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South Asia Regional Energy Partnership (SAREP)

Presentation

on

Study on International Best Practice for Developing Cross-Border Electricity Transmission Infrastructure

South Asian Regional Context, Rationale, Scope of Work, Methodology & Approach of the study

Stakeholder Consultation Workshop
28th February 2024, Inspire Hall, Hotel Le Meridien, New Delhi, India

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Contents

01

Cross Border Electricity Trade (CBET) & Transmission Interconnection in South Asia

Current and Future Scenario

01.1

South Asian Current Scenario-Evolution of Cross Border Electricity Trade

A decade of action and Implementation

2014

- Agreement JV Hydro Projects
- Power Trade Agreement
- SAARC Framework Agreement on Energy Cooperation

2016

- Guidelines on Cross Border Trade of Electricity (CBTE), Nodal agency for CBTE notified
- MoU on Cooperation in Power Sector

2018

- MoU- Cooperation in power sector
- MoU on BIMSTEC Grid Interconnection
- New CBTE Guidelines Issued
- launch of 900 MW Arun III
- 2nd 500 MW HVDC

2019/20

- CERC (CBTE Regulations) notified
- 720 MW MHP Commissioned
- One Sun One World One Grid (OSOWOG) Idea put forth
- CA for 600 MW Kholongchhu Signed

2021/22

- CEA Conduct of Business Rules (CBR) for CBTE issued by DA Indian Opens up It's Power Market
- Nepal Buys and Sells in Indian PX
- Bhutan Buys from Indian PX
- Joint Vision Statement on Power Sector Cooperation

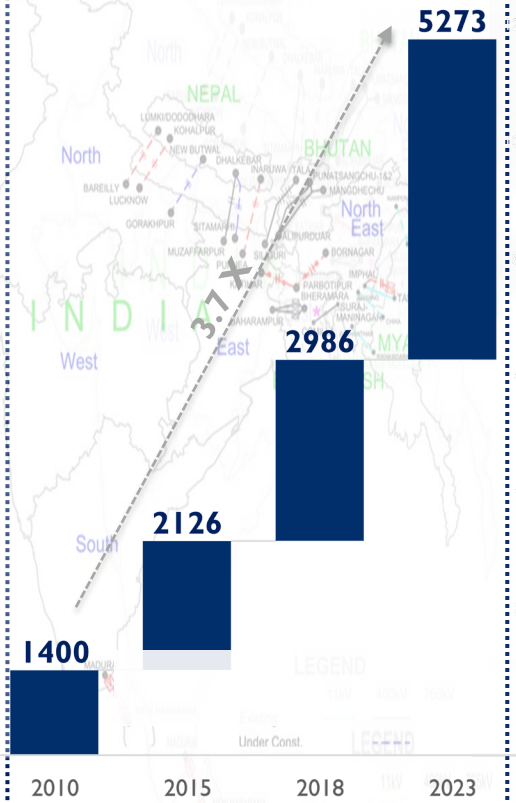
2023/24

- 10 GW Import from Nepal
- Economic Partnership Vision-Grid Interconnection
- Recognised Cross-border Power Systems integration

Data Source- Compile by Author from various Sources

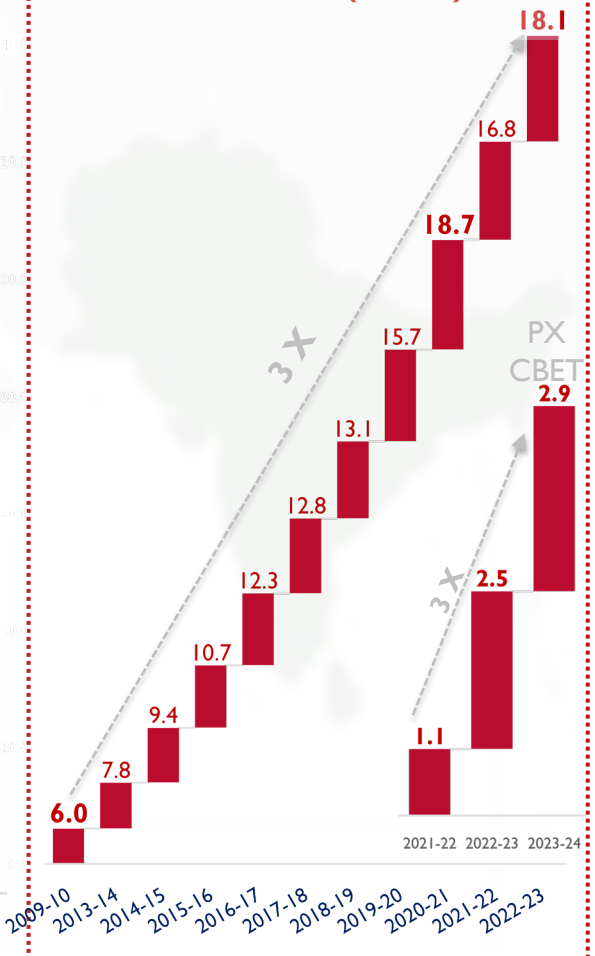
01.1 South Asian Context : *Current Scenario-Increasing Cross Border Electricity Trade*

Bhutan-India ~2100 MW
Nepal-India ~ 600 MW
India- Bangladesh ~2568 MW
Myanmar -India ~3-5 MW
South Asia CBET* (~ 5273 MW)



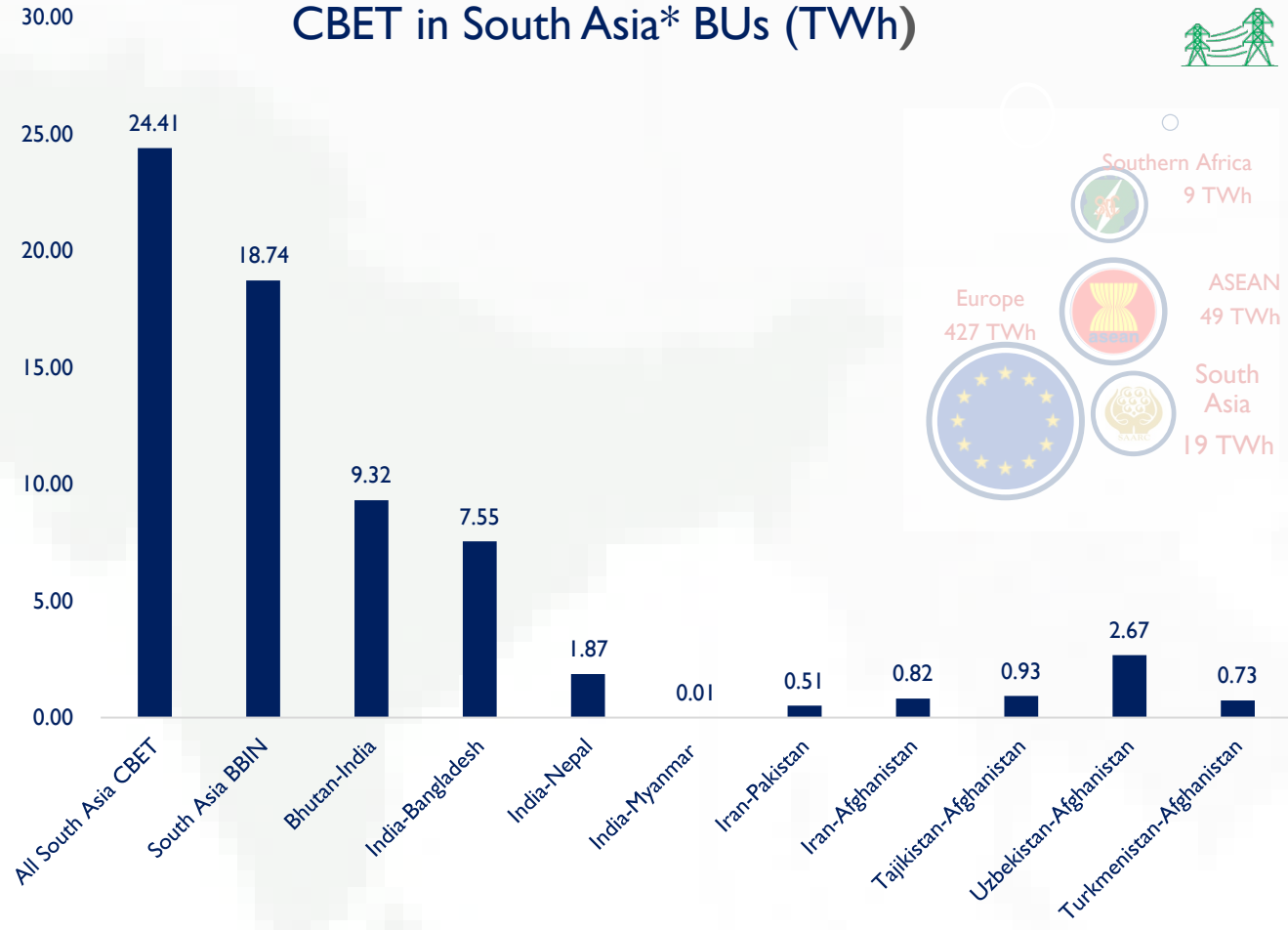
* BBINM, ~ Maximum Peak Trade Data Source-CERC, POSOCO, NEA, MEA, NSB, Grid India Daily Report, Includes Godda -> Bangladesh day Peak –Ex-1408 MW on 12-Sep-2023 & Other Sources

South Asia (BBINM) CBET BUs (TWH)



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

CBET in South Asia* BUs (TWh)

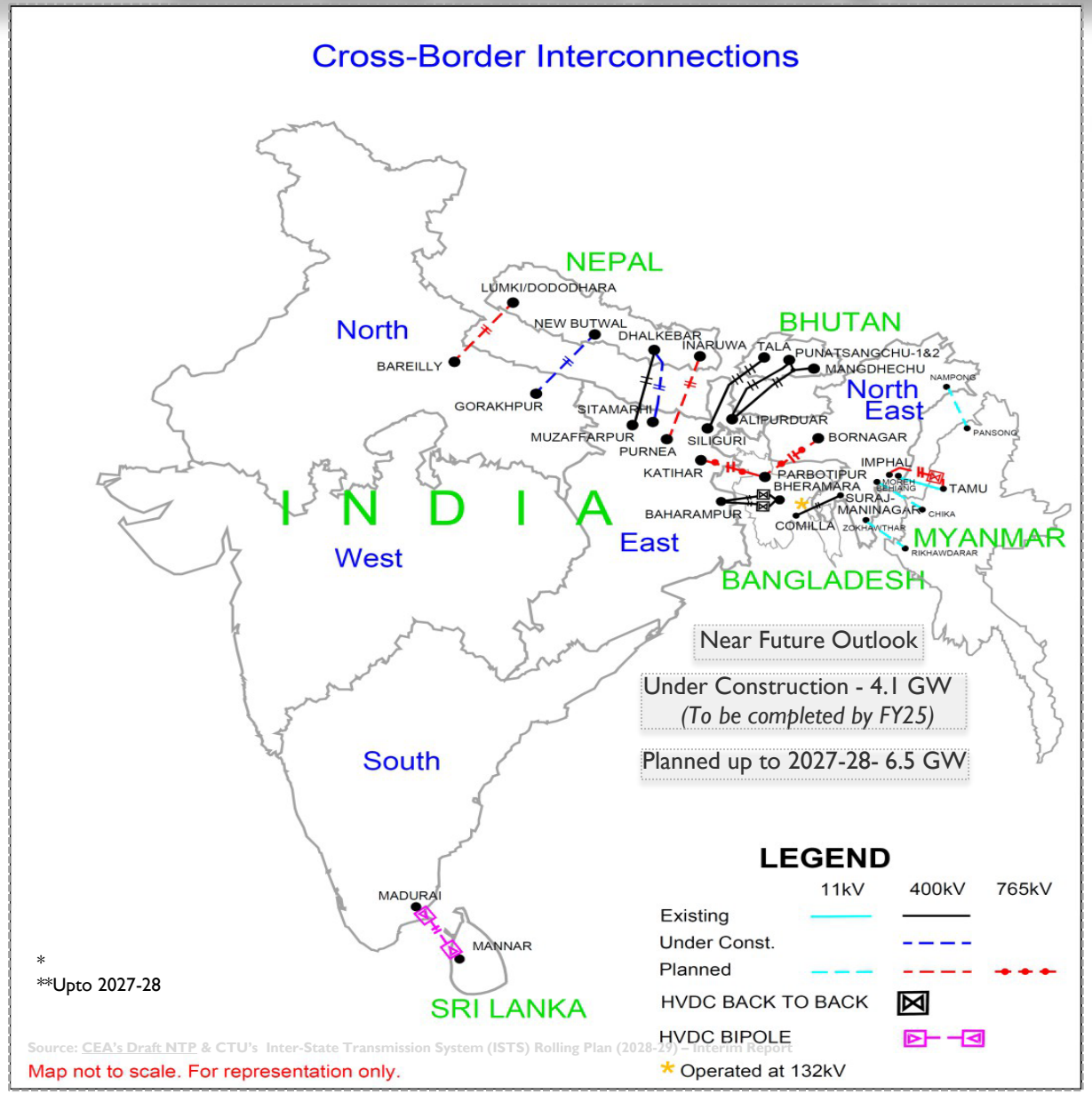


* BBIN & Trade with Neighbouring Region's Countries i.e., Afghanistan's CBET with Central Asian Countries and Iran, Pakistan's CBET with Iran, India's CBET with Myanmar
Data Source- Compile by Author from various Sources -CERC, POSOCO, NEPRA, Afghanistan Statistics , CBET-Cross Border Electricity Trade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

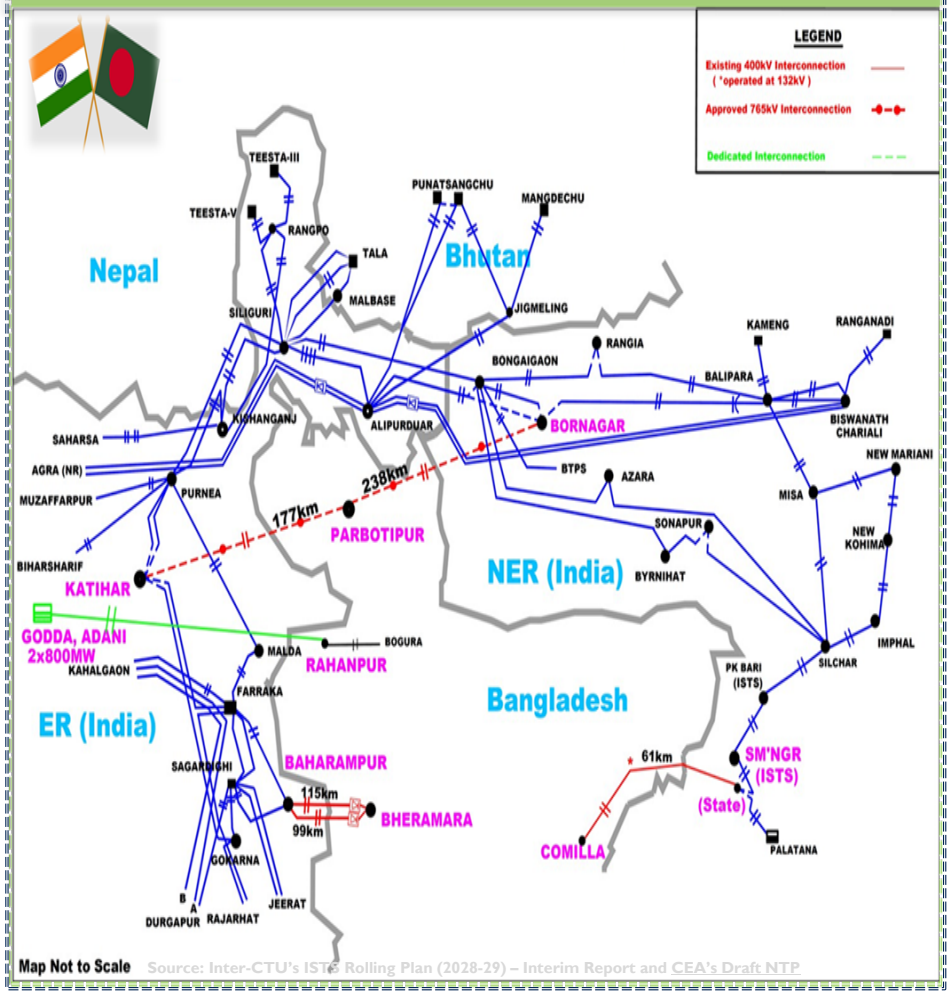
01.2 South Asia: Current Scenario & Future Outlook-*Cross Border Transmission Interconnection*



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

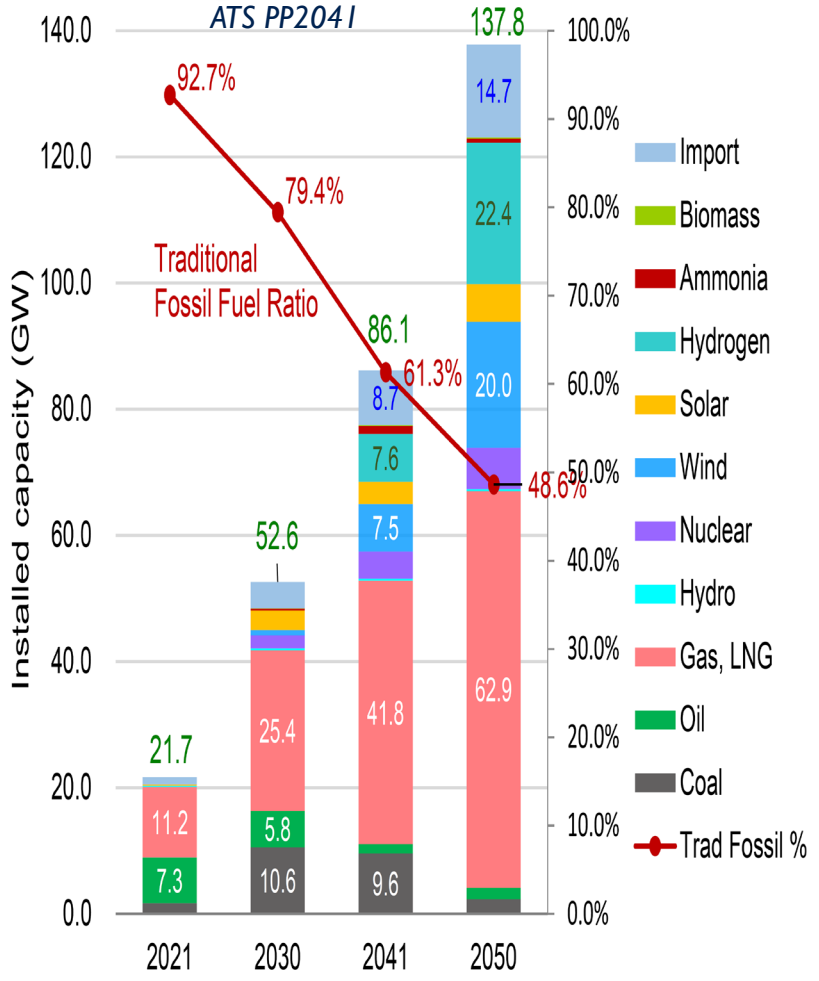
02 Planned/Under Discussion Cross Border Transmission: *India-Bangladesh*

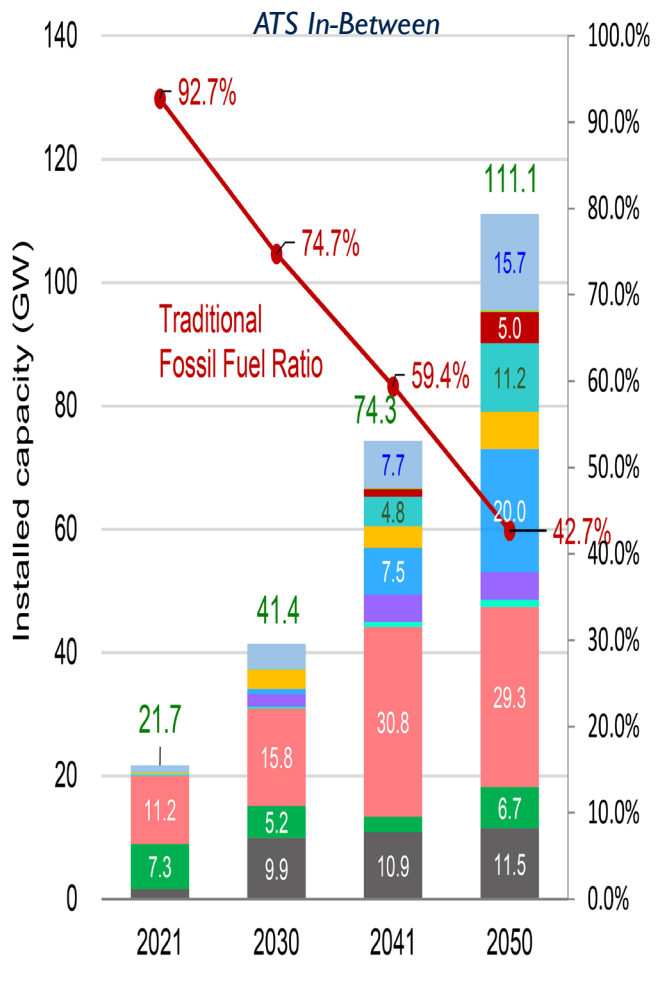
India-Bangladesh's Planned Katihar (Bihar) – Parbotipur (Bangladesh) – Bornagar (Assam) 765kV D/c line



Map Not to Scale Source: Inter-CTU's ISTS Rolling Plan (2028-29) – Interim Report and CEA's Draft NTP

Bangladesh-15.7 GW of Import by 2050 *(IEPMP) 2023*



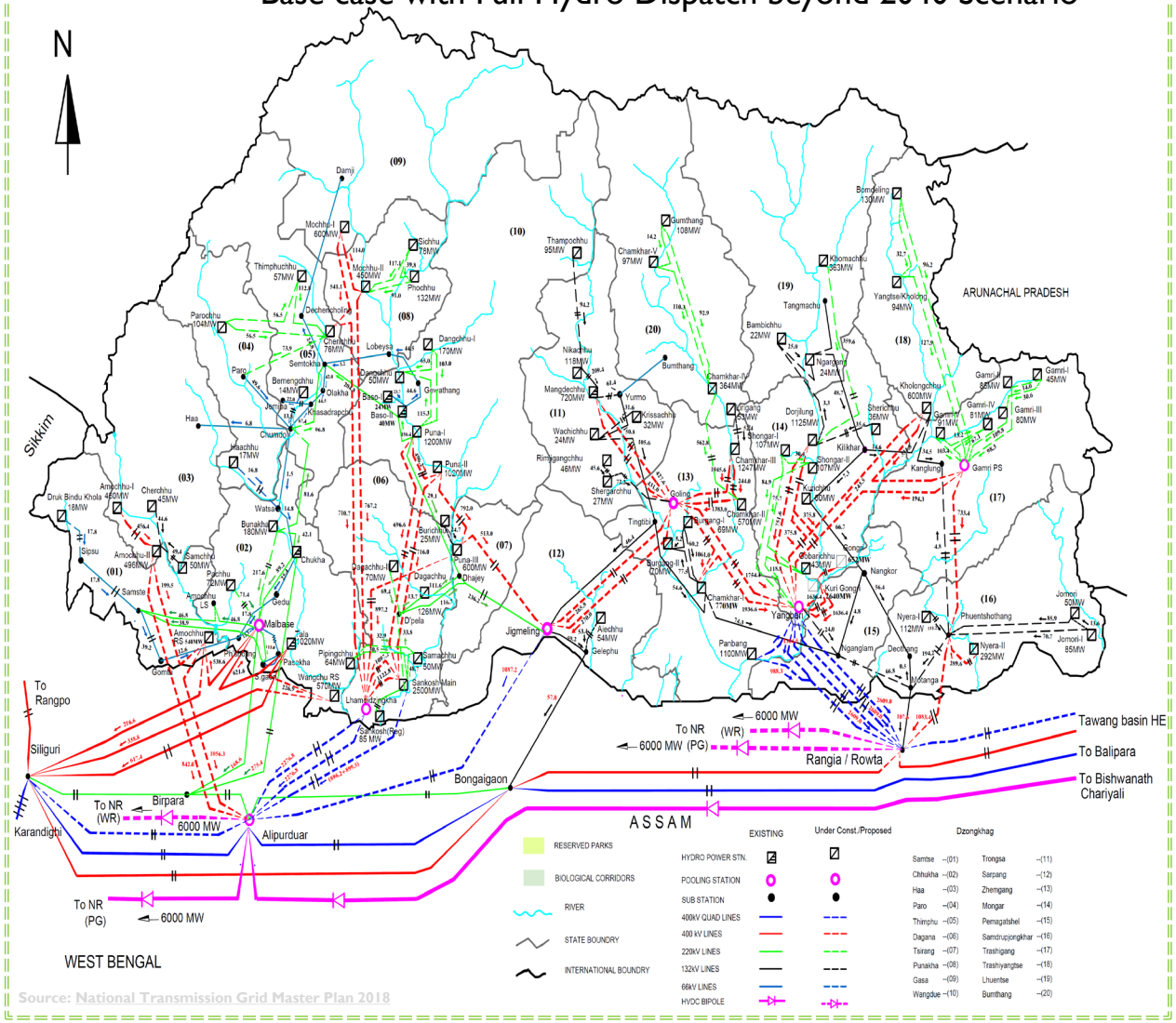


Source: Integrated Energy and Power Master Plan (IEPMP) 2023

First 765 KV Cross-Border Transmission System Interconnection I More Interconnection would be needed for 15.7 GW of Import

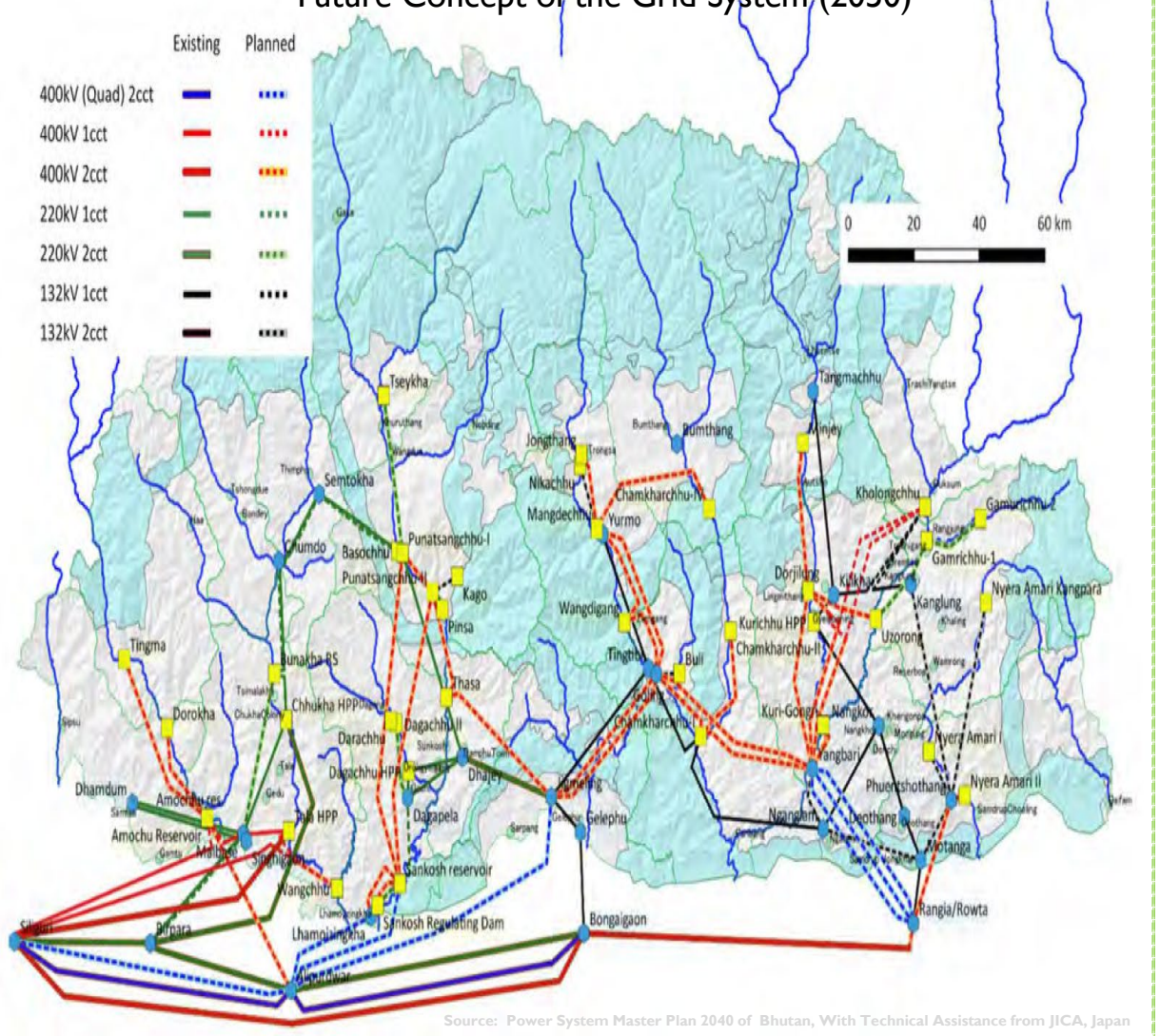
02 Bhutan's Planned Cross Border Transmission Interconnection: *Bhutan-India*

Base case with Full Hydro Dispatch beyond 2040 Scenario



Source: National Transmission Grid Master Plan 2018

Future Concept of the Grid System (2050)



Source: Power System Master Plan 2040 of Bhutan, With Technical Assistance from JICA, Japan

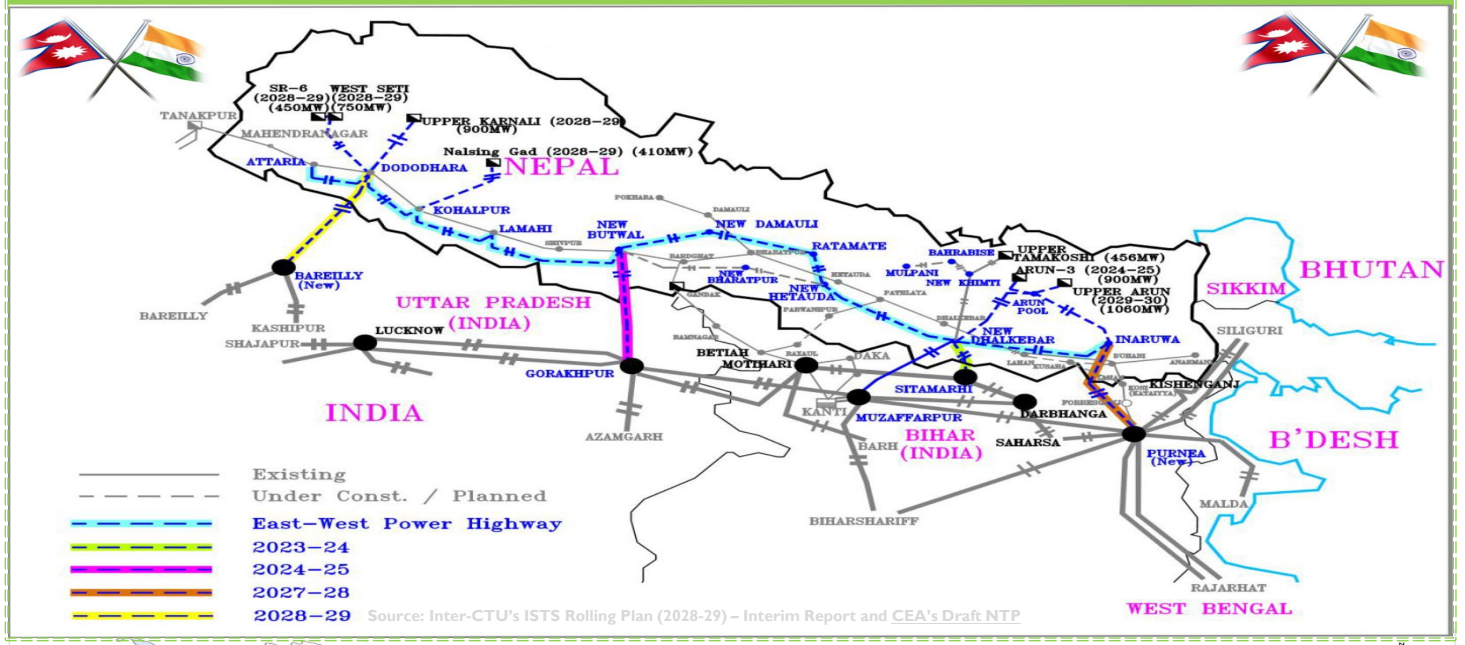
Bhutan Has Robust X Border Interconnection with India. Several High-Capacity Interconnections are Envisaged

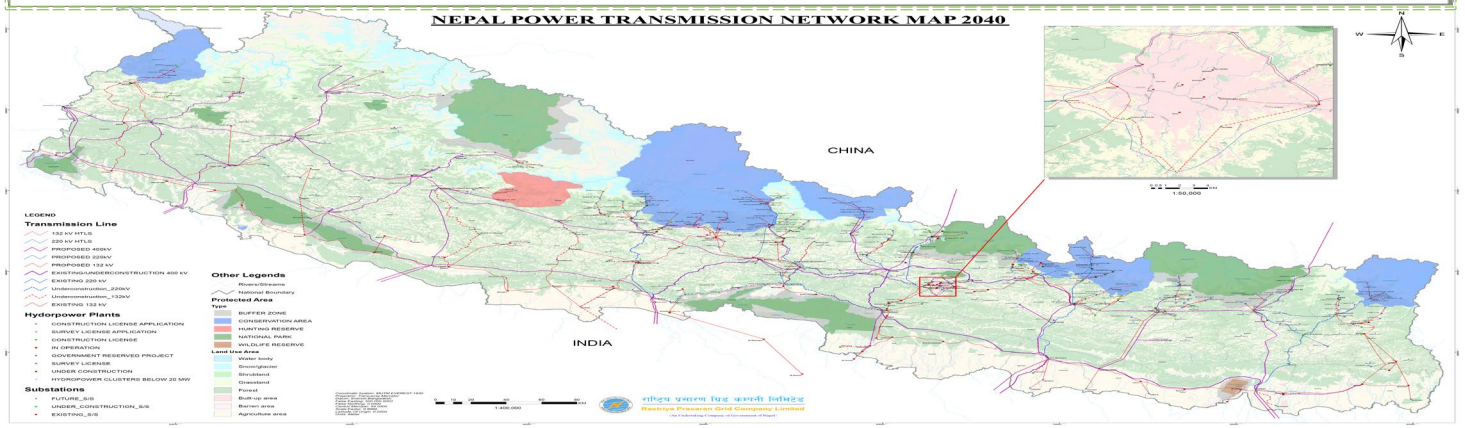
02 Planned/Under Discussion Cross Border Transmission : India-Nepal

NEPAL 's PROPOSED CROSS BORDER LINE WITH INDIA			
Name	From BUS	To BUS	MW Flow
Attariya- Bareily Cross Border Transmission Line			
Attariya-Bareily	Attariya 400	Bareily	700
Dododhara–Bareily Cross Border Transmission Line			
Dododhara-Bareily	Dododhara 400	Bareily	3000
Phulbari–Lucknow Cross Border Transmission Line			
Phulbari-Lucknow	Phulbari 400	Lucknow	2600
New Butwal–Gorakhpur Cross Border Transmission Line*			
Butwal-Gorakhpur	Butwal 400	Gorakhpur	2500
Dhalkebar – Muzaffarpur Cross Border Transmission Line			
Dhalkebar-Muzaffarpur	Dhalkebar 400	Muzaffarpur	3100
Inaurwa – Purnea - Cross Border Transmission Line			
Inaurwa-Purnea	Inaurwa 400	Purnea	1800

Source: Transmission System Development Plan of Nepal-July 2018 * Under Construction

India-Nepal Cross Border Transmission Interconnections Plan upto 2029-2030





Six Number of 400 KV Cross-Border Transmission System Interconnection

02 Planned/Under Discussion Cross Border Transmission : India-Sri Lanka & India-Myanmar

India-Sri Lanka

±320kV HVDC link (2x500 MW) between Madurai (India) and Mannar (Sri Lanka)

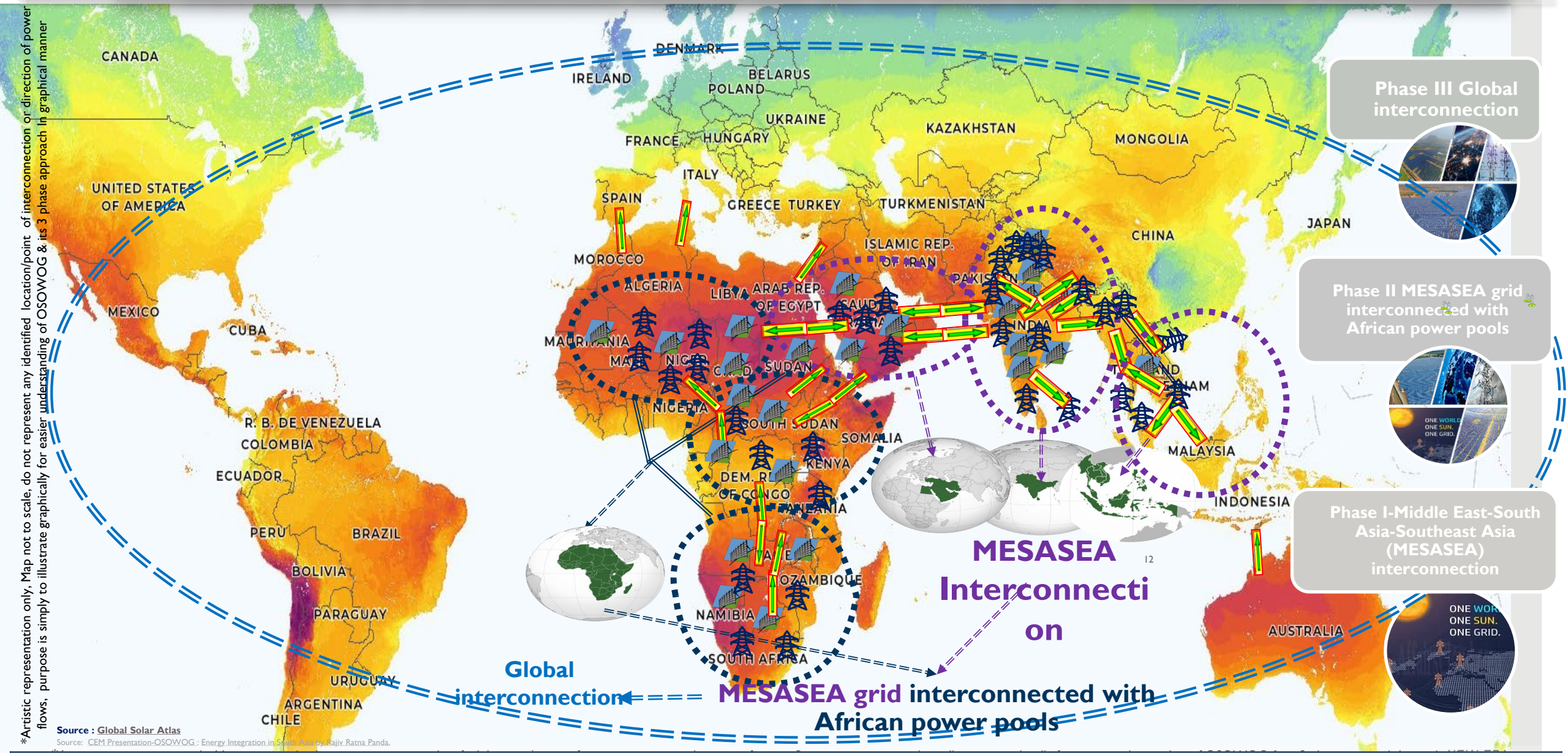
India-Myanmar

Imphal (India) - Tamu (Myanmar) AC line along with 1x500 MW HVDC back-to-back

03 Trans-Regional Transmission/Grid Connectivity

One Sun One World One Grid (OSOWOG)

03 Transregional Grid Interconnections Potential :One Sun One World One Grid (OSOWOG)- *3 Phase Approach*



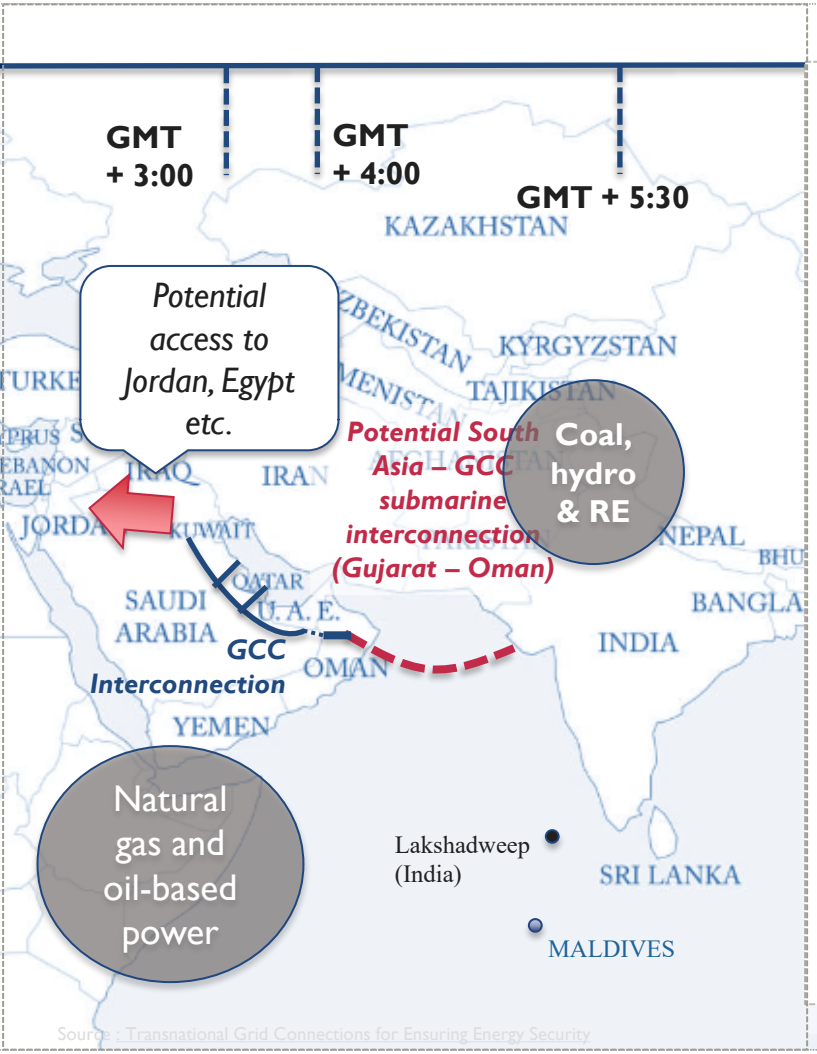
*Artistic representation only, Map not to scale, do not represent any identified location/point of interconnection or direction of power flows, purpose is simply to illustrate graphically for easier understanding of OSOWOG & its 3 phase approach in graphical manner

Source : Global Solar Atlas

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

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

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



India (Gujarat) – GCC (Oman) Interconnection

HVDC Submarine Cable

Oman is connected to GCC Grid

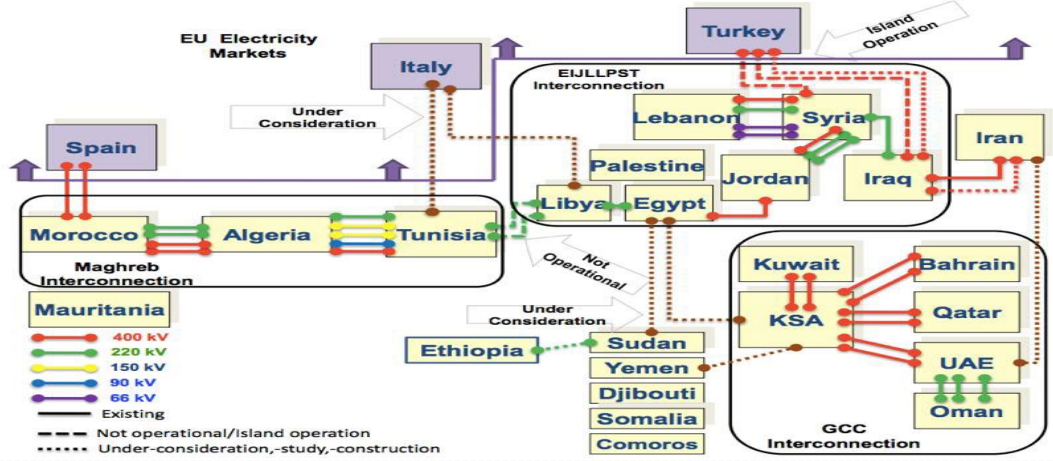
Oman–India transmission 2300 km, of , 1000 km across sea, while the maximum depth 3500 m.

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)**

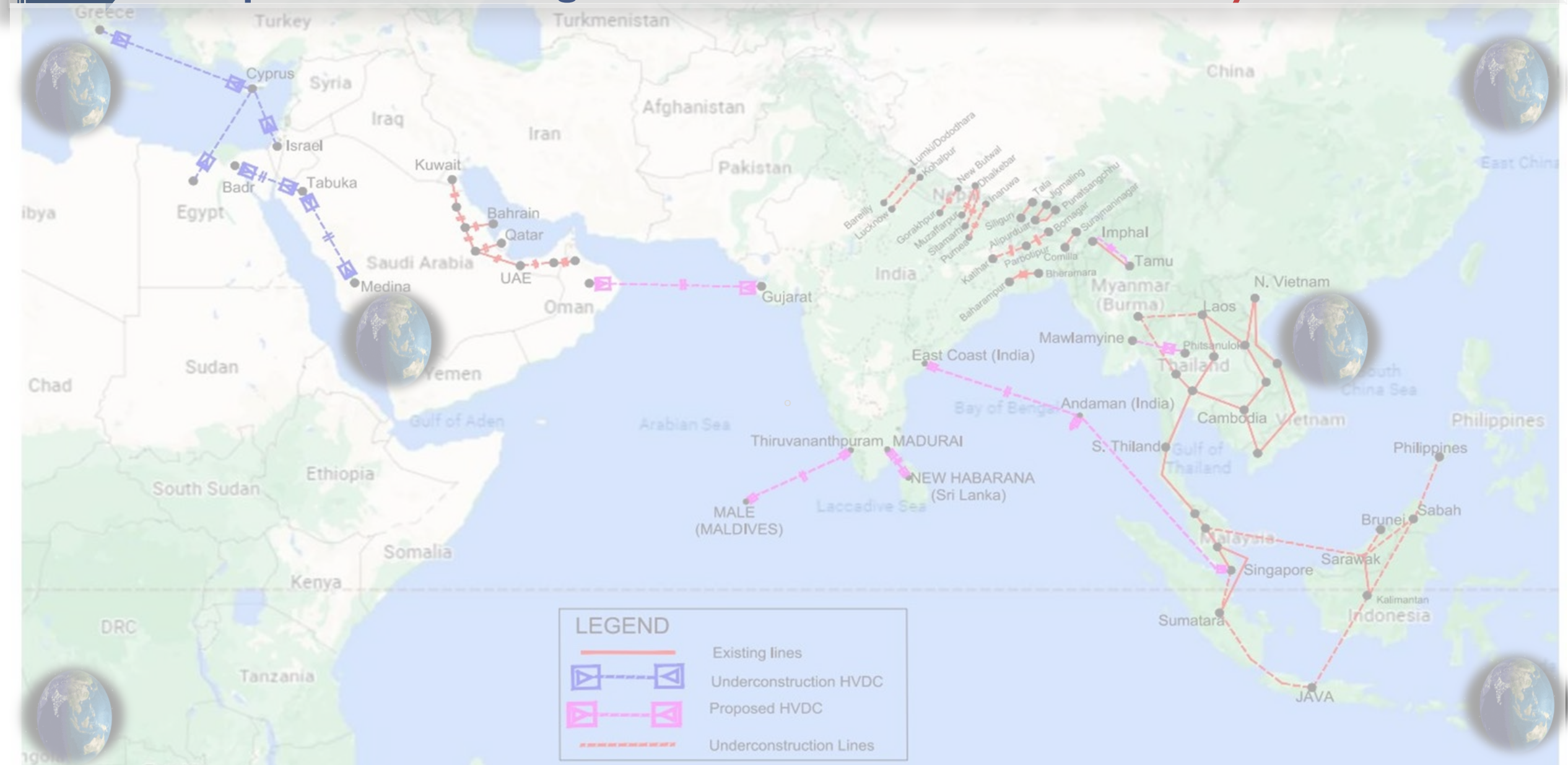
A solar park in Egypt can sell excess green peaking power to India (given the 3.5-hour time difference)

Source : Inter-Continental Grid by Pratik Agarwal



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

03 Prospects of Trans-Regional Interconnection- *Solar Diversity, Sun Never Sets*



Source : Courtesy : 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) on Colombo, Sri Lanka, on October 12 and 13, 2023 , South Asia (BBIN) Power Summit 2023 , Joint Statement: Visit of Prime Minister to the United Arab Emirates (February 13-14, 2024) , Various News Article on OSOWOG, Roundtable on 'Interconnection of Regional Grids in Asia – Cross Border Electricity Trade Across Regions', at India Smart Utility Week (ISUW) 2023, organized by USAID and European Union

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04

Study on International Best Practice for Developing Cross-Border Electricity Transmission Infrastructure : Study Rationale, Scope, Approach & Methodology

04 Study on International Best Practice for Developing Cross-Border Electricity Transmission Infrastructure : Study Rationale

Rationale for the Study

Considering that multiple cross border lines are under planning and/or construction phase in the South Asia region, a ***consolidated study report based on International Best Practice*** *on the* ***available options for business model, project structuring, cost sharing, benefit sharing, risk allocation etc.*** *which may facilitate* ***faster decision making*** *among regional participants and help in* ***investment mobilization of cross border transmission interconnection*** *and also help in* ***trans-regional interconnection being worked upon under OSOWOG***

Sl. No.	Key Cross Border transmission lines in South Asia (BBIN) Region	Investment Made by the Entity for		Investment Recovery by the entity of	
		Indian Portion	Neighboring Country	Indian portion	Neighboring Country
1	Muzaffarpur - Dhalkebar 400kV D/c line	JV of PGCIL, SJVN, IL&FS & NEA	JV of NEA, PGCIL and others	NEA	NEA
2	Kataiyya - Kusaha 132kV S/c on D/c line & Raxaul-Parwanipur 132kV S/c on D/c line	Grant from GoI	Grant from GoI	-	-
3	Butwal - Gorakhpur 400kV D/c (Q) line	JV of PGCIL and NEA	NEA	NEA	NEA
4	Dhalkebar– Sitamarhi 400 kV D/c (Quad) line	SAPDC	SAPDC	SAPDC	SAPDC
5	Baharampur - Bheramara 2xD/c	PGCIL	PGCB	BPDP	BPDP
6	Surajmaninagar - Comilla 400kV line (Op. 132kV)	PGCIL	PGCB	BPDP	BPDP
7	Tala - Siliguri 400kV 2xD/c line	PGCIL	Tala HPA	Indian beneficiaries	Tala HPA
8	Chukha - Birpara 220kV (3 circuits)	PGCIL	Chukha HPA	Indian beneficiaries	Chukha HPA
9	Deothang - Rangia 132kV S/c line	Grant from India (GoI)	Grant from GoI	-	-
10	Punatsangchu - Alipurduar 400kV D/c (Q) line	PGCIL	Punatsangchu HPA	Indian beneficiaries	Punatsangchu HPA
11	Jigmeling - Alipurduar 400kV D/c (Q) line	PGCIL	Mangdechu HPA	Indian beneficiaries	Mangdechu HPA
12	Moreh - Tamu 33kV line	Grant from India (GoI)	Grant from GoI	-	-

Note: HPA-Hydro Power Authorities, GoI, Government of India , SAPDC-SJVN Arun-3 Power Development Company Pvt. Ltd.

Source: Compiled from various Sources, CTU's Presentation, PGCIL, ISTS Rolling Plan (2028-29) – Interim Report and CEA's Draft NTP

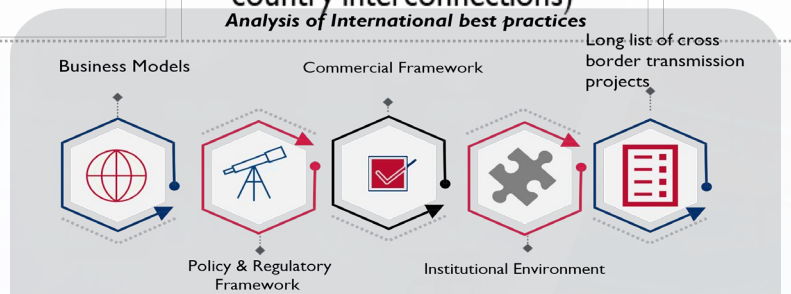
South Asia would spend **29 billion US$** for planned inter-grid connection by 2040*. Except in case of 400 kV Dhalkebar-Muzaffarpur line, & dedicated transmission line of Godda thermal power, conventional Government owned model have been tried out & preferred for CB lines.

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

04 Study on International Best Practice for Developing Cross-Border Electricity Transmission Infrastructure : Summarised Scope of Work, Approach & Methodology

A. REVIEW | **B. DEVELOP**

	1 Review & Analysis	2 Contextual Assessment	3 Case Studies	4 Workshop	5 Report
Target	In depth review & analysis of CBET infrastructure development ecosystems	Contextual analysis of cross-border electricity transmission infrastructure projects	Detailed case studies from inception of projects till execution and operation	Stakeholder workshop	Report on international best practices on financial models for developing CBET infrastructure
Activities	• Business and financing model • Investment entity structuring • Ownership, financing mechanism • Risk management • Funding source • Contractual design & arrangements • Role of regional markets	• Role of Governments in development • Project Planning Procedure & implementation approval • Social economic analysis • Payment Security Mechanism • Dispute Resolution Mechanism	• Africa • ASEAN • North America • Australia • Gulf and Arab Region • European Union • Central Asia • South Asia (existing cross-country interconnections)	• Workshop with key stakeholders from all the regions • Summary proceeding of key findings and suggestions • Draft report on international best practices on business and financial models	• Key lessons learned • Recommendations for South Asia • Summary for Policy makers



04 Study on International Best Practice for Developing Cross-Border Electricity Transmission Infrastructure : Approach & Methodology

Typical Business Models for CBET Interconnections

Public/Govt. ownership	Owned by Government or a Government owned/controlled entity	Across the globe
Independent Power Transmission / Concessions	Line developed by a private entity under a Build-Own-Operate-Transfer (BOOT) or similar model of concession arrangement. Sometimes, the entity may also be a JV with some amount of Govt. ownership also.	Across the globe
Merchant Power Transmission	Line developed without any long-term revenue assurance through long term contracts – Relies on short term markets and anchor customers for revenue generation.	USA, Australia etc. Example – Basslink in Australia
Financial ownership	While line will be developed, constructed and operated by a state-owned transmission/system operator, a private entity to have partial ownership stake, and resulting dividend/share on profits.	Europe, Africa etc. Example – Denmark Germany interconnection
Dedicated transmission line	Dedicated line for evacuation from a power plant, typically operated by entity owning the plant also. Cost towards transmission is typically bundled within the Power Purchase Agreement (PPA) price.	Across the globe

The CBET line ownership also have a geographic element to it – Whether there is separate legal entity and ownership for infrastructure in each of the countries through which the line passes, or whether there is a single entity that has ownership of the entire infrastructure.

Based on Literature Survey, typical business model identified and were categorized into five models, accordingly a list of Croos border interconnection across the globe were drawn upon while maintaining the diversity across business models and regional presence

04 Study Approach & Methodology : *A long list of nearly 30 projects were analyzed to create shortlist for case study*

Typical Business Models for CBET Interconnections

Public/Govt. ownership	**500 kV HVDC Ethiopia- Kenya Power interconnection** **500 kV HVDC NEMO link (UK – Belgium)** **400 kV HVAC GCC Interconnector** **400 kV HVAC MOTRACO** 220 kV HVAC Egypt Sudan Interconnector 330 kV HVAC Nigeria Benin Interconnector 330 kV HVDC Zambia Namibia (Caprivi) Interconnector	220 kV HVAC Egypt Libya Interconnection 400 kV HVAC Egypt Jordan Interconnection 500 kV HVAC Uzbekistan-Kyrgyzstan Interconnection 320 kV HVDC COBRAcable (COpenhagen-BRussels-Amsterdam) 515 kV HVDC Northsea Link (Norway - UK) 230 kV HVAC Colombia Ecuador line 400 kV HVAC Mexico Guatemala interconnection 500 kV HVAC Manitoba–Minnesota Transmission Project (MMTP)
Independent Power Transmission / Concessions	**115 kV HVAC Cambodia Thailand interconnection** **500 kV HVDC Garabi Interconnector (Argentina – Brazil)** **230 kV HVAC Central American Interconnection (SIEPAC)**	320 kV HVDC Eleclink (France-UK) 220 kV HVAC Zambia - DRC interconnector line (Copperbelt) Lines of Mozambique Transmission Company (MOTRACO) 450 kV HVDC BritNed 450 kV HVDC NordNed
Merchant Power Transmission	**500 kV HVDC Basslink Interconnector (Australia)** **230 kV HVAC Montana Alberta Tie Line**	
Financial ownership	170 kV HVAC Kriegers Flak Denmark-Germany interconnection	
Dedicated transmission line	533 kV HVDC Cahora Bassa Interconenctor 500 kV HVAC Nam Theun 2 line to Thai border 600 kV HVDC Itaipu (Paraguay Brazil)	

04 Study Approach & Methodology : *Case studies covered*

In addition to the Literature Survey and Analysis of Available information ,Virtual Interaction were also Conducted wherever possible

05

Study on International Best Practice for Developing Cross-Border Electricity Transmission Infrastructure : Expectation and Way Forward

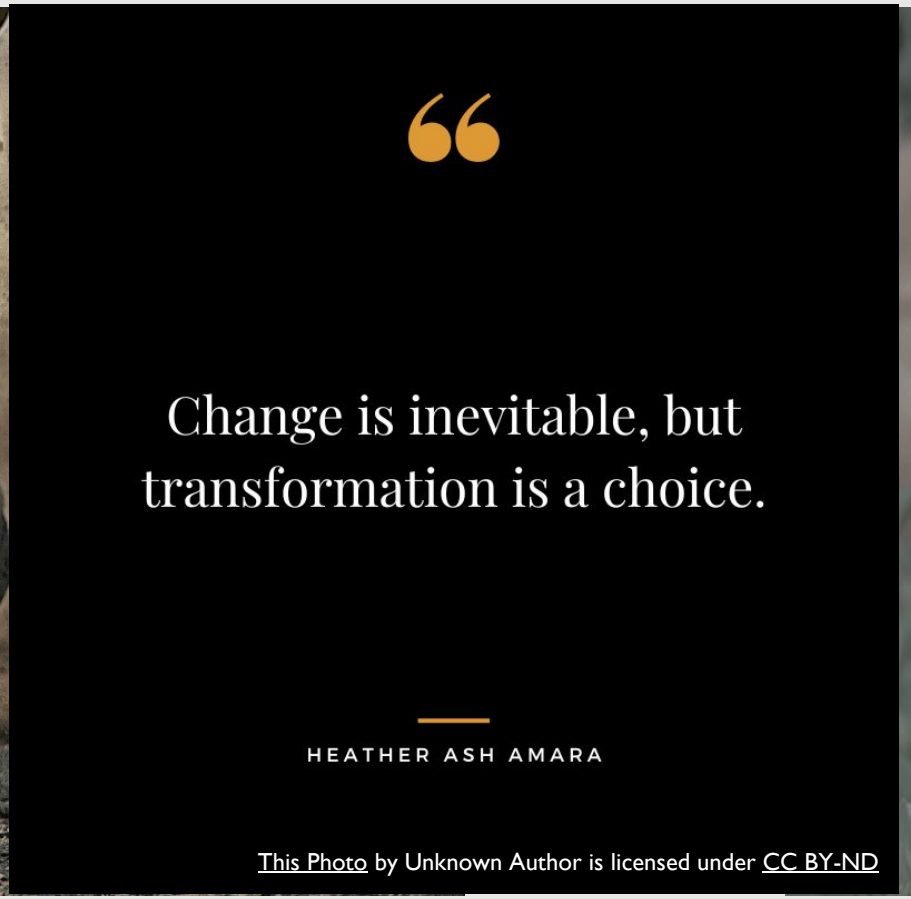
05 Expectation from the Workshop and Way Forward

Summarized Scope Of Work

Task 1: Review and analysis of the different cross-border transmission infrastructure development ecosystems	C1	Carry out a comprehensive review and in-depth review and analysis of different CBET infrastructure
	C2	Review of similarities/commonalities and differences amongst the models, benefits etc.
	C3	Review of examples covering key regions of the globe
	C4	Virtual meetings/interactions
Task 2: Gap analysis and interim report	C5	Draft interim report on international best practices on business and financial models
Task 3: Conduct stakeholder workshops to discuss draft findings	C6	Conduct stakeholder workshop to present the key findings and seek comments
	C7	Draft report on international practices on business & financial models for developing CBET infrastructure
Way Forward **Task 4: Finalization of report and key findings**	C8	Final report on international practices on financial models for developing CBET infrastructure, key lessons learned , recommendations suggested options for South Asia.
	C9	Based on the final report, prepare a summary for policymakers

Stakeholder and International Experts in the Workshop

Thank You



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01 Cross border interconnections in South Asia

CBET lines at 132 KV and above in BBIN region