



# USAID 11<sup>th</sup> Meeting SAREP Task Force-2

**Grid Controller of India Limited**

# Indian Grid...One of the World's Largest

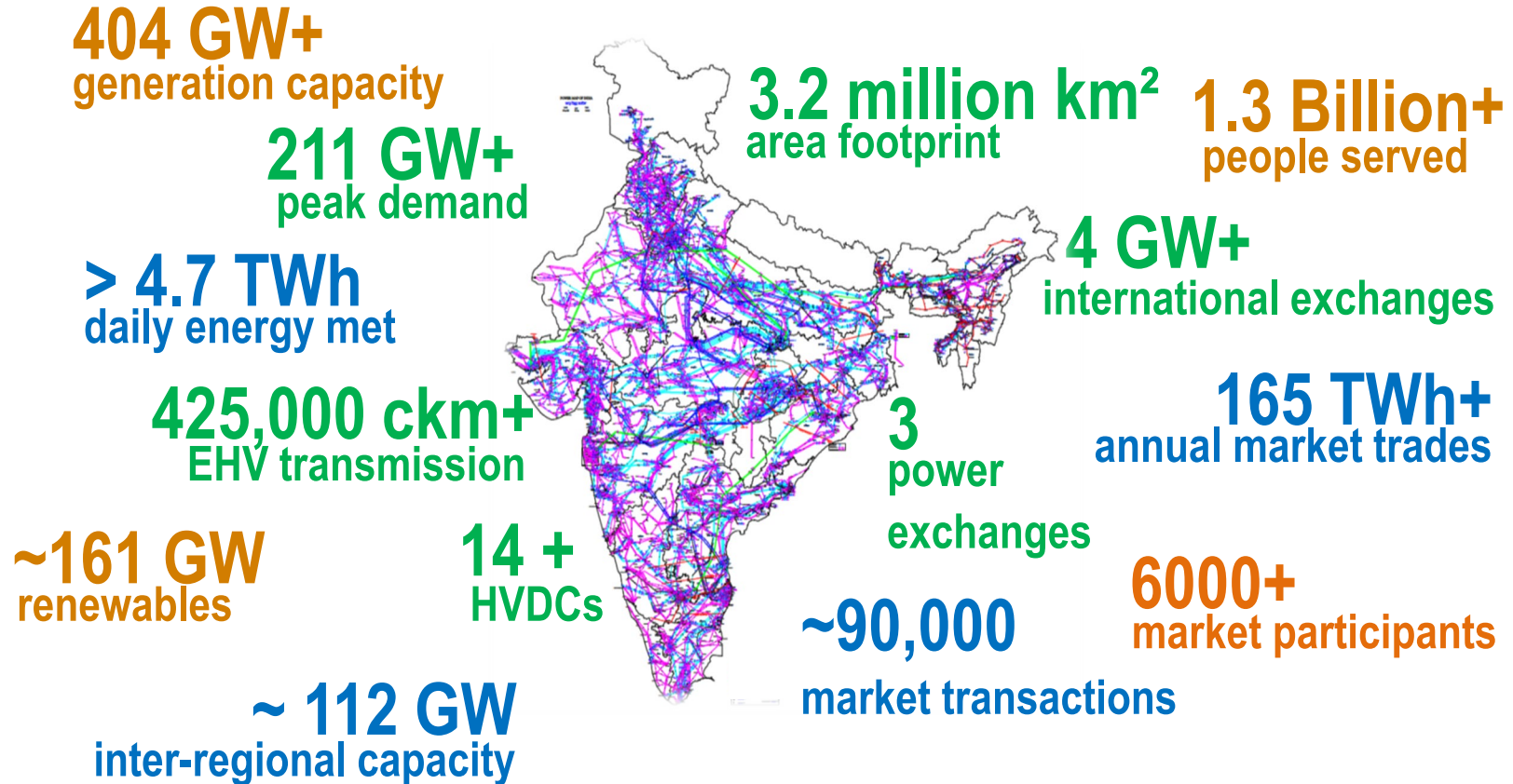


Source: GO15

- 1 national synchronous grid
- electricity generation
- 3 electricity consumption
- installed generation capacity
- transmission system
- 4 wind generation
- solar generation
- 6 hydro generation
- 9 pumped storage installed capacity

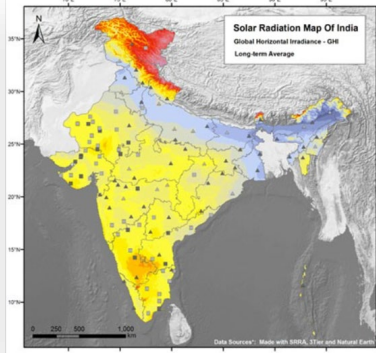
Source: IEA Key World Energy Statistics 2021 & IHA 2021 Hydro Status Report (2019 data, 2019 provisional data)

# Dimensions

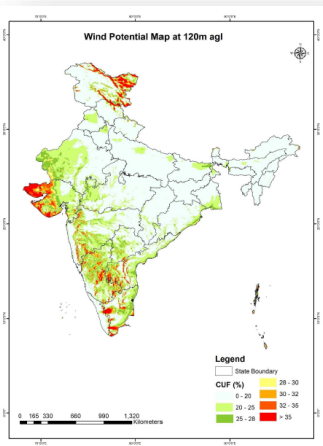


# Clean Energy Transition in India

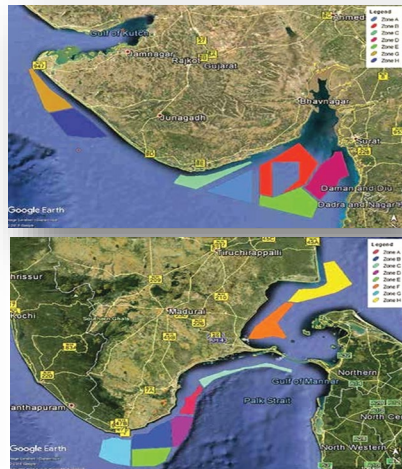
## Solar Radiation Atlas



## Wind Atlas



## Offshore Wind



**Present Total Installed Capacity ~410 GW**  
**Present Renewable Installed Capacity ~ 167 GW**  
**Present Solar + Wind Installed Capacity ~110 GW**

**Solar Potential ~ 750 GW, Wind Potential @ 120 mtr agl ~ 700 GW**  
**Off-shore wind potential ~ 70 GW (coast of Gujarat & Tamil Nadu)**

Region/State	Annual VRE Penetration for 2021-22 (Energy Terms)	Maximum Daily VRE* Penetration upto Sept-22 (Energy Terms)	Maximum Instantaneous VRE Penetration upto Sept-22 (MW Terms)
Karnataka	28.1%	72.5%	132%
Andhra Pradesh	21.0%	58.6%	85.6%
Tamil Nadu	16.0%	50.1%	76.7%
Telangana	9.7%	17%	50.3%
Gujarat	13.8%	37.6%	56%
Madhya Pradesh	7.8%	32.4%	54%
Maharashtra	5.2%	23%	37%
Rajasthan	15.5%	36.5%	68.4%
Southern Region	17.0%	36.5%	61.4%
Western Region	9.5%	26.5%	35%
Northern Region	6.9%	14.7%	37.5%
All India	9.5%	20.4%	31.8%

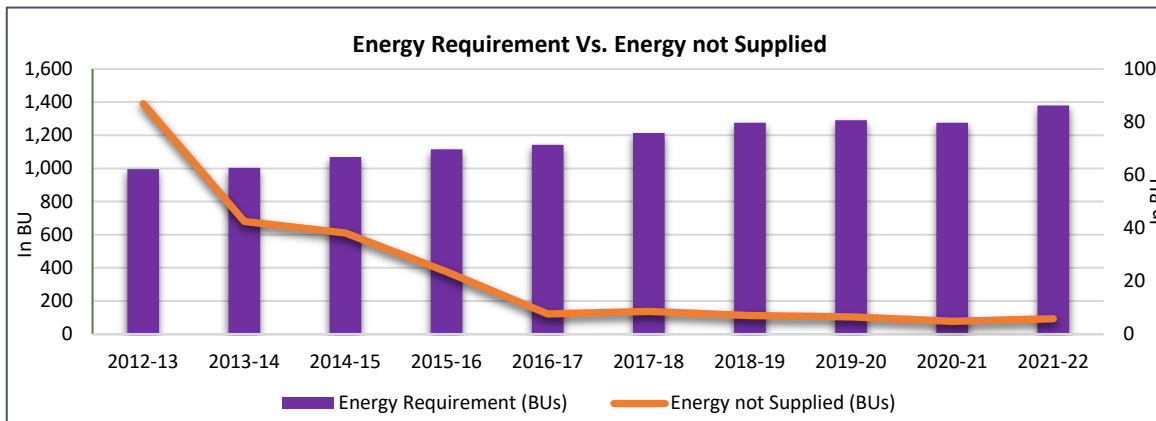
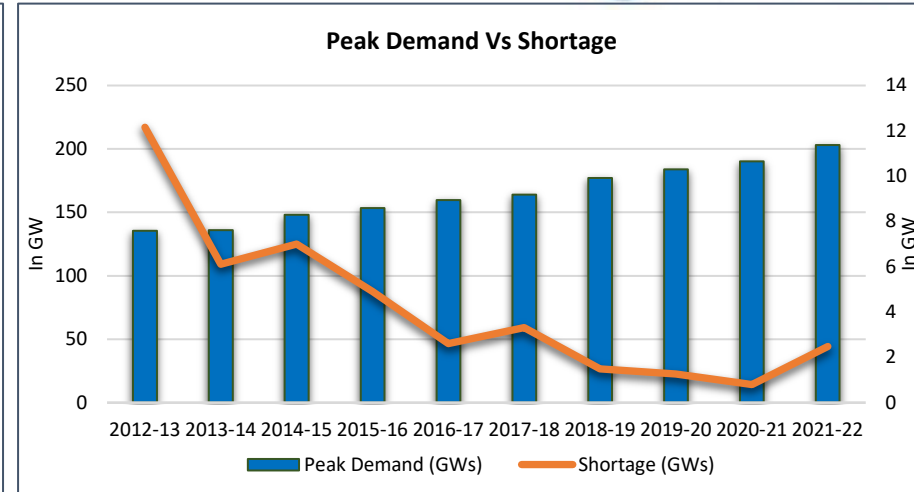
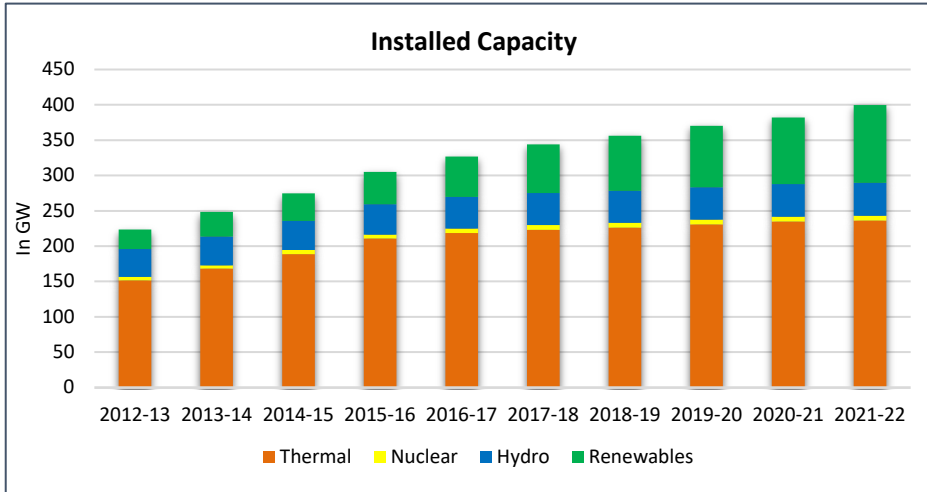
\*VRE:Wind and Solar only

# Overview of ongoing CBET with neighbouring countries



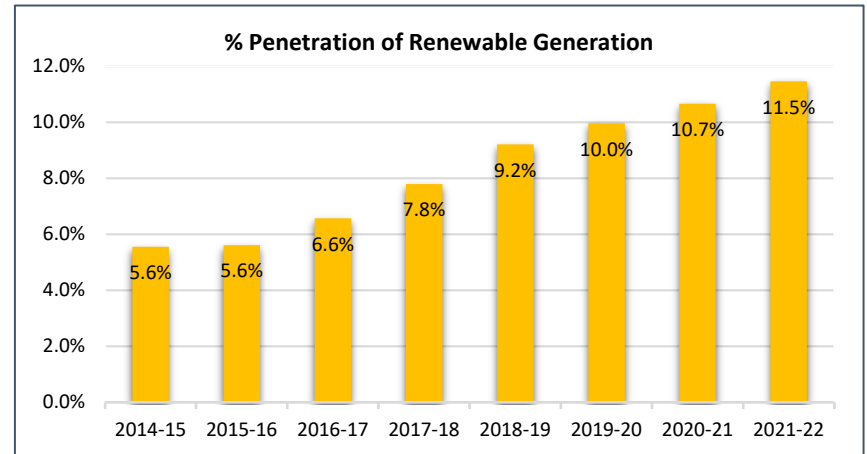
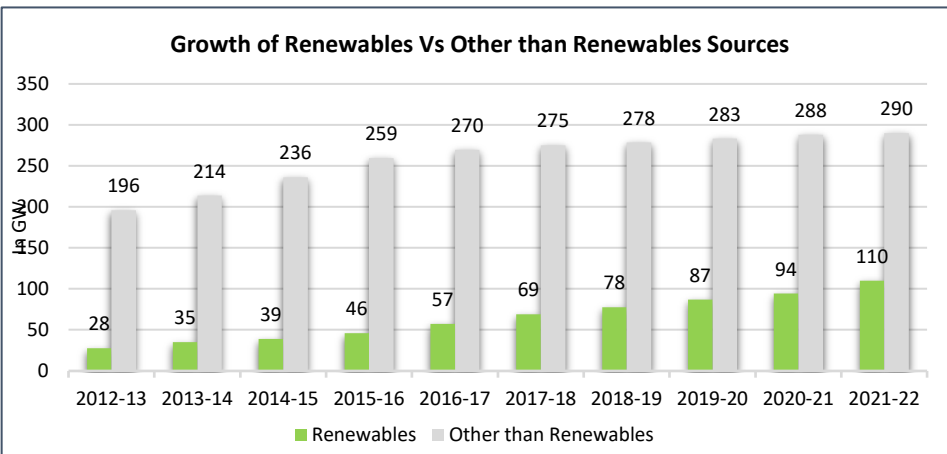
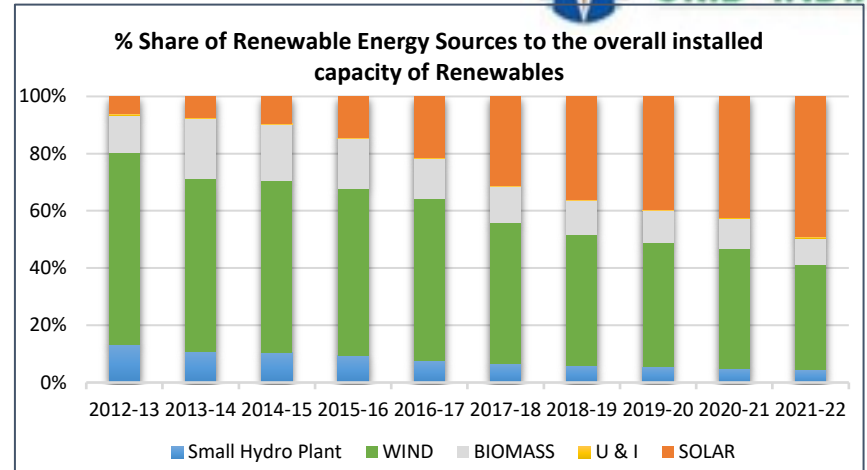
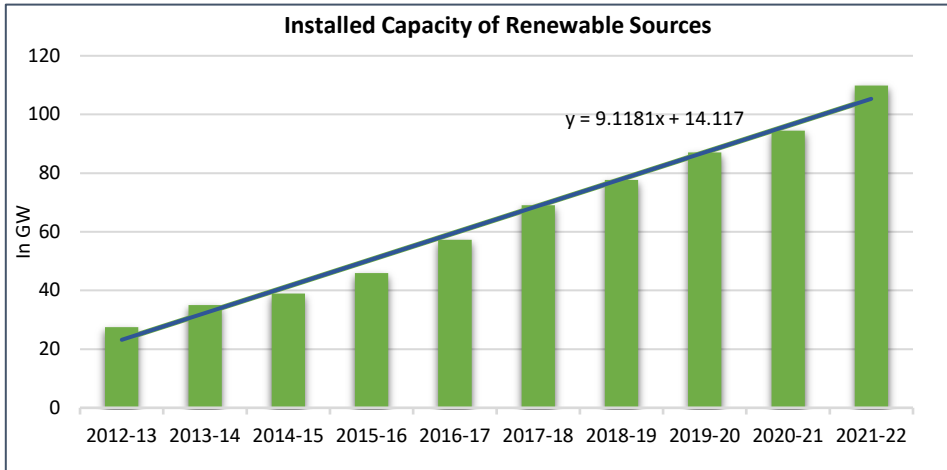
Partiulards	Quantum(MW)	Interconnecting links
India-Bangladesh	1160 (export)	Behrampur-Bheramara 400kV D/C with 1000MW B-t-B HVDC at Bheramara, 400kV Suryamaninagar-Comilla (charged at 132kV)
India-Nepal	600-800 (export) 200-250 (import)	400kV Muzaffarpur-Dhalkebar D/C, 132kV Tanakpur(N)-Mahendranagar(UK) S/C, several other 132kV and below lines between Nepal and Bihar
India-Bhutan	2300 (import) ≈ 400-500 (export)	400kV Tala-Binaguri T/C, 400kV Malbase – Binaguri S/C, 400kV Jigmeling-Alipurduar Q/C, 220kV Chukkha-Birpara D/C, 220kV Malbase-Birpara S/C 132kV Geylegphu-Salakati S/C 132kV Motanga-Rangia S/C
India-Myanmar	3-5	Radial 11kV Line Tamu-More

# Power Sector's Trend over a decade



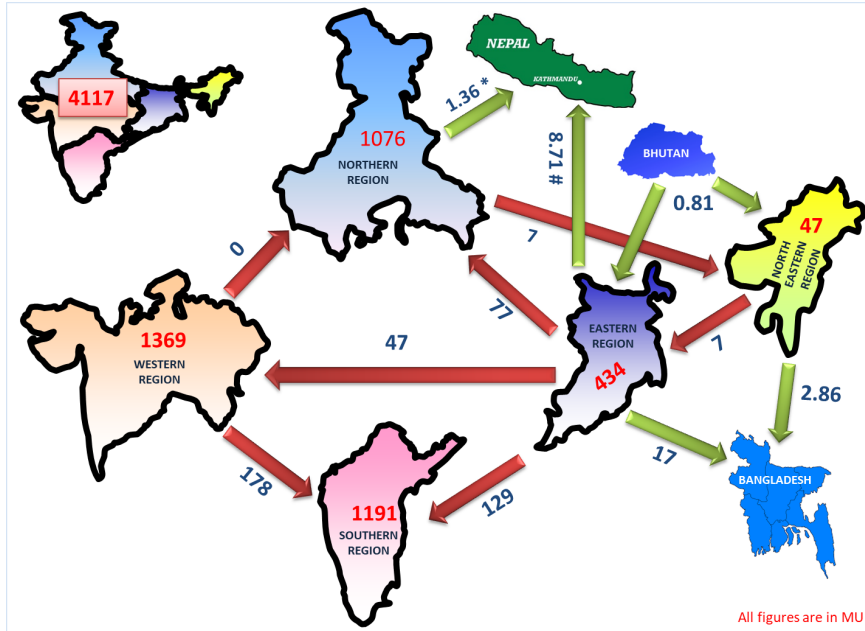
Source: cea

# Growth in Renewable Energy over a decade

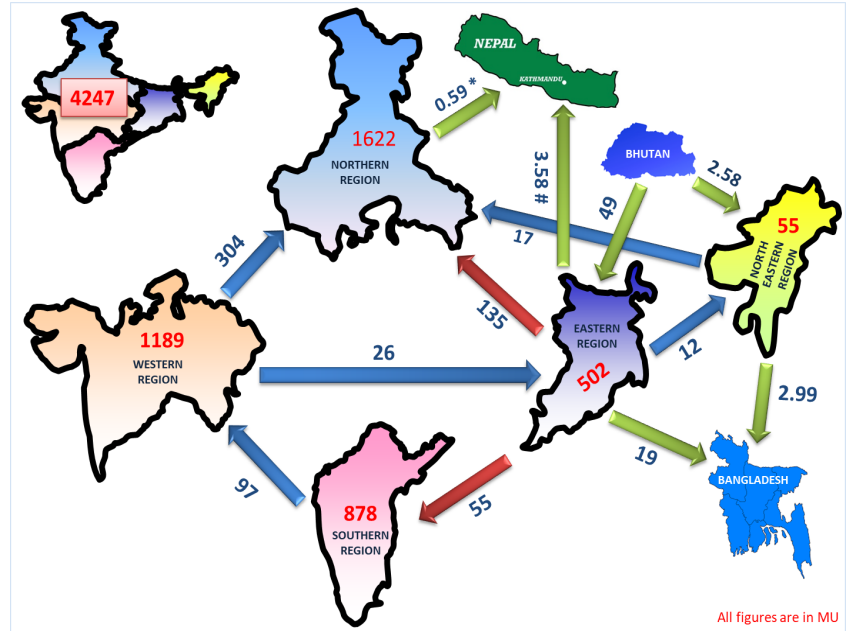


Source: cea

## Transmission Flows – Behaviour Change



Low RE (Wind) Period – March 2022



High RE (Wind) Period – July 2021



# Institutional Arrangements

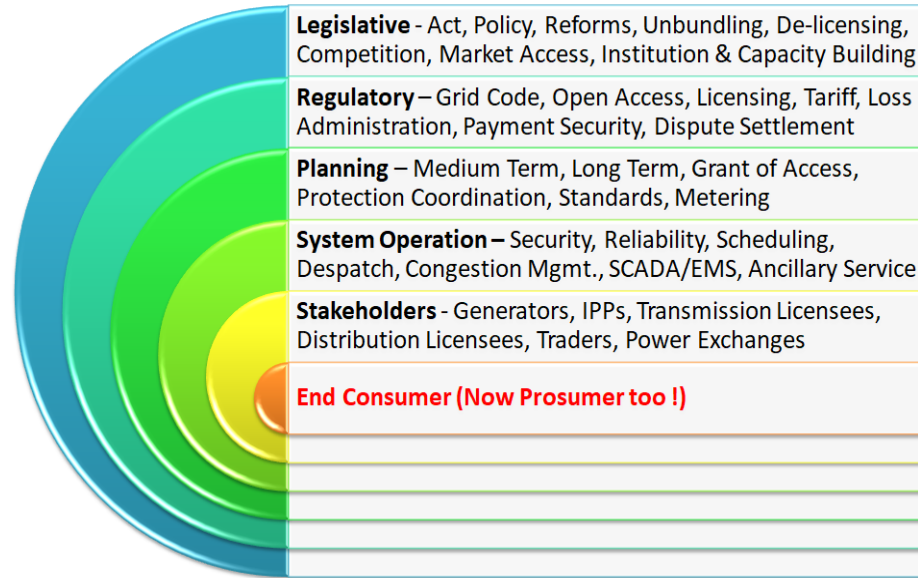


Policy Making	Central Government	CEA	State Government
Regulators	Central Electricity Regulatory Commission		State Electricity Regulatory Commission
System Operators	National Load Despatch Centre	Regional Load Despatch Centres	State Load Despatch Centres
Generation	Central Generating Stations	State Generating 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



<http://www.forumofregulators.gov.in/Data/Reports/FOR%20Report%20CABIL.pdf>

# Roles and Responsibilities of Governance in India as per Electricity Act, 2003



Section EA'03	Deals With
26	National Load Despatch Centre
27-28	Regional Load Despatch Centre
31-32	State Load Despatch Centre
38	Central Transmission Utility
39	State Transmission Utility
40	Transmission Licensees
42	Distribution Licensees
52	Electricity Traders
66	Development of Market
70	Central Electricity Authority
76	Central Electricity Regulatory Commission
82	State Electricity Regulatory Commission
83	Joint Commission
110	Appellate Tribunal for Electricity

# Institutional Empowerment of Load Despatch Centres Act and Policies



## Indian Electricity Act, 2003

- **Section 26** - “Central Government may establish a center at the national level, to be known as the National Load Dispatch Center (NLDC) for optimum scheduling and dispatch of electricity among the Regional Load Dispatch Centers.”
- **Section 27(2)** - “The Regional Load Dispatch Center (RLDC) shall be operated by a Government Company or any authority or corporation established or constituted by or under any Central Act, as may be notified by the Central Government”
- **Section 28(1)** - “The Regional Load Dispatch Center shall be the apex body to ensure integrated operation of the power system in the concerned region.”
- **Section 29(1)** - The Regional Load Dispatch Center may give such directions and exercise such supervision and control as may be required for ensuring stability of grid operations and for achieving the maximum economy and efficiency in the operation of the power system in the region under its control.
- Mirror provisions for State Load Dispatch Centers (SLDCs) in Section 31, 32 and 33.

## National Electricity Policy, 2005

- “...5.3.7....The spirit of the provisions of the Act is to ensure independent system operation through NLDC, RLDCs and SLDCs....”

## Tariff Policy, 2016

- “...7.4 Ancillary Services...(2) The Central Commission shall also consult the Central Electricity Authority, State Electricity Regulatory Commissions/JERCs, Central Transmission Utilities/State Transmission Utilities and NLDC / RLDC / SLDCs while specifying the norms for ancillary services....”



# Grid-India – Independent System Operator



- **Integrated National Power System Operation through Six Control Centres**
  - National Load Despatch Centre (NLDC)
  - 5 Regional Load Despatch Centres (RLDCs)
    - Northern RLDC (NRLDC)
    - Western RLDC (WRLDC)
    - Southern RLDC (SRLDC)
    - Eastern RLDC (ERLDC)
    - North-Eastern RLDC (NERLDC)
  - Corporate Centre - Delhi

- Mandate through Electricity Act, 2003 Sec 26 – 29
- National Electricity Policy, 2005 Section 5.3.7
- CPSE Registered under Companies Act, 2013
- POSOCO as Independent Government Company under Ministry of Power – January, 2017
- Discharging Mission Critical Statutory Functions of National Importance

Integrated operation of National Power System

Fair, neutral and accountable

Knowledge based organization

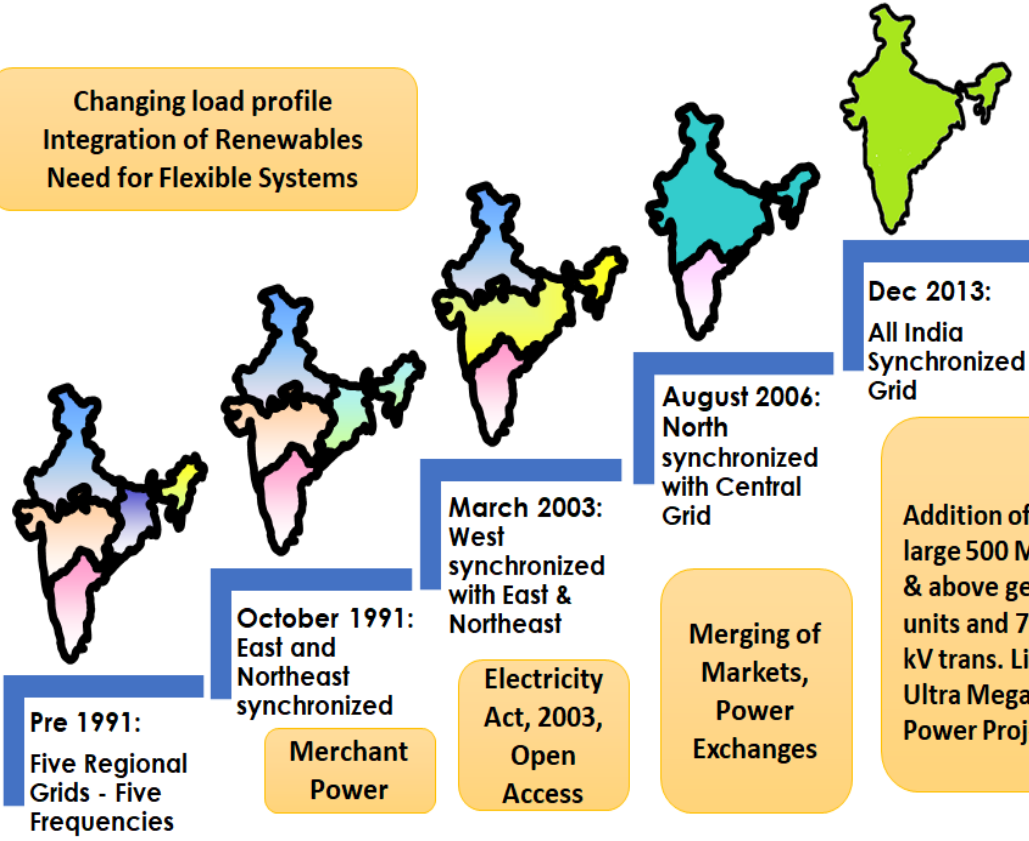
Regulatory oversight – Profit not an objective

Financial & Functional autonomy

# Grid Evolution and System Operation



Changing load profile  
Integration of Renewables  
Need for Flexible Systems



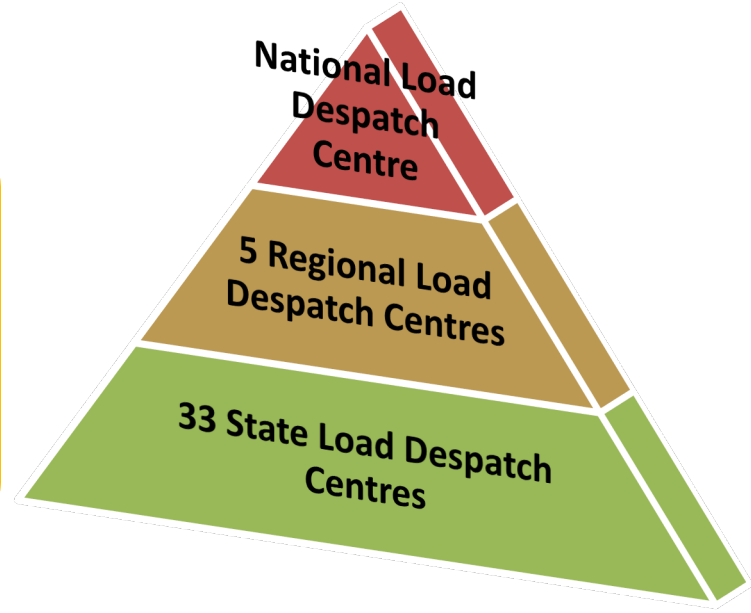
Merchant Power

Electricity Act, 2003, Open Access

Merging of Markets, Power Exchanges

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

**Multi-tiered & Multi-lateral Coordinated System Operation**



## CERC - 21 Regulations

- [Open Access in Inter-State Transmission](#)
- [Grant of Connectivity, LTA and MTOA](#)
- [Measures to relieve Congestion](#)
- [Grant of trading licence](#)
- [Renewable Energy Certificate](#)
- [Indian Electricity Grid Code](#)
- [Sharing of ISTS Charges & Losses](#)
- [Intervening Transmission Facilities](#)
- [Standards of Performance](#)
- [Planning, Coordination and Development of Economic and Efficient ISTS by CTU](#)
- [Power Market](#)
- [Terms and Conditions of Tariff](#)
- [Power System Development Fund](#)
- [Deviation Settlement Mechanism](#)
- [Fees and Charges of RLDC](#)
- [Ancillary Services Operations](#)
- [Energy Savings Certificates](#)
- [Communication in Power Sector](#)
- [Planning of Transmission System](#)
- [Cross Border Trade of Electricity](#)
- [Terms and Conditions for Tariff determination from RE Sources](#)

## CEA - 8 Standards

- [Grid Standards;](#)
- [Connectivity to the Grid](#)
- [Installation and Operation of Meters](#)
- [Technical Standards for Connectivity of the Distributed Generation Resources](#)
- [Safety and Electricity Supply](#)
- [Transaction of Business](#)
- [Furnishing of Statistics, Returns & Information](#)
- [Technical Standards for Communication System in Power System Operation](#)



# Electricity Market– Present Vs. Future



Dimension	India at Present	Various future alternatives
Market	Energy only , Capacity contracts competitive	Capacity and Ancillary Market
Losses	Paid in kind	Cash settlement Operator procures
Balancing	Frequency-linked passive balancing	Active Balancing Explicit Market
Settlement period	15-minute time block	Moving to 5 minute
Settlement cycle	Weekly	Weekly / Monthly
Transmission charge	Point of Connection	Zonal / Nodal / Locational
Trading	Physical	Physical, Financial

# Cross border Electricity Market

## Transactions



### India – Bhutan

- **Chukha HEP (336 MW), Kurichu HEP (60 MW), Tala HEP (1020 MW) and Mangdechu HEP (720 MW)** have long term contracts
- **Dagachhu HEP (126 MW)** participates in short term market
- **400 kV, 220 kV and 132 kV** interconnections



### India – Bangladesh

- Transactions
  - **Long Term**
  - **Medium Term**
  - **Short Term**
- **1000 MW HVDC and 400 kV** (charged at 132 kV) interconnection
- **250 MW** from 13 Number of NTPC stations
- **300 MW** power from DVC
- **160 MW** from Tripura



### India – Nepal

- Transactions
  - **Long Term**
  - **Short Term**
- **400 kV** (charged at 220 kV), 132 kV, 33 kV & 11 kV interconnections
- Upto **600 MW** export through Muzaffarpur-Dhalkebar link
- Upto **70 MW** export through 132 kV Tanakpur-Mahendranagar link



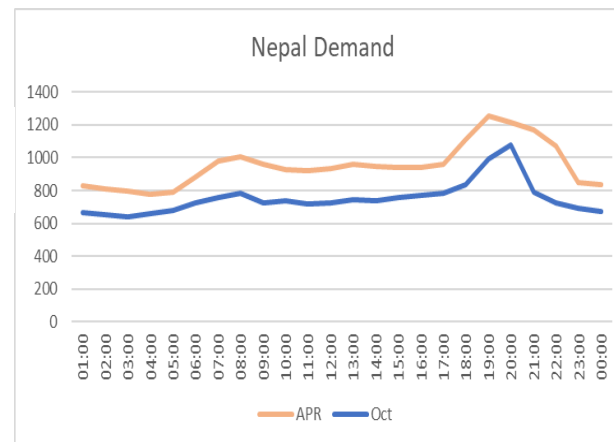
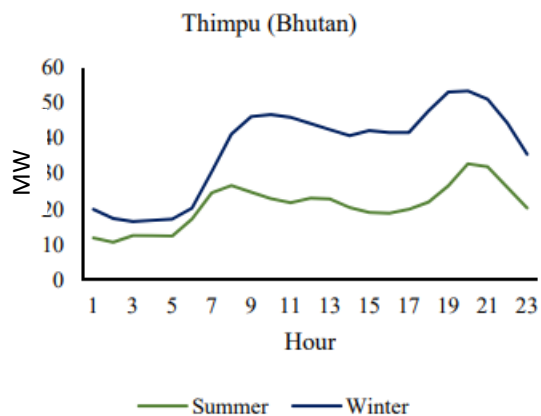
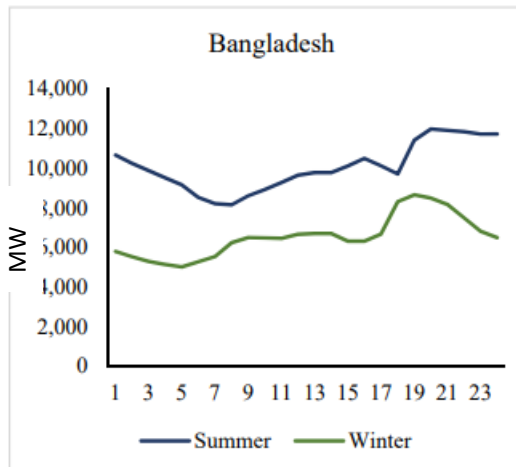
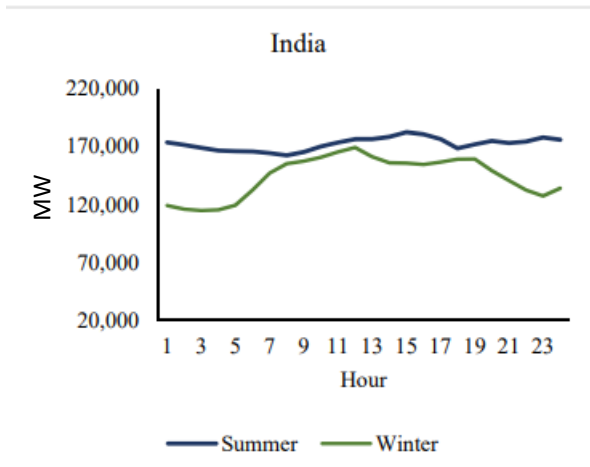
### India – Myanmar

- Transactions
  - **Short Term**
- 11 kV interconnection

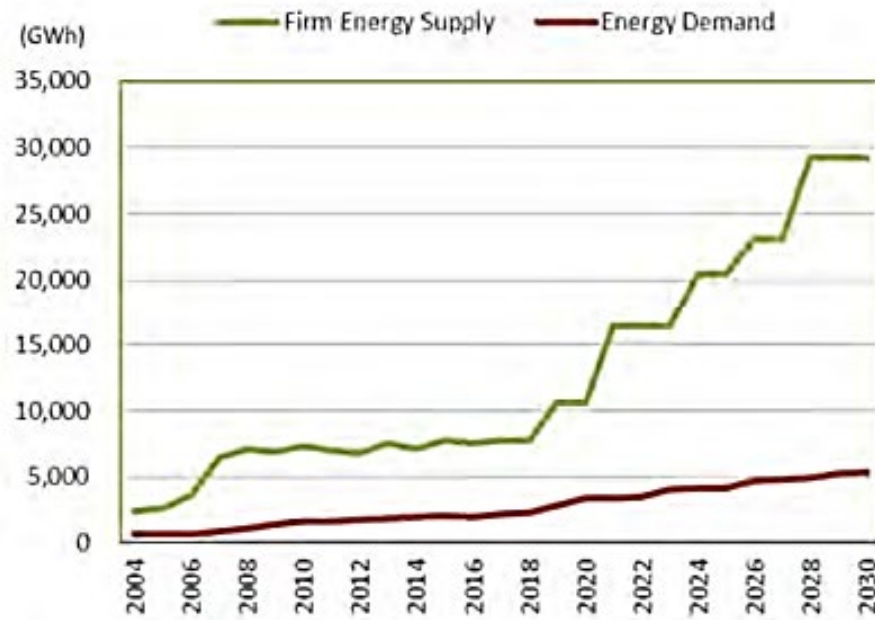
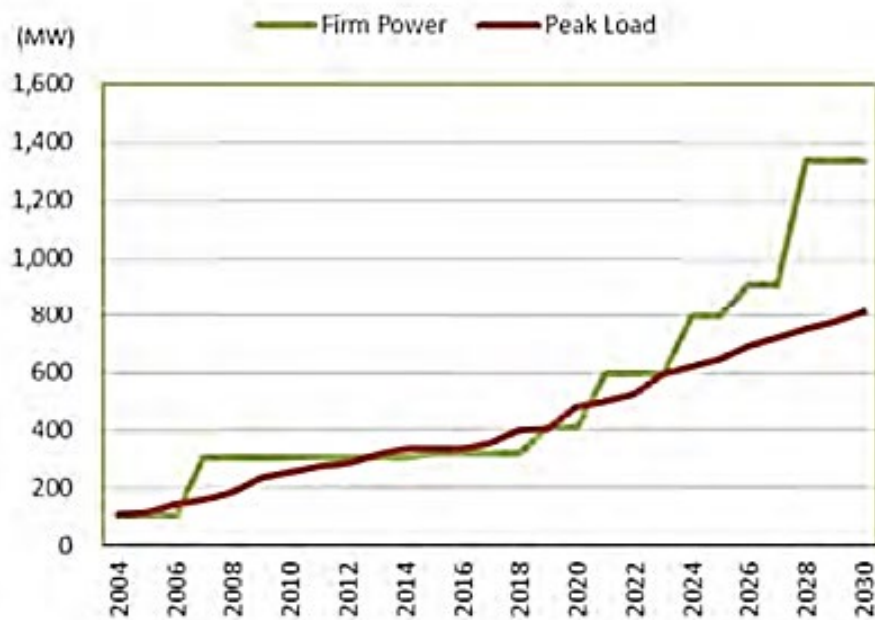




# Typical Demand Pattern of BBIN countries



# Bhutan Demand Trend



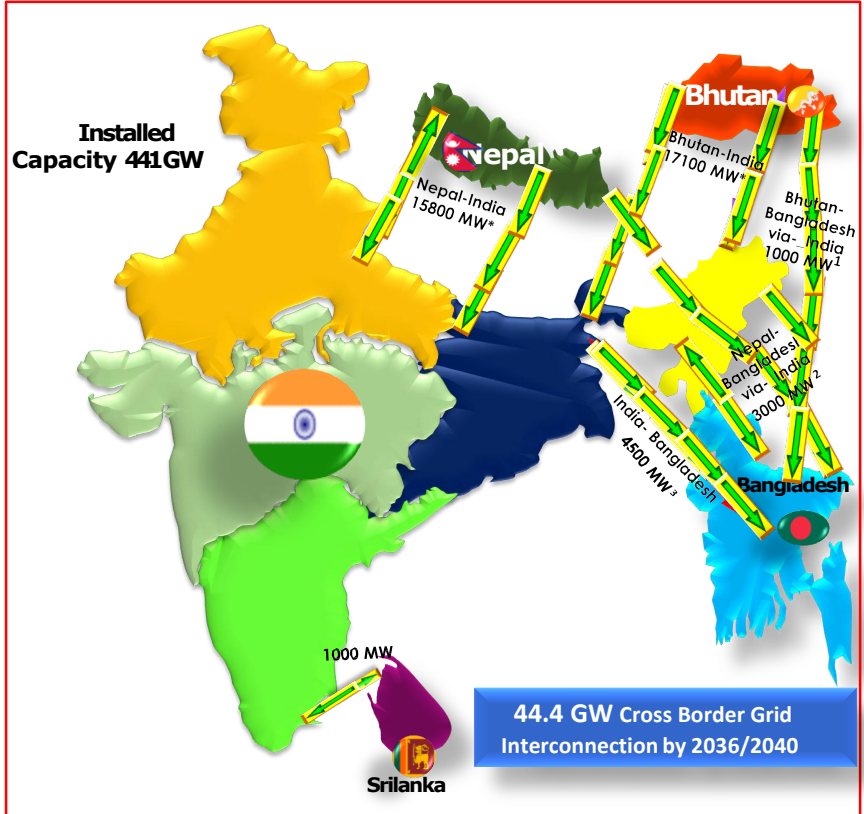
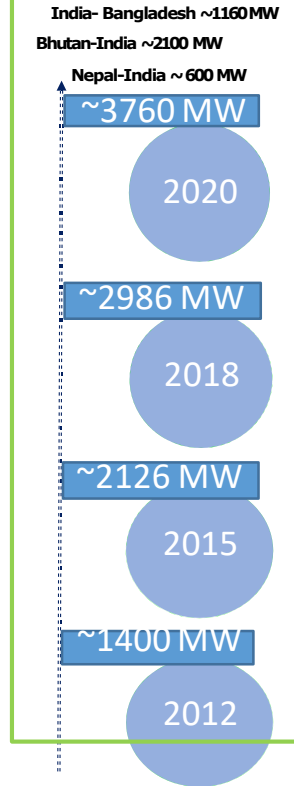
Source: Bhutan Master Plan 2040

# Scenario of Cross Border Electricity Trade (CBET) & Future Outlook







- ❑ CBET – Increased by 2.6 times since 2012. (~3760 MW)- Peak Trade
- ❑ Historically CBETs are bilateral, Now trilateral trade envisaged

- ❑ Bangladesh- Plan to Import from Bhutan (1 GW), Nepal (3 GW) through India.
- ❑ Bangladesh issued LoI for import of electricity from Upper Karnali (GMR) in Nepal



# Benefits of Cross Border Trade

**Rapid Renewable Energy Expansion**

 <b>India</b> 450 GW by 2030	 <b>Bangladesh</b> 7.9 GW by 2041
 <b>Sri Lanka</b> 50% Generation from RE by 2030	 <b>Pakistan</b> 16 GW by 2040

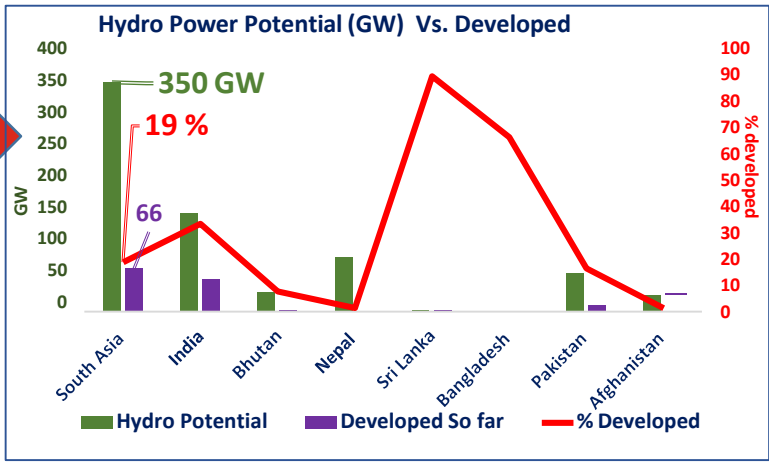
CBET can act as a tool for flexibility, managing RE Intermittency, Grid Balancing RE Integration

**Large Regional hydro potential**  
~350 GW (19% developed)

Hydro is one of the best Balancing resource  
Sharing of reserves

Opportunity for developing Regional Power Market  
Trading of balancing services  
Ancillary Market

Successful 9 PM, 9 Minute-A generation flexibility of ~ 400 MW was achieved from hydropower plants in Bhutan



# Prerequisite for Multilateral Cross Border Trade

## Political



- Political Concurrence
- Intergovernmental agreement

## Regulatory



- Use of intermediary transmission network
- Congestion Handling
- Imbalance & settlements

## Techno Commercial

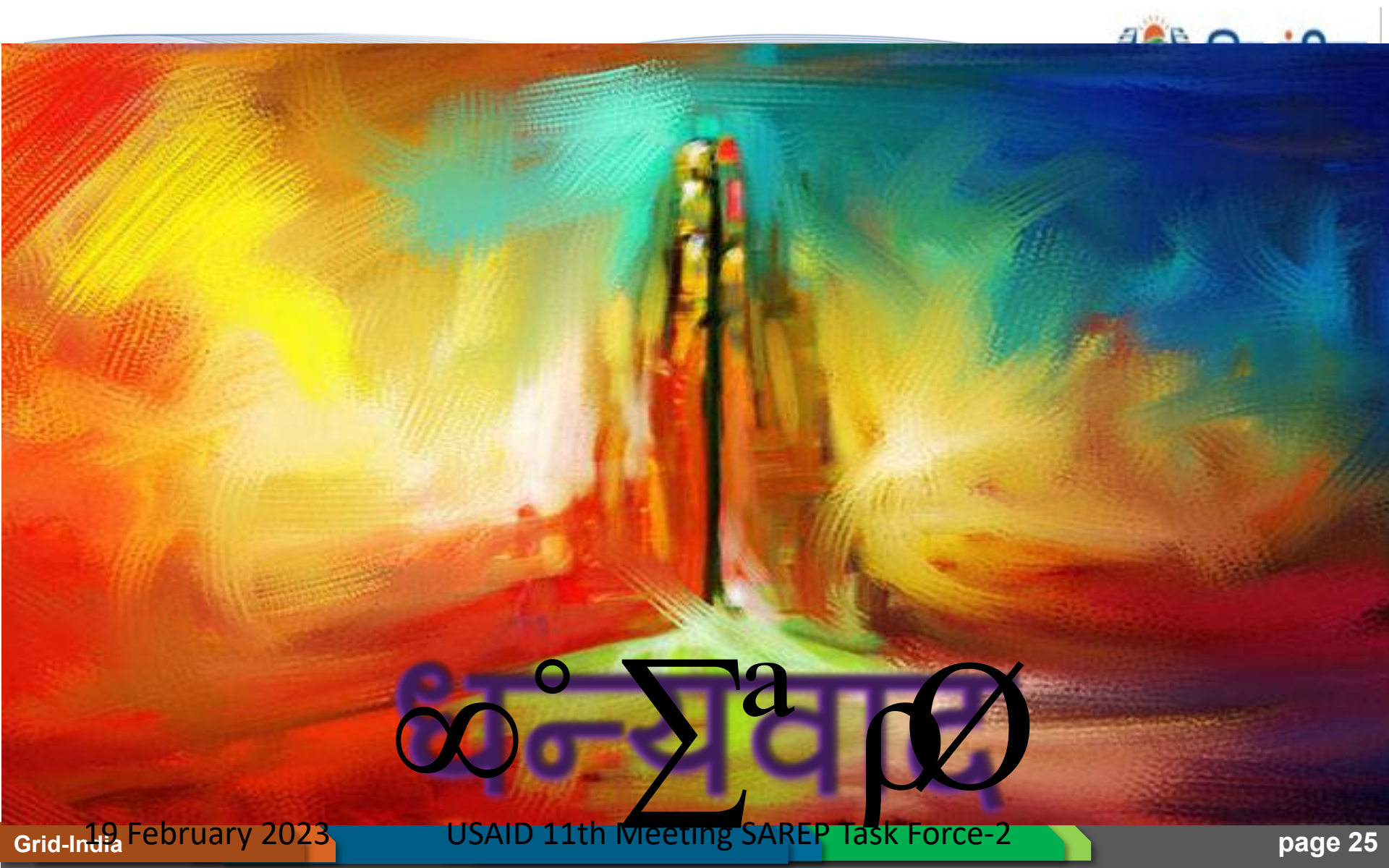


- Standards Grid Codes
- Transmission charge
- Co-ordinated Grid Planning
- Settlement & payment Dispute resolution

## Institutional



- Joint Steering Committee
- Joint Working Group
- Joint Operation Committee
- Joint Technical Team



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