NSGM & Smart Grids

A.K. Mishra
Director, NPMU
Historical trends

Peak Shortages

Energy Deficit
Electrical Energy Requirement: Projected and Actual data*

<table>
<thead>
<tr>
<th>Year</th>
<th>Electrical Energy (BU)</th>
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<tr>
<td>2016-17</td>
<td>1160</td>
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<tr>
<td>2017-18</td>
<td>1358</td>
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<td>2018-19</td>
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<td>2021-22</td>
<td>2047</td>
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<td>2036-37</td>
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Electrical Energy Requirement: 81 BU/year

Details of Electrical Energy in 2018-19*

- Thermal: ~1072, 78%
- Nuclear: ~38, 10%
- Hydro: ~134, 3%
- Bhutan IMP: ~126, 9%
- ~1, <1%

Details of RES 2018-19*

- Wind: ~62, 49%
- Solar: ~39, 31%
- Small hydro: ~9, 7%
- Bagasse: ~14, 11%
- Others: ~1, <1%
- Biomass: ~3, 2%

*19th EPS & CEA Annual Report

* CEA Annual Report

* CEA Annual Report
Energy Capacity in GW (Sep’19)

Peak Demand Projection* and Actual data**

Peak Demand: 183.83 GW (in May’19)

13 GW/ year

*19th EPS & CEA Annual Report
** upto Sep’19

All India installed capacity (in GW) 363.36 GW

Thermal, ~228, ~63%
Nuclear, ~6.8, ~2%
Hydro, ~45, ~12%
Solar, ~31, ~9%
Wind, ~37, ~10%
Small Hydro, ~5, ~1%
Bio-power, ~10, ~3%

RES, ~83, ~23%

Peak Demand: Projection and Actual data

*CEA monthly report
RE & Smart Grid

5G and Cloud Interoperability for Smart Utility and Telecom domain.

Logos of DISCOMs are for illustration purposes only

EU India joint opportunity to convert challenges.

Target to achieve all time low Tariff in the country, Rs. 2.44.

Power prices (< Rs. 3 / unit)

Interoperability supporting Eco's emerging role of DSOs. Wire & Supply segregation of 97.5MW Grid connected to govt. buildings across the state. Electrification of off-grid solar mini-grid.

Wind Power: Rs. 2.44
Solar: Rs. 2.41

Ministry of Power
Government of India

National Smart Grid Mission

Rs. 2.44

Wind Power
Solar

One Pribose
Sun, One-Grid
Emerging Scenario

- 100% electrification
- Growing AMI and Renewable Energy
  - Need for cost effective interoperable devices
- Demand side management and demand response program
  - Need of advanced Load segregation algorithms
  - Transition from Blackout’s to Managed Services with Consumers
- Emerging role of DSOs
- Separation of Content & Carriage
- Micro grids and self sustainable local grids
  - Consumers as participants to local grid management program
- Proliferation of EVs, storage and their charging infrastructure
Smart Grid Vision for India

Transform the Indian power sector into a secure, adaptive, sustainable and digitally enabled ecosystem that provides reliable and quality energy for all with active participation of stakeholders.
National Smart Grid Mission

NSGM has been established in March 2015 with institutional framework as follows:

- **Governing Council**
  - Chair – Minister of Power
  - Convenor – JS (D)

- **Empowered Committee**
  - Chair – Secretary (Power)
  - Convenor – JS (D)

- **NSGM Project Management Unit**
  - Head – Director NPMU

- **Smart Grid Knowledge Centre (SGKC)**

- **Technical Committee**
  - Chair – Chairperson, CEA
  - Mem. Secy. – Dir. NPMU

- **State Level Project Management Unit**
  - Chair – Energy Secretary (State)

- **Utility Smart Grid Cells**

Bilingual website: [www.nsgm.gov.in](http://www.nsgm.gov.in)
Need of SLPMU

• Every state is to have a State Level Project Management Unit (SLPMU) chaired by Power Secretary (or equivalent) of the state

• SLPMU will be the apex body for steering the state level programs
  • State DISCOMs
  • Regulators
  • State Power And Finance Departments
  • Academia (IIT/NIT/IIM Etc.)
  • Prominent NGOs etc.

• Expected to meet @ Quarterly

• Address technical and commercial implications
• Interact with possible development partners/ agencies
• Mobilize cooperation
• Analyze as is state
• Enable informed goals for SG
  • ARU – Feeder/ Consumer Groups
  • Pricing
    • Reliability
    • Temps+Reliability
    • Feeder Load profile
      • Confirmative to DISCOM average
      • Contrarian
NSGM Support for Smart Grids

• Funding of projects (up to 30%)
• Assistance in formulation of projects including
  • pre-feasibility studies, technology selection, cost benefit analysis, financing models etc.
• Training and capacity building for State Level PMUs & project implementation teams
• Technology selection guidelines and best practices
• Facilitate consumer awareness initiatives
• Project appraisal post implementation

NSGM Documents were released by Hon’ble MoSP (I/C) on 16th January 2019 and are available at our website

NSGM Achievements

- Five projects (Rs.686.6 Cr.) for ~7.50 lakh consumers
- AMI functional requirements
- Model Smart Grid Regulations adopted by 6 states
- Smart Grid Readiness – Self Assessment Tool (SGR-SAT)
- 6 National & 3 International workshops
- SG Course Developed
- 10 Training programs for utilities
- 2 Brainstorming sessions
- NSGM Framework, Model RfP & Model DPR released
- Smart Meter Rollout plan submitted
- 19 State Level PMUs formed

Under NSGM

IS 16444 (Part 1 & 2) and IS 15959 (Part 2 & 3)
## Smart Grid Projects under NSGM

### 2 projects at Chandigarh, CH (CED)

- **Utility**: Chandigarh, CED (SD-5)
- **Functionalities**: AMI, SCADA
- **Cost (₹ Cr)**: 28.58
- **Consumers**: 29,500
- **Status**: Implementation In Process

### 6 Towns, RJ (JVVNL)

- **Utility**: Ranchi, JBVNL
- **Functionalities**: AMI, DTMU
- **Cost (₹ Cr)**: 228.69
- **Consumers**: 3,60,000
- **Status**: Technical bid evaluation in progress

- **Utility**: Rourkela, OPTCL
- **Functionalities**: AMI, SCADA, DTMU
- **Cost (₹ Cr)**: 96.97
- **Consumers**: 87,000
- **Status**: Tendering in process

- **Utility**: Chandigarh, CED (City)
- **Functionalities**: AMI, SCADA, DTMU
- **Cost (₹ Cr)**: 241.49
- **Consumers**: 1,84,000
- **Status**: Sanctioned

- **Utility**: Kochi, KSEB
- **Functionalities**: AMI, PLM, DTMU, EVCI, PV
- **Cost (₹ Cr)**: 90.87
- **Consumers**: 90,000
- **Status**: Sanctioned

### Total

- **Cost (₹ Cr)**: 686.60
- **Consumers**: 7,50,500
Smart Grid Pilot Projects

Impact assessment

- All pilots declared go-live / completed / commercially operated
- ~1.6 lakh Smart Meters installed
- 11 pilots including SGKC

- New generation communication technology with improved performance based on RF mesh developed as an evolution of Technology deployed at CESC, Mysore
- Undue doubt on DISCOMs infrastructure w.r.t. PLC technology was negated – performed well in Tripura SG Pilot
- Two new product (Smart Meter) developed & deployed
- Developed Products Sustainability especially in International Cooperation – Panipat Pilot Exp
The center was inaugurated by Hon’ble Union Minister of State for Power, New & Renewable Energy (I/C) Shri R.K. Singh on 19th Sept 2018.

Periodic training programs scheduled for Utility officials and other stakeholders on residential basis.
- Total 5 programs conducted and 120 executives trained.

Four Site visit and detailed demonstration carried out
- 60 delegates from IEEMA Metering India 2019 edition on 10th Aug’2019
- 30 officials from BSES Rajdhani Ltd. on 13th Aug’2019
- Foreign delegation from USAID on 21st Aug’2019
**Smart Grid Knowledge Centre**

**Focus Areas**

- **Advanced Technologies, Innovations & Demonstrations**
  - **Innovation Park**
    - Platform for live demonstration of new and innovative products and technologies relevant to the power sector.
  - **Technology Incubation**
    - Supporting innovative ideas to progress in their journey from concept to market.
  - **Demand Based Research**
    - Prepare fact sheets and direct the research to appropriate agencies to support informed policy and regulatory decision making.

- **Partnerships / Alliances**
  - **Twining Arrangements**
    - Building network with national and international agencies to leverage complimentary expertise of partner institutions across all key activities.

- **Capacity Building & Outreach**
  - **Training Hub**
    - Tailored training programs on relevant topics for various stakeholders including utilities, policy makers and regulators.
  - **Outreach**
    - Technical webinars /Conferences/ Industry conclaves/digital presence/international forums /research events etc.
  - **Exchange Programs**
    - International exchanges for knowledge & resources sharing, showcasing latest know-how & facilities at the center, focused discussions/panel discussion, etc.
Smart Meter Roll Out

Smart Meter Rollout Strategy

• Identifying DISCOMs areas into four zones
  • Green Zone (Smart City and State Capitals Areas)
  • Fast Track Areas (RAPDRP/IPDS Areas with Losses $\geq 15\%$)
  • Healthy Consumption Areas (Balance RAPDRP/IPDS Areas)
  • Basic Consumption Consumer Base Areas (Rural and under DDUGJY and SAUBHAGYA)

• Deployment of Smart Prepaid Meters in next three years
  • strategy,
  • partners and
  • Technologies

As these areas have heterogeneous challenge
Smart Metering Present Scenario

- Completed, 846,058, 5%
- Tenders yet to be issued, 783,599, 5%
- Tender Issued, 1,374,556, 8%
- Bids under Evaluation, 5,270,000, 32%
- Ongoing, 5,113,360, 31%
- Approved Under IPDS, 3,247,561, 19%
International Engagement

- **ISGAN** is an Implementing Agreement under a framework of International Energy Agency (IEA)
  - Strategic platform to support high-level government attention and action for the accelerated development and deployment of smarter, cleaner electricity grids around the world
  - Director, NPMU is Vice Chair of ISGAN Presidium
  - NSGM has organized 13th ISGAN ExCo meeting in March 2017
  - ISGAN in collaboration with NSGM organized 3 days event for dynamic knowledge in Nov 2017 at CPRI, Bangalore-100+ domestic & international participants
  - NSGM-USAID training module on Smart Grids and Model Smart Grid Regulations were accepted for global use adoption

- **Mission Innovation (MI)** is a global initiative of 23 countries and the EU to dramatically accelerate global clean energy innovation
  - DST (Department of Science and Technology) is the nodal agency in India
  - NSGM is engaged with MI and working closely with DST for early adoption of technology(ies) under development
    - Organized SG R&D Conclave workshop jointly with DST at IIT Delhi in August 2018 (exceptional platform to bring together 177 experts from academia, R&D labs, Industry and utilities)
    - Leading Mission Innovation POW Task#2 Demand Response
International Engagement

United States Agency for International Development (USAID), USA

• AMI test pilot at AVVNL
• Basic Smart Grid Training Program for Utility Professionals
• NSGM framework document
• Digital and Behavioral Interventions to enhance customer experience and CBA tool development in progress
• SGKC roadmap development in progress

Department for International Development (DFID), UK

• Smart Grid Readiness and Self Assessment Tool (SGR-SAT) under finalization
• Demand Response Assessment in progress
Learning From Pilots/Projects

• **Technical**: Pilots envisaged installation of Smart Meters. Need for ‘standard’ & ‘specific tampers’ necessitated redesign of existing meters. IS 16444 developed and followed for NSGM projects.

• **Financial**: Delay in arranging counterpart funding (50% for pilot projects/ 30% for NSGM projects) from own resources/ loans/ business models etc. hampered the implementation.

• **Commercial**: Latest opportunities in smart grid is generating more interest amongst vendors. Regulatory support for ToD metering, connect/disconnect, benefits from operational efficiency and loss reduction etc. may facilitate the same.

• **Procurement & Contractual**: Stringent technical & commercial QRs hampered workable consortiums/JVs. At least 5-7 years O&M be included in project for sustainability, Projects on ESCO/lease model with minimal financial risk to utilities.

• **Focus Constraints**: Utility focus remained on equipment deployment & technology demonstration. Process redesign, regulatory & requisite change management lag behind.
Interoperability Challenges

Where We Started | Where We Stand Now
---|---
No standards or specifications | IS 16444 and companion standards for Smart Meters
Communication
- PLC – not so reliable
- RF – very little market penetration
- GPRS – higher charges | Communication
- PLC – Dependable results
- RF – canopy and mesh based
- GPRS – arbitration for interoperability
No availability of data | Analytics and various ancillary services
DISCOM Challenges & Opportunities

**Challenges**
- Tariff framework - cross subsidy
- Demand uncertainty and long term PPAs
- Decreased generation to counter demand
- Increased RE: planning and scheduling
- Low Cost RE Shift demand - Day Peak
- Energy Storage and EVs
- Last mile connectivity and maintenance
- Stranded, aging and under utilized assets
- Mismatch of fixed cost payable & fixed asset recoverable
- Stiff scheduling norms and lack of forecast maturity

**Opportunities**
- Dynamic Tariffs
- Better IT solutions
- Demand/Data analysis & BI tools
- Business Process Redesign
- Decommissioning
- Low cost RE
- Shift demand - Day Peak
National Energy Storage Mission (NESM)

- February 2018, Committee constituted by MNRE to propose draft for National Energy Storage Mission (NESM).
- Draft NESM -leadership in energy storage -enabling policy and regulatory framework - encourages manufacturing, deployment, innovation and cost reduction.
- NITI Aayog and Rocky Mountain Institute’s joint report - Energy Storage Mission – 3 stage approach
  - Enabling battery manufacturing growth;
  - scaling supply chain strategies;
  - scaling of battery cell manufacturing.
- Known Energy Storage Application:
  - integrating RE with distribution and transmission grids
  - Setting Rural micro grids with diversified loads or stand-alone systems
  - developing Storage component of electric mobility plans.
  - Infrastructure Constrain - Metro RoW → Peak Off-peak Capacity Arbitrage
R&D projects under DST involving Storage

• Reconfigurable Distribution Networks : (at IIT Kharagpur) (partners: IIT Bombay & IIT Kanpur)

Objective: to design and develop a Microgrid test facility composed of PV, FC, Battery& Supercapacitor hybrid storage and control platforms to host prototype new devices.

The facility was designed to include Solar and Wind energy system with three layers of storage, Battery and Supercapacitor at first, Fuel Cell at second and Diesel generator at third with distributed control platforms and real time communication system.

• Intelligent MicroGrids with Appropriate Storage for Energy (IMASE) (at IIT Bombay)

A typical urban residential scenario with load shedding is considered. This is a backup power system with different battery chemistries – VRLA, Li-ion, NiCd, NiMH, LiS, VRFB – are compared.

Technical-Environmental-Economic Analysis (TEEA) of the energy storage technologies done for the three scales of storage: quality of supply, daily storage and seasonal storage. A dedicated modeling software is also developed for design and analysis of the microgrid.
R&D projects under DST involving Storage

- **Modular Storage Element for Micro-grid Integration** (at IISc Bangalore)

  Objective: develop cost-effective lead acid batteries and supercapacitors as hybrids for integration with the micro grid. HUCs and lead acid batteries were used for energy storage.

  The battery solutions work efficiently within a current range (both charging and discharging). However, using HUCs extends this range effectively for both low and high currents.

  It is critical to manage charge/discharge profiles of batteries to improve their life span & to improve the efficiency of the entire system by harvesting low energy sources (e.g. cloudy conditions, low winds, etc.) effectively.

- **SMART Planning and Operations of Grids with Renewables and Storage (SPOReS)**
  
  (At IIT Bombay) (partners: GERMI Gandhinagar)

  Work carried to provide suite of tools to address planning and operational issues for facilitating transition to a large-scale deployment of renewable generation.

  A lab based prototype of Smart Brown Box has been designed using embedded hardware and user interface has been developed. Algorithms for Smart Storage Manager and Smart Signalling Framework are being developed and tested.
Delhi: Std. Deviation in FY 2018-19

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<th>Month</th>
<th>Std. Deviation Peak Hrs</th>
<th>Std Deviation Off Peak Hrs</th>
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<td>Apr'18</td>
<td>313.36</td>
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<td>May'18</td>
<td>403.48</td>
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Utilities Need to assess their current stage with help of SGR-SAT prepared by NSGM-PMU, discuss priority steps, investment requirements and likely tangible and intangible returns in SLPMU meetings

Smartness of the system requires
- Sensors,
- Switches,
- Software
Partially these are effective,
Together these are ultimate solution
• Showcased during 1st SLPMU meeting-cum-workshop organized on 7th February 2019.
• Online SGR-SAT is ready and will be hosted on NSGM website for use by DISCOMs shortly.
Design Consideration: Six Domains reflect key utility functions

1. Organization (Utility)
   - Represented by: (i) vision & strategy; (ii) people/HR; (iii) Skills and capacities; (iv) mgt. reporting

2. Network
   - Network & load planning, network (substation & distribution) modernization, communication systems and asset maintenance
   - Network planning, Asset deployment and Mgmt.

3. Grid operations
   - Enabling Grid observability, reliability and quality of power supply

4. Revenue Management
   - Process related to metering, billing, and collection

5. Customer
   - Customer services and enabling customer engagement & participation

6. Regulatory & Policy
   - This also includes utility’s external interaction with policy makers/regulators for enabling investments & ensuring consumer protection

National Smart Grid Mission
Ministry of Power
Government of India
Smart Grid Goals

No. of Utilities / States / Micro Grids

Utilities with AMI
SLPMU in states
Utility Smart Grid roadmaps
Utilities with DSM / DR practice
Utilities with Maturity rank 3 or 4
Micro grids
NSGM Documents

NSGM Implementation Framework

Model DPR for NSGM SG Projects

Model RfP for AMI Projects