Transmission Expansion Advisory Committee Meeting

2014 Market Efficiency Analysis
Input Assumptions

April 10, 2014
Market Simulation Input Data

• Study Years
  - 2015 and 2019 to study approved RTEP projects for accelerations and modifications
  - 2015, 2019, 2022, 2025, and 2029 to study new system enhancements
  - Underlying input data based on February 2014 NERC 9.7 PROMOD IV Powerbase Data Release
    - 2014 update to loads, generation, demand resources, emissions, and fuels
    - Simulations performed using PROMOD IV v11.1 engine
Power flow Models

- 2014/2015 PJM and external world topology based on the 2015 summer peak case from the 2013 ERAG MMWG series
  - Any significant upgrades will be included/excluded based on simulation year
- 2019 and later PJM topology will be based on the 2014 RTEP 2019 Summer Topology case
  - External World representation will be developed in coordination with the Interregional Planning group
  - PJM Topology will include all upgrades through February 2014 PJM board approvals
Key Input Parameters

- Fuel prices
- Load and energy
- Demand resource
- Future generation
- Emissions price
- Transmission constraints
- Carrying charge rate and discount rate
Figure 1 - Fuel Price Assumptions

- Coal
- Gas
- OIL-H
- OIL-L

$/MMBtu

- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021
- 2022
- 2023
- 2024
- 2025
- 2026
- 2027
- 2028
- 2029
Load & Energy Input Data

- PJM zonal peak and zonal energy forecast from 2014 Load Forecast Report – February Revision

<table>
<thead>
<tr>
<th>Load</th>
<th>2014</th>
<th>2015</th>
<th>2019</th>
<th>2022</th>
<th>2025</th>
<th>2029</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak (MW)</td>
<td>156,757</td>
<td>159,574</td>
<td>165,982</td>
<td>170,299</td>
<td>174,164</td>
<td>179,099</td>
</tr>
<tr>
<td>Energy (GWh)</td>
<td>814,051</td>
<td>827,267</td>
<td>851,634</td>
<td>872,650</td>
<td>884,557</td>
<td>902,890</td>
</tr>
</tbody>
</table>

Notes: 1.) Unrestricted peak load and energy reduced by energy efficiency.
2.) Model inputs are at the zonal level, to the extent zonal load shapes create different diversity - modeled PJM peak load may vary.
3.) Unrestricted energy values from Load Forecast Report Table E-1a.
• Model zonal demand resources consistent with Table B-7 of the 2014 Load Forecast Report.

Table 2 - Forecast PJM Demand Resources

<table>
<thead>
<tr>
<th>Demand Resource (MW)</th>
<th>2014</th>
<th>2015</th>
<th>2019</th>
<th>2022</th>
<th>2025</th>
<th>2029</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14,442</td>
<td>14,812</td>
<td>12,402</td>
<td>12,402</td>
<td>12,402</td>
<td>12,402</td>
</tr>
</tbody>
</table>
Figure 2 - PJM Market Efficiency Reserve Margin

- **Forecasted Summer Peak Net Internal Demand**
- **Reserve Requirement**
- **Existing + Not Suspended ISA Generation - Retirement**
- **Existing + ISA and FSA Queue Generation - Retirement**

 capacion MW
• Generation included in Market Efficiency models include all ISAs and FSAs

• Machine list posted at February TEAC
  • http://www.pjm.com/~/media/committees-groups/committees/teac/20140206/20140206-2014-rtep-machine-list.ashx

• Future generation not included is the same as reliability as described at February TEAC
Emission Prices

• SO2 emission price set to zero for all study years
  - CSAPR vacated in 2012.
  - CAIR rules in place, less stringent requirement

• Annual and Seasonal NOx prices
  - CAIR rules in place, less stringent requirement
  - See Figure 3

• National CO2 emission price set to zero for all study years
  - Reflects the stalled federal legislation regarding greenhouse gases and CO2

• RGGI State (MD, DE) CO2 emission price non-zero for all study years
  - See Figure 4
Figure 3 - NOx Emission Price Assumptions

- CAIR Annual NOx
- CAIR Seasonal NOx (May - Sep)
Figure 4 - CO2 Emission Price Assumptions

- Red: RGGI CO2
- Blue: National CO2

$/Ton

Year: 2014 to 2029
Transmission Constraints

• Thermal Constraints
  ➢ NERC Book of Flowgates
  ➢ Planning study results for monitored facilities and monitored/contingency pair facilities
  ➢ Historical PJM congestion events

• Voltage Constraints
  ➢ PJM reactive interface limits
  ➢ MW limits based on historical values and voltage stability analysis
  ➢ RTEP upgrades impact future reactive interface limits
Carrying Charge Rate and Discount Rate

- Discount rate and levelized carrying charge rate developed using information contained in TO Formula Rate sheets (Attachment H) [1]

- Discount rate based on weighted average after-tax embedded cost of capital [2]
  
  **Discount rate = 7.8%**

- Levelized annual carrying charge rate based on weighted average net plant carrying charge levelized over an assumed 45 year life of project [3]
  
  **Levelized Annual Carrying Charge Rate = 16.2%**


[2] Average weighted by TO total capitalization

[3] Average weighted by Total Transmission Plant In service included in PJM Tariff
Next Steps

Market Efficiency Training: April 17 (10am-2pm)
- Discuss Market Efficiency process/timeline
- Benefit/Cost Calculation

Board Review of Market Efficiency Input Assumptions: May

Market Efficiency Preliminary Results: June
- Stakeholder feedback on model: June-September
- PJM review for acceleration candidates: June-September
- Proposal window opens: November