

South Asia Regional Energy Partnership (SAREP)

Theme Presentation

on

Envisioning Trans-Regional Energy Connectivity between the South Asia Region–Southeast Asia Region–Gulf Region Prospects and Opportunities

ROUNDTABLE ON INTERCONNECTION OF REGIONAL GRIDS IN
ASIA: GCC GRID – SOUTH ASIA GRID – ASEAN GRID

ISUW 2023 03 MARCH 2023 (FRI) | 14:00 ~ 17.30 IST | Venue: Regency - I, Lalit Hotel, New Delhi, India

Presented by
Rajiv Ratna Panda, Power Market Specialist, SAREP



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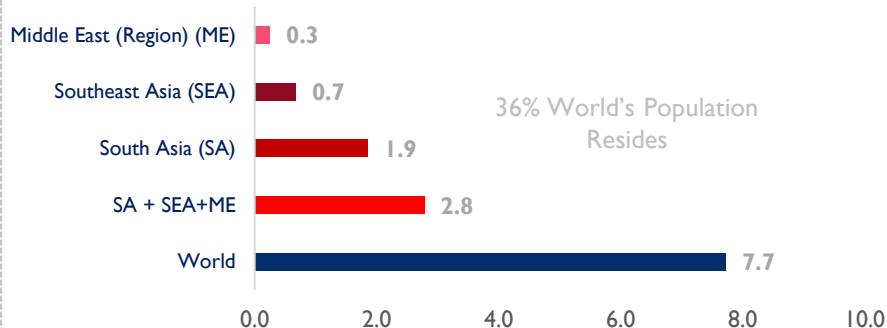
Way Forward

Marco-Economic , integration and energy situation in South Asia, South-East Asia and Middle East



Overview of South Asia, South-East Asia and Middle East : Diverse Regions of the World

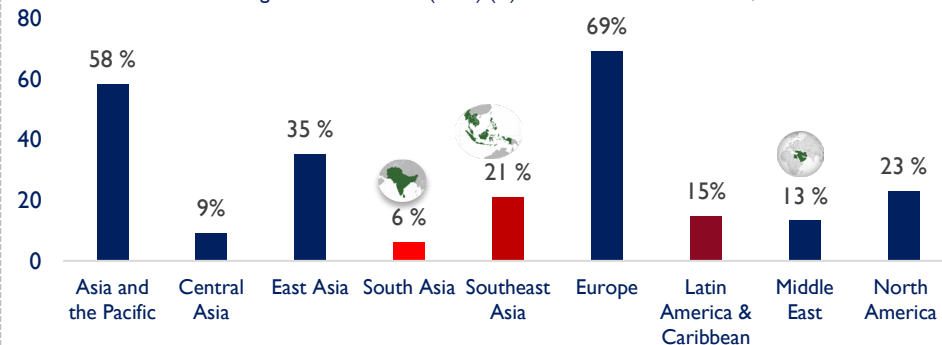
Population (Billion), 36% World's Population
(South Asia+ South-East Asia+ Middle East)



Source: IMF World Economic Outlook (October, 2022)

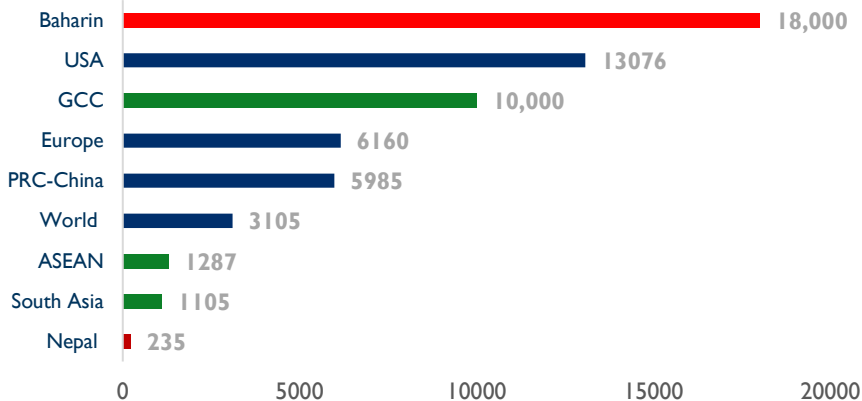
Diverse Level of Economic Integration

Intra-Regional Trade Share (IRTS) (%) 2021 SA-IRTS in 1990- 3%, 2015- 6 %



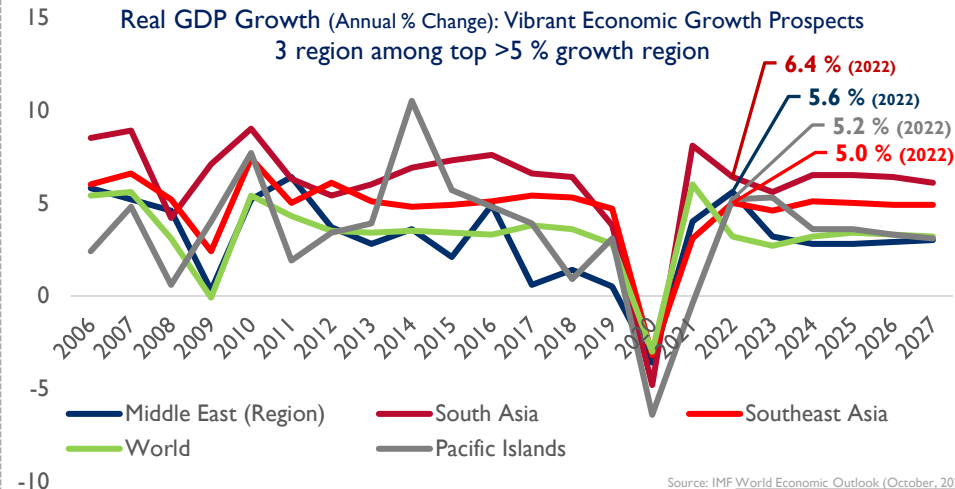
IRTS: % of intra-regional trade to total trade of the region | Data Source: <https://aric.adb.org/>

Diverse Electricity Consumption (kWh per capita)



Source: World, USA, South Asia, EU, ASEAN, GCC-MDI, Nepal-SAREP

Real GDP Growth (Annual % Change): Vibrant Economic Growth Prospects
3 region among top >5 % growth region

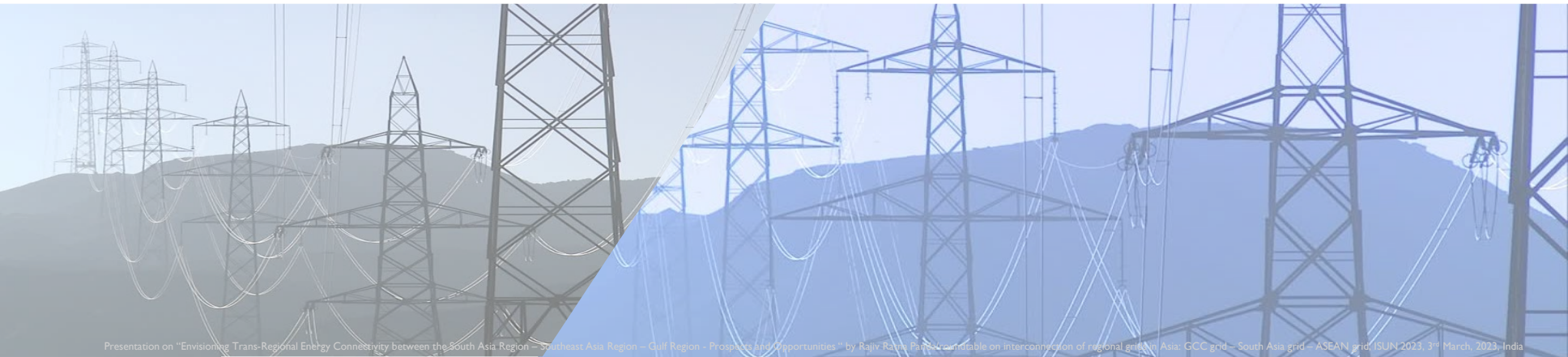


Source: IMF World Economic Outlook (October, 2022)



GCC-South Asia-Southeast Asia Power Grid

Current Scenario of Power Sector & Future Outlook Cross Border Interconnection



Interconnection of Regional Electricity Grids in Asia: GCC- South Asia- ASEAN Grid:

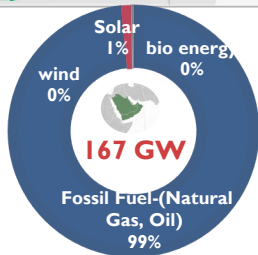
Current Scenario and Future Outlook for Cross Border Interconnection

01.2



GCC

Bahrain
Kuwait
Oman
Qatar
Saudi Arabia,
UAE
6 Countries



Installed Capacity- **167 GW** (2020/2) | Fossil Dominance- **165 GW (99%)** | Natural gas & Oil dominated | RE- **2.5 GW (1%)**

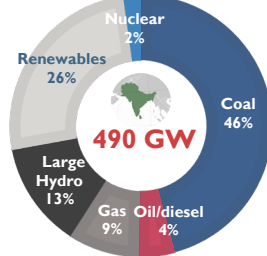
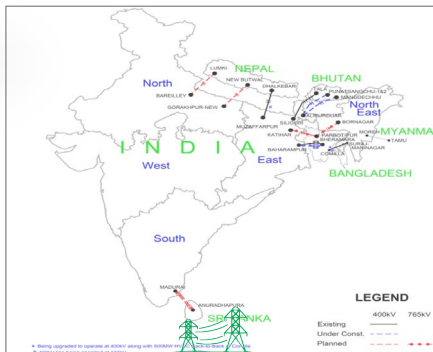
Cross Border Interconnection (xBI)- **2.4 GW** with varying capacities for country's xBI | KSA-Kuwait-1.2 , Bahrain -KSA 0.6 , Qatar-KSA-0.75 , KSA-UAE 0.9 UAE-Oman 0.4, Future xBI- Egypt, Jordan-PAEM *

PAEM-Pan-Arab Electricity Market; Magreb, Mashreq (BSP/LPT), and GCC



South Asia

Afghanistan
Bangladesh
Bhutan
India
Maldives
Nepal
Pakistan
Sri Lanka
8 Countries



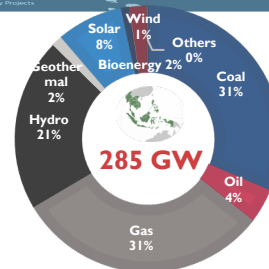
Installed Capacity- **490 GW** (2023) | Fossil Dominance- **289 GW (60%)** | Coal Dominated- **224 GW (45%)** | Natural gas (9%), Oil (4%) based | RE- **190 GW (38%)** | RE-Hydro: **126 GW (25%)**

~ **4.5 GW** of x Border Interconnection | ~ **10 X** increase in xBI | Total **43.8 GW** of xBI by 2036/2040



ASEAN

Brunei
Darussalam
Cambodia
Indonesia
Lao PDR
Malaysia
Myanmar
Philippines
Singapore
Thailand
Vietnam
10 Countries



Installed Capacity- **285 GW** (2021) | Fossil Dominance- **189 GW (66%)** | Coal (31%), Natural gas (33%), Oil-based | Renewable - **95 GW (33.5%)** | RE without Hydro- **35 GW (12%)**

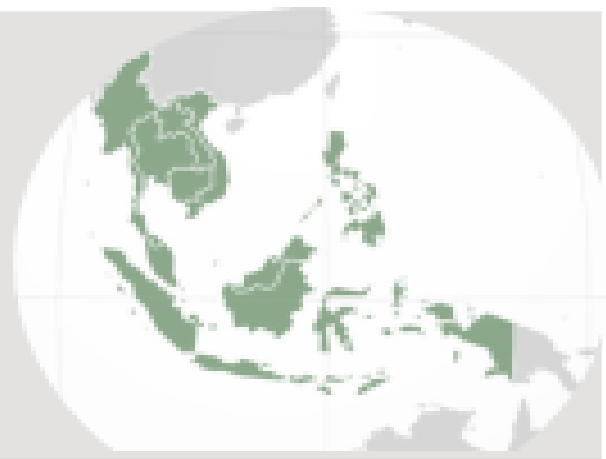
~ **7.7 GW** of xBI | ~ **4 X** increase in x Border | **26-30 GW** x Border Interconnection by 2040

Peak Demand ~120 GW

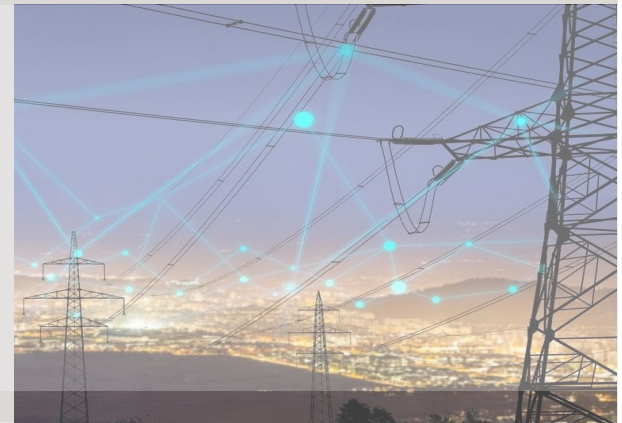
Peak Demand ~264 GW

Peak Demand ~ GW

Fossil Domination | Diverse Fuel Mix | 150-500 gw Size Power System | Nascent Stage of Cross Bordered Interconnection | Rapid Expansion in Cross Border Interconnection Planned



Cross Border Electricity Trade Volume and Nature of CBET Power Market in **GCC-South Asia-Southeast Asia Power Grid**



Interconnection of Regional Electricity Grids in Asia: GCC– South Asia– ASEAN Grid:

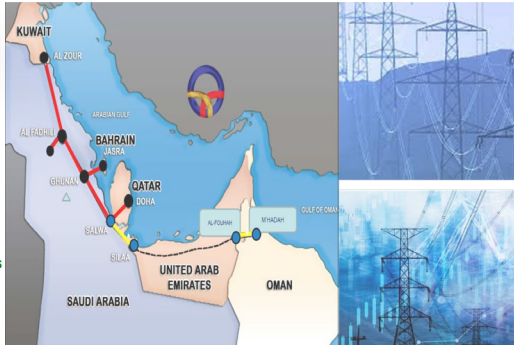
Current CBET Volume , CBET Power Market



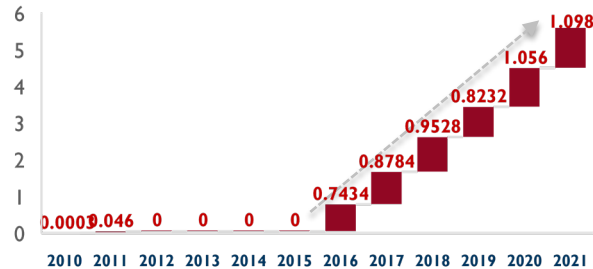
GCC



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6 Countries



Power Trading on GCC Interconnector in TWh (BUs)



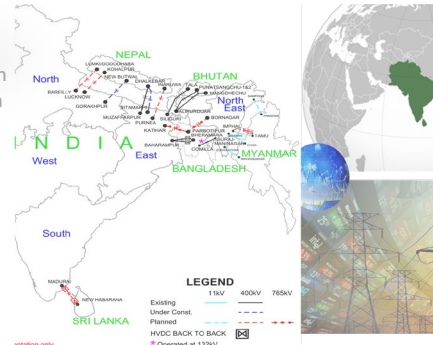
Mostly **in-kind trade (97%)** and in-cash energy trade (3%) | GCC Market Potential Study | A **GCC day ahead market (DAM)** could have trading volume of **16 TWh for 2022**



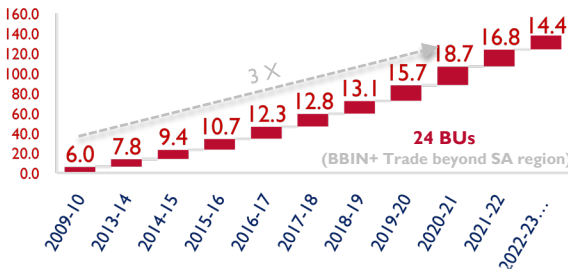
South Asia



Afghanistan
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South Asia (BBIN) CBET BUs (TWh)



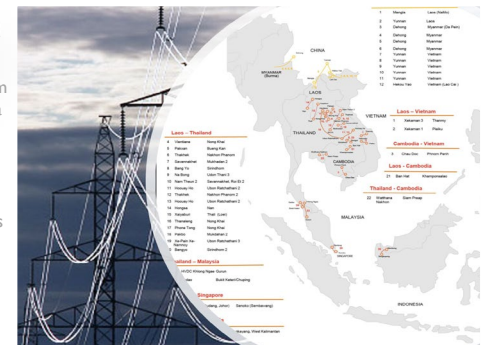
Bilateral CBET, Mix of G-G & Commercial CBET, CBET Through PX Platform (Only in the Asia), Bidirectional, Trilateral CBET Upcoming * 2022-23: TII 28th Feb, 2023



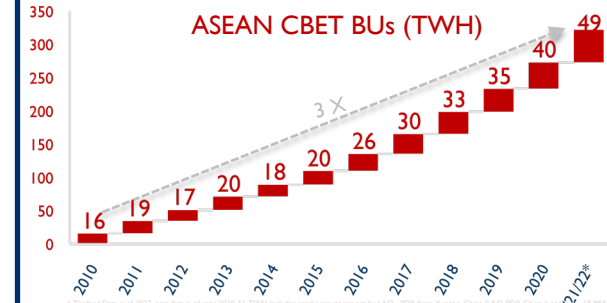
ASEAN



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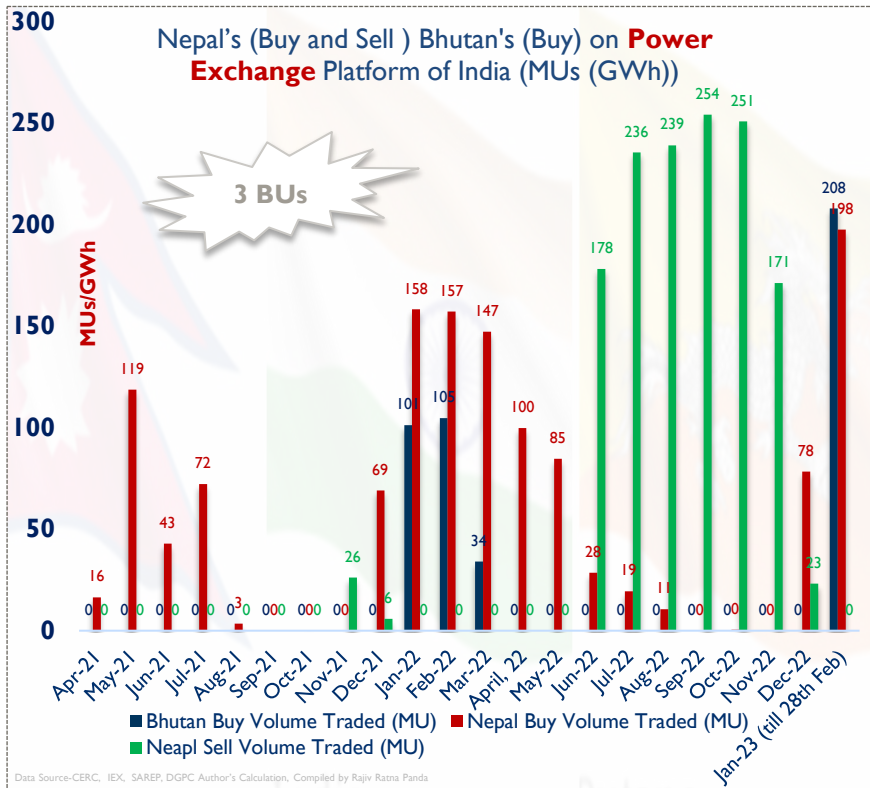
ASEAN CBET BUs (TWh)



Mostly **Unidirectional CBET**, Thailand's Import jumped from **25.5 TWh in 2019 to 35.4 TWh in 2022**. CBET, **Multilateral CBET – LAOS-Thailand-Malaysia- Singapore.**

Bilateral CBET | Beginning of Market Based/Commercial CBET | South-East Asia- Successful Trilateral and Multilateral CBET–A Pathfinder Project for Other Region

Market (Power Exchange) form of CBET (South Asia) & Multilateral CBET (South-East Asia): 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

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

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

As of 31 July 2022, **72 GWh of electricity** traded.

Data Source-Regional electricity trade in ASEAN, Author's Presentation on Blitting to Trilateral, Compiled by Rajiv Ratna Panda



**Interconnection of Regional Electricity Grids in Asia: GCC– South Asia– ASEAN Grid:
Emerging Policy Landscape- Climate Induced Energy Sector Transformation**



Interconnection of Regional Electricity Grids in Asia: GCC– South Asia– ASEAN Grid :

01.4

Emerging Policy Landscape- Climate Induced Energy Sector Transformation

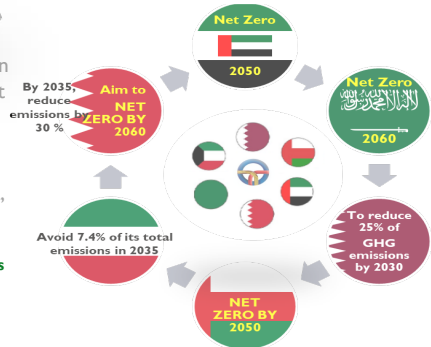


GCC



Bahrain
Kuwait
Oman
Qatar
Saudi Arabia,
UAE

6 Countries



1. Net Zero by 2050 –Oman, UAE
2. Net Zero by 2060-Bahrain, Saudi Arabia,
3. Kuwait- 7.4 % emission reduction by 2035
4. Qatar- 25% GHG emission reduction by 2030

Saudi Arabia : 50 % electricity from RE by 2030, Giga project Neom city will use only RE & world's largest RE hydrogen project

GCC : 72 GW of renewable energy capacity by 2030*

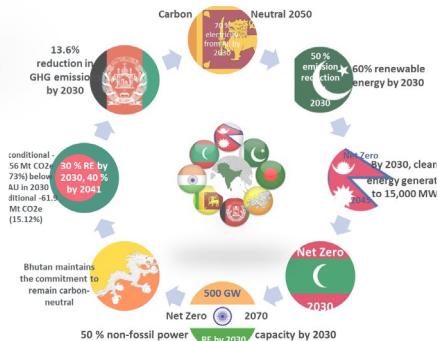


South Asia



Afghanistan
Bangladesh
Bhutan
India
Maldives
Nepal
Pakistan
Sri Lanka

8 Countries



1. Home to **World's 1st Carbon Neutral Country-Bhutan**
2. Net Zero by 2030-Maldives
3. Net Zero by 2045-Nepal
4. Carbon Neutral by 2050-Sri Lanka
5. Net Zero by 2070-India

India- 500 GW RE Installed Capacity by 2030

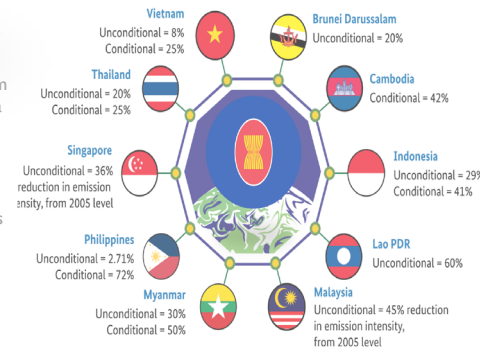


ASEAN



Brunei Darussalam
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10 Countries

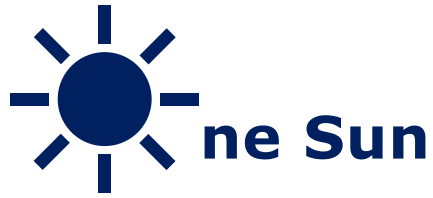


1. **Rapid Emission Reduction Targets**
2. Net zero by 2050 - Brunei Darussalam, Lao PDR, Vietnam, Singapore*
3. Carbon Neutral by 2050 – Cambodia, Malaysia, Myanmar, Thailand
4. Net zero by 2060/65- Indonesia (2060), Thailand (2065)

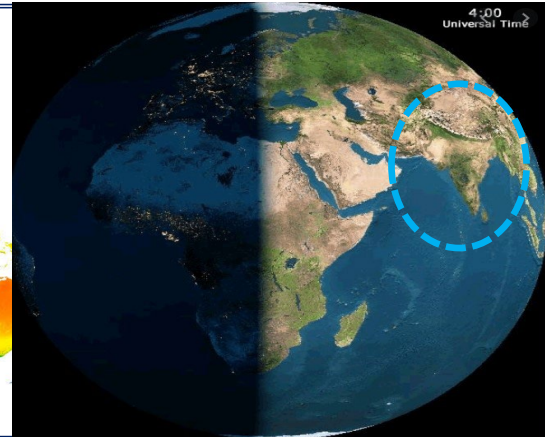
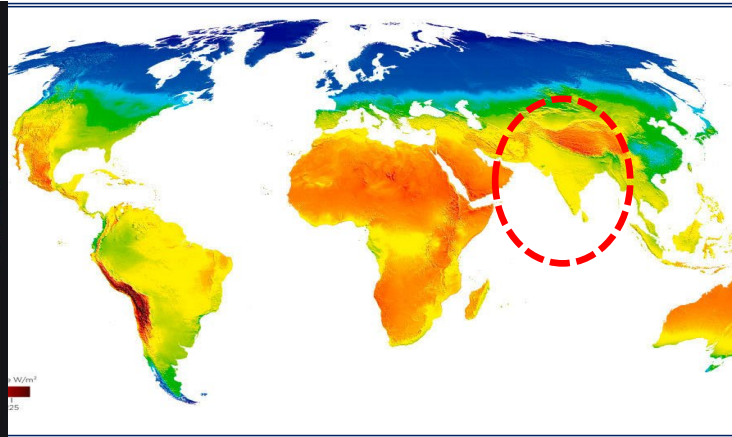
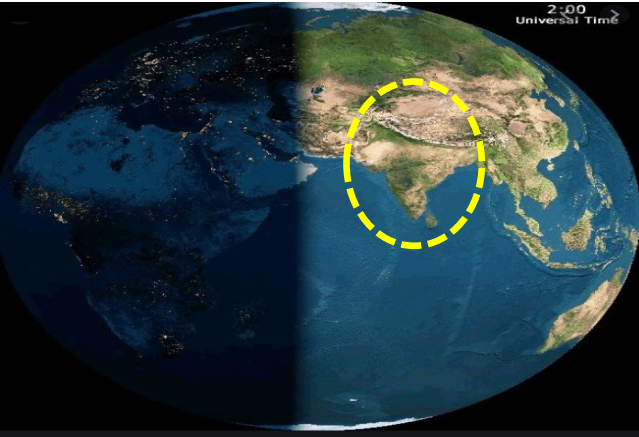
ASEAN AMS Target Scenario (ATS):
2025- 380 GW , 144 GW RE (37.9 %)
2050- 787 GW, 387 GW RE (49.3%)

*by or around mid-century

Decarbonization of Power Sector | Regional Leadership – KSA/GCC, India/South Asia , Thailand, Indonesia/Southeast Asia | Rapid Expansion in Renewable Energy Planned



India at Fulcrum - Enabler for OSOWOG



One Sun One World One Grid (OSOWOG)- India at Fulcrum



Idea Announced in October 2018



The “**Sun Never Sets**”, globally, at any given point of time.



Building a global ecosystem of **interconnected RE**, seamlessly shared for **mutual benefits & global sustainability**



With India at the fulcrum, the solar spectrum can easily be divided into two broad zones viz. **far East and far West**

Far East include countries like Myanmar, Vietnam, Thailand, Lao, Cambodia etc. and far West which would cover the Middle East and the Africa Region.



Matching the demand and supply centre across geographies



Interconnectors as a mean/solution to manage **intermittencies**



Reduce Curtailment, Exploiting the **time zone difference**.



Grid safety and security

Source : Based on RFP OSOWOG



Economies of Scale



Attracting investments



Reduced project costs



Higher efficiencies and increased asset utilization



Resulting economic benefits would positively impact



Poverty alleviation



Support in mitigating water, sanitation, food and

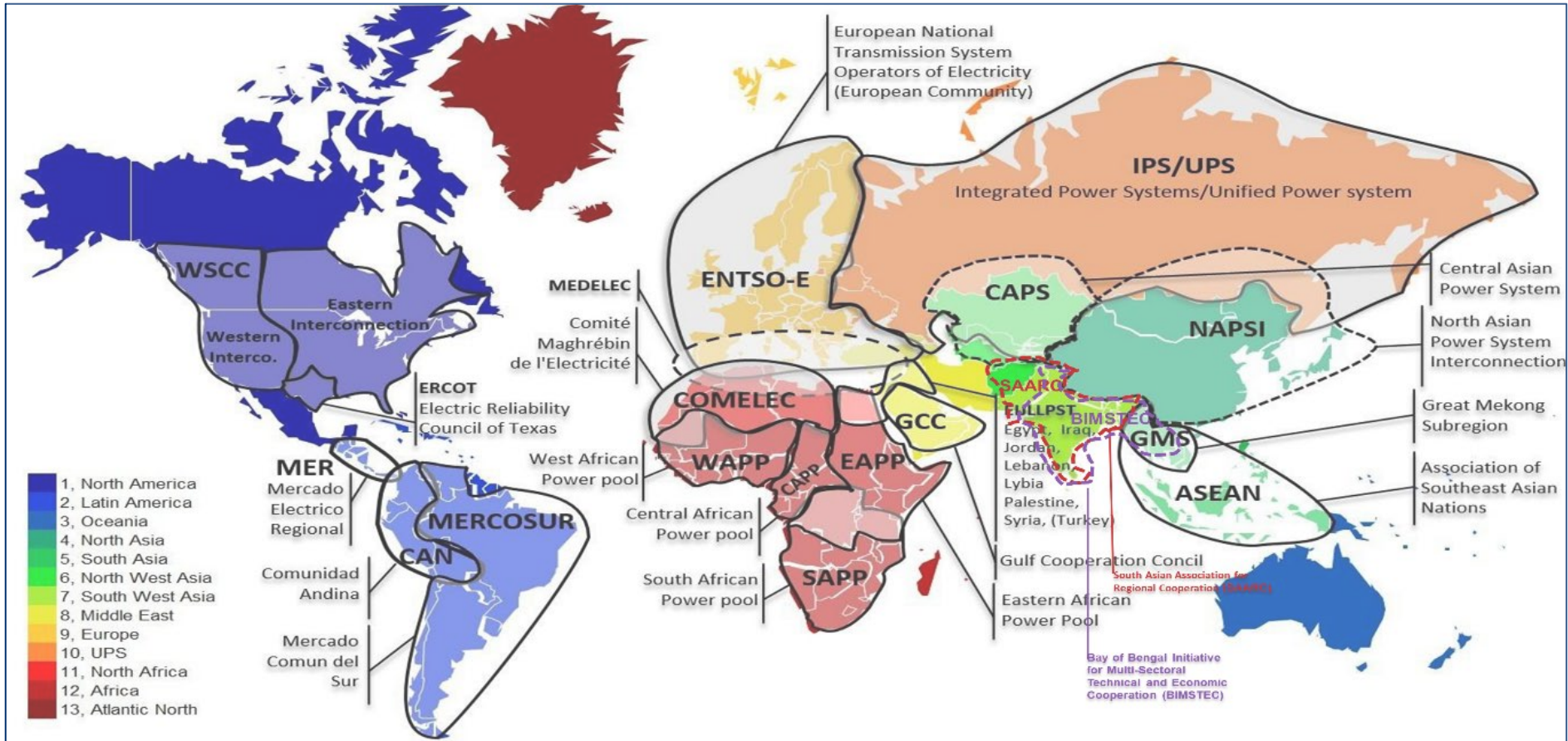


Other socioeconomic challenges.

OSOWOG- Potential for Regional & Trans-Region Transmission Interconnection, Interconnectors among countries

While plan is grand, we have various **proven regional grid interconnection exist around the globe** such as Europe etc. backed with HVDC technologies

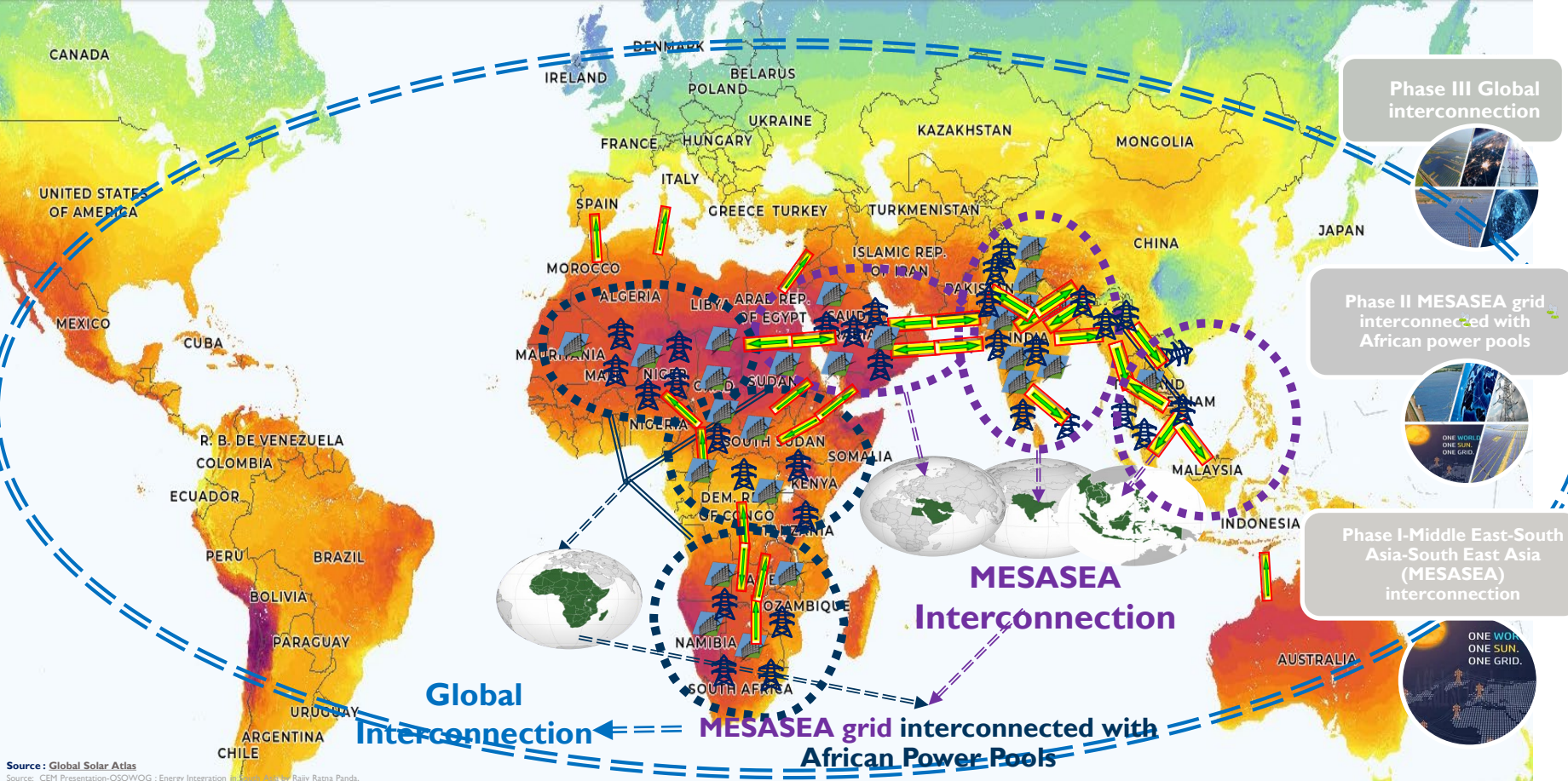
Various Regional Grid Integration Initiatives across the Globe



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

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



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

“Developing a Long-term vision, Implementation Plan, Road Map and Institutional Framework for Implementing “One Sun One World One Grid”

Phase I Assessment stage



- 🔗 Demand supply scenario till 2050.
- 🔗 Renewable energy resource potential assessment (including decentralized sources).
- 🔗 Power market assessment.
- 🔗 Comprehensive vision & road map for OSOWOG.

Phase II: Potential assessment and pilots identification



Pilot
project

- 🔗 Identify 2-3 cross-border projects (that can be initiated within 1 or 2 years)
- 🔗 Preferably one with each of Middle East, South East and Africa regions considering India as the grid fulcrum.
- 🔗 Detailed policy and regulatory scan of the identified countries, to identify readiness

Phase III: Full scale roll out



- 🔗 Develop institutional framework for international co-operation, steering arrangements and governance
- 🔗 Support in developing an implementation roadmap
- 🔗 Includes the establishment of a framework for Project Management Office (PMO) as per MNRE's requirement



The International Solar Alliance (ISA) Acts as a Nodal Agency for all activities including implementation of the OSOWOG study for developing a long-term vision, implementation plan, road map and institutional framework for implementing the initiative.

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 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

Union Minister for Power and New and renewable Energy Shri R. K. Singh met Ma Aminath Shaana, Minister of Environment, Climate Change and Technology of Maldives here today.

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 on Energy cooperation and another on transmission interconnection under One Sun, One World, One Grid (OSOWOG). To facilitate energy transition programme, India and Maldives have proposed to establish transmission interconnection for renewable power transfer as part of One Sun One Grid initiative.

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

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

Union Minister for Power and New and renewable Energy Shri R. K. Singh said on Monday that a draft charter for One Sun One World One Grid (OSOWOG) has been prepared and is awaiting a final approval through which clean energy can be transferred across borders. He said the charter will be approved by the steering committee soon.

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

part of India's Act East policy, with the ties with Southeast Asian countries and

are in talks to upgrade their / which may be extended / aware of the matter said, as / connect the national power / rients.

the draft document of the One Sun One World One Grid (OSOWOG) initiative is ready and will soon be approved by the steering committee concerned, Union power minister RK Singh said on October 26.

Talking about the mission, Singh said the government set up a technical group in the ministry of power which has worked out the feasibility of having interconnected transmission network. "We have drawn up a draft, which will soon be open for signatures from the members after the steering committee approves it," he said while talking to reporters on the sidelines of the 10th anniversary meeting of the International Solar Alliance (ISA) in Delhi.

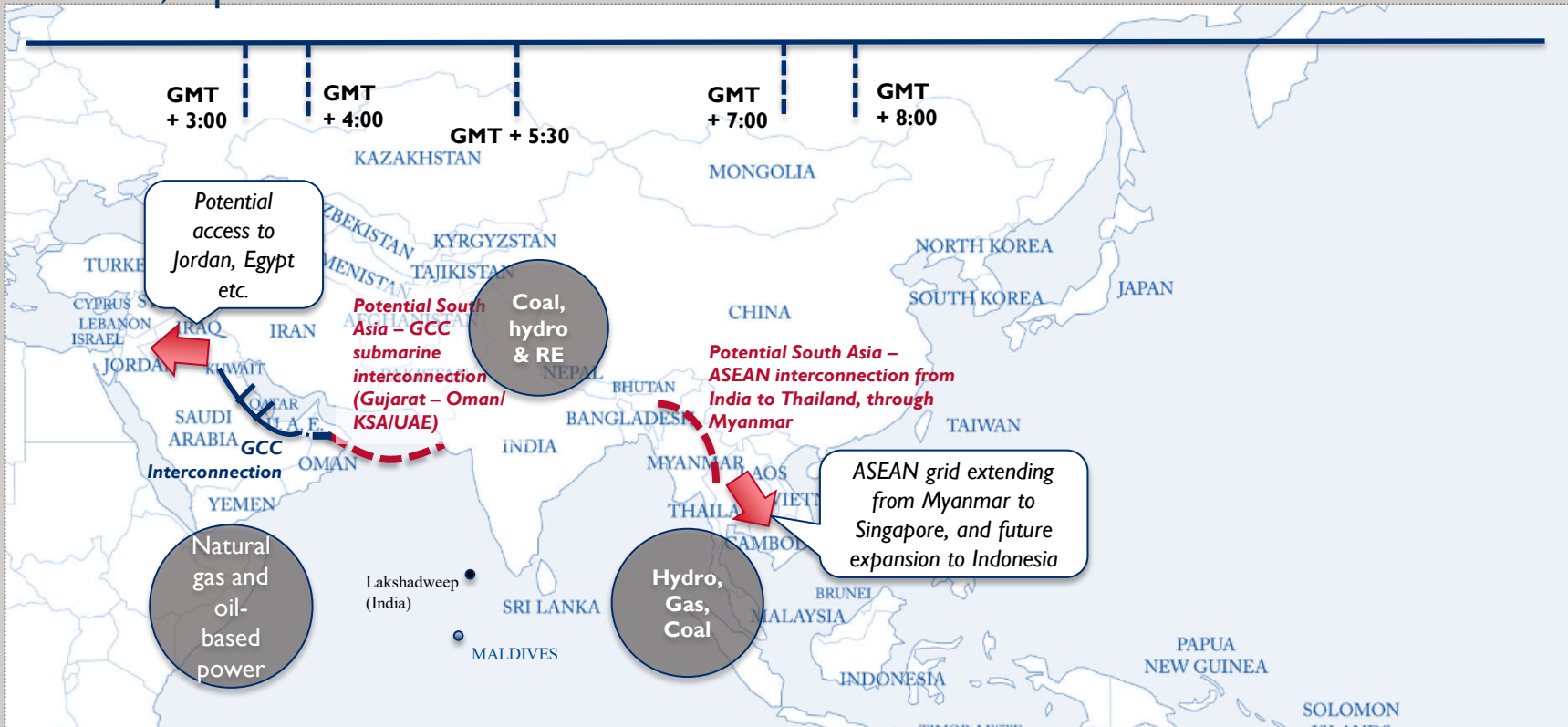


Inter Regional Grid Interconnection

GCC-South Asia-ASEAN Power Grid

Prospects of GCC-South Asia– ASEAN grid interconnection

Time zone variation, reserve sharing , Resource complementarity, Diversity of peak demand , Optimum utilization of RE Resources and increased reach to additional markets



Inter Regional Grid Interconnection

South Asia-GCC Power Grid

EGYPT

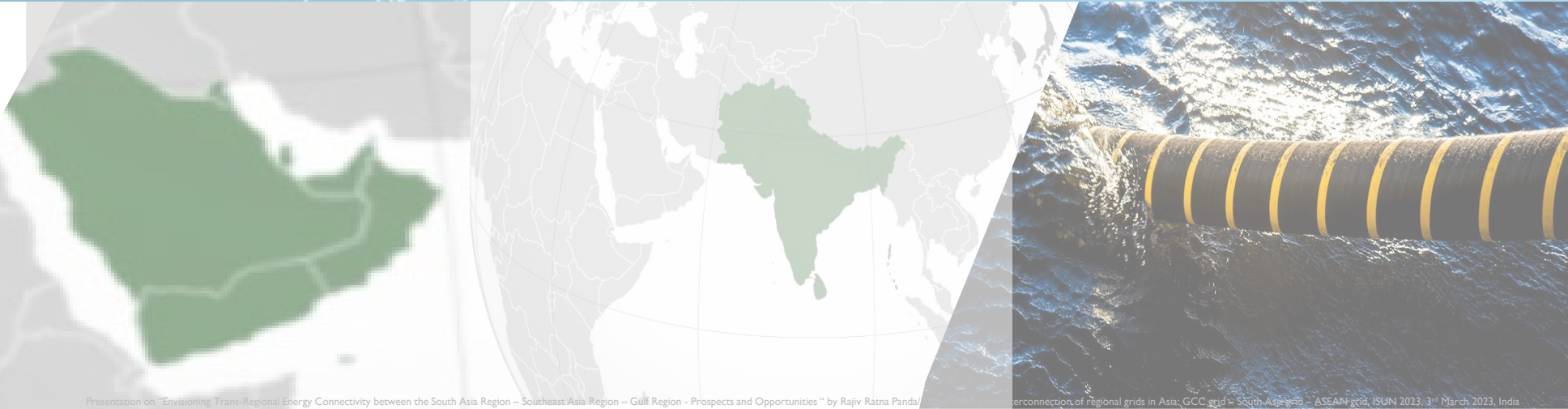
BAHRAIN

SAUDI ARABIA

UAE

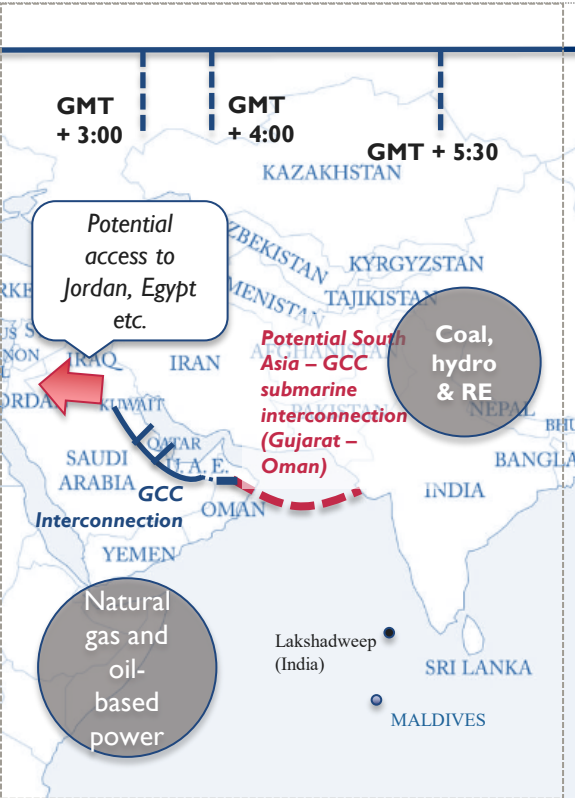
OMAN

INDIA



Prospects of South Asia – GCC Grid Interconnection

Time zone variation, reserve sharing, Resource complementarity, Diversity of peak demand, Optimum utilization of RE Resources and increased reach to additional markets



India (Gujarat) – GCC (Oman) Interconnection

HVDC Submarine Cable

Oman is connected to GCC Grid

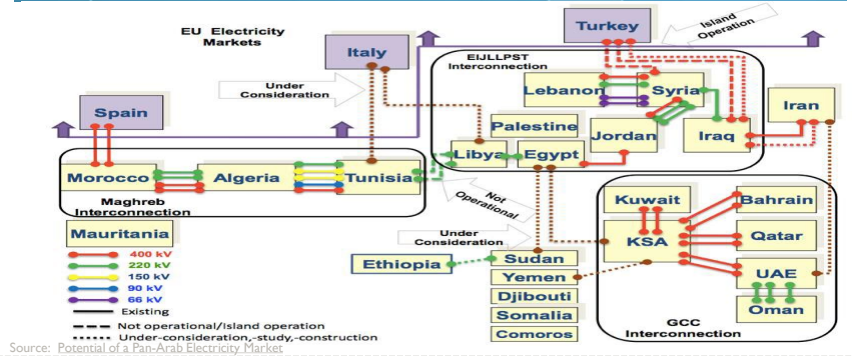
Oman–India transmission 2300 km, of 1000 km across sea, while the maximum depth 3500 m.

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





Inter Regional Grid Interconnection

South Asia-ASEAN Power Grid

South Asia – ASEAN Grid Interconnection

Laying the foundation through India-Myanmar Grid Interconnection



Potential additional Low-Capacity interconnections:

Namong (Arunachal Pradesh, India) – Pansong (Myanmar) 11kV line

Behiang (Manipur, India) – Cikha (Myanmar) 11kV line

Zokhawthar (Mizoram, India) – Rikhawdar (Myanmar) 11kV line

High-Capacity interconnections: Asynchronous mode

Imphal – Tamu 400kV DC line along with 2x500 MW HVDC Back-to-Back at Tamu (Myanmar)

Source : Ministry of Power , GOI



Myanmar is the gate way to ASEAN. Strengthening India-Myanmar Connection will kick start the process of larger South Asia-ASEAN Grid integration

South Asia – ASEAN Grid Interconnection

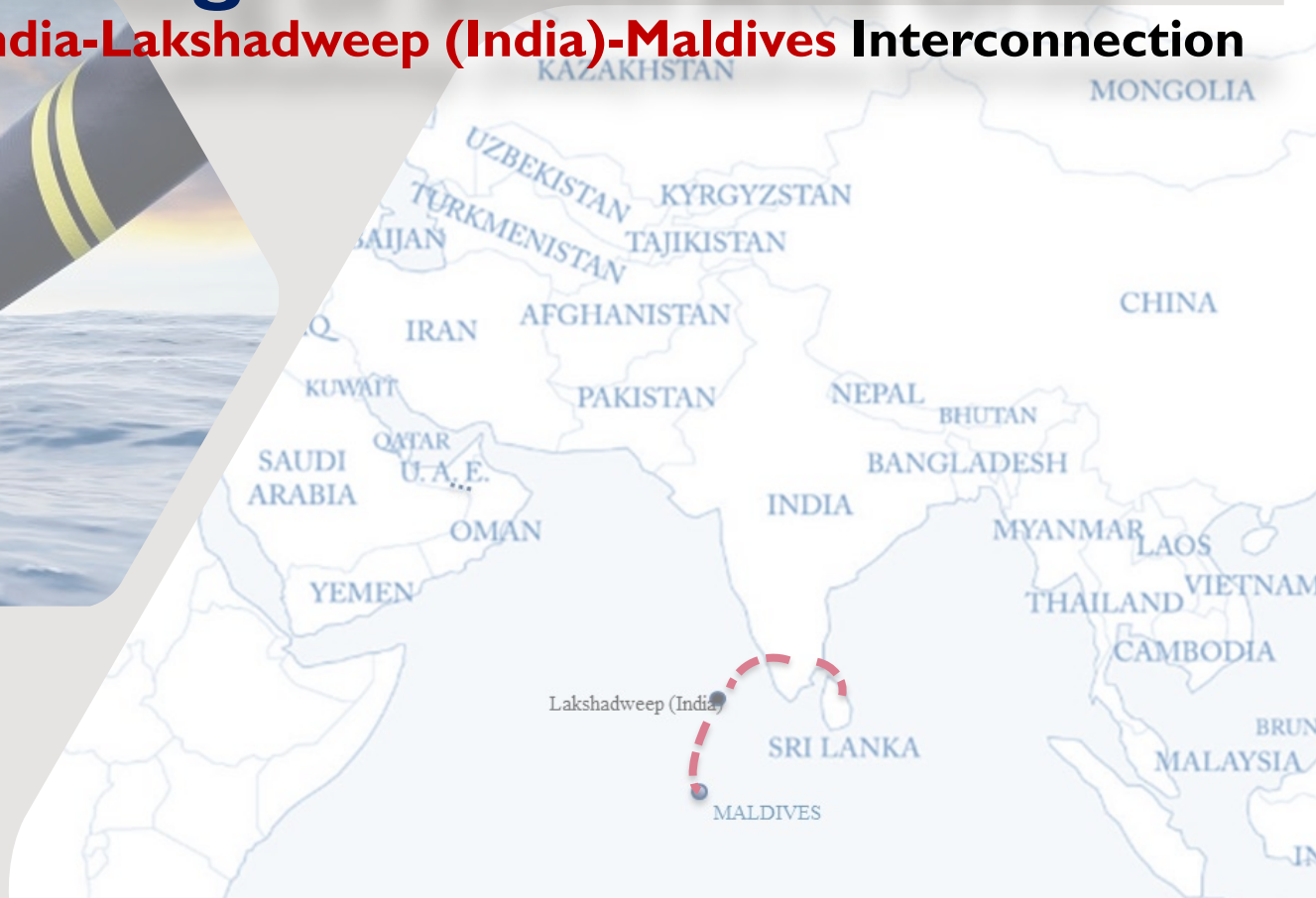
India-Myanmar-Thailand-ASEAN Power Grid (APG) Integration



APG is evolving at a relatively accelerated pace due to climate & RE priority. Opportunity for tapping potential benefits of South Asia-ASEAN Power Grid

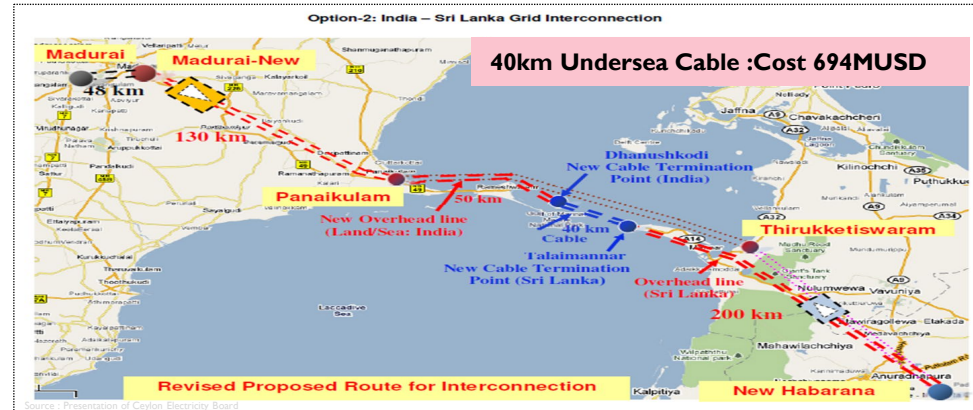
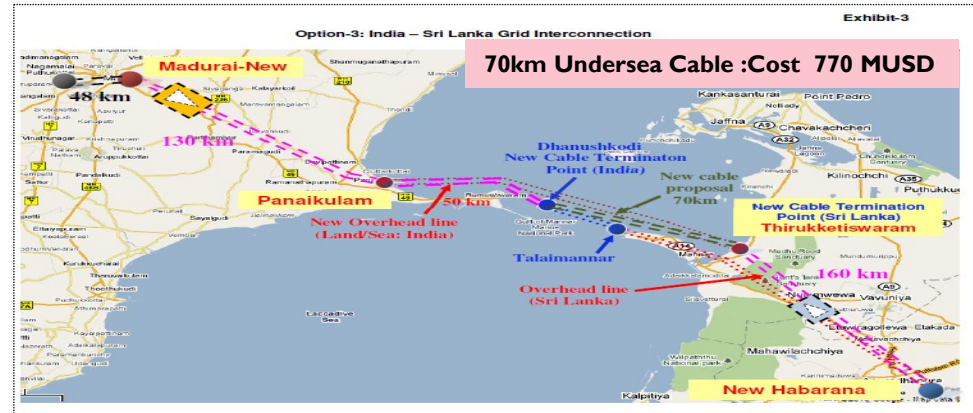
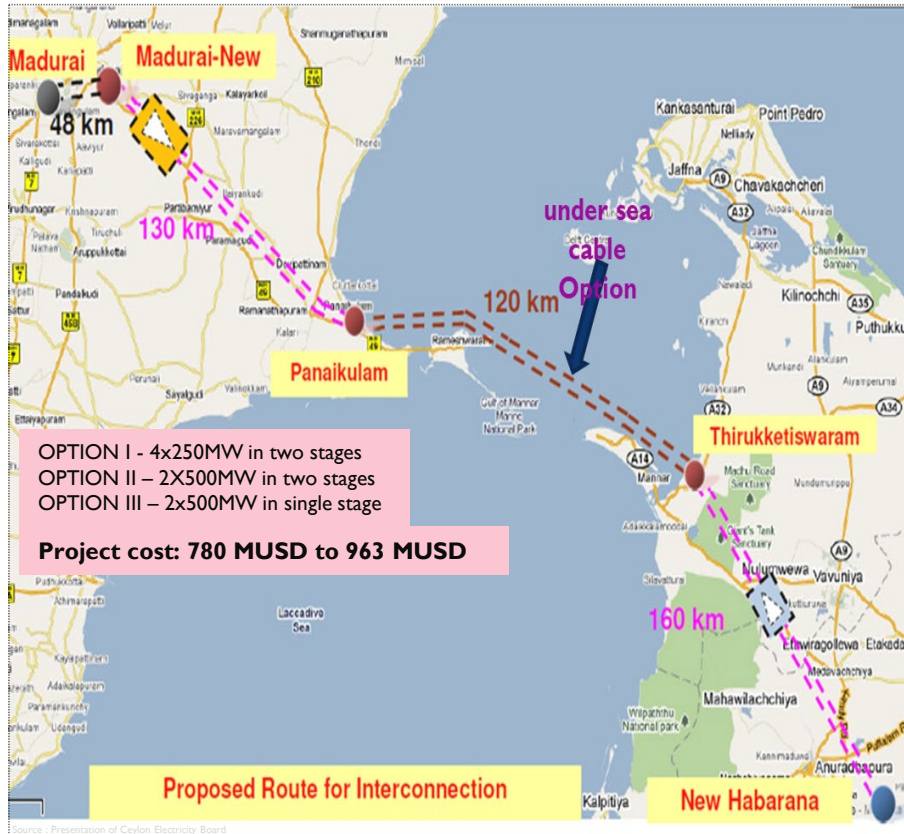
Strengthening of South Asia Grid

India – Sri Lanka and India-Lakshadweep (India)-Maldives Interconnection



Strengthening of South Asia Grid

India –Sri Lanka Cross Border Electricity Transmission Interconnection



High Cost of Interconnection – Financially Challenging

India – Sri Lanka Cross Border Electricity Transmission Interconnection

DRAFT DETAILED PROJECT REPORT

Madurai (New), India – New Habarana, Sri Lanka
 $\pm 320\text{kV}$ VSC HVDC Bipole
 (Phase-1: 500MW)



Prepared by:
 Joint Technical Team (JTT)
 India and Sri Lanka

November 2020

Source: Presentation of Ceylon Electricity Board



Project Cost Reduction | 963 MUSD to 460 MUSD , Looks Promising | Fresh Financial & Economic Feasibility Study Is Underway

Strengthening of South Asia Grid

India-Lakshadweep (India)-Maldives Cross Border Electricity Transmission Interconnection



Decarbonisation of Maldives (95% fossil) and Lakshadweep (89% Fossil)

India-Lakshadweep (India)-Maldives Electricity Transmission Interconnection can provide sustainable energy security



Way Forward

Inter Regional Grid Interconnection GCC-South Asia-ASEAN Power Grid

Way Forward



Building Regional, Sub-Regional, Continental and Global **Consensus** on Interconnections



Navigating
Centralised ~ Decentralised
Approach
~ **Combination**



Deepening International **Energy Cooperation** and **Navigating** Geopolitical realities
Idealism vs Realism



Feasible & Credible Inter-Regional/Continental **Pilots**, Further Optimisation of **cost of Transmission**

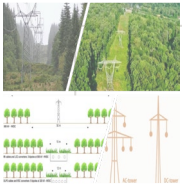


Navigating Economies of Scale
~ Economies of Large Numbers



Policy, Regulatory and market **Harmonization**, Mobilising Investment & Finance, **Regional Forums, World Solar Bank**

Efficiencies



Non Engineering Cost
(Right of Way, Environmental, Land Acquisition, Compensation)

Vulnerabilities



Commercial **Feasibility, Cost** and **Benefit** sharing of transmission Assets

Strategic implications



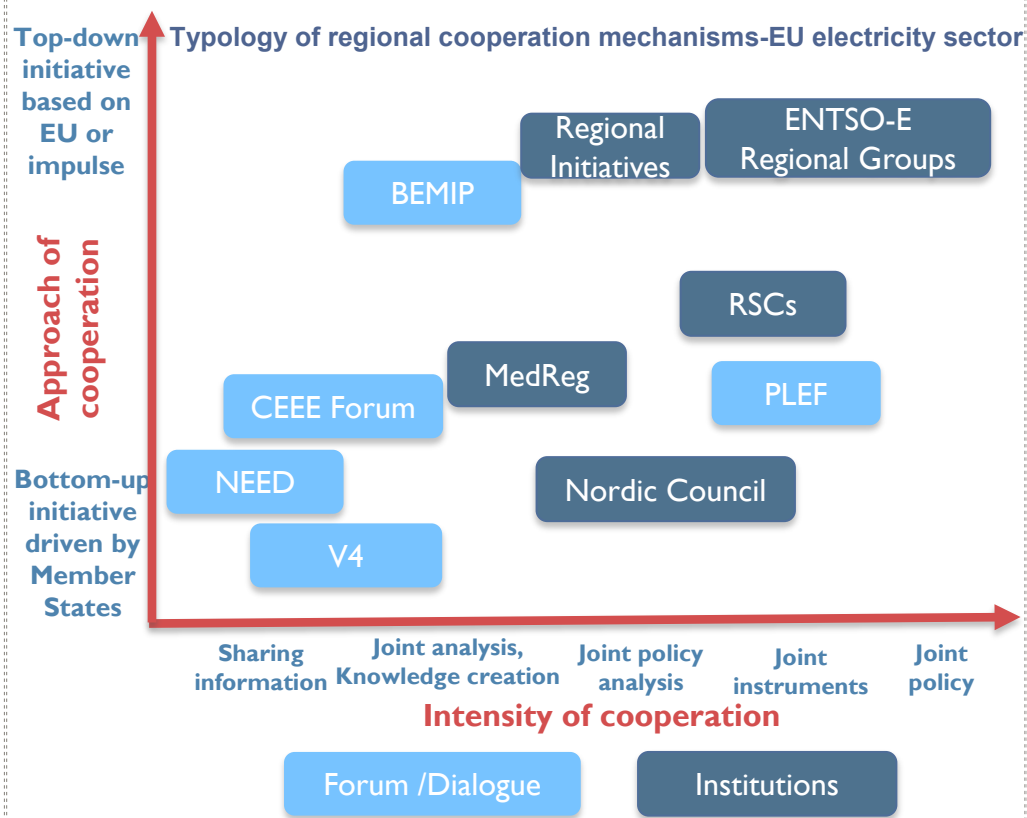
New Technological & Threat **Trade off** -Energy Storage, Hydrogen & Cyber Security

In South Asia Context, OSOWOG will provide further impetus to Power System Integration in South Asia Region & Greening the CBET in the SA Region

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Way Forward

1. To carry out the **Pre Feasibility study** of the potential Inter Regional Grid Interconnection (**IRGI**).
2. **EVS** (Efficiencies, Vulnerabilities, Strategic implications) **assessment of IRGI**.
3. **Democratise** the dialogue, **Joint Analysis** and **Knowledge exchange** on IRGI.
4. A Broad Pan **Asia Regional Transmission Interconnection Master Plan (ARTIP)**
5. **IRGI Civil Society/Think Tank Network**
6. **Annual IRGI CEO Dialogue**



Source: Based on Cross-border cooperation for interconnections and electricity trade

Thank You



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