Transmission Expansion Advisory Committee Meeting

2012 Market Efficiency Analysis
Input Assumptions

April 12, 2012
Market Simulation Input Data

- Study years: 2012, 2015, 2018, 2021, 2026
- PROMOD IV model from Ventyx
- Underlying input data contained in PROMOD Powerbase (February 2012 update)
  - Release contains updates to generation, emissions and fuels
- Powerflow Cases
  - 2012 power flow case to represent today’s “as-is” system
  - ERAG MMWG 2011 Series for 2012 Summer Peak
  - 2016 RTEP power flow case to represent future system
Key Input Parameters

- Fuel prices
- Load and energy
- Demand Response
- Future generation scenario
- Emissions prices
- Transmission topology
- Carrying charge rate and discount rate
Figure 1 - Fuel Price Assumptions*

* Gas prices updated since March TEAC
• PJM zonal peak and zonal energy forecast from PJM 2012 Load Forecast Report

Table 1 – Forecast PJM Peak Load and Energy[1]

<table>
<thead>
<tr>
<th>Load</th>
<th>2012</th>
<th>2015</th>
<th>2018</th>
<th>2021</th>
<th>2026</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak (MW)</td>
<td>153,201</td>
<td>162,364</td>
<td>168,228</td>
<td>173,834</td>
<td>182,708</td>
</tr>
<tr>
<td>Energy (GWh)</td>
<td>816,696</td>
<td>863,593</td>
<td>898,358</td>
<td>929,899</td>
<td>979,482</td>
</tr>
</tbody>
</table>

[1] Values reduced by Cleared Energy Efficiency (EE) form RPM.
• Model zonal demand response consistent with Table B-7 of the 2012 Load Forecast Report.

<table>
<thead>
<tr>
<th>Forecast Year</th>
<th>2012</th>
<th>2015</th>
<th>2018</th>
<th>2021</th>
<th>2026</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand Response (MW)</td>
<td>8,556</td>
<td>14,165</td>
<td>14,165</td>
<td>14,165</td>
<td>14,165</td>
</tr>
</tbody>
</table>
Future Generation Scenarios

• Generation model includes all existing in-service generation plus actively queued generation with an executed ISA less planned generator deactivations [1]

• Installed reserve requirement is met through 2015 study year

• To meet the installed reserve requirement for study years 2018, 2021, and 2026 - 3,700 MW, 8,600 MW, and 18,900 MW of additional generation will be added to model, respectively

• For study years 2018, 2021 and 2026 - new generation will be added in proportion to the regional location and generation type of active generation projects without signed ISAs through Generation Interconnection Queue X

Figure 2 - PJM Market Efficiency Reserve Margin*

Forecasted Summer Peak Net Internal Demand Reserve Requirement
Existing + Expected New Generation - Retirement

*Updated since March TEAC
### Future Generation Scenario

**Table 3 – Location and Generator Type to Maintain Reserve Margin**

<table>
<thead>
<tr>
<th>Region</th>
<th>Nuclear</th>
<th>Coal</th>
<th>Gas</th>
<th>Oil</th>
<th>Wind</th>
<th>Other Renewables</th>
<th>Total Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>AECO/DPL/JCPL/PECO/PSEG</td>
<td>0.8%</td>
<td>0.2%</td>
<td>18.1%</td>
<td>0.0%</td>
<td>0.6%</td>
<td>1.1%</td>
<td>20.7%</td>
</tr>
<tr>
<td>AEP/APS/COM/DAY/DUQ/ATSI/DOEK</td>
<td>1.0%</td>
<td>4.2%</td>
<td>18.7%</td>
<td>0.0%</td>
<td>11.2%</td>
<td>2.6%</td>
<td>37.6%</td>
</tr>
<tr>
<td>BGE/PEP</td>
<td>3.4%</td>
<td>0.0%</td>
<td>13.4%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>16.8%</td>
</tr>
<tr>
<td>DOM</td>
<td>0.0%</td>
<td>0.0%</td>
<td>9.7%</td>
<td>0.0%</td>
<td>0.3%</td>
<td>0.1%</td>
<td>10.1%</td>
</tr>
<tr>
<td>ME/PN/PPL</td>
<td>0.0%</td>
<td>0.1%</td>
<td>13.8%</td>
<td>0.0%</td>
<td>0.6%</td>
<td>0.3%</td>
<td>14.8%</td>
</tr>
<tr>
<td>All Regions</td>
<td>5.2%</td>
<td>4.4%</td>
<td>73.6%</td>
<td>0.0%</td>
<td>12.6%</td>
<td>4.1%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
Emission Prices

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

• SO2 & NOx emission price
  – Forecasts reflect the Cross State Air Pollution Rule which replaced the Federal Clean Air Transportation Rule (CATR) and Clean Air Interstate Rule (CAIR).
  – CSAPR results in more stringent emissions reduction requirements than the CATR rule and consequently much higher prices through the compliance years.
  – Ventyx original forecast for SO2 and Annual NOx is reflected through the 2017 Study Year, however the prices are set to 0 after this period as allowances are presumed to no longer be scarce due to unit environmental retrofits and unit retirements resulting in emissions compliance targets being met.
  – Ventyx forecast of Seasonal NOx prices is used for the whole study period (2012-2026) reflecting continued demand for allowances in the summer season.
Figure 3 - SO2 Emission Allowance Price Assumptions

$/Allowance

Year

Figure 4 - NOx Emission Allowance Price Assumptions

- **Annual Nox**
- **Seasonal Nox**

The graph shows the decrease in NOx emission allowance prices from 2012 to 2026. The prices are depicted in dollars per allowance unit. The annual NOx line shows a steady decline, while the seasonal NOx line indicates a trend that aligns with the annual NOx but with seasonal variations.
Transmission Topology and Constraints

• Power flow Cases
  – 2012 power flow case to represent today’s “as-is” system
  – 2016 RTEP power flow case to represent future system

• 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 voltage analysis, historical values, and Operations study for “as-is” case and adjusted for future upgrade impacts in RTEP case years
## Market Efficiency Model Inputs

### Backbone Line Upgrades

<table>
<thead>
<tr>
<th>Project</th>
<th>PATH</th>
<th>MAPP</th>
<th>Susquehanna - Roseland</th>
<th>Mount Storm - Doubs&lt;sup&gt;[1]&lt;/sup&gt;</th>
<th>Jacks Mountain&lt;sup&gt;[1]&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Efficiency Model Year</td>
<td>Not Modeled</td>
<td></td>
<td>2015 and beyond</td>
<td></td>
<td>2018 and beyond</td>
</tr>
</tbody>
</table>

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 = 7.7%

• 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 = 17.8%

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

- Determine Reactive Interface Ratings
- PJM Board approval of input assumptions in April
- Begin analysis with regular updates to TEAC