



USAID
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South Asia Regional Energy Partnership (SAREP)

Presentation

on

Cross Border Electricity Trade, Regional Energy Cooperation and Emerging Outlook for South Asia

**Session 2: Country Updates on Advancement of Transmission system Interconnection
to support Cross Border Electricity Trade (CBET)**

**11th Meeting of SAREP Task Force-2 on “Advancement of Transmission System Interconnections for Cross Border Electricity Trade”
11.00-13.15 Hrs., 16th February 2023, Karnali Hall, Kathmandu Marriott Hotel, Kathmandu, Nepal**

**Presented by
Rajiv Ratna Panda**



Content

01

Cross Border Electricity Trade (CBET), Regional Energy Cooperation (REC), Emerging outlook for South Asia

01.1

Marco Economic Growth & Level of Economic Integration

01.2

Overview of SA regional power Sector

01.3

Evolution of Energy Integration & CBET

01.4

Current and Future Scenario of CBET

01.5

Emerging Outlook in South Asia-Opportunity for Deepening CBET and REC

01.5.1

Climate Change induced Renewable Based CBET

01.5.2

Impacting Clean Energy Transformation vision through CBET

01.5.3

Gradually Transitioning from Bilateral to Trilateral CBET in SA

01.5.4

Market Instruments, Regional Energy Market

01.5.5

One Sun One World One Grid (OSOWOG)

02

Challenges in Energy Integration & CBET in South Asia Region.

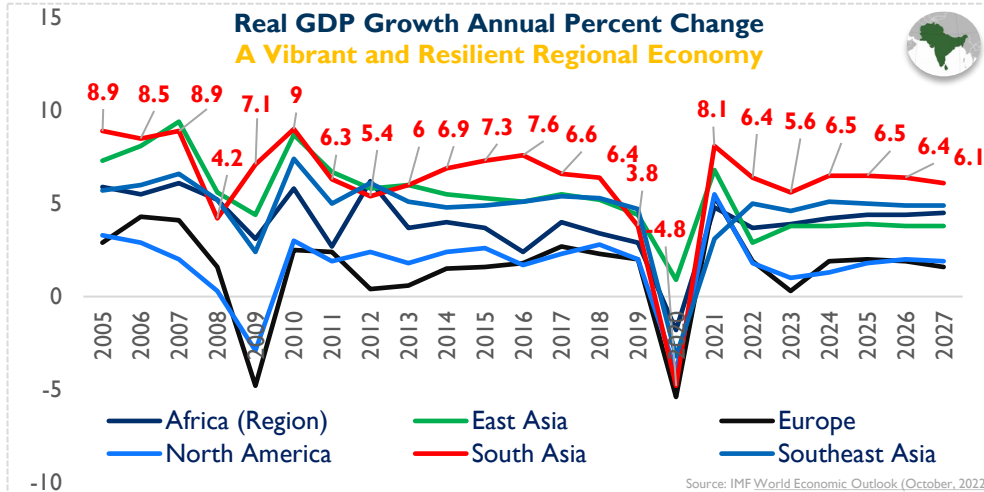
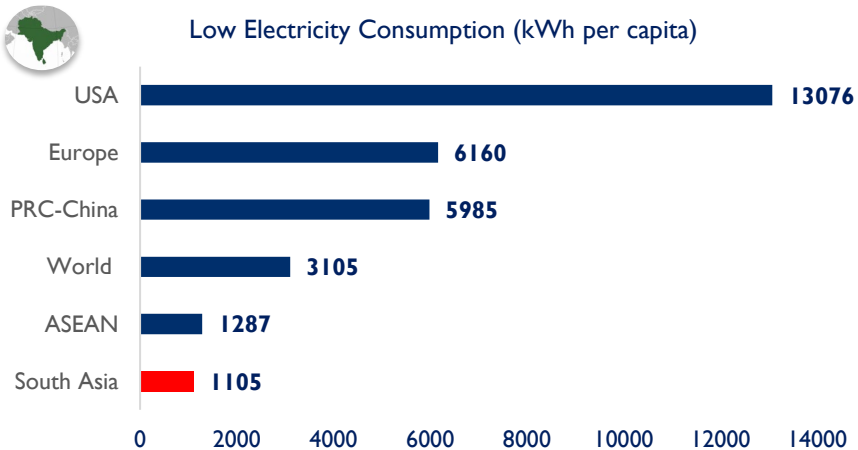
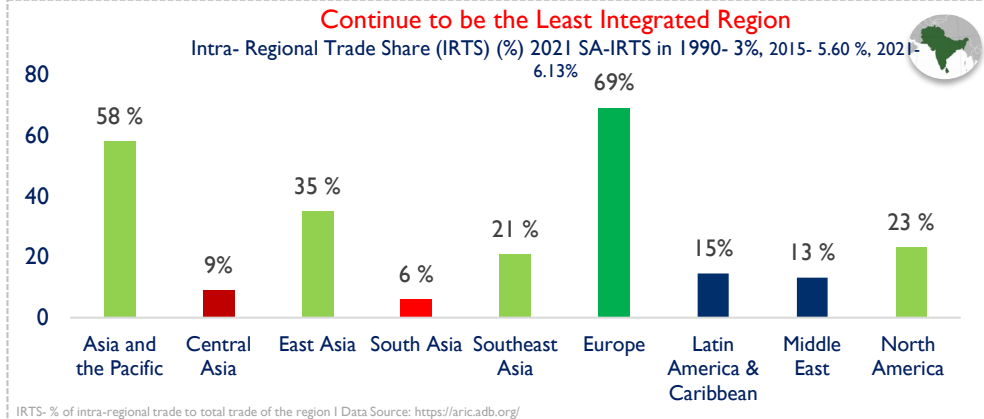
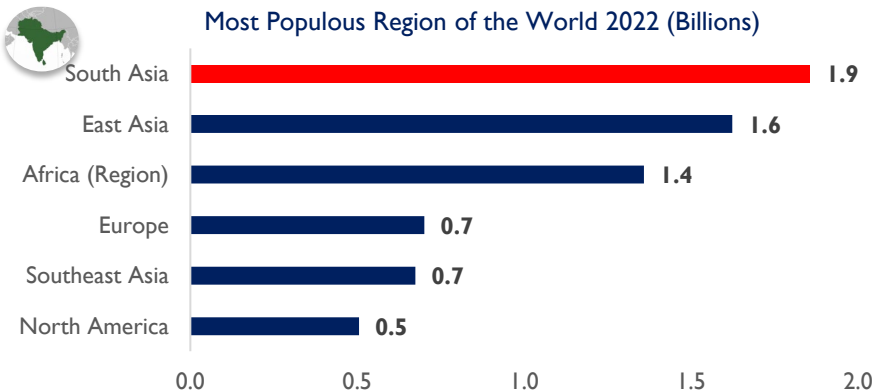
03

Enablers for Facilitating Cross Border Energy Integration & CBET in Coming Future.

Marco-Economic , Integration and Energy Situation in South Asia



Overview of South Asia (SA): A Unique & Dynamic Region of the World






Overview of South Asia Power Sector-A Snapshot



Overview of South Asia Power Sector-A Snapshot


Size: < 200 GW-Large, < 400 GW-Small, < 50 GW-Mid
 < 200 GW-Large, < 500 GW-Very Large

Afghanistan




- #Very small power system (~.6 GW)
- #High Electricity Imports
- #Hydro and Oil Dominated

Bangladesh




- #Mid size power system (~26 GW)
- #High gas dependence
- #Resource Crunch

Bhutan




- #Small power system (~2.3 GW)
- #Large Exporter of hydro power
- #Champion of Hydro CBET in SA

India




- #Very Large System (~410 GW)
- #Coal Dominated-210, RE-167 GW
- # Central to CBET in SA
- # Competitive Power Market

Maldives




- #Fragmented & very small power systems (~.5 GW)
- #Oil, Diesel dependent, Island's limited possibility of interconnection

Nepal




- #Very Small power system (2.1 GW)
- #Under utilized hydro (82 GW)
- #Potential-large exporter in future

Pakistan

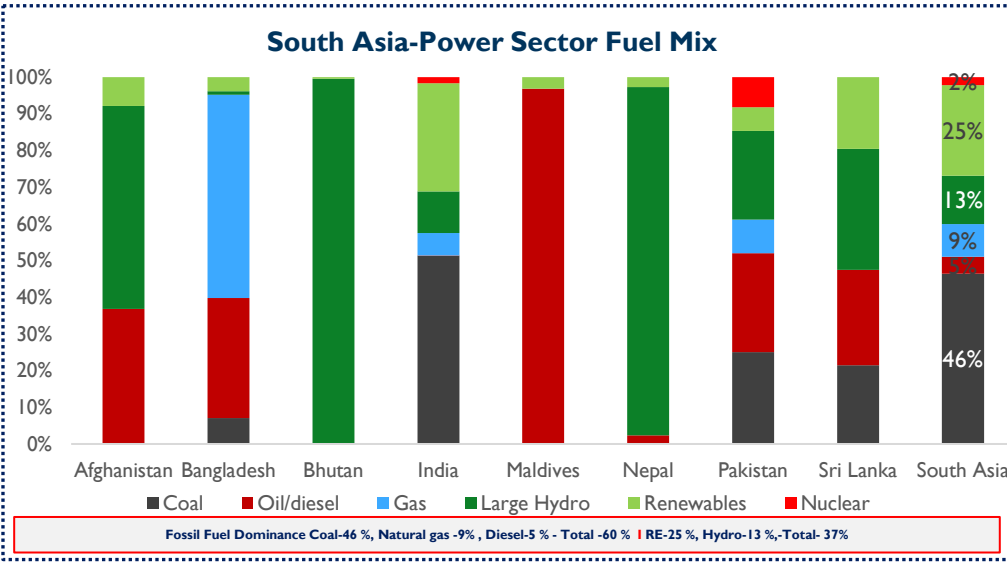
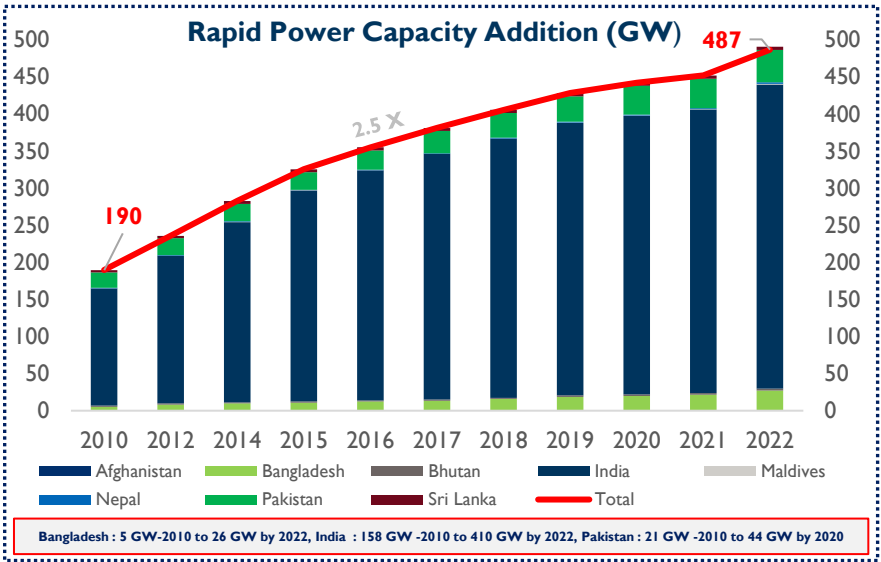


- #Mid sized (44 GW) power system
- #Gas and Oil dependent.

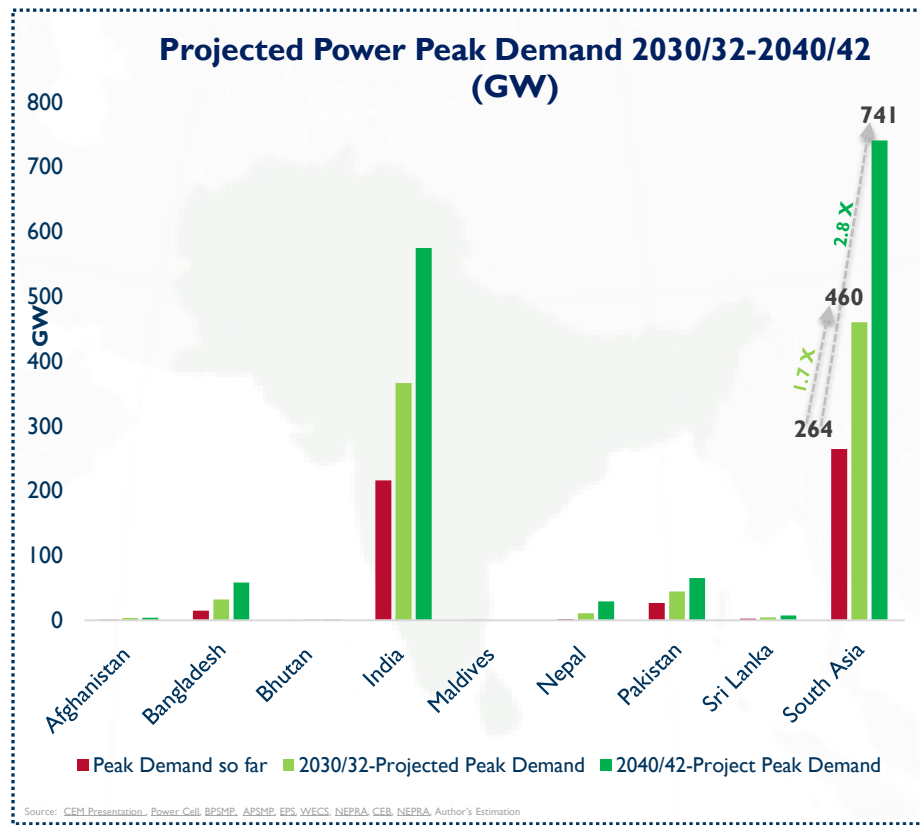
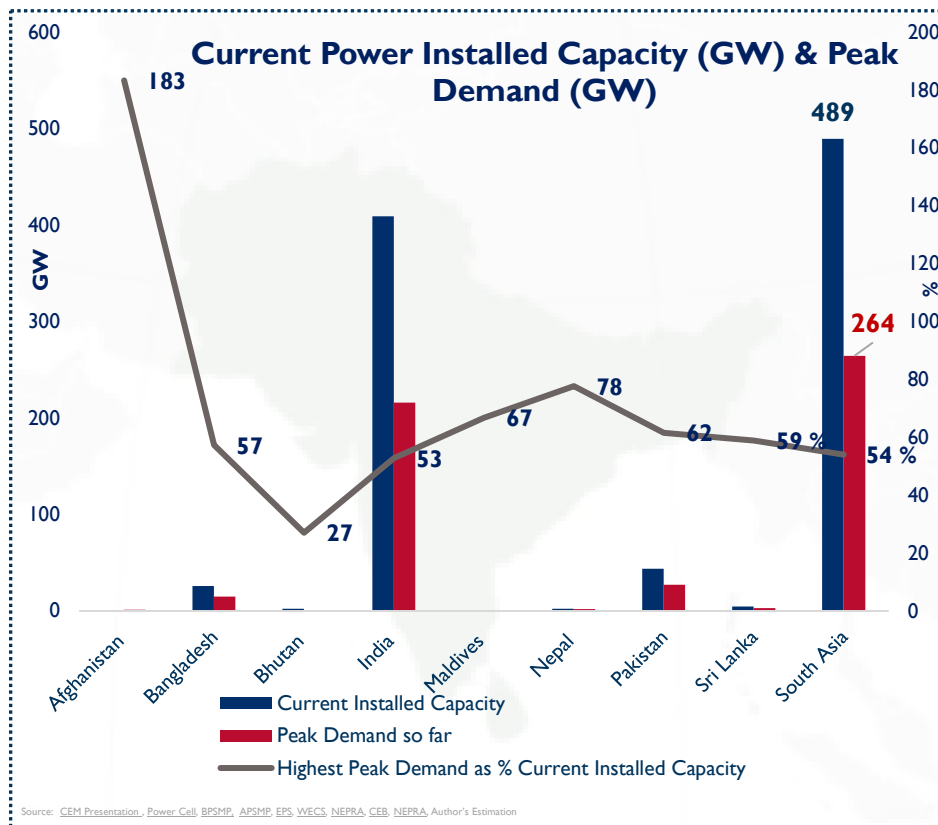
Sri Lanka



- #Small power system (~4 GW)
- # Hydro and Oil dominated
- # High Peak –Off peak differential



Overview of South Asia Power Sector-A Snapshot



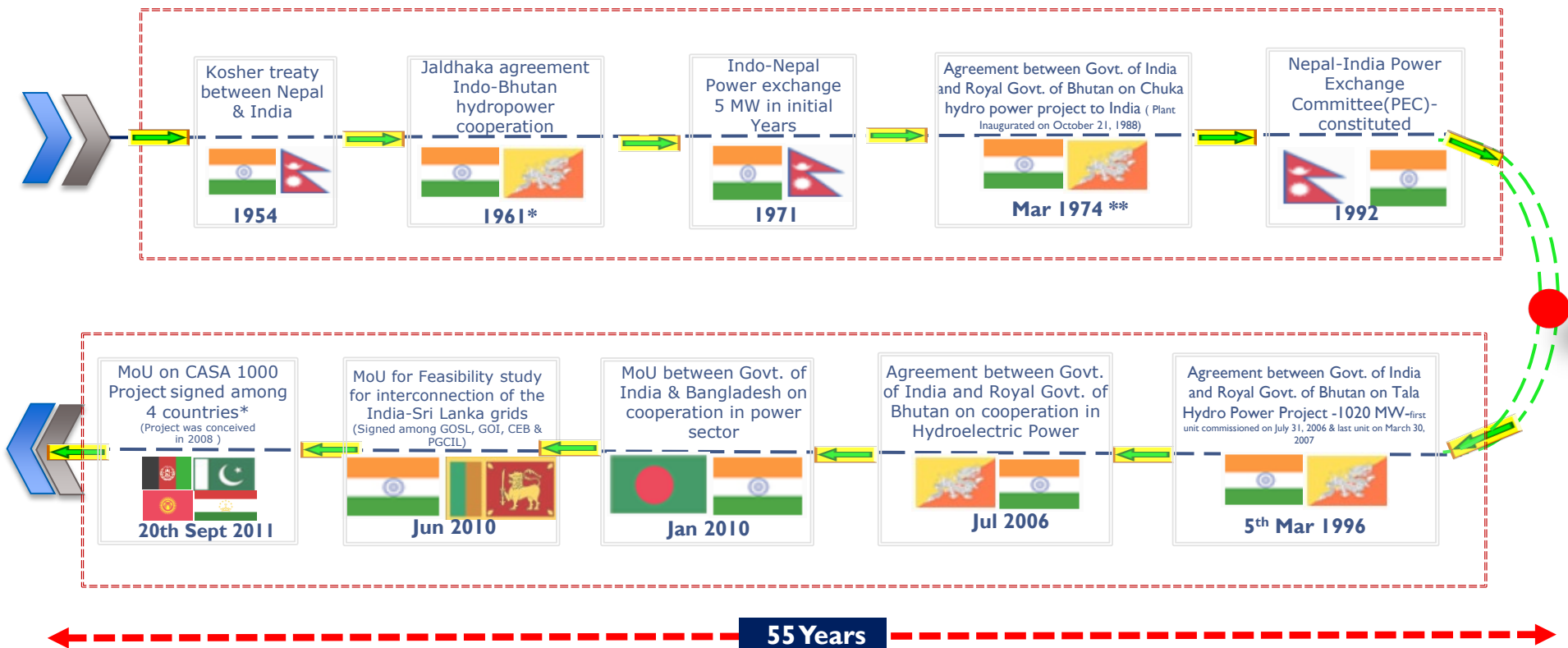
Opportunity for Generation Capacity Optimization | Massive demand growth in future | Significant Capacity addition will be needed



Evolution of Regional Energy Cooperation & Cross Border Electricity Trade (CBET)



Evolution of Regional Energy Cooperation and Cross Border Electricity Trade (CBET) : Half a Century Journey

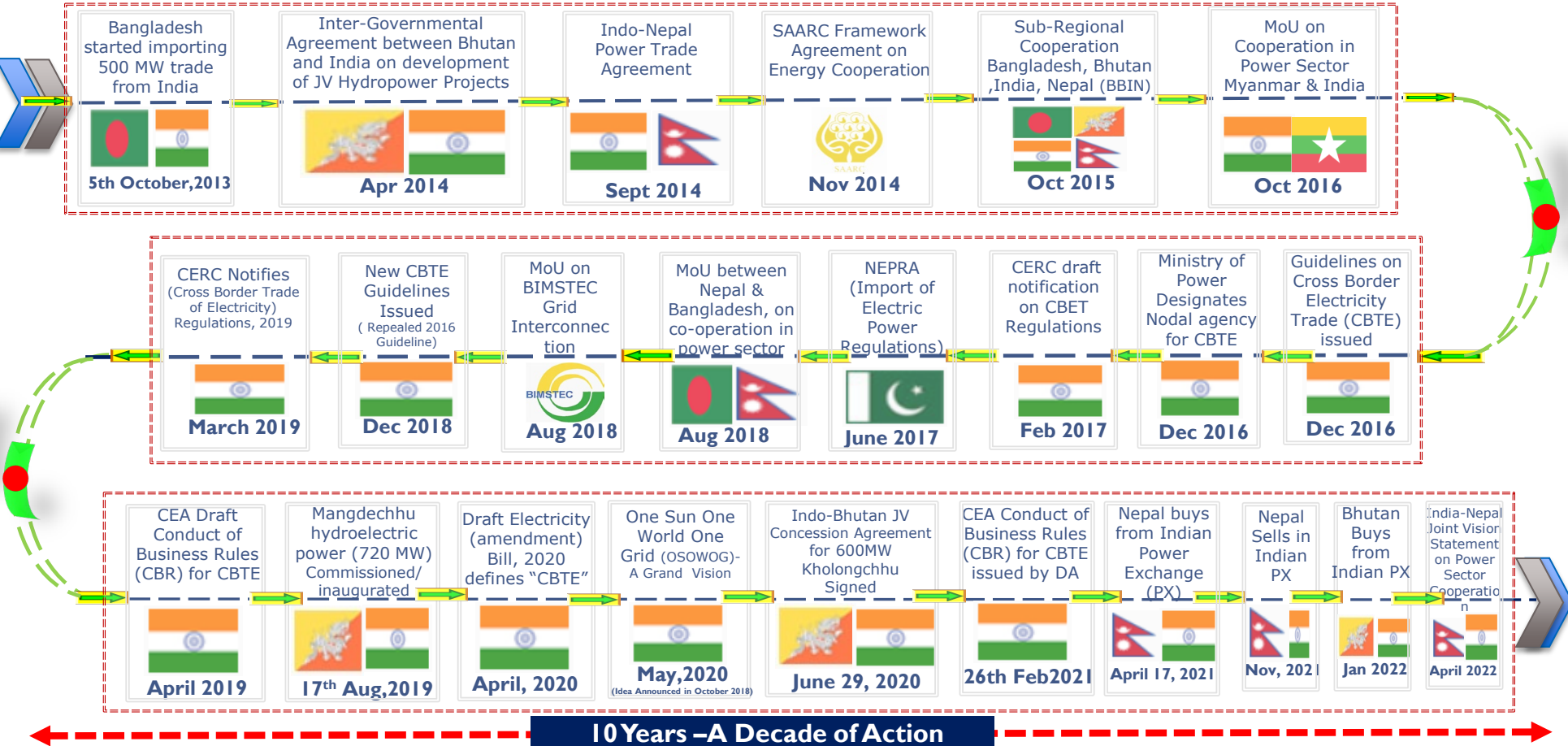


* http://www.mfa.gov.bf/rbedelhi/page_id=28 Source: CEM Presentation-OSQWOG : Energy Integration in South Asia by Rajiv Ratna Panda. ** <http://www.mea.gov.in/bilateral-documents.htm?dtl/6349/agreement>

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

Significant Developments in Energy Cooperation, CBET- Key Policy & Regulatory

A Decade of Policy and Regulatory Action and Implementation

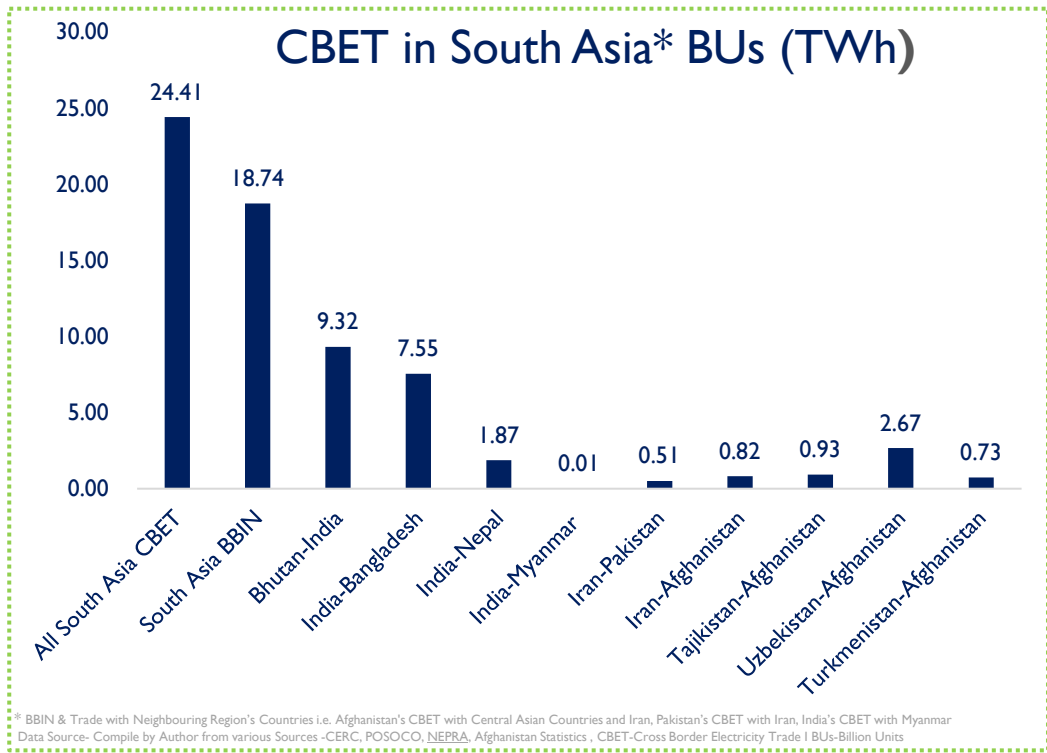
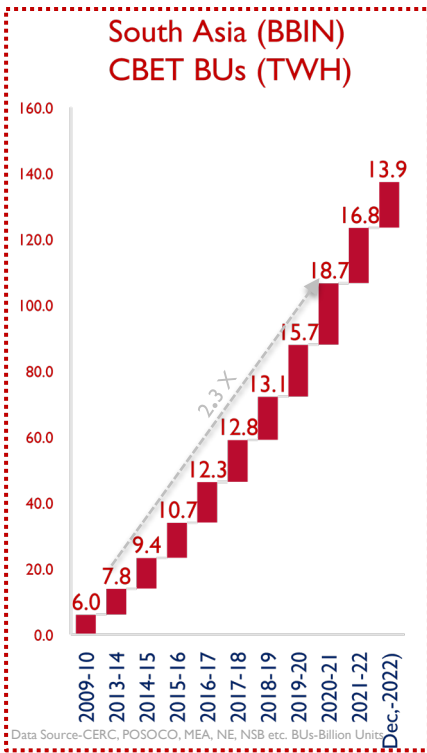
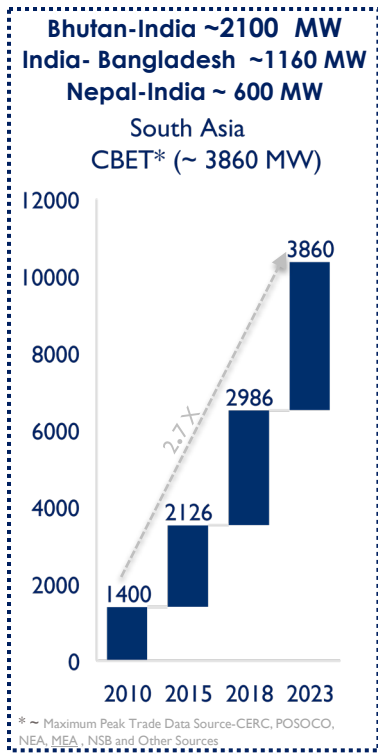




Cross Border Electricity Trade (CBET) in South Asia

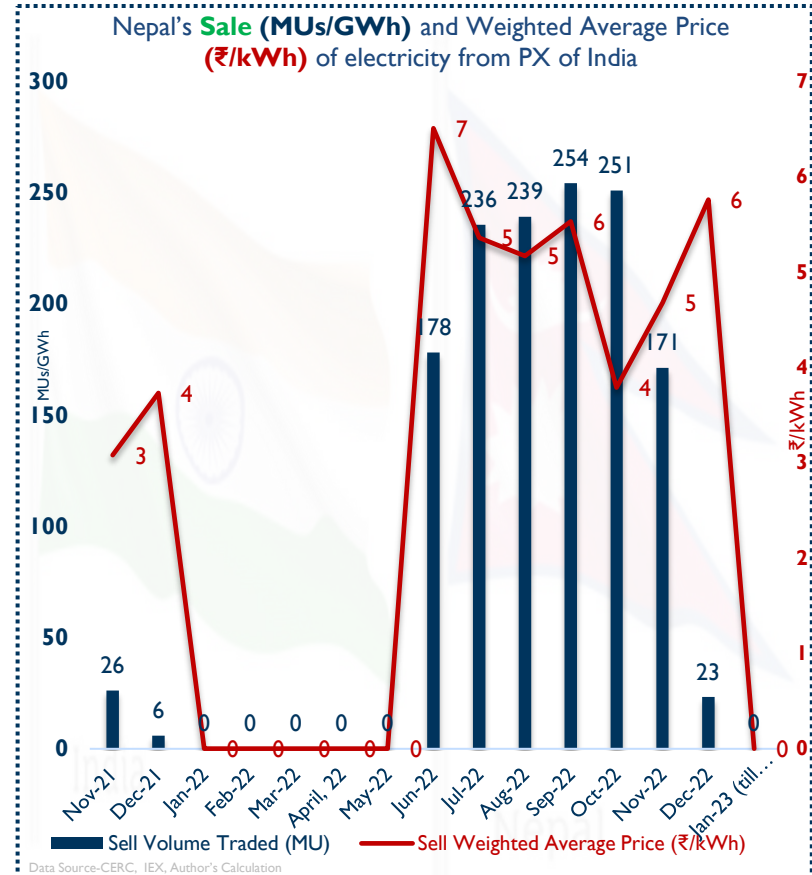
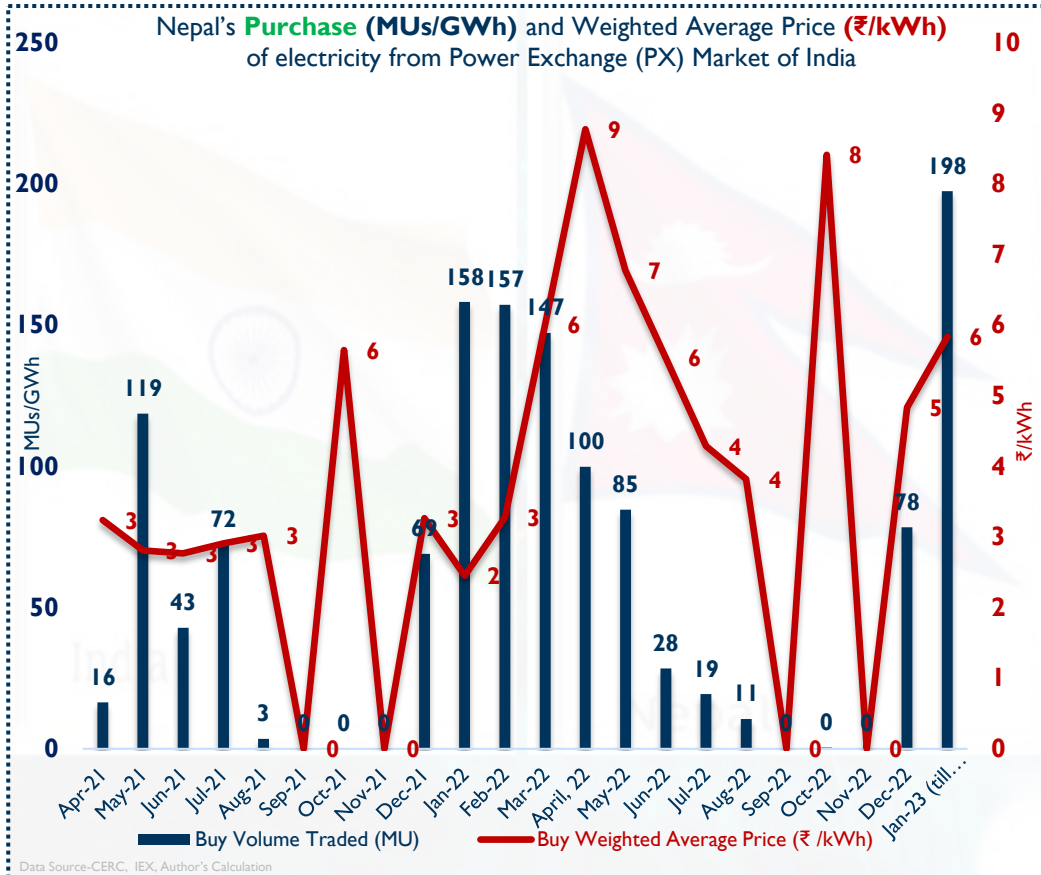
Current Scenario

01.4 Cross Border Electricity Trade (CBET) in South Asia : Current Scenario



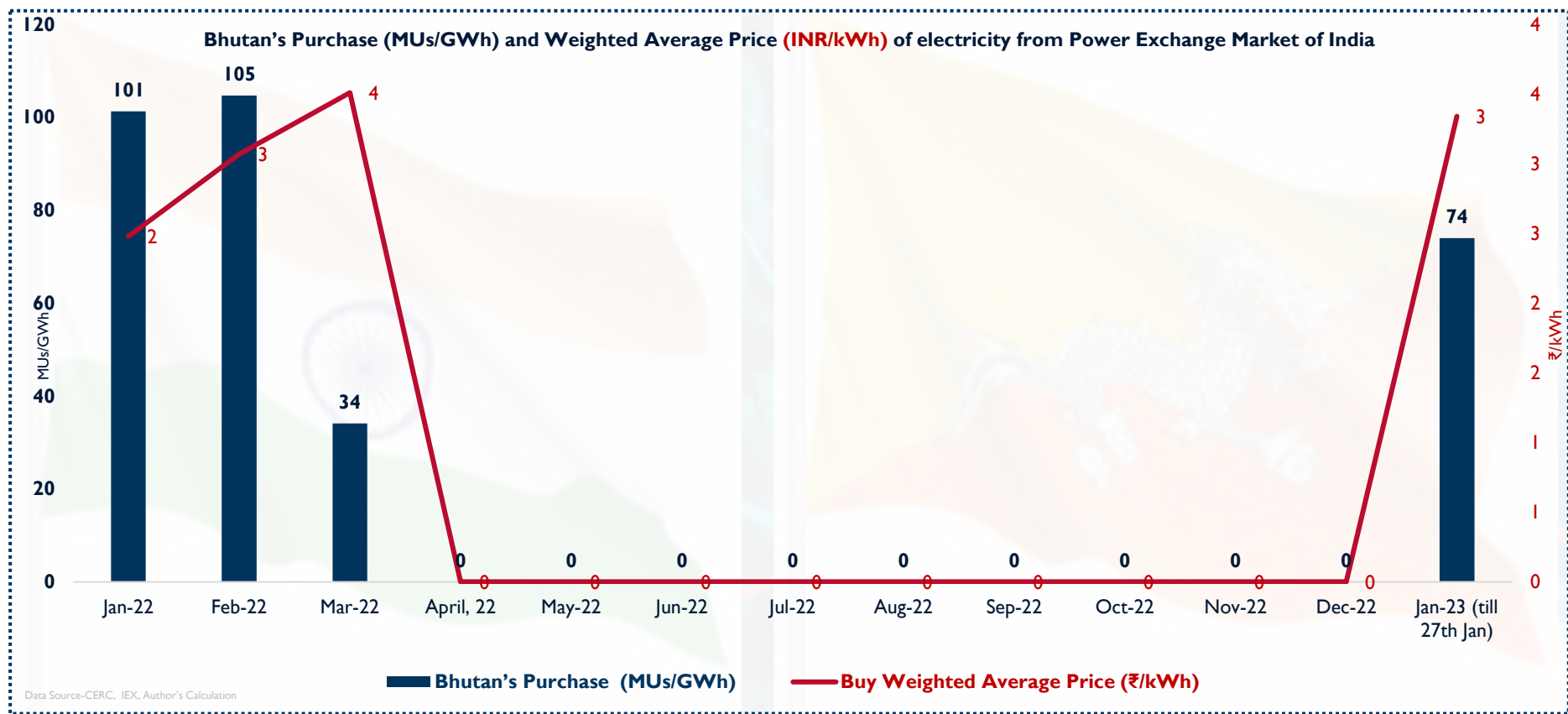
CBET Doubled | Potential Remains Large | Prospects for Inter-Regional Integration

01.4 Market form of Cross Border Electricity Trade: A Beginning of a new Renaissance

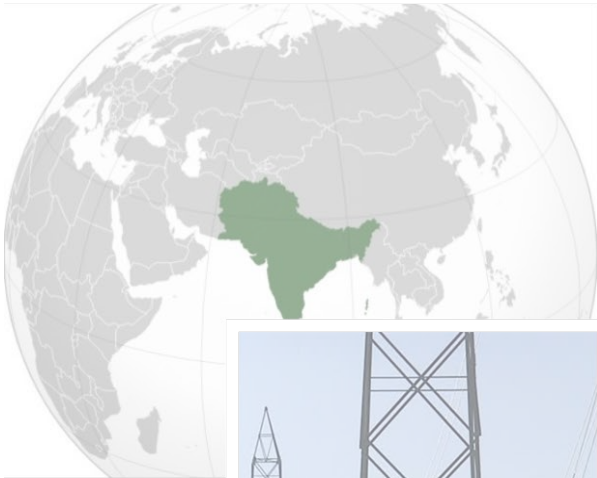


Nepal has earned over Nepalese Rs 11 billion (6.87 billion INR) by selling excess power to India from early June 2022 through December 2022

01.4 Market form of Cross Border Electricity Trade: A Beginning of a new Renaissance



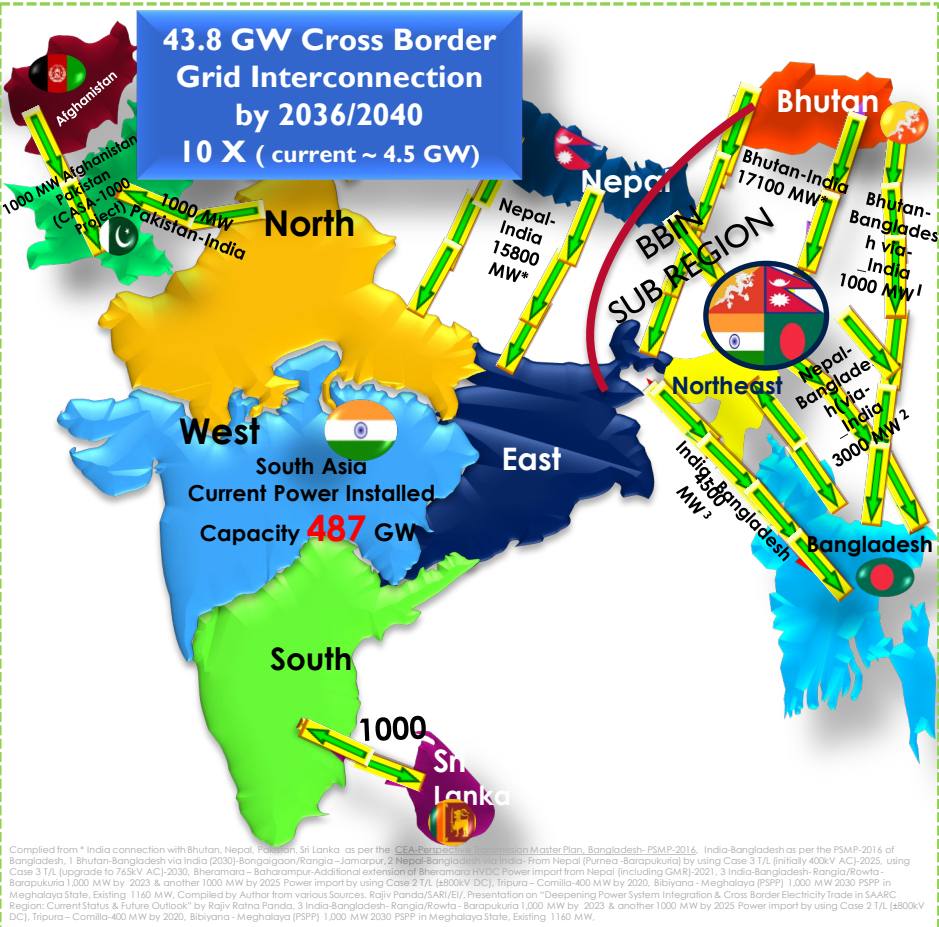
January 1 and March 16, 2022, Bhutan imported a little over 240MU of electricity from India through the energy exchange at a cost of Nu 798 M.



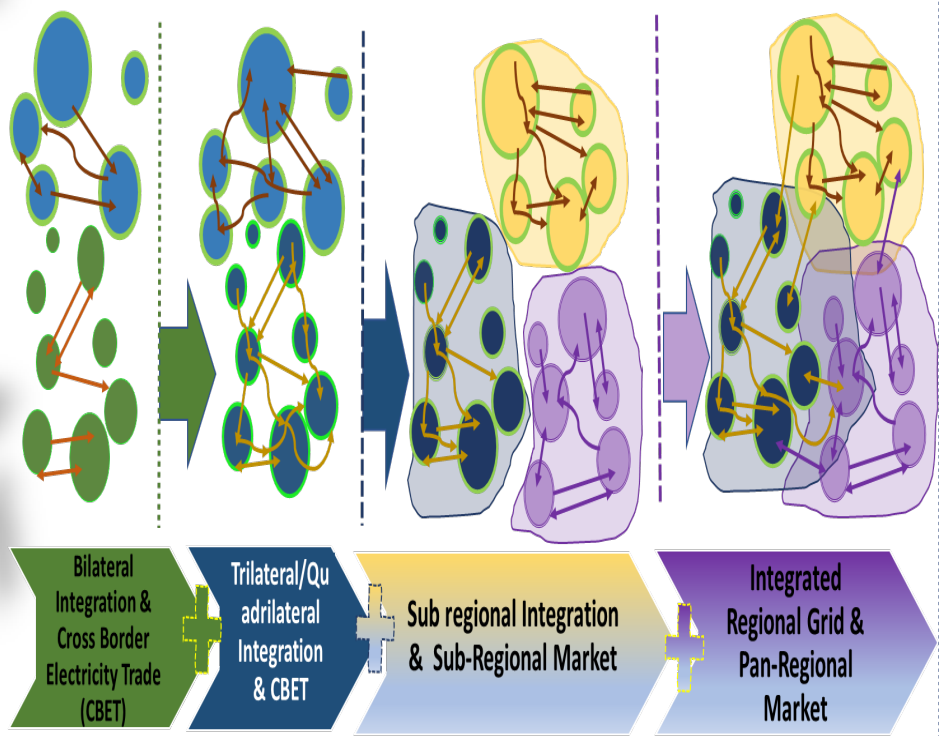
Cross Border Electricity Trade in South Asia

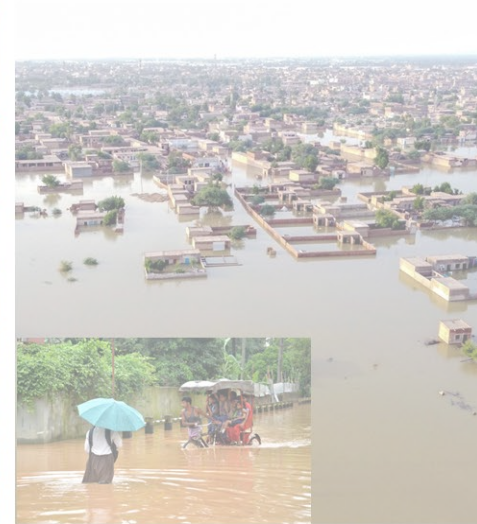
Future Scenario

Cross Border Electricity Trade (CBET) in South Asia : Future Scenario



Transition of Cross Border Electricity Grid Integration Bilateral-Trilateral-Multilateral-Regional Electricity Market Development





Emerging Outlook in South Asia- Opportunity for Deepening CBET and REC

01.5.1 Emerging Outlook in South Asia : Opportunity for Deepening CBET and REC

Emerging Outlook 1



Climate Change induced
Renewable Based
CBET

01.5.1

Emerging Outlook 2



Impacting Clean
Energy
Transformation
vision through
CBET

01.5.2

Emerging Outlook 3



Gradually
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01.5.3

Emerging Outlook 4



Commercial
form of CBET,
Market
Instruments
Regional Energy
Market
Development

01.5.4

Emerging Outlook 5



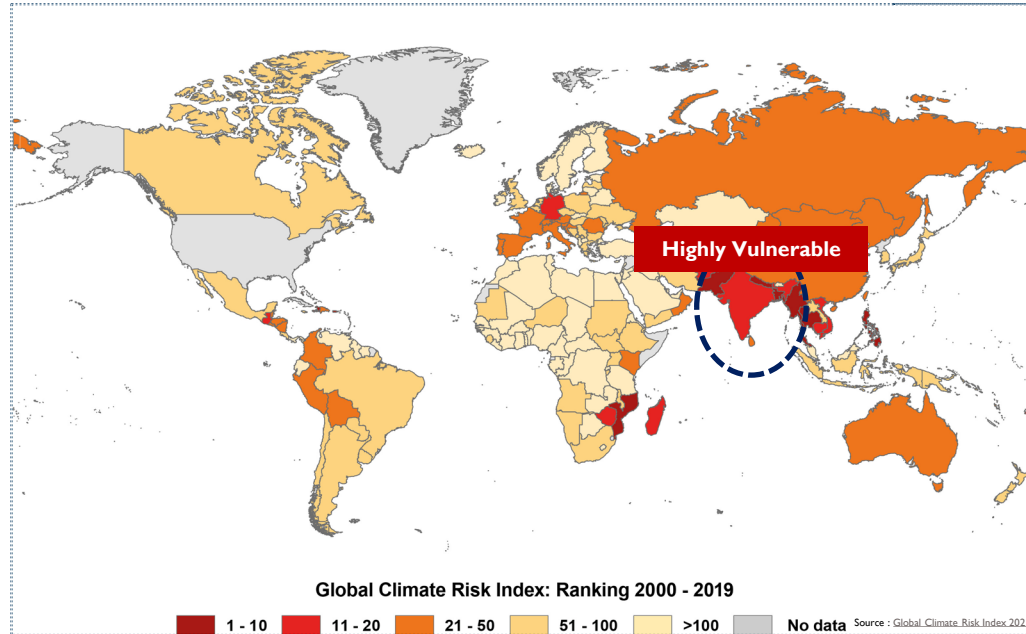
One Sun One
World One Grid
(OSOWOG)

01.5.5

01.5.1 Extremely Vulnerable to Adverse Impact of Climate Change

Global Climate Risk Index 2000 – 2019

10 Most Affected Countries (2000-2019)

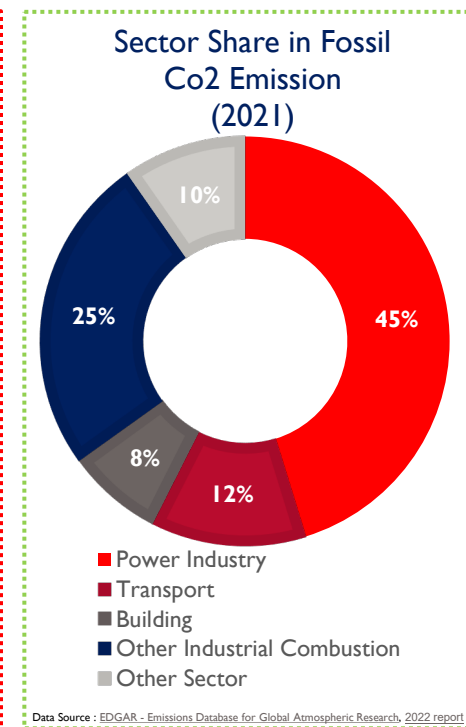
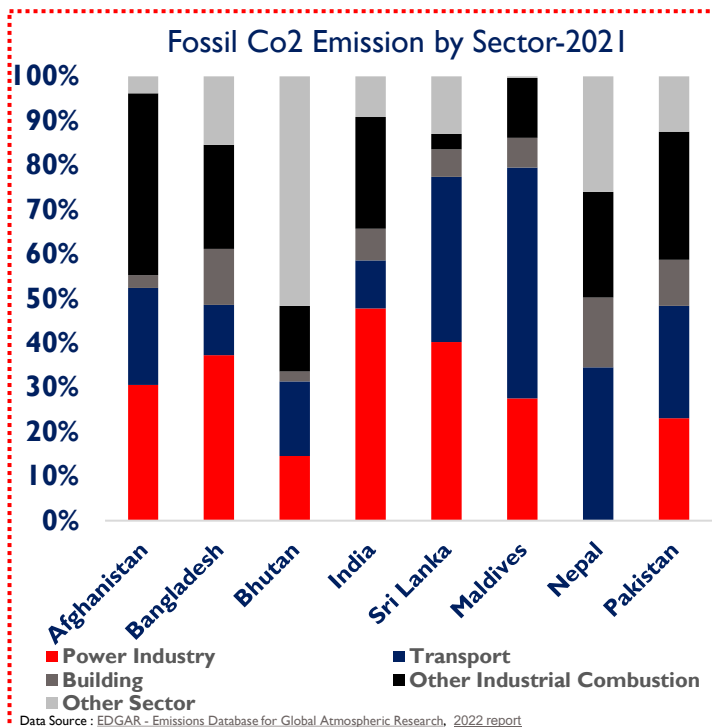
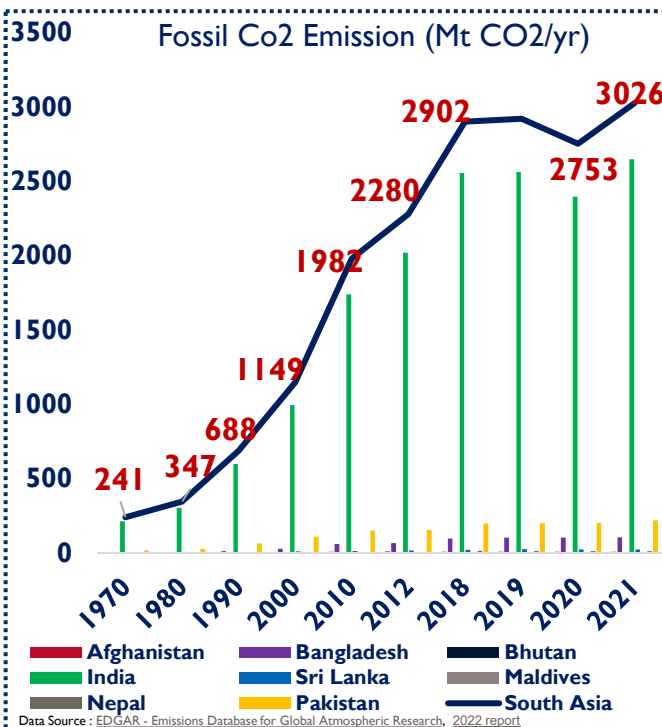


| Country | CRI score | Fatalities | Fatalities per 100 000 inhabitants | Losses in million US\$ PPP | Losses per unit GDP in % | Number of events (2000–2019) |
|-------------|-----------|------------|------------------------------------|----------------------------|--------------------------|------------------------------|
| Puerto Rico | 7.17 | 149.85 | 4.12 | 4 149.98 | 3.66 | 24 |
| Myanmar | 10.00 | 7 056.45 | 14.35 | 1 512.11 | 0.80 | 57 |
| Haiti | 13.67 | 274.05 | 2.78 | 392.54 | 2.30 | 80 |
| Philippines | 18.17 | 859.35 | 0.93 | 3 179.12 | 0.54 | 317 |
| Mozambique | 25.83 | 125.40 | 0.52 | 303.03 | 1.33 | 57 |
| The Bahamas | 27.67 | 5.35 | 1.56 | 426.88 | 3.81 | 13 |
| Bangladesh | 28.33 | 572.50 | 0.38 | 1 860.04 | 0.41 | 185 |
| Pakistan | 29.00 | 502.45 | 0.30 | 3 771.91 | 0.52 | 173 |
| Thailand | 29.83 | 137.75 | 0.21 | 7 719.15 | 0.82 | 146 |
| Nepal | 31.33 | 217.15 | 0.82 | 233.06 | 0.39 | 191 |

Source: Global Climate Risk Index 2021

Three SA Countries: Bangladesh (7), Pakistan (8), Nepal (10) among the 10 most affected from 2000-2019 (Average)
Five SA Countries: Bangladesh (7), Pakistan (8), Nepal (10), India (20), Sri Lanka (23) within the initial 30 rankings out of 180

01.5.1 Rising Emissions, Needs Energy Transformation for a Just Sustainable Future



Transformational Action in Power followed by Transport Sector will be Crucial in South Asia
Greening Power Sector and Electrifying Transport

01.5.1 South Asia-Blessed with huge Clean Energy Resources

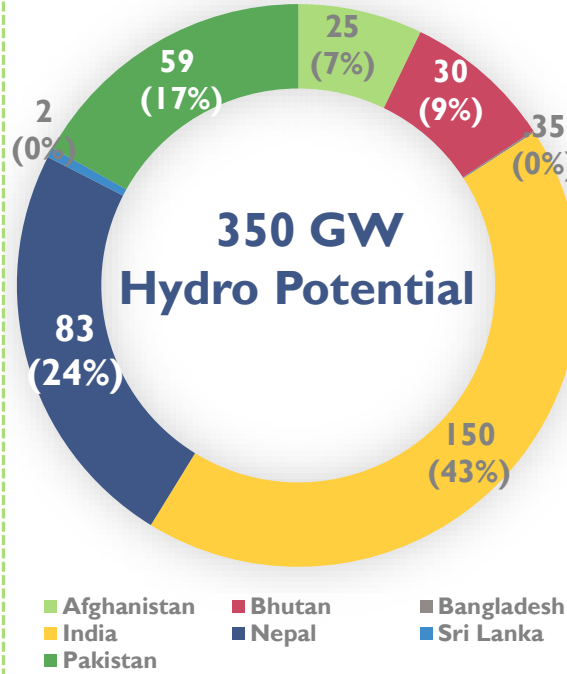
350 GW Hydro, 1289* GW Wind, > 1000* GW Solar Potential

World Bank Study finds:

- ❑ Unconstrained flow of electricity across the borders in South Asia can increase the development of hydropower by **2.7 times** over next two decade.
- ❑ **8% reduction** of regional power sector CO2 emissions.
- ❑ The **share of RE** in total electricity generation during the 2015-2040 period could expands to **31%** under regional cooperation.
- ❑ Unrestricted electricity trade provision would **save US\$226 billion** (US\$9 billion per year) of electricity supply costs over the period (2015–40).

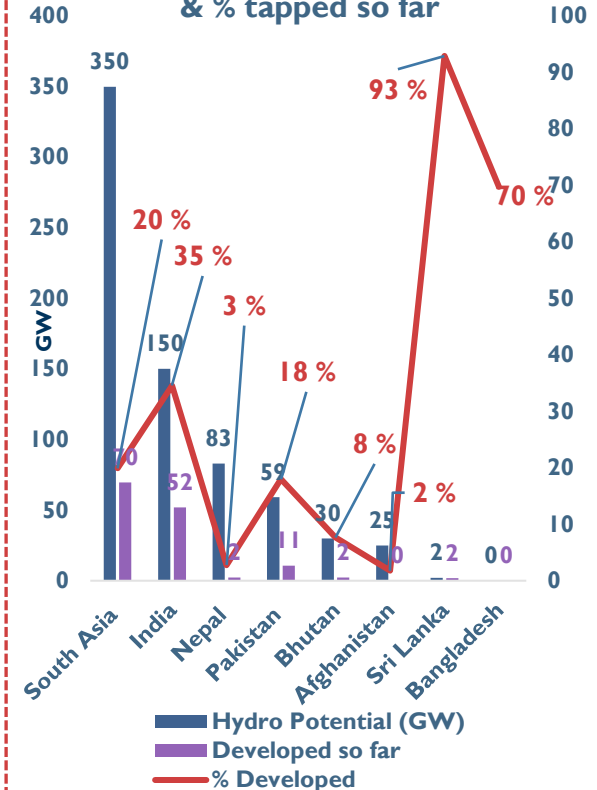
Data Source: * CEM Presentation-OSOOWOG, WB Study-WP58513, WB Study-WP57341

South Asia Hydro Power Potential in GW (%)



Data Source: Compiled by Author from Various Sources, CEM-OSOOWOG Presentation

Hydro Power Potential (GW) & % tapped so far



Data Source: Compiled by Author from Various Sources, CEM-OSOOWOG Presentation

South Asia : Large Renewable Energy Resource within the Region-Potential for clean energy transition, sustainability & energy security

01.5

Emerging Outlook in South Asia : Opportunity for Deepening CBET and REC

Emerging Outlook 1



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01.5.1

Emerging Outlook 2



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Emerging Outlook 4



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01.5.4

Emerging Outlook 5



One Sun One
World One Grid
(OSOWOG)

01.5.5

Impacting Clean Energy Transformation Vision



Bangladesh Source: Mujib Climate Prosperity Plan

Mujib Climate Prosperity Plan
30% of energy from renewables by 2030



Bhutan Source: Bhutan's 2nd Nationally Determined Contribution

To remain Carbon Neutral



India

Five nectar elements, 'Panchamrit'
Unprecedented contribution of India to
Global climate action

Non-fossil energy
capacity to 500 GW by
2030

50% energy
requirements from
renewable energy by
2030

Reduce the total
projected carbon
emissions by one billion
tonnes from now till
2030.

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

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

Source: National Statement by Prime Minister Shri Narendra Modi at COP26 Summit in Glasgow



Maldives Source: Update of Nationally Determined Contribution of Maldives

Net zero Emission by 2030



Nepal Source: Nepal's Long-term Strategy for Net-zero Emissions submitted to UNFCCC

Net zero Emission by 2045

(Illustrates Cross Border Energy Trade potential for
emissions reductions outside of Nepal)



Pakistan Source: Pakistan Updated Nationally Determined Contributions

**By 2030, 60 % of all energy will be
generated from renewable energy
resources (including hydropower)**



Sri Lanka Source: UPDATED NATIONALLY DETERMINED CONTRIBUTIONS

Carbon Neutrality by 2060

Source: SAARC Energy Center: Mitigation of Challenges and Attracting Investment for Cross Border Electricity Trade (CBET) Projects-Rajiv, 11 November 2021

Key Initiatives and Recent Developments in South Asia: A Regional Approach will be an Economical, Cost effective, Optimal and sustainable over a long period of time

South Asia Power & Energy System is undergoing transformation



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 and Cross Border Power Transmission



Natural gas, LNG and Region Gas Grid

01.5.2 Impacting Clean Energy Transformation Vision- Scale of Transformation

Understanding Scale of Transformation-Case of India

Power sector:

1. Coal-based power- peak by 2040, reduce by 99% in 2040-2060.
2. Solar, **1,689 GW** by 2050, **5,630 GW** by 2070.
3. Wind, **557 GW** by 2050 and **1,792 GW** by 2070.
4. Nuclear, **68 GW** by 2050 and to **225 GW** by 2070.

Transport sector:

1. % electric cars in car sales, **84 %** by 2070.
2. % electric trucks in freight trucks, **79 %** by 2070, the rest being fuelled by hydrogen.

Industrial sector

1. Coal use in industry- peak by 2040, reduce by 97% 2040-2065.
2. Hydrogen share in total industrial energy use (heat and feedstock) must increase to **15 %** by 2050 and **19 %** by 2070.

Source : Implications of a Net-Zero Target for India's Sectoral Energy Transitions and Climate Policy Vaibhav Chaturvedi and Ankur Malan



Surplus hydropower potential can be tapped for Green Hydrogen (GH₂) electrolyzers



Surplus hydropower from the countries can be exported & GH₂ can be generated at the point of requirement in the region.



Hydropower generators can integrate electrolyzers at or nearby hydropower sites, to produce GH₂ as a zero-carbon product & revenue option.

Source : JHA , How South Asia's massive renewable energy potential can boost green hydrogen production

Cross Border Electricity Trade and Regional Power Market can contribute to Clean Energy Transformation and Green Hydrogen economy in South Asia

Emerging Outlook in South Asia : Opportunity for Deepening CBET and REC

Emerging Outlook 1



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01.5.4

Emerging Outlook 5



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01.5.5

01.5.3

Gradually Transitioning from Bilateral to Trilateral CBET in SA



\$2 billion , 1125 MW Dorjilung Project
Proposed Trilateral Project



Bangladesh will import 500 MW of electricity from 900 MW Upper Karnali (GMR) in Nepal @ 7.72 cents/unit for 25 years##

(Price Negotiation is Concluded, Discussion on transmission and other aspects is under consideration)



Bangladesh Master Plan# envisaged to import from Bhutan (1 GW) & Nepal (3 GW) through India

Power System Master plan 2016 (Final)- <https://powerdivision.gov.bd/site/page/f68eb32d-cc0b-483e-b047-13eb81da6820/Power-System-Master-Plan-2016>
 ## <https://kathmandupost.com/money/2020/02/09/bangladesh-issues-letter-of-intent-to-purchase-500-mw-from-upper-karnali-hydro-project>

Enabling the Frameworks



Guidelines for the Import / Export (Cross Border)-2018 of Electricity
Clause 3.1, Clause 8.6

Source: Ministry of Power, India



Central Electricity Regulatory Commission (Cross-border Trade of Electricity) Regulations, 2019
Clause 3. (2) , Clause 12. (6)

Source: CERC, India



Procedure for approval and facilitating Import/Export (Cross Border) of Electricity by the DA Authority-February, 2021
Clause 8. , Annex-V

Source: CEA, India



Source: Economic times

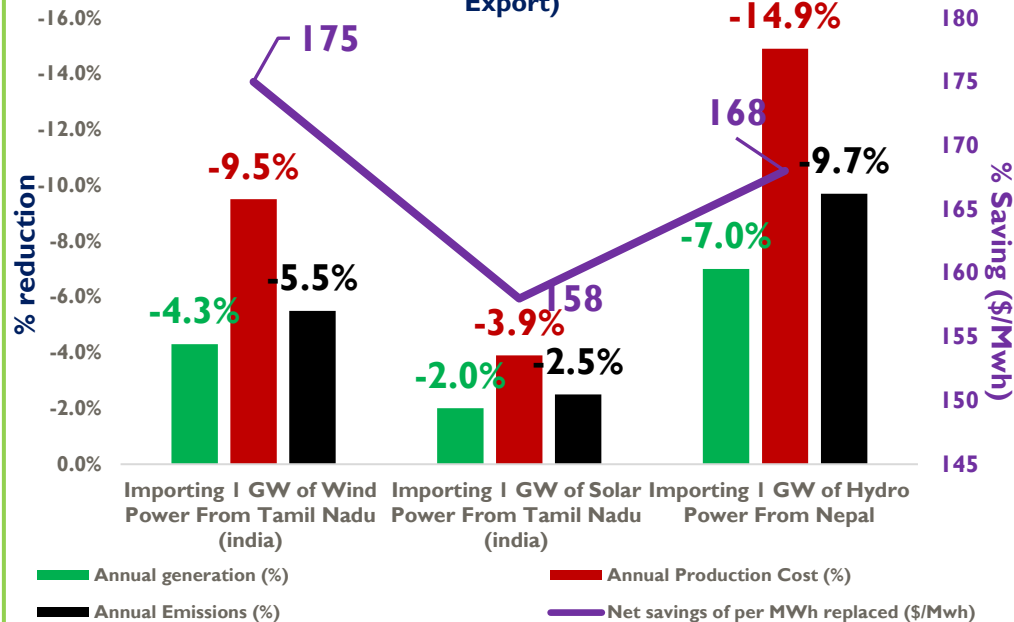
Nepal has sought approval from Indian authorities to export 40-50 MW of electricity to Bangladesh through India's existing transmission infrastructure

01.5.3

Trilateral Cross Border Electricity Trade From Renewable Energy Zones



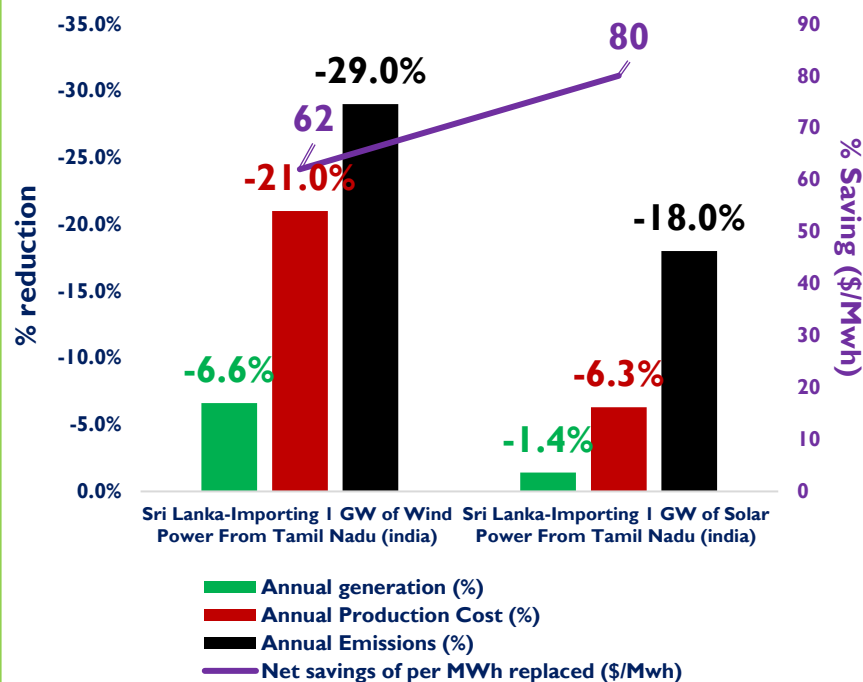
Bangladesh Importing from Renewable Energy Zones (Tamil Nadu State (Solar & wind export), India & Nepal (Hydro Power Export))



Source: **NREL** NREL Report on "Cross-Border Electricity Trading and Renewable Energy Zones"
<https://www.nrel.gov/docs/fy20osti/76919.pdf> <https://www.nrel.gov/docs/fy20osti/77029.pdf>
 1 GW of solar capacity in Tamil Nadu generates less energy than 1 GW of Nepal hydropower or 1 GW of Tamil Nadu wind power. Also, because solar's sunrise to-sunset profile is less correlated with Bangladesh load, the savings per unit of energy was also less—\$158 per MWh replaced.



Sri Lanka Importing from Renewable Energy Zones (Tamil Nadu State (Solar and wind export), India)



South Asia : GW scale RE based Trilateral CBET offers cost saving, clean energy transition:-leads to enhance energy affordability & sustainability

01.5

Emerging Outlook in South Asia : Opportunity for Deepening CBET and REC

Emerging Outlook 1



Climate Change induced
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Emerging Outlook 4



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01.5.4

Emerging Outlook 5



One Sun One
World One Grid
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01.5.5


01.5.4


Market Instruments, Regional Energy Market Development

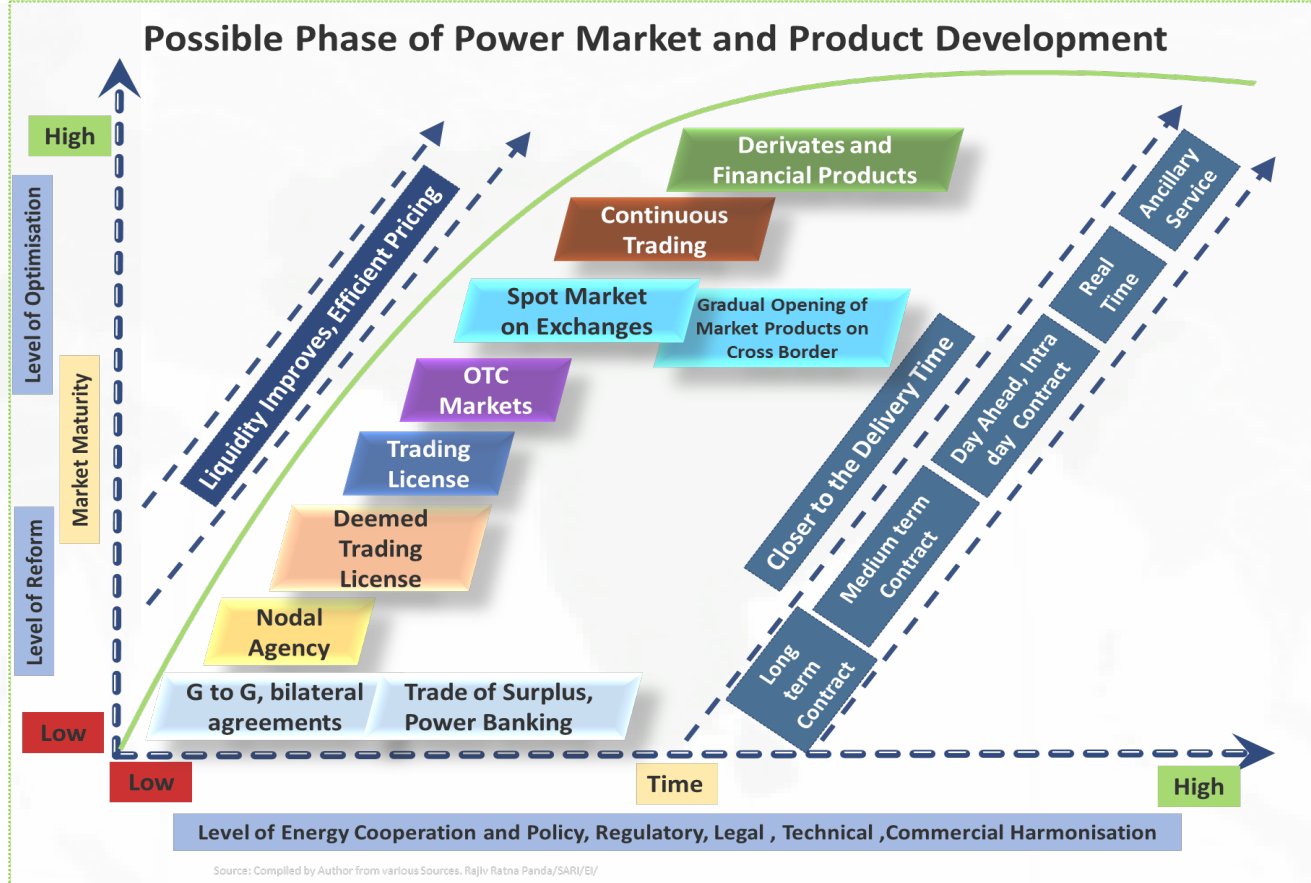
 Trend is to Rely on Competition & Market Instruments under Policy & Regulatory Oversight

 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

 Carbon Market, Carbon Credits



~ 33% increase in Commercial/Market CBET since 2010 | Integrated Regional Power Market will facilitate optimal allocation of cost & benefit and clean energy transition.

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Emerging Outlook 4



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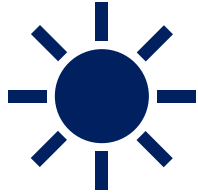
01.5.4

Emerging Outlook 5



One Sun One
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ne Sun

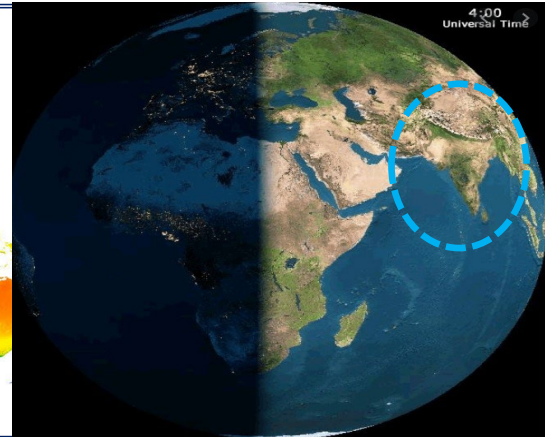
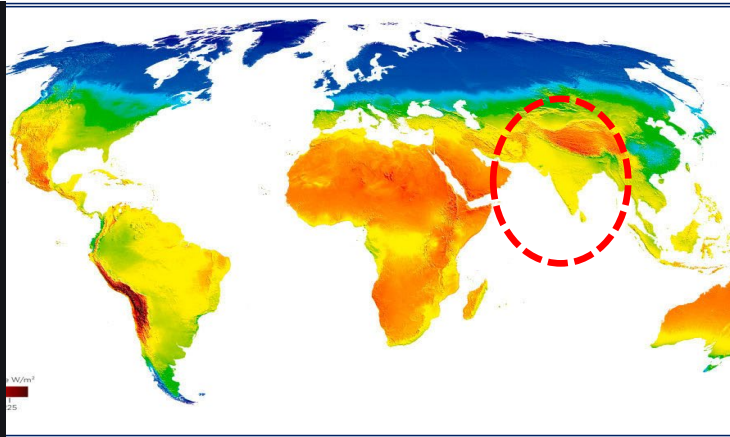
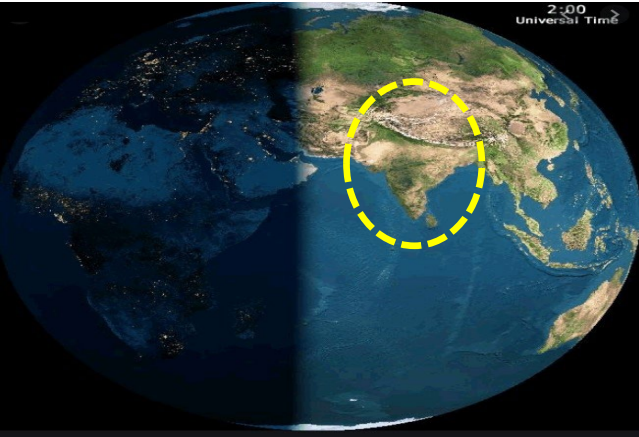


ne Grid



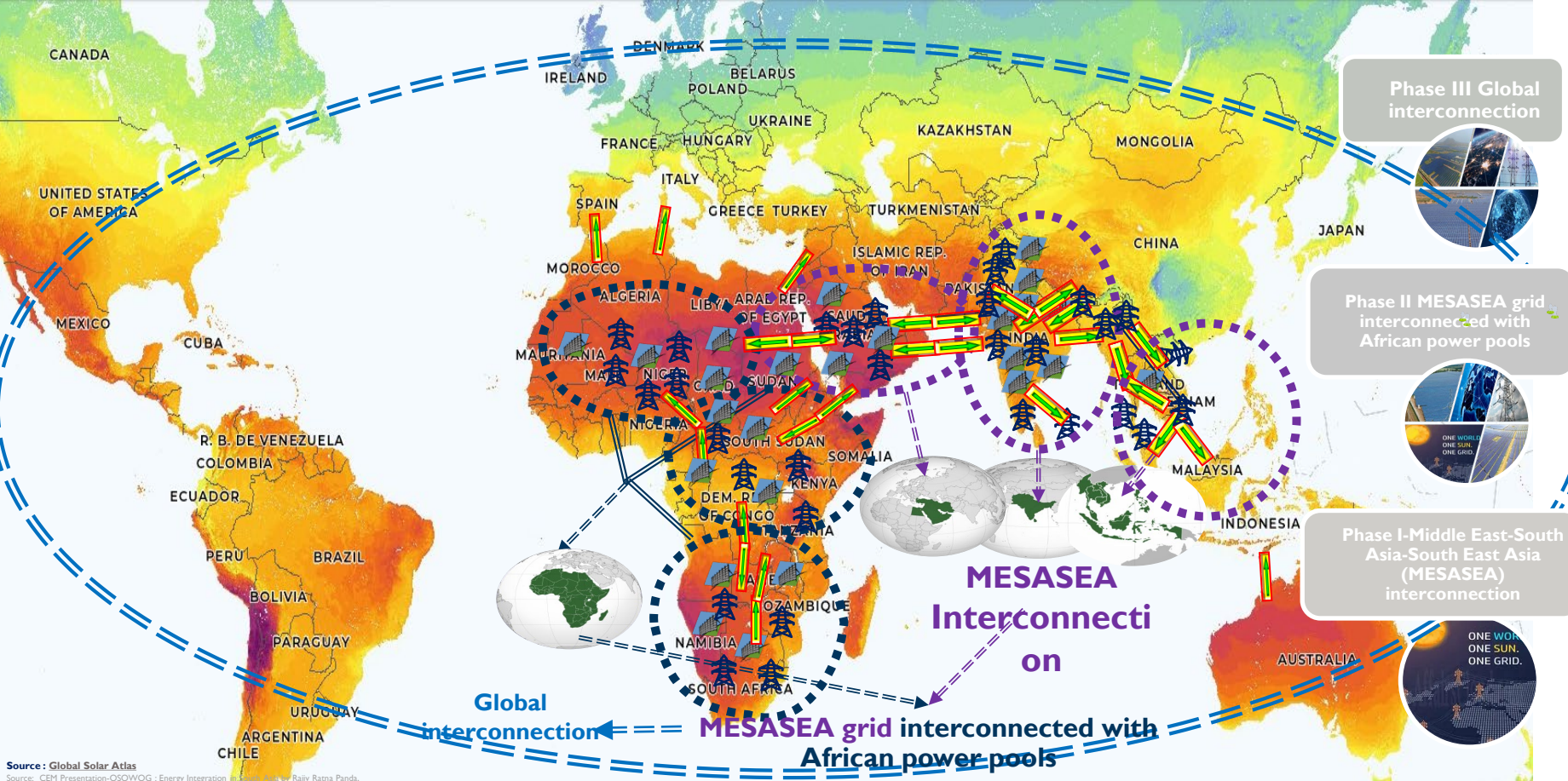
ne World

01.5.5 India at Fulcrum - Enabler for OSOWOG



01.5.5 One Sun One World One Grid (OSOWOG)-3 Phase Approach

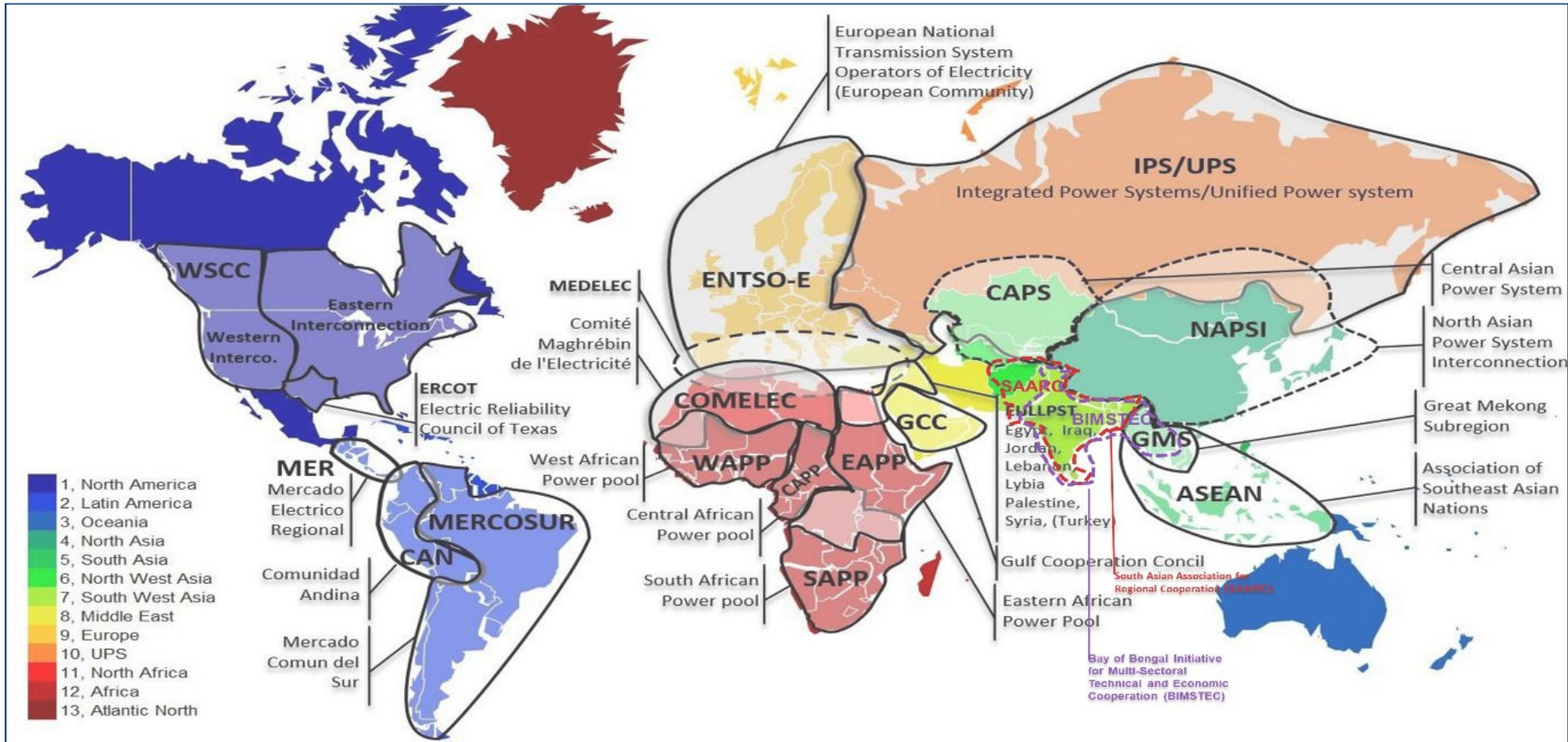
*Artistic representation only. Map not to scale, do not represent any identified location/point of interconnection or direction of power flows, purpose is simply to illustrate graphically for easier understanding of OSOWOG & its 3 phase approach in graphical manner



Source : Global Solar Atlas
Source: CEM Presentation-OSOWOG : Energy Integration in South Asia - Rajiv Rama Panda.

Building Regional, Sub-Regional, Continental and Global Consensus on Interconnections will be the key

01.5.5 Various Regional Grid Integration Initiatives across the Globe



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 BIMSTEC Region

Presentation on "Cross Border Electricity Trade, Regional Energy Cooperation and Future Outlook for South Asia" by Rajiv Ratna Panda/SAREP-11th Meeting of TF-2 on Advancement of Transmission system Interconnection to support Cross Border Electricity Trade (CBET) – 16th February 2023, Kathmandu, Nepal

01.5.5 One Sun One World One Grid (OSOWOG)-Developments

One Sun, One World, One Grid (OSOWOG)

- MoP constituted **Task Force on OSOWOG** for steering the agenda for OSOWOG.
- The Task Force **studied techno-economic feasibility** of interconnection of regional grids viz. South East Asia, South Asia, Middle East (Gulf Cooperation Council), Africa & Europe for exchange of renewable power and after discussion,
- It was agreed that **initially interconnection with Sri Lanka, Myanmar and Maldives** would be explored to further the objective of OSOWOG.
- An Indian technical team has **visited Maldives** for studying the **technical specifications** of interconnection India-Maldives through Lakshadweep.
- Charter for OSOWOG** has been finalized, and a Steering Committee for OSOWOG is being set up.

Source: Ministry of Power, YEAR- FND REVIEW 2022, Posted On: 27 DEC 2022, 3:57PM by PIB

India, Sri Lanka to start top-level G2G talks on power transfer link
1 min read · Updated: 10 Jan 2023, 12:06 AM IST
Rituraj Baruah

India, UAE close to deal on renewable electricity grid link, Indian minister says
By Rachna Uppal

Explained: Plans revived for linking power grids of India, Sri Lanka
Colombo's power secretary says negotiations are at initial stages
Web Desk · Updated: April 20, 2022 15:01 IST

India eyes power transmission link with Thailand via Myanmar
1 min read · Updated: 12 Jan 2023, 12:11 AM IST
Rituraj Baruah

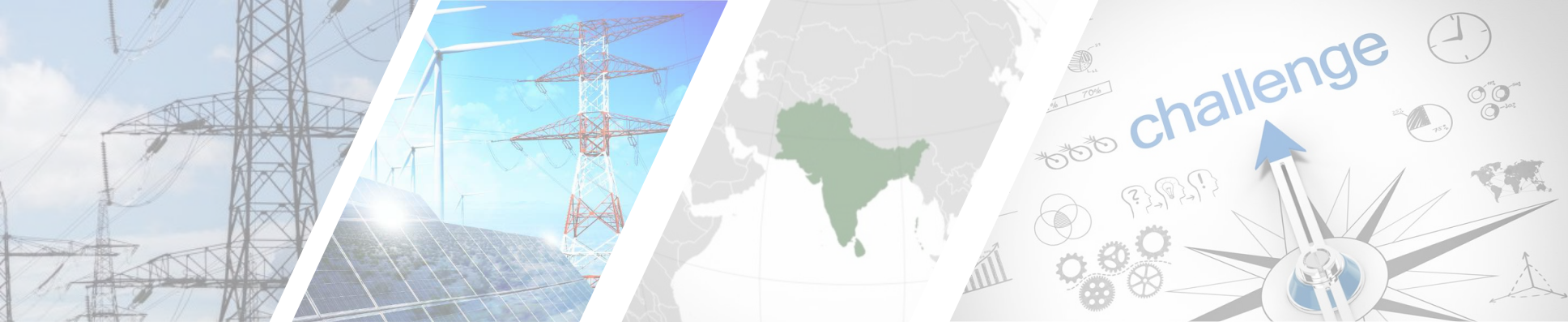
India and Maldives to establish transmission interconnection for renewable power transfer
Union Power Minister meets Maldives Minister of Environment, Climate Change and Technology
Posted On: 26 APR 2022 6:34PM by PIB Delhi

Draft 'One Sun One World One Grid' ready, to be approved by steering committee soon: RK Singh

ONE SUN, ONE WORLD, ONE GRID
Connects energy grids across borders to facilitate transition of solar power
Aims to boost use of renewable energy
Addresses high cost of energy storage

Shri Singh appreciated the resolve of Government of Maldives to achieve the set zero emission target by 2030. During the meeting, both leaders proposed an understanding – one on Energy cooperation and another on transmission interconnection under One Sun, One World, One Grid (OSOWOG). To further the objective of OSOWOG, India and Maldives have proposed to establish transmission interconnection for renewable power transfer as part of the OSOWOG initiative.

In South Asia Context, OSOWOG will provide further impetus to Power System Integration in South Asia Region

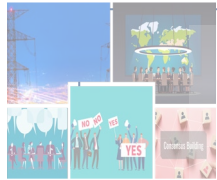


02

Challenges in Energy Integration & CBET in South Asia Region



02 Challenges in Energy Integration & CBET in South Asia Region



Political, Political-Economy, Consensus Building



Process of building Consensus takes time

Trust Building, Geopolitical Realities

Political Capital & Will, Cooperation Spirit

Required sustained efforts, Continuity



Policy, Regulatory, Market, Technical



Different level/stage of Policy, Regulatory, Market, Technical (PRMT) Frameworks, Harmonisation

Implementation of agreements, lack of clear PRTM framework

Power Market Development & Competition



Financial/Commercial feasibility, Investment attractiveness, focused Investment Facilities



Project Feasibility, Financial Challenges of building Hydro

Sharing of cost of cross border transmission

Policy, Regulatory Risks Amplifies viability

Lack of Dedicated Investment Facilities



Trilateral, Multilateral, Regional Institutional Platforms



Moving from Bilateral, Building consensus on Trilateral took time

Sharing of cost of cross border transmission

Desirable to have Dedicated Regional Institutional Platforms

Enabling Procedure

Enablers for Facilitating Energy Integration & CBET in Coming Future

Political



- **Regional Outlook/Vision**
- **Political Consensus**
- **Intergovernmental agreement(s)**
- **Implementation & Review Mechanism**
- **Power Market Reform**
- **Navigating the Political-Economy, Energy Geopolitics realities**

Regulatory



- **Permissibility to use intermediary transmission network under open access**
- **Rules for identification of transmission capabilities & congestion**
- **Rules for measurement of imbalance and settlements**
- **A conducive & friendly ecosystem for investors**
- **Power Market Development**

Technical and Commercial



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

Institutional



- **Institutional arrangements**
- **Regional Coordination Forums are desirable**
- **Will foster long term sustainability**

Thank You



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