Market Efficiency Process

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Market Efficiency Process Enhancement
Task Force – Education Session
February xx, 2018
Overview

• Section 1: Market Efficiency Window Process

• Section 2: Critical Modeling Inputs

• Section 3: Project Selection Process
Section 1: Market Efficiency Window Process
Market Efficiency Goals and Model

• Goals
  – Asses future energy and capacity market congestion
  – Solicit and approve projects to relieve congestion
  – Strategic multi driver project development
    • Address both reliability and congestion
  – Accelerate beneficial reliability projects

• PJM Model
  – Sponsorship model
Inception of ME in RTEP

RTEP Drivers:
- Reliability
- Market Efficiency
- Operational Performance
- Public Policy

Order 1000

Reforms:
- Cost Allocation
- Non incumbent Development

1st Window

Impacts:
- Formal
- Competitive
- Long term

2nd Window

Impacts:
- Fees
• 12 Month Cycle
  – Acceleration

• 24 Month Cycle
  – Input assumptions
  – Base case development
  – Develop target congestion
  – Proposal submission
  – Evaluation
  – Approval
## Market Efficiency Statistics

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Proposed Projects</th>
<th>Analyzed Projects</th>
<th>Approved Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior to 14/15</td>
<td>25 projects (2010, 2011)</td>
<td>25+ projects (with combinations)</td>
<td>2010, 2011 – 1 project approved</td>
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<tr>
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<td>17 projects (2013)</td>
<td>17 projects (2013)</td>
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<tr>
<td>2014/15 Window</td>
<td>93 projects</td>
<td>110+ projects (with combinations)</td>
<td>2012 - No project approved</td>
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<td>2400+ PROMOD runs, 50,000+ runtime hrs.</td>
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<tr>
<td>2016/17 Window</td>
<td>96 projects</td>
<td>120+ projects (with combinations and reevaluations)</td>
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<tr>
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<td>3500+ PROMOD Runs, 90,000+ runtime hrs.</td>
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</tbody>
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In-progress
Market Efficiency Work Flow

- PROMOD NERC Data Annual Release
- Assumptions Analysis
- PJM Load Forecast Update
- PJM Generation Queue Update
- RTEP Power Flow Update
- Bus to Load Zone mapping
- Flowgate model
- Reactive limits (PV Analysis)
- External Model Updates (MISO and others): load, gen, flowgates
- ME Base Case
- Re tooling
- Analysis
- Approval and Communication

External Model Updates (MISO and others): load, gen, flowgates

Re tooling

Analysis

Approval and Communication

www.pjm.com

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Section 2: Critical Modeling Inputs
Market Efficiency Analytical Software

**Inputs**
- Generation data
- Demand & energy
- Fuel forecasts
- Environmental costs
- Power flow case
- Monitored flowgates
- Other information: reserve requirement, market territory, etc.

**Outputs**
- Hourly LMP of buses and hubs, include energy, loss and congestion components
- Hourly unit generation and production cost
- Hourly binding constraints and shadow prices
- Hourly line flows
- Hourly company purchase/sale
- Environmental emissions
- Fuel consumption
## Market Efficiency Inputs – Overview Base Case Inputs

### PROMOD SCED Simulation

- **Generation Expansion Plan (ISA/FSA)**
- **Intermittent resource hourly shapes**
- **Fuel Price Forecast:** Natural Gas, Coal, Oil-H, Oil-L
- **Emissions Price Forecast:** CO2 (National, RGGI), SO2, Nox (seasonal,annual)
- **Demand Forecast:** Annual Peak Load and Energy, Hourly shapes
- **Demand Response Forecast**
- **Transmission Topology (As-Is, RTEP)**
- **Topology Mapping:** Bus-Area, BusLoad-Demand, Gen-Bus (As-Is, RTEP)
- **Reactive Interface PV Analysis**
- **Monitored lines and contingencies, interfaces and nomograms, PARs**

### Interregional Inputs

- **MISO and NY Updates:** GenExp, load forecast, wind profiles, major upgrades, flowgates, transactions with SPP/MRO, imports Canada
- **Pool Interaction Modeling:** M2M flowgates, pseudo-ties, DC schedules, hurdle rates, import/export limits, inactive pools

### Reporting Inputs

- **RTO Weighted Average Cost of Capital**
- **RTO Fixed Carrying Charge Rate**
- **ARR Source Sink Paths and Cleared MW**
- **Project Cost and ISD**
Section 3: Project Selection Process
Market Efficiency Project Selection Flowchart

Start → Review proposals → Perform B/C → Does project pass B/C?

- Yes → Does project reduce or fix congestion driver?
  - Yes → Project Not Recommended
  - No → Does project cause additional unacceptable congestion?
    - Yes → Project Not Recommended
    - No → Sensitivity Analysis Other Factors considered*

- No → Does project require additional upgrades?
  - Yes → Does Reliability and Constructability Analysis (if necessary) require additional changes?
    - Yes → Project Not Recommended
    - No → Project Recommended
  - No → Is the project competitive?
    - Yes → Project Recommended
    - No → Project Not Recommended

Finish
Market Efficiency Process – Congestion Drivers

- PROMOD simulations are used for determining future congestion drivers
- PJM solicits projects for posted congestion drivers
Market Efficiency Process – Proposal Analysis

• Each valid proposal is tested for Benefits/Cost > 1.25
  – Total Benefits = Energy Benefits + RPM Benefits
    (for more details, see *PJM Market Efficiency Benefits Calculation* education session)

• Candidates passing B/C tests:
  – Congestion driver reductions
  – Other factors: overall PJM congestion changes, PJM Load Payments, PJM Production Costs
  – Perform Sensitivities
    • Gas Sensitivity
    • Load Sensitivity
    • Other sensitivities as needed (Examples: gen exp, renewable penetration, carbon tax, imports/exports, etc.)
Market Efficiency Process – Other Analyses

• Reliability Analysis
  – Additional reliability upgrades

• Independent Cost Analysis
  – Projects exceeding $50M Independent cost analysis

• Constructability Analysis
  – Verification of proposed schedule duration
  – Other risks to both cost and schedule

• Project Combinations
  – Combination of components of multiple projects
  – Incremental or multiple projects
Market Efficiency Process – Approval & Communication

- Selected projects require PJM board approval
- Approved projects are communicated at TEAC meetings
- Letter from PJM notifying construction responsibility
Appendix A – Market Efficiency Inputs Modeling
Market Efficiency Inputs – PJM Generation Modeling

• Forecasted generation includes:
  – In-service generation
  – Active queue generation with Interconnection Service (ISA) and Facility Service (FSA) agreements
  – Expected future deactivations

• Modeled inputs:
  – Operational: summer/winter capacity, heat rate, min runtime/downtime, must run status, emission rates
  – Cost: startup cost, variable O&M, curtailment price
Market Efficiency Inputs – PJM Load Forecast

- **PJM Load Forecast Report**
  - Peak Load and Annual Energy adjusted by Energy Efficiency cleared in RPM Auction
  - Load forecast mapped to PROMOD Areas

- **ABB synthetic demand shapes**
  - Based on the average of several years of load shapes
  - Hourly load shapes merged to match PJM load zones

- **Demand Response**
  - Modeled as discrete units
  - Amount based on the level cleared in the RPM BRA auction
Demand Response Modeling

• Level of Demand Response (DR) is based on the level cleared in the RPM BRA auction by delivery year, zone and product type.

• Demand Response is modeled as discrete units.

• Locations (zip codes) of Demand Response are based on registration data submitted through PJM DR Hub system.

• MW by Product Type are mapped to nearest BES facility.

• Strike price is modeled to ensure that DR is called at a level consistent with history and contractual requirements for the product type.
Market Efficiency Inputs – PJM Fuel Forecast

- Forecast prices developed by the ABB fuels group
  - Gas and Oil Price Forecasts
    - Prices derived from NYMEX (short term) and the EIA Annual Energy Forecast (long term)
  - ABB’s Coal Forecast model
    - Mining costs, emission price forecasts, transportation routes and pricing, coal quality

- Additional input from IHS Energy
  - Alternative view on Gas Price forecast
  - Used to create high/low gas sensitivity scenarios
Market Efficiency Inputs - Emissions Forecast

- Emissions prices developed by ABB
  - Three major effluents modeled: SO2, NOx, and CO2
  - Effluents (by trading program) assigned to generators based on location and release rates
  - Sources:
    - EPA CEMS data
    - ABB’s proprietary Emission Forecast Model (EFM)

- PJM checks
  - Consistency with expected emissions legislation affecting PJM Generators
  - Mapping of generating units to emissions price
  - Validate installation of emissions reduction equipment and removal rates for generating units (if necessary)
Market Efficiency Inputs - Transmission Topology

• Same topology used for all study years
  – To evaluate a project expected to be in service in 2019, the same topology is used in the pre-2019 study years simulated in PROMOD IV.
  – The generation (i.e. in-service or retired), fuel and emissions pricings will change by study year, but the topology is held constant.

• RTEP system topology
  – All approved baseline upgrades
  – All FSA network and direct interconnection upgrades

• External world topology
  – Derived from Eastern Interconnection Reliability Assessment Group (ERAG) Multi-Regional Modeling Working Group (MMWG) Series
Market Efficiency Inputs - Flowgates

• Thermal Flowgates
  – Historical market constraints
  – NERC Book of Flow-gates
  – Removed constraints with very low likelihood of binding in any future year simulation
  – Added constraints with increasing likelihood of binding

• Transmission Ratings Modeling
  – Summer 95 degree day-time rating for Normal and Long-term Emergency
  – Winter 32 degree day-time rating for Normal and Long-term Emergency

• Reactive Limits
  – PV Analysis to develop summer and winter MW transfer limits for commercially significant interfaces in PJM
  – Modeled interfaces: AEP-DOM, AP South, BCPEP, Black Oak Bedington, 5004/5005, Central Interface, Cleveland, COMED, Eastern Interface, Western Interface
Appendix B – Operating Agreement & Manual References
References

• Scope, PJM requirements & Member requirements
  • http://www.pjm.com/about-pjm/member-services.aspx

• PJM Manual 14B, Section 2.6:
  http://www.pjm.com/~/media/documents/manuals/m14b.ashx

• PJM Operating Agreement, Schedule 6, Section 1.5.7:

• PJM Market Efficiency Practices
  • http://www.pjm.com/~/media/planning/rtep-dev/market-efficiency/pjm-market-efficiency-modeling-practices.ashx