Regional Roundtable on Infrastructure Governance Regulation, Governance and Transparency

Technology to Improve Infrastructure Governance - A Perspective of Indian Power System

Mrs. Seema Gupta, Director(Operations)
Power Grid Corporation of India Ltd.

May 23, Seoul, Republic of Korea
Indian Power System - Outlook

Installed Capacity ~ 356 GW

Annual Consumption - 1250 BU

Peak Demand Met: 175 GW

One Nation - One Grid - One Frequency

2nd Largest Synchronous Grid in World

<table>
<thead>
<tr>
<th>Voltage Level</th>
<th>Circuit Kilometers (CKM)</th>
<th>Transformation Capacity (MVA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVDC</td>
<td>15556</td>
<td>22500</td>
</tr>
<tr>
<td>765kV</td>
<td>41809</td>
<td>211500</td>
</tr>
<tr>
<td>400kV</td>
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<td>324822</td>
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<tr>
<td>220kV</td>
<td>175296</td>
<td>352481</td>
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</tbody>
</table>

Rising Per Capita Consumption (in kWh per annum)

Peak Demand Met: 175 GW

Annual Consumption - 1250 BU

Installed Capacity ~ 356 GW

2nd Largest Synchronous Grid in World

One Nation - One Grid - One Frequency

24x7, Affordable & Quality Power for All

Seamless Cross-Country power flow

Large Scale Renewables Capacity Addition – 175 GW by 2022

International Cooperation - Towards integrated power system
Towards Integrated Global Power System

Hon’ble Prime Minister, India
Vision
‘One World-One Sun-One Grid’
for flow of solar energy across borders
POWERGRID – Growth Story

**CAPEX (in US$ mn)**
made in 5 Year Plans

<table>
<thead>
<tr>
<th>Year</th>
<th>VIII</th>
<th>IX</th>
<th>X</th>
<th>XI</th>
<th>XII</th>
<th>XIII ( upto Mar.'19)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>738</td>
<td>1218</td>
<td>2708</td>
<td>7926</td>
<td>16138</td>
<td>7446</td>
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</table>

**GFA (US$ mn)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Mar.'97</th>
<th>Mar.'02</th>
<th>Mar.'07</th>
<th>Mar.'12</th>
<th>Mar.'17</th>
<th>XIII ( upto Mar.'19)</th>
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<tr>
<td></td>
<td>797</td>
<td>1968</td>
<td>4145</td>
<td>9055</td>
<td>21390</td>
<td>27360</td>
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**Planwise Growth - CKM (cum.)**

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<tr>
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<td>59461</td>
<td>92981</td>
<td>139077</td>
<td>148149</td>
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</tbody>
</table>

**Planwise Growth - MVA (cum.)**

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<th>VIII</th>
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<td></td>
<td>23331</td>
<td>34288</td>
<td>59417</td>
<td>124525</td>
<td>289543</td>
<td>366097</td>
</tr>
</tbody>
</table>

5 Year Plans: VIII (FY 1992-97); IX (FY 1997-02); X (FY 2002-07); XI (FY 2007-12); XII (FY 2012-17)
Challenges in Building Power Transmission Infrastructure

- **Generation projects issues:**
  - Uncertainties in timeline, Power Purchase Agreements and Long Term Access
- **Renewable Energy Integration with Grid:**
  - RE Generation gestation ~ 1 year while it is 2-3 years for transmission system
  - Issues in grid stability due to inherent intermittency, variability and uncertainty.
- **Implementing multiple large Projects within Time and Cost**
  - Approval of Projects
  - Transparency in Procurement
  - Monitoring of Progress
  - Quality Control & Inspection
- **Land Acquisition & Right-of-Way (RoW)**
  - Delays & Compensation issues
- **Asset Management**
  - Increasing Asset Base, Complexity & Ageing Assets
  - Nature’s Vagaries, Changing Climate and Wind Pattern
  - High Availability and Reliability
Planning based on projected demand

- **High Capacity Transmission Corridors**
  - > 60,000 MW created connecting the major generating pockets to the demand centers.

- **Renewable Energy Integration with Grid:**
  - Special green energy corridors created proactively based on assessment of potential Renewable Energy Generation.
  - To manage intermittency & variability STATCOM, Fault Ride through technology, Renewable energy management centers (REMC) established.

Integrated Project Management & Control

- **Transparency & Quality**
  - E-Procurement, E-Reverse Auction for price efficiency.
  - All payments being done digitally.
  - Process for inspections being carried out online, saving time and ensuring quality and effective monitoring.
  - Enterprise Resource Planning (ERP).
New Technologies – Improving Reliability & Efficiencies

- **Land Acquisition & Right-of-Way (RoW)**
  - High Voltage lines to save RoW.
    - 400kV → 765kV EHVAC → 1200 UHVAC (Highest Voltage in the World)
    - ±500kV → ± 800kV HVDC
  - Multi circuit/ Pole type towers.
  - Use of Gas Insulated Switchgear for land optimisation.
  - Light HVDC - Voltage Source Converter (VSC)
  - Increase in capacity of transmission corridor through - HTLS Conductor, Series Capacitor
- Making grid smarter for enhanced reliability - STATCOMs, WAMS, REMCs

<table>
<thead>
<tr>
<th>Voltage</th>
<th>ROW (m)</th>
<th>Capacity (MW)</th>
<th>MW/m-RoW</th>
</tr>
</thead>
<tbody>
<tr>
<td>400kV (D/c)</td>
<td>46</td>
<td>1000</td>
<td>22</td>
</tr>
<tr>
<td>765kV (S/c)</td>
<td>64</td>
<td>2100</td>
<td>33</td>
</tr>
<tr>
<td>765kV (D/c)</td>
<td>69</td>
<td>4200</td>
<td>61</td>
</tr>
<tr>
<td>±500kV HVDC</td>
<td>52</td>
<td>2500</td>
<td>48</td>
</tr>
<tr>
<td>±800kV HVDC</td>
<td>70</td>
<td>6000</td>
<td>90</td>
</tr>
<tr>
<td>1200kV UHVAC</td>
<td>100</td>
<td>8000</td>
<td>80</td>
</tr>
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- **Reduction in Land Requirement**
  - Cost Saving; Faster Execution through GIS

- **Enhanced Stability & Reliability**
  - RE Integration, Grid Balancing

- **Reduced Carbon Footprint**
  - Forest Area reduced from 6% in 1998 to 2.26%
National Transmission Asset Management Centre (NTAMC)

- Control Centre for Management of POWERGRID’s Transmission Assets.
- Remote Operation of >200 EHV Sub-stations.
- NTAMC is equipped with latest softwares like:
  - AFAS (Automated Fault analysis software);
  - SCADA;
  - Visual Monitoring System (VMS);
  - Remote Access System (RAS) and others for asset management
Meeting Challenges in Transmission through Technology

Patrolling of Lines through Drones, Helicopters and Tablet App based GIS Mapping of transmission assets

84 meters away in 2011  22 meters away in 2016

Process Bus for Substation Automation
International Benchmarking: Comparison with Peers

Philosophy of benchmarking

- **2\textsuperscript{nd} Quadrant**
  - Performance: High
  - Spending: High

- **1\textsuperscript{st} Quadrant**
  - Performance: High
  - Spending: Less

- **3\textsuperscript{rd} Quadrant**
  - Performance: Low
  - Spending: High

- **4\textsuperscript{th} Quadrant**
  - Performance: Low
  - Spending: Low
2011: Low maintenance cost but with high outage level
2013: Reduced outage with lower maintenance cost
2015 & 2017: Good performance with reduced maintenance cost
2011: Very High Cost; Outlier
2013: Good Performance but at higher maintenance cost
2015 & 2017: Good performance with reduced maintenance cost
Way Forward: Planning for future

Technology Integration for Infrastructure Management

- Asset Health Indexing of Transformers
- Use of Hybrid GIS
- Substation Inspection Robots
- Battery Energy Storage Systems
- Superconducting Fault Current Limiter
- Gas Insulated Lines
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Thank you