Presentation to NCRES

The Utility Scale Wind Industry and the Department of Energy’s Wind Vision
10% 2020, 20% by 2030, 35% by 2050

Evelyn Carpenter
Solas Energy Consulting US Inc.
June 16, 2015
Solias Overview

**Alternative & Renewable Energy Solutions For:**
- Utility scale wind power
- Solar power
- Competitive Transmission
- Run-of-river hydro
- Biomass including landfill gas
- Small-scale renewable energy
- Stationary Power Fuel Cells

**Project & Business Development Services:**
- Helping provide developers with assistance through the entire process from prospecting due diligence to post development operations & maintenance planning
- Helping investors with financial and technical project due diligence including acquisitions, divestitures, and joint ventures

**Sustainability and Climate Change Advisory Services:**
- Helping businesses understand emerging policies and programs and their impact on project risks and opportunities.
- Adding sustainability into corporate strategy, from reporting requirements through to day-to-day operations and strategic planning.
American Wind Energy Association

WINDPOWER MARKET UPDATE
16 states have more than 1,000 MW of installed wind

Total of 65,877 MW of wind capacity were operational at the end of 2014, with nearly 48,000 utility scale wind turbines online.

Wind Energy provided 4.4% of the nation’s electricity during 2014, while all forms of renewable energy provided 13% of the nation’s electricity.
U.S. Annual and Cumulative Wind Power Capacity Growth

- The U.S. wind industry now has 66,008 MW of installed capacity and over 48,000 operating wind turbines.
Map of Online and Under Construction Projects

- 23 states have projects currently under construction
- New announcements made in Kansas, Maine, Maryland, Oklahoma, and Texas in the first quarter
Figure 4
U.S. Annual Power Capacity Additions 2011 to 2014, by Region

Percent denotes the market share of wind for all capacity installed 2011-2014

Data Sources: AWEA, EIA, SEIA, SNL
Global Wind Power Capacity Growth

...Wind Power Growth Around the World

39,000 MW of wind capacity installed, representing 25% of that nation’s total power capacity. By comparison, the U.S.’s 65,877 MW of wind capacity represents 6.2% of its 1,070,472 MW of total power capacity. For perspective, Germany’s total power capacity is equivalent to the state of Texas and Georgia combined, or roughly 155,000 MW (one-seventh of U.S. power capacity).

- The UK rose in the ranks of new wind capacity, with 1,736 MW installed during 2014, representing more than 15% growth and remaining the second strongest market in Europe for new capacity.
- China and India led the continent of Asia, with 23,351 MW of new wind capacity added in China for 25.5% annual capacity growth, and 2,315 MW of new capacity installed in India for 11.4% annual growth. Total wind capacity in China was 114,763 MW at the end of 2014, which was more than double the wind capacity of any other country except for the U.S. China is the first country to surpass 100,000 MW of installed wind capacity. China installed more wind power in 2014 than Spain and India, which rank fourth and fifth in the world for cumulative installations, have deployed in total.
Economics, Manufacturing

REGIONAL AND STATE IMPACTS
The wind generated in Texas during 2014 could power over 3.6 million average U.S. households, while the wind generation in Iowa, California and Oklahoma could each power over 1 million average U.S. households. Combined, the top 10 states for wind generation could power 12.2 million average U.S. households.

Wind generation numbers for 2014 show incremental but consistent growth over time for a number of states as the small number of projects that came online during 2013 generated electricity for a full year.

The growth rate in wind generation was most significant in Nebraska, which ranked second in the nation for wind capacity additions during 2013. That state had a 51.9 % increase in wind generation in 2014. Three other states increased their generation by more than 20%, with Michigan wind energy generation growing 38.4% in 2014, Vermont wind energy generation growing 29.5%, and Utah wind energy generation growing 23.2%.

The growth rate in wind generation was most significant in Nebraska, which ranked second in the nation for wind capacity additions during 2013. That state had a 51.9 % increase in wind generation in 2014. Three other states increased their generation by more than 20%, with Michigan wind energy generation growing 38.4% in 2014, Vermont wind energy generation growing 29.5%, and Utah wind energy generation growing 23.2%.
Figure 67
Cumulative Investment in Wind Energy Projects, by State
Regional & State Impacts of U.S. Wind Industry Activity

Figure 68
Estimated Annual Lease Payments to Landowners by Wind Projects
U.S. Wind Energy Industry Employment

As of the end of 2014, the U.S. wind energy industry supported 73,000 full-time equivalent (FTE)* jobs directly associated with wind energy project planning, siting, development, construction, manufacturing and supply chain, and operations.

Employment in the U.S. wind energy industry rebounded in 2014 as strong under construction activity and new turbine orders spurring manufacturing continued to bolster employment numbers. Texas, the largest state in the nation for cumulative installed wind capacity, capacity installed in 2014 and under construction activity led the nation in wind jobs with over 17,000 employed in the wind industry. Texas was followed by Iowa, Colorado, Oklahoma, Michigan, Illinois, North Dakota, Washington, California, and Indiana.

Figure 72
U.S. Wind Energy Industry Total Employment over Time

0 20,000 40,000 60,000 80,000 100,000
2007 2008 2009 2010 2011 2012 2013 2014

- Manufacturing & Supply Chain
- Construction, Development, Transportation
- Construction
- Operations: Wind Technicians
- Operations: Other
- Other Jobs
U.S. Wind Related Manufacturing

During 2014, over 500 wind-related manufacturing facilities across 43 states produced products for the U.S. wind energy industry.

The U.S. wind energy supply chain contains 10 utility-scale blade facilities, nine tower facilities, and six turbine nacelle assembly facilities, all spread across 14 states.

Turbine manufacturers for more than 98% of the wind power capacity installed in the U.S. during 2014 have at least one operational domestic manufacturing facility.

Annual U.S. production capability for wind turbine nacelles stands at approximately 9 GW.

Wind Turbine & Component Manufacturing in the U.S.

- During 2014, over 500 wind-related manufacturing facilities produced a product for the wind industry.
- The geographic diversity of the wind-related manufacturing footprint is vast, with facilities spread across 43 states.
- The current U.S. wind industry supply chain is capable of producing the vast majority of the more than 8,000 components required for turbine assembly.
- U.S.-based factories make everything from major components such as blades, towers, rotor hubs.
Market Share of U.S. Wind Turbine Manufacturers

Market Share & Major Players in Wind Turbine Manufacturing (2014)

- Approximately 48,000 wind turbines make up the U.S. wind turbine fleet of 65,877 MW. At least 50 wind turbine manufacturers are represented in this fleet, along with a number of turbine remanufacturers.

- GE Energy captures 42% market share of the cumulative wind turbine fleet, by capacity, followed by Vestas with 18% market share, and Siemens with 15% market share.

- The number of OEMs installing turbines in the U.S. market remains low after a dramatic drop during 2013, when the number of industry players dropped from 26 during 2012 to only seven. The number of active OEMs remained the same during 2014, with two of the seven OEMs installing only one turbine.

### Table: Market Share of Annual Installed Capacity

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Company</th>
<th>Capacity, MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GE Energy, Enron, Zond, Tacke</td>
<td>27,952</td>
</tr>
<tr>
<td>2</td>
<td>Vestas, NEG Micon, Micon, Nordtank, NedWind, Wind World</td>
<td>11,916</td>
</tr>
<tr>
<td>3</td>
<td>Siemens, Bonus</td>
<td>9,837</td>
</tr>
<tr>
<td>4</td>
<td>Gamesa</td>
<td>3,942</td>
</tr>
<tr>
<td>5</td>
<td>Mitsubishi</td>
<td>3,899</td>
</tr>
<tr>
<td>6</td>
<td>Suzlon</td>
<td>2,684</td>
</tr>
<tr>
<td>7</td>
<td>Clipper</td>
<td>1,700</td>
</tr>
<tr>
<td>8</td>
<td>Senvion</td>
<td>1,259</td>
</tr>
<tr>
<td>9</td>
<td>Acciona</td>
<td>908</td>
</tr>
<tr>
<td>10</td>
<td>Nordex</td>
<td>763</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>1,019</td>
</tr>
</tbody>
</table>


### Graph: Market Share for Wind Turbine Manufacturers over Time

- GE Energy, Siemens, Vestas, Gamesa, REpower, Mitsubishi, Nordex, Clipper, Acciona Windpower, Suzlon, Other

Market Participants

INVESTMENT
Owners & Developers of U.S. Wind Power Capacity

Market Share of U.S. Wind Power Capacity, by Owner

Together, the top 5 wind project asset owners: NextEra Energy Resources, Iberdrola Renewables Berkshire Hathaway Energy (including MidAmerican Energy, PacifiCorp and BHE Renewables), EDP Renewables North America, and Invenergy own 41% of the installed wind power capacity in the U.S. The top 25 wind project asset owners own more than 75% of the installed wind power capacity in the U.S.
Xcel Energy continues to rank No. 1 for wind power on a utility system; it achieves this ranking with a total of 5,736 MW under direct ownership or under contract. Berkshire Hathaway Energy ranks in the No. 2 spot with 4,992 MW of wind capacity, followed by Southern California Edison, American Electric Power, and Pacific Gas & Electric, who round out the top 5.

Xcel Energy is the first utility in the U.S. to exceed 5,000 MW. Only nine countries in the world, in addition to the states of Texas, Iowa and California, have more than 5,000 MW of wind capacity. Wind energy represents 15% of the power supply on the Xcel Energy system, and at one point during May 2013 wind power provided 61% of the electricity generated on its Colorado system.

The top 10 electric utilities for wind power capacity on their system include seven investor-owned utilities, two publicly owned utilities and one federal power agency. Collectively, these utilities own or purchase over 24,600 MW of wind power capacity, representing over 366 of the U.S. wind power fleet.

In the coming years, there will be new entrants into the list of top electric utilities given the significant number of PPAs and near-term wind growth expected from several additional utilities, including rural electric cooperatives.

Berkshire Hathaway Energy (including MidAmerican Energy, PacifiCorp, and NV Energy) continues to lead the U.S. in utility ownership of wind power capacity with 3,862 MW under direct ownership. Of the 3,862 MW of wind power capacity owned by Berkshire Hathaway Energy, over 73% is located in the state of Iowa.

For wind power ownership by utilities, Berkshire Hathaway Energy (including MidAmerican Energy and PacifiCorp) is followed by Puget Sound Energy, Portland General Electric, Minnesota Power and Alliant Energy, which together own 2,480 MW of wind power capacity.
Map of Wind Power Purchase Agreement Activity

- 750 MW of PPAs announced in the first quarter, building on the roughly 11,300 MW of power purchase agreements signed during 2013-2014.
- More than 50% of the 750 MW contracted in the first quarter were by non-utility purchasers.
Department of Energy’s

WIND VISION FOR THE U.S. 2015
The Wind Vision Report

- The US DOE’s comprehensive analysis of future pathways for the wind industry.
- Results reflect a broad-based, collaborative effort involving over 250 experts from industry, electric power operators, state & federal agencies, research institutions & laboratories, stakeholder groups & NGOs.
- The findings analyze feasibility, costs, and benefits of increased wind power deployment to inform policy decisions at the federal, state, tribal and local levels.
Overview: DOE’s Wind Vision Report

In March 2015, the US Department of Energy released its definitive Wind Vision report update.

- Shows that wind can become one of America’s largest sources of electricity & save consumers money
- Sets aggressive targets for growth – and industry stands ready to meet those targets
- With stable policy, wind can unleash even greater benefits
Major Finding:

Wind energy can supply **10% of US electricity by 2020**, **20% by 2030** and **35% by 2050**. In 2050 the projected installed capacity is 404 GW with 318 GW on land and 86 GW offshore.
Wind Vision Analysis Overview

- Wind Vision analysis models three core scenarios in order to better understand the sensitivities in deployment to various external drivers and to understand the likely economic and environmental effects of those drivers on the scenarios.

1. Baseline Scenario
2. Business as Usual Scenario
3. Study Scenario
The Wind Vision Report: Study Scenario

- The resulting *Study Scenario* – 10% by 2020, 20% by 2030, and 35% by 2050 wind energy as a share of national end-use electricity demand – is compared against the baseline scenario to estimate costs, benefits, and other impacts associated with potential future wind deployment.
The Wind Vision Report

The Potential of 35% of the Country’s Electricity Coming from Wind Energy by 2050.

<table>
<thead>
<tr>
<th>Costs</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>$149 Billion [3%] savings</td>
<td>GHG: 14% less GHG; $400 Billion savings</td>
</tr>
<tr>
<td></td>
<td>108 Billion savings; 22,000 lives saved</td>
</tr>
<tr>
<td></td>
<td>260 Billion gallons [23%] less consumption</td>
</tr>
</tbody>
</table>

**Additional Impacts**

<table>
<thead>
<tr>
<th>Energy Diversity</th>
<th>Jobs</th>
<th>Local Revenues</th>
<th>Land Use</th>
<th>Public Acceptance and Wildlife</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity prices 20% less sensitive</td>
<td>~ 600,000 gross jobs</td>
<td>$1.0 Billion/year in land leases</td>
<td>1.5% area of contiguous US</td>
<td>Responsible siting; Optimizing coexistence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$3.2 Billion/year in tax payments</td>
<td>Less than 1/3 area occupied by golf courses in US today</td>
<td></td>
</tr>
</tbody>
</table>
This map illustrates general wind resource potential only and is not suitable as a siting tool. More detailed site and wind speed data, as well as coordination with relevant authorities, are needed to thoroughly evaluate appropriate wind energy development at any given location.

Data sources: AWS Truepower, National Renewable Energy Laboratory

This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy
March 2015
Wind Energy’s Benefits To Date

• 65 GW of wind – enough to power 45,500,000 homes according to the U.S. Energy Information Administration—across 39 states in 2014

• Attracted >$100 billion in private investment to the US since 2008

• Employs more than 73,000 people in the US

• Manufacturing supply chain of more than 500 factories across 43 states

• Cut US electric sector carbon emissions by >5% – in 2014 alone, eliminated 26 million cars’ worth of CO₂
Wind’s Pollution Reduction Benefits

Wind generation in 2013 provided a range of environmental benefits.

- **CO₂**: Carbon Dioxide reduced by 115,000,000 metric tonnes. Equivalent to CO₂ emissions from 270 million barrels of oil.
- **SO₂**: Sulfur Dioxide reduced by 157,000 metric tonnes. Equivalent to annual emissions of 12 uncontrolled coal plants.
- **NOₓ**: Nitrous Oxide reduced by 97,000 metric tonnes. Equivalent to annual emissions of 10 uncontrolled coal plants.
- **H₂O**: Water Consumption reduced by 36.5 billion gallons. Equivalent to 116 gallons/person in the U.S.

Note: Emissions and water savings calculated using the EPA’s Avoided Emissions and Generation Tool (AVERT). ‘Uncontrolled coal plants’ are those with no emissions control technology.

Figure ES.2-4. Estimated emissions and water savings resulting from wind generation in 2013.

WIND ENERGY FOUNDATION
Wind’s Steadily Declining Costs to Date

Scale-up of wind technology has supported cost reductions.

Note: LCOE is estimated in good to excellent wind resource sites (typically those with average wind speeds of 7.5 m/s or higher), excluding the federal production tax credit. Hub heights reflect typical turbine model size for the time period.

Figure ES.2-5. Wind technology scale-up trends and the levelized cost of electricity
Wind Vision: 
*Substantial New Benefits Can Be Realized*

- **Community Economic Benefits**: By reaching 35% of the nation’s electricity mix by 2050, wind energy would:
  - Create an additional **600,000** well-paying jobs;
  - Drive **$650 million** in annual lease payments to landowners;
  - Support nearly **$1.8 billion** in tax payments to communities;
Wind Vision:  
*Substantial New Benefits Can Be Realized*

✓ **Consumer Savings:** Expanding wind power in the US will mean:

- Electricity prices would be 20 percent less sensitive to fluctuations in the price of fossil fuels;
- Consumers would see $280 billion in economy-wide savings from reduced natural gas prices alone; and
- This investment will cost consumers only pennies a month in the early years, with annual consumer savings reaching $14 billion in 2050 alone.
Wind Vision: *Substantial New Benefits Can Be Realized*

- **Environmental Benefits:** Through 2050, expanding wind energy in the US would:
  - Avoid $400 billion in climate damages;
  - Save $108 billion in public health costs;
  - Prevent 22,000 premature deaths; and
  - Displace 23% of total US power plant water consumption.
Reducing Energy Sector Water Use & Shortages

Electric sector water consumption is 23% lower in the Central Study Scenario relative to the Baseline Scenario by 2050.

Figure ES.3-5. Change in water consumption used in electricity generation from 2013 to 2050 for the Baseline Scenario and Central Study Scenario.
Achieving the Wind Vision: DOE Criteria

- Improved weather forecasting & turbine layout;
- Next-generation technology, standards & testing;
- Robust US manufacturing base & supply chain;
- Best practices for performance, reliability and safety;
- Sufficient transmission lines to population centers;
- Responsible siting practices, workable permitting policies and community engagement; and
- Workforce development
Priority of Advocates for Wind Energy: Stable Policy

● Essential that Congress provide longest possible extension of the renewable energy Production Tax Credit & Investment Tax Credit

● Every other energy source enjoys tax incentives – the PTC and ITC are critical for wind and other renewable energy

● State implementation of EPA’s proposed Clean Power Plan also crucial, along with shoring up and maintaining key state policies
Solar and the Wind Vision

- High-Level Wind Vision Roadmap Actions Include
  - **Increase Flexible Resource Supply**: Collaborate with the electric power sector to promote increased flexibility from all resources including conventional generation, demand response, wind and solar generation, and storage.
Spreading the Word: **Wind Vision Ambassadors**

- A new program led by the Wind Energy Foundation and the American Wind Energy Association
- Industry leaders & allies working to help key audiences – especially policy makers – understand Wind Vision and the benefits of expanding wind
- Supports Ambassadors through training, speaking appearances, media coverage
- Contact Charlie Martin: CMartin@windenergyfoundation.org
What Else Can You Do?

- Purchase renewables directly from your utility;
- Urge policy makers to enact renewables-friendly policies;
- Share your stories with WEF, AWEA and local pro-renewables organizations; and
- Continue to develop cutting-edge technologies that help lower costs, create jobs & realize the promise of wind!
Wind Vision:

Driving a New Era of Affordable, Abundant and Reliable Power in the US

Evelyn Carpenter
501-438-9463
ecarpenter@solasenergyconsulting.com