Webinar

Approaches to Utility Resilience: Creating an Energy Sector that is Prepared for the Unexpected

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Indian Grid...One of the World’s Largest

1. national synchronous grid
2. electricity generation
3. installed generation capacity
4. transmission system
5. wind generation
6. solar generation
7. renewable energy generation
8. hydro generation

Source: IEA Key World Energy Statistics 2019
(2017 data, 2018 provisional data)
Dimensions

- 370 GW+ generation capacity
- 182 GW+ peak demand
- > 4 TWh daily energy met
- 3.2 million km² area footprint
- 1.3 Billion+ people served
- 425,000 ckm+ EHV transmission
- 3 GW+ international exchanges
- 87 GW+ renewables
- 120 TWh+ annual market trades
- ~ 100 GW inter-regional capacity
- 2 power exchanges
- 50,000+ market transactions
- 6000+ market participants
India – Natural Disasters

Unique Climatic Regime

Two monsoon seasons (southwest & northeast monsoons)

Two cyclone seasons (pre & post monsoon cyclone seasons)

Hot weather season characterised by violent convective precipitation

Cold weather season characterised by violent snow storms in the mountains

58% of landmass prone to earthquake of moderate to very high intensity

8% of landmass prone to cyclone and tsunami

12% of landmass prone to flood and river erosion.

15% of landmass is prone to land-slides and avalanches

Source: www.portal.gsi.gov.in
Damage to Power Infrastructure

Natural Disasters in Recent History which impacted Electricity Grid in India

Cyclones
- Phailin (2013)
- Hud-Hud (2014)
- Vardah (2016)
- Titli, Gaja (2018)
- Fani, Bulbul (2019)
- Amphan (2020)
- Nisarga (2020)

Flooding
- Uttarakhand (2013)
- Chennai (2015)
- Assam (2016)
- Chennai (2017)
- Kerala (2018)
- Karnataka (2019)
- Kerala (2019)
- Pune (2019)
- Vadodara (2019)

List of Major Earthquakes on India

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 April 2018</td>
<td>India</td>
<td>4.6</td>
</tr>
<tr>
<td>03 Jan 2017</td>
<td>India, Bangladesh</td>
<td>5.7</td>
</tr>
<tr>
<td>04 Jan 2016</td>
<td>India, Myanmar, Bangladesh</td>
<td>6.7</td>
</tr>
<tr>
<td>26 Oct 2015</td>
<td>Afghanistan, India, Pakistan</td>
<td>7.7</td>
</tr>
<tr>
<td>12 May 2015</td>
<td>Nepal, India</td>
<td>7.3</td>
</tr>
<tr>
<td>25 April 2015</td>
<td>Nepal, India</td>
<td>7.8</td>
</tr>
<tr>
<td>01 May 2013</td>
<td>Kashmir</td>
<td>5.7</td>
</tr>
</tbody>
</table>
Impact due to Earthquake on 10th April, 2018

Richter scale: 4.6

- Voltage Transients
- Unit Trippings
- Angular Stress
- Drop in Frequency
Cyclone Amphan

- **Super Cyclonic Storm named ‘Amphan’ – 20 May 2020**
- Wind speed of more than 120 kmph
- West Bengal and Odisha affected
- Generation Loss: 260 MW
- Stations affected: 400 kV: 5, 220 kV: 11, 132 kV: 13, 33 kV: 280 +
- Lines tripped: 400 kV: 12, 220 kV: 17, 132 kV: 40 +
Approach for Resiliency

Long Term: Crisis & Disaster Management Plan (C&DMP) For Power Sector in INDIA

- Formulated in 2004 and updated in 2012 by Central Electricity Authority (CEA)
- Provide guidelines for assistance to utilities
- Inputs provided by experts and stakeholders
- Covers
  - planning,
  - quick response
  - recover from unexpected events and situations
  - ensuring safety of people, protection of environment, protection of installation
  - and restoration of power supply by utilities

Nodal Agency: National Load Despatch Centre (NLDC) for Power Sector

Operation

- Wide dissemination of forecast on cyclones:
  - Trajectory
  - Timing of the landfall by the IMD
- Unit Commitment and rescheduling of critical Generation
- Reduction of the power flow on likely affected transmission
- Toggling of HVDC Links
- Movement of ERS Towers/additional equipment as well as Emergency Response Teams at all critical sub-stations
- Emergency Response Teams at NLDC / RLDC / SLDC (System Operator)
- Precautionary Interventions/Curtailment in Electricity Market
- Advance plans for restoration of the distribution network

Real Time Coordination:
Visualization of faults through Phasor Measurement Units (PMUs)
Logistics and Coordination for Resiliency

- Recovery equipment and spares inventory
- Communication facilities
- Transport and Mobility arrangements
- Financial resources
- Dewatering pumps
- Mobile Diesel Generator (DG) sets
- Emergency Restoration System (ERS) for transmission
- Black start facilities
- Regular check up for healthiness and regular drills
- Annual safety audit
- Regular interaction with disaster management groups
ENHANCING POWER SYSTEM RESILIENCY

**Damage Prevention**
- Strengthening of transmission towers
- Cyber Security Measures
- Vegetation Management
- Planned maintenance
- Selective underground cabling

- Keeping:
  - Emergency Restoration System (ERS) for transmission
  - Recovery equipment and spares inventory

**System Recovery**
- Quick Damage assessment
- Movement of restoration teams to pin point locations
- Early restoration of important centers
- Satellite based area assessment and communication system
- Effective use of Real time security desk
- Spare equipment strategies
- Black start facilities
- Effective use of weather information provided by metrological department.

**Future**
- More distributed generation options such as fuel cell, solar PV & wind to enable urgent services to mobile phones, hospitals and traffic lights.
- Switching of mobile network from local to satellite system.
- Grid forming based solar and wind plants.
- Research on high impact low frequency events.
- Enhancing reliability of Nuclear Power plants.
ENHANCING POWER SYSTEM RESILIENCY

Generation
- Design to minimize damage
- Advance Fuel supply and storage system
- More interconnection lines for plants.
- Black Start capabilities
- Protection from Malware attacks
- Bringing in more flexibility

Transmission
- Protection from cyclone, flood, earthquake and high winds.
- Selective underground cabling
- Protection Relay redundancy
- Vulnerability assessment based on real-life examples
- Online monitoring of spare components
- Protection from Cyber attacks

Distribution
- Reinforcement from overhead distribution system
- Distributed Storage system
- Underground cabling in targeted important areas
- Decentralized restoration system
- Distributed Generation
- Smart Grid technology
- Online health Monitoring of assets at station level
Indian grid operation after Covid-19 pandemic outbreak

22 March 2020  
*Janta curfew*

25 March - 14 April 2020  
Extended to 31 May 2020  
Complete India lockdown

5th April 2020  
*Pan-India lights switch off for 9 minutes @ 9 PM*
Advisory/Guidelines pan-India control centres

General sanitization & social distancing protocols
- Personal hygiene
- Stay at home
- Social Distancing
- Travel Advisory
- Teleworking
- Keep objects and surface clean
- Wearing PPE

Ensuring continuity of load despatch centre operations
- Strategic Oversight / Tactical Teams
- Critical Staff for Core Functions
- Lockdown Travel Permission
- Health Monitoring of Control Room Staff
- Temporary Control Room in same premises
- Cyber security
- Remote access

Impact on reliability of electricity grid
- Interactions by system operators at RLDCs/NLDC with other stakeholders (neighbouring countries too)
- Identification of reserve manpower / roster depth
- Load forecasting / demand variation
- Maintenance (Planned) / Forced outage of G & T
- Fuel stock monitoring
- Transmission capability & grid security
- Generation unit availability and reserves

All India load curve on Janta curfew day compared to previous day/week

- **Reduction in energy consumption**
  ~ 300 GWh

- **Peak demand suppressed**
  ~ 20 GW

Compared to previous Sunday (15th March, 2020)

<table>
<thead>
<tr>
<th>Date</th>
<th>Northern Region</th>
<th>Western Region</th>
<th>Southern Region</th>
<th>Eastern Region</th>
<th>North Eastern Region</th>
<th>All India</th>
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</thead>
<tbody>
<tr>
<td>15-March-2020</td>
<td>774</td>
<td>1119</td>
<td>1061</td>
<td>345</td>
<td>39.82</td>
<td>3339</td>
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<tr>
<td>22-March-2020</td>
<td>739</td>
<td>977</td>
<td>965</td>
<td>319</td>
<td>35.10</td>
<td>3035</td>
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</tbody>
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Commercial load reduction
25 March - 14 April 2020 extended to 31 May 2020
Complete India lockdown

- All India energy consumption at the start of lock down period is less by 20-30 % compared to normal day
- Percentage reduction in energy met is highest for NR followed by Western region and Southern region
- Energy reduction > 30 % - Uttarakhand, HP, AP, Telangana, TN, Arunachal, Assam and Meghalaya.
- Consumption kept on increasing with rise in temperature due to upcoming summer.
Actual All India demand during lights switch off event @ 9 PM on 05th April 2020

The total reduction in all India demand recorded during the event was **31089 MW**.

All India demand started reducing from **20:45 Hrs** and minimum demand of **85,799 MW** was recorded at **21:10 Hrs**.

Subsequently, from **21:10 Hrs**, the demand started picking up and settled around **114400 MW** at **22:10 Hrs**.
Generation Profile during lights switch off event on 05th April 2020

- 22% hydro generation on 05th April, 2020 as compared to 16% on previous day at 2045 hrs (↑)
- 9% of hydro generation on 05th April, 2020 as compared to 16% on previous day at 2110 hrs (↓)

Resiliency: Covid-19

- Shutdown of costly Generation
  - Low prices in the market
- Incentives for flexibility: Ramping
- Focus of hydro generation and pumped storage
- Starting of Real-Time Market from 1st June 2020
- Expansion of Security Constrained Economic Dispatch
- Renewable Energy Management Centres
- Government of India intervention and support
“Faith is the bird that feels the light and sings when the dawn is still dark.” – Rabindranath Tagore

STOP Coronavirus!

Thank you!!