Transmission Outage Economic Analysis using Market Simulation Software

FERC Staff Technical Conference on Increasing Real-Time and Day-Ahead Market Efficiency through Improved Software

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Need for Economic Analysis Program

• ISO New England (ISO) recognized need for better coordination of outages when markets are affected.
  – Heavy congestion and/or high LMPs in Day Ahead market
  – Negative congestion fund balance when short term outages are not coordinated in Financial Transmission Right (FTR) auctions

• Transmission Owners (TO)/Load Serving Entities recognized need for cost analysis
  – Responsible to state regulators and ratepayers for keeping transmission costs down
Background

• In 2005, ISO New England:
  – Was designated as a Regional Transmission Organization, broadening its authority over the operation of the region’s high voltage transmission system
    • Outage coordination role is expanded to include economic evaluations
  – ISO and stakeholders finalize Transmission Operating Agreement
    • ISO given central authority for congestion management
    • Participating Transmission Owners responsible for working with ISO on congestion management
  – Applicable Market Rules*
    • ISO has authority to deny or reposition transmission outages if they can result in “significantly reduced congestion costs”
      – Threshold set at $200,000 per week

* Section III, Market Rule 1 – Appendix G
Economic Analysis in Outage Coordination has Helped to Reduce Congestion

Day-Ahead Congestion Revenue

- 2005: $273,449,871
- 2006: $273,449,871
- 2007: $1,000,000
- 2008: $1,000,000
- 2009: $1,000,000
- 2010: $1,000,000
- 2011: $1,000,000

- 2012: $17,957,030
ISO’s Economic Analysis – the Early Years

• Initial Economic Analysis studies used simple generator economic-minimum hourly-energy over minimum run-time cost-calculation.

• Desire for more accurate analysis resulted in developing a study-time environment where the production Day Ahead market software could be run.
  – Slow: 45 minutes per market run
  – Inflexible: market parameters not easily changed
  – Manual commitment decisions (due to binding constraints): required many corrections and re-runs
  – Single day analysis only: extrapolation needed for multi-day outages
ISO’s Current Economic Analysis

• Outage Coordination Economic Analysis Tools (OCEAT)
  – ISO issued requests for proposal to vendors of market simulator products
    • PowerGEM PROBE market simulator chosen in 2008

• PROBE features:
  – Fast: 1 minute per one-day market simulation run
  – Flexible: input parameters easily changed
  – Proven Security Constraint Unit Commitment (SCUC) engine
PROBE Market Simulator

- Designed and customized to closely replicate the ISO’s Day Ahead market
- Full EMS network breaker/node model
  - Detailed hourly models accounting for intra-day outages
  - Full scale contingency analysis for all N-1 and selected N-2 interfaces
- Detailed modeling of all DA bids and market rules
- Advanced features
  - Limited Energy Generator model
  - Ancillary Services co-optimization
- Batch-mode automation allows execution of multiple days/scenarios
- Developed automated interface to production environment
Long-Term Outage Economic Analysis

- Evaluates transmission outages submitted at least 90 days in the future
  - Major transmission elements (i.e. 345KV and 115KV lines that affect generation or internal and external interfaces, etc.)

- Purpose:
  - Identify expensive or conflicting outage applications so they can be adjusted for cost savings
    - Move start/end dates
    - Coordinate conflicting transmission/generator outages
  - Provides economic approval
    - Provides relative certainty to Line owner that outage will proceed as scheduled even if conflicts occur in the short term.
    - Enables Market Administrators to confidently select the outage for inclusion in a monthly or annual FTR auction
    - Enables Long Term Outages Coordinators to confidently select the outage for monthly Forward Capacity Market reconfiguration auctions
Long Term Process

Submittal T - 365 days

- Outage Request (Preliminary State)
- Outage Request (Submitted State)
- Economic Study Required? MTE = Yes
- Economic Analysis
- Re-position?
- Negotiate (State)
- Interim Approved (State)
- Long-term Economic Approval (Flag)
- Damaged (State)
- Reliability Analysis (Study State)
- Acceptable
- Successful
- Unsuccessful
- Long-term Public Report (Updated Daily)

Submittal T - 90 days

- Outage Request (Preliminary State)
- Outage Request (Submitted State)
- Economic Analysis
- Re-position?
- Negotiate (State)
- Interim Approved (State)
- Long-term Economic Approval (Flag)
- Outages may be selected as MTO (Flag)

Submittal T - 21 days

- Outage Request (Preliminary State)
- Outage Request (Submitted State)
- Reliability Analysis (Study State)
- Acceptable
- Interim Approved (State)
- At Risk for Economics in Short-term Process
- Short-term Process
Short-Term Outage Economic Analysis

• Evaluates transmission outages 3-5 days prior to operating day
  – All transmission elements

• Purpose:
  – Identify expensive or conflicting applications
    • Prior to Day Ahead Market runs and Real Time Operations
    • Coordinate cost saving options with Transmission Owners
      – Move start/stop dates
      – Identify compensatory measures

• Outages with long-term economic approval or taken in FTR auction generally not considered
  – Conflicting outages with later timestamp evaluated and coordinated instead
Short Term Process

**Short-term Process**

**Submittal T – 21 days**
- Outage Request (Submitted State)
  - Reliability Analysis (Study State)
    - Acceptable
      - Yes: Approved (State)
      - No: Denied (State)
  - Acceptable
    - Yes: Denied (State)
    - No: Denied (State)

**Submittal T – 5 days**
- From Long-term Process
  - At Risk for Economics
    - Yes: Approved (State)
    - No: Denied (State)
  - Final Economic Analysis
    - Acceptable
      - Yes: Denied (State)
      - No: Denied (State)
    - No: Denied (State)

**Submittal T – 1 day**
- Unplanned Outages (Submitted State)
  - Reliability Analysis (Study State)
    - Acceptable
      - Yes: Denied (State)
      - No: Denied (State)
  - Approved (State)
    - Yes: Approved (State)
    - No: Denied (State)
  - Day Ahead Market Topology
    - Real-time Implementation

**Short-term Public Report** (Updated every 15 minutes)
PROBE Inputs and Assumptions

- All transmission and generation outages for study day populated to create 24 hourly models; approx. 13,000 buses.
- All interface and external tie limits enforced.
- Security Constrained solution
  - 1st Contingencies: approx. 1,500 total
  - 2nd Contingency in certain areas
- Actual bids/offers (including external transactions) from markets database, from very recent past day used.
- 7-day load forecast used for short term; 50/50 load forecast for long term.
How ISO uses PROBE

• Provides single-day or multi-day (hourly solution granularity)

• Day-Ahead style market run with following differences:
  – Forecast loads loaded (as opposed to price-sensitive demand and virtual bids)
  – Reliability commitments forced, if necessary

• Incremental production cost identified for each outage of interest

• Applications with more than $200,000 (per week) production-cost noted and reviewed with ISO supervision and affected Transmission Owners.
PROBE Outputs

• Incremental production cost represents:
  – Reliability-committed generation incremental costs
  – Reliability-committed generation startup and no-load costs
  – Expensive units dispatched out-of-merit due to transmission constraints causes by outages
  – Generation cost-savings of units displaced by reliability commitments
  – Cleared External Transaction differences due to different commitment/LMPs and transmission constraints
Benefits of OCEAT Process

• Ability to study more outage scenarios and outage combinations
• Flexible and simplified method to setup case assumptions
• Provides market solution information (binding constraints) earlier to enhance outage coordination
  – Greater awareness of cost by TOs; better scheduling
• Significant data availability to study additional impact of outages
  – FTR funding
  – Uplift
  – Total load payments
  – LMPs
  – Ability to export future models for more detailed AC and stability analysis
OCEAT Process has Resulted in Significant Savings

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<th>Year</th>
<th>Long-Term Savings</th>
<th>#LT Outages Repositioned</th>
<th>Short-Term Savings</th>
<th>#ST Outages Repositioned</th>
<th>Total Transmission Outage Applications</th>
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Total Savings to Date: $96.77 million

Future Considerations

• Is Bid Production Cost (BPC) the best parameter for evaluating the cost of transmission outages?
  – BPC is the most conservative measure

• Other options for BPC:
  – Congestion fund payments
  – Uplift
  – FTR funding adequacy
  – Total load payments

• Anticipated future software efforts at ISO New England
  – Weekly (i.e., 168-hour) unit-commitment optimization
  – Methods for determining reposition dates for outages denied in cost
Questions