

The future ain't what it used to be

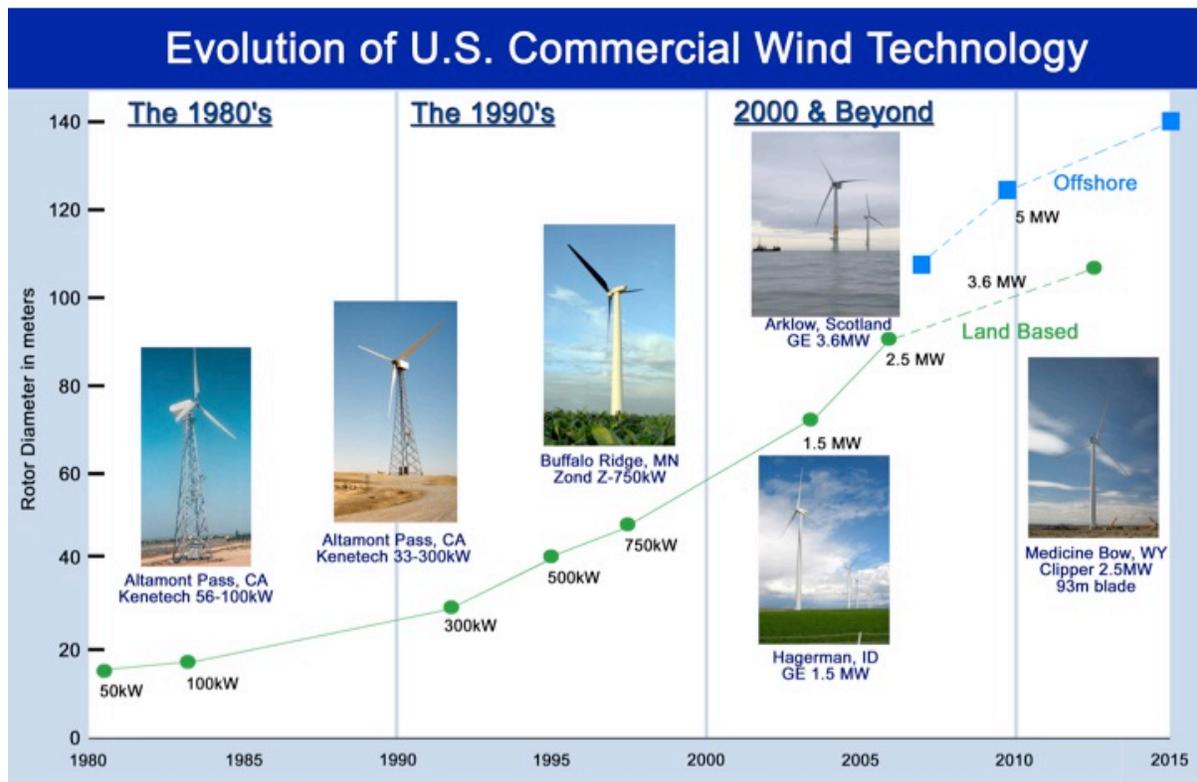


Larry Flowers

National Renewable Energy Laboratory

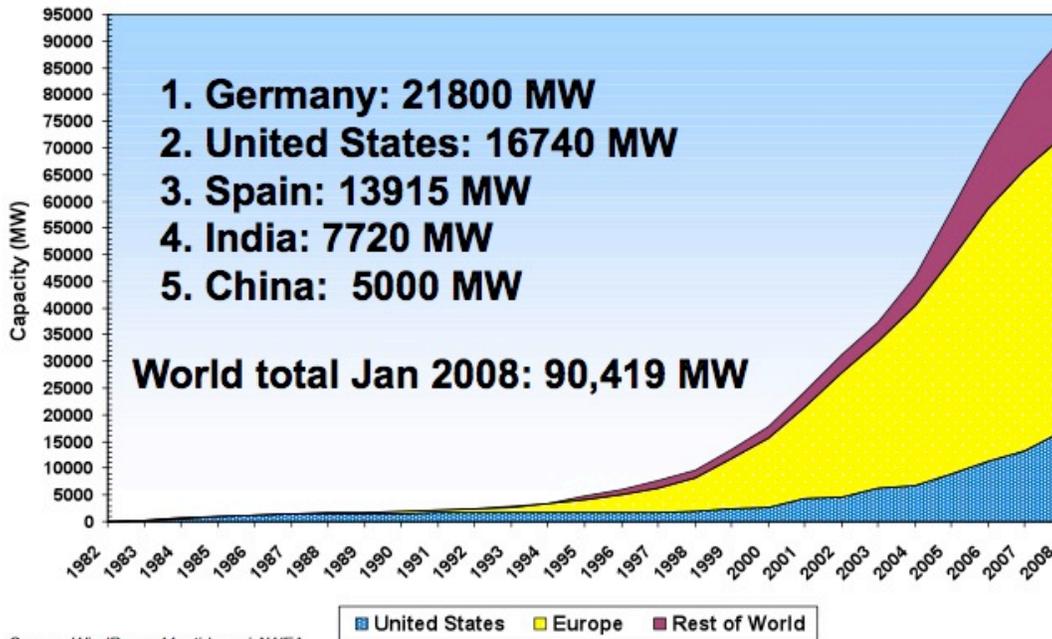
Anchorage, AK

April 2008



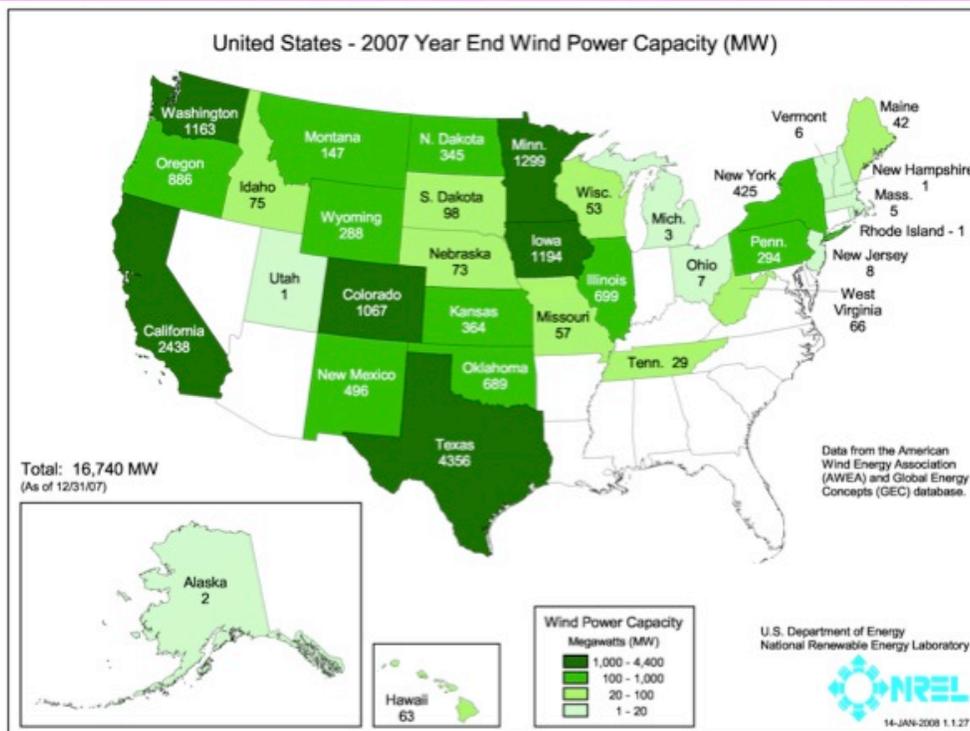
People Want Renewable Energy!

Total Installed Wind Capacity

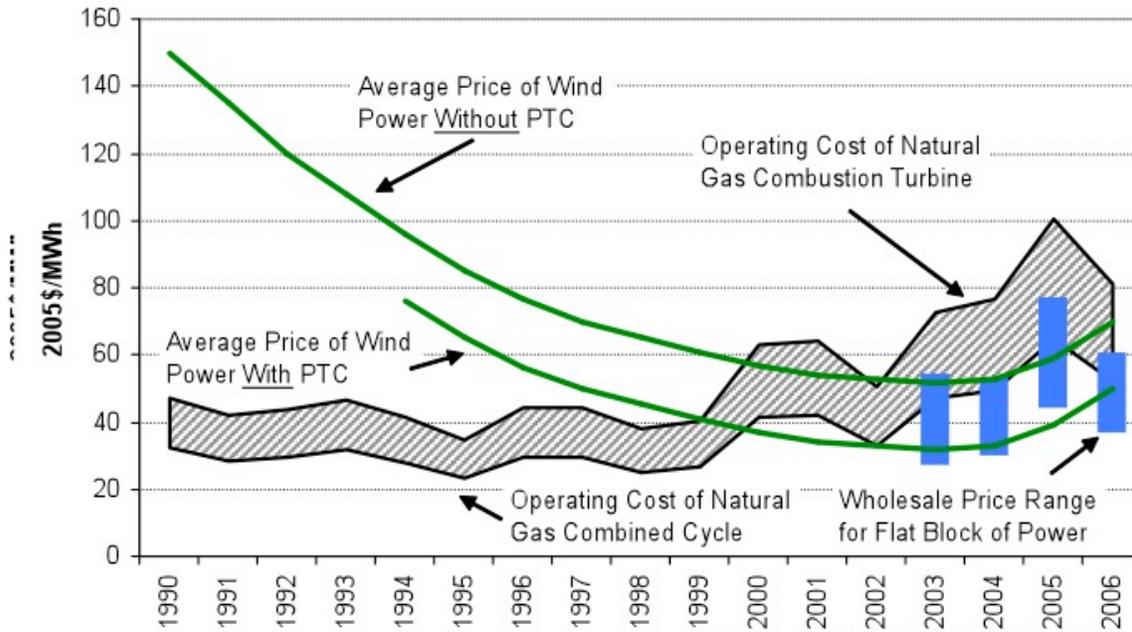


Source: WindPower Monthly and AWEA

Installed Wind Capacities

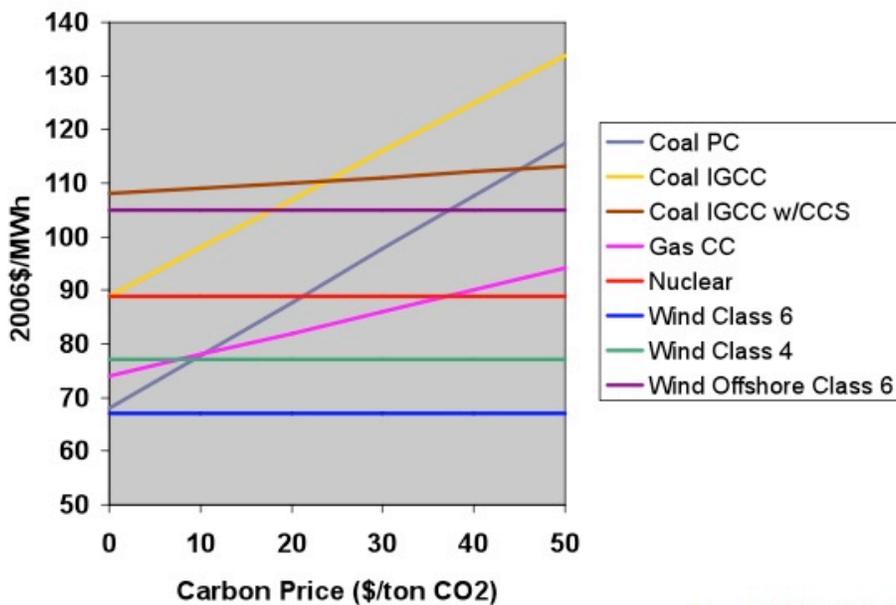


Comparative Generation Costs



CO₂ prices significantly increase the cost of coal

Levelized Cost of Electricity (2010) vs. CO₂ Price



Source: UCS/Black & Veatch



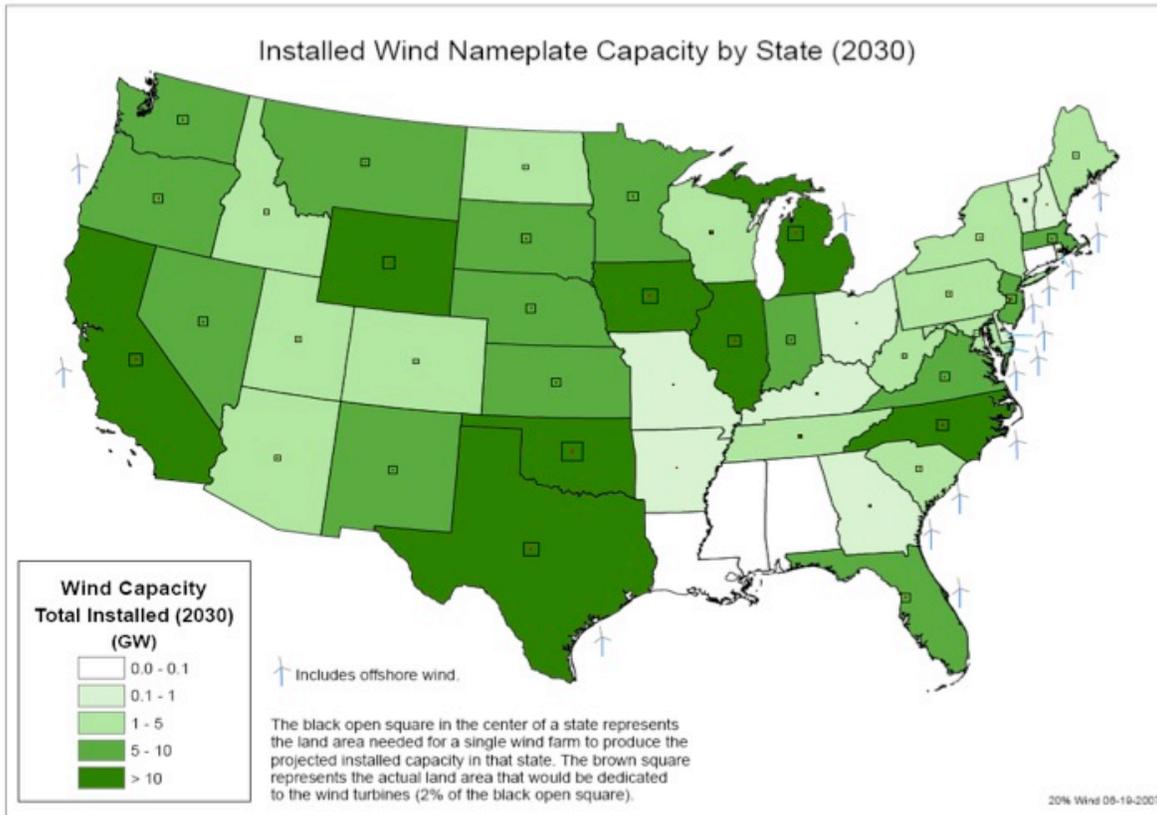
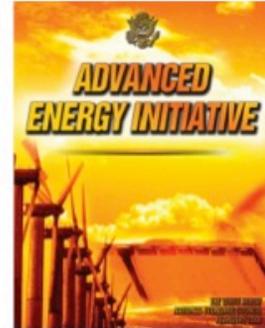
White House photo by Eric Draper

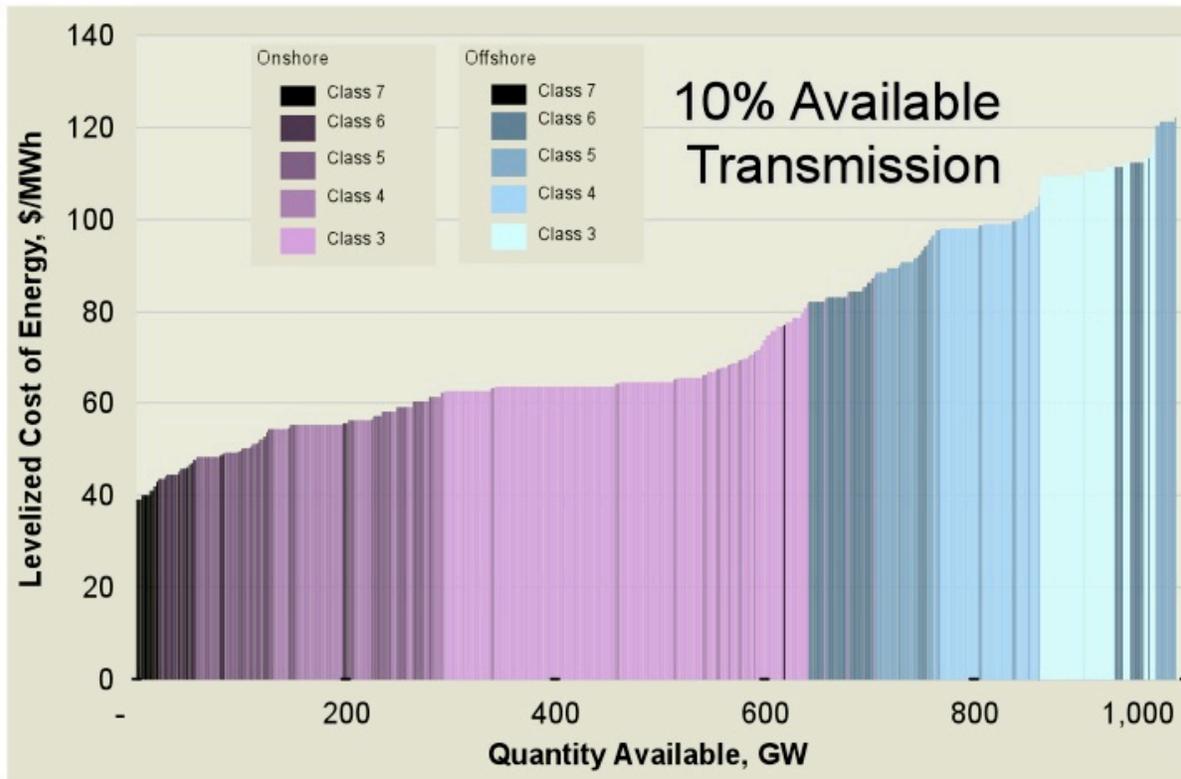
State of the Union Address

“...We will invest more in ...
revolutionary and...**wind technologies**”

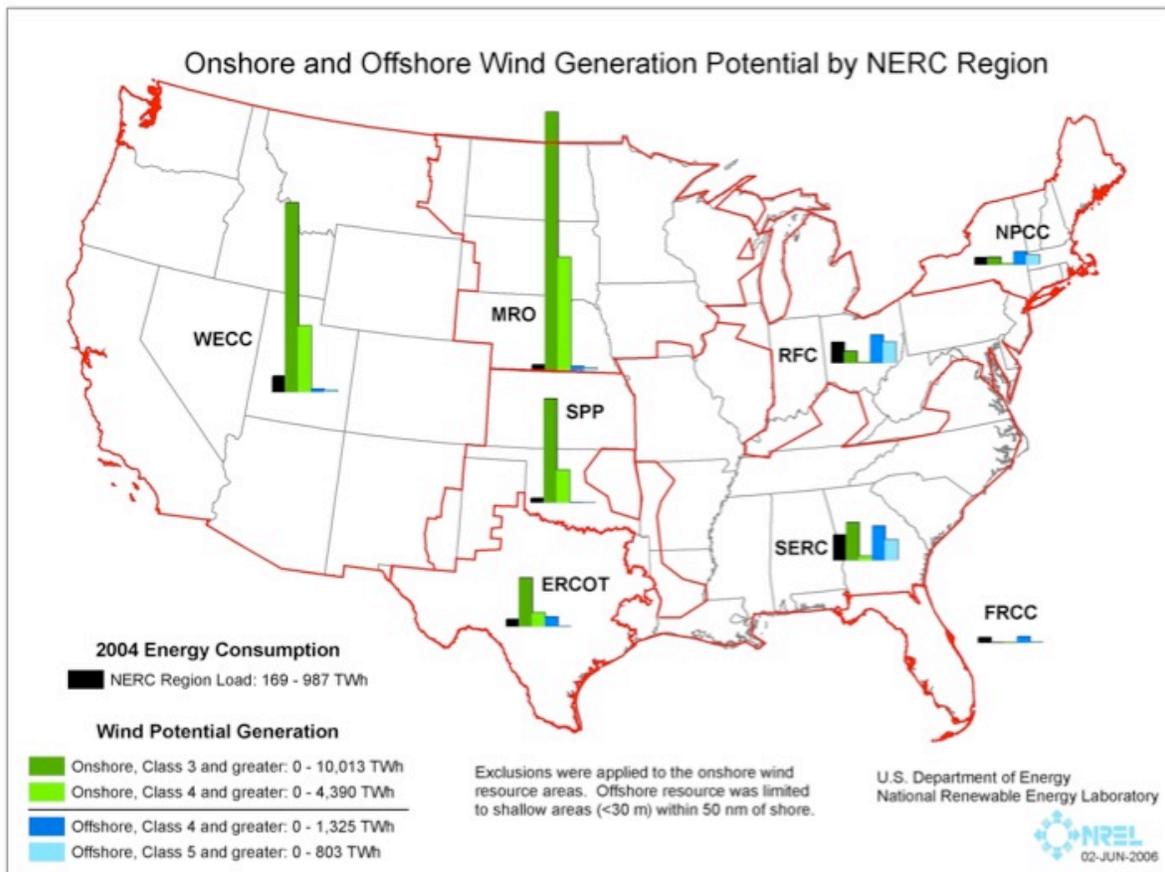
Advanced Energy Initiative

“Areas with good wind resources have the potential to **supply up to 20% of the electricity** consumption of the United States.”

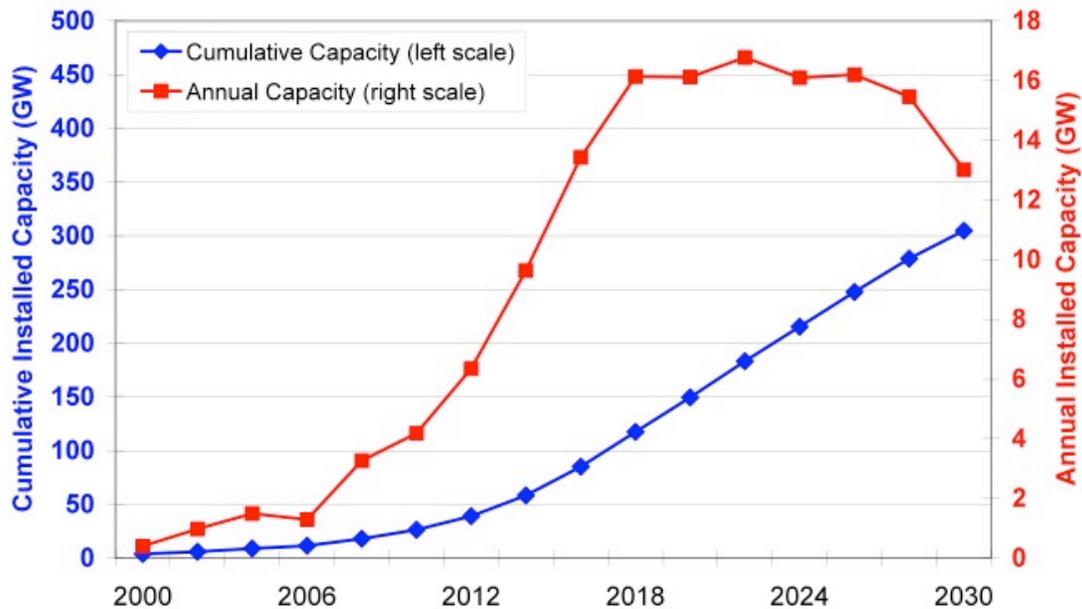




2010 Costs w/ PTC, \$1,600/MW-mile, w/o Integration costs



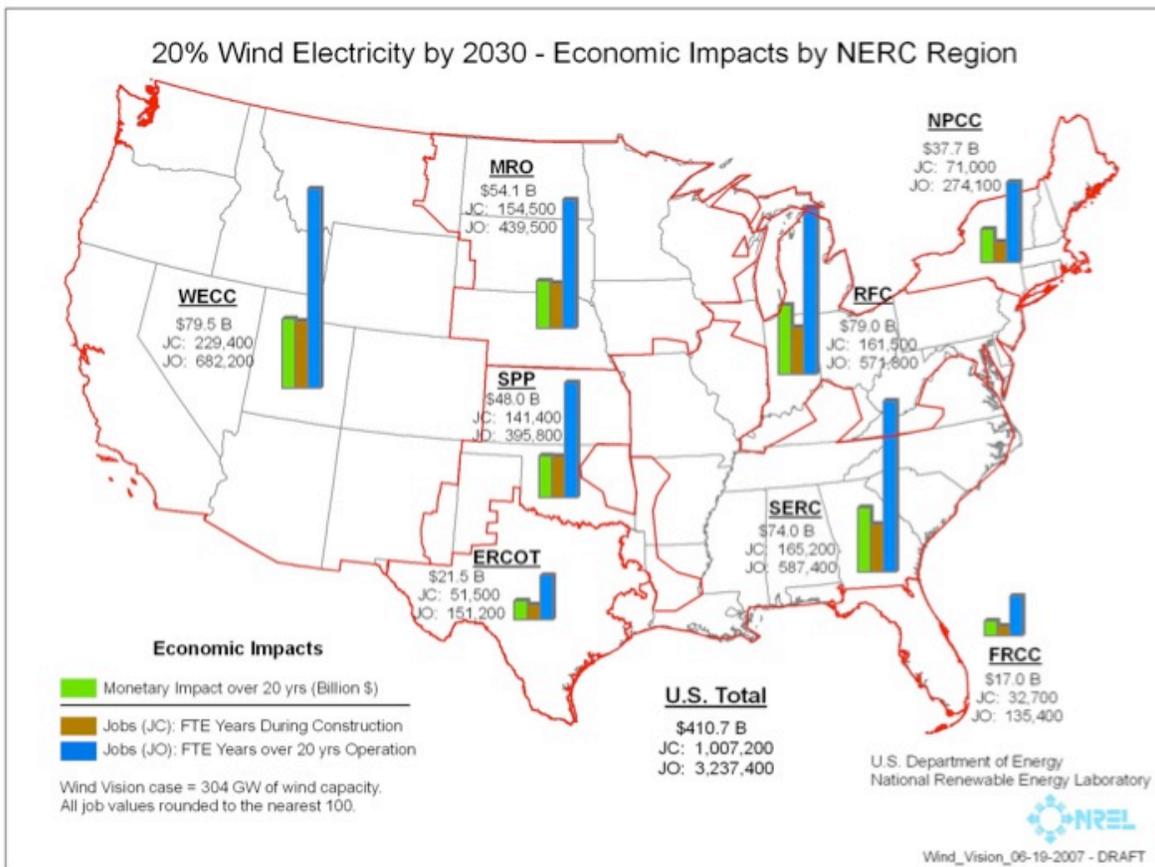
What does 20% Wind look like?



Source: AWEA 20% Vision

Market Challenges

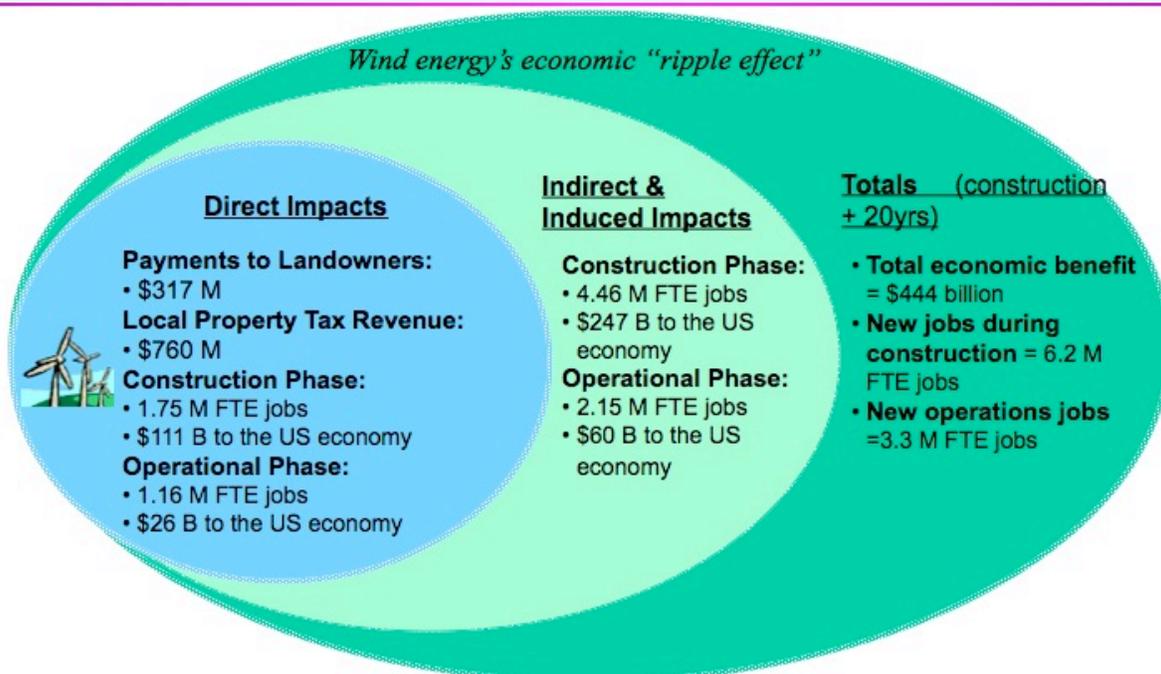
- National and state policy uncertainty
- Mixed stakeholder perspectives and knowledge
- Electricity supply planning based on capacity
- Variable wind output viewed as unreliable
- Incomplete comparative generation assessments
- Mismatch of wind and transmission development timeframes
- Federal lending all source requirements for G&T's
- Lack of interstate approach to transmission development
- Uncertainty in emerging emissions REC markets
- High cost and low turbine availability for community projects
- High cost and permitting challenges of <1 MW turbines



National (U.S.) – Economic Impacts Cumulative impacts between 2007-2030 (NPV)



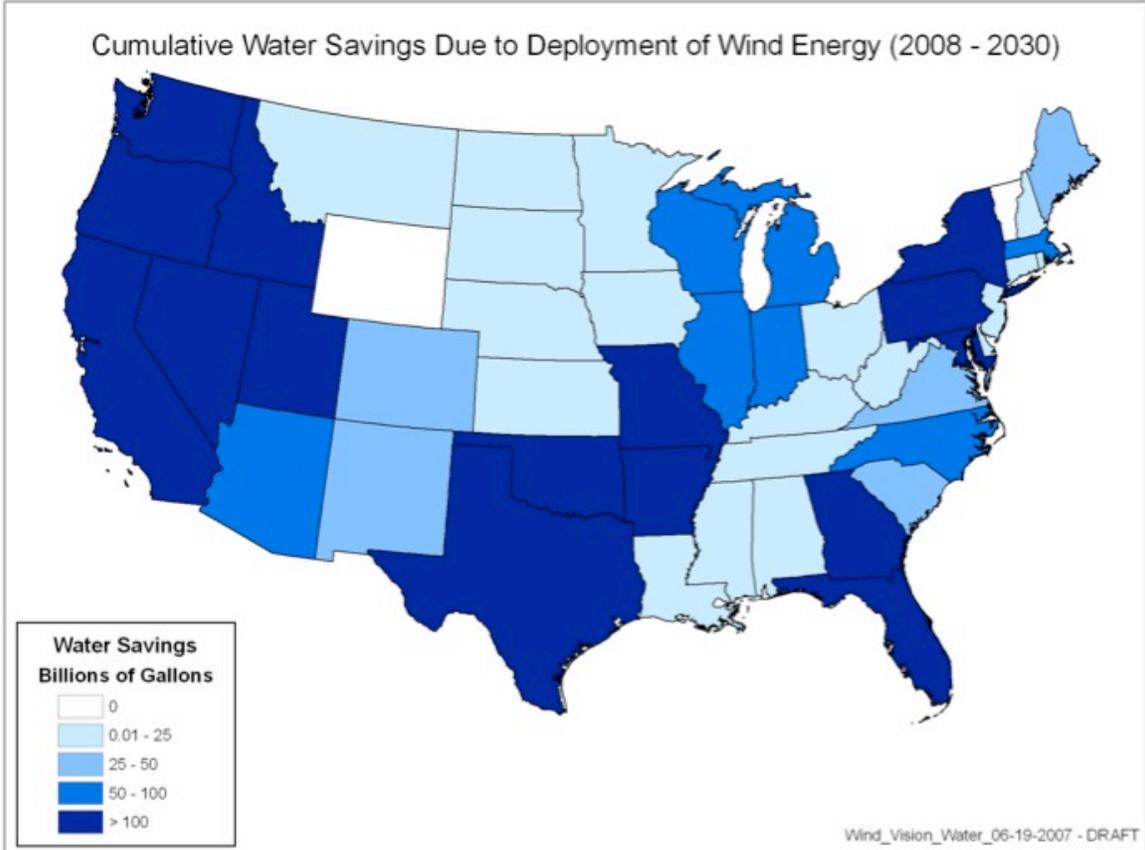
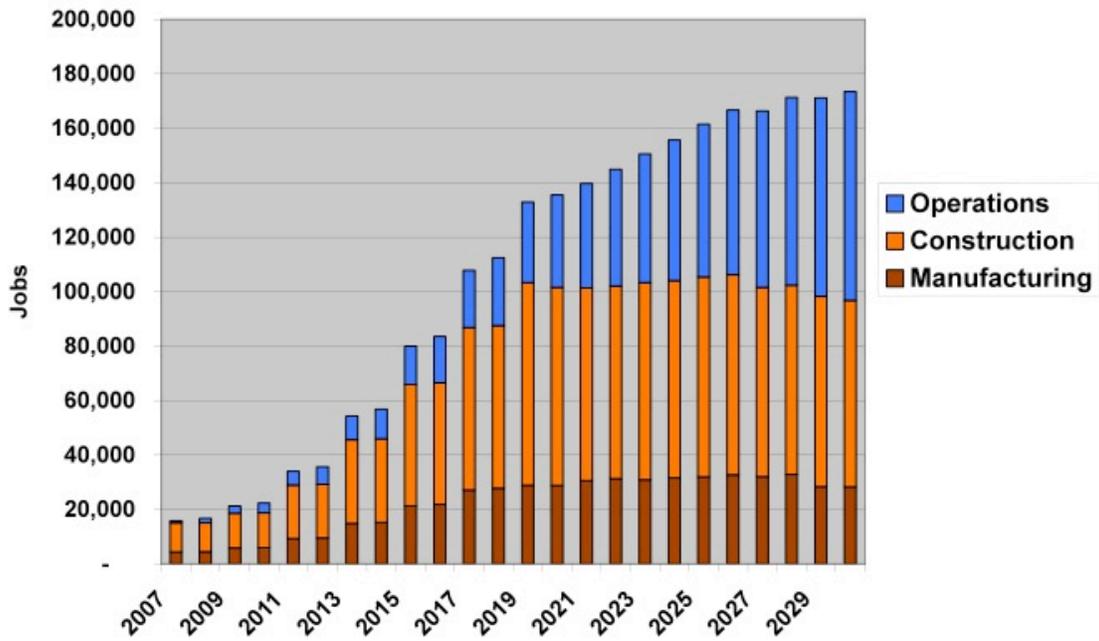
From the 20% Scenario- 300 GW new Onshore and Offshore development

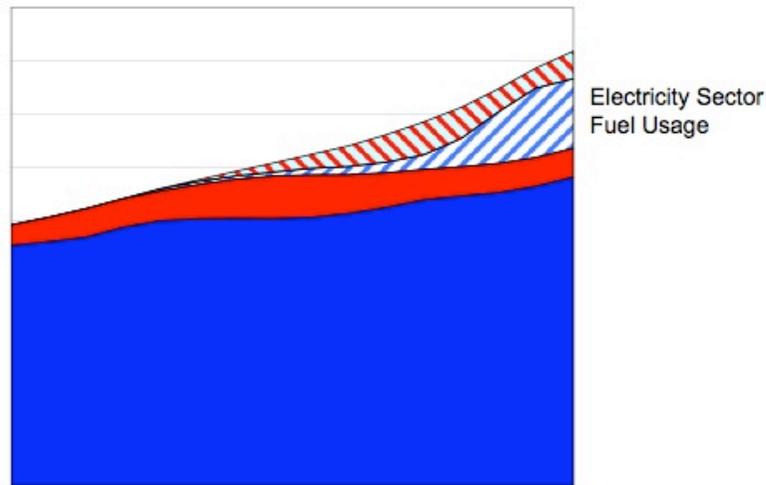


All monetary values are in 2006 dollars. Net present value (PV) adjustments are made based on a discount rate of 7%

Construction Phase = 1-2 years

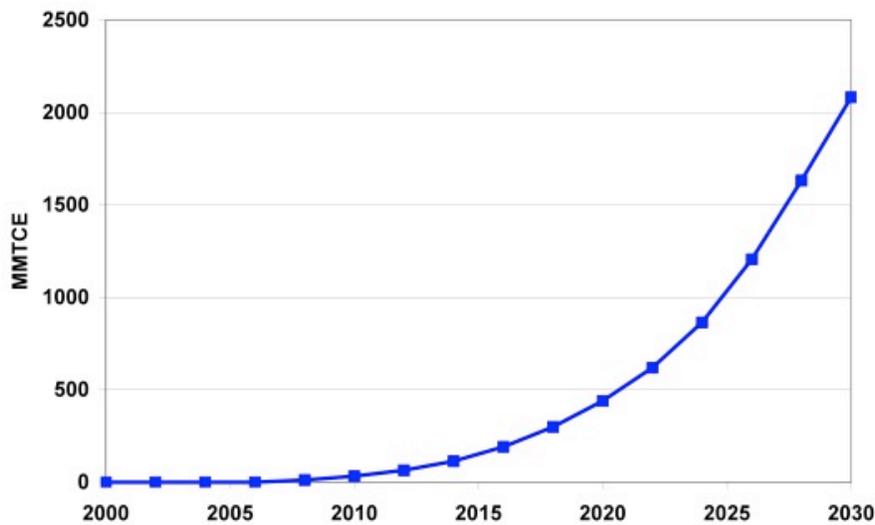
20% Wind Vision Employment





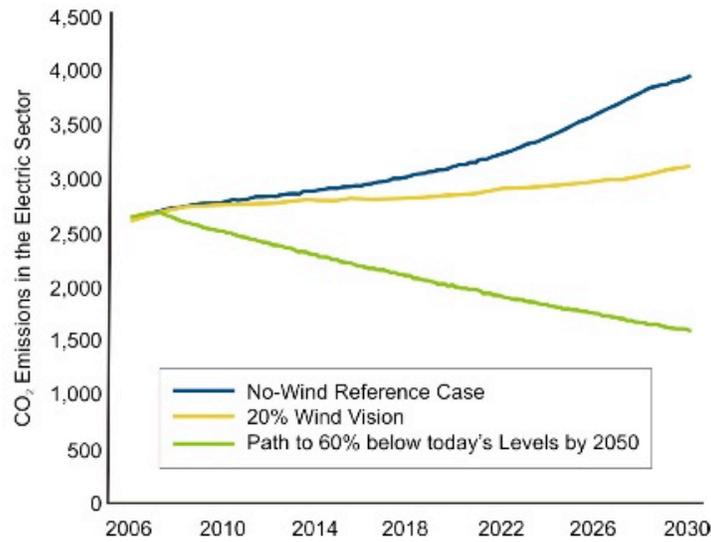
Reduction in National Gas Consumption in 2030 (%)	Natural Gas Price Reduction in 2030 (2006\$/MMBtu)	Present Value Benefits (billion 2006\$)	Levelized Benefit of Wind (\$/MWh)
11%	0.6 -1.1- 1.5	86 - 150 - 214	16.6 - 29 - 41.6

Cumulative Carbon Savings



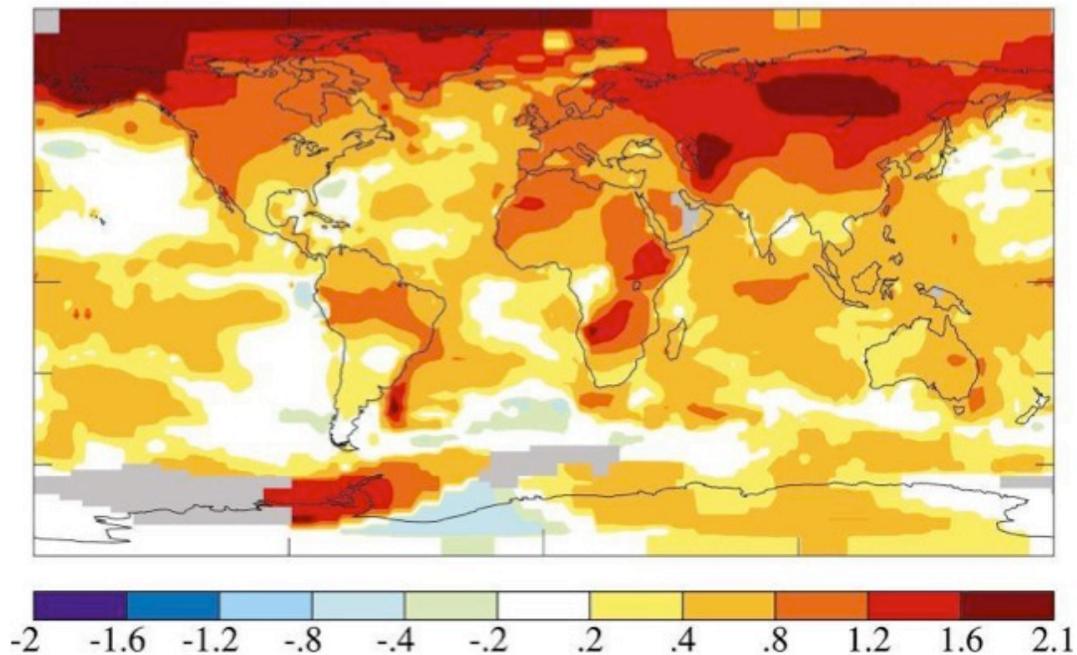
Cumulative Carbon Savings (2007-2050, MMTCE)	Present Value Benefits (billion 2006\$)	Levelized Benefit of Wind (\$/MWh-wind)
4,182 MMTCE	\$ 50 - \$145	\$ 9.7/MWh - \$ 28.2/MWh

Electric Sector CO₂ Emissions



The heating is not uniform geographically

Average T for 2001-2005 compared to 1951-80, degrees C



Current change: Coastal glaciers are retreating

Muir Glacier, Alaska, 1941-2004

August 1941



August 2004



NSIDC/WDC for Glaciology, Boulder, compiler. 2002, updated 2006. *Online glacier photograph database*. Boulder, CO: National Snow and Ice Data Center.



NASA

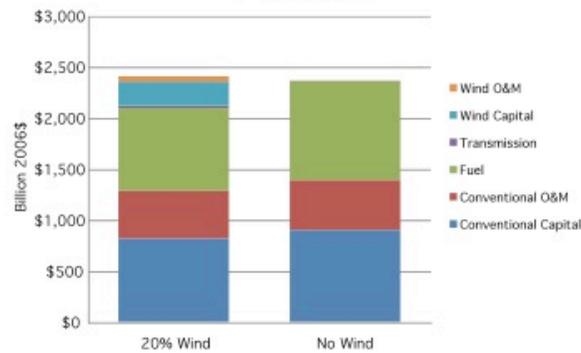
Sea ice is receding

Extent of Arctic summer ice in 1979 (top satellite image) and in 2003 (lower satellite image).

North Polar ice cap is sea ice -- it's floating and so does not change sea level when it melts.

But the reduced reflectivity when the ice is replaced by water amplifies the warming effect of greenhouse gases.

Incremental Cost of 20% Wind Vision



Vision Scenario	Present Value Direct Costs (billion 2006\$) ^a	Average Incremental Levelized Cost of Wind (\$/MWh-Wind) ^a	Average Incremental Levelized Rate Impact (\$/MWh-Total) ^a	Impact on Average Household Customer (\$/month) ^{**}
20% Wind	\$43 billion	\$8.6/MWh	\$0.6/MWh	\$0.5/month

^a 7% real discount rate is used, as per OMB guidance; the time period of analysis is 2007-2050, with WinDS modeling used through 2030, and extrapolations used for 2030-2050.
^{**} Assumes 11,000 kWh/year average consumption

Results: Costs & Benefits

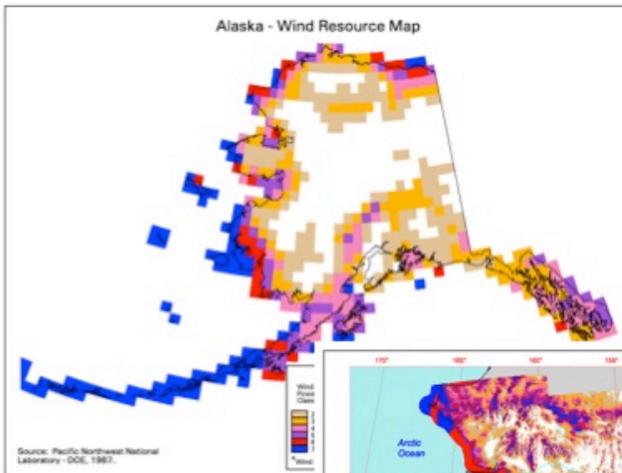
Incremental direct cost to society	\$43 billion
Reductions in emissions of greenhouse gasses and other atmospheric pollutants	825 M tons (2030) \$98 billion
Reductions in water consumption	8% total electric 17% in 2030
Jobs created and other economic benefits	140,000 direct \$450 billion total
Reductions in natural gas use and price pressure	11% \$150 billion
Net Benefits: \$205B + Water savings	

1. Wind energy provides multiple benefits at the national, regional, state, and local levels
2. Targeted messages and education are needed for the diverse set of stakeholder interests and perspectives, including regional variations in same.
3. Convergence of energy security, carbon liability and fuel uncertainty concerns is likely to transform the market for US electricity supply.
4. Federal and state policies are needed for a diversified and robust wind energy portfolio
5. Community and distributed wind are important building blocks for public acceptance of a 20% wind future.
6. Resource planning and procurement should maximize use of low marginal cost, zero-emissions energy resources, which displace more expensive fossil fuel

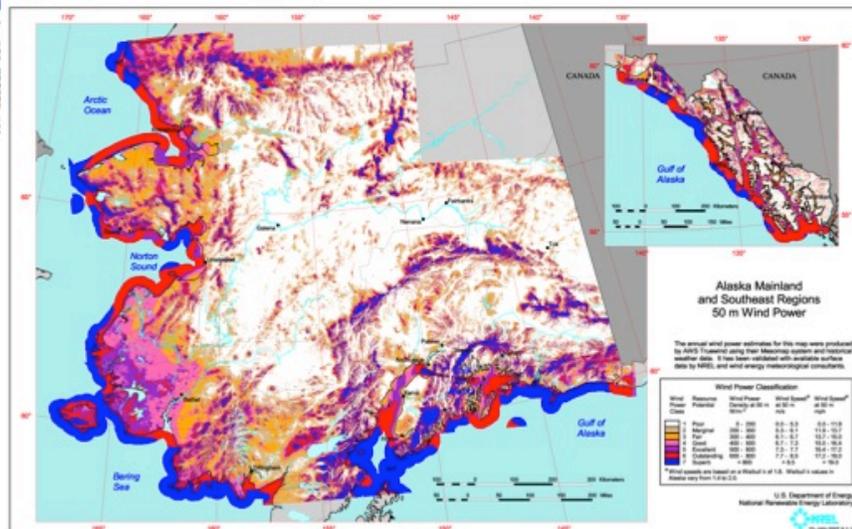
7. All environmental (including water savings) and economic impacts and risks should be included in comparative resource economics.
8. Wind is the crop of the 21st Century for rural America, and the resulting economic benefits need to be included in comparative assessments of generation options.
9. Wind deployment can ramp up rapidly and incrementally to meet local and regional load growth.
10. The federal sector (both facilities and transmission) represents significant opportunities for leadership in use and transmission of wind.
11. Meeting most load growth with wind power buys time for the development and commercialization of advanced coal technologies able to sequester carbon.
12. In air quality markets, policies need to be crafted carefully to account for non-emitting technologies.

Conclusions

- 20% wind energy penetration is possible
- 20% penetration is not going to happen under business as usual scenario
- Policy choices will have a large impact on assessing the timing and rate of achieving a 20% goal
- Key Issues: market transformation, transmission, project diversity, technology development, policy, public acceptance
- 20% Vision report: Spring 2008



Alaska Wind Resource





Carpe Ventem



www.windpoweringamerica.gov