20% Wind Energy by 2030
Presentation and Objectives Overview

- Background
- 20% Wind Scenario
- Costs
- Benefits
- Challenges
- Summary
Explores one scenario for reaching 20% wind energy by 2030 and contrasts it to a scenario in which no new U.S. wind power capacity is installed.

Is not a prediction, but an analysis based on one scenario.

Does not assume specific policy support for wind.

Is the work of more than 100 individuals involved from 2006 - 2008 (government, industry, utilities, NGOs).

Analyzes wind’s potential contributions to energy security, economic prosperity and environmental sustainability.
The 20% Wind Energy Scenario

Primary Assumptions:
• U.S. electricity consumption grows 39% from 2005 to 2030 -- to 5.8 billion MWh (Source: EIA)
• Wind turbine energy production increases about 15% by 2030
• Wind turbine costs decrease about 10% by 2030
• No major breakthroughs in wind technology

Primary Findings:
• 20% wind electricity would require about 300 GW (300,000 MW) of wind generation
• Affordable, accessible wind resources available across the nation
• Cost to integrate wind modest
• Raw materials available
• Transmission a challenge
Resource Potential Exceeds Total Electricity Demand

2010 Costs w/o PTC, w/o Transmission or Integration costs
Cost of Wind and Transmission: Economically Available

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

10% of existing transmission capacity available to wind
Installed Capacity as of January 2008 = 16,904 MW

20% Wind Scenario

Cumulative Installed Capacity (GW)

- Offshore
- Land-based
Actual installations 2007: 5,329 MW
Project installations 2008: 7,500 MW*

Source*: AWEA, 2008
46 States Would Have Substantial Wind Development by 2030

Wind Capacity
Total Installed (2030)
(WW)

- 0.0 - 0.1
- 0.1 - 1
- 1 - 6
- 6 - 10
- >10

↑ Includes offshore wind.

The block open 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 brown square represents the actual land area that would be dedicated to the wind turbines (2% of the block open square).
Need for New Transmission: Existing and New in 2030
Costs, Benefits, and Impacts of the 20% Wind Scenario
Economic Costs of 20% Wind Scenario

Incremental investment cost of 20% Wind Scenario

Billions of 2006 Dollars

2% investment difference between 20% Wind and No New Wind
Incremental economic costs reflect:

- Capital costs of wind projects relative to other projects
- Incremental transmission investment

No New Wind scenario costs over $2 trillion in new investment in net present value terms by 2030

20% Wind Scenario requires only 2% more investment ($43 billion in net present value)

50 cents per month on average household bill
Reduces electric utility natural gas consumption by 50%
Reduces total natural gas consumption by 11%
Natural gas consumer benefits: $86-214 billion*
Reduces electric utility coal consumption by 18%
Avoids construction of 80 GW of new coal power plants

Source *: Hand et al., 2008
The benefits from reduced pressure on natural gas prices across all gas users would be $150 billion (NPV), by itself exceeding the incremental cost of investing in the 20% Scenario.

Source: Hand et al., 2008
Most area available for farming or grazing
Total area required: 15 million acres

Actual footprint only 2-5% of area, ~ 618,000 acres: slightly less than area of Rhode Island or half the size of Anchorage, Alaska

The black open 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 brown square represents the actual land area that would be dedicated to the wind turbines (2% of the black open square).
CO$_2$ Emissions from the Electricity Sector

CO$_2$ Emissions in the Electric Sector (million metric tons)

- No New Wind Scenario CO$_2$ emissions
- 20% Wind Scenario CO$_2$ emissions
- USCAP path to 80% below today’s levels by 2050
Annual CO₂ Emissions Reductions

CO₂ emissions reductions by 2030 = ~825 million metric tons annually

Could avoid ~$98 billion* CO₂ regulation cost

Source *: Hand et al., 2008
Wind power avoids the negative impacts of generated fossil fuels:

- Air emissions of mercury or other heavy metals
- Emissions from extracting and transporting fuels
- Lake and streambed acidification
- Production of toxic solid wastes, ash, or slurry
Cumulatively, the 20% Wind Scenario would avoid the consumption of 4 trillion gallons of water through 2030.

The 20% Wind Scenario cuts electric sector water consumption by 17% in 2030.

Major component assumptions: 50% of blades are manufactured in U.S. in 2007 increasing to 80% by 2030, 26% of towers are from the U.S. in 2007 increasing to 50% by 2030 and 20% of turbines are made in the U.S. increasing to 42% by 2030.
Jobs Supported by 20% Scenario

Over 500,000 jobs supported by wind in 20% Scenario

Approx. 180,000 supported by wind in 20% Scenario
Challenges to Achieving the 20% Wind Scenario
Transmission

- Enhancement of electrical transmission system required in all electricity-growth scenarios

- Transmission is needed to:
  - Relieve congestion in existing system
  - Improve system reliability for all customers
  - Increase access to lower-cost energy
  - Access new and remote generation resources

- Wind requires more transmission than some other options as best winds are often in remote locations

Photo courtesy: NREL
Continued Evolution of Commercial Wind Technology is Needed
Examples of Technology Improvements in Support of 20% Scenario

Increase capacity factors
- Pursue larger rotors and taller towers
- Continue improvements to blades, rotors, drive-train components and controls
- Enhance reliability of major components

Reduce capital costs
- Reduce aerodynamic and mechanical loads through advanced blade and rotor concepts
- Reduce turbine weight through judicious use of newer, high-strength materials
- Improve component manufacturability and manufacturing processes

Mitigate risks
- Evaluate performance to enable early identification of issues
- Track O&M needs to enhance experience base for turbines and components
- Conduct testing and certification activities
Project siting often raises local concerns about:

- Visual impacts
- Property value impacts
- Impacts on local wildlife/habitats
- Turbine or rotor noise
- Land use

Wind generation is responsible for 0.003% of human-caused avian mortality (National Research Council, 2007)

- Bat mortality has been higher than expected
- No site or cumulative impacts on bird or bat populations have been demonstrated, to date

Photo courtesy: US Fish and Wildlife
## Siting Processes

Gradually increasing wind installations from 3 GW to 16 GW annually

<table>
<thead>
<tr>
<th>Short-term to Medium-term</th>
<th>Medium- to Long-term</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008-2013 and 2014-2020</td>
<td>2021-2030</td>
</tr>
</tbody>
</table>

- Comparing Lifecycle Effects of Energy Generation Options
- Defining Risk
- Developing Siting Strategies
- Engaging National Leadership
- Addressing Public Concerns
- Applying Adaptive Management Principles
- Planning for the Future

Gradually avoiding CO₂ emissions from 25 million tons to 825 million tons annually
Summary
Explores one scenario for reaching 20% wind energy by 2030 and contrasts it to a scenario in which no new U.S. wind power capacity is installed.

Is not a prediction, but an analysis based on one scenario.

Critically examines wind’s roles in energy security, economic prosperity and environmental sustainability.

Would require about 300 GW (300,000 MW) of wind generation.

Shows that affordable, accessible wind resources available across the nation.
## Summary: Costs & Benefits

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental direct cost to society</td>
<td>$43 billion 50 cents/month/household</td>
</tr>
<tr>
<td>Reduction in emissions of greenhouse gasses and avoided carbon regulation costs</td>
<td>825 million tons of CO$_2$ $50$ to $145$ billion</td>
</tr>
<tr>
<td>Reduction in water consumption</td>
<td>8% through 2030 17% in 2030</td>
</tr>
<tr>
<td>Jobs supported and other economic benefits</td>
<td>500,000 total with 150,000 direct jobs $2 billion in local annual revenues</td>
</tr>
<tr>
<td>Reduction in nationwide natural gas use and likely savings for all gas consumers</td>
<td>11% $86-214$ billion</td>
</tr>
</tbody>
</table>

Sources: DOE, 2008 and Hand et al., 2008

Note: All dollar values are in NPV
References