An Overview of Indian Power Sector and Challenges & Opportunities for Ensuring Efficient, Reliable Electricity

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Players In The Indian Power Sector

Generators

Central/State GENCOs, IPPs, Captive

CTU

Inter-State Trans. System, Open Access

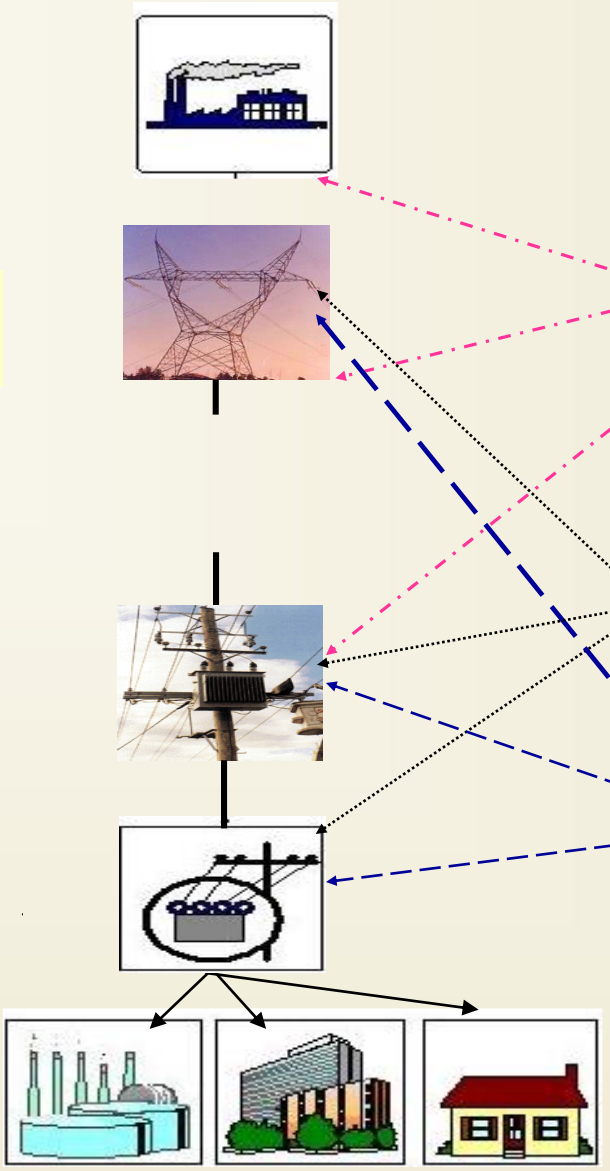
STU

Intra-State Trans./Sub-Trans. System

DISCOMs

Consumers

Industries, Household, Agriculture etc



Indian Power Sector since Independence

Installed Capacity (in GW)	1.36 (1947)	329.30 (30.09.2017)
Gross Electricity Generation (in BU)	4.07 (1947)	1142.9 (2016-17)
Per capita consumption (in kWh)	16.3 (1947)	1122 (2016-17)
% T&D Losses	-	21.81 % (2015-16)
% AT&C Losses	-	23.98% (2015-16)
Peak Demand Met (in GW)	-	160 (2017-18)

Fuelwise Generation Installed Capacity in India

(As on 30-09-2017)

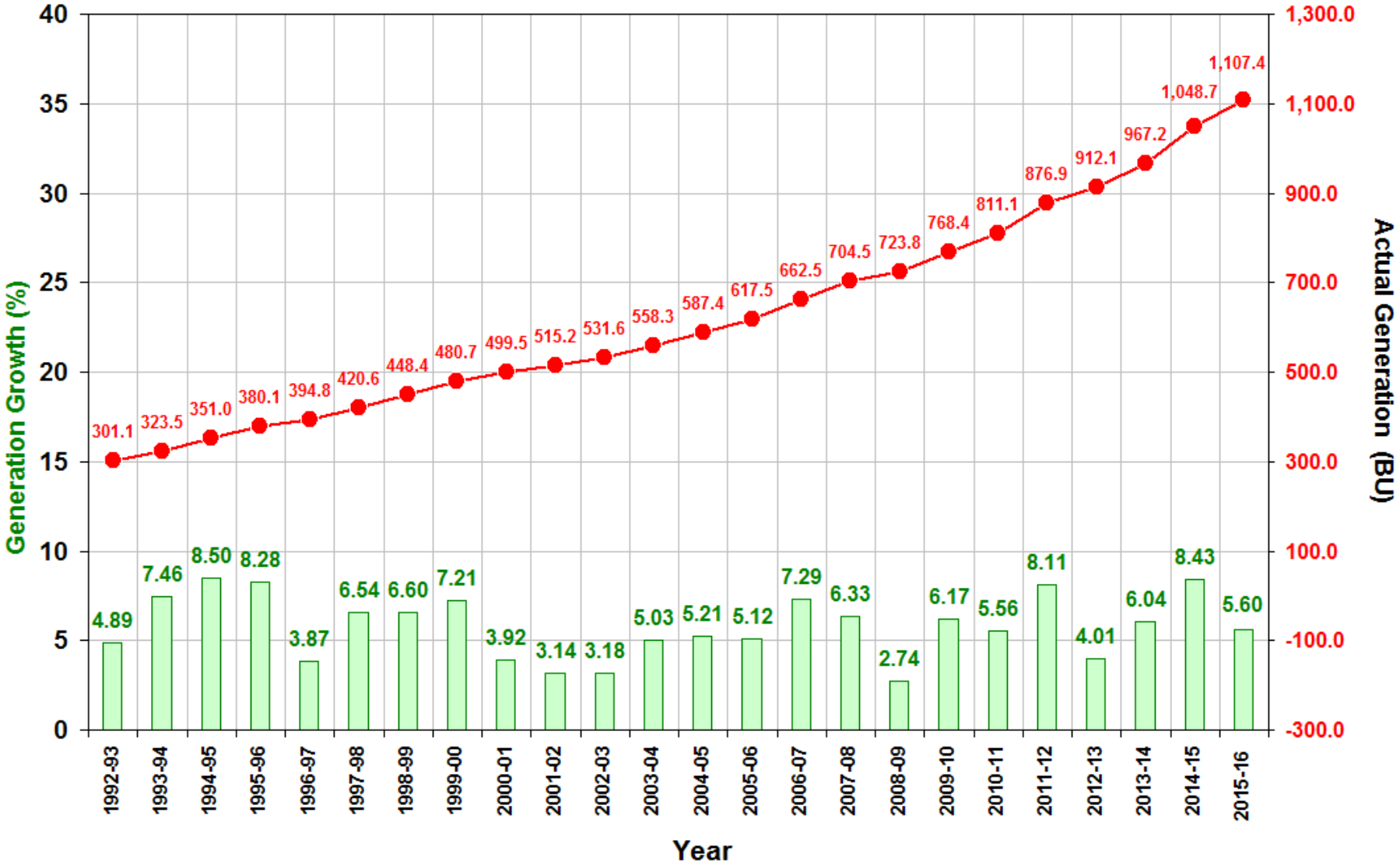
Fuel	Installed Capacity (MW)	% Share in Total IC
Thermal	**219,449**	66.6%
Coal	**193,427**	57.8%
Gas	**25,185**	7.6%
Diesel	**837**	0.3%
Hydro	**44,765**	13.6%
Nuclear	**6,780**	2.1%
RES	**58,303**	17.7%
Total	**329,298**	100.0%

Sector-wise Generation Installed Capacity in India

(As on 30-09-2017)

Sector	Installed Capacity (MW)	% Share in Total
Central Sector	103,033	31.29%
State Sector	81,102	24.63%
Private Sector	145,162	44.08%
Total	329,298	

Electricity Generation & Growth over the years



Power Supply Position

	2016-17	2017-18 (upto Oct 2017)
Energy Requirement (Billion Units)	1142.92	720.43
Energy Supplied (BU)	1135.33	715.24
Shortage %	-0.7%	-0.7%
Peak Demand GW	159.5	164.07
Peak Met GW	156.9	160.75
Shortage %	-1.6%	-2.0%

Sector-wise Energy met

(During 2017-18)

Sector	Installed Capacity (IC %age)	Energy contribution (% age)
Thermal	66.6%	76%
Hydro	13.6%	12.5%
Nuclear	2.1%	2.5%
Renewable	17.7%	9%
Total	100%	100%

Typical Category wise Consumption In India

Category	Avg %age of consumption (CEA General Review)
Domestic	23%
Commercial	8%
Industrial	44%
Agriculture	18%
Misc.	7%

Demand Projections of the Country

Year	Peak Demand (GW)	Energy Requirement (BU)
2021-22	225.7	1566
2026-27	298.8	2047
2031-32	370.5	2531

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

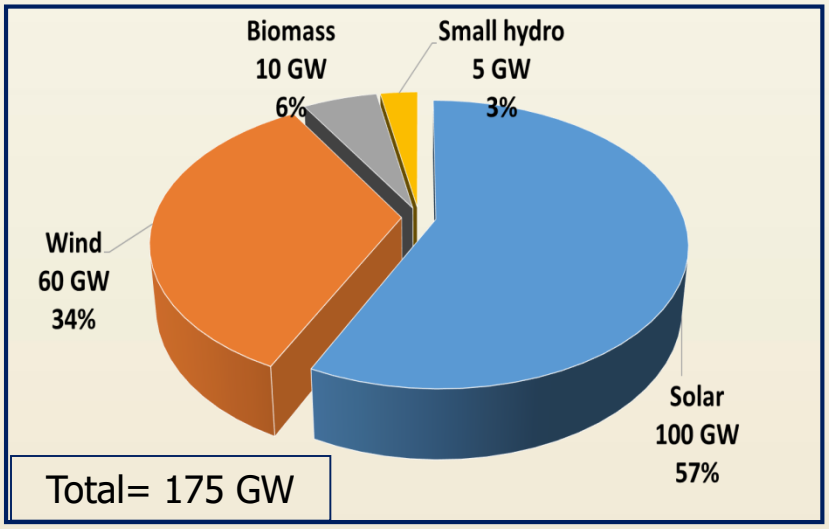
DEMAND

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

DEMAND REDUCTION DUE TO DSM

Year	Energy Requirement (BU)	Peak Requirement (GW)
2021-22	206	9
2026-27	273	12

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 2022 (As per Draft National Electricity Plan)

Source	Capacity in GW
Coal	**217.3**
Hydro	**51.3**
Gas	**25.7**
Nuclear	**10.1**
Renewable	**175.0**
Total IC	**479.4**

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

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

Source	Capacity in GW
Coal	**238**
Hydro	**63**
Gas	**26**
Nuclear	**17**
Renewable	**275**
Total IC	**619**

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

India's Intended Nationally Determined Contribution (INDC)

40 % cumulative power installed capacity 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	kWh
2006-07	672
2007-08	717
2008-09	734
2009-10	779
2010-11	819
2011-12	883
2012-13	914
2013-14	957
2014-15	1010
2015-16	1075
2016-17	**1122**

PER CAPITA CONSUMPTION INDIA (Target)

Year	kWh (Target)*
2017-18	1276
2018-19	1372
2019-20	1473
2020-21	1568
2021-22	1668

* Tentative

PER CAPITA CONSUMPTION
Avg World

Country	kWh
World Average	3104
USA	12988
Australia	10134
Japan	7836
Germany	7019
Italy	5159
Brazil	2529
China	3762
India	1100

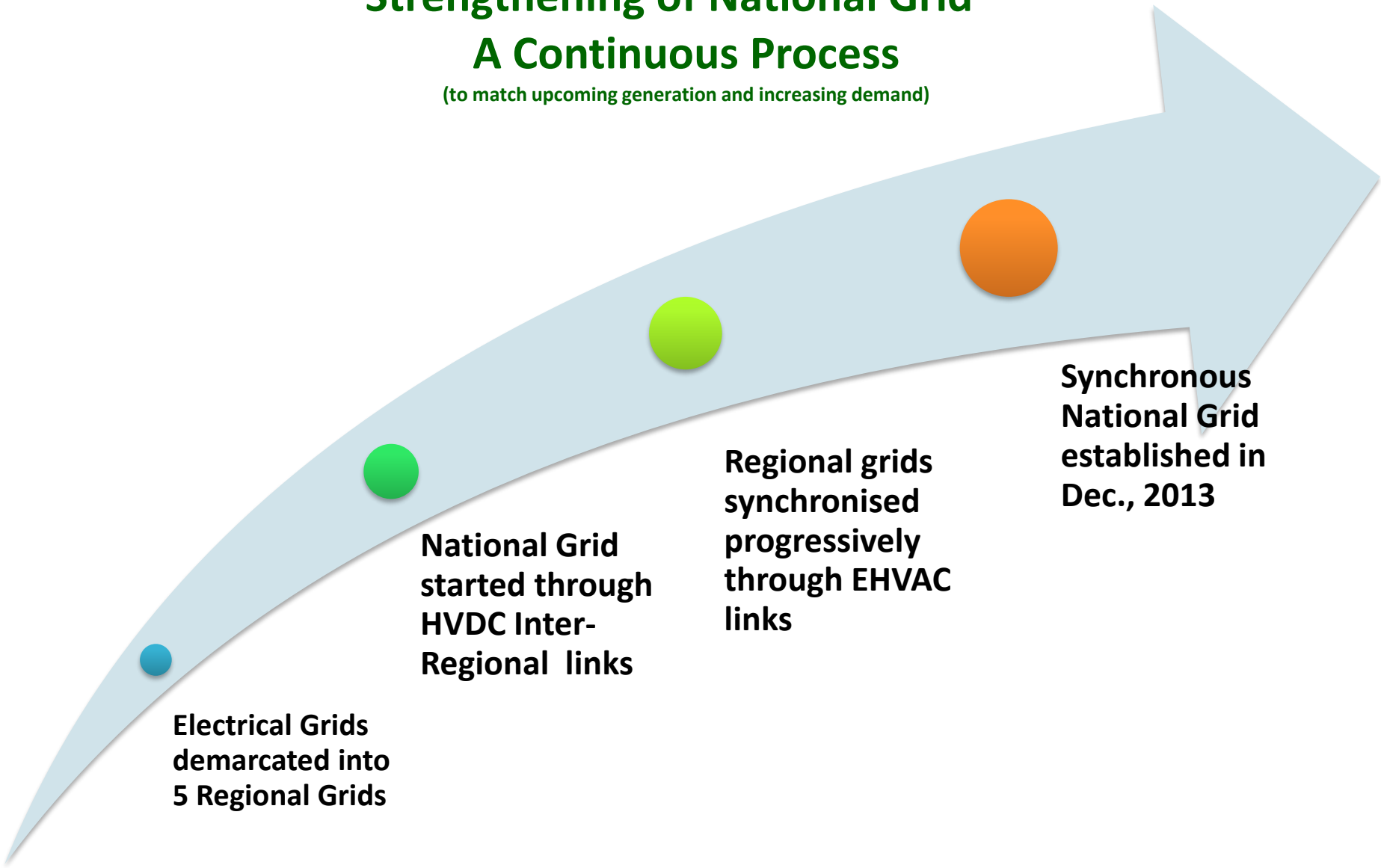
Transmission System – As of Today

- **Strong back bone of 400 kV – Overlay of 765 kV & high capacity HVDC**
- **All India synchronous grid – One of the largest synchronous electricity grid in the World**
- **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 (cKm) & Transformation Capacity (MVA)

(Voltage-wise)

(As on 30-09-2017)

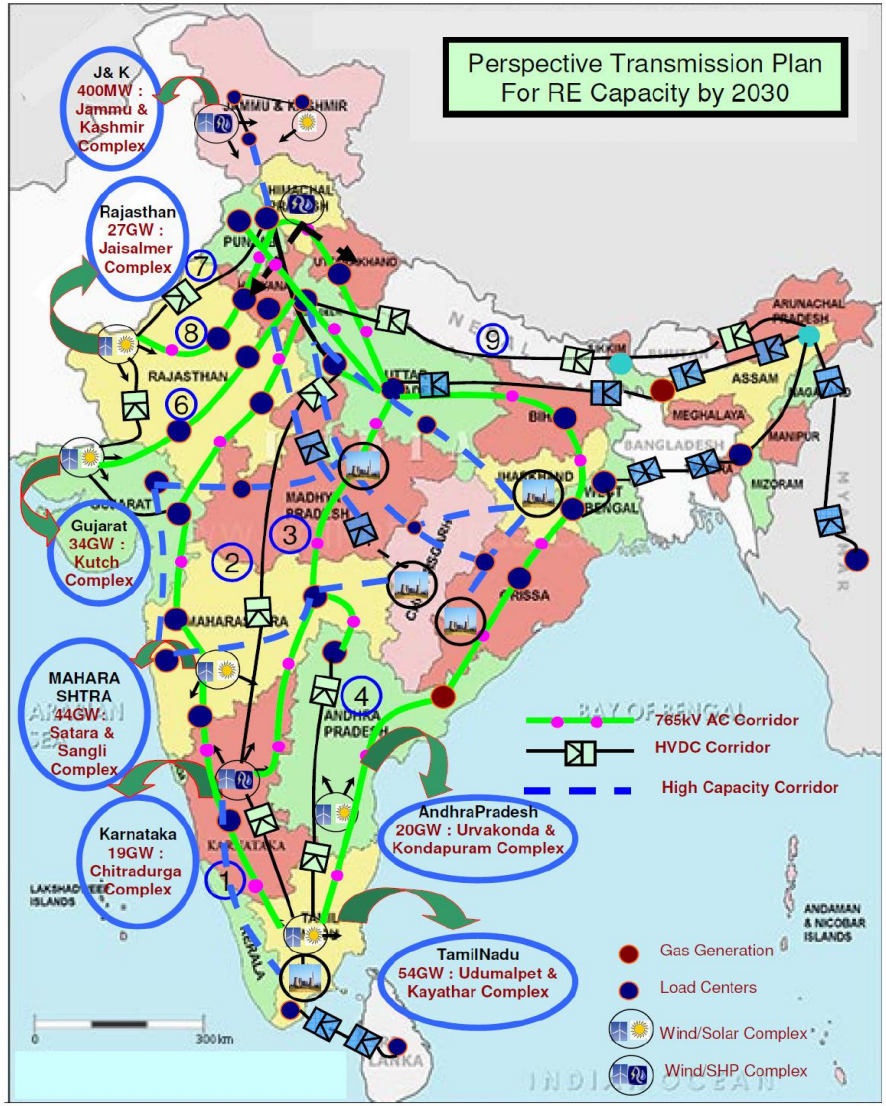
Transmission Lines (cKm)

Voltage	Total Transmission Lines (cKm)	% Share in Total
765 kV	33,286	8.8%
400 kV	166,465	44.0%
220 kV	163,268	43.1%
HVDC	15,556	4.1%
Total	378,575	

Transformation Capacity (MVA)

Voltage	Total Transformation Capacity (MVA)	% Share in Total
765 kV	177,500	22.7%
400 kV	261,252	33.4%
220 kV	321,578	41.2%
HVDC	21,000	2.7%
Total MVA	781,330	

Green Energy Corridor : Integration of Renewables



- The Plan includes
  - Transmission strengthening
  - Dynamic reactive compensation,
  - Energy Storage,
  - Smart grid applications,
  - Establishment of Renewable Energy Management Centre enabling forecasting of renewable generation, real time monitoring, etc.

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 (%)
2005-06	30.42	33.02
2006-07	28.65	30.62
2007-08	27.20	29.45
2008-09	25.47	27.37
2009-10	25.39	26.78
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**
Target 2019-20	**15%**	**15%**

T&D LOSSES OF VARIOUS COUNTRIES

Country	T&D Losses (%)
USA	6%
UK	8%
Japan	5%
Russia	10%
Australia	6%
India	21%
World Avg	**8%**

Issues in Distribution Sector

- Poor Financial Position of Distribution Companies
  - High AT&C Losses
  - Inadequate Metering, Billing & Collection.
- Access to Electricity to All Rural HHs
- Less use of IT, Energy auditing & accounting in Distribution sector.
- Overloaded & old sub-transmission and Distribution network

Initiative being taken for Reduction of AT&C Losses

- 100% metering and improving billing & collection efficiency
- Metering of all 11 KV feeders & Distribution transformers for energy auditing
- Augmentation of overloaded distribution system under various schemes
- Implementation of HVDS
- Use of Arial bunched Conductors (ABC)
- IT initiative like SCADA, GIS, AMR etc
- Segregation of rural & agriculture feeders
- Online feeder data on power portal

RURAL ELECTRIFICATION

- As per census 2011, there are 5,97,464 inhabited villages in the country.
- At present about 2462 (0.4%) villages in the country are still un-electrified and targeted to be electrified by May 2018.
- DDUGJY scheme- launched in Dec 2014 to provide funding to the states to electrify all the un-electrified villages and to provide access to all the households in the country. Under the scheme, more than 1,00,000 villages and more than 20 million Households have been electrified in the country.
- At present, about 40 million HH are un-electrified in the country.
- Out of which, about 10 million HH under DDUGJY and about 30 million under newly launched scheme SAUBHAGAYA are targeted to be electrified by Dec 2018.

Initiatives for Energy Efficiency

- BEE (Bureau of Energy Efficiency) is the Nodal organization for taking energy efficiency measures
- Star labeling of Distribution Transformers
- Introduction of UJALA for providing LED to Domestic consumers for energy efficiency in domestic sector
- Introduction of LED based Street Lightning(NSLP)
- Star Rating of Consumer Appliances (A.C, Refrigerator , motors etc.)
- PAT(Perform Achieve & Trade) Scheme for Industries (Ph-I) and Discoms (Ph-II)

Unnat Jyoti by Affordable LEDs for All (UJALA)

❖Govt. of India launched *UnnatJyoti by Affordable LEDs for All* (UJALA) in 2015 to increase energy efficiency in lighting by replacing the inefficient conventional incandescent bulbs in domestic sector and conventional street lighting by LED based Efficient Lighting in the country.

❖Under UJALA , 77 Crore (770 Million) incandescent bulbs in the Country are targeted to be replaced by high quality LED bulbs

❖Energy Efficiency Services Limited (EESL), a government company under the administrative control of Ministry of Power is designated as the implementing agency for UJALA .

❖Under UJALA, about 27.4 crores (274 Million)LED bulbs have been distributed by 10 Nov 2017 in the Country which on an average results into saving of 35600 MU energy per year and avoiding 7128 MW peak demand .

Street Lighting National Programme (SLNP)

❖Govt. of India also launched Street Lighting National Programme (SLNP) along with UJALA to increase energy efficiency in lighting by replacing conventional street lighting by LED based Efficient Lighting in the country.

❖Under Street Lighting National Programme (SLNP), 3.5 crore (35 Million) conventional street lights are targeted to be replaced with smart and energy efficient LED street lights.

❖Energy Efficiency Services Limited (EESL), a government company under the administrative control of Ministry of Power is designated as the implementing agency for UJALA& SLNP.

❖Under Street Lighting National Programme (SLNP), about 38.75 lakhs (3.8 Million) energy efficient street light have been installed in the country by 10th Nov ,2017 which on an average results into saving of 1.5MU energy per day and avoiding 135 MW peak demand.

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) in 2016**
- **A SBD is being prepared by NSGM for 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 including Smart Grid Knowledge Center under implementation
- ~46,000 Smart Meters installed
- Rs.48.47 Cr. released as grant from MoP
- 11 Smart Grid Pilots to be completed by March 2018

NSGM Projects

- 4 projects worth Rs.578 Cr. sanctioned for ~8.4 lakh smart meters with 30% funding under NSGM

- Installation of smart meters is one of the operational performance parameters under the Ujwal Discom Assurance Yojana (UDAY) launched by GOI in Nov 2015 for financial turn around of the Discoms.
- As per tariff Policy 2016 and UDAY scheme, States have to install smart meters for the consumers consuming more than 500 units/ month by Dec 2017 and for the consumers consuming more than 200 units/ month by Dec 2019. (about 35 Million by Dec 2019)

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Basic Functions of AMI as per Function requirement of AMI issued by CEA

- 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 other existing systems like IVRS, Billing & collection software, GIS mapping, consumer indexing, new connection & disconnections, 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.**

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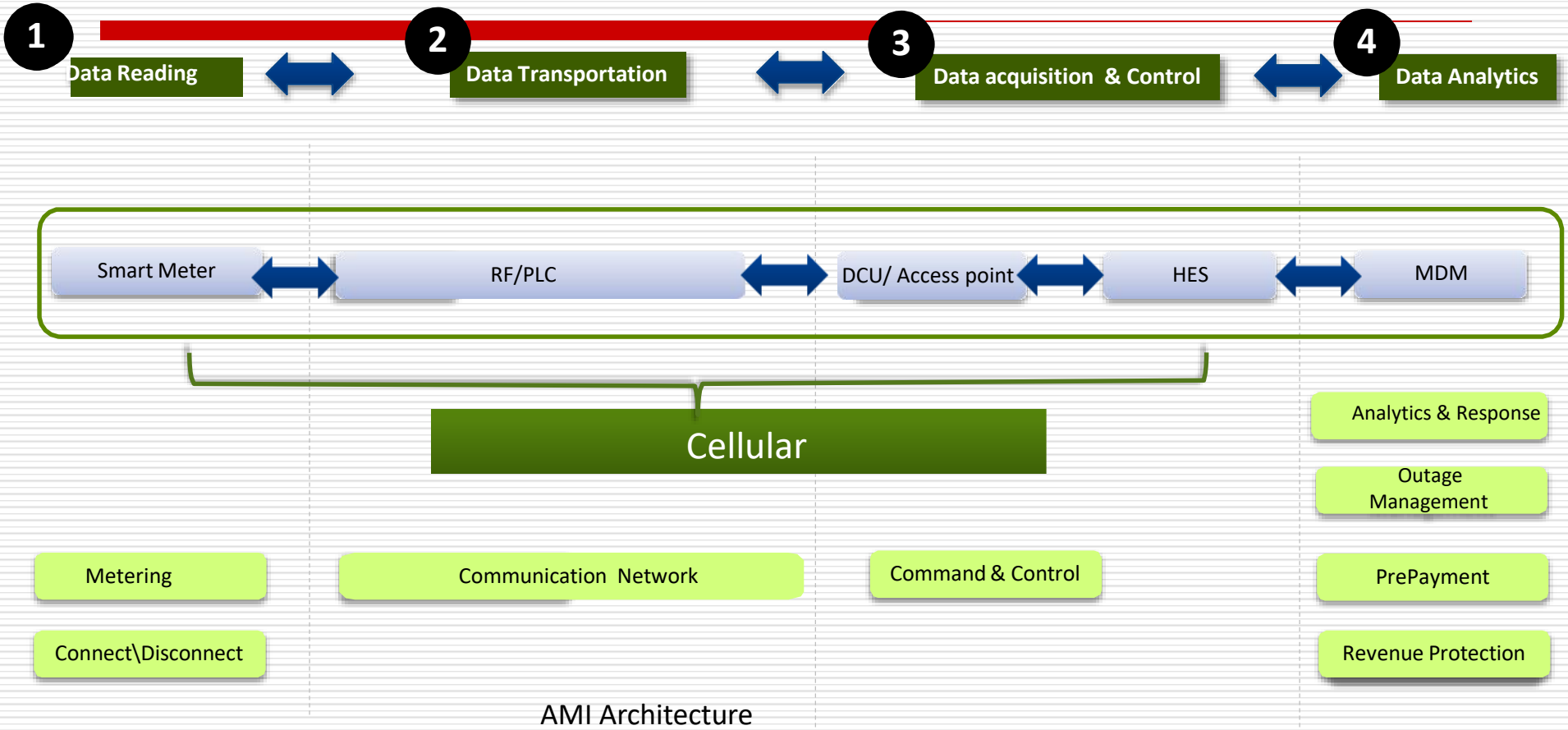
Key Components of AMI



AMI Architecture

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 –Way Forward

- **EESL, a GOI agency, recently floated a tender for 50 lakh (5 million) smart meters for 2 States (Haryana and UP).**
- **Under this proposal, EESL will make the entire upfront investment as well as maintain the entire infrastructure for the next 7-8 years and recover its investment from the savings accruing to the DISCOMs in subsequent years through reduction of AT&C losses.**
- **This approach 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 Goverments in India.**

THANK YOU