Eastern Interconnection Transmission Study: Medium-Priority Topics

Summary of Follow-on Analysis for the EISPC

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EIPC Process Recap

- EIPC create Stakeholder Steering Committee with EISPC and other sectors

- Phase 1 in 2010-2011
  - Capacity expansion modeling through 2040
  - 8 major futures plus 72 sensitivities
  - Regional “Bubble and Pipe” model

- Phase 2 in 2012
  - 3 scenarios for 2030 as “bookends”
  - Build-out of transmission lines for reliability
  - Production simulation for 2030
  - Base scenarios plus 6 sensitivities
  - Capital cost estimations refined from Phase 1

<table>
<thead>
<tr>
<th>Futures Studied (Phase 2 in red)</th>
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<tbody>
<tr>
<td>Business As Usual</td>
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<tr>
<td>Carbon Constraint – National</td>
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<tr>
<td>Carbon Constraint – Regional</td>
</tr>
<tr>
<td>Aggressive EE/DR/DG</td>
</tr>
<tr>
<td>RPS – National</td>
</tr>
<tr>
<td>RPS – Regional</td>
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<tr>
<td>Nuclear Resurgence</td>
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<tr>
<td>Carbon + Aggressive EE/DR/DG</td>
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</tbody>
</table>
Additional Analysis of Results

- Three year EIPC study produced mountain of data
- DOE requested small study to data-mine for added insights
- Survey of EIPC/EISPC/SSC leaders raised 13 topics

High Priority Topics
1. How do Phase 2 results compare to Phase 1?
2. Were there significant changes in earlier years within various regions?
3. When all costs are integrated, how do results compare between scenarios?
4. Do some regions face over-reliance on certain fuels or technologies?
5. What are the gas sector Inter-relationships in the different regions?

Medium Priority Topics
6. Reserve Requirement Impacts
7. Wind Curtailment details
8. Demand Response analysis
9. "No Regrets" lines

Low Priority Topics
10. Regional vs national implementation
11. Load growth sensitivities
12. Environmental Policy sensitivities
13. Technology sensitivity impacts
Topic 6: Reserves Requirements Effect

- Phase 1 used Planning Reserve Requirements
  - Ratio of excess capacity to peak demand for the year
  - All technologies, including DR, qualify
  - Solar and wind capacity partially credited based on expected amount available during peak demand

- Phase 2 used Operating Reserve Requirements
  - Excess capacity available compared to each hour’s demand
  - Only coal, gas/oil steam, gas combined cycle and hydro qualify
  - Limits on availability due to ramp rates, min operating levels
Insights from CO2+ Capacity Ratios

- Significant excess wind capacity in Northwest, Southwest, Northeast
- High DR everywhere contribute to Planned Reserves but not Operating
- Little excess capacity or peakers in Southeast
Topic 7: Why So Much Wind Curtailment in CO2+ Scenario

- Possible reasons that could contribute:
  - Lack of demand across Interconnection
  - Operating reserves requirements and technology limitations
  - Lack of transmission
  - Local generation pockets

- Determined hourly curtailments for five regions with high levels of curtailments
  - MISO_MO-IL
  - MISO_W
  - Nebraska
  - SPP_N
  - SPP_S
Topic 7: Wind Curtailment Timing

- Averaged by hour of day shows curtailments were highest during morning hours when demand lowest
- However, curtailments can occur any time
High Curtailment Day April 1 Examined

- Curtailments all day, but highest in morning
April 1, was Transmission an Issue?

- Tieline flows at 4 a.m. not constrained
- Five region total of 8.9 GW

Phase 2 CO2+ Scenario Tie Line Flows: 4/1 at 4:00

Regional Net Export (GW)

Max: 8.9
- 5.4
- 1.9
- -1.7

Min: -5.2

Blue=Export, Red=Import
April 1, Were Reserve Requirements an Issue?

- PJM had high reserves requirements, 7.5% demand + contingency.
- Had to be provided by Combined Cycle, lack of other sources.
- Hi Spin Sensitivity reduced reserves required and added flexibility.

<table>
<thead>
<tr>
<th></th>
<th>Apr 1, 4am</th>
<th>Curtailments</th>
<th>Transfers</th>
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<tbody>
<tr>
<td><strong>CO₂+ Scenario</strong></td>
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<td>47.0 GW</td>
<td>8.9 GW</td>
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<tr>
<td><strong>Hi Spin Scenario</strong></td>
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<td>19.7 GW</td>
<td>33.2 GW</td>
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</table>

Inter-regional transfers from Curtailed regions versus amount curtailed for all hours.
April 1, Before and After Hi Spin Sensitivity

- Curtailed reduced as PJM CC plants cut back
Most Curtailment Occurred During High Tieline Use

- Red lines indicate medians for curtailed GW and net transfers from Curtailed regions
- Highest curtailments when transfers >30 GW, near max

![Net Transfer from Curtail Regions in Hi Spin Scenario](image-url)

- 3690 hours, 97 TWH
- 690 hours, 9 TWH

Net Xfer from Curtailed (GW) vs. Curtained GW
Topic 8: Demand Response

- Amount for each region based on FERC model and report
- Phase 1 had single price $750/MWh, very rarely used
- Phase 2 used supply curve from ~CT price to $1600/MWh
- VACAR region largest user, SOCO and FRCC next

<table>
<thead>
<tr>
<th>Region</th>
<th>BAU</th>
<th>RPS/R</th>
<th>CO2+</th>
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<tr>
<td>SOCO</td>
<td>573</td>
<td>135</td>
<td>677</td>
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<td>VACAR</td>
<td>212</td>
<td>64</td>
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<td>FRCC</td>
<td>48</td>
<td>24</td>
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Why was DR used more in VACAR than elsewhere?

- In Phase 1, “soft” transfer lines were used <20% of time so not considered economic and not hardened
- Phase 1 modeling called for little peaking capacity in the region
- VACAR was far from excess wind areas with hurdle costs between

![Flow Duration Curve-PJM_ROR_2_VACAR](chart1)

- **Soft transfers**
- **Existing capacity**

![Flow Duration Curve-VACAR_2_SOCO](chart2)

- **Soft transfers**
- **Existing capacity**
Transmission line constraints played a role

- Balancing areas in southern VACAR higher users of DR
- Prices climb up supply curve for each balancing region
**Topic 9: “No Regrets” Line Upgrades**

- There were 89 new transmission lines, substations, or upgrades that occurred in all three cases.
- In another 26 instances, changes made to a bus in all three but not the same change.
- Many used to connect generation added in the Stakeholder Selected Infrastructure.

![Map of Additions Common to All 3 Scenarios](image-url)
## Topic 9: “No Regrets”

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<tr>
<th>Region</th>
<th>Interconnect New Generation</th>
<th>Prevent Overloads</th>
<th>Prevent Low Voltage</th>
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