South Asia Regional Initiative for Energy Integration

Presentation on

Cross Border Electricity Trade in SAARC Region: Current Status & Future Outlook

Presented by

Rajiv Ratna Panda
(Technical-Head, SARI/EI, IRADe)

SAARC Energy Centre’s Webinar on "Cross Border Electricity Trade (CBET) in SAARC Countries"
11.30 AM (IST), Tuesday, 11th August 2020
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02 Overview of South Asian Power Sector

03 Current & Future Scenario of Cross-border Electricity Trade (CBET)

04 Future Outlook for CBET

05 Enablers for accelerating CBET & Development Regional Power Market

06 SARI/EI Initiatives & Way forward
Marco-Economic Growth & Economic Integration of South Asia
South Asia: One of the most populous regions in the world

South Asia: Fastest growing region in the world in recent past & expected to remain so in future

Data Source: World Bank Data base

Real GDP Growth Annual Percent Change
Source: World Economic Outlook (April, 2020)


Cross Border Electricity Trade in SAARC Region: Webinar on “Cross Border Electricity Trade in SAARC Countries: 01:30 AM (IST), Tuesday, 11th August, 2020” by Rajiv Ratna Panda, Technical Head, SARI/IERA

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South Asia: Yet Least Integrated

Intra-regional Trade Share (%) (Intra-regional trade to total trade of the region)

Source: The Integration Indicators Database [https://aric.adb.org/database/integration](https://aric.adb.org/database/integration). ASEAN+3 consists of the 10 ASEAN member economies, the People’s Republic of China (including Hong Kong, China), Japan, and the Republic of Korea.
Overview of South Asian Power Sector
South Asia Power System-Snapshot

South Asia Power System-Snapshot

Rapid Power Capacity Addition (GW)

South Asia-Power Sector Fuel Mix

South Asia- Power Sector Fuel Mix

Afghanistan
#Very small power system (~0.6 GW)
#High Electricity Imports high
#Hydro and Oil Dominated

Bangladesh
#Mid size power system (~23 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 (~371 GW)
#Coal Dominated, RE -133 GW
#Central to CBET in SA
#Competitive Power Market (Only in SA)

Maldives
#Fragmented & very small power systems (~0.4 GW)
#Oil, Diesel dependent, Islands, Limited possibility of interconnection

Nepal
#Very Small power system (1.3 GW)
#Under utilized hydro (82 GW)
#Net importer of electricity now but potential to export in future

Pakistan
#Mid sized (39 GW) power system
#Gas and Oil dependent.

Sri Lanka
#Small power system (~4 GW)
#Hydro and oil dominated
#High Peak –off peak differential

Afghanistan
Bangladesh: 5 GW-2010 to24 GW by 2020, India : 158 GW -2010 to 371 GW by 2020, Pakistan : 21 GW -2010 to 39 GW by 2020

Maldives

Nepal

Pakistan

Sri Lanka

Bangladesh : 5 GW-2010 to24 GW by 2020, India : 158 GW -2010 to 371 GW by 2020, Pakistan : 21 GW -2010 to 39 GW by 2020

Nepal

Pakistan

Sri Lanka

South Asia

Afghanistan

Bangladesh

Bhutan

India

Maldives

Nepal

Pakistan

Sri Lanka

South Asia

Coal+ Lignite
Hydro
Natural Gas
Hydro, incl. Small Hydro
Renewables-Solar, Wind etc.
Fossil Fuel Dominance Coal -48 %, Natural gas -11 %, Diesel-3.9 % - Total -63.6 % | RE-19.6%, Hydro-15.1 %, Total- 34.7 %

South Asia

Afghanistan

Bangladesh

Bhutan

India

Maldives

Nepal

Pakistan

Sri Lanka

South Asia

Coal+ Lignite
Natural Gas
Hydro, incl. Small Hydro
Renewables-Solar, Wind etc.
Fossil Fuel Dominance Coal -48 %, Natural gas -11 %, Diesel-3.9 % - Total -63.6 % | RE-19.6%, Hydro-15.1 %, Total- 34.7 %

South Asia Power System-Snapshot

Data Source: Complied by Author from Various Sources

- SARI/EI Data Source, CEA-India, DHPS-Bhutan, Ministry of Energy, NEA-Nepal, CEB-Ministry Energy-Sri Lanka, NTDC, NEPRA-Pakistan, DABS-Afghanistan

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Rapid Power Capacity Addition (GW)

South Asia-Power Sector Fuel Mix

Afghanistan

Bangladesh

Bhutan

India

Maldives

Nepal

Pakistan

Sri Lanka

South Asia

Coal+ Lignite
Natural Gas
Hydro, incl. Small Hydro
Renewables-Solar, Wind etc.
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South Asia Power System-Snapshot

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## Yet Challenges Remain

### Electricity Consumption (kWh per capita)*

<table>
<thead>
<tr>
<th>Country</th>
<th>2020 SDG Index Score</th>
<th>2020 SDG Index Rank</th>
<th>SDG 7: Affordable &amp; Clean Energy</th>
<th>SDG 7 Trend</th>
<th>SDG 6: Clean Water and Sanitation</th>
<th>SDG 6 Trend</th>
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<tbody>
<tr>
<td>Bhutan</td>
<td>69.27</td>
<td>80</td>
<td>yellow</td>
<td>red</td>
<td>red</td>
<td></td>
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<tr>
<td>Maldives</td>
<td>67.59</td>
<td>91</td>
<td>green</td>
<td>↑</td>
<td>orange</td>
<td>↑</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>66.88</td>
<td>94</td>
<td>red</td>
<td>↑</td>
<td>red</td>
<td>↑</td>
</tr>
<tr>
<td>Nepal</td>
<td>65.93</td>
<td>96</td>
<td>red</td>
<td></td>
<td>red</td>
<td>↑</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>63.51</td>
<td>109</td>
<td>orange</td>
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<td>red</td>
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<tr>
<td>India</td>
<td>61.92</td>
<td>117</td>
<td>red</td>
<td></td>
<td>red</td>
<td>↑</td>
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<tr>
<td>Pakistan</td>
<td>56.17</td>
<td>134</td>
<td>red</td>
<td></td>
<td>red</td>
<td>↓</td>
</tr>
<tr>
<td>Afghanistan</td>
<td>54.22</td>
<td>139</td>
<td>orange</td>
<td></td>
<td>red</td>
<td></td>
</tr>
</tbody>
</table>

*Compiled from various sources, For Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan data is for year 2019, ASEAN-2017, World-2014, China (2017), EU-2014, OECD-2014, USA-2016, For Bangladesh, Per Capita Power generation is considered as per data available from Power Cell, ASEAN, per capita demand is considered as per data available.

### Low Per Capita Electricity Consumption, Affordable and Clean Energy Challenge

- **Goal Achievement** on track or maintaining achievement
- **Challenges remain** moderately increasing
- **Significant challenges** stagnating
- **Major challenges** decreasing

Cross Border Electricity Trade in South Asia: Current Status and Future Scenario
South Asia (SA) - Cross Border Electricity Trade (MW): Current Status & Future Scenario

<table>
<thead>
<tr>
<th>Year</th>
<th>SA CBET</th>
<th>Nepal-India</th>
<th>Bhutan-India</th>
<th>India-Bangladesh</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>~1400 MW</td>
<td>~3760* MW</td>
<td>~2100 MW</td>
<td>~1160 MW</td>
</tr>
<tr>
<td>2015</td>
<td>~2126 MW</td>
<td>~3760* MW</td>
<td>~2100 MW</td>
<td>~1160 MW</td>
</tr>
<tr>
<td>2018</td>
<td>~2986 MW</td>
<td>~3760* MW</td>
<td>~2100 MW</td>
<td>~1160 MW</td>
</tr>
<tr>
<td>2020</td>
<td>~3760* MW</td>
<td>~3760* MW</td>
<td>~2100 MW</td>
<td>~1160 MW</td>
</tr>
</tbody>
</table>

SA CBET in MUs

Compiled from various Sources, Country Authority Websites, across the Region.

Source: Compiled from various Sources, Country Authority Websites, across the Region.

Rapid expansion is envisaged, 43.8 GW Cross Border Grid Interconnection by 2036/2040

Source: Compiled from various Sources, Country Authority Websites, across the Region.

* Nepal-Bangladesh via India (from Nepal) (Purnea-Bangladesh) by using Case 3 T/L (330 kV, 400 kV) by 2030, using Case 3 T/L (upgrade to 765 kV, AC) by 2030, Bangladesh – Baharampur-Additional extension of Baharampur HVDC, Power import from Nepal (including GMR)-2021

Cross Border Electricity Trade in SAARC Region: Webinar on "Cross Border Electricity Trade in SAARC Countries-11.30 AM (IST), Tuesday, 11th August 2020" by Rajiv Ratna Panda, Technical Head, SARI/EI/IRADE
Cross Border Electricity Trade in South Asia: 

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

**CBET Outlook 1**

Transitioning from Bilateral to Trilateral CBET

**CBET Outlook 2**

Renewable Energy based CBET

**CBET Outlook 3**

Commercial form of CBET

**CBET Outlook 4**

Regional Power Market Development & Market Integration

Cross Border Electricity Trade in SAARC Region: Webinar on "Cross Border Electricity Trade in SAARC Countries—11.30 AM (IST), Tuesday, 11th August 2020" by Rajiv Ratna Panda, Technical Head / SARI/EI/IRADE
CBET Outlook -1

Transitioning from Bilateral to Trilateral CBET
Power system Integration evolution across the Globe

Establishing Bilateral connections, bilateral market

Moving towards Trilateral/Quadrilateral Connection, Trilateral Market

Developing Sub regional Grids & Sub-Regional Power Market

Fully Interconnecting sub regional Grids & Creating Common Grid and Unified Market

SA CBET Outlook-1:-Moving from Bilateral to Trilateral
Bangladesh Master Plan# envisaged to import from Bhutan (1 GW) & Nepal (3 GW) through India

404 MW Nyera Amari HPP is envisaged as a trilateral project- sale to both India & Bangladesh.

(DPR under preparation)

$2 billion ,1125 MW Dorjilung Project
(The DPR of the project approved by RGoB)

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 is under discussion)


CBET Outlook-2
Renewable Energy based CBET
South Asia: Vulnerable to adverse impacts of climate change, De-Carbonising the Power Sector is crucial.

South Asia - Significant Environment/Climate Change Challenge

SAARC Countries-fossil_CO2_by_sector_in Mt CO2/yr (2018)

Source: Climate Emergency COP 25: India is the only major economy to be 2 degree compatible, Fossil CO2 and GHG emissions of all world countries 2019 Report - JRC SCIENCE FOR POLICY REPORT

South Asia-Large Renewable Energy Potential

South Asia Hydro Power Potential in GW (%)
- 350 GW Hydro Potential
- 83 (24%)
- 150 (43%)
- 30 (9%)
- 25 (7%)
- 59 (17%)
- 2 (0%)

South Asia-Hydro Power Potential (GW) & % tapped so far

Large Solar & Wind Potential
- ~939 GW Solar Power Potential ~3.8% developed
- ~967 GW Wind Power Potential ~4% developed

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

Data Source: Complied by Author from Various Sources: SARI/EI Data Source, CEA India, DAPS Bhutan, Ministry of Energy, Nepal, CEB, Ministry Energy Sri Lanka, NTDC, NEPRA Pakistan, DABS Afghanistan, SARI/EI/IRADE
**South Asia: 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))

- **Annual generation (%)**
  - Importing 1 GW of Wind Power From Tamil Nadu (India): -4.3%
  - Importing 1 GW of Solar Power From Tamil Nadu (India): -9.5%
  - Importing 1 GW of Hydro Power From Nepal: -5.5%

- **Annual Production Cost (%)**
  - Importing 1 GW of Wind Power From Tamil Nadu (India): -2.0%
  - Importing 1 GW of Solar Power From Tamil Nadu (India): -3.9%
  - Importing 1 GW of Hydro Power From Nepal: -2.5%

- **Annual Emissions (%)**
  - Importing 1 GW of Wind Power From Tamil Nadu (India): -7.0%
  - Importing 1 GW of Solar Power From Tamil Nadu (India): -9.7%

- **Net savings of per MWh replaced ($/Mwh)**
  - Importing 1 GW of Wind Power From Tamil Nadu (India): -14.9%
  - Importing 1 GW of Solar Power From Tamil Nadu (India): -9.5%
  - Importing 1 GW of Hydro Power From Nepal: -3.9%

- **% reduction**
  - Importing 1 GW of Wind Power From Tamil Nadu (India): 175
  - Importing 1 GW of Solar Power From Tamil Nadu (India): 158
  - Importing 1 GW of Hydro Power From Nepal: 168

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

- **Annual generation (%)**
  - Importing 1 GW of Wind Power From Tamil Nadu (India): -6.6%
  - Importing 1 GW of Solar Power From Tamil Nadu (India): -21.0%

- **Annual Production Cost (%)**
  - Importing 1 GW of Wind Power From Tamil Nadu (India): -6.3%
  - Importing 1 GW of Solar Power From Tamil Nadu (India): -1.4%

- **Annual Emissions (%)**
  - Importing 1 GW of Wind Power From Tamil Nadu (India): -18.0%
  - Importing 1 GW of Solar Power From Tamil Nadu (India): -18.0%

- **Net savings of per MWh replaced ($/Mwh)**
  - Importing 1 GW of Wind Power From Tamil Nadu (India): 80
  - Importing 1 GW of Solar Power From Tamil Nadu (India): 168

**South Asia: GW scale RE based trilateral CBET offers cost saving, clean energy transition: leads to enhance energy affordability & sustainability**
One Sun One World One Grid' (OSOWOG)-A grand Vision
One Sun One World One Grid' (OSOWOG)- A grand Vision

India-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

Large Scale regional & trans-region cross border transmission interconnection

OSOWOG- Potential for regional & trans-region transmission interconnection, global sustainability

- Phase I-Middle East-South Asia-South East Asia (MESASEA) interconnection
- Phase II MESASEA grid interconnected with African power pools
- Phase III (Global interconnection)

India-Lowest Solar Tariff*

<table>
<thead>
<tr>
<th>Phase</th>
<th>Region</th>
<th>Lowest Tariff [Rs./kWh]</th>
<th>Lowest Tariff [US Cents $/kWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEC 1GW ISTS TIK</td>
<td>Jun 20</td>
<td>2.36</td>
<td>3.18</td>
</tr>
<tr>
<td>SEC Badia  500MW</td>
<td>May 17</td>
<td>2.44</td>
<td>3.28</td>
</tr>
<tr>
<td>SEC 1GW ISTS</td>
<td>Aug 18</td>
<td>2.36</td>
<td>3.18</td>
</tr>
<tr>
<td>GUWW Pili  320MW</td>
<td>Dec 17</td>
<td>2.47</td>
<td>3.32</td>
</tr>
<tr>
<td>SEC Badia  750MW</td>
<td>Apr 19</td>
<td>2.46</td>
<td>3.34</td>
</tr>
<tr>
<td>SEC 1GW ISTS</td>
<td>Jun 19</td>
<td>2.50</td>
<td>3.36</td>
</tr>
<tr>
<td>SEC 1.2GW ISTS</td>
<td>Jan 20</td>
<td>2.50</td>
<td>3.36</td>
</tr>
</tbody>
</table>

* Cents Calculated based on 1 USD = 74.34 INR, Data Compiled from various sources

OSOWOG
- Potential for regional & trans-region transmission interconnection, global sustainability

India
- Lowest Solar Tariff

*The “Sun Never Sets” globally, at any given point of time.*
CBET Outlook -3
Commercial form of CBET
Initially all CBET, G-G negotiated tariff

Comml. CBET 2010-0 MW, 2020-1226 (~33%*)

Commercial CBET

2020
1226 MW

Commercial approach brings business value

Foster mindset change, will help to transit to market

Competition, better price discovery

South Asia : Commercial form of Cross Border Electricity Trade

<table>
<thead>
<tr>
<th>Country</th>
<th>Source</th>
<th>Type</th>
<th>Trader</th>
<th>Tenure Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bhutan- India</td>
<td>1020 MW Tala</td>
<td>G-G</td>
<td>PTC</td>
<td>35</td>
</tr>
<tr>
<td>(~2262 MW)</td>
<td>336 MW Chhukha</td>
<td>G-G</td>
<td>PTC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>60 MW Kurichhu</td>
<td>G-G</td>
<td>PTC</td>
<td></td>
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<tr>
<td></td>
<td>720 MW Mangdechhu</td>
<td>G-G</td>
<td>PTC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>126 MW Dagachhu</td>
<td>Commercial</td>
<td>TPTCL</td>
<td>25</td>
</tr>
<tr>
<td>India- Bangladesh</td>
<td>250 MW NTPC</td>
<td>G-G</td>
<td>NVVNKL</td>
<td>25</td>
</tr>
<tr>
<td>(~1160 MW)</td>
<td>160 MW Tripura</td>
<td>G-G</td>
<td>NVVNKL</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>250 MW Market</td>
<td>Commercial</td>
<td>PTC</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>500 MW Market</td>
<td>Commercial</td>
<td>NVVNKL/ Sembcorp</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>40 MW Market</td>
<td>Commercial</td>
<td>PTC</td>
<td>2</td>
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<tr>
<td>India-Nepal</td>
<td>237 MW India</td>
<td>G-G</td>
<td></td>
<td>Long Term</td>
</tr>
<tr>
<td>(~587 MW)</td>
<td>80-190 MW Market</td>
<td>Commercial</td>
<td>PTC/NVVN</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>160 MW Market</td>
<td>Commercial</td>
<td>NVVN</td>
<td>Renewed Every year</td>
</tr>
</tbody>
</table>

South Asia : Commercial form of CBET leads to the business case, help in fostering private sector engagement & investment
CBET Outlook -4

Regional Power Market Development & Market Integration
Regional Power Market & Power Exchange (PX)-Transitioning to Market form of CBET in SA

Demand Diversity- Daily, weekly, Monthly, Seasonal
PXs— Fair, Transparent, Neutral Market Place-
Competitive price discovery

PXs offers a platform for trilateral/multilateral CBET
SARI-Study on Gains from BBIN Multilateral electricity Trade (Capex reduces by USD 17 billion due to regional trade)

SARI/EI-Study -SARPEX- Pilot Market Exercise- DAM in PX Platform. Bangladesh, Nepal, Bhutan in PXs, the quantum of MCV increased in the range of 5-7% (2015-16).

New power market initiatives in India also offers an opportunity to leapfrog in Cross Border Front.

Seasonal complementarity— Monthly Electricity Load Profiles across South Asia

<table>
<thead>
<tr>
<th>Country</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
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</thead>
<tbody>
<tr>
<td>Bangladesh</td>
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<td>India-North Eas</td>
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<tr>
<td>Bhutan</td>
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<td>India-Eas.</td>
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<td>Nepal</td>
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<tr>
<td>India-North</td>
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<td>India-West.</td>
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<tr>
<td>Pakistan</td>
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<tr>
<td>India-South</td>
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</tbody>
</table>

Regional Power Market Development

Level of Optimization
- Possible Phases of Market development for CBET
- Continuous Trading
- Spot Markets on exchanges
- Auction Markets
- OTC Markets
- Trading Licence
- Deemed Trading Licence
- Nodal Agency
- Energy Improvements & Harmonization among SAs
- Level of Energy Cooperation & Harmonization among SAs
- SAs: South Asian Countries

Source: World Bank Study

Government of India [GoI], Ministry of Power (MoP) guidelines- Import/Export Cross Border Electricity

SARPEX-South Asia Regional Power Exchange- addition of BBIN to the Indian domestic market resulted in an increase of 1,918 MUs (5.3%) and 2,550 MUs (7.0%) in the MCV for the unified & sequential modes, respectively, over the Indian domestic market.
SA Regional Power Market - Benefits of Regional Grid Balancing & RE Grid Integration

Rapid Renewable Energy Expansion in the horizon in SA

- 175 GW by 2022
- 450 Gw1 2030

Bangladesh
7.9 Gw2 by 2041

Sri Lanka
50% Generation4 from RE by 2030

Pakistan
16 Gw3 by 2040

Hydro Power through CBET for optimised grid balancing

CBET as a tool for flexibility, managing RE Intermittency

Opportunity-Developing Regional Power Market (Trading of balancing services, Ancillary Market)

One Sun One World One Grid' (OSOWOG)- A grand Vision

Successful 9 PM, 9 Minute-A generation flexibility of ~ 400 MW was achieved from hydropower plants in Bhutan5

New power market initiatives in India also offers an opportunity to leapfrog

In 2016, 80% of Denmark’s wind generation6 was balanced through CBET through the utilization of Norway’s hydro resources

http://cea.nic.in/reports/others/planning/irp/Optimal_generation_mix_report.pdf 3
https://posoco.in/download/report-on-pan-india-lights-off-event-9-pm-9-minutes-on-5th-april-2020/?wpdmdl=28819
https://posoco.in/download/report-on-pan-india-lights-off-event-9-pm-9-minutes-on-5th-april-2020/?wpdmdl=28819
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References:
1. Cross Border Electricity Trade in SAARC Region: Webinar on “Cross Border Electricity Trade in SAARC Countries-11.30 AM (IST), Tuesday, 11th August 2020” by Rajiv Ratna Panda, Technical-Head (SARI/EI)/IRADE
5. Successful 9PM, 9 minutes event Highlights the Outstanding Cooperation in Electricity Grid Management in South Asia
6. Cross Border Electricity Trade in SAARC Region: Webinar on “Cross Border Electricity Trade in SAARC Countries-11.30 AM (IST), Tuesday, 11th August 2020” by Rajiv Ratna Panda, Technical-Head (SARI/EI)/IRADE
Enablers for accelerating CBET & Development of Regional Power Market
### Enablers for accelerating CBET & Development of Regional Power Market

#### Political
- Regional Outlook/Vision
- Political Consensus
- Intergovernmental agreement(s)
- Implementation Mechanism
- Power Market Reform

#### 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

#### Technical and Commercial
- Harmonisation of grid codes & standards, Grid Connectivity
- Transmission pricing & transit charge
- Co-ordinated Regional Transmission Grid Planning
- Settlement & payment mechanism
- Dispute resolution mechanism

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

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Cross Border Electricity Trade in SAARC Region: Webinar on "Cross Border Electricity Trade in SAARC Countries-11.30 AM (IST), Tuesday, 11th August 2020" by Rajiv Ratna Panda, Technical-Head /SARI/I/IRADE

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Key Policy & Regulatory Enablers in SA

SAARC Framework Agreement for Energy Cooperation (Electricity) 1 (Nov,2014)

MoU on BIMSTEC Grid Interconnection2 (August 2018)

Guidelines for Import/Export (Cross Border) of Electricity3 (Dec, 2018)

One Sun One World One Grid6 (OSOWOG)- A grand Vision6 (May,2020)

Draft Electricity (amendment) Bill, 2020 defines “CBTE”? (April, 2020)

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Ministry of New and Renewable Energy Government of India

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Ministry of New and Renewable Energy Government of India

OSOWOG which Envisages large scale trans-regional grid integration Phase-I Middle East-South Asia-South East Asia (MESASEA) interconnection: Indian Grid Interconnection with MESASEA, Phase-II MESASEA Grid with Africa Power Pools, Phase-III (Global interconnection) to achieve the OSOWOG vision.
First of its Kind dedicated Regulations on CBET in the Region.

Comprehensively address various aspects of Cross Border Trade of Electricity

Provides clarity, transparency, consistency and predictability in regulatory mechanism

Can be learning process & starting point towards development of Regional Regulatory Framework

A comprehensive and detailed regulation, covers all possible regulatory aspects of CBET
SARI/EI Initiatives
<table>
<thead>
<tr>
<th>Initiative</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmonisation of legal, Policy framework, Common Regulatory Roadmap (CRP)</td>
<td></td>
</tr>
<tr>
<td>Coordinated Regional Generation &amp; Transmission Master Plan (CRGTMP)</td>
<td></td>
</tr>
<tr>
<td>Model Regional Framework for Trilateral &amp; Multilateral Power Trade (MRFTMPT)</td>
<td></td>
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<tr>
<td>Common Operating Standards, Common Minimum Grid Code (CMGC)</td>
<td></td>
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<tr>
<td>Power Exchange Platform for CBET (SARPEX)</td>
<td></td>
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<tr>
<td>Framework-Regional Ancillary Service Market (FRASM)</td>
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<tr>
<td>Potential for Natural Gas Trade Potential (NSTP)</td>
<td></td>
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<tr>
<td>South Asia Energy Knowledge Resource Database (SAEKRD)</td>
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</tr>
</tbody>
</table>
Institutionalizing the Process of CBET: SARI/EI Initiatives

South Asia Forum of Electricity Regulators (SAFER)
Technical Support to SAFIR Working Group & SAARC council of experts of energy (electricity) Regulators

South Asian Forum of Transmission Utilities (SAFTU)

South Asian Forum of System Operators (SAFSO)

South Asian Forum for Electricity Market (SAFEM)

South Asian Forum for Energy Investment (SAFEI)
Conclusion and Way forward
<table>
<thead>
<tr>
<th>Theme</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focusing on Complementary Regulatory framework development for CBET in each SA countries.</td>
<td>Need to strengthen the process of Policy &amp; Regulatory Harmonisation.</td>
</tr>
<tr>
<td>Institutionalizing the Process of CBET-SAHER, SAFTU, SAFSO, SAFEM, SAFEI</td>
<td>De-Risking CBET infrastructure Projects; enhancing bankability of projects; Investment mobilisation.</td>
</tr>
<tr>
<td></td>
<td>Focusing on power market development including ancillary service market.</td>
</tr>
<tr>
<td></td>
<td>Deepening CBET leads to Clean Energy Transition and Sustainability, Climate Change Mitigation.</td>
</tr>
<tr>
<td></td>
<td>Strengthening Institutional Capacity.</td>
</tr>
</tbody>
</table>
It always seems impossible until it's done.

Nelson Mandela

Thank You
Regional Legal, Regulatory, Institutional Framework for CBET in BIMSTEC

A
Enabling Legal framework

Desirable to have specific Legal provisions for cross border energy/electricity trade. Trading as a distinct Activity, desire to have Power/energy Market Development. License requirements and the underlying rules/limitations

B
Regulatory Framework

Licensing for CBET: (Important Regulatory Tool for Trading)
Open Access (OA) to transmission system: (Competitive Market), Grid Connectivity
Setting of fair rules and procedures for non-discriminatory open access, Defining application process, eligibility criteria, priority order and nodal agency for OA (Cumbersome regulatory processes which causes decision making to be time consuming for governments and investors)

C
Regulatory Framework

Transmission Pricing: (cost reflective & efficient)
Country’s requirement and acceptability, Setting up principles and mechanism for determination of economically efficient transmission pricing regime and gradually concept of location specific pricing
Adoption of tariff framework in respective country power system through enabling regulations

D
Regulatory Framework

Transmission Planning: (coordinated Regional Planning)
Regional coordination mechanism of planners, National Transmission Plans to include details of CBET lines (progress towards developing a regional level master plan)

E
Regulatory Framework

Imbalance Settlement: (transparent common procedure), Scheduling, dispatch, energy accounting and settlement procedures: Harmonization of grid codes: (safe and reliable regional integrated system operation), Dispute Resolution: (transparent and fair legal framework), Dedicated Cross Border Electricity Trade Regulations.

F
Structured Institutional Framework

Structured Institutional Mechanisms/Committees/Forums at the Level of Regulators, Transmission utilities/planning Authorities, System Operation.
Committee/Mechanism to track & Monitor the progress of Implementation of MoU & advise needed interventions.

Evolution of Cross Border Electricity Trade (CBET) in South Asia
History of evolution of Energy Cooperation, CBET- Key Policy & Regulatory Development

- **Kosher treaty between Nepal & India**
  - 1954

- **Jaldhaka agreement Indo-Bhutan hydropower cooperation**
  - 1961*

- **Indo-Nepal Power exchange 5 MW in initial Years**
  - 1971

- **Agreement between Govt. of India and Royal Govt. of Bhutan on Chuka hydro power project to India (Plant Inaugurated on October 21, 1988)**
  - Mar 1974 **

- **Nepal-India Power Exchange Committee(PEC)-constituted**
  - 1992

- **Agreement between Govt. of India and Royal Govt. of Bhutan on Tala Hydro Power Project -1020 MW-first unit commissioned on July 31, 2006 & last unit on March 30, 2007**
  - 5th Mar 1996

- **Agreement between Govt. of India and Royal Govt. of Bhutan on cooperation in Hydroelectric Power**
  - Jul 2006

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Cross Border Electricity Trade in SAARC Region Webinar on "Cross Border Electricity Trade in SAARC Countries- 11.30 AM (IST), Tuesday, 11th August 2020" by Raju Ratna Panda, Technical Head (SARI/EI/IRADE)
## Significant Developments in Energy Cooperation, CBET- Key Policy & Regulatory Development

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>MoU between Govt. of India and Govt. of Bangladesh, on cooperation in power sector (500 MW trade started on 5th October, 2013)</td>
<td>Jan 2010</td>
</tr>
<tr>
<td>MoU for carrying out a feasibility study for interconnection of the India-Sri Lanka electricity grids (Signed among GOSL, GDI, CEB &amp; PGCIL)</td>
<td>Jun 2010</td>
</tr>
<tr>
<td>MoU on CASA 1000 Project signed among 4 participating countries* (Project was conceived in 2008)</td>
<td>20th Sept 2011</td>
</tr>
<tr>
<td>Inter-Governmental Agreement between Bhutan and India on development of JV Hydropower Projects</td>
<td>Apr 2014</td>
</tr>
<tr>
<td>Indo-Nepal Power Trade Agreement</td>
<td>Sept 2014</td>
</tr>
</tbody>
</table>

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<tr>
<td>MoU on BIMSTEC Grid Interconnection</td>
<td>Aug 2018</td>
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<tr>
<td>MoU between Nepal &amp; Bangladesh, on co-operation in power sector</td>
<td>Aug 2018</td>
</tr>
<tr>
<td>NEPRA (Import of Electric Power Regulations)</td>
<td>June 2017</td>
</tr>
<tr>
<td>CERC draft notification on CBET Regulations</td>
<td>Feb 2017</td>
</tr>
<tr>
<td>Guidelines on Cross Border Electricity Trade (CBTE) issued</td>
<td>Dec 2016</td>
</tr>
<tr>
<td>Ministry of Power Designates Nodal agency for CBTE</td>
<td>Dec 2016</td>
</tr>
<tr>
<td>MoU on Cooperation in the field of Power Sector Myanmar &amp; India</td>
<td>Oct 2016</td>
</tr>
<tr>
<td>Sub-Regional Cooperation Bangladesh, Bhutan, India and Nepal (BBIN)</td>
<td>Oct 2015</td>
</tr>
<tr>
<td>SAARC Inter-governmental Framework Agreement on Energy Cooperation</td>
<td>Nov 2014</td>
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<td>New CBTE Guidelines Issued (Repealed 2016 Guideline)</td>
<td>Dec 2018</td>
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<tr>
<td>CERC Notifies (Cross Border Trade of Electricity Regulations, 2019)</td>
<td>March 2019</td>
</tr>
<tr>
<td>CEA-Draft Conduct of Business Rules (CBR) for CBTE</td>
<td>April 2019</td>
</tr>
<tr>
<td>Mangdechhu hydroelectric power plant (720 MW) inaugurated</td>
<td>17th Aug, 2019</td>
</tr>
<tr>
<td>Draft Electricity (amendment) Bill, 2020 defines “CBTE”</td>
<td>April, 2020</td>
</tr>
<tr>
<td>One Sun One World One Grid‘ (OSOWOG)- A grand Vision</td>
<td>May 2020</td>
</tr>
<tr>
<td>Indo-Bhutan joint venture hydroelectric project Concession Agreement for 600MW Kholongchu</td>
<td>June 29, 2020</td>
</tr>
</tbody>
</table>

*Project was conceived in 2008*
Regional Hydro Power can help in Renewable Integration and Grid Balancing

- Role of Cross Border Hydro in Renewable Integration and Grid Balancing.
- India RE Target - 175 GW by 2022
- India: 450 GW of renewable energy by 2030 *
- Hydro share in India has been declining over the years (45% in 1970 to Apprx 12 % in 2020)
- National Electricity policy (GoI), spinning reserves at 5%**.
- Developing Regional Ancillary Market- India has started ancillary market.

Very Important Recent Development: Innovative Model to Address RE Intermittency and Ensure RE Grid Integration

- **WIND-SOLAR HYBRID POWER PROJECT** means the wind-solar hybrid power project where the rated power capacity of one resource is at least 25% of the rated power capacity of the other resource | PEAK HOURS” shall mean the energy scheduling hours between (& including) 06:00 hrs up to 09:00 hrs, and between (& including) 18:01 hrs to 24:00 hrs of the same day. For the purpose of scheduling, a ‘day’ shall commence from 00:00 hrs and end at 24:00 hrs.; minimum 6-hour Peak Power supply, on daily basis, during the Peak Hours;

**BIDS**

- SECI -Bids called to develop 1200 MW ISTS Connected RE Projects* with assured Peak Power Supply in India i.e. with Energy Storage System
- (01.08.2019)

**BUSINESS MODEL**

- Provided a flat tariff payment of Rs. 2.70/kWh (Off Peak power )
- peak power tariff through e-Reverse Auction

**Result**

- Reenko-awarded 900 MW peak power tariff - rate of Rs 6.12 (~$0.086)/kWh,
- ReNew Power - 300 MW, peak tariff Rs 6.85 (~$0.096)/kWh on 31.01.2020

Source:  * http://presidentofindia.nic.in/speeches-detail.htm?798 | https://economictimes.indiatimes.com/smallbiz/productline/power-generation/india-to-have-450-gw-renewable-energy-by-2022-predicts/articleshow/73804463.cms?from=mdr | While the timing is sometimes unclear, recent government reports indicate 2020 as the target year for the 450 GW target. CEA’s National Electricity Plan (NEP) 2018 had already projected a higher share of renewables (16%) compared to coal (50%) by 2027. CEA’s draft report on Optimal Generation Capacity Mix for 2029-30, renewable energy sources (solar + wind) installed capacity will become 440 GW by the end of year 2029-30 which is more than 50% of total installed capacity of 831 GW. **(peak 175 DW generating capacity and nearly 150 DW peak demand) Technical Committee for Large-Scale Integration of Renewable Energy, need for balancing, Deviation Settlement Mechanism (DSM) and associated issues.

**INDIA**

- **SECI** - Bids called to develop 1200 MW ISTS Connected RE Projects
- with assured Peak Power Supply in India i.e. with Energy Storage System
- (01.08.2019)

- **BUSINESS MODEL**

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## Five Year Vision Document for Power Sector - Power Markets

<table>
<thead>
<tr>
<th>Goal 04</th>
<th>Implementation Roadmap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal</td>
<td>Potential Interventions/ Actions</td>
</tr>
</tbody>
</table>
| Enhance cross border trade through market products | • Introduce standardized products in Day-Ahead Markets, Intra-day, Term-Ahead market for cross-border electricity trading – physical delivery  
• Introduce products in Balancing market for trading of balancing services from fast response plants such as Hydro  
• Introduction of financial products – futures & derivatives |

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</table>
| Deepen products in markets to enhance clean energy | Introduction of **Real Time Market (RTM)** for improved reliability and control and better absorption of RE  
Move from regulated to market based mechanism for Ancillary Services  
Inclusion and scale up of innovative models for Decentralised Renewable Energy (DRE) based access |