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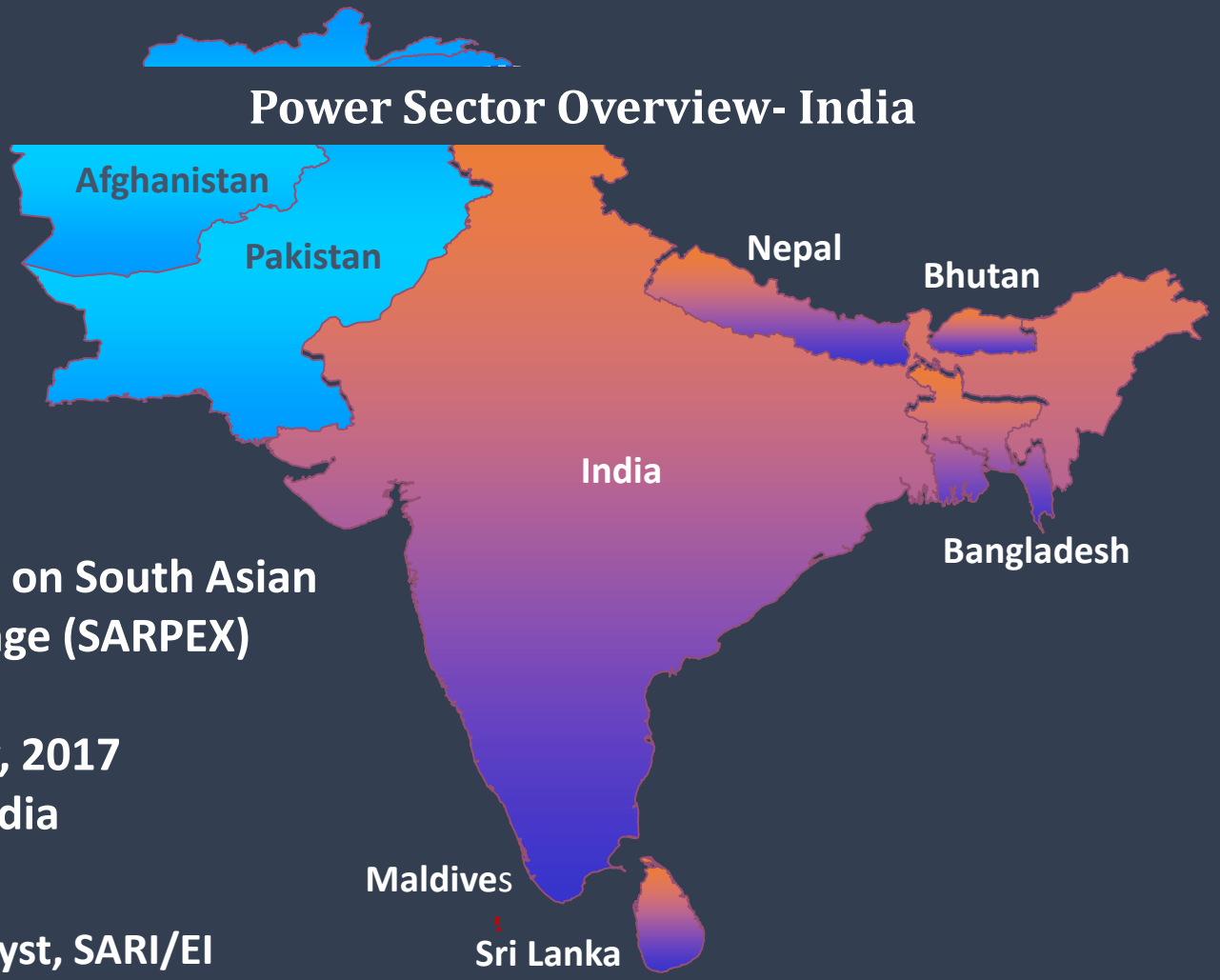
Power Sector Overview- India



First meeting of core team on South Asian Regional Power Exchange (SARPEX)

7th -9th February, 2017
New Delhi, India

Presented by:
Gaurav Jain, Senior Research Analyst, SARI/EI
Suruchi, Consultant KPMG

Power Sector Overview : Highlights

Producer and Consumer Ranking

With a production of 1,031 TWh, India is the third largest producer and fourth largest consumer of electricity in the world. It has fifth largest installed capacity (310 GW) in the world

Government initiated Expansion Plans

The government targets capacity addition of around 100 GW under the 13th Five-Year Plan (2017–22) . The government is keen on promotion of hydro, renewable and gas-based projects, as well as adoption of clean coal technology

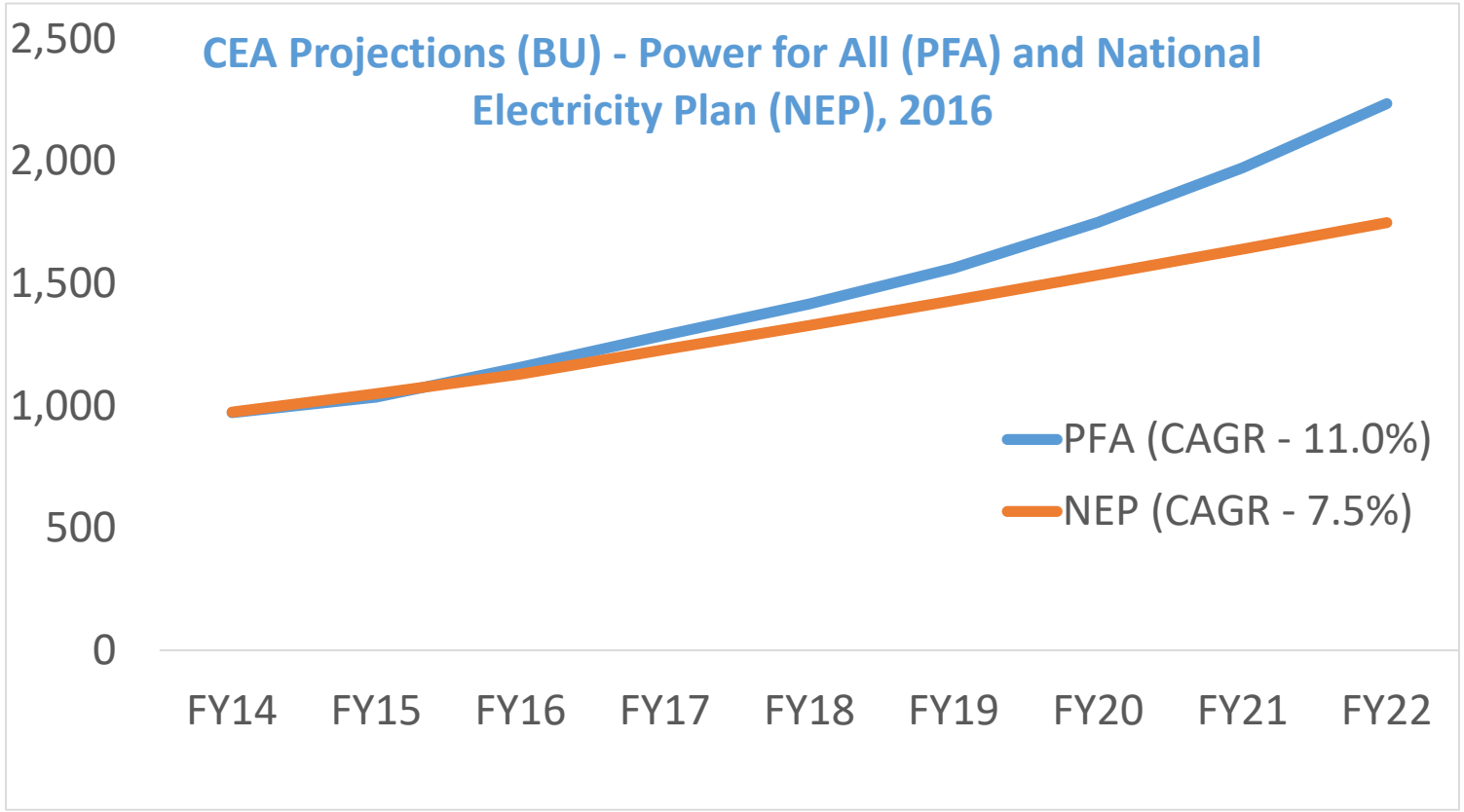
Policy driven Growth in Renewable

The installed capacity of renewable power reached 85 GW as on March 2016. Also, the target for renewable energy has been increased to 175 GW by 2022

FDI with favourable Policy Environment

100 per cent FDI is allowed under the automatic route in the power segment and renewable energy

Electricity Demand Scenario



Drivers of Growth

The growth in demand can be attributed to

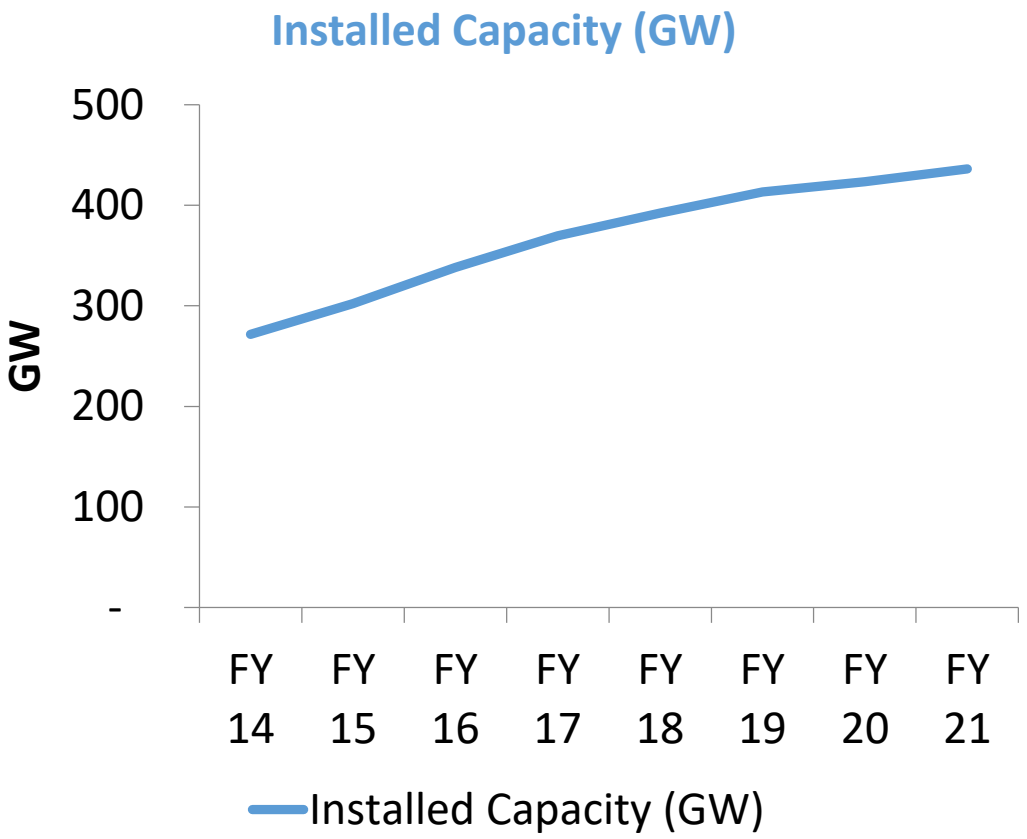
- Expansion in Industrial Activity
- Growing Population
- Increasing Penetration of Power and Per-capita usage

Per capita Demand

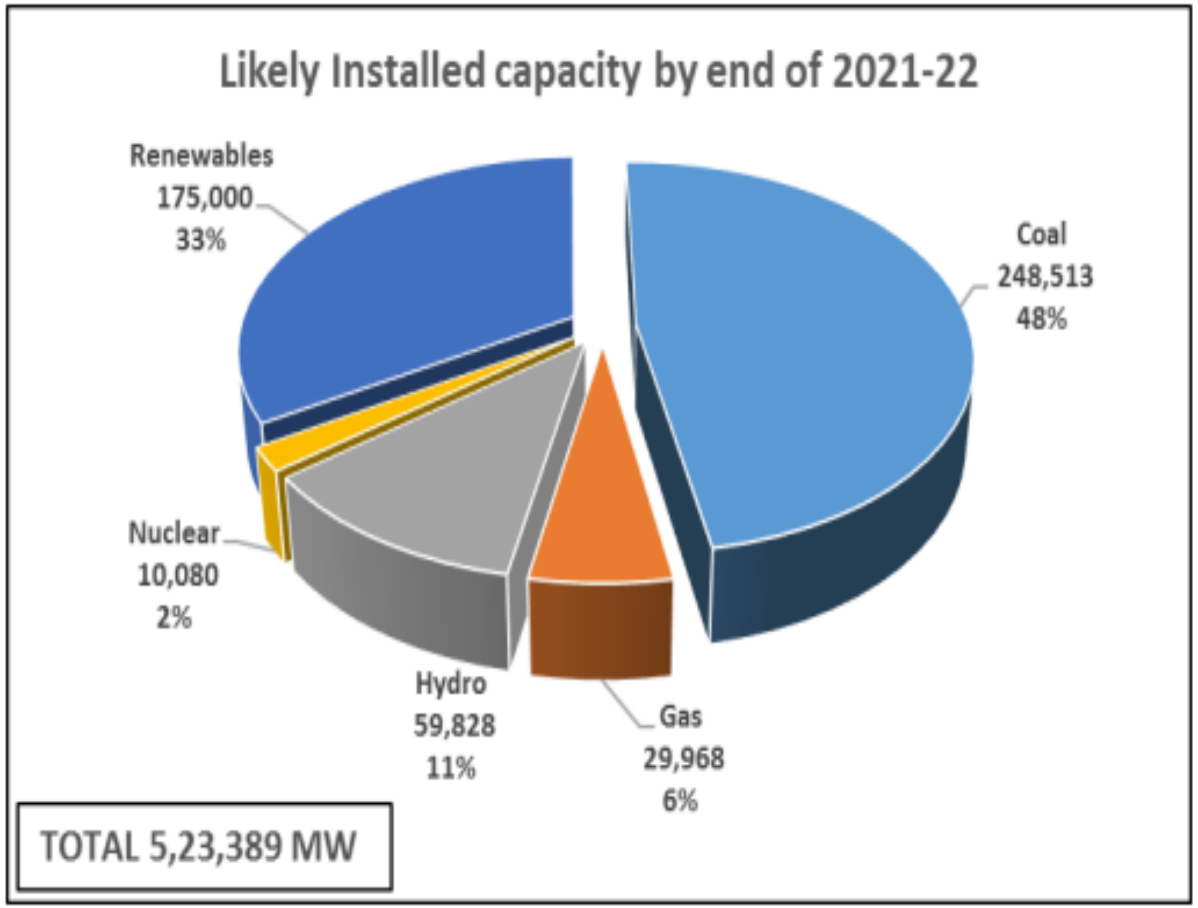
	FY 2017	FY 2022
Per-capita demand, kWh p.a.	1075	1181

Source: NEP, 2016; KPMG Analysis

Electricity Supply Scenario

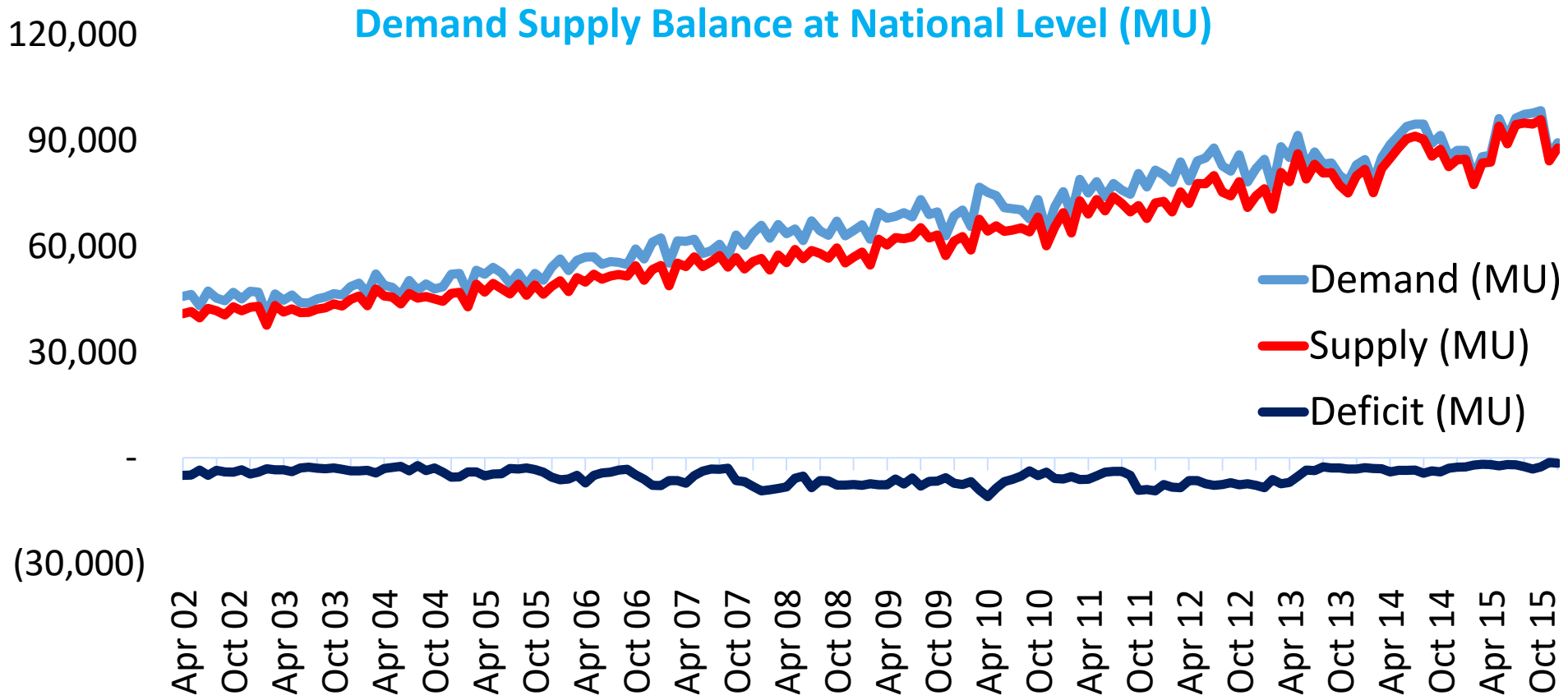


(All figures in MW)



Source: NEP, 2016

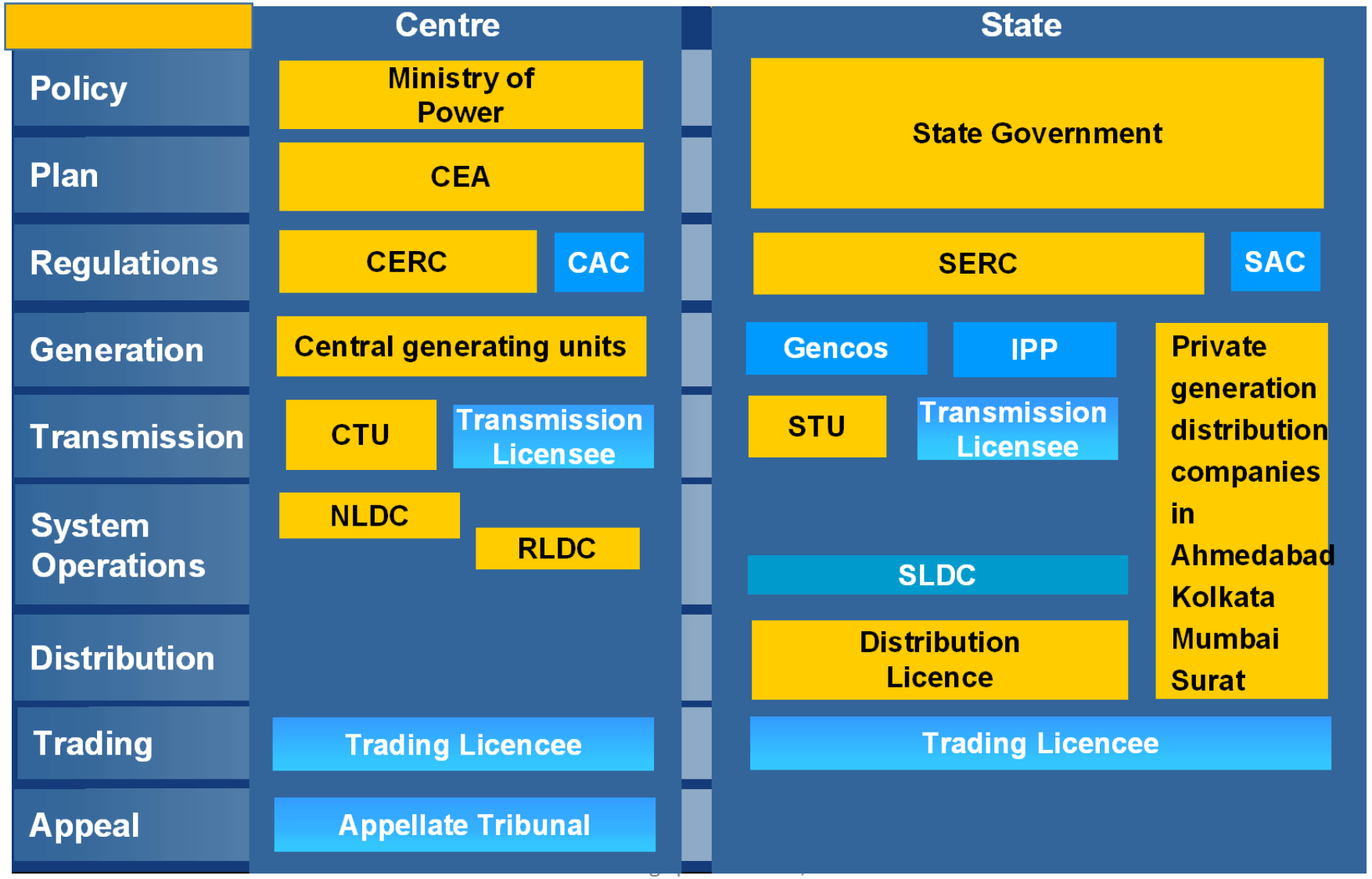
Historical Demand-Supply Position



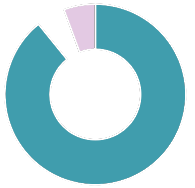
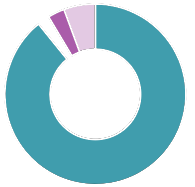
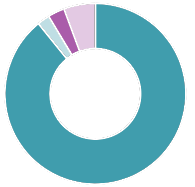
Source: Economics Division, CERC

Source: CEA

Industry Structure



Market Structure

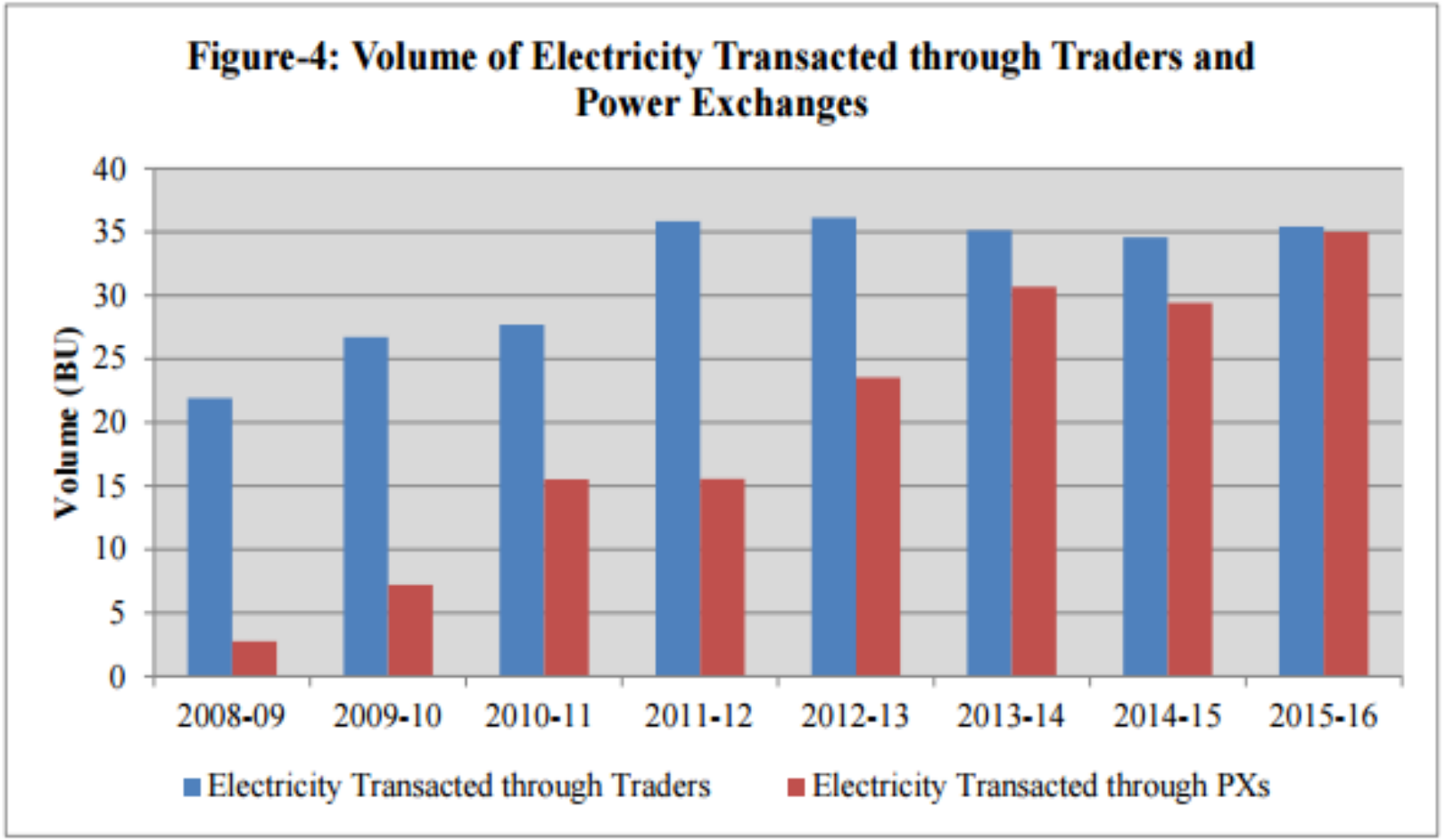
Tenure		Contract Type	Market Share
Long Term	Medium Term	**Power Purchase Agreements** with DISCOMS	 89 %
7 - 25 Years	1 - 7 Years		
Short Term		Bilateral Trade	 5.7 %
Less than 1 year			
Less than 2 weeks 1. Day-Ahead Market 2. Intra-Day Market 3. Term Ahead Market		**Exchange (IEX / PXIL)** IEX Indian Energy Exchange PXIL Power Exchange of India Limited	 3 %
Balancing Market Real Time		Deviation Settlement Mechanism	 1.9 %

Short Term Transactions

In India, the Short Term transactions includes the electricity transacted through following segments

- Trading licensees (inter-state part only) under bilateral transactions
- Day Ahead, Term Ahead and Intraday Market
- Deviation Settlement Mechanism
- Direct transactions of electricity between DISCOMs.

Volumes : Short Term Transactions



Source: Economics Division, CERC

- The graph shows that under Short Term Transactions of Electricity, there was more demand for DAM of power exchanges than the bilateral transactions of traders

- The share of electricity transacted through traders and power exchanges as a percentage of total short-term transactions of electricity has increased from 51.45% in 2009-10 to 64.62% in 2014-15 and further decreased to 61.12% in 2015-16

Prices : Short Term Transactions

Year	Price of Electricity transacted through Traders (₹/kWh)	Price of Electricity transacted through Power Exchanges (DAM+TAM) (₹/kWh)
2008-09	7.29	7.49
2009-10	5.26	4.96
2010-11	4.79	3.47
2011-12	4.18	3.57
2012-13	4.33	3.67
2013-14	4.29	2.90
2014-15	4.28	3.50
2015-16	4.11	2.72

Source: Economics Division, CERC

- Volume of electricity transacted in the short term market registered a positive growth in the year 2015-16 compared to 2014-15

- The price of electricity declined both in bilateral and power exchange during the period.

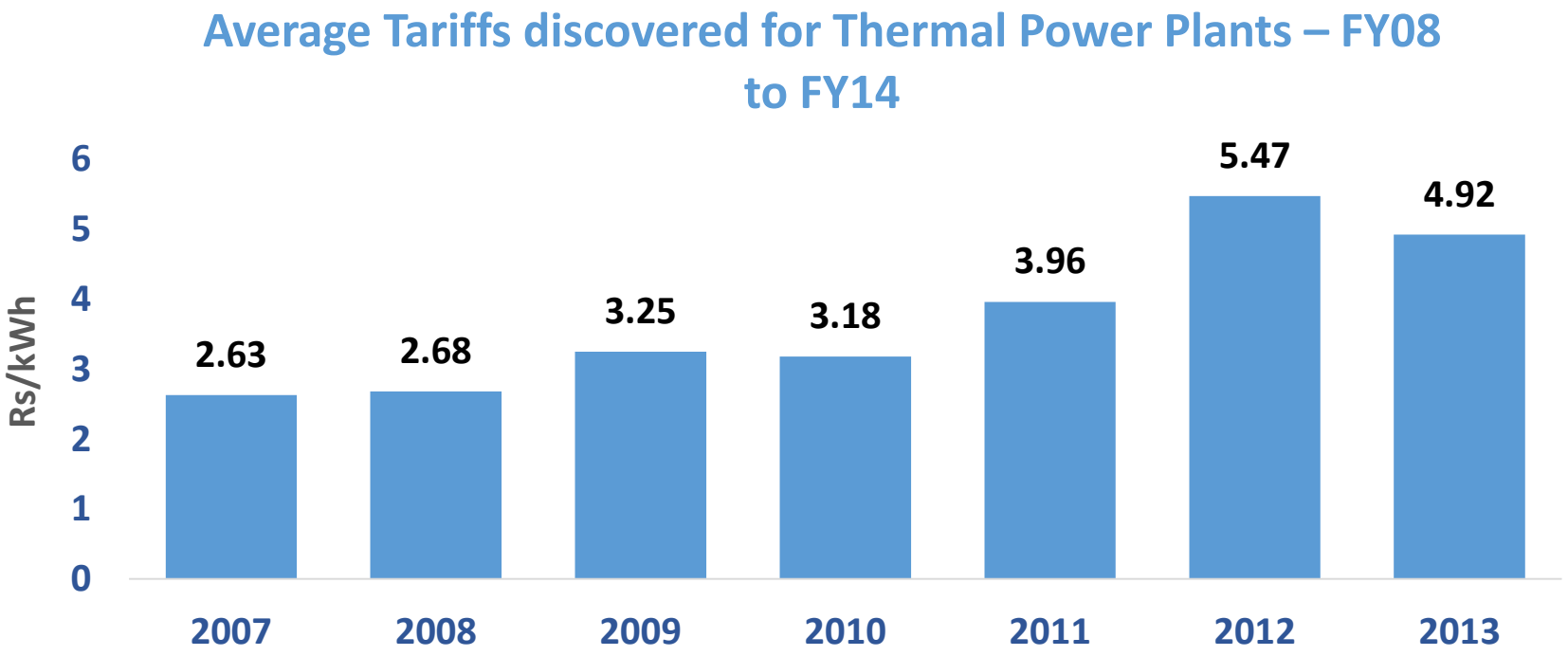
Volumes : Long Term Transactions

- Currently, the total procurement by states through PPAs is 26 GW (~ 66%) only, while the total tenders sought since its inception were for about 40 GW
- Gujarat leads in terms of concluded PPAs under Case 1 followed by UP and Maharashtra
- Recent tenders are from the Southern States and UP

Capacity – MW (Tenders Invited for PPA)											
Bid Year -	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Cumulative**
Uttar Pradesh					3,000				6,000	2,800	**11,800**
Gujarat	3,200			3,000							**6,200**
Andhra Pradesh					2,000		800		2,400		**5,200**
Maharashtra			1,320	4,000							**5,320**
Tamil Nadu							1,000	3,320			**4,320**
Rajasthan				1,200			1,000				**2,200**
Haryana			2,000							-	**2,000**
Karnataka										1,200	**1,200**
Bihar					450	560				-	**1,010**
Kerala									450	-	**450**
Madhya Pradesh			150								**150**
Cumulative	**3,200**	**0**	**3,470**	**8,200**	**5,450**	**560**	**2,800**	**3,320**	**8,850**	**4,000**	**39,850**

Capacity – MW (PPAs)											
Bid Year -	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Cumulative**
Gujarat	3,200			2,810							**6,010**
Uttar Pradesh					2,956				2,811		**5,767**
Maharashtra			1,320	3,815							**5,135**
Tamil Nadu								3,320			**3,320**
Andhra Pradesh					2000		800				**800**
Rajasthan				1,200			1,000				**2,200**
Haryana			1,724							-	**1,724**
Bihar					450	560				-	**1,010**
Kerala									200	-	**200**
Madhya Pradesh			150								**150**
Karnataka											**-**
Cumulative	**3,200**	**-**	**3,194**	**7,825**	**3,406**	**560**	**1,800**	**3,320**	**3,011**	**-**	**26,316**

Prices : Long Term Transactions



Note: (a) Above tariffs are weighted average tariffs of the bids that were successful in that year, however some of them are still under negotiation and one bid process was cancelled.

Source: State Electricity Regulatory Commissions, KPMG Research

- Starting 2011, the tariffs for Case 1 have increased significantly. Tariffs of some bids in the recent past are upwards of 4.75 Rs/kWh

- The increasing tariff trends were in line with the increase in costs, particularly domestic and imported coal, besides the experience gained from the projects which had bid aggressively in the initial years

Price and Volume: Medium Term Transactions

Medium-Term PPAs since 2011-12						
State (Buy)	Region	Plant (Seller)	Capacity	Period of Sale		Rate
			MW	From	To	Rs./kWh
Maharashtra (MSEDCL)	NEW Grid	Adani Power Ltd.	300	Aug-11	Oct-12	4.10
Maharashtra (MSEDCL)	NEW Grid	JSW Energy Ltd.	475	Oct-11	Oct-12	4.10
Maharashtra (MSEDCL)	NEW Grid	Adani Power Ltd.	800	Mar-11	Feb-12	4.10
Maharashtra (MSEDCL)	NEW Grid	JSW Energy Ltd.	200	Mar-11	Feb-12	4.10
Maharashtra (R Infra)	NEW Grid	Wardha Power Company Limited	260	Apr-11	Mar-14	4.85
Maharashtra (R Infra)	NEW Grid	Abhijeet MADC Nagpur Energy Private Ltd	55	Apr-11	Mar-14	4.80
Maharashtra (R Infra)	NEW Grid	Vidarbha Industries Power Limited	134	Apr-11	Mar-14	4.80
BSEB	NEW Grid	Adani Gujarat	200	Mar-12	Dec-15	4.42
Andhra Pradesh, APCDPDCL	SR Grid	KSK Mahanadi Power Company Limited	400	Jun-13	Jun-16	4.29
Andhra Pradesh, APCDPDCL	SR Grid	Corporate Power Limited (Abhijeet Group)	150	Jun-13	Jun-16	4.39
Karnataka, PCKL	SR Grid	Ideal Energy Pvt. limited	200	Aug-13	Jun-15	4.79
Karnataka, PCKL	SR Grid	Essar Power - Mahan Power plant	300	Aug-13	Jun-15	4.90
Karnataka, PCKL	SR Grid	GUVNL	1,000	Aug-13	Jun-15	4.90
TANGEDCO	SR Grid	JPL (Jindal)	200	Sep-12	Aug-17	4.91
TANGEDCO	SR Grid	Adani Gujarat (Mundra)	200	Sep-12	Aug-17	4.99

- Volumes under MT PPAs are presently very low.
Going ahead, the market is expected to grow significantly due to contractual issues experienced in the LT PPAs, lack of clear visibility on the availability and treatment of coal pricing in PPAs, and unavailability of hedging mechanisms for LT PPAs

- The MT market is also expected to grow due to supply replacement for the existing contracts as most of the contracts would be over by FY17

Retail tariffs: Industrial and Domestic

State	Industrial Tariff - Cost per Unit (Rs/Kwh)	Industrial Tariff -Kva/Month	Domestic Tariff - Cost per Unit (Rs/Kwh)
Tamil Nadu			3.00 - 6.60
General High Tension Industry	6.35	Rs 350	
Maharashtra			0.55 - 12.5
General High Tension Industry	6.33-7.01	Rs 190	
Gujarat			3.05 - 5.20
High Tension	4.25-4.35	Rs 245-300	
Andhra Pradesh			1.45 - 8.8
General Hight Tension Industry	5.15-6.02	Rs 371	
Uttar Pradesh			4.00 - 5.50
High Tension	6.2-6.8	Rs 225	
Punjab			1.21 - 9.31
Medium Supply	5.87	Rs 188	
General Industry	6.14	Rs 188	

Regulatory Framework :Ministry of Power

Ministry of Power

- The Ministry of Power is primarily responsible for the development of electrical energy in the country
- The Ministry is concerned with perspective planning, policy formulation, processing of projects for investment decision, monitoring of the implementation of power projects, training and manpower development and the administration and enactment of legislation in regard to thermal, hydro power generation, transmission and distribution
- The Ministry of Power is responsible for the Administration of the Electricity Act, 2003, the Energy Conservation Act , 2001 and to undertake such amendments to these Acts, as may be necessary from time to time, in conformity with the Government's policy objectives
- The Ministry also undertakes the key responsibilities relating to Research, development and technical assistance relating to hydro-electric and thermal power, transmission system network and distribution systems in the States/UTs

Source: NEP, 2016

Regulatory Framework : Statutory Bodies

1 Central Electricity Authority

- To serve as the main technical Advisor of the Govt. of India/ State Government with the responsibility of overall planning
- To formulate short-term and perspective plans for transmission system
- To specify technical standards for construction of electrical plants, electric lines and connectivity to the grid and to specify safety requirements for construction, operation and maintenance of electrical plants and electrical lines
- Promote and assist timely completion of schemes
- To collect and record electrical data- cost, efficiency

2 Central Electricity Regulatory Commission

- To regulate the tariff of inter-state generating companies
- To regulate the inter-state transmission of electricity
- To determine tariff for inter-state transmission of electricity
- To issue licenses for inter state electricity transmission and trading
- To adjudicate upon inter-state disputes
- To specify and enforce the standards with respect to quality, continuity and reliability of service
- To fix the trading margin for inter-state trading of electricity
- To develop national power market
- To discharge other functions as may be assigned under Electricity Act 2003

Regulatory Framework : Statutory Bodies

3

Central Transmission Utility

- To undertake transmission of electricity through inter-State transmission system;
- To discharge all functions of planning and co-ordination relating to inter-state transmission system with STUs, Central/State Government; generating companies; RPCs, CEA, and Distribution Utilities
- To ensure development of an efficient, coordinated and economical system of inter-State transmission lines for smooth flow of electricity from generating stations to the load centers;
- To provide non-discriminatory open access to its transmission system for use by any licensee or generating company or any consumer

4

State Transmission Utility

- To undertake transmission of electricity through intra-State transmission system;
- To discharge all functions of planning and co-ordination relating to intra-state transmission system with CTUs, Central/State Government; generating companies; RPCs, CEA, and Distribution Utilities
- To ensure development of an efficient, coordinated and economical system of intra-State transmission lines for smooth flow of electricity from generating stations to the load centers;
- To provide non-discriminatory open access to its transmission system for use by any licensee or generating company or any consumer

Policy Framework

Consolidation of laws

- Investor friendliness
- Administrative ease

Policy formulation
- National energy policy
- Tariff policy
- Rural electrification policy
- Obligation to supply

- Optimum utilization of resources
- Facilitate participative models for distribution in rural areas

Mandates consultative process for policy formulation

Market development and competition
Recognition of business activities

- **Open access on non-discriminatory basis**
- **Competitive bid based tariff for generation projects**
- Multiple license for distribution area
- Minimum purchase requirement from renewable
- Facilitates unbundling of SEBs
- **Trading, Co-generation, Franchisee**

Regulatory Framework strengthened
Appellate tribunal
Anti-theft provisions
Quality of supply standards
Ombudsman

- Regulatory orders to be reviewed by expert body
- **Incorporates provisions for penalizing theft**
- To be specified along with compensation in case of failure
- To settle consumer grievances

Power System Operation : Key Role of NLDC

POSOCO comprises of:
1. National Load Dispatch Centre (NLDC)
2. Five Regional Dispatch Centers (RLDCs)
Northern
Western
Southern
Eastern
North-Eastern

- Scheduling on Inter-Regional Links
- Scheduling Collective Transactions

Coordination with Regional Power Committees for regional outage schedule in the national perspective to ensure optimal utilization of power resources

Main Functions of NLDC

- **Scheduling and Dispatch of Electricity**
- **Coordination with RLDCs**
- **Maintaining Grid Security**
- **Energy Accounting**

Providing operational feed back for national grid planning to the Authority and the Central Transmission Utility

Levy and collection of such fee and charges from the generating companies or licensees involved in the power system, as may be specified by the Central Commission

Power System Operation : Key Role of RLDCs and SLDCs

ROLE OF RLDCs

To ensure integrated and power system in each such region, the Regional Load Dispatch Centre ((RLDC) has been envisaged as an apex body for dispatch of electricity within the regions, monitoring grid operations etc. Key roles of RLDC include:

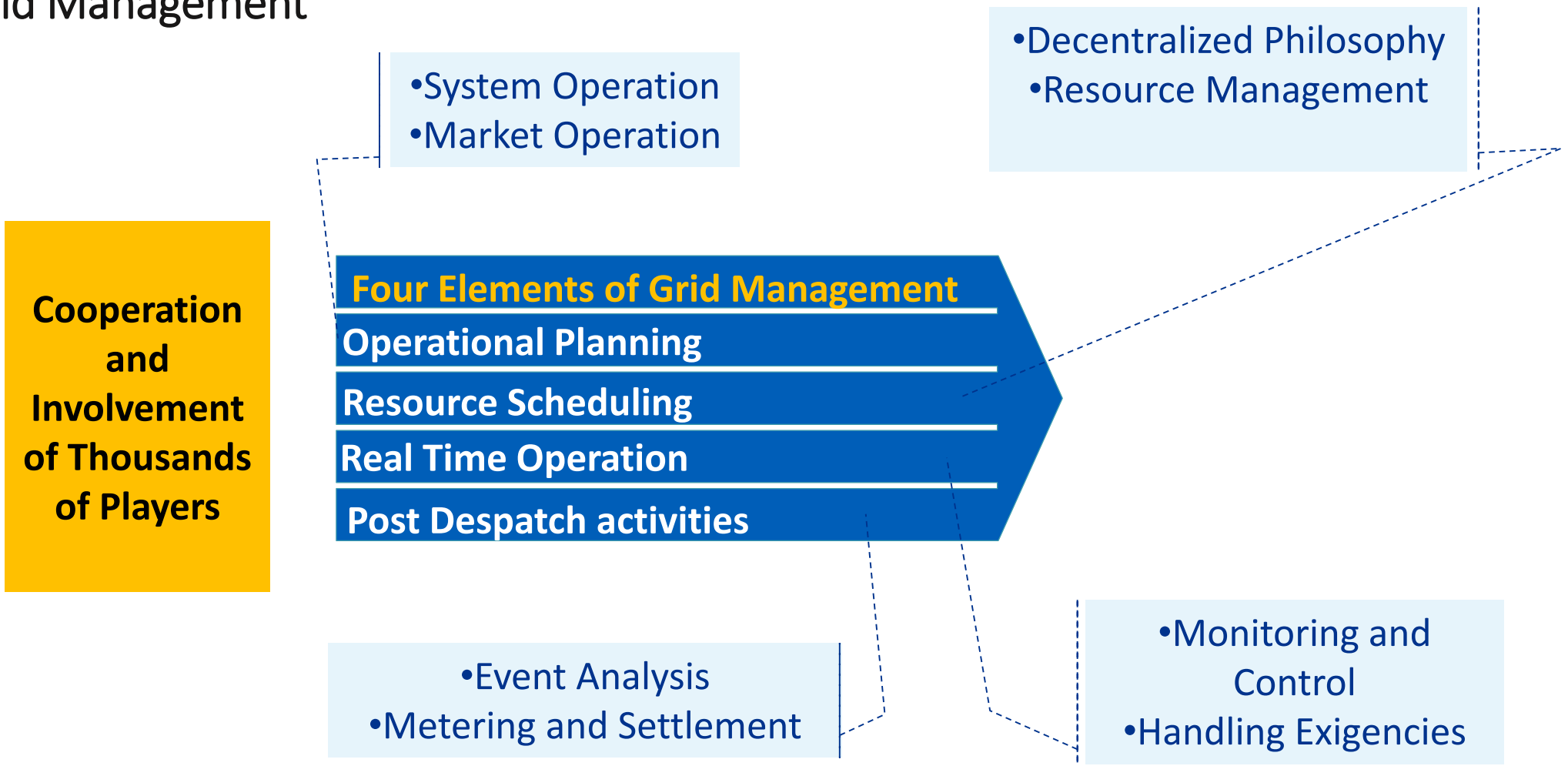
- Real Time Operation , Control and Contingency Analysis
- Generation Scheduling / Re-scheduling
- Restoration
- Metering and Data Collection
- Operation of DSM (Deviation settlement Mechanism)
- Operation of reactive energy account and congestion charge account
- Operation of Ancillary services

ROLE OF SLDCs

Corresponding to the RLDC which operates at the regional level, the SLDCs have been envisaged at the State level with the responsibility of ensuring integrated operations of the power system in State. Key Roles of SLDC include:

- Real Time Operation
- Optimum Scheduling and Dispatch
- Monitoring Grid Operations
- Exercise Supervision and Control
- Ensure Compliance to RLDCs

Grid Management

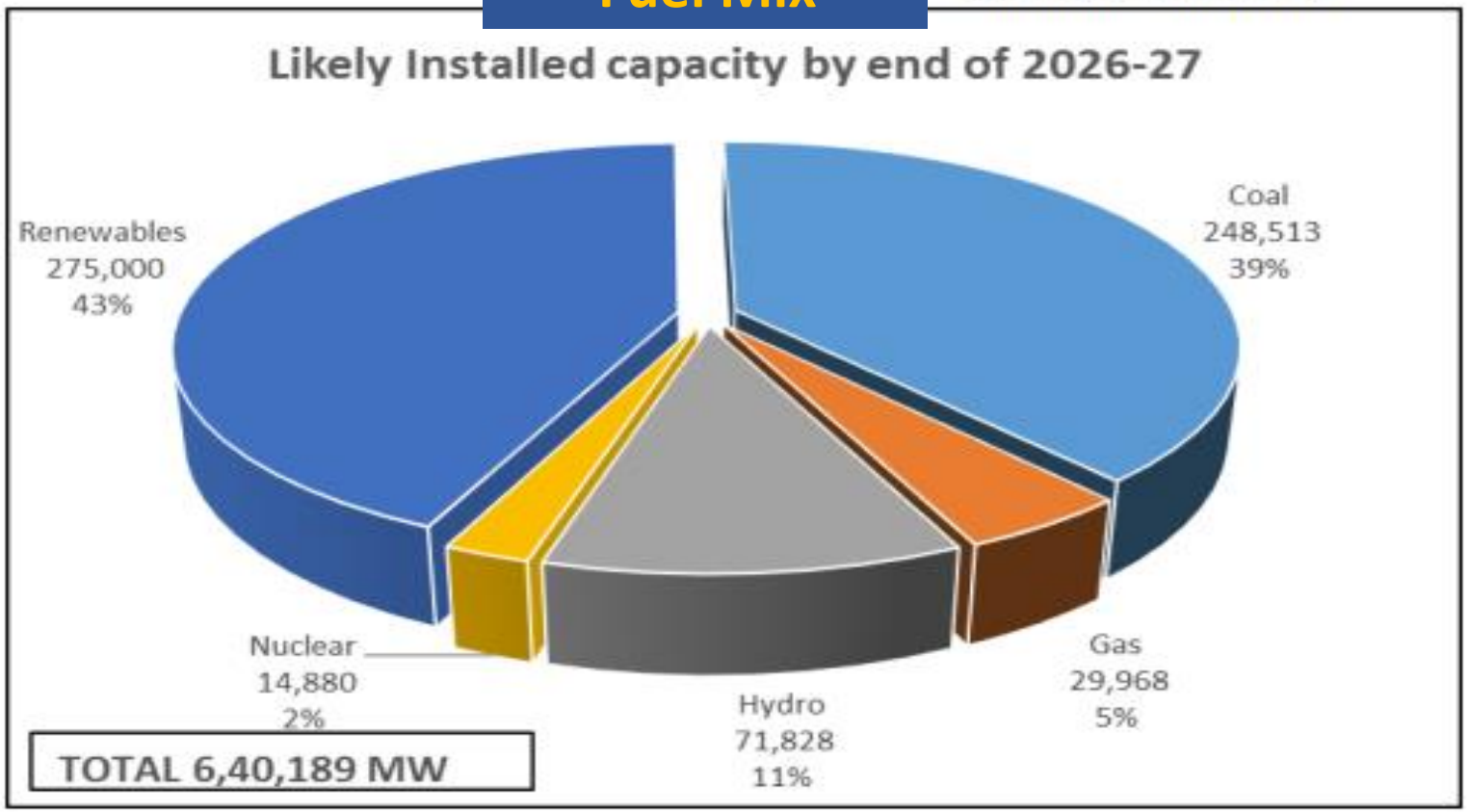


Perspective Plans : Generation

Based on the estimates of individual source-wise capacity addition, the total installed capacity of India by 2027 is estimated to reach ~640 GW

Fuel Mix

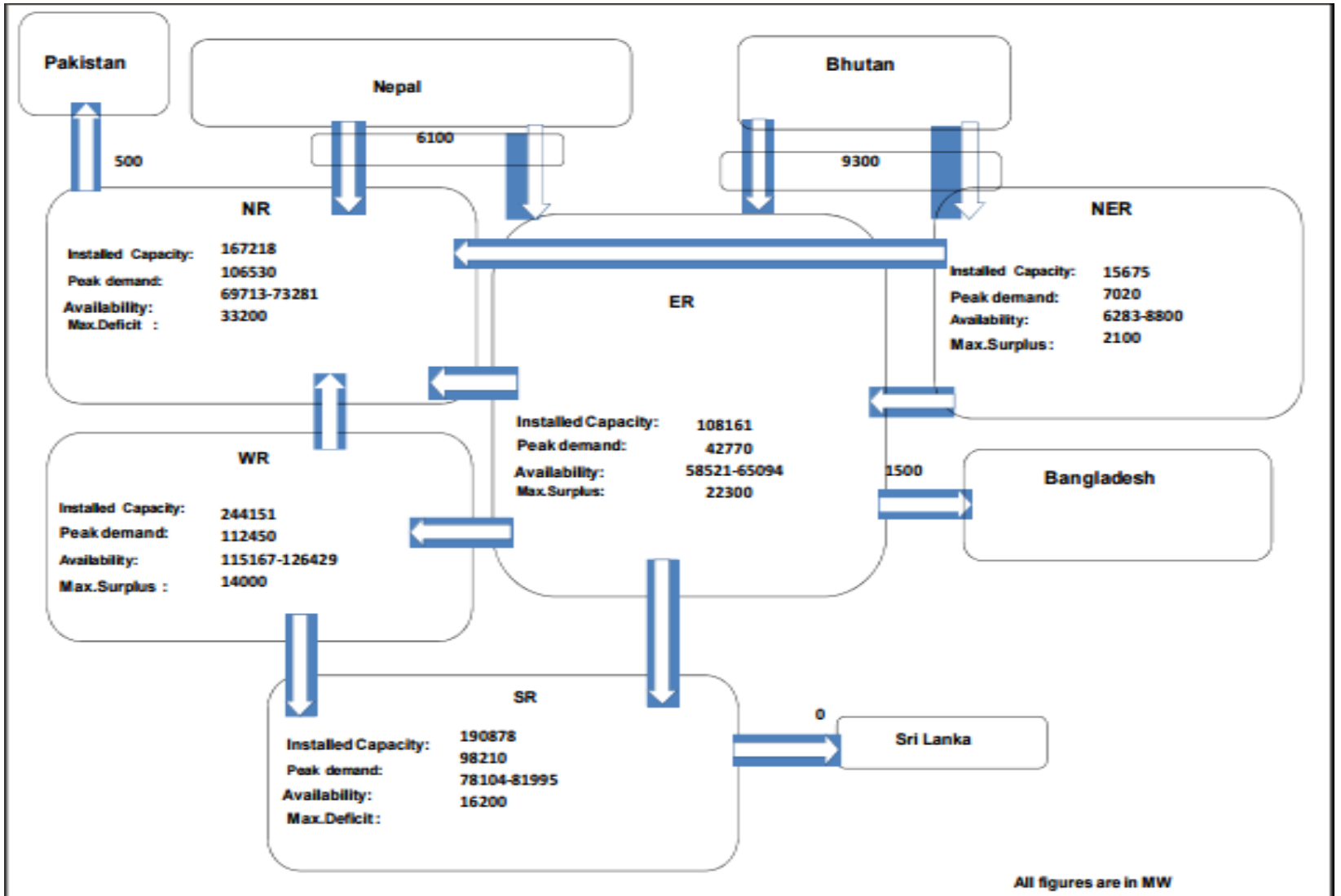
(All figures in MW)



Source: NEP, 2016

Perspective Plans : Transmission

Transmission Capacity Requirement for 2026-27



Perspective Plans : Distribution

The distribution sector requires most significant priority since the efficiency, financial viability and losses effect the viability as the total power sector as a whole. The following areas need to be studied:

- **Design Automation**: There is a strong need to standardize and promote design automation techniques which would reduce costs and improve performance
- **Feeder Load Characteristics**: A methodology needs to be evolved for studying feeders in order to characterize them. The technique should be relatively simple and trade off accuracy against effort involved, since any distribution entity has a large number of feeders, and needs to accurately predict their contributions to the total load curve for the next day, so as to contract for energy supplies from generation companies
- **Appropriate tariff models**: Along with the usual charges based on monthly energy charging, it is possible to factor in charges based on time-of-day and the ratio of peak energy to average energy consumption
- **Load Shedding**: Currently load shedding is generally carried out at the feeder level, with an entire feeder being disconnected as a single entity. With the facilities of a smart grid, it is possible to be more selective, and enable the system operator to shed non-essential loads, while maintaining service to critical loads.
- **Security and Protection**: In conventional distribution schemes, loads are protected mainly through over-current relays and fuses. A smart grid has the facility to provide more sophisticated protection.

Cross Border Trade

Power transfer between countries

- ***Need for Nodal Agency***

–Settle transactions and deviations in Indian Pool

–Back to back arrangement with buying entities in other country

–Coordinate day-to- day scheduling with Load Despatch in both Countries

–Transactions feasible

- ***Long term Access/ Medium Term Open Access***

–Schedule to the LDCs on Day ahead basis

- ***Short Term Open Access***

–Bilateral transactions - Revision as per Open Access regulations

- ***Net schedule – Quantum for exchange of power through the link***

- ***Deviations settled as per CERC Deviation Settlement Regulations***

Cross Border Operational Coordination