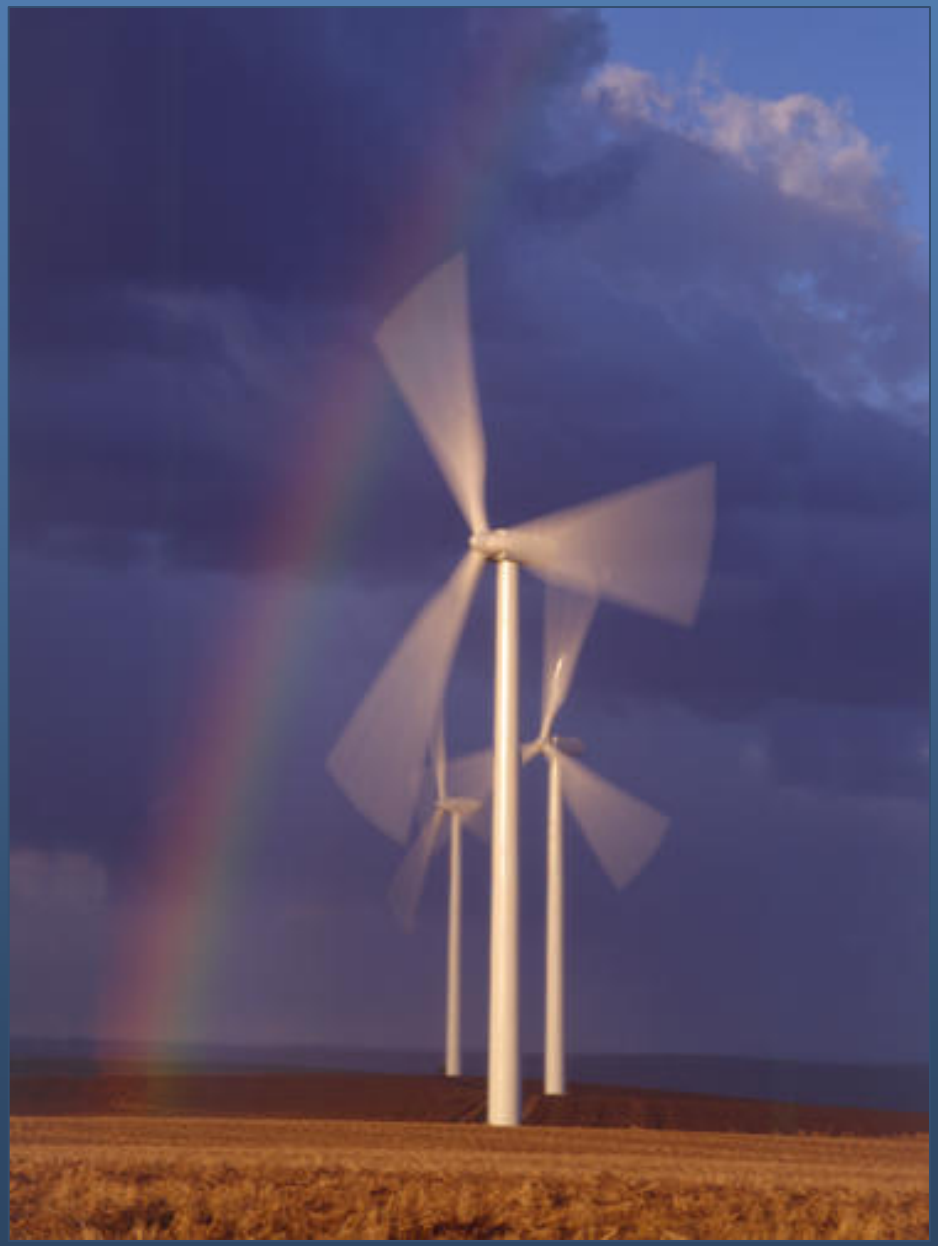
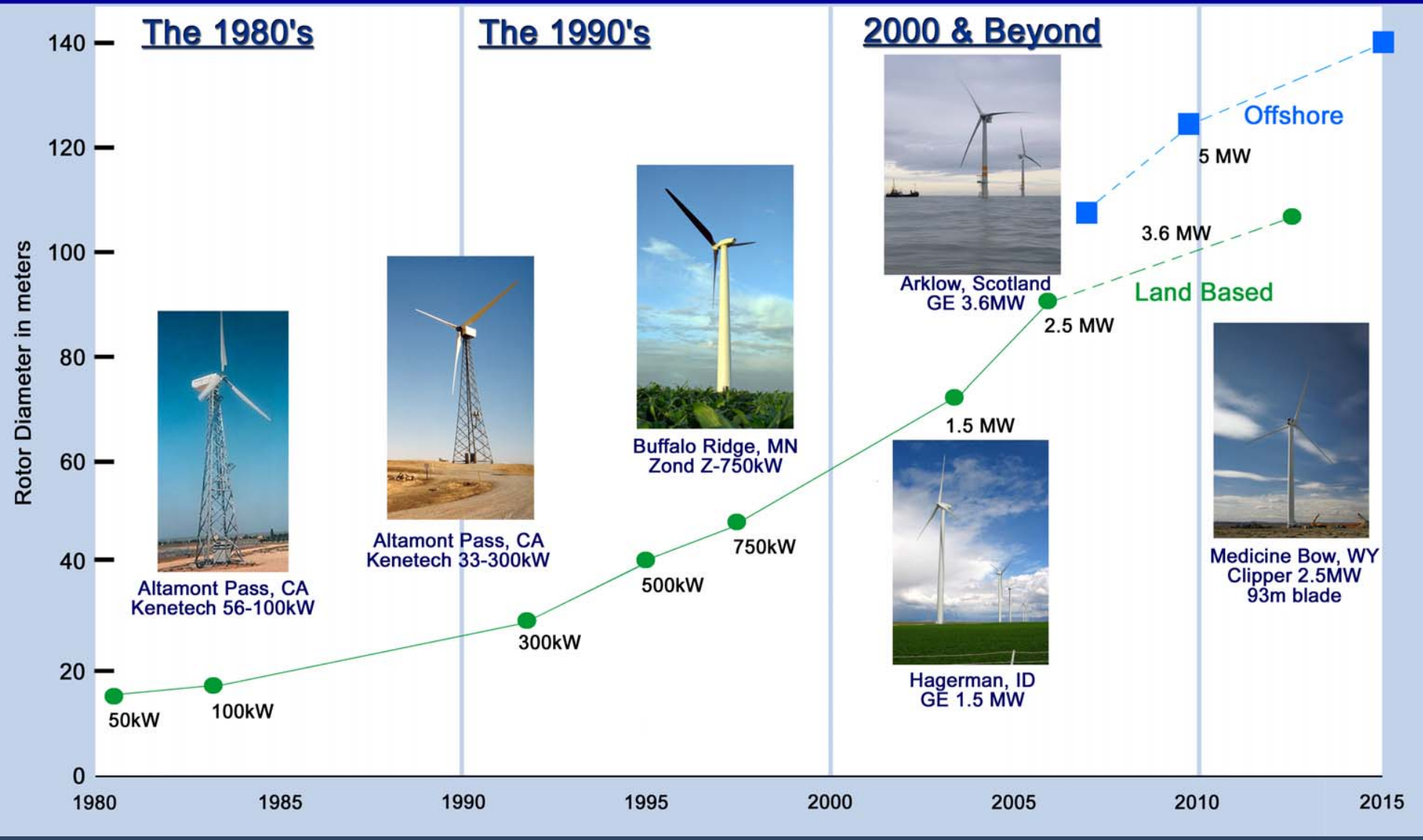
Wind Energy: 20% Future Scenario

Wind for Schools Summit

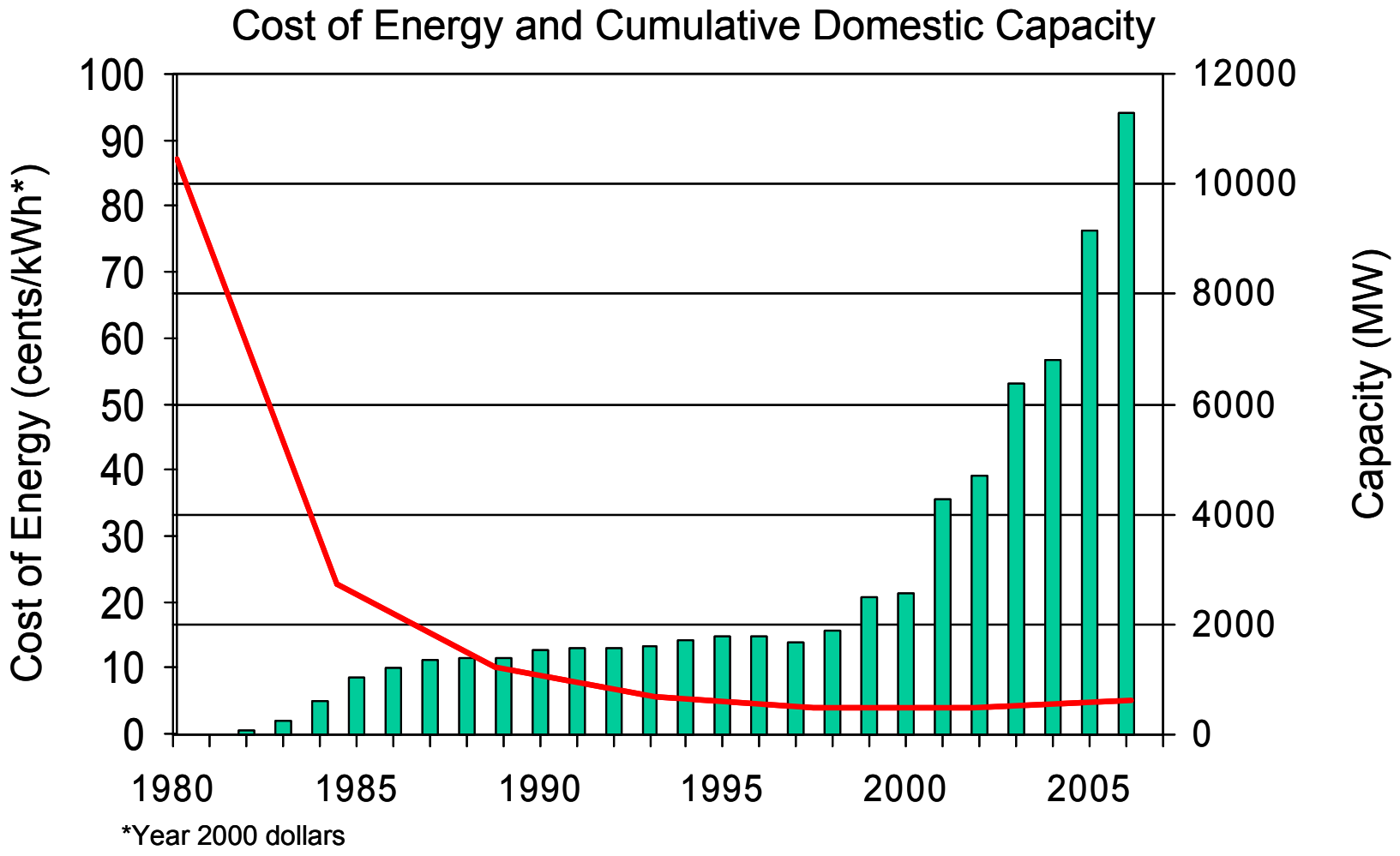
Larry Flowers, NREL
September 13, 2007



Evolution of U.S. Commercial Wind Technology



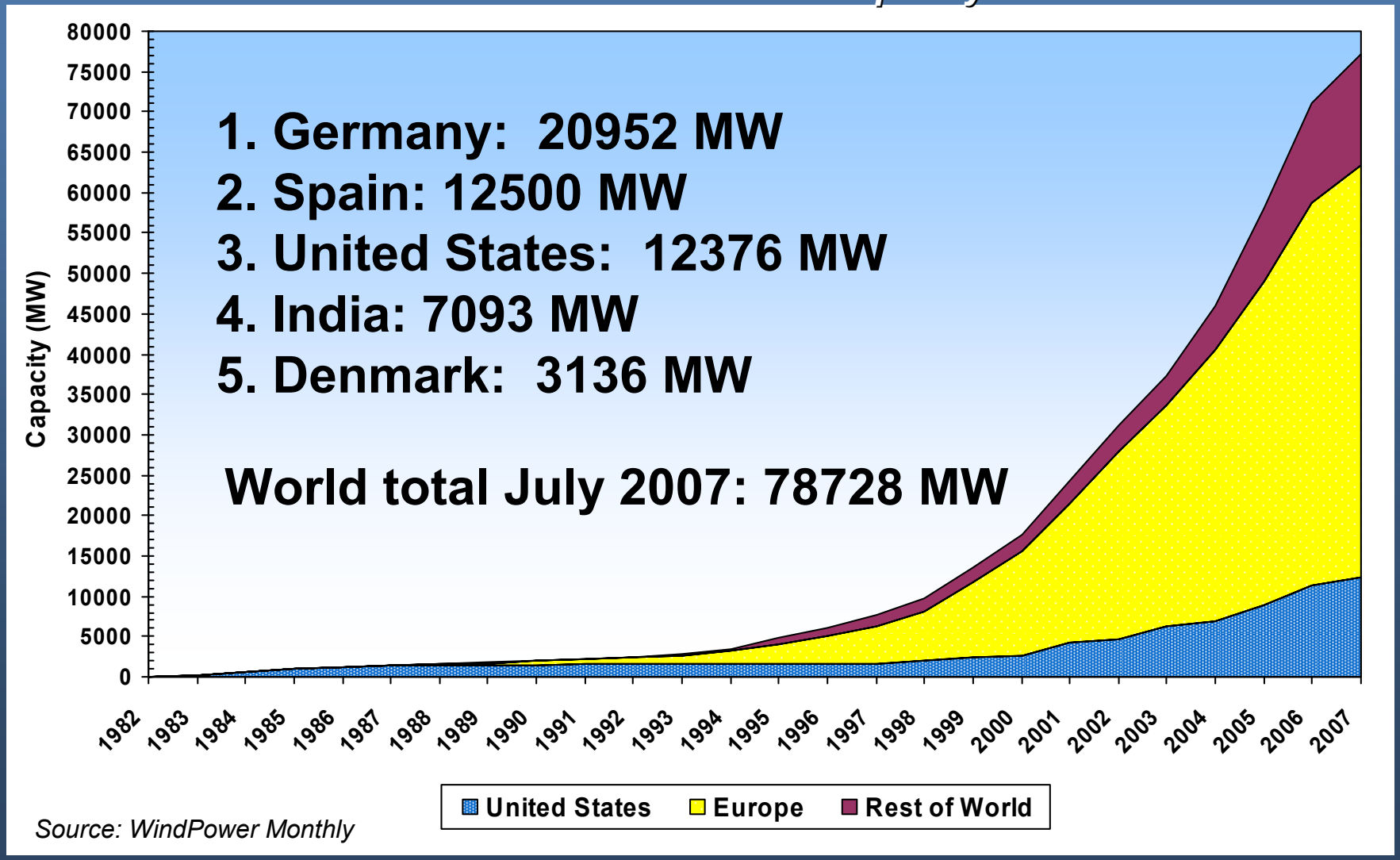
Capacity & Cost Trends



Increased Turbine Size - R&D Advances - Manufacturing Improvements

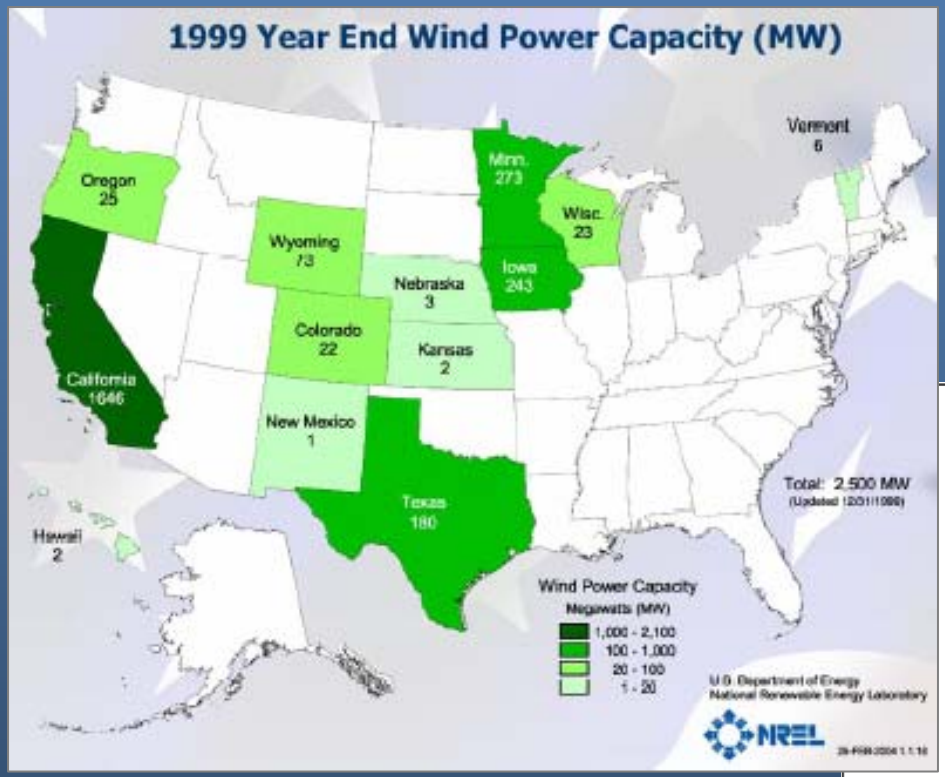
People Want Renewable Energy!

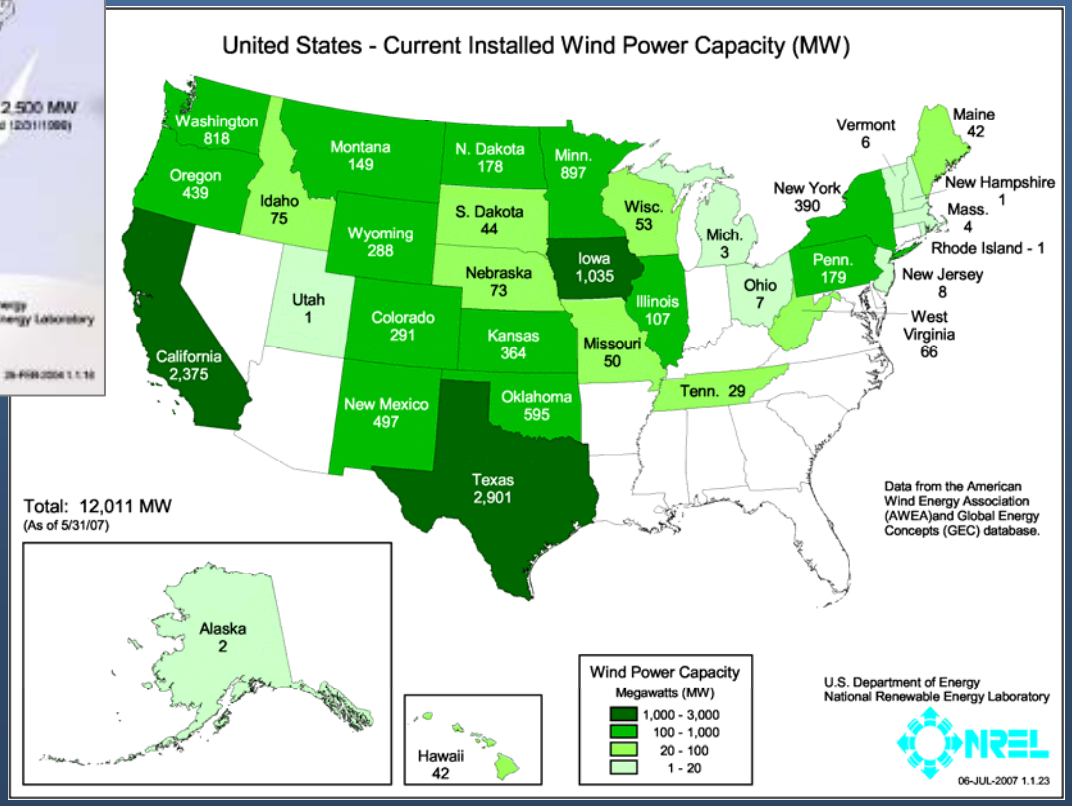
Total Installed Wind Capacity



Source: WindPower Monthly

Installed Wind Capacities (99-May 07)

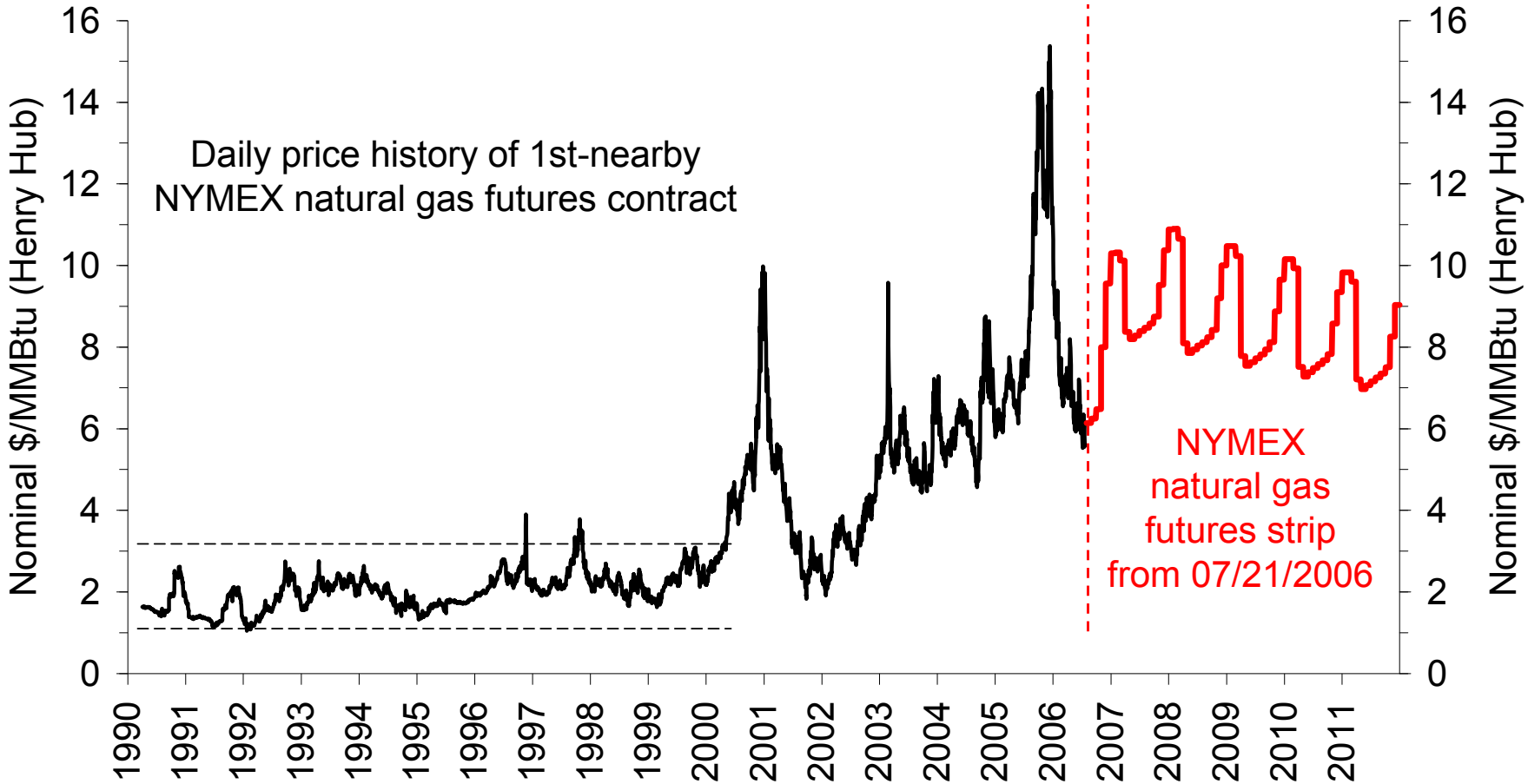




Drivers for Wind Power

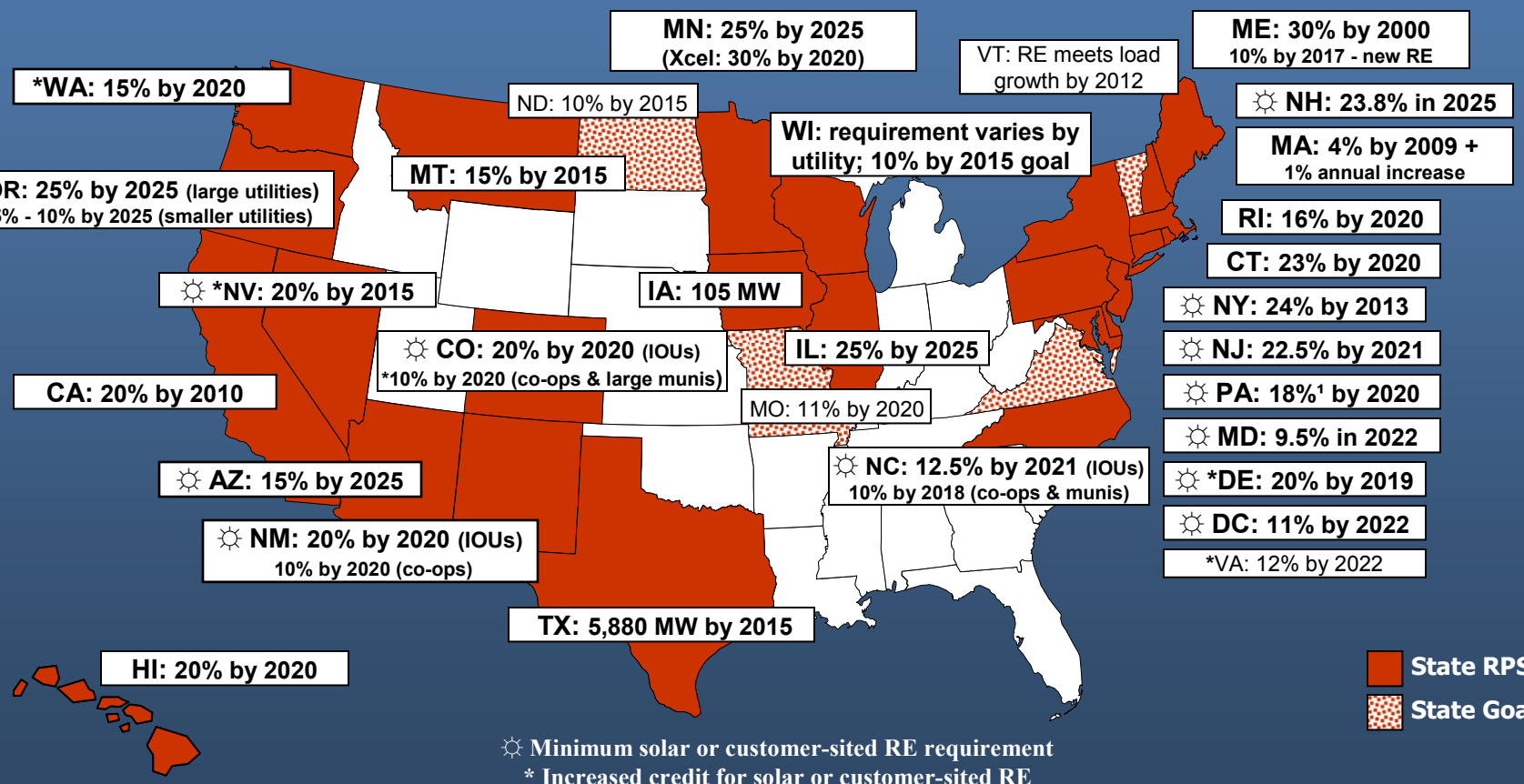
- Declining Wind Costs
- Fuel Price Uncertainty
- Federal and State Policies
- Economic Development
- Green Power
- Energy Security

Natural Gas – Historic Prices



Source: LBNL

Renewables Portfolio Standards



☼ Minimum solar or customer-sited RE requirement
* Increased credit for solar or customer-sited RE
¹PA: 8% Tier I / 10% Tier II (includes non-renewables); SWH is a Tier II resource

Wind Energy Investors

GE

SIEMENS

bp BP Solar

JOHN DEERE

FPL

Vestas

AEP AMERICAN ELECTRIC POWER

Gamesa

Xcel Energy Windsource®

AES

MIDAMERICAN ENERGY HOLDINGS COMPANY

Goldman Sachs

Environmental Benefits

- No SOx or NOx
- No particulates
- No mercury
- No CO2
- No water

Key Issues for Wind Power

- Policy Uncertainty
- Siting and Permitting: avian, noise, visual, federal land
- Transmission: FERC rules, access, RTO formation, new lines
- Operational impacts: intermittency, ancillary services, allocation of costs
- Accounting for non-monetary value: green power, no fuel price risk, reduced emissions

A New Vision

For Wind Energy in the U.S.

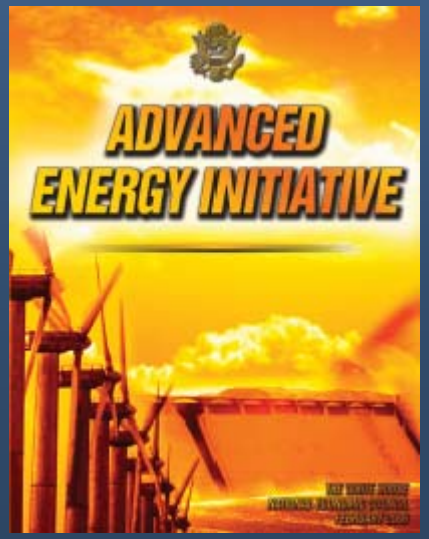
White House photo by Eric Draper

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."



20% Wind-Electricity Vision

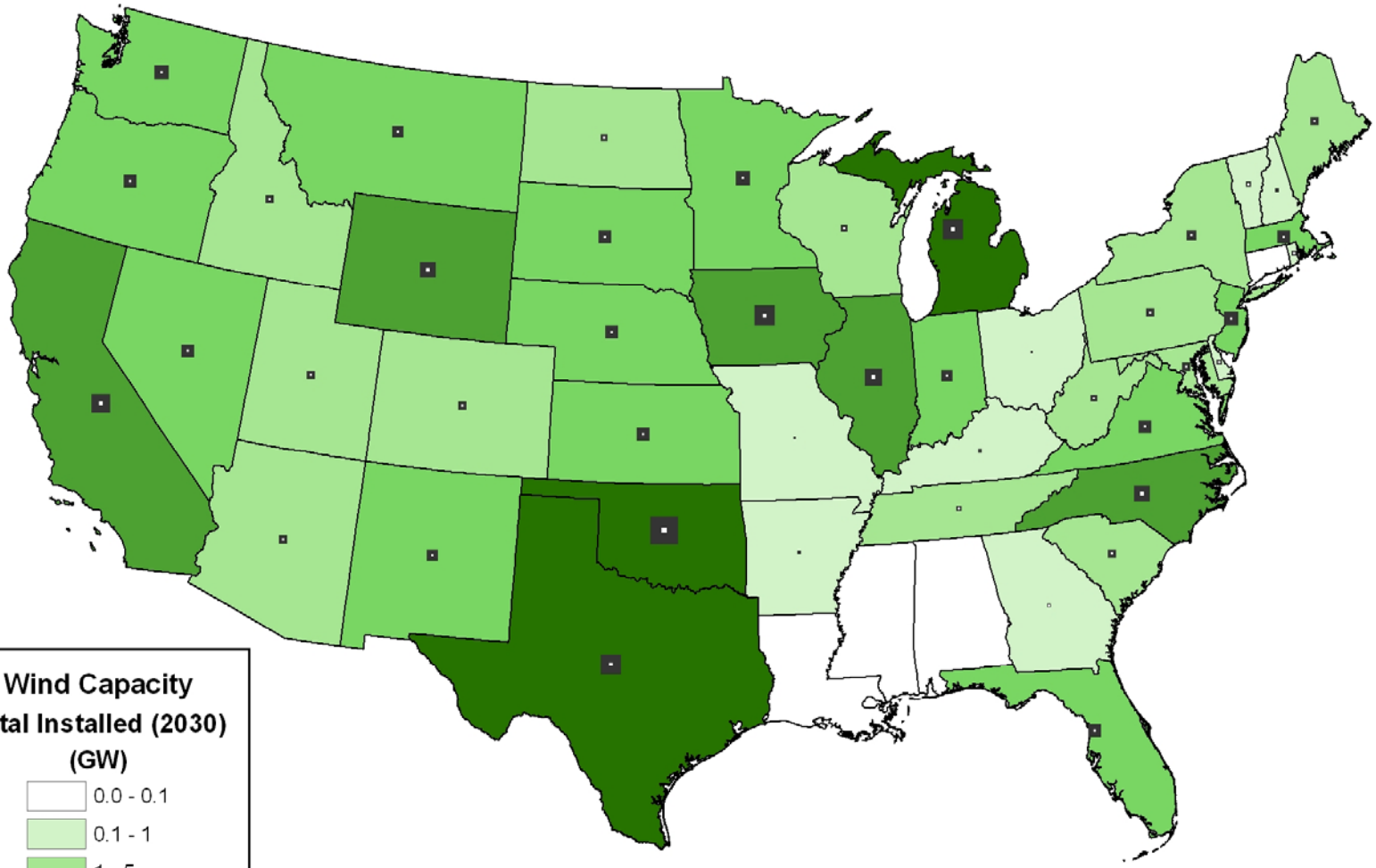
Wind energy will provide 20% of U.S. electricity needs by 2030, securing America's leadership in reliable, clean energy technology. As an inexhaustible and affordable domestic resource, wind strengthens our energy security, improves the quality of the air we breathe, slows climate change, and revitalizes rural communities.

awea
american wind energy association

“The future ain’t what it used to be.”

- Yogi Berra

Installed Wind Nameplate Capacity by State (2030)



Wind Capacity Total Installed (2030) (GW)

- 0.0 - 0.1
- 0.1 - 1
- 1 - 5
- 5 - 10
- 10 - 20
- > 20

The black square in the center of a state represents the land area needed for a single wind farm to produce the projected installed capacity in that state. The white square represents the actual land area that would be dedicated to the wind turbines (2% of the black square).

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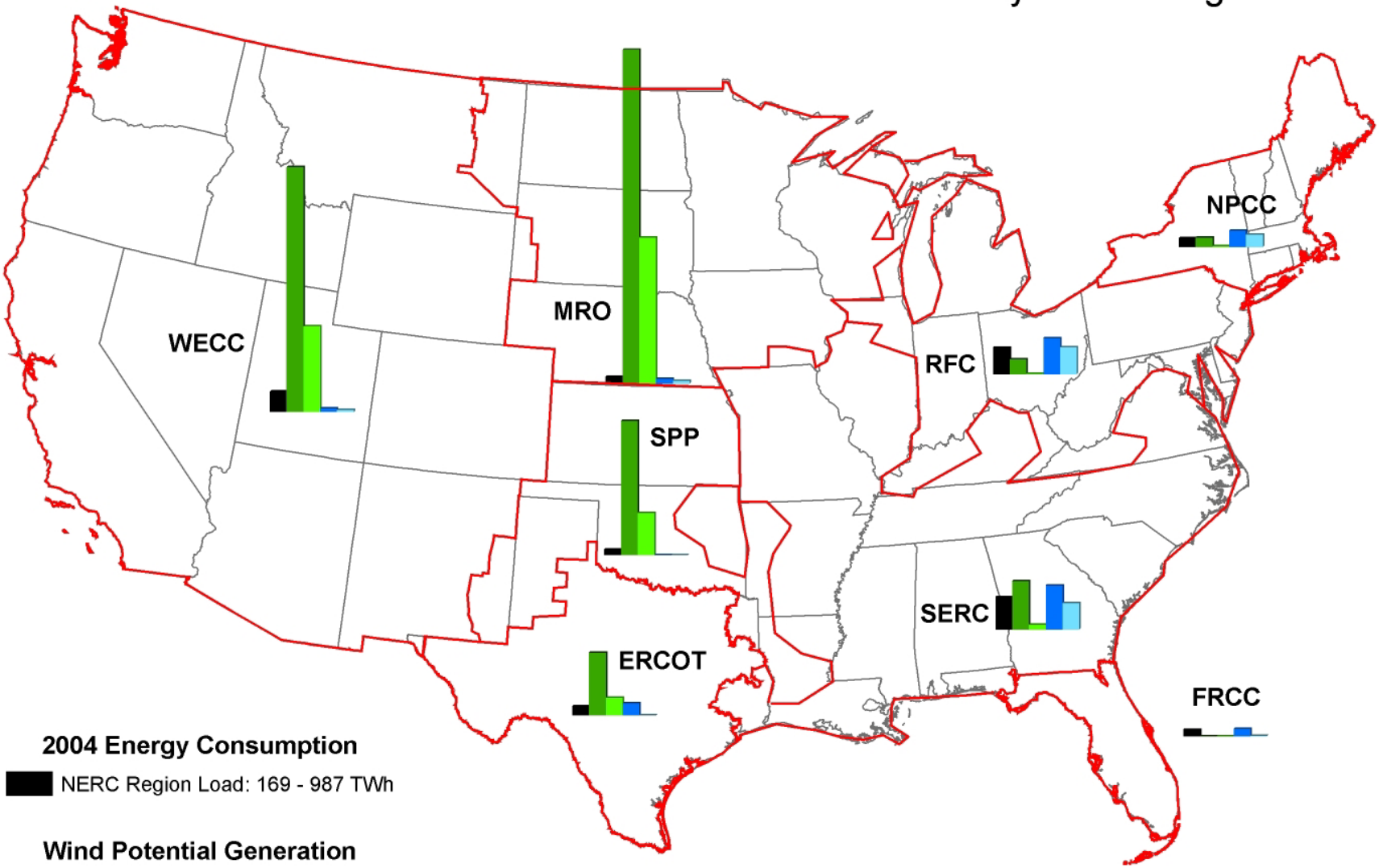
Market Challenges

- 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
- Lack of utility financial incentives to own wind facilities
- High cost and low turbine availability for community projects
- High cost and permitting challenges of <1 MW turbines
- Uncertainty in emerging emissions REC markets

Onshore and Offshore Wind Generation Potential by NERC Region



2004 Energy Consumption

NERC Region Load: 169 - 987 TWh

Wind Potential Generation

Onshore, Class 3 and greater: 0 - 10,013 TWh

Onshore, Class 4 and greater: 0 - 4,390 TWh

Offshore, Class 4 and greater: 0 - 1,325 TWh

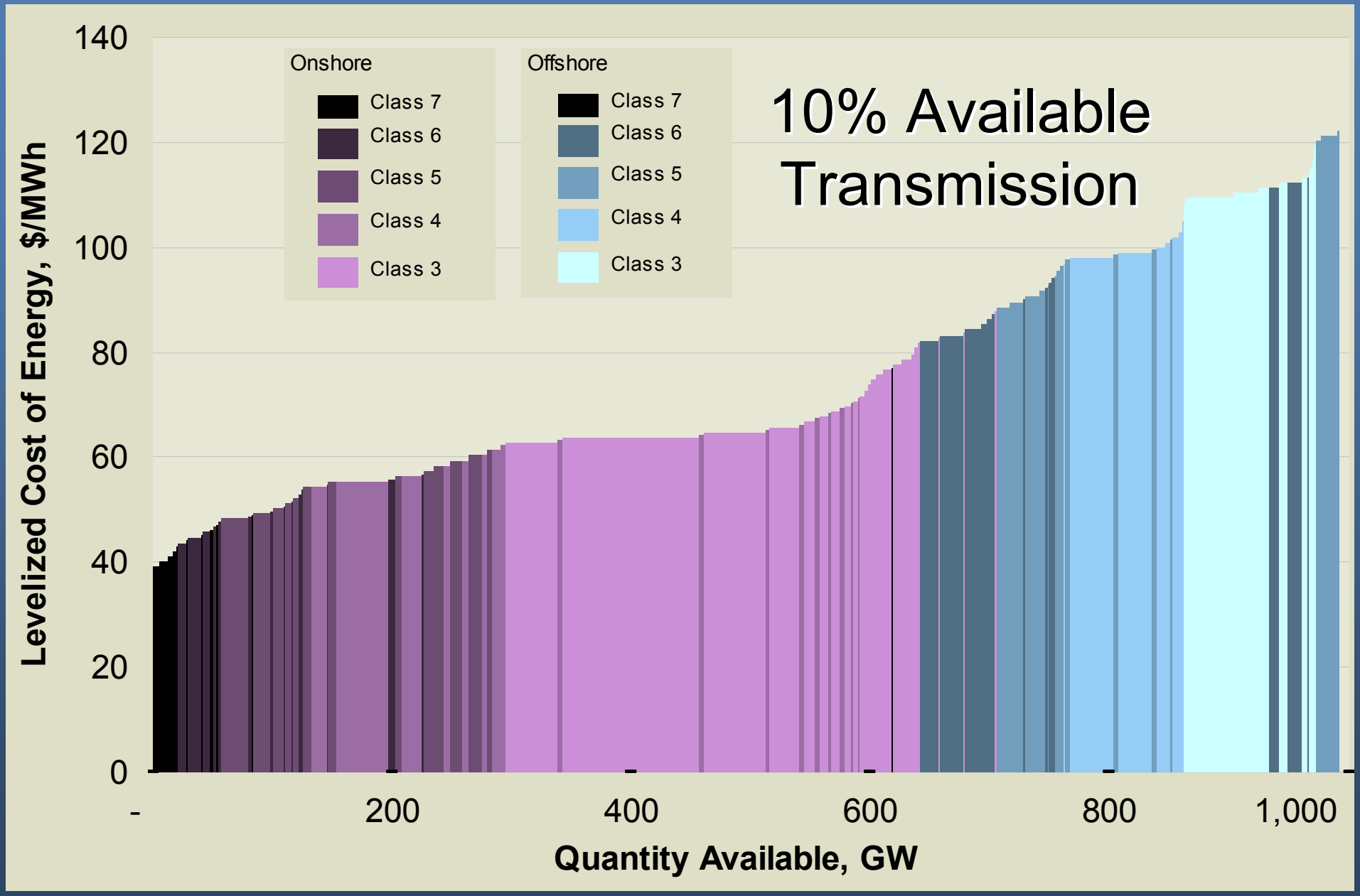
Offshore, Class 5 and greater: 0 - 803 TWh

Exclusions were applied to the onshore wind resource areas. Offshore resource was limited to shallow areas (<30 m) within 50 nm of shore.

U.S. Department of Energy
National Renewable Energy Laboratory

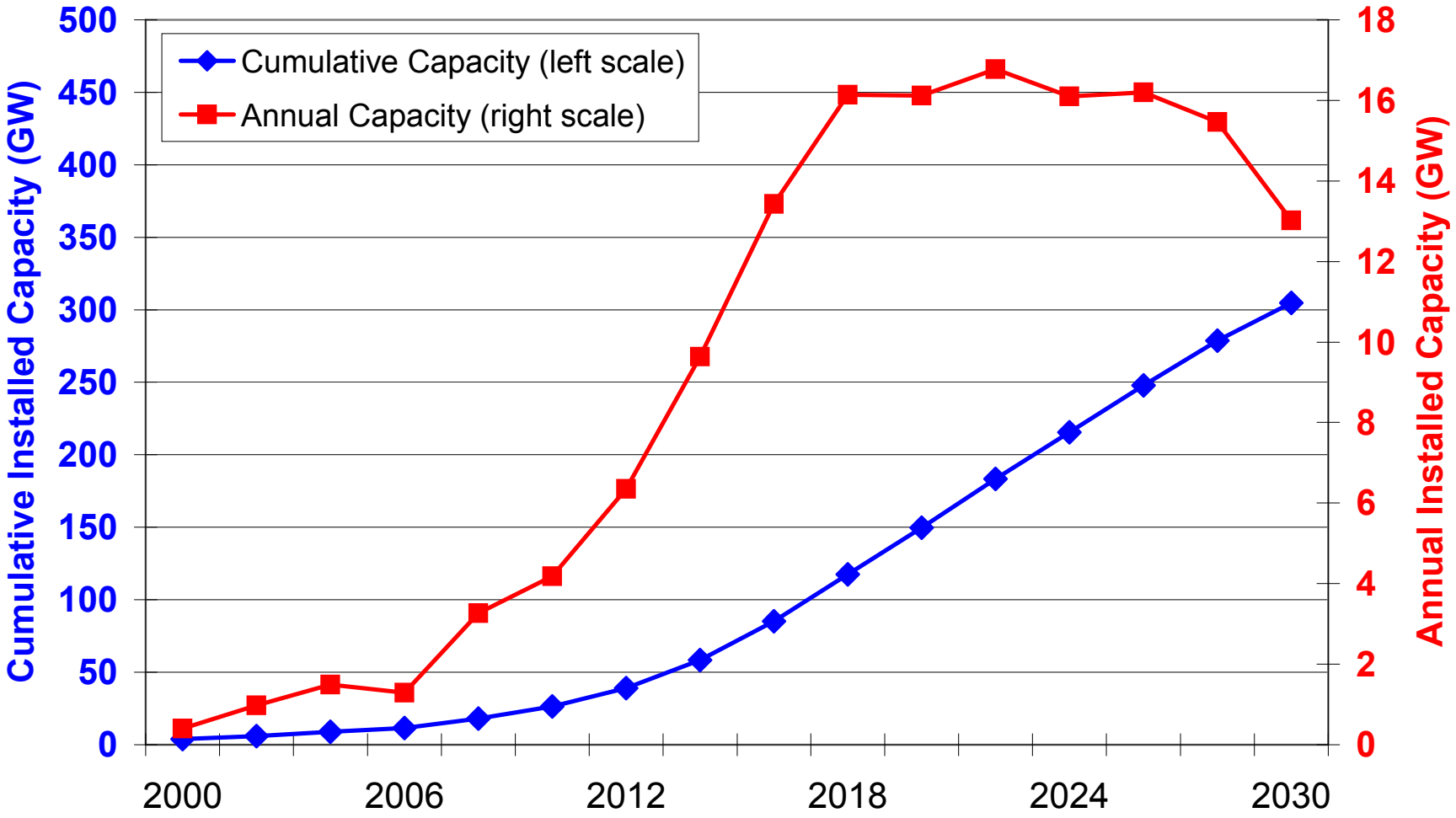
NREL

02-JUN-2006



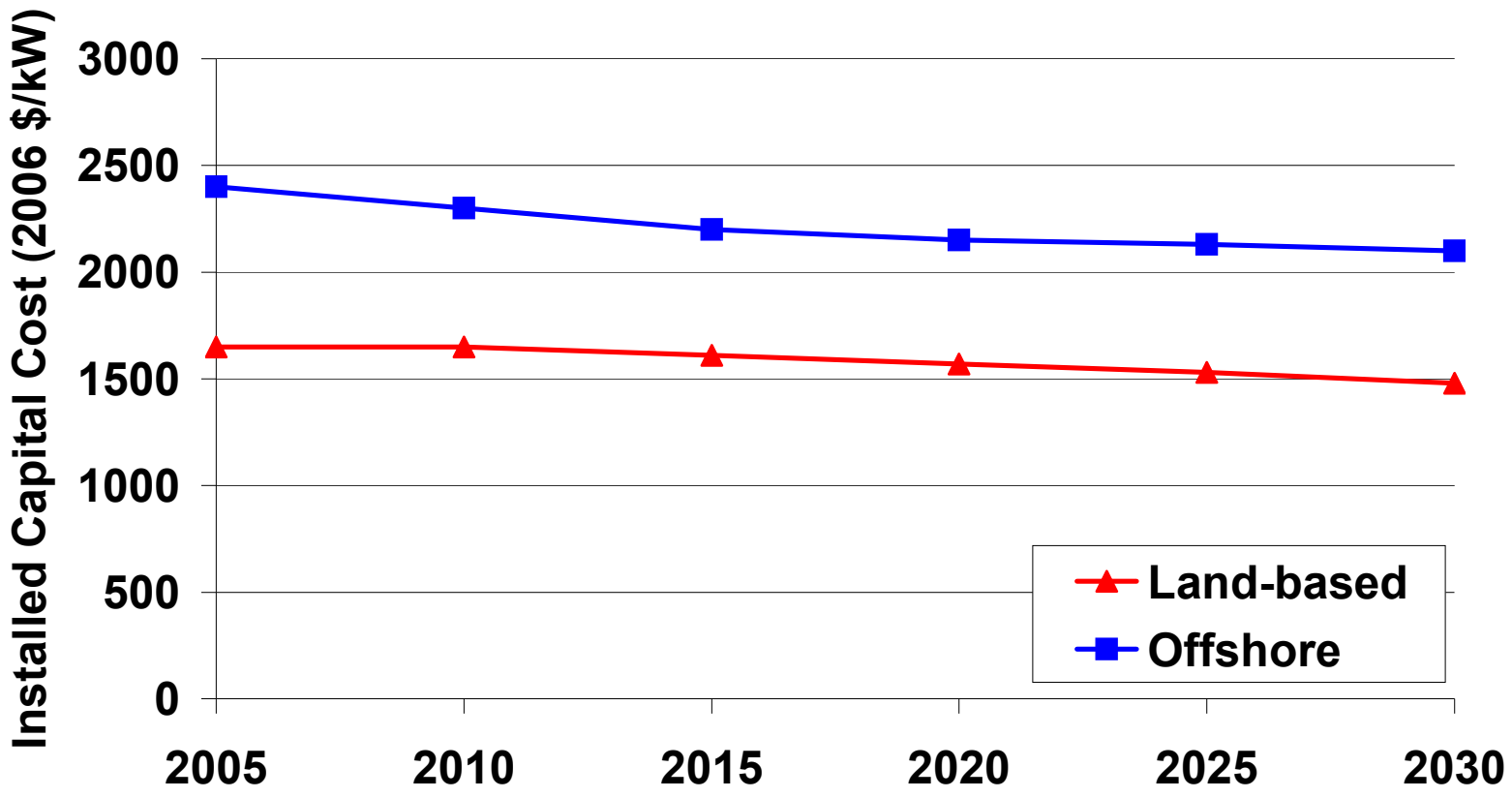
2010 Costs w/ PTC, $1,600/MW-mile, w/o Integration costs

What does 20% Wind look like?



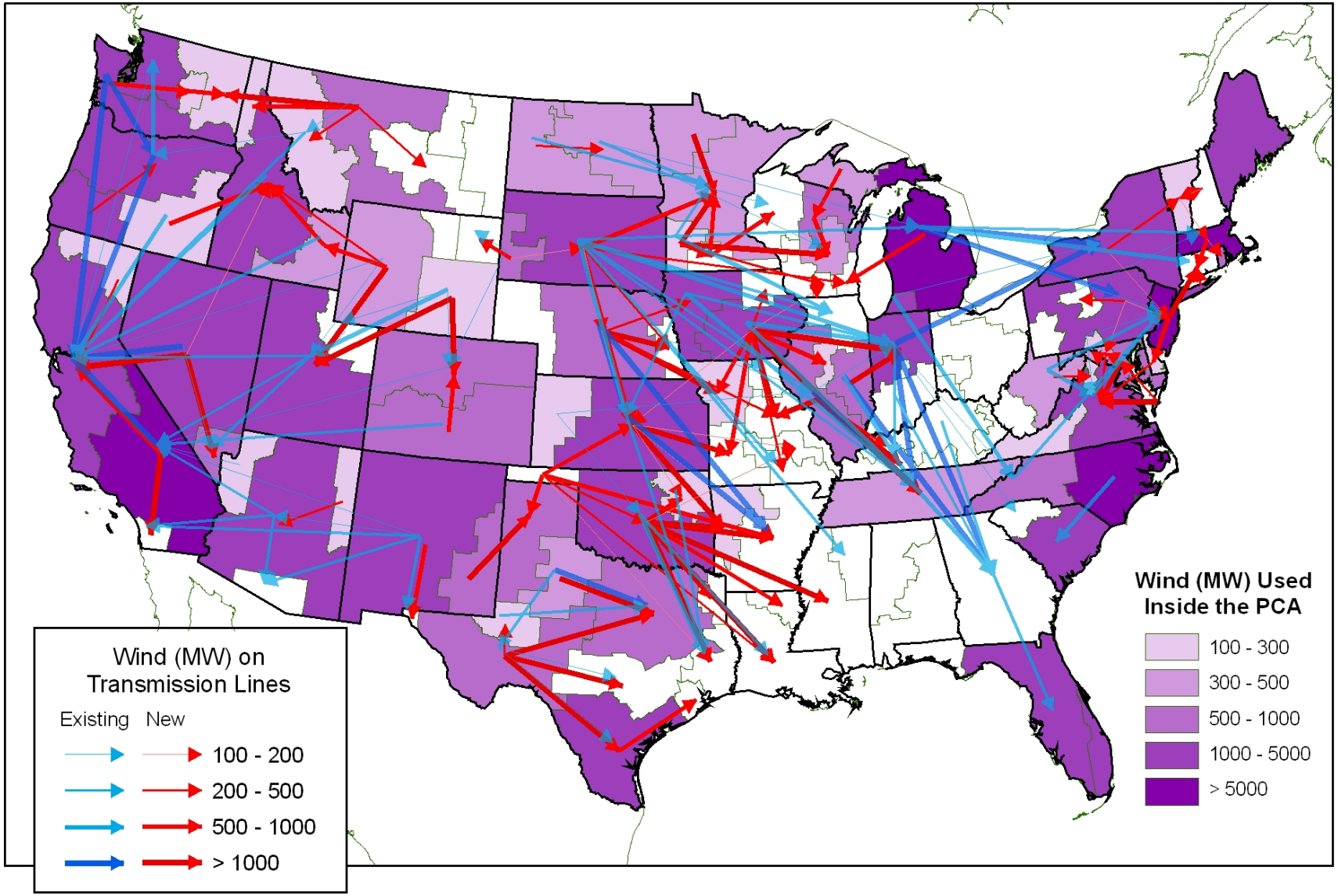
Source: AWEA 20% Vision

Wind Capital Cost



2030 - Between PCA Transfers and In-PCA Use for Wind (All Classes)

Total Between PCA Transfer >= 100 MW (all power classes, onshore and offshore)
Arrows originate and terminate at the centroid of the PCA for visualization purposes; they do not represent physical locations of transmission lines.



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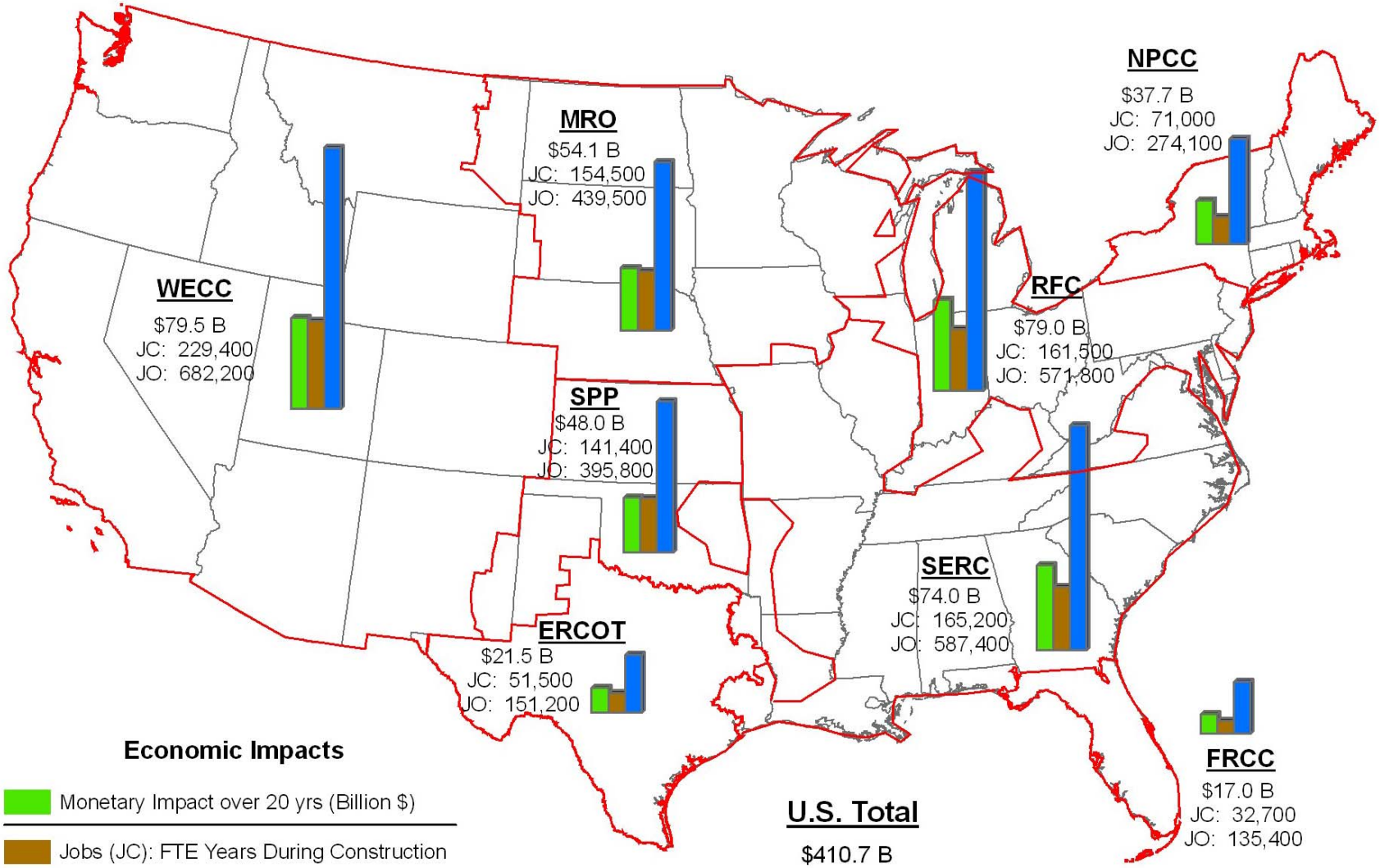
20% Wind Electricity by 2030 - Economic Impacts by NERC Region



Economic Impacts

- Monetary Impact over 20 yrs (Billion $)
- Jobs (JC): FTE Years During Construction
- Jobs (JO): FTE Years over 20 yrs Operation

Wind Vision case = 304 GW of wind capacity.
All job values rounded to the nearest 100.

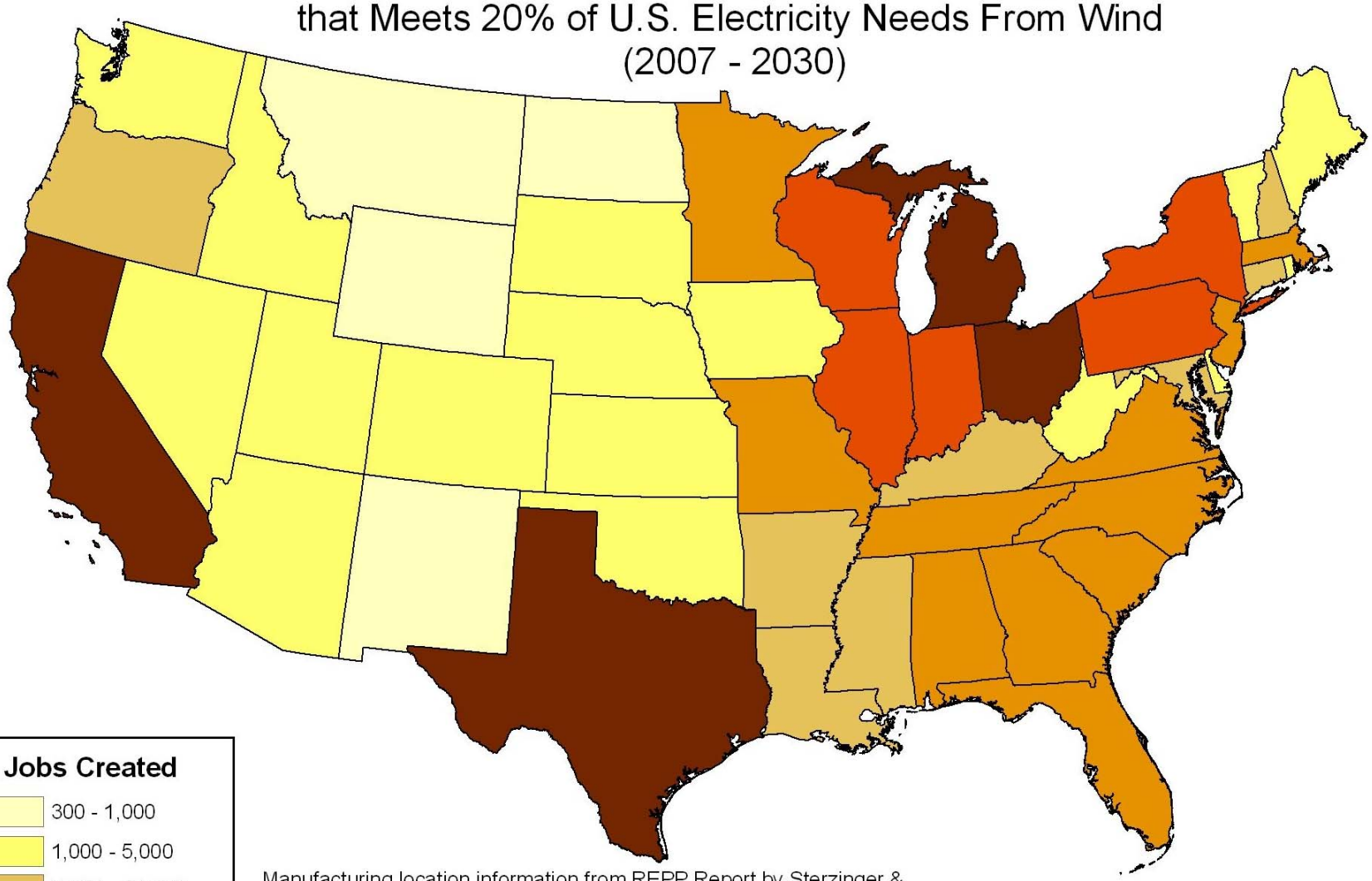
U.S. Total

$410.7 B
JC: 1,007,200
JO: 3,237,400

U.S. Department of Energy
National Renewable Energy Laboratory

Wind_Vision_06-19-2007 - DRAFT

Total Cumulative Manufacturing Jobs Created by Scenario that Meets 20% of U.S. Electricity Needs From Wind (2007 - 2030)



Jobs Created

- 300 - 1,000
- 1,000 - 5,000
- 5,000 - 10,000
- 10,000 - 20,000
- 20,000 - 30,000
- > 30,000

Manufacturing location information from REPP Report by Sterzinger & Svrcek (2004)

Major component assumptions: 50% of blades are manufactured in U.S. in 2004 increasing to 80% in 2030, 26% of towers are from the U.S. in 2004 increasing to 50% in 2030 and 20% of turbines are made in the U.S. increasing to 42% by 2030.

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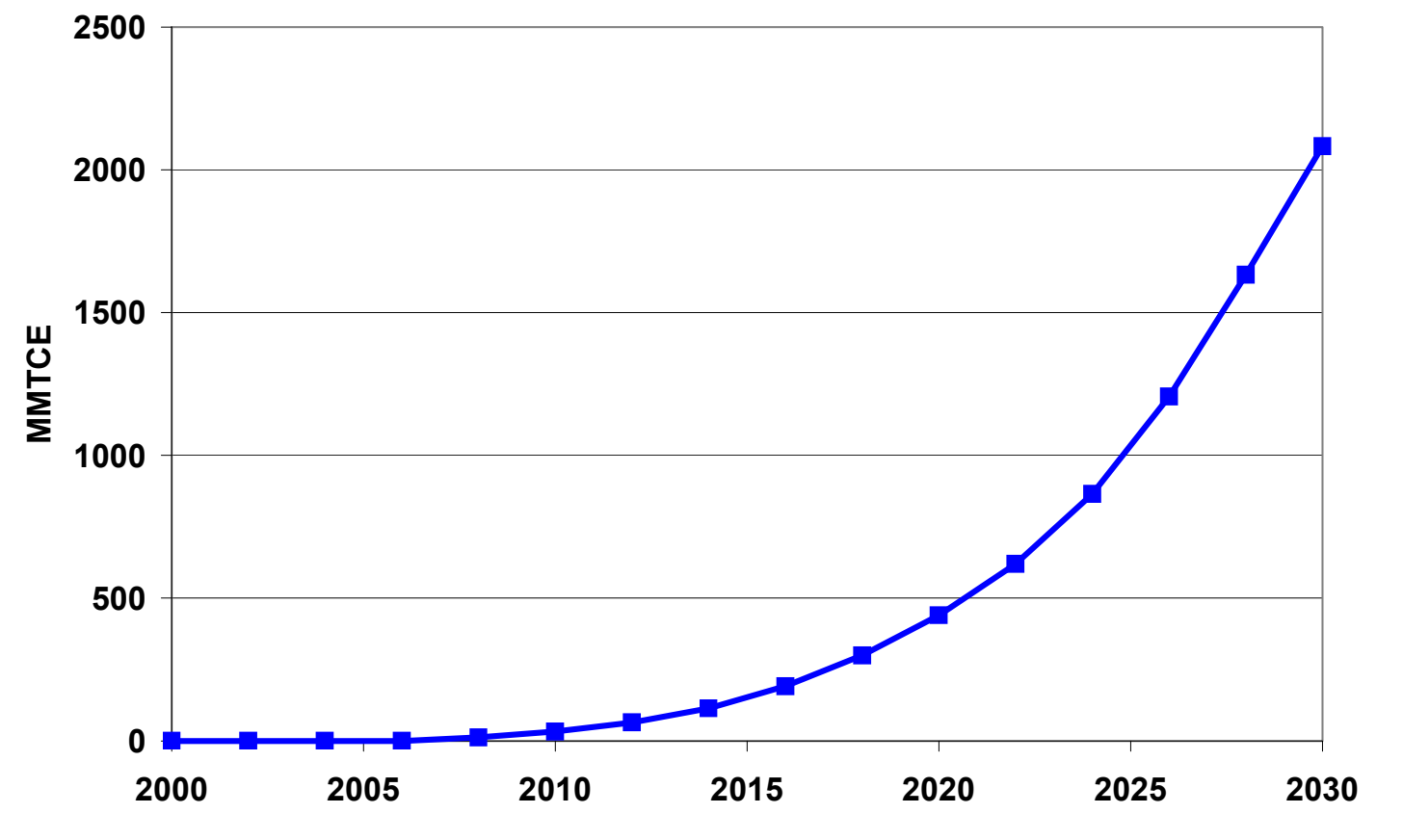
Cumulative Carbon Savings



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

12 Key Messages

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

12 Key Messages con't.

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 action plan: Fall 2007

Source: AWEA 20% Vision

"With public sentiment nothing can fail; without it, nothing can succeed."

- A. Lincoln

Humanity's Top Ten Problems for next 50 years

1. Energy
2. Water
3. Food
4. Environment
5. Poverty
6. Terrorism & War
7. Disease
8. Education
9. Democracy
10. Population

Source: Nobel laureate, Richard Smalley

Carpe Ventem

www.windpoweringamerica.gov