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#SACEF2024

Transforming Regional Electricity Green Grids: South Asia and Beyond

South Asia Regional Energy Partnership (SAREP)

Session Theme Presentation

on

“Transforming Regional Electricity Green Grids for Enhanced Energy Security and Accelerating Clean Energy Transition – Integrating South Asia and Beyond”

Presented by
Rajiv Ratna Panda, Regional Energy Trade Lead, SAREP

South Asia Clean Energy Forum (SACEF), Oct 22, 2024 , Time: 11:30 AM to 1:00 PM | Hyatt Regency Mansarovar | Jaipur, India





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Transforming Regional Electricity Green Grids: South Asia and Beyond

01

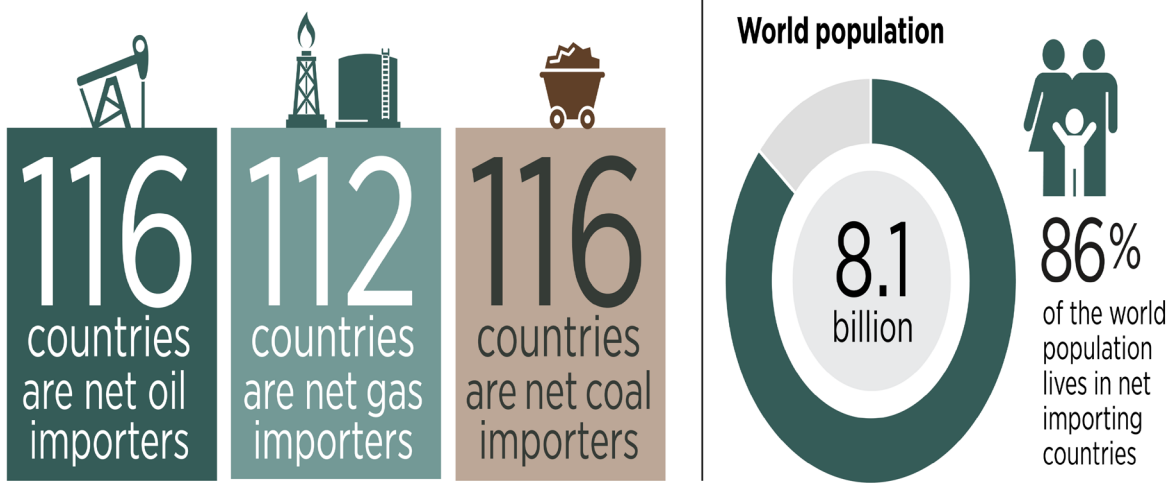
State of Play in Energy Security and Energy Transition

{Global and South Asia Scenario}

Transforming Regional Electricity Green Grids: South Asia and Beyond

01.1 State of Play in Global Energy Security: {Import Dependency, Supply Disruptions, Price Volatility in Energy Fossil Fuels}

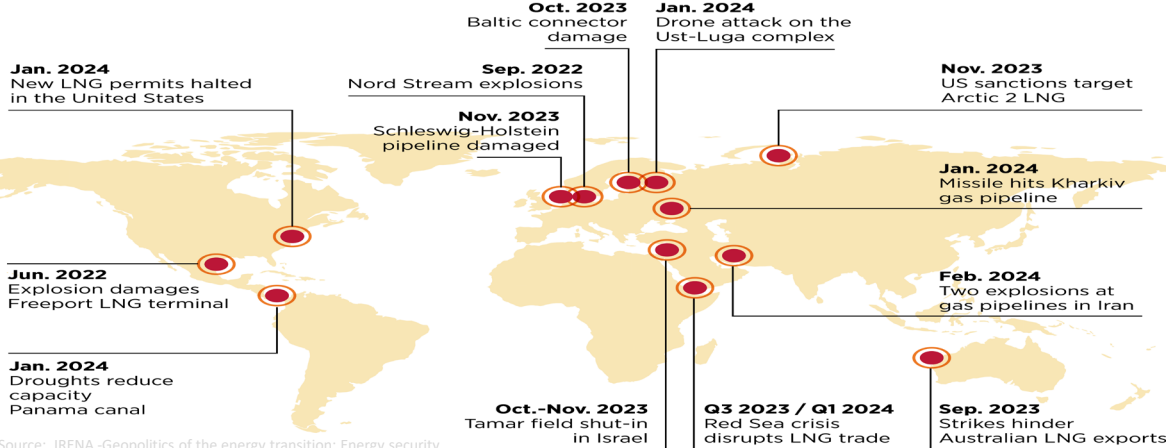
Share of countries & global population dependent on net imports of fossil fuels



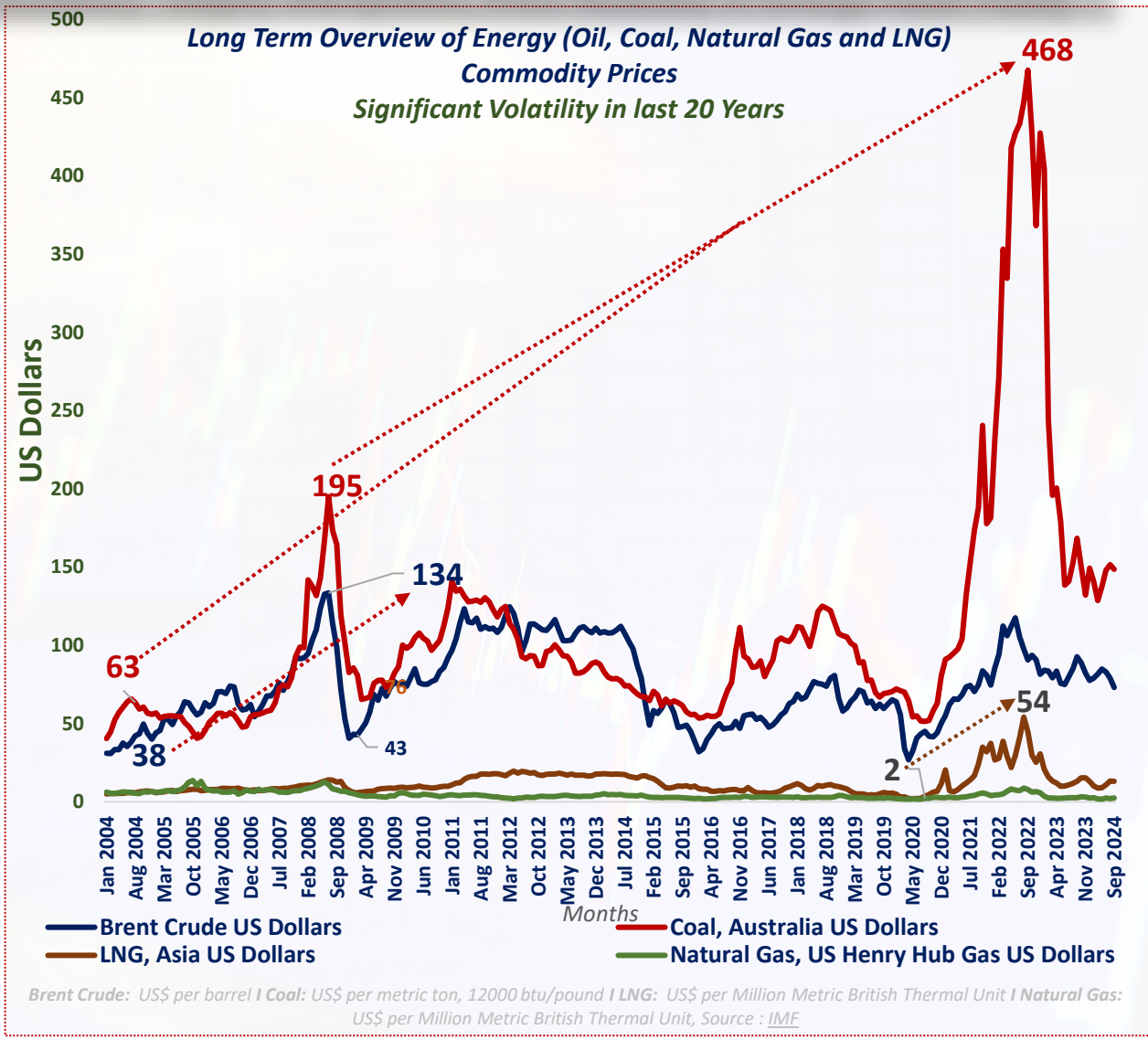
Source: IRENA -Geopolitics of the energy transition: Energy security | Source: (UN Comtrade Database, 2022).

40% products transported by global shipping are fossil fuels or derivatives | 99% shipping energy demand is met by fossil

Recent disruptions of natural gas supply

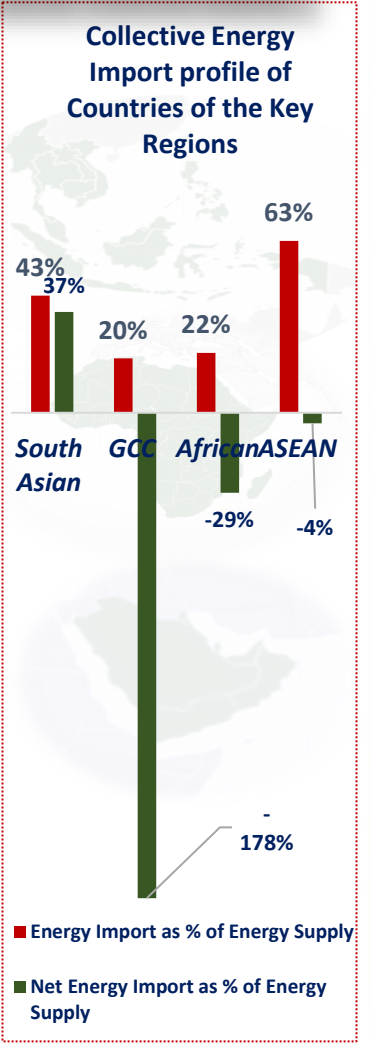
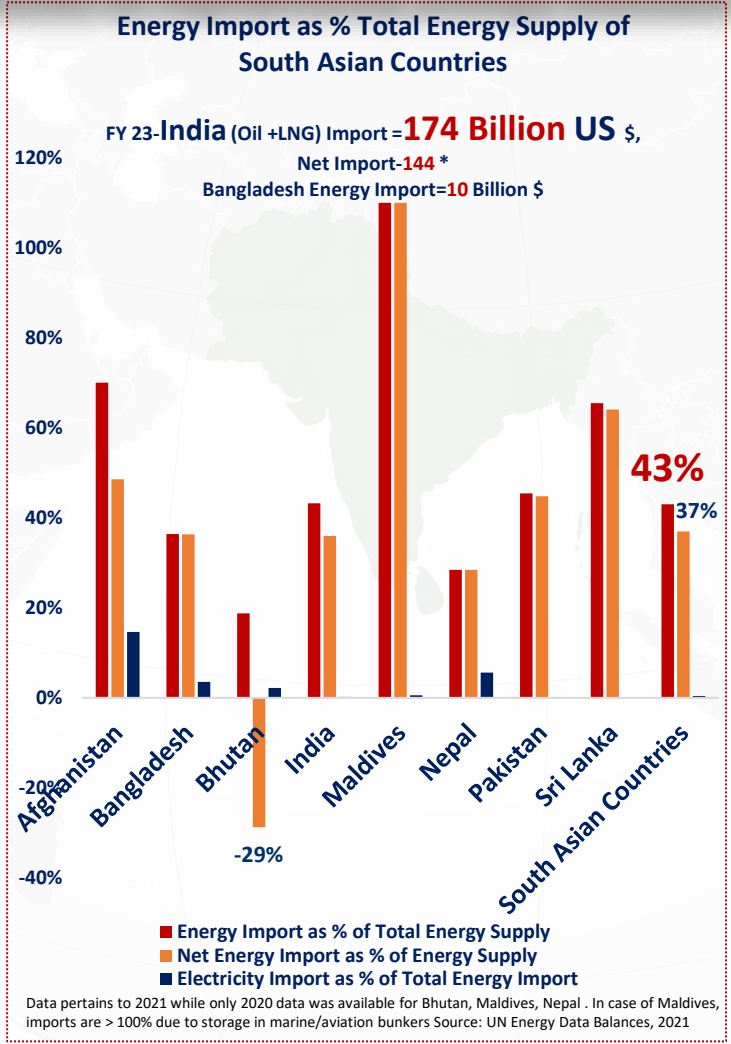
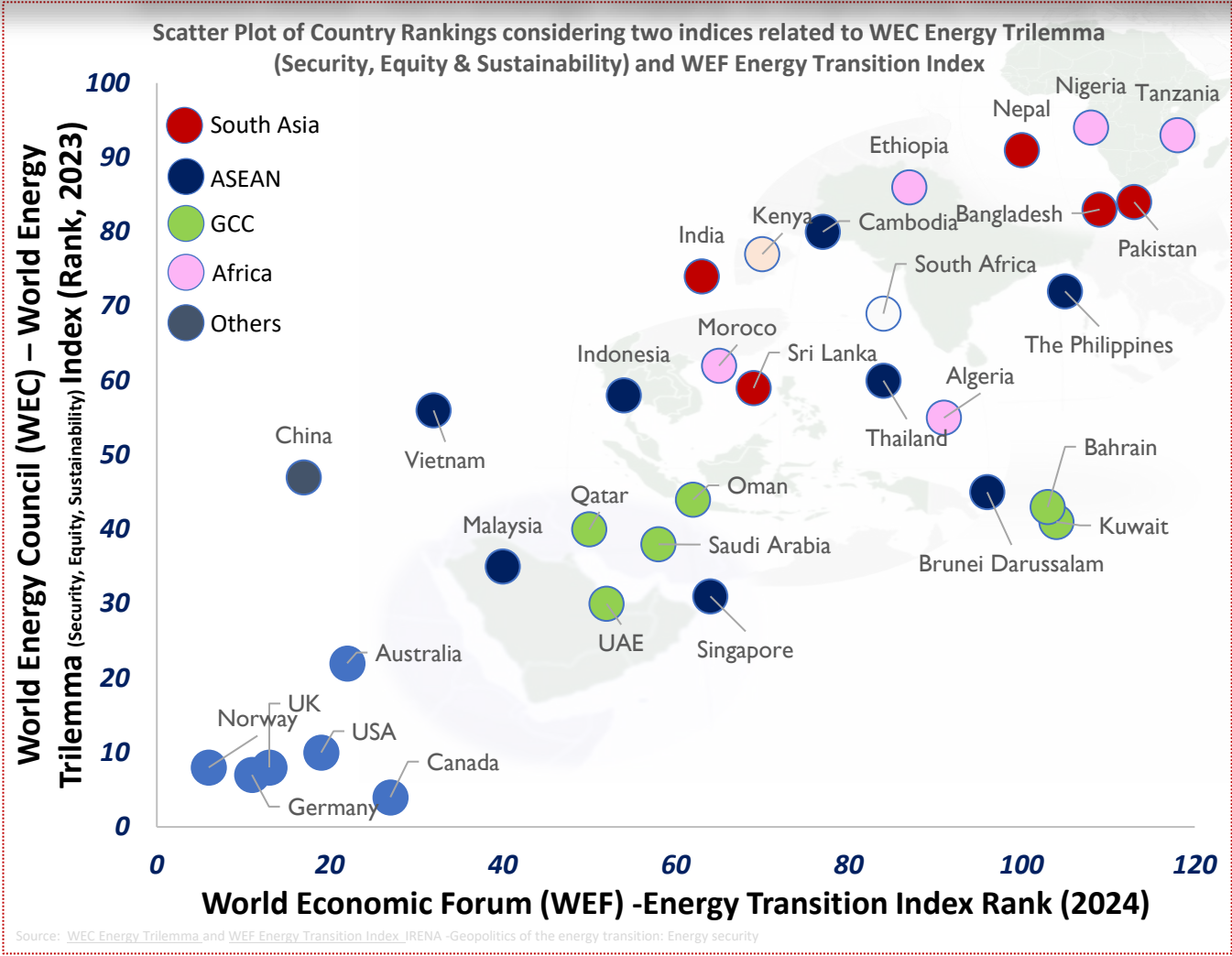


Source: IRENA -Geopolitics of the energy transition: Energy security



Transforming Regional Electricity Green Grids: South Asia and Beyond

01.2 South Asia : 43% Energy Supply is Imported, Mostly Fossil, Ranks as Significantly Energy Insecure and Vulnerable



Countries in GCC score well in Energy Security rankings when compared with most of South Asia, ASEAN and Africa but still have energy transition challenges



02 → **Role of Regional Green Grids & Power Pools/Markets**
{A Framework for De-risking Energy Insecurity and Climate Vulnerability}



02.1 Expanding Green Grid is Key to Manage Energy Security and Meet Clean Energy Transition & Climate Goals

A Framework for Managing Energy Insecurity & Climate Vulnerability

Strategy-1
Immediate Intervention to Prevent a Major Supply Disruption

Strategy-2
Energy Supply Source and Supply Chain Diversification

Strategy-3
Strategic Energy Reserves (Domestic & International)

Strategy-4
Increase use of Domestic Energy Resources, Accelerate Exploration

Strategy-5
Increased/Maximized the Utilization of Renewable Energy

Strategy-6
Green Grids, Mega Grids, Green Electrification of the way of Life

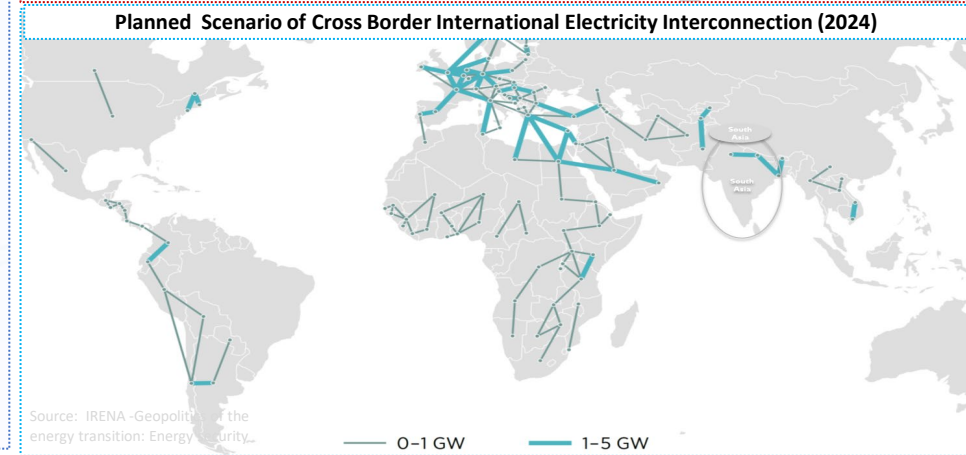
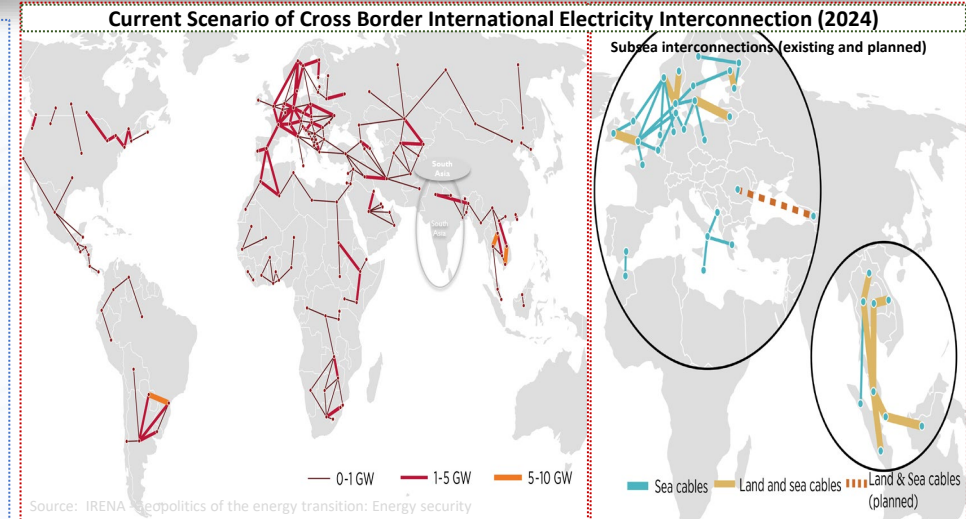
Strategy-7
Regional Green Grids & X border Electricity Trade

Strategy-8
Regional Electricity Markets & Internal Energy Market

Strategy-9
Moderating Energy Demand, Fuel Substitution, Energy Efficiency

Massive Green Grid Needs

- ❖ For Reaching national Energy & Climate goals Announced **length of grids** to reach **167 Million Km by 2050** from 77 Million Km in 2021, **2.3 X Increase** globally (Source: IEA's Electricity Grids & Secure Energy Transitions)
- ❖ To meet national climate targets, **grid investment** needs to **nearly double by 2030 to over USD 600 billion per year** after over a decade of stagnation at the global level. (Source: IEA's Electricity Grids & Secure Energy Transitions)
- ❖ At least **\$21.4 trillion** needs to be invested in the **electricity grid by 2050** (BNEF)



- ❑ Historically origin of **CBET Green Grids** are often associated with green **Hydro Power** (LAO's Hydro in ASEAN, Itaipu hydro in Brazil, Hydro in Central Asia, Norway's Hydro in Europe, Canada's Hydro in NA and so on.
- ❑ IRENA report indicates **cross-border electricity trade (CBET) dependency** provides relatively **better energy security as compared fossil fuel import** dependencies. Since electrons can flow both ways, it is best to think about **electricity trade as co-dependency**, rather than the asymmetrical dependency.
- ❑ **Regional Power Grid & Markets Provides Reduced Exporter Dominance : During 2023, none of the 27 member countries was an exporter all of the time (ACER, 2024).**

Source: IRENA - Geopolitics of the energy transition: Energy security



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Transforming Regional Electricity Green Grids: South Asia and Beyond

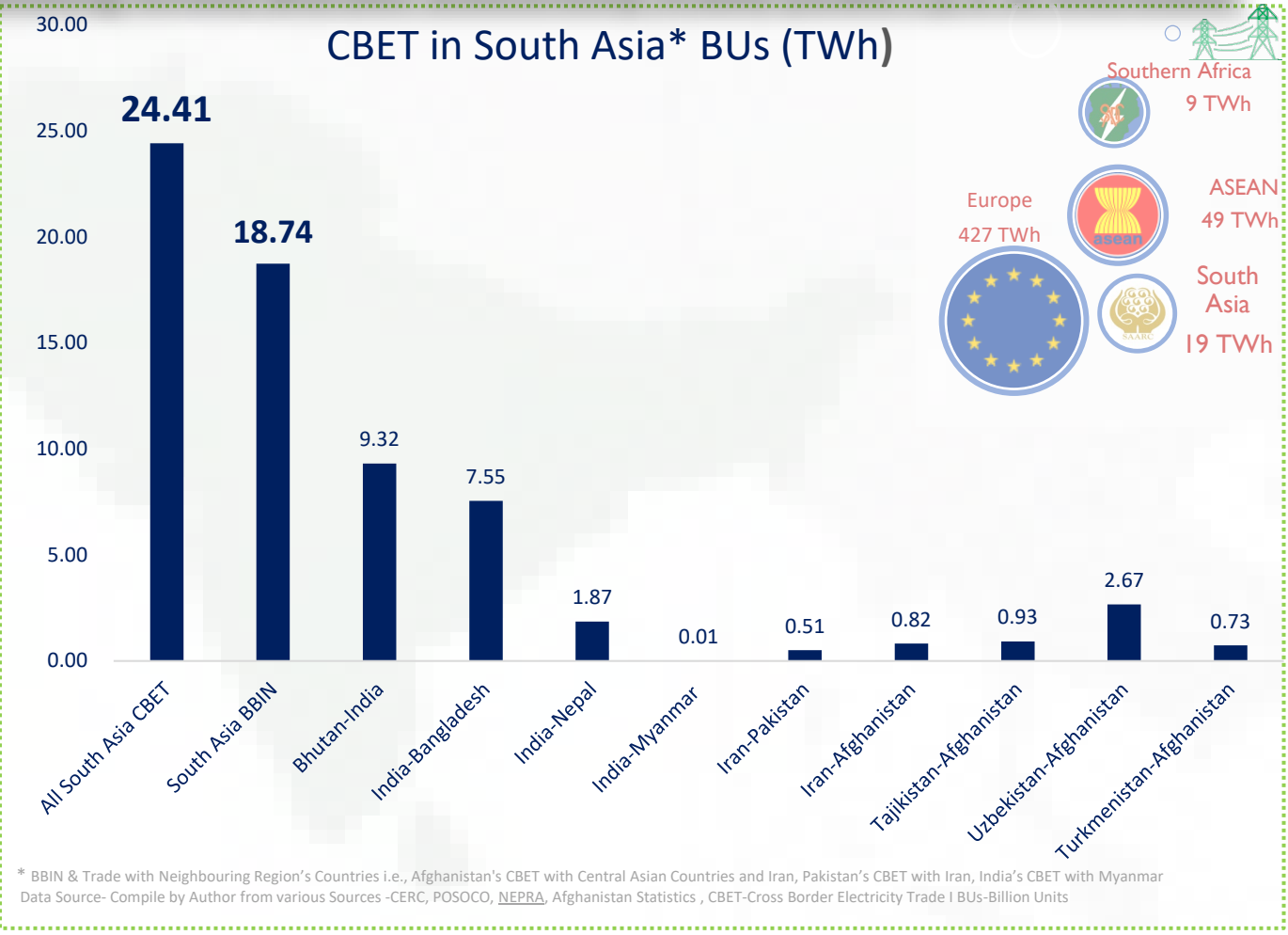
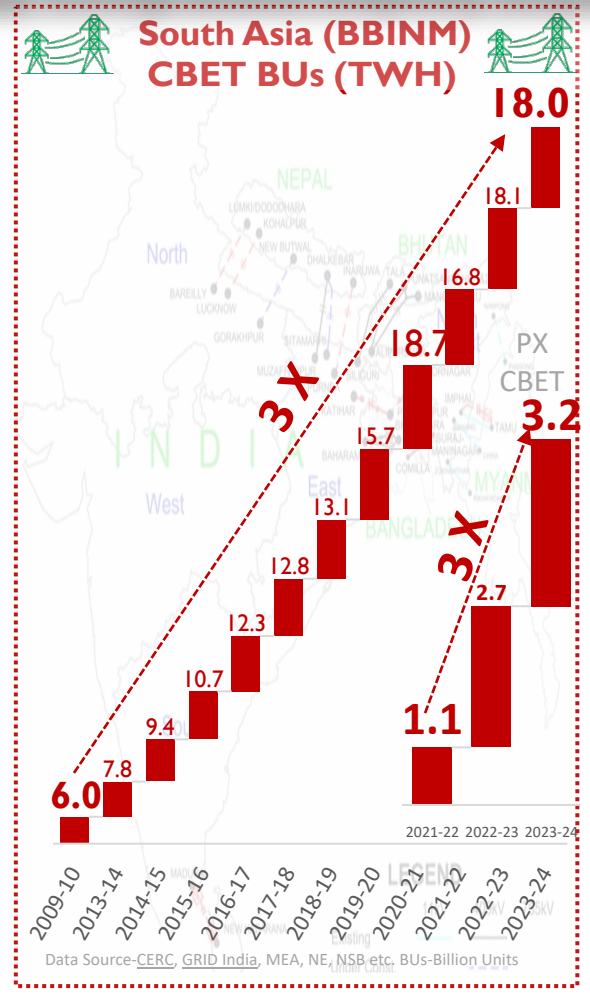
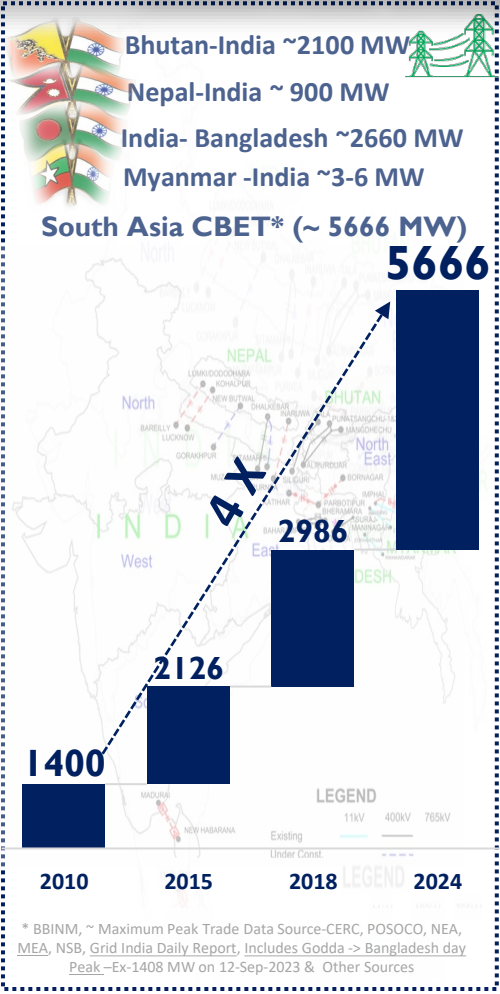
03

Energy Integration in South Asia : Cross Border Green Grids Opportunities

{Cross Border Electricity Trade Growth, Clean Energy Resources and Potential Regional Benefits}

Transforming Regional Electricity Green Grids: South Asia and Beyond

03.1 South Asia Energy Integration: Rapidly Expanding Cross Border Electricity Trade (CBET), 3 X Increase

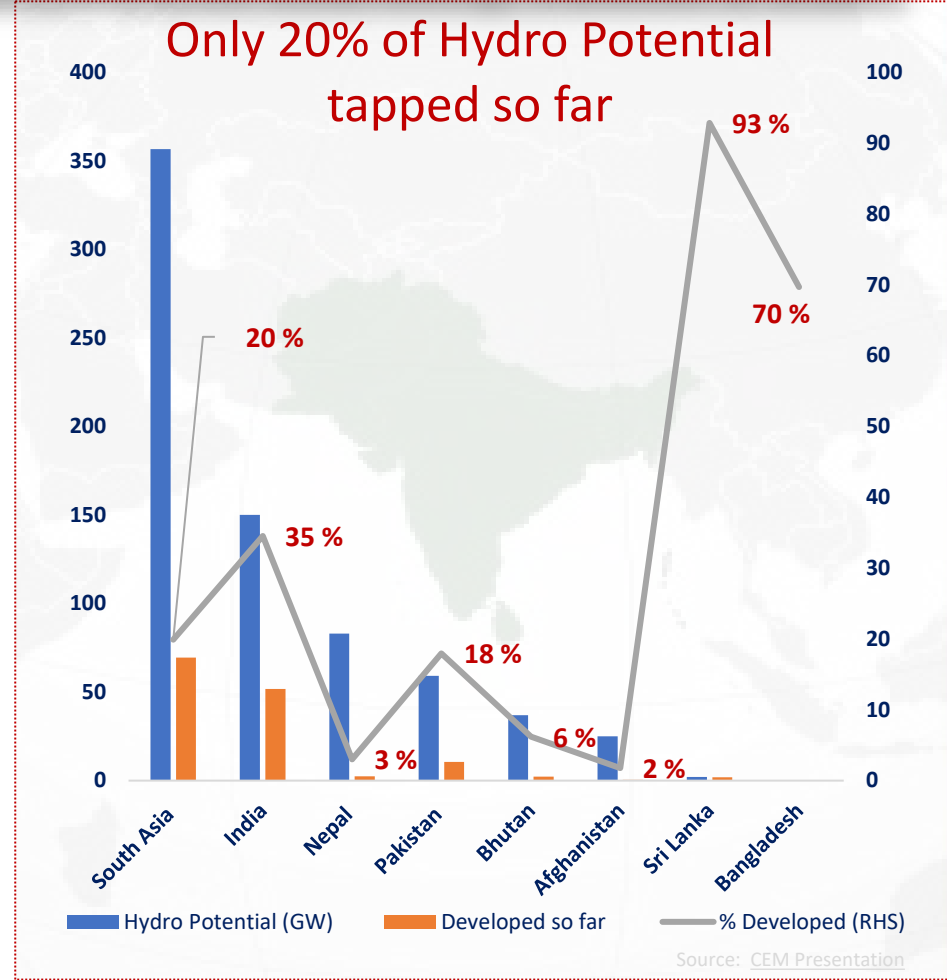
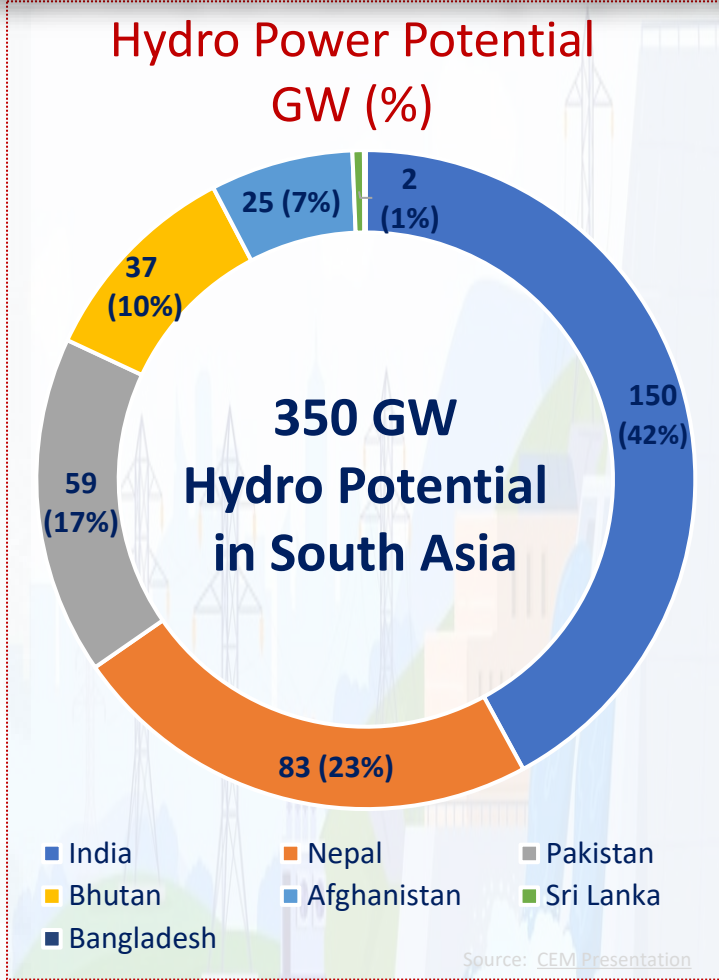
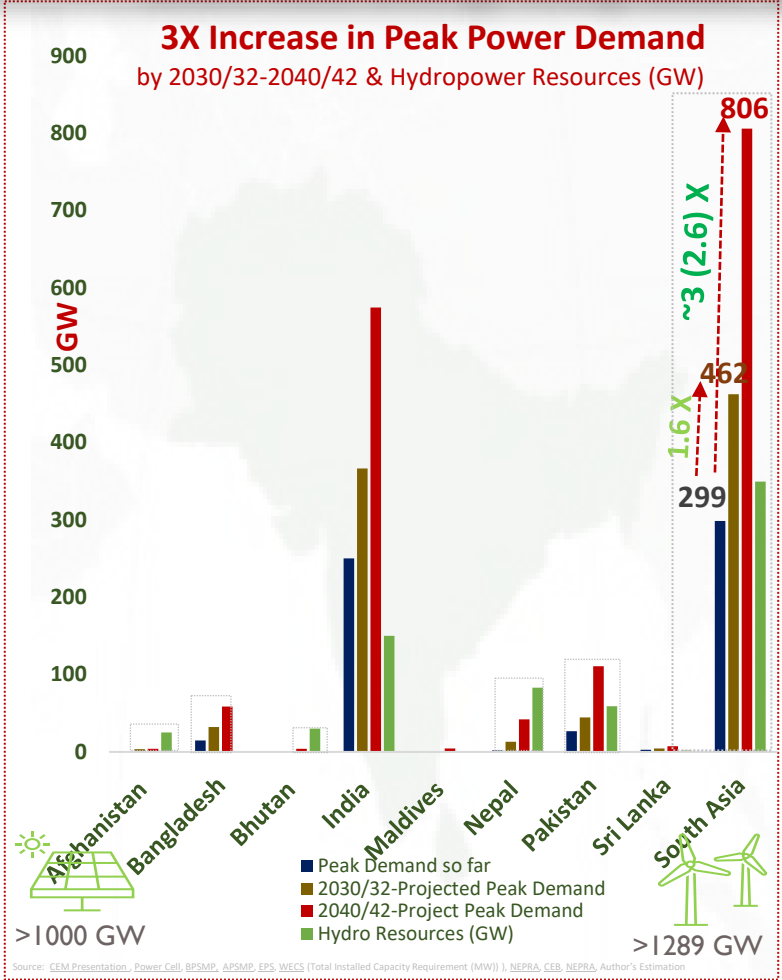


CBET Tripled | EU (ENTSOe)-427 TWh | CBET PX- 6.7 BUs* | Price (₹/Kwh)-FY23-Buy (Nepal @ 5.95 ₹, Bhutan @ 4.39 ₹) Sale (Nepal @ 5.14 ₹)

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

Transforming Regional Electricity Green Grids: South Asia and Beyond

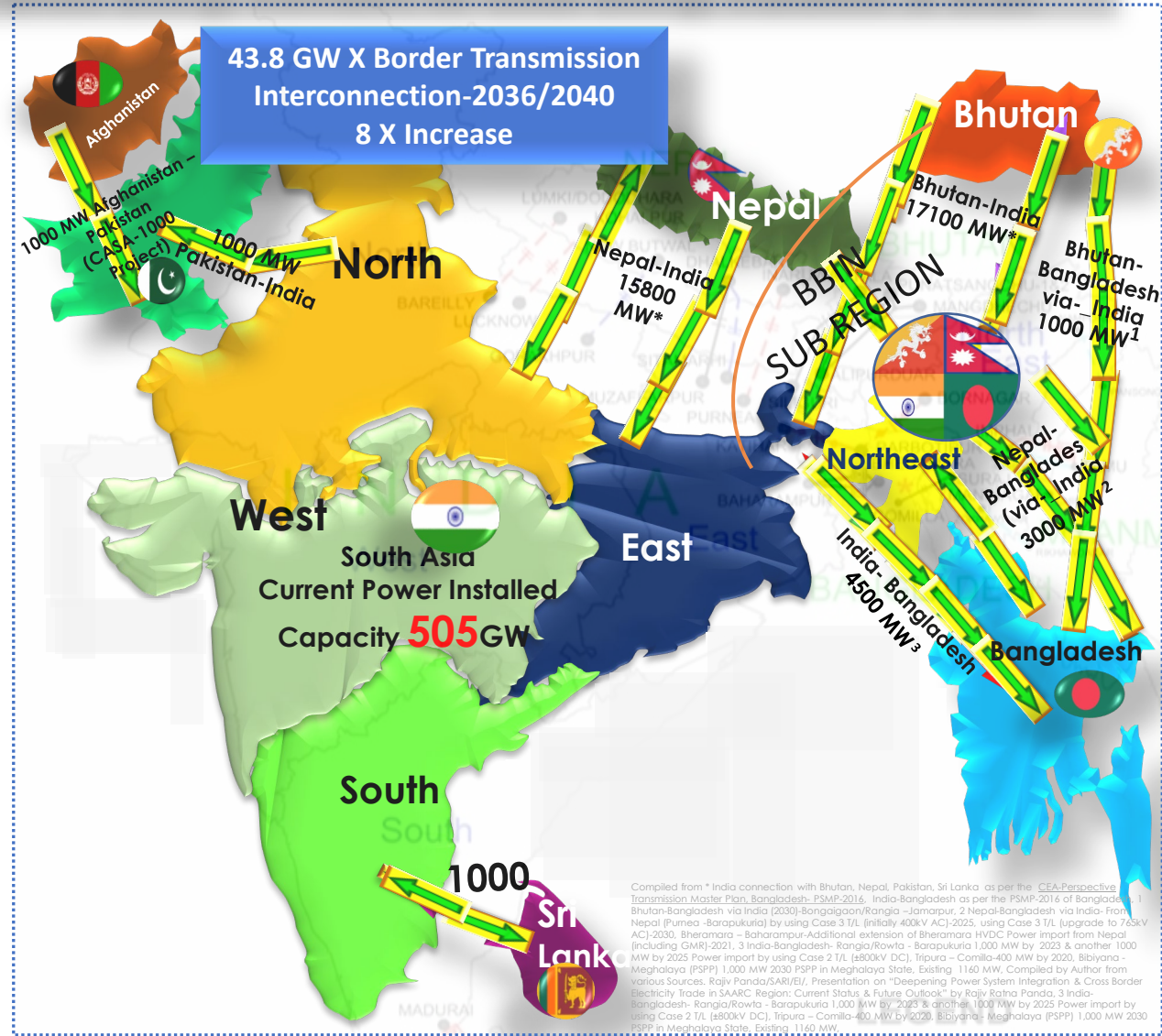
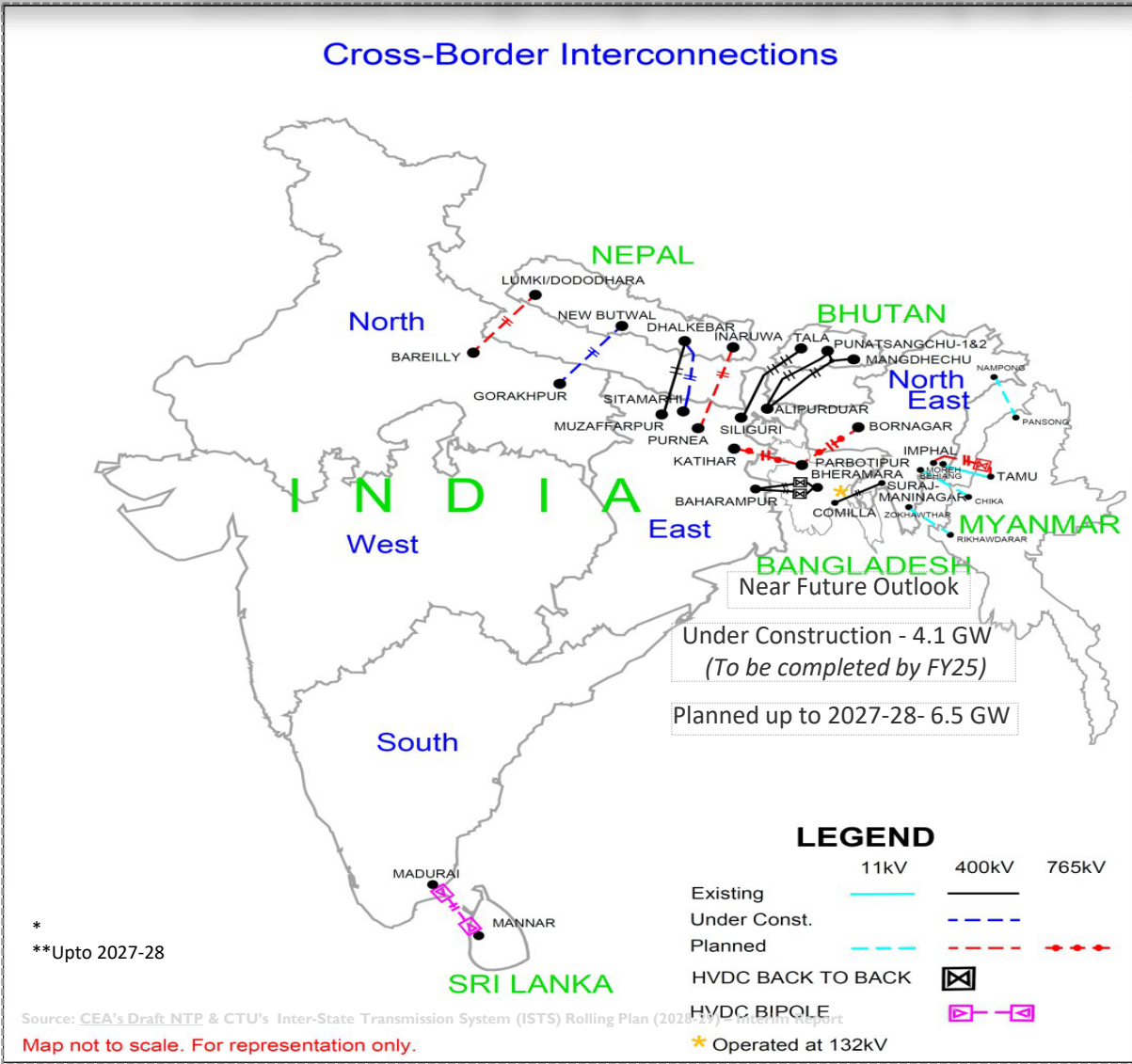
03.2 South Asia Energy Integration: Opportunity for Transforming Regional Green Grid for Clean Energy Transition at Scale



World Bank Study- *Hydropower would increase by 2.7 times* if there is *unconstrained flow of electricity* across the borders in SA *CO₂ emissions* for the entire region over the 2015-2040 period *decline by 8%* under regional cooperation relative to the baseline

Transforming Regional Electricity Green Grids: South Asia and Beyond

03.3 South Asia Energy Integration: Expanding Regional Green Energy Corridors for Clean Energy Transition at Scale



03.4 South Asia Energy Integration: Immense Benefits of Transforming Cross Border Electricity Trade and Regional Green Grid

World Bank Study

- ❑ **Hydropower would increase by 2.7 times** if there is **unconstrained flow of electricity** across borders in SA Source: WB Study
- ❑ **CO₂ emissions** for the entire region over the 2015-2040 period **decline by 8%** under regional cooperation relative to the baseline
- ❑ Unrestricted electricity trade provision would save **US\$226 billion** (US\$9 billion/year) of electricity supply costs over the period (2015-2040). Source: WB Study

USAID Study

- ❑ **Nepal-India-Bangladesh Multilateral Electricity Trade- all three countries together reduces Capex of power sector by USD \$ 17 billion (2015-45).** Source: USAID Study

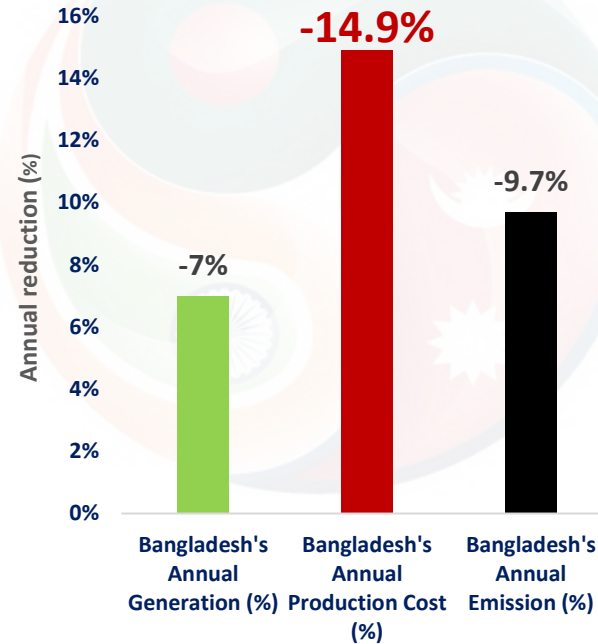


Regional Trade Prospects

Bangladesh's Potential Proposition for Regional Electricity Import
[A case of Bangladesh Importing 1000 MW from Nepal through India]

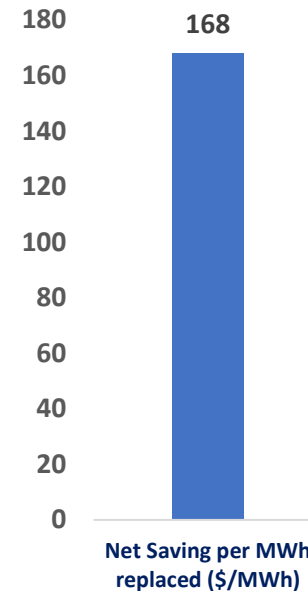


Bangladesh Importing 1 GW Hydro From Nepal (Benefits to Bangladesh)



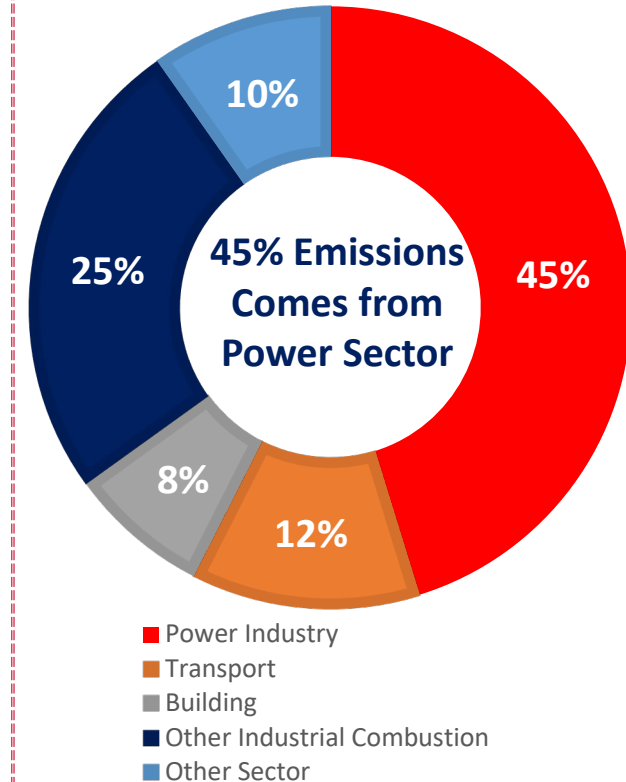
1 GW of Nepal hydropower offset more domestic generation in Bangladesh—5.5 TWh, at a savings of \$168/MWh for the energy replaced.
Source: NREL Study on CBET and Renewable Energy Zones and technical presentation of the study results

Bangladesh's Net Saving per MWh replaced (\$/MWh)



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

South Asia (SA) Sector Share in Fossil CO₂ Emission (2021)



Data Source: EDGAR - Emissions Database for Global Atmospheric Research, 2022 report

Large Regional Clean Hydro Power Export by Nepal & Bhutan | 350 GW of Hydro Potential | Need a Regional Planning Approach for Strengthening SA Energy Security

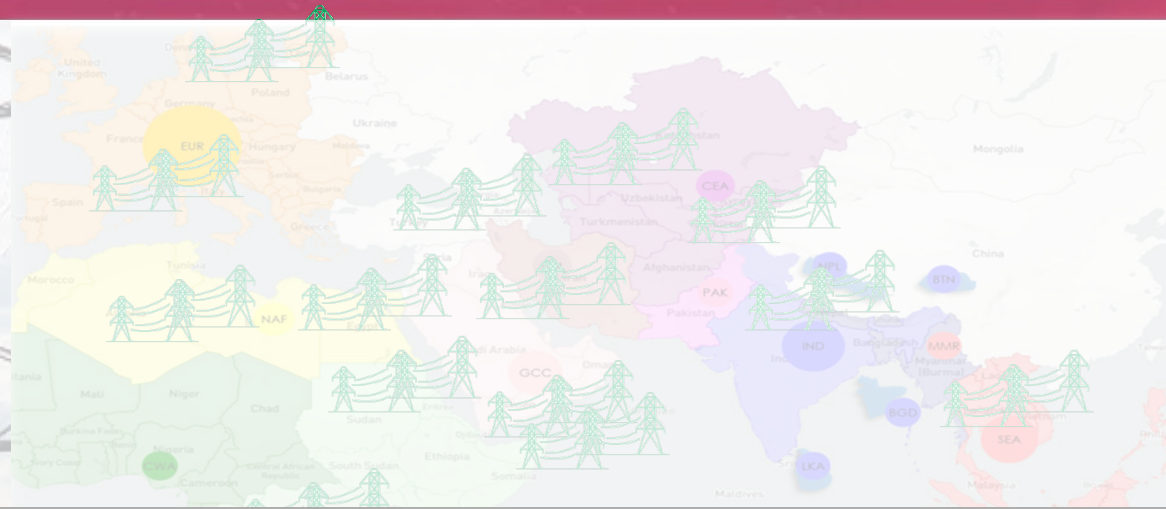


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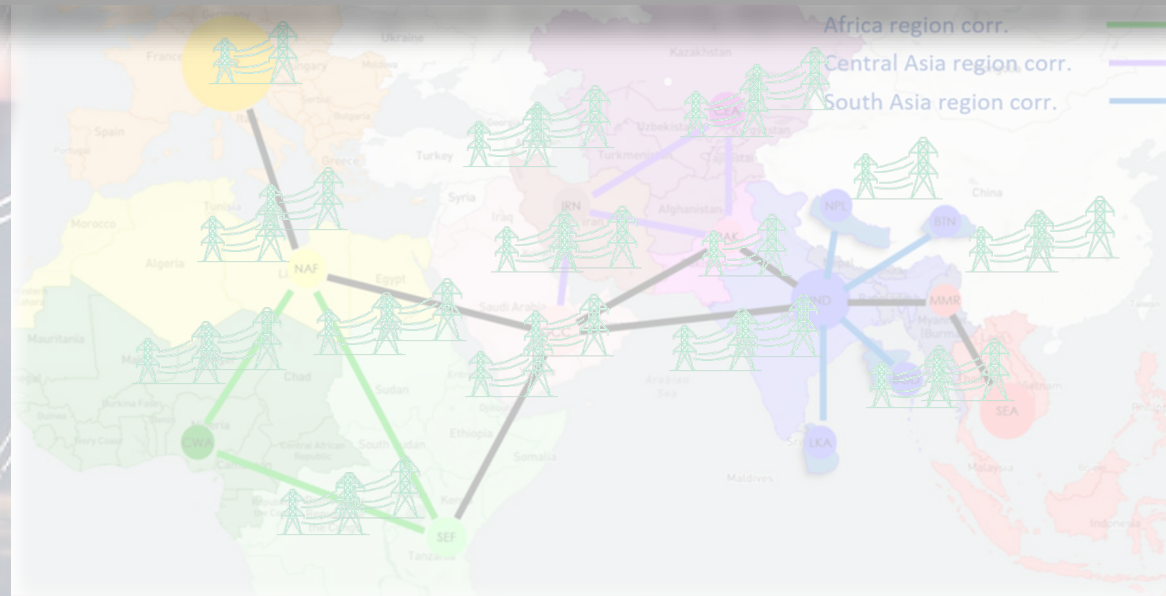
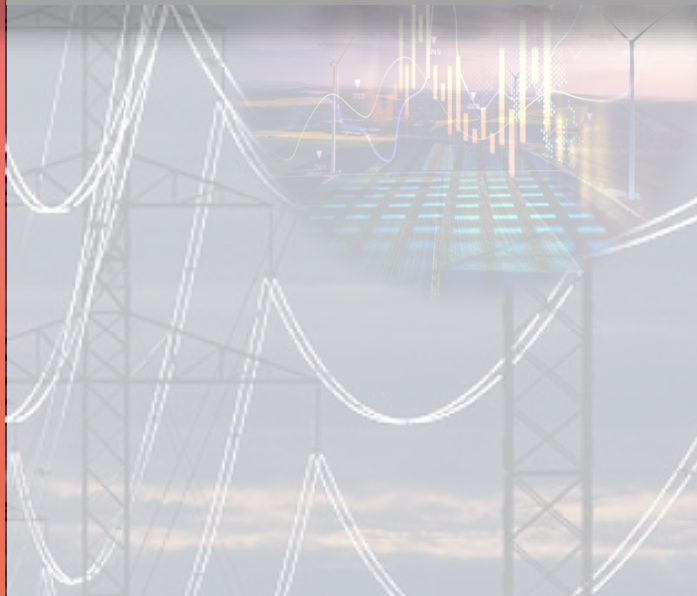
Transforming Regional Electricity Green Grids: South Asia and Beyond



04

Energy Integration Beyond South Asia through Trans-Regional Interconnection

{One Sun One World One Grid, Trans-Regional Green Grid, Africa-GCC-South Asia-ASEAN Interconnection}





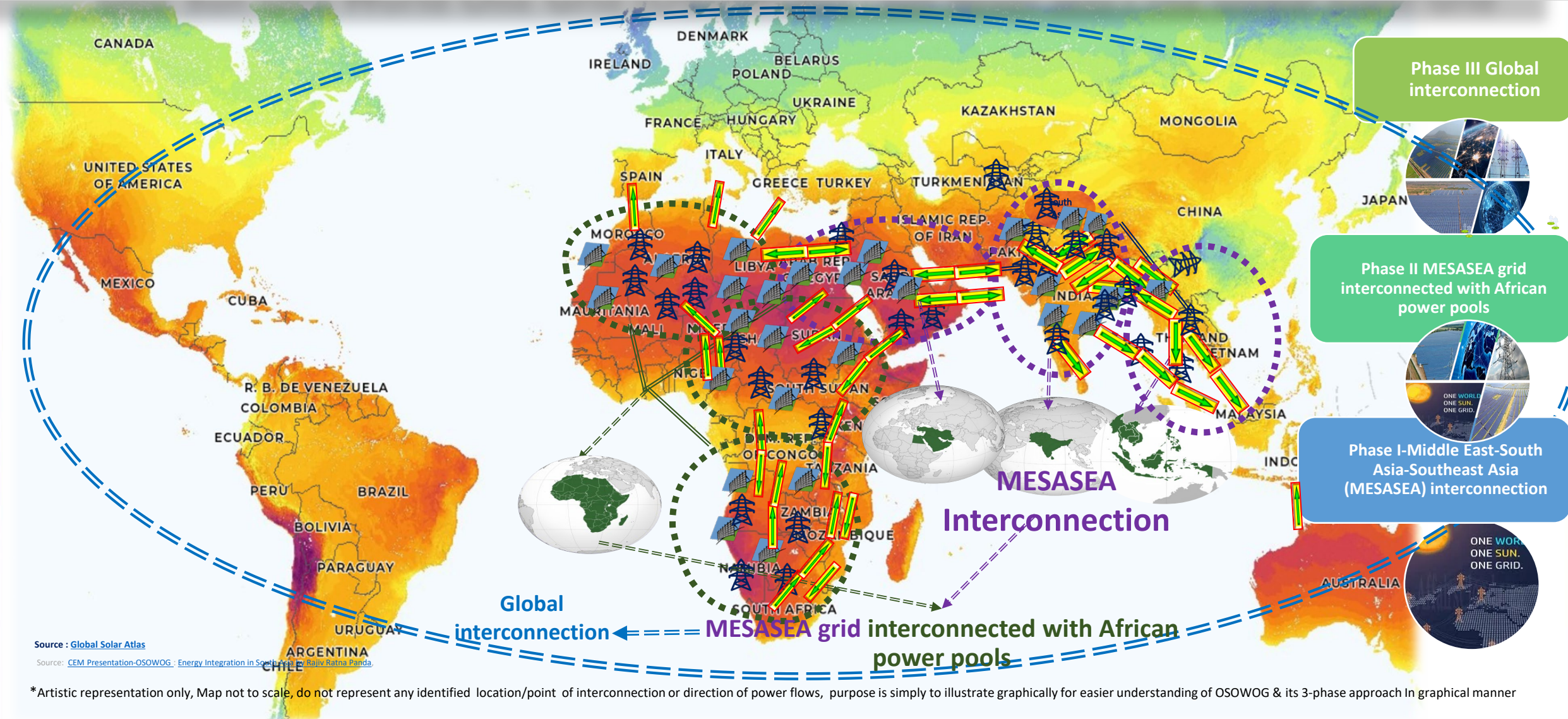
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Transforming Regional Electricity Green Grids: South Asia and Beyond

04.1 One Sun One World One Grid (OSOWOG) : *Sun Never Sets* | The Global Super Grid

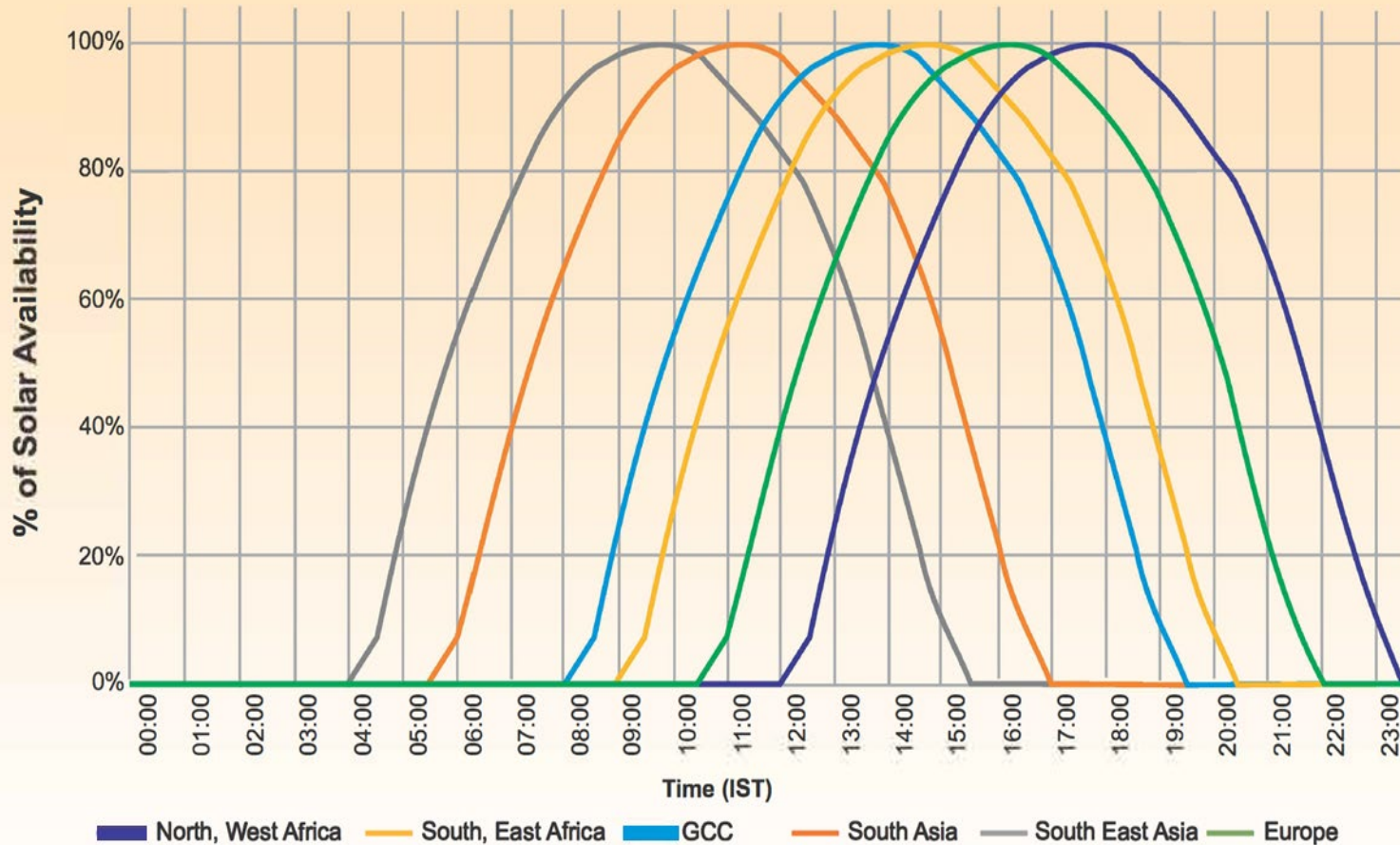


*Artistic representation only, Map not to scale, do not represent any identified location/point of interconnection or direction of power flows, purpose is simply to illustrate graphically for easier understanding of OSOWOG & its 3-phase approach In graphical manner

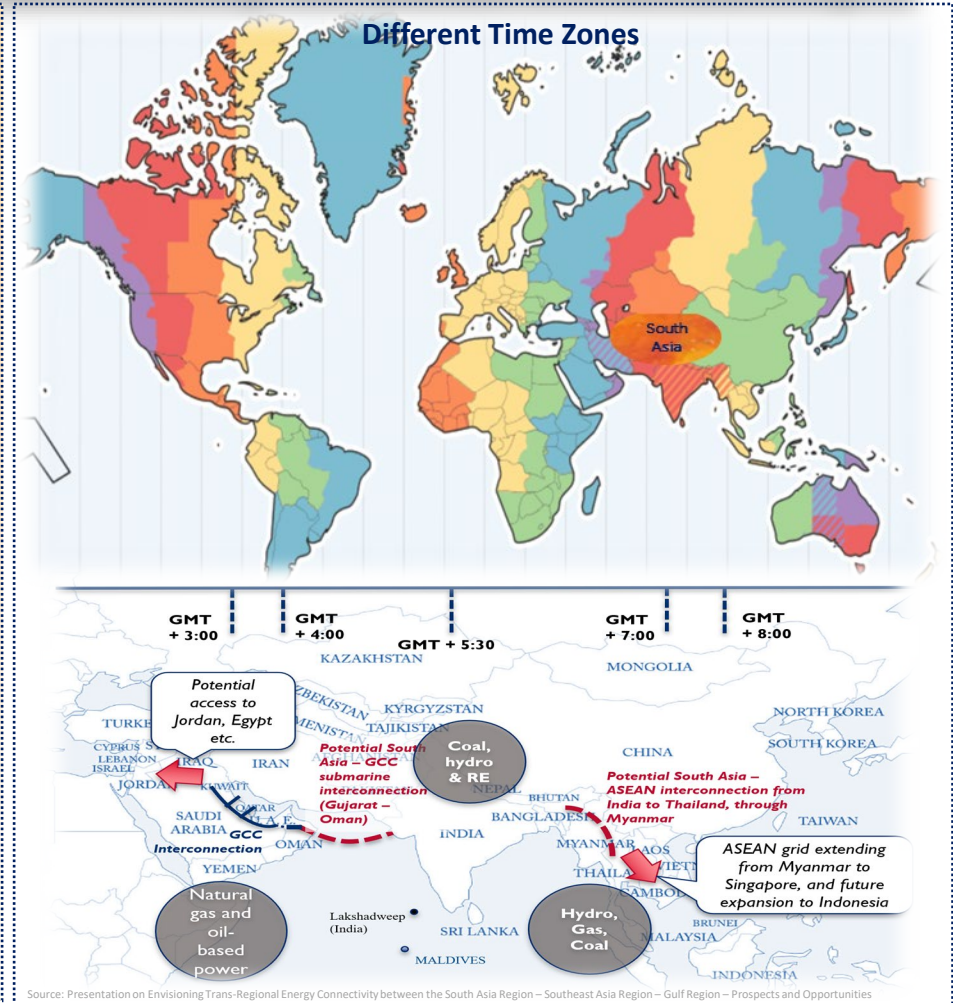
Transforming Regional Electricity Green Grids: South Asia and Beyond

04.2 Trans-Regional Green Grid Interconnections : Diversity in Solar Availability

Diversity in Solar Availability Across GCC, AFRICA, South Asia, South East Asia and Europe



Source: Transnational Grid Connections for Ensuring Energy Security

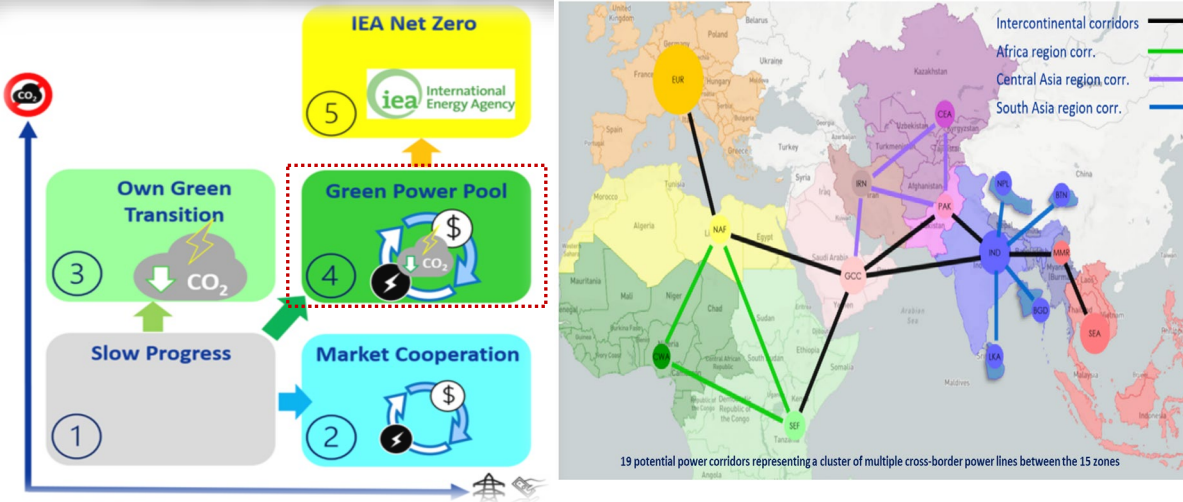


Source: Presentation on Envisioning Trans-Regional Energy Connectivity between the South Asia Region – Southeast Asia Region – Gulf Region – Prospects and Opportunities

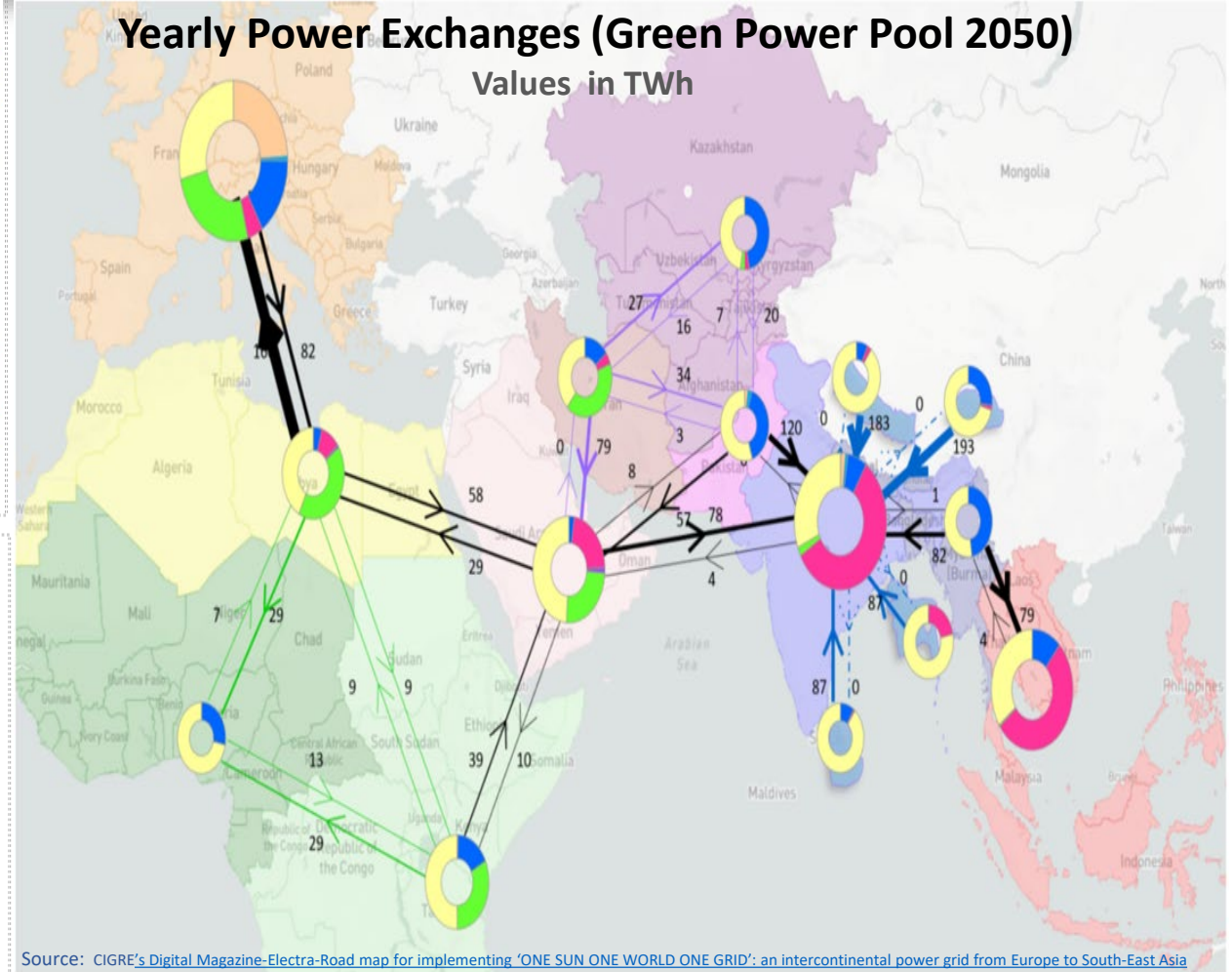
Time Zone Variation, Reserve Sharing, Resource complementarity, Diversity of Peak Demand, Optimum Utilization of RE Resources and increased reach to additional markets

Transforming Regional Electricity Green Grids: South Asia and Beyond

04.3 Trans-Regional Green Grid and Green Power Pool : Electricity Cost decrease by 60% from 20 to 9 \$/MWh by 2050



Source: CIGRE's Digital Magazine-Electra-Road map for implementing 'ONE SUN ONE WORLD ONE GRID': an intercontinental power grid from Europe to South-East Asia



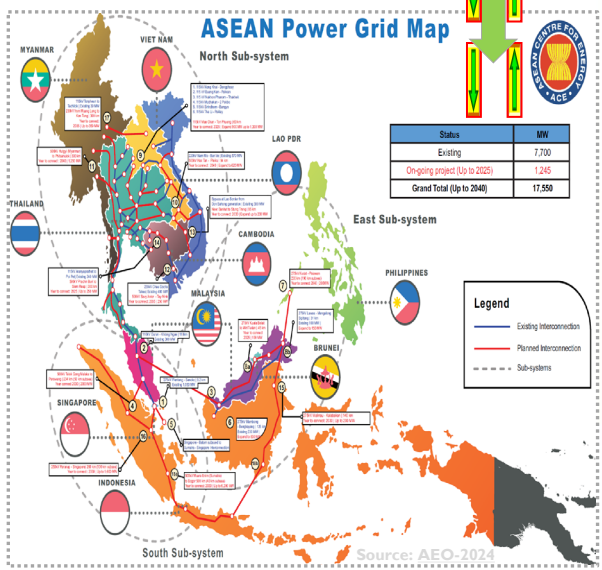
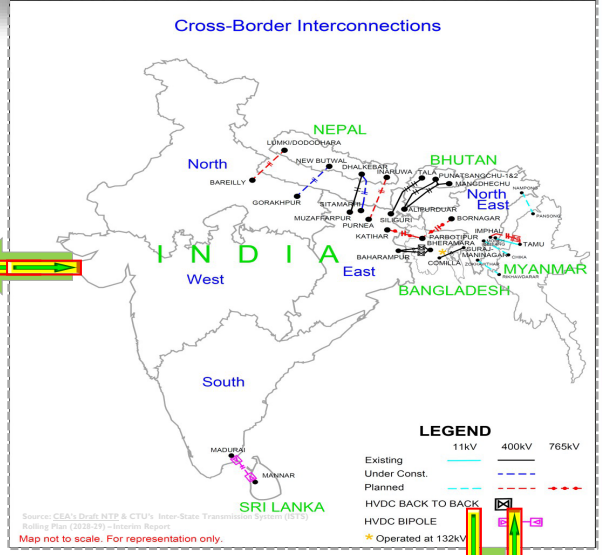
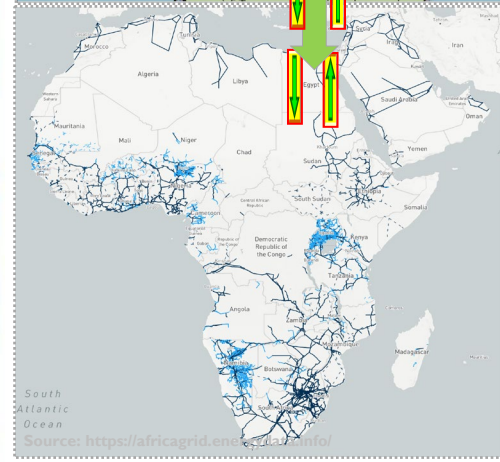
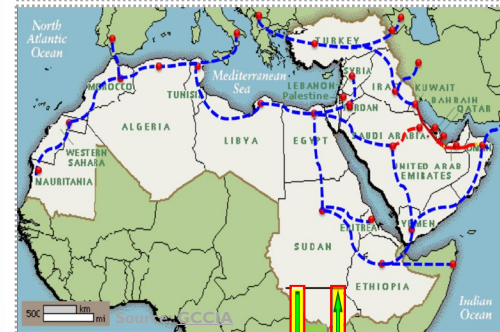
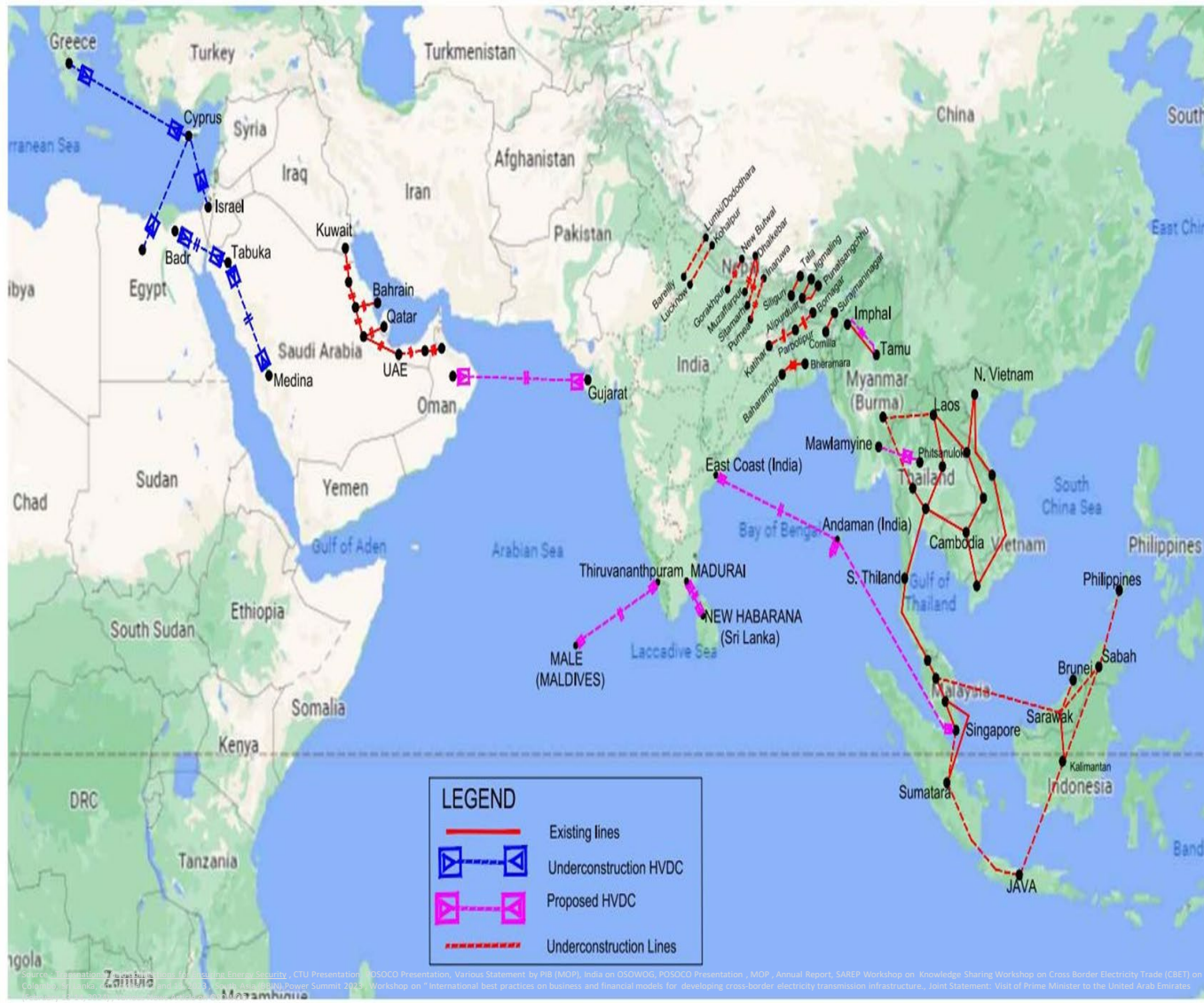
Source: CIGRE's Digital Magazine-Electra-Road map for implementing 'ONE SUN ONE WORLD ONE GRID': an intercontinental power grid from Europe to South-East Asia

- ❖ **Global Study:** The study perimeter incorporates a heterogeneous electricity power landscape from Europe, via Africa, the Middle East to Asia including **117 countries representing 33% of the load, growing to reach 40% in 2050.**
- ❖ **Global Power Pool Embryo:** South Asia GDP growing, become the main load center.
- ❖ **Intercontinental green power corridors (IGPC):** By 2050, sum of IGPC could hit 49 GW for \$25 billion investment.
- ❖ **In green Power Pool scenario,** the overall **unit electricity cost (\$/MWh) decrease by 60% from 20 to 9 \$/MWh.**

2022-2050 Roadmap: An eco-sustainable intercontinental power system to be developed between Europe, Africa, Middle East, and Asia, with India as the fulcrum of a Global Power Pool Embryo

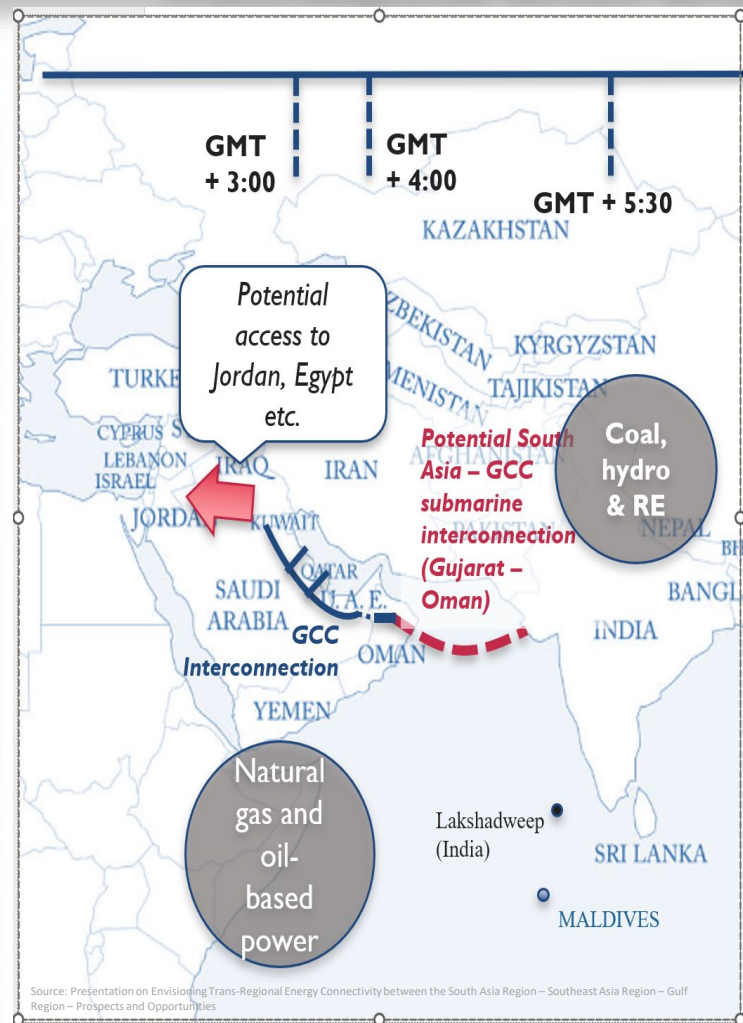
As per CEA, India By 2047 to have 708 GW of Peak Demand, 2053 GW of Installed Capacity, 1200 GW of Solar, 436 GW of wind

04.4 Trans-Regional Green Grid Interconnections : Interconnecting AFRICA-GCC-SOUTH ASIA-ASEAN



Transforming Regional Electricity Green Grids: South Asia and Beyond

04.5 Trans-Regional Green Grid and Green Power Pool: Prospects of South Asia – GCC Grid Interconnection



India (Gujarat) – GCC (Oman) Interconnection

HVDC Submarine Cable

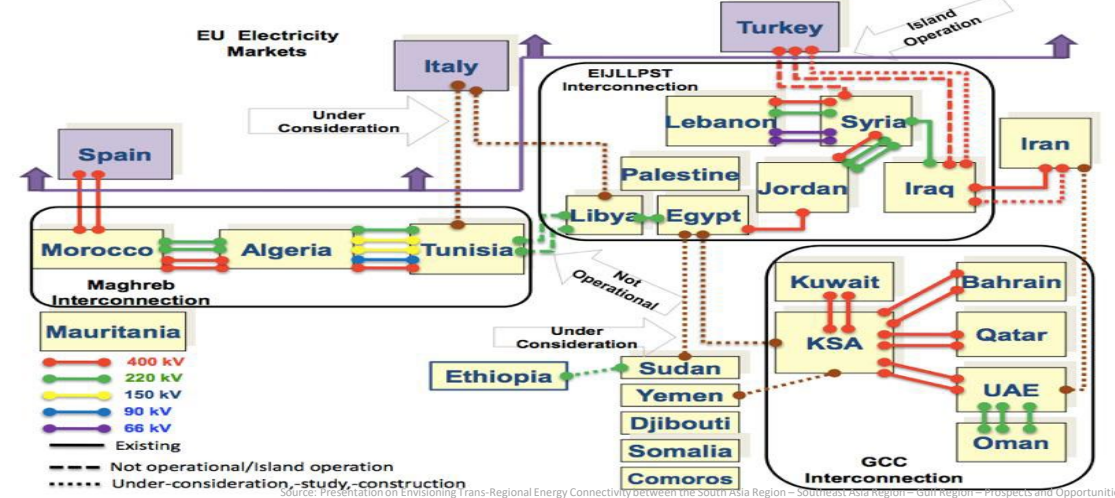
Oman is connected to GCC Grid

Oman–India transmission 2300 km, of which 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 hour time difference)

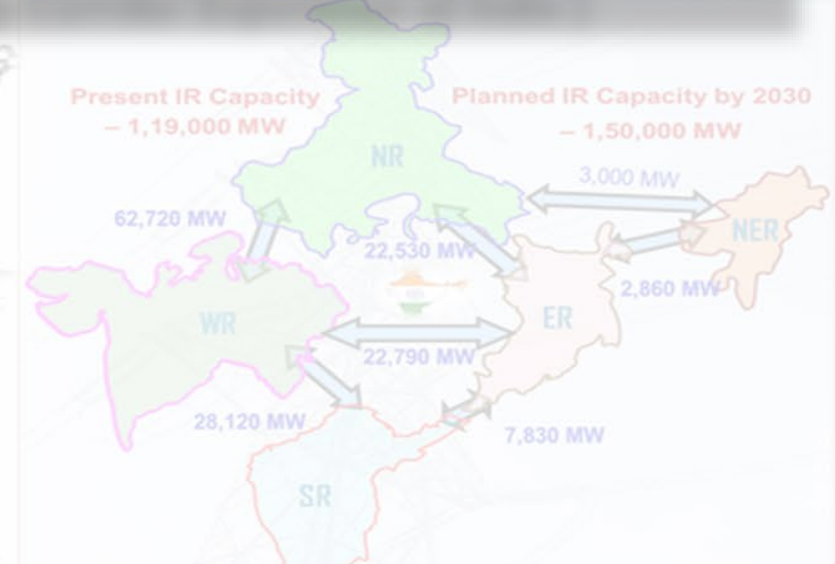


2022-2050 Roadmap: 24 GW of cumulated power corridors developed around Middle East: GCC represent 78% of the investment, confirming the importance of the GCC

Source: CIGRE's Digital Magazine-Electra-Road map for implementing 'ONE SUN ONE WORLD ONE GRID': an intercontinental power grid from Europe to South-East Asia



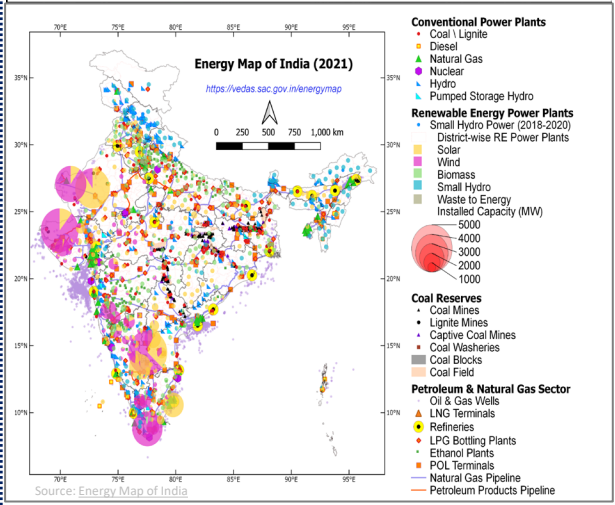
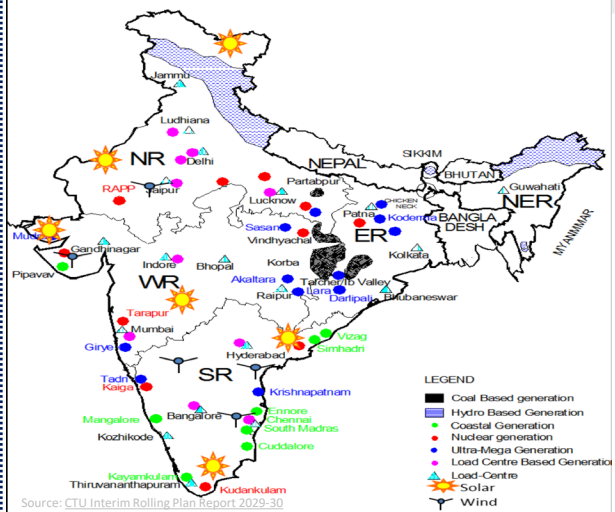
05 Making of World's largest National Synchronous Electricity Grid
{ One Nation | One Grid | One Frequency | One Price, Green Energy Corridor Experience of India }



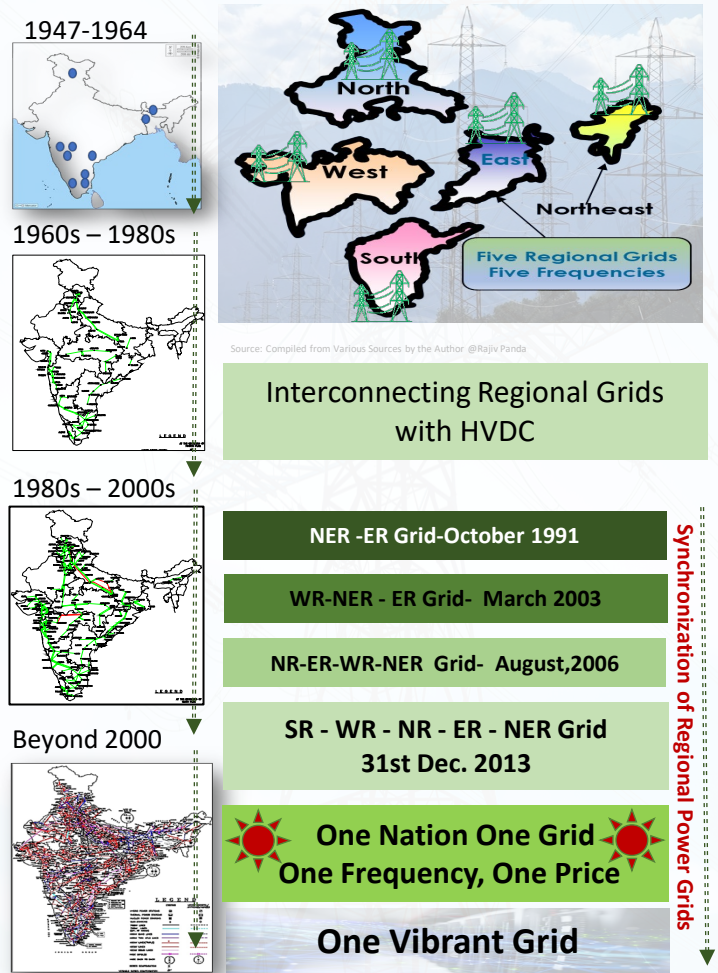
05.1 Made in India : Making of World's Largest Nationally Synchronously Connected Power Grid



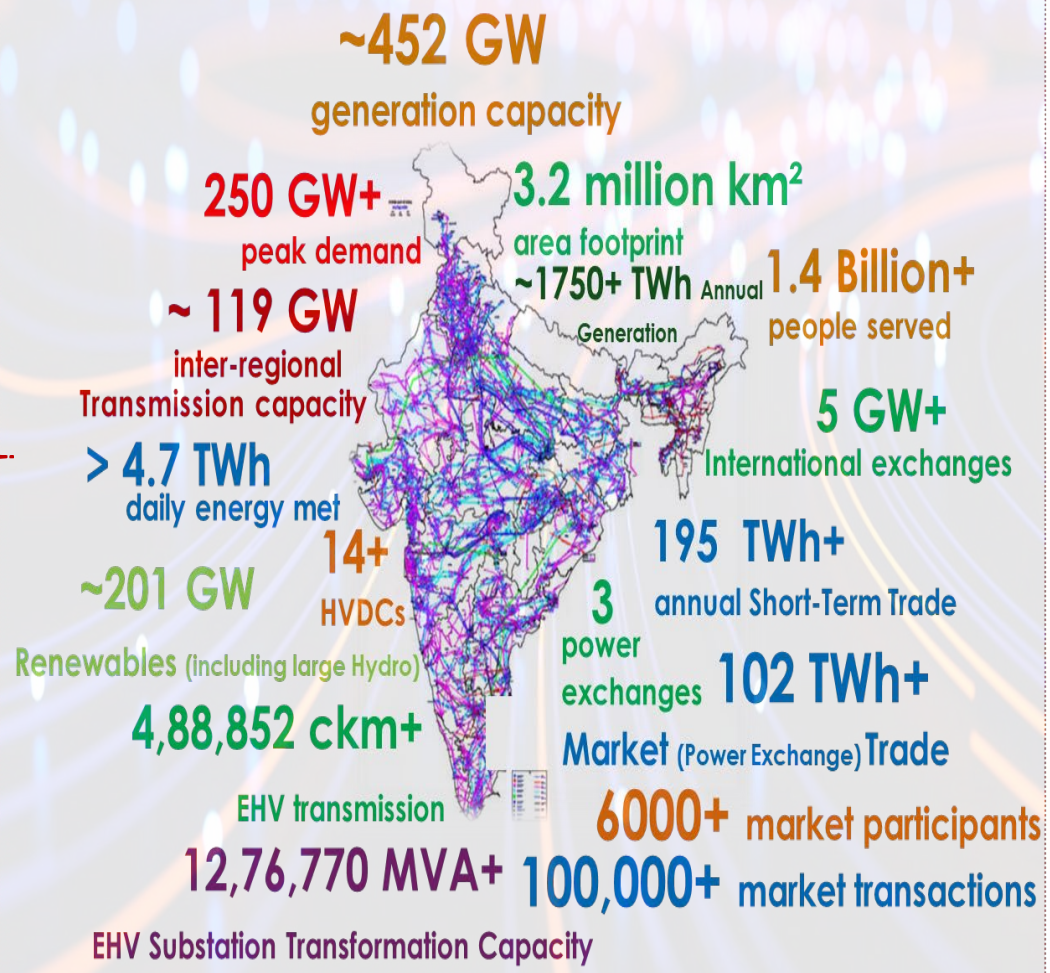
Energy Resource Diversity, Distribution & Load Centre



Regional Grid Integration Journey One Grid One Frequency



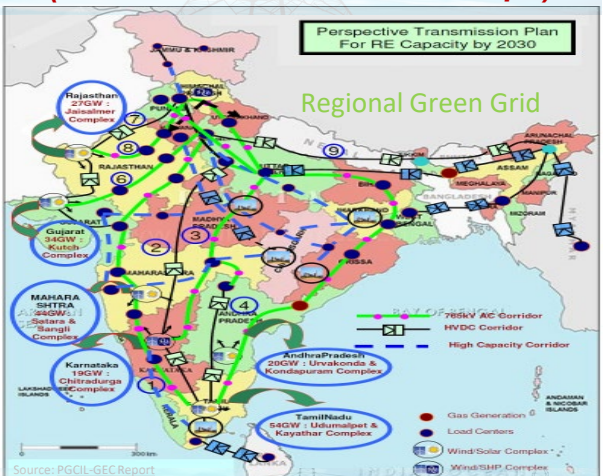
Largest National Synchronously Connected Electricity Grid in the world



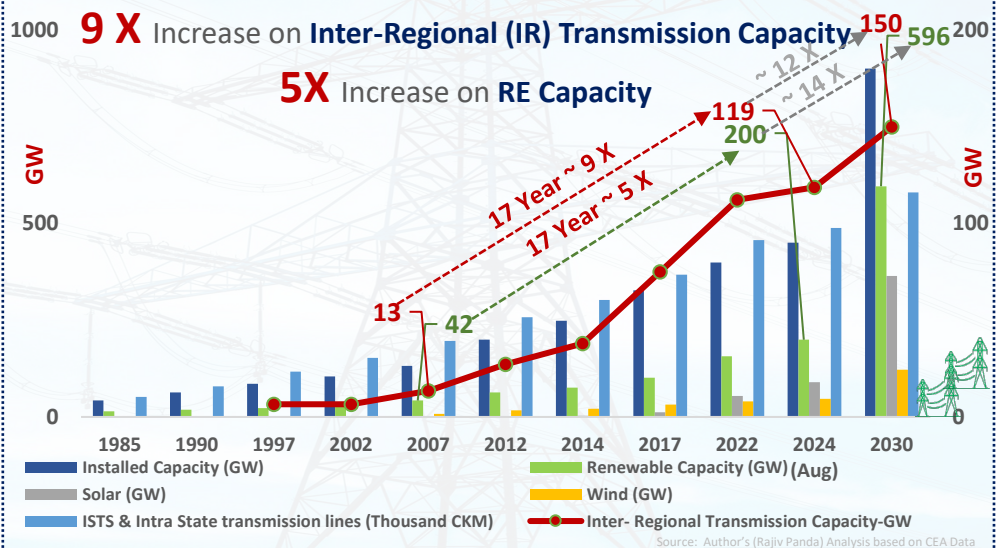
Transforming Regional Electricity Green Grids: South Asia and Beyond

05.2 Indian Experience : Green Energy Corridors | Transforming RE Landscape | Robust Grid as Enabler for OSOWOG

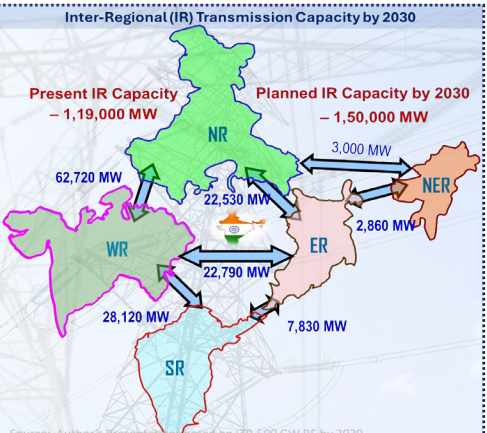
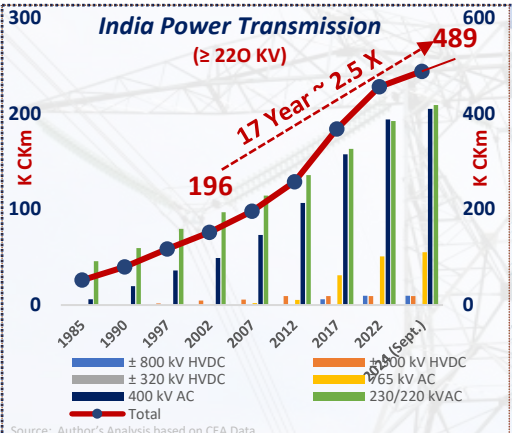
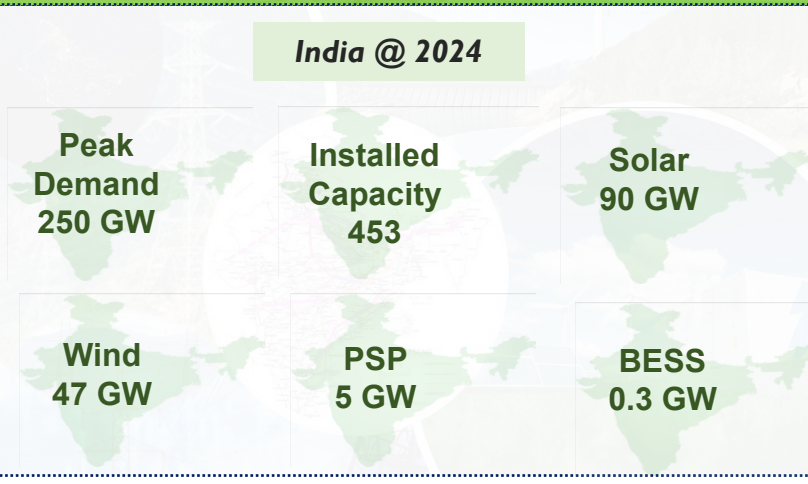
High-Capacity Green Energy Corridor (GEC) for Large Scale Renewable Energy (A Massive 71 GW Initiative so far)



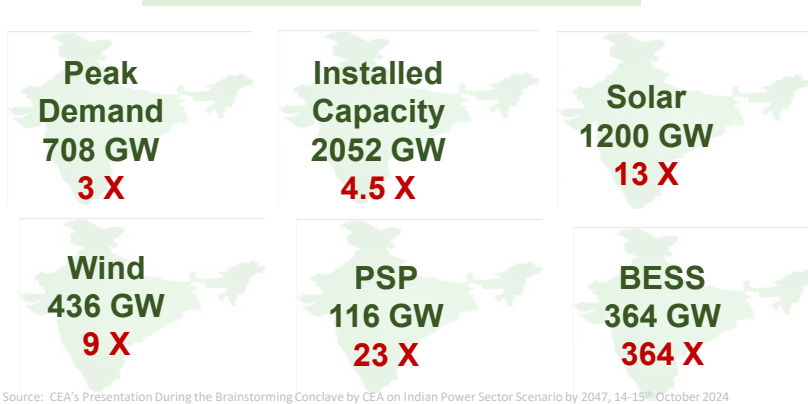
- Inter-State GEC Phase-I**
- 3200 ckm for 6 GW RE Evacuation-Completed
 - Transmission system for Solar Parks (8.5 GW)-Completed
- Intra-State GEC Phase-I**
- 9700 ckm, 24 GW RE Evacuation 9135 ckm (94%) Completed
- Intra-State GEC Phase-II**
- 10,750 ckm, 20 GW RE Evacuation Under implementation
- Inter-State GEC Phase-II**
- 1.730 ckm, 13 GW RE Evacuation from Ladakh Under implementation



India's Long Term (2047) Pathways for a Developed Nations



India @ 2047-Vikashit Bharat



With India at the Fulcrum, India's Integrated National Electricity Grid can act a Regional Energy Hub for Trans-Regional Interconnection with ASEAN, GCC & Africa



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Transforming Regional Electricity Green Grids: South Asia and Beyond

06

Transforming Regional and Trans-Regional Green Grids {Key Strategies}



06

Transforming Regional and Trans-Regional Green Grids : *Strategies*

Bigger Regional Green Grid

Transforming Strategy 1



Harmonise With Consensus

Develop Common Vision & Shared Responsibility on Regional Green Grids (RGGs)

Transforming Strategy 2



Accelerate Bilateral CBET and Green Energy Corridors (GECs)

Enrich Bilateralism With Market Feature

Transforming Strategy 3



Foster Trilateral/Multilateral CBET & RGGs

Constructive Multilateralism with Regional Planning, Regional Pride Project

Better Regional Green Power Pool, Regional Green Corridors

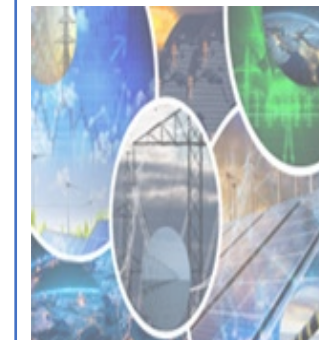
Transforming Strategy 4



Coupling Regional Green Corridors (RGGs) & CBET in Net Zero

Special Incentives for RGGs as these are Strategic Assets

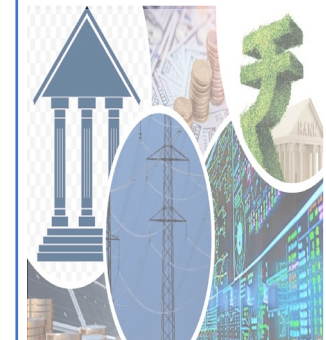
Transforming Strategy 5



Regional Green Power Pool Innovative Market Instruments
Transcending Gradualness to Growth

Bolder Trans Regional Green Grid and International Grid Integration

Transforming Strategy 6



International & Regional Institution and Funding

Regional Green Grid Integration Fund, Institutions and Treaty

Transforming Strategy 7



Trans-Regional Connection

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

NO TRANSMISSION NO TRANSITION



Thank You



“

Change is inevitable, but
transformation is a choice.

HEATHER ASH AMARA

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“It always seems
impossible until
it’s done.”

- Nelson Mandela

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Disclaimer

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