Law of Supply and Demand: Dimensions of Short Term Market

S S Barpanda
Director (Market Operation), POSOCO, India
### Dimensions

- **390 GW+** generation capacity
- **200 GW+** peak demand
- **> 4 TWh** daily energy met
- **425,000 ckm+** EHV transmission
- **100 GW+** renewables
- **~ 100 GW** inter-regional capacity
- **3.2 million km²** area footprint
- **1.3 Billion+** people served
- **4 GW+** international exchanges
- **120 TWh+** annual market trades
- **50,000+** market transactions
- **6000+** market participants
- **2** power exchanges
- **10 + HVDCs**

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Dimensions

Short Term Market

17 November 2021

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Power Supply Position (Peak)...over the years
Power Supply Position (Energy)...over the years
Inter regional energy exchanges...over the years
Indian Power System Pattern and Behaviour

Load shape changes necessitating resource flexibility

- Minimal shortages leading to natural load shape
- Agricultural load shifting to solar hours
- Space cooling impact
- Induction cooking...Future?
Flexibility Need and Provision

Increasing demand side uncertainty
> 20 GW/hour variation

Increasing trend of thermal generation ramp to facilitate uncertainty in demand and accommodate intermittent renewables.
Daily Operations

**All India Load Curve of a Typical day**

- **Summer**
  - All India Load Profile - Typical Summer Day
  - Year 2021
  - Year 2015
  - Year 2010

- **Monsoon**
  - All India Load Profile - Typical Monsoon Day
  - Year 2021
  - Year 2015
  - Year 2010

- **Winter**
  - All India Load Profile - Typical Winter Day
  - Year 2021
  - Year 2015
  - Year 2010

**Diurnal Variation**

**Seasonal Variation**
Need for Reserves

Buy Bids >> Sell Bids

Need for SCUC mandate
System Balancing Continuum

- **Inertial**
- **Primary**
- **Secondary**
- **Fast Tertiary**
- **Slow Tertiary**

<table>
<thead>
<tr>
<th>Response Attribute</th>
<th>Inertial</th>
<th>Primary</th>
<th>Secondary</th>
<th>Fast Tertiary</th>
<th>Slow Tertiary</th>
<th>Generation Rescheduling/Market</th>
<th>Unit Commitment</th>
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<tbody>
<tr>
<td>Time</td>
<td>First few secs</td>
<td>Few sec - 5 min</td>
<td>30 s - 15 min</td>
<td>5 – 30 min</td>
<td>&gt; 15 – 60 min</td>
<td>&gt; 60 min</td>
<td>Hours/day-ahead</td>
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<tr>
<td>Quantum</td>
<td>~ 10000 MW/Hz</td>
<td>~ 4000 MW</td>
<td>~ 4000 MW</td>
<td>~1000 MW</td>
<td>~8000-9000 MW</td>
<td>Load Generation Balance</td>
<td>Load Generation Balance</td>
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<td>NLDC/RLDC</td>
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<td>Code / Order</td>
<td>IEGC / CEA Standard (?)</td>
<td>IEGC / CEA Standard</td>
<td>Roadmap on Reserves</td>
<td>CERC Order on ERAS Pilot</td>
<td>RRAS Regulations</td>
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<td>Implementation</td>
<td>Existing ; Testing under progress</td>
<td>Pilot 5 plants; Pan India by end of FY20</td>
<td>Pilot 19 plants (Nov’18 – May’19)</td>
<td>Existing (62 GW)</td>
<td>Existing; Real time market w.e.f. June’20 with hourly gate closure</td>
<td>Existing</td>
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</table>

Need for strengthening from both ends of continuum for introduction of markets!
Transmission Access Administration

- **Long Term (> 7 years)**
- **Medium Term (> 3 m - 5 y)**
- **Bilateral Advance STOA**
- **Bilateral FCFS STOA**
- **Day Ahead**
- **Contingency STOA**
- **Real Time Market**

**One hour ahead - 3 months**

**STOA – Short Term Open Access**

### Nodal Agency (Inter-state Transactions)
- Central Transmission Utility (CTU)
- Regional Load Despatch Centre(s) (OTC Market)
- National Load Despatch Centre (Spot/Real Time Market)

### Nodal Agency (Intra-state Transactions)
- State Transmission Utility (STU) for intra-state
- State Load Despatch Centre(s) (OTC Market)

**Spatial Division**
- Among states or regional entities CERC Regulations
- Within state boundaries SERCs Regulations

**Tariff Based Competitive Bidding**

**DEEP Portal E-Bidding**
Thank you!!

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