Indian Grid...Large Footprint

Indian Power System
- Generating Stations > 900 Nos.
- Generating Units > 2200 Nos.
  - > 7000 Sub-stations,
  - > 3100 transformers
  - 11 Nos. HVDC Bi-pole/BtB
  - > 100 nos. 765 kV lines
  - > 1300 nos. 400 kV lines.

High growth

- Demand met – 175590 MW on 18th Sep 2018
- Energy met – 3925 MU on 19th Sep 2018
- Hydro Generation – 741 MU on 31st Aug 2018

International Interconnections
- Nepal
- Bhutan
- Myanmar
- Bangladesh
Renewables on the Rise...MW to GW

Wind Potential ~ 100 GW (at 80 m hub-height)

Solar Potential ~ 750 GW (4-7 kWh per sq. m per day)

National Offshore Wind Energy Policy & wind & Solar Hybrid policy

Green Energy Corridors

Solar CAGR ~ 67% (2014-17)

Solar Cities ~ 60 Nos.

Wind CAGR ~ 13% (2014-17)

Solar Parks – 40 GW

Installed Capacity – as on 31 Dec’18

All India 349.28 GW
Thermal 223.02 GW
Hydro 45.39 GW
Nuclear 6.78 GW
RE 74.08

Wind Atlas

Wind Reverse Bidding ~ Rs. 2.43/kWh

Solar Reverse Bidding ~ Rs. 2.44/kWh

175 GW by 2022

Solar RPO ~ 8% of total generation by 2022 (Excluding Hydro)
Impact of Weather on Power System

• **Peak Summer Period (April-June)**
  – High Temperature – Increase in Demand due to Weather beating Loads
  – Dust-storms - Load crash, High voltage
  – Agricultural Demand due to ‘Kharif crop’

• **Monsoon Period (July-Sept)**
  – Widespread rains- sudden load crash & high voltage
  – Sudden hydro generation outage - due to high silt content

• **Winter Period (Dec-Feb)**
  – Agricultural Demand due to ‘Ravi Crop’
  – Fog/smog
  – Demand due to use of Heating equipments

• **Cyclones**
  – Power outages, damage to transmission & distribution network

• **Solar Eclipse**
  – Impact on Solar Generation
Impact of Different Weather phenomena on Power system

Cyclone

Fog

Silt

Voltage A Magnitude

19/7/2017

Generation Output in 19/7/2017

NR Hydro vs NR Demand
Minimizing Impact on Power System

- Prior knowledge of Weather Conditions
  - Demand estimation
  - Generation Optimization
  - Maintenance scheduling of generating units and transmission lines
  - Issuance of Advisory in case of warning
    - Power Generation Increase/Decrease
    - Assessment of Impact on Power Transmission lines
    - Simulation Studies
  - Better Plan for early restoration
Meteogram

• Inputs to Meteogram
  – Automatic Weather Stations, Satellite data, Radar, Land station ..etc

• Meteogram provides Plots for Meteorological Variables
  – Rainfall,
  – Cloud Cover,
  – Temperature ,
  – Humidity &
  – Wind Speed & direction ..etc

• It is 3 hourly forecast for 10 days.
• Each Meteogram Provides information for 10 kM radius
• Updated at 00:00 Hrs UTC and 12:00 Hrs UTC
Meteogram: Three Hourly Forecast for 10 Days

Available for 450 Locations in the Country
RADAR

• The Doppler Weather Radar generates different displays and derived products of practical utility based on standard algorithms.
• These displays are updated @ every 10 minutes
Reflectivity (dBZ)

• The colors on the legend are the different echo intensities (reflectivity) measured in dBZ.
• "Reflectivity" is the amount of transmitted power returned to the radar receiver.
• Typically, light rain is occurring when the dBZ value reaches 20, 35-40 Moderate, 40-50 Moderate to Heavy 50-55 Heavy rain
• Hail is a good reflector of energy and will return very high dBZ values
  – Greater than 55
Thunderstorms:
- A likely phenomena during summers
- Leads to Load Crash
- Excursion in Voltage and Frequency
Radar Image for Rain/Thunderstorm Monitoring
• Near Real time Radar image helped in Timely Reduction of Generation in State Control area/ISGS Generation, RRAS (Reserves Regulation Ancillary Services) Regulation leading to better Load Generation balance in the Grid
Cyclone Gaja

- Cyclonic Gaja made landfall in Nagapattinam district of Tamil Nadu around 1:40 am on 16th November 2018

- All the Control Centres referred the reports generated by IMD and closely monitored the RADAR/Satellite Pictures available on the Weather Portal
Gaga Cyclone:- Precautions Taken

- System parameters of following Substations were closely monitored
  1. 400kV Sriperumbudur S/s
  2. 400kV Nagapattinam S/s
  3. 400kV SV Chattram S/s
  4. 400kV ILFS S/s
  5. 400kV Kalivendapattu S/s
  6. 400kV Trichy S/s
  7. 400kV Neyveli S/s
  8. 400kV Pondicherry S/s

- Reactors were made available to control voltages
- All the outages were deferred in East Chennai, Nagapattinam area, Neyveli area and Pondicherry area
- Followings units were hand tripped in anticipation of reduction in demand:
  1. NCTPS -210 MW
  2. NCTPS Stage-2 – 600 MW
  3. STCMS (IPP) – 250MW

Close monitoring of cyclone helped in controlling the System parameters and restoration of power supply in the affected area.

As anticipated, UP demand went down from 19000 MW to 17000 MW due to change in weather conditions.

Accordingly, STOA & purchase from Power Exchange of the order of 2000 MW was reduced. i.e Backing down of approximately 13 MU of costly thermal generation.

**Total Power Exchange & Bilateral**
Benefit achieved by BSES

Load Crash of around 450 MW
## Savings by BSES

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<th>S.no.</th>
<th>Date</th>
<th>Savings (Mus)</th>
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<tr>
<td></td>
<td><strong>Total</strong></td>
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</table>
Road Ahead

• RADAR/Satellite image may be layered with Topographical Maps, Transmission lines, Highways, State boundaries, Cities and Weather Warnings

• Rainfall estimate in catchment area of hydro plants for inflow forecasting /silt forecasting