Standard Market Design

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Key Attributes for Market Characterization

- **Congestion Management**: Market-bids, TLR, hybrids
- **Transmission Rights**: physical vs. financial
- **Locational Model**: zonal, nodal, hub, dynamic, static….
- **Bilateral Transactions**: physical vs. financial trades
- **SO/ MO Interactions**: tightly integrated vs. loosely coordinated
- **Control Areas**: Single vs. multiple control area operators
- **Commodities**: energy, reserves, transmission rights…
- **Markets**: single settlement (realtime), multiple (DA, RT)
- **Resource entity**: portfolio vs. resource-specific model
- **Resource Commitment decisions**: self vs. pool commit
- …..
# Markets At-A-Glance

<table>
<thead>
<tr>
<th></th>
<th>PJM/ISO-NE</th>
<th>CA-ISO</th>
<th>ERCOT</th>
<th>SPP</th>
<th>MISO (Day 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Congestion Management</strong></td>
<td>LMP</td>
<td>Inter/Intra-zonal</td>
<td>CSC/Local TLR/LMP</td>
<td>TLR/MRD</td>
<td></td>
</tr>
<tr>
<td><strong>Transmission Rights</strong></td>
<td>Financial</td>
<td>Physical</td>
<td>Financial</td>
<td>Phy-&gt;Fin</td>
<td>Physical</td>
</tr>
<tr>
<td><strong>Markets</strong></td>
<td>DA, RT, FTR</td>
<td>DA/HA/RT PTR</td>
<td>DA, RT TCR</td>
<td>DA, RT</td>
<td>RT(MRD)</td>
</tr>
<tr>
<td><strong>Bilateral Transaction (Internal)</strong></td>
<td>Financial</td>
<td>N/A</td>
<td>Physical</td>
<td>Phy -&gt; Fin</td>
<td>Physical</td>
</tr>
<tr>
<td><strong>Location Model</strong></td>
<td>Node, zone, hub</td>
<td>Zone (no loop)</td>
<td>Zonal (meshed)</td>
<td>Node, zone, hub</td>
<td>Zone (CA)</td>
</tr>
<tr>
<td><strong>Resource Model</strong></td>
<td>Physical</td>
<td>Portfolio&amp; Physical</td>
<td>Portfolio</td>
<td>Physical</td>
<td>Physical</td>
</tr>
<tr>
<td><strong>Commitment Decision</strong></td>
<td>Choice of self /pool</td>
<td>Self</td>
<td>Self</td>
<td>Self</td>
<td>Self</td>
</tr>
</tbody>
</table>
Global Market Evolution

- **Integrated Utility Oper (ED, SA..)**
- **Pool Oper**
  - Price/cost bids
  - MCP
- **Spot/Fwd Mkt**
  - Self-schedule
  - LMP
- **Multi-Settle.**
  - FTR (PtP)
  - LMP
- **SMD**
  - Spot/Fwd
  - FTR(PtP/FG)
  - AncService
  - BilatSched
  - CAO’s Seams

**OASIS, ITS**
- TTC/ATC
- Physical Sched
- Tagging/ESched
- Flowgates

**OASIS 1x**
- Tagging/ESched
- Flowgates

**Bal Energy**
- Mkt Redisp

**CAO’s**

**Seams**

**LMP**: Locational Marginal Pricing

**FTR**: Financial Transmission Right
SMD Fundamentals

- **Primary Objectives**
  - Provide Market Participants with Effective Incentives & Business Choices
  - Enable Market Operators to operate the market with high degree of transparency and system reliability

- **Salient Characteristics**
  - Market-based Congestion Management
  - Financial Transmission Rights
  - Financial Energy Schedules
  - Real-time and Day-Ahead Market
  - Regional Adaptation of Best Practices
Congestion Management w/ LMP

- Economic incentives consistent with grid re-dispatch requirements
  - Marginal pricing leads to long term economic efficiency (compared with pay-as-bid pricing)
  - Location-specific pricing leads to precise economic signals for scheduling resources in specific locations.
  - MWh injection (withdraw) are paid (charged) LMP at its location.
  - Flexible location model supports requirements for commercial trading and physical operation.
    - Static model for trading hubs
    - Dynamic model for load zones and individual nodes
Financial Transmission Right

- Provides financial hedge for congestion charge
  - Charges are differences in $LMP_{m,n} \times MWFlow$
  - Hedge w/ credit for FTR-Holder ($LMP_{m,n} \times MWFTR$)

- Transmission Customer does not need FTR to schedule transaction

- FTR-Holder does not need to schedule physical transaction to receive congestion credit

- RTO maintains revenue adequacy by applying Simultaneous Feasibility Tests (SFT)

- FTR Auction: dynamic re-configuration, revenue adequacy, forward (obligations) vs. options
Financial Bilateral (Energy) Schedules

- Provides financial hedge for spot market volatility
- Party 1 sells 100MWh to Party 2 for $10/Mwh at location L1. (source L2, sink L3)
- Bilateral agreement reached outside of RTO, and may be registered with RTO (participant option)
- If registered, RTO will adjust LMP-based Settlement MWh by the contracted MWh
- Financial bilateral schedule does not imply physical MWh schedule (no tagging, reservation..)
- Physical scheduling requires bidding to the spot market (e.g. self schedule, price curves)
Multi-Settlement (DA & RT)

- Day-Ahead Market is purely financial and produces financially binding results
- Mwh deviation in realtime physical delivery from the DA schedule is settled at RT prices
- Participation in DA and RT market is voluntary (except for Capacity Resources)
- Market Clearing is based on:
  - Bids (generator, demand, virtual, external transactions)
  - Demand bids (DA), Demand forecast (RT)
  - System Security & Reliability constraints
Migration Case Study: PJM

Market Migration Cycles:
- Planning horizon: 12-18 months in the future
- New phases of market: release every 9-12 months
- Project implementation: 6 - 9 months
- Number of phases in different stages: 2-3 at a time

Criteria for Success:
- Shared vision
- Prioritization
- Earned mutual respect