An Update on Wind Energy Research at Marshall University

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Photo courtesy of Dave Saville
DOE Research

Market Impact Issues:

- Recommendations to efficiently integrate large quantities of wind generation, focusing on our region.
- Siting Requirements – Are state policies affecting the rate of development? (WA & OR vs. PA & WV).
- Property Values – Can we say whether or how they are affected.
- Assess wind speeds on surface-mined land in WV (with MU CEGAS).
Wind and Wind Behavior in PJM

- Wind is about 2% of installed MW
- Wind levels have not impacted the need for reserves, yet

A Common Diurnal Wind Trend

<table>
<thead>
<tr>
<th>PJM State</th>
<th>Nameplate MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE</td>
<td>2</td>
</tr>
<tr>
<td>IL</td>
<td>1,608</td>
</tr>
<tr>
<td>IN</td>
<td>649</td>
</tr>
<tr>
<td>NJ</td>
<td>9</td>
</tr>
<tr>
<td>OH</td>
<td>7</td>
</tr>
<tr>
<td>PA</td>
<td>680</td>
</tr>
<tr>
<td>WV</td>
<td>330</td>
</tr>
<tr>
<td>Total</td>
<td>3,286</td>
</tr>
</tbody>
</table>

- High-speed wind patterns are opposite of human electricity demand
<table>
<thead>
<tr>
<th>Time</th>
<th>PJM Load (MW)</th>
<th>Wind Output (MW)</th>
<th>Wind as % of Load</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Friday October 15, 2010</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2:23 am</td>
<td>56,709</td>
<td>3,110</td>
<td>5.5%</td>
</tr>
<tr>
<td>7:53 am</td>
<td>74,304</td>
<td>2,446</td>
<td>3.3%</td>
</tr>
<tr>
<td>12:20 pm</td>
<td>75,717</td>
<td>1,131</td>
<td>1.5%</td>
</tr>
<tr>
<td>4:40 pm</td>
<td>72,653</td>
<td>1,154</td>
<td>1.5%</td>
</tr>
<tr>
<td><strong>Sunday October 17, 2010</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9:40 am</td>
<td>64,288</td>
<td>1,286</td>
<td>2.0%</td>
</tr>
<tr>
<td>1:40 pm</td>
<td>64,625</td>
<td>741</td>
<td>1.1%</td>
</tr>
<tr>
<td>5:40 pm</td>
<td>66,035</td>
<td>579</td>
<td>0.9%</td>
</tr>
<tr>
<td>9:40 pm</td>
<td>67,820</td>
<td>977</td>
<td>1.4%</td>
</tr>
<tr>
<td>1:40 am</td>
<td>54,322</td>
<td>787</td>
<td>1.4%</td>
</tr>
</tbody>
</table>
Wind Generation Trends (PA, WV & NY) - Actual Capacity Factors

Monthly Max: Locust Ridge, 54% (Dec 2008)

Annual Averages: 23 to 27%
General Recommendations to Maximize System Efficiency at Wind Grows

1) Wind forecasting and integration of that information.
2) Consolidation of balancing areas
3) Use intra-hour markets (flexibility)
4) Create supplementary markets with services or protocols to ramp supply up or down.
5) Expand markets for demand response.
6) Develop more energy storage.
7) Expand transmission.

Efficient integration is technically feasible according to many, including: USDOE, Carnegie-Mellon, NERC
What is PJM Doing to Integrate Wind?

- Gives wind capacity credit (at 13%)
- Allows wind to be a capacity resource by choice
- Allows wind farms to submit negative offers
- Have eliminated penalties for generation differing from schedule
- Developing a **Wind Farm Communication Model Strawman** to manage wind in real-time (outage data, curtailment ability, meteorological data)
- Are developing **light load planning criteria** from a reliability perspective – some contention, market for curtailment?
- **Energy Resource Curtailment Initiative** – for resources that aren’t capacity resources. If no CIR, eco min = 0 MW.
- A **PJM Wind Integration Study** will be completed in 2012
- Will probably adopt any NERC recommendations from the IVGTF (e.g. use of EUE - Expected Unserved Energy - instead of LOLP/LOLE)
Initial Integration Questions

• What is the impact of wind plant generation on fossil plant fuel input? **It varies.** Average daily coal MW displaced in PJM is between 240 and 370 MW (max in shoulder hours); average natural gas is 30 to 90 MW (max in peak hours).

• How much can/do fossil plants ramp down/up when the wind blows/stops blowing? **It varies.** STs less, GTs more. Large-scale wind ramping is fairly slow.

• How much additional system reserves are required to balance wind capacity on the system? **None in PJM (yet).** It is not necessary to install a MW of coal for every MW of wind.

• How is PJM different from Texas? **Can easily assign costs of new transmission to load.**
Details for Report

• Situation in WA with Bonneville Power Authority
  – As of October 2009, wind reserve needs surpassed reserve needs for load in BPA. Solution protocol: wind curtailment when under-generation by wind causes a reserve to be over deployed (curtail to schedule)
    – In March 2010, wind was 50% of load served by BPA.

• NERC Final Report recommendations

• Summary of unique recommendations from other ISOs, power pools, public service commissions, etc.
Aspects of State-Imposed Siting

Large differences by state and within states:

One-stop shopping with a central authority: can simplify the process (in VA have to get more than 3 permits)

Local wind ordinances: can promote (guidelines for acceptance) or restrict (height restrictions);

Length of time to review a permit (state-run processes can be quicker than local)

Formal land-use guidelines at the local level: absence of guidelines and zoning can lead to high levels of installations (Somerset County); some basic criteria such as distance setbacks can reduce uncertainty

The state-level differences apply to all energy facility siting. Local involvement is just as important.
Siting Requirements

• Is there a State Authority for Wind Siting? Can it pre-empt local decisions? **It varies by state, but it doesn’t appear to be a primary driver of installations.**

• Are there formal land use guidelines at the local level? Must get a local approval? **Usually not, but local approval is very important.**

• How complicated is the application process? **Even states with a “simplified” approach have fairly complex requirements.**

• Does conditional permit approval cause delays? **Maybe**

• Is the “simplified” approach used by WA & OR better? **Maybe, but it probably doesn’t impact the level of installations.**

• Is Appalachia different? – **Goodness, yes.**
Comparisons

VS.

&

&

vs.

&
## Another Angle

<table>
<thead>
<tr>
<th>State</th>
<th>Actual MW (2009)</th>
<th>Potential Installed MW</th>
<th>Windy Land Area (km²)</th>
<th>Available Windy Land Area</th>
<th>Actual as % of Potential</th>
<th>KW/sq mi</th>
<th>KW/km² windy area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washington</td>
<td>1,849</td>
<td>18,479</td>
<td>11,933</td>
<td>2.1%</td>
<td>10.0%</td>
<td>28</td>
<td>155</td>
</tr>
<tr>
<td>Oregon</td>
<td>1,758</td>
<td>27,100</td>
<td>17,110</td>
<td>2.2%</td>
<td>6.5%</td>
<td>18</td>
<td>103</td>
</tr>
<tr>
<td>New York</td>
<td>1,274</td>
<td>25,781</td>
<td>17,706</td>
<td>4.1%</td>
<td>4.9%</td>
<td>27</td>
<td>72</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>748</td>
<td>3,307</td>
<td>2,124</td>
<td>0.6%</td>
<td>22.6%</td>
<td>17</td>
<td>352</td>
</tr>
<tr>
<td>West Virginia</td>
<td>330</td>
<td>1,883</td>
<td>1,495</td>
<td>0.6%</td>
<td>17.5%</td>
<td>14</td>
<td>221</td>
</tr>
<tr>
<td>Maine</td>
<td>175</td>
<td>11,251</td>
<td>6,027</td>
<td>2.7%</td>
<td>1.6%</td>
<td>6</td>
<td>29</td>
</tr>
</tbody>
</table>

*AWS TrueWind and NREL for potential capacity and windy land area.*

- 78% of windy area in West Virginia is excluded
- Potential power is assumed to be 5 MW/km² but could be higher on a WV ridgetop
<table>
<thead>
<tr>
<th>Area</th>
<th># WTGs</th>
<th>Total # Homes Sold in Area</th>
<th># Sold w/in 1 Mile of a WTG</th>
<th># Sold 1-3 Miles</th>
<th>% w/in 3 Miles</th>
<th>% of WTGs in Study</th>
<th>% of Sold Homes in Study</th>
<th># of Sold Homes with a Minor or Moderate View</th>
<th># of Sold Homes with a Substantial or Extreme View</th>
<th>Total # Homes Sold in Study</th>
<th># of Sold Homes with a View of a Turbine</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA/IL/WI</td>
<td>515</td>
<td>2044</td>
<td>43</td>
<td>620</td>
<td>32%</td>
<td>38%</td>
<td>27%</td>
<td>26</td>
<td>179</td>
<td>1345</td>
<td>63</td>
</tr>
<tr>
<td>PA/NY</td>
<td>104</td>
<td>2201</td>
<td>61</td>
<td>387</td>
<td>20%</td>
<td>8%</td>
<td>30%</td>
<td>13</td>
<td>197</td>
<td>1345</td>
<td>63</td>
</tr>
<tr>
<td>TX/OK</td>
<td>144</td>
<td>2424</td>
<td>21</td>
<td>992</td>
<td>42%</td>
<td>11%</td>
<td>32%</td>
<td>24</td>
<td>181</td>
<td>1345</td>
<td>63</td>
</tr>
<tr>
<td>WA/OR</td>
<td>582</td>
<td>790</td>
<td>0</td>
<td>20</td>
<td>3%</td>
<td>43%</td>
<td>11%</td>
<td>0</td>
<td>110</td>
<td>1345</td>
<td>63</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1345</strong></td>
<td><strong>7459</strong></td>
<td><strong>125</strong></td>
<td><strong>2019</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>63</strong></td>
<td><strong>667</strong></td>
<td><strong>1345</strong></td>
<td><strong>63</strong></td>
</tr>
</tbody>
</table>

PA/NY region had the smallest # of turbines in study but the greatest # of homes sold with a view of a turbine.

WV/OR region had the largest # of turbines in study but the fewest # of homes sold with a view of a turbine.
Social Differences

• Elected Officials: Maria Cantwell (D-WA) along with Susan Collins (R-ME) sponsored the Carbon Limits and Energy for America’s Renewal (CLEAR) Act - upstream carbon cap
• RPS with no alternative provisions
• Utility organization and history of support for wind research in Oregon
• …
• “Contextual factors are the existing natural resource, economic, environmental, and social conditions that set the stage for renewable energy development.” – NREL study
Property Values

- Still a paucity of data to describe the scene within one or two miles of turbines; can’t expect either positive or negative impact.
- Can’t promise that no negative impact will occur.
- Logical to assume that if a negative impact occurs it is more likely with closer proximity (viewshed or sound).
- Ben Hoen/Ryan Wiser study final.
  - No pervasive evidence of consistent negative impacts, even within one mile of turbines, but only 125 transactions analyzed in 9 states (61 of 125 in PA/NY).
  - Sound evidence that no negative impacts occur in aggregate within a 4-mile radius.
- U.K. studies by Sims/Dent useful (proximity based) – found that existing stigmas complicate analysis
Property Values II

- Evidence from High-Voltage transmission lines (HVTLs) shows view and proximity matter, but value diminution is not a systematic trend and is often temporary (up to 10 years)
  - Properties that may be more affected: custom homes, those in “scenic” areas, homes next to poorly maintained properties, those with a good view of tower/turbine, non-participating properties, properties sold after facility announcement but before actual construction
- Impact on viewshed can be minimized with careful micro-siting

Next Step:
- Summary document to the Council - “FINDINGS ON THE IMPACT OF WIND TURBINES ON RESIDENTIAL PROPERTY VALUES: A Reference Guide as of 2010”
THANK YOU