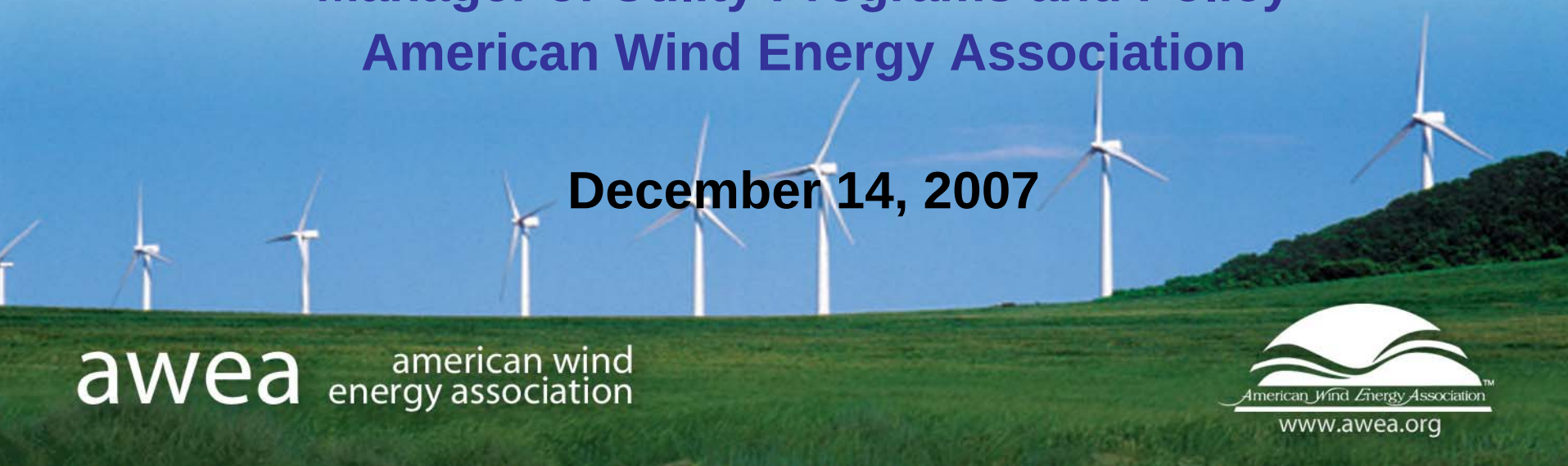
Indiana Wind Working Group (IWWG)
8th Meeting

Clean Energy in Indiana
The Time is Right for Wind Power

Jeffrey E. Anthony
Manager of Utility Programs and Policy
American Wind Energy Association

December 14, 2007



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Who is AWEA ?

- American Wind Energy Association
  - ***www.awea.org***
- National Trade Association for Wind Industry
  - Legislative / Lobbying
  - Education & Outreach
  - Member Services
- Currently >1200 business, manufacturers, utility, academic, and non-profit members

Topics

- Overall Trends
- Benefits of Wind Power
- Policy / Renewable Portfolio Standards
- Wind Turbine Manufacturing
- Utility Trends in Wind Power
- Q&A

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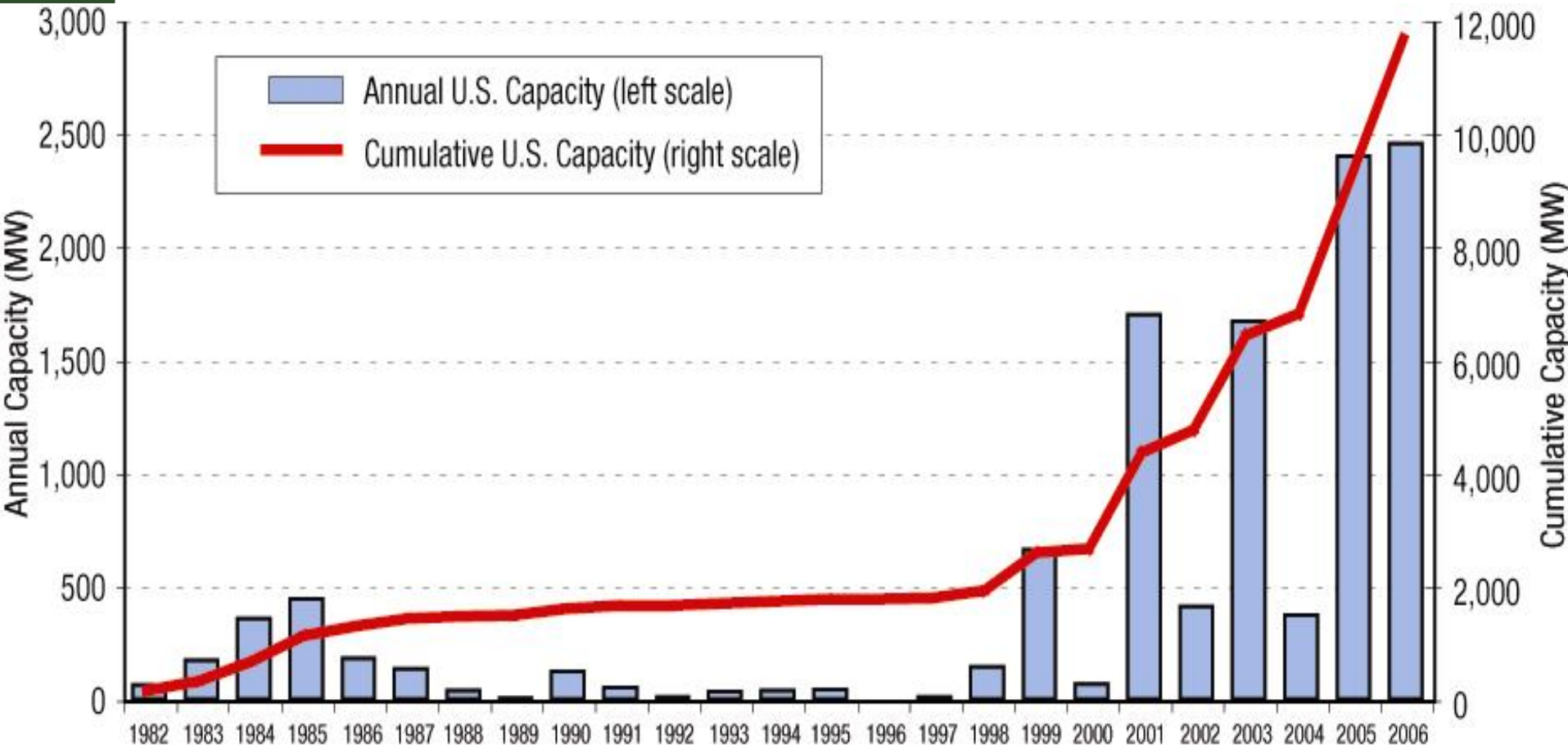
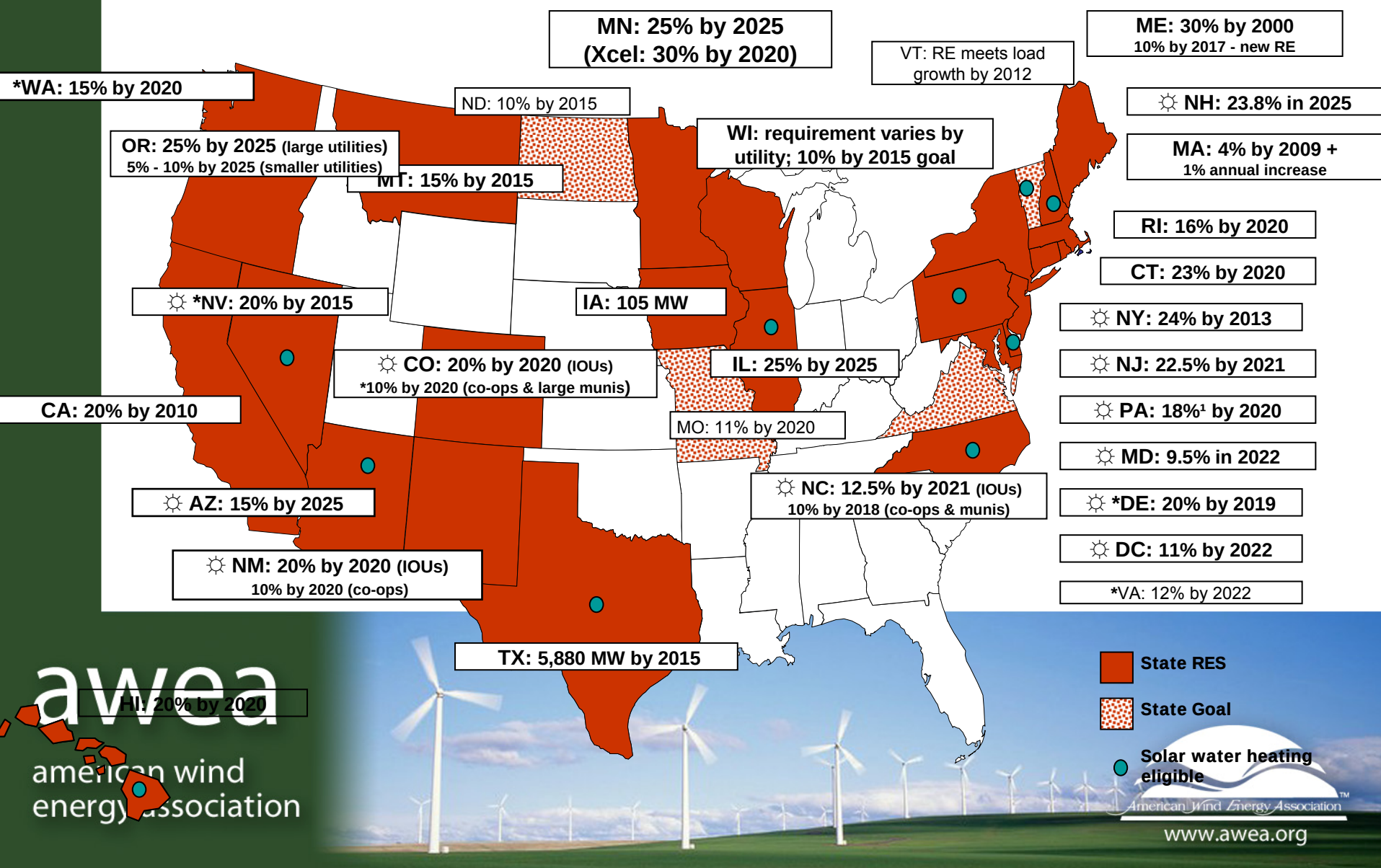
Wind Power Taking Off in U.S.



Source: AWEA/GEC database.

State RPS Requirements



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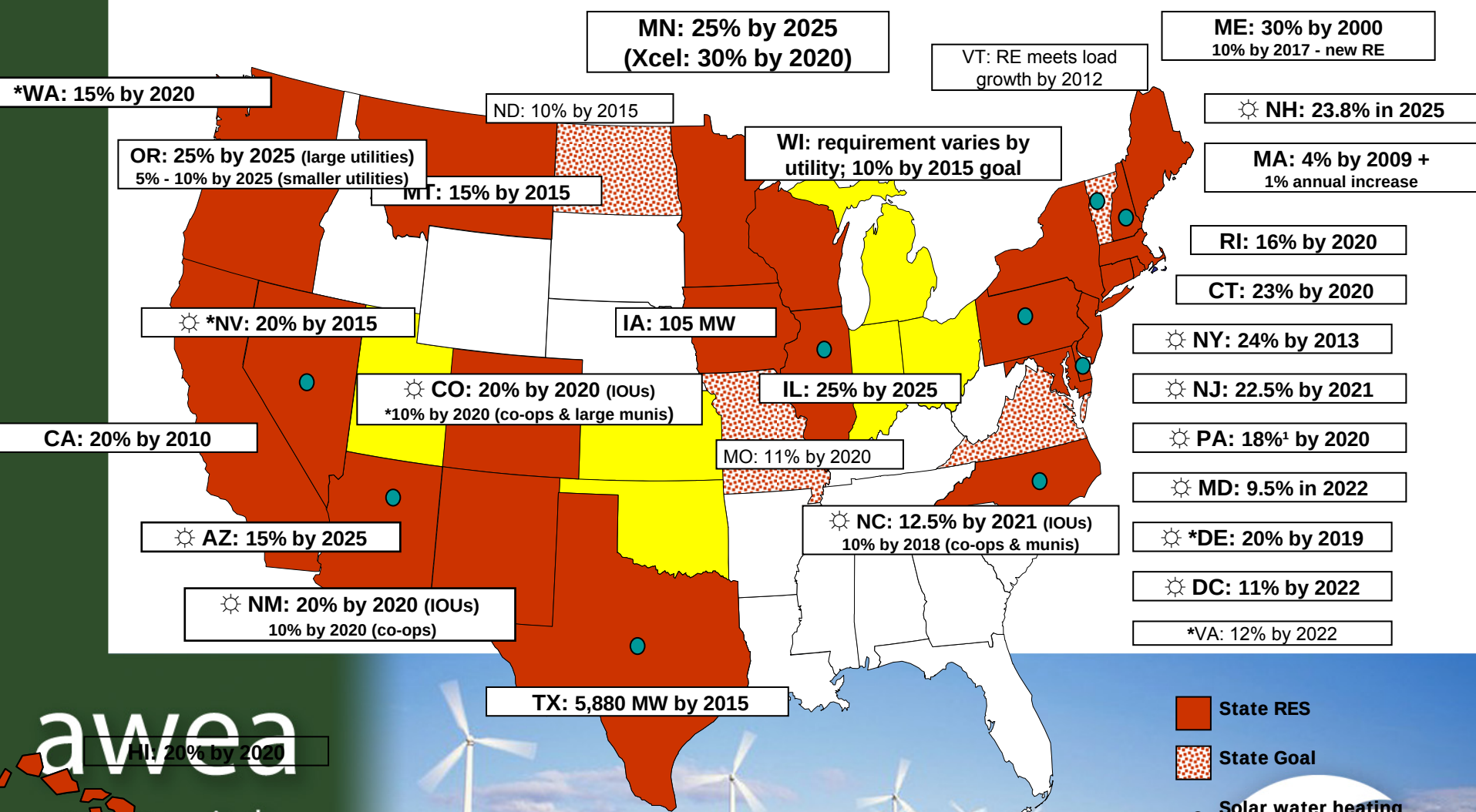

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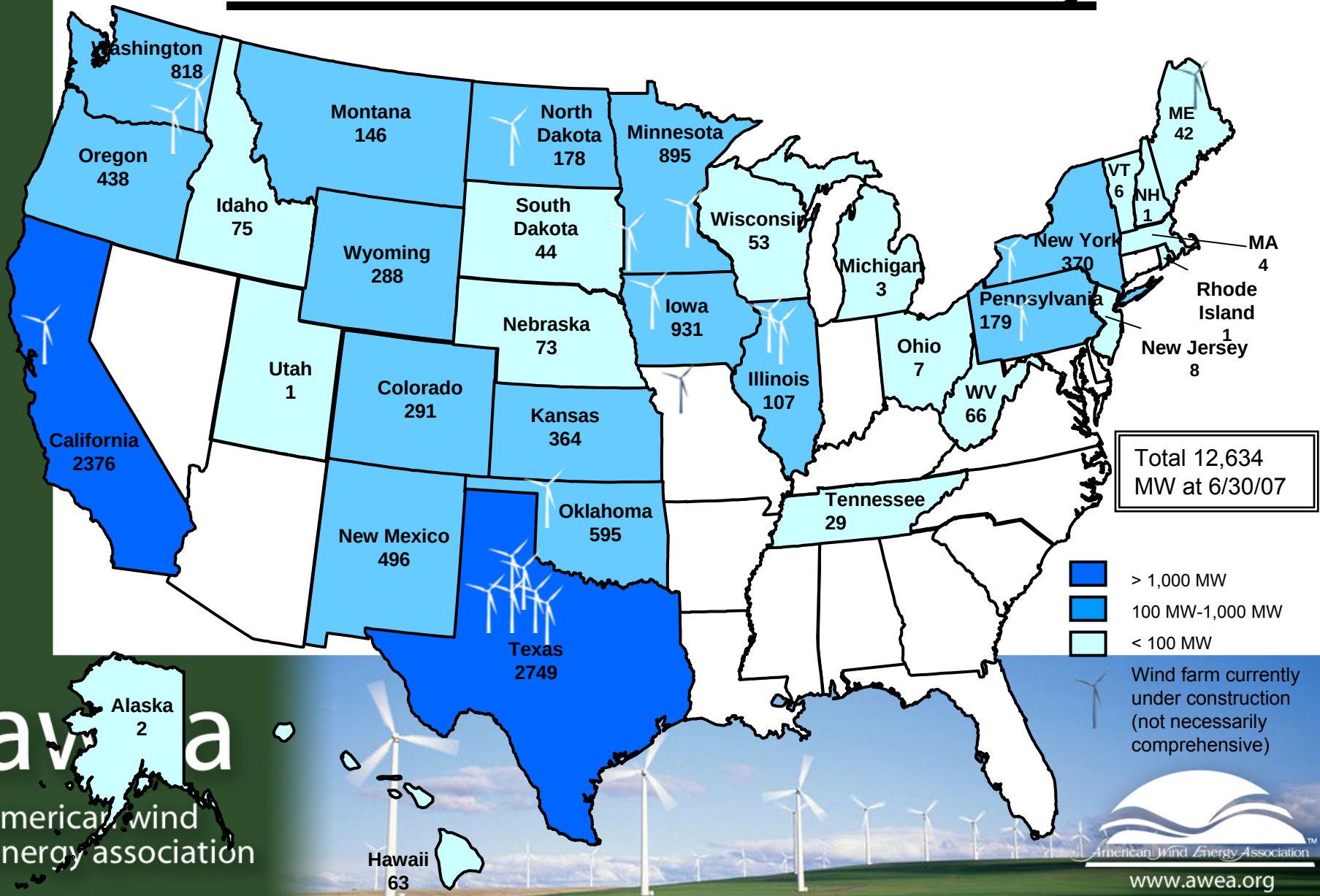
U.S. Wind Power Today



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Benefits of Wind Power

Utilities are recognizing new and existing benefits

- Environmental
- Economic Development
- Cost Stability
- Fuel Diversity
- Energy Security

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Benefits of Wind Power

Environmental

- No air pollution (SO_2,NOx,Hg)
- No water pollution
- No global warming impacts
- No fuel = no mining / drilling
- No water use

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Benefits of Wind Power

Economic Development

Case Study: 162MW Colorado Green Project near Lamar, Colorado

- $3,000-$6,000 per 1.5-MW turbine in revenue to farmers
- Up to 400 construction jobs and ongoing 15-20 O&M jobs
- Sales tax revenues jumped 62% in one year, from $95,000 to $154,450. The tax base has increased by 29%.

Source: U.S. DOE report, “From Snack Bars to Rebar” by Craig Cox

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Benefits of Wind Power

Energy Security

- Almost all new electricity generation in the last decade has been natural gas-fired.
- Biggest sources for future U.S. natural gas supplies are Iran, Russia, and Qatar.
  - **These 3 countries have ½ of global natural gas reserves**.
  - Increasing electricity from domestic wind power reduces our dependence on such countries, ***and*** reduces payments we send to these nations.

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Benefits of Wind Power

Cost Stability

- **Known pricing can offer hedge against fuel price volatility risk**
- **Electricity from the wind is inflation-proof once a wind farm is installed**
- **Utilities starting to value this “price hedge”**

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Benefits of Wind Power

Fuel Diversity

- **Domestic energy source**
- **Inexhaustible supply**
- **Small, dispersed design reduces supply risk**
- **Reduced natural gas consumption**

Renewable Energy Policy

- National Energy Policy
- Federal Renewable Energy Standard (RES)
- State Renewable Portfolio Standards (RPS)

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National Energy Goals

- *"affordable, reliable, secure, and clean sources of energy"* *"Advanced Energy Initiative"*
- *"help secure our energy future by **encouraging conservation and efficiency**, **diversifying our energy supply with alternative and renewable sources**, expanding domestic energy production in an environmentally sensitive way, and modernizing our electricity infrastructure."* *Energy Policy Act*

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Renewable Energy as a Solution

- ✓ Affordable: Substantial cost savings to consumers.
- ✓ Reliable: Reduces fuel price and regulatory risk, and stabilize prices for utilities and consumers.
- ✓ Secure: Provide energy diversity and energy independence.
- ✓ Clean: The only currently-available, readily-deployable, cost-effective, zero-emissions energy technology.

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A Federal RES Saves Money

- **Union of Concerned Scientists report**: a 20% RPS by 2020 would result in $ 49 billion in natural gas and electricity savings
- **Department of Energy EIA report**: a 10% RPS by 2020 would result in $ 22 billion reduced natural gas & electricity expenditures
- **Wood Mackenzie report**: a 15% RPS by 2020 would result in $100 billion in net savings to consumers

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Federal RES Benefits

- **Wood Mackenzie** found that a Federal 15% RES will produce net savings of $100 billion across US
- By 2026, implementing a Federal RES:
  - Natural gas price will decrease 15-20%
  - Wholesale electricity prices will decrease 7-11%

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Federal RES Benefits to Indiana

- **Payments to Rural Landowners of $5 to 10 Million/per year by 2020**
  - If Indiana developed wind capacity to meet just half of the state's needs for the 15% National RPS requirement by 2020, it would result in $5 to $10 million in additional revenue to rural landowners per year.
- **Jobs, Jobs, Jobs: More Wind Could Require over 8,000 jobs in Indiana**
  - Indiana would be a top 10 state to see an increase in manufacturing jobs to support a growing renewable energy industry across the U.S, and additional 50,000 megawatts of wind in the U.S. could require over 8,000 manufacturing jobs in Indiana.[1]

[1] Renewable Energy Policy Project. *Wind Turbine Development: Wind Manufacturing Activity.* September 2004.

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Federal RES Benefits to Indiana

- **Investment of over $5 billion in Indiana**
  - Wind resource maps show that Indiana has over 40,000 megawatts (MW) of wind potential, enough to power 10 million homes.[1]
  - If Indiana developed wind capacity to meet just half of the state's needs for the 15% National RES it would result in > $5 billion invested in the state.
- **Lower Natural Gas Prices by 20% and Lower Wholesale Electric Power Prices up to 11%**
  - Over two-thirds of Indiana households use natural gas as their source of energy for home heating, Indiana imports over 99% of their natural gas.
  - A 15% RPS would decrease natural gas demand and could lower natural gas prices by 20% by 2026. Indiana uses a majority of coal for electric generation, but lower natural gas prices would translate into cost savings for the two-thirds of Indiana consumers that use natural gas for heating.[2]
  - A 15% RPS will lower wholesale electric power prices by lowering the price of fuel. Wholesale prices decrease 11 percent at the Cinergy wholesale power hub in Indiana.

[1] Testimony to Indiana General Assembly on House Bill 1379 by Dennis Elliot of the Department of Energy's National Renewable Energy Laboratory, January 2006.

[2] Wood Mackenzie. *The Impact of a Federal Renewable Portfolio Standard*. March 2007.

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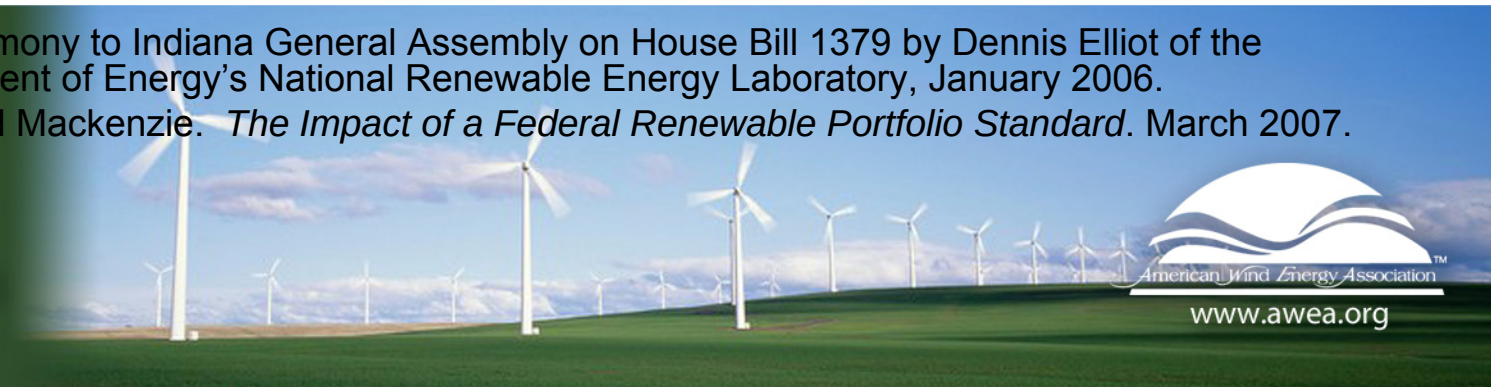
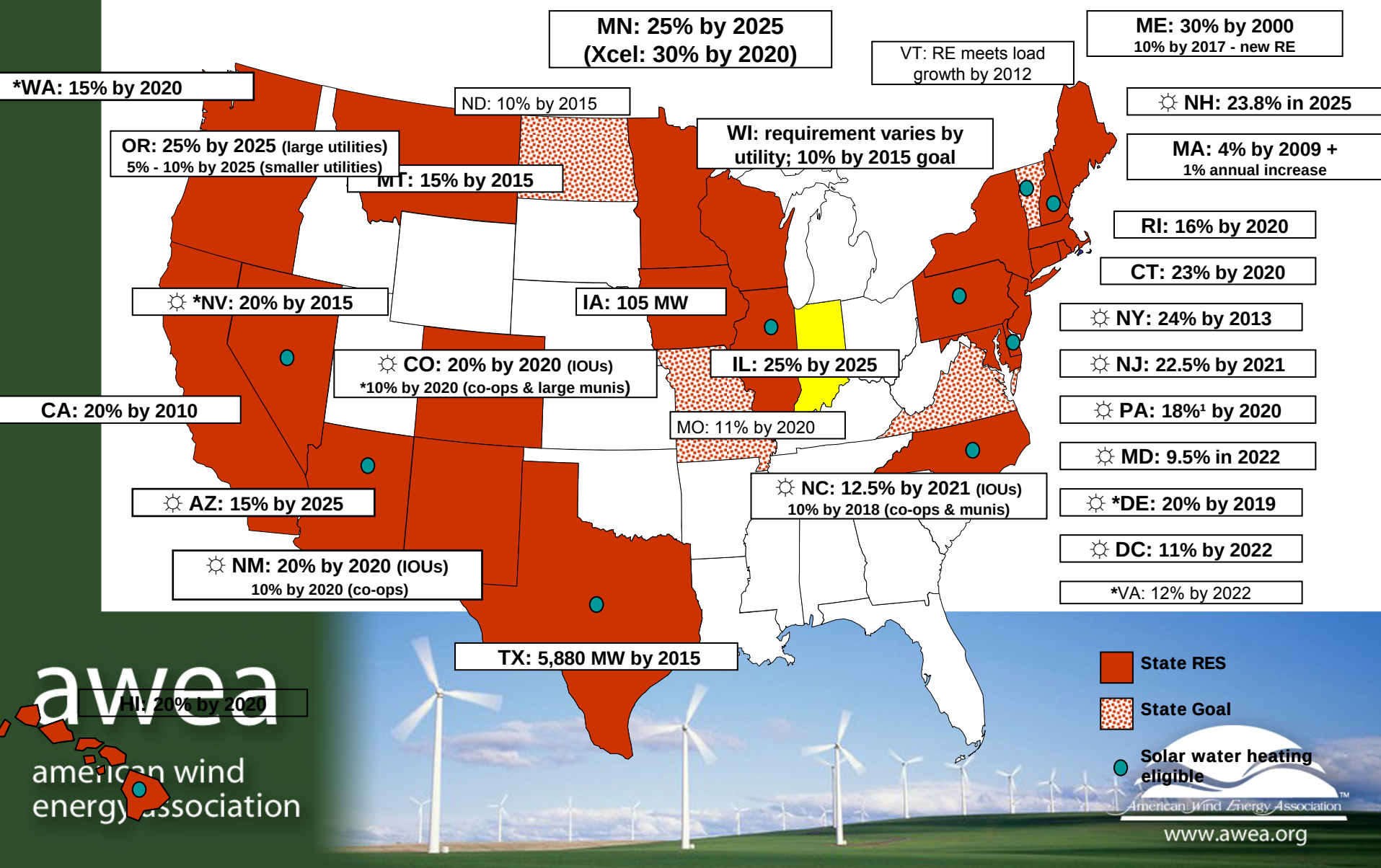


State RPS Requirements



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State RPS Design

- **What Makes an Effective State RPS ?**
  - **LBNL: "Evaluating Experience with Renewable Portfolio Standards in the U.S." (Wiser, Porter, Grace - LBNL-54439, March 2004)**
  - Socially Beneficial
  - Cost Effective and Flexible
  - Predictable
  - Nondiscriminatory
  - Enforceable
  - Consistent with Market Structure
  - Compatible with Other Policies

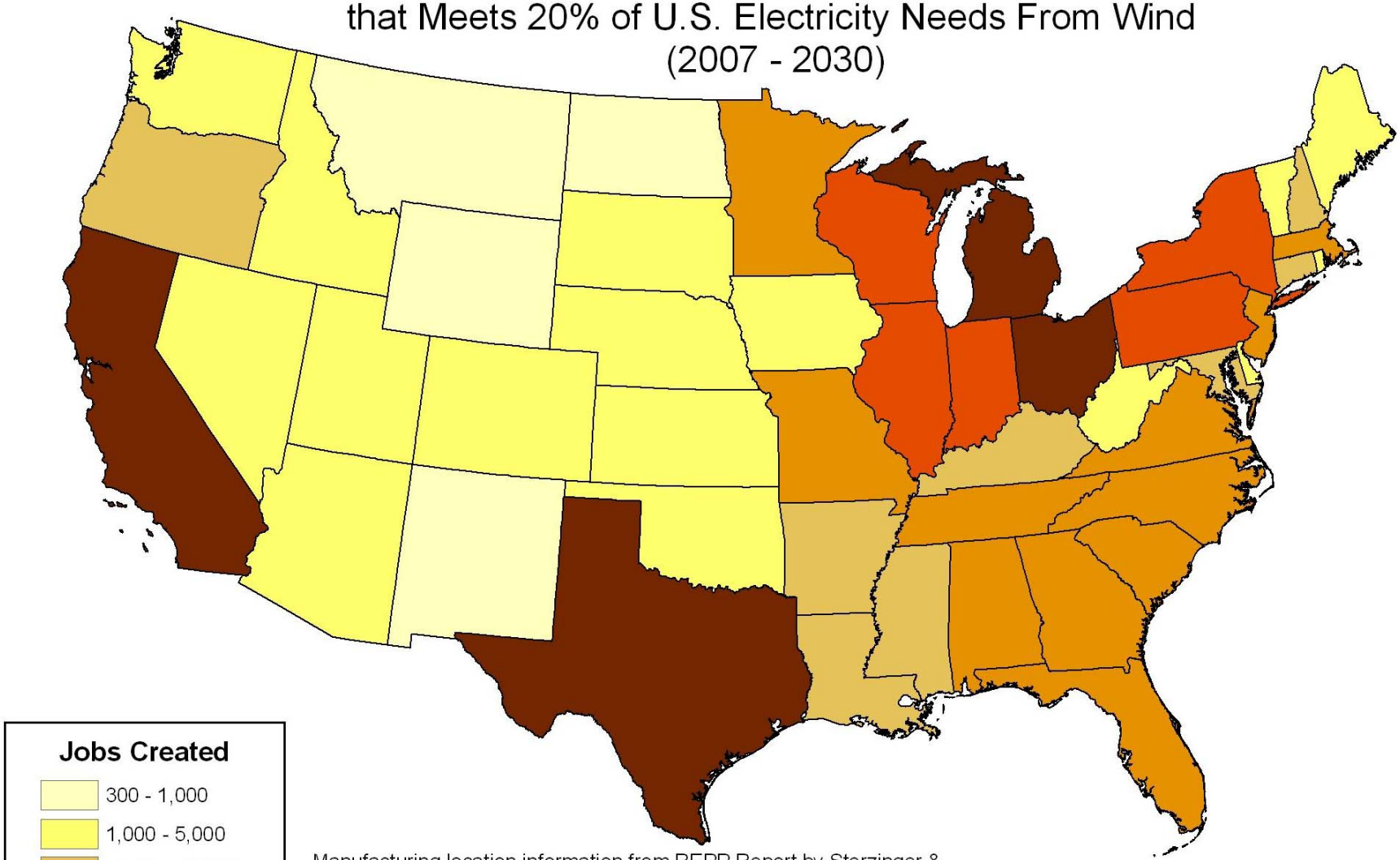
State RPS Design

- **Examples of What Not to Do:**
  - California: far too complex
  - Maine: poor consideration of supply-demand
  - Arizona: timing and duration
  - Wisconsin: ill-defined treatment of RECs
  - New Mexico: unstable political/regulatory support
  - Several: inconsistent or vague treatment of out-of-state renewable energy applicability

Wind Power: Mfg & Jobs

- To install 16,000 megawatts per year, the U.S. wind industry will require:
  - Over 185,000 jobs, with over 30,000 jobs in the manufacturing sector and over 55,000 jobs in the construction sector.
  - An additional 110,000 positions would be required by 2030 to support the operations of the installed wind fleet for the life of the turbines.
  - While meeting increased labor demands could present a challenge for the wind industry, it also presents a huge opportunity for the U.S. to pursue an industry that employs people across multiple sectors – particularly other sectors currently experiencing a downturn.

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



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.

Renewable Energy Jobs Creation

New Manufacturing Jobs, Investment for 74,000 MW Renewable Energy Development

Location	# of Firms	New Jobs Wind	New Jobs Solar	New Jobs Geothermal	New Jobs Biomass	Total New Jobs
California	5,409	12,830	19,558	3,387	2,481	38,256
Texas	3,358	10,024	9,289	1,864	2,869	24,046
Illinois	2,289	12,013	7,720	1,358	1,550	22,641
Ohio	2,465	11,937	4,733	2,031	1,813	20,514
New York	1,925	7,415	5,848	3,260	2,653	19,176
Pennsylvania	2,188	7,841	6,308	1,363	1,564	17,076
Indiana	1,321	10,078	2,995	1,277	1,345	15,695
Wisconsin	1,331	10,079	1,977	815	1,190	14,061
Michigan	2,050	9,750	2,657	602	914	13,923
North Carolina	1,096	4,391	4,423	1,123	1,480	11,417
10 States	23,432	96,358	65,508	17,080	17,859	**196,805**

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Renewable Energy Jobs Creation

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Source: Renewable Energy Policy Project, 2006

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Wind Turbine Manufacturing

The Wind Energy Supply Chain:
(non-exhaustive list)

- **Component Manufacturing**
  - Electrical
  - Mechanical
  - Fabrications
  - Other Sub-components
- **Commodities**
  - Fasteners
  - Connectors
  - Other Electrical & Mechanical
- **Base Industry Components**
  - Castings
  - Forgings
  - Rolled Steel
  - Resins
  - Woven Glass
- **Turbine Manufacturing**
  - Components
  - Composites
  - General Assembly
  - Tower Manufacturing
  - Site Infrastructure
- **Transportation & Construction**
  - Cranes
  - Specialized Transport
- **Operation & Maintenance (O&M)**
  - Operations & Monitoring
  - Maintenance & Repair
  - Asset Management
- **Off-take & Transmission**
  - Grid Management
  - Transmission Services
  - Utility Services

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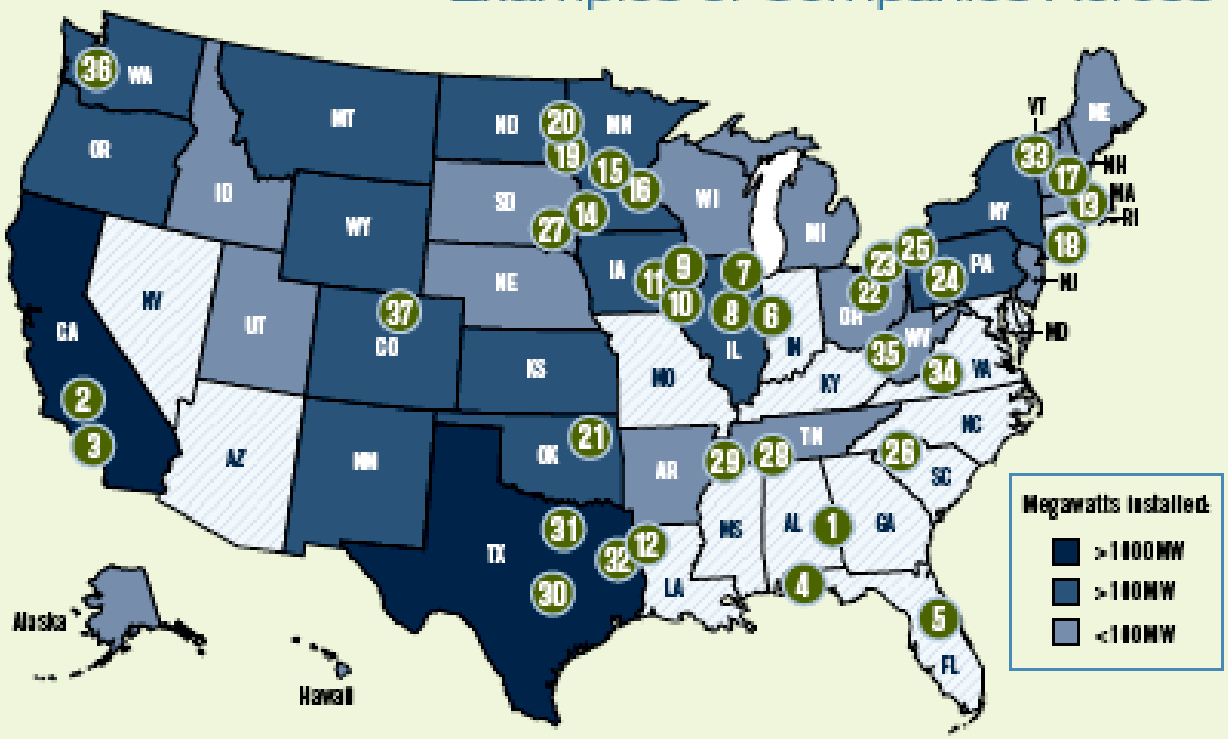
Utility-scale Wind Turbine Manufacturing and Supply Chain:
Examples of Companies Across the U.S.



Wind power creates manufacturing jobs even in regions like the Southeast that do not have a large wind resource.

1 **Vectorply**, Phenix City, AL (composites for blades)

2 **GE Energy**, Tehachapi, CA (wind turbine manufacturing facility)

3 **Bragg Crane & Rigging Service**, Long Beach, CA (cranes, rigging, transportation)

4 **GE Energy**, Pensacola, FL (blade technology development)

5 **Mitsubishi Power Systems**, Lake Mary, FL (gear boxes)

6 **White Construction Inc.**, Clinton, IN (construction services)

7 **Winergy Drive Systems Corporation**, Elgin, IL (gear units, generators, power converters)

8 **Trinity Industries**, Clinton, IL (towers)

9 **Clipper Windpower**, Cedar Rapids, IA (turbine manufacturing, assembly)

10 **Siemens**, Fort Madison, IA (blades)

11 **Acciona Energia**, West Branch, IA (planned) (turbine manufacturing)

12 **Beaird Industries**, Shreveport, LA (towers, tower flanges and bolts)

13 **Second Wind Inc.**, Somerville, MA (anemometers, electronic controllers, sensors/data loggers)

14 **Suzlon Wind Energy**, Pipestone, MN (blade manufacture, turbine assembly)

15 **D.H. Blattner & Sons**, Avon, MN (construction)

16 **M.A. Mortenson Co.**, Minneapolis, MN (construction)

17 **Hendrix Wire & Cable Inc.**, Milford, NH (cables to substations)

18 **Hallo LLC**, Holbrook, NY (ladder and lift systems)

19 **DMI Industries**, West Fargo, ND (towers)

20 **LM Glasfiber**, Grand Forks, ND (blades)

21 **Trinity Structural Towers**, Tulsa, OK (towers)

22 **Owens Corning Composites**, Granville, OH (composites for blades)

23 **Hamby Young**, Aurora, OH (substations and high voltage applications)

24 **Gamesa**, Ebensburg, PA (blade, nacelle, tower manufacturing)

25 **GE Energy**, Erie, PA (wind turbine components)

26 **GE Energy**, Greenville, SC (turbine assembly plant)

27 **Knight & Carver**, Howard, SD (blade manufacturing)

28 **Aerisyn Inc**, Chattanooga, TN (towers)

29 **Thomas & Betts Corp.**, Memphis, TN (towers, tower flange and bolts)

30 **DeWind, Inc./TECO Westinghouse**, Round Rock, TX (wind turbine manufacturing)

31 **Trinity Structural Towers**, Fort Worth, TX (towers)

32 **CAB Incorporated**, Nacogdoches, TX (blade extende hub, nacelle frame, tower flange and bolts)

33 **NRG Systems**, Hinesburg, VT (anemometers, sensors/data loggers)

34 **GE Energy**, Salem, VA (wind turbine components)

35 **Tower Logistics**, Huntington, WV (lifts for turbines)

36 **PowerClimber**, Seattle, WA (traction hoists, rigging equipment)

37 **Vestas**, Windsor, Colorado (planned) (blade and turbine manufacturing)

Wind Turbine Manufacturing

- AWEA ramping up support of wind industry supply chain activities
  - Entire project development life cycle
  - Examining shortcomings and obstacles
    - policies
    - logistics
    - skilled labor
    - manufacturing of equipment, components, & supplies.
  - Outreach, awareness & bring together organizations involved in, or will be involved in, the wind industry.

Utility Trends in Wind Power

- Recent Drivers towards Utility Ownership of Wind Projects
- Industry Trends
- Examples of Specific Utilities
- Emerging Drivers
- Concerns (from wind developers, IPPs)

Utility Ownership Drivers

Recent Drivers

- Mature Technology
- Wind Integration Impacts
- Assets in Rate Base
- Regulatory Mandates / RPS Compliance
- Economic Development
- Energy Security
- PPAs as Imputed Debt

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Wind Energy Output Variability

- Source of many misconceptions
  - NOT unreliable: wind energy readily integrated into large, robust electricity markets
  - NOT expensive to integrate into utility system
  - Backup for every megawatt of wind NOT needed
- Wind Integration studies are invaluable (MN, CA, NY, Ontario) – 2 new studies launched
- Wind is different – but, so was nuclear

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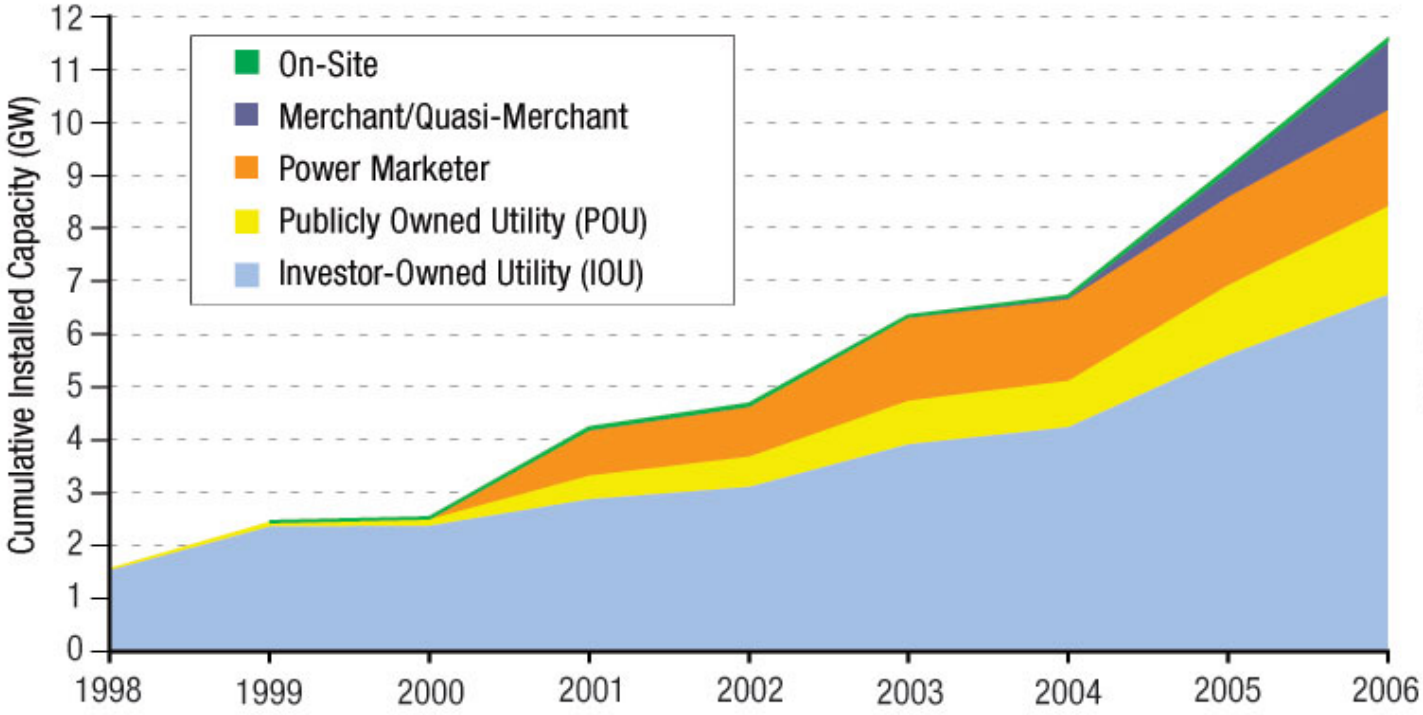
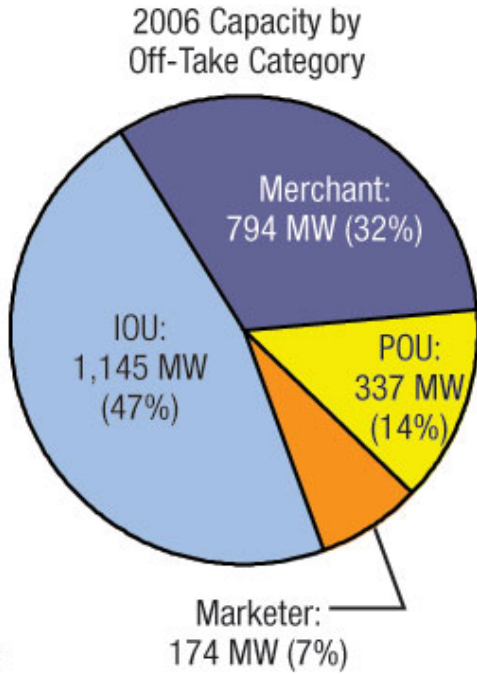
Industry Trends

Who Buys The Output of Wind Projects Today ?

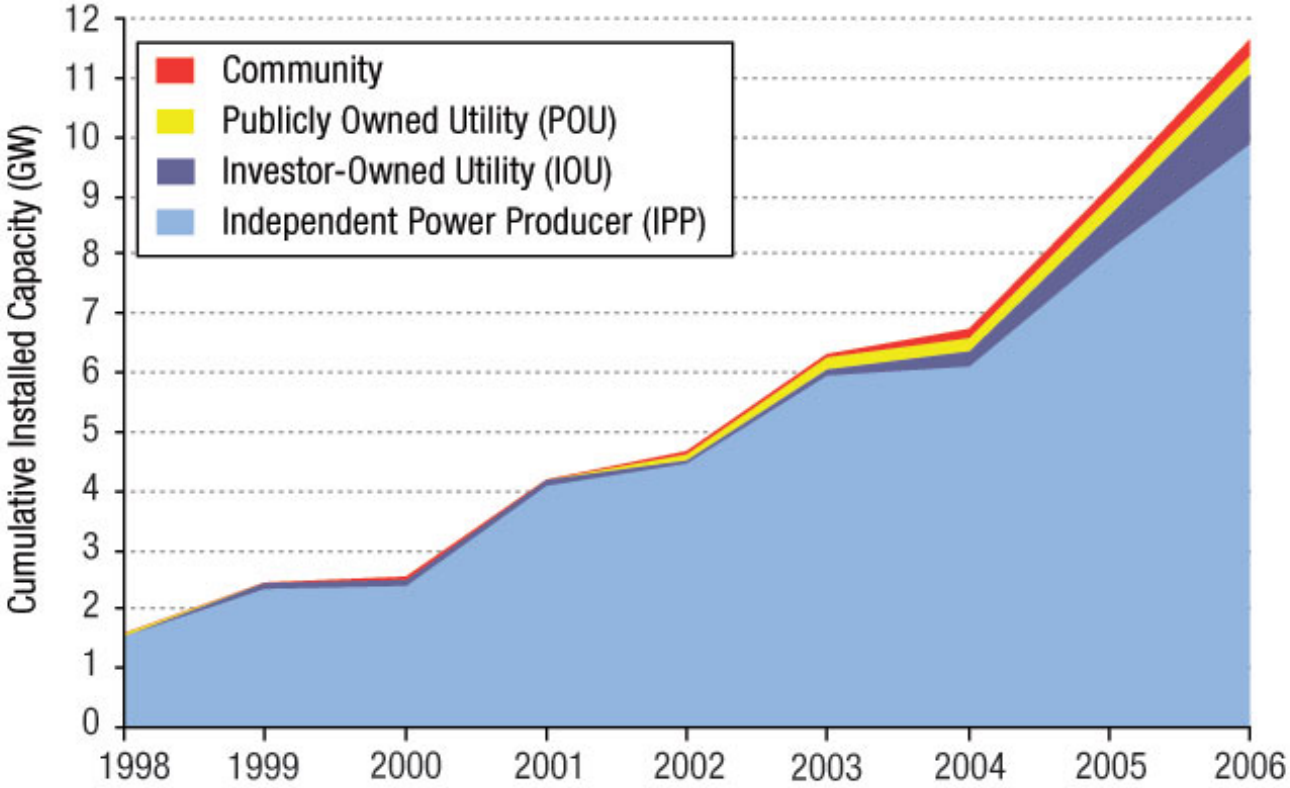


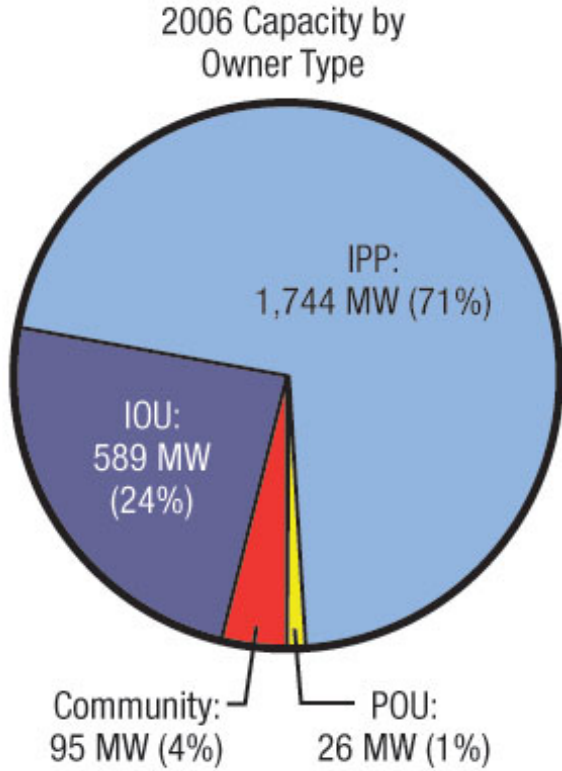


Source: Berkeley Lab estimates based on AWEA/GEC wind project database.

Industry Trends

Who Owns Wind Projects Today ?





Source: Berkeley Lab estimates based on AWEA/GEC wind project database.

Utility Ownership: Leaders

- **Current**
  - American Electric Power
  - Kansas City Power & Light
  - MidAmerican Energy
  - Nebraska Public Power District
  - Portland General Electric
  - Puget Sound Energy
  - Sacramento Municipal Utility District
  - Xcel Energy
- **Soon**
  - Alliant Energy
  - LADWP
  - Oklahoma Gas & Electric
  - PacifiCorp
  - We Energies

Emerging Drivers

- **Transmission**
  - Utilities have interest in both wind development and transmission development
- **Financial Impacts**
  - PPAs as imputed debt
  - Tax credits
- **Project Control**
  - Cost control
  - Local relationships
- **Strategic Objectives**
  - Hedge Value
  - Sustainability
  - Global Warming

THE TIME IS RIGHT FOR WIND POWER

- **Your Questions ?**

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Wind Power Variable Output

- The variability of wind power plant output is a known, manageable feature of wind energy
  - Several “Wind Integration” studies have evaluated this aspect of wind power and how to manage it
  - All studies indicate that costs are minimal and operational challenges are manageable
  - See ***www.uwig.org*** for details
- Wind power integration is part of system-wide integration of all resources, including load

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Comparison of Cost-Based U.S. Operational Impact Studies

Date	Study	Wind Capacity Penetration (%)	Regulation Cost ($/MWh)	Load Following Cost ($/MWh)	Unit Commitment Cost ($/MWh)	Gas Supply Cost ($/MWh)	Tot Oper. Cost Impact ($/MWh)
May '03	Xcel-UWIG	3.5	0	0.41	1.44	n/a	1.85
Sep '04	Xcel-MNDOC	15	0.23	n/a	4.37	n/a	4.60
June '06	CA RPS	4	0.45*	trace	n/a	n/a	0.45
Feb '07	GE/Pier/CAIAP	20	0-0.69	trace	n/a***	n/a	0-0.69***
June '03	We Energies	4	1.12	0.09	0.69	n/a	1.90
June '03	We Energies	29	1.02	0.15	1.75	n/a	2.92
2005	PacifiCorp	20	0	1.6	3.0	n/a	4.60
April '06	Xcel-PSCo	10	0.20	n/a	2.26	1.26	3.72
April '06	Xcel-PSCo	15	0.20	n/a	3.32	1.45	4.97
Dec '06	MN 20%	31**					4.41**
Jul '07	APS	14.8	0.37	2.65	1.06	n/a	4.08

* 3-year average; total is non-market cost

** highest integration cost of 3 years; 30.7% capacity penetration corresponding to 25% energy penetration; 24.7% capacity penetration at 20% energy penetration

*** found $4.37/MWh reduction in UC cost when wind forecasting is used in UC decision

Wind Power & Reliability

- Some question the "reliability" of wind power due to the variable output aspect
  - Reliability needs to be viewed as a system-wide concept, not a generator-specific issue
  - Wind plants do not need back-ups one-for-one, anymore that a nuclear or coal plant does – rather, a reserve margin is maintained on a system basis
- *Key implications:*
  - ***It is not necessary, economic, or desirable to match wind's movements on a 1-1 basis***
  - ***If there is sufficient capacity to supply load without wind, no additional capacity is needed to supply load with wind***

Wind Forecasting

- Wind Forecasting is emerging as a key
  - Wind Integration studies cites it as a huge benefit
  - Control Room integration of wind forecasting is next
- State of the art forecasting can reduce costs
  - majority of the value obtained with current state-of-the-art forecasting
  - additional incremental returns from increasingly accurate forecasts

Wind & Energy Storage

- Energy Storage is often cited as a “must have” for wind power to deal with variable energy output
  - Energy storage technologies still experimental in some cases; very expensive in most cases; hard to site in other cases.
  - Wind Energy does not need energy storage on a project basis – large, regional markets are best
- Value of energy storage is on a system basis

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Wind Capacity Credit

- Wind projects are typically given a “capacity credit” as a portion of their nameplate generating capacity
  - Many different methodologies in place in the U.S.
  - Most credit wind projects with set value initially
  - Adjusted based on performance after 2-3 years
- Efforts to refine approaches underway (NERC, etc.), not a priority for wind industry
  - Wind Turbines are energy machines, not capacity

Strategic Integration of Wind

- Wind industry poised for accelerated growth
  - 2007 will be a record-setting year
  - Growth expected to increase rapidly
  - Policies will determine if growth is limited
- Additional operational costs are moderate for near-term wind penetration levels
- For large, diverse electric balancing areas, wind integration costs are low

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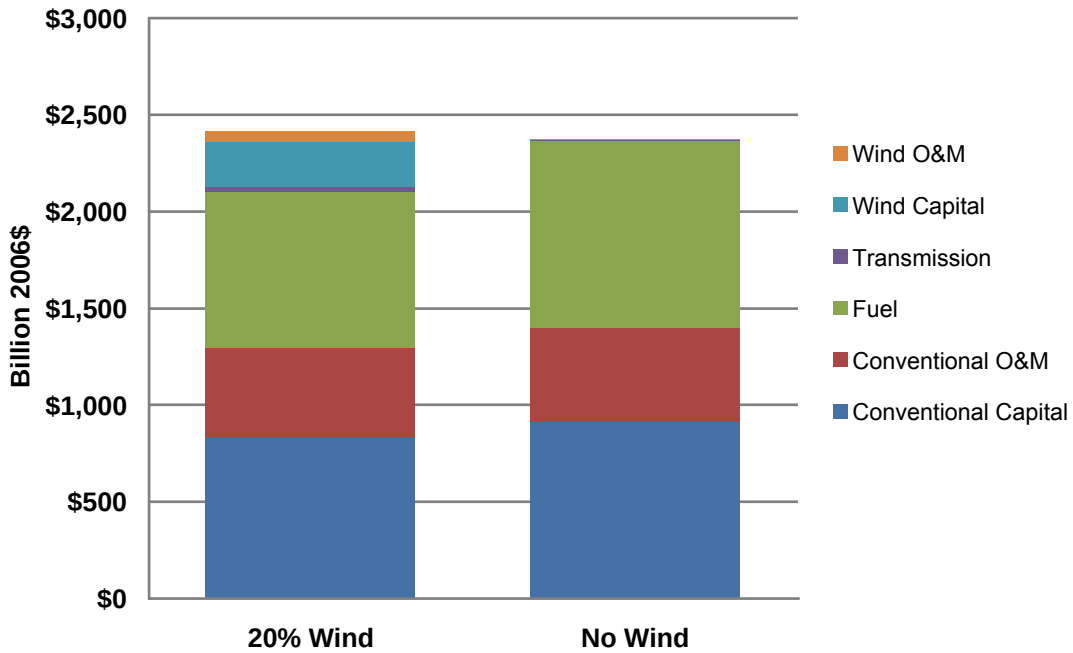
Wind Capacity Value in the US

Region/Utility	Method	Note
CA/CEC	ELCC	Rank bid evaluations for RPS (mid 20s); 3-year near-match capacity factor for peak period used by CA PUC and CA ISO
PJM	Peak Period	Jun-Aug HE 3 p.m. -7 p.m., capacity factor using 3-year rolling average (20%, fold in actual data when available)
Minnesota 20% Study	ELCC	Found significant variation in ELCC: 4%, 15%, 25% based on year
ERCOT	ELCC	ELCC based on random wind data, compromising correlation between wind and load (8.7%)
MN/DOC/Xcel	ELCC	Sequential Monte Carlo (26-34%)
GE/NYSERDA	ELCC	Offshore/onshore (40%/10%)
CO PUC/Xcel	ELCC	12.5% of rated capacity based on 10-year ELCC study. Load forecast algorithm compromised correlation between wind & load
RMATS	Rule of thumb	20% all sites in RMATS
PacifiCorp	ELCC	Sequential Monte Carlo (20%). Z-method 2006
MAPP	Peak Period	Monthly 4-hour window, median
PGE		33% (method not stated)
Idaho Power	Peak Period	4 p.m. -8 p.m. capacity factor during July (5%)
PSE and Avista	Peak Period	PSE will revisit the issue (lesser of 20% or 2/3 Jan C.F.)
SPP	Peak Period	Top 10% loads/month; 85th percentile

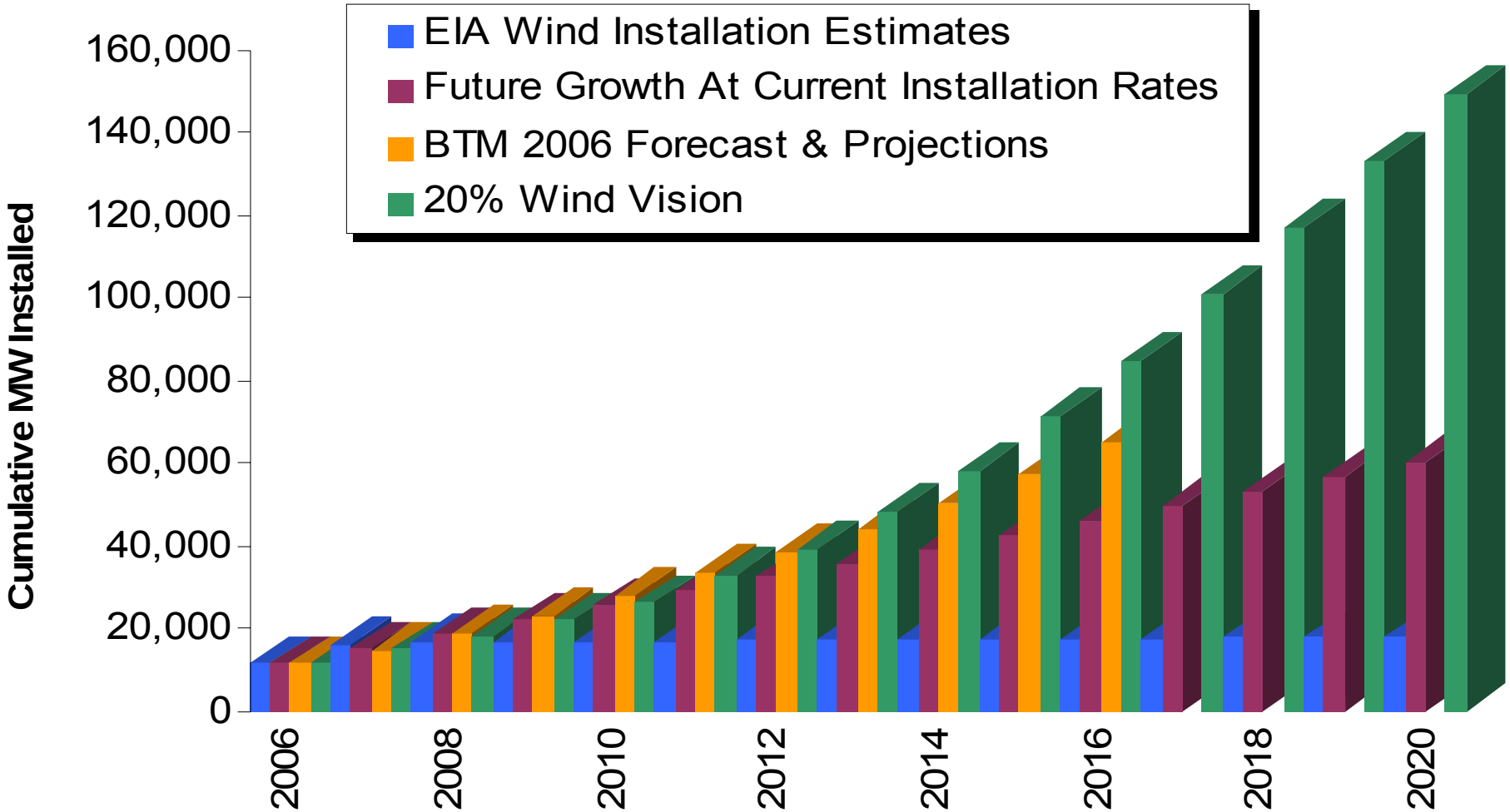
Incremental Cost of 20% Wind Vision



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

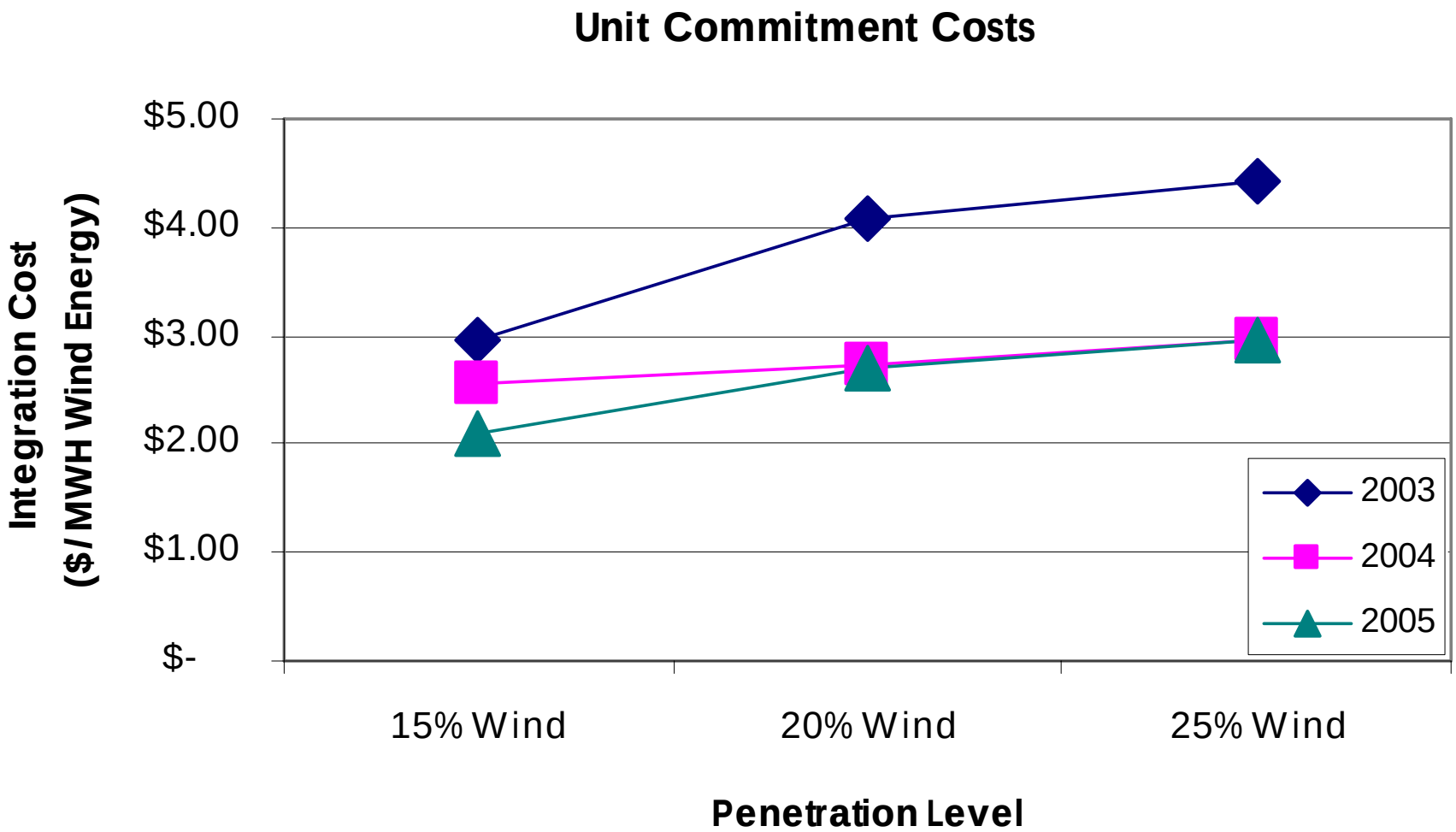
* 7% real discount rate is used, as per OMB guidance; the time period of analysis is 2007-2050, withWinDS modeling used through 2030, and extrapolations used for 2030-2050.
** Assumes 11,000 kWh/year average consumption

Wind Scenario Comparisons

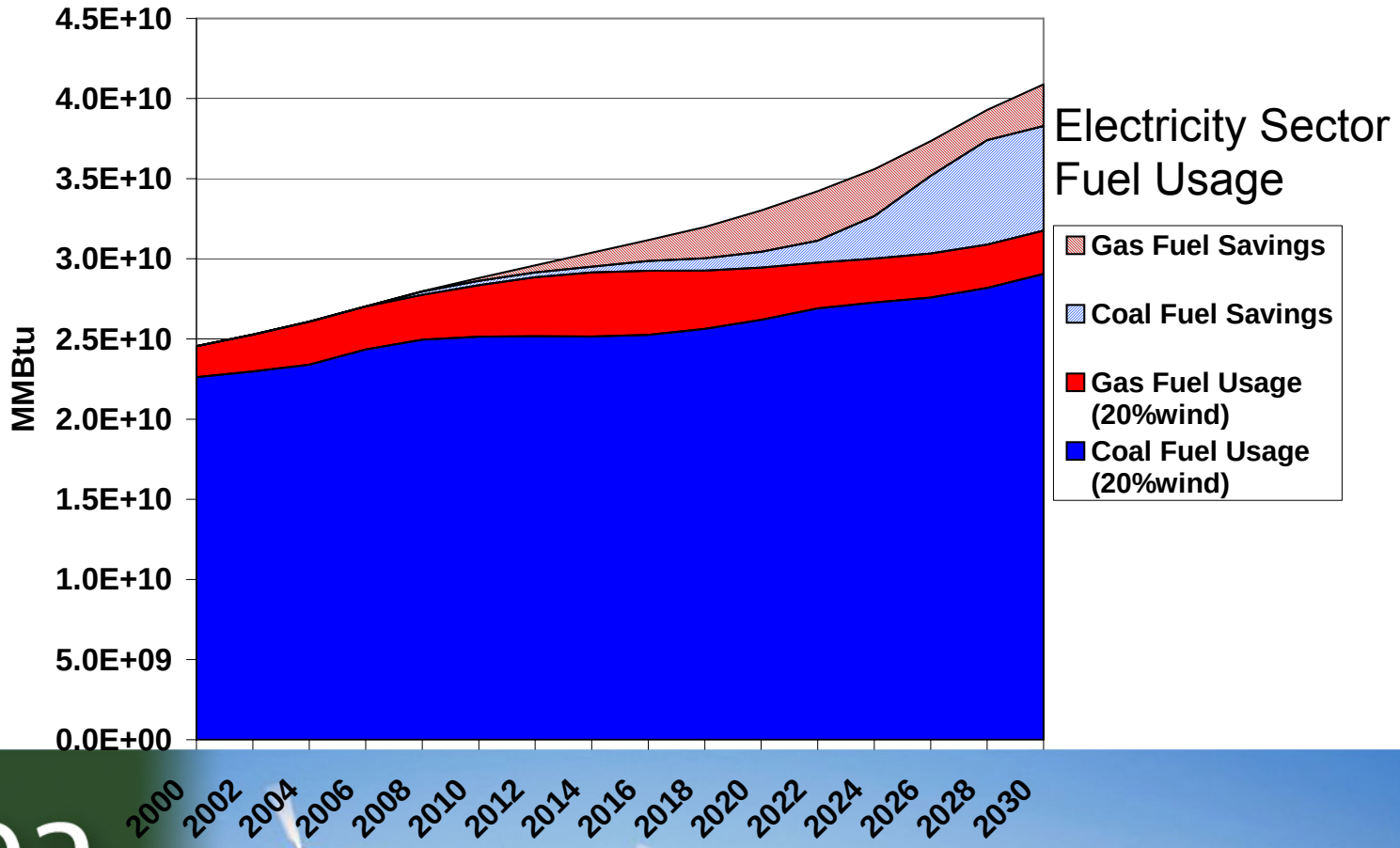


BTM: Danish consulting firm that provides annual global wind energy projections out 5 to 10 years

Integration of 20% Wind Energy Can Be Managed



Fuel Savings From Wind



% 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 - 1.5	86 - 214	16.6 - 41.6

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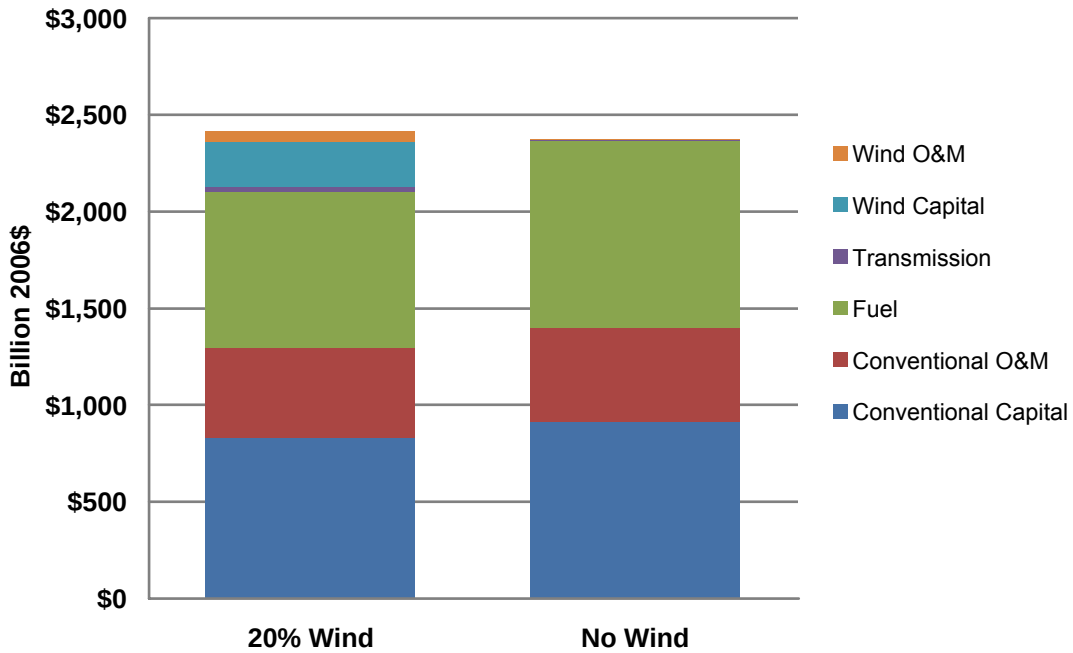
Incremental Cost of 20% Wind Vision



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Background: Transmission

- Existing transmission system built to carry power from large, centrally-planned power plants to population centers
- Wind resource best in remote areas, challenge to obtain capacity on transmission network to get power to market
- Capacity often inadequate, transmission system operating rules discriminate against variable resources
- Many rules of planning for expansion of generation and operating transmission written with conventional generation characteristics in mind.

Transmission + Wind Issues

- Wind growth tied directly transmission growth
  - Hundreds or Thousands of Megawatts can be added to existing transmission system
  - Tens or Hundreds of Gigawatts will require major transmission upgrades
- Transmission as a Key Issue
  - Most significant long-term constraint for wind
  - Making cost recovery more certain
  - Providing a federal backstop on siting
  - Need “Renewable Energy Superhighways” to access enormous wind, solar & geothermal resources

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AWEA Transmission Agenda

- AWEA strategic objective:
  - "Transform electric industry practices, including transmission, through advocacy and outreach"
- Use More Grid
  - FERC, NERC, RTOs, market rules, integration
- Get More Grid to Use
  - Regional planning, cost allocation, siting, DOE corridors, state and federal legislation
- Spread the gospel

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"We believe wind and solar energy are likely to be among the largest sources of new manufacturing jobs worldwide during the 21st Century."
John Krenicki Jr.
President and CEO of GE Energy
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Promoting Energy Security

Greater reliance on domestic renewable energy helps insulate American electricity consumers from global market volatility, and makes us more energy independent.

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RPS: A Boost to Rural Economic Development

- Example: Wind Energy
  - – Installing a wind turbine on rural land takes up minimal space and generates additional revenue for landowners through lease payments
  - – Rural landowners receive $3,000-8,000 per turbine annually, even in tough times of drought or crop failure, while still able to work the land.

RPS: A Boost to Rural Economic Development