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ISO New England
Energy Markets Overview
Day Ahead and Real Time

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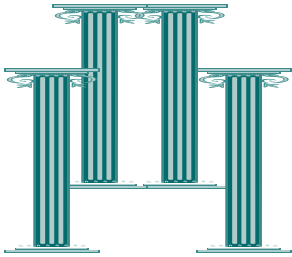
Ingredients of Reliable Power System

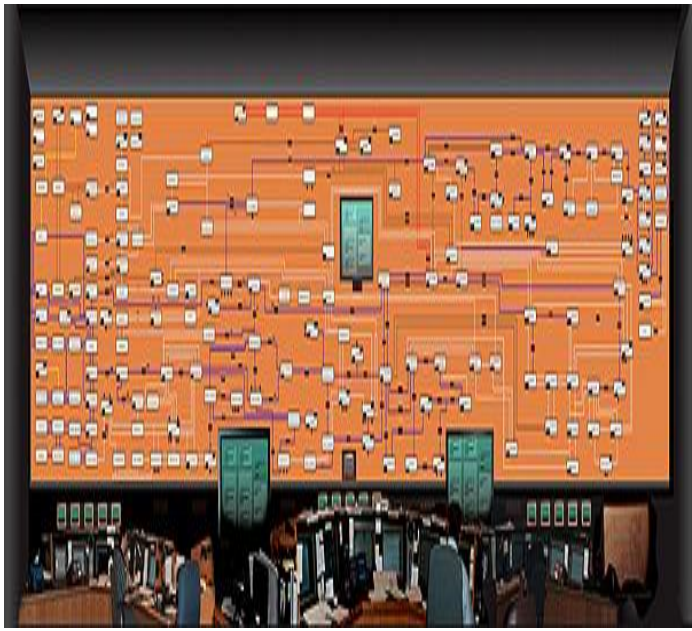


Reliable bulk power system is based on four pillars:

1. **Fair and Efficient Market Structure**: Sends price signals to promote appropriate investment in supply, transmission, and conservation; guided by fair and understandable rules; market monitoring ensures a level playing field
2. **Adequate Power Supply**: Power supplies in the right locations to meet demand and growth
3. **Reliable Transmission System**: Adequate and updated power delivery system
4. **Active Demand Participation:** Incentives for reduced use through Conservation and Demand Response

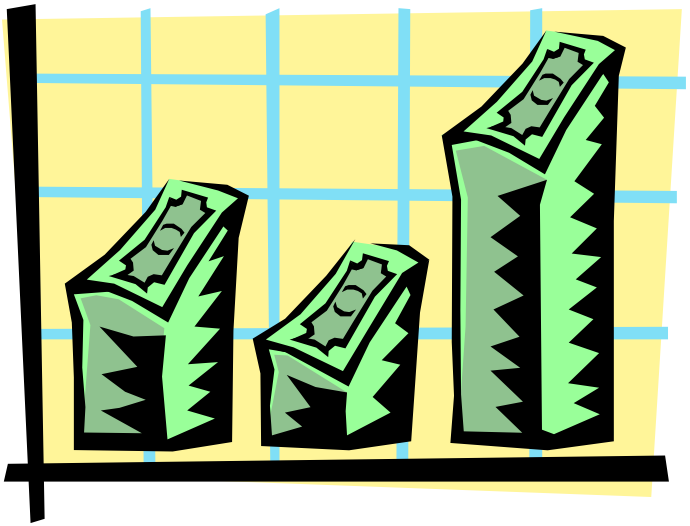
ISO New England's Role

- **24/365 Power System Operations**
  - Dispatch of bulk power system to continuously balance supply and demand; analyze power system to be able to react to power system events; provide hourly updated load forecast and available generation
- **Power System Planning**
  - Annual and on-going assessment detailing the needs of the power system today and in the future
  - Transmission plan to preserve reliability – approximately 250 projects, with a current cost estimate of between $1.5 billion and $3 billion



The Role of ISO New England (Continued)

- **24/365 Market Operations**
  - Dispatch the most economic mix of resources; administer ‘Day Ahead’ and ‘Real Time’ spot markets; continuous market monitoring and mitigation



- **Market Administration**
  - Financial settlement of a wholesale market valued at $7 billion annually

Wholesale Electricity Markets Administered by ISO

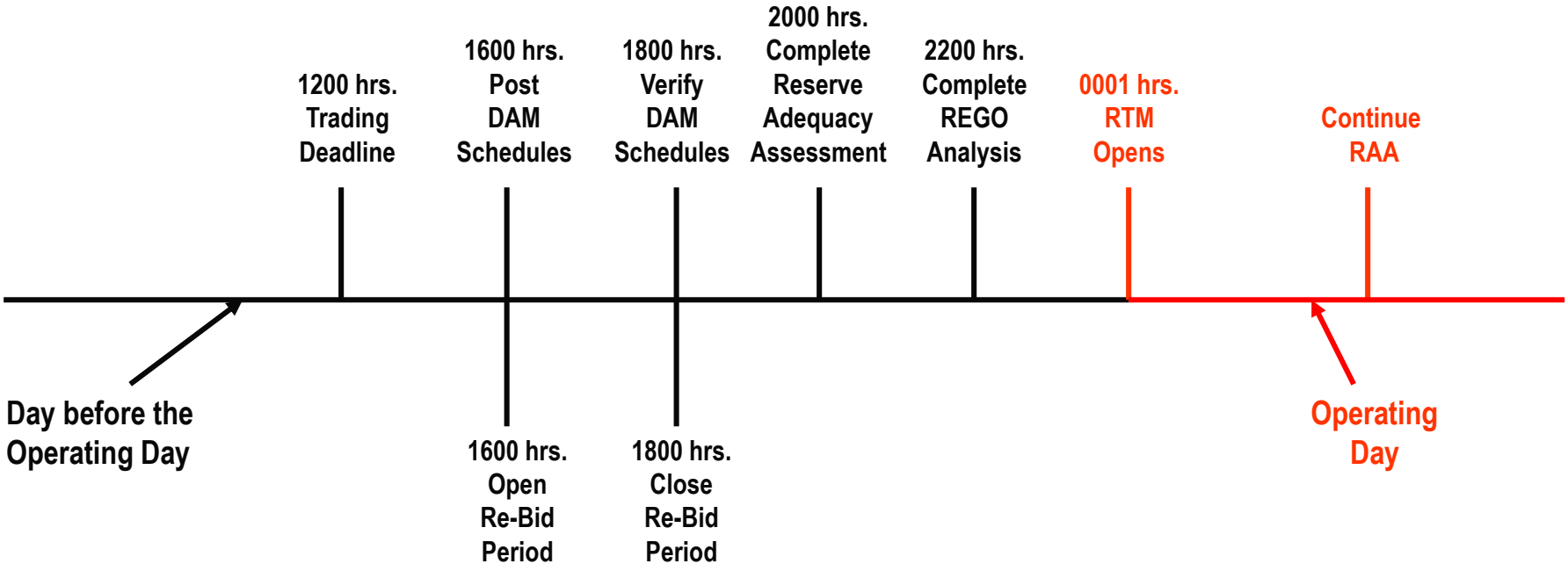
- Electricity Energy Market
  - Day Ahead, Real Time Markets
  - Locational Marginal Prices (LMPs) determined through least-cost dispatch
  - Approximately 1,000 prices every five minutes
- Ancillary Services
  - Reserve Market
    - Forward Reserve Market
  - Regulation Market
  - Installed Capacity Market (ICAP Market)
- Demand Response Programs
  - Real Time

Locational Marginal Pricing

- LMP designed to reveal the cost of producing or consuming power at each node
  - Load pays zonal average price
  - Eight separate load zones in New England
- Encourages investment in needed infrastructure by providing clear economic signals for:
  - Locating new generation and transmission where they are needed.
  - Participating in load management/conservation programs.

Day Ahead Energy Market Overview

SMD Timeline for Day-Ahead & Reserve Adequacy Assessment Processes



Why a Day-Ahead Market (DAM)?

- A “financial” market to hedge against Real-Time (RT) “physical” market price volatility
  - Allows Participants to secure Day-Ahead (DA) prices and reduce vulnerability to RT price fluctuations
  - Allows wholesale demand to participate in price determination

Fundamentals of the DAM

- DAM clearing based on Participant-submitted supply and demand
  - Clearing is based on least cost means of satisfying cleared demand using a security constrained economic dispatch.
- DAM produces financially binding schedules for demand and generation.
  - Based on hourly Locational Marginal Pricing (LMP)
  - LMP is Zonal for demand and Nodal for generation

Inputs to the DAM

- Network information
  - Network model
    - Transmission elements and ratings
  - Approved transmission outages
    - Expected topology
    - Abnormal limits
  - Generation Requirements for Transmission (GRT) spreadsheet
    - Interface limits
    - Generation requirements
  - Transmission Related Abnormal Generation (TRAGO) sheet
    - Units committed for VARS

Inputs to the DAM (cont.)

- Reserve requirements
  - Ten Minute Reserve
    - 100% of 1st Contingency
      - 50% is spinning
  - Operating Reserve
    - 50% of 2nd Contingency
  - Replacement Reserve
    - 25% of 2nd Contingency

Inputs to the DAM (cont.)

- Bids
  - Actual demand
    - Fixed
    - Price-sensitive
  - Virtual demand
    - Decrement bids (Decs)

Inputs to the DAM (cont.)

- Offers
  - Actual resources
    - Generation
      - ICAP resources
        - Must-run
        - Economic
        - Unavailable
      - ICAP - Limited Energy Resource (LEG)
      - Intermittent resources
      - Non-ICAP resources
  - Virtual resources
    - Increment offers (Incs)

Inputs to the DAM (cont.)

- Transactions
  - DA externals only
    - Three types
      - Fixed
      - Dispatchable
      - Up-to-congestion

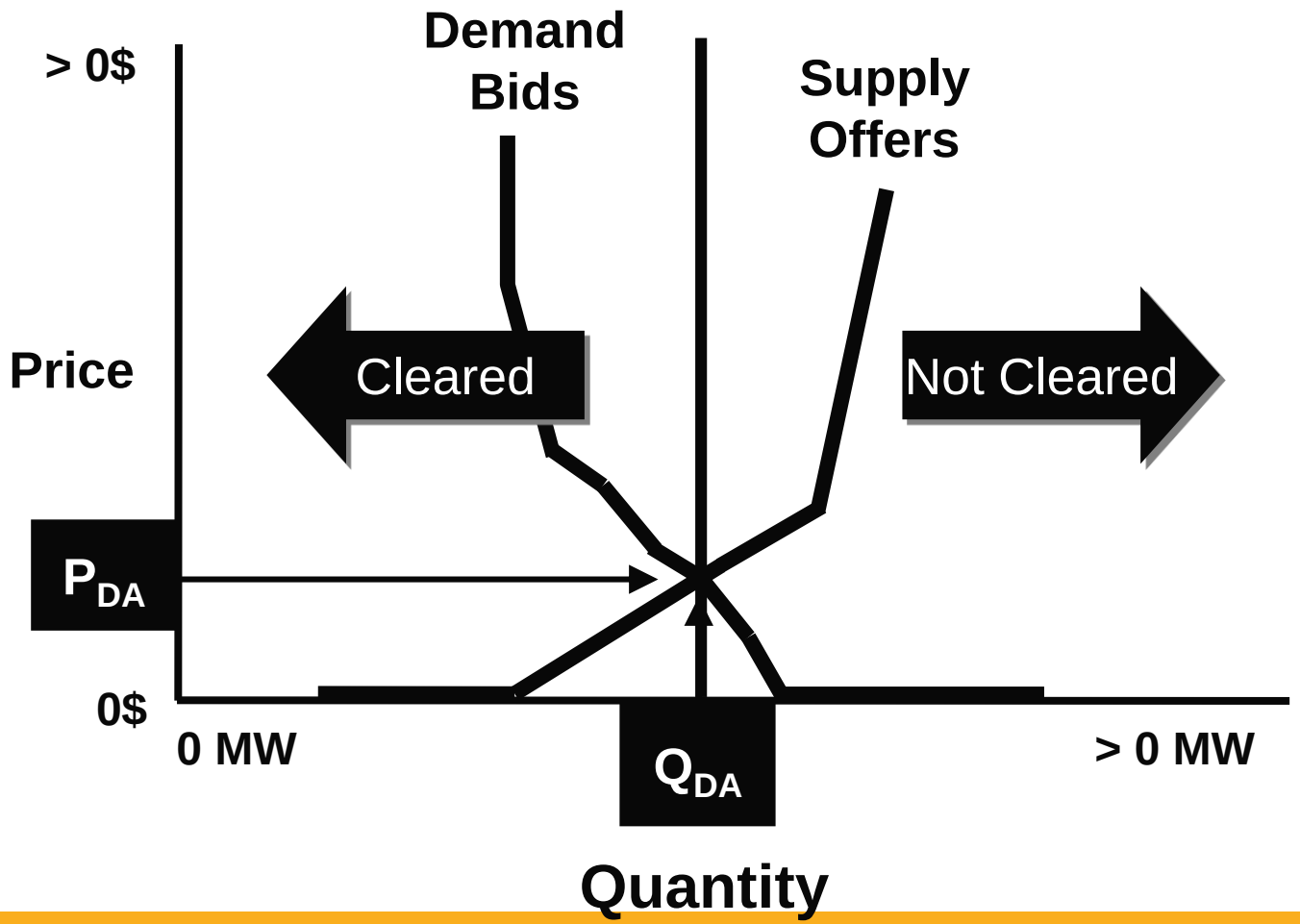
Clearing of the DAM

- Least Cost Security Constrained Economic Dispatch
  - New England Power Pool, Market Rule 1
    - Section 1.10.8, ISO Responsibilities
      - (a) The ISO shall use its best efforts to determine (i) the least-cost means of satisfying hourly purchase requests for energy, the projected hourly requirements for Operating Reserve, Replacement Reserve and other ancillary services of the Participants, including the reliability requirements of the NEPOOL Control Area, of the Day-Ahead Energy Market

Clearing of the DAM (cont.)

- Least Cost Security Constrained Economic Dispatch
  - NEPOOL Manual for Market Operations (Manual M-11)
    - Section 5.1, ISO Philosophy
      - The ISO scheduling philosophy in the Day-Ahead Energy Market is to schedule and Dispatch generation, Increment Offers and External Transaction purchases on a least cost, security-constrained basis (minimize Start-Up Fees, No-Load Fees and incremental Energy costs) to meet the aggregate cleared Demand Bids, cleared Decrement Bids, cleared External Transactions sales and Operating Reserve and Replacement Reserve requirements, while maintaining the reliability of the NEPOOL Control Area.

Clearing the DAM (cont.)



Clearing of the DAM (cont.)

- Software applications
  - Resource Scheduling & Commitment (RSC)
    - Security constrained unit commitment
  - Scheduling, Pricing and Dispatch (SPD)
    - Security constrained economic dispatch using the commitment profile produced by RSC
  - Simultaneous Feasibility Test (SFT)
    - Contingency analysis of SPD results
    - Constraint sensitivities fed back to SPD for reiteration

Outputs of the DAM

- Public
  - DAM LMP
  - DAM hourly net tie schedules
  - Binding constraints
  - DAM summary
    - Cleared demand
    - Operating reserves

Outputs of the DAM (cont.)

- Private
  - Supply schedules
    - Generation
    - Incs
  - Demand schedules
    - Load
    - Decs
  - External transaction schedules

Outputs of the DAM (cont.)

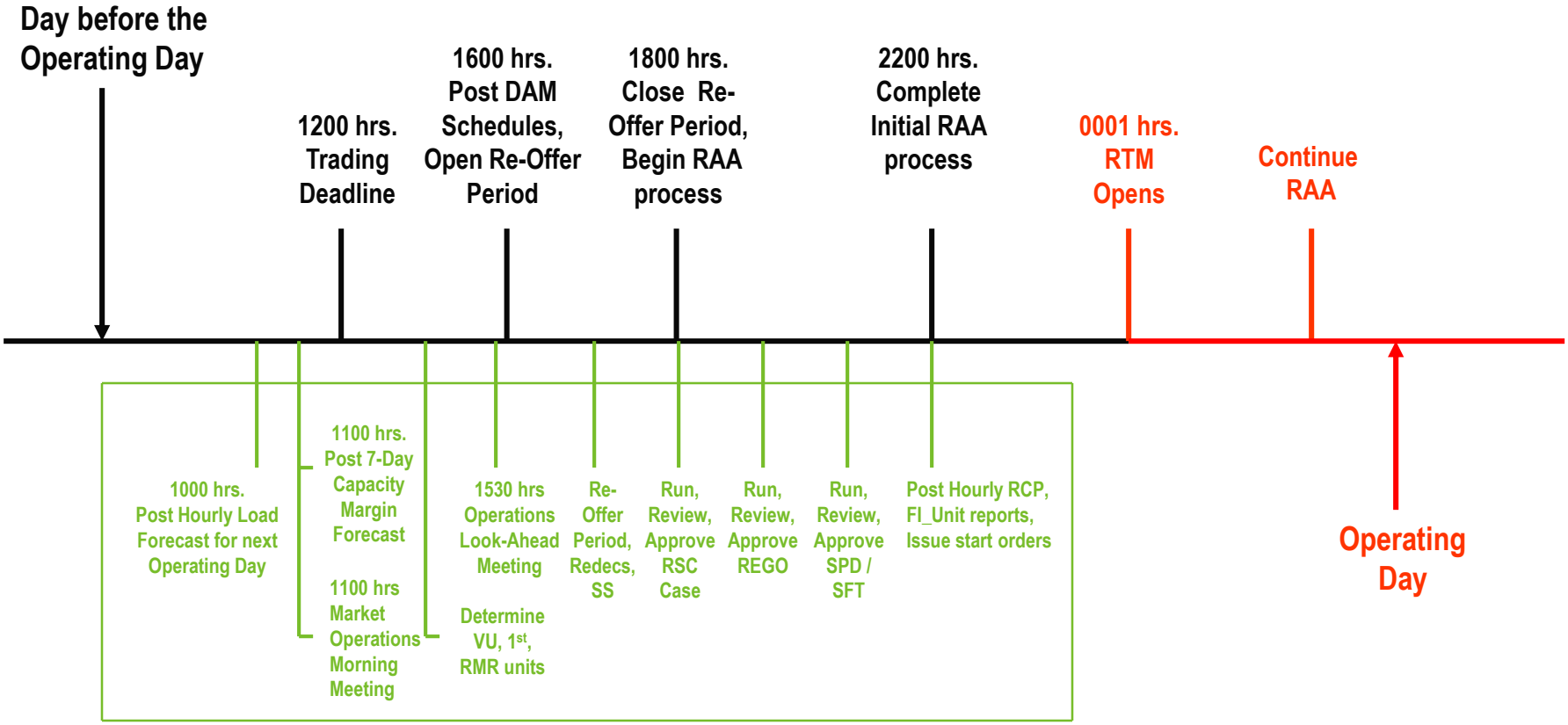
- DAM schedules are an initial input to the Resource Adequacy Assessment (RAA).

Overview of DAM Settlement

- Cleared Fixed and Price Sensitive demand pays at the price of the zone in which it cleared (the Zonal LMP)
- Cleared supply is paid at the price of its node (the Nodal LMP)
- Cleared Virtual demand pays at the location where bid (i.e., Hub, Zone, Node)
- Financial Transmission Rights (FTR) holders are charged or credited based on the difference between the DAM congestion component between source and sink nodes.

Real Time Market Overview

SMD Timeline for Day-Ahead (DA) and RAA Processes



RAA Objective

- To ensure there is sufficient capacity available to meet the ISO-NE Real-Time (RT) demand, reserve requirements, (including replacement reserves), and regulation requirements
  - If sufficient capacity is scheduled in the Day-Ahead Market (DAM), and all system, congestion, and local area requirements are satisfied, no additional capacity will be scheduled by ISO-NE.
  - If insufficient capacity is scheduled in the DAM, ISO-NE will commit internal generators to meet ISO-NE system, congestion, and/or local area requirements:
    - The objective is to minimize the cost of bringing the capacity to the Market (Minimize the start-up, no load, and energy cost to operate at EcoMin).

RAA Deliverables

- Forecast of ISO-NE hourly demand for current and next six days by 10:00
  - Periodic Updates
- 7-Day Forecast of ISO-NE Capacity Margin (11:00)
- Publish FI_Unit reports for non-Fast Start units with each RAA update. Notify long lead time units of start-up times.
  - Initial RAA published by 22:00 for next Operating Day
  - RAA updates of the current operating day are published periodically throughout the operating day.

Determine Reliability Requirements

- ISO-NE reliability commitments include
  - Voltage control during light load periods (VU flag)
  - Special Constraint Resource request by Satellite, Transmission Owner of Load Serving Entity (SCR flag)
  - 1st line contingency for local and import congestion area (no flag)
  - Reliability Must Run to meet 2nd line/generator contingency in an import congestion area (RMR flag)
  - Spinning Reserve Requirement (SPIN flag)
  - Regulation Requirement (REG flag)
  - ISO-NE System Operating Reserve Requirement (no flag)

Re-Offer Period

- Re-Offer Period (16:00 – 18:00)
  - Generators not scheduled in DA can waive start and no load prices and can change energy prices for consideration in RAA and real-time dispatch.
  - Intermittent Resources can SS for Real-time.
  - Generators can re-declare operating limits to reflect the station physical capabilities.
  - Generators can request self commitment or de-commitment and changes to Self-Schedules (SS)
    - Approved if request does not cause or worsen a reliability constraint
      - Capacity Deficiency, Minimum Generation Emergency, congestion area or local requirement

RAA Process Software

- Resource Scheduling and Commitment is the commitment engine of the MSS software
  - No access to transmission network model
  - Single system marginal price
- SPD is the dispatch engine of the MSS software
  - Transmission network model
  - ISO-NE Forecast Hourly Demand
  - Locational Marginal Pricing (LMP)
    - Produces hourly generator, external transaction, and pumped storage schedules.
    - FI_Unit Reports are produced from the final SPD case.

RAA Process Software (cont.)

- SFT is a power flow application that performs Contingency Analysis (CA).
  - Uses a pre-defined set of contingencies,
  - Determines post contingency power flows,
  - Returns a set of generator constraints to SPD for re-dispatch
- SPD / SFT iterations are performed for each hour

Questions