Western Wind and Solar Integration Study

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NREL
NM RETA Board Meeting
Apr 23, 2008
Why undertake a regional integration study?

• DOE/NREL/AWEA’s 20% Wind by 2030 Scenario
  – 20% scenario needs 25% wind in WECC
• Western Governor’s Association Clean and Diversified Energy Initiative
• WestConnect’s Virtual Control Area Study
• RPS targets in most of WestConnect states and rapid growth in wind/solar expected in this region
Control areas:
1) Arizona Public Service
2) El Paso
3) Nevada Power
4) Public Service of New Mexico
5) Sierra Pacific
6) Salt River Project
7) Tristate
8) Tucson
9) Xcel
10) Western Area Power Administration
Overview

• Goal
  – To understand the costs and operating impacts due to the variability and uncertainty of wind, PV and concentrating solar power (CSP) on the grid
  – Not the cost of wind or solar generation

• Issues
  – Does geographic diversity help?
  – How do local resources compare to out-of-state resources
  – Can balancing area cooperation help manage variability?

• Scope of study
  – Operations, not transmission study
  – Study year – 2017 to line up with WECC studies
  – Simulate load and climate patterns of 2004, 2005, 2006 forecast out to 2017
  – Simulate all of WECC but all subhourly variability accommodated by WestConnect
## High Renewables Basecase 2017

<table>
<thead>
<tr>
<th></th>
<th>Wind</th>
<th>Solar PV</th>
<th>Concentrating Solar Power</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study footprint</td>
<td>30% by energy</td>
<td>1.5%</td>
<td>3.5%</td>
<td>35%</td>
</tr>
<tr>
<td>WestConnect</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>28,256 MW</td>
<td>2472 MW</td>
<td>2884 MW</td>
<td></td>
<td>33,613 MW</td>
</tr>
<tr>
<td>Rest of WECC</td>
<td>20%</td>
<td>0.9%</td>
<td>2.1%</td>
<td>23%</td>
</tr>
<tr>
<td>36,767 MW</td>
<td>2895 MW</td>
<td>3378 MW</td>
<td></td>
<td>43,040 MW</td>
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<tr>
<td>Total</td>
<td>65,023 MW</td>
<td>5368 MW</td>
<td>6262 MW</td>
<td>76,654 MW</td>
</tr>
</tbody>
</table>
Tasks and Schedule

- Stakeholder Meeting (5/23/07)
- Data Collection (until 5/08)
  - Wind and solar mesoscale modeling (3TIER)
  - Utility load, generator, transmission data (Exeter)
- Preliminary Analysis (3-7/08) - GE
  - Extensive statistical analysis with various options for wind/solar sites and transmission
- Scenario Development (8/08) - GE
  - In-state vs out-of-state resources
  - Geographically diverse resources
  - Mega projects
  - Best correlated with load
- Stakeholder Meeting (8/14/08)
- Run Scenarios (starting 8/08) - GE
  - Examine costs due to regulation, load following, unit commitment
  - “Dives” to investigate issues such as Hoover
  - Examine mitigation strategies/options
  - Determine contributions to reliability and capacity value
- Preliminary Technical Results (end ‘08)
- Reporting and Stakeholder Meeting (mid ‘09)
Wind Data

- Previous data sets assembled from various years, measurements and assumptions
- Hired 3TIER to undertake largest wind mesomodeling to date
- Wind speed database (24TB)
  - Entire western US at 2km x 2km grid
  - 10, 20, 50, 100, and 200m hub heights
  - 10 minute intervals for 2004-6
- Wind power database (100’s GB)
  - Selected 32,000 grid points
  - Each grid points holds 30 MW
  - Based on Vestas V90 3MW turbine and 3TIER’s SCORE process
  - Hourly forecast for day-ahead wind output
This database was designed for:

• Spatial and temporal comparisons of sites
  – Geographic diversity
  – Load correlation

• Estimates of power production from hypothetical wind plants
  – Investigating needs for storage based on wind variability
  – Examining potential transmission line loadings from hypothetical wind farms
  – Simple economic calculations comparing cost of delivered energy from in-state versus out-of-state
This database was not designed for:

• Needs for high accuracy, absolute wind speed or power output
• Long-term average wind speed or wind power output
• This was not designed to be used as the only basis for investment. Ground-truthing modeled data with actual measurements is critical.
Average Wind Power Density 2006
Site selection

- 3TIER downselected from 1.2M to 30,000 points. GE will select final sites.
  - Exclusions - recreation, urban, forests, slopes, high elevation, etc. (NREL)
  - Preselected sites - existing or planned wind plants (Platts database/NREL)
  - Transmission corridors or zones (200 GW) - based on proposed new transmission and initial zone information (excl new NV zones)
  - Load correlation (250 GW) - best diurnal correlation with Westconnect load
  - Best resource (450 GW) - best wind power density
  - Additional sites added in to help validate model results
Preselected Transmission corridor/zone
Load correlated

Best resource
Web-based interface for wind data

- Similar to 3TIER’s FirstLook ->
- Click on site and download 10 minute wind speed and wind power output data stream for selected periods
- Planned release in summer to be accompanied by webinars explaining use of database
Solar Modeling

• Perez of SUNY ran solar model for US
  – 10km x 10 km grid
  – 1 hour intervals for 2004-2006
  – Direct normal and global insolation

• PV Modeling
  – By weather station site (150 sites for western US)
  – Template of different orientations and tracking configurations

• Concentrating Solar Power (CSP) Modeling
  – Parabolic trough plants with 6 hours thermal molten salt storage, similar to APS Abengoa plant
  – Modeled over 200 GW of CSP sites
Need for Subhourly PV Analysis

Source: Tom Hansen, Tucson Electric Power
Contact Information

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