

EXCHANGE OF POWER AND HARMONISATION OF REGULATIONS AND POLICIES

- INDIAN FRAMEWORK

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Indian Power System -Some Typical Numbers ...

Power System Related

Installed Capacity:
248 GW

Renewables Installed Capacity:
30 GW – Wind (20 GW), Solar (2 GW), Small Hydro (3 GW)

No. of 400kV & above Trans. Line: **1050 Nos.**
765 kV (35 Nos.)

Total Length of Trans. Line (220 kV & above – AC + HVDC):
291,336 Ckt. Km

Number of Generating Units:
1750 Nos.
500 MW & above (140 Nos.)

HVDC Links (BTB & Bipole):
9 Nos.

Grid Operation Related

Peak Demand Met:
131 GW

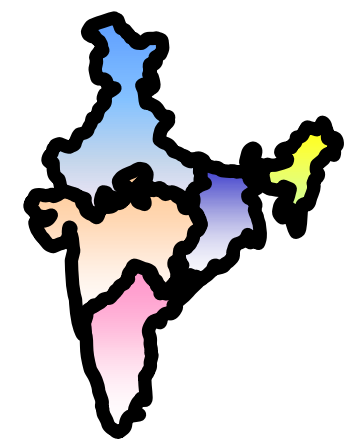
Energy Met (Avg.):
2600 MU/day

Short Term Open Access:
240 MU/day

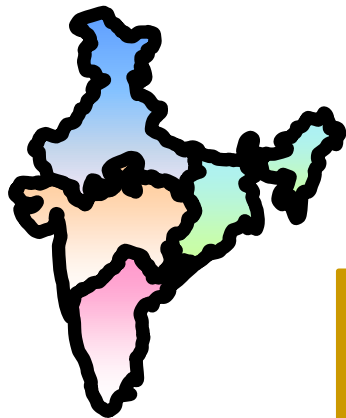
Inter-regional Exchange:
200 MU/day

Evolution of the Grid

Changing load profile
Integration of Renewables
Need for Flexible Systems

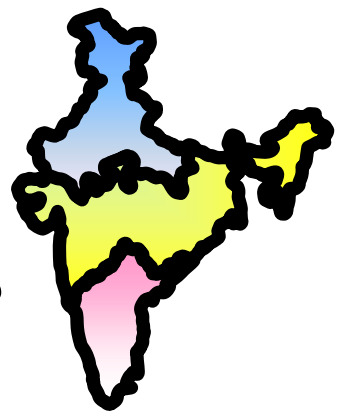


Pre 1991:
Five Regional
Grids - Five
Frequencies



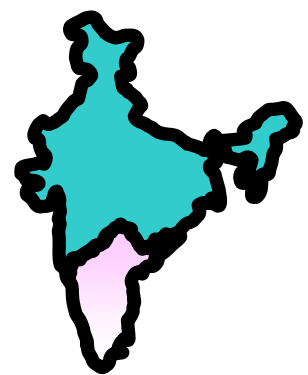
October 1991:
East and
Northeast
synchronized

**Merchant
Power**



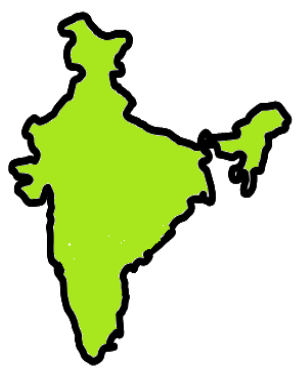
March 2003:
West
synchronized
with East &
Northeast

**Electricity
Act, 2003,
Open
Access**



August 2006:
North
synchronized
with Central
Grid

**Merging of
Markets,
Power
Exchanges**



Dec 2013:
All India
Synchronized
Grid

**Addition of
large 500 MW
& above gen.
units and 765
kV trans.
Lines,
Ultra Mega
Power
Projects**

Maps not to scale

Structure of Indian Electricity Sector



Policy Making	Central Government	CEA	State Government
Regulators	Central Electricity Regulatory Commission	State Electricity Regulatory Commission	
System Operators	National Load Despatch Centre	Regional Load Despatch Centres	State Load Despatch Centres
Generation	Central Generating Stations	State Generating Stations	Private Sector Players
Transmission	Central Transmission Utility	State Transmission Utilities	Private Sector Players
Distribution	State Sector Distribution Licensee	Private Sector Distribution Licensee	
Markets	Trading Licensee	Power Exchanges	Bilateral Markets

Legal Framework

- **Indian Electricity Act' 2003**
 - **Subordinate Legislations**
 - National Electricity Policy
 - National Tariff Policy
 - Standards (Metering, connectivity)
 - **Regulations and Orders by ERCs**
 - **Indian Electricity Grid Code**
 - **Procedures by CTU / System Operators**
-

Key Features of Electricity Act, 2003(1)

■ **National Electricity Policy / Tariff Policy**

- Central Government to prepare in consultation with State Governments.

■ **Thrust on rural electrification and management of rural distribution**

■ **Generation de-licensed and captive generation freely permitted.**

- Hydro projects would, however, need clearance from CEA.

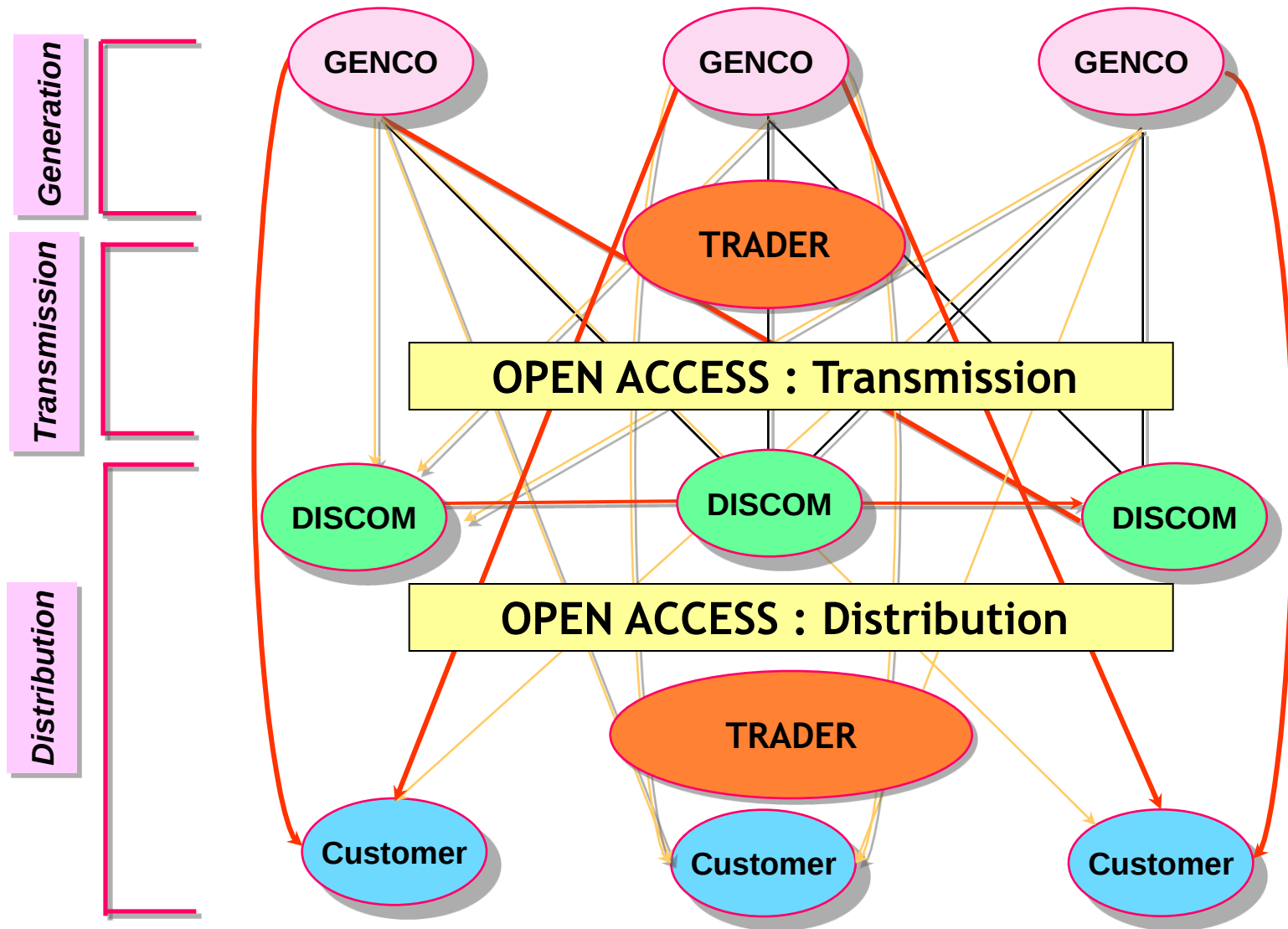
■ **Transmission Utility at the Central, as well as State level,**

- Responsible for planned and coordinated development of transmission network.
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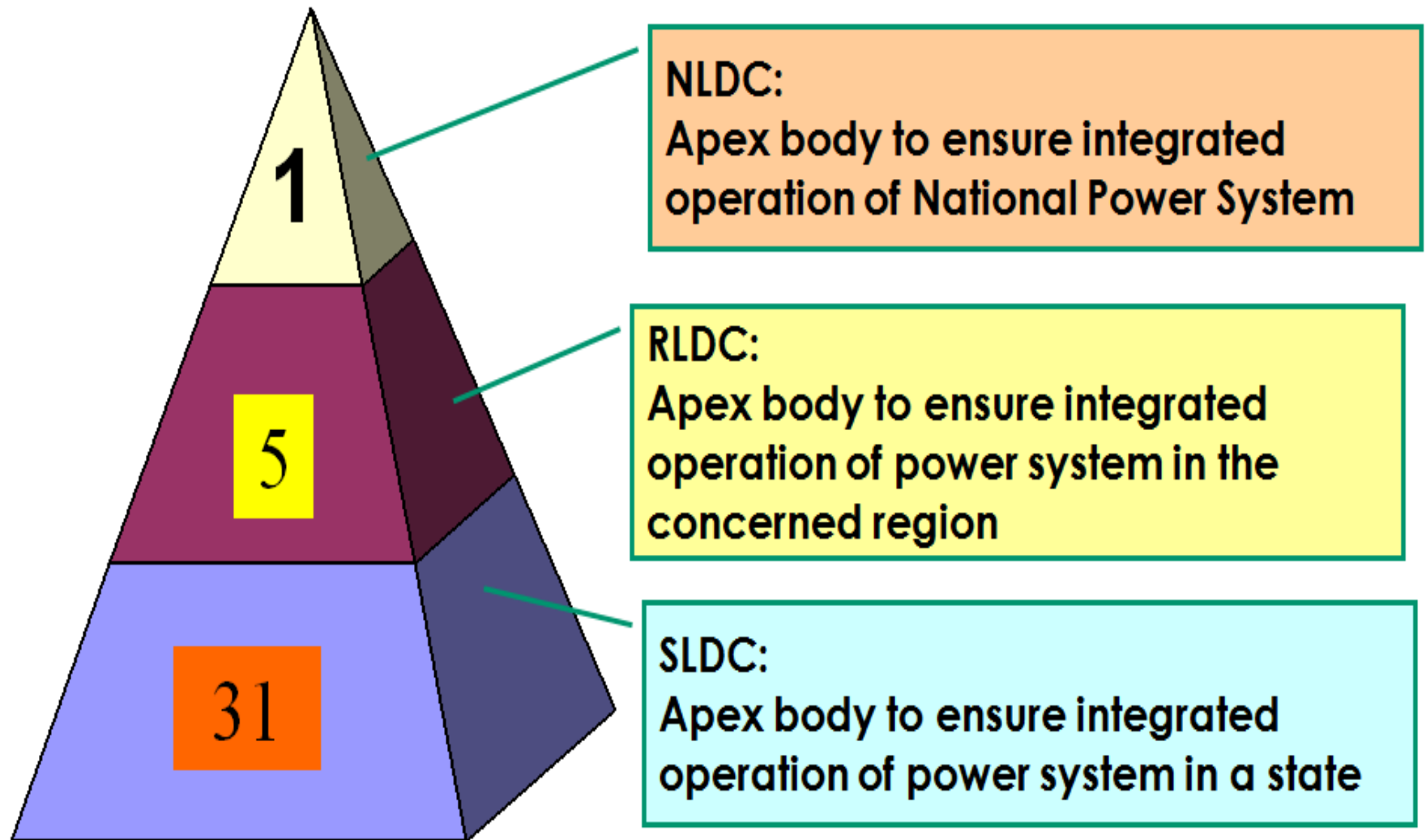
Key Features of Electricity Act, 2003(2)

- Private sector participation in transmission and distribution
 - Open access in transmission and distribution
 - Redefinition of the roles of CERC, SERC and CEA.
 - Trading recognized as a distinct activity.
 - Provisions for reorganization of State Electricity Boards.
 - Appellate Tribunal to hear appeals against the decision of the CERC and SERCs.
-

Market Structure after Electricity Act, 2003



Jurisdiction of Load Despatchers in India



Indian Electricity Grid Code

- The Indian Electricity Grid Code (IEGC) is a regulation made by the Central Commission.

- A Set of rules, guidelines and standards
 - to be followed by various persons and participants in the system
 - to plan, develop, maintain and operate the power system,
 - in the most secure, reliable, economic and efficient manner,
 - To facilitate healthy competition in the generation and supply of electricity

Objective of Grid Code

- Documentation of the principles and procedures which define the relationship between the various Users of the inter-State transmission system (ISTS), NLDC, RLDCs as well as SLDCs.
- **Facilitation**
 - ❑ Optimal operation of the grid
 - ❑ Coordinated and optimal maintenance planning of generation and transmission facilities in the grid
 - ❑ Development & planning of economic and reliable National / Regional Grid
 - ❑ Functioning of power markets and ancillary services by defining a common basis of operation of the ISTS
 - ❑ Development of renewable energy sources by specifying the technical and commercial aspects for Grid integration

Structure of IEGC(1)

- **Part 2: Role of various Organizations and their linkages**
 - Functions of the various Organizations relevant to IEGC.

- **Part 3: Planning Code for inter-State transmission**
 - Guidelines be adopted in the planning and development of bulk power transfer and associated ISTS.
 - Information exchange required between the planning agencies and the various participants of the power system for load forecasting, generation availability, and power system planning etc. for the future years under study.

- **Part 4: Connection Code**
 - Minimum technical and design criteria to be complied with by STU, CTU and any User connected to the system or seeking connection to the ISTS, to maintain uniformity and quality across the system. This also includes procedure for connection to the ISTS

Structure of IEGC(2)

■ Part 5: Operating Code

- (a) Operating Philosophy
- (b) System security aspects
- (c) Demand Estimation for operational purposes
- (d) Demand management
- (e) Periodic Reports
- (f) Operational liaison
- (g) Outage Planning
- (h) Recovery procedures
- (i) Event Information

■ Part 6: Scheduling and Despatch Code

■ Part 7: Miscellaneous, Complementary Commercial Mechanisms

Market development initiatives

■ Evolution of Power Market in India

- ❑ Indian Electricity Grid Code - February, 2000
- ❑ Settlement System(Availability Based Tariff)- 2002-03
- ❑ Open Access in inter-state transmission Regulations -2004
- ❑ Power Exchange- 2008
- ❑ Unscheduled Interchange and related matters Regulations- 2009
- ❑ Measures to relieve congestion in real time operation Regulations- 2009
- ❑ Power Market Regulations- 2010
- ❑ Renewable Energy Certificate for Renewable Energy Generation Regulations, 2010
- ❑ Point of Connection Tariff (Sharing of Inter State Transmission Charges and Losses) Regulations- 2010
- ❑ Model Terms and Conditions for Intra State Open Access by Forum of Regulators
 - Intra-state Open Access Regulations by SERCs

Open Access to Consumers(1)

Provisions in the Indian Electricity Act' 2003

“open access” means the non-discriminatory provision for the use of transmission lines or distribution system or associated facilities with such lines or system by any licensee or consumer or a person engaged in generation in accordance with the regulations specified by the Appropriate Commission;”

Transmission licensees to provide non-discriminatory open access to its transmission system for use by-

- (i) any licensee or generating company on payment of the transmission charges; or*
 - (ii) any consumer as and when such open access...”*
-

Open Access in Inter-State Transmission

- Long term open access
 - Medium term open access and Short-term open access granted depending upon
 - Inherent design margin
 - Margins available due to variations in power flows
 - Margins available due to in-built spare transmission capacity created to cater to future load growth
 - Permits usage of spare transmission capacity through a transparent process
 - Offers choice and freedom to buy & sell power
-

Power Exchanges

■ **Enabling Regulations/Orders:**

- CERC Open Access Regulations, 2008 & subsequent amendments
- Procedure for Scheduling of Collective Transactions by CTU, approved by CERC vide order dated 13th June 2008 and subsequent amendments thereof
- Power Market Regulations 2010

■ **Nodal Agency:** National Load Dispatch Centre (NLDC)

■ **Commencement of Operations**

- IEX: 27th June 2008
- PXI: 22nd October 2008

Interconnection with SAARC Countries

Cross-Border Interconnection - Purpose

A. Optimal Utilization of Natural Resources

- Need of meeting growing power demand (*Utilising Peak Diversity and time diversity*)
- Concentration of various types of energy in different countries
 - *Limitation in Large scale trading of coal and natural gas due to constraints in its handling & transportation*
 - *Hydel energy can be traded thru transmission network only*
 - *Transmission of power - only feasible solution for exchange of energy*
- Economy of scales (*investment on large sized generating stations can be deferred*)
- Better hydro-thermal mix

B. Improved Security and Reliability

C. Economic Benefit

- *exporting country would earn revenue by exporting power and the importing country can defer the investment*

D. Increased economic efficiency in system operation

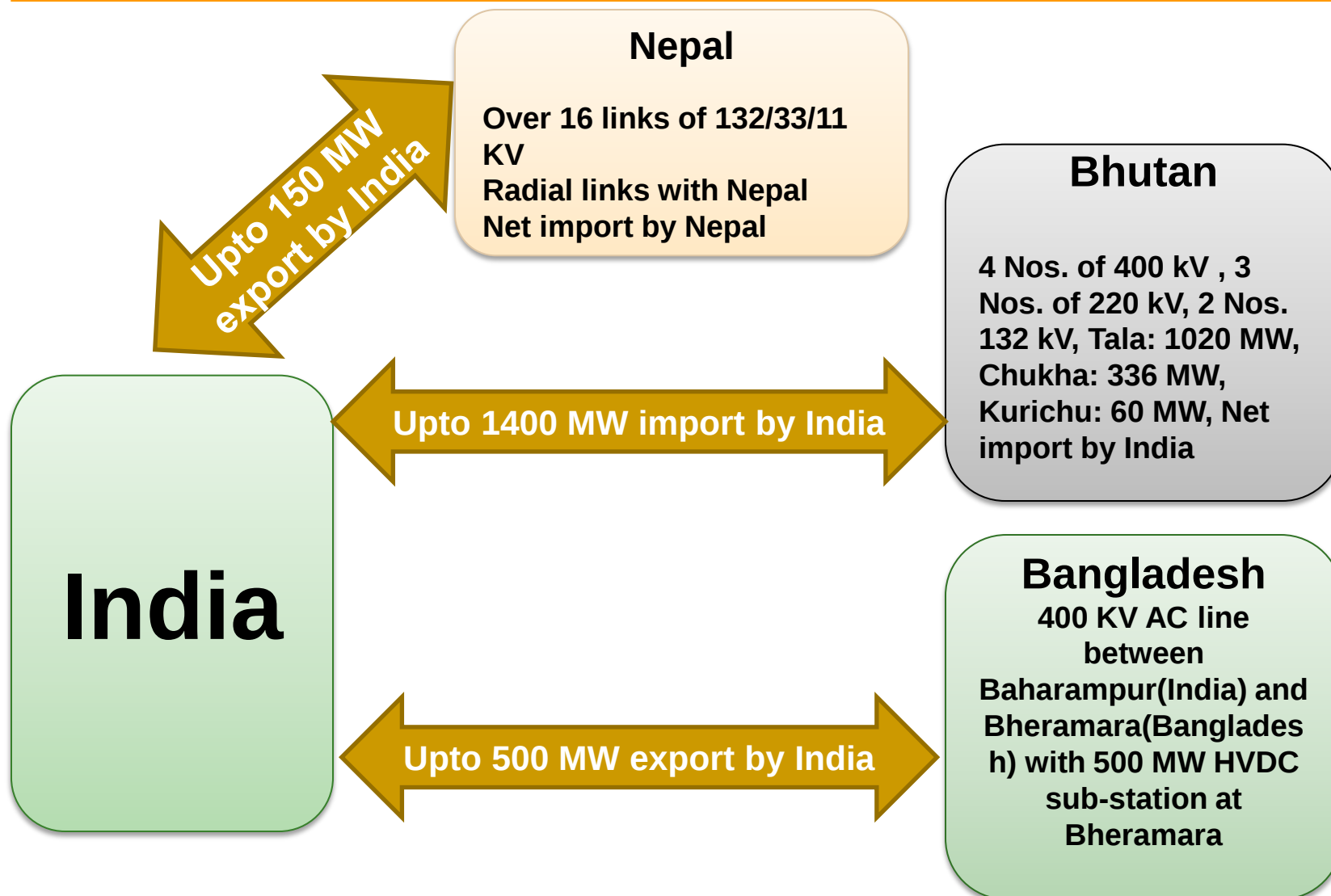
- *Merit order operation on larger scale*

E. Reduced Environmental Damage

Opportunities for Interconnection

- **Evolving Open Electricity market**
- **Countries with limited resources would be benefited, e.g. Sri Lanka**
- **Thermal resources – cheaper to transport in electricity form; Hydro resources – can only be transported in electricity form**
- **Huge hydro Resources of countries can be effectively utilised**
- **Export countries benefited economically, Import countries benefited by deferring investment towards setting up power plants**

Existing International Interconnections



India - Bhutan : Existing Interconnections

For import of power from following Projects

- **Chukha HEP (4x84 = 336 MW)**

- Chukha – Birpara 220kV 3 ckts

- **Kurichu HEP (4x15 = 60 MW)**

- Kuruchu - Geylegphug(Bhutan) – Salakati(NER) 132 kV

- **Tala HEP (6x170 MW = 1020 MW)**

- Tala – Siliguri 400kV 2x D/c line

India - Bhutan : On Going Trans. System

❑ Tr. System for Punatsangchu-I (1200 MW)

- **Interconnection (Bhutan Portion)** : Punatsangchu-I HEP – Lhamoizingkha (Bhutan Border) 400 kV 2xD/c line with twin moose Conductor.
- **Interconnection (Indian Portion)** : Lhamoizingkha (Bhutan Border) – Alipurduar 400kV D/c (Quad)
- **Other Major Transmission System in India**
 - New ± 800 kV, 3000MW HVDC pooling station at Alipurduar.
 - Extn. of ± 800 kV, 3000MW HVDC station at Agra
 - LILO of Bishwanath Chariali – Agra 800kV, 6000MW HVDC line at Alipurduar
 - LILO of Bongaigaon – Siliguri 400kV D/c line(quad) at Alipurduar
 - LILO of Tala-Siliguri 400kV D/c line at Alipurduar.

India - Nepal : Present Interconnection

- **Existing Interconnections : 22 links at 132/33/11 kV**
 - About 80-100 MW of power being exchanged in radial mode
 - Supply of 70MU/annum from Tanakpur (India) to Nepal (as per the Mahakali Agreement)
 - Net export to Nepal (about 10-15% of demand of Nepal met from India)
- **On-going Transmission Line**
 - 400kV inter-connection (initially op. at 220kV level) between Muzaffarpur(India) and Dhalkebar(Nepal) : 125 km

Issues for Interconnection

- **Purpose of Interconnection**
 - Generation Linked
 - Strengthening Scheme for power exchange
- **Techno-economical viability need to be assessed**
 - Voltage, Capacity, Mode(synchronous/asynchronous), location, time frame
 - Quantum of power exchange in either direction, its duration and source
 - Cost-benefit analysis to be carried out
- **Funding of the project**
- **Recovery of transmission charges**
- **Issues like scheduling of power exchange, operation, maintenance etc to be firmed up**
- **Regulatory Framework**
- **Institutional Arrangement for settling legal disputes etc.**

Institutional Arrangement

- **Agreements/ MOUs between the participating countries** need to be signed at various levels (Government, Planning, Operation and Regulatory) between the participating countries in order to study, finalise, implement, operate and maintain the interconnection between the electrical grids of the countries.
- **Identification of Nodal Agencies**
 - For Planning and preparation of feasibility study report
 - For Operation and Maintenance of the transmission system
 - For operation of the grid
 - For Sale/Purchase of Power

Commercial Arrangements

- Long term secured agreements
- Pricing of power and tariff mechanism
- Security Mechanism including payment
- Terms for Indemnification for disruption of Transmission service

Financial Arrangements

- Funding arrangement like multilateral, private etc
- Recovery of Investment
- In either case following aspects are to be considered:
 - Sale/ Purchase of Power on a sustained/ long term basis
 - Security of Payment / Signing of Covenant
 - Immunity to Political Changes and changes in Law

Operation of the Interconnection

- **For reliable and secure operation of the combined grid, operational and maintenance procedures of the interconnected system between the participating countries would have to be similar, so as to minimize the outages and breakdown of transmission system and ensure satisfactory performance of costly components of the transmission systems for their entire life, thus avoiding premature replacements.**

Operation of the Grid

■ Operating Code

- ❑ *Operating Philosophy* : Both countries would agree to abide by a common grid code for reliable, secure and stable operation of the cross border interconnection.
- ❑ *System Security Aspects* : The system security aspects incorporating isolation/tripping of interconnection link from the grid of respective countries under various conditions and its restoration under supervision by respective System Operator, in co-ordination with System Operator of the other country etc would be specified.
- ❑ *Protection Coordination* : Provision of protections and relay settings shall be coordinated periodically by the System Operators of the respective countries.

Operation of the Grid

- Scheduling and Despatch Procedure
- Congestion Management
- Metering, Accounting, Deviations from Schedule and Settlement
- Real Time SCADA Data, Communication Facilities, Cyber Security
- Data Recording Instruments such as Data Acquisition System/Disturbance Recorder/Event Logging Facilities/Fault Locator (including time synchronization equipment) shall be provided and shall always be kept in working condition at both ends of the cross border interconnection for recording of dynamic performance of the system.

Legal Issues

■ Firming up of procedures for dispute settlement and Arbitration

- ❑ Agreements on liability for power line failure or damage, and other issues of legal liability concerning grid operation
- ❑ Institutional arrangements for governing grid interconnection
- ❑ Agreements on operation of power line
- ❑ Agreements on power line security

Applicability of Laws of Respective countries/
International Laws should be specified

**Thank you for your kind
attention!!**
