Preliminary Assumptions for On-Shore Wind Technologies (Revisited)

Gillian Charles
GRAC
December 18, 2014
At the last meeting...

- Discussed trends in technology, cost, development
- Discussed capacity factors
  - Sixth Power Plan vs. actual generation
- Introduced preliminary generic reference plant, capital cost, and O&M
- Introduced preliminary levelized cost
Today’s Discussion

- Narrow down:
  - Capacity factors for regions in the PNW
  - Reference plant characteristics
- Discuss updated capital cost estimate
- Discuss updated levelized cost estimate
  - No PTC assumed
  - Transmission assumptions
Historical and Projected
CAPACITY FACTORS
Spion Kop – Central MT

<table>
<thead>
<tr>
<th>Duration</th>
<th>Capacity Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013 Annual Average</td>
<td>41 %</td>
</tr>
<tr>
<td>Monthly Peak (Dec 2013)</td>
<td>68%</td>
</tr>
<tr>
<td>Monthly Min (May 2014)</td>
<td>18%</td>
</tr>
</tbody>
</table>

- **Capacity**: 40 MW
- **Location**: Judith Basin, MT
- **Technology**: (25) 1.6MW, 82.5m GE WTG
- **Service Date**: November 2012

Data from SNL
Judith Gap – Central MT

- Capacity: 135 MW
- Location: Wheatland, MT
- Technology: (90) 1.5MW, GE WTG
- Service Date: December 2005

Data from SNL

<table>
<thead>
<tr>
<th>Duration</th>
<th>Capacity Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013 Annual Average</td>
<td>43 %</td>
</tr>
<tr>
<td>Monthly Peak (Jan 2014)</td>
<td>73.6 %</td>
</tr>
<tr>
<td>Monthly Min (July 2009)</td>
<td>21 %</td>
</tr>
</tbody>
</table>
**Palouse – Eastern WA**

**Capacity** 104 MW

**Location** Whitman, WA

**Technology** (58) 1.8MW, Vestas V100 WTG

**Service Date** December 2012

<table>
<thead>
<tr>
<th>Duration</th>
<th>Capacity Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013 Annual Average</td>
<td>32.3 %</td>
</tr>
<tr>
<td>Monthly Peak (April 2013)</td>
<td>53.3 %</td>
</tr>
<tr>
<td>Monthly Min (Aug 2014)</td>
<td>17.4 %</td>
</tr>
</tbody>
</table>

Data from SNL
Lower Snake River – E. WA

**Capacity** 343 MW

**Location** Garfield, WA

**Technology** (149) 2.3MW, Siemens 101 WTG

**Service Date** March 2012

<table>
<thead>
<tr>
<th>Duration</th>
<th>Capacity Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013 Annual Average</td>
<td>27.2 %</td>
</tr>
<tr>
<td>Monthly Peak (April 2013)</td>
<td>46.6 %</td>
</tr>
<tr>
<td>Monthly Min (Oct 2014)</td>
<td>15.2 %</td>
</tr>
</tbody>
</table>

Data from SNL
Meadow Creek – Southern ID

<table>
<thead>
<tr>
<th>Capacity</th>
<th>116 MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Bonneville Cty, ID</td>
</tr>
<tr>
<td>Technology</td>
<td>(57) 2.1MW Suzlon S97 WTG</td>
</tr>
<tr>
<td>Service Date</td>
<td>December 2012</td>
</tr>
</tbody>
</table>

**Duration**  
- 2013 Annual Average: 30.3 %
- Monthly Peak (Feb 2014): 56.5 %
- Monthly Min (Dec 2013): 15.6 %

Data from SNL
High Mesa – Southern ID

<table>
<thead>
<tr>
<th>Capacity</th>
<th>40 MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Elmore, ID</td>
</tr>
<tr>
<td>Technology</td>
<td>(19) 2.1MW Suzlon S97 WTG</td>
</tr>
<tr>
<td>Service Date</td>
<td>December 2012</td>
</tr>
</tbody>
</table>

Data from SNL

<table>
<thead>
<tr>
<th>Duration</th>
<th>Capacity Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013 Annual Average</td>
<td>25.6 %</td>
</tr>
<tr>
<td>Monthly Peak (Feb 2013)</td>
<td>37.7 %</td>
</tr>
<tr>
<td>Monthly Min (Aug 2013)</td>
<td>11.8 %</td>
</tr>
</tbody>
</table>
Rockland – Southern ID

**Capacity:** 80 MW

**Location:** Power Cty, ID

**Technology:** (44) 1.8MW V100 Vestas

**Service Date:** December 2011

### Duration vs. Capacity Factor

<table>
<thead>
<tr>
<th>Duration</th>
<th>Capacity Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013/2012 Annual Average</td>
<td>32.8% / 35.2%</td>
</tr>
<tr>
<td>Monthly Peak (Feb 2014)</td>
<td>55.8%</td>
</tr>
<tr>
<td>Monthly Min (Sep 2012)</td>
<td>17.7%</td>
</tr>
</tbody>
</table>

Data from SNL
Comparison of Regional 2013 Generation Shapes (MWh)

Central MT – Peak in Dec/Jan
Southern ID and Columbia Basin – Peak in Mar/April, Sept/Oct
Summer months – low in all areas
# Capacity Factors

## Sixth Power Plan

<table>
<thead>
<tr>
<th>Wind Resource Area</th>
<th>Columbia Basin</th>
<th>S. Idaho</th>
<th>Central Montana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg annual capacity factor</td>
<td>32%</td>
<td>30%</td>
<td>38%</td>
</tr>
</tbody>
</table>

## Proposed Draft Seventh Power Plan

<table>
<thead>
<tr>
<th>Wind Resource Area</th>
<th>Columbia Basin</th>
<th>S. Idaho</th>
<th>Central Montana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg annual capacity factor</td>
<td>32%</td>
<td>32%</td>
<td>40%</td>
</tr>
</tbody>
</table>
Updated

REFERENCE PLANT
### Preliminary Reference Plant

<table>
<thead>
<tr>
<th>Year Dollars</th>
<th>2012 $</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology &amp; Configuration base</strong></td>
<td><strong>(40) 2.5MW Wind Turbine Generators</strong></td>
</tr>
<tr>
<td>Output Total (MW)</td>
<td>100 lifecycle avg*</td>
</tr>
<tr>
<td>Capacity Factor</td>
<td>Based on location</td>
</tr>
<tr>
<td>Economic Life (Years)</td>
<td>25 years (↑ 20 years)</td>
</tr>
</tbody>
</table>
| Construction Lead Time (Months) | 24 planning & development  
24 construction (↓ 30 months)  
48 months total, ~4 years (↓ 4.5 yrs) |

* Assuming 0% derate over lifetime of plant, based on insufficient information. GRAC agreed this was OK at last October 2 meeting.
COST ASSUMPTIONS

Capital, O&M
Preliminary Capital Cost of Wind

- **OVERNIGHT CAPITAL COST (2012 $/kW)**

- **VINTAGE OF ESTIMATE**

**Sources and Projects**:
- Generic Studies
- DOE Wind Tech Report
- Preconstruction Estimates
- As-built or Committed Costs
- 6th Plan Final
- 7th Plan Draft

**Locations**:
- Goshen North II (ID)
- Lime Wind (OR)
- Biglow Canyon (OR)
- Kittitas (WA)
- Palouse (WA)
- Dunlap I (WY)
- Shepard’s Flat (OR)
- Spion Kop (MT)
- Lower Snake River I (WA)
- Tucannon (WA)
- Dunlap I (WY)
- E3 for WECC
- DOE 2013
- Lazard 2013
- Lazard 2014
- Lazard 2014

*No change from last meeting*
## Preliminary Capital and O&M Estimates for Wind Reference Plant

<table>
<thead>
<tr>
<th>Year Dollars</th>
<th>2012 $</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capital Cost (MM)</strong></td>
<td>$225MM (lifecycle)</td>
</tr>
<tr>
<td><strong>Capital Cost ($/kW)</strong></td>
<td>$2,240 (lifecycle)</td>
</tr>
<tr>
<td><strong>Capital Cost Escalation</strong></td>
<td>-0.5% annual after 2016*</td>
</tr>
</tbody>
</table>

* We discussed possibly changing this to 0% at the last GRAC meeting – not sure it had enough traction to warrant a change. Still ok?

<table>
<thead>
<tr>
<th>Fixed O&amp;M ($/kw-yr)</th>
<th>$35.00 <em>(Sixth Plan $35.80)</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable O&amp;M ($/MWh)</td>
<td>$2.00 <em>(Sixth Plan $2.20)</em></td>
</tr>
</tbody>
</table>
Financial Incentives

- Production Tax Credit (PTC) expired in 2013, was just renewed by Congress through 2014
  - Projects that began construction before end of 2014 eligible
  - Extension doesn’t do much for wind development – too late and not long enough (there was a possibility of extending through 2015)
- Investment Tax Credit (ITC)
  - Ability to take 30% ITC in lieu of PTC now expired

Draft Seventh Plan Proposal:
- No financial incentives included in levelized costs for wind power
COST ASSUMPTIONS

Levelized Cost
Remote Wind Transmission Cases

1. **Wind: MT>OR/WA via Colstrip Transmission System Upgrade**
   - Judith Gap MT to I5 corridor
   - Fixed transmission cost $134/kW-year
   - Losses 10.0%

2. **Wind: MT>S. ID**
   - Proposed Mountain States Transmission Intertie - Townsend
     MT to Midpoint ID
   - Fixed transmission cost $34.62/kW-year
   - Losses 4.2%

3. **Wind: MT>OR/WA via S. ID**
   - MSTI & Hemingway-Boardman projects
   - Fixed transmission cost $65.54/kW-year
   - Losses 6.4%
Wind - Levelized Cost of Energy

- Capital
- O&M Fixed and Var
- Fuel Fixed and Var
- Trans. Fixed/Integ/Losses

$/MWh 2012 dollars

Wind-Col. Basin

Wind-MT (to I5 Corrid Load)
Modeling Wind in the RPM

- What should we limit Columbia Gorge wind development to?
  - 3,000 MW limit? 5,000 MW? 1,000 MW?
  - What is realistic development potential for next 20 years?