Who Are the Players?

- Load Bearing Entities (Utilities) - Duquesne Light
- Independent Power Producers - Calpine
- Marketers - Enron
- Brokers - TFS
- System Operators - CAISO
- Market Coordinators - PJM
And What Exactly Do They Trade?

- All Contracting is Effectively Financial

1. Bulk Power Market
   - Spot Market/Real-Time Market: Contracting generally one-hour ahead for one-hour blocks of energy
   - Day-Ahead/"Prescheduled" Market: Contracting generally one-day ahead for peak/off-peak blocks of energy; Firm and Non-firm contracting
   - Forward Markets: Contracting for month/quarter/year-long (or longer) blocks of energy

2. Transmission Rights

3. "Ancillary Services"
   - Spinning Reserves, RMR, etc.

Where Exactly Do They Trade?

- North American Grid Divided into 3 ½ Pieces
  - "Interconnects"

   1. Eastern Interconnect: NEPP, MAAC, SERC, ECAR, SPP, MAPP, MAIN, FRCC (sort of)
   2. Texas Interconnect: ERCOT
   3. Western Interconnect: WSCC

- Hubs Within Each Interconnect
Brief History of the North American Power Market

• 1940s, 1950s: Pacific Interiors Constructed
  - Seasonal Exchanges of “Economy Energy” Between Northwestern and Californian/Southwestern Utilities

• PURPA (1978), EPA (1992), FERC Order 888
  - PURPA Allows Nonutility Generation, EPA Opens Wholesale Markets to Nonutility Traders (e.g., Enron), FERC Order Guarantees Nondiscriminatory Access

• 1991: WSPP Recognized by FERC
  - Market-based Ratemaking “experiment”

• 1996: Futures Market Opens
  - NYMEX Offerings at COB and Palo Verde in WSCC in Anticipation of Western Market Restructuring

Why Have Markets At All?

• Successes in Oil and Gas Markets

• Three Objectives
  1. Keep Grid in Balance Through Real-Time Purchases and Sales
  2. Manage Congestion Throughout the Grid
  3. Provide Accurate Price Signals for System Planners

• Formerly the Job of Engineers
Prices As Signals

• Aid in System Planning
  
e.g., Give advance warning to generators as to whether operation or shut-down is most cost-effective

• So, What Should These Signals Look Like?
  1. Hydro-Based Systems (Pacific Northwest)
  2. Thermal-Based Systems (PJM)

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Hydro-Based Systems

• Hydro or Pumped Storage Generators can “Store” Electricity Through Reservoir Management
• Prices Reflect Expected Future Hydro Supply
• Price Structure Generally Stable and Reflective of Low Marginal Cost
• Price “Spikes” Normally Associated with Poor Water Supply
• Spikes Generally not Severe, but Sustained Over Long Periods
Mid-Columbia Electricity Prices and Columbia River Water Conditions

Thermal-Based Systems
- Storage Options Virtually Nonexistent
- Prices Reflect Cost and Availability of Fuel
- Price Structure More Volatile
- Price "Spikes" Normally Associated with Generation Outages or Fuel Supply Disruptions
- Spikes Generally Severe, but not Sustained
"Spark Spread" is calculated using the spot (day-ahead) PJM price and the spot Henry Hub gas price, with an assumed heat rate of 10,000 and $2.50 variable O&M.

Prices as a Congestion Management Tool

- Generally Used in Restructured Systems
  - Command-and-Control Mechanisms such as TLRs
    Common in Non-Restructured Settings
- In California, Mixed System of “Incremental” and “Decremental” Market Bids, Combined with Centralized Decision-Making
- In PJM, Non-economic Dispatch
- Information Problem
The Information Problem in Congestion Management

• Unlike in Most Commodity Markets, Transportation Costs in Electricity are not Fixed in the Short-Term
• Principal Causes of Congestion (Weather, Generation/Transmission Outages) are Unpredictable
• Also Unlike Most Commodity Markets, Transmission Charges for One Market Participant Depend on the Behavior of All Other Market Participants
• Variable Congestion Fees Imply High Transactions Costs for Bilateral Negotiations (Or an Infeasible Solution)
Prices as Balancing Mechanisms (Real-Time Energy)

- Ancillary Services
  - Spinning Reserves, RMR, Must-Take, Must-Run, etc.

- Real-Time Bidding
  - Meant to be Small Fraction of Overall Market (5 or 10% of Load)
  - High Costs of Gathering Information, High Transactions Costs
  - High Running Costs (Seem to Increase More Than Proportionally With Number of Participants)
  - Less Flexibility in Load than Generation

California ISO Scheduled Real-Time Load vs. Actual

Real-Time Load

Scheduled as % of Actual

70% - 115%
Remaining Issues

• FERC Order 2000 Mandating Development of RTOs
  - Intended to Ensure Open Access to Transmission Lines

• Development of Forward Markets
  - Nonstorability has Inhibited Growth
  - NYMEX Futures Contracts a Failure
  - All Restructured Markets To Date Centered Around Spot Markets
  - System Planning in a Market Environment Impossible Without Clear Price Signals
  - Tradeoffs Between Speed and Accuracy of Pricing Signals in Electricity Markets, Necessitates Separate Markets/Institutions for Forward and Balancing Energy

Commoditization in North American Power Markets

Seth Blumsack
Carnegie Mellon Electricity Industry Center
Carnegie Mellon University
5000 Forbes Ave.
Pittsburgh, PA 15213
(412) 268-5068
blumsack@cmu.edu