Annual Conference

Report on

CROSS BORDER COOPERATION IN ENERGY INFRASTRUCTURE

1ST & 2ND MARCH, 2024

KALUTARA, SRI LANKA

South Asia Forum

For Infrastructure Regulation

Contents

Executive Summary

Cross-border power links have the potential to bring enormous benefits to the South Asian region. Current bilateral interconnections between Nepal-India, Bhutan-India, Myanmar-India, and Bangladesh-India, though at a small scale, indicate promising outcomes. These connections allow for the effective utilization of diverse load and generation patterns across the region, particularly with the integration of more renewables into the grid. However, there are pertinent issues that need to be addressed to facilitate greater traction on cross-border electricity trade.

To delve deeper into the complexities of cross-border electricity dynamics, a two-day conference on "**Cross Border Cooperation in Energy Infrastructure**" was convened . This Conference was organized in Sri Lanka at the invitation of Public Utilities Commission of Sri Lanka (PUCSL), a member of the SAFIR Forum. Notably, this large-scale conference also featured sessions led by newly on boarded SAFIR members.

The conference was scheduled from March 1st to 2nd, 2024, in the beautiful city of Kalutara, Sri Lanka. The two-day event comprised an inaugural session and seven working sessions. These sessions delved into various critical topics related to cross-border electricity dynamics:

1. Transmission system operations in the context of Cross Border Energy Trade
2. Transforming Cross Border Electricity Trade and Regional Electricity markets
3. Importance of Cross Border energy co-operation: Nepal Perspective
4. Cross Border Interconnections and its Importance
5. Role of Markets in Cross Border Electricity Trade
6. Role of transmission Inter-Connection as facilitator of Cross Border Electricity Trade
7. Cross Border electricity trade as an enabler of Development in South Asian region

In the inaugural session, Professor M A R M Fernando, Chairman, PUCSL, encouraged everyone to work for a sustainable and interconnected future for all. Mr. Jishnu Barua, Chairperson, SAFIR/CERC emphasized that the South Asian Region holds the key to unlocking the world's Net Zero ambitions, and everyone should come together and work diligently towards shared initiatives. Ms. Deki Choden, CEO, Electricity Regulatory Authority of Bhutan, complimented the opportunities that the Forum provides. Mr. Dilli Bahadur Singh, Chairperson, Electricity Commission of Nepal, encouraged all to act now for the betterment of all.

The Working Sessions featured presentations from experts representing both public and private sector entities in the power sector. These presentations provided valuable insights into cross-border power trading and infrastructure challenges.

The conference concluded with a vote of thanks delivered by Mr. Harpreet Singh Pruthi, Secretary, SAFIR/CERC, who acknowledged the comprehensive presentations delivered and provided valuable insights that will guide the efforts to foster a robust power market and enhance cross-border grid connections, facilitating sustainable growth across the region.

Some of the notable insights that surfaced during the conference include:

1. As regional links are established, the flexibility of the system increases, facilitating the integration of more renewable energy sources.
2. Cross-border energy trading can not only help to balance a renewable-rich system or seasonal imbalances but also support cooperation during exigencies.
3. Cross-border energy transactions will significantly boost the economy and also at the same time reduce carbon footprints.
4. The establishment and management of such grids involve politically and administratively sensitive matters. Technical standards also vary from nation to nation, and these need to be matched.
5. “Transmission as a Service” could form an ideal model for the region.
6. Breaking down silos and collaborating on shared public good initiatives is essential.
7. Extension of the Indian market to encompass other jurisdictions could be a promising option

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Conference Schedule

DAY 1 – 1st MARCH, 2024; FRIDAY	
INAUGURAL SESSION	
9.30-10.00 AM	Registration & Group photograph
10.00 – 10.05 AM	Welcome Address by Prof M A R M Fernando, Chairperson, Public Utilities Commission of Sri Lanka (PUCSL)
10.05 – 10.10 AM	Address by Ms Deki Choden, CEO, Electricity Regulatory Authority of Bhutan
10.10-10.15 AM	Address by Mr Dilli Bahadur Singh, Chairperson, Electricity Regulatory Commission of Nepal
10.15 – 10.20 AM	Keynote Address by Mr Jishnu Barua, Chairperson, SAFIR / CERC
BUSINESS SESSION	
10.25 – 11.00 AM	Session 1: Transmission system operations in the context of Cross Border Energy trade – Mr S R Narasimhan, CMD, Grid Controller of India Ltd, followed by discussion
11.00 – 11.35 AM	Session 2: Transforming Cross Border Electricity Trade and Regional Electricity markets – Mr Rajiv Ratna Panda, Power market specialist, SAREP, followed by discussion
11.35 – 12.05 PM	Session 3: Importance of Cross Border energy co-operation: Nepal perspective: Mr. Dilli Bahadur Singh, Chairperson, Electricity Regulatory Commission of Nepal, followed by discussion

DAY 2 – 2nd MARCH, 2024; SATURDAY	
BUSINESS SESSION	
10.25 – 11.00 AM	Session 1: Cross Border Interconnections and its importance - Mr. Kanchana Siriwardena, Deputy Director General – Industrial, PUCSL, Sri Lanka followed by discussion
11.00 – 11.35 AM	Session 2: Role of Markets in Cross Border electricity trade – Mr Rohit Bajaj, Executive Director and the Head of Business Development, Strategy and Regulatory Affairs , Indian Energy Exchange, followed by discussion
11.35 – 12.05 PM	Session 3: Role of transmission inter-connection as facilitator of Cross Border Electricity Trade – Mr Dilip Rozekar, ED , Power Grid Corporation of India Ltd, followed by discussion
11.30-12.00 PM	Session 4: Cross Border electricity trade as an enabler of development in South Asian region – Ms Swetha Ravi Kumar , Executive Director, FSR Global, followed by discussion
12.00-12.05 PM	Vote of thanks by Mr. Harpreet Singh Pruthi, Secretary, SAFIR/CERC

Inaugural Session

Welcoming all the delegates, ***Professor M A R M Fernando*** *expressed his pleasure in hosting the conference. He conveyed that the conference on "Cross Border Cooperation in Energy Infrastructure" stands as a testament to the shared commitment towards advancing sustainable energy practices and promoting regional cooperation. Professor Fernando highlighted the agendas for the conference, noting that the discussions would provide valuable perspectives and strategies for the collective growth of the region. He encouraged active participation and knowledge sharing, emphasizing that these efforts would pave the way for a brighter, interconnected future for South Asia. In conclusion, Professor Fernando wished everyone fruitful deliberations and a memorable experience in Kalutara, urging them to work together towards a sustainable energy future.*

Ms. Deki Choden *expressed her satisfaction with the high level of participation in the conference, noting it as a sign of commitment to cross-border cooperation. She praised the South Asian Region for its strong energy exchanges and cooperation in harmonizing regulatory frameworks, while urging further progress. Ms. Choden highlighted the importance of maintaining the region's goodwill, complementary supply-demand situation, and existing infrastructure. The conference offered a platform for dialogue, idea exchange, and strengthened partnerships to address challenges and opportunities in cross-border cooperation. She stressed the importance of sharing solutions and best practices among nations and called on leaders to enhance regional energy infrastructure for socio-economic development. Ms. Choden concluded by thanking participants and looking forward to productive collaborations.*

Addressing the Conference, ***Mr. Dilli Bahadur Singh*** *thanked SAFIR for inviting ERC Nepal to the conference, despite it not being an official member. He expressed optimism that ERC Nepal would acquire membership of the Forum in a couple of months. Regarding cross-border cooperation, he emphasized the importance of training and engaging more stakeholders in understanding and pursuing such aspects. He highlighted the need for broader participation in the South Asian Power Market, including the Real-Time Market, to fully realize its potential. He spoke about the requirement of further connections across South Asia, ultimately leading to the establishment of a fully-fledged power market. Concluding his address, Mr. Bahadur conveyed his pleasure in hearing more from the participants over the course of the conference.*

In his inaugural address, ***Mr. Jishnu Barua****, Chairperson of SAFIR, welcomed all the attendees and expressed his delight in attending his first conference after taking over as the Chairperson of SAFIR. He briefed the audience about the role SAFIR plays as an organization and ecstatically pointed out the new members that have joined the forum, validating the values this Forum upholds. SAFIR now comprises a total of 32 members. Mr. Jishnu, speaking about the conference, emphasized its focus on crucial aspects of energy, stressing the theme of cross-border cooperation in energy infrastructure and sharing insights on the phenomenal growth that the region is experiencing. Mr. Barua stated that the region holds the key to unlocking the world's Net Zero ambitions. He commended the associates USAID, SAREP, and the World Bank for extending their expertise to various Working Groups of the Forum.*

Concluding his remarks, Mr. Barua thanked Professor Fernando for the hospitality extended and wished a wonderful learning experience for all.

TRANSMISSION SYSTEM OPERATIONS IN THE CONTEXT OF CROSS BORDER ENERGY TRADE -

- MR. S R NARASIMHAN, CMD, GRID CONTROLLER OF INDIA LTD.

Mr. S R Narasimhan presented the intricate efforts needed for maintaining reliable cross-border electricity transmission systems. He cited examples of unforeseen changes over his career, like the shift in power flow from France to the UK due to renewable energy additions. He discussed India's interconnections with neighboring countries and showcased graphical representations of power exchange patterns, highlighting the importance of cooperation and balancing renewable energy variations. Narasimhan delved into reliability assessments, outage coordination, and defense plans, stressing the need for transparent information sharing and protocols to mitigate disruptions. He illustrated instances of system protection mechanisms, under-frequency load shedding schemes, and black-start capabilities, emphasizing the importance of testing and drills for preparedness. Narasimhan underscored the role of frequency control mechanisms in maintaining grid stability, citing examples of support provided during outages in interconnectors. Planning for natural calamities and event analysis for understanding system impacts were also discussed. He emphasized continuous dialogue and coordination among operators for efficient system functioning and highlighted the importance of robust cyber security measures to mitigate threats. Overall, Narasimhan's presentation emphasized the complexities and necessities of cross-border energy trade and the importance of collaboration, preparedness, and cybersecurity in ensuring system reliability and resilience.

Key Takeaways

Continuous augmentation of transmission infrastructure is obligatory for long-term reliability.
Cross-border energy trade necessitates outage coordination and defense plans for system protection.
Reliability assessment and real-time visualization ensure optimal cross-border system operation.
Flexibility increases with regional links, supporting integration of renewable energy sources.
Event analysis and dialogue between operators are crucial for system understanding and transparency.
Robust cyber security measures are imperative to safeguard system stability and reliability.

■ *Presentation attached as Annexure -* ❶

TRANSFORMING CROSS BORDER ELECTRICITY TRADE AND REGIONAL ELECTRICITY MARKETS - USAID / SAREP

- MR. RAJIV RATNA PANDA, POWER MARKET SPECIALIST, SAREP PROGRAM, USAID

Mr. Panda focused his presentation on transformative ideas/approaches to reshape CBET and REMs. He covered four main themes: Current and Future Scenarios of Cross-Border Electricity Trade & Regional Electricity Markets; Assessment of Regional Energy & Market Integration Dilemma in the Developing World - Finding a Balancing Act; 7-Point Framework Strategy for CBET & REM Transformation (7P-FSCR); and Way Forward for Transforming Regional Energy Cooperation (REC), CBET & REMs. He shared that Nepal-India-Bangladesh Electricity Trade has the potential to reduce the capex of the power sector by USD $17 BILLION (2015–2045). Mr. Panda highlighted that CBET and REMs can be important tools in scaling this transition and facilitating the achievement of net-zero goals. He suggested that CBET generation and transmission, and regional energy projects can be financed through a fund specifically created for this purpose. He also spoke in detail about the potential of Trans regional Connection, Inter-Continental & Super Grid & One Sun One World One Grid (OSOWOG) VISION.

Mr. Panda lastly presented actionable enablers for strategizing CBET and Electricity Market Development through political & policy, regulatory, technical, commercial, institutional, and financial steps.

Key Takeaways

Align policy and regulation with consensus, foster cross-border electricity trade, and develop a unified vision based on shared principles.
With the continued dominance of bilateral trade, it should be made more sustainable. Market access must be enhanced through competition and adherence to market rules.
Promote the development of electricity market in the region with a fair, transparent trading platform, transcending gradualness to foster market growth
Establish shared principles for Equitable Sharing/allocation of Cost & Benefits, and manage risks in regional energy cooperation, CBET and Regional market development.

■ *Presentation attached as Annexure - ❷*

IMPORTANCE OF CROSS BORDER ENERGY CO-OPERATION: NEPAL PERSPECTIVE –

- MR. DILLI BAHADUR SINGH, CHAIRPERSON, ELECTRICITY REGULATORY COMMISSION OF NEPAL

Mr. Singh began his presentation by discussing the establishment of the Commission and its role in ensuring that electricity operations are simple, regular, systematic, and transparent. The Commission also oversees tariff regulations to protect consumer rights and interests. He shared that the Commission crafted various guidelines and regulatory instruments, including the Nepal Electricity Grid Code published in 2023, which serves as a key for cross-border electricity trade. Mr. Singh presented Nepal's stance on cross-border electricity trade, stating their goal is to develop hydroelectricity as an exportable commodity. By 2035, Nepal aims to export 15 GW of electricity to India and Bangladesh. He illuminated the future course of action by suggesting mechanisms for enhancing regional cooperation in South Asian electricity trade, including constructing dedicated transmission lines, creating transmission hubs and pooling stations. He explained the rationale behind the proposed course of action, highlighting the considerable hydroelectric potential estimated at around 125,684 MW across Bhutan, India, and Nepal. Concluding the presentation, Mr. Singh outlined some long-term visions for the regional countries that are in place and expressed optimism, urging immediate action to achieve the goals.

Key Takeaways

The Electricity Regulatory Commission of Nepal was established to ensure transparent, systematic, and regular electricity operations while protecting consumer interests.
Nepal aims to export 15 GW of electricity to India and Bangladesh by 2035, requiring regional interconnection and infrastructure development.
Proposal for Construction of transmission lines, hubs and pooling stations in the region.
These transactions will boost regional economy, cut carbon footprints significantly, and promote 'Net Zero' goal in South Asia.
India possesses the capability to be the regional leader, but achieving this requires all regional countries to collaborate closely to reach common goals.

■ *Presentation attached as Annexure - ❸*

CROSS BORDER INTERCONNECTIONS AND ITS IMPORTANCE –

- MR. KANCHANA SIRIWARDENA, DEPUTY DIRECTOR GENERAL – INDUSTRIAL, PUCSL, SRI LANKA

Mr. Siriwardena began his presentation by asserting that the importance of cross-border interconnection is indisputable. He elaborated on the current status of existing links between India, Nepal, Bhutan, and Sri Lanka, highlighting that the most substantial hydropower exchanges occur between Bhutan and India. However, the scale of these exchanges is relatively small compared to the overall size of India's power grid, and the uptake has been quite slow. Mr. Siriwardena discussed projects, noting Bhutan's hydropower exports to India and minimal winter imports. The energy exchange between India and Bangladesh relies on coal, with India's energy exports being primarily coal-based. Mr. Siriwardena emphasized that interconnections offer economic benefits and resource optimization. Countries with low-cost resources can benefit from sharing, and interconnected nations can effectively manage seasonal energy shortages due to varied weather patterns. Regarding Sri Lanka, he mentioned that the country primarily relies on liquid fuel, and during the dry season, importing power from India offers numerous advantages. He also emphasized the environmental benefits derived from these inter-regional connections. However, technical standards vary from nation to nation and must be harmonized to avoid potential issues.

Mr. Siriwardena, concluding, urged faster interconnections, highlighting substantial initial costs but significant benefits for regional energy cooperation.

Key Takeaways

Currently, the quantum of cross-border exchanges is relatively small compared to the overall size of India's power grid, indicating that the uptake has been quite slow.
The importance of cross-border interconnection is incontestable.
Establishing regional interconnections fosters both environmental preservation and economic prosperity, yielding significant advantages.
Coordination required for heterogeneous technical standards and political sensitivity.
Grid integration should be approached phase-wise.
Enhance regional energy cooperation by accelerating interconnections.

■ *Presentation attached as Annexure -* ❹

ROLE OF MARKETS IN CROSS BORDER ELECTRICITY TRADE

- MR ROHIT BAJAJ, EXEC DIRECTOR AND THE HEAD OF BD, STRATEGY AND REGULATORY AFFAIRS, IEX

Mr. Bajaj in his presentation focused on the ongoing Energy Transition and the shift towards decarbonization and energy security. He noted the rebound in energy demand after COVID and the disruption from the Ukraine-Russia war, leading to high gas and electricity prices and forcing countries like Germany and France to reinstate thermal and nuclear capacity. Bajaj highlighted India's goal of achieving 50% renewable energy in its mix, noting that it currently has 20%. Nepal and Bhutan have a higher proportion of renewables due to abundant hydro resources. Bajaj emphasized the importance of transmission in India's power sector, with inter-regional capacity tripling in recent years. He discussed the rise of power exchanges (PXs) in the market, noting their flexibility and benefits, and explained IEX's market mechanisms such as auctions and price discovery. Bajaj discussed the stabilization of coal prices and the influence of demand and seasonal changes on prices. He overviewed cross-border trade, emphasizing the need to enhance interconnection capacity, consider regional power markets for competition and flexibility promote renewables and battery storage, facilitate open access, and encourage spot market participation for an efficient energy transition.

Mr. Bajaj concluded by outlining future opportunities in cross-border electricity markets.

Key Takeaways

Energy transition emphasizes decarbonization, with India aiming for a 50% share of non-conventional power in its energy generation mix.
India has made significant investments in transmission, tripling its inter-regional capacity in recent years to nearly 112 GW.
The power market primarily consists of long-term transactions, with exchanges growing at a CAGR of 14% and providing flexibility.
Cross-border entities can participate in all market segments offered by IEX, enhancing regional energy cooperation.
Interconnection capacity should be improved, and power markets to be considered over bilateral trade to enhance competition and flexibility.
Future market opportunities include promoting renewable energy integration and battery storage, facilitating open access, and encouraging spot market participation.

■ *Presentation attached as Annexure -* ❺

ROLE OF TRANSMISSION INTER-CONNECTION AS FACILITATOR OF CROSS BORDER ELECTRICITY TRADE

- MR DILIP ROZEKAR, ED, PGCIL

Mr. Rozekar discussed the climate impact of the power sector and the region's vulnerability to natural calamities. He emphasized the importance of Nationally Determined Contributions (NDCs) for climate change mitigation and noted India's commitment, with renewable energy penetration increasing from 9.7% in 2009-10 to 26.5% in 2022-23. He presented projected generation landscapes for 2029-30. Rozakar highlighted the crucial role of the transmission system in supporting sector growth and discussed changing trends in cross-border trade, noting Nepal's use of power exchanges and India's agreement to import 10,000 MW from Nepal in the next decade. He pointed out the potential of enhanced cross-border transmission links for significant growth in regional energy cooperation. Despite impressive potential, he acknowledged challenges, such as private investment requirements, cost-reflective tariffs, and stranded transmission assets. Rozakar proposed General Network Access and the "normal minus one" (N-1) standard as solutions. He also discussed the environmental impact of transmission systems and the importance of balancing protection for flora and fauna with reliable operations. Mr. Rozekar recommended "Transmission as a Service" for mutual benefit, emphasized security measures, quick decision-making, etc.

Lastly, Mr. Rozekar showcased business models for future cross-border links.

Key Takeaways

India's RE penetration increased from 9.7% in 2009-10 to 26.5% in 2022-23, demonstrating progress towards climate goals.
Nepal's power trade with India is flexible, utilizing power exchanges to benefit financially during different seasonal demands.
India's agreement with Nepal for importing 10,000 MW in the next decade highlights increasing cross-border energy cooperation.
Private investment and cost-reflective tariffs are crucial to advancing cross-border transmission projects like India-Sri Lanka interconnection.
Transmission systems' flexibility in generation assets utilization reduces the risk of stranded assets and assures continuous returns.
"Transmission as a Service" model fosters open access transactions and economic sourcing, enhancing regional grid collaboration.

■ *Presentation attached as Annexure -* ❻

CROSS BORDER ELECTRICITY TRADE AS AN ENABLER OF DEVELOPMENT IN SOUTH ASIAN REGION

- MS SWETHA RAVI KUMAR, EXECUTIVE DIRECTOR, FSR GLOBAL

Ms. Kumar began her presentation by providing an overview of FSR Global as an organization, its work, and the current Energy Transition Webinar programs it is running in association with SAFIR. She defined models of regional electricity market integration and, drawing from the experiences of the European Union market, explained that the approach to project financing in Europe involves two levels: planning and formulating regulations to facilitate the implementation of planned initiatives. She shared and explained key observations on cross-border electricity trade in the South Asian region, focusing on aspects of shared vision, commercialization, and economic development. Regarding the socio-economic aspect, Ms. Kumar discussed statistical details on carbon emissions and the impact of climate change. She emphasized the need to 'act now' on cross-border electricity trade to help economies grow and promote cleaner and greener fuels to mitigate the impact of climate change. Ms. Kumar recommended the path forward in terms of energy transition, focusing on decentralization, decarbonization, digitalization, and deregulation. She emphasized that external assistance is unnecessary, as the region possesses the requisite knowledge and resources, and that non-political platforms like SAFIR play a vital role in this process.

With the offers in place that FSR Global has for all the members of the SAFIR countries, Ms. Kumar brought her presentation to a close.

Key Takeaways

Regional electricity market integration involves harmonizing market rules across countries for efficient cross-border energy trade. Extension of the market in one jurisdiction to encompass other jurisdictions could be a promising option.
The European Union's Ten-Year Network Development Plan (TYNDP) guides regional and national planning for gas and electricity markets.
Funding challenges for regional projects can be addressed through dedicated pools like the Connecting Europe Facility (CEF).
Cross-border electricity trade can promote clean energy use and mitigate climate change impacts.
Regional collaboration is essential for addressing socio-economic challenges related to energy security and climate change.
Breaking down silos and acting now on shared public good initiatives can accelerate energy transition progress.

■ *Presentation attached as Annexure -* ❼

Vote of Thanks

At the conclusion of the conference, SAFIR/CERC Secretary Mr. Harpreet Singh Pruthi extended his appreciation to the hosts, distinguished speakers, and SAFIR Chair for their roles in the event's success. He emphasized the significance of the insights garnered from presentations and discussions on importance of cross-border grid connections, common grid code and a robust power market, for fueling sustainable growth across the region. Mr. Pruthi warmly welcomed new members and their expertise, while advocating for further growth in SAFIR's membership by engaging more industries, corporations, and regulatory commissions within the South Asian region. Lastly, he acknowledged the vital contributions made by the SAFIR Secretariat and conference staff in facilitating a productive and engaging event.

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List of Participants

S. NO.	NAME	ORGANIZATION
01.	Mr. Jishnu Barua Chairperson, CERC & Chairman, SAFIR	Central Electricity Regulatory Commission (India)
02.	Ms. Deki Choden CEO	Electricity Regulatory Authority, Bhutan
03.	Prof. M.A.R.M. Fernando Chairperson	Public Utilities Commission of Sri Lanka (Sri Lanka)
04.	Mr. Dilli Bahadur Singh Chairperson	Electricity Regulatory Commission, Nepal
05.	Mr. Pravas Kumar Singh Member,	Central Electricity Regulatory Commission (India)
06.	Mr. Douglas N. Nanayakkra Member	Public Utilities Commission of Sri Lanka (Sri Lanka)
07.	Mr. Sellampola Gedara Senarathna, Member	Public Utilities Commission of Sri Lanka (Sri Lanka)
08.	Mr. Ranjith Kaluthanthirige Member	Public Utilities Commission of Sri Lanka (Sri Lanka)
09.	Justice (Mr.) C.V. Nagarjuna Reddy Chairperson	Andhra Pradesh Electricity Regulatory Commission (India)
10.	Mr. Hemant Verma Chairperson	Chhattisgarh State Electricity Regulatory Commission (India)
11.	Mr. D.K. Sharma Chairperson	Himachal Pradesh Electricity Regulatory Commission (India)
12.	Justice (Mr.) Amitav Kumar Gupta Chairperson	Jharkhand State Electricity Regulatory Commission (India)
13.	Mr. S.P.S. Parihar Chairperson	Madhya Pradesh Electricity Regulatory Commission (India)
14.	Mr. Sanjay Kumar Chairperson	Maharashtra Electricity Regulatory Commission (India)

15.	**Mr. Viswajeet Khanna Chairperson**	**Punjab State Electricity Regulatory Commission (India)**
16.	**Mr. K.B. Kunwar Chairperson**	**Sikkim State Electricity Regulatory Commission (India)**
17.	**Mr. T. Sriranga Rao Chairperson**	**Telangana State Electricity Regulatory Commission (India)**
18.	**Mr. D. Radhakrishna Chairperson**	**Tripura Electricity Regulatory Commission (India)**
19.	**Mr. Arvind Kumar Chairperson**	**Uttar Pradesh Electricity Regulatory Commission (India)**
20.	**Dr. M.V. Rao Chairperson**	**West Bengal Electricity Regulatory Commission (India)**
21.	**Mr. Gajendra Mohapatra Member/Chairperson In-charge**	**Odisha Electricity Regulatory Commission (India)**
22.	**Mr. D.P. Gairola Member/Chairperson In-charge**	**Uttarakhand Electricity Regulatory Commission (India)**
23.	**Mr. B. Pradeep Member**	**Kerala State Electricity Regulatory Commission (India)**
24.	**Mr. S.R. Narasimhan CMD**	**Grid Controller of India (India)**
25.	**Mr. Dilip Nagesh Rozekar Executive Director (IB)**	**Power Grid Corporation of India Limited (India)**
26.	**Mr. Rohit Bajaj Executive Director**	**Indian Energy Exchange Limited (India)**
27.	**Ms. Swetha Ravi Kumar Executive Director**	**FSR Global (India)**
28.	**Mr. Sangay Phuntsho Chief Policy & Research Division**	**Electricity Regulatory Authority, Bhutan**
29.	**Ms. Thukten Wangmo Chief Licensing & Technical**	**Electricity Regulatory Authority, Bhutan**
30.	**Mr. E. Prabhakara Rao General Manager**	**NTPC Limited, New Delhi (India)**
31.	**Mr. Bharat Sharma AVP**	**PTC India, New Delhi (India)**

SAFIR SECRETARIAT		
32.	**Mr. Harpreet Singh Pruthi** **Secretary**	**Central Electricity Regulatory Commission (India) / SAFIR**
33.	**Ms. Shilpa Agarwal** **Joint Chief (Engg.)**	**Central Electricity Regulatory Commission (India)**
34.	**Ms. Rashmi Somasekharan Nair** **Dy. Chief (RA)**	**Central Electricity Regulatory Commission (India)**
OTHERS		
35	**Mr Damitha Kumarasinghe** **Director General**	**Public Utilities Commission of Sri Lanka (Sri Lanka)**
36	**Mr Kanchana Siriwardana** **Deputy Director General**	**Public Utilities Commission of Sri Lanka (Sri Lanka)**
37	**Mr. K.G.C. Jayasekara** **Director (R&D)**	**Sri Lanka Sustainable Energy Authority**
38	**Rajiv Ratna Panda** **Power Market Specialist**	**Indo Pacific Office** **USAID/SAREP**

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Cross Border Cooperation in Energy Infrastructure

Transmission System Operations in the Context of Cross Border Energy trade

1st March 2024

S.R. Narasimhan
Chairman and Managing Director
Grid Controller of India Ltd.

Operational Interconnections between India and neighbours

India – Bhutan

- 400 kV, 220 kV and 132 kV synchronous interconnections
- **Transaction:** Both Export/import

India – Bangladesh

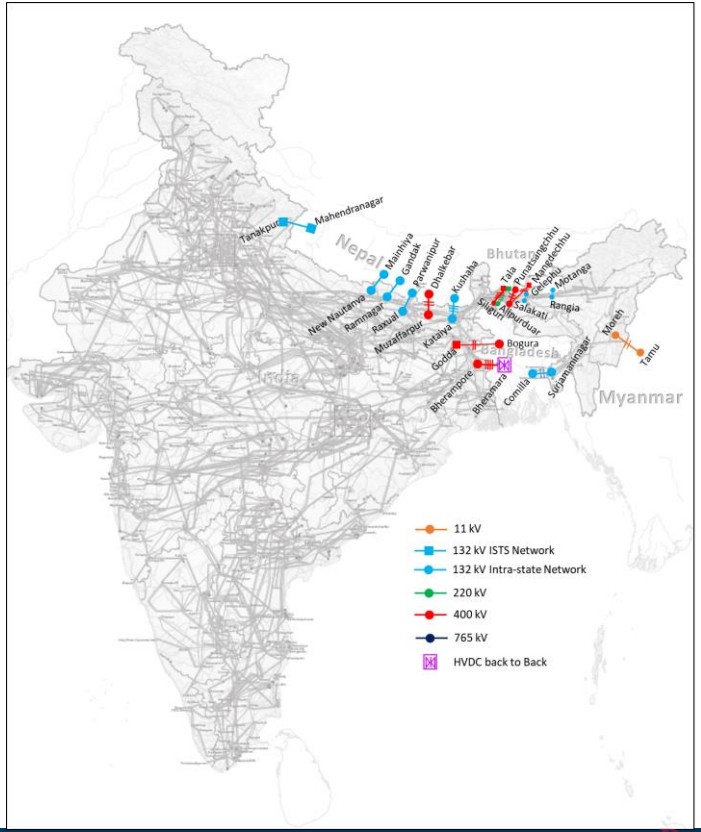
- 400 kV 2xD/C with HVDC back to back. 132 kV D/C with radial connection.
- **Transaction:** Export from India

India – Nepal

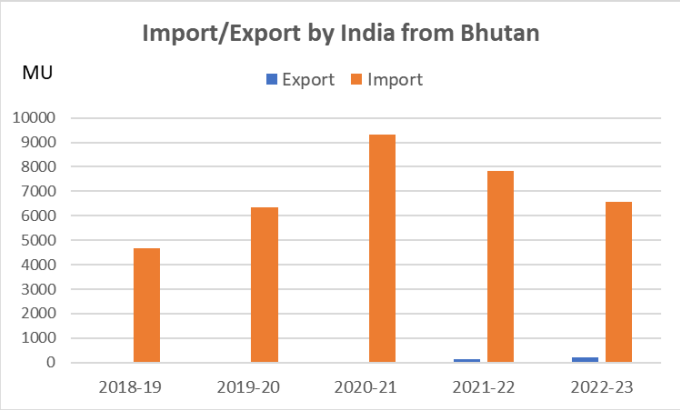
400 kV, 132 kV, 33 kV & 11 kV interconnections
Transaction: Both Import/Export

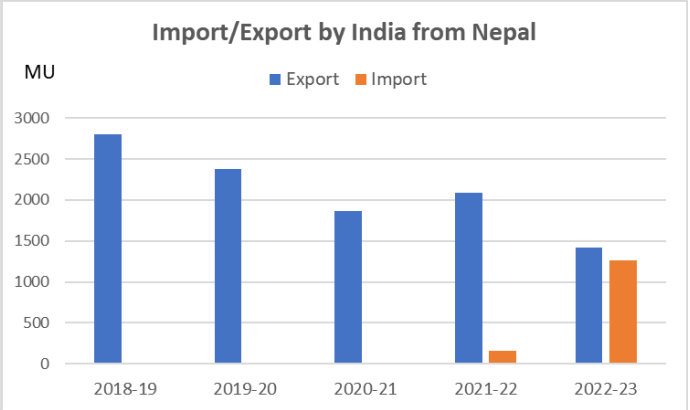
India – Myanmar

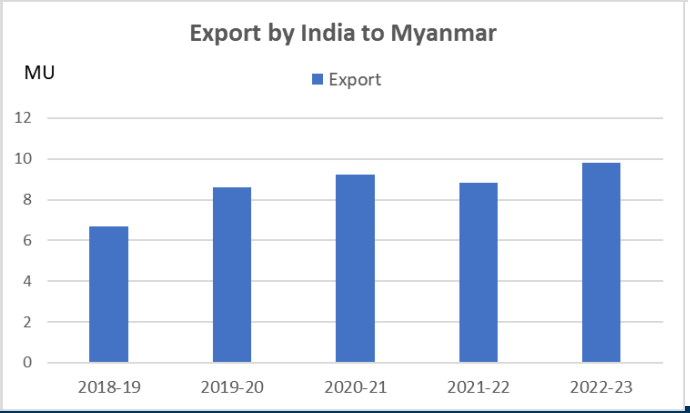
- 11 kV radial interconnection
- Transaction: Export from India



Cross Border exchanges







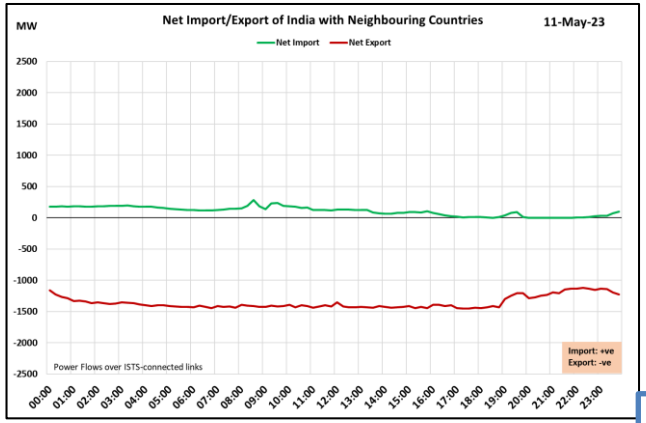
Participation in Indian energy markets – long, medium & short term, including power exchanges

Harnessing diversity in load and generation patterns

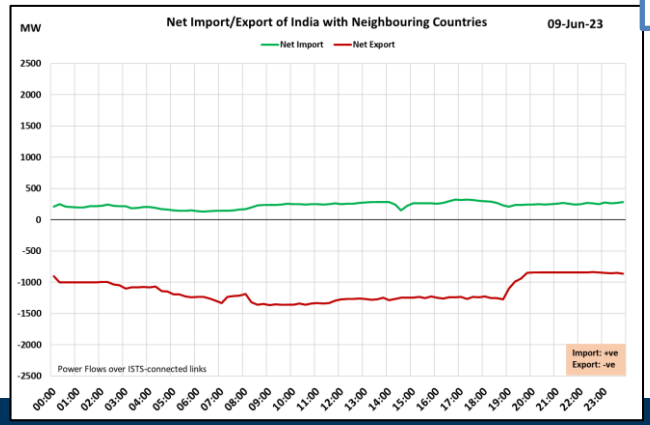
Help in balancing renewable-rich systems

Cooperation during exigencies

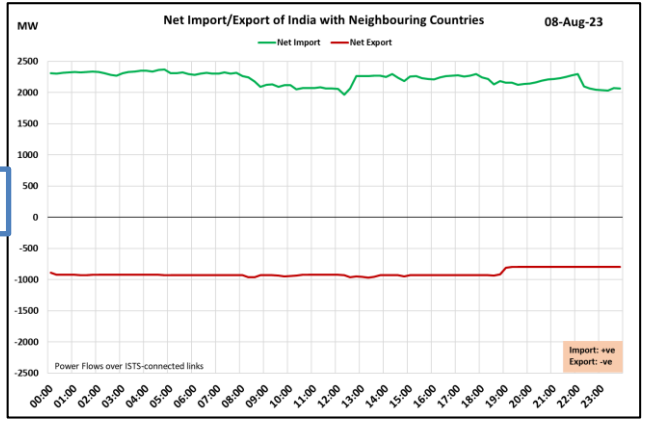
Typical day cross border Import/Export profile…



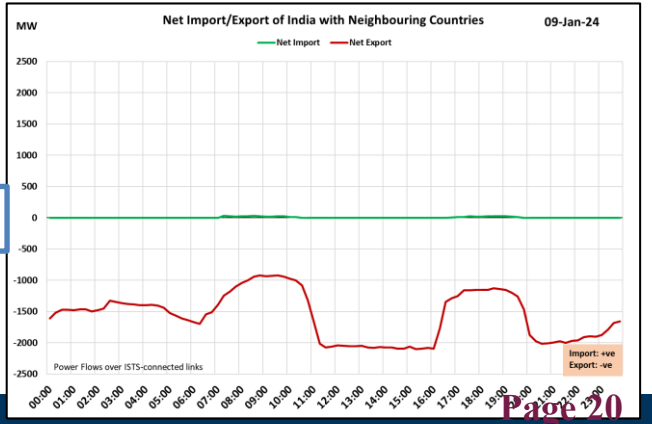
Summer



Monsoon

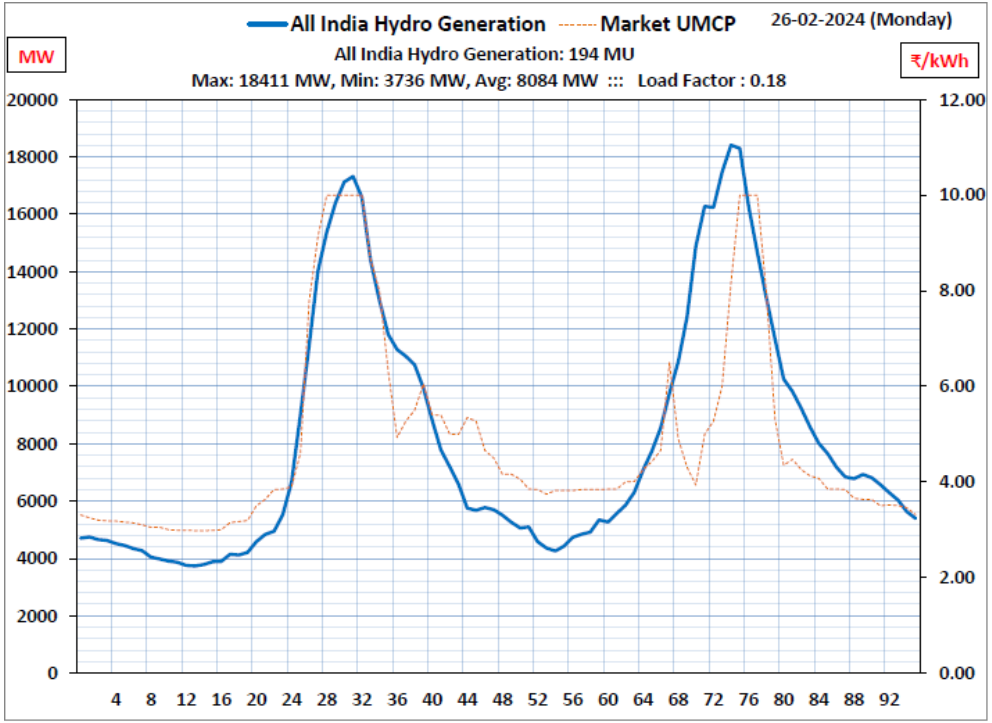


Winter



Decentralized but co-ordinated generation Despatch

- Market price a great unifier
- Hydro is optimally utilized in India to provide peak power support
- Optimization over larger geographies possible



Building Blocks for Cross Border Interconnection…System Operation

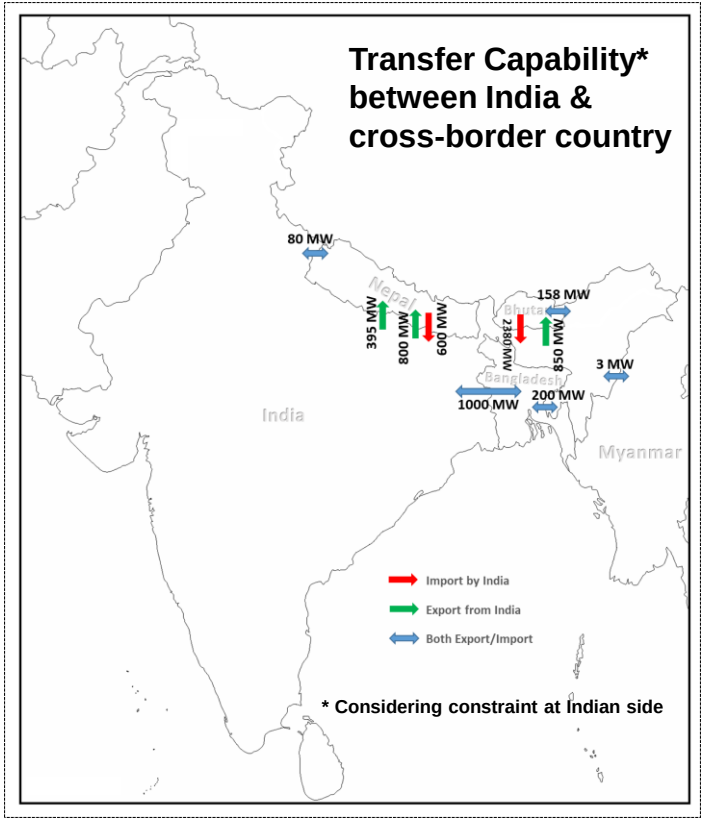
- **Operational Planning (0-1 year)**
  - Resource Adequacy and Outage planning
  - Transfer capability assessment
  - Defense plans such as Under Frequency Load Shedding (UFLS), System Protection Schemes
  - Modeling and simulation studies
- **Scheduling & Dispatch**
  - Estimation and procurement of reserves for frequency regulation
  - Security Constrained Economic Despatch (SCED)
- **Real Time Operation**
  - Visualization and Situational Awareness
- **Post dispatch analysis and feedback to the transmission planning process**
- **Decision Support systems; EMS/WAMS, off-line IT systems and cyber security**

Building Blocks for Cross Border Interconnection… Market Operation

- **Control Area Demarcation**
- **Market Design**
  - Bilateral, Day Ahead Market, Real Time/Intra-day markets
- **Transmission charges and losses**
- **Scheduling, Accounting, Metering And Settlement of Transactions (SAMAST)**
  - Who pays whom for what quantities and at what prices?
- **Imbalance pricing and settlement**

Reliability Assessment...
11 months in advance till real-time

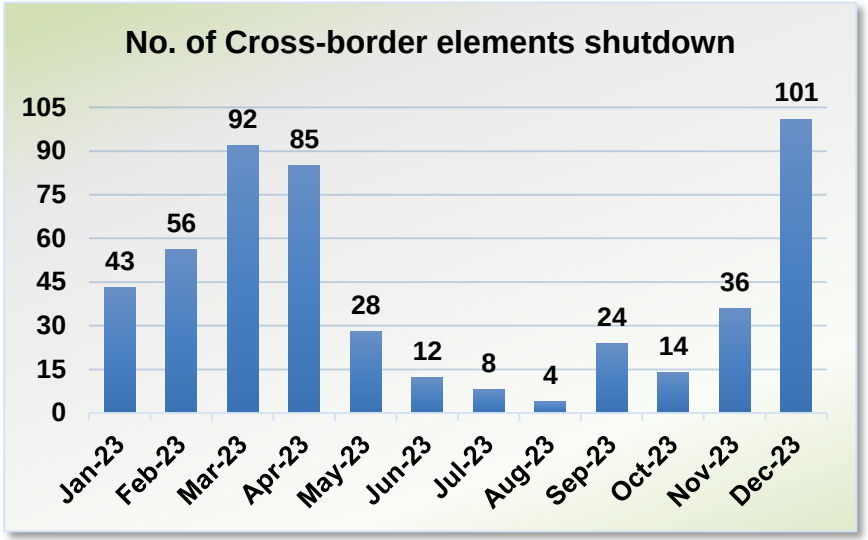
- All the transnational import/export energy transactions approved by designated authority
  - Considers margins available on transmission network and generation availability
- NLDC, India declares transfer capability between India & neighboring countries for both Import & Export considering constraint at Indian side (https://grid-india.in/en/market/monthly-atc-inter-country/)
  - Declared 11 months in advance and revised with change in network conditions
  - Scheduling of transactions subject to transfer capability
- Cross-border country can also declare the transfer capability considering the constraint at their end.
- Minimum of the transfer capability declared by the respective country would be reckoned for the purpose of scheduling.



Outage Co-ordination

- Outage co-ordination for planned outages
  - Planning of outages on annual basis
  - Consultation in monthly outage coordination meetings
  - Request for availing outages on D-3 basis
- Facilitation of emergency outages considering real-time grid conditions
- Real-time coordination for switching/set-point changes
- Identification of elements having impact on operation of cross border elements or power system of neighbouring country
  - Mutual consent and advance intimation in case of outages of such elements

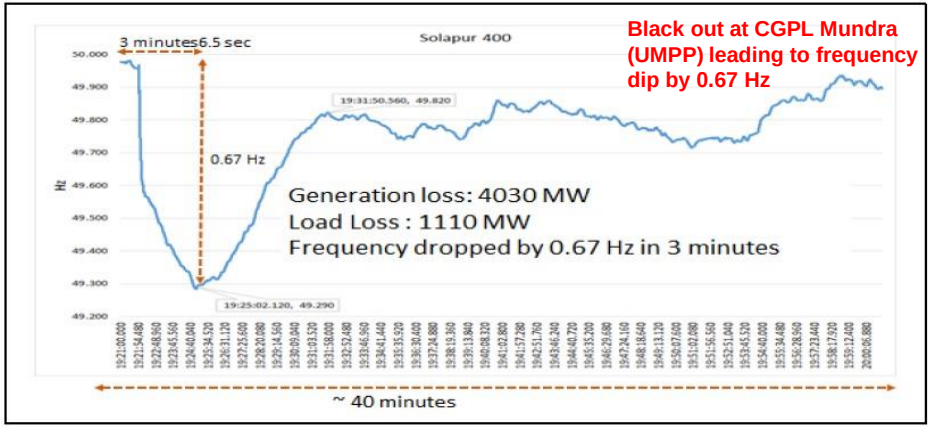
503 no. of Cross-border elements shutdown approved in 2023

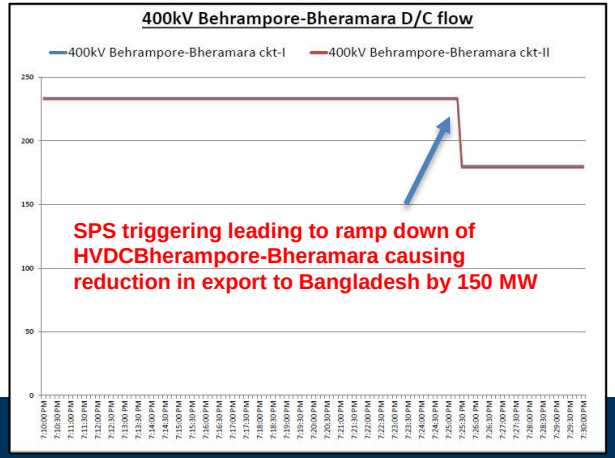


Disclaimer – No of cross-border elements shutdown also include intra-regional shutdowns having impact on cross-border lines

Defense Plans

- Implementation of System Protection Schemes (SPS) to safeguard system integrity in critical pockets
  - Actions including HVDC runback, load throw-off, transmission element switching
- Support from neighbouring countries while formulating restoration plan
  - Sharing of black start resources for extending support during blackouts





Defense Plans….

- Harmonization of Under-frequency load shedding scheme settings across synchronously connected systems
- Protection coordination for cross-border elements
  - Adopt more stringent standard in case of differences between grid codes

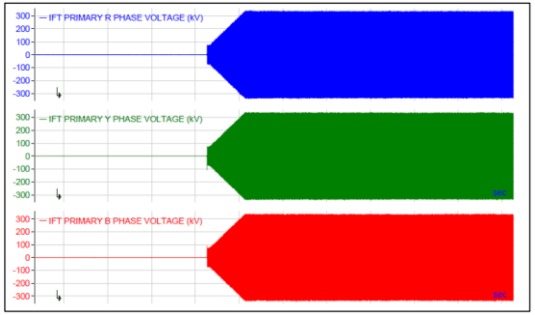
S. No	Stage of UFR Operation	Frequency (Hz)
1.	Stage-I	49.40
2.	Stage-II	49.20
3.	Stage-III	49.00
4.	Stage-IV	48.80

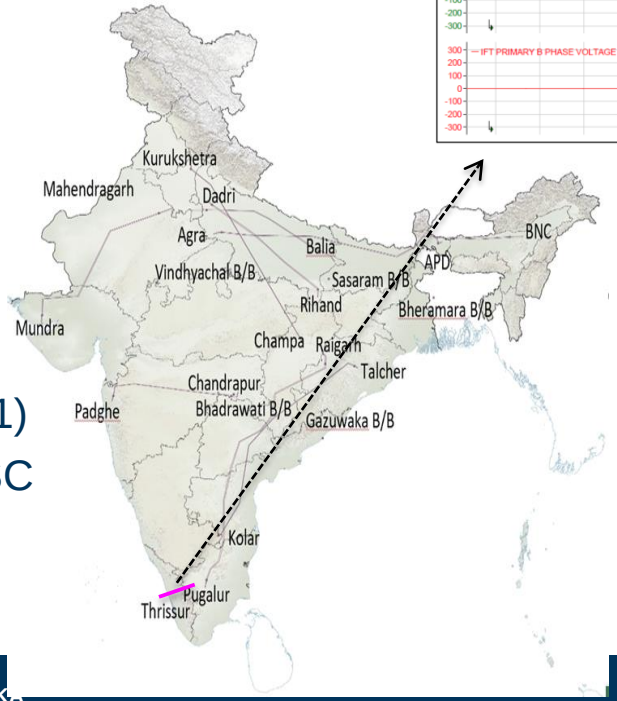
Default UFR setting in Indian Grid code 2023

*Pumped storage & ESS are automatically disconnected before UFR stage-I

Black Start through asynchronous HVDC

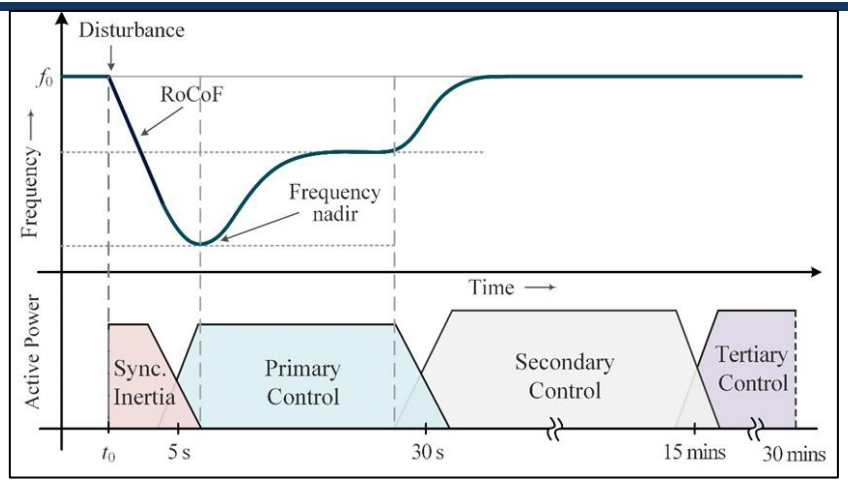
- VSC HVDC can facilitate interconnection of asynchronous grid
- It can provide black start facility during partial or complete outage
- VSC HVDC can also provide active power and reactive power control during restoration
- Mock exercise carried out demonstrating black start capability of 2x1000 MW HVDC VSC Pugalur-Thrissur (commissioned 2021)
- Similar facilities in case of cross-border VSC HVDCs must be commissioned and available





Gradual build – up of voltage during mock black start exercise of HVDC VSC Pugalur – Thrissur

Frequency Control



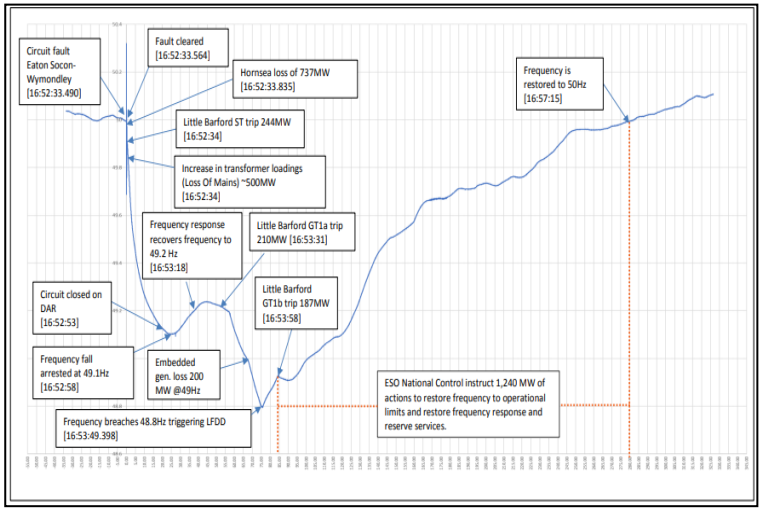
Reserve	Start of activation	Full Availability/ deployment	Ability to sustain the full deployment
Primary Response	Immediately as soon as frequency crosses dead band	Within 45 sec	5 min
Secondary Reserves	Within 30 seconds after the receipt of AGC signal	Within 15 Min	30 min or till replaced by Tertiary Reserves
Tertiary Reserves	Within 15 minutes of dispatch instruction from NLDC/RLDC		60 min

Sharing of reserves & frequency control

- Two countries having asynchronous interconnections can support each other in controlling the frequency.
- HVDCs are capable of controlling the primary frequency by providing very fast active power regulation
- In Europe, which is home to a number of asynchronous HVDCs, general requirement under article 58 of ENTSOE network code on load frequency control and reserves states:
  - *"Each operator and/or owner of an HVDC Interconnector interconnecting Synchronous Areas shall provide the capability where the technology is installed permitting the Connecting TSOs of the HVDC Interconnector to perform Exchange and Sharing of FCR, FRR and RR on HVDC Interconnectors."*

  Article 59 of network code also suggests the methodology for exchange of frequency containment reserve (FCR) between synchronous areas:

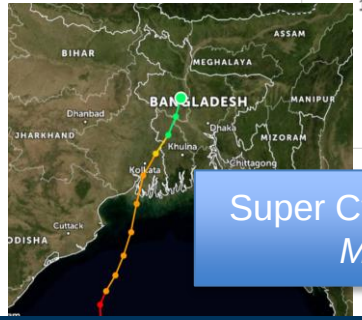
  - *"Each operator of a HVDC Interconnector shall control the Active Power Flow over the HVDC Interconnector in accordance with instructions defined by the TSOs of the Reserve Receiving TSO in accordance with the FCR requirements established in Article 44."*
- Feasibility of similar mechanism can be explored among South Asian countries also.
- HVDC interconnection can help in getting primary response of 150-200 MW from India alone.



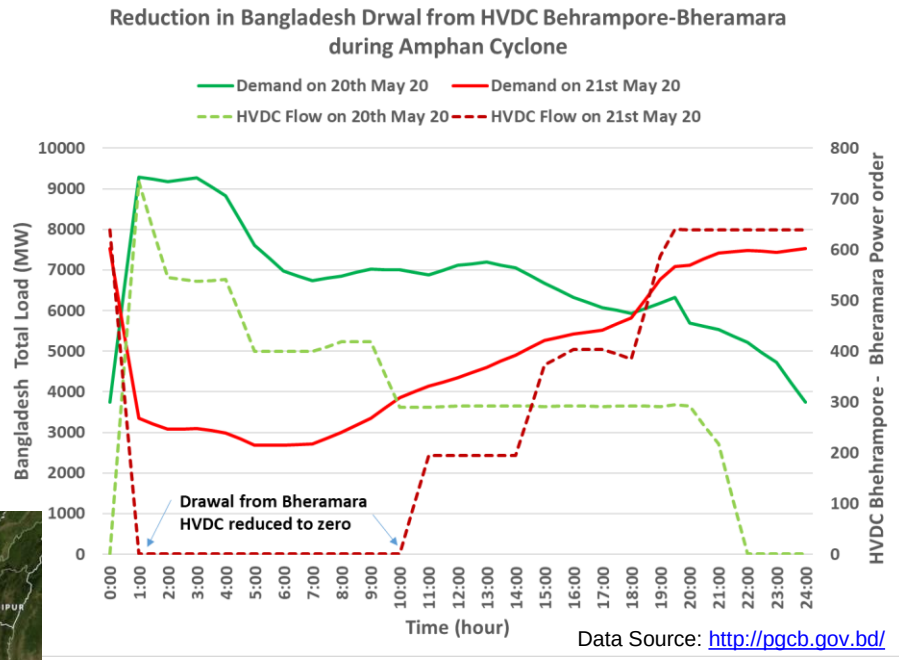
UK-French interconnector providing frequency support during an event in Aug 2019

Power System Resilience- Mutual Assistance amongst Neighbours

- Natural calamities impact each country
- Impact on power system operation
  - Tripping of power system elements
  - Tower collapse/damage
  - Load crash & high voltage conditions
- Action plans for preparation and mitigation
  - Modulation of HVDC set points (During cyclone Amphan, Bangladesh reduced its drawal from India through HVDC Bherampore-Bheramara)
  - Proper generation re-scheduling
  - Reactive power management



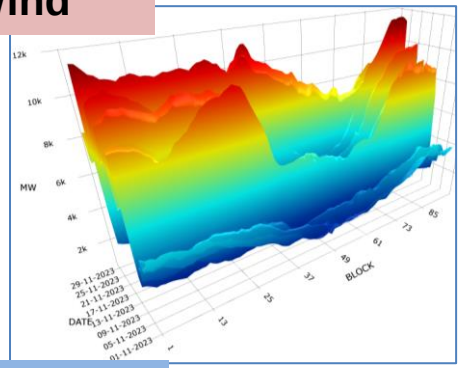
Super Cyclone Amphan
May 2020



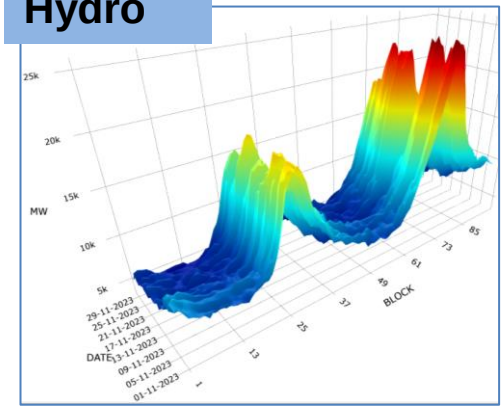
Data Source: http://pgcb.gov.bd/

Growing Need for Flexibility

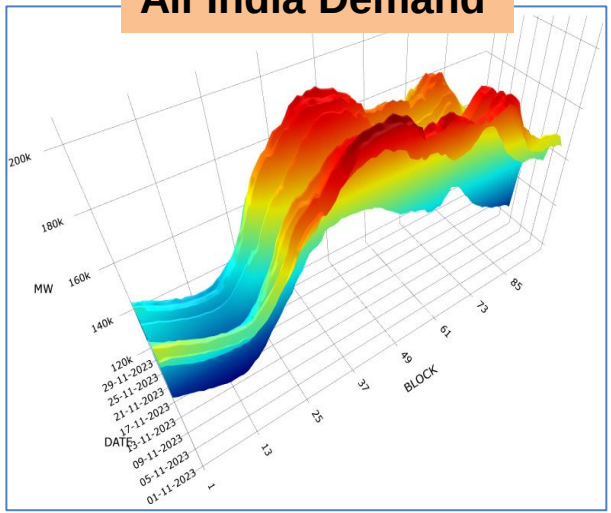
Wind



Hydro

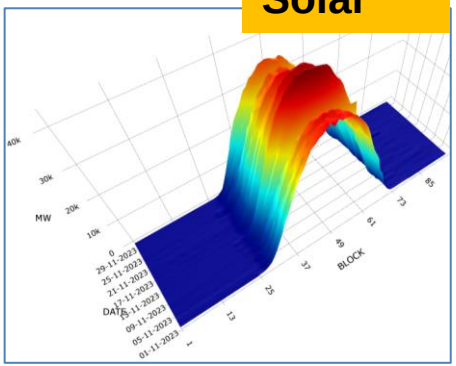


All India Demand



- Typical Ramp rate ~ 250 MW/min
- Special Days ~ 500 MW/min

Solar



Cross-border Interconnector

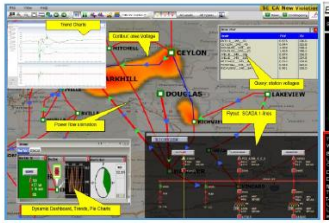
AC

HVDC

Post-dispatch event analysis

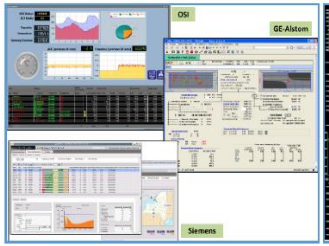
- Any manual or automatic tripping communicated immediately by the System Operator detecting such event to counterpart in the other country
  - Reporting of such events by NLDC to designated Authority within 48 hours
  - Exchange of written communication covering the date and time of event, location, plant/equipment affected and including Flags, disturbance recorder and sequence of events recorder output etc.
- Detailed analysis of all tripping events carried out using SCADA, Synchrophasor, DR/EL data
  - Identification of root cause and protection related issues, if any with suggested remedial measures

Real Time Monitoring & Power System Visualization
Situational Awareness through State-of-the-Art Control Centres

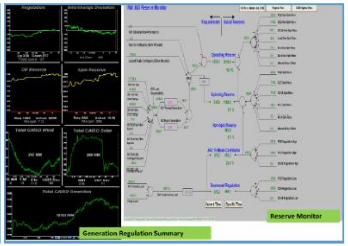


Trends, Contour Effects of Power Flow

State Estimator Performance Monitoring



Sample AGC Dashboards

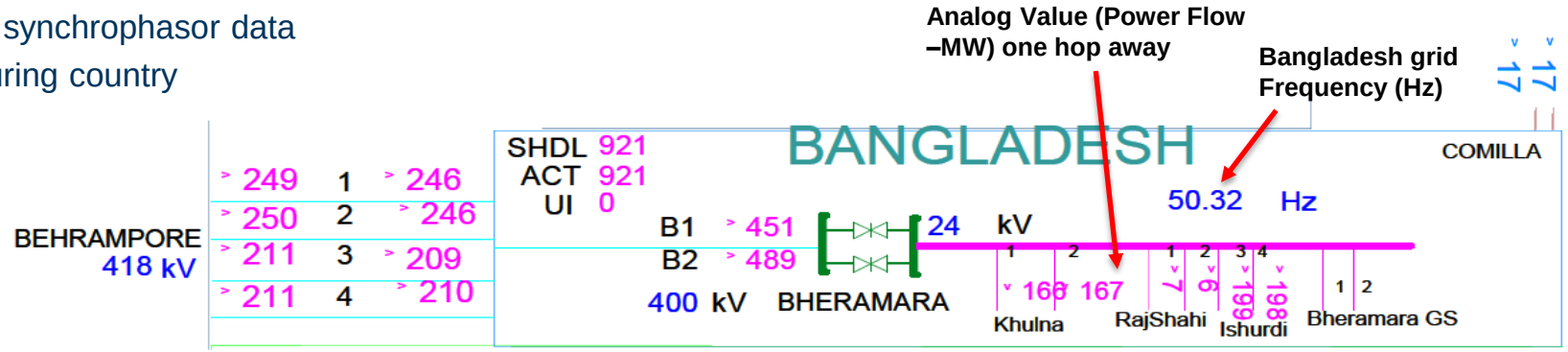


Generation Regulation & Reserve Monitor

Data and Voice Communication

- Complete analog and digital telemetry of cross-border points
  - Exchange of data till one hop away from interconnection point with neighbouring countries control centre
  - Dedicated visualization of cross-border exchanges in control centres
- Dedicated voice communication between control centres and cross-border substations
  - Real-time operational coordination
  - Public communication networks used as backup
- Installation of phasor measurement units (PMUs) at cross border points and integration with PDCs of respective control centres.
  - Sharing of synchrophasor data

  with neighbouring country



Metering

IEMs: Interface Energy Meters

All India
IEMs – 8822
Locations - 1131

NR
- Nepal

IEMs – 6
Locations - 2

ER
- Nepal

IEMs – 8
Locations – 2
- Bangladesh

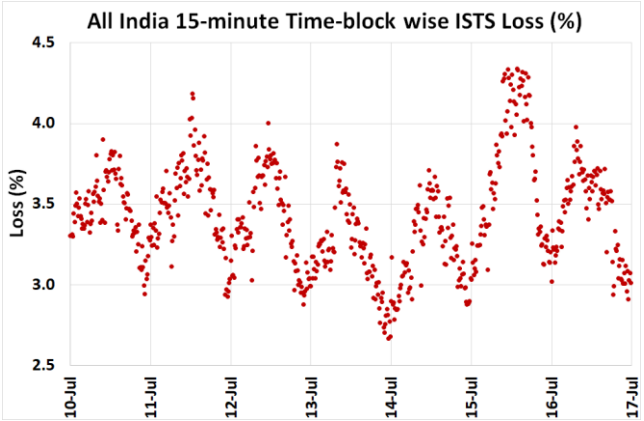
IEMs – 12
Locations – 2
- Bhutan

IEMs – 11
Locations - 3

NER
- Bangladesh

IEMs – 2
Locations – 1
- Bhutan

IEMs – 2
Locations -2

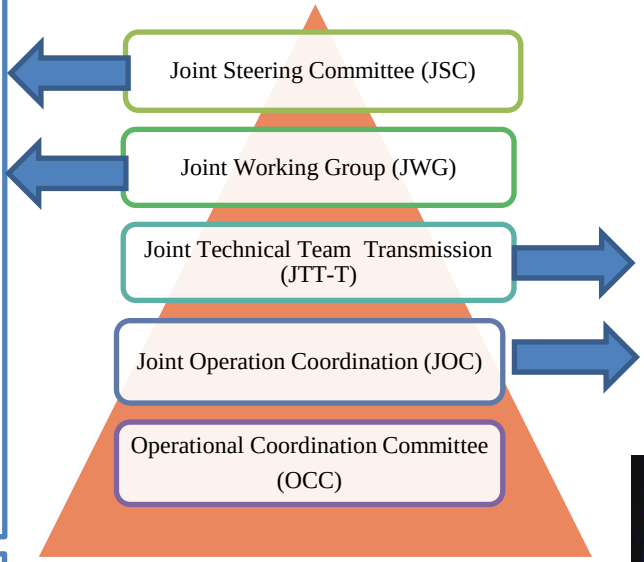


- Grid-India completed Pilot project on five-minute metering, scheduling, accounting, and settlement
- Grid-India, as part of NPC Joint Committee, formulated Technical Specifications on Five-Minute Meters, Automated Meter Reading and Meter Data Processing in July 2022 for procurement of meters

Multi Layered Coordination & Communication

Constitution of Joint Steering Committee (JSC) and Joint Working Group (JWG) :

- High-level decision making for electricity cooperation
- First activity – establishment of cross-border link



JTT-T has been constituted with the mandate :

- To discuss and coordinate planning/ implementation /monitoring of cross border transmission lines and related matters

Grid Security, Safety and Operation

- For operation coordination, grid security and reliability
- Held between system operators bilaterally at least once in a year.

Maintaining Information Security

Security by Design	Regulatory & Administrative Controls	Monitoring & Compliance	Training, Awareness & Collaboration
• Layered Network Architecture • Well Defined Security Perimeter • Restricted access • Encrypted data transfer	• Strict Policy implementation • ISO 27001 Controls • Periodic Security Audits • Defined Crisis & Disaster Management	• 24 x 7 Monitoring through SOC • Compliance to Regulatory Requirements • Root Cause Analysis & isolation of suspects	• Regular training Sessions • Collaboration with peers through CERT-GO Platform • Cyber Security Coordination Forum

www.grid-india.in

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ANNEXURE-2

South Asia Regional Energy Partnership (SAREP)

Presentation

on

Transforming Cross Border Electricity Trade and Regional Electricity Markets

Business Session: Session-2, 11.00 – 11.35 AM, 1st March 2024
South Asia Forum For Infrastructure Regulation (SAFIR) Conference on "Cross Border Cooperation in Energy Infrastructure"
1st & 2nd March 2024, Hotel Anantara Kalutara Resort, Kalutara, Sri Lanka

Presented by
Rajiv Ratna Panda, Power Market Specialist, SAREP

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Content

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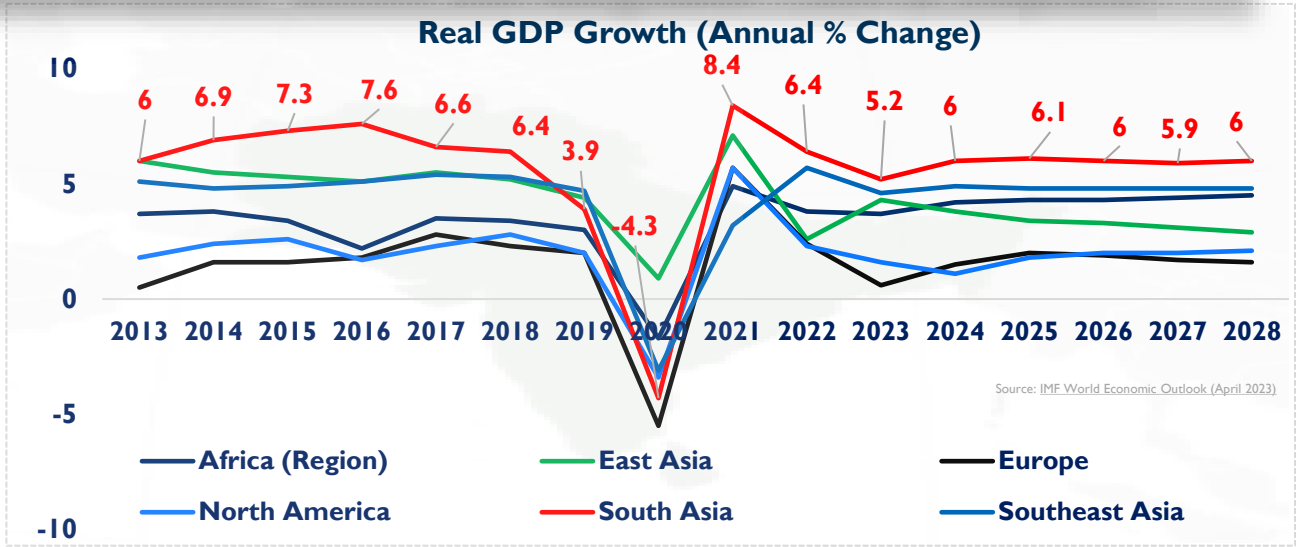
01.1

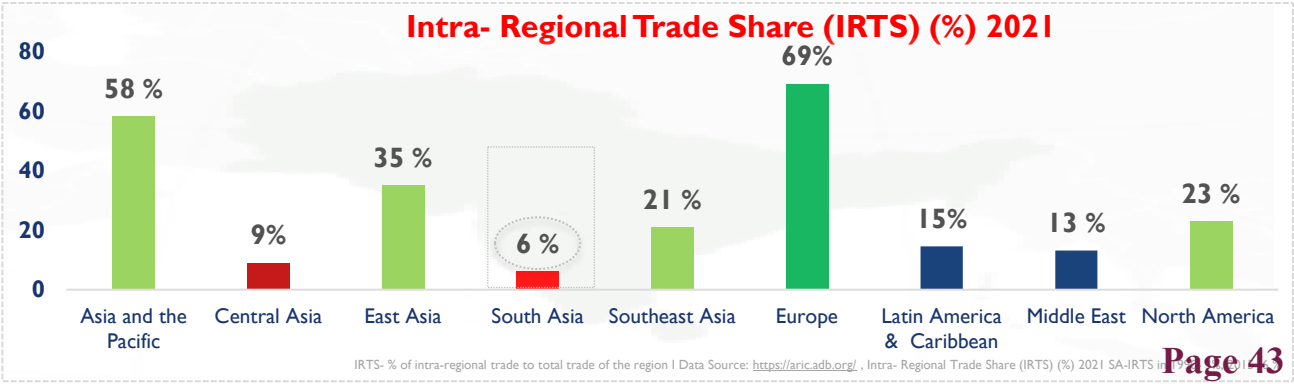
Macroeconomic Growth & Level of Economic Integration in South Asia

01.1 South Asia (SA): Macro-Economic Growth and Integration : *Level of Integration*

- Decade of High Growth
- Resilient economy
- High growth prospects despite economic headwinds
- Fastest growing region



- Intra-Regional Trade
- Continue to be the Least Integrated Region
- Only 6% IRTS



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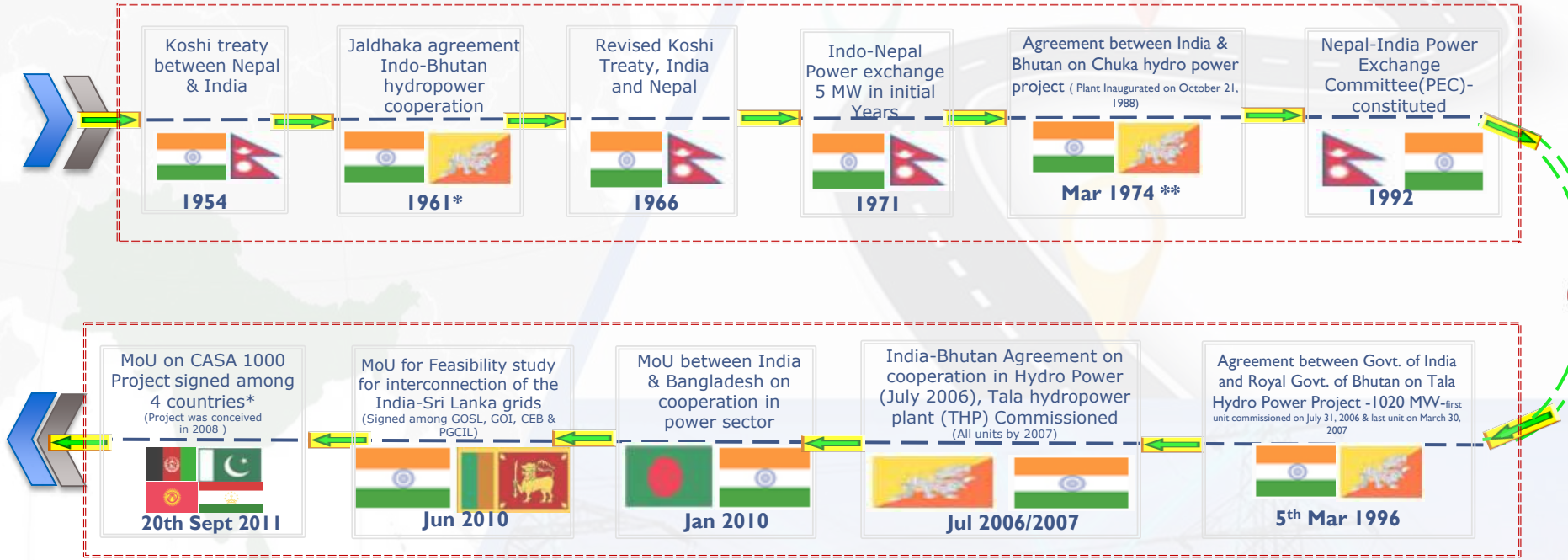
01.2

Evolution of Political, Policy & Regulatory Initiatives for CBET & REM

{Six Decade of Foundational Efforts & One Operational Long Decade in South Asia}

01.2 Evolution of Political, Policy, Regulatory Initiatives for CBET & REM in South Asia

{Around Six Decade of Mostly Foundational and Governing Agreements}

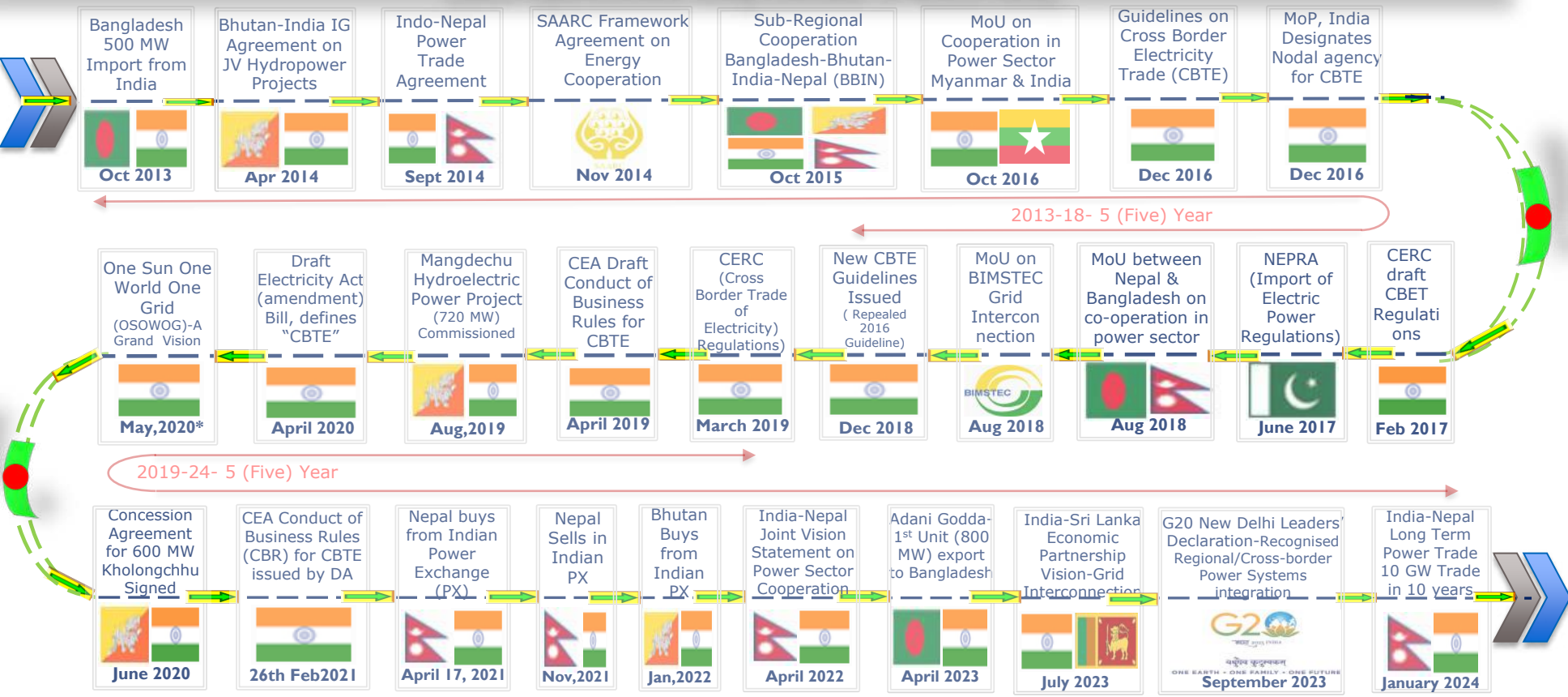


More than Half a Century Journey (57 Years)-Mostly Foundational and Governing Agreements

Source: 1954 , * 1961 ,CEM Presentation-OSOWOG- Energy Integration in South Asia by Rajiv Ratna Panda, ** 1974

01.2 Evolution of Political, Policy, Regulatory Initiatives for CBET and REM in South Asia

{One Operational Long Decade in South Asia}



Last 10 Year I Significant Developments I A long Decade of Multidimensional Action & Implementation

Source: CEM Presentation-OSOWOG ; Energy Integration in South Asia by Rajiv Ratna Panda, Godda, 2nd commissioned in June 2023 , MEA-10 GW Import, ISEPV-MEA , G 20 Delhi Declaration , OSOWOG Idea Announced in October 2018

01.2 Highest Level Engagement for Enhancing Regional Energy Cooperation and Cross Border Energy Trade in South Asia : { *Demonstrating Political Commitment* }

Foundation Stone of the Arun 3 , 900 MW Hydropower project jointly laid by Prime Minister of India Shri Narendra Modi & Prime Minister of Nepal Shri K P Sharma Oli on May 11th, 2018

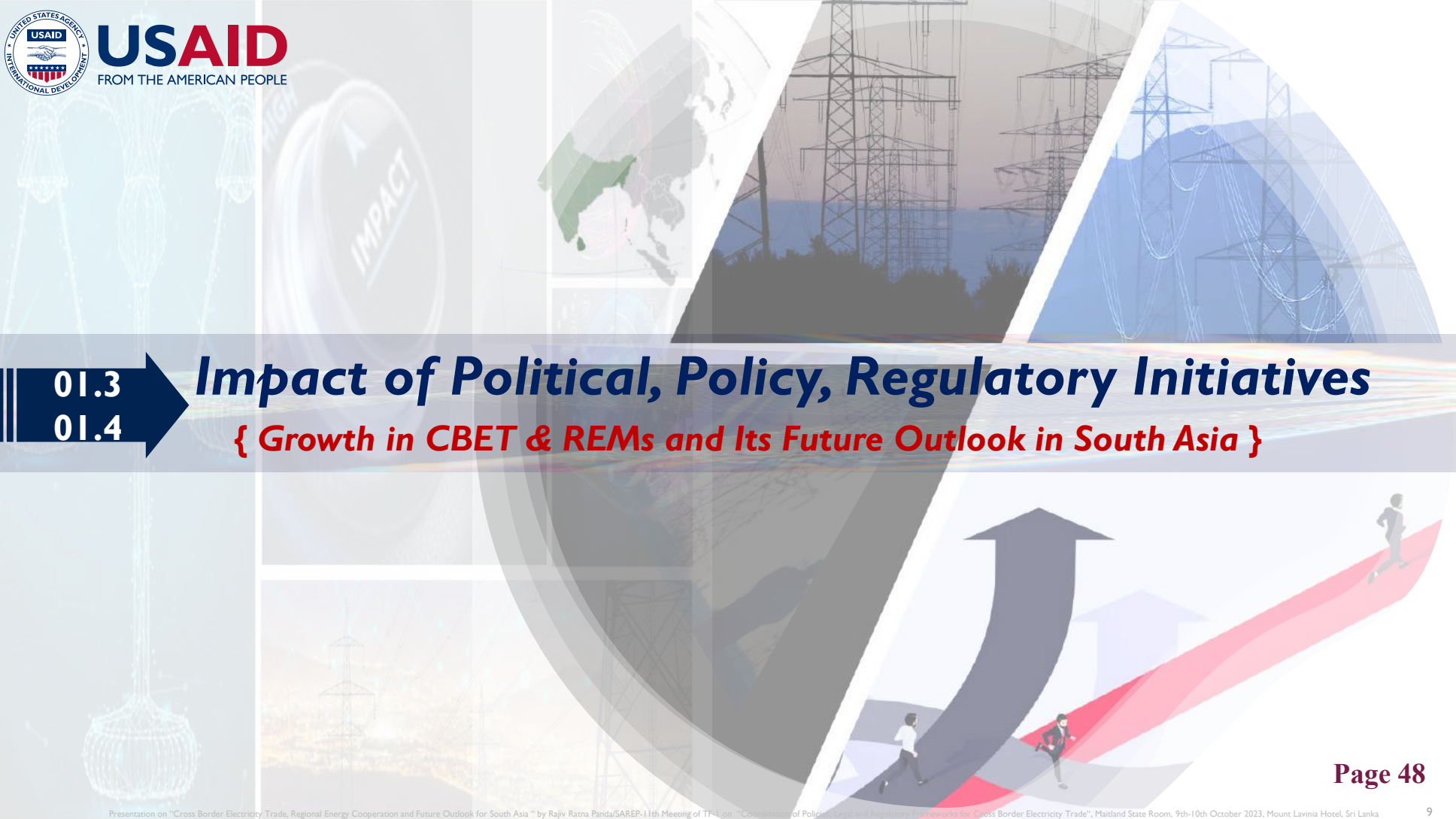
Commissioning of 2nd HVDC 500 MW link jointly inaugurated by Bangladesh Prime Minister HE Sheikh Hasina and India's Prime Minister HE Narendra Modi on 10th September 2018

Commissioning of 720 MW Mangdechu hydropower jointly inaugurated by Bhutan Prime Minister Lotay Tshering and India's Prime Minister Narendra Modi in August 2019

Visit of by Bangladesh Prime Minister HE Sheikh Hasina to India, 07 Sep 2022, Agreement on to expeditiously implement 765 KV transmission line from Katihar (Bihar) to Bornagar (Assam) through Parbatipur in Bangladesh,

Visit of Prime Minister of Nepal Rt Hon'ble Mr. Pushpa Kamal Dahal 'Prachanda' to India, June 02, 2023, Finalized an Agreement for Long-Term Power Trade to strive to increase the quantum of export of power from Nepal to India to 10 GW in next 10 years , MOU for development of Phukot Karnali Hydro Electric Project (480MW)

Prime Minister of India Shri Narendra Modi and the President of Sri Lanka H.E. Ranil Wickremesinghe agreed on India-Sri Lanka Economic Partnership Vision which covers power grid interconnection in New Delhi on 21st April 2023

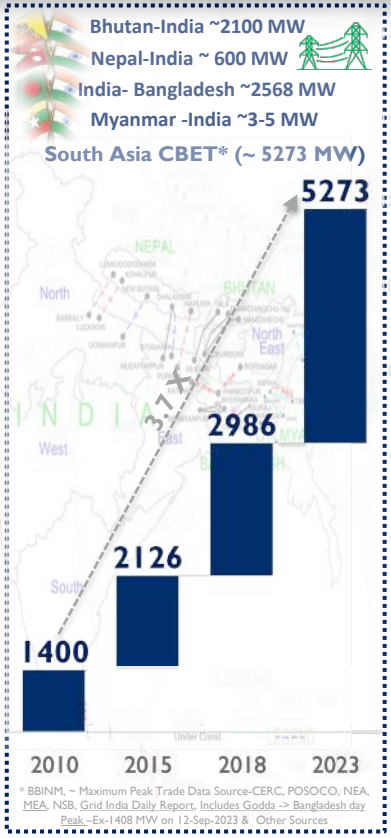


01.3
01.4

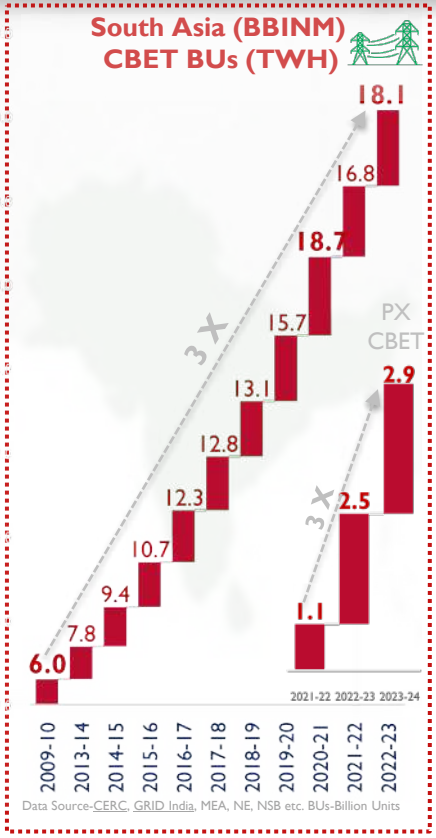
Impact of Political, Policy, Regulatory Initiatives

{ Growth in CBET & REMs and Its Future Outlook in South Asia }

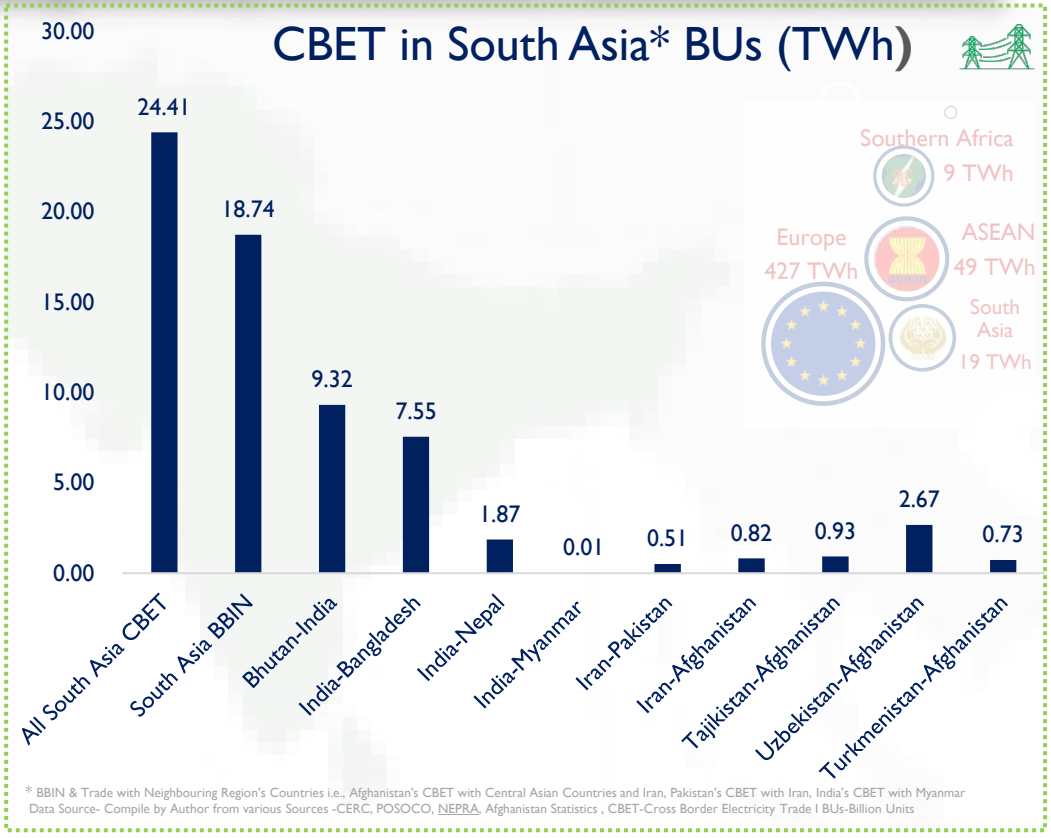
01.3 Impact of Political, Policy, Regulatory Initiatives : *Growth in CBET*



* BBINM, ~ Maximum Peak Trade Data Source-CERC, POSOCO, NEA, MEA, NSB, Grid India Daily Report, Includes Godda -> Bangladesh day Peak –Ex-1408 MW on 12-Sep-2023 &. Other Sources



Data Source-CERC, GRID India, MEA, NE, NSB etc. BUs-Billion Units

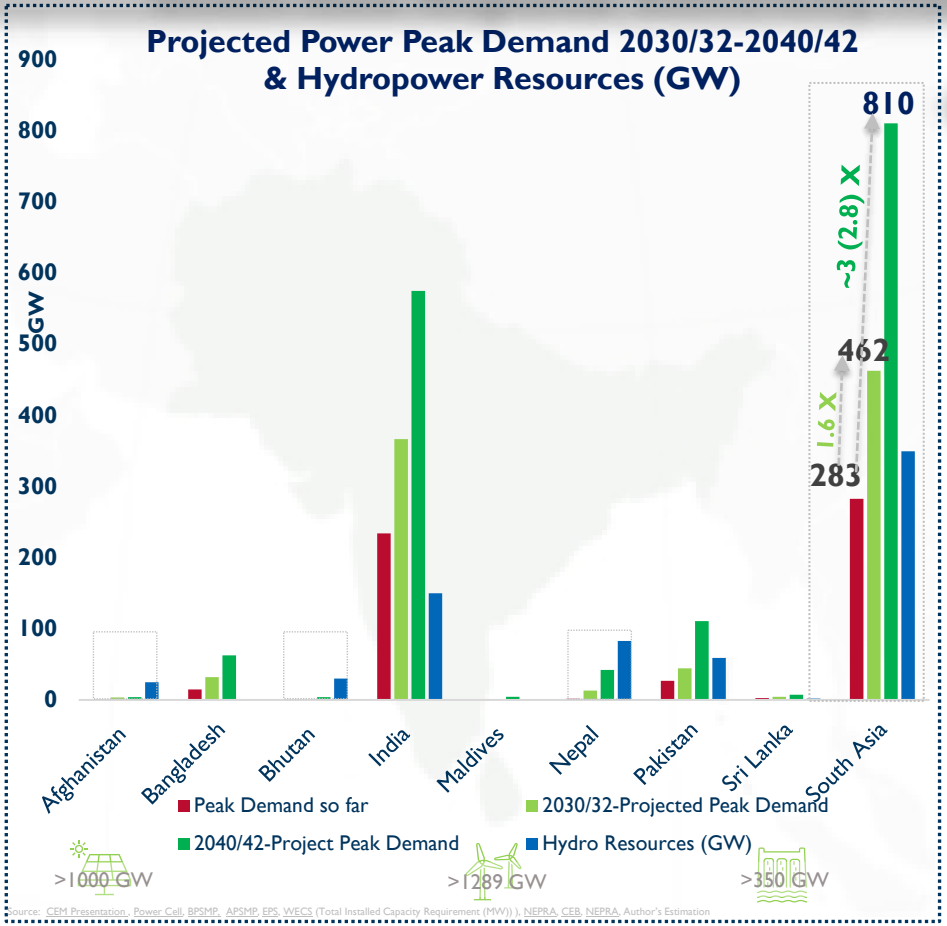


* BBIN & Trade with Neighbouring Region's Countries i.e., Afghanistan's CBET with Central Asian Countries and Iran, Pakistan's CBET with Iran, India's CBET with Myanmar
Data Source- Compile by Author from various Sources -CERC, POSOCO, NEPRA, Afghanistan Statistics , CBET-Cross Border Electricity Trade I BUs-Billion Units

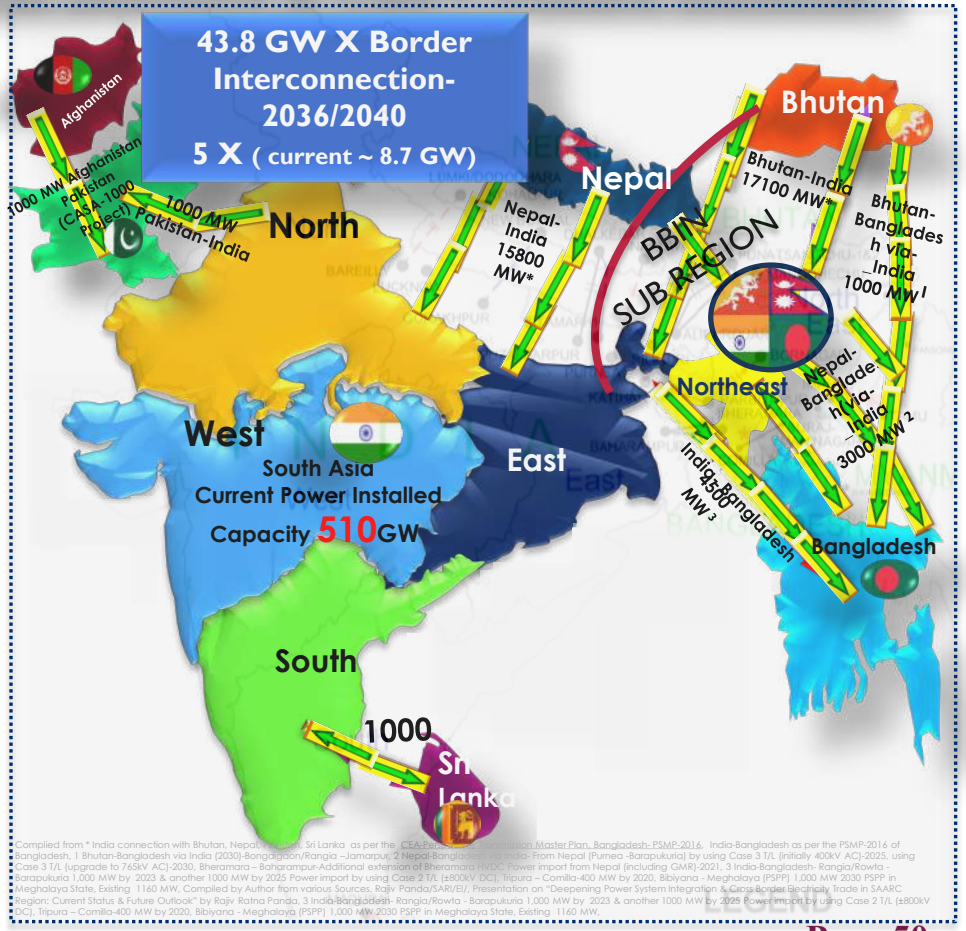
CBET Tripled I EU (ENTSOe)-427 TWh I CBET PX- 6.48 BUs* I Price (₹/Kwh)-FY23-Buy (Nepal @ 5.95 ₹, Bhutan @ 4.39 ₹) Sale (Nepal @ 5.14)

*Till January 2024, PX India Price FY 23 6.25 ₹, Trader 5.85 ₹

01.4 South Asia Regional Electricity Peak Demand & CBET: Future Outlook



Source: CEM Presentation., Power Cell, BPSMP, APSMP, EPS, WECS (Total Installed Capacity Requirement (MW))), NEPRA, CEB, NEPRA, Author's Estimation



Recent Announcement are Encouraging- Prime Minister Shri Narendra Modi during the visit of Prime Minister of Nepal June 01, 2023, said, India to Import 10,000 MW of Power from Nepal in Next 10 Years

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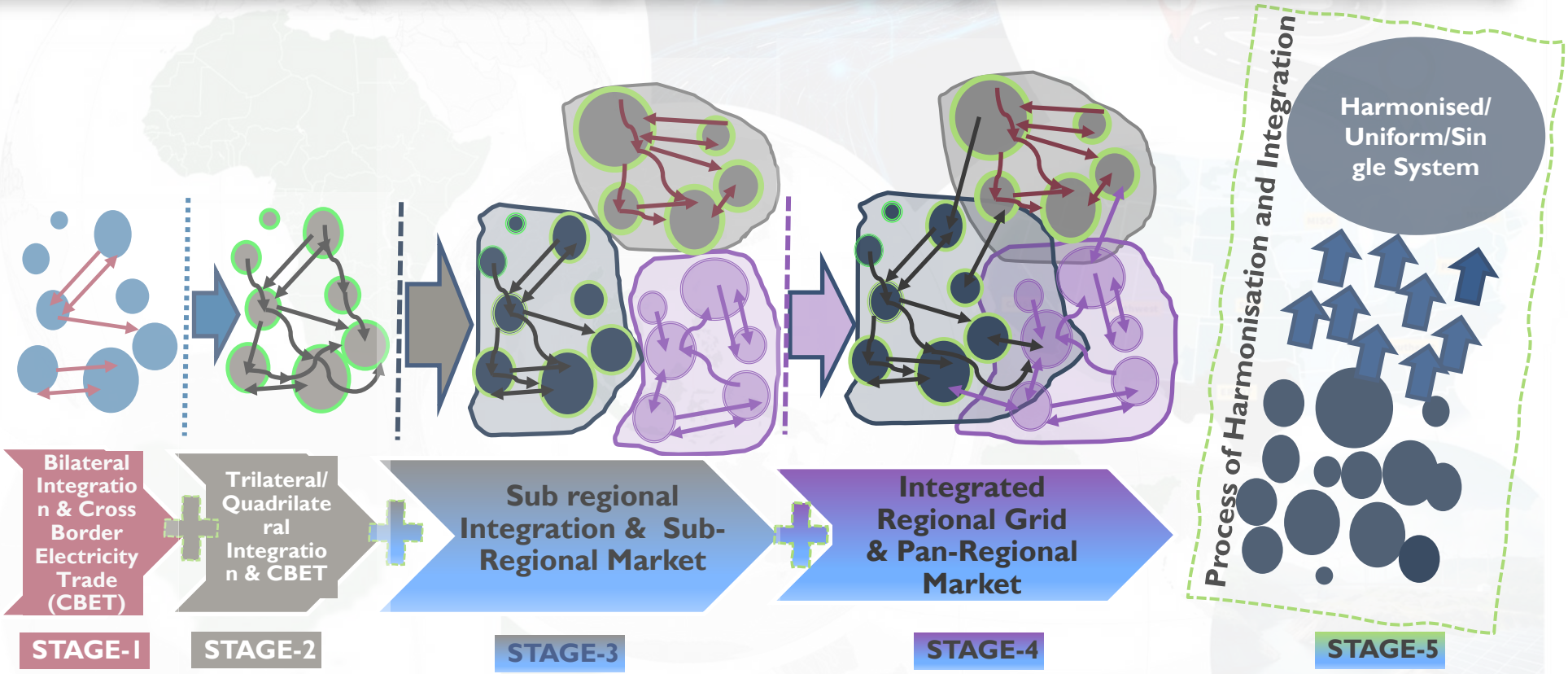
02

Assessment of Regional Energy & Market Integration Dilemma

{Finding a Balancing Act for Policy and Regulatory Design}

02 Typical Regional Energy & Market Integration and CBET Journey



SA CBET Outlook-1:-Moving from Bilateral (Stage 1) to Trilateral (Stage-2) I Potential Remains Large I EU (ENTSOe)-427 TWh

02 Assessment of Regional Energy/Electricity & Market Integration Dilemma in developing world

{Finding a Balancing Act for Policy and Regulatory Design}

Regional & National Interest ?

(How to Balance ? Which one to Prevail ? Finding Win-Win Proposition)

Energy Security & Energy-Interdependence ?

(How much Interdependence ? Green Attribution to whom ?)

Navigating Geopolitical Realities

(Idealism vs Realism, Managing Uncertainty)

Energy Resource Nationalism & State Governance

(How Much State Control ? Resource Sharing at what cost ?)

Competitive & Cooperative Principle

(Relying on Competition ? Sharing of Burden of Grid Integration ?

Political-Economy of Undertaking Power Market Reform

(How to steer CBET market integration in the absence of adequate market reform ?)

Common Agreed Principle for Equitable Sharing of Cost & Benefits

(How ? Setting the Expectations ?)

Limited Public Resource & Investment Strategy

(How to attract investment while in a dominant state control environment ?)

Market & Developmental Approach

(limitation of market ? Is developmental approach, is a better for South Asia)

Source: CEM Presentation-OSOWOG; Energy Integration in South Asia by Rajiv Ratna Panda, Transforming Regional Electricity Markets in South and Southeast Asia for a Greener and More Sustainable Future , Envisioning Trans-Regional Energy Connectivity between the South Asia Region – Southeast Asia Region – Gulf Region – Prospects and Opportunities, Author's Assessment

Regional Energy/Electricity & Market Integration Policies (REMICs) & regulations often needs to Navigate various long-term consideration and depends on the political economy of the jurisdiction that creates it, it requires Policy and regulatory leaders to navigate these difficult trade-offs in a balanced manner.

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FROM THE AMERICAN PEOPLE

03

Transforming Cross Border Electricity Trade and Regional Electricity Market in South Asia

{7 Point Framework Strategy for CBET & REM Transformation (7P-FSCR) in South Asia }

03 Transforming Cross Border Electricity Trade and Regional Electricity Market in South Asia

{7 Point Framework Strategy for CBET & REM Transformation (7P-FSCR) in South Asia }

Bigger CBET & REM | **Better CBET & REM** | **Bolder CBET & REM**

Transforming Strategy 1

Harmonise With Consensus & *Develop Common & Shared CBET Vision*

03.1

Transforming Strategy 2

Accelerate Bilateral CBET *Enrich Bilateralism with Market Feature*

03.2

Transforming Strategy 3

Foster Trilateral/Multilateral CBET *Constructive Multilateralism with BBIN Regional Pride Project*

03.3

Transforming Strategy 4

Mainstreaming CBET in Clean Energy Transition, Net Zero Journey *Integrated Regional Energy System Planning, & outreach to Climate advocacy*

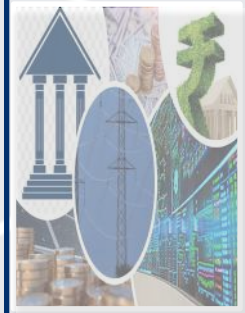
03.4

Transforming Strategy 5

Regional Energy Market Development *Innovative Market Instruments Gradualness to Grwothness to Marketness*

03.5

Transforming Strategy 6



Regional Institution and Funding *Regional Electricity Grid Integration Fund & Institutions*

03.6

Transforming Strategy 7

Trans-Regional Connection *Inter-Continental & Super Grid & One Sun One World One Grid (OSOWOG)*

03.7

03.1 Transforming Cross Border Electricity Trade and Regional Electricity Market in South Asia

{ *Transforming Strategy-1 of 7P-FSCR* }

Bigger CBET & REM

Better CBET & REM

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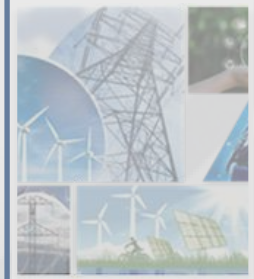


Mainstreaming CBET in

Clean Energy Transition & Net Zero Journey

03.4

Transforming Strategy 5

Regional Energy Market Development

Innovative Market Instruments

Gradualness to Grwothness to Marketness

03.5

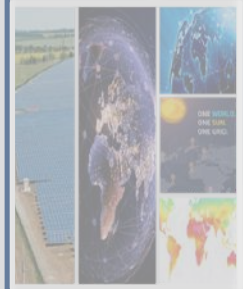
Transforming Strategy 6

Regional Institution and Funding

Regional Electricity Grid Integration Fund & Institutions

03.6

Transforming Strategy 7



Trans-Regional Connection

Inter-Continental & Super Grid & One Sun One World One Grid (OSOWOG)

03.7

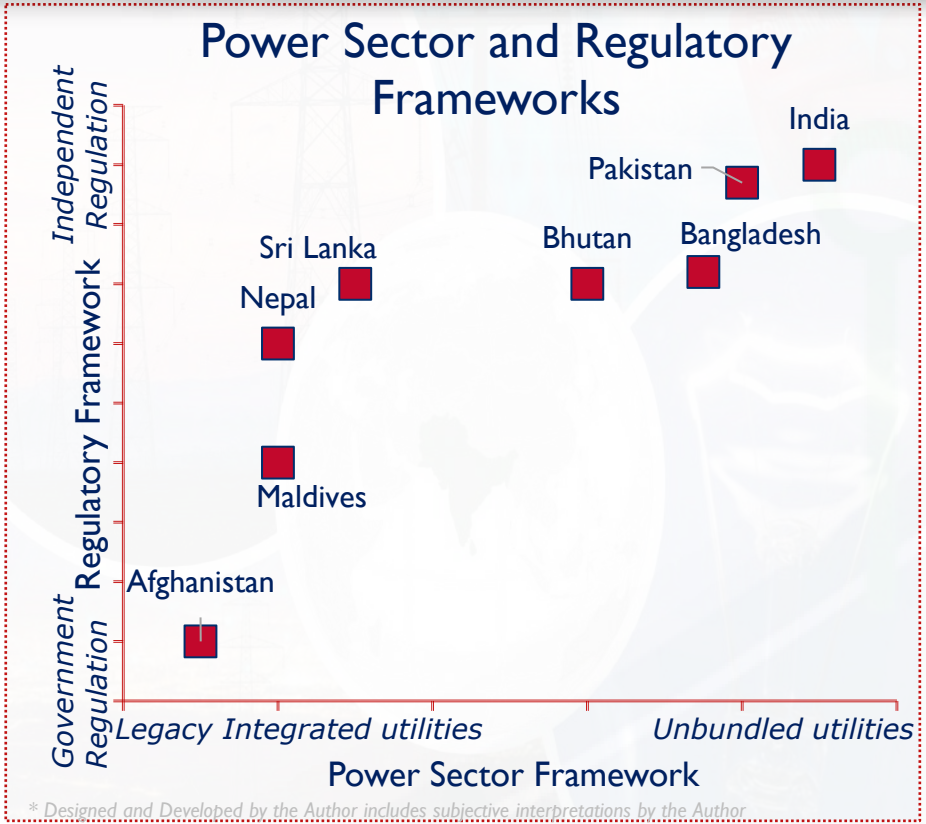
03.2 Enabling CBET Policy & Regulatory Framework : Need for Harmonisation

Desirable Requirement for CBET	Afghanistan	Bangladesh	Bhutan	India	Nepal	Pakistan	Sri Lanka
Regulations, legislations and policies directly related to Regional Energy Cooperation/Exchange, Cross Border Electricity Trade vis-à-vis Electricity Market							
Law (incl. export/import licensing)	✘	✘	✓	✘✓	✓	✘	✘✓
Policy	✘	✘	✓	✓	()	✘	✘
Regulation	✘	✘	✘	✓	✘	✓	✘
Regulations indirectly related to Regional Energy Cooperation/Exchange and Cross Border Electricity Trade vis-à-vis Electricity Market							
Power Market Policy, Regulations	✘	✘	✘	✓	✘	✘	✘
Open Access & Connectivity	✘	()	()	✓	()	✓	✘
Trading License (including import/export license)	()	✘	✘✓	✓	()	✓	✘
Grid Code	✘	✓	✓	✓	✓	✓	✓
Transmission Pricing	✘	✓	()	✓	✘	✓	()
Commercial Deviation Settlement	✘	✘	✘	✓	✘	✓✘	✘
Appellate Electricity Dispute Settlement Body	✘	✘	✘	✓	✘	✘	✘

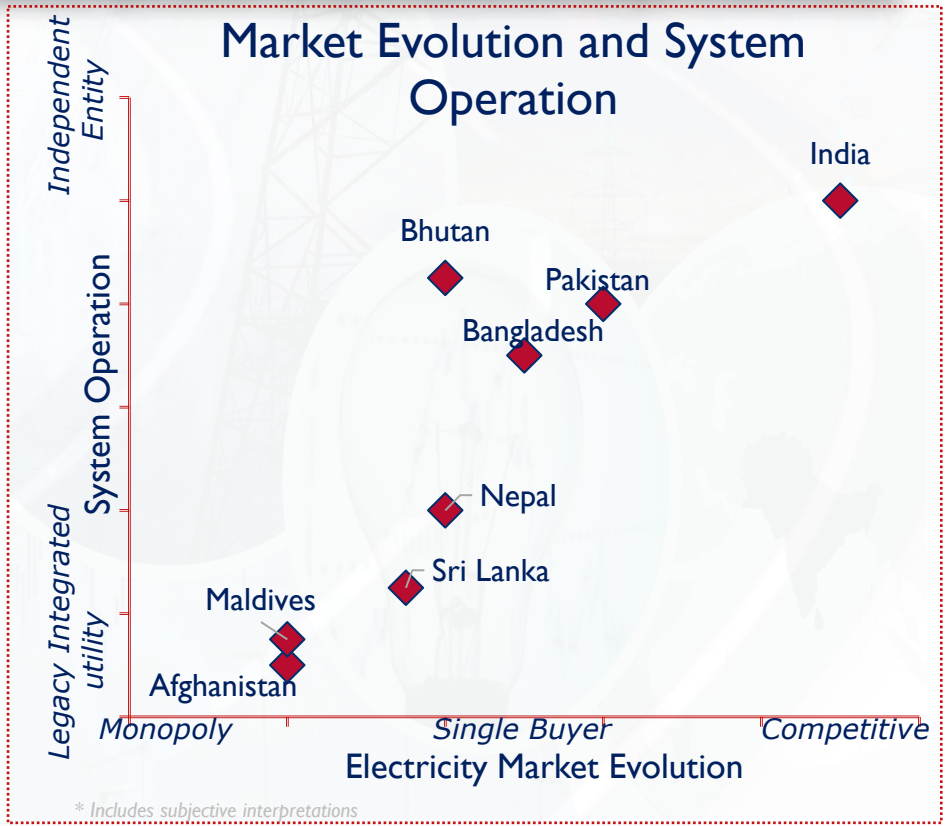
✓ Available () Partially Available ✘ Not Available ✘✓ Proposed

Develop Complementary Policy & Regulatory Framework for Electricity Market Development and Integration for Advancing CEET

03.1 Varied Level of Sector Evolution, Market Development : Harmonise through Consensus



* Designed and Developed by the Author includes subjective interpretations by the Author



* Includes subjective interpretations

Develop a Common & Shared Policy Vision on CBET & Regional Electricity Market and Harmonise Regulation through Consensus Building

Continuous and Customised Training and Capacity Building and Experience Sharing to improve regulatory Capacity

03.2 Transforming Cross Border Electricity Trade and Regional Electricity Market in South Asia

{ *Transforming Strategy-2 of 7P-FSCR* }

Bigger CBET & REM

Better CBET & REM

Bolder CBET & REM

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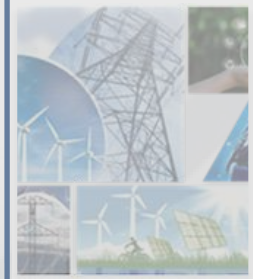


Mainstreaming CBET in Clean Energy Transition, Net Zero Journey

Integrated Regional Energy System Planning, & outreach to Climate advocacy

03.4

Transforming Strategy 5

Regional Energy Market Development

Innovative Market Instruments

Gradualness to Grwothness to Marketness

03.5

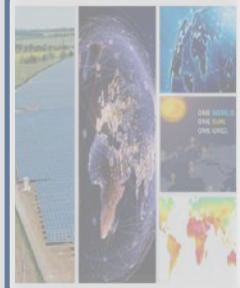
Transforming Strategy 6

Regional Institution and Funding

Regional Electricity Grid Integration Fund & Institutions

03.6

Transforming Strategy 7



Trans-Regional Connection

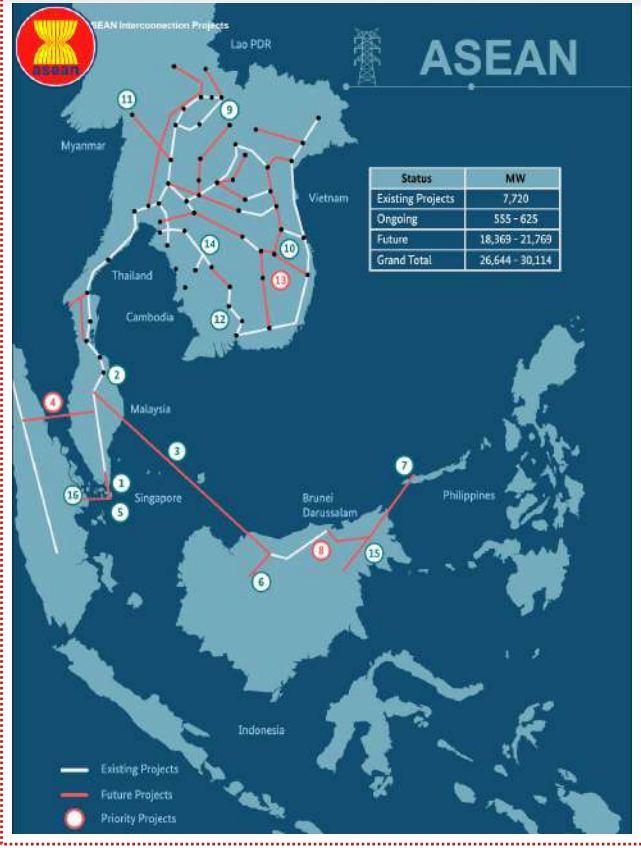
Inter-Continental & Super Grid & One Sun One World One Grid (OSOWOG)

03.7

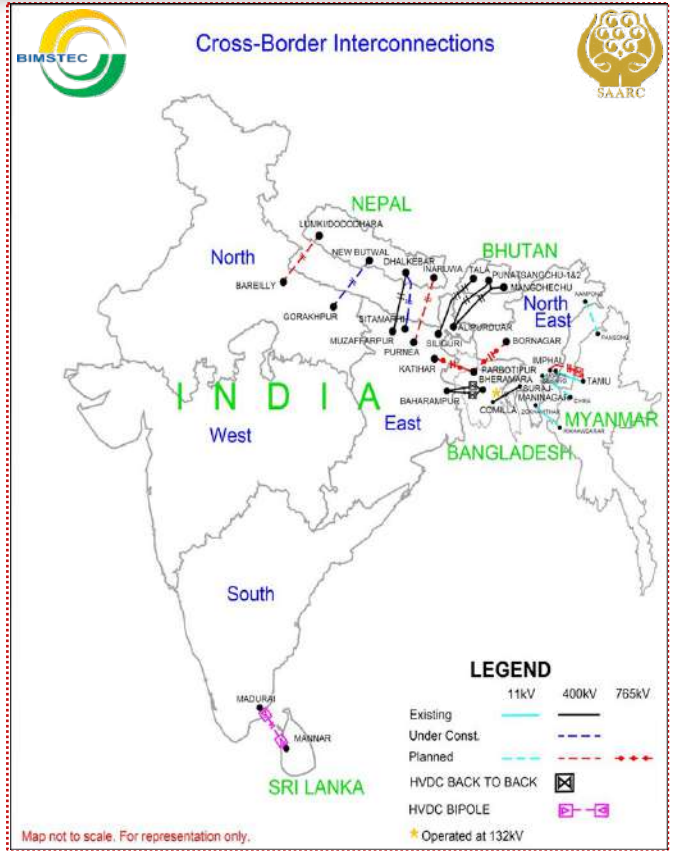
03.2 Accelerate X Border Bilateral Electricity Trade: Enrich Bilateralism with Market Feature

For Bigger CBET

- Cross Border Power Trade are primary *through Bilateral Mode*.
- In general, in Developing World, Bilateralism in Power Trade continues be the dominant Choice (Ex-ASEAN , South Asia).
- Number of bilateral agreement has been signed (Ex-ASEAN , South Asia).
- Bilateral Power trade will remain the dominant mode in near future.
- Pricing is largely based on Negotiation basis.
- Market Feature (certain capacity could be kept for market-based trade) can be introduced more strongly while undertaking Bilateral CBET.
- Use existing Domestic Market Platform such as Power Exchange Platform for market based CBET.



Status	MW
Existing Projects	7,720
Ongoing	555 - 625
Future	18,369 - 21,769
Grand Total	26,644 - 30,114



South Asia has taken positive step to introduce commercial CBET and market features under overall bilateral trading arrangement

03.3 Transforming Cross Border Electricity Trade and Regional Electricity Market in South Asia

{ *Transforming Strategy-3 of 7P-FSCR* }

Bigger CBET & REM

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Harmonise With Consensus & *Develop Common & Shared CBET Vision*

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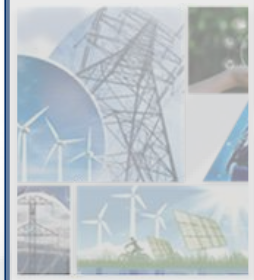
Accelerate Bilateral CBET *Enrich Bilateralism with Market Feature*

Transforming Strategy 3

Foster Trilateral/Multilateral CBET *Constructive Multilateralism with BBIN Regional Pride Project*

Better CBET & REM

Transforming Strategy 4



Mainstreaming CBET in Clean Energy Transition, Net Zero Journey *Integrated Regional Energy System Planning, & outreach to Climate advocacy*

Transforming Strategy 5

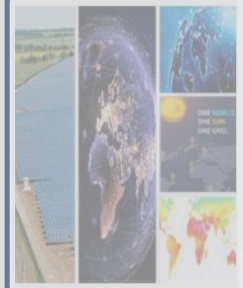
Regional Energy Market Development *Innovative Market Instruments Gradualness to Grwothness to Marketness*

Bolder CBET & REM

Transforming Strategy 6

Regional Institution and Funding *Regional Electricity Grid Integration Fund & Institutions*

Transforming Strategy 7



Trans-Regional Connection *Inter-Continental & Super Grid & One Sun One World One Grid (OSOWOG)*

03.3 Foster Trilateral/Multilateral CBET: *Constructive Multilateralism with BBIN Regional Pride Project*

For Bigger CBET

- Bangladesh aims to import 500 MW of electricity from 900 MW Upper Karnali Hydropower in Nepal through India.
- Bangladesh exploring Joint investment in the Sankhuwasabha-3 hydropower project in Nepal.
- Bangladesh aims to Import 9 GW by 2041 and 14.7 GW by 2050 from Neighbouring Country.
- $2 billion ,1125 MW Dorjilung Project in Bhutan, Proposed to developed as Trilateral Project
- Pursue the development one/two Trilateral & multilateral electricity generation & associated transmission projects as a "BBIN Regional Pride Projects" in order to build confidence and trust.

Source: CEM Presentation-OSOWOG by Rajiv Ratna Panda, Bangladesh's IEPMP 2023 , Transforming Regional Electricity Markets in South and Southeast Asia

Lao PDR, Thailand, Malaysia, Singapore (LTMS) Multi Lateral Trade Project

Phase-I
100 MW
Trilateral
Lao-Thailand
Malaysia
32.8 GWh
traded between
2018-21

Phase-II
100 MW
Multilateral
Lao-Thailand
Malaysia-
Singapore
23 June 2022

Singapore-fully liberalised power market
4 GW import
Plan by Singapore

Energy Purchase and Wheeling Agreement
(EPWA)

A 40 MW electricity export from Nepal to Bangladesh through India's existing transmission infrastructure can be pursued as Pilot project for Trilateral power trade which is at advance stage

03.3 Nepal's Economic Impact by accelerating CBET & Prospects of Multilateral/Regional Trade

Economic Wide Impact

Economic Benefits from Nepal-India Electricity Trade: Analytical Study

[A case for Economic Prosperity and Better Quality of Life]

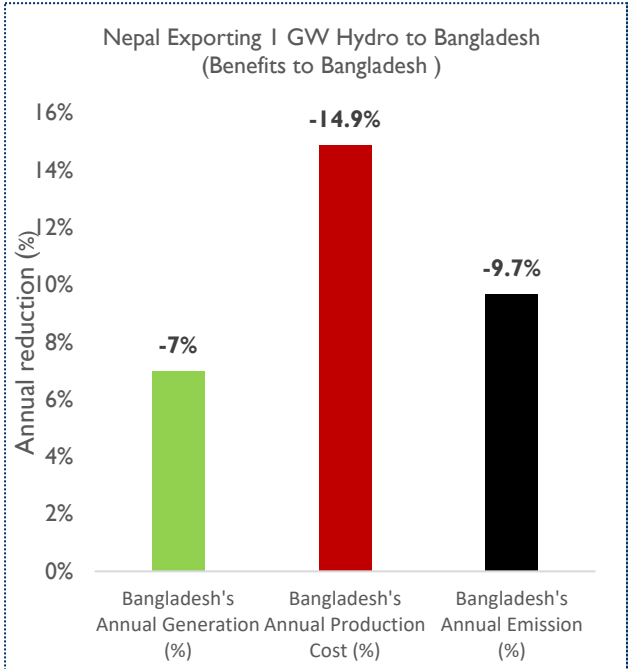
- With accelerated CBET between India & Nepal, Nepal's GDP could reach **NPR 13,100 billion** (over $120 billion) in 2045, which is **39 percent** more than with existing trading mechanisms with India.
- Increased CBET will also fuel **Nepal's per capita electricity demand** to jump from the current 139 kWh/year to 1,500 kWh/year by 2045.
- India also benefits from lower emission.
- Cumulated (2012–2045) CO2 emissions from Indian Power Generation reduces by 5.6%.

Source: Economic Benefits from Nepal-India Electricity Trade

Regional Trade Prospects

Nepal's Potential attractive Proposition for Regional Trade

[A case of exporting 1000 MW to Bangladesh through India]



Source: NREL Study on CBET and Renewable Energy Zones and technical presentation of the study results

Nepal-India-Bangladesh Multilateral Electricity Trade- all three countries together reduces Capex of power sector by USD $ 17 billion.

(Nepal Capex from 2012 to 2045 increases to US $ 70 billion compared to US $ 15 billion in BASE scenario- higher economic activities in Nepal.)

Page 63

03.4 Transforming Cross Border Electricity Trade and Regional Electricity Market in South Asia

{ *Transforming Strategy-4 of 7P-FSCR* }

Bigger CBET & REM

Better CBET & REM

Bolder CBET & REM

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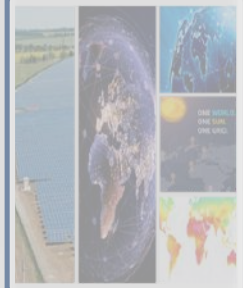


Trans-Regional Connection

Inter-Continental & Super Grid & One Sun One World One Grid (OSOWOG)

03.7

03.4 Mainstreaming CBET & REM in Clean Energy Transition & Net Zero: *Integrated Energy System Planning*

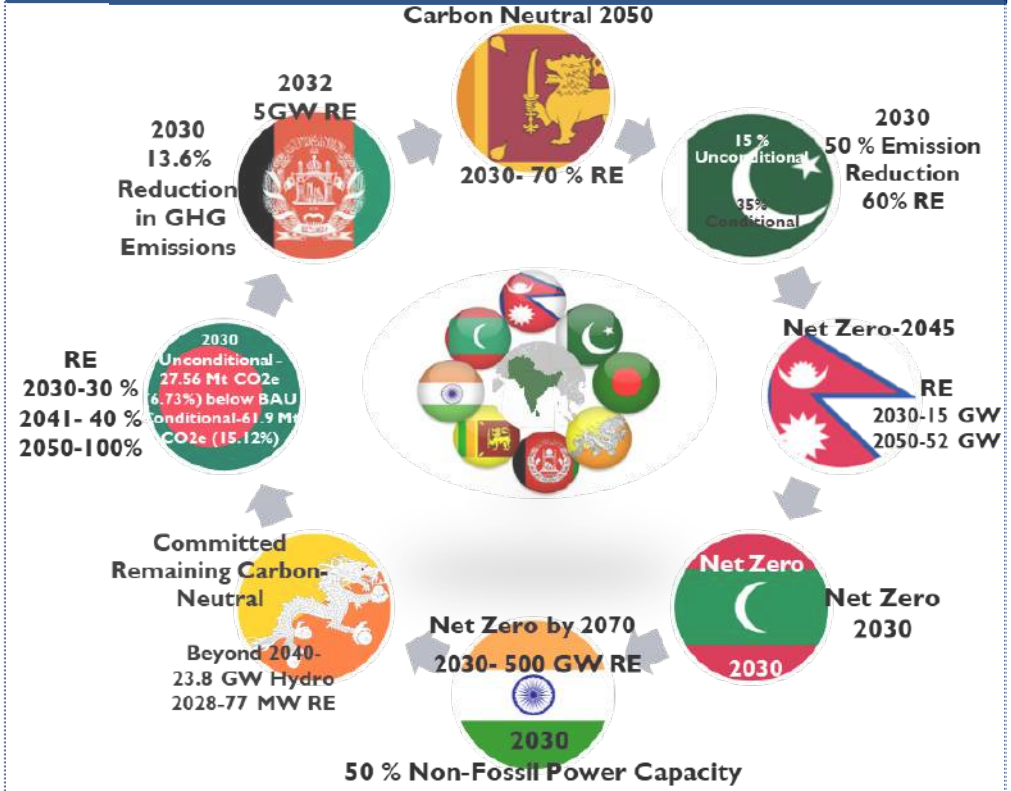
Net Zero & RE Goals/Ambitions

- **World's 1st Carbon Neutral** Country-**Bhutan**
- **Net Zero**
  - **2030-Maldives**
  - **2045-Nepal**
  - **2050-Sri Lanka** (Carbon Neutral)
  - **2070-India**
- **Renewable Energy by 2030**
  - **500 GW-India**
  - **35 GW-Pakistan**
  - **16 GW-Bangladesh**
  - **15 GW-Nepal**
  - **9.3 GW-Bhutan**
  - **8.7 GW-Sri Lanka**

584 GW RE by **2030**

Note: RE- Renewable+ Hydro/Clean Energy/Non-Fossil /Hydro as the case in a Country Context, BD-16 GW-MCPP-M Scenario (Page-82), India, Pakistan-IEGEP Plan 2018-40 Page 78 of 147, MCPP (Page 82), Sri Lanka-CEB LGTEP 2023-2042, Nepal –WAM Scenario- Page-27 of Nepal's LTS for Net-zero, Bhutan- NTGM-2018 (Page 17, Graph -2)

Climate-Induced Energy Sector Transformation



Source : Compiled by Author from Various Sources, RE-Renewable/Clean Energy, Afghanistan - UNFCC , AREP , Bangladesh – UNFCC ; MCPP (Page 84 & 81) , Bhutan- UNFCC , NTGM-2018 , 88 MW (Page-15 UNFCC) , India - UNFCC , 500 GW RE/Non-Fossil Capacity by 2030 , Maldives- UNFCC , Nepal- UNFCC , Pakistan- UNFCC , Sri-Lanka (UNFCC) Presentation on Envisioning Trans-Regional Energy [illegible]

03.4 Transformational Action across Energy Value Chain in South Asia : *Need Integrated Energy System Planning For Better CBET and REM*

Rapid De-carbonising Power Sector

Cleaner and Efficient Public Transport

Renewable Energy

Electric Vehicle & Charging Infrastructure

Modernising power grid , smart grid, smart utility

Green Hydrogen Economy and Energy Storage

Cross Border Hydro Power Projects & Cross Border Power Transmission

Natural Gas, LNG and Region Gas Grid

Electrifying and Greening the Way of Life

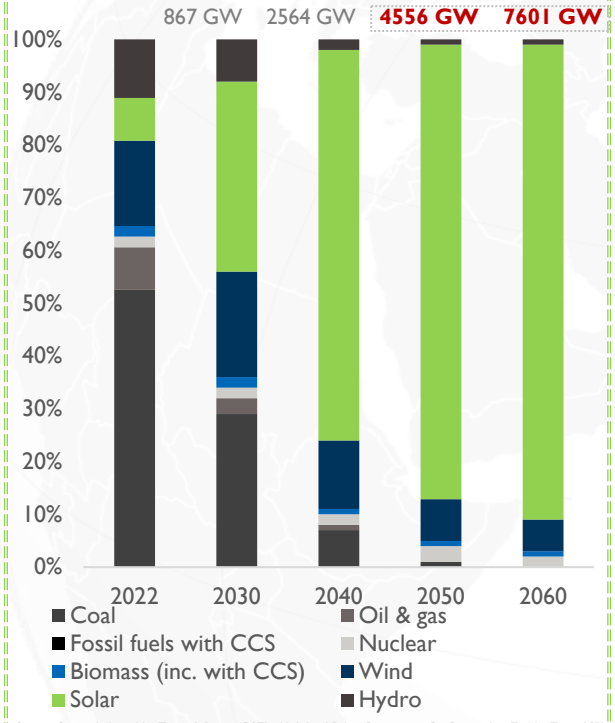
South Asia Power & Energy System is Undergoing Transformation : Electrifying and Greening the Way of Life

World Bank Study- Hydropower (only 20% exploited so far) Development would increase by 2.7 times if there is unconstrained CBET across SA

Source: Presentation on Creating Conducive Environment-Regional Investment Framework for Mobilizing Investment in Regional Energy Infrastructure projects in South Asia

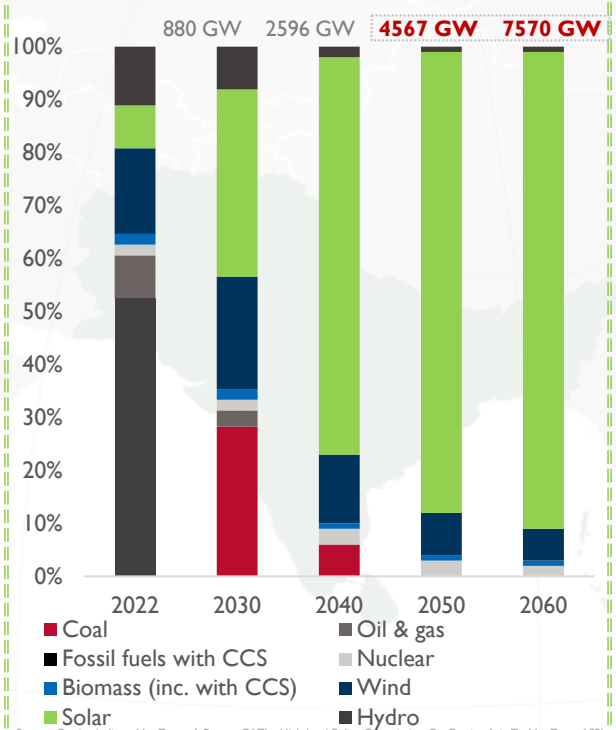
03.4 Long Term Implication of Net Zero Goals : *Understanding the Scale of Transition*

India-Projected Power Capacity (GW) mix in 2070 Net Zero **(balanced policy mix) scenario**



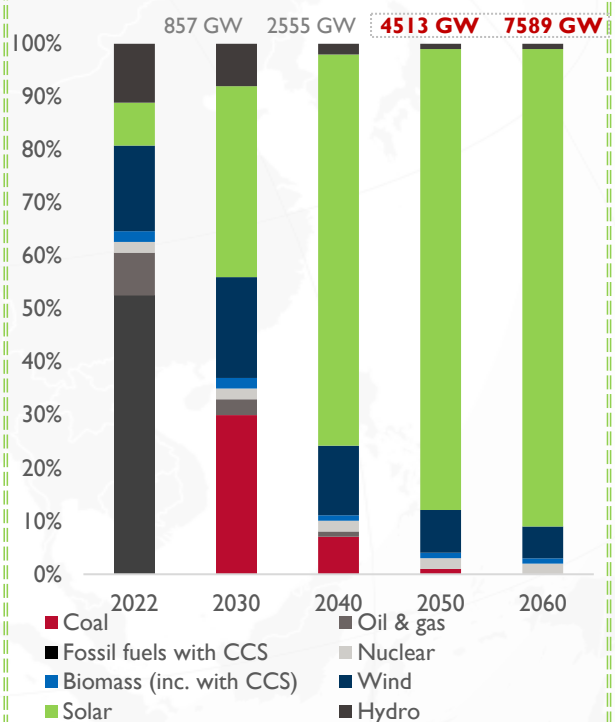
Source: Getting India to Net Zero , A Report Of The High-level Policy Commission On Getting Asia To Net Zero, ASPI

India-Projected-Power Capacity (GW) mix in 2070 Net Zero **(regulation focus) scenario**



Source: Getting India to Net Zero , A Report Of The High-level Policy Commission On Getting Asia To Net Zero, ASPI

India-Projected-Power Capacity (GW) mix in 2070 Net Zero **(Market-Based Focus) scenario**



Source: Getting India to Net Zero , A Report Of The High-level Policy Commission On Getting Asia To Net Zero, ASPI

Getting India to Net Zero

India-17 X Increase in Capacity I 7601 GW by 2060 I Need $10.1Trillion Cumulative Economy-wide Investment for 2070 target

03.5 Transforming Cross Border Electricity Trade and Regional Electricity Market in South Asia

{ *Transforming Strategy-5 of 7P-FSCR* }

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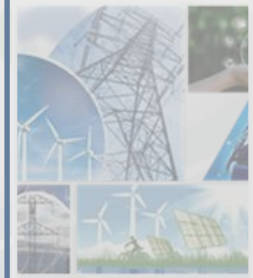

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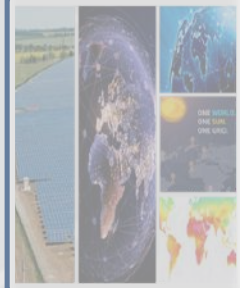


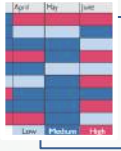
Trans-Regional Connection

Inter-Continental & Super Grid & One Sun One World One Grid (OSOWOG)

03.7

03.5 Regional Energy Market Development : *Relying on Innovative Market Instruments*

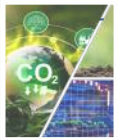
Trend is to Rely on Competition & Market Instruments under Policy & Regulatory Oversight



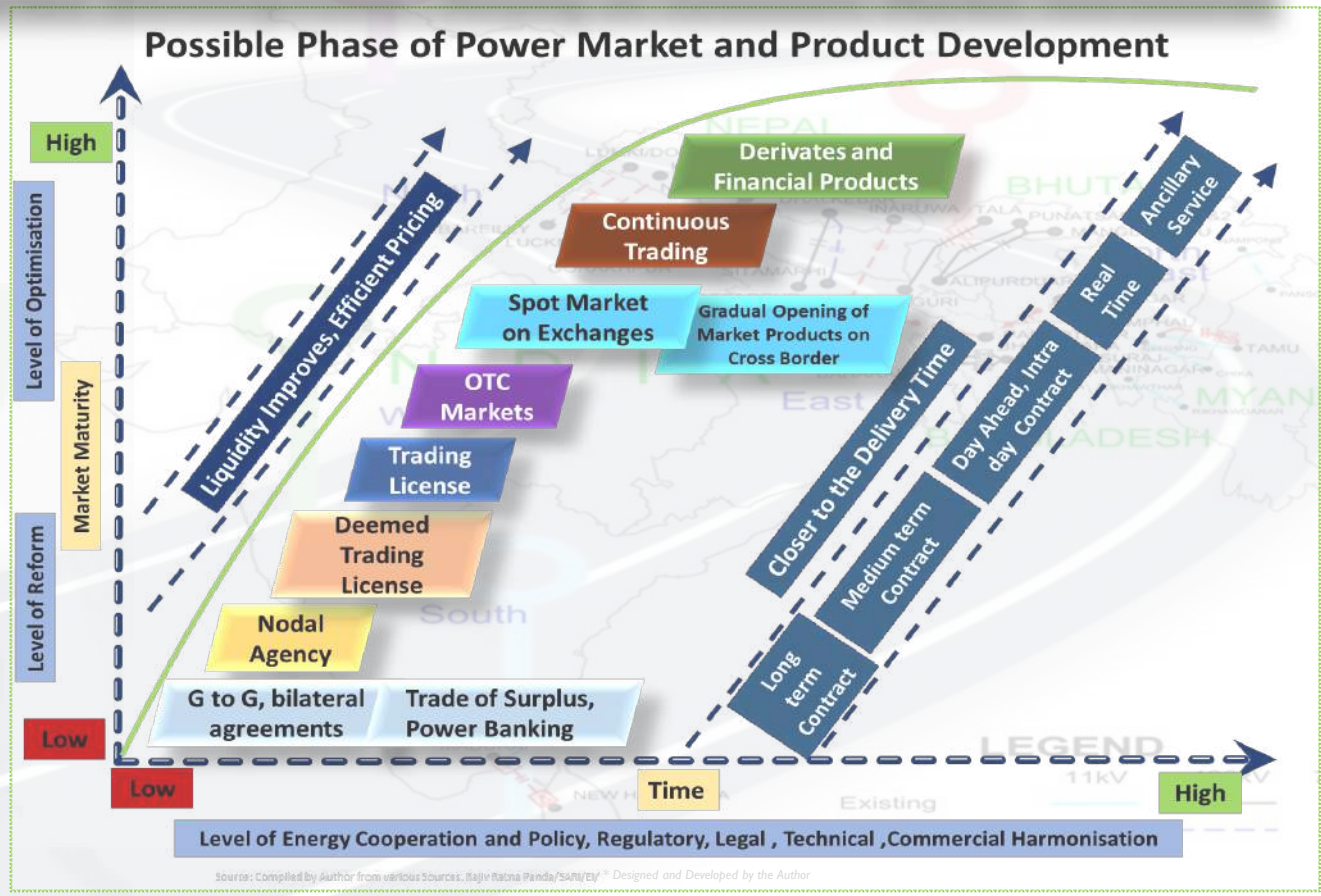
Tapping Demand Diversity- Daily, Weekly ,Monthly, Seasonal

Power Exchange- Competitive price discovery, Auction Platforms

Portfolio of Product, Electricity (DAM, RT) , Green (G-DAM, G-TAM) , REC, ESCRTs, Ancillary Service Market, Energy Storage Products

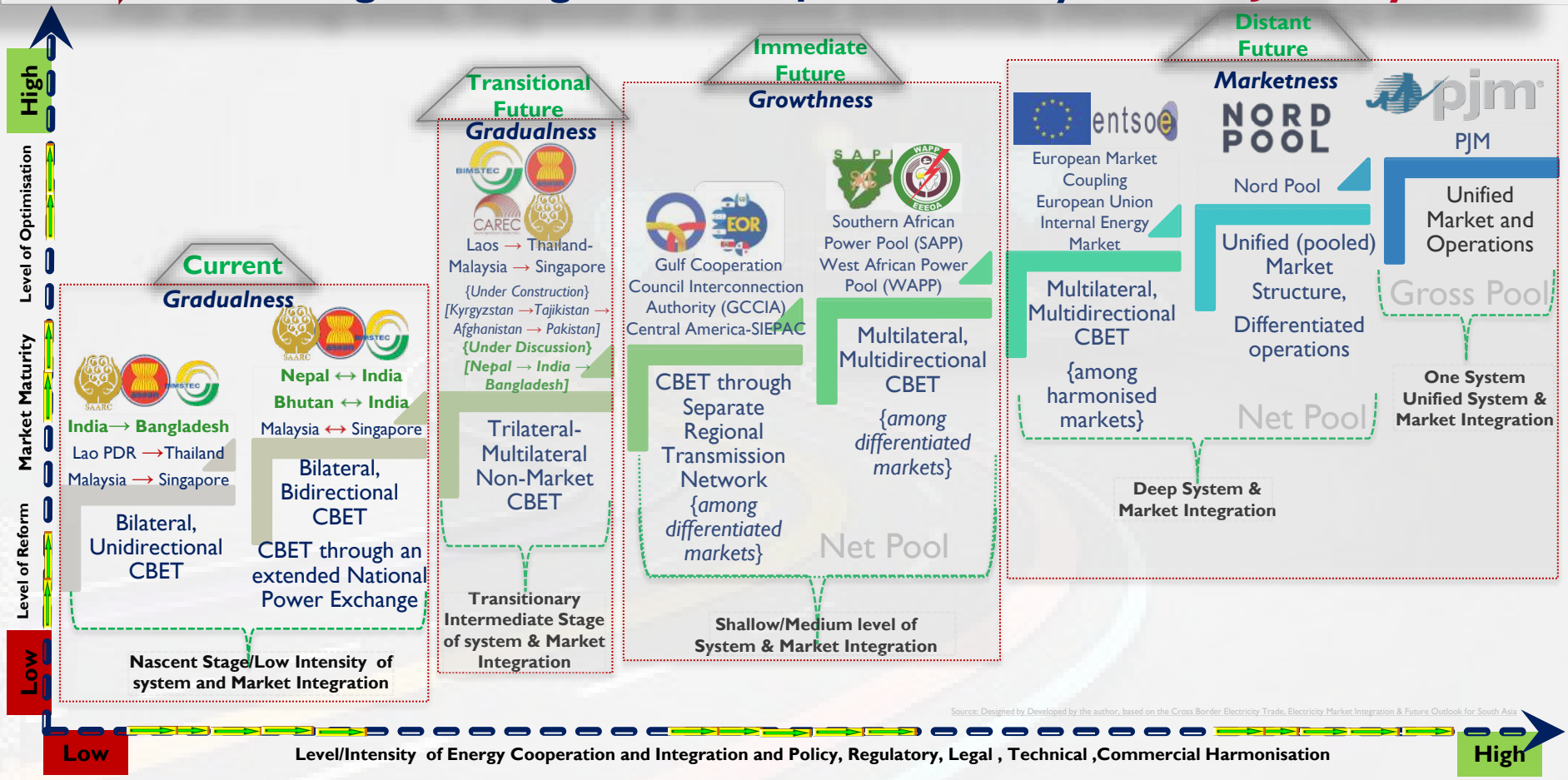


Emergence of Carbon Market, Resurgence of Carbon Credits



Increase in Commercial/Market CBET since 2010 I Integrated Regional Power Market will facilitate optimal allocation of cost & benefit of clean energy transition.

03.5 For an Integrated, Regional & Unified Electricity Market: Journey Ahead



Source: Designed by Developed by the author, based on the Cross Border Electricity Trade, Electricity Market Integration & Future Outlook for South Asia

A South Asian Regional Market Model should be evolved through a collective & shared vision among SA countries. Gross Pool Vs Net Pool

03.6 Transforming Cross Border Electricity Trade and Regional Electricity Market in South Asia

{ *Transforming Strategy-6 of 7P-FSCR* }

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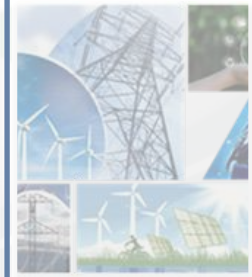
Constructive Multilateralism with BBIN Regional Pride Project

Transforming Strategy 4



Mainstreaming CBET in Clean Energy Transition, Net Zero Journey

Integrated Regional Energy System Planning, & outreach to Climate advocacy

Transforming Strategy 5

Regional Energy Market Development

Innovative Market Instruments

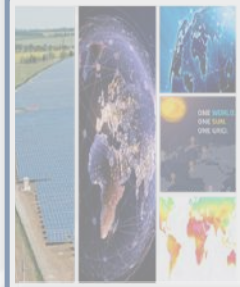
Gradualness to Grwothness to Marketness

Transforming Strategy 6

Regional Institution and Funding

Regional Electricity Grid Integration Fund & Institutions

Emerging Perspective 7



Trans-Regional Connection

Inter-Continental & Super Grid & One Sun One World One Grid (OSOWOG)

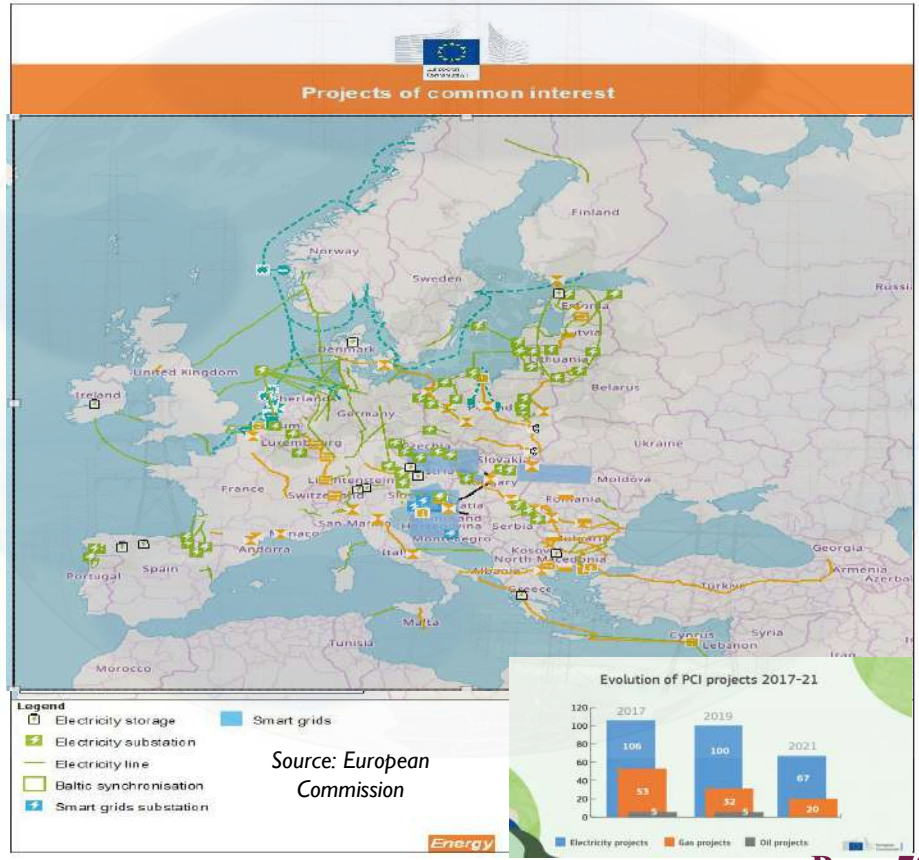
03.1 | 03.2 | 03.3 | 03.4 | 03.5 | **03.6** | 03.7

03.6 Regional Funding Facility : Access to Affordable Finance, Blend/Co-Financing

South Asia Regional Electricity Grid Integration Fund

- South Asia would spend **1.39 trillion US$** to add ~750 GW of electricity generation capacity and **29 billion US$** for planned inter-grid connection by 2040*.
- **43.8 GW** of Cross Border Interconnection by 2040
- BIMSTEC region needs **958 billion US$** for generation and **122 billion US$** for Transmission** **by 2035.**
- **3.4 Trillion** Climate Smart Investment opportunities by 2030 in South Asia ***
- A dedicated funding facility "South Asia Regional Electricity Grid Integration Fund " could be created as a New Fund or as Special Funding window under any Existing Financing facility.
- Projects of Common Interest (PCIs) Projects support EU to achieve its energy policy and climate objectives. Key cross border high risk infrastructure projects that link the energy systems & funded through Connecting Europe Facility (CEF)
- PCIs benefit from accelerated permitting procedures and funding. CEF support comes in the form of grants. €5.8 billion budget for CEF, for 2021-2027.

* World Bank , ** IFC , BIMSTEC Energy Outlook 2035***

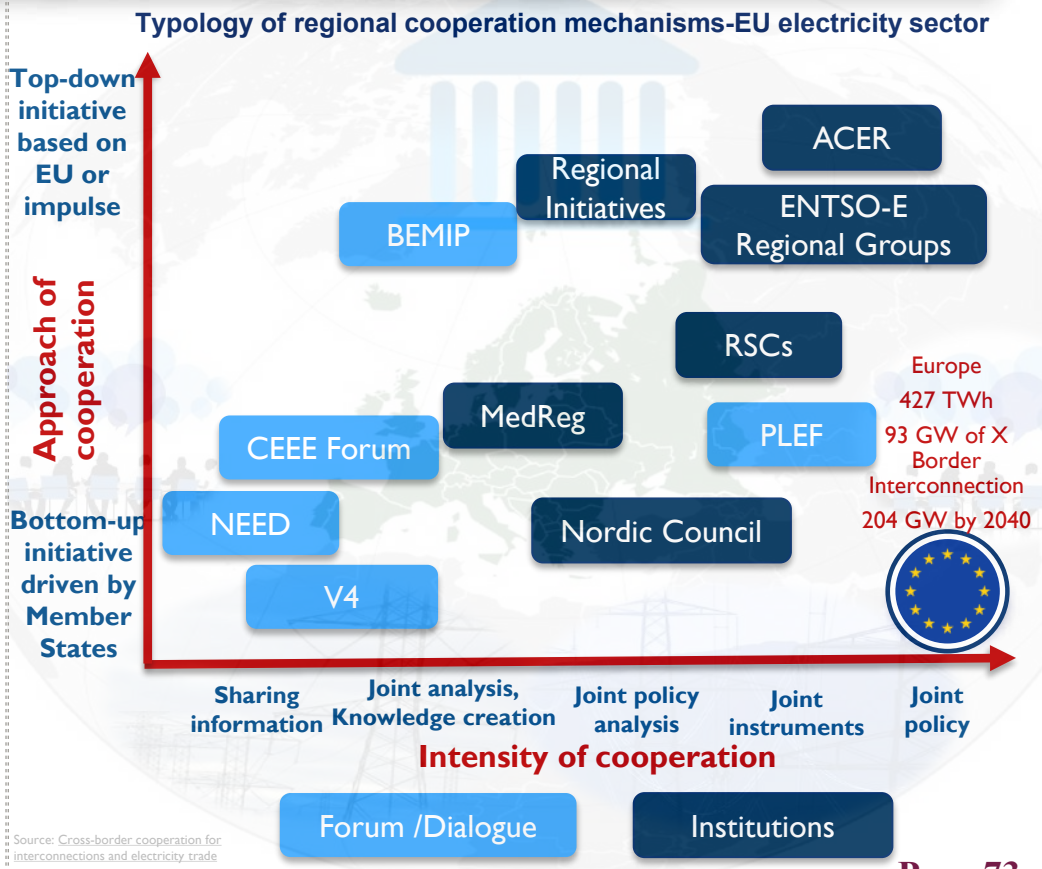


Source: European Commission

03.6 Preferable to have Regional Institution for Dialogue, Coordination, Harmonisation

Multistakeholder Engagement and Hybrid (Formal and Informal) Approach

1. Democratize Dialogue and intensify Regional Institutionalization.
2. Build, Maintain Political Trust and Consensus by engaging in continuous dialogue on Regional Energy Cooperation (REC), CBET, REM across all levels of Stakeholders.
3. Creating & Strengthen function-specific regional Institutions/Forums/Network/Associations
   - *Parliamentarians (RPF)*
   - *Energy Policymakers*
   - *Electricity/Energy Regulators (SAFIR)*
   - *System Operators (SAFSO)*
   - *Transmission Planners (SAFTU)*
   - *Consumer Organizations*
   - *Investors & Industry bodies (SAFEI)*
   - *Think Tanks (TTF)*
4. Regional Institutions shall provide Long-term Sustainability of REC, CBET & REMs.



03.7 Transforming Cross Border Electricity Trade and Regional Electricity Market in South Asia

{ *Transforming Strategy-7 of 7P-FSCR* }

Bigger CBET & REM

Better CBET & REM

Bolder CBET & REM

Transforming Strategy 1

Harmonise With Consensus & *Develop Common & Shared CBET Vision*

Transforming Strategy 2

Accelerate Bilateral CBET

Enrich Bilateralism

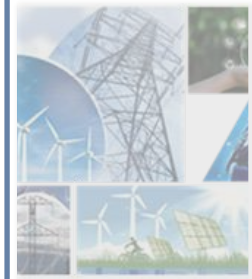
with Market Feature

Transforming Strategy 3

Foster Trilateral/Multilateral CBET

Constructive Multilateralism with BBIN Regional Pride Project

Transforming Strategy 4



Mainstreaming CBET in Clean Energy Transition, Net Zero Journey

Integrated Regional Energy System Planning, & outreach to Climate advocacy

Transforming Strategy 5

Regional Energy Market Development

Innovative Market Instruments

Gradualness to Grwothness to Marketness

Transforming Strategy 6

Regional Institution and Funding

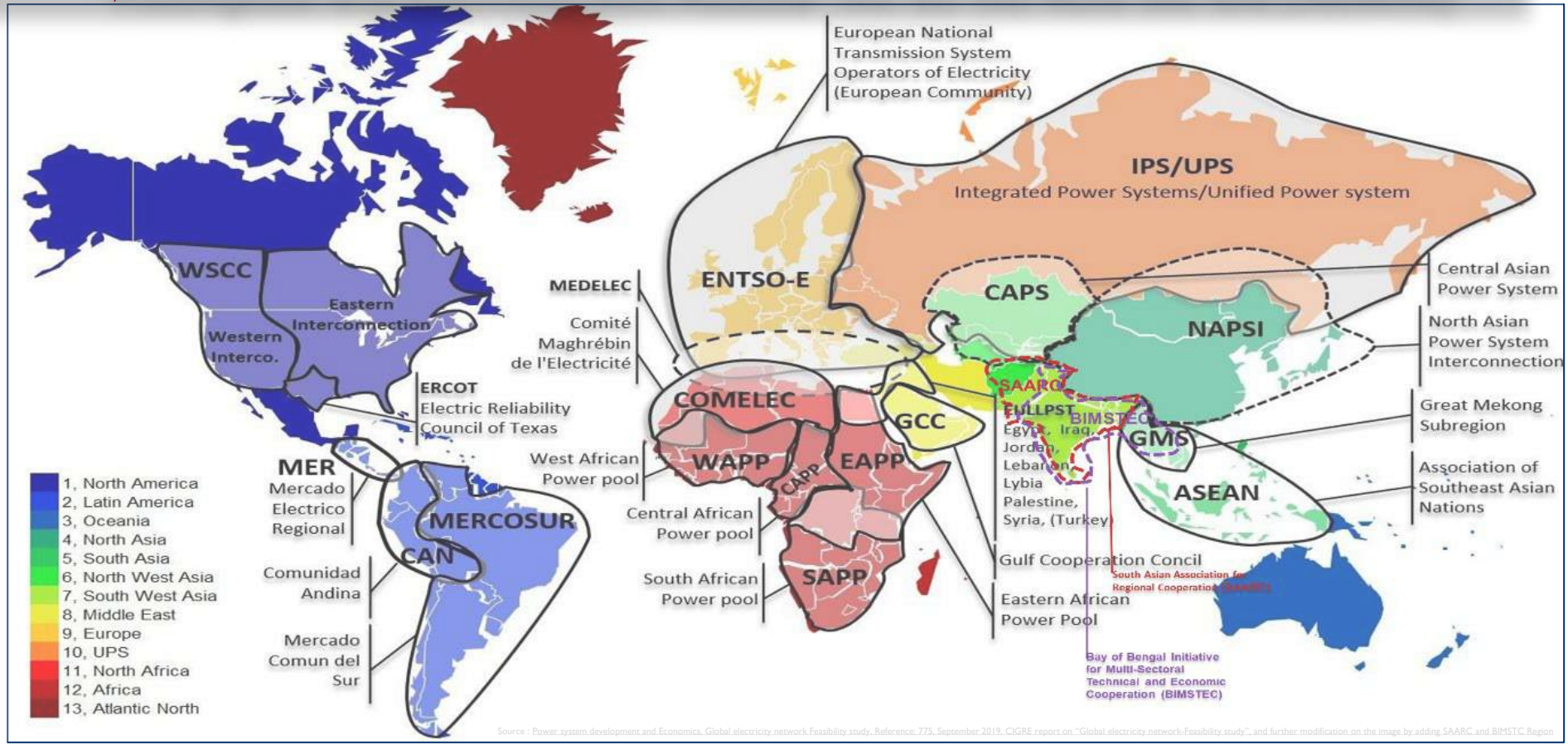
Regional Electricity Grid Integration Fund & Institutions

Emerging Perspective 7

Trans-Regional Connection

Inter-Continental & Super Grid & One Sun One World One Grid (OSOWOG)

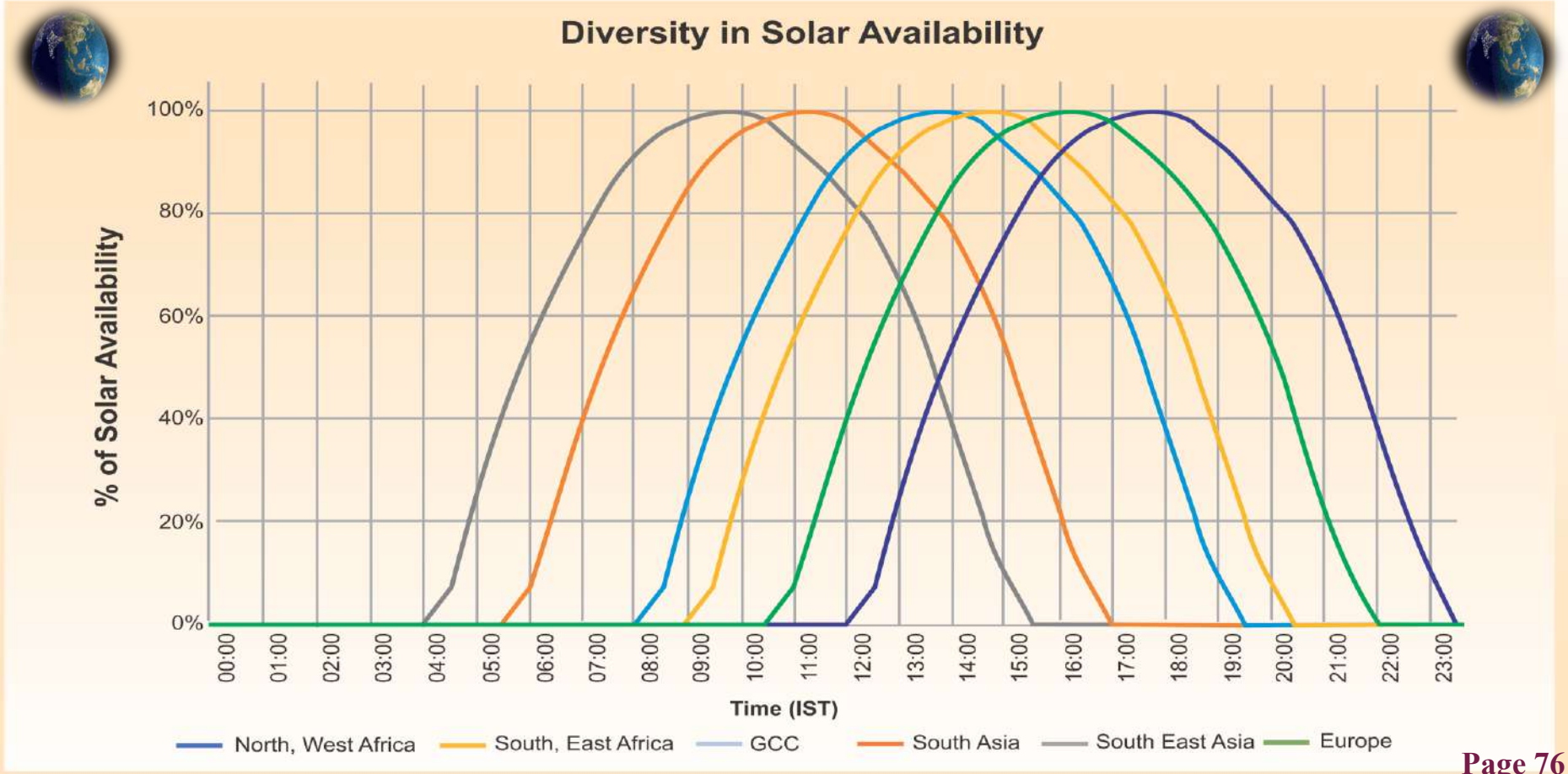
03.7 Transregional Grid Interconnections Potential- *One Sun One World One Grid (OSOWOG)*



Source : Power system development and Economics, Global electricity network Feasibility study. Reference: 775, September 2019. CIGRE report on "Global electricity network-Feasibility study", and further modification on the image by adding SAARC and BIMSTC Region

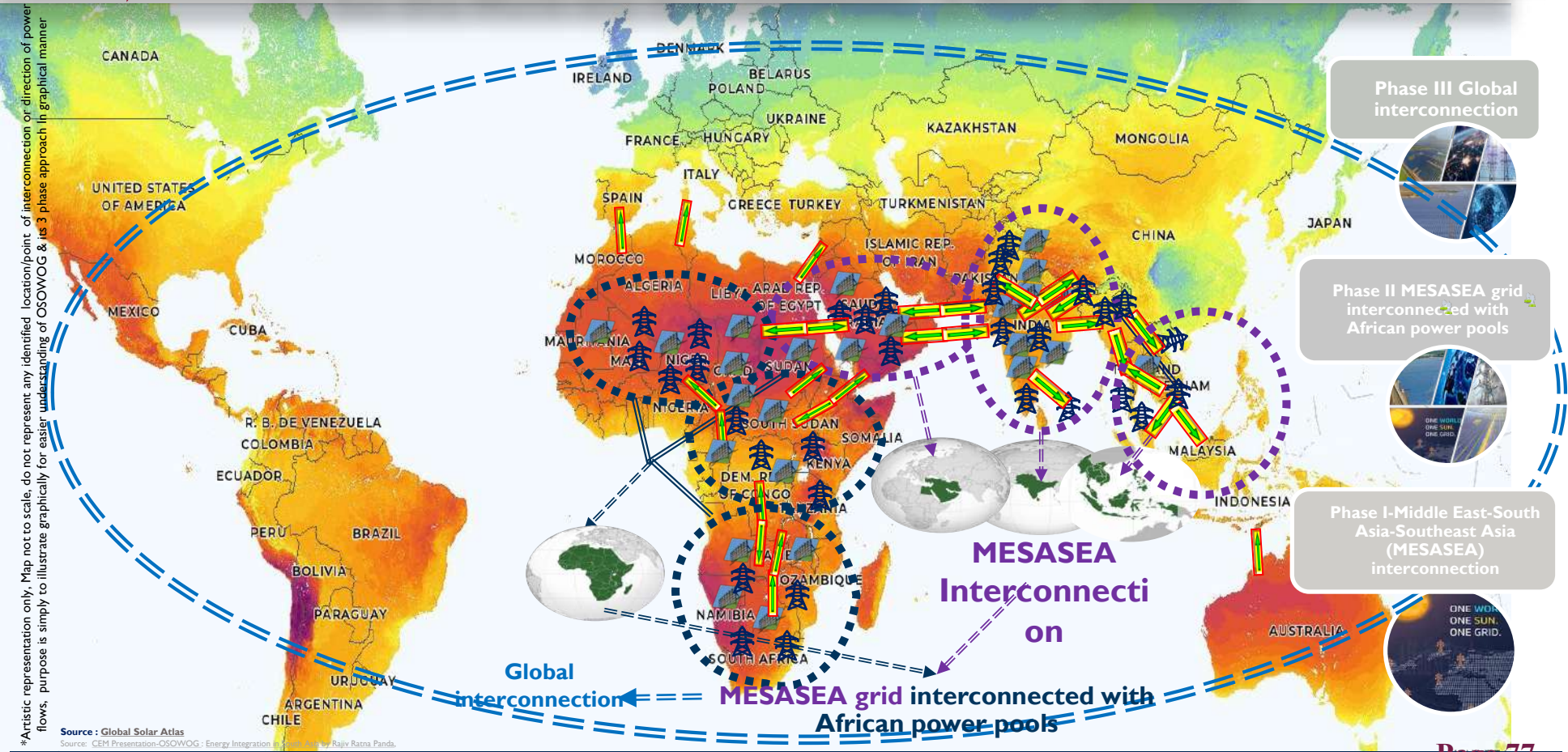
February 14, 2024 : India-UAE Signed MoU in the field of Electricity Interconnection & Trade, which will bring to life the GGI –OSOWOG Initiative

Transregional Grid Interconnections , Super Grid , OSOWOG- *Solar Diversity , Sun Never Sets*



Source : Courtesy , MOP Report Transnational Grid Connections for Ensuring Energy Security

One Sun One World One Grid (OSOWOG) : *3 Phase Approach*



*Artistic representation only, Map not to scale, do not represent any identified location/point of interconnection or direction of power flows, purpose is simply to illustrate graphically for easier understanding of OSOWOG & its 3 phase approach in graphical manner

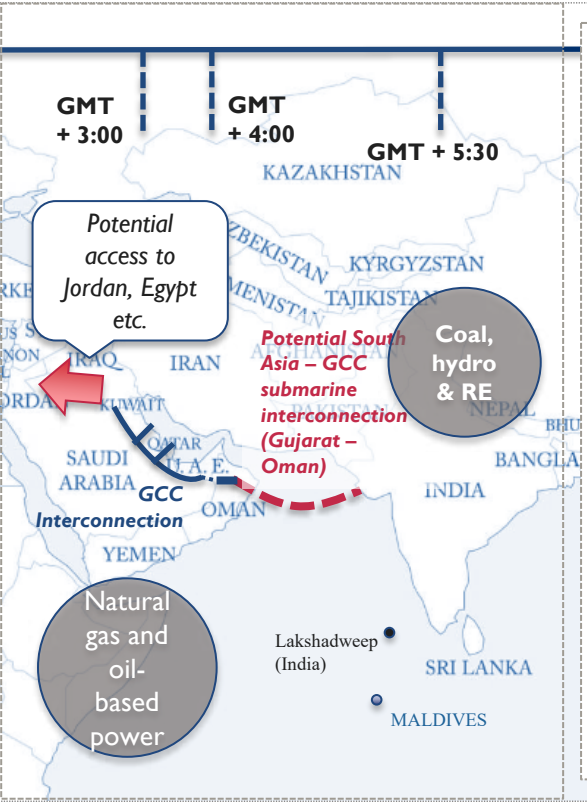
Source : Global Solar Atlas

Source: CEM Presentation-OSOWOG : Energy Integration in South Asia by Rajiv Ratna Panda.

One Sun One World One Grid (OSOWOG) will further facilitate the Grid Integration in the South Asia

03.7 Prospects of South Asia – GCC Grid Interconnection- *Solar Diversity , Sun Never Sets*

Time Zone Variation, Reserve Sharing , Resource Complementarity, Diversity of Peak Demand, Optimum Utilization of Solar RE Resources and Increased Reach to Additional Large Markets



India (Gujarat) – GCC (Oman) Interconnection

HVDC Submarine Cable

Oman is connected to GCC Grid

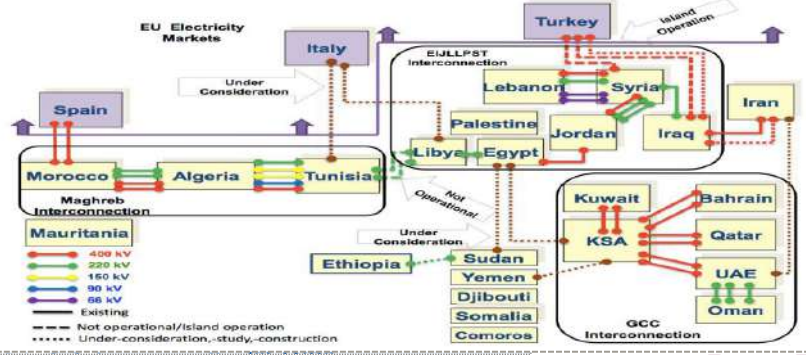
Oman–India transmission 2300 km, of , 1000 km across sea, while the maximum depth 3500 m.

For a 3000 MW GCC-India interconnection via sub-sea cable is estimated to be **3.5 billion US $**

GCC grid plans to connect with **PAEM-Pan-Arab Electricity Market, Maghreb, Mashreq (EIJLLPST)**

A solar park in Egypt can sell excess green peaking power to India (given the 3.5-hour time difference)

Source : Inter-Continental Grid by Pratik Agarwal

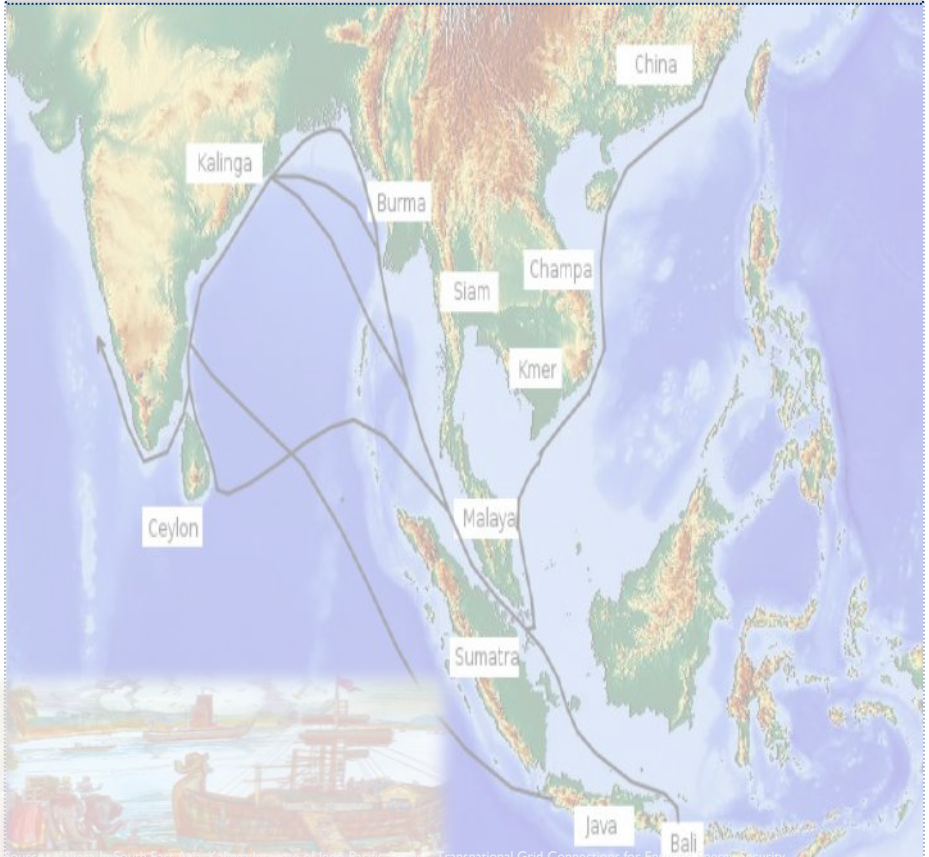


Source : Presentation on Envisioning Trans-Regional Energy Connectivity between the South Asia Region – Southeast Asia Region – Gulf Region – Prospects and Opportunities by Rajiv Ratna Panda

03.7 Transregional Grid Interconnections , Super Grid , OSOWOG- *Solar Diversity , Sun Never Sets*

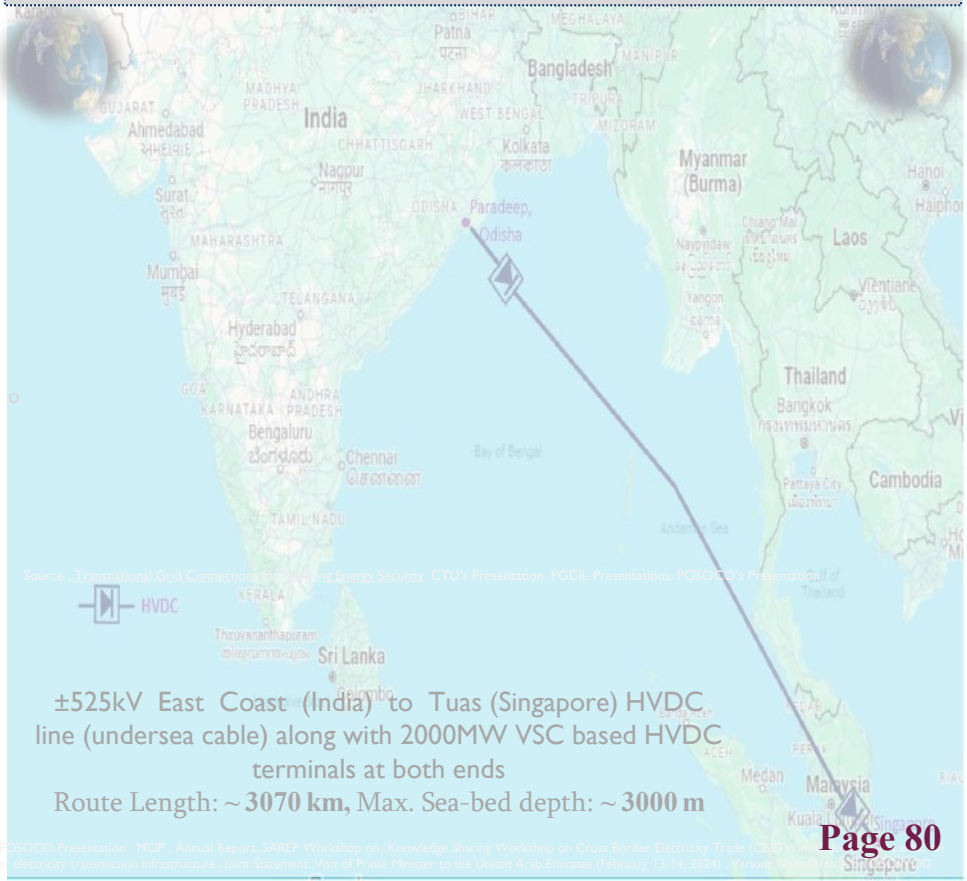
03.7 Super Grid , OSOWOG- Can lead to Reigniting Ancient X Border Trade Integration in Modern terms

Ancient Cross Border Trading Route of Kalinga



Reigniting Ancient X Border Trade Integration in Modern terms

Prospect for India – Singapore Interconnection



±525kV East Coast (India) to Tuas (Singapore) HVDC line (undersea cable) along with 2000MW VSC based HVDC terminals at both ends

Route Length: ~ **3070 km,** Max. Sea-bed depth: ~ **3000 m**

Source : Transnational Grid Connections for Ensuring Energy Security, CTU's Presentation, PGCIL Presentations, POSOCO's Presentation

Source : Kalinga in South East Asia, Kalinga the name of India, Pacific Studies, Transnational Grid Connections for Ensuring Energy Security

Source : Transnational Grid Connections for Ensuring Energy Security, CTU Presentation, POSOCO Presentation, Various Statement by PIB (MOP), India on OSOWOG, POSOCO Presentation , MOP , Annual Report, SAREP Workshop on Knowledge Sharing Workshop on Cross Border Electricity Trade (CBET) Workshop on cross border electricity transmission infrastructure, Joint Statement, Visit of Prime Minister to the United Arab Emirates (February 13-14, 2024) , Various

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04

Summary & Way Forward

for

Transforming Regional Energy Cooperation (REC), CBET and REMs and Regional Electricity Market in South Asia

04 Summary : Actionable Enablers (desirable) for implementing the " 7 Point Framework Strategy for Transforming CBET, Electricity Market Development (*7P-FSCR*) "

Political & Policy

- Regional Long-Term Vision for Regional Electricity Market (REM)
- Political Consensus
- Fostering Power Market Policy Reform
- Developing a suitable Market Model for REM.
- Mainstreaming CBET & REM UNFCC COP dialogues as a solution to Climate Change.

Regulatory

- Permissibility to use intermediary transmission network under open access
- Rules for settlement of imbalance, Ancillary Services
- Rules for Congestion management
- A Robust Electricity Market Monitoring and Surveillance System
- Appropriate Regional Power Market Design

Technical and Commercial

- Harmonisation of grid codes & standards
- Transmission pricing & transit mechanism/charge
- Co-ordinated Regional Generation and Transmission Planning- Regional Energy System Master Plan
- Common Cost sharing principles of cross-border transmission

Institutional and Financial

- Regional Institutional arrangements
- Regional Coordination Forums are desirable
- Regional Dispute Settlement Mechanism
- Regional Electricity Grid Integration Fund

Way Forward : Principle for Transforming Regional Energy Cooperation and Cross Border Electricity Trade and Regional Electricity Market in South Asia

- Accentuate the Harmonization of Policy & Regulatory Framework ***with Consensus*** & Develop ***Common & Shared*** Cross Border Electricity Trade ***Policy & Regulatory Vision*** based on ***Common Principles***.
- Bilateral Trade will continue to play an dominant role. ***Enrich Bilateralism*** with ***Market Feature*** for advancing sustainable bilateral trade. Enhance Market access based on ***Competition & Rule of Market.***
- ***Foster Constructive Multilateralism*** with ***BBIN Regional Pride Project*** for advancing ***Trilateral/Multilateral*** Cross Border Electricity Trade
- ***Spur*** the Development of ***Regional Electricity Market*** with Fair, Transparent Regional Trading Platform by Transcending the ***Principle of Gradualness to Grwothness to Marketness***.
- Accelerate the ***Development*** and ***Strengthening*** the capacity of ***Regional Institution/Platform*** and Developing a ***Regional Funding Facility***-South Asia Regional Electricity Grid Integration Fund (SARGIF).
- ***Develop*** Common understanding and Principle for ***Equitable Sharing/allocation*** of ***Cost & Benefits*** and also the **Burden** of Regional Energy Cooperation, CBET and Regional Market Development for Risk Management.

Thank You

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Disclaimer

The data, information and assumptions (hereinafter 'data-set') used in this document are in good faith and from the source to the best of SAREP (the program) knowledge. The program does not represent or warrant that any data-set used will be error-free or provide specific results. The results and the findings are delivered on "as-is" and "as-available" data-set. All data-set provided are subject to change without notice and vary the outcomes, recommendations, and results. The program disclaims any responsibility for the accuracy or correctness of the data-set. The burden of fitness of the data-set lies completely with the user. In using the data-set data source, timelines, the users and the readers of the report further agree to indemnify, defend, and hold harmless the program and the entities involved for all liability of any nature.

Way forward : Principle (1/2) Transforming Regional Energy Cooperation and Cross Border Electricity Trade in South Asia

Political Consensus and Collective efforts for Realisation of Political Will

{ Translating will into Action }

Building and Sustaining Mutual Trust and Confidence for Regional Energy Security

(Need a shared Regional Vision)

Adequate, Conducive, Harmonisation for Legal, Policy, Regulatory Frameworks

{Desirable to have Power Market Reforms}

Establishing a Vibrant Regional Competitive Power Market

(Free, Fair, Transparent Regional Trading Platform)

Cooperative Sprit with Competition Principle

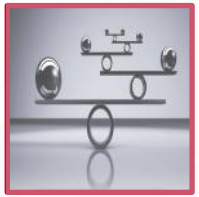
{Level playing field, Enhance Market access based on Competition & Rule of Market }

Managing Policy and Regulatory Risks

(Enhancing Regulatory and Institutional Capacity)

Regional Forums and Networks – RPF, SAFTU, SAFSO, SAFEI, TTF

{Continuous Dialogues & Knowledge Sharing }



Balancing the interest of stakeholders, Reasonable Return on Investments and Tapping into climate finance

{Democratising the benefits and Innovative Financing Mechanism}

Common Pringles for Equitable Sharing of Cost and Benefits Regional Energy Projects

{Setting the Expectation and Risk Management }

A survey comparing centralized and decentralized electricity markets

Table 1
Examples of centralized and decentralized electricity markets.

	Day-ahead	Nodal pricing
US Markets		
PJM	Centralized	Yes
Texas (ERCOT)	Centralized (from 2010)	Yes (GNP)
Midwest ISO (MISO)	Centralized	Yes
California	Centralized (from 2009)	Yes
New England	Centralized	Yes (GNP)
European & International Markets		
Nord Pool	Decentralized	No (zonal)
Great Britain	Decentralized (from 2001)	No (zonal)
Germany	Decentralized	No (zonal)
Ireland	Decentralized (from 2018)	No (zonal)
Spain	Semi-decentralized	No (zonal)
Italy	Semi-decentralized	No (zonal)
NEM, Australia	Decentralized	No (regional)
New Zealand	Decentralized	Yes
Chile	Cost-based	Yes

Table 2
Some issues and potential remedies for centralized day-ahead markets.

Issue	Remedy
Slow market response to updated wind prognoses	Introduce intra-day clearing
Budget imbalanced due to uplift payments	1) Design tariffs to minimize welfare losses, subject to an acceptable welfare distribution. 2) Achieve budget balance by setting market prices sufficiently high so that no plant that is called to produce would make a loss.
Uplift payments give discriminatory pricing, which causes inefficiencies.	1) Restrict offers to have a shape/slope that is similar to the shape/slope of the marginal cost. 2) Avoid discriminatory pricing by setting market prices sufficiently high so that no plant that is called to produce would make a loss.
Non-transparent market and inefficient hedging due to uplift payments.	Avoid uplift payments by setting market prices sufficiently high.
Illiquid financial markets due to nodal pricing.	Use frequent auctions instead of continuous trading in financial markets.

Some issues and potential remedies for decentralized day-ahead markets.

Issue	Remedy
Inefficient allocation of transmission capacity and congestion rents in intra- day market.	Replace continuous trading with frequent auctions in intra-day market
Collusive bidding	Restrict the number of intra-day auctions.
Inefficiencies due to zonal pricing	1) Increase the number of zones, especially for producers. 2) Introduce flow-based zonal pricing 3) Regulate redispatch market Avoid block orders
Complex and non-transparent market	Avoid block orders

Source: A survey comparing centralized and decentralized electricity markets Victor Ahlqvist a, P¨ar Holmberg b,c,d, Thomas Tangerås b,c,d,*

Importance of Cross-Border Energy Cooperation: Nepal's Perspective

Dilli Bahadur Singh (B.Sc. Eng.; M.E.T.M.; P.Eng.)
Hon. Chairman: Electricity Regulatory Commission

Kalutara, Sri Lanka,
1st March, 2024

Introduction

- An **independent regulator** for Nepal's electricity sector established pursuant to **Electricity Regulatory Commission Act, 2017** and **Electricity Regulatory Commission Rules, 2018**, on **9th, May 2019**
- An **autonomous** and **organized regulatory body** to **regulate the electricity sector** and to **maximize the use of the available resources** under the provisions of the Act and Regulation; to **maintain balance between the demand and supply of electricity** by making the generation, transmission, distribution, and or trading of electricity simplified, regular, systematic, and transparent; to **regulate the electricity tariff**; and to **protect the rights and interests of the electricity consumers.**

Major Duties, Responsibilities and Rights of

- To **perform technical management** of electricity sector,
- To **determine electricity consumer tariff** and **power purchase rate of electricity,**
- To **maintain competition** in electricity sector and **protect interests of consumers,**
- To **enhance organizational capacity** of licensees,
- To **resolve disputes,**
- To **make policy suggestions and recommendations to government**,
- To **investigate and inspect,**
- To **provide directions,**
- To **enact byelaws,**
- To **enact directives, standards and codes,**
- To **conduct public hearing,**
- To **impose fine and service charges** and,
- To **review decisions**

Major Accomplishments

1) Regulatory Instruments

- Bylaws on Power Purchase Agreement (PPA) and Conditions to be Followed by Licensees, 2076 (2019)
- Guidelines regarding procedures of meeting of ERC, 2076 (2019)
- Directive relating to determination of consumer tariff, 2076 (2019)
- Directive relating to public issuance of companies related to electricity, 2076 (2020) (Repealed)
- Directive relating to operation of public hearing of ERC, 2076 (2020)
- Directive relating to merger, acquisition, amalgamation, transfer of shares, purchase, and sale of plant, 2077 (2020)
- Directive relating to monitoring and pre-approval for issuance of shares, 2078 (2021)
- Regulatory Road Map of ERC for 5 years (2022)
- ERC Employee Administration Byelaw (submitted to the Ministry of Energy, Water Resources and Irrigation (MoEWRI) and forwarded to the Ministry of Finance for approval)
- ERC Financial Administration Byelaw (submitted to the MoEWRI for seeking approval of the Ministry of Finance)
- Guidelines on the Services, Facilities & Conditions for the members of ERC (submitted to MoEWRI for seeking approval of the Ministry of Finance)
- Common Minimum Grid Code for South Asia (Actively participated during preparation by South Asian Forum For Infrastructure Regulations, SAFIR).
- **Nepal Electricity Grid Code, 2080 (2023)**
- **Key Performance Indicators Manual 2080 (2023)**
- **Consumer Protection Directives 2080 (2023)**

Cont…

2) Consumer Tariff

- Pursuant to Consumer Electricity Tariff Determination Directive, 2019, ERC has determined consumer electricity tariff of Nepal Electricity Authority (NEA) consumers for Fiscal Years 2019/20 and 2021/22.
- ERC determined the tariff such that consumer tariff was reduced **by an average of 9% and 1.04% in FY 2019/20 and FY 2021/22** respectively.
- ERC also decided to **waive energy charge** for all marginalized electricity consumers consuming up to **10 units** of electricity by using energy meter of **5 Ampere** capacity, through the tariff order for **FY 2019/20** and followed up with a decision to **waive energy charge** for all marginalized electricity consumers consuming up to **20 units** of electricity through the tariff order for **FY 2021/22**.
- This reduction on tariff and waiver of energy charges for certain consumers such as **irrigation**, was aimed at promoting consumption of electricity within the nation and promoting the **agriculture sector.**
- FY 2019/20 onwards, ERC **removed the redundant provision of providing uninterrupted electricity supply through dedicated** and **trunk line system**, even during the load shedding period to specific Industrial, Commercial and non-Commercial consumers by charging premium tariff of **65% extra.**
- Through tariff order for FY 2019/20, **ERC reduced the tariff of off-peak hours** for Industrial consumers, to encourage them to consume more electricity in the off-peak hours.
- Since **FY 2021/22, Seasonal tariff has been introduced for domestic consumers (three-phase)** with relatively lower tariff during wet season to encourage them towards more consumption.

Cont…

3) Determination of Power Purchase Rates and Consent on PPA Agreement

- ERC provided consent to the Power Purchase Agreement of **154** projects as of Feb 12, 2024,
- ERC also provided timely approvals for the **amendment of Power Purchase Agreement to 490** projects as of Feb 12, 2024,
- In FY 2020/21, for the first time ERC determined Power Purchase Rate for a power project more than **100 MW** installed capacity, with its tariff to be subject to downward revision if the **ROE** of the project exceeds **17%.** Power Purchase Rate for other **seven power plants above 100 MW** were determined till to-date.
- In this way, ERC has been ensuring that the addition of installed capacity is continued by balancing the need for adequate return of investors and the desire of people to receive electricity at affordable price.

Cont…

4) Drafting of Regulatory Instruments

- Software **Development for E-filing System** of: (i) **Initial Public Offering** & **Right Share Offering** (ii) **Sale and Purchase of Shares and Change in Shareholding Structure** (iii) Approval of **Power Purchase Rates & Agreement** and their Amendment.
- **Open Access Guidelines**
- **Dispute Resolution Byelaw**
- Bylaws on Internal Conduct of Business
- Directives on Transmission Tariff **(Wheeling Charge)**
- ERC Internal **Control System**
- Directives on determination of generation tariff of **brownfield hydropower projects** and PPA
- Bylaws on Utilization of ERC Fund
- Regulatory Accounting System
- Directives on determination of **Solar Tariff**
- Regulatory Information Management System
- Technical standards of Utility
- Directives on Generation Tariff of Hydropower Projects
- **Development of Distribution code** etc.

Cont…

5) Approval on Petitions/Applications

S. N.	Particulars	FY 2019/20 and 2020/21 Combined	FY 2021/22	FY 2022/23	Current FY (till 12 Feb 2024)	Total
1	Pre-approvals relating to issuance of initial public offering and right shares offering	24	18	34	25	101
2	Pre-approvals for changes in shareholding structures	56	21	22	13	112
3	Determination of Power Purchase rates and granting consent to P.P.Agreement	28	25	61	40	154
4	Consent on amendment of PPA	56	153	220	61	490
5	Approvals provided to transfer of ownership, acquisition/merger and takeover	8	8	4	2	22
6	Approvals on share purchase and	0	10	32	10	52

As of **Feb 12, 2024**, ERC finalized a total of **946** decisions including **931** petitions/applications and is regulatory instruments.

6) Others

- Played a key role in coordinating with the Nepal Rastra Bank **(Central Bank)** and the MoEWRI for providing **refinancing facility at the rate of 3% interest rate for sick hydropower projects**, not being able to pay-off their bank interest from the production of electricity by their hydropower plants.
- Change in the clause of Power Purchase Agreement between NEA and Independent Power Producers (IPPs) regarding the **availability declaration of energy from 1 month to 1 week and reduced the clause of cent percent penalty to 5 %** based on not being able to meet the availability declaration due to adverse changes in hydrology, for the hydropower projects less or equal to 10 MW. Till today **60 companies** have benefitted due to this facility.
- Offered multiple level of inputs to the draft of ***"Common Minimum Grid Code for South Asia"*** prepared by **South Asian Forum for Infrastructure Regulation (SAFIR)** for power trading in SA region.
- Provided comments on Report of *Study on '**South Asia Energy/Electricity Regulations to develop Regulatory Road Map for Electricity/Energy Exchange and Energy Cooperation (EC) among South Asian Countries**'* prepared by SARI/EI.
- Provided comments on Report of ***Study on transition from bilateral to trilateral and multilateral power trade in South Asia*** prepared by SARI/EI.

Nepal's Stance on Cross-Border Electricity

- **Hydropower Policy, 2000** aimed to develop hydroelectricity as an **exportable commodity**,
- **Energy Development RoadMap and Action Plan 2080**, issued by MoEWRI targeted to **export up to 15,000 MW of electricity to India and Bangladesh by 2035,**
- Nepal's electricity **import decreased from 21.82 billion Rupees in 2020/21 to 15.46 billion Rupees in 2021/22**, signalling a shift towards becoming a **net exporter** of electricity,
- Nepal's earnings from electricity constituted the third-largest export earnings from a single commodity in FY 2021/22,
- The **Butwal-Gorakhpur Cross-Border Transmission Line progress indicates increased interconnection and energy cooperation between Nepal and India,**
- Nepal seeks **further regional interconnection and energy cooperation, with discussions between Nepal and Bangladesh showing potential progress in energy collaboration,**
- Nepal aims to supply **electricity to Bangladesh** through India, with initial interest in purchasing **40 MW** of electricity expressed by Bangladesh,

Way Forward

- ERC has already finalized the **Nepal Electricity Grid Code, 2023**, making provisions for development of transmission lines up to 765 kV,
- ERC will be determining **Wheeling Charge** and **Transmission Charges** along with developing **Open Access Guidelines** in near future. However, for this the Act should be allow or related Policy should be formulated by the GoN,

Status of Power Trade in South Asian Region

- Significant increase in CBET in the SA region, particularly in BBIN subregion, in the past decade,
- CBET capacity surged from **1,400 MW in 2012 to 3,900 MW in 2022[1]**,
- Trading of **17,700 GWh of electricity between June 2022 and July 2023[2]**,
  - ✓ Nepal-India – **2,950 GWh**
  - ✓ Bhutan-India – **6,150 GWh**
  - ✓ Bangladesh-India – **8,670 GWh**
- Power trade in the region projected to reach around **43.8 GW by 2040[3]**.

Challenges and Opportunities

- Current electricity trades are **exclusively bilateral,**
- **Lack of adequate electricity transmission infrastructure** has impeded achieving expected levels of electricity trade and realizing possibilities for multilateral trade,
- The scale of cross-border power trade in the BBIN region depends significantly on the advancement and growth of transmission line infrastructure,
- **Regional cooperation is essential for the strategic development of transmission infrastructure through tripartite and multilateral mechanisms** to ensure the success of cross-border power trade within the BBIN region.

3. Future Course of

Three mechanisms have been proposed to enhance the regional cooperation on electricity trade in the South Asian region/ BBIN subregion

A. Construction of a Dedicated Transmission Line from Nepal to Bangladesh and other BBIN countries,
B. Construction of transmission hub and pooling stations in BBIN subregion (Rahamu, South of Siliguri or Tetuliya, Bangladesh) and
C. Establishment and full operationalization of South Asian Power Pool

Proposal 1: Construction of Dedicated Transmission Line from Nepal to Bangladesh and other BBIN countries

- Absence of direct territorial connection between Nepal and Bangladesh necessitates power trade between the two nations **through the national grid of India**. However, for **trading larger quantum** of electricity, **India needs to build separate high voltage transmission lines** only for **catering power trade between Nepal and Bangladesh**. Hence, **construction of a dedicated line from Nepal to Bangladesh will address this issue.**
- An **Underground Dedicated 765 kV Transmission Line/ Cable may be constructed** in Indian territory,
- Implementation of a **multi-circuit Underground Dedicated 765 kV Transmission Line/Cable** can facilitate transmission of larger quantum of electricity between the two countries,

Cont.…

- Direct transmission from Nepal's Bhadrapur substation to Tetuliya in Bangladesh without overloading on India's system,
- Installation of **a 26 km long** underground transmission line required,
- Initial design of the transmission line as a **765 kV double circuit** with provisions for **future upgrades** and **additional circuits,**
- Eliminates the need for India to upgrade its system for electricity trade between Nepal and Bangladesh,
- Construction of the transmission line underground to mitigate environmental, demographic, social, economic, and structural impacts on India,

Cont.…

Figure 1: Probable diagram of Dedicated Transmission Line between Nepal and Bangladesh (As per Google Maps)

- Requires negotiations with India **to permit** the use of its land and facilitate the construction of the infrastructure,
- For the construction of dedicated line from Nepal to Bangladesh, ERC chairman had a **meeting with Energy Advisor to PM of Bangladesh, Mr. Tofiq-e-Elahi Choudhary** during BBIN meeting in 2021. Mr. Choudhary was very much convinced and he assured to convince the PM of Bangladesh on this matter. Due to this initiation, Nepal Government has received a **letter regarding a tripartite negotiation** between Bangladesh, Nepal and India with regards to building the transmission line.
- Agreement outlining terms for Nepal and Bangladesh to **bear construction cost** on Indian territory **(approx. 50%:50%)** and **pay specified royalty to India** for using its territory for the transmission line construction and operation.

Proposal 2: Construction of transmission hub and pooling stations in BBIN subregion

- A Regional Electricity Transmission hub in BBIN region can facilitate regional trading of electricity generated in Bangladesh, Nepal, Bhutan and northeastern provinces of India (Sikkim and West Bengal) and mainland India,
- The hub can link proposed national and regional pooling stations,
- Two alternative locations are proposed:
  1. South of Banglabandh in Bangladesh or
  2. Rahamu area, situated southwest of Phulbari under Siliguri Sub-division in West Bengal, India.

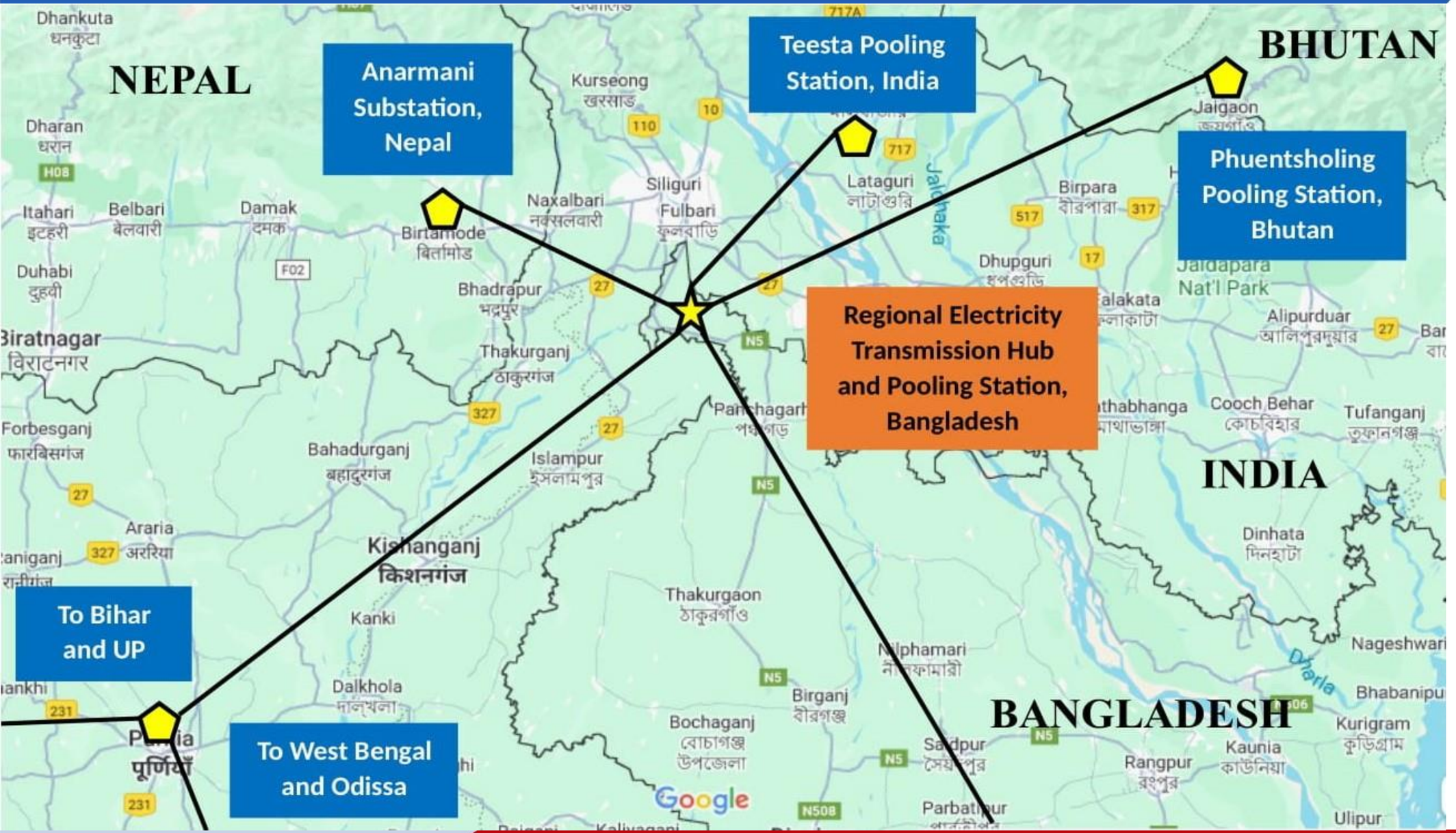


Figure 2:

(Alternative-1) Probable Diagram of Regional Transmission Line Hub and Pooling Station at Banglabandh, Bangladesh

(As per Google Maps)

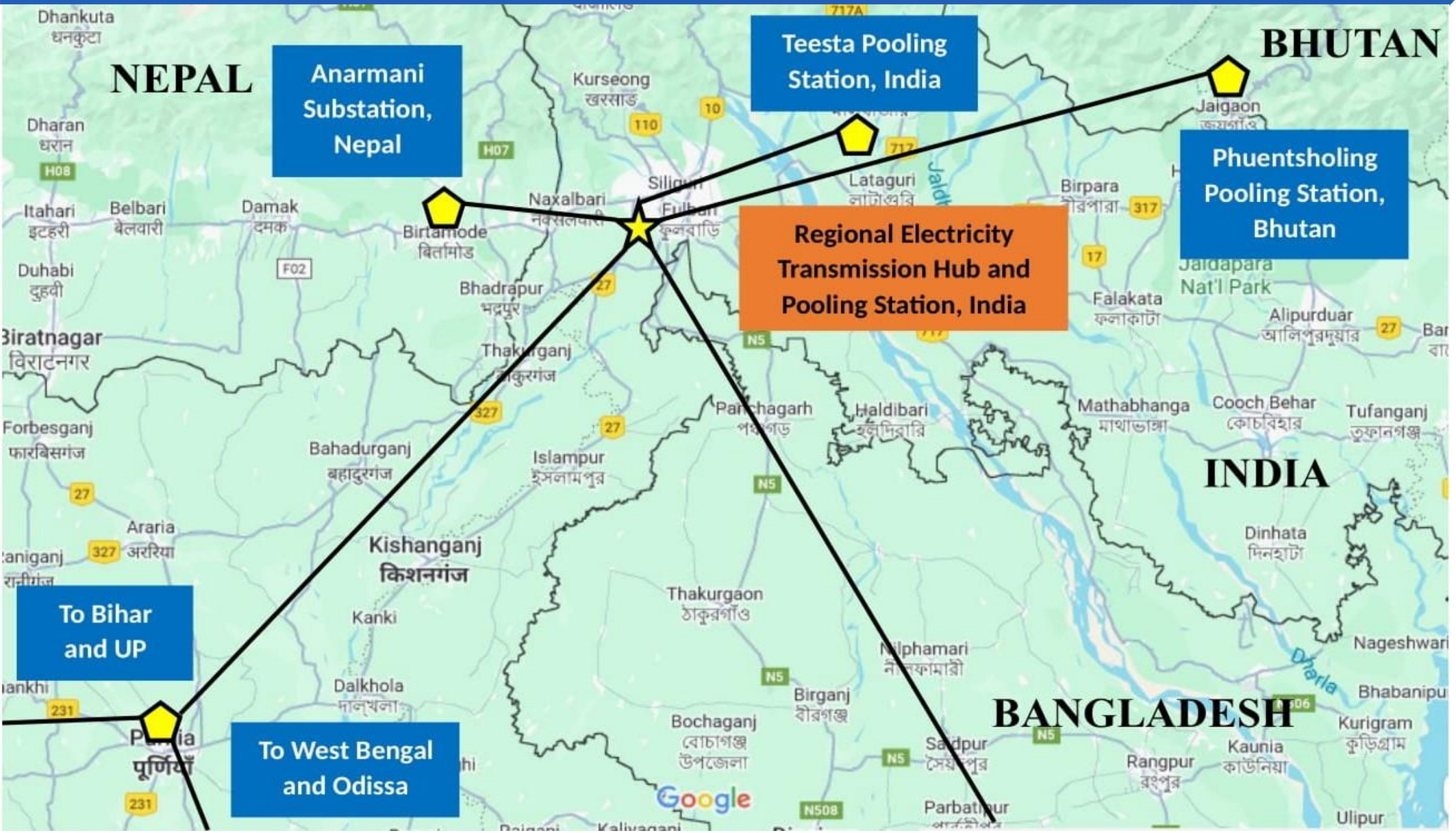


Figure 3:

(Alternative-2) Probable Diagram of Regional Transmission Line Hub and Pooling Stations at Rahamu area, south-west of Phulbari, West Bengal, India

(As per Google Maps)

Proposal 3: Construction and Operation of South Asian Power Pool

- Successfully implemented **power pools** in **North America, South America, Europe, Africa, Eastern Asia, and Western Asia,**
- **South Asian region lagging** behind necessitates the South Asian Power Pool,
- Can function as **autonomous electricity market** for **free and fair buying/selling of electricity** in South Asia,
- Mechanisms include Day-Ahead Market, Real Time/Spot Market, Ancillary Services, Renewable Energy Certificates, etc.
- Potential for favourable pricing for **green energy** from **Nepal and Bhutan** due to demand for clean energy in **India and Bangladesh,**
- **In the dry season**, **Nepal, Bhutan and north east region of India may need to import** electricity from **Bangladesh and India** as the production drops to only **25-30%** in dry season.

4. Justification

- Huge Hydropower Potential in Bhutan, India and Nepal
  - ✓ Exploitable Hydropower Capacity in North-East India – 66,065 MW [4]
  - ✓ Gross Hydropower Potential of Koshi Province, Nepal – 22,619 MW [5]
  - ✓ Potential Installed Generating Capacity of Bhutan by 2030 – 37,000 MW [6]

  Total Hydropower Potential in the area = 125,684 MW
- 4,687 MW in operation and 5,740 MW in construction in North-East India
- 459 MW in operation and 2,877.69 MW in construction in Koshi Province, Nepal
- 2,334 MW in operation and 2,338 MW in construction in Bhutan (overall)
- A total of **7,480 MW in operation** and **10,955.69 MW under construction** in the region

5. Cost Sharing

- Company established via **MoU** among participating countries,
- **Investment sourced from sale of shares to participating countries**; share allocation determined through negotiations,
- Potential for **securing loans from development partners** or financial institutions,
- **Board of Directors** composed of representatives appointed by each **country's Ministry of Energy,**
- Revenue generated from wheeling charges on constructed infrastructure,
- **Profit dividends distributed** among participating countries based on their share proportions,
- **Unprecedented consensus required at highest political, technical, financial and administrative levels.**

6.

All the SA countries benefit enormously from these arrangements for attaining socio-economic benefit, energy security, attaining the overall goal of "Net-Zero"; carbon neutral region & increasing harmonization in SA region as:

A. Economic Benefits

- Research study "Economic benefits of Nepal-India electricity trade" projects Nepal's potential electricity **exports to be worth NPR 246 billion to 310 billion by 2030**,
- Another report suggests **Bhutan could generate 157 billion Ngultrum by 2030**[7] through rapid hydropower project development,
- **Implementation of systems in Bangladesh, Bhutan, Nepal, and eastern India could reduce costs per unit generated by 5.4%, according to a separate study.** Energy **cost savings could increase by 1.1% if these systems operate under an independent system controller**[8].

B. Environmental Benefits

- **India** has committed to achieving **net-zero carbon emissions by 2070**,
- **Bangladesh** in process of establishing a target for **net-zero emissions by 2070** ,
- Shift towards hydropower expected to phase out old and less efficient thermal power plants in India and Bangladesh, known for significant air pollution,
- Utilizing hydropower from neighbouring countries could help **India reduce cumulated CO_2 emissions over the period 2012-2045 by about 3.5-3.6 gigatons[9],**
- Carbon emissions negatively impact lives, development, and growth in the region, making regional electricity trade crucial for emissions reduction and eventual achievement of **"net zero" in South Asia**.

Regional Interconnection

- Plans of Grid Interconnection of India with Sri Lanka and Maldives through undersea cables are being made,
- India plans to connect its grid with Saudi Arabia through 1,600 km long undersea cables from Mundra Port in Gujrat to Saudi Arabia's coastal city of Fujairah
- India also plans of constructing undersea transmission lines to Singapore through Andaman/ Nicobar island,

Long Term Vision

One Sun One World One Grid (OSOWOG)

- Currently led by the **International Solar Alliance,**
- Aims to connect more than **100 countries** through a "common grid"
- The vision behind the plan is that in essence "**the sun never sets**" as it is always a constant at some or the other geographical location at any given point of time. The aim of the initiative is to generate round the clock electricity from the sun, **as it sets in one part of the world, it rises in the other part**
- OSOWOG is expected to be implemented in a phased manner and is divided into three main phases:
  Phase 1: Interconnection of Indian Grid with grids in **South Asia**, South-East Asia and Middle East
  Phase 2: Interconnection of the functional first phase to the pool of renewable resources in **Africa (through Egypt)**
  Phase 3: Interconnection with other regions (This could begin with interconnection to **European Grid through Turkey**)

.

References

[1] https://sarepenergy.net/wp-content/uploads/2023/08/SAFIR-SAREP-Conference-Proceeding-2023-Deepening- Cross-Border-Electricity-Trade-Regional-Electricity-Market-Development-for-Sustainable-Energy-in-South- Asia.pdf

[2] https://sarepenergy.net/wp-content/uploads/2023/08/SAFIR-SAREP-Conference-Proceeding-2023-Deepening- Cross-Border-Electricity-Trade-Regional-Electricity-Market-Development-for-Sustainable-Energy-in-South- Asia.pdf

[3] https://posoco.in/reports/monthly-reports/

[4] https://pdf.usaid.gov/pdf_docs/Pnada888.pdf

[5] http://wecs.gov.np/storage/listies/February2021/final-report-july-2019-on-hydropower-potential.pdf

[6] https://openjicareport.jica.go.jp/pdf/12326856_01.pdf

[7] https://sarepenergy.net/wp-content/uploads/2022/07/Impact-of-Cross-Border-Electricity-Trade-on-Bhutan.pdf

[8] https://www.nrel.gov/docs/fy19osti/72066.pdf

[9] https://irade.org/Executive%20Summary-Economic%20Benefits%20from%20Nepal-India%20Electricity%20Trade-SARI-EI-IRADe-Bajiv.pdf

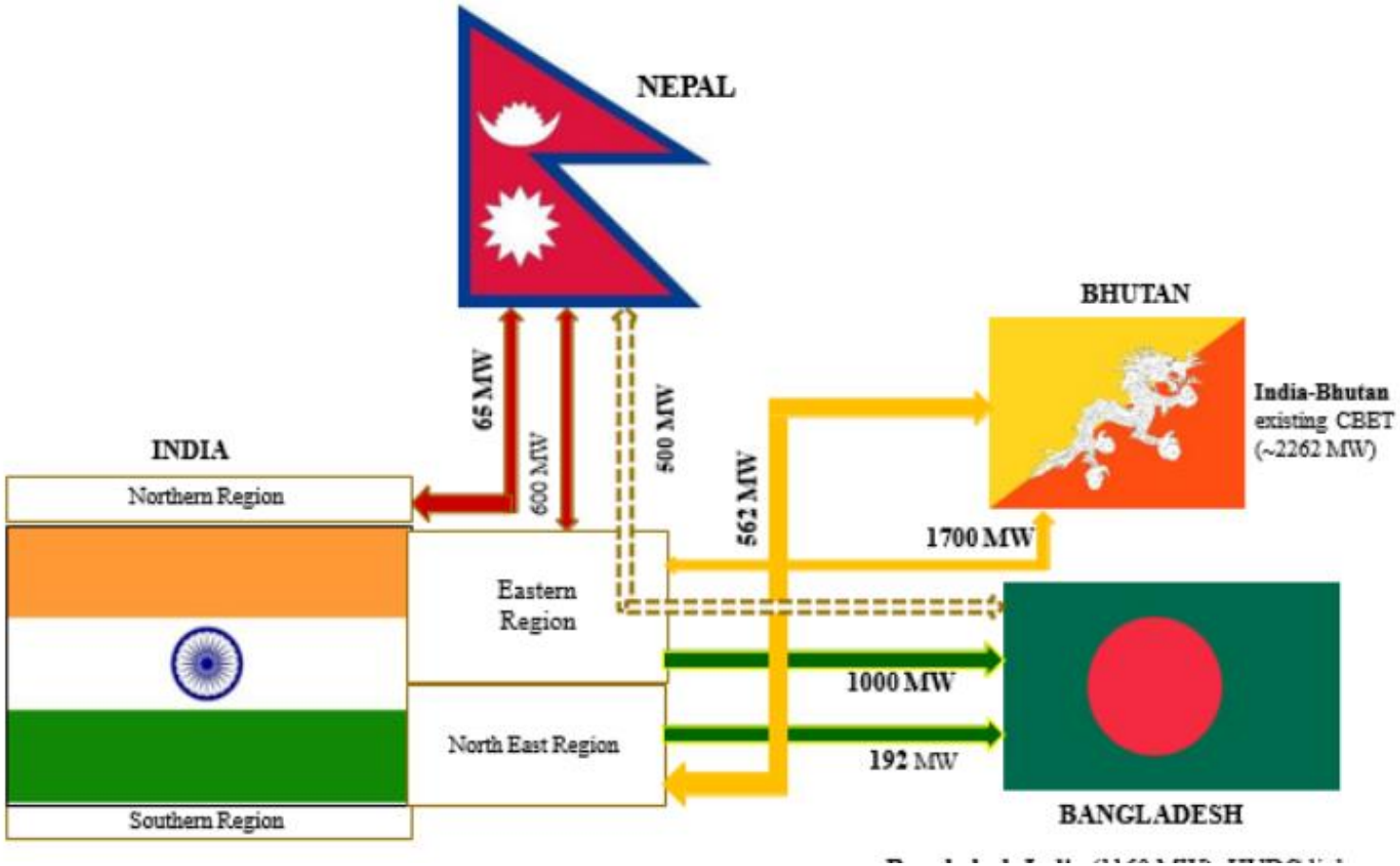
THANK YOU!!

Cross Border Transmission Interconnections

Kanchana Siriwardena
Public Utilities Commission of Sri Lanka

2nd March 2024

Existing Connections > 4,000 MW



Under Construction / Committed

(> 5,000 MW)

- Bhutan – India 2,220 MW
- Bangladesh - India 1,000 MW
- Nepal – India 1,800 MW
- Nepal - Bangladesh 500 MW

Primary Sources of traded Electricity

- Bhutan and Nepal to India – Hydro during better hydro periods
- India to Bangladesh - Coal
- India to Bhutan and Nepal - mainly Coal ?

- Overall India is a net Exporter of Coal power?

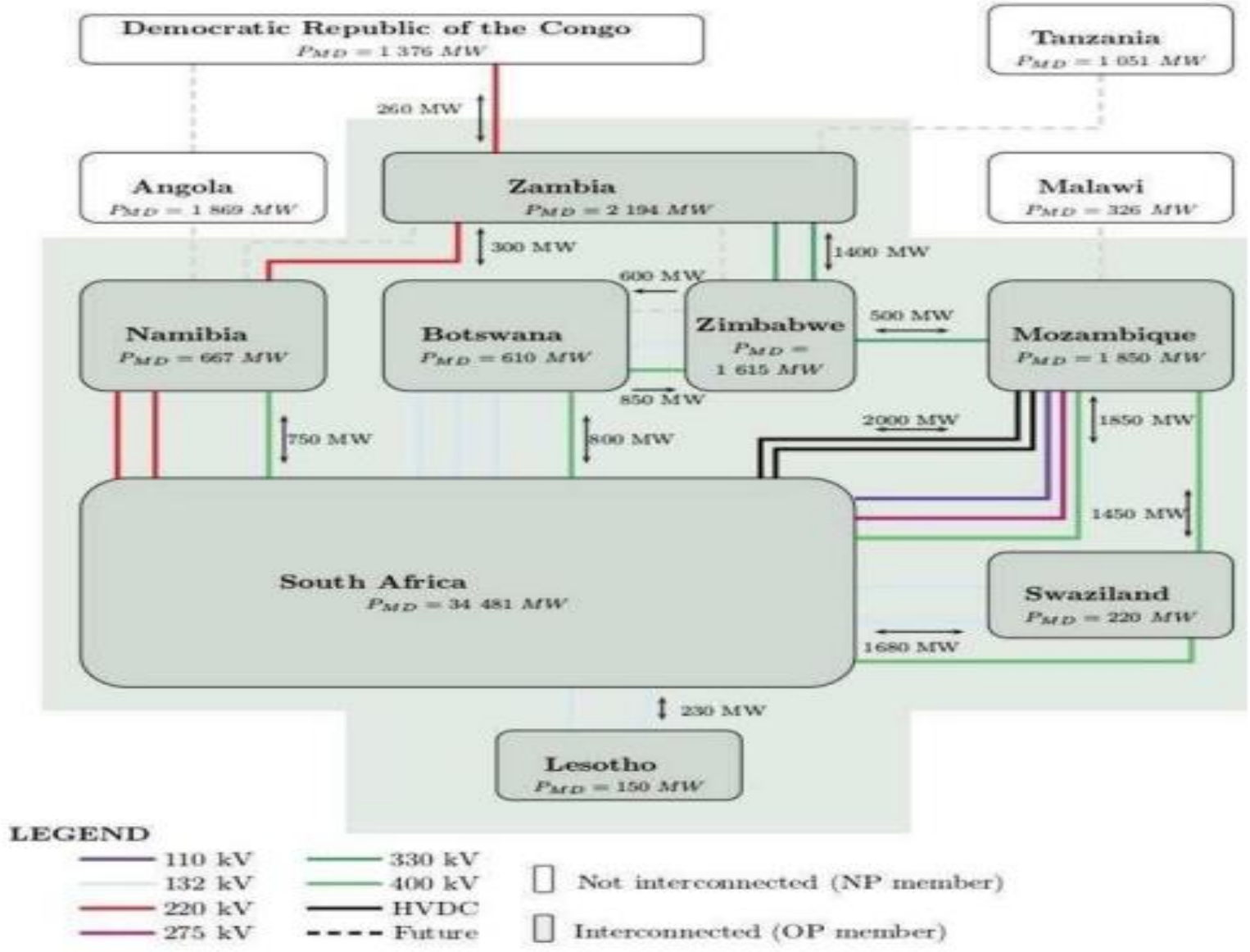
Why Interconnect?

- Resource Optimization
  - Investment optimization – integrated regional resource planning
  - Weather/ seasonal resource utilization
  - Cost advantage
- Energy Security
  - Lower reliance on imports as a region
  - 24/7 availability
  - Affordability and price stability
  - System reliability
- Environmental Benefits
  - Higher efficiency of thermal plants and thus lower emissions
  - Accelerated development of RE

Need to address concerns against CBT

- Sovereignty concerns
- Grid mismatch
- Regional Regulation and Governance
- Size of Investment

SAPP


Democratic Republic of the Congo
P_{MD} = 1 375 MW
Tanzania
P_{MD} = 1 051 MW
260 MW
Angola
P_{MD} = 1 869 MW
Zambia
P_{MD} = 2 194 MW
Malawi
P_{MD} = 326 MW
300 MW
1400 MW
600 MW
Namibia
P_{MD} = 667 MW
Botswana
P_{MD} = 610 MW
Zimbabwe
P_{MD} = 1 615 MW
500 MW
Mozambique
P_{MD} = 1 850 MW
850 MW
2000 MW
1850 MW
750 MW
800 MW
1450 MW
South Africa
P_{MD} = 34 481 MW
Swaziland
P_{MD} = 220 MW
1680 MW
230 MW
Lesotho
P_{MD} = 150 MW
LEGEND
110 kV
132 kV
220 kV
275 kV
330 kV
400 kV
HVDC
Future
Not interconnected (NP member)
Interconnected (OP member)

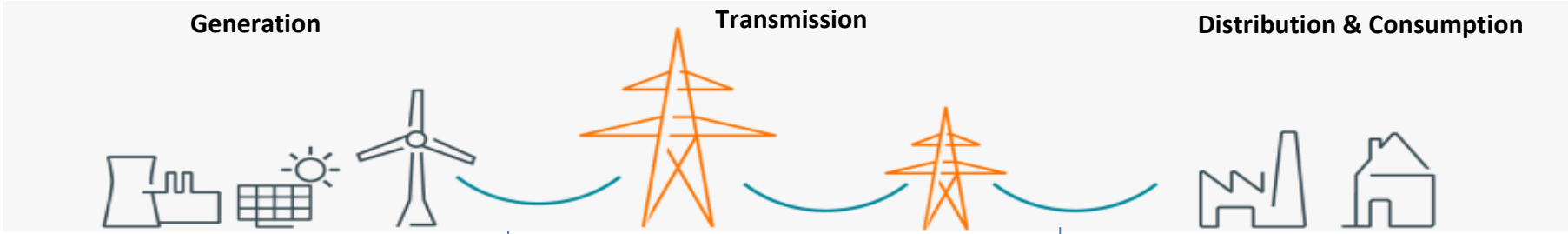
Thank You

Role of Power Market - Cross Border Trade

2nd March, 2024

Rohit Bajaj
Executive Director
Indian Energy Exchange Ltd

Electricity Value Chain



Energy Transition

Installed Capacity	As on 31st Dec'23	FY 2030 CEA Proj.
Total GW	428	817
Fossil Cap GW	240	267
Coal (%)	56	32.7
RE & Hydro GW	188	506
RE & Hydro %	43	61.9
Upcoming Coal Cap GW (in next 3 Yrs)	27 GW	-

50% Non-fossil fuel based Capacity by 2030

World's largest network

- Inter-reg. trans. Cap.: 112.3 GW
- 4.72 Lakh CKM of trans. Lines (FY'25)
- Green Corridor: RE rich states; projects for evacuation of RE into National grid
- 99.9% times no congestion

One Nation One Grid One Price

Reforms Underway

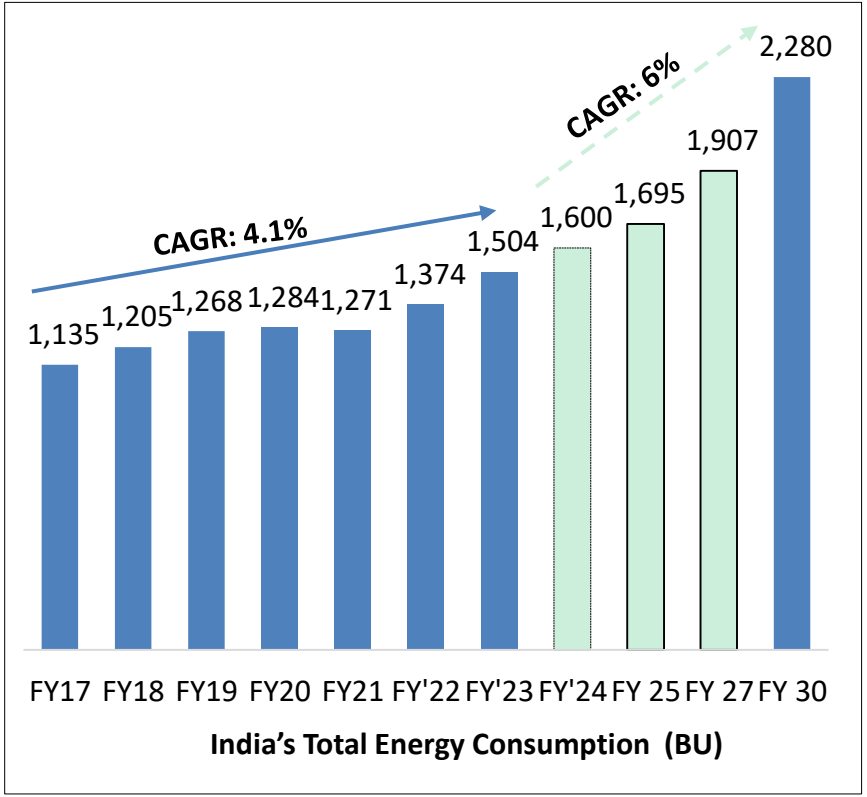
- **Avg. AT & C Losses**: FY'21 – 22.3%; FY'22 – 16.4%; Have declined to 15.4% for FY23
- Providing Choice to Consumers
- Smart Metering, 24x7 power
- Electrification as Decarbonization Lever: EV, Cooking, Traction

Regulatory Strengthening

Electricity Growth Drivers

India is placed as the most promising economy on the global map

- **Industrialization**
  - ✓ High GDP growth of about 7% expected to drive electricity
  - ✓ Core sector, traction, EV, cooking will drive electricity consumption
- **Rapid urbanization/ Rural Electrification**
  - ✓ 17 out of 20 of world's fastest growing cities in India
- **Consumer demand growth**
  - ✓ Last mile connectivity – Power on 24x7 basis
  - ✓ FY23 energy consumption growth 9% YoY
- **Power Demand Projection for FY 23-30**
  - ✓ FY 23 onwards – CEA demand growth projections
  - ✓ FY 25 CEA Peak Demand Projection – 256 GW
  - ✓ Expected to grow at CAGR of 6%

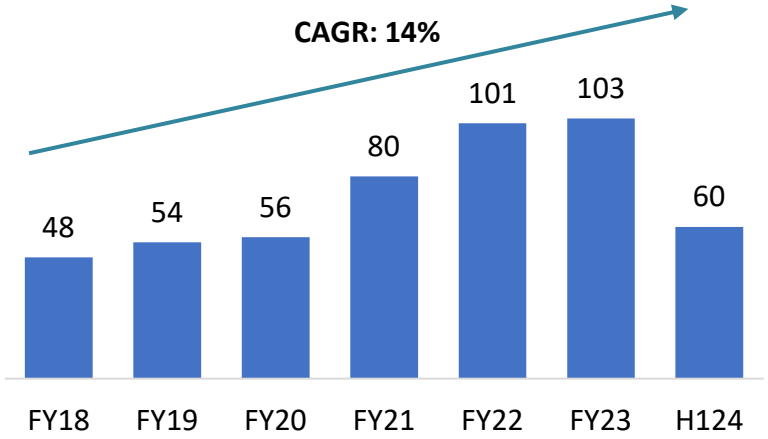


Electricity Market Construct

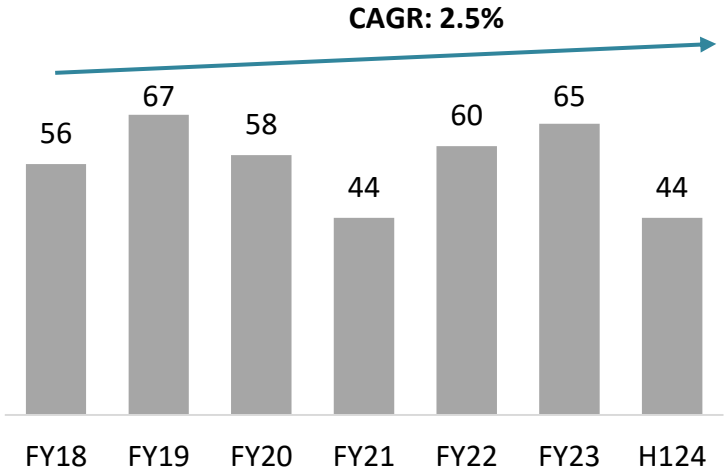
Long-Term (86%)	Short-Term (14%)		
Total Power Consumption FY'23: 1,504 BU			
Up to 25 years	Bilateral: Less than 1 year	Exchanges: Real Time (1hour) – 90 days	DSM
86%	5%	**7%**	2%
Long-term PPA	Bilateral & Banking Transactions	Day Ahead Market, Real Time, Intraday, Contingency, Term Ahead up to 90 days, GTAM, GDAM, High-Price DAM, High-Price TAM and Certificates	Deviation Settlement/ Unscheduled Interchange

Exchange Markets are growing fast

Exchanges (BU)



Bilatéral (BU)



Driven by competition and flexible procurement, the Exchange markets constitute >50% of ST power market.

India's premier technology-led energy marketplace

- Nation wide, automated and transparent trading platform for physical delivery of electricity, renewables & certificates
- Commenced operations in 2008; CERC regulated
- Publicly listed company – 2017 (NSE and BSE)
- ISO 9001:2015, ISO 27001:2013, ISO 14001:2015
- **IEX is on the Board of Association of Power Exchanges (APEx) where 40 Global exchanges are members**
- **IEX has diversified into Gas Exchange (IGX)**
- **IEX is member of 13 State Regulatory Commission advisory committees.**

Robust Ecosystem

7500+
Registered participants

4500+
Commercial & Industries

1500+
RE Generators & Obligated Entities

600+
Generators

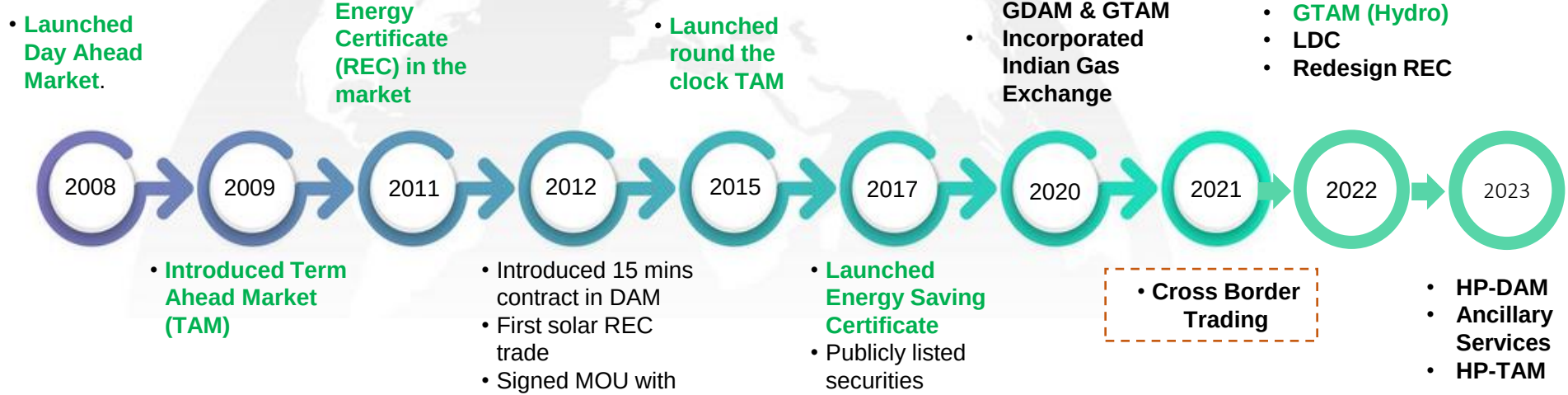
55+
Discoms (all)

100+
ESCert Entities

15+
Cross Border Entities

Leading the future of energy with innovation and technology

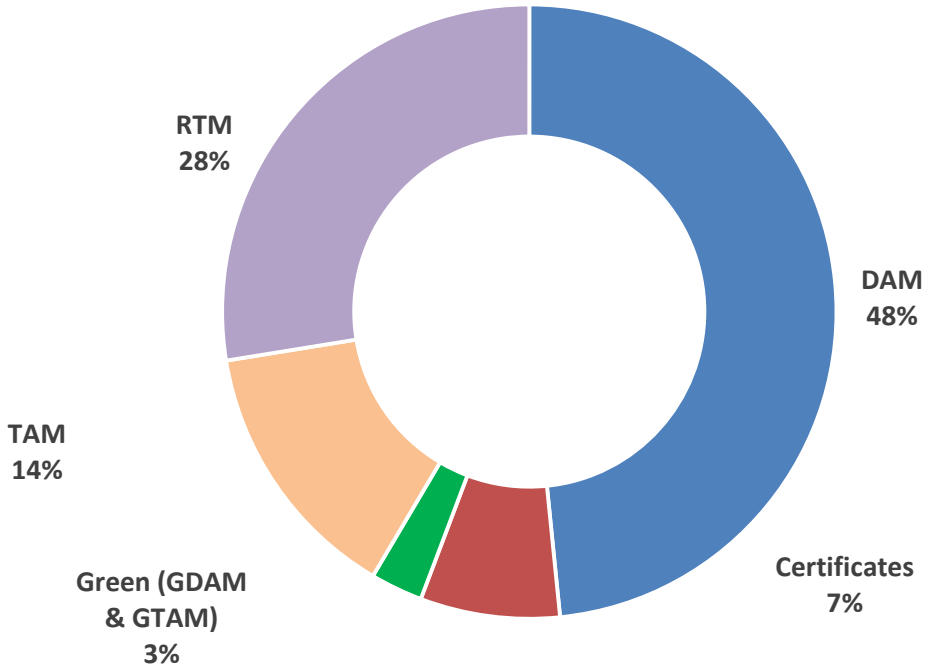
IEX Over the Years – Journey of innovation basis the market



Existing Products & Auction Mechanism

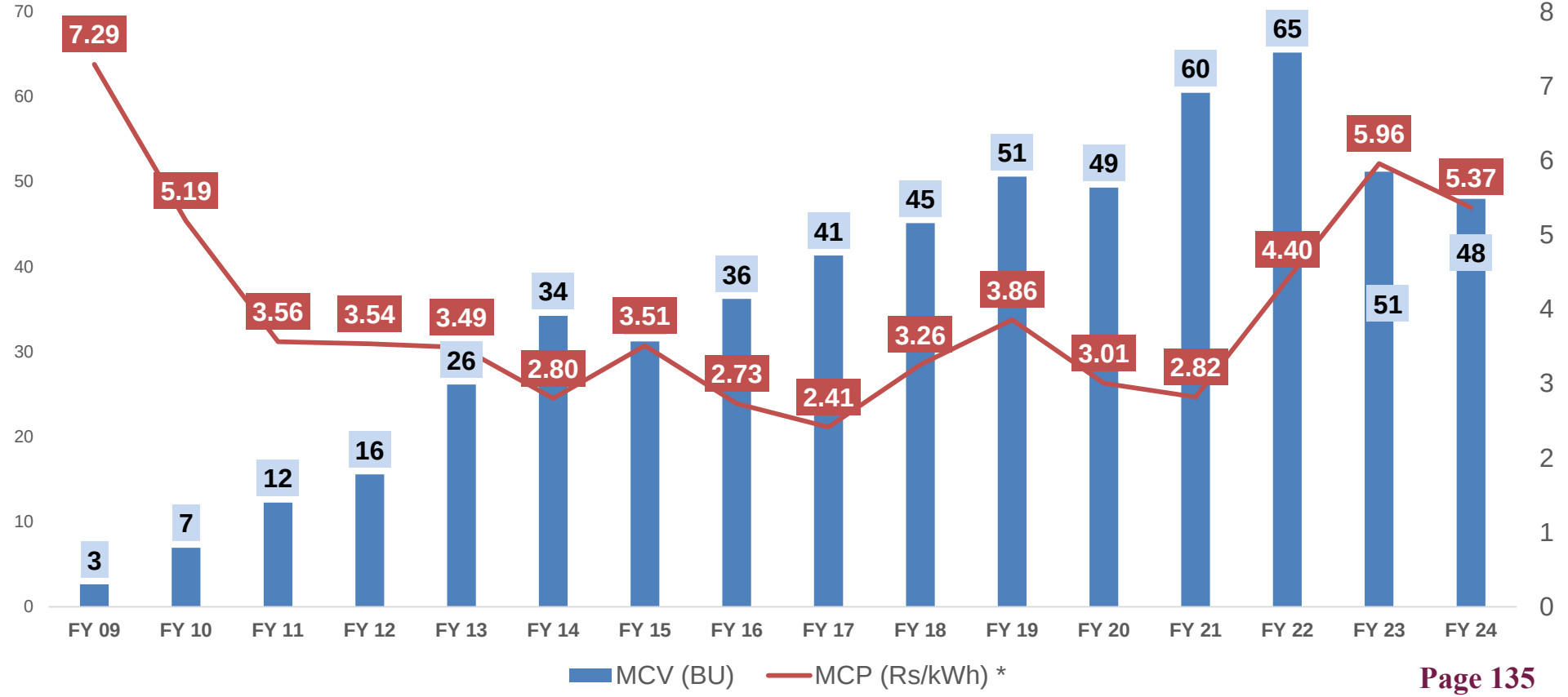
- Integrated DAM - *Closed double sided auction*
  - **G-DAM**
  - DAM (includes Cross Border Trade)
  - High Price DAM
- Real-Time Market (RTM) - *Closed double sided auction*
- Intraday Market (Conv., HP ITD & **Green**) – *Continuous matching*
- Day Ahead Contingency (Conv., HP DAC & **Green**) – *Continuous matching*
- TAM, HP-TAM & **Green TAM** **(up to 3 Months)**
  - Daily, Weekly, Monthly – *Uniform price step auction*
  - Any Day Single-Sided Contract (Conv. & **Green**) – *Reverse auction*
- Tertiary Reserve Ancillary Services (TRAS): AS-DAM & AS-RTM
- **Certificates: RECs & ESCerts** – *Closed double sided auction*

IEX Product Mix (till Jan’24)

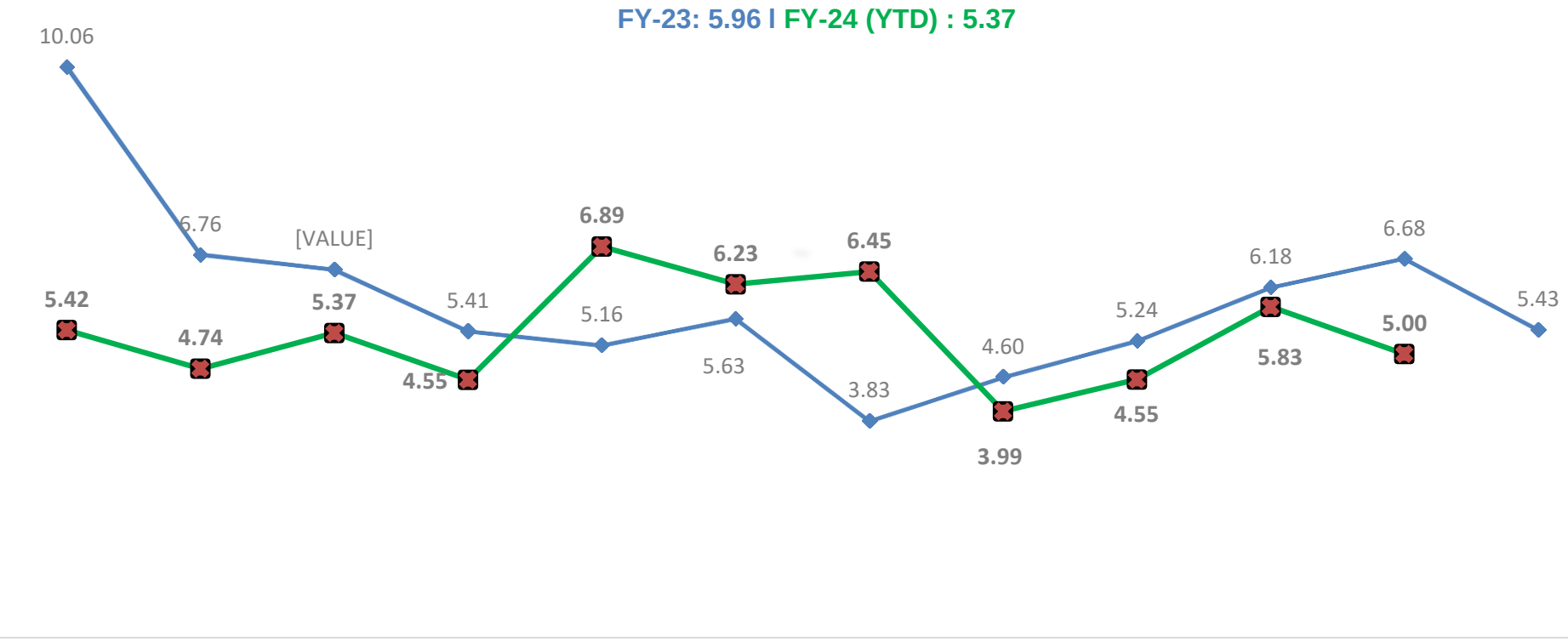


Total Volume: 91 BU

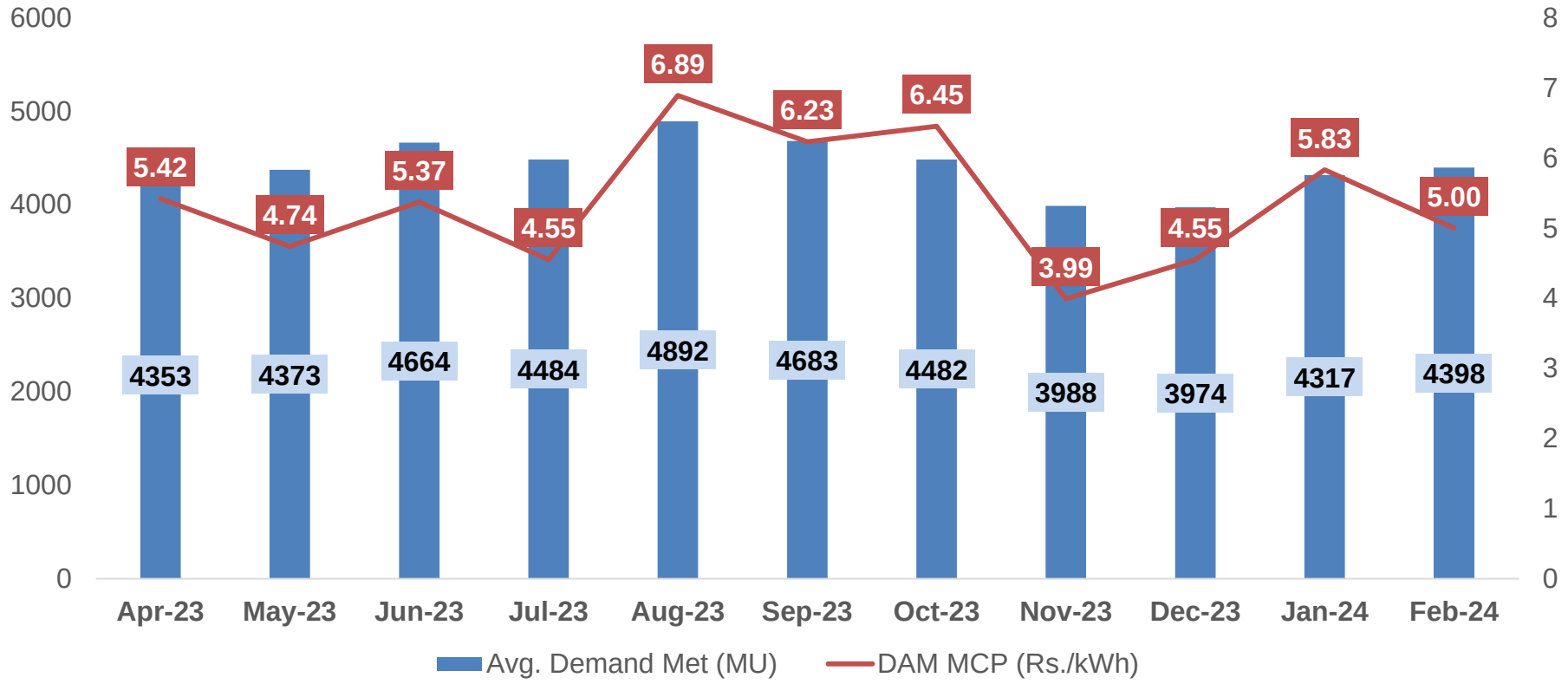
Yearly DAM Snapshot



Price Trends (Rs./kWh) at DAM



Variation of Demand and MCP – FY 24*



Country faces lower demand in winter and accordingly lower prices are discovered on Exchanges

CBET Overview

Leveraging of Cross Border Trade through Power Market

- ✓ In 2018, the Ministry of Power (GoI) issued comprehensive Guidelines for Import/Export (Cross Border) of Electricity. These guidelines aimed to enhance transparency, consistency, and predictability in regulatory approaches across jurisdictions for CBET.
- ✓ The Central Electricity Regulatory Commission (CERC) established the CERC (CBET) Regulations, 2019.
- ✓ The Central Electricity Authority (CEA) notified the Procedure for Approval and Facilitating Import/Export by Designated Authority (DA).
- ✓ In 2021, Procedure for approval and facilitating Import/Export (Cross Border) of Electricity by the DA.
- ✓ In 2023 CERC Amendment to procedure to enable Cross Border Entities to participate in RTM

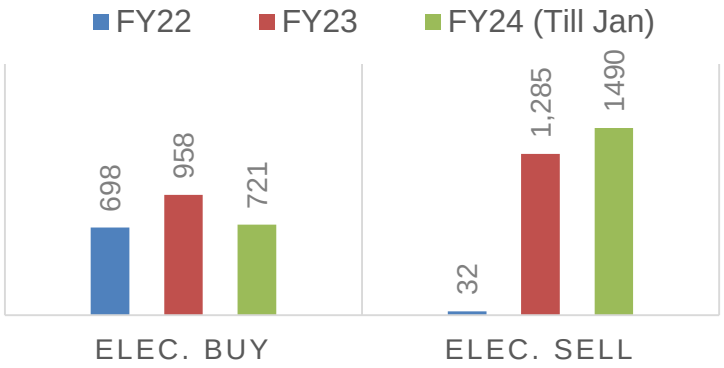
- Optimum Utilization of resources of the South Asian Regions
- Fostering Economic Growth and Regional Integration
- Making use of seasonal demand and supply
- Harnessing Renewable Energy
- Low Per capita electricity consumption
- Facilitating access to electricity and quality supply to all

Prerequisites for a Competitive Electricity Market

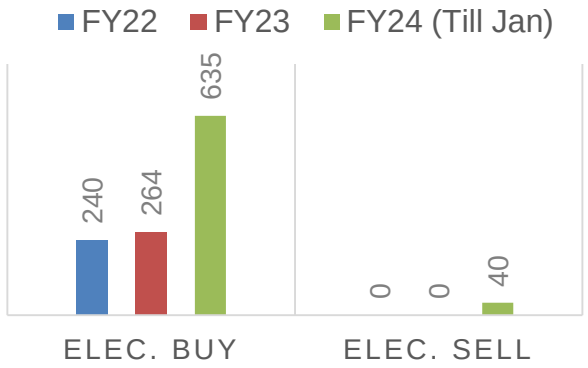
Unbundling of Utilities	• Separation of Vertically integrated utilities, transmission should be separated from generation & supply
Multi Buyer Model	• Choice to consumers to buy & generator to sell to any entity
System operator	• ISO: To maintain grid security and reliability, transmission allocation
Open Access	• Open Access in Transmission & Distribution Network
Imbalance Settlement Mechanism	• Deviation or Imbalance settlement mechanism to ensure discipline
Trading	• Recognizing trading as a distinct activity
Autonomous Regulator	• To overlook the working of the Market

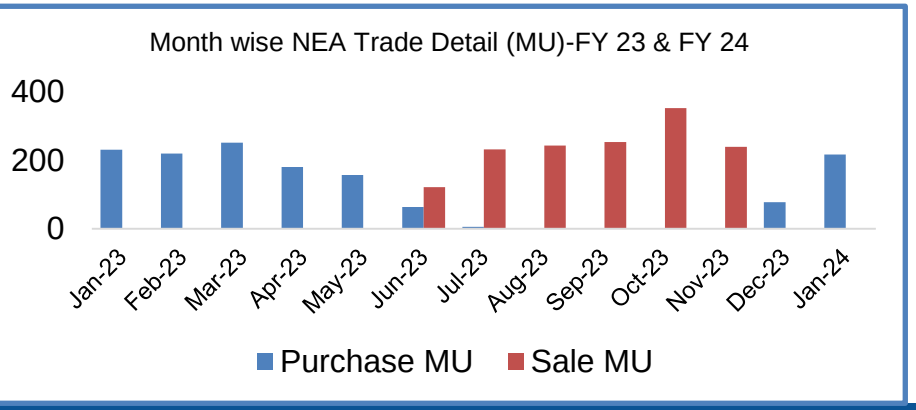
CBET Highlights

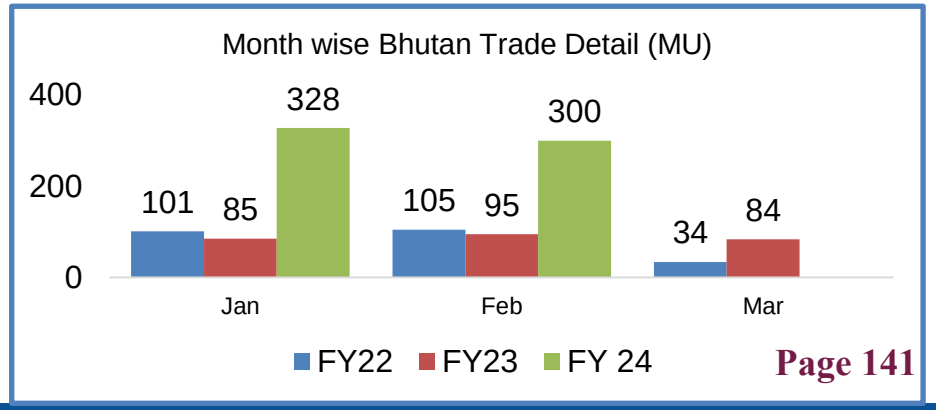
Nepal Electricity Snapshot (MUs)



Bhutan Electricity Snapshot (MUs)







Regional Electricity Market Development - Way Forward

- Interconnections Capacity posses a bottleneck. Capacity addition considering Long Term requirement
- Move from Bilateral Power Trade to a Harmonized Regional Power Market – Competition, Flexibility
- Capacity Building – System Optimization, Determining Priority Dispatch, RE integration
- Capacity Building - Regulatory Mechanisms to Incentivize Flexibility, Integrate Energy Storage
- Enabling provisions for open access, eligibility criteria for connectivity along with open access charges
- Effort to increase spot market participation – essential for Energy transition

Future Opportunities

Future Market Opportunities

New Products	➢ IEX planning to introduce TAM Contracts up-to 11 months, petition has been file in Nov'23 ➢ RE capacity through exchanges; Contract for Differences; Deepen Ancillary Market ➢ Derivatives will provide price hedging opportunity and lead to lower volatility in prices thereby increasing liquidity in the spot market ➢ Capacity Market
Contracts for Difference (CfDs)	➢ CfD model beneficial for RE generators, provides long-term stable price to mitigate project development and finance risks ➢ Under market-based CfD mechanism for RE, power traded and scheduled at PXs at market prices ➢ If discovered market price > strike price, generator pays difference to pool maintained by Government entity. If market price < strike price, pool pays difference to generator
P2P Trading	➢ P2P trading of electricity is emerging in different parts of the world due to increasing number of Prosumers ➢ IEX through its MoU Partners ISGF & Power Ledger, Australia has been jointly exploring P2P opportunities in various states.

Launch of IEX Academy; Price Index - PowerX

- ✓ Launched in June to create pool of skilled professionals for capacity building in the power market
- ✓ Customized certification courses to develop skills and expertise in Electricity Markets across topics such as power sector policies, regulatory frameworks, and power exchange operations
- ✓ Courses designed based on in-house experience of IEX, and in collaboration with academic institutions and think tanks.

- ✓ Launched IEX Power Price Index – 'PowerX' – India's first Electricity Price Index.
- ✓ Provides competitive benchmark signals and enable market participants to make more effective decisions.
- ✓ Calculated based on weighted average price of Day-Ahead Market and Real-Time Market.

IEX Cross Border Interactions & Commitments

Organised a “**Capacity Building Workshop”** in Bhutan

Interactive session in Nepal at “**BIMSTEC Energy Forum**”

Organised a Knowledge sharing Study tour to Berlin, Germany with Stakeholder & Market Participant

Participated in “**Power Summit 23”** Shared view on RE & CBET Integration

Thank you

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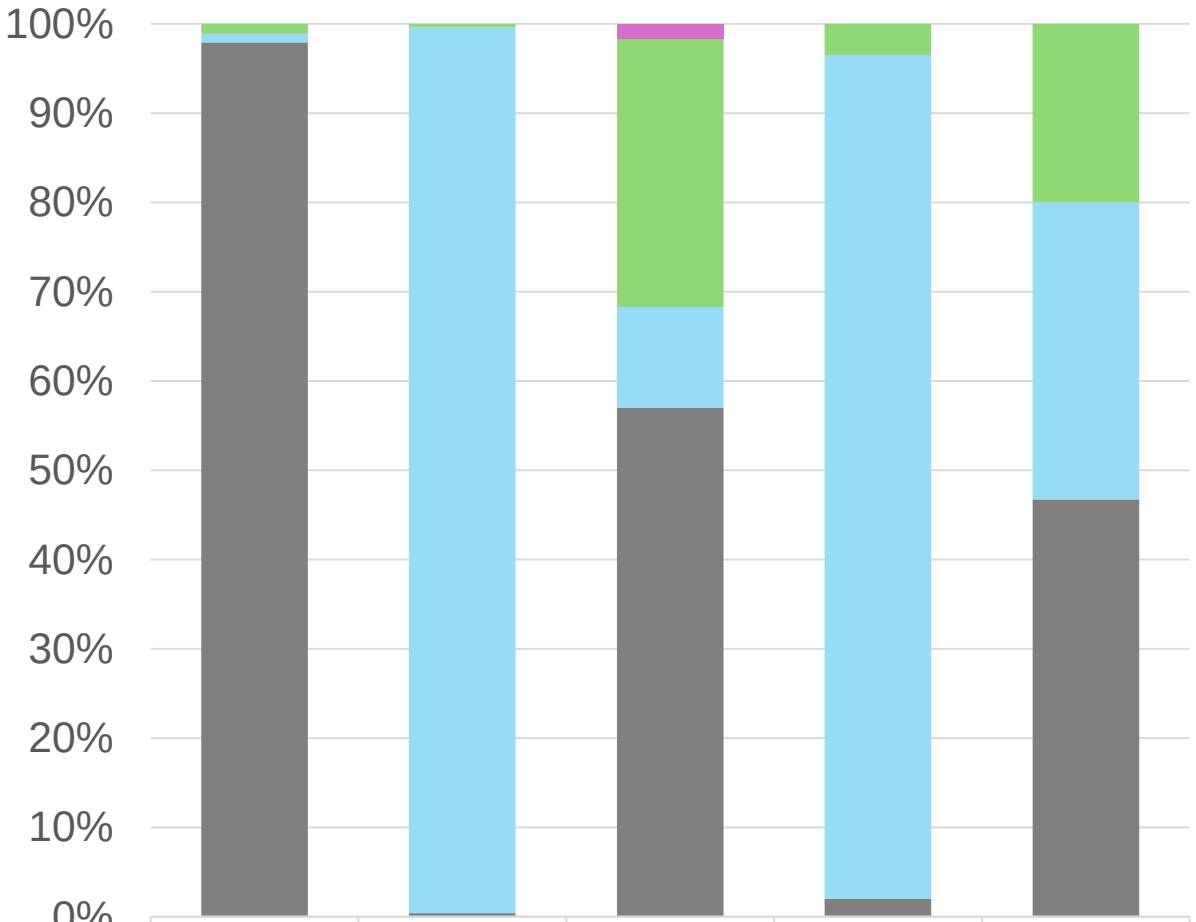
Role of Transmission Interconnection as Facilitator of cross border Electricity Trade

DILIP ROZEKAR
Executive Director (International Business),
POWERGRID India

Imperatives for Cross-Border Trade – South Asian Region

- Diverse Generation and Demand Characteristics
- Climate Concerns
- Changing Generation Landscape – High RE Penetration
- Growing Economy - Affordability of Power Supply

Generation Mix in the South Asian Countries



	Bangladesh	Bhutan	India	Nepal	SriLanka
Nuclear	0.00	0	6780	0.00	0.00
RES other than Hydro	259	8.7	1,25,159.81	92.94	844
Hydro	230	2,326	46,850.17	2,533.73	1,409
Thermal	23,262	9	2,37,268.91	53.41	1,978
Total	23,751	2,344	4,16,060	2,680	4,231

- Nepal and Bhutan are predominantly hydro-dominated and will continue to be so in the near future.
- India is Coal dominated but by 2030 the penetration of RES shall overtake by a large margin.
- Bangladesh is dominated by gas-based generation, with minimal hydro or RES generation; As gas reserves are finite alternate sources necessary for sustainable power supply.
- Sri Lanka presently has a balanced thermal, hydro and RES; but its hydro resources are almost entirely harnessed – No Coal Generation in the future.

Source: South Asia Energy Database

Climate Concerns

South Asia is the most vulnerable to the climate change than any other part of the World

- **In the GLOBAL CLIMATE RISK INDEX 2021, published by the NGO German Watch, entire region is found to be vulernable in terms of its risk to climate change.**
  - **Prolonged and Intense monsoon in one part of the country while some parts faced severe drought conditions**
  - **Flash floods lead to land slides, damage to human lives and property.**
  - **Numerous Tropical Cyclones**
  - **Faster melting of the Himalayas**
- **Catastrophes like**
  - **Rising sea levels**
  - **Changes in Temperature and weather patterns**

Responsible Nations are self imposing targets to Mitigate these changes

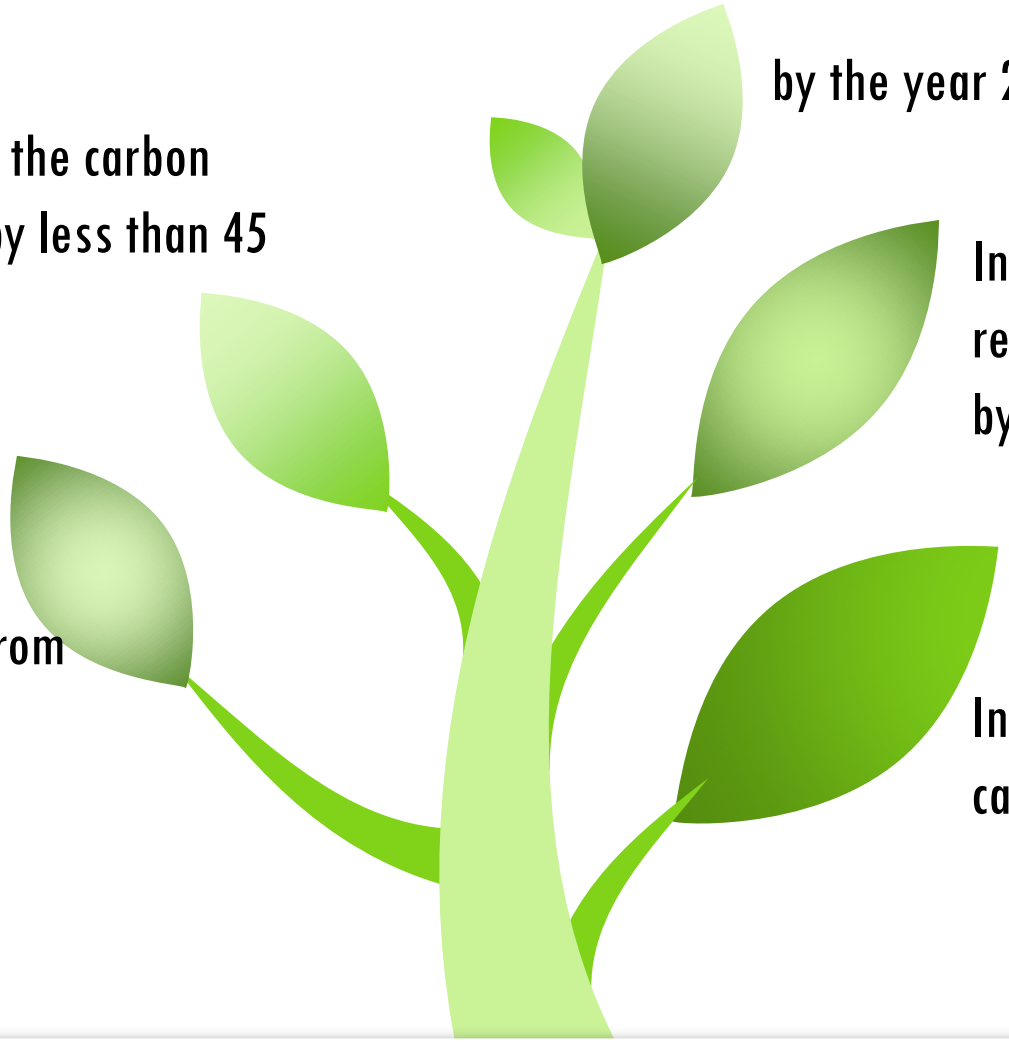
Indian Commitment to Address Climate Change Challenges

by the year 2070, India will achieve the target of Net Zero.

By 2030, India will reduce the carbon intensity of its economy by less than 45 percent.

India will meet 50% of its energy requirements from renewable energy by 2030

Reduce total projected carbon emissions by one Bn tonnes from 2021 onwards till 2030

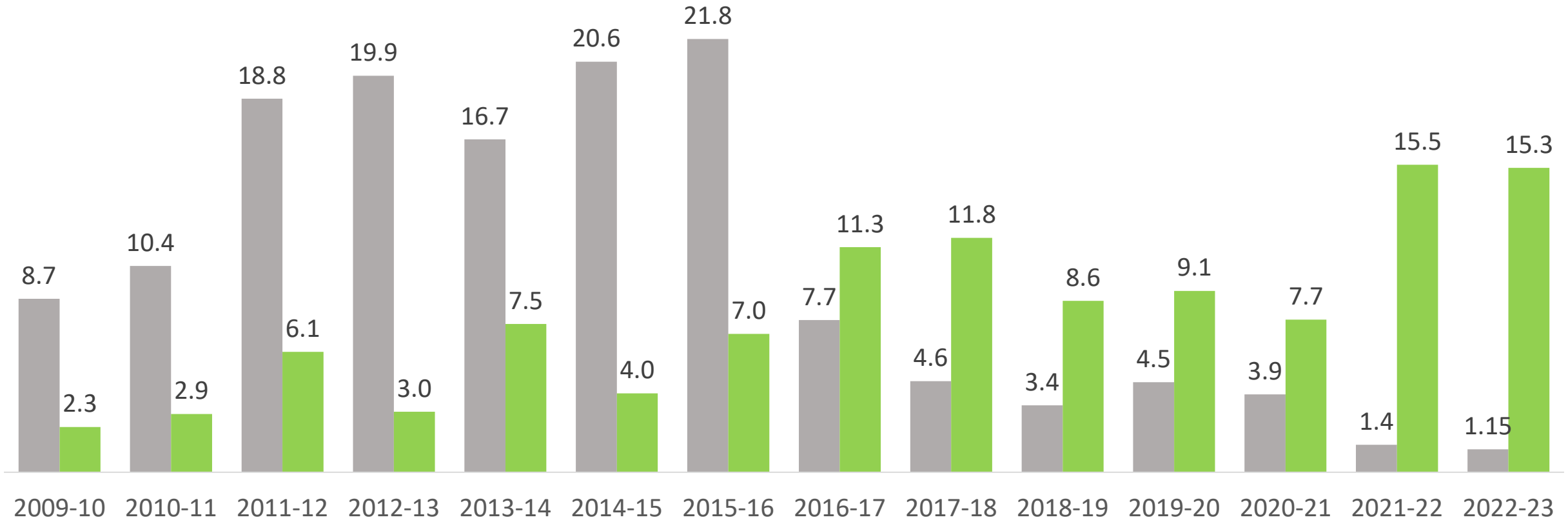


India will reach its non-fossil energy capacity to 500 GW by 2030

Panchamrit (Nectar elements) Proposed by India at COP26 to serve future Power System

Changing Generation Landscape

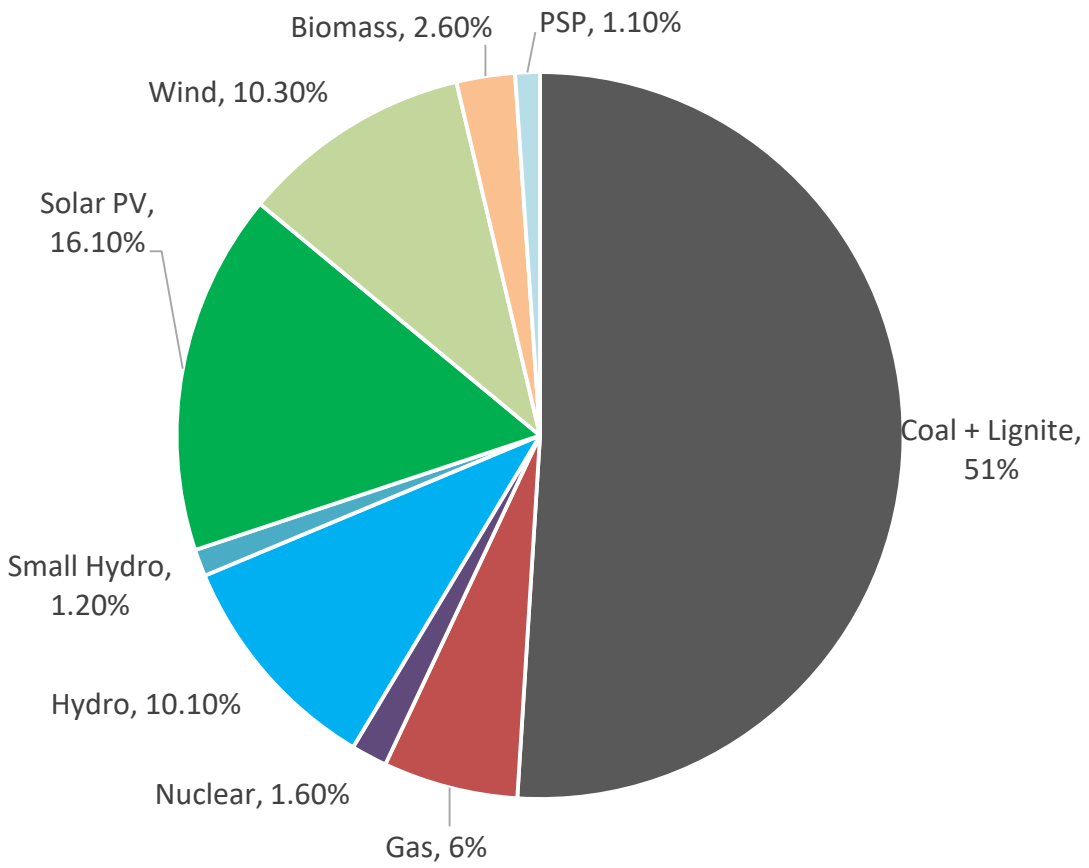
	Thermal	RE	Total	RE Penetration
2009-10	102,450	15,520	159,400	9.7%
2022-23	237,110	111,000	417,600	26.5%



Source: CEA Reports

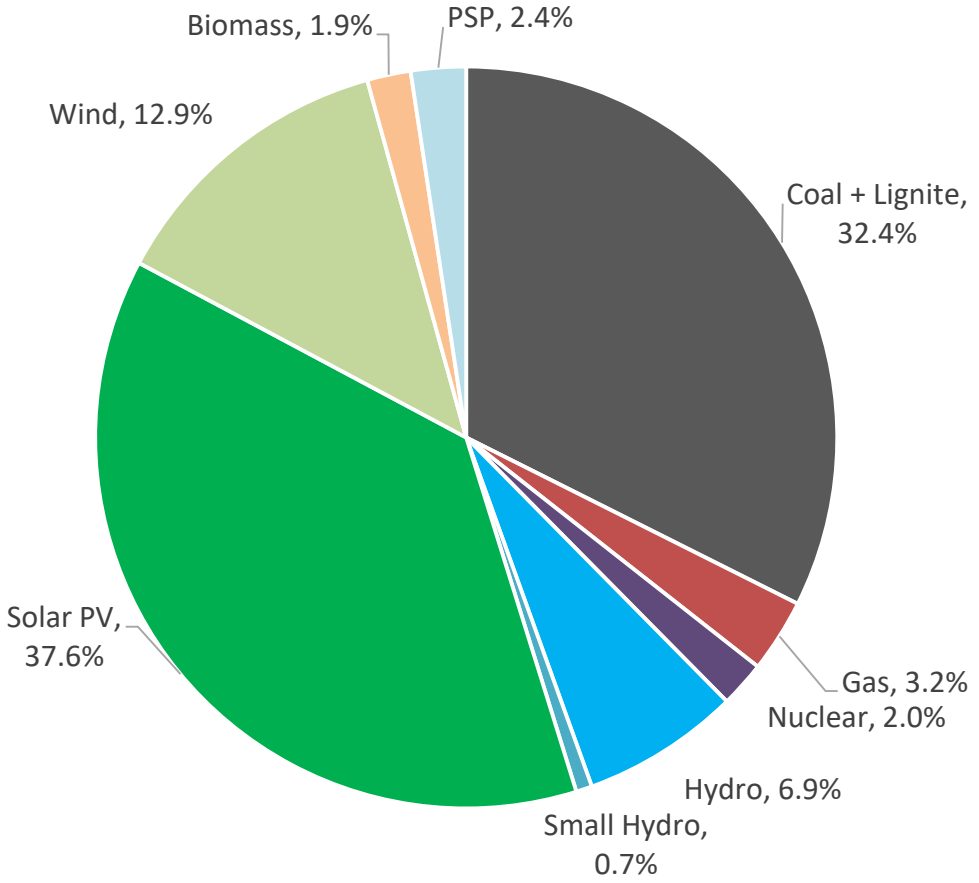
Changing Generation Landscape

FY 2022-23



Total Installed Capacity: 416 GW

FY 2029-30



Total Installed Capacity : 777 GW

Role of Transmission System

- Vital Element in entire Electricity Supply Chain
- An enabler for movement of electricity from distant generation resources to load centers
- Facilitates seamless integration of Renewable Resources
- Enables non-discriminatory and Competitive Electricity Market
- Lack of Transmission or Constraints Distort Market
- Facilitates Optimal Utilisation of Energy Resources

Trends in Cross Border Transactions

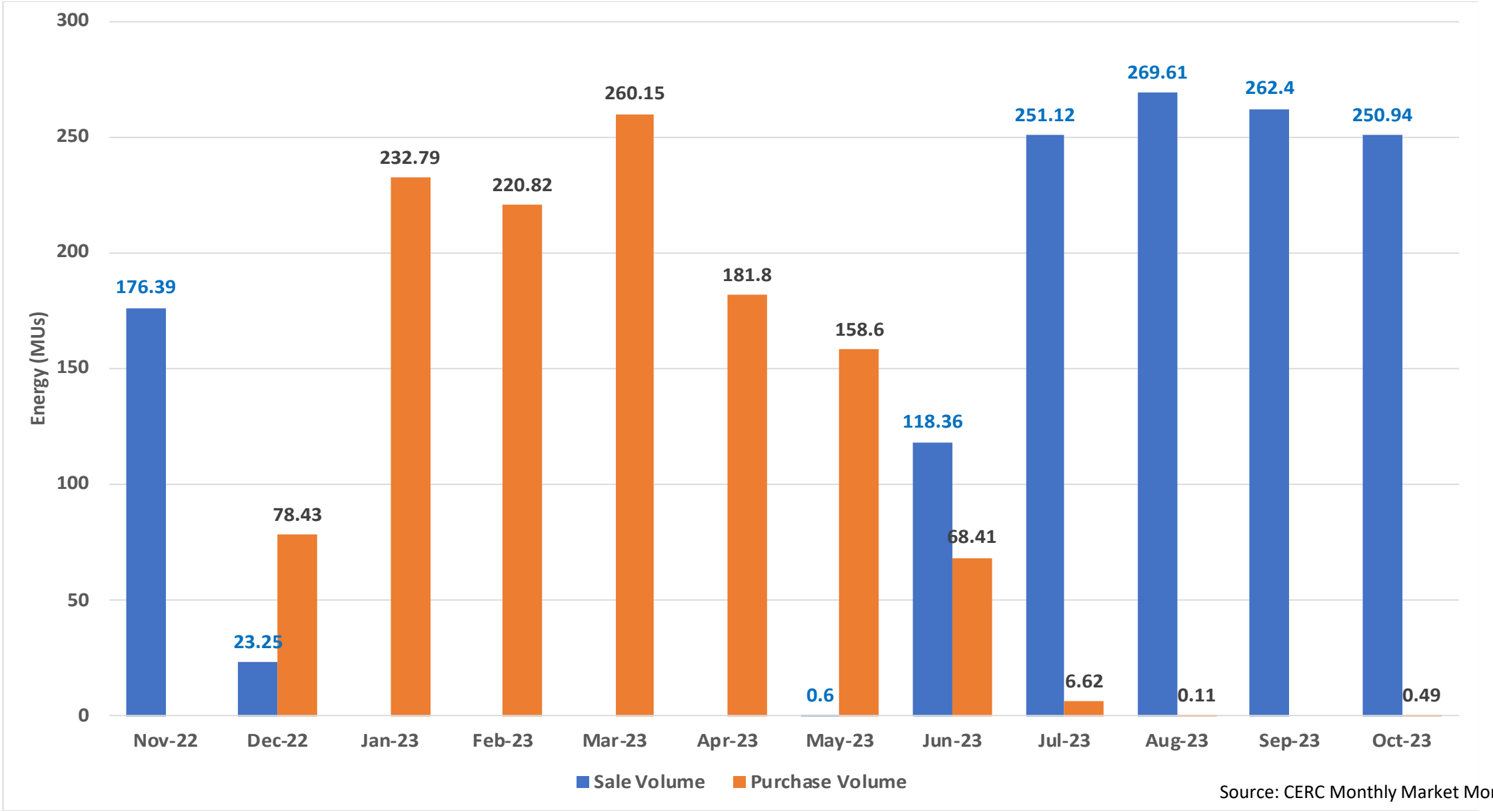
All Figures in MUs

	Bhutan	Nepal	Bangladesh	Myanmar
Import from India				
2017-18	0	-2400	-4800	-5.07
2018-19	0	-2800	-5690	-6.67
2019-20	0	-2370	-6990	-10
2020-21	0	-1870	-7550	-10
2021-22	-120	-2060	-7300	-10
2022-23	-200	-1420	-8620	-10
2023-24 (upto Dec'23 only)	-285	-1650	-6500	-7.1
Export to India				
2017-18	5600	0	0	0
2018-19	4660	0	0	0
2019-20	6310	0	0	0
2020-21	9320	0	0	0
2021-22	7790	130	0	0
2022-23	6580	1260	0	0
2023-24 (upto Dec'23 only)	4870	800	0	0

Source: NLDC Reports

- Bhutan has started importing power from India during the winters when hydro generation is at a minimum.
- Similarly, Nepal which had been mainly importing power have started to export to India, which is expected to increase much more in future.
- Both are now active on the Power Exchanges for harnessing the economic benefits of competition.
- The exports to Bangladesh have been increasing and have now reached its maximum; exhibiting the urgent need for augmenting the transmission capacity.

Nepal's Transaction on PX – Past 12 months



Source: CERC Monthly Market Monitoring Report

Nepal's Transaction on PX – Past 12 months

	Volume (MUs)		Weigted Avg Price (INR/kWh)		Money (INR Miilion)	
	Sale Volume	Purchase Volume	Sale (Price)	Purchase (Price)	Received	Paid
Nov-22	176.39	-	4.66	#N/A	822.0	0.0
Dec-22	23.25	78.43	5.76	4.84	133.9	-379.6
Jan-23	-	232.79	-	5.62	0.0	-1308.3
Feb-23	-	220.82	-	6.07	0.0	-1340.4
Mar-23	-	260.15	-	5.39	0.0	-1402.2
Apr-23	-	181.8	-	5.07	0.0	-921.7
May-23	0.6	158.6	2.32	4.22	1.4	-669.3
Jun-23	118.36	68.41	5.07	4.43	600.1	-303.1
Jul-23	251.12	6.62	4.46	4.06	1120.0	-26.9
Aug-23	269.61	0.11	6.98	3.63	1881.9	-0.4
Sep-23	262.4	-	6.19	-	1624.3	0.0
Oct-23	250.94	0.49	3.79	8.43	951.1	-4.1
Net Transaction					**7134.6**	**-6355.9**

Source: CERC Monthly Market Monitoring Report

If the Imperatives are so pressing

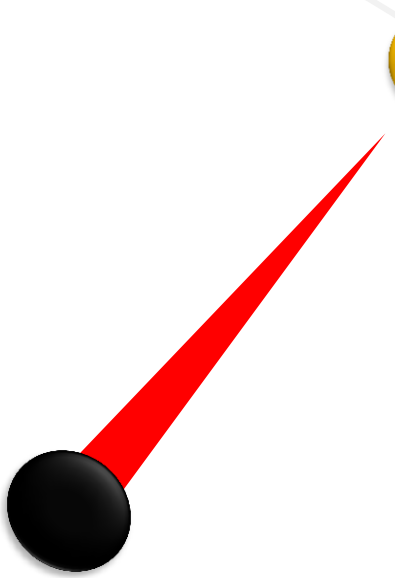
There is an established economic benefit

There is consensus and appreciation at the Policy maker, Regulator and Utility Level

There is consensus and appreciation at the Policy maker, Regulator and Utility Level

Then Where is the Hitch

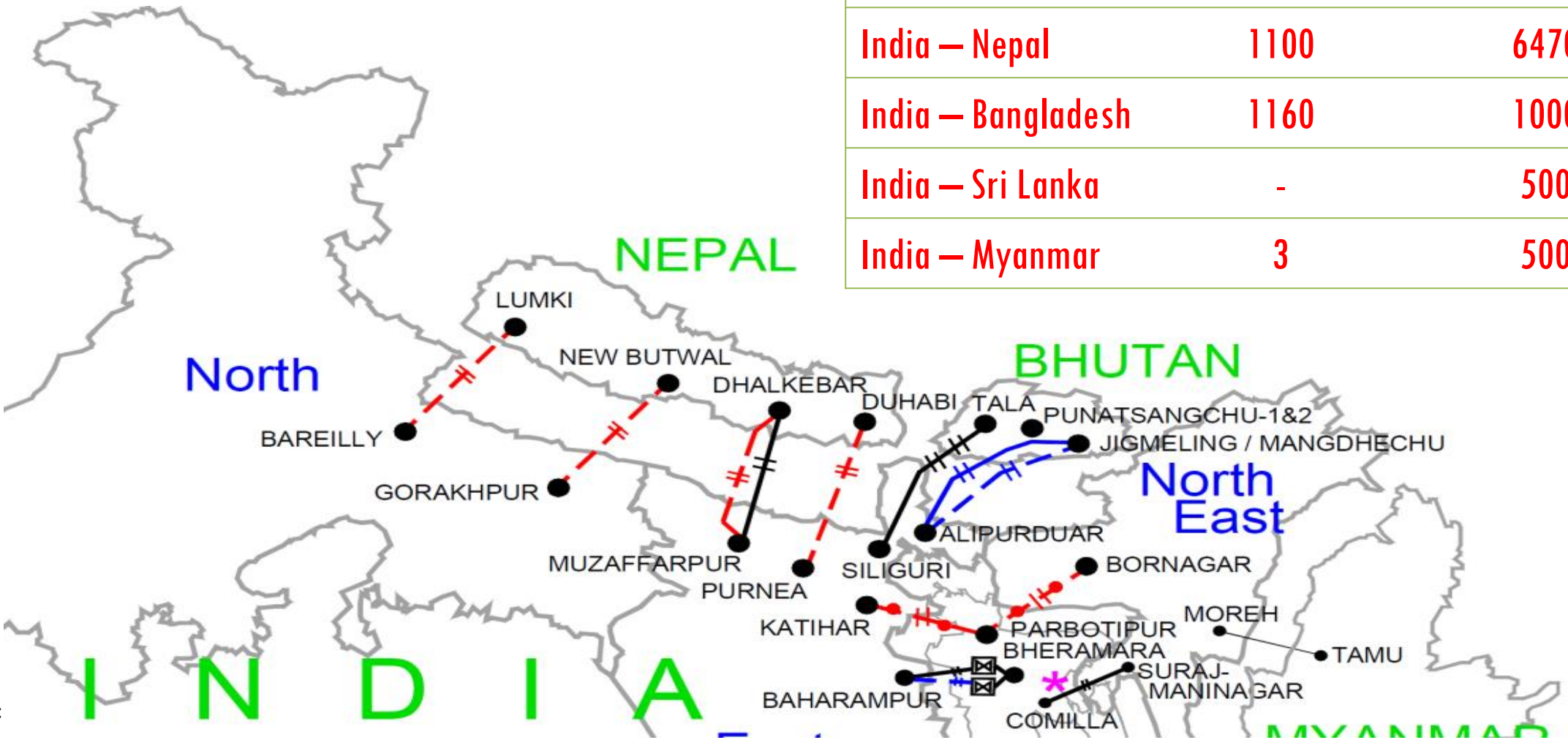
Unique Characteristics of Transmission System



1. Licensed Activity
2. Bound to a given User(s)
3. Comes in discreet capacity
4. Involves Environmental and Social aspects
5. Cross country by nature
6. Skewed Mindset for the Transmission Charges

Cross border Transmission Capacity

	Existing	UC/planned
India – Bhutan	2070	2220
India – Nepal	1100	6470
India – Bangladesh	1160	1000
India – Sri Lanka	-	500
India – Myanmar	3	500



Source:

Business Models for Cross-Border Links - Nepal

- **Long History of Cross-Border Links** – with several low voltages lines (33kV, 132 kV and 220 kV) essentially constructed for the transfer of power from small-sized generation projects.
- **1st High Capacity Synchronous link – Muzaffarpur – Dhalkebar 400 kV D/c line**
  - Developed as "Transmission As Service" – Not linked to any associated power sale/purchase transaction.
  - Two separate JVs (CPTC and PTCN) developed Indian and Nepalese portions of transmission lines.
  - NEA holds a minority stake (16%) in JV responsible for developing the Indian portion and a majority stake (50%) in the JV responsible for developing the Nepalese portion.
  - Similarly, Indian companies hold a majority share in the Indian side JV (POWERGRID – 42% & SJVN – 42%) and a minority stake in the Nepal side of JV.
  - NEA is bearing entire transmission charges for the Indian portion of the link and its entire capacity is booked for NEA.
- **2nd High Capacity Synchronous link – Dhalkebar – Sitamarhi 400 kV D/c line**
  - Being developed as an "Associated Transmission System" of Arun – 3 (900 MW) project
  - The Nepal portion is developed by SAPDC (A subsidiary of SJVN incorporated in Nepal).
  - The Indian portion is developed as an ISTS project under RTM mode - The TSA is signed by SAPDC for sharing transmission charges of the Indian portion.

Business Models – Nepal ….contd

- **3rd High Capacity Synchronous link – Gorakhpur – New Butwal 400 kV D/c line**
  - Developed as "Transmission As Service" – Not linked to any associated power sale/purchase transaction.
  - Indian portion is being developed by 50:50 JV of NEA and POWERGRID
  - The Nepalese portion is being developed by NEA
  - NEA is bearing entire transmission charges for the Indian portion of the link and its entire capacity is booked for NEA.
- **4th and 5th High Capacity Synchronous link – Dododhara – Bareilly and Inarwa – Purnea (Quad) 400 kV D/c line**
  - Identified for development for transfer of surplus power from future generation projects in Nepal to India.
  - The business models is currently under discussion.

Presently, Nepal import power through bilateral contracts and through Indian Power Exchange(s) in Day Ahead Market (w.e.f. 18th April 2021). Nepal also export power to India through Indian Power Exchange(s) (w.e.f. 03rd November 2021)

Business Models for Cross-Border Links - Bhutan

- Presently there exists network of 400kV, 220kV, and 132kV transmission lines, primarily established to import power from hydroelectric projects like **Tala HEP (1020MW), Chukha HEP (336MW), Kurichu HEP (60MW), and Mangdechu HEP (720 MW)** to India.
- The funding for the number of above-generation projects was facilitated through a grant from the Government of India.
- Model - "Associated Transmission System" - Power to the tune of 50% initial capacity was allocated by Govt of India from Central Sector Generation projects, balance procured by BPDB from the market.
- The respective entities in the two countries implemented their portion of transmission lines within their territories.
- The Transmission charges for the Indian portion are part of the ISTS pool.

✓ Presently, about 2000 MW power from the existing hydro projects in Bhutan is being imported to India.
✓ Bhutan has also started import of power through Indian Power Exchange(s) w.e.f. 01st January, 2022.

Business Models for Cross-Border Links - Bangladesh

- **Bherampur – Bheeramara 1000 MW HVDC Back-to-back**
  - Objective – to facilitate the export of power to Bangladesh.
  - Model - "Bundled Transmission and Generation service" - Power to the tune of 50% initial capacity was allocated by Govt of India from Central Sector Generation projects, balance procured by BPDB from the market.
  - The respective portion of the link in the territory of India and Bangladesh were implemented by POWERGRID and PGCB respectively – this has allayed the Licensing Issue.
  - The transmission charges for the Indian portion are being borne by BPDB.
- **Surajmani nagar – Comilla 400 kV D/c line**
  - Initially, this link was planned for adoption on the lines of above interconnection with HVDC back-to-back link.
  - But with the Katihar – Parbaotipur - Bornagar 765 kV Cross-border link on the planning consideration – the back-to-back interconnection was dropped.
  - Presently, it is being operated on radial mode facilitating export of about 160 MW from India to Bangladesh.

Business Models for Future Cross-border Links

- The following major Cross-border links are on anvil
  - 1000 MW Indo – Sri Lanka HVDC interconnection.
  - Katihar – Parbotipur – Bornagar 765 kV D/c line.
  - 1000 MW Imphal – Tamu – Kalay HVDC interconnection.
- Looking into the growth in the power markets in the South Asian region
  - “Transmission As a Service” – without linking to any identified sale and Purchase – appears to be the more appropriate model
  - Enables the entire capacity to be harnessed for Open Access power transactions which are guided by economic considerations - with a win-win situation for both buyers and sellers.
  - Adequate security mechanisms are required to be in place to have a bankable project.
  - Urgency in decision making necessary to realise constraints free South Asian Electricity Grid.

Thank You !!!

- DILIP ROZEKAR
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- e-mail : drozekar@powergrid.in
- Web : www.powergrid.in

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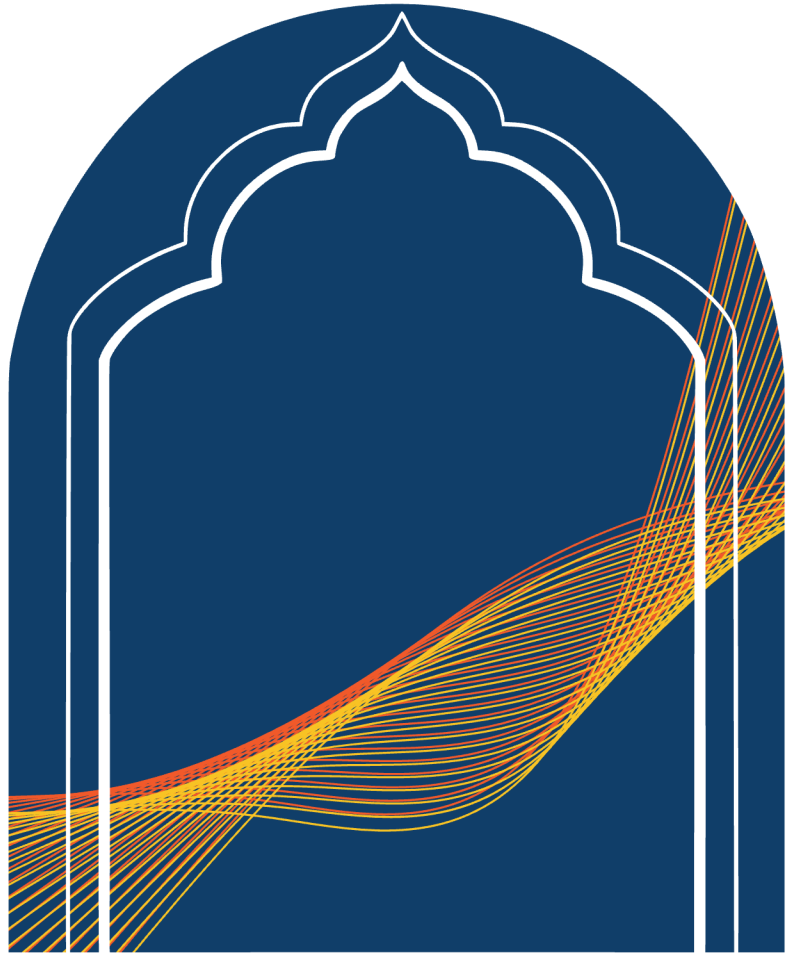
CBET as an enabler of development in the South Asian Region



For SAFIR Conference, Sri Lanka, March 2, 2024

Swetha Ravi Kumar, Executive Director

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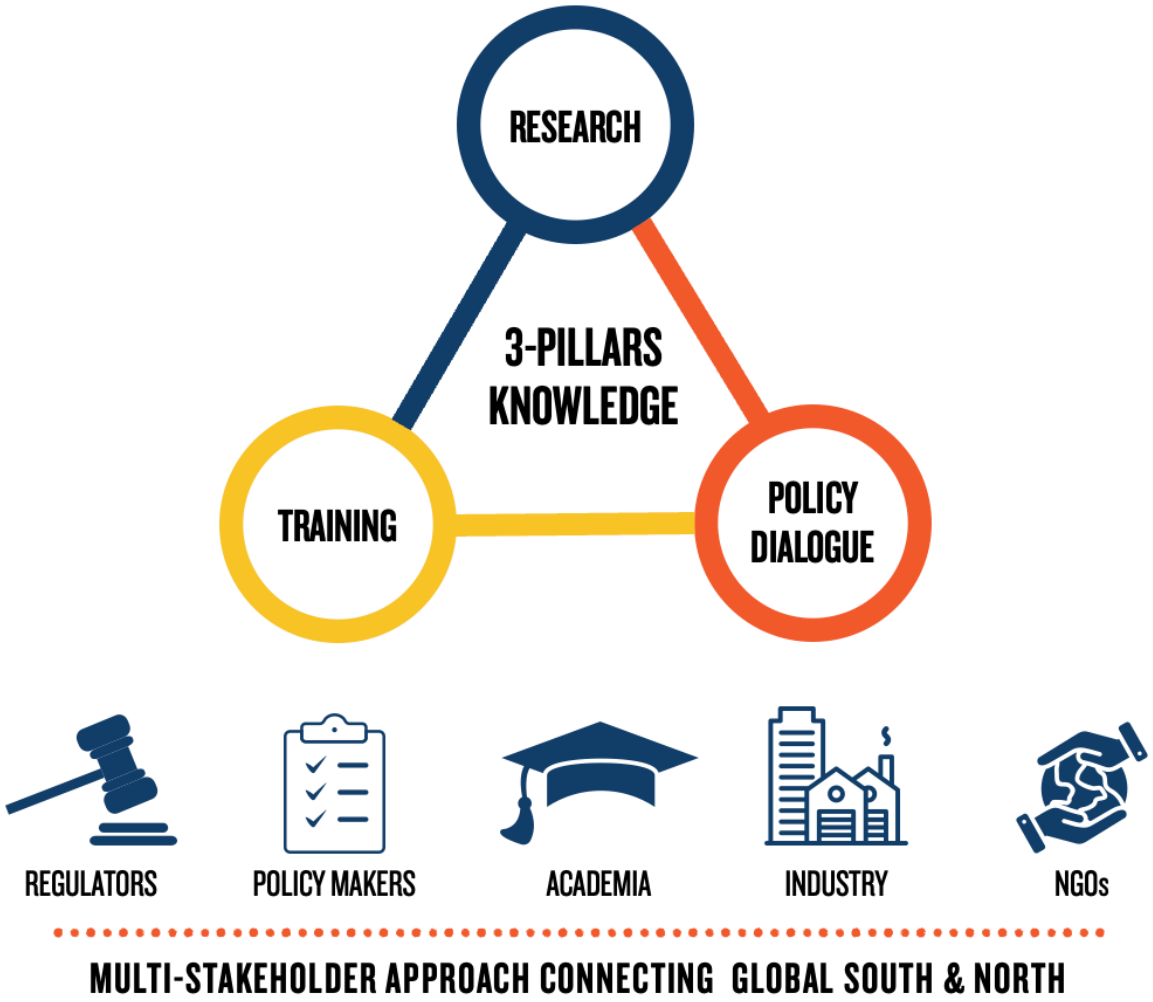
OUR APPROACH



Research organization –

delivering to practitioners (speed and condensed)

with the quality of academic rigor

Knowledge exchange on policy and regulation

Global North – Global South

Global South – South and to the North

SISTER SCHOOLS

Florence School of Regulation
(Global North),
2004, Florence, Italy

FSR Global
(Global North-South &
South-South, Asia),
2019, New Delhi, India

African School of Regulation
(Africa),
2022, Accra, Ghana

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Energy Transition: Synergies towards regional energy security (for SAFIR)

India	Bangladesh	Bhutan
13 February 2024	27 February 2024	19 March 2024

Sri Lanka	Nepal
2 April 2024	16 April 2024

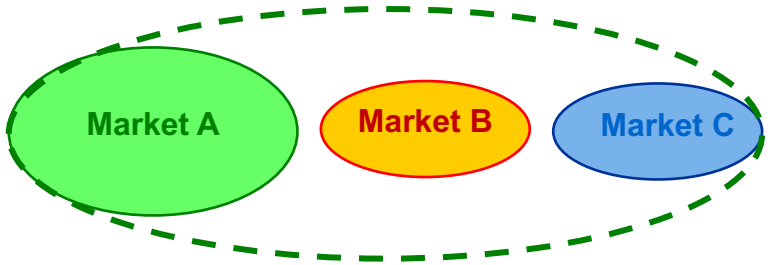
Occurring
14.00 - 15.30 IST

Discussion (s) --> Regional Report - Tuesday, 21 May 2024

Regional Electricity Market Integration: Many possible models

1) Extension of the market in one jurisdiction to encompass other jurisdictions

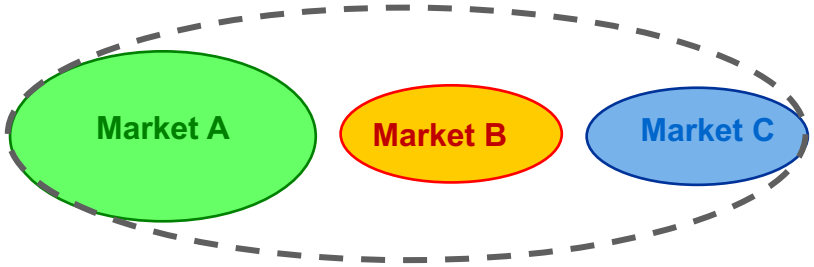
Extension of Market A and its rules to Markets B and C



Example: Italy-Slovenia (2011) in Europe

2) Establishment of a regional market, replacing existing markets, with new rules agreed by all involved jurisdictions

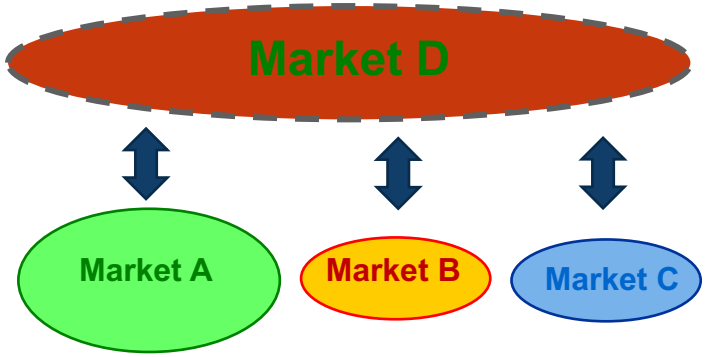
New market and common rules for the regional market



Example: the Internal Electricity Market in Europe

3) Superimposing a regional market on the trading arrangements in the different jurisdictions

Regional market, with its own rules, superimposed to trading arrangements in the different jurisdictions



Example: SIEPAC in Central America

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The EU Experience - Planning

- European Network Planning performed over a two-year cycle
  - EU Ten-Year Network Development Plans – EU TYNDP, separate for electricity and gas
    - Developed by the European Networks of Transmission System Operators (ENTSOs)
    - Based on:
      - Common scenarios for electricity and gas defined by the ENTSOs
      - submission by TSOs and other transmission infrastructure promoters
    - Subject to the opinion of the EU Agency for the Cooperation of Energy Regulators (ACER)
      - Discrepancies (often timing) between the EU TYNDP and the binding national TYNDPs are identified by ACER and investigated
- Projects of Common Interest (PCI)
  - The Projects of Common Interest (PCIs) are the priority projects for interconnecting the EU energy system infrastructure
  - PCIs are a subset of the projects in the EU TYNDP

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The EU Experience – TEN-E Regulation

- Projects of Common Interest (PCIs)
- Cross-border Cost Allocation (CBCA)
  - PCIs can apply for Cross-border Cost Allocation (CBCA)
  - CBCA solves the problem of uneven distribution of costs and benefits, which hampered the development of beneficial infrastructure
  - Internal projects in one Member States benefitting other Member States
- CEF – Connecting Europe Facility
  - CEF provide grants to project with the PCI status
    - Grants for studies
    - Grants for works
  - For PCIs to be available for CEF funding, they should have applied and obtained a CBCA decision

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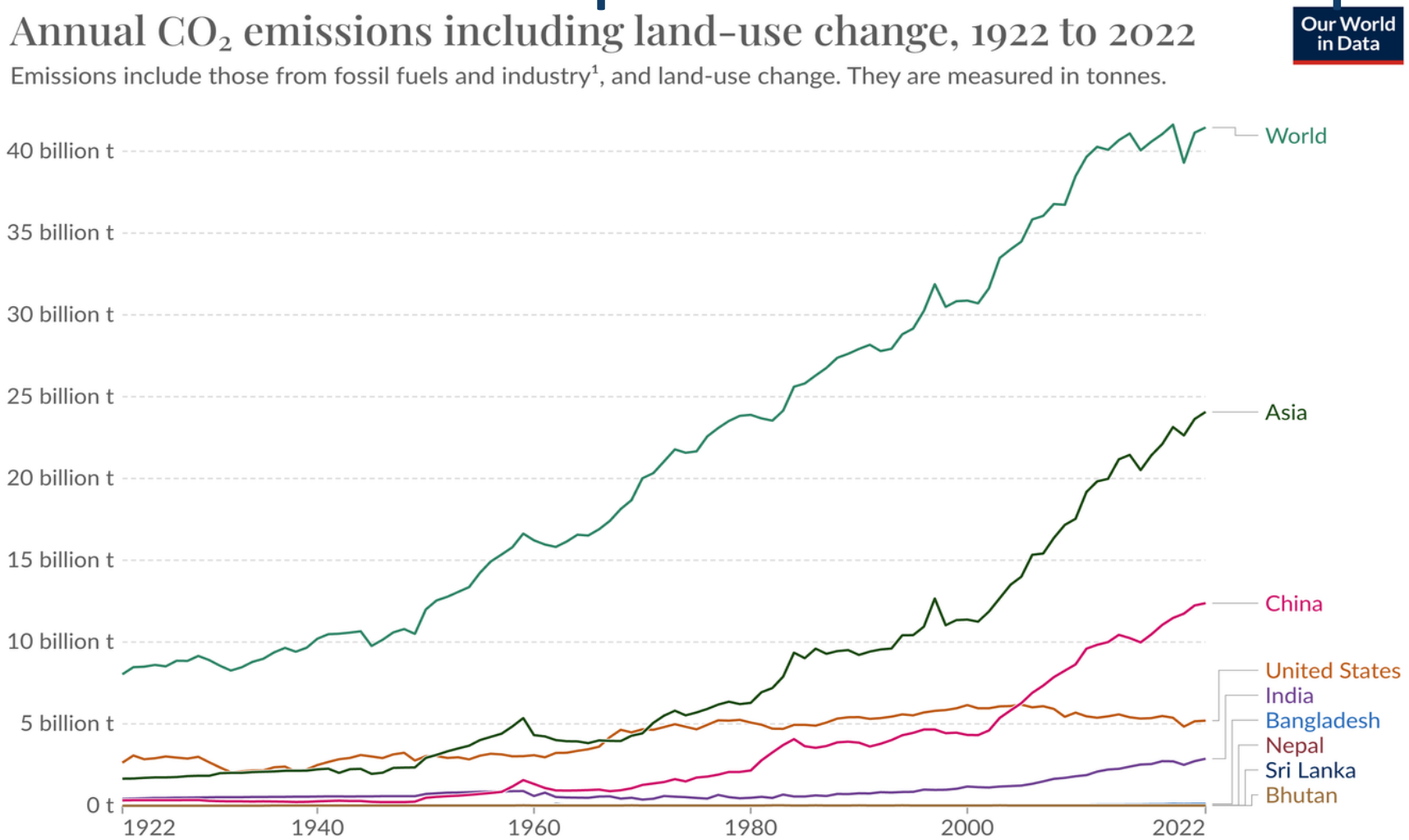
Key observations – CBET in SAR

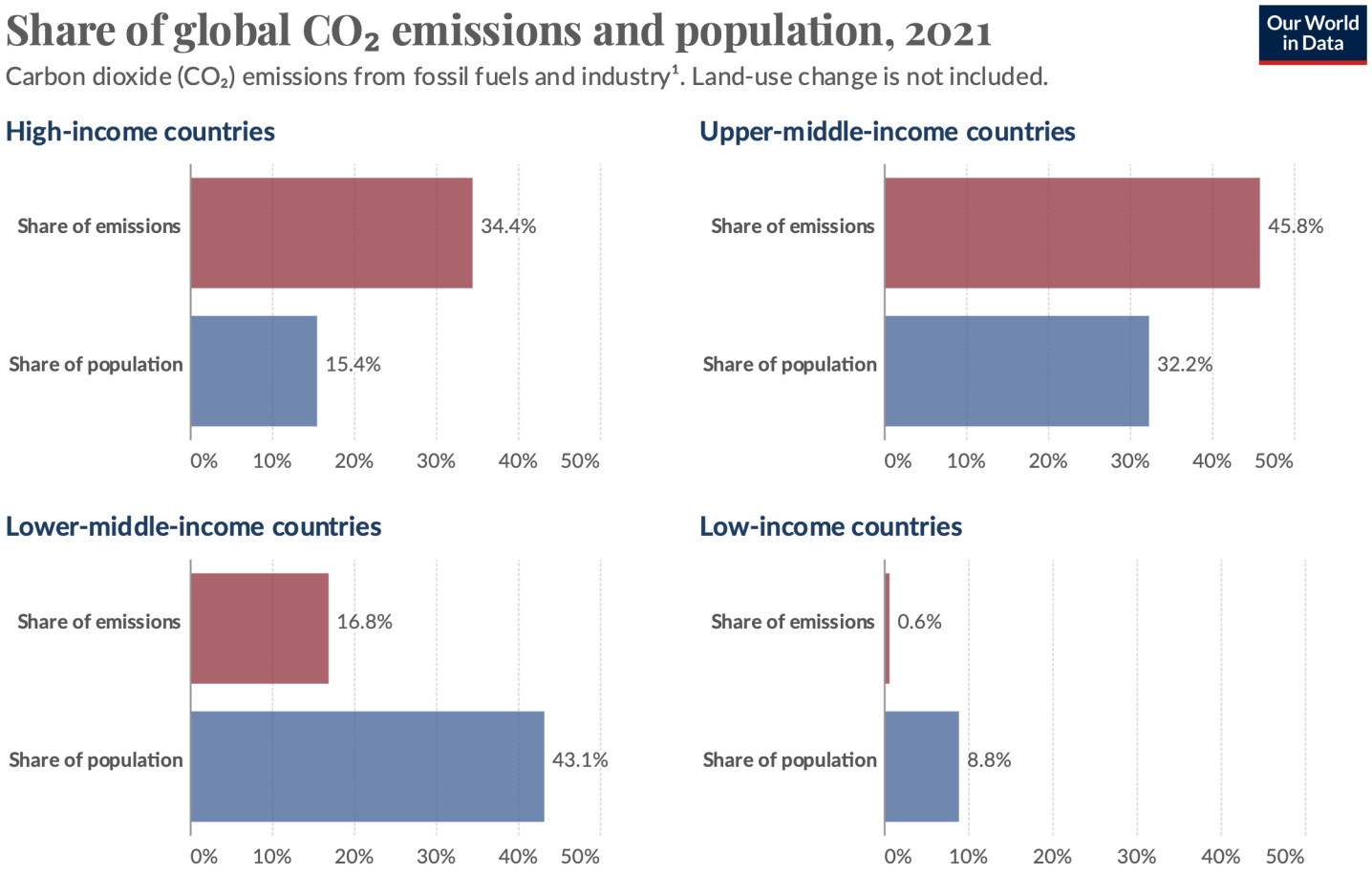
- Shared Vision – Shared Projects : But How?
  - Use existing frameworks such as BIMSTEC, SAARC, SAFIR
  - Develop a new regional institutional body (umbrella) or platforms (connecting same set of stakeholders)
- Shared Vision – Shared Projects : But When?
  - Wait for market to mature – till then bilateral is ok
  - In the meanwhile setup the framework for regional entity
- Commercialization is key – equitable approach needed (social and economical)
  - Transmission corridors will be key to facilitating market interactions
- Economic Development – a key push for G-G willingness
  - Need to present the picture looking beyond electricity to convince policy makers
  - Spill over effects need to be captured – water, trade, transit …

So far we all know the story…here on we can change the narrative ?

How much carbon space have we occupied?



How much carbon space have we really occupied?



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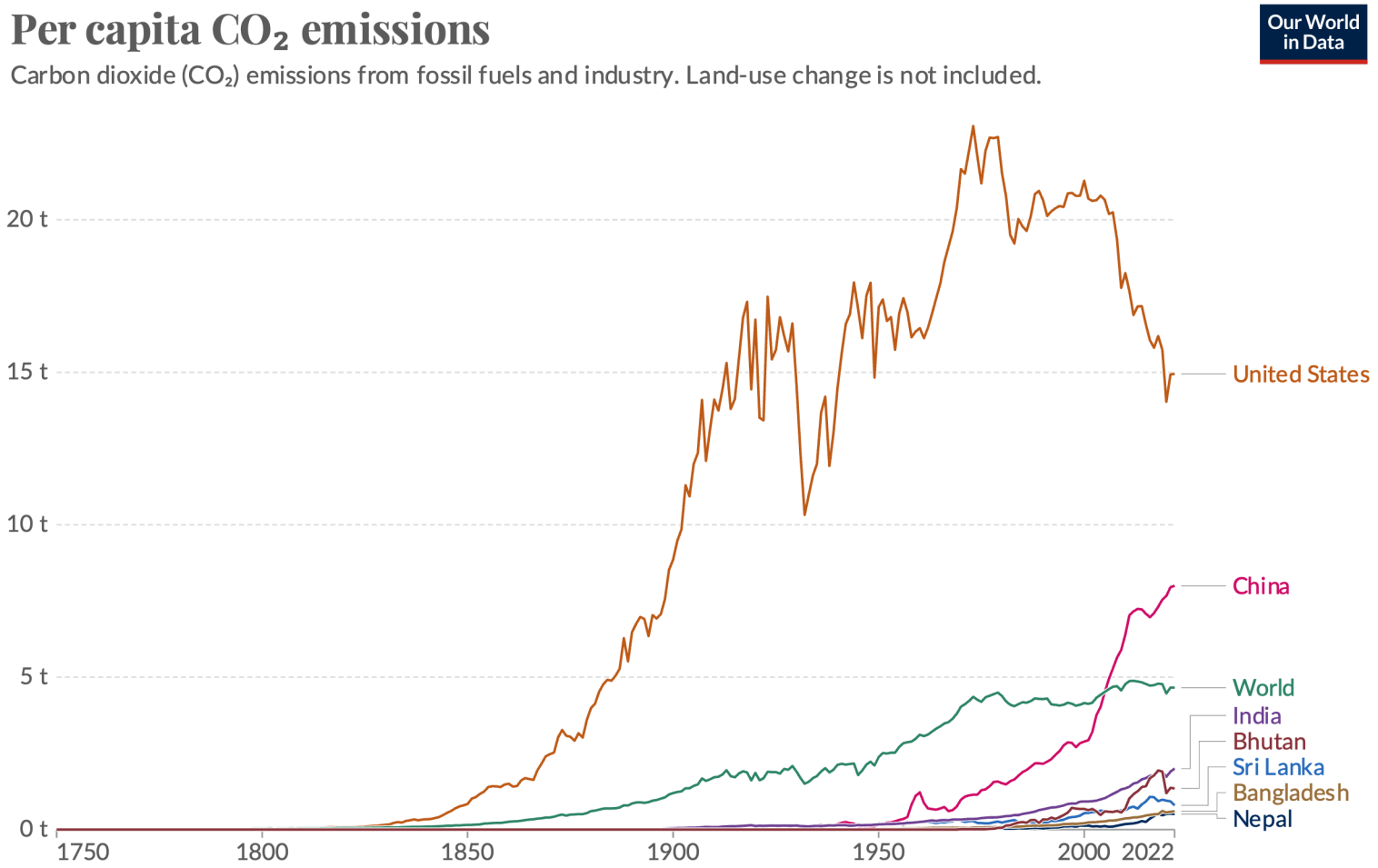

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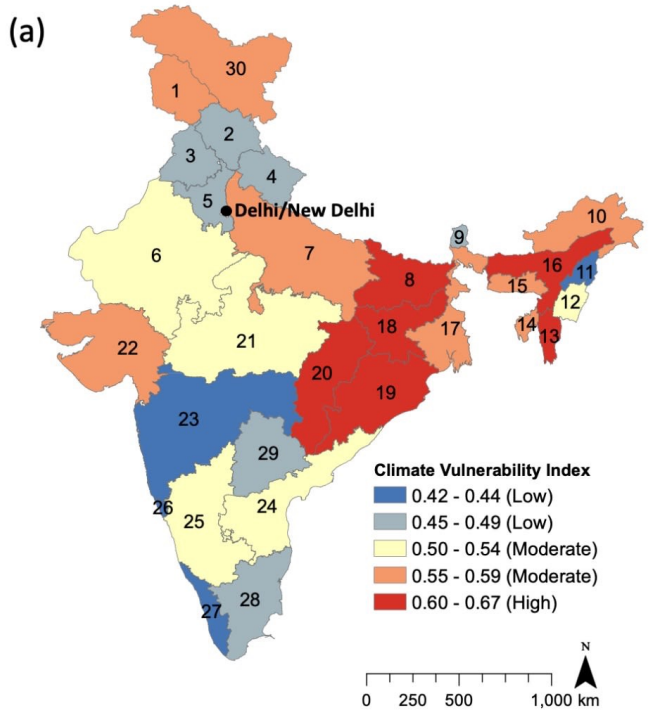
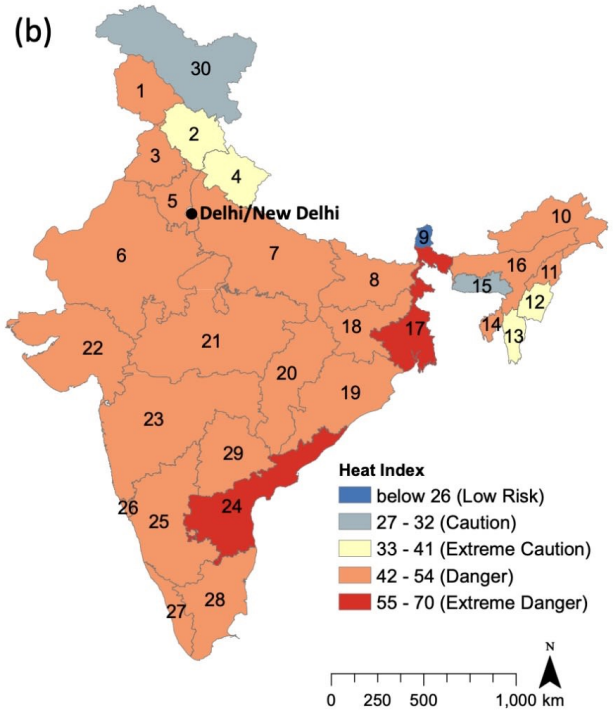
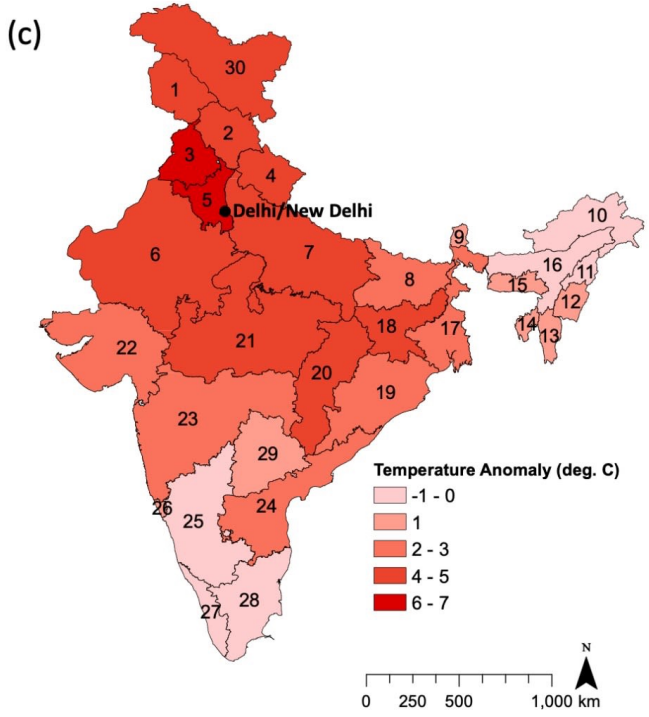
But the reality is also this…







Legend: State identifiers

1	Jammu and Kashmir	16	Assam
2	Himachal Pradesh	17	West Bengal
3	Punjab	18	Jharkhand
4	Uttarakhand	19	Odisha
5	Haryana	20	Chhattisgarh
6	Rajasthan	21	Madhya Pradesh
7	Uttar Pradesh	22	Gujarat
8	Bihar	23	Maharashtra
9	Sikkim	24	Andhra Pradesh
10	Arunachal Pradesh	25	Karnataka
11	Nagaland	26	Goa
12	Manipur	27	Kerala
13	Mizoram	28	Tamil Nadu
14	Tripura	29	Telangana
15	Meghalaya	30	Ladakh

Source: Cambridge University

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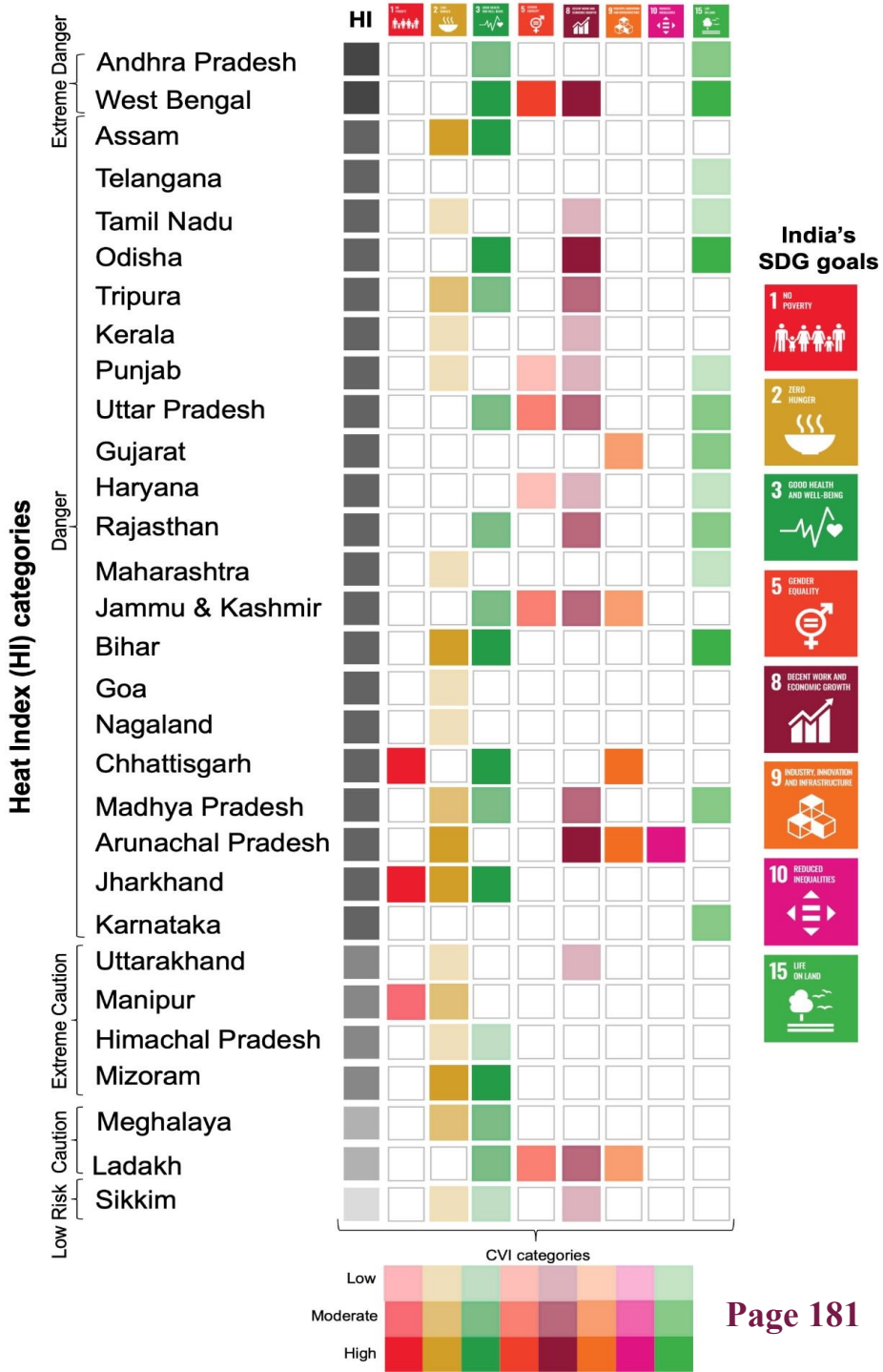
But the reality is also this…

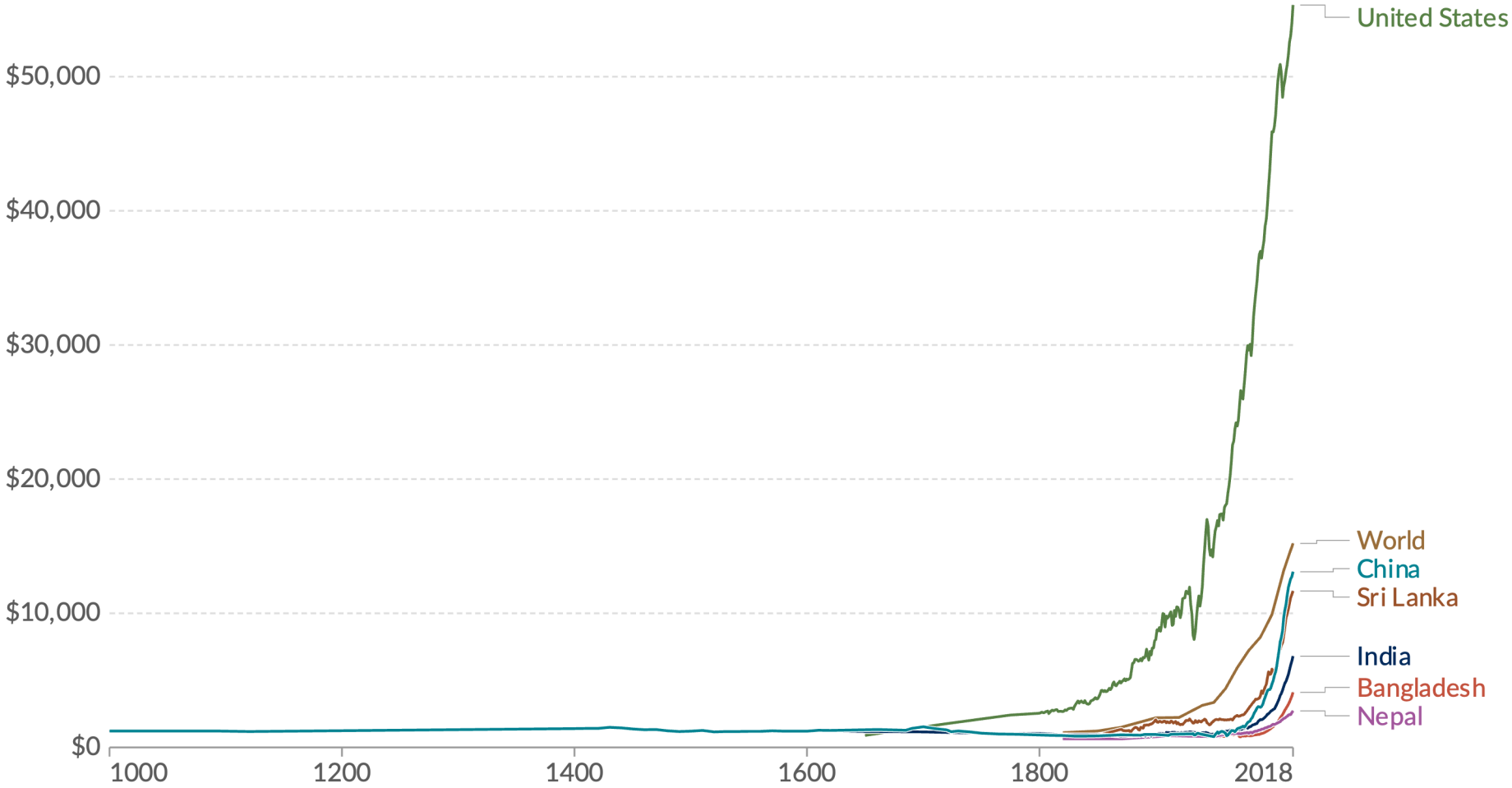


Source: Cambridge University

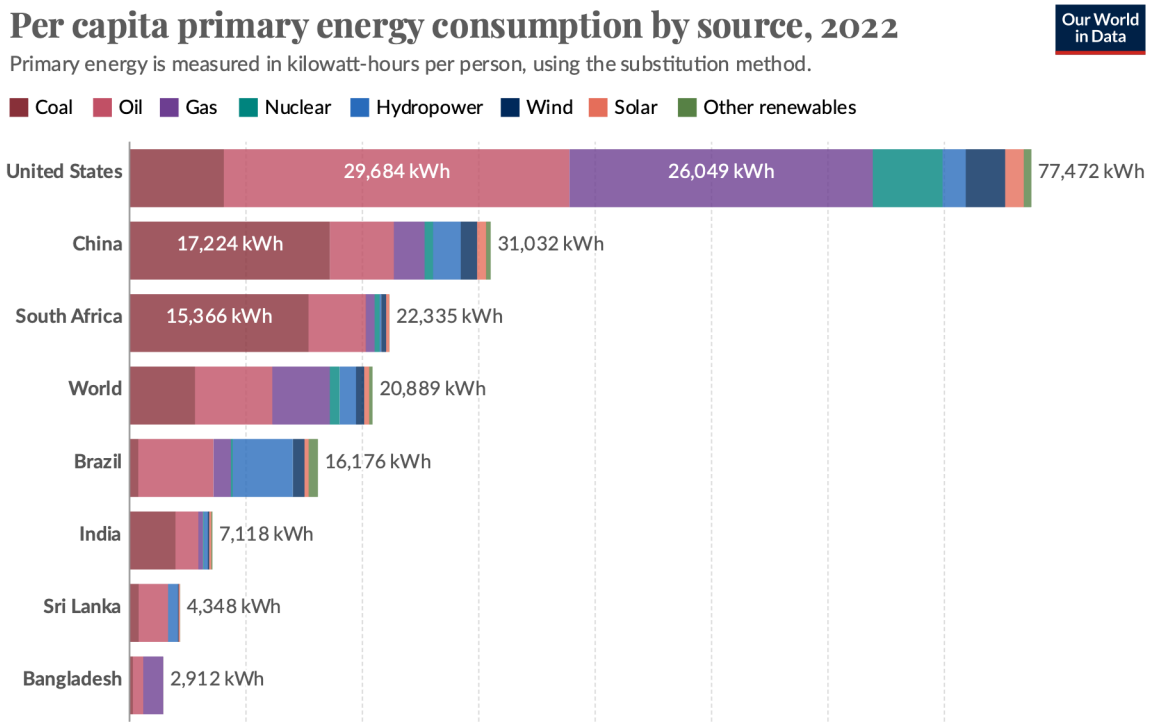
GDP per capita, 1000 to 2018

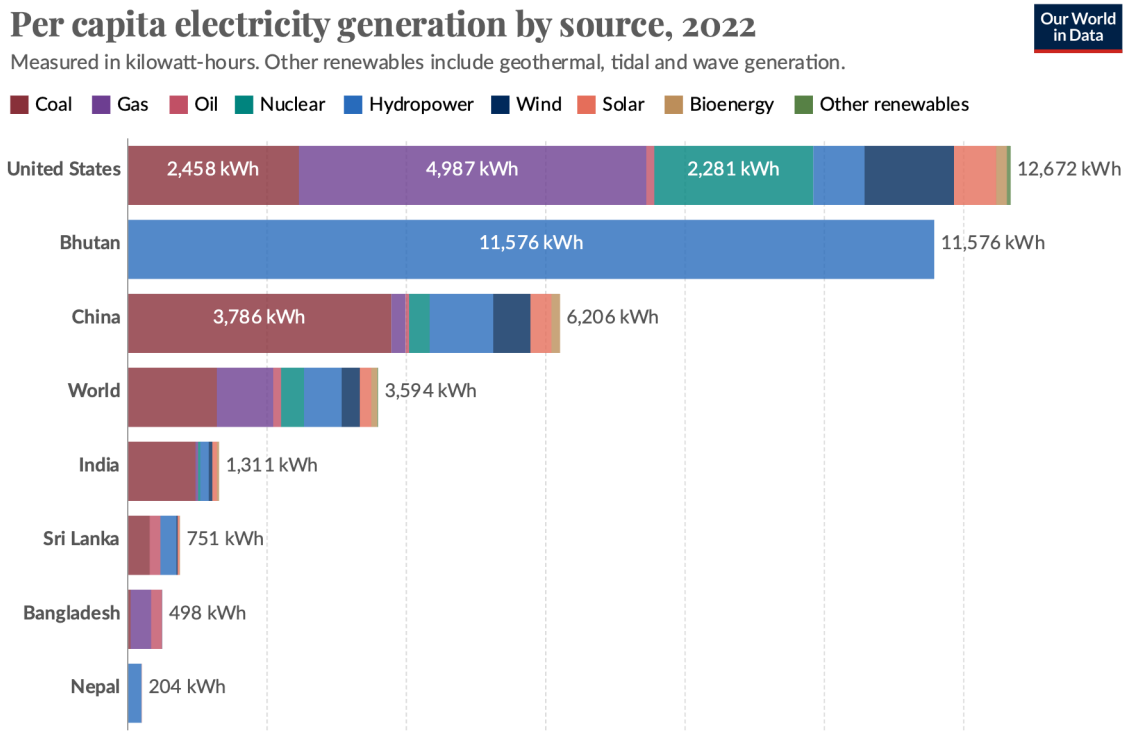
This data is adjusted for inflation and for differences in the cost of living between countries.

Our World in Data

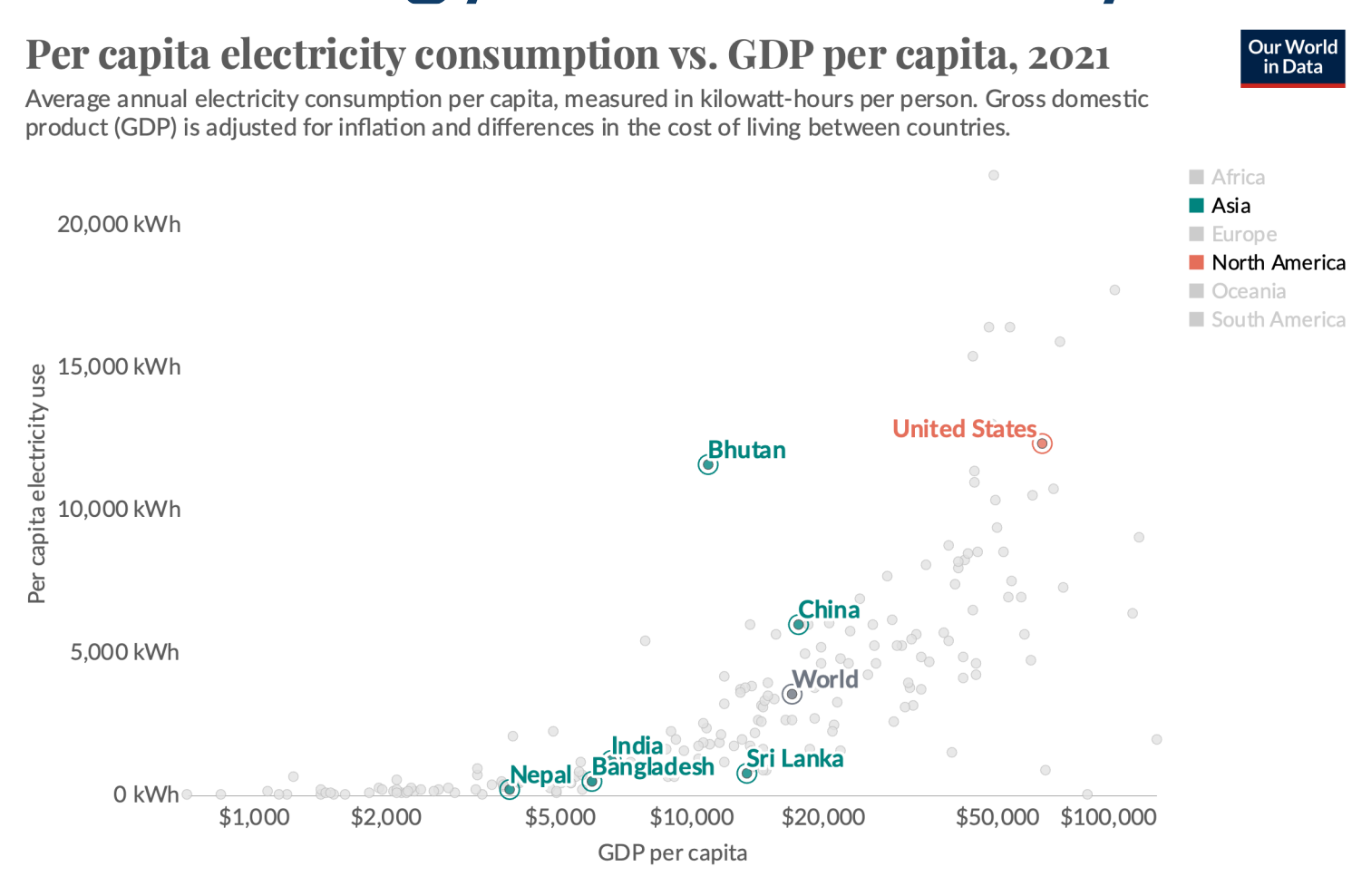


Our energy and electricity use is?





Our energy and electricity use is?



Energy is needed to fuel Economic Growth!

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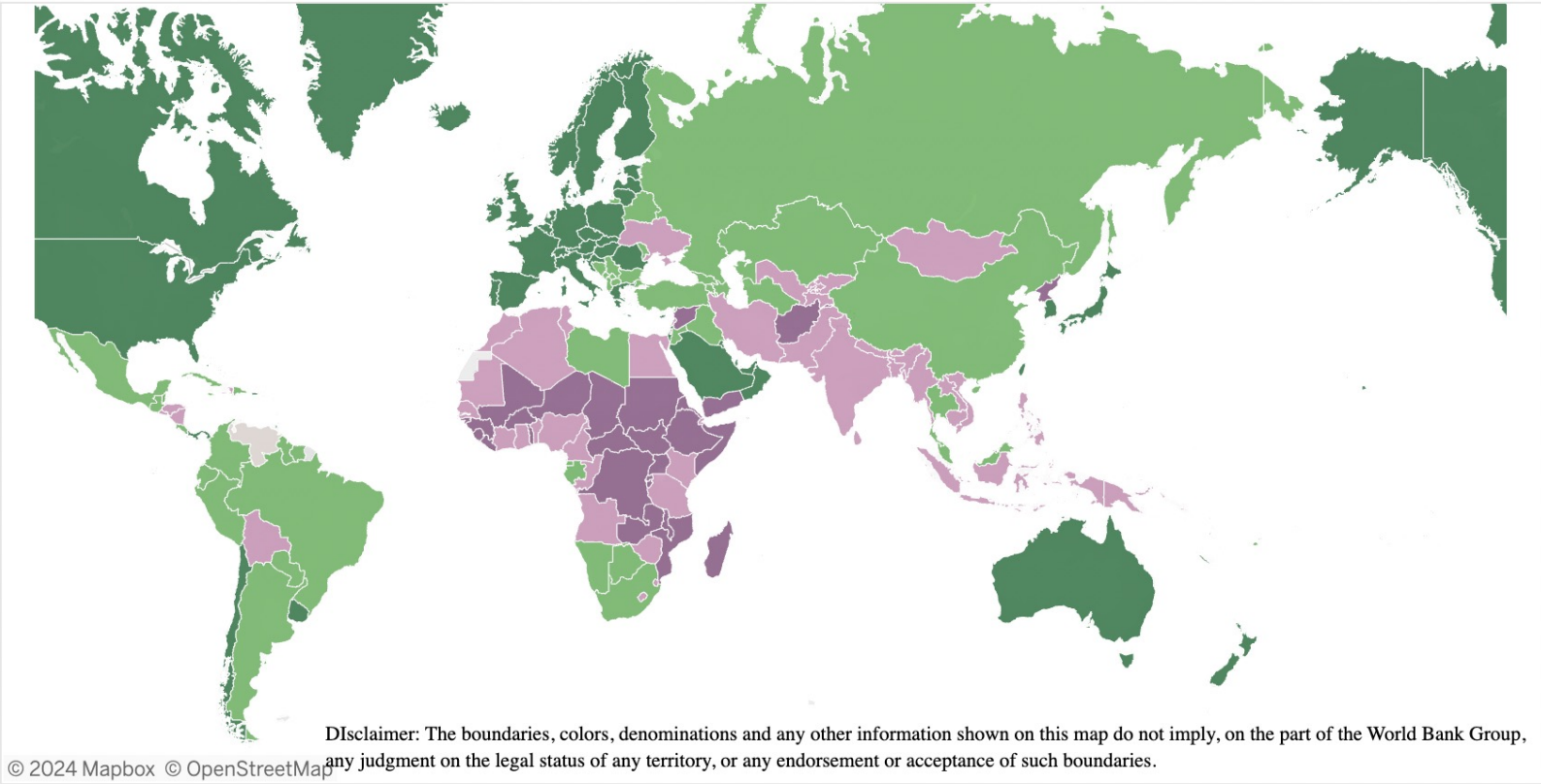
The power of narratives…



Here is where CBET will help unlock our regional value

Powering the growth of South Asia





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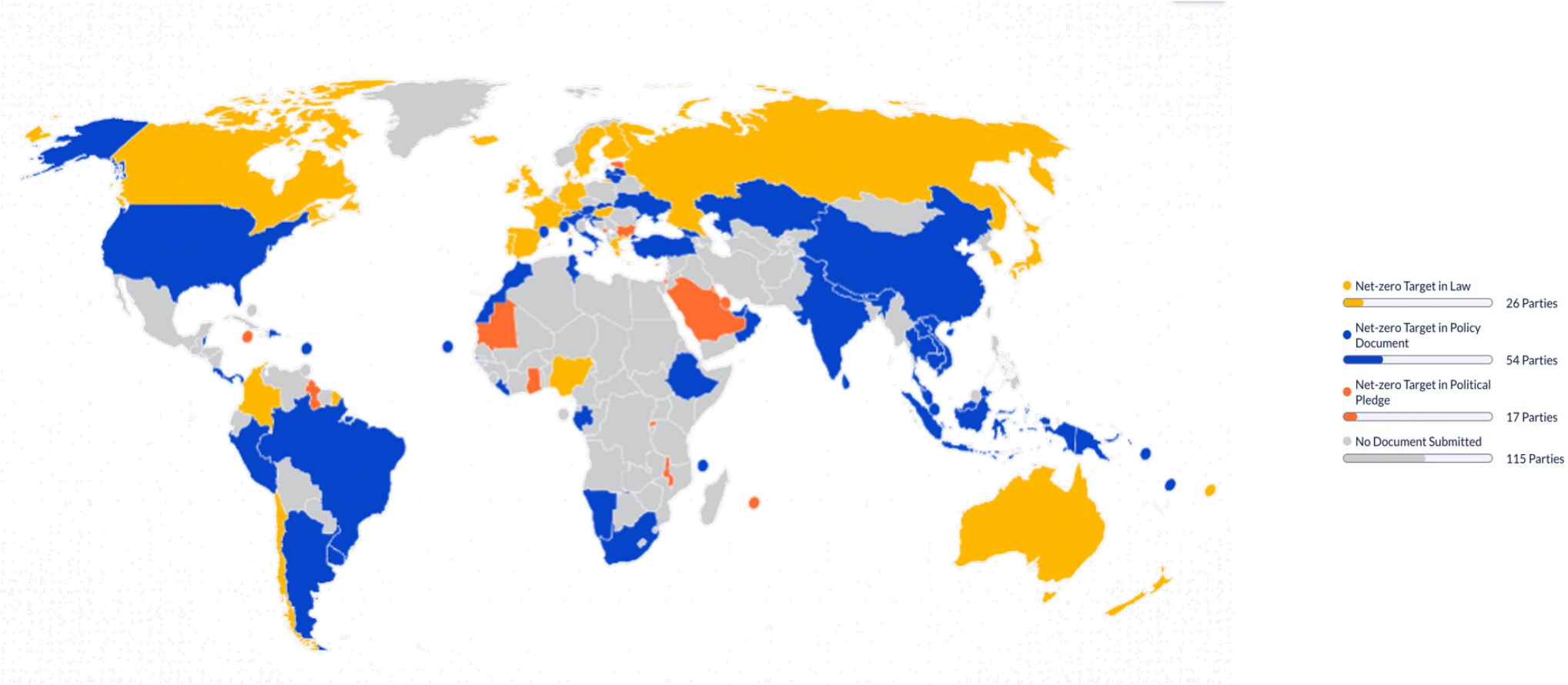
Going forward… Net-Zero Targets



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Going forward…

- Energy Transition
  - Decentralization – technology and governance
  - Decarbonization – going beyond electricity, we need to onboard other sectors
  - Digitalization – we need to embrace the new technologies and improve the process
  - Deregulation – how much to do and not to do

Generation Networks Operations Markets

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So what can we do ?

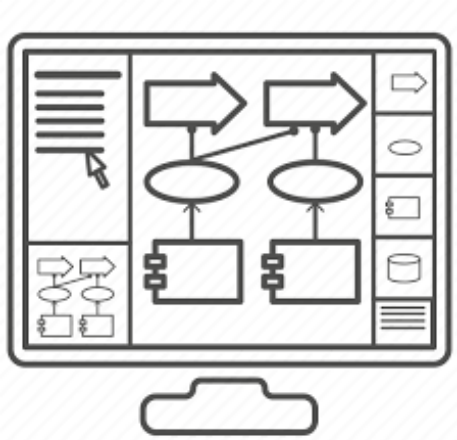
- Bring in a stronger regional identity?
  - We have been at this for more than a decade, but now time to accelerate, as climate change is happening now!
  - Voice of the 'Third Pole' aka South Asia in the global discourse
- Non-political platforms have a role to play?
  - Platforms such as us – SAFIR need to put out stronger recommendations as course of actions needed, governments may pick up the lead from there?
- Share tools and knowledge more quickly
  - We have all that we need amongst us, why then is it taking time to speed up?
  - Is working in silos the issues? Then SAFIR can play a much stronger role since we are all here ☺

What is coming?

Smart Grid Observatory India

DATA

Make all relevant data open access in a curate easy to access manner



Open access modelling tool to plan 'Resource Adequacy' at

MODELLING TOOL

Utility Level

Aggregated Level – State/Country/Regional

KNOWLEDGE TRANSFER

TRANSITION TO CLEAN ENERGY

Capacity building + Roadmaps

FSR GLOBAL
Regulatory Knowledge Hub

Thank You

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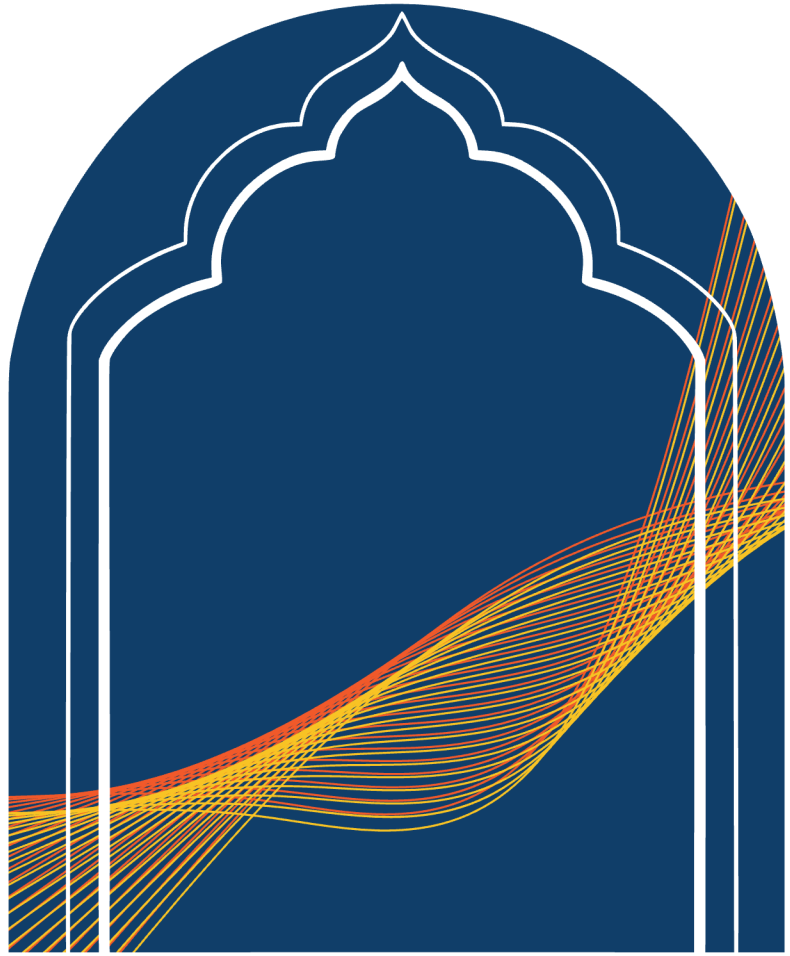

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