An Overview of Indian Power Sector and Development Plan for Distribution Sector

Vivek Goel
Chief Engineer (Dist)
Central Electricity Authority

Nov 2018

Present status of Indian Power Sector

Installed Capacity	344.72 GW (Sep 2018)
Gross Electricity Generation	1303 BU (2017-18)
Per capita consumption (in kWh)	1149 (2017-18)
% T&D Losses	21.42 % (2016-17)
% AT&C Losses	~22% (2016-17)
Peak Demand Met (in GW)	176 GW (2018)

Fuelwise Generation Installed Capacity in India

(As on 30-09-2018)

Fuel	Installed Capacity (MW)	% Share in Total IC
Coal	196,098	56.89%
Gas	24,867	7.21%
Diesel	837	0.24%
Thermal -Total	221,802	64.34%
Hydro	45,487	13.20%
Nuclear	6,780	1.97%
RES	70,649	20.49%
Total	344,718	100.00%

Ownership-wise Installed capacity

(30-9-2018)

Sector	Central	State	Private	Total
Thermal	64193	71009	86600	221802
Hydro	12151	29942	3394	45487
Nuclear	6780	0	0	6780
Renewable	1502	2005	67142	70649
Total	**84,626**	**1,02,956**	**1,57,136**	**3,44,718**
%age contribution	**25%**	**30%**	**45%**	100%

Sector-wise Energy Conttibution

(During 2017-18)

Sector	Installed Capacity (IC %age)	Energy contribution (% age)
Thermal	65.7%	76%
Hydro	13.5%	12.5%
Nuclear	2.0%	2.5%
Renewable	18.8%	9%
Total	100%	100%

Power Supply Position

(as per CEA report)

	2016-17	2017-18	2018-19 (upto Sep 2018)
Energy Requirement (BU)	1142.92	1213.33	658.00
Energy Supplied (BU)	1135.33	1204.69	654.15
Shortage %	-0.7%	-0.7%	-0.6%
Peak Demand GW	159.5	164.07	176.5
Peak Met GW	156.9	160.75	175.5
Shortage %	-1.6%	-2.0%	-0.6%

Category wise Consumption In India

Category	Avg %age of consumption (2017-18)
Domestic	24.2%
Commercial	8.5%
Industrial	41.5%
Agriculture	18.1%
Misc.	6.5%

Demand Projections of the Country

Year	Peak Demand (GW)	CAGR	Energy Requirement (BU)	CAGR
2016-17	156.9		1160	
2021-22	225.7	7.5%	1566	6.2%
2026-27	298.8	5.8%	2047	5.5%

Source: 19th Electric Power Survey (EPS) published by CEA

Proposed Installed Capacity by 2022 (As per National Electricity Plan of CEA)

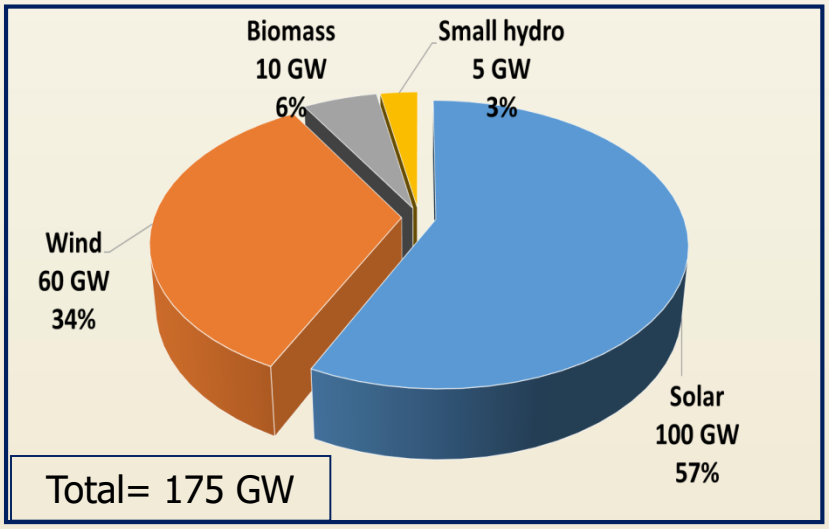
Source	Capacity in GW	%age
Coal	**217.3**	**45%**
Hydro	**51.3**	**11%**
Gas	**25.7**	**5%**
Nuclear	**10.1**	**2%**
Renewable	**175.0**	**37%**
Total IC	**479.4**	**100%**

IC of non-fossil fuel/Total IC (%)
49.3%

DEMAND PROJECTION (19th EPS)

Year	Peak Demand (GW)	Energy Requirement (BU)
2021-22	225.7	1,566
2026-27	298.8	2,047

RES CONTRIBUTION IN TOTAL ENERGY REQUIREMENT DURING 2017-22



Scenario	RES IC by 2022 (GW)	RES Energy Contribution (BU) in Total Energy requirement
I	175	327 (20.19%)

Proposed Installed Capacity by 2027 (As per Draft National Electricity Plan)

Source	Capacity in GW	%age
Coal	**238**	**39%**
Hydro	**63**	**10%**
Gas	**26**	**4%**
Nuclear	**17**	**3%**
Renewable	**275**	**44%**
Total IC	**619**	**100%**

IC of non-fossil fuel/Total IC (%)
57.4%

India's Intended Nationally Determined Contribution (INDC)-

40 % cumulative power installed capacity should be from non-fossil fuels by 2030.

Year	Likely IC (GW)	Likely IC of Fossil Fuel (GW)	Likely IC of Non-Fossil Fuel (GW)	% of Non-Fossil Fuel in IC
March 2022	479.5	243.1	236.4	49.3%
March 2027	619.1	263.9	355.2	57.4%

PER CAPITA CONSUMPTION (All INDIA)

Year	Per Capita Consumption
2012-13	914
2013-14	957
2014-15	1010
2015-16	1075
2016-17	1122
2017-18	**1149**
Target	
2018-19	1372
2019-20	1473
2020-21	1568
2021-22	1668

PER CAPITA CONSUMPTION (Avg World)

Country	kWh
World Average	3052
USA	12833
Australia	9892
Japan	7865
Germany	7015
Italy	5099
Brazil	2516
China	4047
India	1100

(IEA 2015)

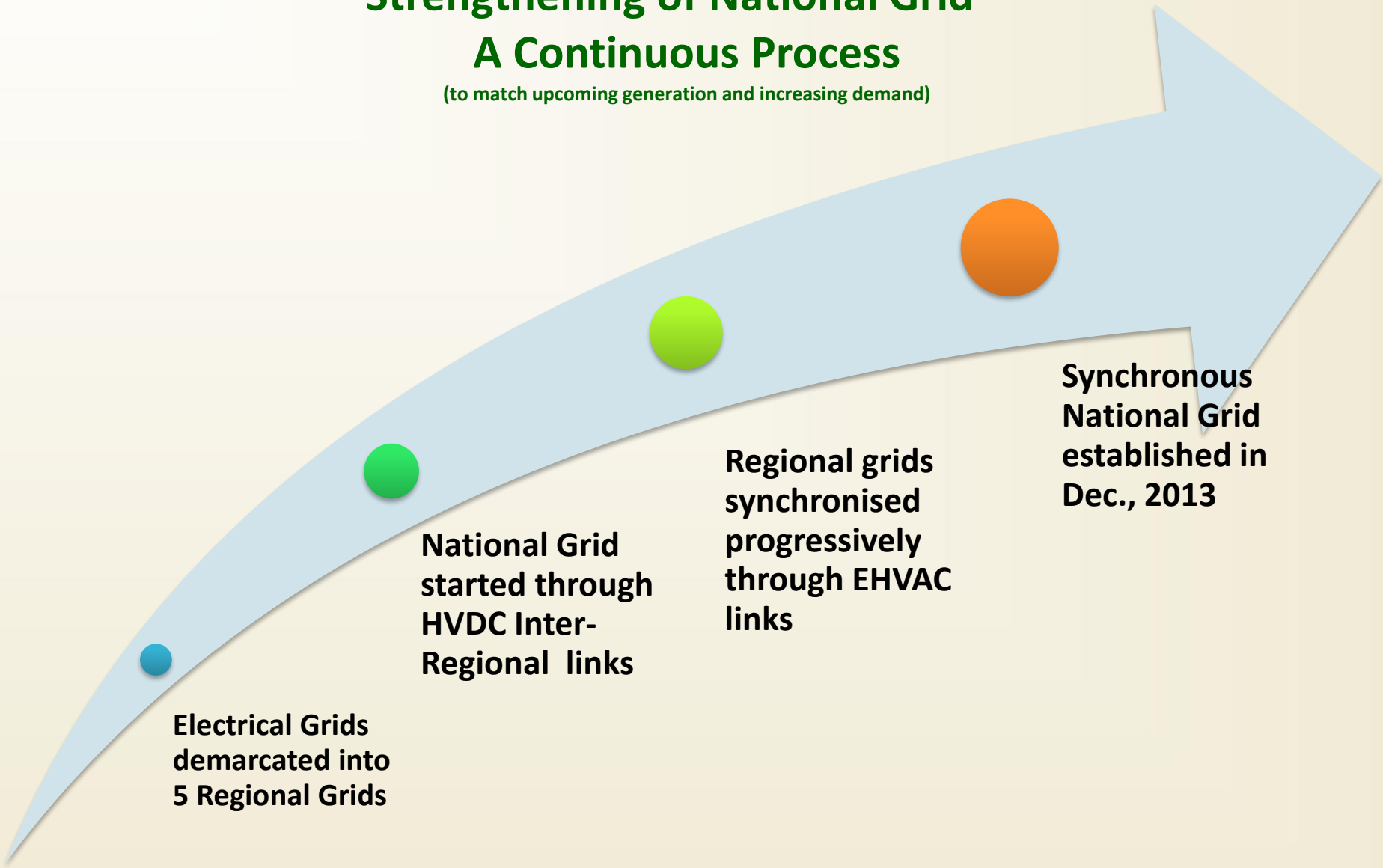
Transmission System – As of Today

- **All India synchronous grid – One of the largest synchronous electricity grid in the World**
- **Strong back bone of 400 kV – Overlay of 765 kV & high capacity HVDC**
- **Green energy corridor for facilitating transmission of about 40,000 MW RE power**
- **PMU (Phase Measurement Units) have been installed at various locations by CTU (PGCIL) for Grid security**
- Establishment of Renewable Energy Management Centres enabling forecasting of renewable generation, real time monitoring, etc

Development of Synchronous National Grid

Strengthening of National Grid – A Continuous Process

(to match upcoming generation and increasing demand)



Total Transmission Lines & Transformation Capacity

(Voltage-wise)

(As on 30-09-2018)

Transmission Lines (cKm)

Voltage	Total Transmission Lines (Ckm)	Proposed by 2022 (Ckm)
765 kV	36794	56731
400 kV	175677	203644
220 kV	172875	190325
HVDC (+/- 800KV)	6124	9800
HVDC (+/- 500KV)	9432	10015
Total	**4,00,902**	**4,70,515**

Transformation Capacity (MVA)

Voltage	Total Transformation Capacity (MVA)	Proposed by 2022 (MVA)
765 kV	201500	269000
400 kV	295182	337372
220 kV	339726	373265
HVDC (+/- 800KV)	9000	18000
HVDC (+/- 500KV)	13500	13500
Total MVA	**8,58,908**	**10,11,135**

Distribution Utilities in India

➢ Electricity Departments (EDs)	10
➢ Private Distribution Companies	25
➢ Corporatised Distribution Companies	59
➢ Total	94

T&D LOSSES AND AT&C LOSSES

Year	T&D (%)	AT&C (%)
2010-11	23.97	26.04
2011-12	23.65	26.63
2012-13	23.04	25.48
2013-14	21.46	22.62
2014-15	22.77	25.72
2015-16	21.81	23.98
2016-17	21.42	22.00
2017-18 (Appx)		**18%**
Target 2019-20		**15%**

T&D LOSSES OF VARIOUS COUNTRIES

Country	T&D Losses (%)
USA	6%
UK	8%
Japan	5%
Russia	12%
Australia	6%
India	21%
World Avg	**9%**

MAIN FACTORS FOR HIGH T&D LOSSES

Technical Losses

- Overloading of existing lines and substation equipment
- Low HT:LT lines ratio
- Poor repair and maintenance of equipment
- Non-installation of sufficient capacitors/reactive power equipment
- Non balancing loading of system

Commercial Losses

- Low metering/billing/collection efficiency
- Theft, pilferage of electricity and tampering of meters
- Absence of Energy Accounting and Auditing
- Wrong estimation of un metered/ agriculture energy

THRUST AREAS IN DISTRIBUTION

- 24x7 RELIABLE, QUALITY & AFFORDABLE POWER TO ALL
- 100% HOUSEHOLDS ELECTRIFICATION
- REDUCTION OF AT&C LOSSES BELOW 10%
- FINANCIALLY VIABLE DISCOMS
- IMPROVEMENT IN SUB-TRAN. AND DIST.NETWORK
- 100% METERING, BILLING & COLLECTION
- ADOPTION OF IT FACILITIES IN DISTRIBUTION
  (Smart Grid, GIS Mapping , SCADA, AMR, RMUs etc.)
- MORE CONSUMER SATISFACTION
- EFFECTIVE CONSUMER GRIEVANCES REDRESSAL

INITIATIVE BEING TAKEN BY DISTRIBUTION COMPANIES

- Achieving 100% Metering, Billing & Collection efficiency
- Metering of all 11 KV feeders & Dist transformers for energy auditing
- Augmentation of overloaded distribution system
- Implementation of HVDS
- Use of star rated Distribution Transformers
- Use of ABC in theft prone areas
- IT initiative like SCADA, DMS, GIS mapping, AMR/AMI etc
- Segregation of rural & agriculture feeders etc

GOI SCHEMES/PROGRAMS FOR DEVELOPMENT OF DISTRIBUTION SYSTEM

- **24x7 Power For All:** A joint initiative of GOI with States to provide 24x7 power supply to All consumers
- **IPDS:** Launched in 2014 for providing funding for augmentation of distribution system in urban areas. Earlier RAPDRP scheme subsumed in this scheme.
- **DDUGJY** : Launched in 2014 for electrification of villages, augmentation of distribution system in rural areas and feeder segregation etc. Earlier RGGVY scheme subsumed in this scheme. 100% villages have been electrified in May 2018 under the scheme.
- **SAUBHAGAYA :** Launched in 2018 for providing funding for 100% household electrification by Dec 2018
- **UDAY :** Launched in 2015 for Operational and Financial Turnaround of Power Distribution Companies (DISCOMs)
- **NSGM:** Launched in 2015 for development of smart Grid in the country.30% funding is being provided for smart grid projects

Initiatives taken in Energy Efficiency

- Star labeling of appliances and equipments (A.C, Refrigerator, fans, Ag motors, Dist Transformers etc.)- covered 21 appliances /equipment
- UJALA Scheme for providing LED bulbs to Domestic consumers for energy efficiency in domestic sector- Replacement of 770 million bulbs with LED bulbs- about 310 million LED bulbs distributed
- LED based Street Lightning(NSLP)- Replacement of 14 million Street Lighting with LED lighting- 7 Million completed
- PAT(Perform Achieve & Trade) Scheme for energy efficiency in Industries and Discoms (Ph-I, II & III)
- Demand side Management (DSM) in Agriculture-use of energy efficient Agriculture pump sets
- Energy Conservation Building Code(ECBC) Revised in 2017- applicable for commercial buildings having load more than 100 KW
- Certification of Energy Auditor and Energy Managers

Distributing Plan up to 2022

NATIONAL PLAN– NETWORK EXPANSION

SN	Description	Unit	March 2017	March 2022	Increase %
1	S/S (66/33/22 kV)--Count	Nos	32,991	43,097	31%
2	S/S (66/33/22 kV)--Capacity	MVA	3,81,583	5,25,539	38%
3	Feeders(66/33/22kV)-Count	No	30,373	45,330	49%
4	Feeders(66/33/22kV)-Length	CKM	4,30,011	5,39,934	26%
5	Feeders (11kV) Nos	Nos	1,93,911	2,68,087	38%
6	Feeders (11kV) Length	CKM	42,05,043	56,22,121	34%

NATIONAL PLAN– NETWORK EXPANSION

Sr	Description	Unit	March 2017	March 2022	Increase %
7	Capacitor Bank	MVAR	51,250	77582	51%
8	Distribution Transformer(DT) (11/0.433 KV) count	Nos	93,29,354	122,67,104	31%
9	Distribution Transformer(DT) (11/0.433 KV) capacity	MVA	5,04,831	6,61,632	31%
10	LT Feeders (1-Ph & 3 Ph)	CKM	75,96,311	95,92,453	26%

- *Above network expansion would strengthen the sub-transmission and distribution system and help to provide 24x7 reliable and quality power to the end consumers.*
- *Est fund requirement for the above expansion Plan would be around 3 Lakh Crores.*

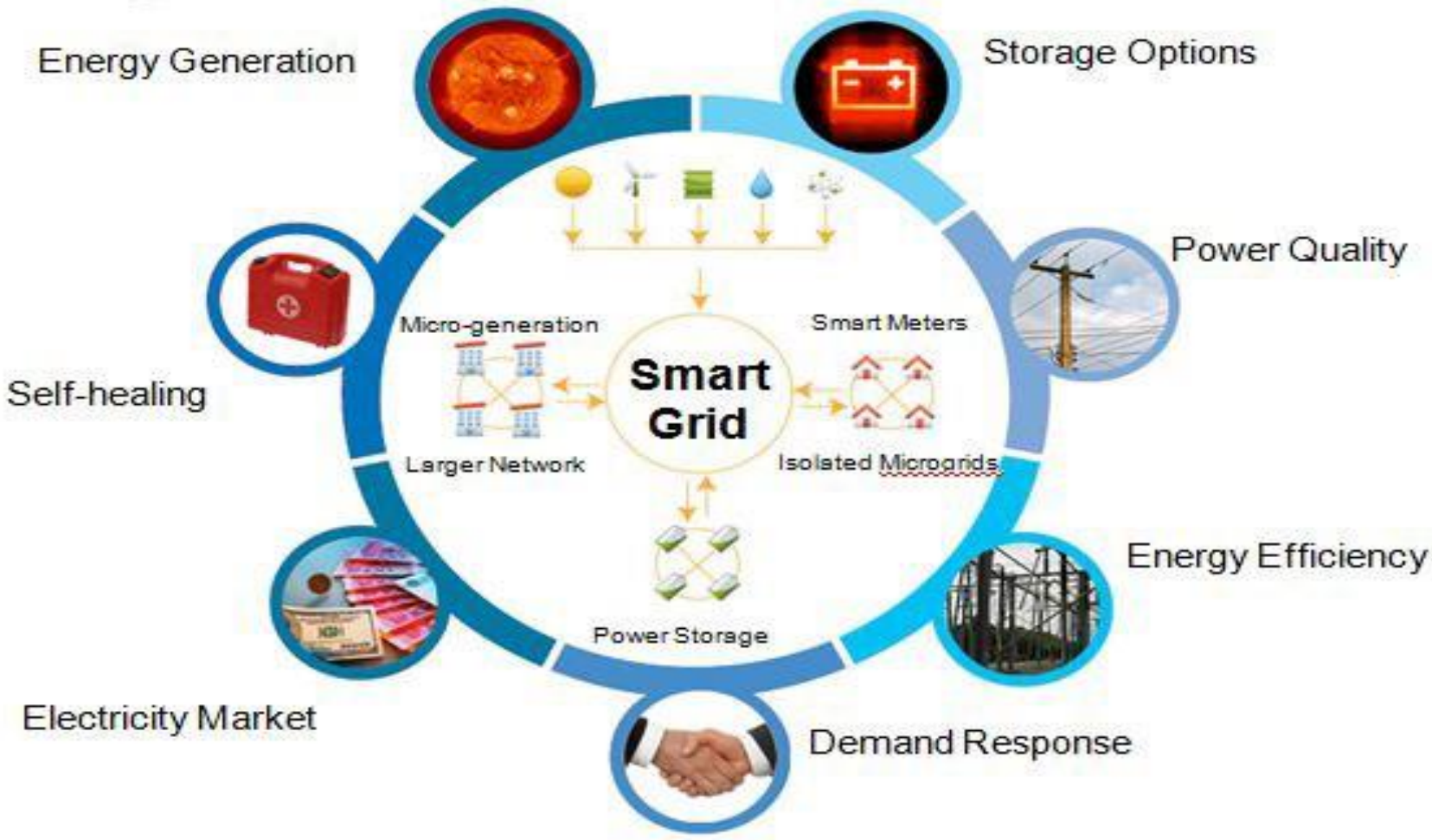
- All India HT/LT ratio is about 0.53 during 2015-16 which is likely to be improved to 0.6 by 2022.

Central Electricity Authority

Infrastructure under implementation - IPDS/DDUGJY

SN	Description	Unit	Scope	Achievement	Remaining scope	Plan Add.	%age wrt Dist plan
1	S/S (66/33/22 kV)—new	Nos	3752	1715	2037	10106	**37%**
2	S/S (66/33/22 kV) capacity (New+ Aug)	MVA	27922	9514	18408	143956	**19%**
3	Feeders(66/33/22kV)-Length	CKT	54736	18737	35999	109923	**50%**
4	Feeders (11kV) -length	CKM	794536	426492	368044	1417078	**56%**
5	Dist. Transformers-count	Nos	1590719	862813	727906	2937750	**54%**
6	Dist. Transformers-MVA	MVA	42373	13492	28881	156801	**27%**
7	LT Lines length	CKT	935439	619702	315737	1996142	**47%**
8	Meters	Nos	4 Cr	2 Cr	2 Cr	7 Cr	**57%**

Central Electricity Authority



Introduction of Smart Grid in India Initiatives

India is not far behind developed nations for introduction of smart Grid in the country -rather forefront!

Journey So far -

- 2008-09: R-APDRP – Introduction of IT in distribution sector -basic building blocks of Smart Grids
- 2011: India Smart Grid Task Force(ISTF) and India Smart Grid Forum (ISGF)
- 2012: approval of Smart Grid Pilot Projects
- 2013: release of Smart Grid Vision and Roadmap for India
- **National Smart Grid Mission approved in 2015 for development of smart grid in the country**
- **Model Smart Grid Regulations approved in June 2015 by Forum of Regulators**
- **Standards for Smart Meters (IS 16444) issued by Bureau of Indian Standards**
- **Central Electricity Authority issued Functional requirement of Advanced Metering Infrastructure (AMI) including specifications of smart meters in 2016**
- **A SBD is prepared by NSGM for Smart Grid projects which may be used by the utilities for tendering smart grid projects**

Initiatives

Smart Grid Pilots

- 15 pilot projects sanctioned with 50% funding by GOI having functionalities like AMI for domestic and Industrial consumers, PLM, RE integration, OMS etc
- 12 pilots projects under implementation
- A Smart Grid Knowledge Center has been established for capacity building of the utilities

NSGM Projects

- 7 projects worth Rs.915 Cr. have been sanctioned for installation of about ~10 lakh smart meters with 30% funding under NSGM

Basic Functions of AMI

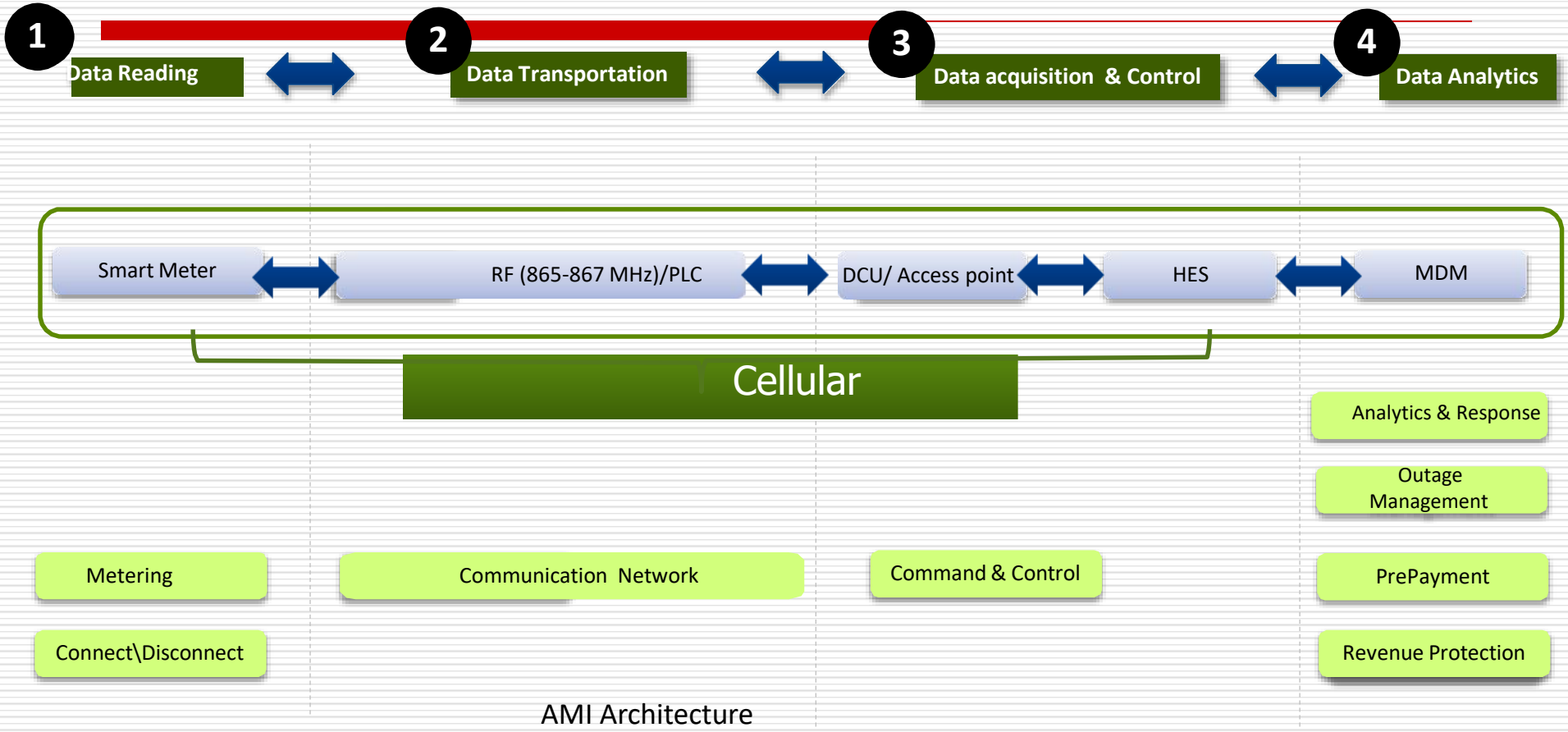
- Remote Meter data reading at configurable intervals(push/pull)
- Time of day (TOD)/Time of use (TOU) metering
- Pre paid functionality
- Net Metering
- Alarm/ Event detection, notification and reporting
- Remote Load Limiter and connection/ disconnection at defined/on demand conditions
- Remote firmware upgrade
- Integration with existing systems created under RAPDRP like Billing & collection software, GIS mapping, consumer indexing, analysis software, Outage Management System etc / Import of data from existing modules/ MDAS of RAPDRP where ever possible
- Security features to prevent unauthorized access to the AMI including Smart meter & meter data etc. and to ensure authentication for all AMI elements by third party

General AMI System requirements

- **Smart Meters -**Single Phase & Three Phase whole current smart meters shall comply with the Technical Specifications as included in the document (As per IS 16444/ IS 15959)
- **Communication infrastructure – RF/PLC/Cellular or combination of these**
- **Head End System(HES)**
- **Meter Data Management System (MDMS)**
- **Web application with updated on-line data of consumers etc.**
- **Mobile App- through which consumer shall be able to see information related to his energy consumption. App shall also provide platform for implementation of peak load management functionality by providing existing tariff & incentives rates, participation options etc.**

Central Electricity Authority

Key Components of AMI



AMI Architecture

SMART METERING PLAN

- There is a plan to replace all the existing consumer meters (about 250 Million) by Smart meters in next 3 years which can be used in the prepaid mode.
- Central Government is supporting States for adoption of smart meters through schemes like National Smart Grid Mission , IPDS etc
- Rs 830 Crores under IPDS and Rs 270 Crores GBS have been approved
- A Huge Financial Implication for replacement of all existing meters with smart meters (After taking an avg Cost per node of Rs 3000/-, there would be an additional requirement of funds of about Rs 75000 Crores for replacement of all existing 25 Crores meters with smart meters.)

Challenges in Smart Meter Deployment in the Country

- High meter/AMI costs
- Upfront Capex investment a challenge for utility
- Utilities not having any proven case – low confidence level
- Low utility skill/ initiative to implement the project
- Information Asymmetry on benefits of data analytics
- Regulatory issues

SMART METERING PLAN- Financial Modals

- To avoid the capital cost on smart metering projects, we may move to OPEX modals in place of Capex modal.
- Utilities may explore/adopt any of financial model available in the market for financing the smart metering projects in the country like self financing BOOT modal of EESL /funding under IPDS or NSGM etc
- Recently, about 50 lakh smart meters (5 Million meters) are being deployed by EESL in Uttar Pradesh and Haryana under self-financing model in which capital cost is being provided by EESL and the recovery is based on per node per month cost based on some pre defined parameters.

Smart Metering –Way Forward

- Under the EESL Modal, EESL is making the entire upfront investment as well as will maintain the entire infrastructure for the next 7-8 years and recover its investment on per node basis based on certain parameters.
- In some modals, the recovery may also be linked with the savings accruing to the DISCOMs in subsequent years through reduction of AT&C losses.
- The self financing modals has made the Smart Metering project feasible as most of the state utilities are not in a position for such rollouts due to their financial constraints.
- Now, all the enablers including standards and financial modals for implementing smart metering in the country are in place, States have to take initiatives for implementation of Smart Metering in their respective Discoms as Distribution of Electricity falls under the purview of State Governments in India.

THANK YOU