India – Nepal Interconnection

R P SASMAL
1ST JUNE 2016

Players in Indian Power Sector

Indian Power System Framework

❖ Electricity - A Concurrent Subject

- **Both Central & State Govt. are responsible for overall development of Power Sector**

Central Level

Central Electricity Authority

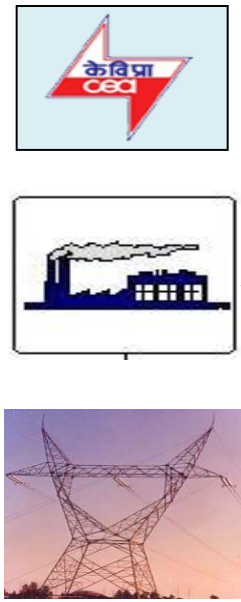
- Perspective Planning & National Electricity Plan

Generators

- Central Public Sector
- Private Sector/IPP

Inter-State Transmission

- **CTU/ POWERGRID**
- **Private Tr. Licensee**

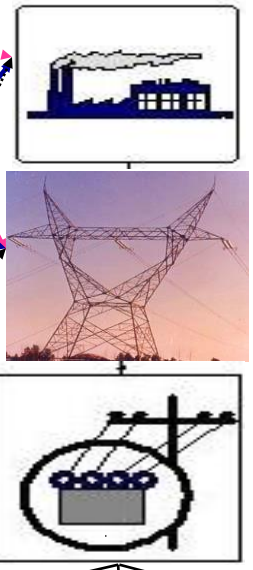


System Operator

POSOCO

Power Exchange

Traders



State Level

Generators

- **State Public Sector**
- **Private Sector/IPP**

Intra-State Transmission

- **State Tr. Utility (STU)**
- **Pvt. Tr. Licensee**

Distribution

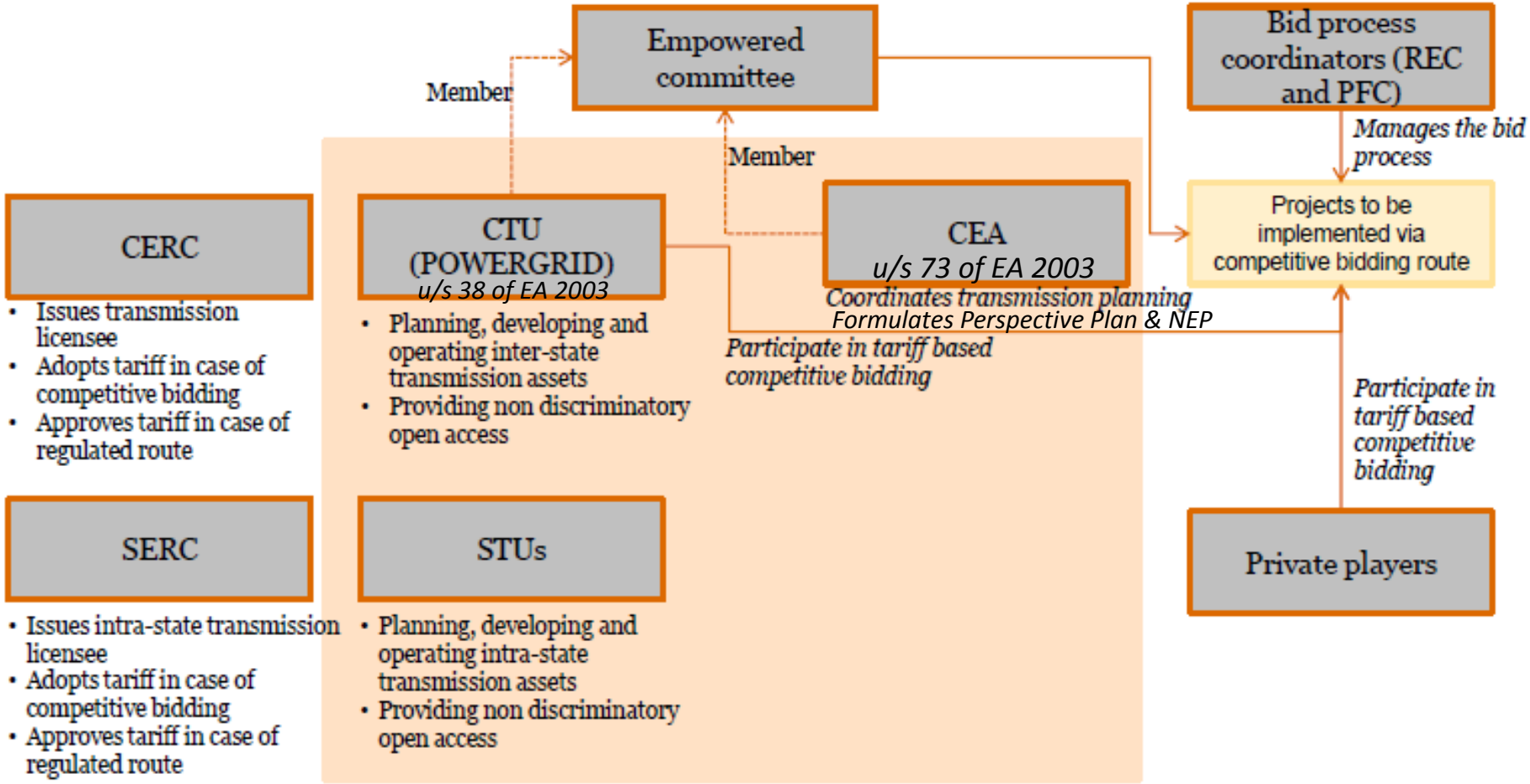
- **State DISCOMs**
- **Pvt. Dist. Licensee**

Consumers

- **Industries,**
- **Household,**
- **Agriculture**

Key Players

Key players in transmission sector

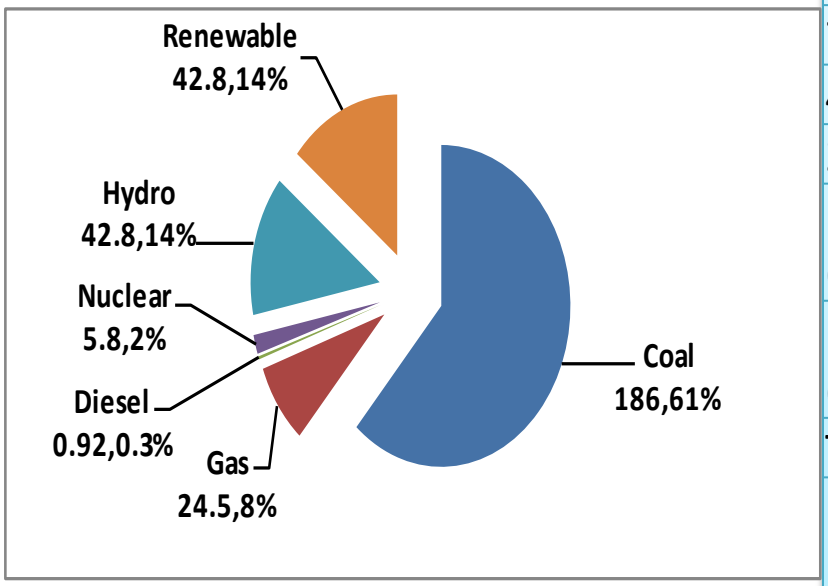


Indian Power Scenario

Indian Power System : A Glimpse

Total Installed Capacity – 302.8 GW | **Peak Demand: 153.3 GW** | **Renewable: 42.8 GW** | **Growth Rate: 8–9 % p.a.**

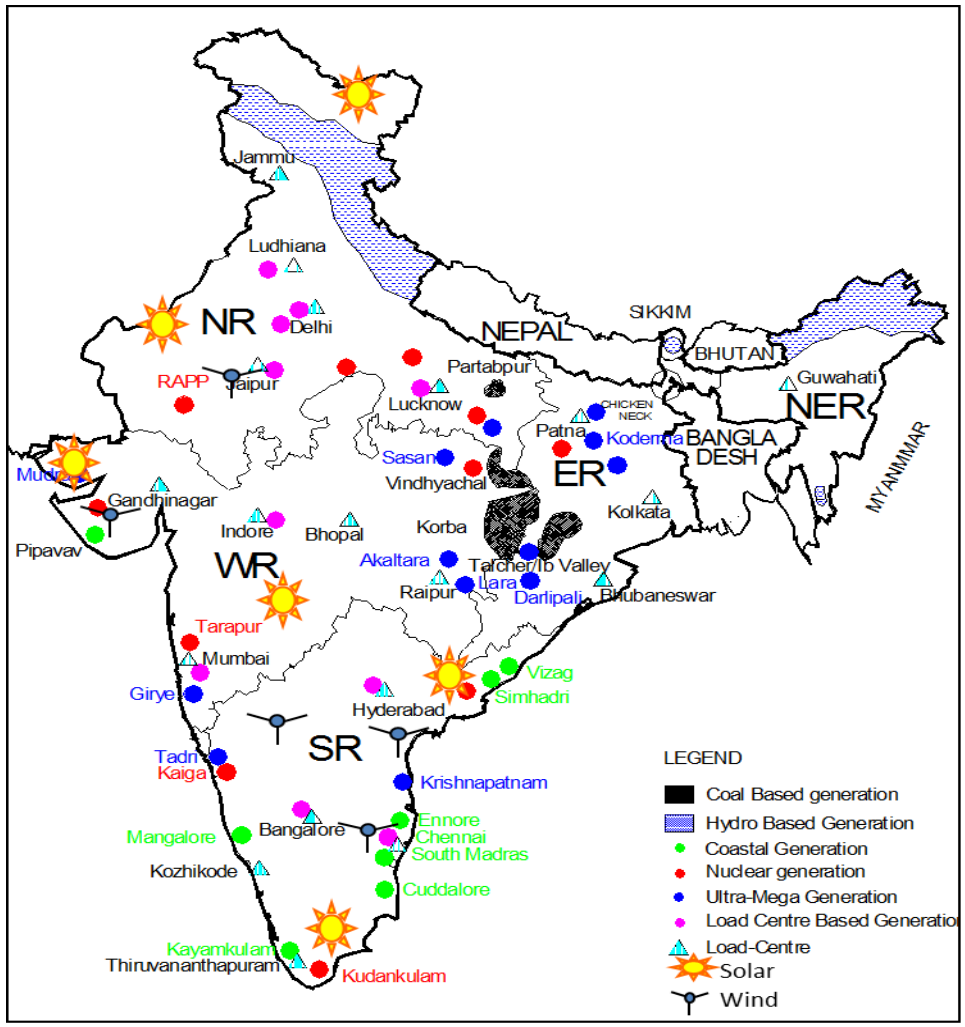
Figures (as on 30.04.2016)



Generation Mix

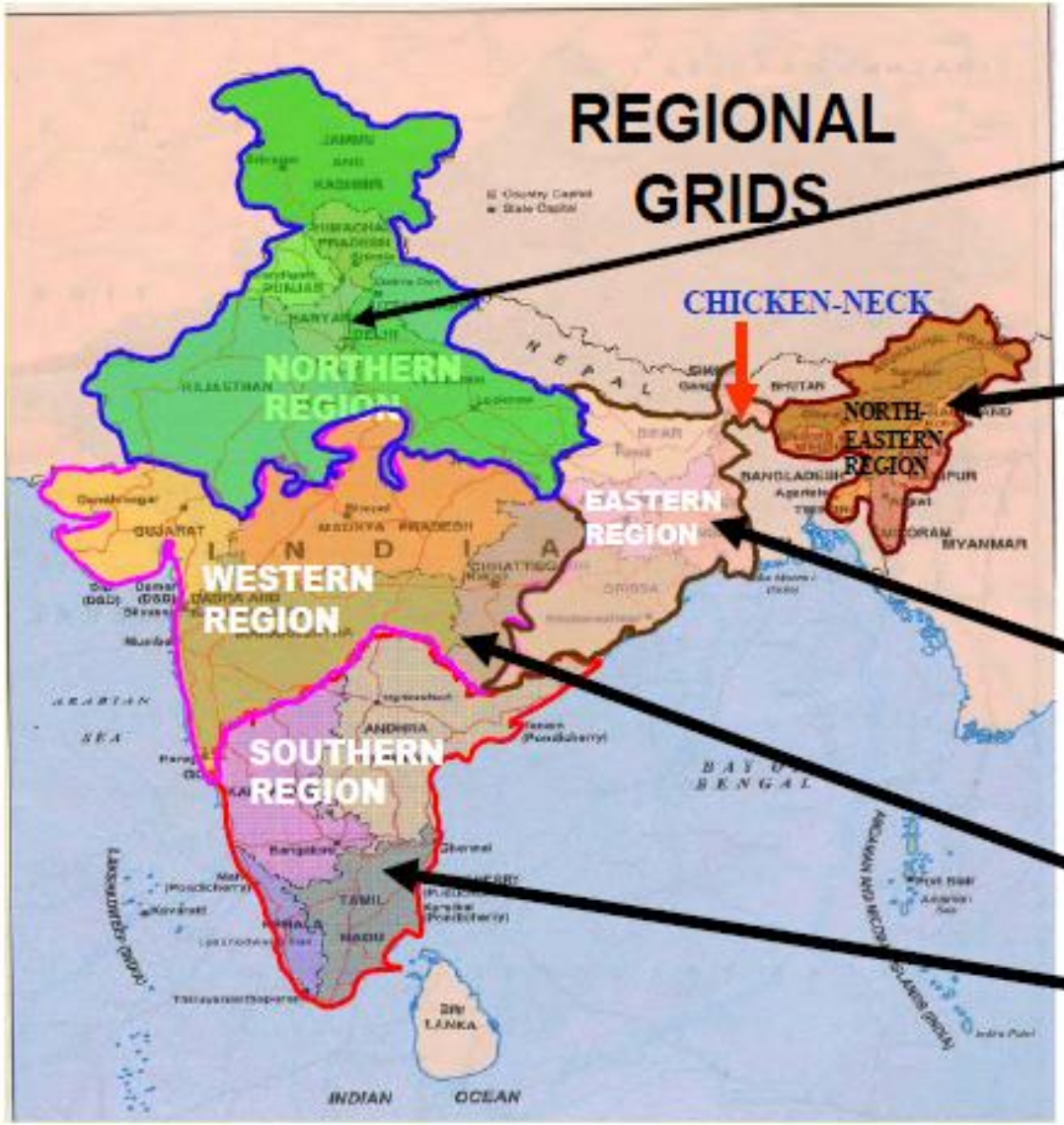
Transmission line	Existing (Apr '16)	By Mar'17
	ckm	
1200 kV		363
765kV	24,529	29,431
400kV	147,512	157,644
220kV	157,648	170,980
HVDC Bipole (±500kV)	9,432	9,432
HVDC Bipole (±800kV)	3,506	6,103
Total	342,627	373,953
Transformation capacity	Existing (Apr'16)	By Mar'17
	MVA	
765kV	142,500	155,000
400kV	210,652	234,372
220kV	295,062	298,265
HVDC	15,000 MW	22,500 MW
Total	663,214	710,137

Energy Resources Concentrated in Few Pockets



- **Hydro – In North Eastern & Northern Himalayan region. Difficult terrain**
- **Coal – In Central India**
  - *Chhattisgarh, Orissa, Jharkhand, Madhya Pradesh*
  - *Forest, coal block*
- **Renewable Energy**
  - *Six major RE rich states: Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra, Gujarat, Rajasthan*

Peculiarities of Regional Grids in India



Deficit Region

Snow fed - run-of -the -river hydro

Highly weather sensitive load

Adverse weather conditions: Fog & Dust Storm

Very low load

High hydro potential

Evacuation problems

Low load

High coal reserves

Pit head base load plants

Industrial load and agricultural load

High load (40% agricultural load)

Monsoon dependent hydro

National Grid - Development

State → Region → Nation: A Paradigm Shift

Self Sufficiency at State Level

Self Sufficiency at Regional level

Optimal Utilization of Resources at National level

1950s
- Local

1950s-60s
- State Grid by SEBs

1970s-80s
- Regional Grids with Trans. Systems of Central Gen. Stations

1990s
- Interconnecting Regional Grids with HVDC

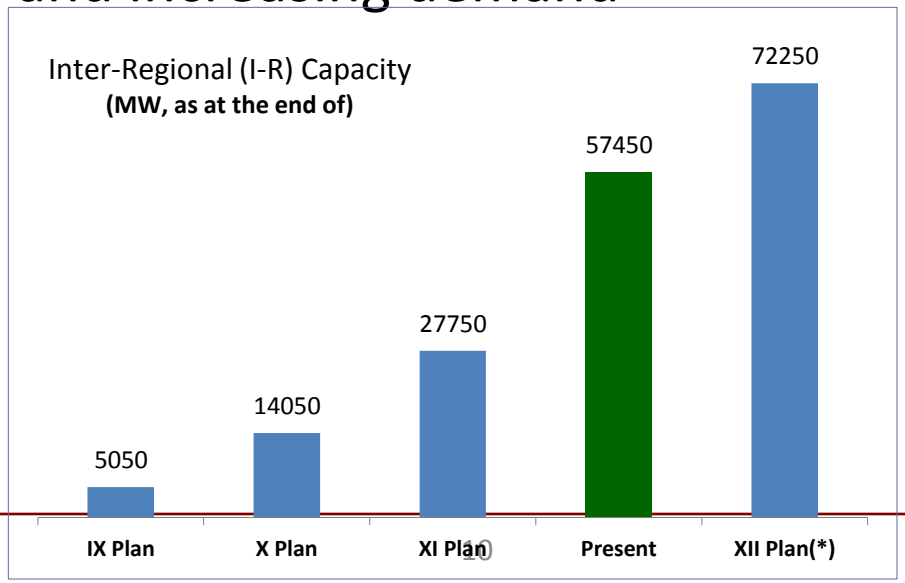
2000s-2010s
- National Grid [One of the largest Grids in the world]

Now
- Installed Capacity: 302 GW
- Peak Demand: 153GW
- Tr. Lines: 342,627ckm
- Trf. Capacity: 663 GVA

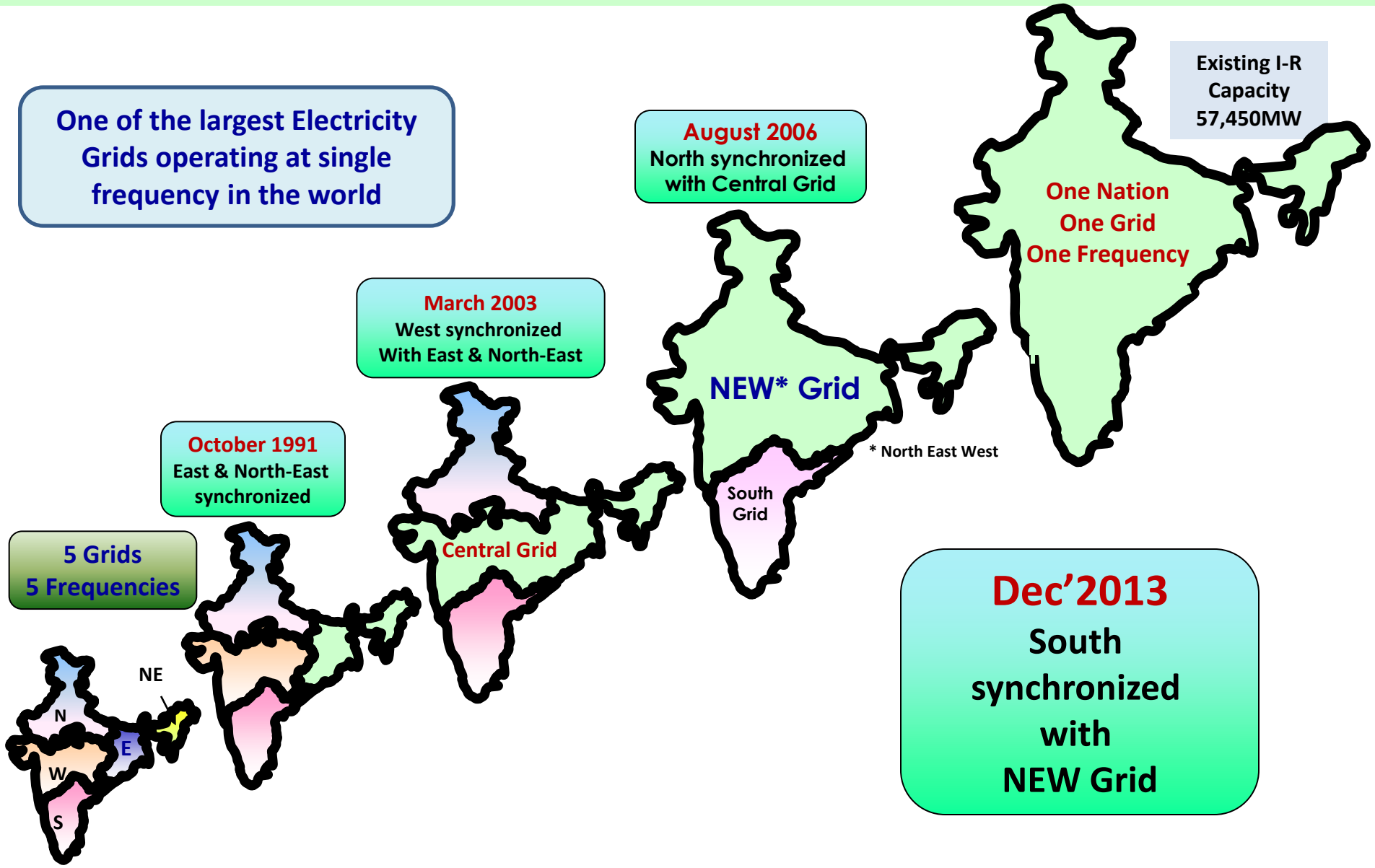
Installed Capacity
1947: 1,362MW

Development of National Grid

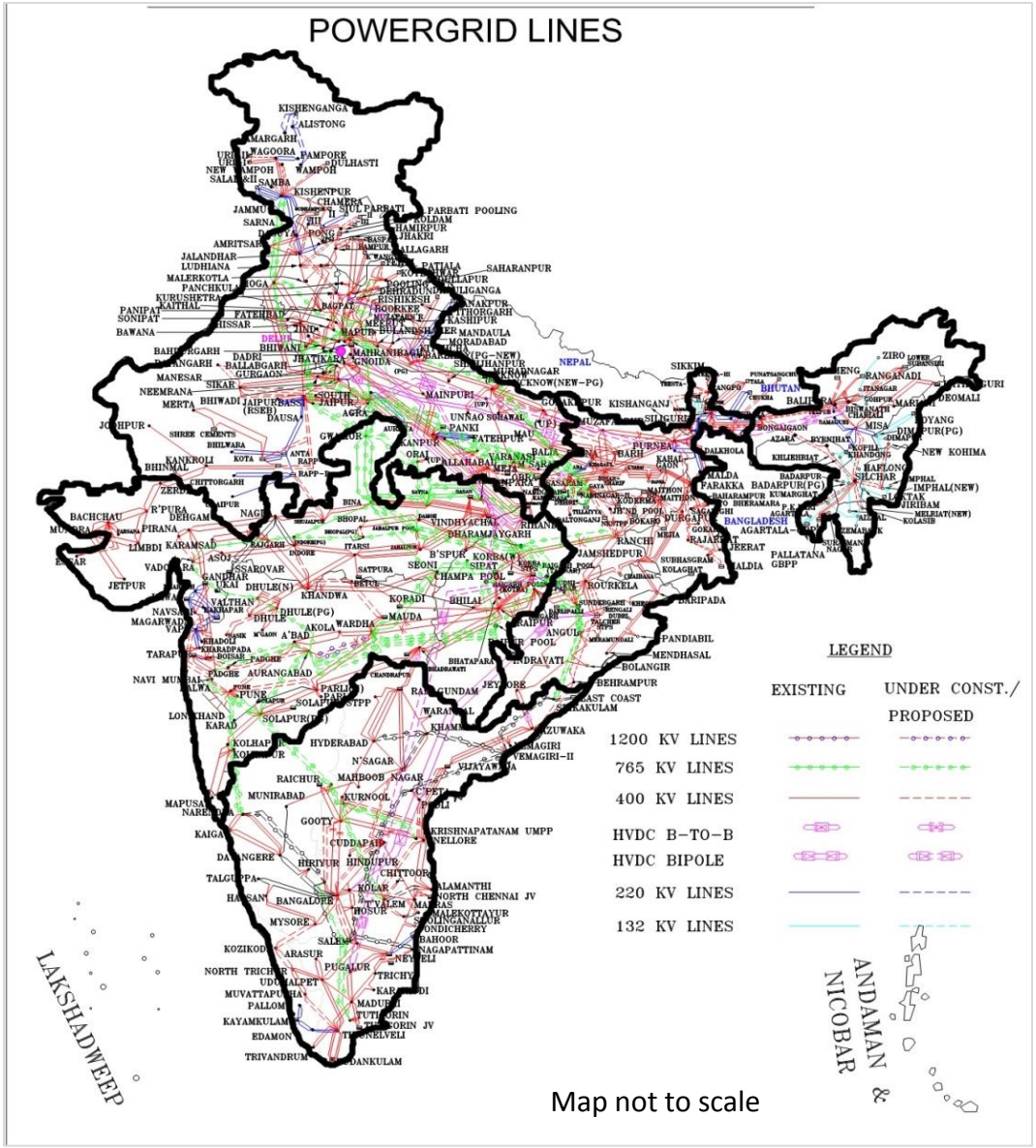
- Indian Grid was divided into 5 independent Regional Grids
- Initially, National Grid was formed by interconnecting different regions through HVDC Back-to-Back Links
- Subsequently, regional grid have been synchronised in progressive manner through EHVAC links
- Presently, synchronous National Grid has been established. National Grid is a continuous process to match with upcoming generation and increasing demand



Development of Synchronous National Grid

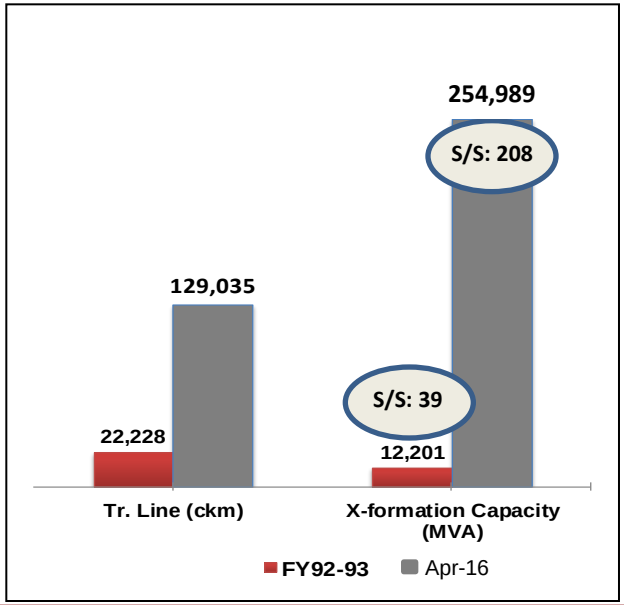


National Grid – As on today



National Grid – Apr 2016	
Lines	342,627 ckm (PG – 129,035 ckm)
S/S	PG-208 nos
X-f Capacity	663,214 MVA (PG-254,989 MVA)

Growth of National Grid (PG System)

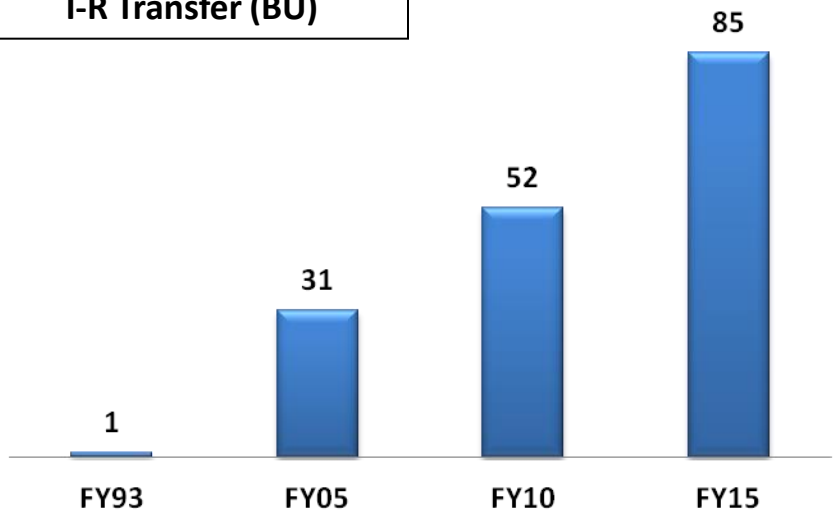


Benefits of National Grid

- Reduction in Market price of energy has enabled merit order operation of generators.
  - CLP-Jhajjar (1320MW), Aravali-Jhajjar (1500MW), NTPC Dadri (1820MW), Badarpur (705MW) in NR & Kayankulam(360MW) Gas Project in SR are under shut down due to availability of cheaper power from adjoining regions
  - Due to merit order operation, aged/polluting power plants are being phased out thereby reducing the Carbon Footprint.
- Power market is moving towards uniform price in all regions
- Substantial increase in Inter-Regional power exchange through STOA utilising margins in the ISTS network

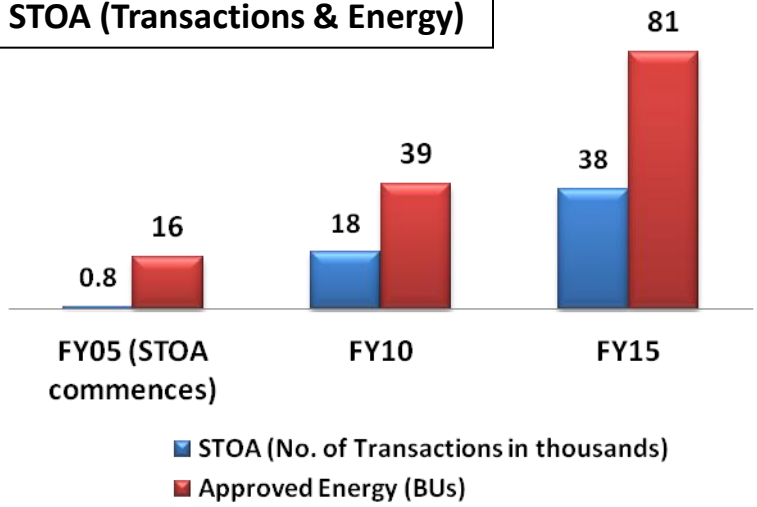
Benefit of the National Grid

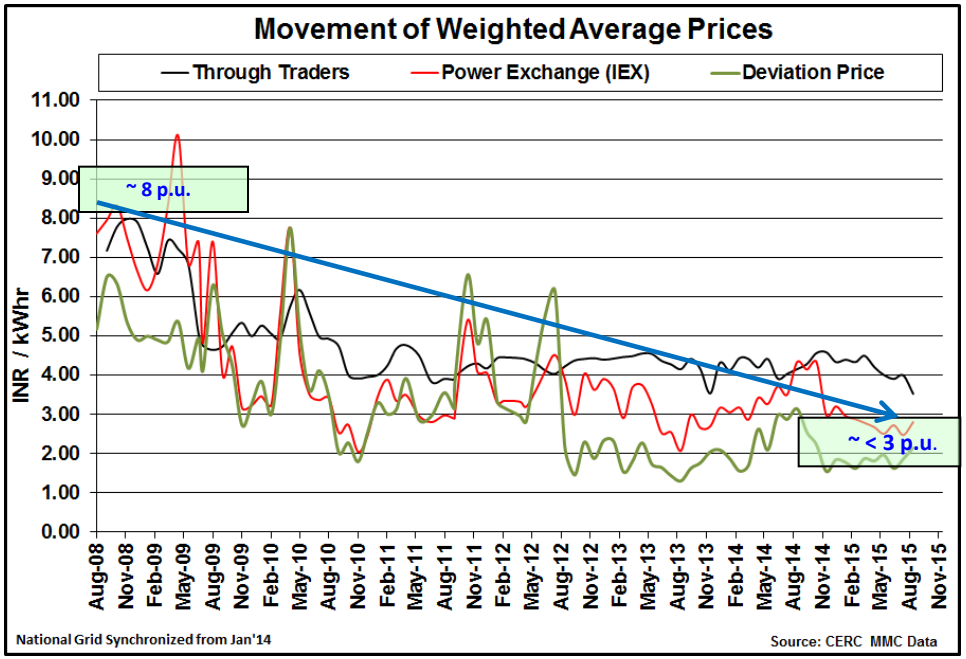
I-R Transfer (BU)



- ✓ Optimal Utilization of Resources through IR Exchanges and STOA
- ✓ Development of Vibrant Electricity Market
- ✓ Reduction in per unit energy charges

STOA (Transactions & Energy)





SAARC
Inter-connection

Developing SAARC[1] Grid – SAARC Interconnections

➢ **Bhutan**

- ✓ Presently, interconnections exist with Bhutan at 400kV level
- ✓ Alipurduar (India) – Punatsangchu-I HEP (Bhutan) 400kV D/c and Jigmeling – Alipurduar 400kV D/C are under implementation – completion in 2015/ 2018

➢ **Nepal**

- ✓ Presently, interconnections exist with Nepal through 132 kV and lower voltage trans. lines.
- ✓ Muzaffarpur (India) – Dhalkebar (Nepal) 400kV D/c is commissioned by CPTC (Indian Portion) and PTCN (Nepal Portion) in Feb 2016.

➢ **Bangladesh**

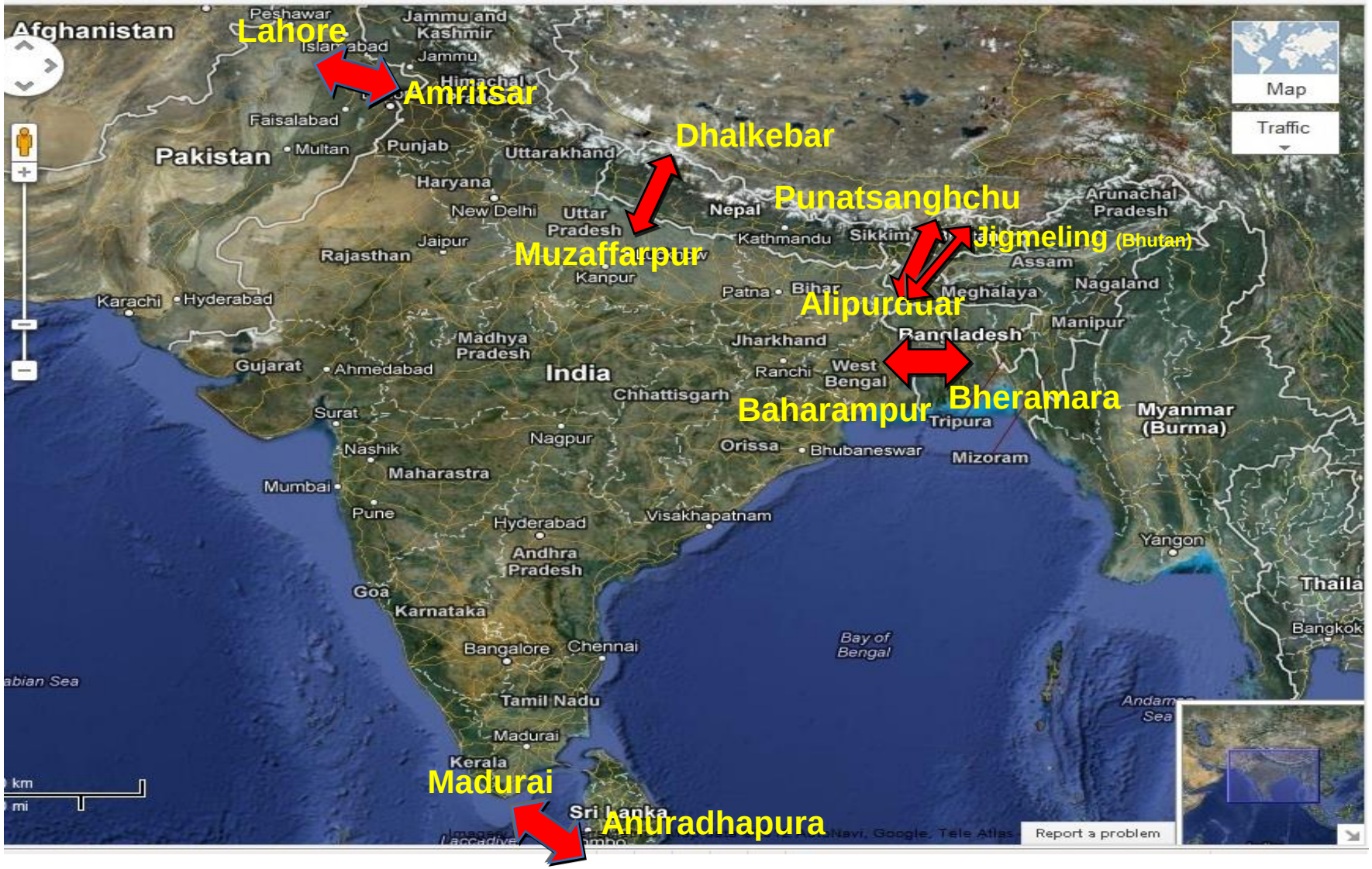
- ✓ Baharampur (India) – Bheramara (Bangladesh) HVDC back-to-back system under operation. Transfer of power upto 500MW to Bangladesh.
- ✓ 400kV (charged at 132kV) Surajyamaninagar (India) – Comilla (South) (Bangladesh) is under implementation.
- ✓ 500MW HVDC module at Bheramara (Bangladesh) has been firmed up.

➢ **Sri Lanka** - under sea HVDC line is under finalization

➢ **Pakistan** - under discussion at Govt. level

1- SAARC: South Asian Association for Regional Cooperation
Members: India, Pakistan, Sri Lanka, Bangladesh, Afghanistan, Bhutan, Nepal & Maldives

Developing SAARC Grid – SAARC Interconnections



India – Nepal Cross border Inter-connection

India - Nepal : Present Interconnection

- **Power Supply Scenario - present**
  - Peak Demand : 1300 MW
  - Installed Capacity : 760MW
  - Self Generation : 350 MW
  - Import from India : 300 MW
  - Peak Deficit : 600-700 MW

- **Nepal is suffering from acute power shortage scenario and daily load-shedding of about 12-13 hours.**

India - Nepal : Power Transfer

Power Transfer through Cross-border Interconnections

	Transmission system	Additional Power Transfer (MW)
Existing	➢ 132 kV & below Radial links • Ramnagar – Gandak (Surajpura) 132 kV S/c • Kataiya (Kosi) – Duhabi (Kusaha) 132 kV S/c • Tanakpur – Mahendranagar 132 kV S/c	220-240
	➢ Muzaffarpur – Dhalkebar 400kV charged at 132 kV	80
	Sub-Total	300-320
On going (by Oct' 16)	➢ 2 nos 132 kV links being implemented by WAPCOS • 132 kV Kataiya – Kusaha S/C on D/C line (Panther) • 132 kV Raxaul – Parwanipur S/C on D/C line (Panther)	120-150
	➢ Charging of Muzaffarpur- Dhalkebar 400kV at 220kV (Total Power Flow ~200MW)	120
	Sub- Total	540-590
Future (by Dec '17)	➢ Charging of Muzaffarpur- Dhalkebar 400kV at 400kV (Power Flow ~500-600MW)	300-400
	Total	840-990

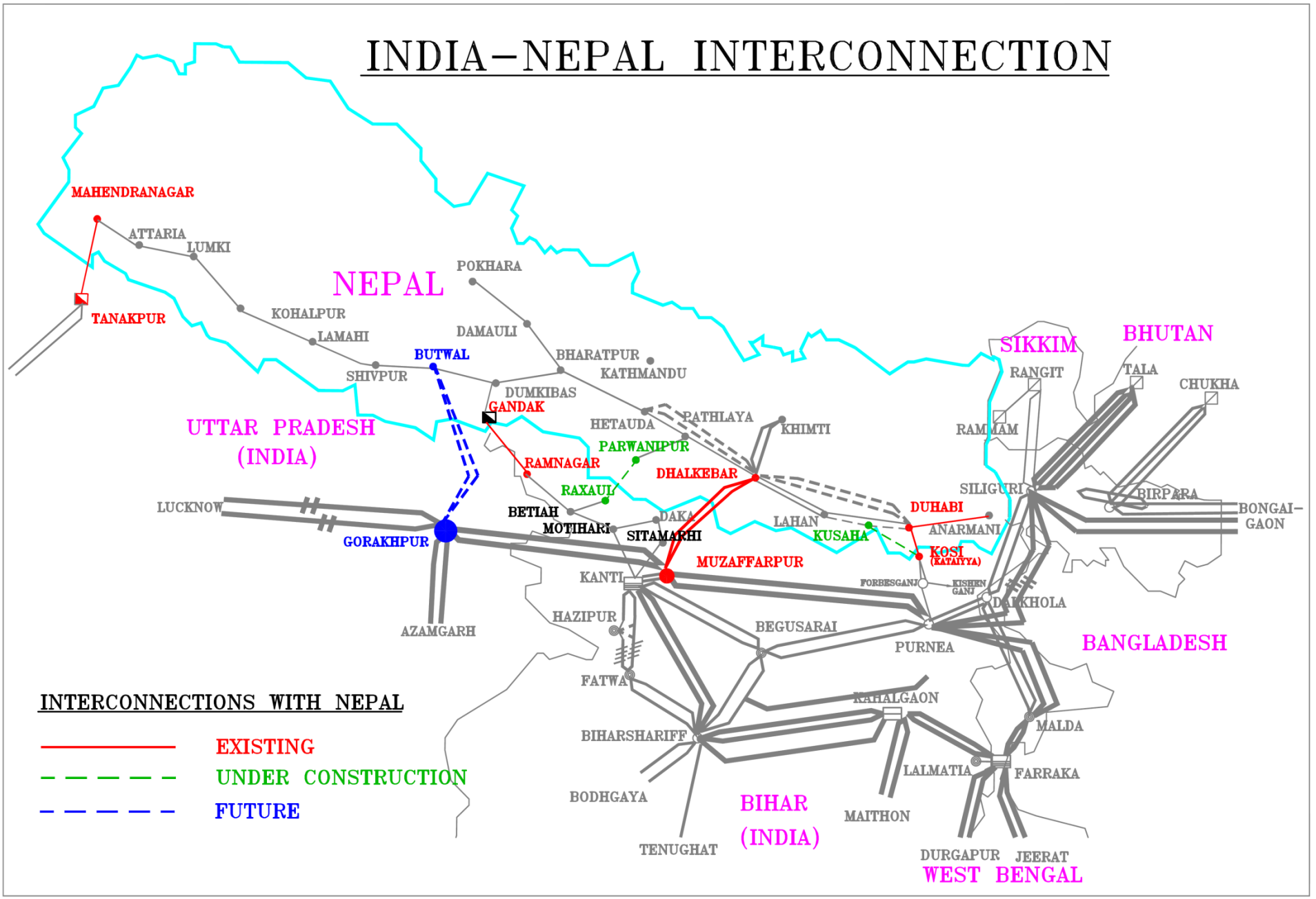
2nd Cross Border Interconnection

- The 2nd cross border interconnection is required for reliable operation of India – Nepal synchronous grid interconnection. It would take care of the power transfer requirement in case of outage of Muzaffarpur – Dhalkebar 400kV D/c line.

- 2nd JSC/JWG meeting held on 28th Jan 2016, advised the JTT to explore the option for **2nd synchronous interconnection** (by 2018-19 time-frame) irrespective of development of new hydro project in Nepal.

- The JTT proposed **Gorakhpur-New (India) – New Butwal (Nepal) 400kV D/c line (Quad)**

India – Nepal Existing and On going interconnections



Future Power Scenario

- Lot of hydro generation is expected in Nepal upto 2035 time-frame (282 projects, 45GW)
- A Joint Technical Team (JTT) was constituted in the 1st JWG / JSC meeting to identify the transmission requirements for evacuation of power hydro projects in Nepal corresponding to the time frame of 2021-22, 2025 and 2035.

	2021-22	2025	2035
Total New Projects	6.9 GW (168 Projects)	14.7 GW (229 Projects)	45 GW (282 Projects)
Load Demand (Peak)	2.4 GW	2.9 GW	6.2 GW
Maximum Exportable Power from Nepal to India (During Off-Peak demand)	5.6 GW	12.9 GW	24.4 GW

Future Cross Border Interconnections

- 6 number of Cross Border corridors have been identified progressively till 2035 along with the development of Hydro Projects

S.No.	Time- frame	Maximum Export (GW)	Additional Cross border Inter-connections
1	2021-22	5.6	2
2	2025	12.9	2
3	2035	24.4	5

- Along-with cross border inter-connections, East-West Power Highway in Nepal to be developed progressively.
- 2021-22 timeframe

Cross Border Interconnection	East West Power Highway
Muzaffarpur – New Dhalkebar 400kV D/c (Quad) -2nd line	LILO of New Butwal – New Hetauda 400kV D/c (Quad Moose) line at New Damauli
Lumki – Bareilly 400kV D/c (Quad) : 1st	LILO of New Butwal – New Hetauda 400kV D/c (Quad Moose) line at Naubise

Future Cross Border Interconnections

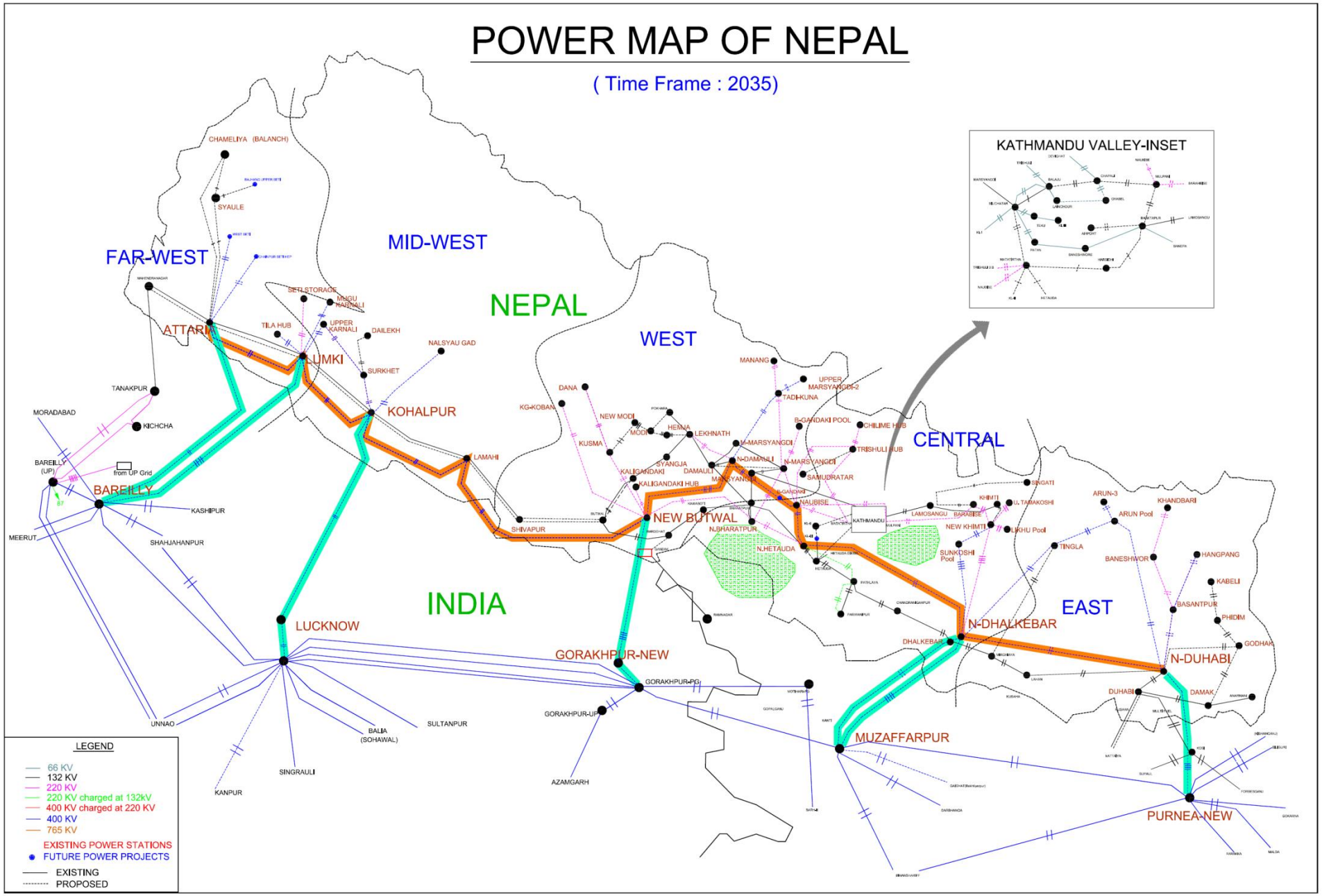
- 2025 timeframe

Cross Border Interconnection	East West Power Highway
Gorakhpur (New) – New Butwal 400kV (Quad): 2nd	Charging of New Duhabi – New Dhalkebar 400kV D/c (Quad Moose) at 400kV
Attaria – Bareilly 400kV D/c (Quad)	New Damauli – New Butwal 400kV D/c (Quad): 2nd
Reconductoring of Muzaffarpur – Dhalkebar 400kV D/c (Twin) to Twin HTLS	New Butwal – Kohalpur via Lamahi 400kV D/c (Quad) line
	Lumki – Attaria 400kV D/c (Quad)
	Kohalpur – Lumki 400kV D/c (Quad)
	LILO of New Butwal – Kohalpur 400kV D/c (Quad) line at Lamahi

- 2035 timeframe

Cross Border Interconnection	East West Power Highway
New Duhabi – New Purnea 400kV D/c (Quad): 1st	Already developed in 2025 time-frame
New Duhabi – New Purnea 400kV D/c (Quad): 2nd	
New Dhalkebar – Muzaffarpur 400kV D/c (3rd line - Quad) line	
Lumki – Bareilly 400kV D/c (Quad): 2nd	
Kohalpur – Lucknow 400kV D/c (Quad)	

Evacuation of Future projects – 2035 timeframe



Issues for Interconnection

- **Muzaffarpur – Dhalkebar line** to be charged at 220kV & 400kV within scheduled timeframe (Oct'16 and Dec'17) to facilitate more power transfer to the Nepal grid.

- The **Second cross- border interconnection** (Gorakhpur-New (India) – New Butwal (Nepal) 400kV D/c quad line) should be implemented at the earliest for reliable and secure operation of the grid.

- Institutional developments (including Regulatory Commission) may be expedited so as to facilitate smooth transfer of power across the border.

- NEA should be involved in planning and development of evacuation system from Private Sector generation projects in Nepal so that the transmission system within Nepal could be optimised.

Thank You