AWEA AMERICAN WIND ENERGY ASSOCIATION

WIND TECHNOLOGY: A US Case Study

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Manager of Federal Legislative Affairs

American Wind Energy Association

Overview

- Introduce AWEA
- History of the Wind Industry in the US
- 4 Challenges to Wind Deployment
- Conclusions

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American Wind Energy Association

Trade association for the wind energy industry

Over 2,500 business members

www.awea.org

- **Develops policies and conducts analysis to support wind industry growth**
- **Executes wind industry's legislative agenda**
- **Promotes wind energy through advocacy, advertising and media relations**
- **Convenes conferences and workshops to educate the public and bring industry members together**

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Countries with Highest Cumulative Wind Energy Capacity (MW)

1. China: 44,733
2. USA: 40,181
3. Germany: 27,214
4. Spain: 20,676
5. India: 13,065
6. Italy: 5,797
7. France: 5,660
8. UK: 5,204
9. Canada: 4,009
10. Denmark: 3,752

Rest of the World Combined: 26,749

Source: Global Wind Energy Council, Global Wind Report 2010

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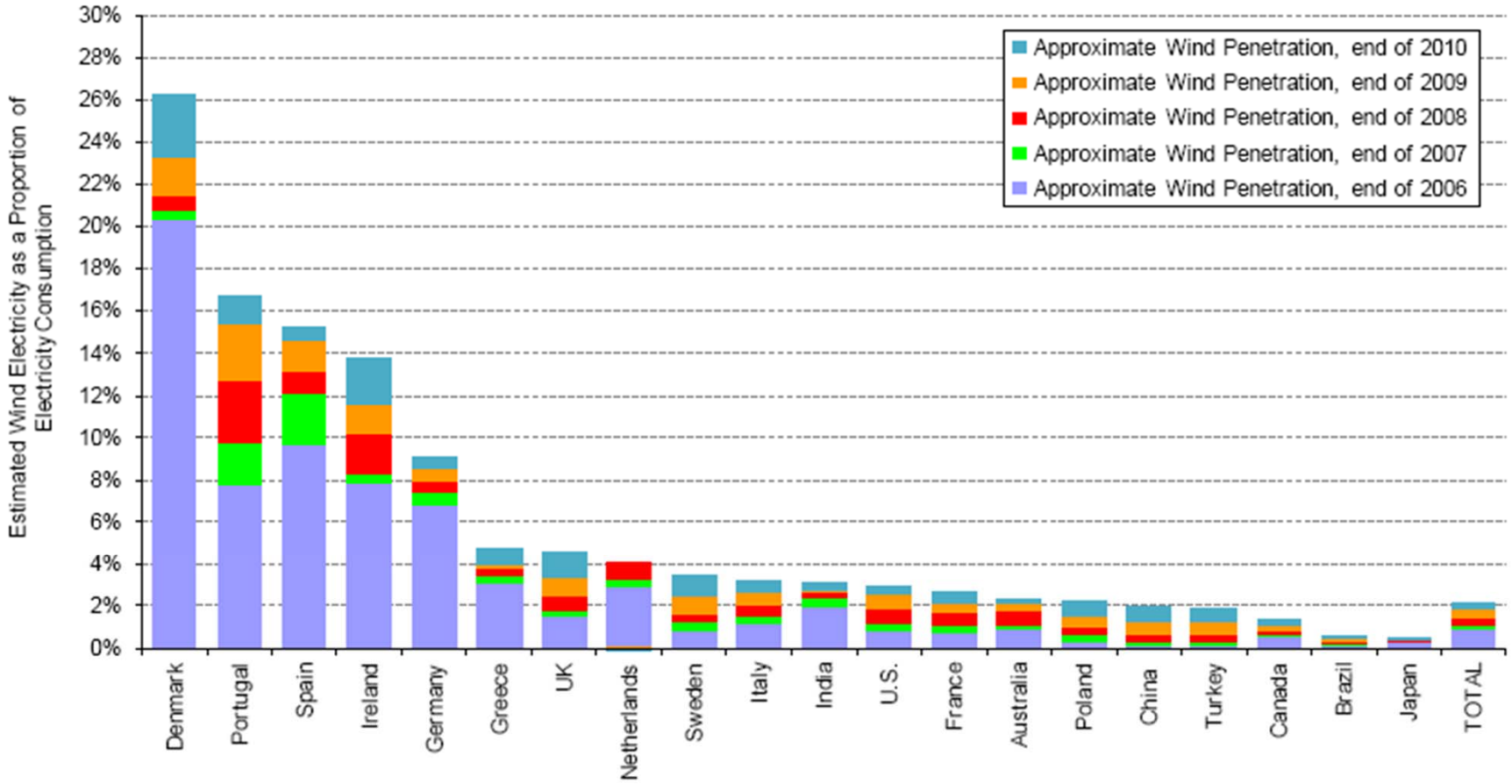
Approximate Wind Energy Penetration in Top 20 Countries



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

Source: U.S. Department of Energy 2010 Wind Technologies Market Report, June 2011

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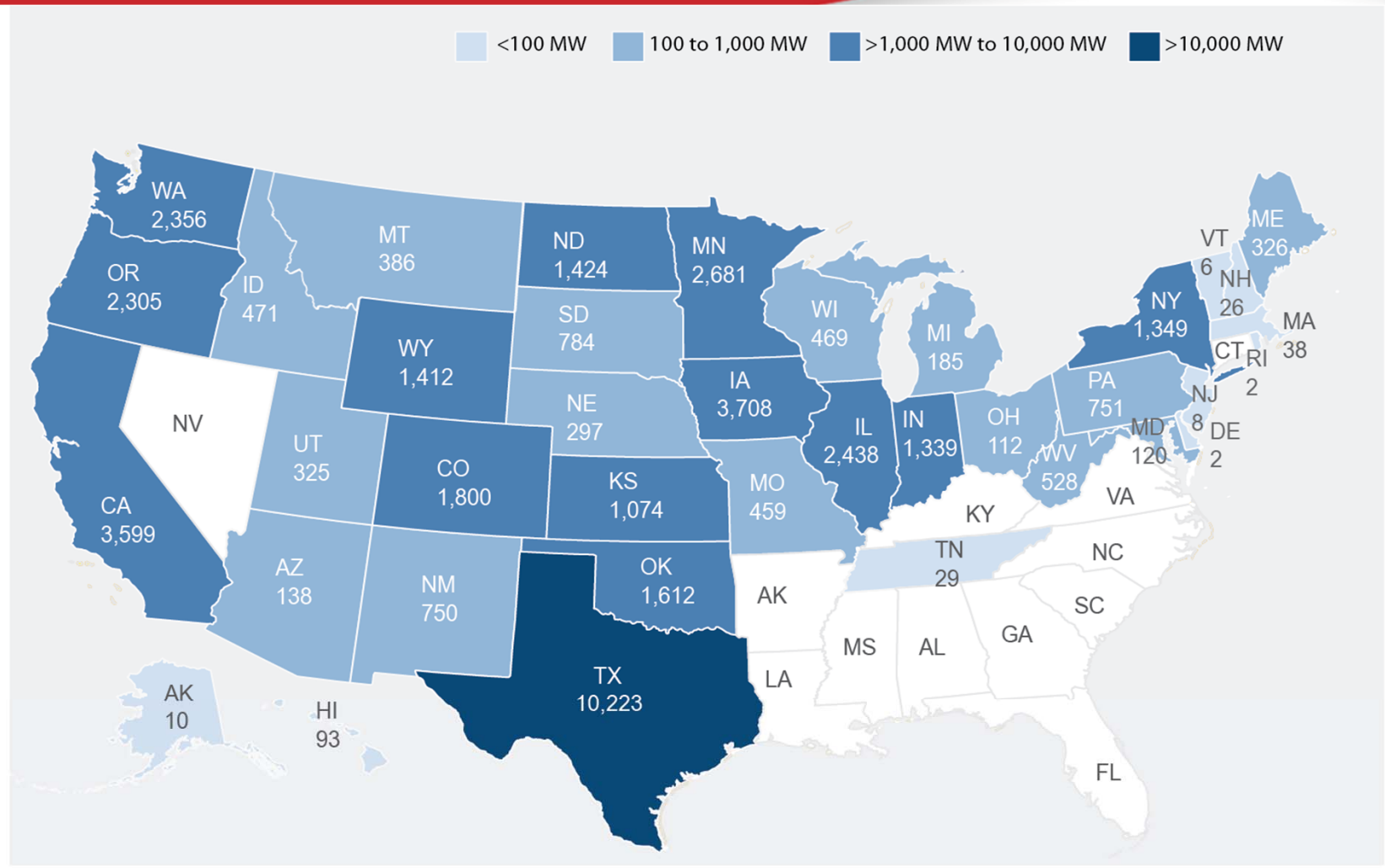
American Wind Power is Delivering Today.

- **Inexhaustible American energy resource**
- **35% of all new generation since 2007**
- **Cheaper than new nuclear and coal plants and competitive with natural gas**
- **Hedge against fuel price volatility risk**
- **Hedge against risk posed by environmental regulations through EPA, federal legislation, state regulations**
- **Unique in that it uses virtually no water**

U.S. Wind Power Installations by State



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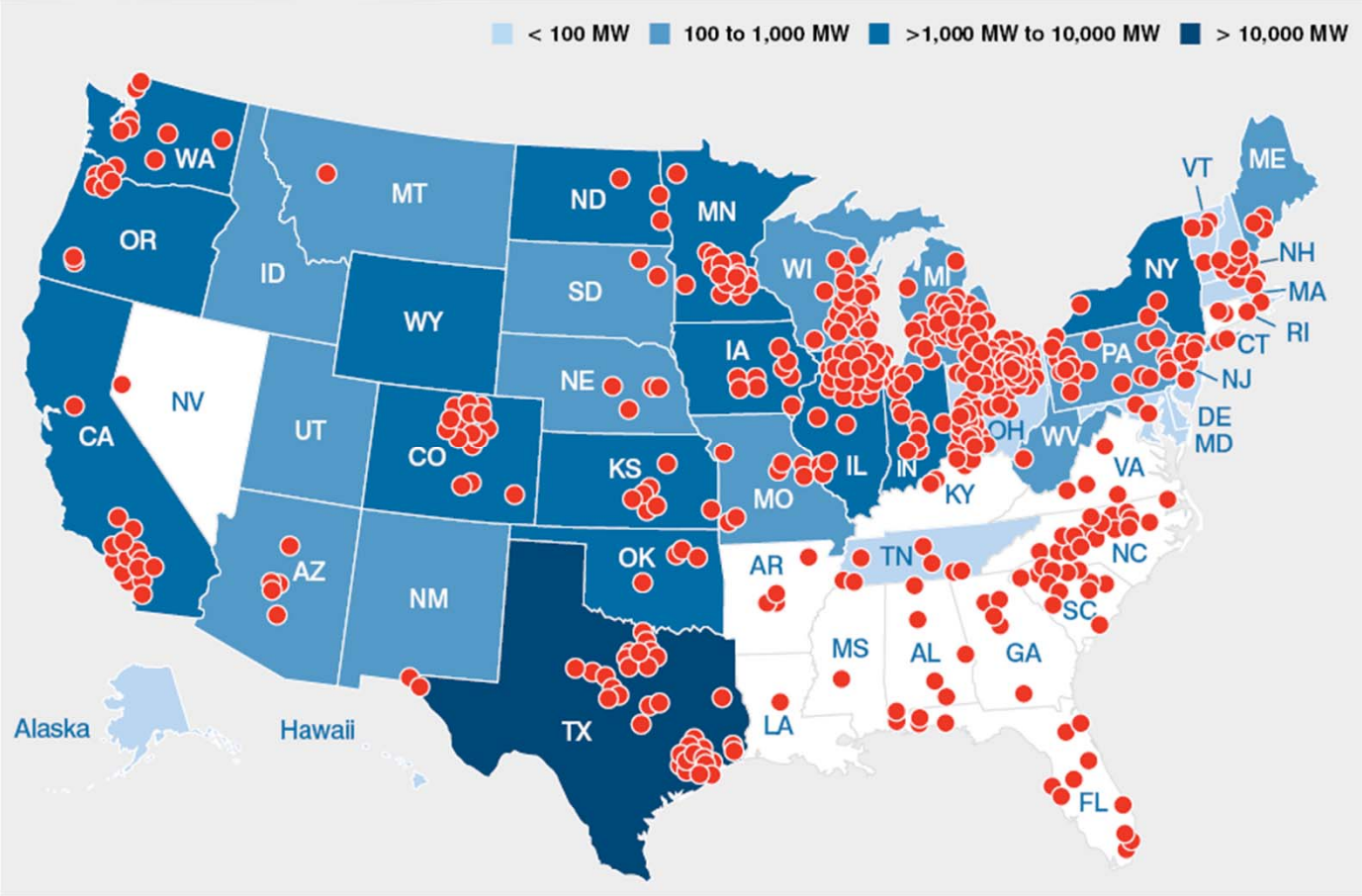
With 400 facilities, Wind is One of the Fastest-Growing Sources of U.S. Manufacturing Jobs.



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

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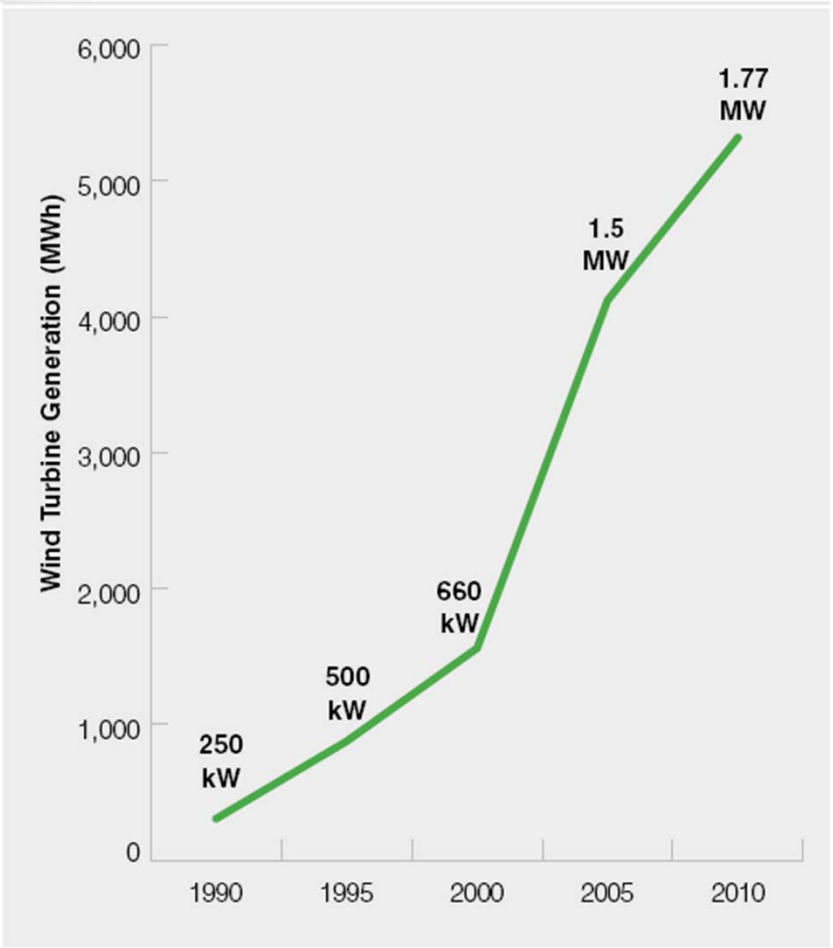
Wind Turbine Productivity is Increasing; Costs are Decreasing.

- Turbines' availability to generate is usually above 98%
- Taller towers and better siting technology have enabled project owners to achieve capacity factors in the high 30% and low 40% annually in the best wind resource areas
- A turbine with a nameplate capacity seven times larger can produce more than 15 times more power



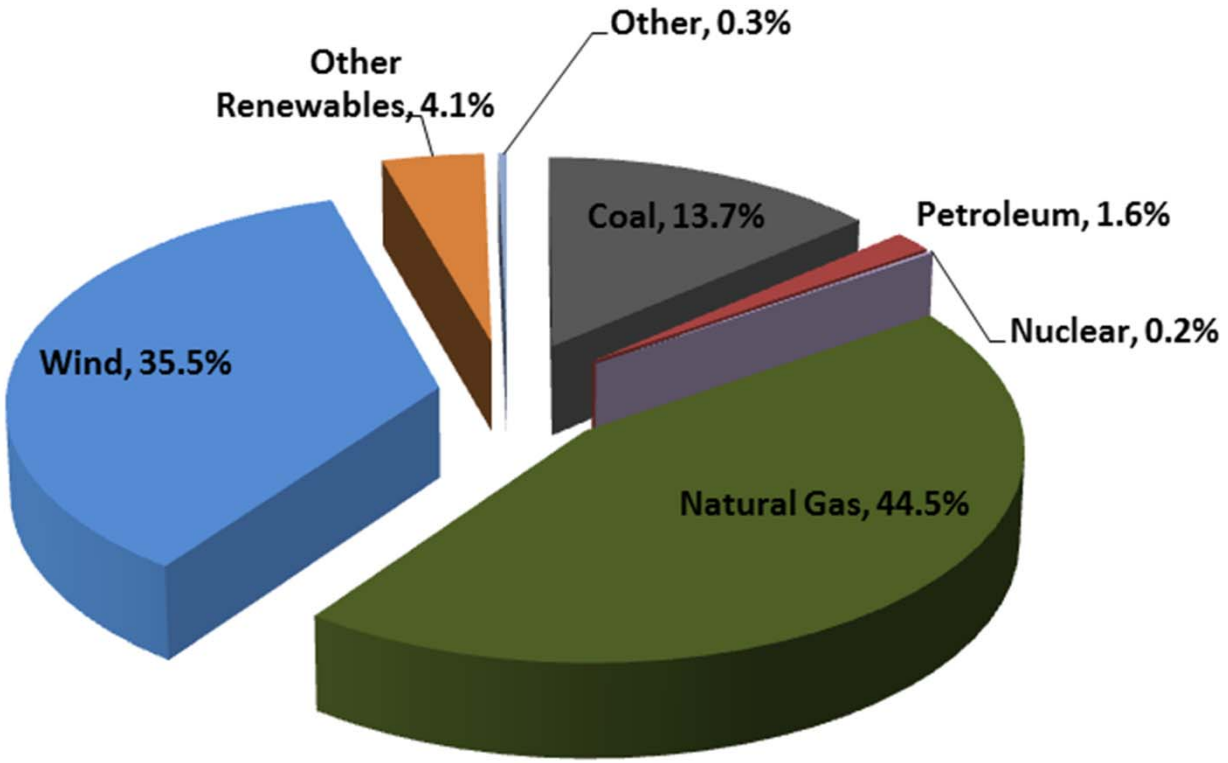
Source: AWEA, U.S. Wind Industry Annual Market Report Year Ending 2010

Wind has Captured 35% of All New Generating Capacity in America Since 2007.

Nearly 81,000 MW of new generating capacity installed between 2007 and 2010.

Wind installed over 35% of all new generating capacity between 2007 and 2011, over 29,000 MW.

Percent of New Installed Capacity, 2007-2010



Source: AWEA, EIA, SEIA, SNL

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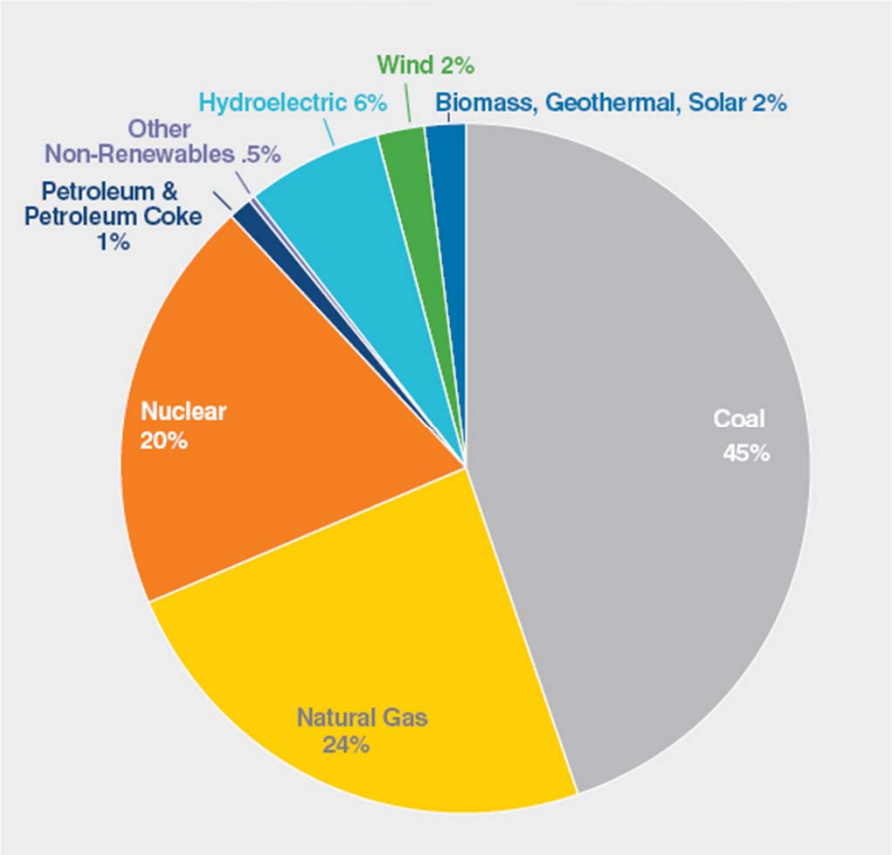
U.S. Electricity Generation Mix in 2010



Source: Energy Information Administration Electric Power Monthly

- **94.6 million MWh of wind produced in 2010.**
- **Wind provided 2.3% of U.S. electricity in 2010, up to 3.25% today**
- **Electricity from wind power capacity in the U.S. will supply the equivalent of:**
  - **Over 10 million American homes**
  - **10 nuclear power plants**

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

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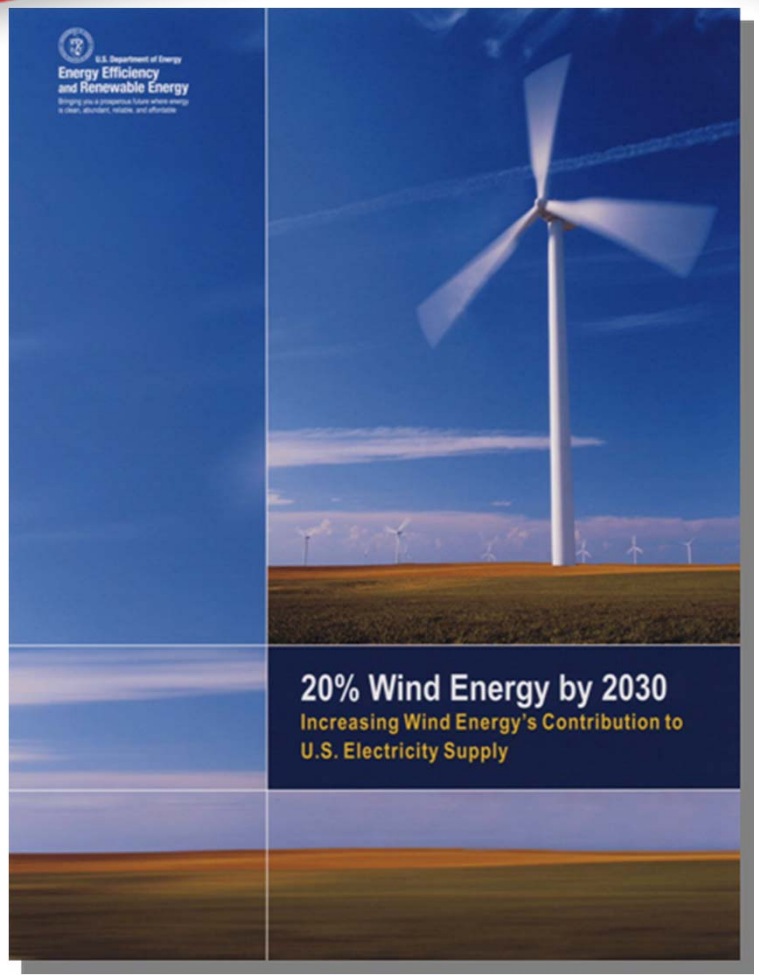
20% Wind Energy by 2030

Bush Administration Report Identifies the Path

- **U.S. Department of Energy:**

  “The U.S. possesses sufficient and affordable wind resources to obtain at least 20% of its electricity from wind by the year 2030.”



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Five Challenges to Wind Deployment

- Siting
- Transmission
- Policy and Financing
- Storage


FINISH
Wind Industry
Public
Affected Land Owners
Environmental Organizations
Tribes
Indian Lands
Military
T&E Species
Wetlands
Noise
Visual
Radio Interference
Wilderness, Parks, Refuges, etc.
Avian/Bat
Cultural/Tribal Resources
Unwilling Landowners
Community/Political Sentiment
Constructability
Proximity to Load
Transmission
Buyer/PPA
Wind
Developers
Federal, State, Local Agencies

Overview of the Wind Project Development Process

Land-Use and Species Permits Are Only Part of the Puzzle -- Multiple Pieces Must Come Together:

- Confirmation of the wind resource
- Multiple willing land-owners
- Compliance with setback requirements
- Technical & meteorological restrictions
- Labor negotiations
- Transmission lines & substation access
- Military clearance (flight path & radar)
- FAA “no hazard” determination
- Power purchase agreement & CPUC approval
- Financing (requiring quantification of all risks to revenue stream)

Wind Resource

- Meteorological towers (met towers) collect wind data for at least one year before project is financeable
- New technologies entering market (SODAR, LIDAR)
- Detailed data analysis performed in-house and by independent engineers
- Incremental differences in resource can result in significant differences in production
- Developments in wind turbine technology are allowing lower wind resource sites to be developed – Midwest, Southeast

Wind Project - General Timeline

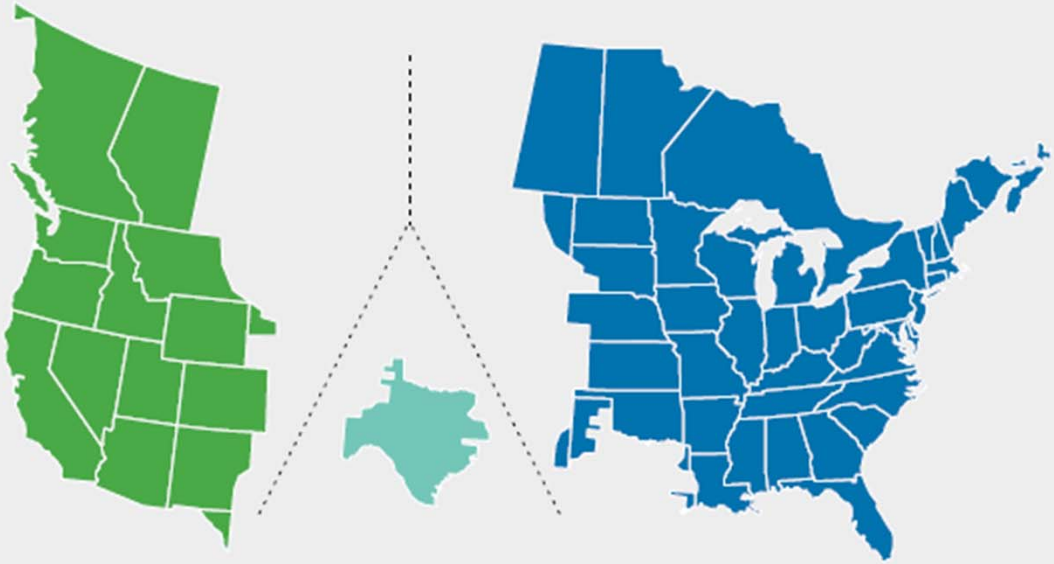
Engineering	3 months
Procurement	6 months
Construction	6 months
Commissioning	1 month
Turbine Procurement	Up to 2 years

Case Study: Development of a Wind Project in California

www.stoel.com

Chrysanthemum Wind Company ("**C-Wind**") is developing a 200 MW wind project in Desert County in southern California. The project is part of a multi-phase development that C-Wind eventually plans to build out to 600 MW in several projects of 100 MW to 200 MW each. Site acquisition began in Year 1, with the first 200 MW project slated for a commercial operation date ("COD") by the end of Year 3. The end of Year 3 is also the sunset date for the currently available federal tax subsidies, and Congress is doing its usual dithering with no assurance that the subsidies will be extended before the sunset date.

Wind Power Capacity Installed by Interconnection



Capacity Installed MW	
Eastern Interconnection	18,947
Western Interconnection	11,763
Electric Reliability Council of Texas	9,397

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

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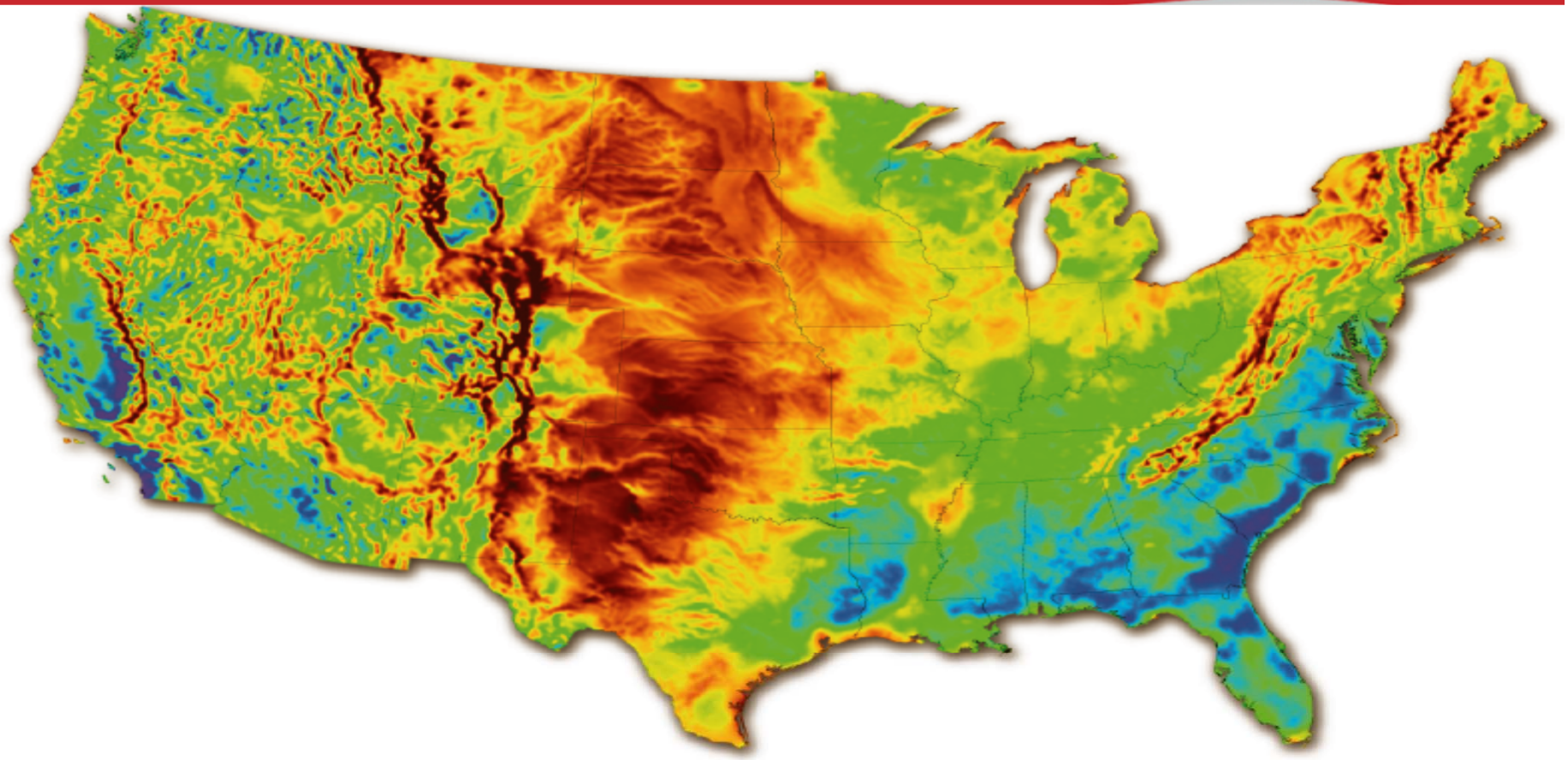
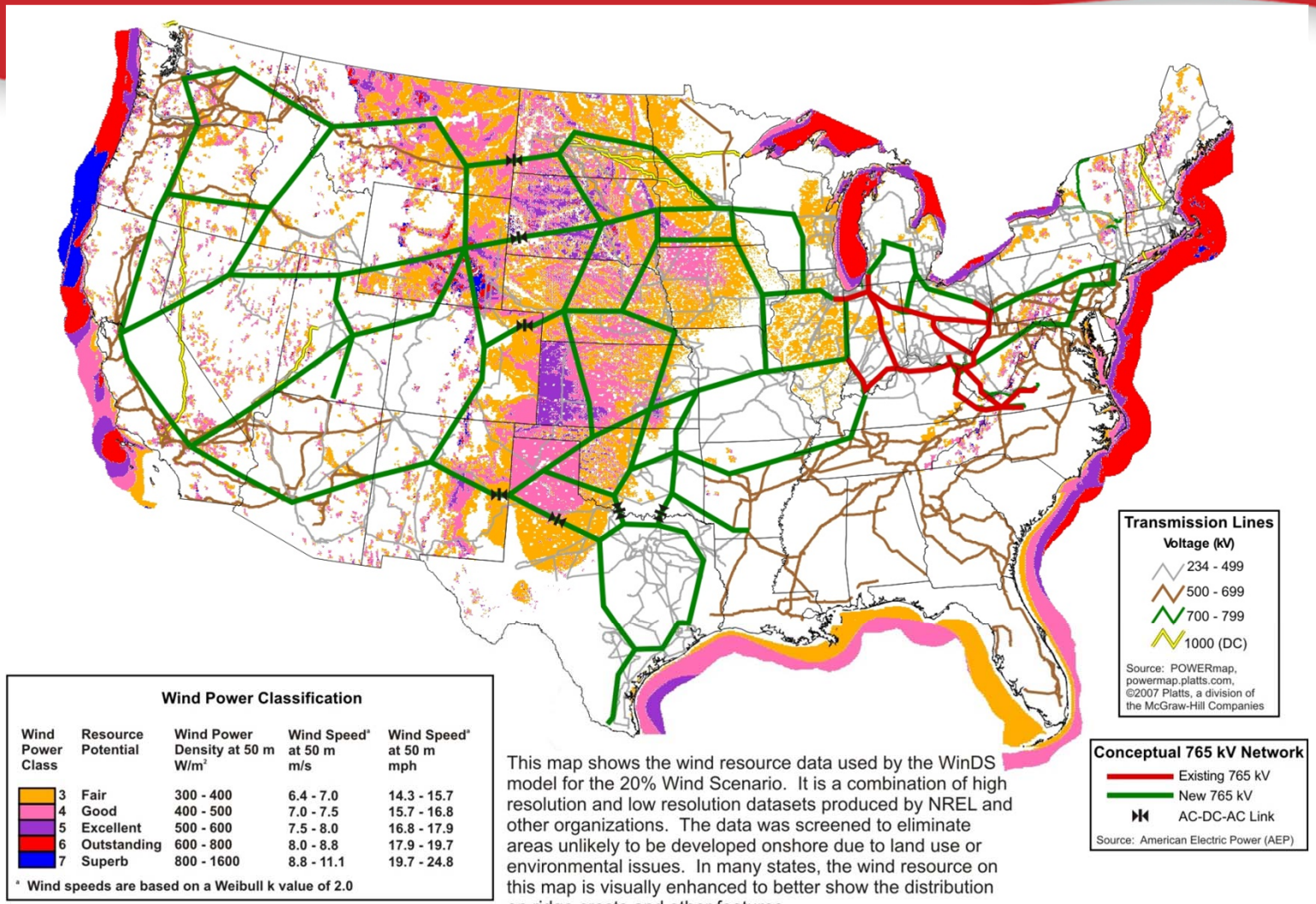
Lack of Transmission is a Problem

- Renewable projects cannot connect to the grid – **275,000 MW** of proposed wind projects waiting in interconnection queues
- Country's best wind and solar resources are far from cities
- Project output can be curtailed because of inadequate transmission
- Cannot capture benefits of geographically diverse wind resources

Wind Resources Distant from Demand



Conceptual Transmission Expansion Plan



Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m²	Wind Speed* at 50 m m/s	Wind Speed* at 50 m mph
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

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

This map shows the wind resource data used by the WinDS model for the 20% Wind Scenario. It is a combination of high resolution and low resolution datasets produced by NREL and other organizations. The data was screened to eliminate areas unlikely to be developed onshore due to land use or environmental issues. In many states, the wind resource on this map is visually enhanced to better show the distribution on ridge crests and other features.

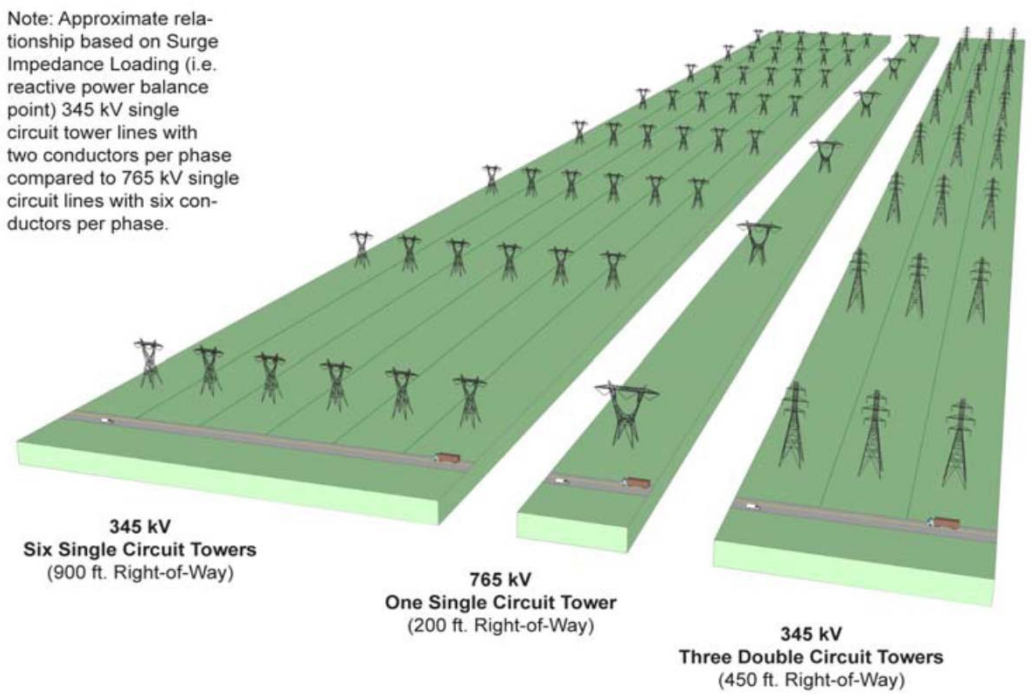
Reduced Land Use

765-kV benefits are substantial over 500-kV and 345-kV.

Description	765	500	345	345
Circuits/Tower	1	1	1	2
Conductors/Phase	6	3	2	2
SIL per Line (MW)	2400	910	400	800
Lines Required for 2400 MW Capacity	1	3	6	3
ROW per line (ft)	200	200	150	150
Total ROW (ft)	200	600	900	450
ROW utilization factor	100%	38%	22%	44%
Typical Height (ft)	132	124	110	172
*Cost/Mile ($M) for 2400 MW capacity	2.6	6.9	6.6	4.5

* Cost in 2007 $US, based on average terrain.

** SIL is a relative capacity measure, thermal capacity is over 4000 MW for 765 kV and ~ 2000 MW for 500 kV.



Source: AEP

Transmission voltage selection significantly affects performance, cost and the environment.

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The Market Failures

- Economic benefits of transmission do outweigh costs:
  - Texas study: Transmission for wind pays for itself in 3 years
  - Reliability benefits
  - Fuel price volatility benefits
  - Benefits of connected renewables: environmental, economic development, energy security

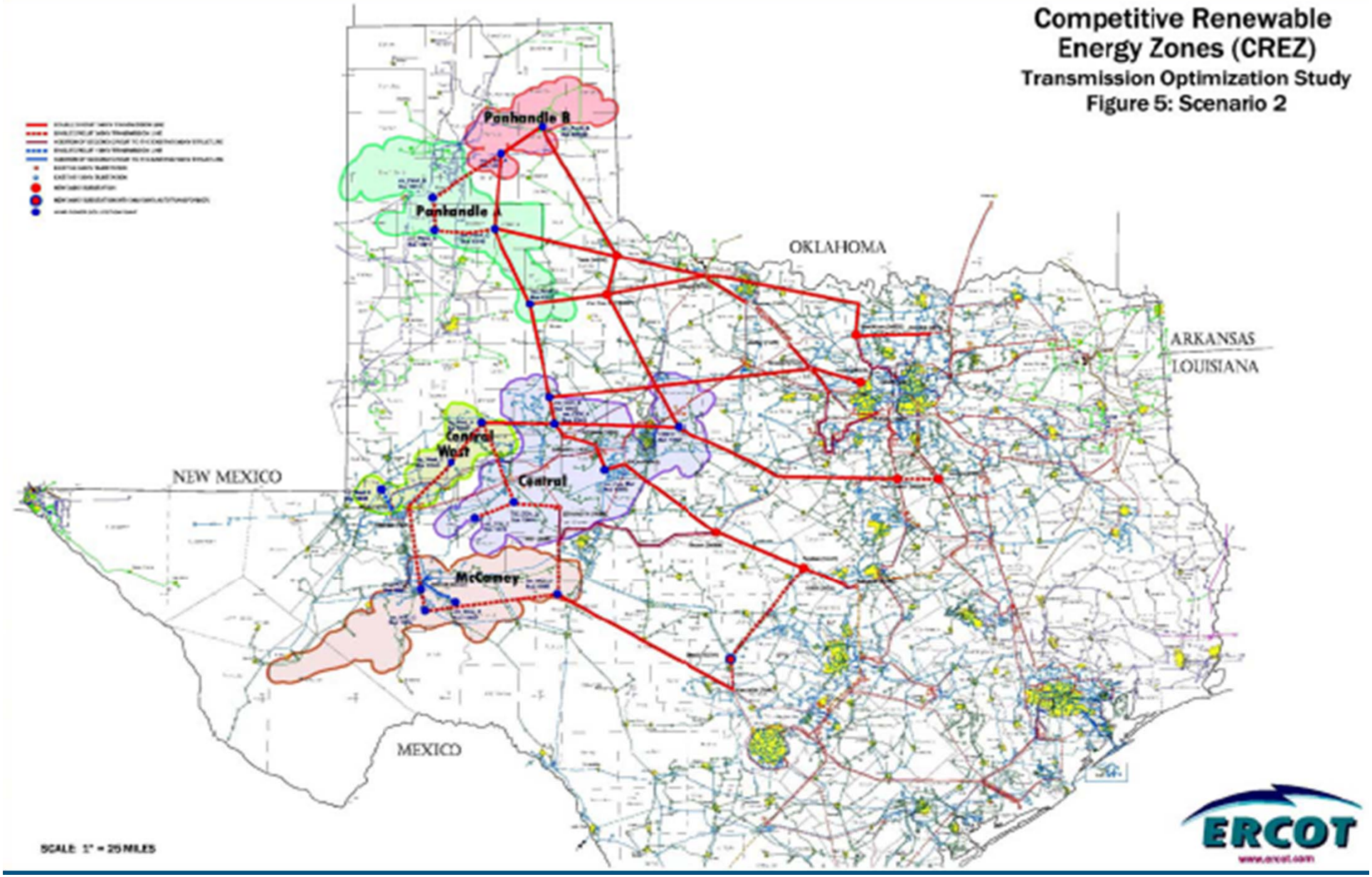
- Why don't we just build the transmission?

Transmission Policy

- Policies for new transmission construction
  - Planning (pro-active planning)
  - Paying (broad regional cost allocation)
  - Permitting (streamlined siting)

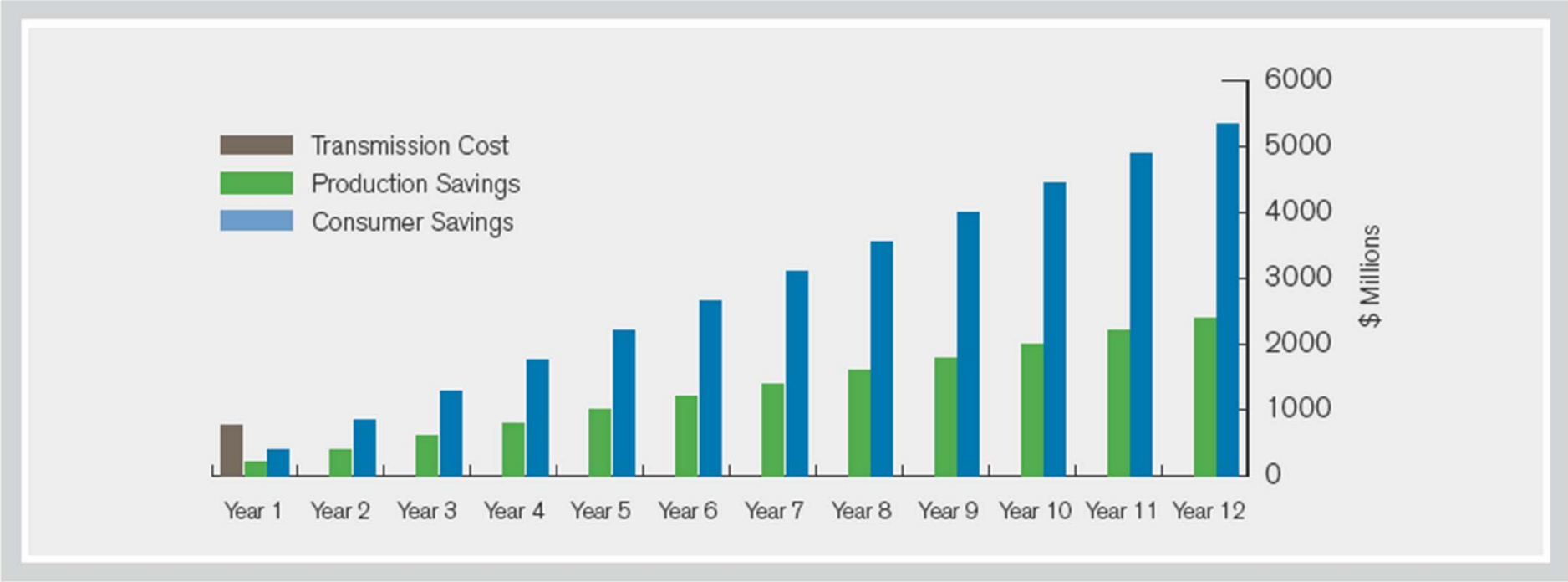
- AWEA-SEIA “Green Power Superhighways” white paper at www.awea.org

Success Story: Texas CREZ Process



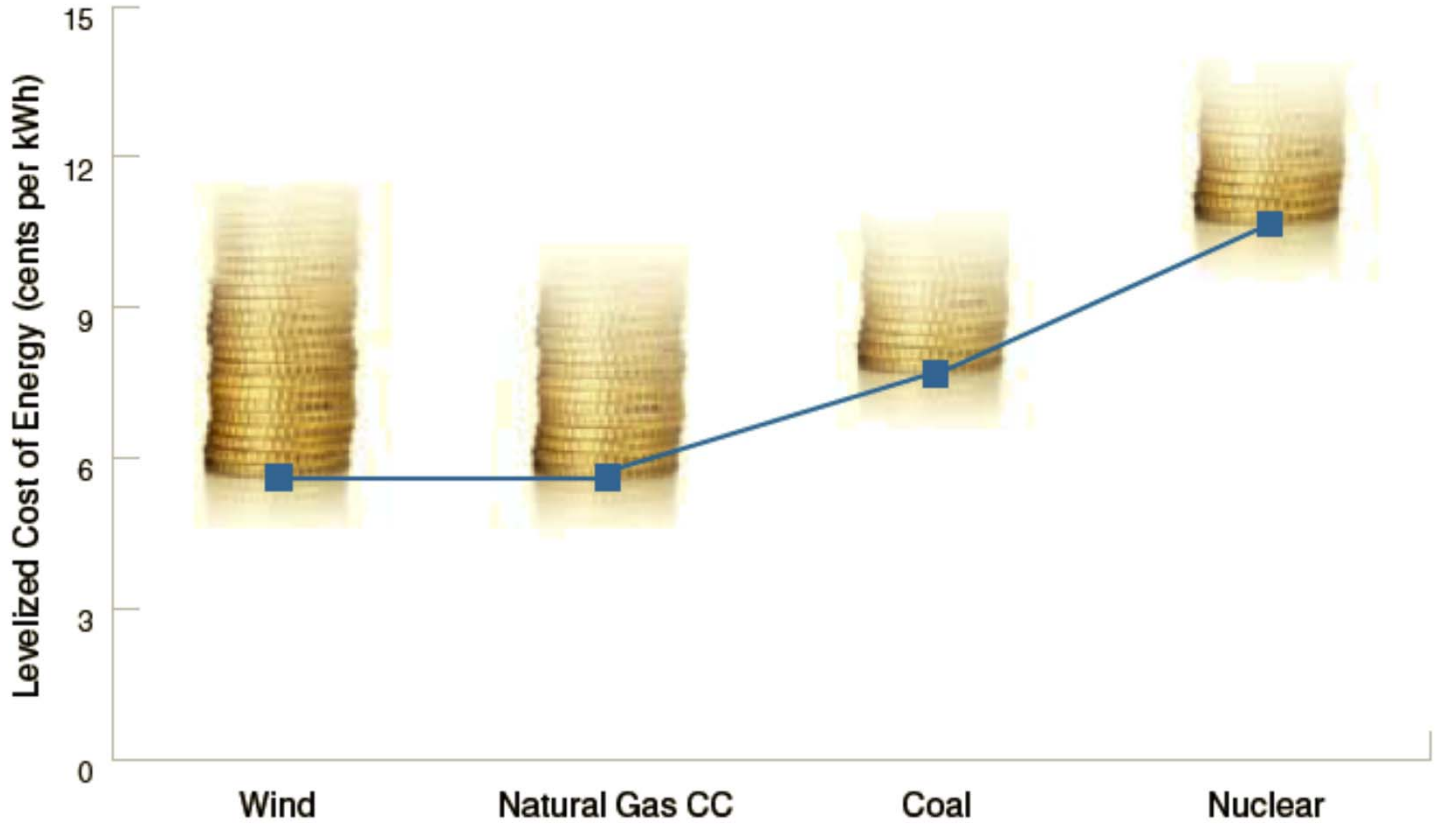
Texas: Savings From Transmission

Results from Texas Study Show that Benefits of Transmission for Wind Exceed Costs



(Source: Electric Reliability Council of Texas)

American Wind Power is Affordable



Source: Lazard, Levelized Cost of Energy, June 2009

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Project Financing

• Massive upfront capital investment. Approximately $2 million per megawatt Installed

• Diverse financial institutions who are key partners in obtaining investment dollars are highly risk-averse; scrutinize projects carefully for all risks

• Ability to definitively model operating revenues/expenses is key to successfully partnering with investor

– Open-ended operational restrictions such as curtailment will significantly impact the ability of projects to get financing

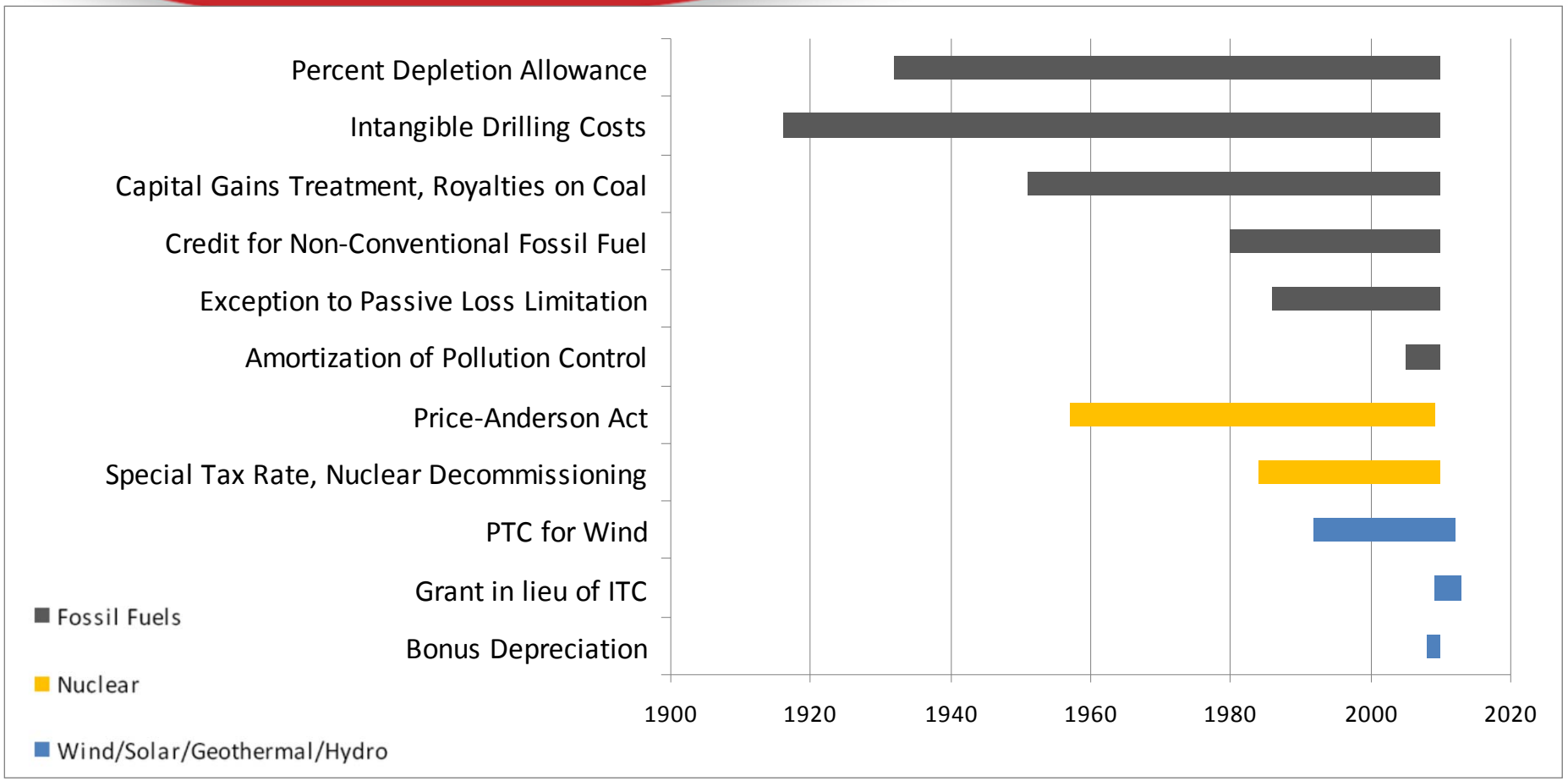
• Wind industry is aided by government financial incentives to provide funding for project financing

– Intermittent federal incentive policy creates difficulty in long-term development forecasting

Policy Status & Path Forward
U.S. "Portfolio Approach" to Policy

- **U.S. approach to energy policy often involves a portfolio of policies at the state and national level:**
- **Continued focus to pass a national long term renewable energy policy for utilities to have a more balanced generation mix, and long term tax policy that encourages investment, and expedites transmission build.**
- **Greater focus by AWEA on state jurisdiction over power generation through state regulatory process. States like California, Colorado increasing targets so new opportunities. With wind cost competitive with nat gas encourage greater balance in state portfolios as well as look for tweaks in state RES and tax policy to drive demand.**

All Domestic Energy Has Had Long-Term Support, Except Renewables



Data Sources: Congressional Research Service, Federal Legislation

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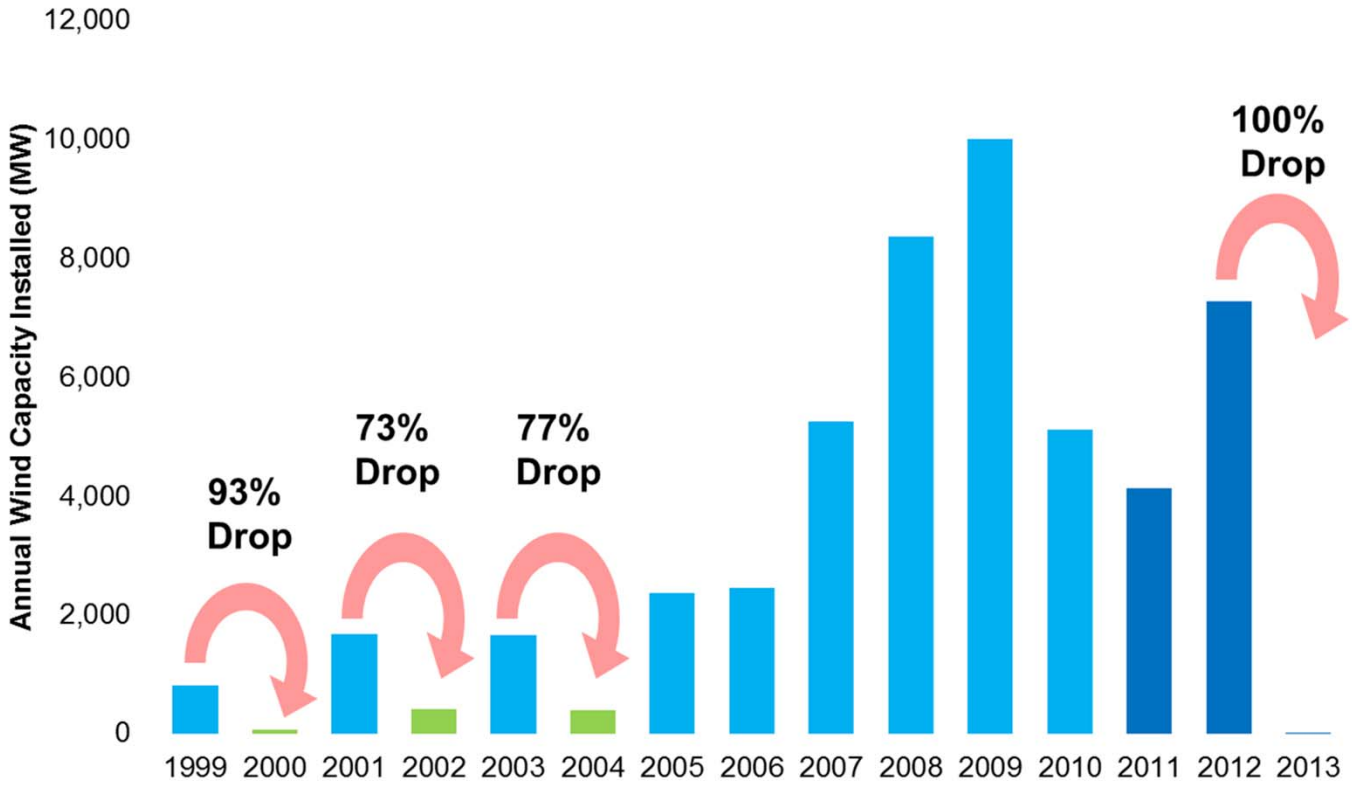
Historic Impact of PTC Expiration on Annual Wind Installation



Data Sources: AWEA, EIA

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Federal Tax Incentives

- **Production tax credit for large wind available through 2012**
  - **Ability to claim 30% investment credit, and receive cash grant in its place through 2011**
- **30% investment tax credit for small wind**
- **30% tax credit for expanding, building manufacturing facilities**

A Strong 25% RES by 2025

- **8-fold increase in homegrown renewable energy – from 28,000 MW to 248,000 MW**
- **297,000 new jobs**
- **$13.5 billion in income to farmers, landowners, and ranchers**
- **$11.5 billion in new local tax revenue**
- **$64.3 billion savings from lower consumer expenditures**

Source: Union of Concerned Scientists, 2009

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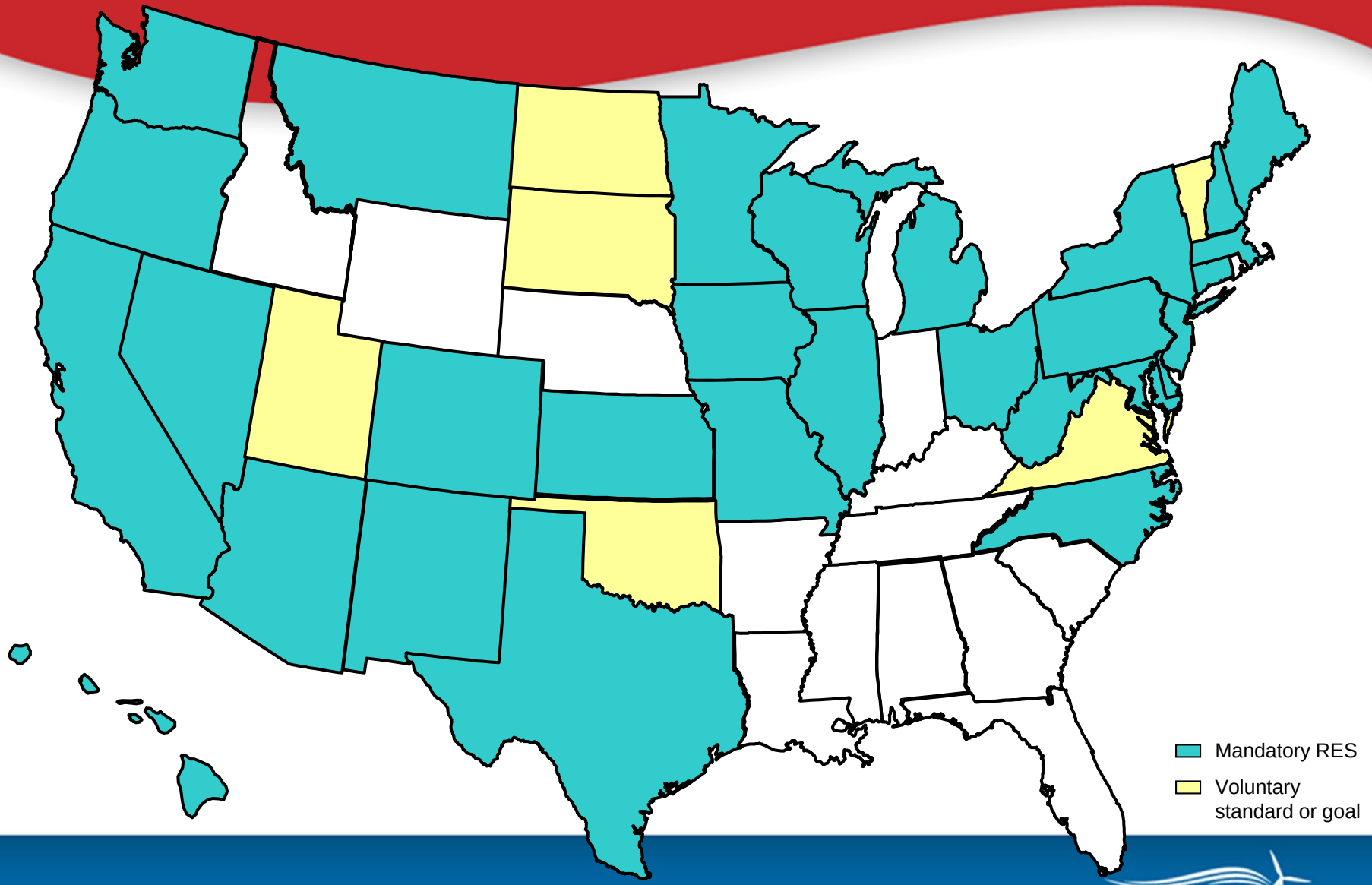
Majority of States Have Established Long-Term Renewable Electricity Standards



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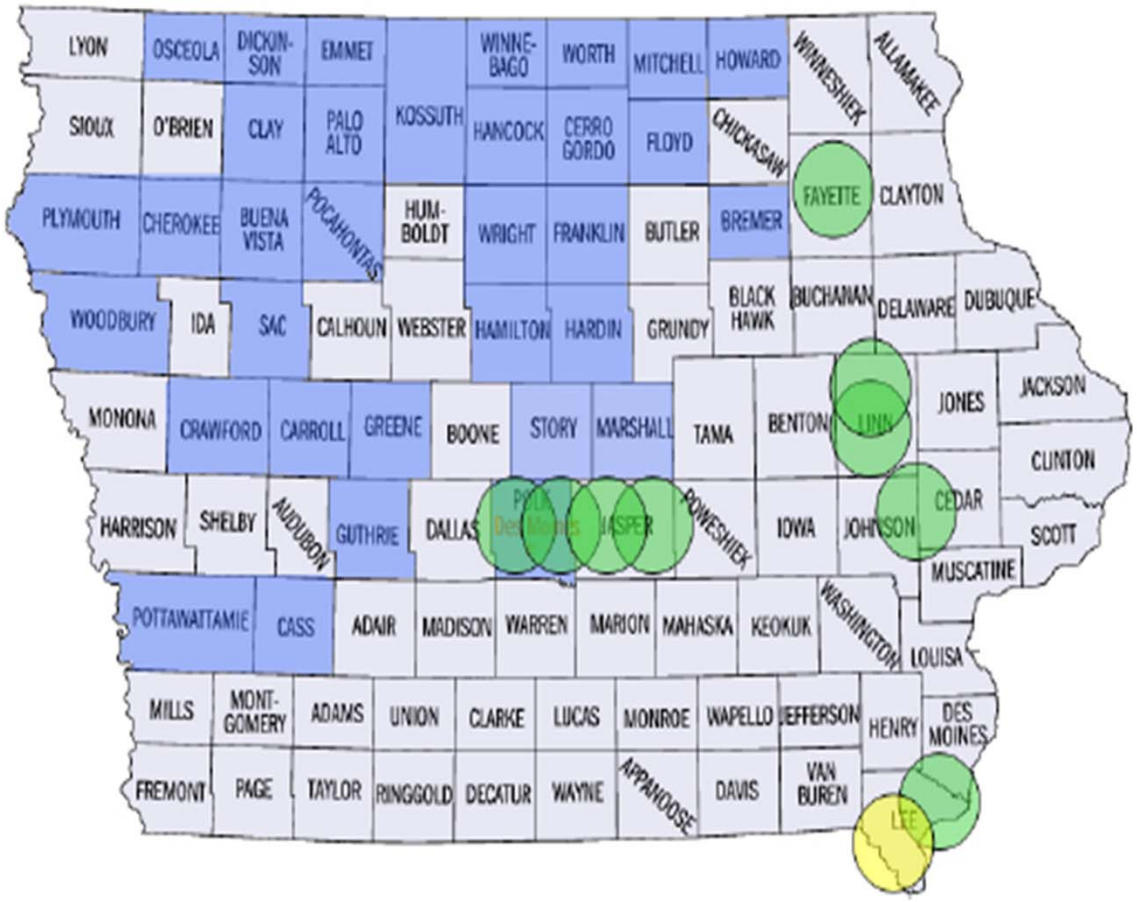
Iowa: Case study of state leadership in growing wind generation and manufacturing

Iowa which enacted a renewable standard in 1983, now has the greatest percentage of electricity generated fror wind:
3,675 MW, approaching 20% of the state's electricity, and is a leadir state in attracting manufacturing.



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Portfolio Approach: State Leadership Recent Successes

Ohio: After passing an aggressive 30% RPS, the state reformed critical state tax laws to provide better business environment for development. 1,100 MW of proposed projects can now move Ohio ahead to join the other 14 states in the "Gigawatt Club".

Colorado: After passing by voter initiative in 2004, the state RPS has been increased twice, most recently to 30% by 2020.

Nebraska: The 4th highest wind potential state in the U.S. passed a portfolio of policies in the "Wind Bill" to open the state for business

Oklahoma: This conservative plains state was the most recent state to pass a renewable energy target for its utilities

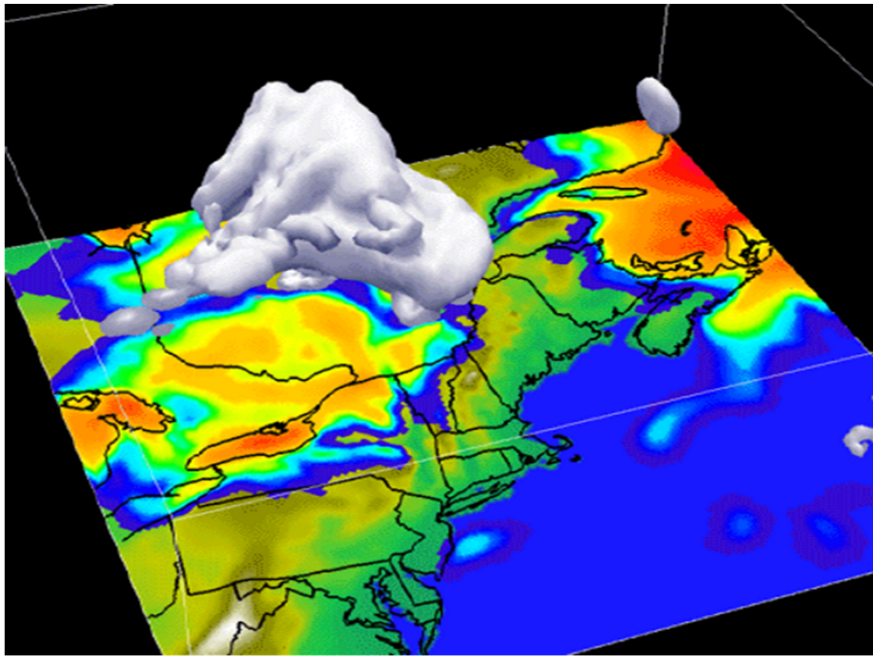
Storage

The Variable Nature of Wind Energy

- **Wind is an energy resource, not a capacity resource**
  - **'Reliability' concerns often founded on serious misunderstandings of how grid operates, how wind projects fit into system operations**
- **Wind power output is 'variable,' not 'intermittent'**
  - **Wind forecasting plays key role today, will play increasingly important role in future**
- **There is a cost to managing wind's variability – depends upon system's characteristics, but is generally low**
  - **Many wind integration studies have been performed in US, EU**

Improve Use of Wind Forecasting

- **Wind integration costs are largely due to uncertainty about the next day's wind output**
- **Wind energy forecasts are already remarkably accurate**
- **Largest opportunities for improvement:**
  - **Better integrating forecasts into power system operations**
  - **Providing grid operators with useful information**



What is the answer to Renewable Energy Storage?

"World's largest wind-power storage system charges ahead"

"GE, EDF to develop gas generator for backing up renewables"

"Developers pitch hydropower solution to West's fickle winds"

"Startup raises more than $20M for air compression technology"

"Company plans to build Wyoming water reservoirs for wind power storage"

"DOE and DOD propose energy storage project "

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Main Takeaways

- **Trade Associations** can be useful in shaping smart, effective policy
- Establishing **domestic manufacturing** drives down costs
- **Long-term planning** for electricity grid avoids transmission problems
- Utilize already developed and cost-effective **technology**

Thank You

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