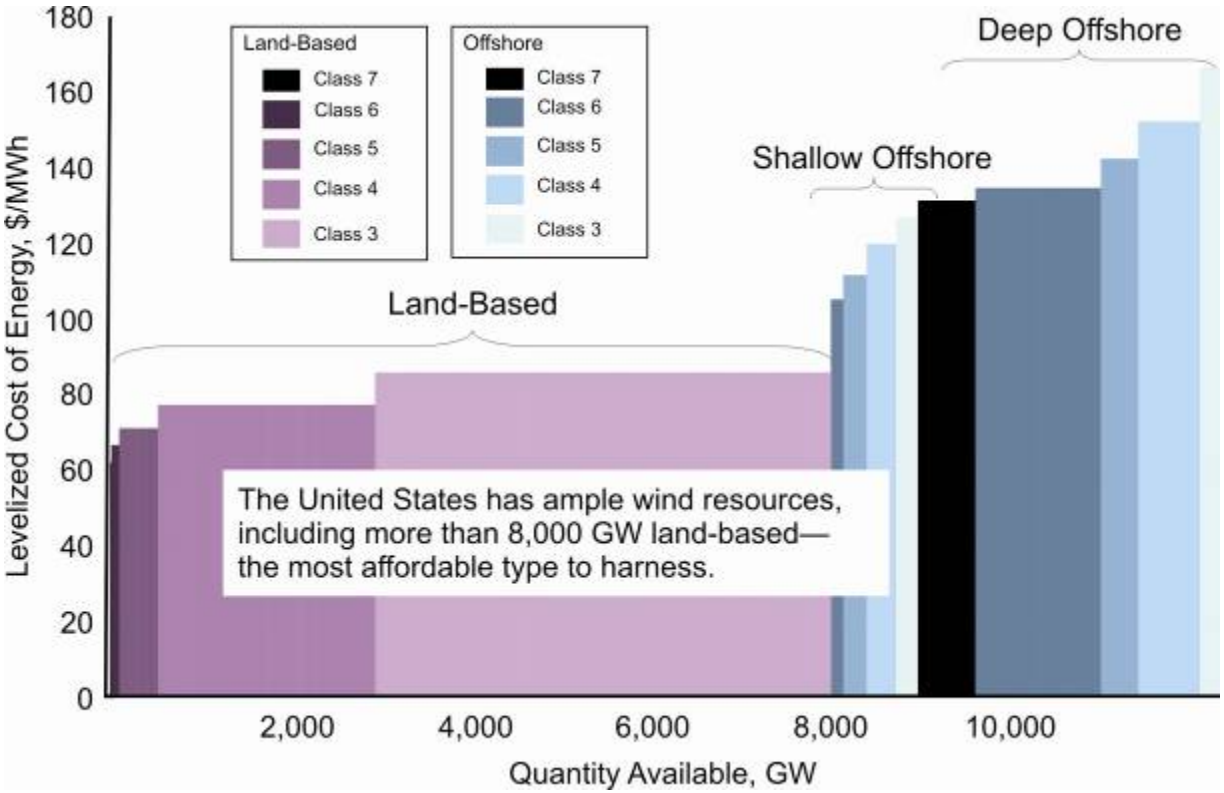


Key Issues Examined

- Does the nation have sufficient wind energy resources?
- What are the wind technology requirements?
- Does sufficient manufacturing capability exist?
- What are some of the key impacts?
- Can the electric network accommodate 20% wind?
- What are the environmental impacts?
- Is the scenario feasible?

Wind Resource Supply Curves

Wind Resource Potential in the U.S.

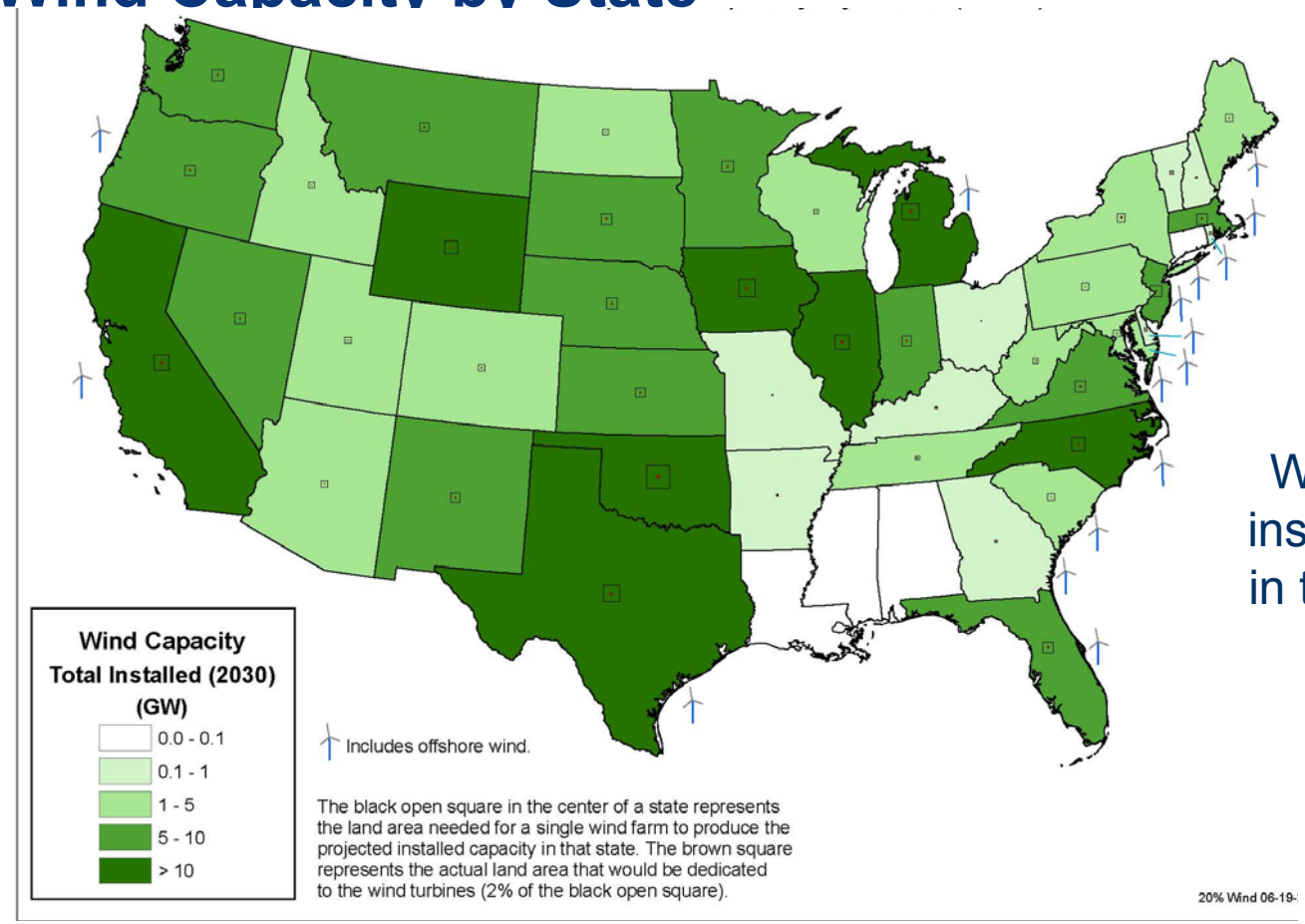


The technical wind resource potential far exceeds the total electricity demand of the U.S.

Onshore technical wind resource exceeds 8,000 GW (8,000,000 MW), accounting for standard land exclusions.

Costs not including PTC, Transmission and Integration costs

Wind Capacity by State



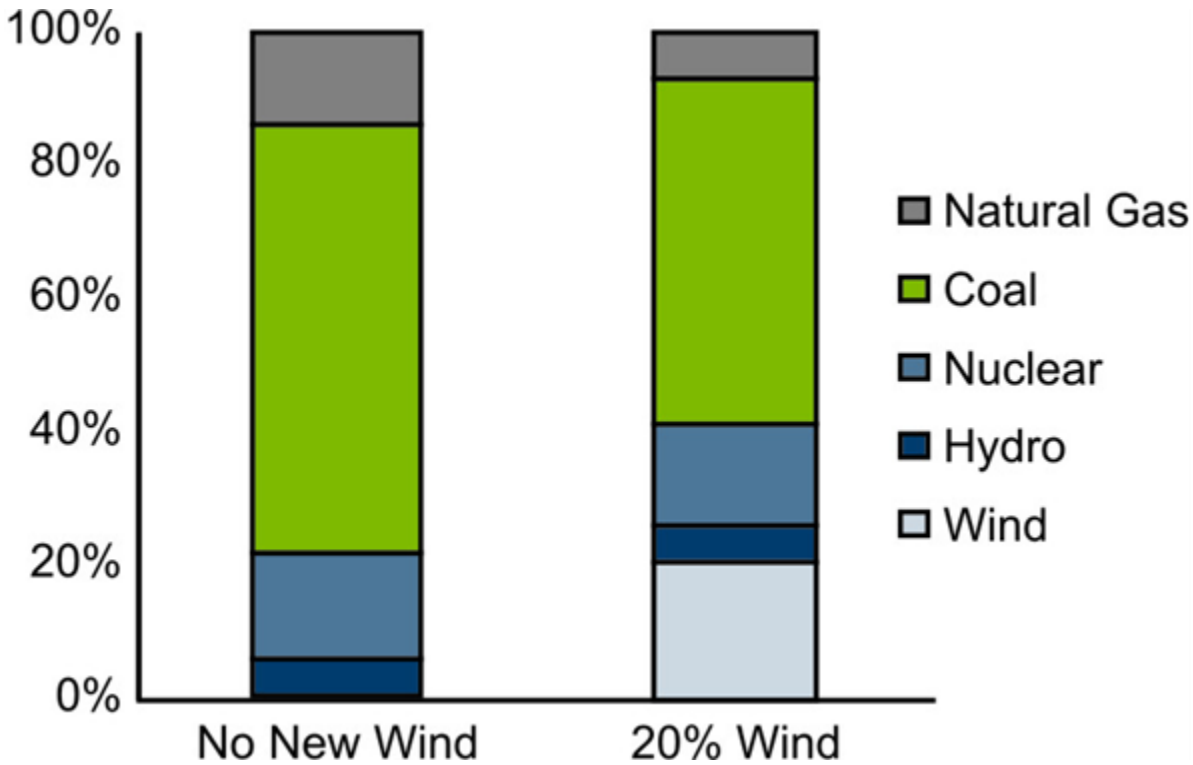
Installed Wind Nameplate Capacity by State (2030)

Wind capacity would be installed across **46 states** in the 20% wind scenario.

Land Use

- New onshore installations would require approximately 12.3 million acres (19,300 square miles) of land.
- Yet, the **actual footprint of land-based turbines and related infra-structure would require only 2-5% of land covered, or about 618,000 acres** (960 square miles) of dedicated land—slightly less than the area of Rhode Island.
- According to the Brazilian government, during the last 5 months of 2007, an area of the Amazon rain forest the size of Rhode Island was deforested.

Electricity Generation Mix

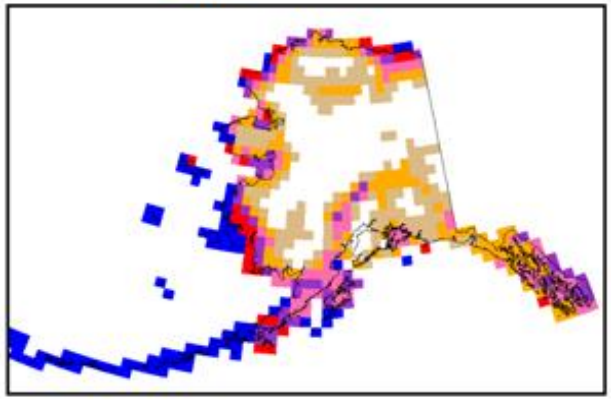


The 20% Wind Scenario would decrease generation from natural gas by 50% and generation from coal by 18%.

AEP's Transmission Vision

NREL Updated Maps:
Arizona (2003)
California (2002)
Colorado (2004)
Connecticut (2001)
Delaware (2002)
Hawaii (2004)
Idaho (2002)
Illinois (2001)
Indiana (2004)
Maine (2001)
Maryland (2002)
Massachusetts (2001)
Michigan (2004)
Missouri (2005)
Montana (2002)
Nebraska (2005)
Nevada (2003)
New Jersey (2002)
New Hampshire (2001)
New Mexico (2003)
North Carolina (2002)
North Dakota (2000)
Ohio (2004)
Oregon (2002)
Pennsylvania (2002)
Rhode Island (2001)
South Dakota (2001)
Texas mesas (2000)
Utah (2003)
Vermont (2001)
Virginia (2002)
Washington (2002)
West Virginia (2002)
Wyoming (2002)

The remaining states use data from the 1987 "Wind Energy Atlas of the United States".



Existing 765 kV
New 765 kV
AC-DC-AC Link

Transmission Lines
Voltage (kV)
345 - 499
500 - 699
700 - 799
1000 (DC)

Source: POWERmap, powermap.platts.com, ©2007 Platts, a division of the McGraw-Hill Companies

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
7	Superb	800 - 1600	8.8 - 11.1	19.7 - 24.8

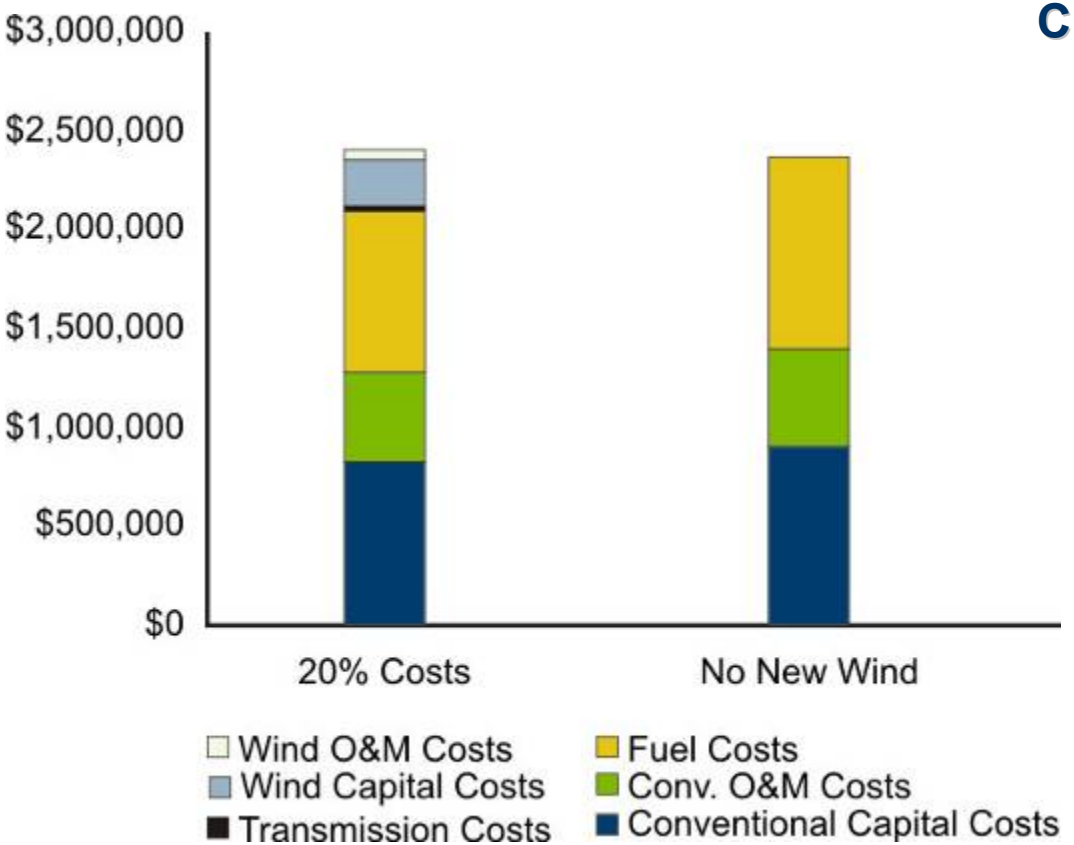
[a] Wind speeds are based on a Weibull k value of 2.0

U.S. Department of Energy
National Renewable Energy Laboratory

NREL

19-APR-2007 1.5.9

Estimated Electric System Costs



Cumulative Discounted Electric System Cost through 2030 (Millions of 2006 Dollars)

Approximately a 2% **increase in cost**, or $43 billion in net present value.

Equivalent of 50 cents per month per household, not accounting for positive, offsetting impacts.

Projected Impacts and Major Challenges

20% Wind Scenario: Projected Impacts

- **Environment:** Avoids air pollution, reduces GHG emissions, and reduces water use in electricity generation. Reduces electric sector CO_2 emissions by 825 million metric tons.
- **U.S. energy security:** Diversifies our electricity portfolio and represents an indigenous energy source with stable prices not subject to fuel volatility
- **Energy consumers:** Wind potentially reduces demand for fossil fuels, in turn reducing fuel prices and stabilizing electricity rates
- **Local economics:** Creates new income source for rural landowners and tax revenues for local communities in wind development areas.
- **American workers:** Generates well-paying jobs in sectors that support wind development, such as manufacturing, engineering, construction, transportation, and financial services. The new manufacturing will cause significant growth in the wind industry supply chain.
- **Water savings:** Reduce cumulative water use in the electric sector by 8% (4 trillion gallons)

20% Wind Scenario: Major Challenges

- Investment in the nation's transmission system so the power generated is delivered to urban centers that need the increased supply;
- Larger electric load balancing areas, in tandem with better regional planning, so that regions can depend on a diversity of generation sources, including wind power;
- Continued reduction in wind capital cost and improvement in turbine performance through technology advancement and improved manufacturing capabilities; and
- Addressing potential concerns about local siting, wildlife, and environmental issues within the context of generating electricity.

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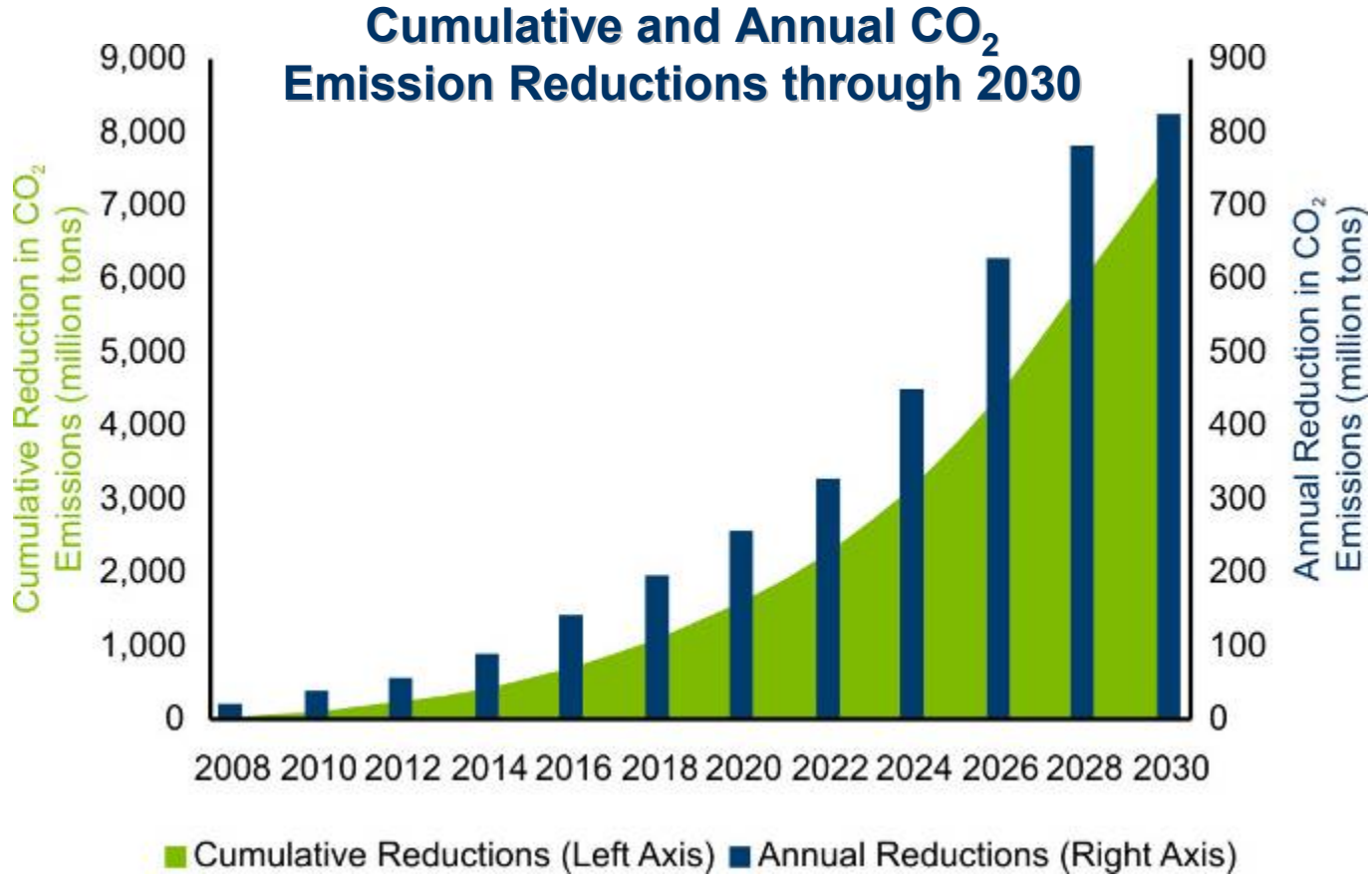
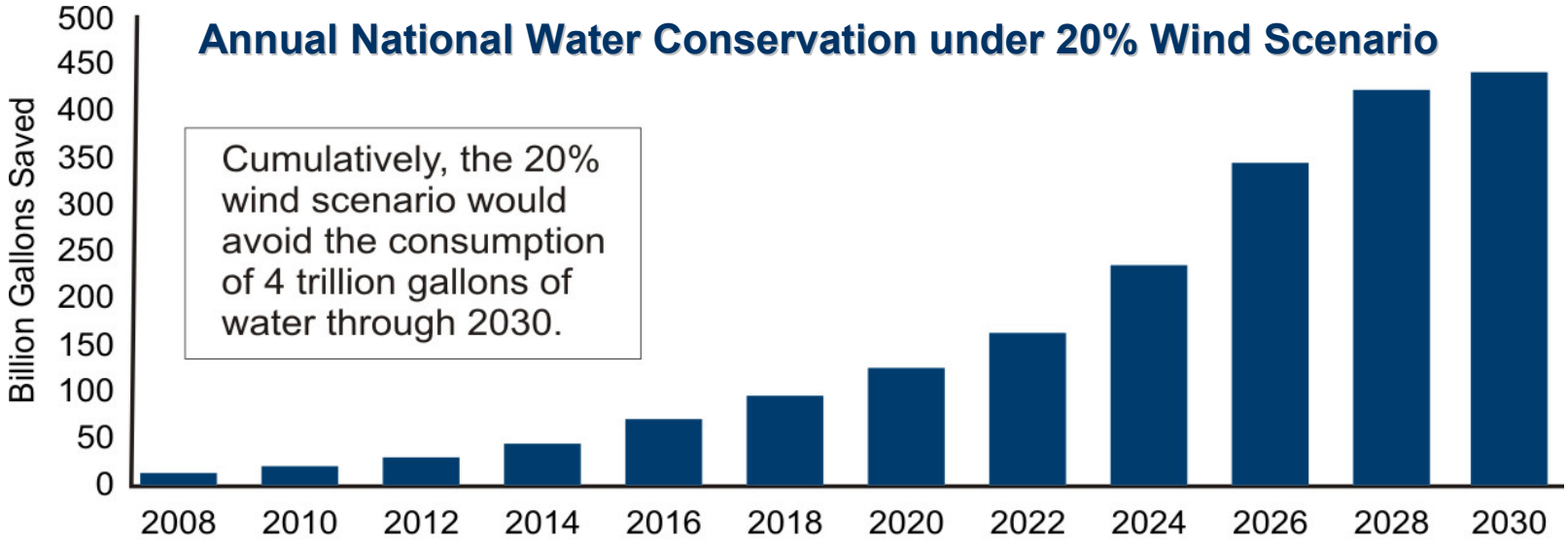
CO_2 Emission Reductions



Annual reductions would reach 825 million tons of CO_2 by 2030, an equivalent a **reduction of 25%** of expected electric sector emissions by 2030.

Water Conservation

- Cumulatively between 2007 and 2030, 20% wind reduces water consumption in the electric sector by 8%, or 4 trillion gallons.
- In 2030, reduces water consumption by 450 billion gallons or 17% of total electric section water consumption, a third of water conservation occurs in the arid west.

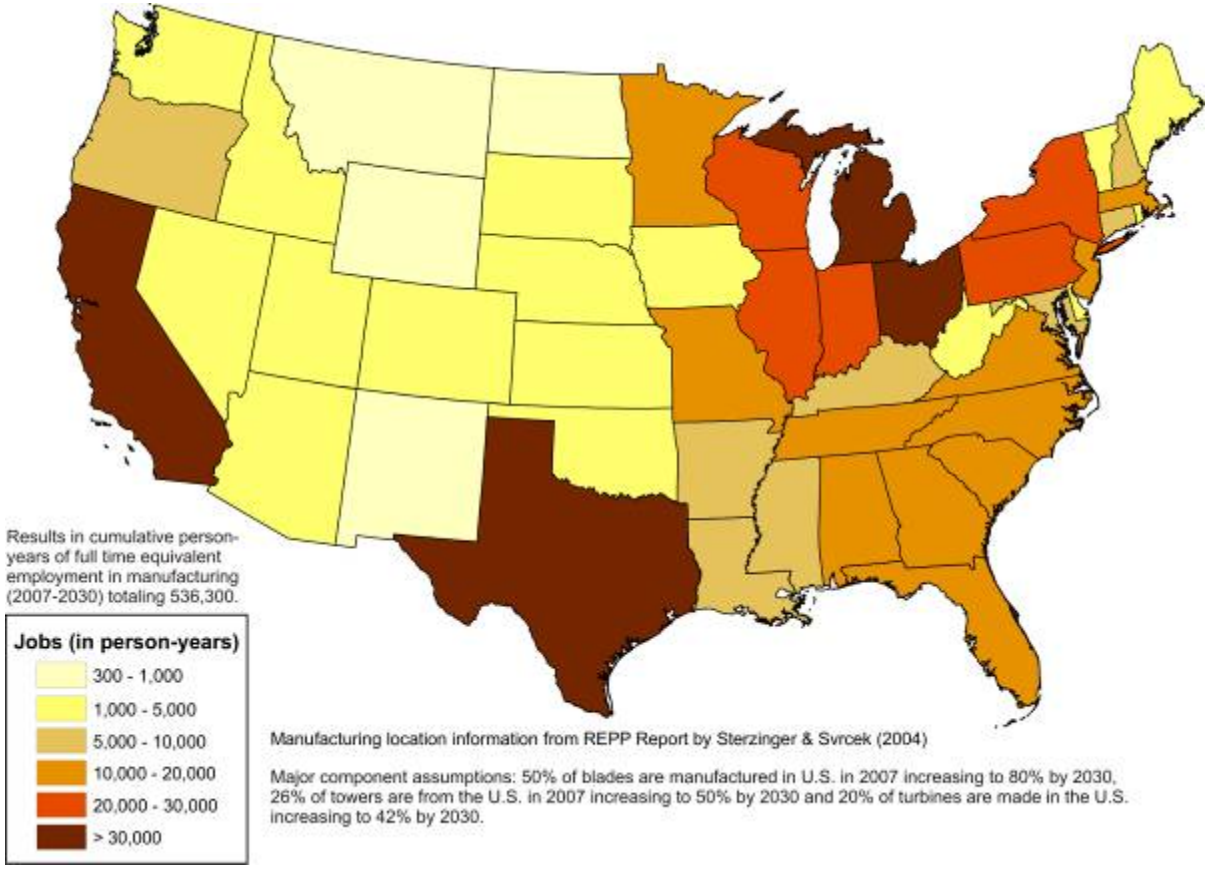


Employment Impacts: Manufacturing

Possible Distribution of Wind Equipment Manufacturing Jobs

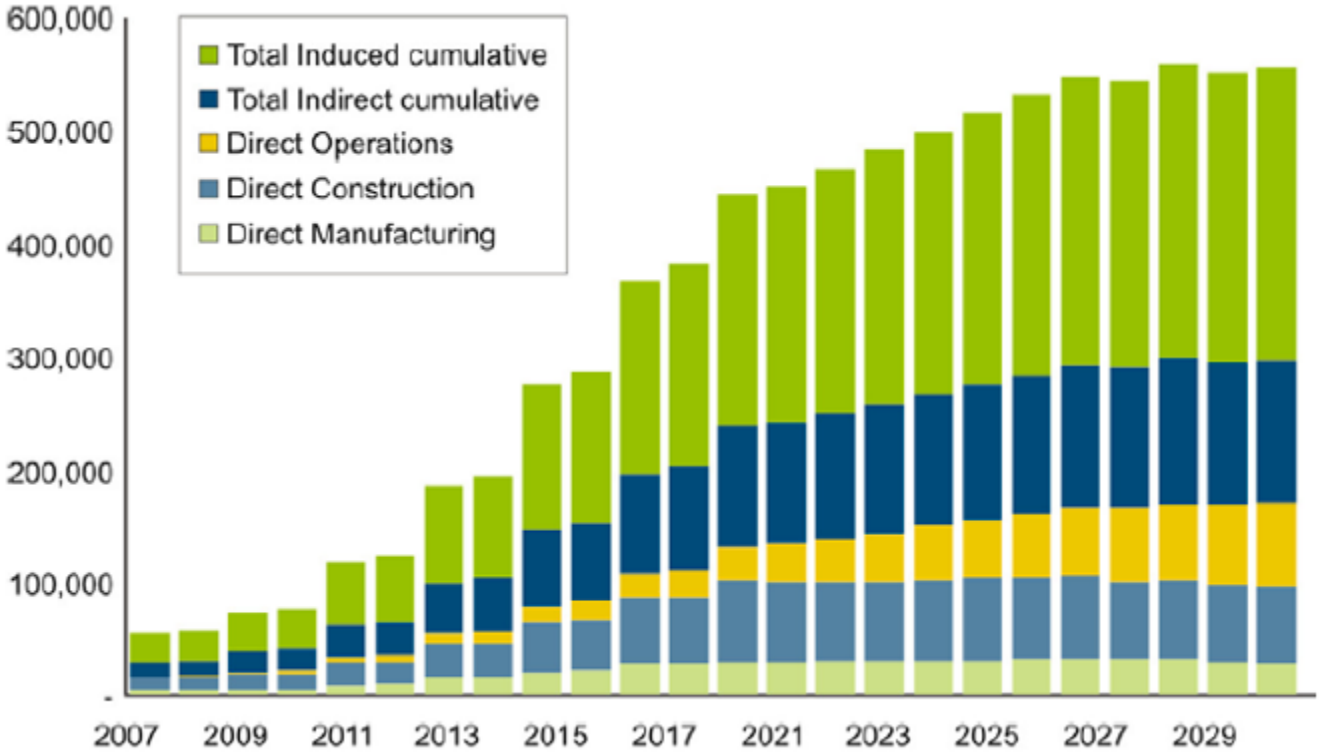
Of the 180,000 jobs directly employed by the wind industry, there are over **40,000** direct manufacturing jobs in 2030.

Cumulatively, there is employment of 536,300 FTE in direct manufacturing between 2007 and 2030.



Employment Impacts

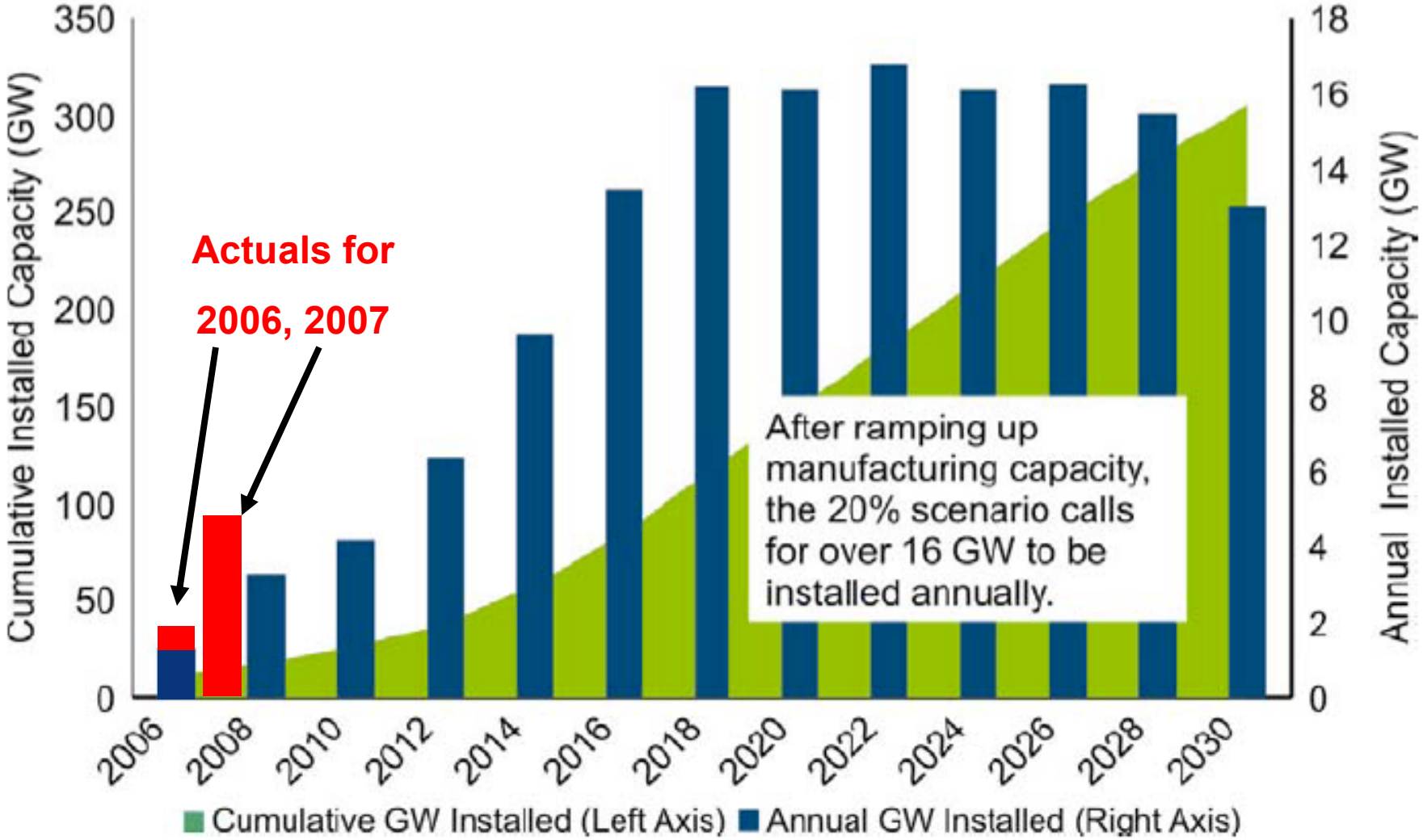
Industry Employment from direct, indirect, and induced categories



Over 500,000 jobs supported by the industry in 2030.

Approx. 180,000 directly employed by the wind industry

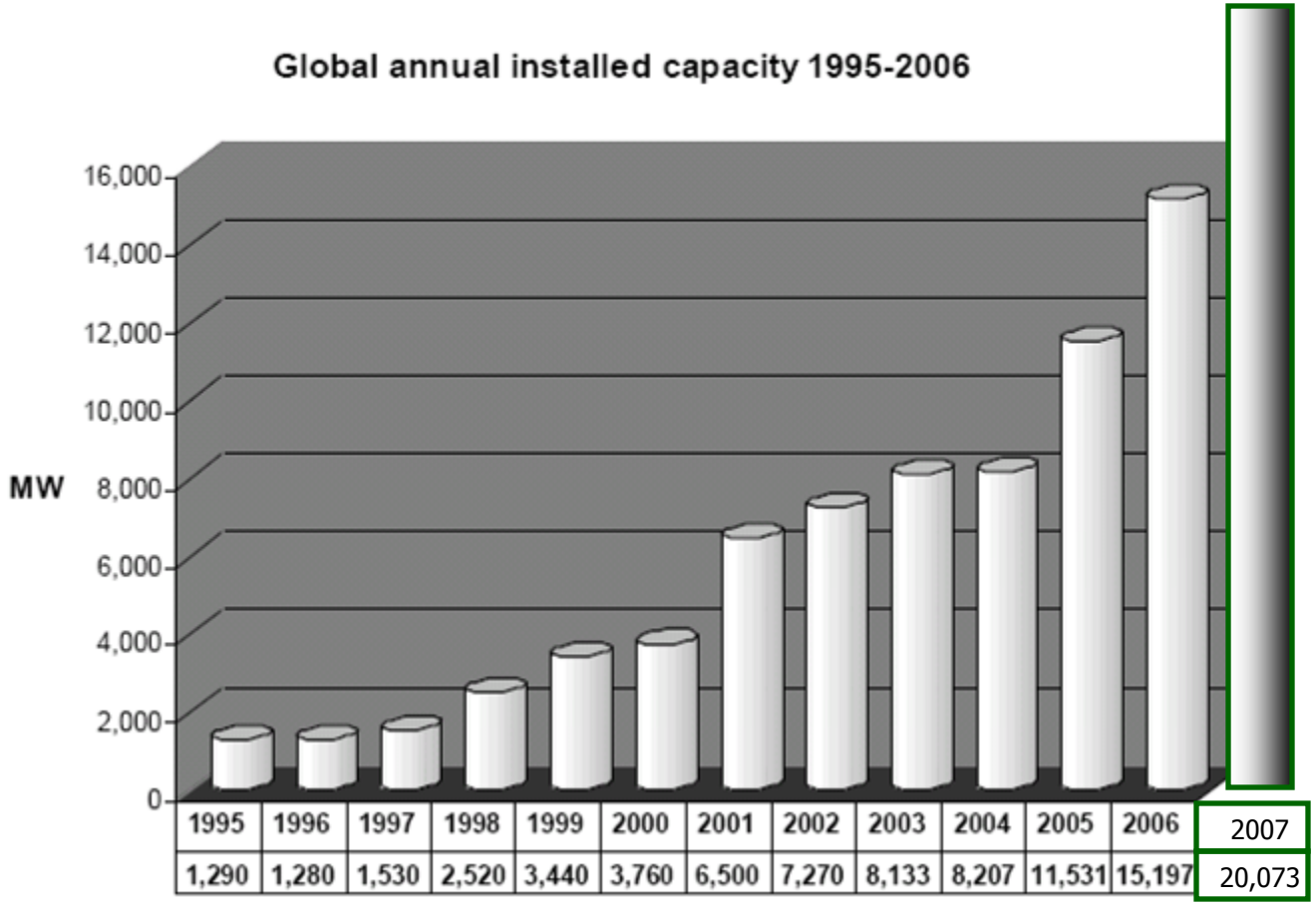
20% Vision:
Growth Path For Wind



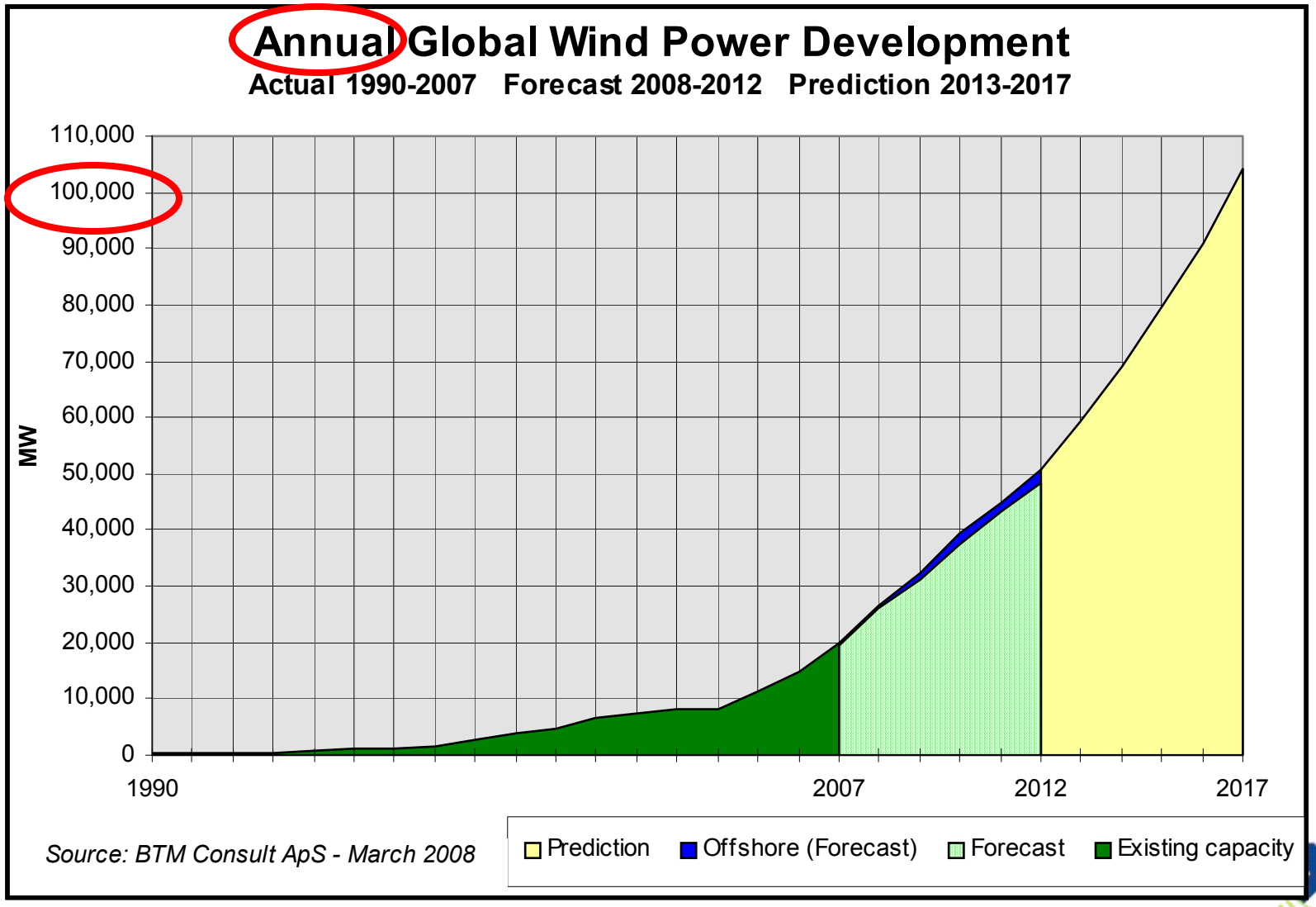
Preliminary: from forthcoming report

Our species has already shown it can deploy wind at the 20% rate if it wants to.

20,073 MW in 2007



BTM Consult March 2008 World Market Update



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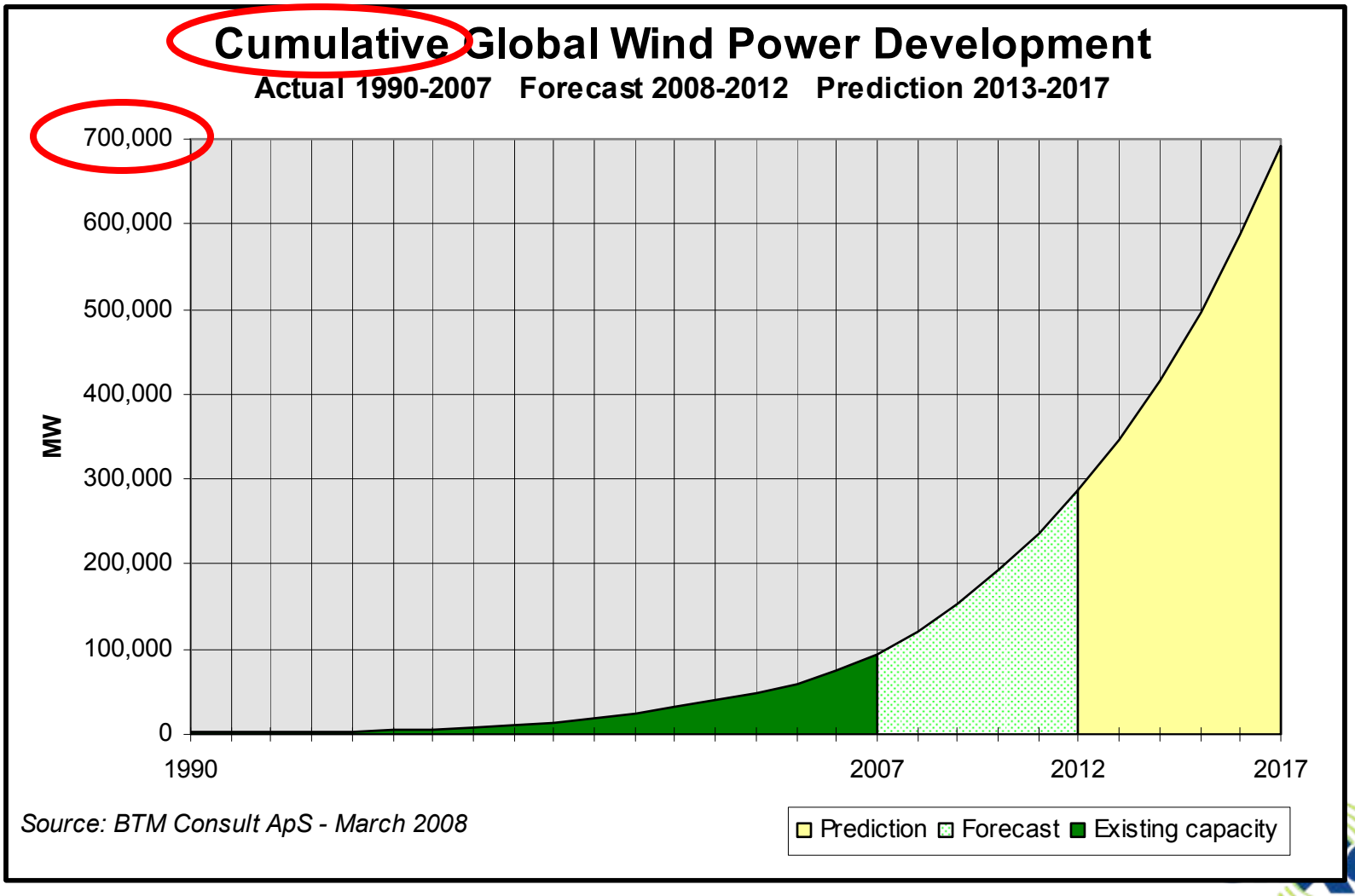
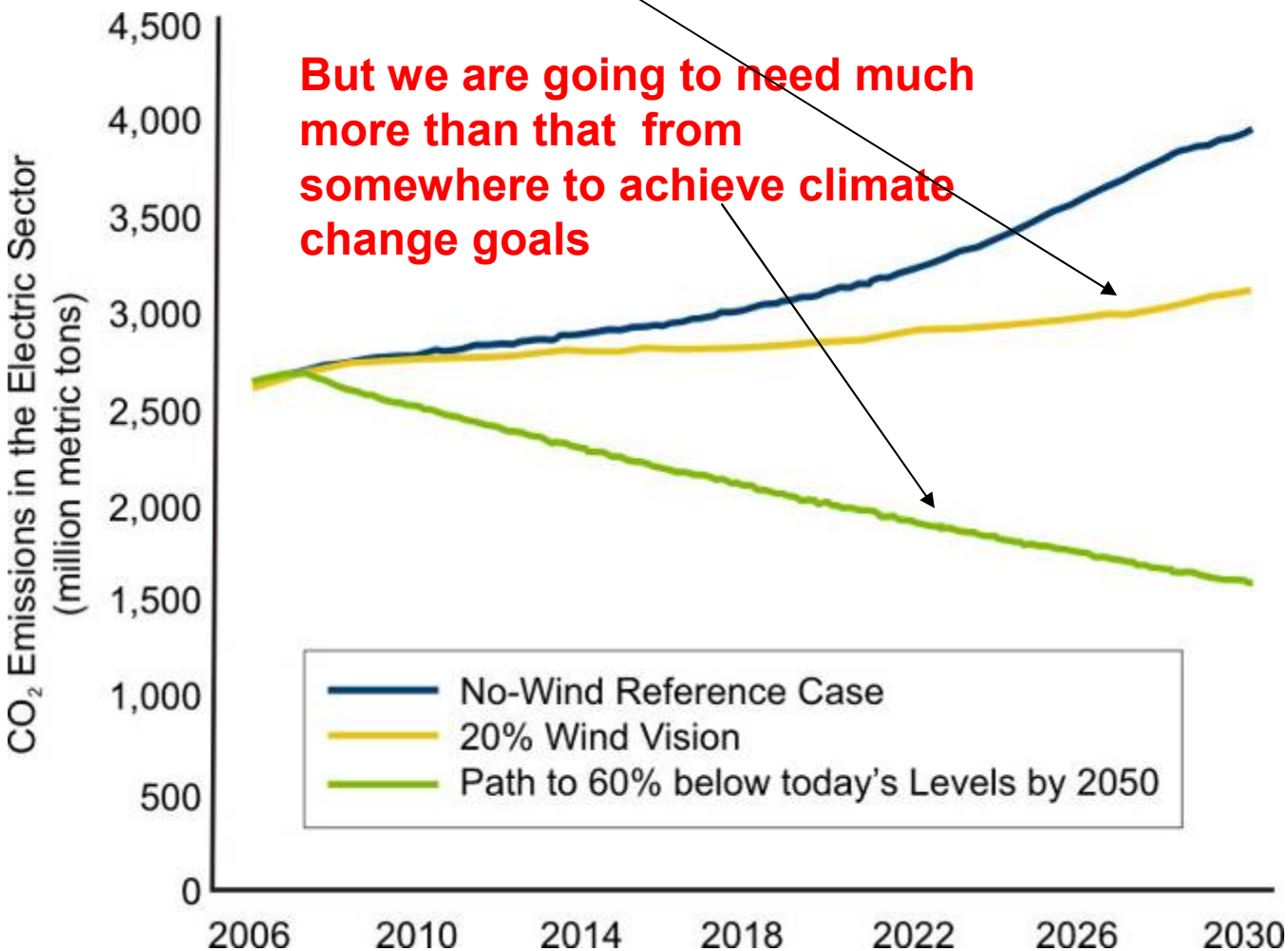


20% Wind Flattens Electric Industry CO_2 Emissions



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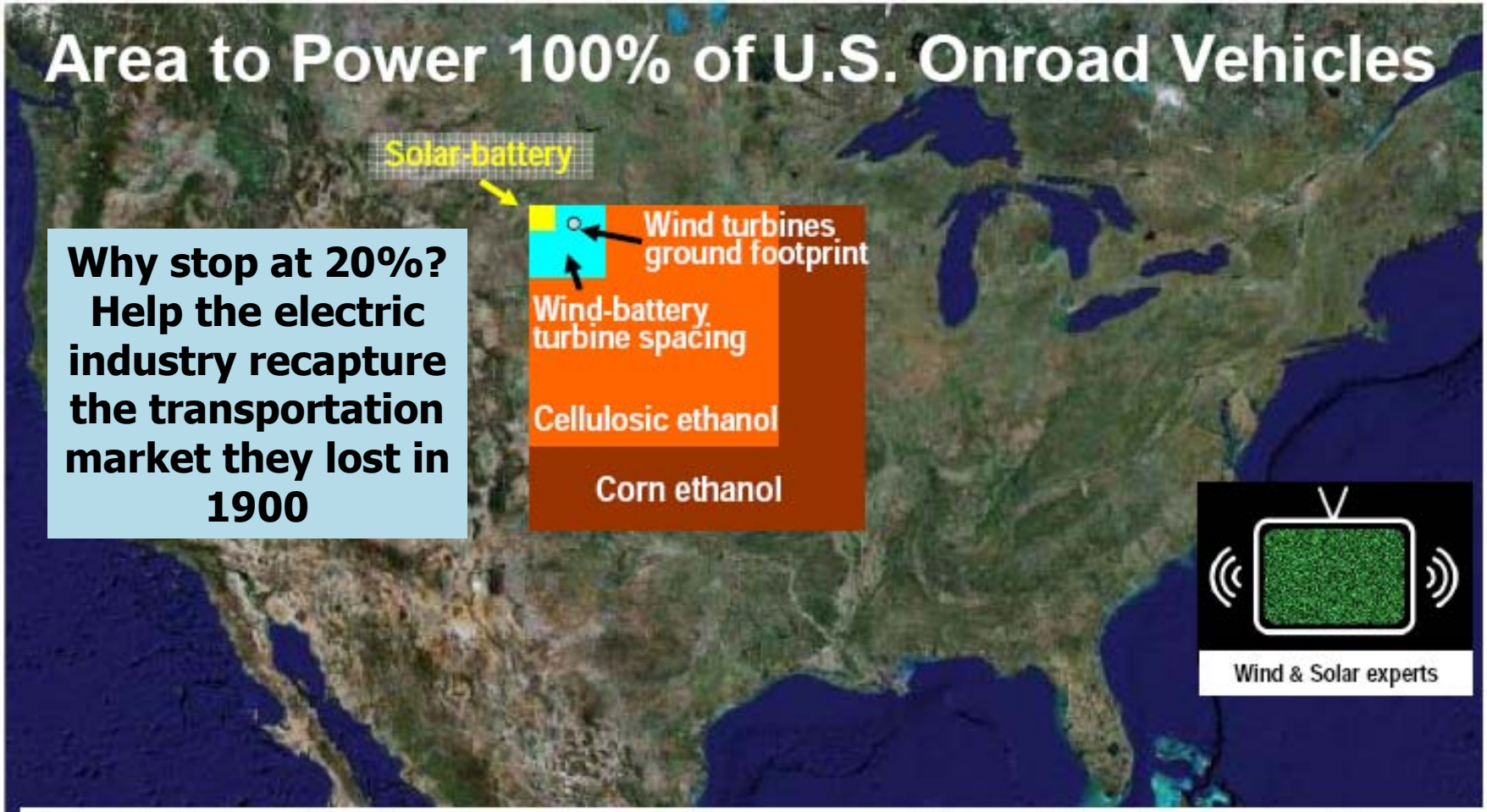


Solar-battery and Wind-battery refer to battery storage of these intermittent renewable resources in plug-in electric driven vehicles

WEB CALCULATOR- VISUALIZER – COMPARISON OF LAND NEEDED TO POWER VEHICLES

Mark Z. Jacobson, Wind Versus Biofuels for Addressing Climate, Health, and Energy, Atmosphere/Energy Program, Dept. of Civil & Environmental Engineering, Stanford University, March 5, 2007, http://www.stanford.edu/group/efmh/jacobson/E85vWindSol

What the report does well

- B&V Supply Curve an important result
- Long term overview of technology trends
- Useful job and economic development numbers
  - Though already see need for “net jobs” analysis to fully answer critics
- Good treatment of transmission and grid issues
- Manufacturing analysis offers hope on turbine supply side
- Recognizes importance of siting issues and implies some paths for addressing them (enXco a founding member of the American Wind Wildlife Institute – “AWWI”)
- Big step forward in analysis of overall costs and benefits of wind
- Exercised models and methods (WinDS, JEDI) for future use

What the 20% report is not

- It is not a guide to prospecting or a real lead generator
  - Mesoscale wind maps “impressionistic” and no substitute for developer prospecting and met program
  - Though surprising potential in some states could deserve some attention
- Ignores some important economics
  - Price elasticity of demand for wind power. At what point do we price ourselves out of the market?
- Avoided head to head technology comparison
  - Trends in relative pricing
  - European Commission’s ExternE analyses of externalities addresses key issues “off limits” in our own government
  - National Academy of Sciences taking up the externalities
- Ignored the transportation sector market potential
  - But this is not a near term issue for a developer

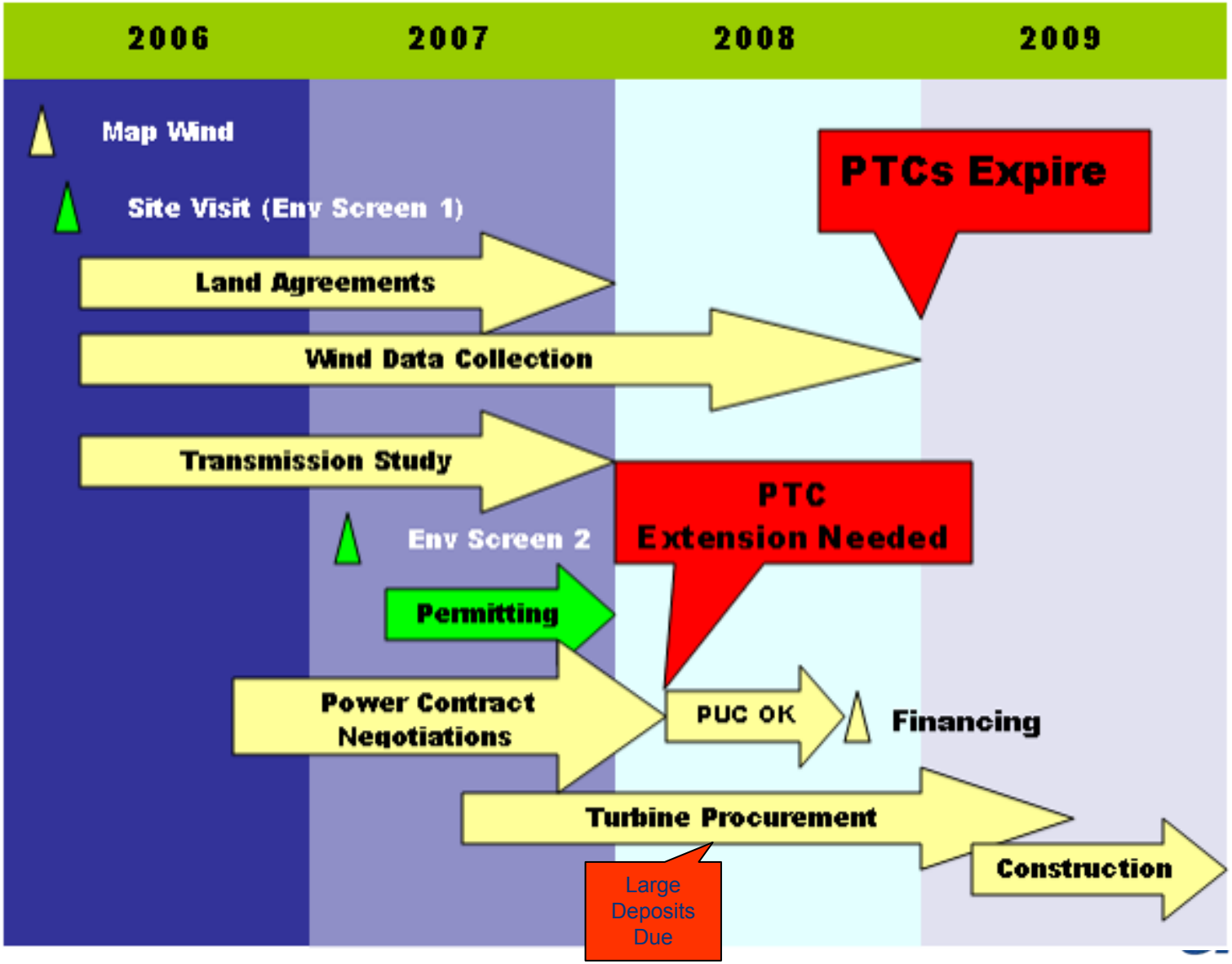
What the 20% report is not (2)

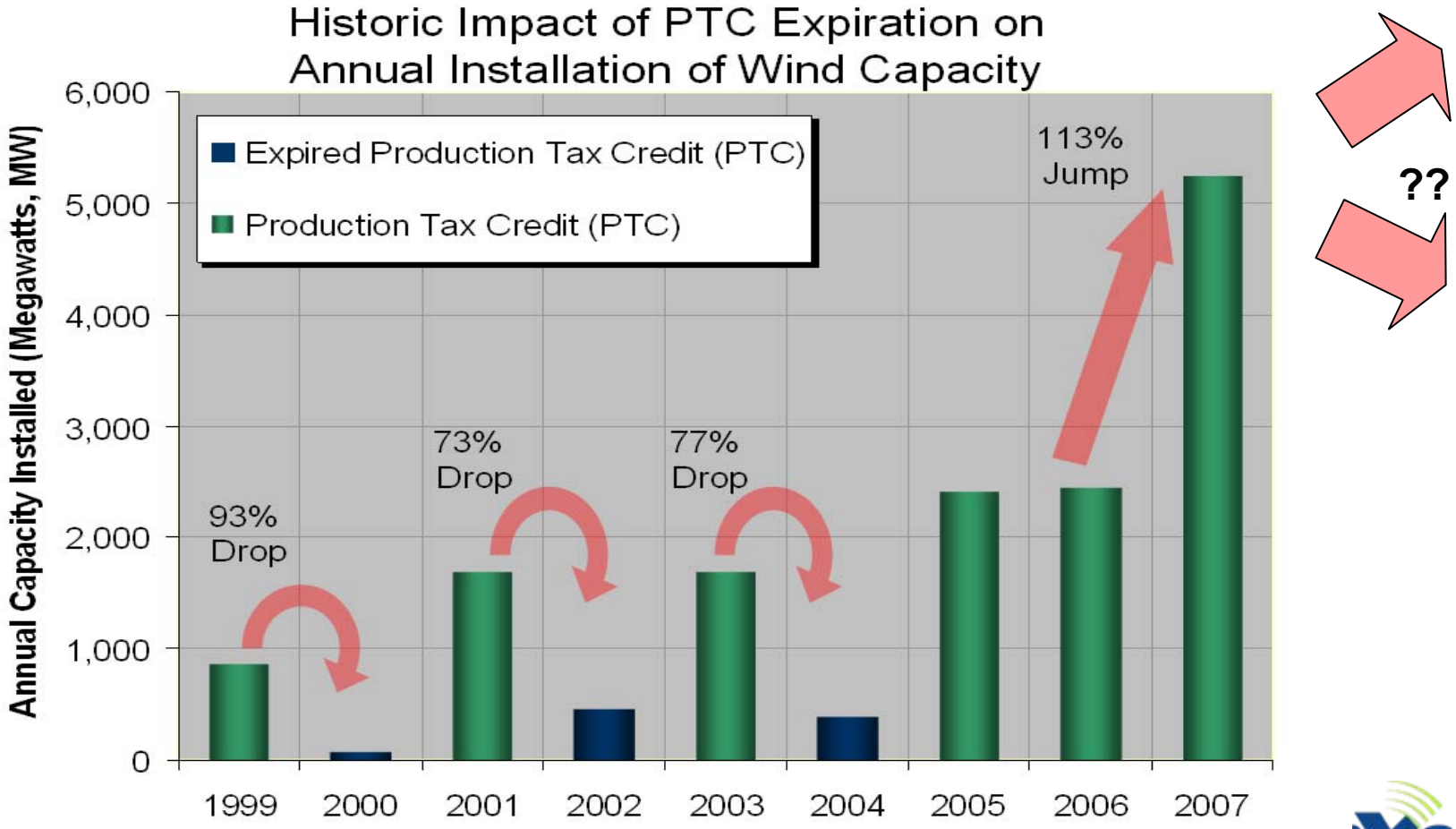
- Was intentionally not a policy analysis – yet lack of policy is the problem
  - But provided insights useful in policy in siting, transmission, other areas
- Is just one building block in the "portfolio of the future"
  - Wind, Solar, Efficiency, Smart Grid, Electric, biofuels and gas vehicles
- Does not drive home the point that wind is a "wedge" available now, not in 10 years or after some technical breakthrough

Conclusions

- A landmark work, whatever its limitations
- Unprecedented wind industry/government cooperative effort
- A good foundation to build on – keep developing the tools
- A timely confirmation that wind can make a huge contribution to energy needs, climate change and sustainable economic development
- A call to action that speaks for itself, even if diplomatically silent on controversial issues (national RES, externalities of conventional alternatives, opportunities for an industrial policy left to states to pursue)

"Lame Duck" Tax Extender Schedule Ignores Financial Commitment Timelines



Source: enXco, Inc., based on FPLE 2006

Uncertainty and Political Stalemate is the Worst Policy of All