Broader Regional Markets

Solutions to Loop Flow

Technical Conference

Joint Meeting of NYISO-PJM-MISO-IESO Stakeholders

Desmond Hotel and Conference Center

Albany, NY

October 29, 2009

Agenda

- **Welcome** -- *Stephen G. Whitley - NYISO*
- **Technical Conference** -- *Rana Mukerji - NYISO*
  - *Introductions*
  - *Background*
- **Proposed Solutions to Loop Flow** -- *Robert Pike - NYISO*
  - *Physical Solutions -- Peter Sergejewich - IESO*
  - *Parallel Flow Visualization -- Tom Mallinger - MISO*
  - *Market Solutions*
    - Buy-Through of Congestion -- *Robert Pike - NYISO*
    - Congestion Management -- *Stan Williams - PJM*
    - Interregional Transaction Coordination -- *Robert Pike - NYISO*
- **Next Steps** -- *Rana Mukerji - NYISO*
  - *Potential Implementation Timeline*
  - *Feedback*
  - *Ongoing Efforts*

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Welcome

- **Coming together is a start…**
- **Staying together is progress…**
- **Working together is success!**

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Technical Conference

- Introductions
- Conference Expectations
- Background

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FERC Order

July 16, 2009 Lake Erie Loop Flow Report/Order

- Finds no evidence of market manipulation by market participants scheduling external transactions around Lake Erie
- Determines that there were no tariff violations by the NYISO or by market participants
- Orders the NYISO to “expeditiously develop long-term comprehensive solutions to the loop flow problem with its neighboring RTOs, including addressing interface pricing and congestion management.”
  - *NYISO must submit a report to FERC detailing its proposed solution, including necessary Tariff revisions, by mid-January 2010*

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Proposed Solutions

Robert Pike - NYISO

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Concept Development

- Stakeholder meetings to review background issues and solutions to loop flow concepts.
  - *Individual ISO briefings to stakeholders on concepts*
- Joint ISO Meetings
  - *Senior level scope reviews and updates*
  - *Weekly conference calls and additional in-person meetings to develop concepts of buy-through of congestion and congestion management as well as potential timeline.*
  - *Developing whitepaper that describes the proposed solutions in greater detail*
- Any solutions will require tariff development and stakeholder support.

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Current Market Outcomes

- Day-Ahead Modeling:
  - *All ISO's incorporate a prediction / forecast of Lake Erie loop flows into their respective Day-Ahead evaluations.*
    - NYISO updates weekly based upon the hourly loop flows experienced in real-time over the past 30 days.
    - PJM updates annually based upon hourly loop flows experienced in real-time over the past year.
    - IESO updates daily based upon previous days experienced loop flows resulting from firm transaction schedules.
    - MISO updates quarterly, with daily incremental revisions, based upon system projected conditions.
- Real-Time Operation:
  - *All ISO's incorporate real-time actual loop flows into the market solutions.*
- Transmission Loading Relief (TLR) events initiated to address reliability constraints on flow gates impacted by Lake Erie loop flows.

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Broader Regional Markets

- Proposed Solutions to Loop Flows
  - *Physical Solution*
    - Installation and operation of the Michigan/Ontario PARs to better conform actual power flows to scheduled power flows
  - *Parallel Flow Visualization*
  - *Market Solutions*
    - Buy-Through of Congestion
    - Congestion Management (Market-to-Market Coordination)
    - Interregional Transaction Coordination

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Solution Objectives

- Reduce need for, frequency of, and magnitude of Transmission Loading Relief (TLR) events to address loop flow.
  - *Buy-Through of Congestion provides an alternative to market and operational interruptions caused by TLR events; establishes an economic based alternative to imposed curtailments.*
- Align constraint management cost recovery with sources of flow
  - *Parallel Flow Visualization and Buy-Through of Congestion facilitate identification of sources of loop flow and provide a mechanism to recover congestion management costs incurred to support loop flows.*
- Reduce constraint management costs for consumers across region.
  - *Congestion Management achieves a more cost effective utilization of the region's collective assets to address constraints across multiple systems.*
- Improve regional price consistency and transmission utilization
  - *Congestion Management expands asset pool to address regional constraints.*
  - *Interregional Transaction Coordination provides for the more frequent adjustment of interchange schedules in response to changing market conditions; expands pool of flexible assets to balance intermittent power resources output.*

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Physical Solution

Peter Sergejewich - IESO

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Physical Solutions to Loop Flows

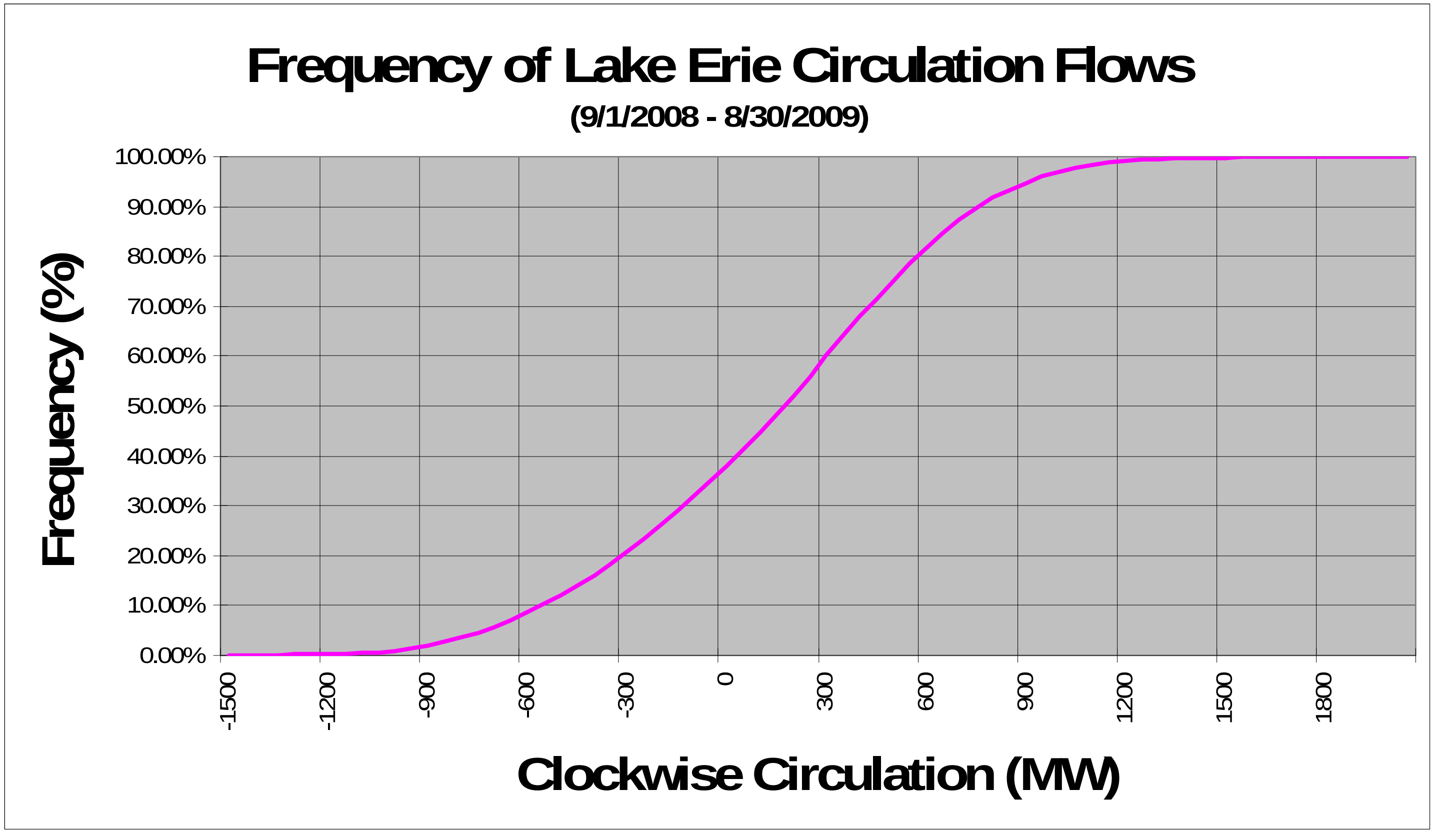
- Some control of loop flow can be achieved through the use of physical devices such as phase shifting transformers, also know as phase angle regulators or PARs.
- In addition to PARs, variable frequency transformers, series capacitors, and other such devices have the ability to alter flows and should be coordinated and included in solutions to loop flows.
- Of particular note in respect to controlling loop flows around Lake Erie are the Ontario-Michigan PARs which are soon to be in-service. Once in-service, Ontario will have the ability to control the flows across each of its interconnection interfaces to some extent, and in particular the circulation flow across the top of Lake Erie.
- The intent is to operate the Michigan-Ontario PARs so as to better match actual flows with the scheduled flows across the interconnection.

Status of Michigan-Ontario PARs

- Initial installation completed in 1999
- Ongoing operation delayed due to equipment failures & difficulties in getting operating agreements in place
- Failed equipment replaced and additional further protection upgrades scheduled to be in place by the end of Q1 2010

Capability of Michigan-Ontario PARs

- Expect to be able to control up to 600 MW of loop flow in either direction



Coordinated Operation of All Devices

- All physical controls will play a complementary role in any comprehensive loop flow solution
- Since uncoordinated operation of physical devices could increase circulation flows, it is important that the operation of such devices by the four markets around Lake Erie be coordinated to avoid detrimental impacts.

Parallel Flow Visualization

Tom Mallinger - MISO

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Parallel Flow Visualization/Mitigation Proposal

Joint Meeting of NYISO-IESO-MISO-PJM Stakeholder
October 29, 2009

History of TLR in Eastern Interconnection (EI)

- Primary congestion management procedure used during the past 10 years. Only minor modifications have been made during this time period.
- Where TLR is not the primary congestion management mechanism, it has been used as a reliability backstop when significant, externally induced parallel flows make local procedures insufficient to control facility loading.
- Historically, Reliability Coordinators (RCs) have relied on tag curtailments to curtail non-firm usage and a combination of tags and NNL relief obligations to curtail firm usage (share-the-pain approach).

Recent Enhancements to the TLR Procedure

- With the expansion of the PJM market and the start of the Midwest ISO and SPP markets, the TLR procedure has been enhanced to include market flows on the systems of these entities in place of tags.
- Midwest ISO and PJM have implemented a M2M congestion management process where they use the most cost effective generation in the two markets to meet their combined relief obligations during TLR.

RCs Rely on IDC for Parallel Flow Information

- RCs monitor real-time flows using RTCA and SCADA. This process is effective monitoring total flow but does not identify the source and magnitude of parallel flows.
- Transaction impacts for current hour and next hour are available in the IDC.
- Likewise, Midwest ISO, PJM and SPP generator-to-load (GTL) impacts for current hour and next hour are available in the IDC.
- An RC should know its own GTL impacts. However, there is no real-time information in the IDC on parallel flows caused by the GTL impacts from outside the RC area.

Instances When Parallel Flows in the EI Caused Reliability Concerns

Lake Erie Circulation Flow

- The MISO-PJM Loop Flow Study Phase I report documented instances when high clockwise and counter-clockwise loop flows occurred around Lake Erie:
  - Two dates involved high clockwise flows (on Feb 17, 2005 and April 17, 2005).
  - Two dates involved high counterclockwise flows around Lake Erie (on March 1, 2005 and June 23, 2005).
- The Loop Flow Study Phase I report identified the magnitude of the circulation flows, their direction and the time of the day when they occurred.
- Due to the difficulty of obtaining historical tag impacts and GTL impacts, the Loop Flow Study Phase I report recommended creating an Energy Schedule Tag Archive that contains tag impacts, market flow impacts and GTL impacts for all flowgates contained in the IDC.

Instances When Parallel Flows in the EI Caused Reliability Concerns

Lake Erie Circulation Flow

High counter-clockwise Lake Erie circulation flows occurred on June 11-13, 2007. IESO implemented TLR 3a on FG 7102 (QFW) that resulted in the following PJM relief obligations:

June 11, 2007 TLR 3a	13:00-14:00 CST	29.8 MW
	15:00-16:00 CST	373 MW
June 12, 2007 TLR 3a	10:00-11:00 CST	235 MW
	11:00-12:00 CST	243 MW
	12:00-13:00 CST	76.8 MW
	13:00-14:00 CST	177.7 MW
	14:00-15:00 CST	180.9 MW
	15:00-16:00 CST	299 MW
June 13, 2007 TLR 3a	14:00-15:00 CST	9.9 MW
	15:00-16:00 CST	152.5 MW
	16:00-17:00 CST	25.8 MW

Instances When Parallel Flows in the EI Caused Reliability Concerns

Lake Erie Circulation Flow

- IESO reported that on June 12, 2007, a combination of transmission and generation contingencies plus high Lake Erie circulation contributed to IESO initiating its voltage reduction program.
- January-December, 2008-IESO call TLR on Lake Erie flowgates 163 times. This is usually an indication that there are high circulation flows around Lake Erie.

Major Issues Being Addressed by Proposal

- Replacing the current native and network load (NNL) calculation made in the IDC with the reporting of near real-time flows addresses three major issues:
  - NNL calculation made in IDC is used when TLR 5 is called (firm curtailments). Use of static data in NNL calculation produces questionable results, delays in calling TLR 5 and allows no after-the-fact reviews.
  - RCs in EI lack visualization as to the source and magnitude of parallel flows when they experience congestion.
  - IDC NNL calculation currently assumes all GTL impacts are firm and can only be curtailed on a pro-rata basis during TLR 5.

Use of Static Data in NNL Calculation

- NNL calculation in the IDC relies heavily on operating information submitted to the SDX to model system conditions. There is no NERC requirement that operating data be submitted to the SDX.
- Default assumptions are used where operating information is missing (i.e. generator outages, load and net scheduled interchange).
- There must be a total of 20 MW or more generation at a bus in order to have NNL impacts determined.
- Because NNL calculation is made on an on-demand basis, RCs must adjust the static data to improve the NNL relief obligation. This can delay calling TLR 5 anywhere from 30 to 45 minutes.
- Because NNL calculation is made on an on-demand basis, there is no real-time view of GTL parallel flows (except during TLR 5). There is no historical archive of impacts that could be reviewed on an after-the-fact basis.

RCs Lack Parallel Flow Visualization

- Because NNL calculation is made on-demand and uses static operating information, it is not a suitable source for real-time impact of parallel flows.
- Midwest ISO and PJM issued a Loop Flow Study Phase I report in May 2007 that focused on Lake Erie circulation flow and PJM Southeast versus Southwest Interface flows (http://www.jointandcommon.com/working-groups/joint-and-common/joint-and-common-wg.html).
- Midwest ISO and PJM issued a Loop Flow Study Phase II report in November 2008 that focused on the source and magnitude of parallel flows on 35 flowgates that experienced significant congestion in 2007 (http://www.jointandcommon.com/working-groups/joint-and-common/joint-and-common-wg.html).
- Both loop flow studies took longer to produce and required extensive simulation due to limited historical information on loop flows. One of the Loop Flow Study Phase I recommendations is to create an archive of tag impacts, GTL impacts and market flow impacts that can be used to make after-the-fact reviews.

Generators Using Non-Firm Transmission Service

- For TSPs that are subject to an OATT, designated resources are considered firm use of the transmission system. Non-designated resources are considered non-firm use of the transmission system.
- The IDC is unable to assign relief obligations to non-firm GTL impacts during TLR. If a non-designated resource is below the 20 MW threshold, transmission usage is treated firmer than firm.
- Tagging these non-firm uses not effective since the IDC lacks the granularity to determine tag impacts of intra-BAA transactions.
- Instances where non-firm transmission service is used to serve load within the BAA:
  - Non-designated resources that are being used to serve load inside the BAA have the highest priority of non-firm service (Priority 6-NN).
  - Renewable resources that have elected to use non-firm transmission service to deliver to load inside the BAA.
  - Qualifying facilities that are delivering to load within the BAA.

Parallel Flow Visualization/Mitigation Proposal

- RCs would report their GTL impacts to the IDC on a real-time basis or make arrangements to have someone report on their behalf.
- The IDC would indicate the source of all flows on a flowgate and the priority of these flows (tag impacts, GTL impacts and market flow impacts).
- An RC experiencing congestion would have visualization of the magnitude and source of all flows affecting their flowgate using information from the IDC.
- An RC experiencing congestion would request an amount of flow reduction that would be processed by the IDC. A relief obligation would be issued to all parties contributing to the loading.
- NAESB will establish methodology for assigning the GTL flows into the appropriate buckets.

NERC Involvement in Parallel Flow Proposal

- A comprehensive parallel flow motion was approved at the May 6, 2009 ORS meeting (see attached motion). It provided direction to the IDCWG to develop a final set of requirements, to seek revised vendor estimates and to prepare a recommendation that will be reviewed at the Nov ORS meeting.
- The ORS addressed a number of issues on the approach to be taken:
  - A single vendor will make the GTL calculation for all RCs in the EI.
  - The three RTOs that currently report their market flows to the IDC will replace their own calculation with the vendor calculation.
  - A staged implementation of the new software where it would run in parallel with the existing IDC for some period of time. There will be a set of reliability metrics that demonstrate an improvement over the NNL calculation before changing to the new software.

NERC Involvement in Parallel Flow Proposal

- The IDCWG has held a number of meetings on the parallel flow visualization process. They have identified data requirements and are reviewing IDC COs.
- The IDCWG presented the data requirement at the Sept 23, 2009 ORS meeting.
- The IDCWG will recommend a parallel flow process and a vendor at the Nov 2009 ORS meeting.
- The 2010 NERC Budget includes funding for this project.

NAESB Involvement in Parallel Flow Proposal

- The NAESB Annual Plan included a line item on Future Path of TLR. An accompanying white paper described two phases of this initiative:
  - The first phase involves enhancements to the TLR reporting process to provide near real-time GTL reporting by all RCs in the EI similar to MISO, PJM and SPP.
  - The second phase involves enhancements to the TLR curtailment process to replace the “share the pain” approach with an approach that is more efficient in managing congestion. The second phase is dependant on completion of the first phase.
- The line item in the NAESB 2008 Annual Plan was carried forward into the NAESB 2009 Annual Plan.

NAESB Involvement in Parallel Flow Proposal

- The NAESB BPS has been working on a mechanism that assigns the GTL priorities used in the IDC.
- The NAESB BPS is working on concepts that would be applicable to jurisdictional entities, non-jurisdictional entities and Canadian entities.
- The NAESB BPS will work jointly with the IDCWG such that the mechanism used to assign GTL priorities is consistent with the calculations in the IDC.

General Timeline for Parallel Flow Proposal

- The IDCWG will not finalize this timeline until after a vendor has been selected and there is a commitment by the ORS to move forward with this project.
  - It is expected that a vendor will be recommended and the NERC ORS will approve the recommendation at their Nov 2009 meeting.
  - It is expected that the IDCWG will oversee IDC software development in parallel with the NAESB BPS working on prioritization in spring and summer 2010.
  - It is expected that by Sept 2010, will start parallel operation in staging environment. Will run in this mode anywhere from 3 to 6 months to evaluate results while benchmarking against current NNL calculation. The visualization features will be available while in staging environment.
  - It is expected that no later than summer 2011, will implement new software and rely on this process to assign relief obligations during TLR.

Parallel Flow Visualization/Mitigation Proposal

- Questions?

Parallel Flow Visualization/Mitigation Proposal

Attachment

Parallel Flow Proposal Motion Approved on May 6, 2009

- . . . moved that the ORS agrees that the future use of GTL impacts, as identified in the MISO, PJM, and SPP “Generation-to-Load Reporting Requirements” white paper, will improve visibility and as such will enhance reliability of the Eastern Interconnection. The ORS believes the IDC should be modified to accept GTL calculations. The GTL impact calculation should be consistent for all EI RCs and, as such, a single vendor should be selected to implement the methodology and to perform the actual calculations for all EI RCs.
- These changes are intended to provide information only at this point (i.e. providing the calculated GTL impacts without changing the functionality of the tools) until the ORS agrees that it is appropriate to utilize the additional data to enhance tool processes or possible changes to TLR procedures. It is recognized that any changes to the TLR process to utilize the additional data made available as a result of this initiative will be determined preferably by the existing joint NAESB/NERC TLR SDT. Industry support will be critical to the success of this initiative and will be best achieved by ensuring appropriate industry input and transparency in the decisions taken.

Parallel Flow Proposal Motion Approved on May 6, 2009

- The ORS directs the IDCWG to take the following actions:
  - Identify the minimum data set required to achieve the required calculations by the September 2009 ORS meeting.
  - Identify the required changes to the IDC to identify the GTL impacts
  - Recommend a vendor to perform the GTL calculations for all EI RCs
  - Determine, in cooperation with the vendor, the GTL calculation methodology.
  - Identify to the ORS any additional items that are required to incorporate GTL impacts
- The IDCWG should target having proposed recommendations to the ORS for the November 2009 meeting.
- The GTL impacts should be archived in the IDC for an initial period of 12 to 18 months to allow analysis to be performed to assess the potential impact of any proposed changes to the TLR process including the possible use of near real time data for NNL calculations and possible use of near real time data for other TLR calculations as determined by NAESB. Process changes may be incorporated before the completion of the analysis period if the ORS determines it is appropriate.

Parallel Flow Proposal Motion Approved on May 6, 2009

- In addition, the NERC ORS will develop reliability metrics to confirm that the Generation-to-Load calculation is an improvement in accuracy over the static NNL calculation which must be met before changing to using the Generation-to-Load calculated impacts for TLR.

Buy-Through of Congestion

Robert Pike – NYISO

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Buy-Through of Congestion

- Benefits
  - *Buy-Through of Congestion provides for the recovery of congestion management costs incurred in managing loop flow impacts.*
    - Provides for an alternative to market and operational interruptions caused by Transmission Loading Relief (TLR) actions by establishing an economic based alternative to imposed curtailments.
    - More efficient utilization of the transmission network.
    - More consistent transaction scheduling decisions with regional prices.

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Buy-Through of Congestion

- Concept
  - *Parties scheduling transactions with any of the other ISO/RTOs surrounding Lake Erie would be billed for the real-time congestion costs incurred by neighboring systems supporting the loop flow created by the transaction to maintain the schedule.*
    - Sources of loop flow identified via the NERC IDC tools
    - Congestion costs captured by regions LMP prices.
    - Allocate costs to the transaction schedules in proportion to the schedules loop flow impacts
    - Exposure to congestion costs can be hedged with existing Day-Ahead transmission scheduling processes, or avoided with real-time scheduling processes

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Buy-Through of Congestion

- Parallel Flow Visualization
  - *Provides single common source and methodology for isolating sources of flow.*
    - Identify sources of flowgate impact, included Balancing Authority to Balancing Authority interchange schedules, and intra-regional generation-to-load impacts.
    - Incorporates state of phase angle regulator controls.
  - *Market visibility of impacts available through the NERC IDC or OATi tools.*
  - *Loop flow impacts calculated by IDC will reflect the ability (or lack thereof) of the PARs to maintain actual flow consistent with scheduled flow.*

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Buy-Through of Congestion

- Responsible Control Area (RCA)
  - *Define RCA as the sink balancing area or the last control area of the four Lake Erie ISOs to be engaged in a transaction.*

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Buy-Through of Congestion

- Biddable Options
  - *Provide capability at bid submission for market participant to identify whether they are willing to pay, or not willing to pay, for congestion charges caused by their off-control path flow impacts*
    - Transactions that indicate they are not willing to pay congestion will be curtailed when congestion detected and flowgate impacted by the transactions loop flow. Those transactions will not be charged for congestion related impacts.

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Buy-Through of Congestion

- Biddable Options
  - *There will not be an option to specify an “up-to” congestion charge value. Implementation not viable given the:*
    - Dynamic nature of markets in establishing market clearing prices;
    - Complexity of multiple ISOs engaged in applying congestion charges for loop flow impacts, and the;
    - Operational uncertainty associated with continuously adjusting interchange values.

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Buy-Through of Congestion

- Transaction Removal Process
  - *A monitoring ISO that encounters congestion, will:*
    - Determine impact on flowgate from loop flows
    - Identify the transaction schedule sources of the loop flows
    - Coordinate with the RCA(s) of transactions identified.
  - *The RCA(s) will:*
    - Review the set of transactions and curtail the set that is not willing to pay congestion costs. This set will not be billed for congestion charges.
    - Communicate with the monitoring ISO upon completion of review and curtailment.
- Throughout the process, TLR procedures remain as an alternative to the monitoring ISO to address system overloads.

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Buy-Through of Congestion

- Transaction Re-Instatement Process
  - *Applicable after a transaction has been curtailed due to not be willing to pay for congestion costs.*
  - *An RCA will not re-initiate transaction schedules (or add new transaction schedules) that have an indication they are not willing to pay for congestion costs if scheduling the transaction would increase loop flows on an active flowgate.*
    - An RCA can initiate transaction schedules that have indicated they are willing to pay for congestion costs associated with their loop flow impacts.
  - *A monitoring ISO will continue to evaluate congestion on the original flowgate and notify the RCA(s) when the constraint is relieved.*
    - Notification will be provided in advance of the bottom of the hour for next hour scheduling changes, consistent with TLR procedures.

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Buy-Through of Congestion

- Settlement of Allocated Charges
  - *The monitoring ISO will determine the congestion costs to be recovered based upon NERC IDC tools to identify transaction and their respective impact on the constrained flowgates and LMP calculations of constraint cost and will provide the costs to the respective RCA(s).*
  - *The RCA(s) will apply charges to specific transactions as part of their normal billing procedures, collect revenue, and return revenue to the monitoring ISO.*

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Buy-Through of Congestion

- Settlement of Allocated Charges
  - *Loop flows having a counter-flow impact on prevailing flows will produce lower net flows and lower constraint management costs, thereby lowering the costs to be recovered from prevailing flow loop flows.*
  - *Counter-flow transaction will not be compensated for the relief they provide via Buy-Through of Congestion.*
  - *Counter-flow transactions must be explicitly represented into the ISO-market that is expected to benefit from the transaction in order to receive the compensation.*

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Buy-Through of Congestion

- Responsible Control Area (RCA)
  - *Responsibilities include:*
    - Collecting bidding indicators of willingness to pay congestion;
    - Manage transaction schedules in response to identification by monitoring control area of transactions impact and occurrence of flowgate constraints;
    - Process, collect and distribute settlement charges.
  - *RCA(s) settlement necessary as all market participants may not be members of all market areas.*

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Buy-Through of Congestion

- Monitoring ISO
  - *Responsibilities include:*
    - Monitoring for flowgate congestion impacted by loop flow resulting from transaction schedules;
    - Coordinate with RCA(s) to identify and review transaction schedules impacting flow gates;
    - Release flowgate transaction scheduling restrictions;
    - Calculate and communicate congestion charges to RCA(s) for transaction impacts.

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Buy-Through of Congestion

- Managing Congestion Cost Exposure
  - *NYISO: Up-to congestion product available in DA. Opportunities to expand virtual trading to the proxy bus locations.*
  - *PJM: Up-to congestion product available in DA. 20-minute advance notice schedule termination. Virtual bidding options available.*
  - *MISO: Up-to congestion product available in DA. 20-minute advance notice schedule termination. Virtual bidding options available.*
  - *IESO: No products currently available.*

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Buy-Through of Congestion

- Example
  - *A 100 MW transaction from IESO to PJM, via MISO. The transaction has indicated they are willing to pay for congestion costs.*
  - *Transaction is submitted, reviewed and scheduled through the standard ISO/RTO processes.*
  - *The OH-Michigan PARs are operated and control schedule to 90 MWs. 10 MWs remain flowing through NY as loop flow (10% of the transaction schedule).*
  - *A flow gate within NY becomes constrained at xx:30 of the hour. The flowgate is impacted by the loop flows.*
  - *The resulting congestion cost is $10/MWhr.*
  - *The transaction would receive a buy-though of congestion settlement of:*

    (10%)(100 MW)*(0.5 hour)*($10) = $50 (or $0.50/MWhr)*

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Congestion Management

Stan Williams - PJM

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PJM & Midwest ISO Market-to-Market Coordination

Broader Regional Markets
Joint Stakeholder Meeting
October 29, 2009

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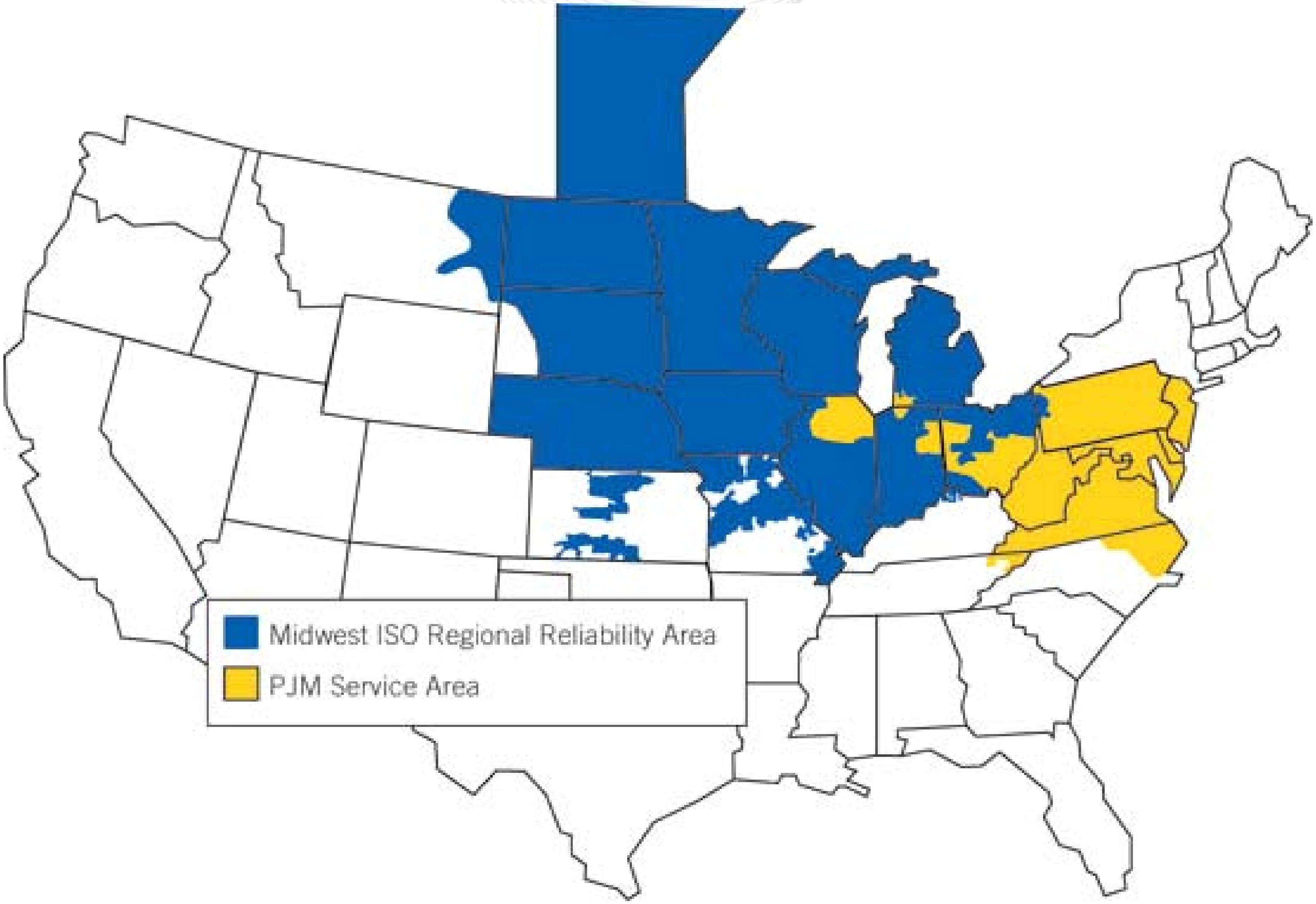
Market-to-Market Coordination

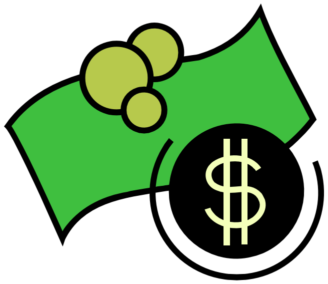
- Objectives
- Overview
- Example
- Results

PJM and Midwest ISO Service Area

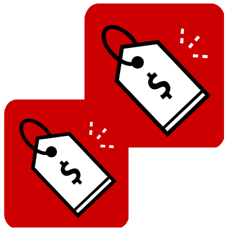


Objectives of Market-to-Market Coordination

- Achieve the least cost redispatch solution for coordinated constraints across multiple systems.



- Provide a more <u>consistent pricing</u> profile across the two markets.



- Enhance <u>system reliability</u> by pooling resources from both RTOs to jointly control transmission constraints near the RTO border.

- When the monitoring RTO (MRTO) controls a reciprocal coordinated flowgate (RCF) in its real-time dispatch system, it will initiate the Market-to-Market coordination process with a relief MW request.
- The non-monitoring RTO (NMRTO) will respond by adjusting the RCF limit using the desired relief request from the MRTO and redispatching its generation to control the RCF to either
  - (a) provide the relief requested by the monitoring RTO;
  - (b) redispatch up to the current shadow price from the MRTO.

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Market-to-Market Coordination Overview (cont'd)

- As the relief provided by the NMRTO is realized in the RCF, the MRTO can control the RCF at a lower shadow price. The updated shadow price is sent to the NMRTO.
- Both RTOs will then continue to redispatch their systems respecting the constrained flowgate.
- The result of this coordination will be a cost effective redispatch solution for the combined footprint.
- The RTOs will then compensate each other for the redispatch provided based on the real time market flow of the NMRTO comparing to the historic usage.

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Market-to-Market Coordination Example

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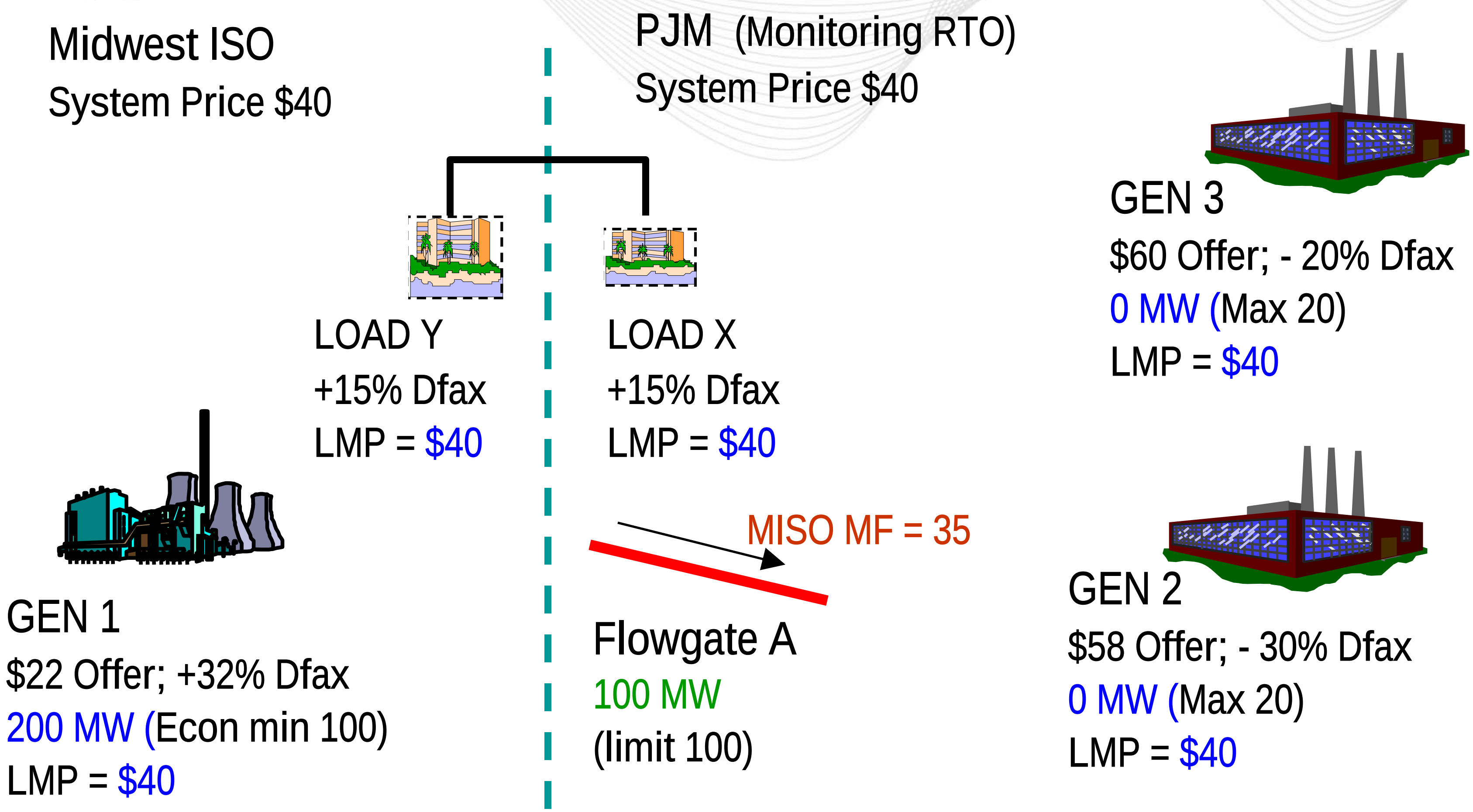
Market-to-Market Example – Stage 1



LOAD X (in PJM) and LOAD Y (in Midwest ISO) are electrically close to each other and have the same impact on Flowgate A.

The initial Midwest ISO Market Flow on Flowgate A is 35 MW.

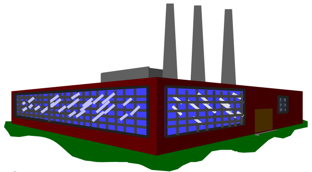
Market-to-Market Example – Stage 2a

Midwest ISO

System Price $40

PJM (Monitoring RTO)

System Price $40



GEN 3

$60 Offer; - 20% Dfax

0 MW (Max 20)

LMP = $40

LOAD Y

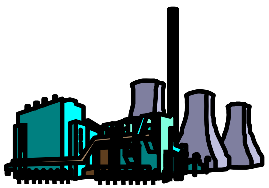
+15% Dfax

LMP = $40

LOAD X

+15% Dfax

LMP = $40



GEN 1

$22 Offer; +32% Dfax

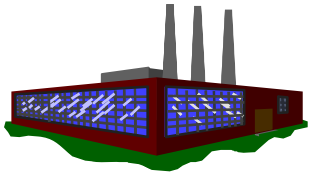
200 MW (Econ min 100)

LMP = $40

Flowgate A

110 MW

(limit 100)



GEN 2

$58 Offer; - 30% Dfax

0 MW (Max 20)

LMP = $40

The flow on Flowgate A increases to 110 MW due to higher load in PJM

Market-to-Market Example – Stage 2b

Midwest ISO
System Price $40

PJM (Monitoring RTO)
System Price $40

LOAD Y
+15% Dfax
LMP = $40

LOAD X
+15% Dfax

GEN 3
$60 Offer; - 20% Dfax
20 MW (Max 20)
20 * 0.2 = 4 MW of relief

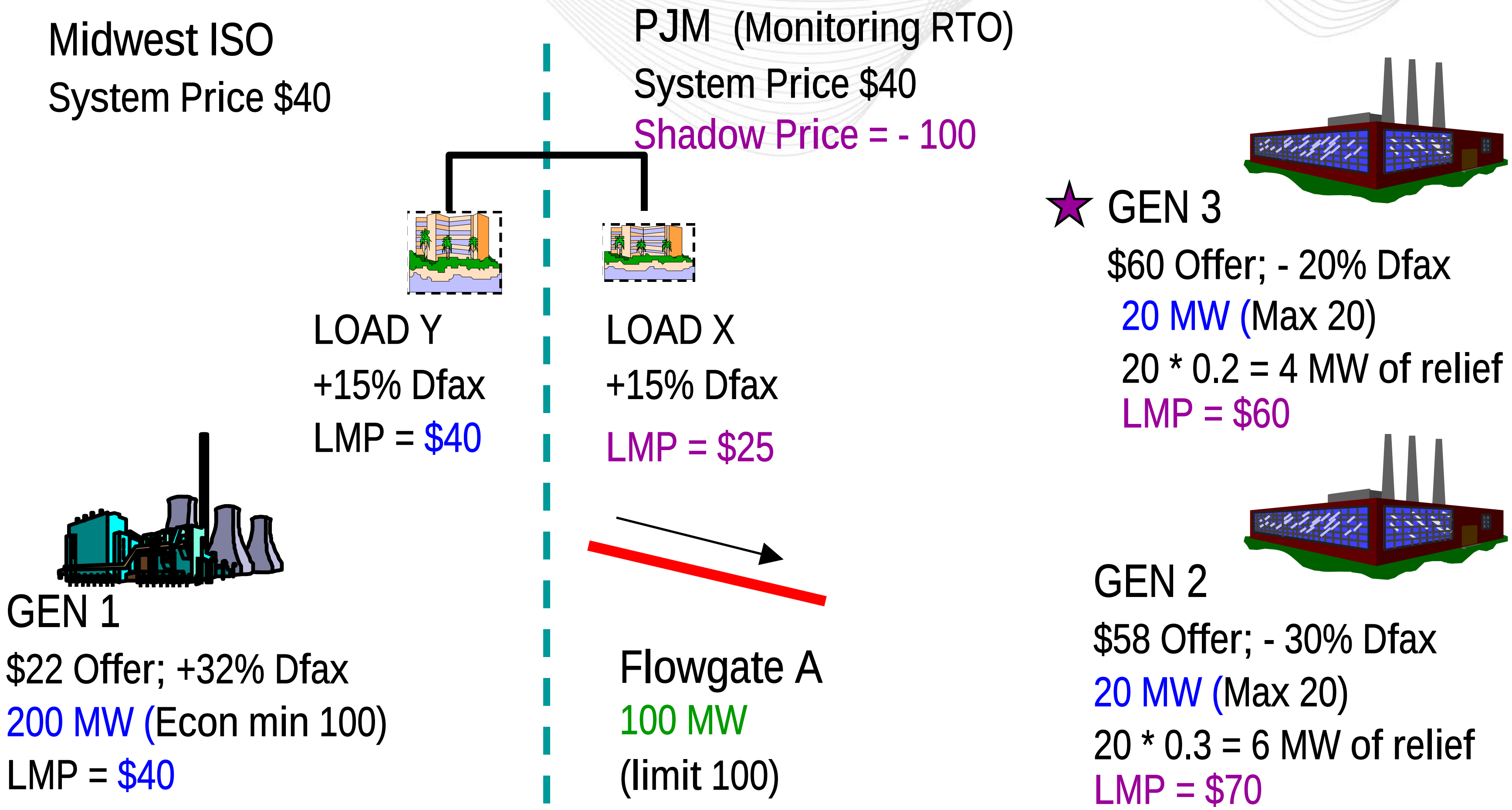
GEN 1
$22 Offer; +32% Dfax
200 MW (Econ min 100)
LMP = $40

Flowgate A
110 MW
(limit 100)

GEN 2
$58 Offer; - 30% Dfax
20 MW (Max 20)
20 * 0.3 = 6 MW of relief

PJM dispatches GEN 2 and GEN 3 to control the Flowgate A

Market-to-Market Example – Stage 2c



PJM dispatches GEN 2 and GEN 3 to control the Flowgate A

GEN 3 is the marginal unit and constraint shadow price is (60-40)/(-.2)=-100

GEN 2 LMP = 40 +(-0.3 * -100) = $70; LOAD X LMP = 40 + (0.15 * -100) = $25

Market-to-Market Example – Stage 3a

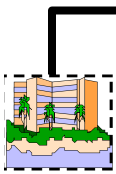
Midwest ISO

System Price $40

PJM (Monitoring RTO)

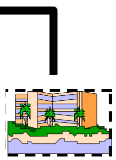
System Price $40

Shadow Price = - 100



LOAD Y

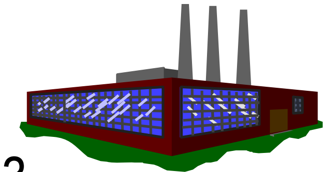
+15% Dfax



LOAD X

+15% Dfax

LMP = $25



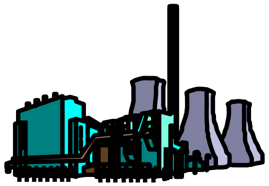
★ GEN 3

$60 Offer; - 20% Dfax

20 MW (Max 20)

20 * 0.2 = 4 MW of relief

LMP = $60



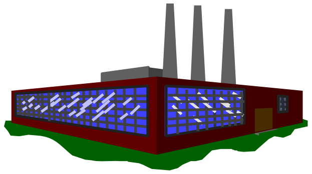
GEN 1

$22 Offer; +32% Dfax

Flowgate A

100 MW

(limit 100)



GEN 2

$58 Offer; - 30% Dfax

20 MW (Max 20)

20 * 0.3 = 6 MW of relief

LMP = $70

PJM notifies Midwest ISO to invoke M2M to control Flowgate A.

PJM requests 4 MW of relief at the current shadow price of -100.

Midwest ISO reduces GEN 1 to provide the relief requested by PJM

Market-to-Market Example – Stage 3b

Midwest ISO

System Price $40

Shadow Price = - 56.25

PJM (Monitoring RTO)

System Price $40

Shadow Price = - 100

LOAD Y

+15% Dfax

LOAD Y LMP = $31.6

LOAD X

+15% Dfax

LOAD X LMP = $25

MISO MF = 31

Flowgate A

96 MW

(limit 100)

GEN 1

$22 Offer; +32% Dfax

187.5 MW (Eco min 100)

12.5 * 0.32 = 4 MW of relief

LMP = $22

GEN 3

$60 Offer; - 20% Dfax

20 MW (Max 20)

20 * 0.2 = 4 MW of relief

LMP = $60

GEN 2

$58 Offer; - 30% Dfax

20 MW (Max 20)

20 * 0.3 = 6 MW of relief

LMP = $70

GEN 1 is reduced by 12.5 MW (to 187.5 MW) to provide 4 MW of relief.

Midwest ISO constraint shadow price is (22-40) / 0.32 = - 56.25

LOAD Y LMP = 40 + (0.15 * - 56.25) = 31.6

Market-to-Market Example – Stage 4a

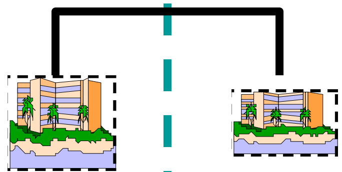
Midwest ISO

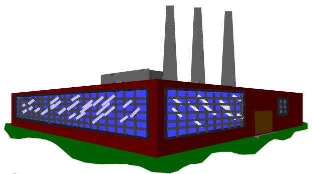
System Price $40

Shadow Price = - 56.25

PJM (Monitoring RTO)

System Price $40





GEN 3

$60 Offer; - 20% Dfax

0 MW (Max 20)

0 * 0.2 = 0 MW of relief

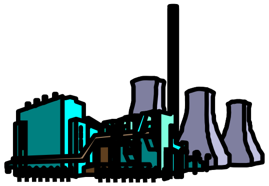
LOAD Y

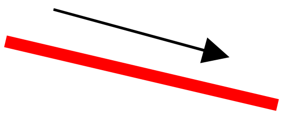
+15% Dfax

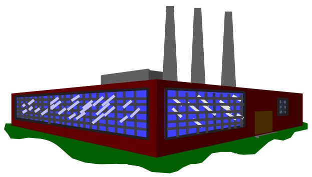
LMP = $31.6

LOAD X

+15% Dfax







★GEN 1

$22 Offer; +32% Dfax

187.5 MW (Eco min 100)

12.5 * 0.32 = 4 MW of relief

LMP = $22

Flowgate A

100 MW

(limit 100)

GEN 2

$58 Offer; - 30% Dfax

20 MW (Max 20)

20 * 0.3 = 6 MW of relief

With loading decreases on Flowgate A, PJM can release the less cost-effective GEN 3.

Market-to-Market Example – Stage 4b

Midwest ISO

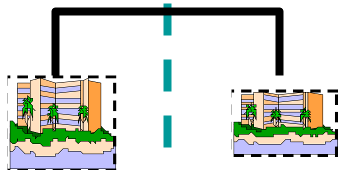
System Price $40

Shadow Price = - 56.25

PJM (Monitoring RTO)

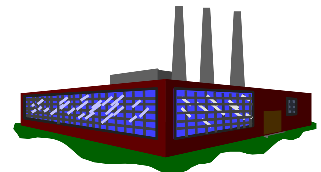
System Price $40

Shadow Price = - 60

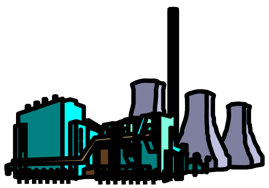


LOAD Y
+15% Dfax
LMP = $31.6

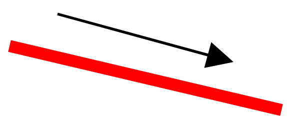
LOAD X
+15% Dfax
LMP = $31



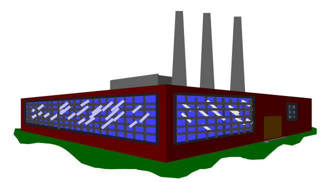
GEN 3
$60 Offer; - 20% Dfax
0 MW (Max 20)
0 * 0.2 = 0 MW of relief
LMP = $52



★GEN 1
$22 Offer; +32% Dfax
187.5 MW (Eco min 100)
12.5 * 0.32 = 4 MW of relief
LMP = $22



Flowgate A
100 MW
(limit 100)



★ GEN 2
$58 Offer; - 30% Dfax
20 MW (Max 20)
20 * 0.3 = 6 MW of relief
LMP = $58

With GEN 3 offline, GEN 2 becomes the new marginal unit for the constraint
Constraint shadow price is (58 - 40) / (- 0.3) = - 60
GEN 3 LMP = 40 + (- 0.2 * - 60) = 52; LOAD X LMP = 40 + (0.15 * - 60) = 31

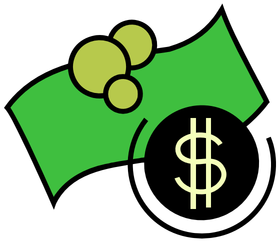
Market-to-Market Coordination Results

PJM©2009

What have been the Market-to-Market Results?

PJM has observed the following:

- <u>Lower congestion cost</u>: The redispatch cost for the PJM market would have been higher if PJM had to control all transmission constraints on its own.



- <u>More consistent pricing across the RTO border:</u> When the market-to-market coordination is in effect, the prices at the Midwest ISO and PJM border converge better than before.

- <u>More Reliable operation:</u> Since economic generation in Midwest ISO is now available for constraint control, PJM has experienced fewer emergency transmission operations.

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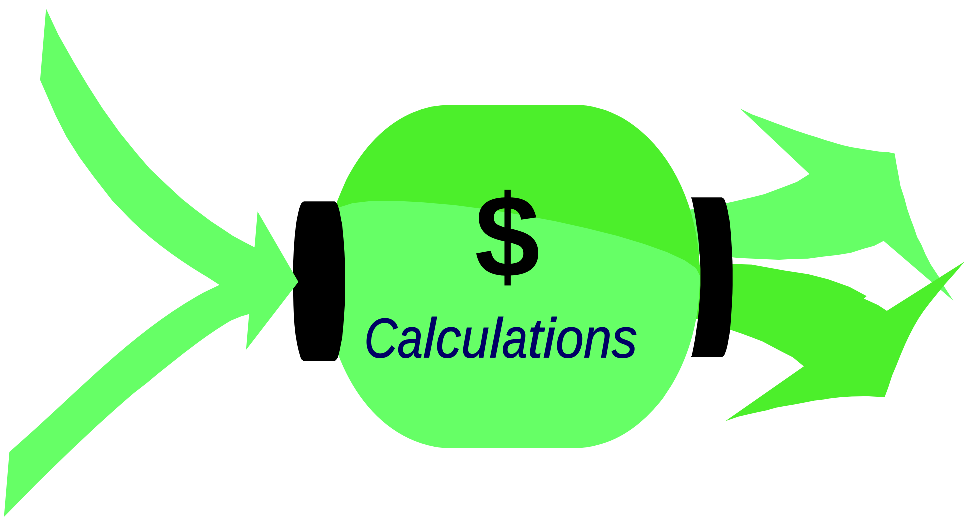
Market-to-Market Coordination Example – Settlement Calculations



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(assuming Stage 4 from the example went on for one full hour)

Scenario 1 : Midwest ISO is below the **Network and Native Load (NNL*)**

NNL for Midwest ISO on Flowgate A per the example = 40MW
Real-Time Market Flow MW by Midwest ISO on Flowgate A
= 31MW (requested by PJM)
Midwest ISO Shadow Price on Flowgate A = -$56.25/MWh

Payment (PJM to Midwest ISO) = (NNL – Real-Time Marketflow) * Transmission Constraint Shadow Price in Non-Monitoring RTO's Dispatch Solution

Payment (PJM to Midwest ISO) = (40/MWh-31/MWh) * -$56.25/MWh

Payment (PJM to Midwest ISO) = -$506.25

*** Midwest ISO NNL on Flowgate A is the Midwest ISO generation-to-load impact on Flowgate A (in PJM) based on historic usage.**

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Market-to-Market Settlement Calculations (cont'd)

Scenario 2: Midwest ISO is above the Network and Native Load (NNL)

NNL for Midwest ISO on Flowgate A per the example = 28MW
Real-Time Market Flow MW by Midwest ISO on Flowgate A
= 31MW (requested by PJM)
PJM Shadow Price on Flowgate A = -$60/MWh

Payment (Midwest ISO to PJM) = (NNL – Real-Time Marketflow) * Transmission Constraint Shadow Price in Monitoring RTO's Dispatch Solution

Payment (Midwest ISO to PJM) = (28/MWh-31/MWh) * -$60/MWh

Payment (Midwest ISO to PJM) = $180

Interregional Transaction Coordination

Robert Pike - NYISO

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Interregional Transaction Coordination

- Benefits
  - *In-hour transaction scheduling lowers total system operating costs through improved consistency of transaction schedules with market-to-market price patterns.*
  - *Expand pool of flexible assets to balance intermittent power resources output.*
  - *Improve price consistency and transmission utilization across markets.*
  - *Address uncertainty in forward looking scheduling horizons.*

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Interregional Transaction Coordination

- Concept
  - *Allow Market Participants to provide flexible energy, reserve and regulation transaction bids, where the real-time dispatch tools will evaluate these flexible transactions on an intra-hour basis.*
  - *Phase 1 – Adjust HQ energy interchange on a 5-minute frequency based upon NY economic evaluation of flexible bids.*
    - Pre-coordination of flexible bids and automated coordination of energy schedules necessary to support frequency of interchange adjustments.

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Interregional Transaction Coordination

- Future Steps
  - *Phase 2 – Establish market and coordination processes to support purchase and sale of reserve and regulation between markets.*

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Interregional Transaction Coordination

- Future Steps
  - *Phase 3 – Define process to apply dynamic scheduling between two market systems.*
    - Creation of new “spread” bid product.
      - Market Participant supplies single bid to be used by both neighboring ISOs, indicating desired profitability for transaction.
      - ISO uses current/forecasted prices to schedule transactions. Select spread bids with lower bid than predicted difference between market prices.
      - ISOs incorporate updated transaction schedules into dispatch tools.
      - Process is repeated at defined intervals.
    - Market participant assumes risk of final prices being different than those used in scheduling decisions.

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Next Steps

Rana Mukerji – NYISO

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*Implementation Timeline**

- Parallel Flow Visualization
  - *Software Ready / Parallel Operations* — *2010*
- Buy-Through of Congestion
  - *Design Development* — *2010*
  - *Implementation* — *2011*
- Congestion Management
  - *PJM-NYISO Implementation* — *2011*
  - *Extend to Additional Regions* — *2012*
- Interregional Transaction Coordination
  - *Energy Scheduling with NY/HQ* — *2010*
  - *Extend to Additional Regions* — *2011-12*

**Prospective timeline pending design development and approval from Market Participants, neighboring Control Areas and the Commission.*

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Ongoing Efforts

- **Request feedback to rpike@nyiso.com by November 13, 2009 or through each ISO's stakeholder discussion.**
  - *Follow-up Joint Stakeholder meeting in December*
- **Ongoing Solution and Schedule Development**
  - *MIWG: September – December, 2009*
  - *Joint ISOs: August – December, 2009*
  - *Joint Stakeholder Meetings: October, December, 2009*
  - *BIC: Concept Review – December 9, 2009*
  - *FERC: Response – January 12, 2010*
- **Design and Stakeholder Approvals**
  - *Detailed design, Joint Operating Agreements and tariff development beginning in 2010*

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The New York Independent System Operator (NYISO) is a not-for-profit corporation that began operations in 1999. The NYISO operates New York's bulk electricity grid, administers the state's wholesale electricity markets, and conducts comprehensive planning for the state's bulk electricity system.

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