Financial Viability and Demand Management for Discoms

Ganesh Srinivasan
CEO
Tata Power Delhi Distribution Limited
Tata Power Delhi Distribution

A Joint Venture of The Tata Power Company Limited (51%) and the Government of Delhi (49%) Formed on 1st July 2002

Consumer Base
1.9 Million
(0.7 million)

Area
510 Sq. Km.

Peak Load
2228 MW
(930 MW)

Units
9905 MUs
(3928 MU)

(Figures in bracket are for 2002)
Market landscape | Distribution & Retail Supply

**Recent priorities**
- Bridging the supply gap
- One Grid One Nation
- Universal Access
- Strengthening Distribution Systems
- RE penetration

**Key milestones**
- **100%** household electricity access
- **Rise in Hours of Supply** to 22.5 hours
- **3rd largest electricity consumer** globally - 1,326 BU Energy Requirement | **0.6%** Deficit
- **320 Mn+** Consumer Base | Per capita consumption of **1,255 kWh** vs. **3,260 kWh** World avg.
- Peak Demand of **215 GW**
- **408 GW Installed Capacity (40% RES)** | **Fastest-growing** RE (4th globally*) – doubled to ~**165 GW** in 6-7 years

**Sales Mix (FY21):** 1,005 BU

- 11%
- 32%
- 25%
- 8%
- 24%

**Revenue Mix (FY21):** INR 632k Cr

- 9%
- 25%
- 31%
- 12%
- 23%

*In terms of installed capacity
Financial Viability of Discoms: Focus of GoI and MoP over last 2 decades

Exhibit 3: Total discom losses (after tax, with tariff subsidy received) over time
(Source: PFC, see A)

APDRP
R-APDRP
PMDP

GUIDELINES
REVAMPED DISTRIBUTION SECTOR SCHEME
REFORMS-BASED AND RESULTS-LINKED

UDAY
UJWAL DISCOM ASSURANCE YOJANA
Contents

- Key Parameters for Financial Viability of Discoms
- AT&C loss reduction Trends
- Demand & Power Management
- Technological Interventions –
  - Smart Metering
  - Battery Energy Storage
  - Demand Response
  - Peer to Peer Trading
- Expectations of Discoms from the Regulator
Integrated Report
# Integrated Rating Methodology for DISCOMs

**Summary of the 10th Integrated Rating Methodology for State & Private discoms**

15 Base Metrics and 9 Specific Disincentives

<table>
<thead>
<tr>
<th>Integrated Rating</th>
<th>10th Integrated Rating Methodology for State &amp; Private discoms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial Sustainability</strong></td>
<td><strong>Performance Excellence</strong></td>
</tr>
<tr>
<td>Overall Profitability and Cash Position</td>
<td>75%</td>
</tr>
<tr>
<td>ACS - ARR Gap (cash adjusted)</td>
<td>35</td>
</tr>
<tr>
<td>Days Receivable</td>
<td>3</td>
</tr>
<tr>
<td>GenCo, TransCo &amp; Operational Obligations</td>
<td></td>
</tr>
<tr>
<td>Days Payable to GenCos &amp; TransCos Adjusted Quick Ratio</td>
<td>10</td>
</tr>
<tr>
<td>Lender Obligations</td>
<td></td>
</tr>
<tr>
<td>Debt Service Coverage Ratio (cash adjusted)</td>
<td>10</td>
</tr>
<tr>
<td>Leverage (Debt/EBITDA) (cash adjusted)</td>
<td>7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specific Disincentives1,2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditor’s Adverse Opinion</td>
<td>-15</td>
</tr>
<tr>
<td>Audit Qualifications</td>
<td>-4</td>
</tr>
<tr>
<td>Tariff Independent of Subsidy</td>
<td>-1</td>
</tr>
<tr>
<td>Availability of Audited Accounts</td>
<td>-15</td>
</tr>
<tr>
<td>Governance (Audit Committee, Exclusive MD &amp; DF, Quarterly Accounts)</td>
<td>-3</td>
</tr>
<tr>
<td>Uncovered Revenue Gap (Current Year)</td>
<td>-4</td>
</tr>
<tr>
<td>Default to Banks/PIs</td>
<td>-15</td>
</tr>
<tr>
<td>Tariff Cycle Delays</td>
<td>-4.5</td>
</tr>
<tr>
<td>Regulatory Assets2</td>
<td>-5</td>
</tr>
</tbody>
</table>

1. The cumulative impact on the integrated score from all Specific Disincentives will be capped at -10 points, except in the case of Red card metrics.
2. Red card metrics carry a heavy disincentive score which is not capped under the limit for Specific Disincentives and results in ineligibility for A, A- grades.
3. Increase in regulatory assets balance will result in ineligibility for A, A- and B grades.
Integrated Rating Performance of DISCOMs

Split of state and private discoms by grade:

- A+: 12
- A: 4
- B: 3
- B-: 6
- C: 12
- C-: 20
- D: 3

No. of Discoms

Split of discoms by performance trajectory:

15: Improving
16: Stable
21: Declining

ACS-ARR gap (cash adjusted) trajectory
## Financial Sustainability Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACS – ARR Gap (INR/kWh)</td>
</tr>
<tr>
<td>Days Receivable</td>
</tr>
<tr>
<td>Days Payable to Gencos &amp; Transcos</td>
</tr>
<tr>
<td>Adjusted Quick Ratio</td>
</tr>
<tr>
<td>Debt Service Coverage Ratio</td>
</tr>
<tr>
<td>Leverage(Debt/EBITDA)</td>
</tr>
</tbody>
</table>
Overall Profitability (ACS-ARR Gap)

• **ACS - ARR gap (cash adjusted)** = Average Cost of Supply (ACS) – Average Revenue Realized (ARR)

• **Average Cost of Supply (ACS)** = Total pre-tax expenditure / Gross Input Energy / Gross Input Energy

• **Average Revenue Realized (ARR)** = Revenue from operations + other income + tariff/revenue subsidy received + other revenue/subsidy received (excluding capital grants under UDAY or other schemes) + gross opening receivables (current + non-current) - gross closing receivables (current + non-current) / Gross Input Energy
## ACS-ARR Gap Components

### Breakdown of ACS-ARR gap components (INR ‘000 crores)

<table>
<thead>
<tr>
<th>ACS - ARR Components</th>
<th>Amount (FY 21) (INR ‘000 Crores)</th>
<th>Amount (INR/kWh)</th>
<th>CAGR for FY 19 to FY 21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash adjusted revenue</td>
<td>644</td>
<td>5.26</td>
<td>1%</td>
</tr>
<tr>
<td>Power purchase costs</td>
<td>573</td>
<td>4.68</td>
<td>0.5%</td>
</tr>
<tr>
<td>O&amp;M costs</td>
<td>88</td>
<td>0.72</td>
<td>6%</td>
</tr>
<tr>
<td>Interest costs</td>
<td>56</td>
<td>0.46</td>
<td>7%</td>
</tr>
<tr>
<td>Other expenses</td>
<td>40</td>
<td>0.32</td>
<td>2%</td>
</tr>
<tr>
<td><strong>Gap / Surplus</strong></td>
<td><strong>-113</strong></td>
<td><strong>0.93 (0.69)^1</strong></td>
<td><strong>5.5%</strong></td>
</tr>
</tbody>
</table>

^1 Accrual basis ACS-ARR gap (excluding subsidy billed but not received, grants for loan takeover under UDAY, regulatory income)
National Cash adjusted (ACS-ARR) gap

**Absolute cash adjusted gap (INR '000 Cr)**
- FY 19: 102
- FY 20: 98
- FY 21: 113

**Gross input energy in sector ('000 Crore units)**
- FY 19: 123
- FY 20: 123
- FY 21: 122

**Per unit cash adjusted gap (INR per kWh)**
- FY 19: 0.83
- FY 20: 0.8
- FY 21: 0.93

Distribution utilities are making a loss of **93 paisa per unit** (average) of input energy.
Trade Receivables Days (Ex. Subsidy)

Net trade receivables (current + non-current incl. electricity duty/cess) * 365 / (Revenue from operations incl. electricity duty/cess)
Days Payable to Gencos & Transcos

(Liability for purchase of power (current + non-current) + Liability for purchase of fuel (coal, oil, gas etc.) + Liability to railways for coal receipts) * 365 / (Generation costs + Cost of power purchased + Transmission and SLDC charges)
Adjusted Quick Ratio

(Total current assets - Inventories - Net current tax assets - Assets classified as held for sale - Regulatory assets (current) - Pre-paid expenses and advances - Receivables > 3 months) / Total current liabilities

Breakdown of Adjusted Quick Ratio components
INR '000 crores

FY 2021 value

<table>
<thead>
<tr>
<th>Current assets</th>
<th>Current Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>352</td>
<td>124</td>
</tr>
<tr>
<td>175</td>
<td>34</td>
</tr>
<tr>
<td>272</td>
<td>227</td>
</tr>
<tr>
<td>Non-liquid assets</td>
<td>656</td>
</tr>
<tr>
<td>Liquid Assets</td>
<td>Total Current Liabilities</td>
</tr>
<tr>
<td>17%</td>
<td>Gap (wrt Liquid Current Assets)</td>
</tr>
</tbody>
</table>

National Average Adjusted Quick Ratio = 0.54
Debt Service Coverage Ratio

- Cash Adjusted EBITDA / (Interest & Finance Charges charged to operations + current maturities of long-term loans + interest accrued & due (state, bonds, banks/other FIs))
- Cash Adjusted EBITDA = Cash adjusted Revenue (As used in ARR) - Generation Costs - Purchase of Power - Transmission & SLDC Charges - Employee Cost - Repairs & Maintenance - Admin & General Costs
External Factors impacting Financial Sustenance

Pending Subsidies

- In FY21, subsidy receivables amounted to INR 79,577 crore, a jump of 85% from FY19
- 6 states account for INR 67,578 crore or 85% of total subsidy receivables in the sector

Regulatory Asset

- Sector’s regulatory assets also increased to reach INR 90,832 crore in FY21
- 4 states - Rajasthan, West Bengal, Maharashtra and Delhi account for INR 88,118 crore or 97% of the total regulatory assets

Slow Revision of Tariffs

- In FY22, 10 states did not issue tariff orders
- Of these 10 states, 7 did not issue tariff orders in FY21 either
- Partly because of slow revision of tariffs, existing tariffs became non-reflective of costs

Source: MoP, Integrated Report for FY 2021
AT&C loss reduction
Distribution Utilities | Overview

Payables | Receivables
161 days | 151 days

ACS-ARR Gap
0.22 INR / kWh

AT&C Loss
85.17% | 97.7% | 16.87%

Billing Efficiency | Collection Efficiency | AT&C Loss

Peak Demand
0% | 1%

Source: Draft Integrated Ratings Report, PwC (FY22)
AT&C Loss | DISCOM-wise (FY21-22)

Source: Draft Integrated Ratings Report, PwC (FY22)
Tata Power Learnings on AT&C Reduction
**Delhi - Tata Power-Delhi Distribution Ltd**

**Year 2002: Challenges before Delhi Operations**

**Workforce**
5638 employees with little skill sets,
Lack of accountability, initiative & service attitude

**Processes**
Absence of well defined business processes in HR, Finance, Governance

**Technology**
Absence of IT / OT Infrastructure

**Customers**
Customer Dissatisfaction, Poor Fault Management, Wrong Billing, inadequate payment Channels

**Billing**
Backlog of 1 Lac Billing Complaints and 20K New Connections

**System**
AT&C at 53%, Dilapidated Distribution Network, Frequent outages, Overloaded DTs & Cable bursts

**Admin**
No administrative infrastructure and dilapidated / un-sanitary buildings/offices

**Dilapidated Network**

**Rampant Theft**

**Long Queues**

**No IT**
AT&C Loss Trend for Tata Power-DDL

Tata Power- DDL AT&C loss trend

FY02 FY03 FY04 FY05 FY06 FY07 FY08 FY09 FY10 FY11 FY12 FY13 FY14 FY15 FY16 FY17 FY18 FY19 FY20 FY21 FY22

- Tata Power DDL AT&C loss trend
## Key steps that helped reduce AT&C loss

<table>
<thead>
<tr>
<th>Mass Meter Replacement</th>
<th>Energy Audit – DT and Feeder</th>
<th>Enforcement Raids, Collection of Dues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerial Bunched Conductors (ABC) and LVDS to HVDS</td>
<td>Resealing and Relocation of Bus Bar, Tyco Boxes</td>
<td>Replacement of Service Line with joints</td>
</tr>
</tbody>
</table>
PPP Model

- Investment
- Efficiency
- Technology
- Capacity Building
- Social Engineering
- Consumer Services

Formation of Joint Venture Entity

- Private Entity
  - Equity – 51%
  - Management Control

- State Govt
  - Equity – 49%
  - Govt. oversight through Representation

Strong impact on:
- Operational Efficiency
- Financial Self Sustainability
- Capital Investment
- Better Citizen Living Standard
- Future Readiness on technology
- Workforce Development

Delhi and Odisha are the proven example of above model
Tata Power Ajmer

AT&C Loss(%)

<table>
<thead>
<tr>
<th></th>
<th>Jul-17</th>
<th>FY18</th>
<th>FY19</th>
<th>FY20</th>
<th>FY21</th>
<th>FY22</th>
<th>FY23 YTD</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY18</td>
<td>21.92</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY19</td>
<td>17.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY20</td>
<td>11.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY21</td>
<td>10.91</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY22</td>
<td>10.17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY23 YTD</td>
<td>9.51</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>8.36</td>
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</table>

Billing Efficiency(%)

<table>
<thead>
<tr>
<th></th>
<th>FY18</th>
<th>FY19</th>
<th>FY20</th>
<th>FY21</th>
<th>FY22</th>
<th>FY23 YTD</th>
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</thead>
<tbody>
<tr>
<td>FY18</td>
<td>85.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY19</td>
<td>87.81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY20</td>
<td>88.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY21</td>
<td>88.87</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>FY22</td>
<td>89.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY23 YTD</td>
<td>90.57</td>
<td></td>
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</tbody>
</table>

Collection Efficiency(%)

<table>
<thead>
<tr>
<th></th>
<th>FY18</th>
<th>FY19</th>
<th>FY20</th>
<th>FY21</th>
<th>FY22</th>
<th>FY23 YTD</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY18</td>
<td>96.8</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>FY19</td>
<td>100.34</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY20</td>
<td>100.12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY21</td>
<td>101.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY22</td>
<td>100.62</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY23 YTD</td>
<td>101.18</td>
<td></td>
<td></td>
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</tbody>
</table>
### Ajmer – Tata Power Ajmer Distribution Ltd

<table>
<thead>
<tr>
<th></th>
<th>FY 17-18</th>
<th>FY 21-22</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT&amp;C Losses</td>
<td>22.6%</td>
<td>8.86%</td>
</tr>
<tr>
<td>Billing Efficiency</td>
<td>85%</td>
<td>90.3%</td>
</tr>
<tr>
<td>Collection Efficiency</td>
<td>96%</td>
<td>100.92%</td>
</tr>
<tr>
<td>SAIDI</td>
<td>62 hrs</td>
<td>19.71 hrs</td>
</tr>
<tr>
<td>SAIFI</td>
<td>118 nos.</td>
<td>70.9 nos.</td>
</tr>
</tbody>
</table>

#### Achievements

- **SCADA Operation**
  - Reduce Restoration Time
  - Reduce Cost
  - Eliminate human intervention

- **SMRD**
  - Smart Meter Reading Application
  - Real time Reading uploading in SAP
  - 100 % Capturing of meter reading photo

- **AMR & EAG**
  - AMRDA of Consumer Meters

- **SAP**
  - Integration Software of Billing, material management & financial
  - International Standard Software

- **TPADL Mobile App**
  - Integrated Mobile Application for Consumer Services

- **GIS & MARG APP**
  - Geographical Information System, Geographical Mapping of all consumer and electrical assets
  - Mobile App for GIS on the go & navigation
27 lakh customers spread across 29,354 sq.km

<table>
<thead>
<tr>
<th>Category</th>
<th>Consumers as on 31.03.2020 in Nos</th>
<th>Consumers as on 31.03.2022 in Nos</th>
</tr>
</thead>
<tbody>
<tr>
<td>EHT</td>
<td>29</td>
<td>34</td>
</tr>
<tr>
<td>HT</td>
<td>2,364</td>
<td>2,115</td>
</tr>
<tr>
<td>NSBM</td>
<td>26,90,553</td>
<td>29,25,338</td>
</tr>
<tr>
<td>Grand Total</td>
<td>26,92,946</td>
<td>29,27,487</td>
</tr>
</tbody>
</table>

As on 31.03.2020

- 33/11 kV PSS: 279
- STS Capacity: 3799 MVA
- DT Capacity: 4475 MVA
- 33KV Line: 3713 KM
- 11KV Line: 35719 KM
- LT Line: 53940 KM
- PTR/DTR Nos.: 650 / 71240

As on 31.03.2022

- 33/11 kV PSS: 348
- STS Capacity: 4599 MVA
- DT Capacity: 5300 MVA
- 33KV Line: 4000 KM
- 11KV Line: 37903 KM
- LT Line: 56441 km
- PTR/DTR Nos.: 798 / 74926

9 revenue districts of Odisha

5 distribution Circles: Bhubaneswar-I, Bhubaneswar-II, Cuttack, Dhenkanal & Paradeep.

20 Division & 65 Sub-divisions

247 sections
Approach To Improve Billing & Collection Efficiency

Implementation of Performance Based Contract

- TPCODL adopted performance based contract to boost performance of Meter readers and bill collectors

SAP-ISU as MBC Engine

- Implementation of SAP-ISU for metering, billing & collection across TPCODL.
- Real Time monitoring of Reading & Collection reports & MIS

Mobile Collection App integrated with SAP-ISU

- Online mobile Collection App in place of manual MR
- Spot billing app
- Integration of billing & collection app with SAP
- Monitoring of Individual performance of each bill collectors and meter readers through IT enabled applications

Installation of Prepaid Smart meters

- 4373 Smart meters have been installed till Sep’2022 (MTD)

Quality Check Parameters at the time of Bill generation
**Approach To Improve Billing & Collection Efficiency**

- **Self Meter Reading App for customers**
- **OCR based meter reading**
- **Replacement of defective/mechanical meters**

- **Increasing Payment Avenues**
- **Self-Meter Reading App**
- **OCR based meter Reading** for cracking the suppressed reading cases introduced
- **8.5 lakhs meters have been installed till Aug’2022**

- **Reconciliation of Receivables**
- **Real time performance monitoring of bill collectors** through Mobile collection App integrated with SAP-ISU
- **Virtual Account Number** introduced (SBI) for auto updating of RTGS/NEFT payment in SAP

- **Enforcement activities**
- **De-hooking drives across 247 sections**
- **Rectification of unsafe network conditions**
- **Bringing non-consumer to billing net of utility**
- **Increase of Collection Counters across TPCODL**
- **Mobile Collection Van** for rural Consumers
- **Gaon Chalo Camps, Bill Revision Camps** for resolving consumer bill related issues
## Performance Improvement Journey

<table>
<thead>
<tr>
<th>Key Parameters</th>
<th>Status before takeover FY19-20</th>
<th>FY 20-21</th>
<th>FY 21-22</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT&amp;C %</td>
<td>30.44</td>
<td>29.54</td>
<td>25.1</td>
</tr>
<tr>
<td>Billing Efficiency %*</td>
<td>75.40</td>
<td>74.1</td>
<td>76.38</td>
</tr>
<tr>
<td>Collection Efficiency %</td>
<td>90.51</td>
<td>95.09</td>
<td>98.06</td>
</tr>
<tr>
<td>Provisional Billing %</td>
<td>38</td>
<td>18</td>
<td>6</td>
</tr>
</tbody>
</table>

*Note: Due to impact of FANI provisional billing was high leading to increase in Billing Efficiency*
Demand & Power Management
Demand – Typical Factors Impacting Demand

**Factors**

- Weather
- Day-of-the-week
- Time-of-the-day
- Holidays
- Recent Demand

**Key Challenge**

With *deterministic and stochastic parameters*, utility has to predict the **time-wise demand** of energy in the consumer base at **15 minute intervals**.

- Temperature
- Humidity
- Cloud cover
- Rainfall
- Wind Speed
- Wind Direction
**Demand – Seasonal Variation in the Demand Curve**

**SUMMER (MAY-SEPTEMBER)**
- Sharp rise from 08:30
- Dip during lunch
- Load picks up to an afternoon peak at 15:30 (Highest Peak of the Day)
- Load starts falling after 17:30
- Third peak at 20:00 (lighting load)
- Another dip at 21:00 (closing of shops)
- Final peak in the night at 23:00

**WINTER (NOVEMBER-MARCH)**
- Load rises sharply at 6:00, stabilizes at 08:00
- Load again rises at 09:30, stabilizes at 10:30
- Forenoon peak is the highest of the day
- Evening peak at 19:00

**INTERMEDIATE (APRIL & OCTOBER)**
- Intermediate between summer & winter patterns
- Day time & evening shape similar to summer load curve
- Late night & early morning curve is almost flat in nature
Power Manager Software (PMS) for Real Time Power Management
Demand Forecasting - Day Ahead

Model Output - AI/ML Based

MAPE FY’22 – 4.45
Battery Storage
- Key applications demonstrated and integrated by Tata Power-DDL

- BESS can be efficiently used for Peak Load Management, this will also ensure the CAPEX deferral for upcoming years. Replacement to the end of life thermal plants.

- Dynamic change in Load behaviour due to External factor results in forecast error and which can be catered through BESS thereby DSM/ADSM penalty can be reduced and ensure Grid discipline.

- Support to Frequency regulation Ancillary market in terms of Second and Tertiary reserve for maintaining frequency of the Grid.

- BESS can provide Dynamic power supply to Rohini Transport Grid to support unexpected peak charging requirements due to its fast ramping feature.


- Energy Arbitrage: Fill When Cheap, Drain When Price is high. This will reduce the Power Purchase cost during Peak load.
Technological Interventions

Demand Response
Peer to Peer
Smart Metering
Tata Power-DDL’s roadmap

- Advanced DMS
- Electric Vehicles
- Distribution Network Automation & Mechanization
- Distributed Energy Storage
- Distributed Generation
- Digitization
- Data analytics
- ADMS

Utilities of the future

- Power Quality
- Dynamic Power Management & Weather Forecasting
- Smart Meter Communication Technologies
- Intelligent Substations
- Energy Efficiency and Demand Response

FUTURE is NOW
Demand Response – Types, Benefits, Uses
Types of Demand Response

**Automated DR:**
Load controlled by Utility through connectivity with customers systems

**Benefits:**
- Utility is in control of switching off loads during its requirement
- More suitable & cost-effective for C&I loads

**Downsides:**
- Requires segregation of essential & non-essential loads at consumer’s end
- Requires high level of technological intervention in terms of switching equipment, smart meters & IT communication platforms
- Not preferred by customers due to external switching off

**Behavioral DR:**
Load curtailment is done by customer based on requirement by Utility

**Benefits:**
- Most preferred mode of DR by customers as they feel “in control”
- Requires limited technological support - Only pre & post event meter data is used
- No load segregation at customer’s end mandated
- Suitable & cost-effective for all types of customers

**Downsides:**
- Extremely high dependency on customer for participation & quantum of load shed
Peak pricing methodologies in DR

**Critical Peak Pricing (CPP)**
- **Higher tariff during peak hours.** Peak tariff may vary according to season.
- **On critical days (5 to 10 days a year) - Very high tariff during peak hours.** Informed a day in advance.
- Consumer stands to benefit, lower bills, if he/she conserves energy during peak.

**Critical Peak Rebate (CPR)**
- **On critical days (5 to 10 days a year) consumer asked to curtail load during peak.** Informed a day in advance.
- Consumer rewarded handsomely with incentives for curtailing load. (Use cases from US show 20X incentives)

*Suitable Tariff Support helps in increasing customer participation in Demand Response Programs*
Benefits & Use Cases

- **Customers are empowered** to control their consumption in response to time-varying electricity rates or incentive-based programs & reduce bill amount or earn incentive payments.

- Averts the need to use the most costly-to-run power plants during periods of high demand, **driving down Power Purchase Cost**.

- Over the longer term, sustained demand response **lowers aggregate system capacity requirements**, allowing load-serving entities (utilities and other retail suppliers) to purchase or build less new capacity.

- **Lowers likelihood and consequences of forced outages** that impose financial costs and inconvenience on customers.

- Helps in grid stabilization & **better integration with renewable sources of generation** & Distributed Energy Resources.
Potential for Demand Response on the rise

Expected:
Avg annual AC sales 8 million

Flexible DR Added every year > 3GW MW

Aggregated:
30GW Flexible capacity in next 10 years
Automated Demand Response Project Overview (2015-16)

First in India
- Utility to implement Automated Demand Response pilot in India with Honeywell.

Objective
- Estimate the potential for C&I customers in Delhi
- Establish technology effectiveness
- Maximize gains from DR in the interest of customers
- Manage grid stress situations

Components
- Automated Demand Response infrastructure including DR server and site controllers
  - Smart Meters
  - RF Mesh based Communication
  - 25 TPDDL Zones; 39 Grids & 108 Feeders covered
  - MDMS and its integration with other OT & IT systems like OMS, SAP, ADR

Features
- 162 consumers connected out of 550 potential consumers (29% success rate)
- 17 ADR Events and cumulative saving 0.063 MUs
- Total Non Critical Load Connected: 11 MW,
- Max Shed potential achieved: 7.2 MVA
- Shed performance of 12.5% to 22.5% of aggregated peak load of enrolled consumers (50.89% response rate)
# Learnings from ADR Program

- Successful deployment of ADR with Smart Meter demonstrated
- Integration of AMI with ADR & existing IT/OT applications

<p>| Non-functioning Smart Meter/Router/GPRS systems / DRAS software in many premises | Improved Smart Metering Infrastructure &amp; Use of globally accepted DERMS-Flex platform |
| Most of the customer sites had Manual Starters which made remote DR difficult to handle | Movement from Automated DR to Behavioral DR, eliminating the need for remote operations infrastructure |
| Low awareness among customers about benefits of program | One-to-one discussion &amp; awareness generation with emails &amp; FAQs |
| Expectation of higher financial incentives in lieu of the forgone consumption | Incentive Structure based on reduction in consumption by customer with minimum 10% drop |</p>
<table>
<thead>
<tr>
<th>Exploding Demand requiring DER integration</th>
<th>Technological Advancements</th>
<th>Customer Voices</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Delhi’s EV Policy - Additional EV Load projection in Network - 100 MW (FY 26)</td>
<td>• Matured AMI &amp; Smart Meter technologies for real time monitoring</td>
<td>• Large establishments are facing cash flow issues &amp; are looking for avenues to save cost</td>
</tr>
<tr>
<td>• Solar policy expansion – 25 MW net metering addition by FY 26</td>
<td>• Better IT-OT landscape helping in stronger back-end integration</td>
<td>• Interested in Behavioral DR programs - voluntarily participate in programs where internal systems do not require modifications</td>
</tr>
<tr>
<td>• Retail consumer load growth @5% per annum</td>
<td>• Availability of internationally proven M&amp;V technologies</td>
<td></td>
</tr>
<tr>
<td>• Grid stabilisation requirement in face of DER integration</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Renewed Need for Demand Response in 2020
DER Program Roadmap through E3 (USTDA)

Distribution Hot Spot Reduction through Demand Response

Pilot targeted distribution peak load programs through targeted small-scale storage, DR program with Critical Peak Rebate*

* Critical Peak Pricing method not adopted as ToD is already deployed for C&I customers
<table>
<thead>
<tr>
<th>Program Highlights</th>
<th>Goals</th>
<th>Methodology</th>
</tr>
</thead>
</table>
| • Offer customers incentives on reduction in consumption from normal levels during critical events as called by utility (CPR)  
• Only for Residential customers (First in India) using smart meters  
• **Availability Period**: 15th Jul to 30th Sep 21 (Multiple Events)- Residential  
• **Response Timing**: Day & Night Peaks  
• **Technology used**: Smart meters, Big data platform, Measurement & Verification through DERMS platform of AutoGrid (Current acquired by Schneider)  
• **Funding partner**: Shakti Sustainability Foundation | • Test effectiveness of Manual DR as an alternative to Auto DR  
• Assess the acceptability of DR programs among consumers.  
• Assess response of consumers to different variants of programs  
• Create a Tariff structure which stimulates consumers to change their load pattern.  
• Measure response of consumers to incentives/additional pricing | • **Notification to customers**: 24 hrs in advance thru sms, email & calls  
• **Measurement**: Drop in consumption compared to last 10 days during same slot  
• **Calculation**: Porting of customer profile data, last 10 day’s 30-minute interval data & consumption data of day of event  
• **Customer Compensation Structure**: Cash rewards & Lucky Draw Schemes for top participants |
Implementation Statistics

- No. of Customers Targeted: 4,417
- No. of Customers Enrolled: 2,044
- No. of Event Executed: 16
- Total Load Shed: 7.69 MW
- 11 Day Events & 5 Night Events
- Avg. Per Meter Shed: 0.4 KW

**Customer Incentives of Rs 45 lacs disbursed**
(INR 200 for enrollment; INR 250 per event for successful participation)
Scaled up pilot in 2022

- Enrolled customers: **26,700 Customers** (15,800 Residential and 10,900 C&I)

- Customer sampling done with guidance from Indian Statistical Institute

- Benchmarking with China Light & Power, Hong Kong

- **Included C&I customers for BDR (First in India)**

- **Addition of AMR meters along with smart meters**

- 12 events successfully executed. (C&I + Resi - 6 events; Resi - 6 events). Cumulative load shed of 85.05 MW

- Incentive support through Shakti Foundation

- Extensive customer communication & engagement under branded communication “Urja Arpan”

- Behavioral shifts observed through zero incentive events; Other incentives reduced to Rs 50 & Rs 100
### Event-wise Results

<table>
<thead>
<tr>
<th>Day</th>
<th>Night</th>
<th>Load Shed (MW)</th>
<th>Participated Customers (Nos.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>27-05-2022</td>
<td>D</td>
<td>2.7</td>
<td>5,955</td>
</tr>
<tr>
<td>28-05-2022</td>
<td>N</td>
<td>2.4</td>
<td>3,967</td>
</tr>
<tr>
<td>08-06-2022</td>
<td>N</td>
<td>1.7</td>
<td>3,043</td>
</tr>
<tr>
<td>15-07-2022</td>
<td>D</td>
<td>1.7</td>
<td>4,065</td>
</tr>
<tr>
<td>18-07-2022</td>
<td>N</td>
<td>1.5</td>
<td>2,943</td>
</tr>
<tr>
<td>22-07-2022</td>
<td>D</td>
<td>3.2</td>
<td>5,689</td>
</tr>
<tr>
<td>08-08-2022</td>
<td>D</td>
<td>9.7</td>
<td>6,371</td>
</tr>
<tr>
<td>13-08-2022</td>
<td>D</td>
<td>10.8</td>
<td>8,188</td>
</tr>
<tr>
<td>16-08-2022</td>
<td>D</td>
<td>10.5</td>
<td>9,854</td>
</tr>
<tr>
<td>23-08-2022</td>
<td>D</td>
<td>8.58</td>
<td>8,249</td>
</tr>
<tr>
<td>08-09-2022</td>
<td>D</td>
<td>8.58</td>
<td>8,582</td>
</tr>
<tr>
<td>09-09-2022</td>
<td>D</td>
<td>15.57</td>
<td>8,727</td>
</tr>
</tbody>
</table>

**Demand Response Event Details**

- **Customers Participated (Nos.)**
- **Load Shed (MW)**

03 Events of Rs. 100/- Incentive
02 Event of Rs. 50/- Incentive
07 Lucky Draw Events

C&I and Residential Customers from 7th Event Onwards
Comparison of pilots

- **Enrolled consumers**
  - 2022: 1800
  - 2021: 25000

- **Contributing Consumers**
  - 2022: 840
  - 2021: 10000

- **Max Cap Shed (MW)**
  - 2022: 1
  - 2021: 19

- **Avg Energy Shed per Meter (KWh)**
  - 2022: 0.89
  - 2021: 0.99

- **Avg Cap. Shed per Meter (kW)**
  - 2022: 0.47
  - 2021: 0.5
Global Scenarios & Regulations

- **North America & Europe**
  - Laws/policy that require grid access to all entities (traditional regulated utilities, as well as small DER owners)
  - Transmission Operators have adapted their market rules to allow both DERs to participate in grid services.
  - Telemetry requirements in place
  - Smart devices such as smart residential thermostats are contributing significantly
  - Batteries and EVs are expected to grow dramatically over the next 2-3 years.

- **Australia**
  - Quickly becoming a leader in regulatory environments supportive of BTM DERs
  - Market rules changed for ancillary services to make it easier for DERs to participate in all grid services (fast, slow, and delayed).

- **South Asia and East Asia**
  - Regulatory environments are still being developed & distribution utilities still need to convince regulators that DERs are a reliable source of capacity and that there is a clear business case to fund DR programs with customer tariffs.
Peer to Peer Solar Trading
Green Power Demand Not Being Adequately Addressed......

Both on Generation Side as well as Consumption Side

Problem Statement

1. Due to regulatory constraints, most customers size their rooftop plant(s) to their minimum power demand.

2. Customers in Metros & Tier-1 cities living in apartments are unable to adopt flexible green power.

a. Industrial units that have a variation in demand and typically work only 6 days a week.

b. Commercial entities such as warehouses etc. that have a large roof top space but very low electricity consumption.
Case Study Sample

Blockchain Gateway → Blockchain Infrastructure (Digital Platform) → Blockchain Gateway

Smart-Meter ➔ KPM Store (Prosumer) ➔ Excess Solar Power sold ➔ Corporate Office (Consumer)

- **KPM Store (Prosumer)**
  - Annual Gen.: 11,40,055 kWh
  - Annual Cons.: 1613 kWh
  - Surplus Gen.: 11,38,442 kWh

- **Corporate Office (Consumer)**
  - Annual Gen.: 4,312 kWh
  - Annual Cons.: 4,388 kWh
  - Net Cons.: 76 kWh
### Pilot Summary

**Objectives**
- Pilot is conducted by Tata Power - DDL in collaboration with ISGF and Power Ledger
- Test the technical viability and value proposition of P2P energy trading
- Develop business model for Blockchain enabled Peer to Peer (P2P) energy trading in Delhi.

**Pilot Architecture**
- Tata Power-DDL’s Grid Stations with Solar PVs and some real customers (In TPDDL N/w) to be prosumers; Other Grid stations/ Office Buildings along with real customers will be consumers.
- Simulated trading to mirror the scenarios of real trading regimes.

**Unique aspects in Pilot**
- Involvement of a trader who will take over the trading responsibilities for a customer and prosumer
- Involvement of a rooftop provider who will subscribe to data feed
- Opportunity to add other elements pertaining to DERMs such as Storage, V2G and Demand Response
Benefits to Discoms

- Reduction in distribution losses
- Defer investment on system upgrade
- New revenue streams for the utility:
  (a) Wheeling charges
  (b) Billing and transaction fees
- Addl RE generation to meet RPO obligations
- Balancing local generation and demand within the community
- Voltage & capacity constraint management
Smart Metering for Innovative Usage
Innovative Use of Smart Meter Data
– Outage Management

**Meter Ping in consumer complaint:**

Objective: To register no-current complaints pertaining to utility only

Adoption in Business Process:
- Eliminates false no-current complaint registration
- Timely information to consumers if cause of power supply failure at his end.

Benefits:
- Optimize utilization of field crew
- Saving Operational Expenses by using manpower efficiently.

![Diagram showing Meter Ping in Consumer Complaints (No Power Supply)]
Innovative Use of Smart Meter Data – Revenue Protection

**Objective:** To protect revenue by setting up a rule-based algorithm system

**Adoption in Business Process:**
- Filtration of potential cases
- Lesser effort is required as compared to previous system for AMR meters.

**Benefits:**
- 82% more cases booked in H1 (FY23) as compared to H1 (FY22)
- Lesser Manpower requirement in executing the same no. of cases

### Revenue Protection Module: Load Booked

<table>
<thead>
<tr>
<th>No's of Cases</th>
<th>Load (KW)</th>
<th>No's of Cases</th>
<th>Load (KW)</th>
<th>No's of Cases</th>
<th>Load (KW)</th>
<th>No's of Cases</th>
<th>Load (KW)</th>
<th>Total Count (Nos.)</th>
<th>Total Load (KW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment</td>
<td>87 15</td>
<td>1218</td>
<td>36 38</td>
<td>625 590</td>
<td>49 49</td>
<td>362 474</td>
<td>45 53</td>
<td>716 1104</td>
<td>217 155</td>
</tr>
<tr>
<td>DAE</td>
<td>4214</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5918 3386</td>
</tr>
</tbody>
</table>
Innovative Use of Smart Meter Data – Risk Prediction of Distribution Transfer

Objective
To create a prediction of risk for DTs Adoption in Business Process
- From period based mntc/overhaul to data based mntc/overhaul
- Embed in workflow by linking to notification process

Benefits
- Avoid both scheduled and unscheduled interruption
- Reduce opex and capex
- Reduce asset failure rate

Features
- All asset data in different systems like ERP, MDM, etc integrated to create a model.
- Threshold values validated by verifying previously failed DTs
Way forward for improving Financial viability of Discoms
Way forward in current regulatory regime

**Power Purchase**
- Enabling auto pass-through of all power purchase with a pre-defined logic to contain tariff shock
- REC costs, Short Term Power purchase is not covered in some regulatory regimes
- Mechanism for arrear bills of Gencos & Transcos – after true-ip

**Enable Cost Saving**
- Cloud Transition entails Capex to Opex shifting – Current norms do not factor this.
- Smart meter Communication costs
- Mandatory E-Bills to save printing costs

**Customer Discipline**
- No notice period for Cheque bounce cases / Regular Defaulters
- 2X Security deposits for habitual defaulters

**Regulatory Norms**
- Review of Time of Day and Time of Use Tariff
- Enabling Demand Response, Peer to Peer Solar via regulations
Competition and Private participation–Multiple routes

- Distribution Franchisee
- Parallel Licensee
- PPP - Licensee
- Retail Competition/Suppliers
And most importantly ...

- Timely release of Tariff Orders
- Timely true-up
- Cost-reflective Tariff & Regulatory Assets
- Timebound disposal of petitions at SERC & APTEL
Thank You

cer.iitk.ac.in
eal.iitk.ac.in