Supply-side Resources & Planning Assumptions

Generating Resources Advisory Committee

June 20, 2013

What is this about?

- Power generation resources:
  - Central-station and distributed
  - Energy
  - Capacity (peaking and flex)
  - Storage
- Resource assessment data needs and applications
- Resources proposed for assessment
- Proposed depth of assessment
- Topics of special interest
NPCC applications of resource planning assumptions

- MicroFin – Preliminary assessment of comparative generating resource costs; configure AURORA\textsuperscript{xmp} and RPM cost inputs
- ProCost – Calculate EE measure cost-effectiveness
- AURORA\textsuperscript{xmp} – Forecast wholesale power prices, various system wide operational analyses
- GENESYS – Assessment of system adequacy & reliability
- Regional Portfolio Model (RPM) – Evaluate cost and risk of alternative resource portfolios

Information flow
Resource data & planning assumptions

- Reference plant (New resource options)
- Technology status & development timeline
- Costs – current and future
- Fuel prices – current and future
- Development & construction schedule & cash flow
- Financing & incentives
- Operating characteristics
- Project Inventory - existing & confirmed, RPS
- New resource development potential – PNW & WECC

Example Reference Plant: Central-station Solar PV (from 6th Plan)

- 25 MW dc/20 MW net ac output using flat plate, non-concentrating, single crystalline Si modules on single-axis trackers.
- Scope: step-up transformers, switchgear and interconnection facilities and security, control and maintenance facilities.
- PNW reference locations: Billings, MT; Boise, ID; Burns, OR; Yakima, WA and Ely NV (w/interconnection to PNW main grid)
Technology status & development timeline

- Technology status:
  - Conceptual
  - Development
  - Early commercial
  - Mature commercial

- Development timeline
  - Earliest service year for new commercial units

- Inventory of proposed PNW projects
  - Announced
  - Developed (Shovel-ready)
  - Under construction

Cost components

Costs estimated for 2012 base year with forecast escalation/de-escalation.
Capital cost expressed as “overnight” total plant cost; w/uncertainty.
Construction schedule & cash flow: Combined-cycle example for levelized cost analysis

![Chart showing cash flow and expenditure over time]

Construction schedule & cash flow: Combined-cycle example for risk analysis

<table>
<thead>
<tr>
<th>Phase</th>
<th>Development</th>
<th>Early Construction</th>
<th>Committed Construction</th>
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</thead>
<tbody>
<tr>
<td>Milestone</td>
<td>Conceptualization</td>
<td>Notice to Proceed</td>
<td>Major Equipment Delivery</td>
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<tr>
<td>Periods (mo)</td>
<td>24</td>
<td>12</td>
<td>18</td>
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<tr>
<td>Expenditure (Lev. $/kW-yr)</td>
<td>$6</td>
<td>$55</td>
<td>$78</td>
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<tr>
<td>Uncertainty</td>
<td>+30%/-30%</td>
<td>+30%/-30%</td>
<td>+30%/-30%</td>
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<tr>
<td>Suspension ($/kW)</td>
<td>Negligible</td>
<td>$162</td>
<td>--</td>
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<tr>
<td>Hold ($/kW-yr)</td>
<td>$2</td>
<td>$13</td>
<td>--</td>
</tr>
<tr>
<td>Termination ($/kW)</td>
<td>Negligible</td>
<td>$95</td>
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<tr>
<td>Life (mo)</td>
<td>60</td>
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</tbody>
</table>
### Financing assumptions & Incentives

- Developer type (Muni, IOU, IPP, other)
- Debt/Equity ratio
- Debt interest rate
- Return on equity
- Debt term
- Tax obligations (Federal, State, Local; Income, Property)
- Incentives (Production and investment tax credits)
- Discount rate

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### Operating characteristics

- Heat rate (thermal technologies)
- Forced outage rate; mean time to repair
- Scheduled outage rate
- VER* capacity factor (hourly ideal, seasonal OK, annual if that is all that is available)
- Other seasonal and elevation factors
- Min up time, min down time, ramp rate (flex capacity resources)

*Variable Energy Resource (wind, solar, wave, tidal)
Project inventory & development potential

- Project inventory (PNW, WECC)
  - Committed (operating, under construction, planned)
  - Planned retirements
- RPS obligations
- New resource options:
  - Earliest service year
  - Total potential for future development
  - Maximum development rate

Significant components of future system

- Proposed resources:
  - Natural gas combined-cycle
  - Wind plants
  - Solar photovoltaic plants
  - Natural gas peak and flex capacity
    - Simple-cycle gas turbines (frame, aero, intercooled)
    - Reciprocating engine plants
  - Hydropower upgrades?
  - Storage technologies?
- Proposed Assessment: In-depth quantitative characterization to support system integration and risk analysis modeling
Commercial w/Limited PNW availability

- Proposed resources:
  - Biogas technologies
    - Landfill
    - Wastewater treatment
    - Animal, commercial & household wastes
  - Woody residues (mill & forest residues)
  - Geothermal (conventional hydrothermal)
  - New hydropower
  - Waste heat recovery and other CHP options

- Proposed assessment: Quantitative characterization sufficient to estimate levelized costs

Longer-term PNW potential

- Proposed resources:
  - Engineered geothermal
  - Offshore wind
  - Modular nuclear units
  - Wave energy conversion
  - Tidal energy conversion
  - Coal technologies w/CO2 separation
  - CO2 sequestration

- Proposed assessment: Qualitative discussion of status & PNW potential; key numbers as available
Rest-of-WECC potential

- Proposed resources:
  - Coal steam-electric
  - Solar-thermal
  - Large-scale advanced nuclear plants

- Proposed treatment: Qualitative discussion; sufficient quantitative assessment to represent in AURORA xmp.

Proposed topics:
Resource characterization

- Photovoltaic capital cost and trends
- 8760 hourly output estimates for solar technologies
- Combined-cycle models with rapid-response capability vs: bulk energy production
- Natural gas peaking and rapid-response technologies
- Storage technologies
- Development and construction schedules
- Additional PNW wind development potential
- CHP and distributed generation potential.
- Hydropower upgrade potential.
### Proposed topics: Resource & system planning issues

- Accounting for speculative project development
- Current and forecast wind and solar integration costs; demand for and sources of balancing reserves.
- Current and forecast CO2 cost; plausible scenarios
- “Total Fuel cycle” GHG production
- Natural gas price forecast (from NGAC)
- Wholesale electricity price forecast
- Who develops? Who builds? Who owns and operates?
- Financial characteristics Should resources be differentiated?
- Consideration of incentives; plausible scenarios
- WECC retirements and replacements (coal, OTC, other?)