Regional Energy Security, Efficiency and Trade (RESET)

Workshop on Market Models and Information Systems

Metering as a part of the PJM Integrated Information Systems

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PJM Major Information Systems

- OASIS – (**Open Access Same-Time Information System)** is an Internet-based information system for obtaining services related to the Open Access to electric power transmission grids.

- EMS – **Energy Management System**

- E-Tools - are a group of Internet-based software applications that enables Members to communicate with the market systems and make appropriate business decisions

- SCADA – **Supervisory Control and Data Acquisition** is a computer based system that provides for acquisition, processing and display of real time data on the state of Members' electrical plants

OASIS

Open Access Same-Time Information System

- Provides real time information by electronic means about available transmission capability for point-to-point service

- Enables transmission customers to purchase transmission services in accordance with Open Access principles.

- Implemented in response to FERC (Federal Energy Regulatory Commission) Orders 888 and 889 of 1996. It is obligatory for all Regional Transmission Organizations (RTO)

Energy Management System (EMS) Model

- A main elements of PJM's EMS is the EMS Model that is used for real time reliability analysis.
- This model is a basis for State Estimator software. The results of the State Estimator are used for identification of grid congestions and other limitations, and for contingency analysis.
- This model is also used for calculating the Locational Marginal Prices
- The Model comprises about 13 000 buses to be updated every three months.
- State Estimator is triggered every 1 minute; the results are obtained in 30 – 45 seconds
- The State Estimator's results are sent to the PJM System Operator and Member's operators

EMS Model (2)

- Main functions of the State Estimator software:
  - Based on the available telemetry data, obtain an adequate representation of the current state of the PJM Interconnection grid, including the equipment from which telemetry data are missing.
  - Filter the initial near real-time data, identify and eliminate metering inconsistencies and inaccuracies and ensure a consistent and, to the extent possible, full image of the grid processes
  - The grid representation serves as the base condition for further analyses such as Contingency Analysis which takes about 60 seconds

- The State Estimator's results, along with the price bids, are used to calculate Locational Marginal Prices
 - Locational Marginal Price calculation is started every 5 minutes

eTools

PJM Interconnection's eTools are a group of Internet-based software applications that give Members access to a continuous flow of real-time energy data that enables them to make business decisions and manage their transactions.

For markets to function effectively, the participants need accurate information - and the ability to act on it quickly.

–   Real-time price information allows Members to follow market fluctuations and make rapid buy and sell decisions.

–   If prices are rising, sellers can come into the market, while buyers may decide to shift their operations or buy power elsewhere.

eTools. Screenshot example
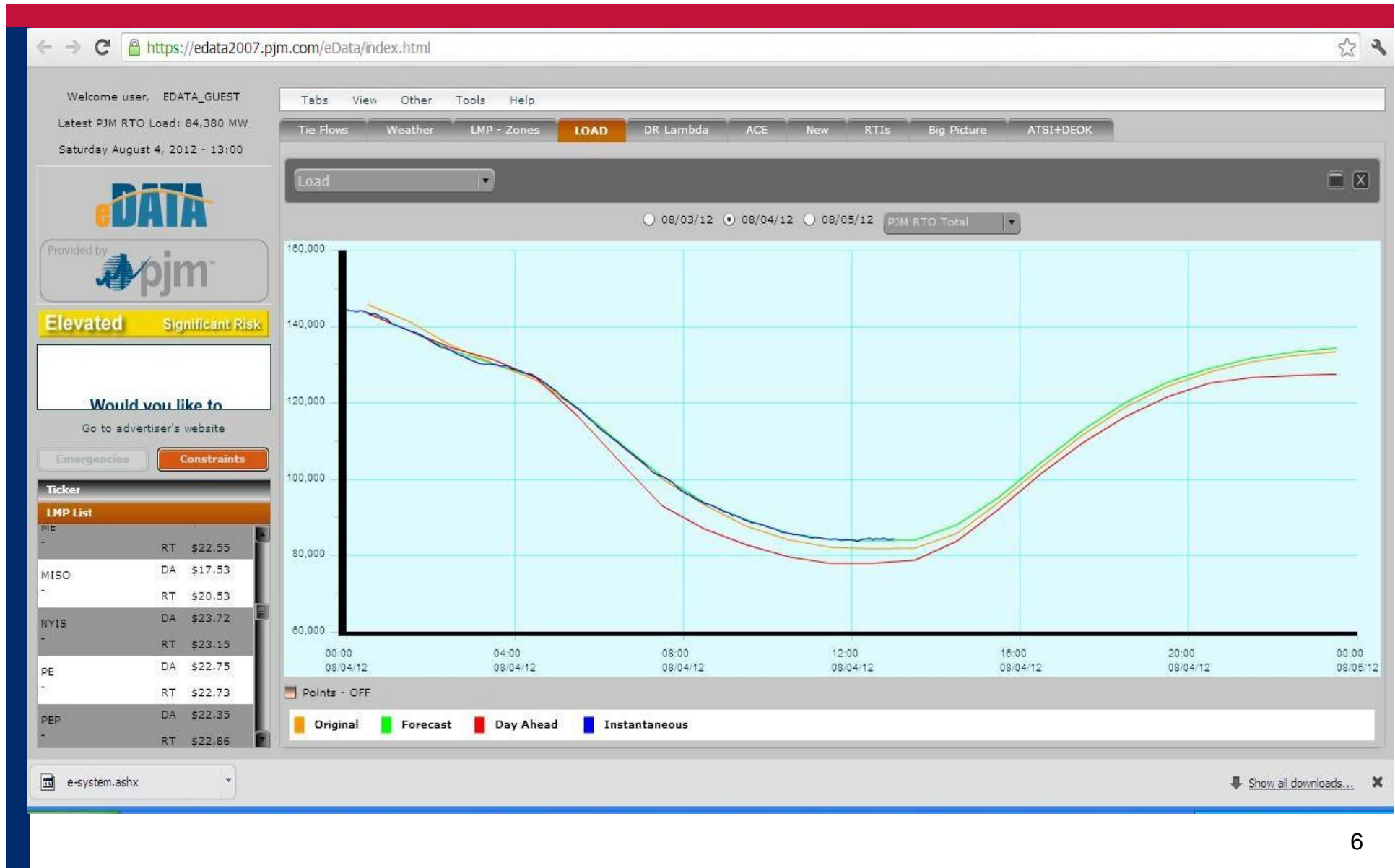
eTools Components

Committee Voting

- Committee Voting is an Internet application created to facilitate voting at selected PJM committee meetings.

eCredit

- This is a Web tool used by PJM Members to view their credit position, view/download relevant credit reports

eDART

- eDART (Dispatcher Application and Reporting Tool) is an Internet application that allows generation and transmission owners to submit generation and transmission outage requests electronically.

eDATA

- eDATA is an Internet application that enables all PJM stakeholders, including generation and transmission owners, traders and transmission customers, to view PJM operational and market data graphically.

eTools Components (2)

EES

- Enhanced Energy Scheduler is an Internet application that facilitates the interchange of bulk power between the PJM control area and other control areas by enabling market participants to request, evaluate and confirm their external bilateral transactions.

eFTR (Financial Transmission Rights)

- This web application is used by members and other transmission customers to manage their FTR portfolios.

eLRS

- The Load Response System allows PJM members to administer the registration, notification, meter data and settlement process for demand side response resources in the PJM markets.

eSchedules

- The eSchedules system is used by Power Marketers, Load Serving Entities (LSEs) and Generation Owners in PJM to submit their internal PJM energy schedule data

eTools Components (3)

eMKT

The Market Management System allows PJM members to submit information and obtain data needed to conduct business in the Day-Ahead, Regulation and Synchronized Reserve markets.

eRPM

The PJM Reliability Pricing Model system is an Internet-based application used by market participants to submit resource-specific sell offers or buy bids into RPM auctions.

eMTR

The Metering System calculates a market participant's actual amounts of interchange energy to be used for real-time energy market settlements.

Computer System Data Exchange protocols

PJM*net* Communications System

PJMnet is the primary, wide-area network for communicating Control Center voice and data to and from PJM.

PJMnet will support:

- Inter-Control Center Communications Protocol (ICCP, IEC 60870-6) data links to Control Centers, in particular for data exchange between different levels of PJM's Energy Management Systems .

- SCADA links to plants via remote terminal units (RTUs) using Distributed Network Protocol (DNP3.0, IEC 60870-5)

PJM*net* Communications System

- PJMnet connects member Local Control Centers, Market Operations Centers and generating plants to PJM's Control Center.

- The number of physical interfaces and their capacity will be determined by the impact of your facilities on overall PJM Operations.

- Local Control Centers, Market Operations Centers and generating plants are expected to install metering and use their own EMS/GMS/SCADA or equivalent system to collect data. PJM will provide ICCP (IEC 60870-6) network connections and router(s) at the member company location.

Summary of EMS Data Requirements and Exchange Rates

Data	Exchange Rates
From PJM Members to PJM	
Data needed for PJM Control Programs (AGC tie-line MW, Locally Sampled Frequencies)	Fast Scan Rate (2 seconds)
Data needed for monitoring generation (Generation MW Telemetry)	Slow Scan Rate (10 seconds)
Data needed for monitoring transmission (Line/Transformer Flows, Voltages)	Slow Scan Rate (10 seconds)
Accumulated Energy Values	Hourly Exchange Rate
Breaker, disconnect, and line status changes	By Exception (on event)
From PJM EMS to PJM Member's EMS	
AGC Regulation Signals	Fast Scan Rate (2 seconds)
AGC Individual Unit MW Set Points	Slow Scan Rate (10 seconds)
Dispatch control values	Slow Scan Rate (10 seconds)
Generation MW Telemetry	Slow Scan Rate (10 seconds)
Line/Transformer Flows and Bus Voltages	Slow Scan Rate (10 seconds)

SCADA System Requirements

SCADA system is used for transmitting both telemetry and revenue meter data

For Real-Time Customer Connections

All data items, regardless of type - instantaneous MW and MVAR data and integrated MWh and MVARh are collected and disseminated on the same 2-second rate data scan.

This configuration minimizes the number of data scan types and simplifies the definition of the customer information in the SCADA database.

The hourly revenue information is extracted from the instantaneous data stream for eventual transmission to the PJM Market Settlement System.

Non-Real-Time Customer Connection

Provides only integrated revenue meter data. Instantaneous MW and MVAR data refresh may be initiated by the PJM SCADA system every 5 to 15 minutes.

PJM SCADA Data Precision Requirements

Real Time Instantaneous Data Sent To PJM	
Frequency	1/1000th of HZ (i.e. 60.001Hz)
Voltage	1/10th of kV (i.e. 69.1 kV)
Real Power MW	1 MW integer (i.e. 52 MW) required, but PJM will accept greater precision if available
Reactive Power MVAR	1 MVAR integer (i.e.42MVAR) required, but PJM will accept greater precision if available
Regulation Capability MW	1 MW integer (i.e. 10 MW)
Real Time Instantaneous Data Sent From PJM	
Lambda cost signal	1/10th of $/MWh (i.e. 23.1 $/MWh)
Regulation Signal (AR)	1 MW integer, + or – (i.e. 10 MW)
Revenue Data Sent To PJM	
MWh Delivered and Received	1/1000th of MWh (i.e. 20.001 MWh)
MVARh Delivered and Received	1/1000th of MVARh (i.e. 15.002 MVARh)

Metering for Billing Purposes

- Locational Marginal Price calculations are based on the telemetry data

- Energy exchange quantities for financial settlements are based on the data from billing meters

- Billing metering data can be automatically retrieved from the meter, sent to PJM on any digital electronic carriers, uploaded to PJM servers or entered manually through the eMTR interface

Metering for Billing Purposes (2)
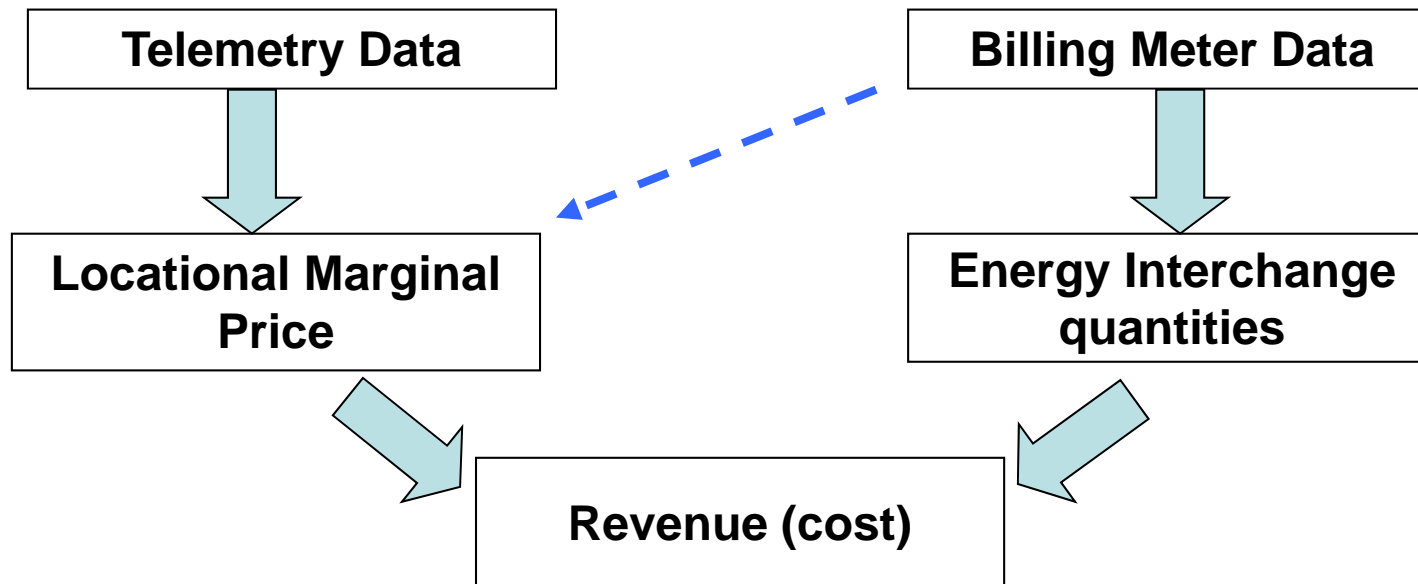
Telemetry data and billing meter data are equally responsible for commercial results of the market.

Accuracy requirements for primary transducers are the same.

Primary Telemetry Accuracy

- Recommended accuracy for primary transducers installed after 1997

Primary Transducer	Accuracy Guideline
Frequency Transducers	0.001 Hz
Potential Transformers	0.30% of Full Scale
Current Transformers	0.30% of Full Scale
MW/MVAR/Voltage Transducers	0.25% of Full Scale
Remote Terminal Units (A/D)	0.25%of Full Scale

- These accuracy guidelines result in an overall telemetery accuracy for instantaneous monitored values better than 2%.
- For other accuracy requirements – reference to the ANSI standards and Good Utility Practice

Billing Meter Accuracy

- The minimum metering accuracy for measuring devices used for billing purposes is defined by prevailing ANSI and NERC standards.

- The manufactured accuracy class of all energy interchange billing devices should be accurate within ±0.3% of full scale.

- An individual metering system at a metering point location includes all components from the meter location through to the system operator destination.

- The accuracy of the total energy interchange billing metering system, at each generator or transformer location, is to be within 1.0%.

eMTR Functions

eMTR is an internet-based system that retrieves revenue meter data for PJM transmission and generation interconnection points and calculates Electric Distribution Companies' and Generation Owners' metered interchange energy amounts used for real-time energy market settlements

Except collecting hourly revenue meter data, the eMTR allows for:

- Accommodating next-hour verification among counter-parties
- Providing downloadable reports of raw and calculated data
- Accepting data correction

eMTR collects hourly revenue meter data (for individual connections and generators) via:

- XML file upload;
- manual submission through the applications user interface
- and direct metering

eMTR Business Rules: Manual Entry

Only Generation Owners must have direct real-time metering to PJM. Other metering data could be submitted manually or uploaded via Internet:

- Generation and transmission revenue meter data must be consistent and real-time telemetry for use by PJM settlements
- One submitter per transmission connection or generator account (full access rights for the account). Other counter-parties have limited access (read only).
- Resubmission and corrections resulted from verification among counter-parties beginning from the end of hour
- PJM accounting deadline is noon next business day. All submitted data is considered final at this time.
- After the deadline only end-of-month corrections are allowed for entities that do not affect the LMP.

eMTR Business Rules: Monthly Correction

End-of-Month Meter Corrections may be submitted by entities for each:

- Internal PJM transmission connection meter account
- An independent generator located inside a distribution company

Monthly corrections are submitted/verified from noon 1st business day through noon 3rd business day of the following month

- The meter corrections, including 500 kV losses and inadvertent flows are charged at monthly load-weighted average LMP.
- Corrections may only be submitted manually through the User's Interface

eMTR System Benefits

- Universal application level communication protocol ICCP and standardized file format allow for implementation of wide range of meters and local AMR systems

- Provides timely access to submitted and calculated metered interchange data

- Streamlines customers' and PJM accounting processes

- Upgrades core PJM settlements function to a flexible, scalable, and integrated system that uses PJM's current software/database/audit standards

- Due to an open architecture, supports customers' initiatives for enhanced data transfer methods, and leverages advances in metering technology

SUMMARY

PJM Metering system:

- is one of the market tools integrated into an internet based information system;

- acquires data via a standardized ICCP protocol and provides corresponding network connection at the member company location;

- sets minimal accuracy requirements, leaving metrological control within the member's jurisdiction;

- is flexible, scalable, open for future upgrading, easy to be integrated in any SCADA, EMS, MMS and other modern systems.

THANK YOU

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