

**SAARC Energy Centre, Islamabad
Pakistan**

THE REPORT



Webinar on “Cross Border Electricity Trade in SAARC Countries”



Session 1: 9th March 2020, Islamabad
Session 2: 11th August 2020, Islamabad

Organized by:
SAARC Energy Centre

March 9, 2020

**SAARC Energy Centre
697, Street 43, Sector E-11/4 (NPF),
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www.saarcenergy.org**



Proceedings of First Webinar – 9th March 2020

Introduction

1. SAARC Energy Centre (SEC), Islamabad under its approved Programme of Activities for the year 2020 successfully conducted a Webinar on “Cross Border Electricity Trade in SAARC Countries” on Monday, 9th March 2020. Webinar Agenda is available at Annexure -I.
2. Focus of the webinar was to share the information on Cross Border Electricity Trade in South Asia to the participants and sensitise the policy/decision makers on the importance and benefits of such trade. Areas discussed were: Rationale for Cross Border Electricity Trade (CBET) and its benefits; CBET Regulations and Guidelines; Status of CBET in SAARC region and European experience of regional markets and interconnections.

Participation

3. The webinar was attended by 31 professionals representing public sector organizations, academia, private sector, and other stakeholders within and outside SAARC region. The experts from Germany, India, Nepal, and Pakistan shared their knowledge pertaining to government policies, existing practices, and international experience with regards to electricity trade between neighbouring countries. The participants list is available at Annexure-II.

Description

4. The webinar was started with welcome remarks by Program Coordinator, Mr. Ahmad Talha, Research Fellow (Technology Transfer) of SEC. The technical session comprised of presentations by the expert speakers. Each presentation was followed by a brief Q & A session. The Program Coordinator read out conclusions, which were gathered during the webinar. Before closing the webinar, the Program Coordinator from SEC offered remarks of appreciation to all the participants and presenters.

Technical Proceedings

5. Four resource persons from Germany, India, Nepal, and Pakistan shared their knowledge in the webinar. All the presentations delivered during the webinar are available at SEC's website (<https://www.saarcenergy.org/2969-2/>). Details of Resource Persons are available at Annexure-III and their Presentations at Annexure-IV. A brief information on the content of the delivered presentations is as follows:

Presentation 1 – Cross Border Trade of Electricity: Policy & Regulations

Mr. Abhijeet Rajendra, TATA Power Trading Company (Pvt.) Ltd. India.

6. Mr. Abhijeet, has over 12 years of experience in working in the Indian power markets. He is currently working for TATA Power Trading Company Limited. The TATA Power Company Limited is India's oldest and largest integrated private sector power utility. Mr. Abhijeet has deep understanding of Indian power markets and has commented extensively on various regulations/whitepapers including CBET. In his presentation, he discussed the status of CBET in India and policy guidelines currently in place to enable and promote CBET. He also covered current electricity trade contracts, institutional framework, tariff determination, conditions for setting up transmission interconnections, benefits of CBET, key issues and way forward for CBET.

Presentation 2 – Rationale for CBET Interconnections and Trade in South Asia

Mr. Salis Usman, National Transmission and Dispatch Company (NTDC), Pakistan.

7. Mr. Salis Usman – currently working as General Manager Power System Planning in NTDC Pakistan – has about 34 years of working experience in the power sector. He has worked in different departments of NTDC including Project Monitoring, Purchasing and Inventory Control, Design, Central Power Purchasing Agency, and Power System Planning. He apprised the participants on rationale for regional energy connectivity SAARC Energy Ring. Mr. Salis briefed the participants on the features and status of Central Asia - South Asia Power Transmission CASA-1000 project. In the end he shared his vision for coping with the challenges of power sector and emphasized the importance of SAARC initiatives for regional connectivity.

Presentation 3 – CBET in SAARC Region

Mr. Sher Singh Bhat, Kabeli Energy (Pvt.) Ltd., Nepal.

8. Mr. Sher Singh is a power sector expert having 36 years of working experience in all elements of the value chain including planning, generation, transmission, system operation and power trade. He started his presentation with objectives and status of CBET in SAARC region. He discussed about the initiatives and agreements currently in place to facilitate electricity trade between SAARC Member States.

9. Mr. Sher Singh briefly explained the regulations and the infrastructure currently in place in SAARC countries for electricity trade. He emphasized the roles of regional, bilateral, and domestic instruments in accelerating the regional connectivity. He also shed some light on the reasons for inadequate trade and regional connectivity between SAARC countries.

Presentation 4 – Regional Markets: A Key Innovation in the Global Energy Transition

Ms. Elena Ocenic, International Renewable Energy Agency (IRENA), Germany.

10. Ms. Elena Ocenic has hands-on experience in solar photovoltaic project development and expertise in European electricity market regulation. She is currently exploring how innovations in enabling technologies, business models, market design and system operation can help IRENA members achieve their ambitious renewable power policy goals by mid-century. In her presentation, Ms. Elena summarised IRENA's systemic approach for the energy transition towards maximising penetration of the renewable energy sources.

11. Ms. Elena apprised the audience about the impact of regional markets on power sector. To emphasize the importance of regional markets, she presented the example of European market. She covered the gradual growth of European electricity market; the status of cooperation, interconnection, and harmonization levels; benefits and various degrees of economic efficiency resulting from regional trade; social welfare gains.

Wrap up and Conclusion

Mr. Ahmad Talha, Research Fellow (Technology Transfer), SAARC Energy Centre

12. Mr. Ahmad Talha thanked everyone for attending the event. He informed the participants that there is great potential for energy trade between SAARC countries. Following are the main conclusions:

- a. CBET is important as it offers multiple benefits. Some of them are listed below:
 - i. Optimal use of electricity infrastructure (generation, transmission system)
 - ii. Enhanced security of supply
 - iii. Allowance for higher penetration of the renewable energy
 - iv. Avoid un-necessary investment by a neighbouring country to enhance generation
 - v. Reduction of environmental costs
 - vi. Enhanced inter-regional cooperation that could result in economic and social benefits

- b. It is important that all SAARC Member States take necessary action to promote multinational regional trade of electricity. SAARC Energy Centre has always played its role to facilitate and encourage regional trade of electricity and will continue to do so by arranging events to allow deliberation on crucial aspects of regional energy trade.

Closing of Webinar

Mr. Ahmad Talha, Research Fellow (Technology Transfer), SAARC Energy Centre

13. Mr. Ahmad Talha, informed all the participants that the presentations and recording of the webinar proceedings will be available on SEC's website (www.saarcenergy.org). He requested the participants to submit suggestions/comments for any further improvement of these webinars and suggest topics to SEC using the feedback survey form. He closed the webinar with a thank you note to everyone attending the Webinar.

Proceedings of Second Webinar – 11th August 2020

Introduction

1. Given the importance of this topic, SEC Islamabad successfully organised a second webinar on “Cross Border Electricity Trade in SAARC Countries” on Tuesday, 11th August 2020. Webinar Agenda is available at Annexure -I.
2. Focus of the webinar was to share the information on present status and outlook of Cross Border Electricity Trade in South Asia. In addition, developments to promote electricity trade in the neighbouring region of ASEAN were also shared with the audience. During the webinar, the topics such as overview of South Asian power sector, current and future scenarios of CBET, outlook of CBET, enablers for accelerating CBET and energy interconnection of ASEAN and China were discussed in detail.

Participation

3. The webinar was attended by 52 professionals from various public and public sector organizations, research centres, academia, and other stakeholders within and outside SAARC region. The experts from India and China shared their knowledge pertaining to current CBET initiatives, future scenarios of regional power market, and international experience with regards to electricity trade between neighbouring countries. The participants list is available at Annexure-II.

Description

4. Program Coordinator, Mr. Ahmad Talha, Research Fellow (Technology Transfer) of SEC began the webinar with his welcome remarks. The technical session comprised of presentations by two expert speakers from India and China. Each presentation was followed by a brief Q & A session. The Program Coordinator read out conclusions, which were gathered during the webinar. Before closing the webinar, the Program Coordinator from SAARC Energy Centre offered remarks of appreciation to all the participants and presenters.

Technical Proceedings

5. Two resource persons from India and China shared their knowledge in the webinar. All the presentations delivered during the webinar are available at SEC's website (<https://www.saarcenergy.org/webinar-on-cross-border-electricity-trade-in-saarc-countries-second-session/>). Details of Resource Persons are available at Annexure-III and their Presentations at Annexure-IV. A brief information on the content of the delivered presentations is as follows:

Presentation 1 – Cross Border Electricity Trade in SAARC Region: Current Status and Future Outlook

Mr. Rajiv Ratna Panda, South Asia Regional Initiative for Energy Integration (SARI/EI), India.

6. Mr. Rajiv Ratna Panda is an energy expert, electrical engineer, management, research, public policy, and strategy professional with multi-regional energy system expertise & experience. He currently works as Head-Technical, USAID's South Asia Regional Initiative for Energy Integration (SARI/EI) at Integrated Research and Action for Development (IRADe). He provides technical inputs/advice as well as the policy, regulatory, legal and market inputs/advice for enhancing CBET, power system integration, transmission system and grid integration, regional power market design & development and energy security in South Asia (SA) & BIMSTEC region. He was instrumental in developing regional regulatory guidelines for CBET, conceptualizing the development of regional regulatory/technical institutional mechanism for deepening energy cooperation and CBET, and energy sector public policy development in the SA & BIMSTEC region.

7. In his presentation, he discussed the economic condition of SAARC region and status of CBET in South Asia. He presented an overview of the power sector in SAARC Member States depicting the varying sizes of power systems in each country. He highlighted some of the challenges faced in the areas of energy access and clean energy development. Discussion on current status and future outlook of CBET was the main focus of his presentation. He talked in detail about the benefits offered by four key areas – transition from bilateral to trilateral CBET, renewable energy based CBET, commercial form of CBET and regional power market development – with regards to future of CBET in the SAARC region.

8. He also shed light on some enablers/accelerators for CBET on political, regulatory, technical and commercial, and institutional sides. He emphasised on the importance of political will, implementation mechanism, open access to transmission systems, harmonisation of grid codes and regional coordination forums to realise regional power market. He also shared some key policy and regulatory enablers, such as SAARC Framework Agreement on Energy Cooperation, developed to nurture CBET in the SAARC region. In the end, he presented some of SARI/EI initiatives to enhance CBET.

Presentation 2 – Energy Interconnection and Trade of ASEAN and China

Dr. Jiang Han, Global Energy Interconnection Development and Cooperation Organisation (GEIDCO), China.

9. Dr. Jiang Han – IEEE and CIGRE member - currently serves as Research Fellow of GEIDCO (Global Energy Interconnection Development and Cooperation Organization). Prior to this, he served as Senior Engineer of China Electrical Power Research Institute. He has been engaged in the fields of power research, planning and operation for a long time, including the building of Central Simulation Centre of SGCC, as well as energy

interconnection planning. He has hosted a series study on Analysis and Model of UHVDC projects, Clean Energy Base Development and Cross-border Power Interconnections in South-East Asia, among which the project of Large-scaled solar/wind base development of Northwest China has won the first prize of Award of Science and Technology Progress of CEPRI. He has held 7 patents and published over 40 articles, including IEEE Trans on Smart Grid and CIGRE conference.

10. Dr. Jiang introduced the idea of global energy interconnection system (GEI) – a platform developed being by GEIDCO to promote clean energy globally – and its associated key concepts. He also provided a summary of research work undertaken by GEIDCO to promote GEI. He shared the current status of energy interconnection in Southeast Asia highlighting some of the drivers behind this interconnection and challenges faced along the way. Coordinate development of clean energy and power grid, coordinate markets at supply & demand sides, and coordinate regional and cross-regional interconnection are the principles followed by Southeast Asian countries to promote CBET. He discussed the layout and development plan of clean energy in the ASEAN region. At the end, he presented the outlook of future energy interconnection between China, ASEAN and SAARC Member States.

Wrap up and Conclusion

Mr. Ahmad Talha, Research Fellow (Technology Transfer), SAARC Energy Centre

11. Mr. Ahmad Talha thanked everyone for attending the event. The following conclusions were drawn from the discussion held in the webinar:

- a. CBET in SAARC region is shifting from bilateral to trilateral agreements which is an important milestone in the journey towards regional power market.
- b. Transition towards regional power market or power exchange will result in transparent and neutral market place for CBET. Achieving the target of SAARC Regional Electricity Market will result in multiple auxiliary benefits including clean energy transition, power balancing and management of renewable energy intermittency thereby increasing grid flexibility.
- c. Political will, implementation mechanism for SAARC Framework Agreement on Energy Cooperation and market reforms will further the cause of CBET in SAARC region.
- d. SAARC Member States need to: develop complimentary regulatory framework, strengthen the process of policy harmonisation, implement CBET agreements, focus on regional level power system planning, develop regional power market and cooperate on regional forums.

Closing of Webinar

Mr. Ahmad Talha, Research Fellow (Technology Transfer), SAARC Energy Centre

12. Mr. Ahmad Talha, informed all the participants that the presentations and recording of the webinar proceedings will be available on SEC's website (www.saarcenergy.org). He requested the participants to submit their feedback by sending an email to rftt@saarcenergy.org. He closed the webinar with a thank you note to everyone attending the Webinar.

Annexures

Webinar Agenda
First Webinar on
“Cross Border Electricity Trade in SAARC Countries”
Monday, 9th March 2020

1100 – 1110	Introduction
1110 – 1130	Cross Border Electricity Trade: Regulations & Guidelines <i>Mr. Abhijeet Rajendra, The Tata Power Company (Pvt.) Ltd India.</i>
1130 – 1140	Q & A session
1140 – 1200	Rationale for CBET Interconnections and Trade in South Asia <i>Mr. Salis Usman, National Transmission and Dispatch Company Pakistan.</i>
1200 – 1210	Q & A session
1210 – 1230	CBET in SAARC Region <i>Mr. Sher Singh Bhat, Kabeli Energy Limited, Nepal.</i>
1230 – 1240	Q & A session
1240 – 1300	Regional Markets - A Key Innovation in the Global Energy Transition <i>Ms. Elena Ocenic, International Renewable Agency (IRENA), Germany.</i>
1300 – 1310	Q & A session
1310 – 1320	Conclusion and Recommendations
1320 – 1330	Closing of Webinar

Information for the participants:

1. All times mentioned in agenda are according to Pakistan Standard Time (PKT). The participants from other Member States may attend Webinar by following their own national time. The time conversion for all Member States is given below for reference:

Country	Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Sri Lanka
Local time	(PKT-00:30)	(PKT+01:00)	(PKT+01:00)	(PKT+00:30)	PKT	(PKT+00:45)	(PKT+00:30)

2. The participants can ask questions to presenters by typing questions or clicking to the raised hand option into the Attendees pane of the main window of GotoWebinar software. You may send in your questions at any time during the presentations; we will collect these and address them during the Q&A session at the end of each presentation.

3. All participants can also submit comments/views and/or observations on the draft study report to SAARC Energy Centre through email to Mr. Ahmad Talha, Research Fellow (TT) (rftt@saarcenergy.org).

Webinar Agenda
Second Webinar on
“Cross Border Electricity Trade in SAARC Countries”
Tuesday, 11th August 2020

1100 – 1110	Introduction
1110 – 1140	Cross Border Electricity Trade in SAARC Region: Current Status & Future Outlook <i>Mr. Rajiv Ratna Panda, SARI/EI IRADe, India.</i>
1140 – 1150	Q & A session
1150 – 1220	Energy Interconnection and Trade of ASEAN and China <i>Dr. Jiang Han, GEIDCO, China.</i>
1220 – 1230	Q & A session
1230 – 1235	Conclusion and Recommendations
1235 – 1240	Closing of Webinar

Information for the participants:

4. All times mentioned in agenda are according to Pakistan Standard Time (PKT). The participants from other Member States may attend Webinar by following their own national time. The time conversion for all Member States is given below for reference:

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6. All participants can also submit comments/views and/or observations on the draft study report to SAARC Energy Centre through email to Mr. Ahmad Talha, Research Fellow (TT) (rftt@saarcenergy.org).

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List of Presenters/Resource Persons in First Webinar

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2.	Mr. Salis Usman	General Manager	National Transmission and Dispatch Company (NTDC), Pakistan	gm.psp@ntdc.com.pk
3.	Mr. Sher Singh Bhat	CEO	Kabeli Energy (Pvt.) Ltd., Nepal	shersingh.bhat@kel.com.np
4.	Ms. Elena Ocenic	Program Officer	International Renewable Energy Agency (IRENA), Germany	eocenic@irena.org

List of Presenters/Resource Persons in Second Webinar

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1.	Mr. Rajiv Ratna Panda	Head Technical	SARI/EI IRADe, India	rajivratnapanda@irade.org
2.	Dr. Jiang Han	Research Fellow	GEIDCO, China	gm.psp@ntdc.com.pk

Presentations Delivered During the Webinars

1. **“Cross Border Trade of Electricity – Policy & Regulations”** by Mr. Abhijeet Rajendra, Senior Manager, TATA Power Trading Company (Pvt.) Ltd., India.



AGENDA

Current Status on Indian Cross Border Trade of Electricity

Cross Border Policy – An Overview

Way Forward

CURRENT STATUS ON INDIAN CROSS BORDER TRADE OF ELECTRICITY

CURRENT CROSS BORDER TRANSACTIONS - INDIA

Country	Contracts	Type	Transmission Link
India to Bangladesh (1160 MW)	Long Term Contract with NVVNL for 250 MW	Govt. to Govt.	Baharampur (India)- Bheramara (Bangladesh) 400kV DC line (500 MW Capacity)
	Medium Term Contract of DVC with Bangladesh 300 MW through NVVNL upto Dec'19	Competitive Bidding	
	a) Sembcorp to Bangladesh (250 MW LT w.e.f. Jan'20 b) DVC to Bangladesh (300 MW LT) w.e.f. Jan'20 c) Meenakshi power to Bangladesh (200 MW LT) w.e.f. Jan'20	Competitive Bidding	
	Long term 160 MW contract Tripura in India to Comilla in Bangladesh through NVVNL	Govt. to Govt.	Tripura(India) Border- Comilla (North) 400 kV D/c line operated at 132 kV

CURRENT CROSS BORDER TRANSACTIONS - INDIA

Country	Contracts	Type	Transmission Link
India to Nepal (320 MW)	Bilateral contracts to the tune of 237 MW through NNVNL	Govt. to Govt.	400 kV Muzaffarpur (India) - Dhalkebar (Nepal) D/C line (charged at 132 kV)
	Contract with PTC upto 100 MW	Market Based	13 no.s of multiple links of 11 KV, 33 KV & 132 KV line between Nepal and India (major being Tanakpur Link)

CURRENT CROSS BORDER TRANSACTIONS - INDIA

Country	Trade Quantum and duration																																										
Bhutan to India (1450 MW) (Existing)	Govt to Govt. - Chukka (336 MW), Kurichhu (60 MW) and Tala (1040 MW), Mangdechhu (720 MW) Market based -Dagachhu (126 MW)																																										
Bhutan to India (upcoming)	Projects under Construction <table><tr><th>Sl No.</th><th>Name of Project</th><th>Location</th><th>Installed Capacity (MW)</th><th>Firm Power (MW)</th><th>Expected COD</th></tr><tr><td>1</td><td>Punatsangchhu-II HEP</td><td>Wangdiphodrang</td><td>1020</td><td>164</td><td>2019</td></tr><tr><td>2</td><td>Punatsangchhu-I HEP</td><td>Wangdiphodrang</td><td>1200</td><td>199</td><td>2021</td></tr><tr><td>3</td><td>Nikachhu HEP (Tangsebjii)</td><td>Trongsa</td><td>118</td><td>22.55</td><td>2019</td></tr><tr><td>4</td><td>Mangdechhu HEP</td><td>Trongsa</td><td>720</td><td>90</td><td>2018</td></tr><tr><td>5</td><td>Kholongchhu HEP</td><td>Trashiyangtse</td><td>600</td><td>113.8</td><td>2023</td></tr><tr><td colspan="3">Total</td><td>3658</td><td>589.35</td><td></td></tr></table>	Sl No.	Name of Project	Location	Installed Capacity (MW)	Firm Power (MW)	Expected COD	1	Punatsangchhu-II HEP	Wangdiphodrang	1020	164	2019	2	Punatsangchhu-I HEP	Wangdiphodrang	1200	199	2021	3	Nikachhu HEP (Tangsebjii)	Trongsa	118	22.55	2019	4	Mangdechhu HEP	Trongsa	720	90	2018	5	Kholongchhu HEP	Trashiyangtse	600	113.8	2023	Total			3658	589.35	
Sl No.	Name of Project	Location	Installed Capacity (MW)	Firm Power (MW)	Expected COD																																						
1	Punatsangchhu-II HEP	Wangdiphodrang	1020	164	2019																																						
2	Punatsangchhu-I HEP	Wangdiphodrang	1200	199	2021																																						
3	Nikachhu HEP (Tangsebjii)	Trongsa	118	22.55	2019																																						
4	Mangdechhu HEP	Trongsa	720	90	2018																																						
5	Kholongchhu HEP	Trashiyangtse	600	113.8	2023																																						
Total			3658	589.35																																							



CROSS BORDER POLICY AN OVERVIEW

GUIDELINES ON IMPORT/EXPORT (CROSS BORDER) OF ELECTRICITY

- Ministry of Power in consultation with Ministry of External Affairs has issued the "Guidelines for Import/Export (Cross Border) of Electricity-2018 on 18th December 2018
- These Guidelines have replaced Guidelines on Cross Border Trade of Electricity issued in 2016
- The objective of these Guidelines are:
 - a. Facilitate import/ export of electricity between India and neighbouring countries;
 - b. Evolve a dynamic and robust electricity infrastructure for import/ export of electricity;
 - c. Promote transparency, consistency and predictability in regulatory mechanism pertaining to import/ export of electricity in the country;
 - d. Reliable grid operation and transmission of electricity for import/ export

GUIDELINES ON IMPORT/EXPORT (CROSS BORDER) OF ELECTRICITY

Institutional Framework

Institution	Responsibility
Designated Authority appointed by MoP, <i>CEA has been appointed as DA</i>	- Facilitating the process of approval - Laying down the procedure for approval - Coordination with Neighbouring Countries - Transmission Planning in capacity of Tr. Planning Agency
Settlement Nodal Agency	- Settlement of Charges for deviation & other charges in relation to CBET - Member of the deviation pool, reactive energy pool and other regulatory pools
National Load Dispatch Centre	- System Operator - Granting short-term open access (STOA) - Billing, collection and disbursement of the transmission charges for STOA as per sharing regulations
Central Transmission Utility	- Granting long-term access and medium-term open access - Billing, collection and disbursement of the transmission charges for MTOA & LTOA, as per sharing regulations

GUIDELINES ON IMPORT/EXPORT (CROSS BORDER) OF ELECTRICITY

Eligibility Conditions for participation in Import/Export

- Indian entities may import or export power directly or through traders from cross-border project after taking approval of Designated Authority
- In case import through bilateral agreement between two countries, GoI to designate an entity for import
- In case coal based projects, only projects generating power from imported coal or spot e-auction coal or coal obtained from commercial mining are permitted to export electricity
- Participating entities from neighboring countries can trade in Indian Power Exchanges through a licensed Indian trader**
- No restriction has been put in terms of contracts or segment in which participating entity from neighboring countries can trade

GUIDELINES ON IMPORT/EXPORT (CROSS BORDER) OF ELECTRICITY

- Designated authority will normally allow imports only when the demand exceeds generation capacity (as available) in the country
- Similarly, Exports may normally be permitted in case of capacity being in excess of the domestic demand
- Application for approval will only be considered after the receipt of the equity pattern of ownership of the said Entity(ies) along with other details as prescribed by the Designated Authority
- Any change in ownership is to be communicated to Designated Authority

GUIDELINES ON IMPORT/EXPORT (CROSS BORDER) OF ELECTRICITY

Tariff Determination

Type	Allowable Methodology for Tariff Determination
Import by Indian Entity	• Competitive bidding • Mutual agreement between the buying Indian entity and the selling entity • The tariff may be determined by CERC as per its Regulations, for hydro projects only if approached by the generator through the Government of the neighboring country & agreed by Indian Utility • Mutually Agreed between Govts of both the countries
Export by Indian Entity	• Competitive bidding • Mutual agreement between selling Indian entity and the buying entity • Mutually Agreed between Govts of both the countries
Tariff of cross border transmission link from pooling station in India till Indian border	• Competitive bidding • Mutually Agreed between Govt. of both the countries • Determined by CERC

Tariff for import or export of electricity already determined through G2G negotiations including under Inter Government Agreements (IGA) shall continue to be determined through G2G negotiations till the expiry of the Agreement

GUIDELINES ON IMPORT/EXPORT (CROSS BORDER) OF ELECTRICITY

Transmission System

- Transmission interconnection between India and its neighbouring country shall be planned jointly by transmission planning agencies of the two countries
- Participating Entity of neighbouring country to seek connectivity, LTOA, MTOA, STOA, as the case may be, through separate applications
- Provisions contained in the STOA Regulations and Connectivity Regulations shall apply mutatis mutandis to the participating entities for cross border trade of electricity

GUIDELINES ON IMPORT/EXPORT (CROSS BORDER) OF ELECTRICITY

Transmission System

Non refundable application fees as under to be payable for connectivity, LTOA & MTOA

S.No.	Quantum of Power to be injected/off taken into/from ISTS	Application fee (Rs. in Lakh)	
		For Connectivity / LTOA	For MTOA
1.	Up to 100 MW	4	2
2.	> 100 MW – 500 MW	6	4
3.	> 500 MW – 1000 MW	12	6
4.	> 1000 MW	18	8

For LTOA, Access Bank Guarantee of Rs 5 lakh/MW valid for five (5) years from the date of operationalization of long term access to be given

GUIDELINES ON IMPORT/EXPORT (CROSS BORDER) OF ELECTRICITY

Application for Grant of Connectivity

- To be applied only by entities getting connected to the Indian grid through dedicated transmission systems
- Entity to submit approval from Designated Authority to engage into CBTE and approval for implementing the dedicated transmission system
- CTU shall process the application and grant Connectivity as per the Detailed Procedure made under Connectivity Regulations
- Upon grant of Connectivity, the Applicant shall sign a Connection Agreement with the CTU
- Grant of Connectivity shall not entitle an applicant to interchange any power with the Indian grid
- Power interchange may only be done after applying for STOA, MTOA or LTOA

GUIDELINES ON IMPORT/EXPORT (CROSS BORDER) OF ELECTRICITY

Application for Short Term Open Access (STOA)

- Application to be made to NLDC for grant of STOA
- Entity to submit approval from Designated Authority to engage into CBTE and approval to use Cross Border Transmission Link(s) in case connectivity is not through dedicated transmission lines
- NLDC shall process the Application and grant short-term open access in accordance with the Procedure made under STOA Regulations

Application for Long-Term Access and Medium-Term Open Access

- Application to be made to CTU
- Entity to submit approval from Designated Authority to engage into CBTE, approval to use Cross Border Transmission Link(s) in case connectivity is not through dedicated transmission lines and access bank guarantee

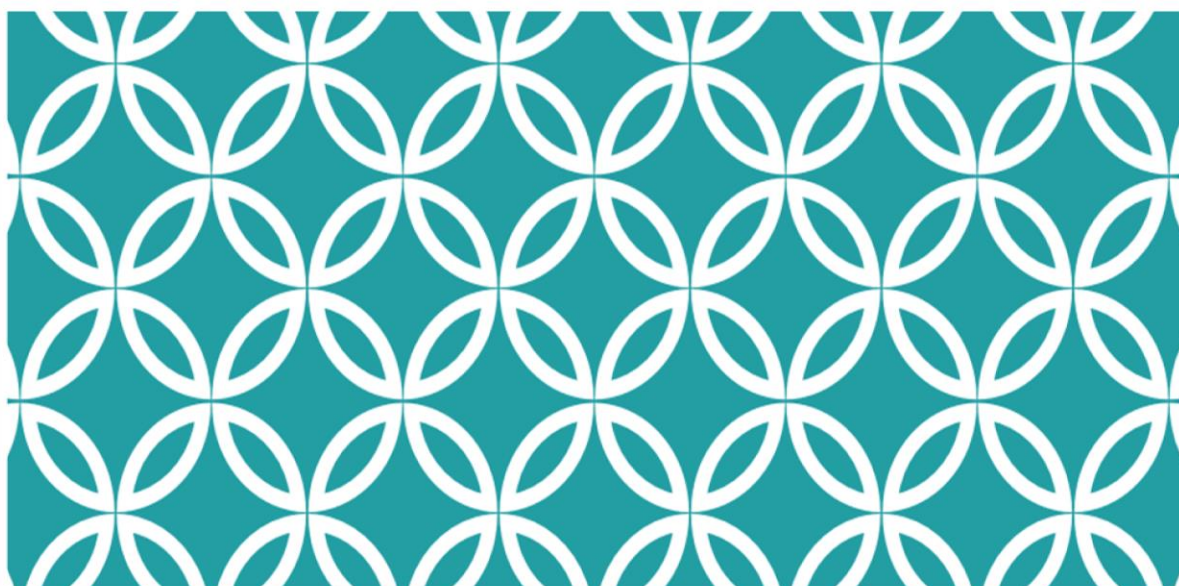
GUIDELINES ON IMPORT/EXPORT (CROSS BORDER) OF ELECTRICITY

- Where tripartite agreement is signed for transaction across India involving two neighbouring countries, the transmission system augmentation in India for transmission of electricity across the territory of India shall be undertaken only after obtaining approval from Government of India and the Commission and the Access Bank Guarantee
- LTOA application to be processed in 120 days (in case network augmentation is required) else 90 days
 - LTOA application will be accompanied by **Access Bank Guarantee ₹ 5 Lakh/MW**
 - In case transmission network augmentation is required, fresh Access Bank Guarantee equal to cost of such augmentation to be furnished.
- MTOA application to be processed in 40 days

GUIDELINES ON IMPORT/EXPORT (CROSS BORDER) OF ELECTRICITY

Treatment of delay in Transmission system and Generation projects

- Designated Authority shall monitor the progress of generating station in neighbouring country along with transmission system for evacuation of power for cross border trade of electricity
- In case of delay in commissioning of project, generator to pay full transmission charges from the date of operationalisation of long-term access
- In case of delay in Cross Border Transmission Link, compensation to be decided by respective Governments
- In case of delay in transmission lines inside India, CTU to arrange for alternate lines or pay pay transmission charges to generating company



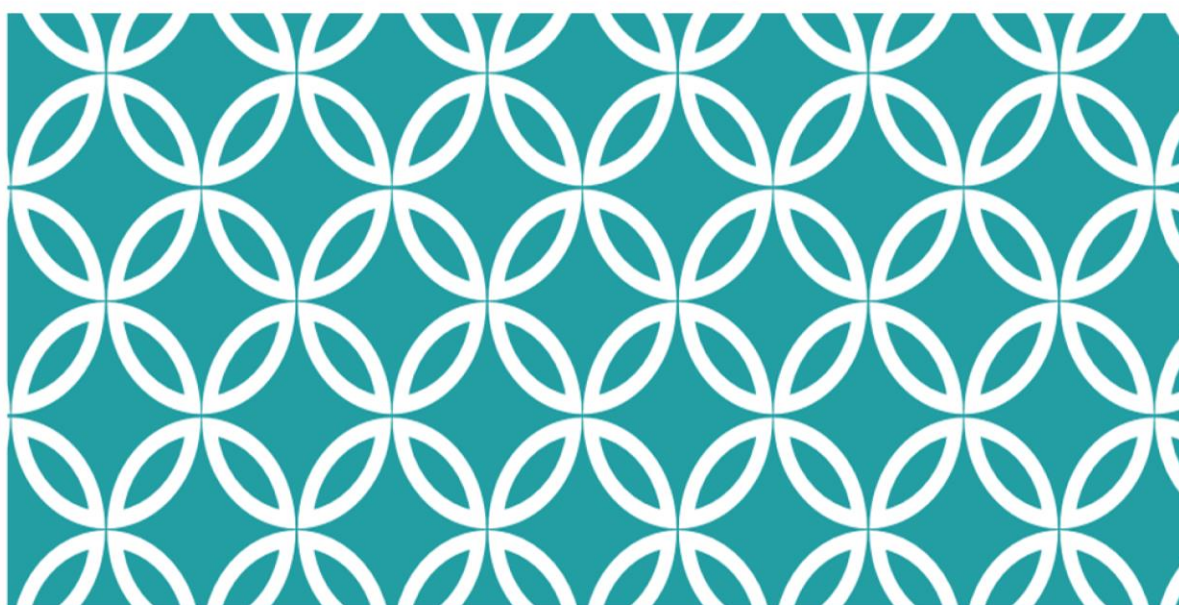
WAY FORWARD

BENEFITS OF CBTE

- Optimal Utilisation of Transmission Lines
- Ensure Security of supply
- Results in higher penetration of intermittent renewables by having hydro power from neighbouring interconnected markets due to Shared generation reserve margins
- Avoid/Defer investments in Transmission and Generation capacities
- Will pave the way for developing a single power market marked by economic integration, and the optimal use of, resources across SAARC countries
- Reduction of environmental costs by increasing availability of cleaner sources of supply (hydro, solar, wind, natural gas
- Economic exploitation of huge hydro potential in NER of India, Nepal & Bhutan which requires access to larger regional markets for the electricity generated.
- Utilisation of stranded capacity and increase in PLF

KEY ISSUES AND WAY FORWARD IDENTIFIED FOR CBTE

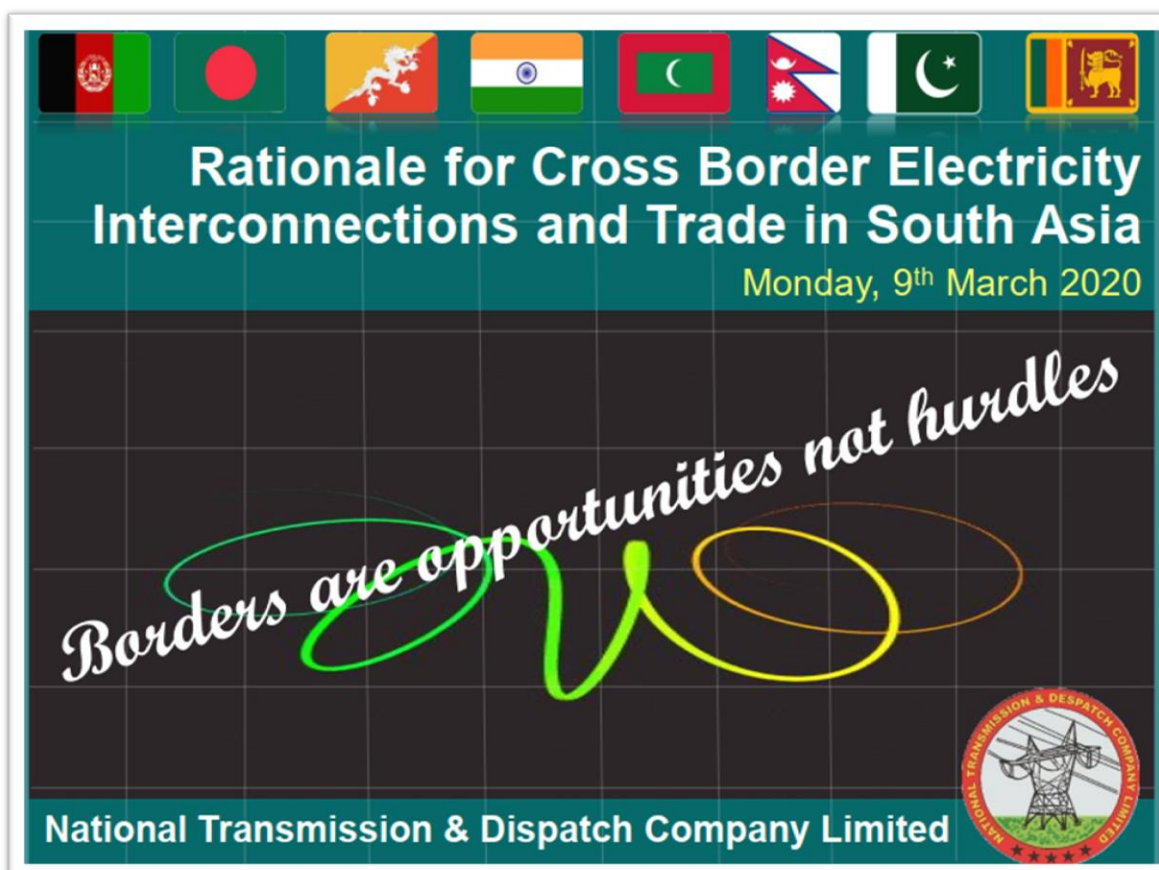
- Common approach to be adopted for setting up regulatory framework for facilitating Cross Border Energy Trade (CBET) and thus achieve transparency, consistency and predictability
- Reasonable Commercial framework
 - Energy Accounting
 - DSM responsibility
- Reliable grid operation and issues related to protection, coordination and scheduling of power
- Market access for Long Term, Medium Term, Short Term or Exchange
- Technical preparedness
- **Question of passing on the fiscal(FIT etc.) and regulatory (RPO compliance, etc.) benefits to renewable power generation stationed in different countries.**
- Market Zones to be created considering the cross border power flow dynamics
- Reliable grid operation and issues related to protection, coordination and scheduling of power



THANKYOU

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2. “Rationale for Cross Border Electricity Interconnections and Trade in South Asia” by
Mr. Salis Usman,
General Manager Power System Planning, National Transmission and Dispatch
Company, Pakistan.



Personal Introduction

Salis Usman

- Knowledge Worker
- Electrical Engineer
- IEEE Fellow
- General Manager, Power System Planning, National Transmission & Despatch Company (NTDC)
- Former Advisor Business Systems - USAID Project; Regulatory Analyst - Saudi Electric Company; and Program Leader (Energy Trade) SAARC Energy Centre
- A social activist
- **A proud learner**



Rationale for Cross Border Electricity Interconnections and Trade in South Asia

Today's Focus

1. Intro to NTDC System
2. Rationale for Regional Energy Connectivity
3. SAARC Energy Ring
4. Connecting Central Asia with South Asia: CASA-1000
5. Scheme to Cope with the Power Sector Challenges
6. Questions and Answers



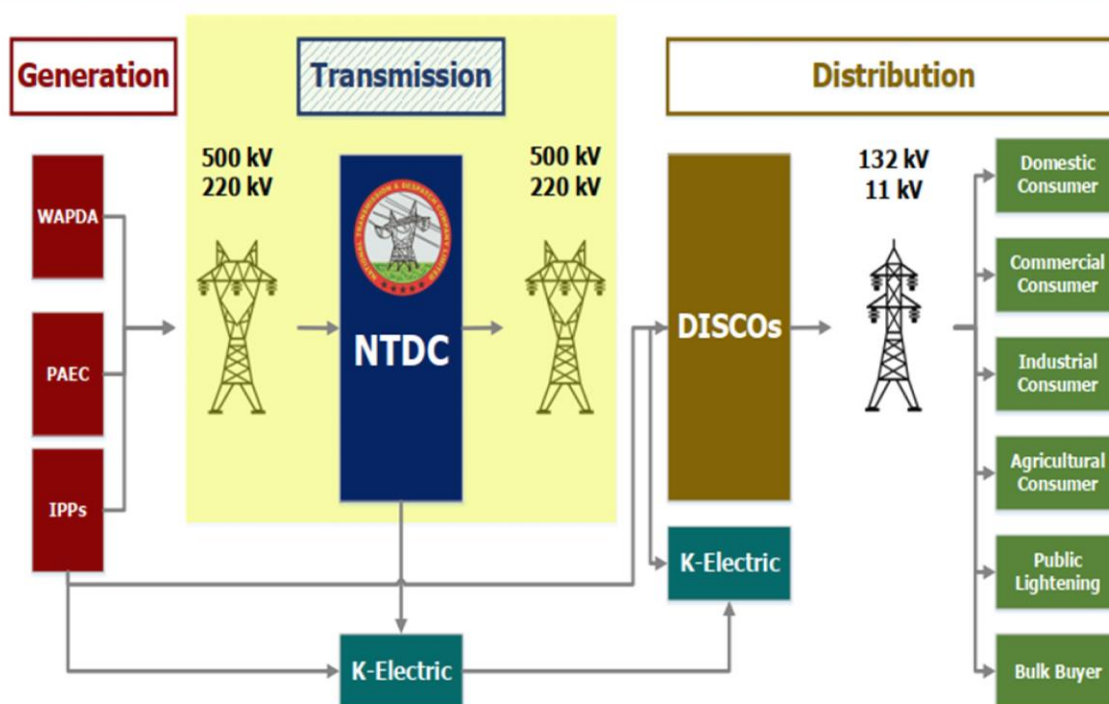
Rationale for Cross Border Electricity Interconnections and Trade in South Asia



1. Intro to NTDC System



National Transmission & Despatch Company



Rationale for Cross Border Electricity Interconnections and Trade in South Asia

NTDC National Grid 2025

Category	Grid Stations	Transmission Lines	Capacity
	Nos.	km	MVA
Existing System 2020			
500 kV	16	5,970	22,350
220 kV	45	11,322	31,060
Total	61	17,292	53,410
Future System 2025			
500 kV	24	12,633	39,150
220 kV	71	15,894	54,100
765 kV	1	500	3,600
± 660 kV	2 (Converter Stations)	890	4,812
± 500 kV	1 (Converter Station)	110	1,576
Total	99	30,027	103,238

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

Long Term Forecast 2018-40

Fiscal Year	Low (4.5% GDP Growth)		Normal (5.5% GDP Growth)		High (7% GDP Growth)	
	Generation	Peak Demand	Generation	Peak Demand	Generation	Peak Demand
	GWh	MW	GWh	MW	GWh	MW
2018-19	144,665	27,072	145,674	27,261	147,188	27,545
2019-20	151,062	27,814	152,914	28,155	155,718	28,671
2020-21	158,842	28,782	161,841	29,325	166,429	30,157
2021-22	166,267	30,127	170,645	30,921	177,416	32,147
2022-23	173,178	30,889	179,142	31,953	188,476	33,618
2023-24	181,051	32,294	188,914	33,696	201,374	35,919
2024-25	188,749	33,640	198,744	35,422	214,788	38,281
2025-26	193,948	34,062	206,155	36,206	226,011	39,693
2026-27	202,763	35,610	217,664	38,227	242,228	42,541
2027-28	211,718	37,183	229,603	40,324	259,492	45,573

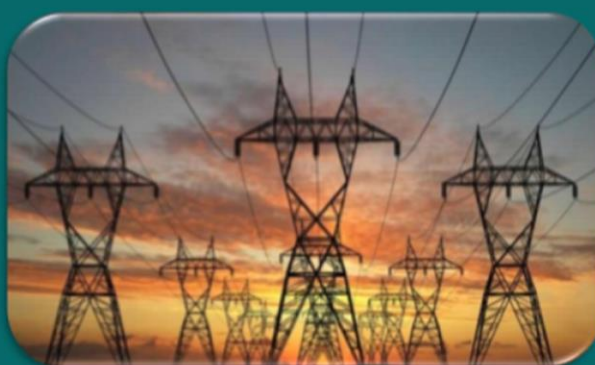
Rationale for Cross Border Electricity Interconnections and Trade in South Asia

Long Term Forecast 2018-40

Fiscal Year	Low (4.5% GDP Growth)		Normal (5.5% GDP Growth)		High (7% GDP Growth)	
	Generation	Peak Demand	Generation	Peak Demand	Generation	Peak Demand
	GWh	MW	GWh	MW	GWh	MW
2028-29	220,940	38,802	242,104	42,519	277,960	48,816
2029-30	231,142	40,594	255,989	44,958	298,670	52,453
2030-31	241,889	42,481	270,792	47,557	321,130	56,398
2031-32	253,101	44,451	286,441	50,306	345,315	60,645
2032-33	265,289	46,591	303,554	53,311	372,070	65,344
2033-34	278,069	48,835	321,710	56,500	400,940	70,414
2034-35	291,403	51,177	340,888	59,868	431,973	75,865
2035-36	305,685	53,686	361,590	63,504	465,916	81,826
2036-37	320,652	56,314	383,529	67,357	502,479	88,247
2037-38	336,293	59,061	406,719	71,429	541,779	95,149
2038-39	352,917	61,980	431,584	75,796	584,509	102,653
2039-40	370,348	65,042	457,939	80,425	630,529	110,736

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

2. Rationale for Regional Energy Connectivity



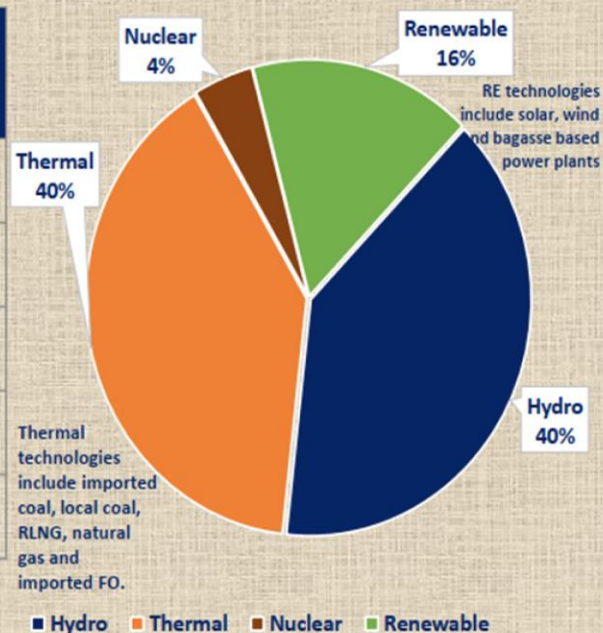
Major Features of Long term Gen Plan 2040

1. Massive utilization of hydro power (29 to 40%). ↑
2. Further balancing the overall basket price with high share of indigenous coal (2 to 25%). ↑
3. Less reliance on imported fuel i.e. coal, RLNG and RFO (48 to 13%). ↓
4. Renewables accounts for the overall share of 16% of the installed capacity (4 to 16%). ↑
5. By the year 2040, a capacity of around 9,000 MW is meant to be retired.

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

Reshaping the Generation Mix 2040

Power Plants	Installed Capacity	%Age
Hydro	38,790	40%
Thermal	38,983	40%
Nuclear	4,278	4%
Renewable	16,040	16%
Total	98,091	100%



Rationale for Cross Border Electricity Interconnections and Trade in South Asia

Seasonal Demand Variation 2018-19

Month	Demand Factor
July	0.902
August	0.965
September	0.823
October	0.770
November	0.614
December	0.601
January	0.599
February	0.582
March	0.682
April	0.786
May	0.947
June	1.000

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

Pakistan: Rationale for Regional Connectivity

1. Energy security due to diversity with respect to cross border interconnection
2. Generation adequacy
3. Optimal utilization of available resources (Investment can be avoided or at least delayed)
4. Interconnections offer opportunities to Pakistan for exporting energy when surplus particularly in winter when demand is low (November to March)

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

Demand Complementarity in Power Systems

Member State	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bangladesh	L	L	M	H	H	H	M	M	M	M	L	L
India – NE	M	L	M	L	L	M	H	H	M	H	H	M
Bhutan	H	H	M	M	M	L	L	L	L	M	M	H
India – E	L	M	H	H	M	H	H	H	H	M	L	L
Nepal	H	H	M	M	L	L	L	L	L	M	M	M
India – N	M	M	L	L	M	H	H	H	H	M	L	M
India – W	H	H	H	M	M	M	L	L	L	H	H	H
Pakistan	L	L	M	M	M	H	H	H	H	M	M	M
India – S	H	H	H	H	M	L	L	M	M	M	L	M

L Low **M** Medium **H** High

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

A Few Examples of Regional Interconnections

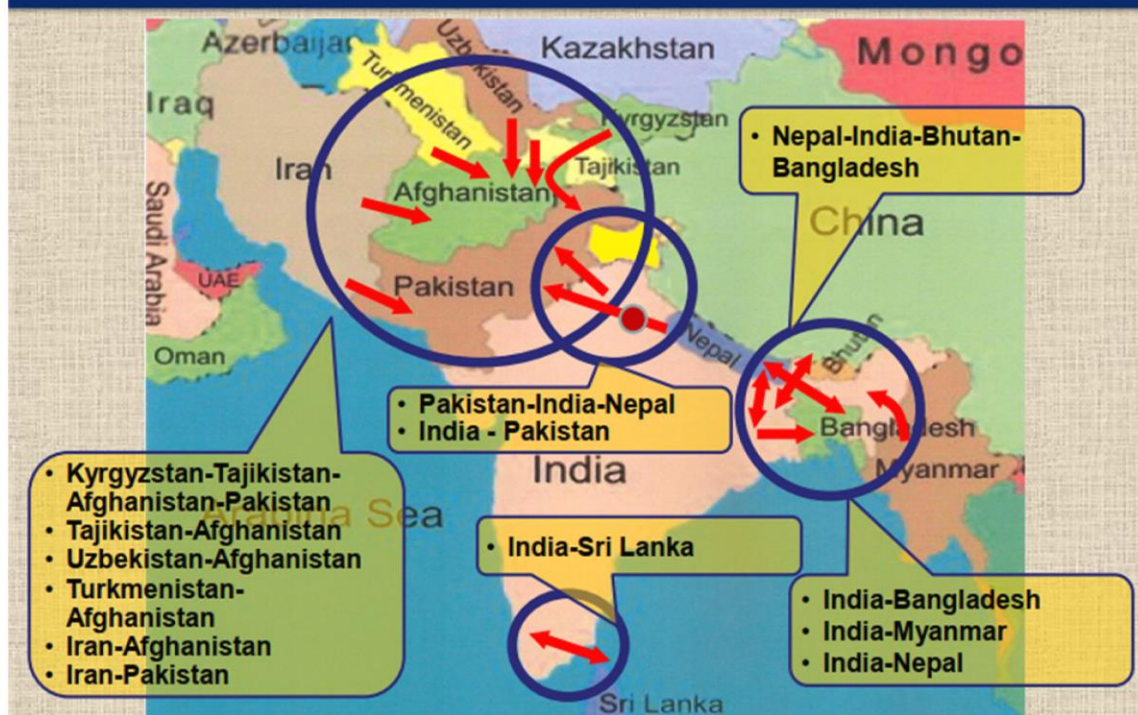
1. Middle East: Gulf Cooperation Council Interconnection Authority (GCCIA) including Bahrain; Kuwait; Oman; Qatar; Saudi Arab; and United Arab Emirates
2. European Network of Transmission System Operators for Electricity (ENTSOE)
3. Central Asian States and Pakistan (Afghanistan, Kazakhstan, the Kyrgyz Republic, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan) *under study*

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

3. SAARC Energy Ring



SAARC Energy Ring: Power Grid



Rationale for Cross Border Electricity Interconnections and Trade in South Asia

SAARC Energy Ring Power Interconnection Opportunities

Grid Interconnection	Capacity (MW)
India-Bhutan	2,100
India-Nepal	1,000
India-Sri Lanka	500
India-Bangladesh	Over 1,000
India-Pakistan	500
CASA 1000	1,000 (+300)

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

SAARC: Rationale for Regional Connectivity

1. **Utilizing**, optimally, electric power resources
2. **Developing** a strong economy with good jobs, modern infrastructure, proper social services
3. **Facilitating** clean power export revenues for the certain member states and by reducing electricity shortages in other member states
4. **Delivering** reliable, affordable electricity to parts of the world that need it in summer and winter
5. **Prompting** inter-regional cooperation, investments in social services, and encourage community benefit-sharing

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

4. Connecting Central Asia with South Asia: CASA-1000



Salient Features of the Project

1. Supplying surplus central Asian power in the summers (May to Sep) to Afghanistan (300 MW) and Pakistan (1,000 MW).
2. Confirmed delivery of 4,000 GWh of energy or above
3. A World Bank study declared CASA Project as viable and beneficial, despite the security risks in Afghanistan.
4. HVDC lines from Sangtuda in Tajikistan passing through Kunduz, Pul-i-Khumri, Kabul and Jalalabad in Afghanistan and end up in Peshawar.
5. Total length of transmission lines: 750 km - 16% would pass through Tajikistan, 75% through Afghanistan and 9% through Pakistan.

Existing and Proposed 500 kV Network



Rationale for Cross Border Electricity Interconnections and Trade in South Asia

CASA 1000: Scope

The CASA-1000 project consists of:

- 750 km 500 kV HVDC Transmission Line between Tajikistan and Pakistan via Afghanistan;
- Converter stations at Sangtuda (1000 MW), Kabul (300 MW) and Peshawar
- A 477 km 500 kV AC link between the Kyrgyz Republic (Datka) and Tajikistan (Khoujand)
- AC system upgrades on existing lines

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

CASA 1000: Potential Option

1. CASA-1000 will supply power in summer months (May to Sept).
2. For the remaining period countries have planned to use the CASA system under open access provision.
3. Pakistan has also offered Russian side to participate in the CASA System through open access regime for the effective utilization of the CASA system.
4. The CASA System is capable for reverse flow of Energy. Pakistan envisions to sell back the energy during winter months (low demand in Pakistan).
5. Project would pave the way for CASAREM (CASA Regional Electricity Market).

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

Current Status of CASA 1000 Project

1. Project COD: December 2022

2. Converter Station

- Land Acquisition process has been completed and Award has also been announced in favour of NTDC.
- **Boundary Wall:** The soil investigation for Boundary wall has also been completed and the results have been provided to M/S ABB and M/S Cobra for issuing the zero-reference level so that the same may be forwarded to NTDC Design team for boundary wall design
- **Transmittals Status:** CASA Documentation flow is based on ERP. All the project documents come in the form of Transmittal and RFI by official emails, which are finally uploaded to Docubin-software. 604 documents (75 Commercial, 529 Technical) have been received for the TW01 package in Pakistan, and 470 (67 commercial, 403 technical) of those have been responded.

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

Progress of Converter Station, Nowshera, Pakistan

1. Possession of land by NTDC is still under process (bottleneck).
2. Tender for Boundary Wall was opened on 14.1.2020 and evaluation is under preparation
3. Electrical design of the converter station – 70% approved.
4. Manufacturing of HVDC Converter transformers has started.
5. Civil works design of the converter station shall be submitted for approval in Feb. 2020
6. Preliminary Studies for site selection of electrode station completed, soil investigation for its electrical properties is in process subsequent to which land acquisition process shall start.
7. Tender document for the 500 kV Nowshera Grid Station is on sale. The tender shall be opened on 26.3.2020. The grid station shall be used for the evacuation of the AC power from the converter station.

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

5. My Scheme to Cope with the Power Sector Challenges



Coping with the Power Sector Challenges

1. Add cheap, clean MWs through indigenous resource and indigenous technology
2. Make and sustain the grid smart
3. Interventions for the low hanging fruit: Energy efficiency and energy conservation
4. Regional Inter-connections to cater shortage as well as surplus

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

My Vision on SAARC Initiatives

Domestic energy development and bilateral cooperation alone will not solve power crisis of South Asia.

Engagements have to be multi-lateral.



Rationale for Cross Border Electricity Interconnections and Trade in South Asia

6. Questions and Answers



For your Patience



Reshaping the Power Generation Mix for Sustainable Power Sector in Pakistan

CASA 1000: Cost and Funding

1. The estimated cost of the CASA-1000 Project is US \$1170 million including US \$208 million IDC and Taxes.
2. Most of the funding for the project is being provided by the World Bank.
3. Funding for the Afghan portion (Transmission Line and Converter Station) is fully secured while there is about 20% funding gap in other countries.
4. The gap is expected to be filled due to WB's serious commitment to the project.

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

CASA 1000: Energy and Tariff

1. Tariff is energy based (US Cents/kWh) on must run basis.
2. Hydrological risk is to be borne by the Sellers, i.e., have to deliver the guaranteed energy or pay LDs.
3. Purchaser will have to pay LDs if it does not off-take the energy
4. The tariff has 3 tiers:
 - P1 for the Min Guaranteed Quantity per annum;
 - P2: for Min Guaranteed Quantity for 5 yr block;
 - P3: for Excess Quantity
5. Total yearly energy committed by the Sellers vary between 4,072 to 4,434 GWh.

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

CASA 1000: Tariff Components

1. Transmission Charge Based on Actual Bid Cost & Agreed ROI (6%): Estimate: 3 Cents/kWh; Includes:
 - Kyrgyz T/L & Tajik T/L & Converter Station Costs
 - Afghan T/L cost
 - DC & AC Operators' cost
 - Reserve Fund
 - Tajik Transit fee payable on Kyrgyz energy
2. Energy Charge (Payable to Sellers): 5.15 Cents/kWh
3. Transit Fee {Payable to Afghanistan (1.25 Cents/kWh)}
4. Total tariff is US Cents: 9.3/kWh

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

CASA 1000: Capacity and Energy

1. CASA-1000 Transmission Line (T/L) to Nowshera would be capable of delivering 1300 MW.
2. 1000 MW is Pakistan's share and 300 MW is Afghanistan's share; however, the Afghan share may be available for Pakistan as Afghanistan may not need the power in near future).
3. Total capacity will be available for Pakistan and Afghanistan will get their share through separate line between Tajikistan and Afghanistan (2017).
4. However Pakistan will be obligated to take only 1000 MW while additional 300 MW will be optional.

Rationale for Cross Border Electricity Interconnections and Trade in South Asia

3. “Cross Border Trade of Electricity in SAARC Region” by Mr. Sher Singh Bhat, CEO, Kabeli Energy (Pvt.) Ltd., Nepal.



**X-BORDER TRADE OF ELECTRICITY
IN SAARC REGION**

Sher Singh Bhat

X-BORDER TRADE OF ELECTRICITY IS SPECIAL

S. No.	Particulars	Details
1.	Specific Nature of Electricity as commodity	▪ It is intangible commodity and cannot be checked at the custom point for custom clearance. ▪ It cannot be stored and has to be consumed at the moment it is generated. ▪ It needs a hard wire connection from generation to point of consumption.
2.	Item list of general trade agreements exclude electricity due to its specific nature.	▪ Typical Agreement/s between/among the countries for X- Border trading of electricity.
3.	Pre-requisites for X- border trade of electricity	▪ Separate bilateral, sub-regional, regional agreement/s for X- Border trade of electricity ▪ Agreed market mechanism (rules) by trading countries ▪ Requisite transmission fabric of hardwires

WHY DO STATES WISH X-BORDER TRADE OF ELECTRICITY?

OBJECTIVE - 1

- Balancing (managing surplus and deficits) the TOD and seasonal demand and supply in the national power systems of SMS.
- Trading in relatively small volumes, short term nature

OBJECTIVE - 2

- Harness the energy sources available as comparative advantage in SMS for export of electricity and attain economic growth through it.
- Trading intended for relatively larger volumes, long term.

OBJECTIVE - 3

- Take advantage of price arbitrage in two national markets

X-BORDER TRADING OF ELECTRICITY AMONG SMS: STATUS

- Currently Bhutan, Bangladesh & Nepal having X-border transaction of electricity with India.
- But this transaction is mostly under G2G facilitation.
- Most power transactions with India are routed through Indian public sector trader (NVVN).
- India have demonstrated strong preference to bilateral G2G for X- border transaction of power.
- Transaction between any other two countries needs use of Indian transmission system.
- But SMS have not been successful to garner this support from India.
- So level of X-Border trading of electricity in SAARC Region is not up to mark.
- Indian preference for bilateral G2G impeding electrically interconnected SAARC region as a whole.

INITIATIVES TO ENHANCE ELECTRICITY TRADE AMONG SMS

Despite poor regional connectivity and trading of electricity, initiatives undertaken in following 4 directions to enhance level of electricity trade among SMS:

1. Regional and Bilateral Agreements for energy cooperation and trade of electricity.
2. Development of requisite X- Border Infrastructure for connectivity and trade.
3. Ramification of domestic systems of SMS to adapt X-border power trade.
4. Regional and bilateral instruments to gear up connectivity and trade through frequent communications.

AGREEMENTS FOR ENERGY COOPERATION AND TRADE OF ELECTRICITY

- **At Regional Level**
 - SAARC Intergovernmental Framework Agreement on Energy Cooperation
- **At Bilateral Level**
 - Umbrella Agreement on cooperation between India and Bhutan
 - Power Trade Agreement between Nepal and India
 - Agreement between Bangladesh and India for cooperation

DEVELOPING REQUISITE X- BORDER INFRASTRUCTURE TO FACILITATE TRADE

- **Between India and Bhutan:**
 - Tala – Kholga - Binnagurhi- New Siligurhi 400 kV D/C line in operation
 - Tala – Pagli / Malbase – Binnagurhi – New Siligurhi 400 k V D/C Line in operation
- **Between India and Nepal :**
 - Muzaffarpur-Dhalkebar 400 k V line in operation but still in radial mode
- **Between Bangladesh and India :**
 - Behrampur –Bheramaara 400 k V DCBTB in operation
- **Between India and Sri Lanka:**
 - Madurai – Anuradhapura +/- 400 k V HVDC Bi-pole including Dhanushkodi - Talaimannar submarine cable. Still at conceptual level.

RAMIFICATION OF DOMESTIC SYSTEMS TO ADAPT X-BORDER POWER TRADE

- **Amendments in domestic regulations**
 - MOP(GOI) Memo dated Dec 18, 2018 on X-Border imports.
- **Reinforcements of domestic infrastructure**
 - Reinforcement in Muzaffarpur Substation (India) and related transmission lines to facilitate the power flow through Muzaffarpur-Dhalkebar 400 k V line.

But these reinforcements are not sufficient.

INSTRUMENTS TO ACCELERATE CONNECTIVITY AND TRADE

• **Regional Level**

- SAARC Energy expert Group: has not been effective

• **Bilateral level**

- Joint Steering Committees, Joint Working Group, Joint Technical Committee formed under the respective bilateral agreements

• **Domestic Level**

- Domestic Task forces have been formed to support the bilateral and regional working groups.

It has been observed that bilateral instruments have been functional but the regional instruments are almost defunct.

REASONS FOR POOR CONNECTIVITY AND TRADING AMONG SMS

1. Geographical proximities not supportive for X-Border Trade

- Except Afghanistan, all SMS have common border with India.
- No other countries have common borders except Pakistan and Afghanistan.
- India is at the King Pin position for X-Border Trade of Electricity among SMS

2. Infrastructure

- Certain X-border infrastructure has been developed between India and other few countries in last few years to facilitate bilateral trade with India.
- But this also does not facilitate third country trade or regional trade.

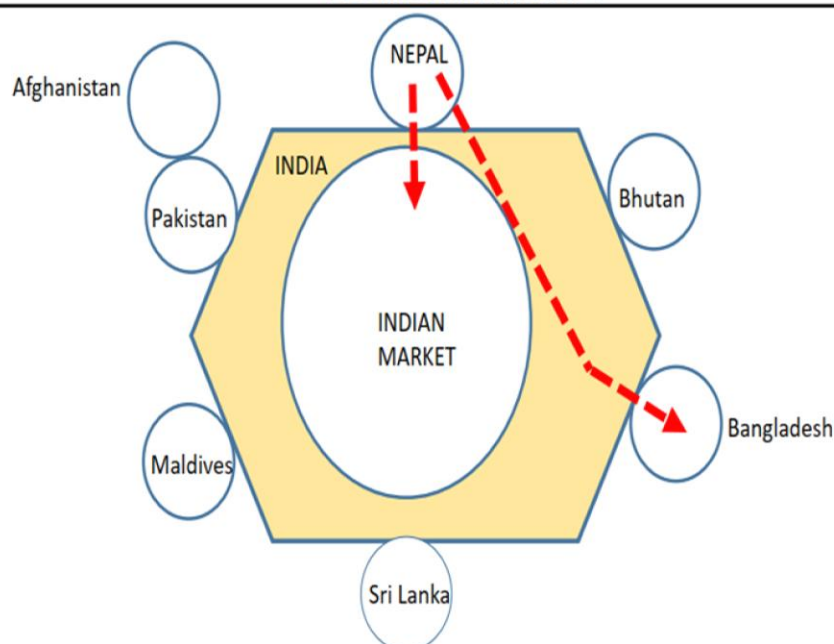
3. Careful Indian Move

- India has been treating electricity as strategic commodity with its neighbors.
- For that reason India has strong preference over bilateral trade in G2G model.
- India has been ring fencing its domestic market through internal regulations allowing limited access to selected SMS to it and that also through G2G facilitation.

4. Geo-political Relations Factor

- Indo-Pakistan geo-political relations are not supportive to regional trade of electricity.
- Indian bidders (service providers or developers) in negative list in international bids in Pakistan.
- India seemingly adopts bilateral G2G option to reciprocate it in electrical connectivity and trade.

GEOGRAPHICAL PROXIMITIES NOT SUPPORTIVE FOR X-BORDER TRADE



INCONSISTENT INDIAN POLICIES

Event	Details	Remarks
Indian Import Policy 2009-2014	Classified electricity as import restricted item	Market concealed for import
SAARC summit in 2011	Signed SAARC IGFA on Energy cooperation but remained reluctant to gear it up	Positive signal but pull back in action
Indian Import Policy 2014-2019	Excluded electricity from the list of import restricted item	Positive signal
Indo-Nepal Power Trade Agreement 2014	India signed Power Trade Agreement with Nepal in 2014 but remained reluctant to actually implement it.	Positive signal but pull back in action
Increased export to Nepal through 400 k V D-M line	Volume of export to Nepal increased but all export routed through NVVN intercepting the export through PTC in past.	Only G2G model
MOP (GOI) Memo of December 18, 2018	These internal guidelines seemingly allowing export of power by neighboring countries to India and to third market through Indian Grid	Seems push forward
Union Budget 2020	Imposed BAT on import of electricity in India	Push back

MY CONCLUDING IMPRESSION

- Selected SMS already making power transaction with India under bilateral G2G arrangement using this opportunity for objective no. 1 i.e. balancing the system.
- India is moving very carefully on opening its domestic market to neighboring SMS. A good experience and comfortable situation on bilateral G2G transactions may lead to third country transactions among selected/limited SMS in future.
- Once India agrees to provide its transmission system for third country transactions of selected/limited SMS in practical terms, such SMS can exercise objective no.2 i.e. harnessing the resources for economic growth.
- With these two experiences, India might open its domestic market to selected/limited SMS and then trading for third objective i.e. price arbitrage may be realized.
- But SAARC Regional Power Exchange, SAARC Regional Electricity Market, SAARC Regional Grid have been and may remain as a good academic exercises for long time in future also unless there is dramatic change in geopolitical relations among SMS. Although trading among selected limited SMS may grow in accordance with Indian preference but very slowly.

THANKS

4. “Regional Markets: A Key Innovation in the Global Energy Transition” by Ms. Elena Ocenic

Programme Officer, International Renewable Energy Agency (IRENA), Germany



Regional markets

A key innovation in the global energy transition

Elena Ocenic
Webinar on Cross-border Electricity Trade in SAARC Countries, 9 March 2020

Agenda

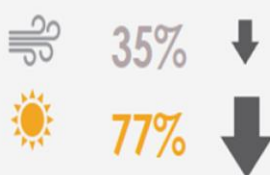


- 1. IRENA's systemic innovation approach for the energy transition**
- 2. Regional markets**
- 3. Pan-European electricity market**

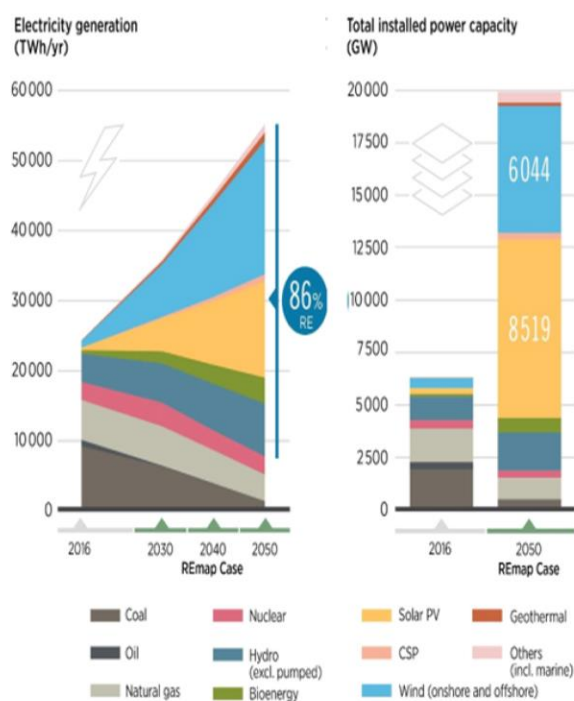
1. IRENA's systemic innovation approach for the energy transition

Wind & solar PV at the core of the energy transition

Cost reduction
2010 – 2018



Onshore wind & solar PV share in
generation mix (2018 vs. 2050)



Sources: IRENA (2019), Global energy transformation: A roadmap to 2050, IRENA (2019), Renewable Power Generation Costs in 2018

Innovation knowledge products

Innovation Landscape Report for wind & solar PV integration + 30 Innovation Landscape Briefs

+ Swedish innovation case study

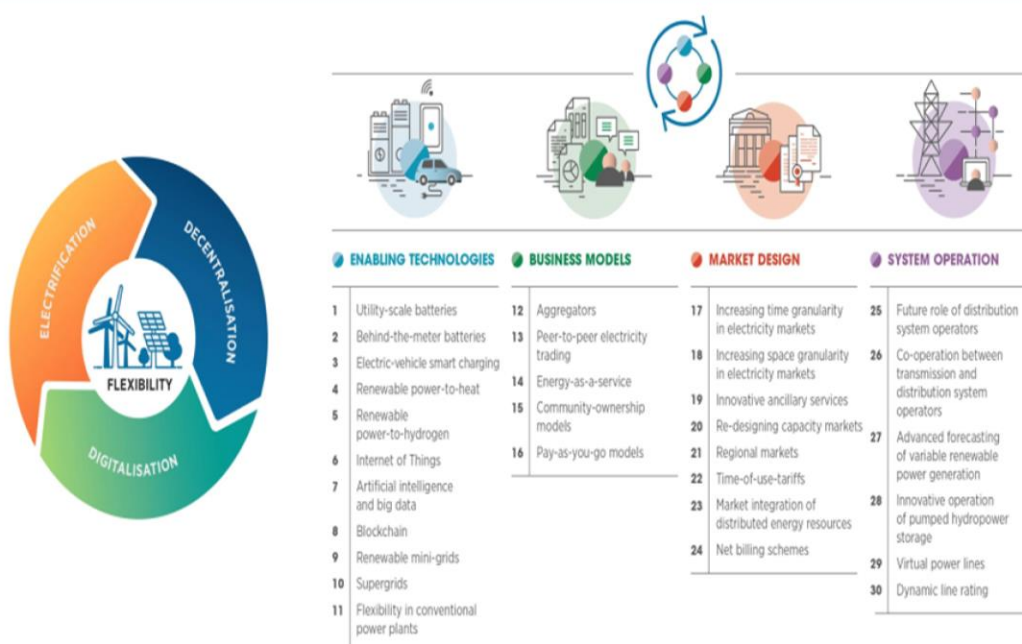


Sources:

IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables
IRENA (2020), Innovative solutions for 100% renewable power in Sweden

5

30 key innovations for wind & solar PV integration

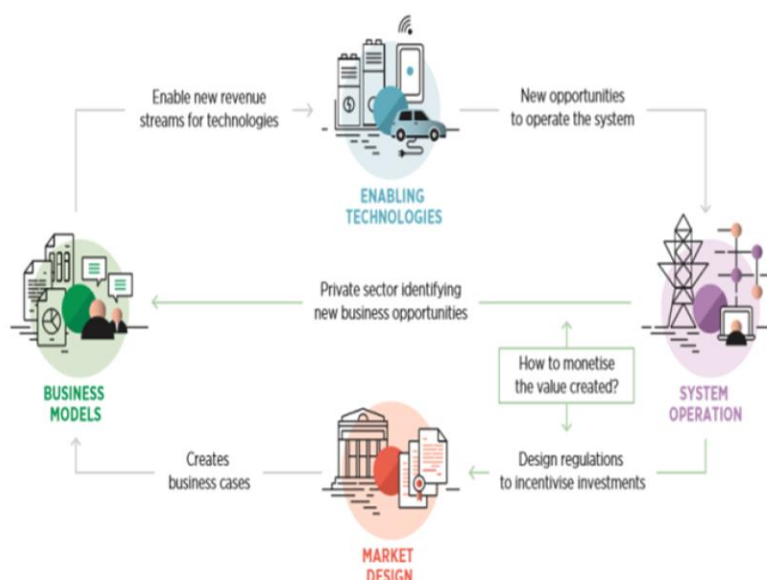


Sources: IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

6

Systemic innovation approach

SYSTEMIC INNOVATION IS NEEDED
FOR AN INTEGRATED RENEWABLE ENERGY SYSTEM



Source: IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

7

Solutions are combinations of innovations



SUPPLY-SIDE FLEXIBILITY SOLUTIONS	GRID FLEXIBILITY SOLUTIONS	DEMAND-SIDE FLEXIBILITY SOLUTIONS	SYSTEM-WIDE STORAGE FLEXIBILITY SOLUTIONS
I Decreasing VRE generation uncertainty with advanced generation forecasting	III Interconnections and regional markets as flexibility providers	VI Aggregating distributed energy resources for grid services	X Utility-scale battery solutions
II Flexible generation to accommodate variability	IV Matching RE generation and demand over large distances with Supergrids	VII Demand-side management	XI Power-to-X solutions
	V Large-scale storage and new grid operation to defer grid reinforcements investments	VIII RE mini-grids providing services to the main grid	
		IX Optimising distribution system operation with distributed energy resources	

11 solutions explored in depth in the report, including advice on their suitability and impact.

Source: IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

8

Interconnections & regional markets as flexibility provider



Source: IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

9

2. Regional markets



10

Different levels of regional market integration

Market integration level	Interconnectivity level	Trading arrangements	Harmonisation rules
Early stage of market integration	Physical interconnection between two countries	Long-term, bilateral, over-the-counter (OTC) ³ power purchase agreements (PPAs)	Simple rules agreed for the operation of the interconnected system
Shallow market integration	Physical interconnection between several neighbouring countries	Long-term PPAs supplemented with short-term wholesale markets	Harmonisation of market rules, grid codes, and transmission tariffs
Deep market integration	Full synchronous operation of a multi-country interconnected system	Well-functioning markets with competition achieved through trading in different timeframes and various markets (OTC vs. power exchanges, capacity vs. power markets, day-ahead vs. intraday markets, etc.)	Regional regulatory agencies, regional market operators and harmonisation of market rules, grid codes, and transmission tariffs



Source: IRENA (2019), Innovation landscape brief: Regional markets

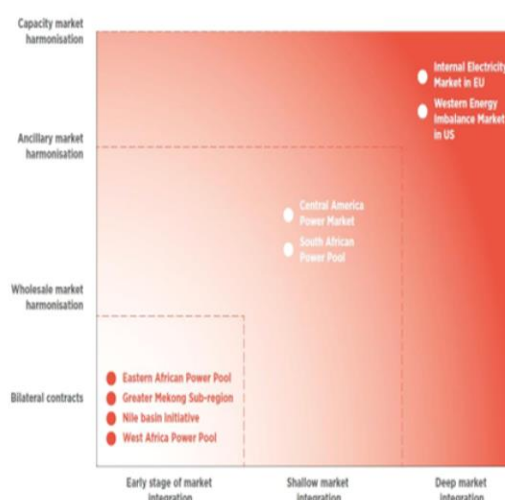
11

International examples

Regional market	Participating countries/systems	Year of establishment
Central America Power Market ¹	6 countries: Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama	2013
European Union ¹	23 countries (day-ahead market): Austria, Belgium, the Czech Republic, Germany, Denmark, Estonia, Finland, France, Great Britain, Hungary, Italy, Lithuania, Latvia, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Spain, Slovenia, Slovakia and Sweden 14 countries (intraday market): Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Latvia, Lithuania, Norway, the Netherlands, Portugal, Spain and Sweden	1990s (NordPool was created) 2018 (XBID Project - intraday market)
Eastern Africa Power Pool ¹	10 countries: Burundi, the Democratic Republic of Congo (DRC), Egypt, Ethiopia, Kenya, Rwanda, Tanzania, Libya, Uganda and Sudan	2005
Greater Mekong Sub-region ¹	6 countries: Kingdom of Cambodia, Guangxi Zhuang Autonomous Region and Yunnan Province of the People's Republic of China (PRC), Lao People's Democratic Republic (Lao PDR), Union of Myanmar, Kingdom of Thailand and the Socialist Republic of Viet Nam	1995
South African Power Pool (SAPP) ¹	12 countries: Angola, Democratic Republic of Congo (DRC), Tanzania, Malawi, Zambia, Zimbabwe, Mozambique, Swaziland, South Africa, Lesotho, Namibia, Botswana	1995
Western Energy Imbalance Market (EIM), United States ¹	8 active members: Idaho Power Company, Powerex, Portland General Electric, Puget Sound Energy, Arizona Public Service, NV Energy, PacifiCorp, CAISO and Balancing Authority of Northern California/SMUD	2014

Sources:

1. Navarete (2016)
2. ENTSO-E (2018C)
3. The Eastern Africa Power Pool (2016); Olingo (2018)
4. Asian Development Bank (2016)
5. SAPP (2016)
6. Westerneim (2019)



Source: IRENA (2019), Innovation landscape brief: Regional markets

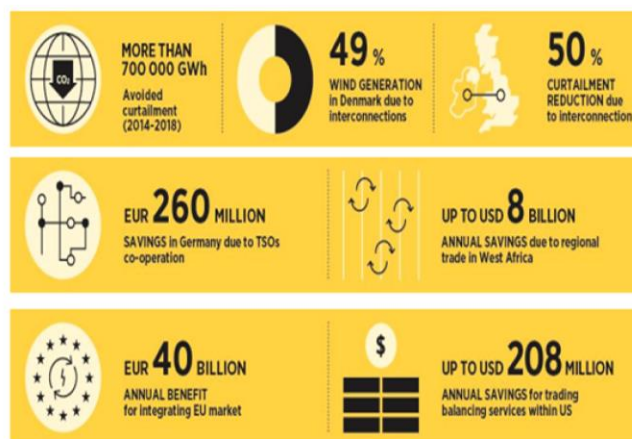
12

Impact of regional markets for wind & solar integration



BENEFITS

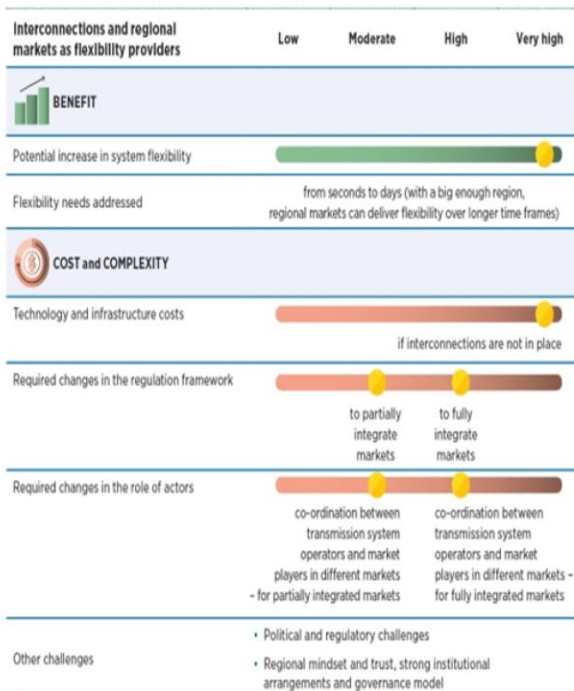
- Increased flexibility through expanding balancing area
- Advantages of spatial complementarity of VRE generation
- Co-ordinate generation planning
- Reduce system operation cost



Sources: IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

13

Costs, benefits & complexity for the implementation



KEY ENABLING FACTORS

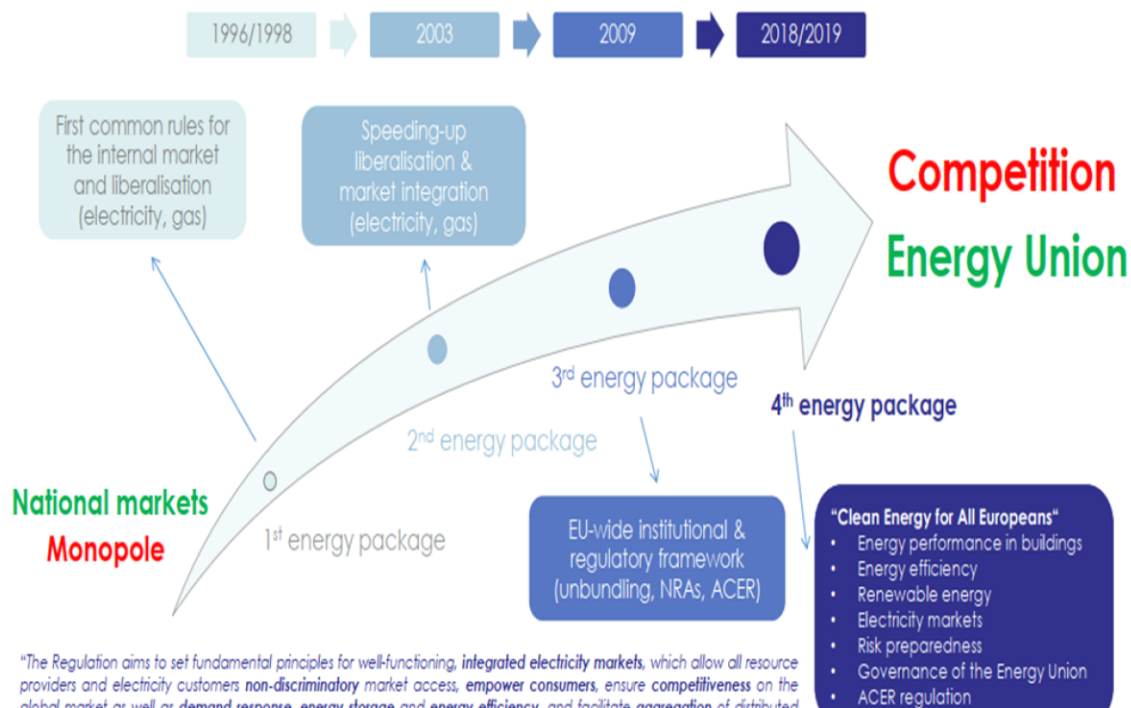
- Physical interconnections with sufficient capacity
- Regional mindset, strong institutional arrangements and governance model
- Robust IT system for market operation

Sources:
IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables
IRENA (2019), Innovation landscape brief: Regional markets

14

3. Pan-European electricity market

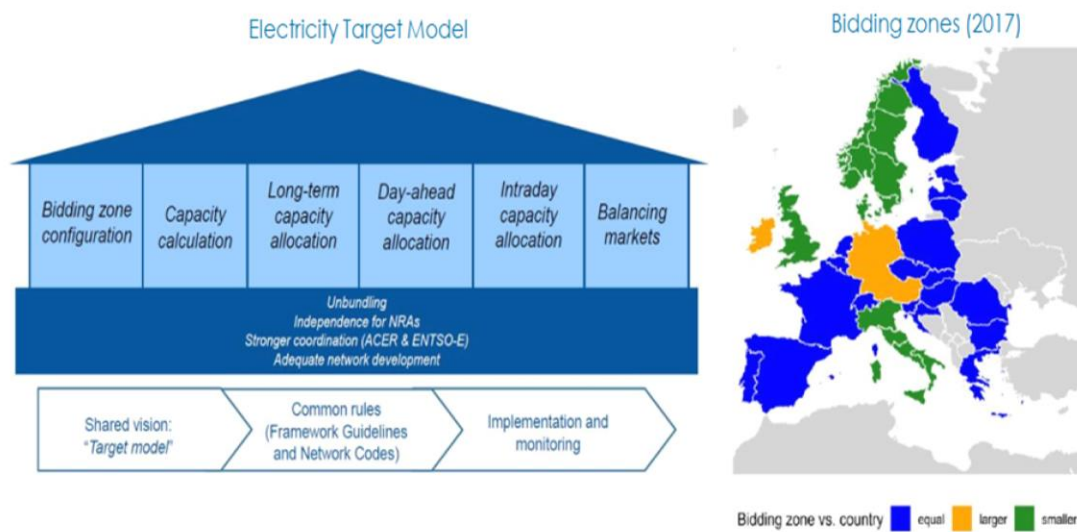
Policy context



Reg. 2019/943 on the internal market for electricity

16

Overview of the Internal Energy Market



„Efficient decarbonization of the electricity system via market integration requires systematically **abolishing barriers to cross-border trade** to overcome market fragmentation and to allow th Union energy consumers to fully benefit from the advantages of integrated electricity markets and competition.“

Reg. 2019/943 on the internal market for electricity

Source: IRENA – Energy Community Joint Workshop on Grid Integration of Variable Renewable Energy Sources, 7 November 2018

17

Implementation status in the EU...

Day-ahead market coupling 26 countries

Austria, Bulgaria, Belgium, Croatia, the Czech Republic, Germany, Denmark, Estonia, Finland, France, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, the Slovak Republic, Slovenia, Spain, Sweden, UK



Intraday market coupling 21 countries

Austria, Belgium, Bulgaria, Croatia, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Latvia, Lithuania, Norway, the Netherlands, Poland, Portugal, Romania, Slovenia, Spain, Sweden



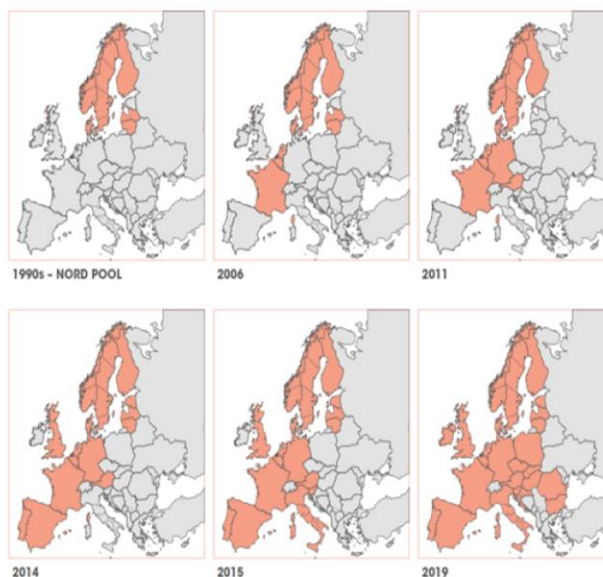
Source: ACER (2019), Market Monitoring Report, Electricity Wholesale Markets Volume

■ Coupled ■ Not coupled

18

...achieved gradually over time

Gradual integration of the European regional wholesale market (day-ahead timeframe)

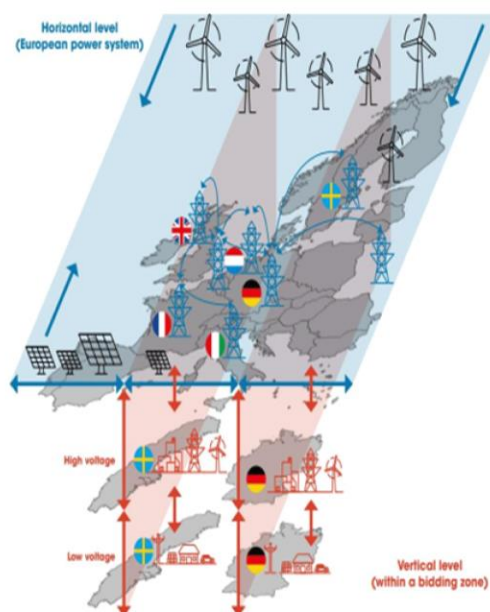


Sources: IRENA (2020), Innovative solutions for 100% renewable power in Sweden

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Cooperation, interconnection & harmonization levels

Horizontal and vertical dimensions of the interconnected European power system



Source: Adapted from IEA-ESG, 2019

Disclaimer: Boundaries and names shown on this map do not imply any endorsement or acceptance by IRENA.

Sources: IRENA (2020), Innovative solutions for 100% renewable power in Sweden

20

Benefits include trades between non-adjacent borders



Share of total traded volumes in intraday markets in Europe (2017-2018)



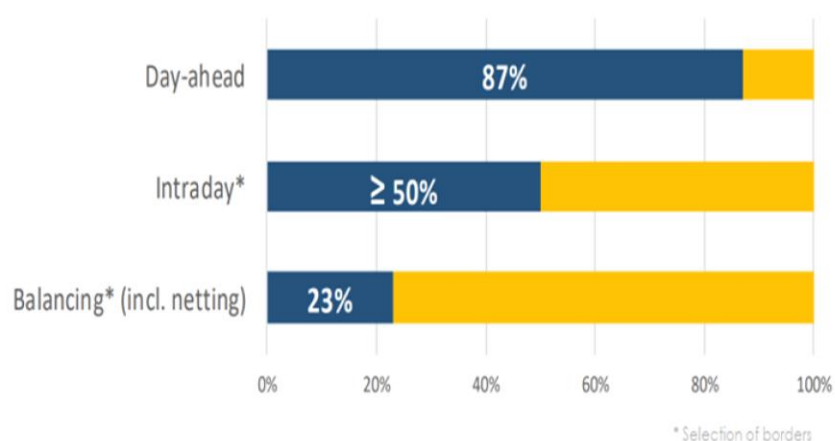
Source: ACER (2019), Market Monitoring Report, Electricity Wholesale Markets Volume

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Various degrees of economic efficiency observed



Efficient use of interconnectors in various timeframes, 2018 (%)

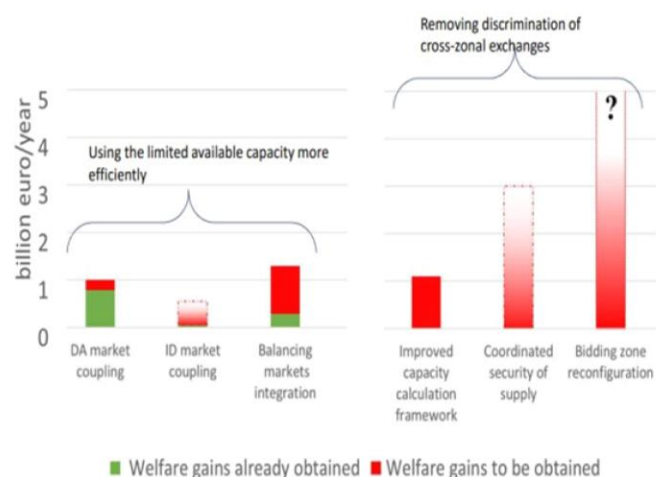


Source: ACER (2019), Market Monitoring Report, Electricity Wholesale Markets Volume

22

Social welfare gains still to be obtained

Social welfare benefits obtained and to be obtained from actions to increase European market integration



Source: ACER (2019), Market Monitoring Report, Electricity Wholesale Markets Volume

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4. References

New webinar series



#IRENAinsights

Tuesday, 17 March 2020, 10:00–10:30 CET

***"Innovations for 100% renewable power:
a systemic approach"***

Registration:

<https://www.irena.org/renewables/Knowledge-Gateway/webinars/2020/Jan/IRENA-insights>

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Save-the-date



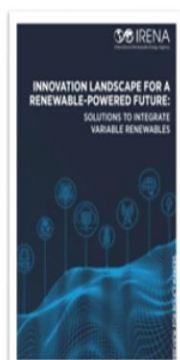
IRENA INNOVATION WEEK 2020

**8-10 September 2020
Bonn, Germany**

<https://www.irena.org/events/2020/Sep/IRENA-Innovation-Week-2020>

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Selection of further reading



- IRENA (2019), Innovation Landscape for a renewable-powered future: *Solutions to integrate variable renewables*: [Link](#)
- IRENA (2019), Innovation Landscape Briefs:
 - ✓ Market design briefs: [Link](#)
 - Regional markets: [Link](#)
 - ✓ Enabling technologies: [Link](#)
 - ✓ Business models: upcoming
 - ✓ System operation: upcoming
- Innovative solutions for 100% renewable power in Sweden: [Link](#)

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Thank you very much for
your attention!

EOcenic@irena.org
www.irena.org

5. “Cross Border Electricity Trade in SAARC Region: Current Status & its Future Outlook”

by Mr. Rajiv Ratna Panda

Head Technical, South Asia Regional Initiative for Energy Integration (SARI/EI), India.



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



Contents

- 01** → Marco Economic Growth & Economic Integration
- 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

SARI/EI

En



Integrated Research and
Action for Development



Conf. Boreo-Eur. Acad. Sci. 2023, 10(1): 10. <https://doi.org/10.2478/2541-7671.100001>

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**SARI/EI**

Integrated Research and
Action for Development

The infographic displays population and GDP data for various world regions and countries in 2019. It uses a vertical flow layout with icons representing each entity and arrows indicating the flow of data. The population data is on the left, and the GDP data is on the right, both measured in US dollars.

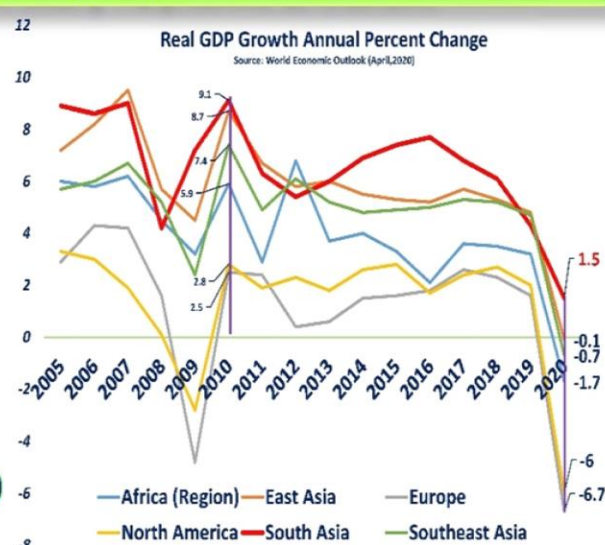
Entity	Population (Billion)	GDP (Trillions of U.S. dollars)
World	7.5	-
USA	-	21.43
China	-	14
Japan	-	5.15
Germany	-	3.8
South Asia	-	3.66
India	1.35	2.9
EU	0.51	2.7
UK	-	2.7
US	-	0.32

Data Source: World Bank Data base

Source: IMF - World Economic Outlook

Data Source: World Bank Data base

Source: IMF, World Economic Outlook, October 2004.



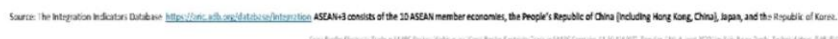
Source: IBS, *World Economic Outlook* (June 2006). <http://www.imf.org/external/relations/press/2006/060106.htm>

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

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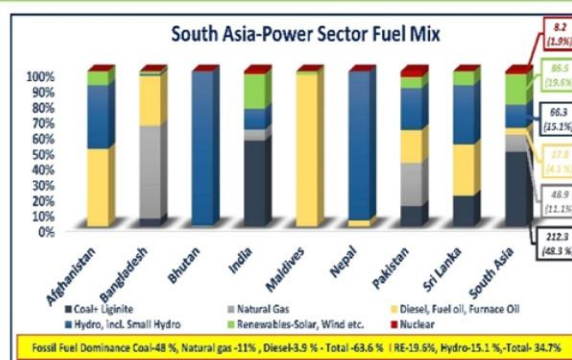
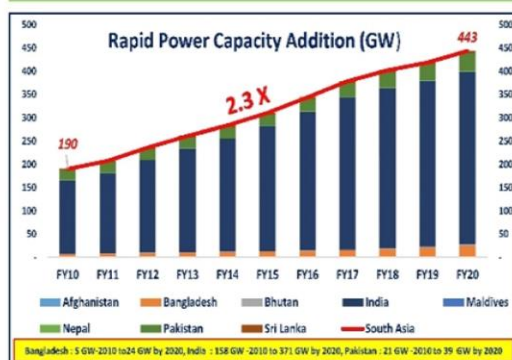
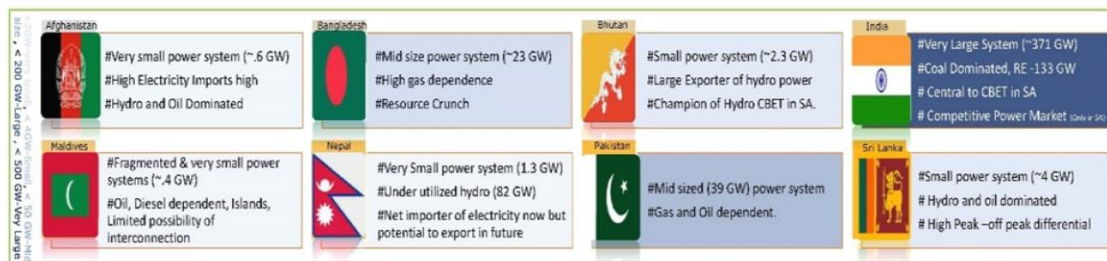
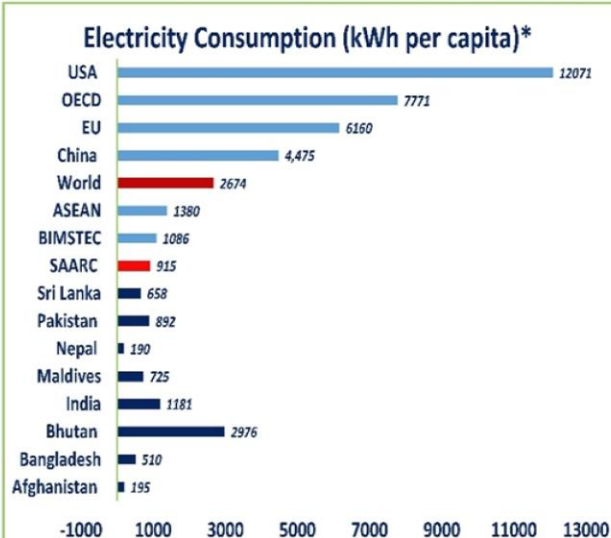
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Conflicts of Interest: The authors declare no conflict of interest.

 Integrated Research and
Action for Development

Sustainability Ranking -The Sustainable Development Report 2020						
	2020 SDG Index Score	2020 SDG Index Rank	SDG-7: Affordable & Clean Energy	SDG 7 :Trend: Affordable & Clean Energy	SDG-6 : Clean Water and Sanitation	SDG-6 :Trend : Clean Water and Sanitation
Country						
Bhutan	69.27	80	yellow		red	
Maldives	67.59	91	green		orange	
Sri Lanka	66.88	94	red		red	
Nepal	65.93	96	red		red	
Bangladesh	63.51	109	orange		red	
India	61.92	117	red		red	
Pakistan	56.17	134	red		red	
Afghanistan	\$4.22	139	orange		red	
green	Goal Achievement				On track or maintaining achievement	
yellow	Challenges remain				Moderately Increasing	
orange	Significant challenges				Stagnating	
red	Major challenges				Decreasing	

Note: Highest Score: Sweden(84.7), Total Countries covered: 166. Sources: Sachs, J., Schmidt-Peeters, G., Kroll, C., Laforêt, G., Fuller, G., Wiedt, P. (2020). The Sustainable Development Goals and SDG 7. Sustainable Development Report 2020. Climate Change Cash/Climate Change Press.

* Compiled from various Sources. For Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan data is for year 2018, 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.

Note: Highest Score-Sweden (84.7), Total Countries covered 166, Citations Sachs, J., Schmidt-Traub, G., Kroll, C., LeFortune, G., Fuller, G., Woelzl, F. 2010. The Sustainable Development Goals: a new 2030 Agenda. 2010. Sustainable Development Goals: 2030. Cambridge: Cambridge University Press.

Low Per Capita Electricity Consumption, Affordable and Clean Energy Challenge

Cons. Border Effects on Trade in 1648C Region: World and 17 Core Region: Excludes Trade in 1648C Coast (see 1. V. 134-135). *Appendix 1* (14 Aug. 2022) in *Reinforcing the Case*. Teal and red in 1648C B&W.

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~ South Asia CBET 2.6 X

Annual CBET Values:

Year	CBET (MW)
2014	7705
2015	9379
2016	10681
2017	12304
FY18	12809
FY19	13146
FY20	15672

Cumulative CBET Values:

Year	Cumulative CBET (MW)
2012	~1400
2015	~2126
2018	~2986
2020	~3760*

Regional Breakdown (2020):

- India-Bangladesh: ~1160 MW
- Bhutan-India: ~2100 MW
- Nepal-India: ~500 MW

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bioRxiv preprint doi: <https://doi.org/10.1101/2020.06.01.299000>; this version posted June 1, 2020. The copyright holder for this preprint (which was not certified by peer review) is the author/funder, who has granted bioRxiv a license to display the preprint in perpetuity. It is made available under aCC-BY-NC-ND 4.0 International license.



CBET Outlook 4



Transitioning from Bilateral to Trilateral CBET



Renewable Energy based CBET



Commercial form of CBET



Regional Power Market Development & Market Integration

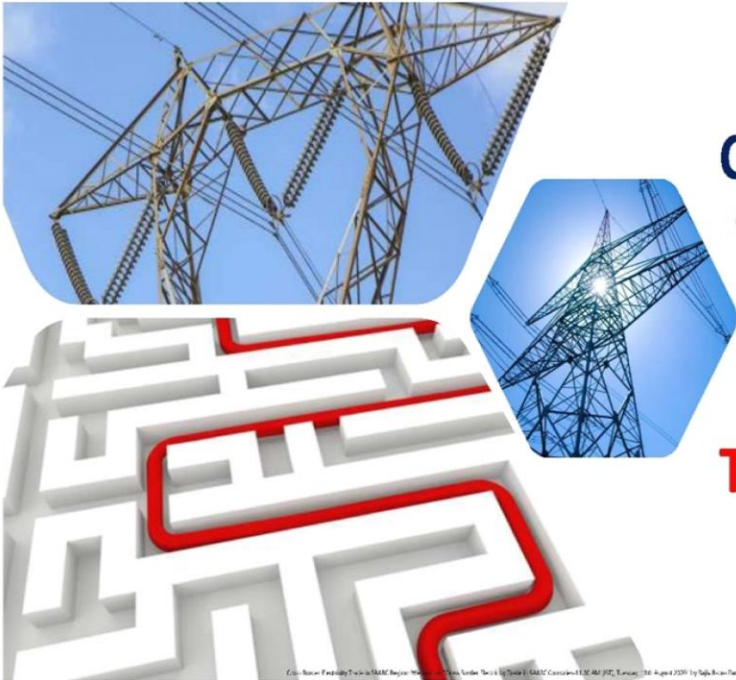


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CBET Outlook -1

Transitioning from Bilateral to Trilateral CBET

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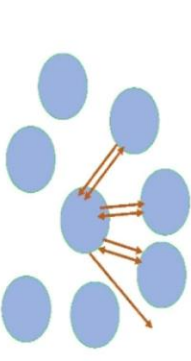
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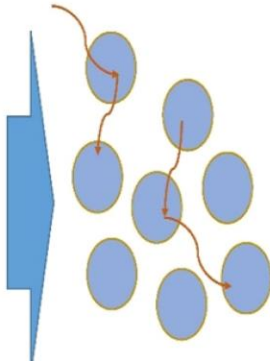


Integrated Research and
IRADe Action for Development

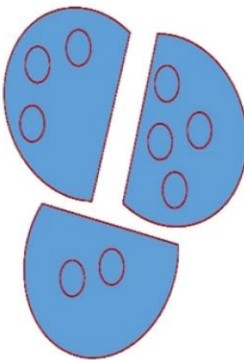
Power system Integration evolution across the Globe



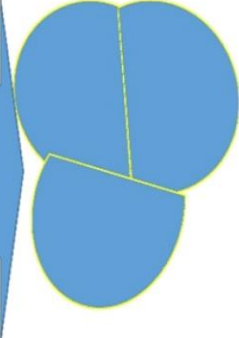
Establishing
Bilateral
connections ,
bilateral market



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

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(DPR under preparation)

(The DPR of the project approved by RGoB)

(Price Negotiation is Concluded, Discussion on transmission is under discussion)



²² Power System Master plan 2016 (Final) (<https://powerdivision.gov.bd/site/page/56ee6326-cc08-483e-b047-13e681de8820/Power-System-Master-Plan-2016>)

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CBET Outlook-2

Renewable Energy based CBET



Crystalline Fracture Traction in GPEC Polymer Matrix on Glass Surfaces: A Study by Traction GPEC Crystallization (1.3C-400-202), January 11, 2023. By: David Brown-Peterson, davidbrown@uconn.edu (GPEC/10146)

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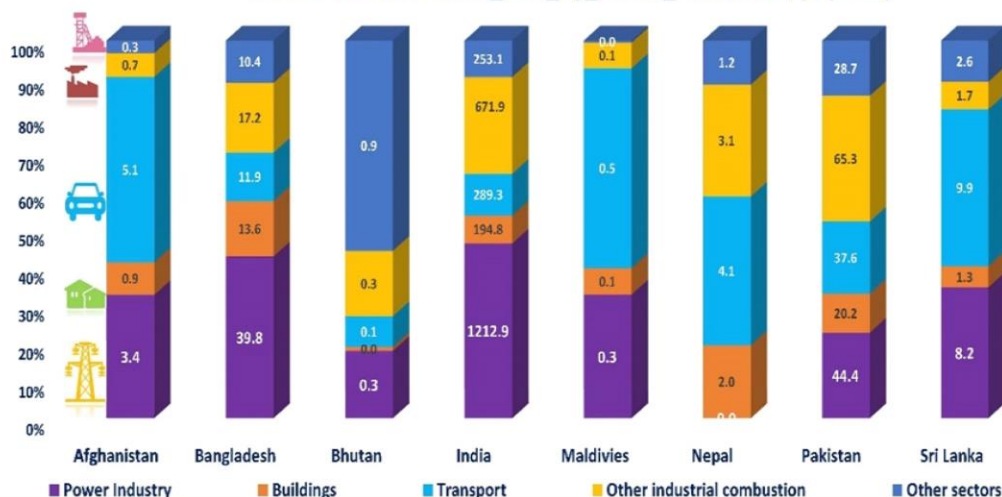


SARI/EI



South Asia-Significant Environment/Climate Change Challenge

SAARC Countries-fossil_CO2_by_sector_in Mt CO2/yr (2018)



South Asia : Vulnerable to adverse impacts of climate change, De-Carbonising the Power Sector is crucial.

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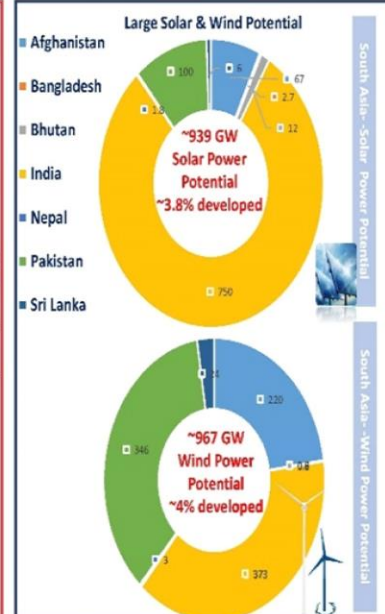
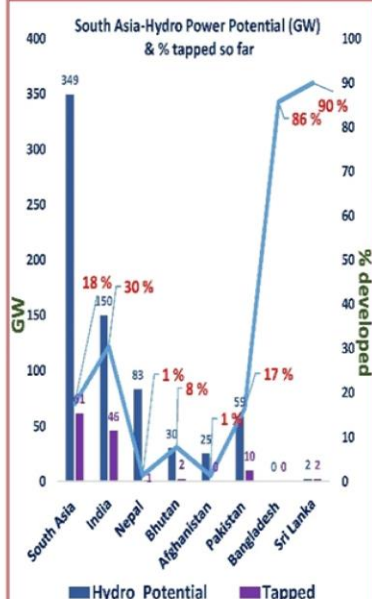
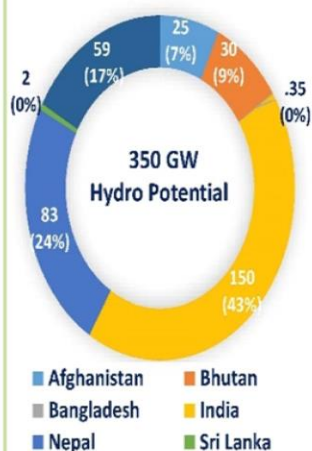


SARI/EI



South Asia-Large Renewable Energy Potential

South Asia Hydro Power Potential in GW (%)

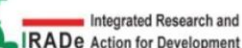


South Asia : Large Renewable Energy Resource within the Region-Potential for clean energy transition, sustainability & energy security

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ONE WORLD.
ONE SUN.
ONE GRID.



Cross-Sectional Study in SLAMC Senior High School on Young People's Placental Tissue - SLAMC Cross-section: 30.4M (ST), December 8th, 2007 by Bodo Eder, Berlin Technical School of ASH of SHS

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South Asia : Commercial form of Cross Border Electricity Trade



Initially all CBET, G-G negotiated tariff



Comm. CBET
2010-0 MW, 2020-1266 (~33%*)



Commercial approach brings business value



Competition, better price discovery



Foster mindset change, will help to transit to market

Commercial CBET

2020
1226
MW

2010
0
MW

Country	Source	Type	Trader	Tenure Years
Bhutan- India (~2262 MW) G-G-2136 Comm-126	1020 MW Tala	G-G	PTC	35
	336 MW Chhukha	G-G	PTC	
	60 MW Kurichhu	G-G	PTC	
	720 MW Mangdechhu	G-G	PTC	
	126 MW Dagachhu	Commercial	TPTCL	25
India – Bangladesh (~1160 MW) G-G-410 Comm-790	250 MW NTPC	G-G	NVVNL	25
	160 MW Tripura	G-G	NVVNL	5
	250 MW Market	Commercial	PTC	3
	500 MW Market	Commercial	NVVNL/ Sembcorp	15
	40 MW Market	Commercial	PTC	2
India-Nepal (~587 MW) G-G-237 Comm-350	237 MW India	G-G		Long Term
	80-190 MW Market	Commercial	PTC/NVVNL	---
	160 MW Market	Commercial	NVVNL	Renewed Every year

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

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CBET Outlook -4

Regional Power Market Development & Market Integration

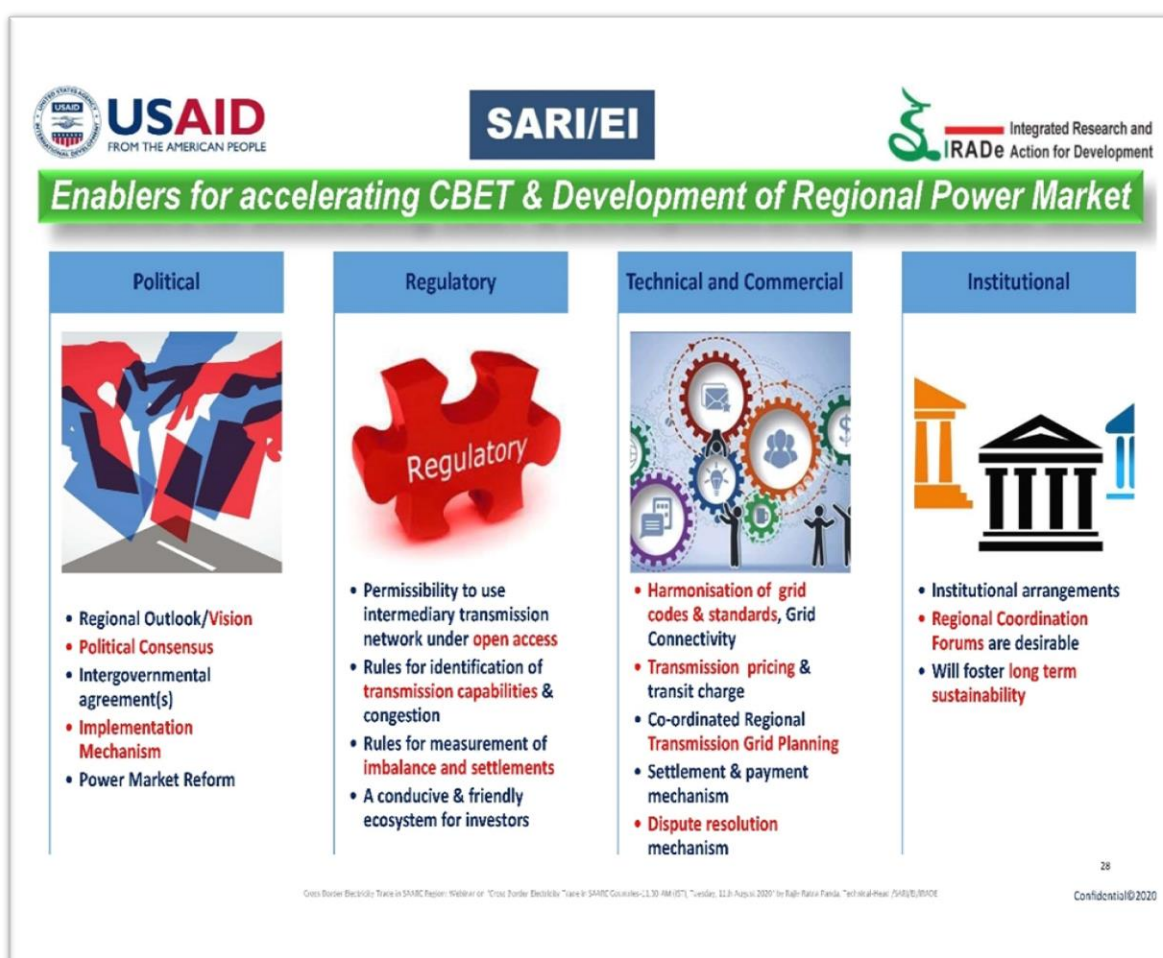
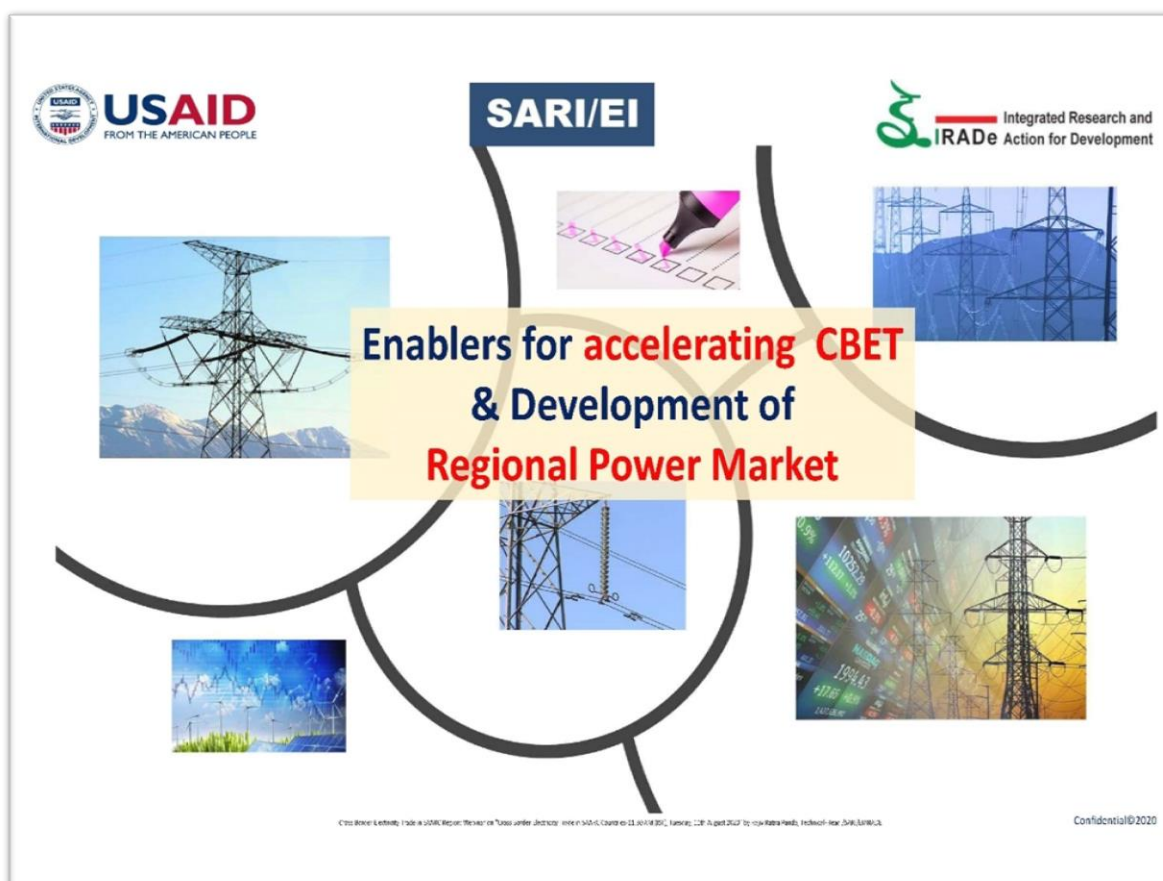


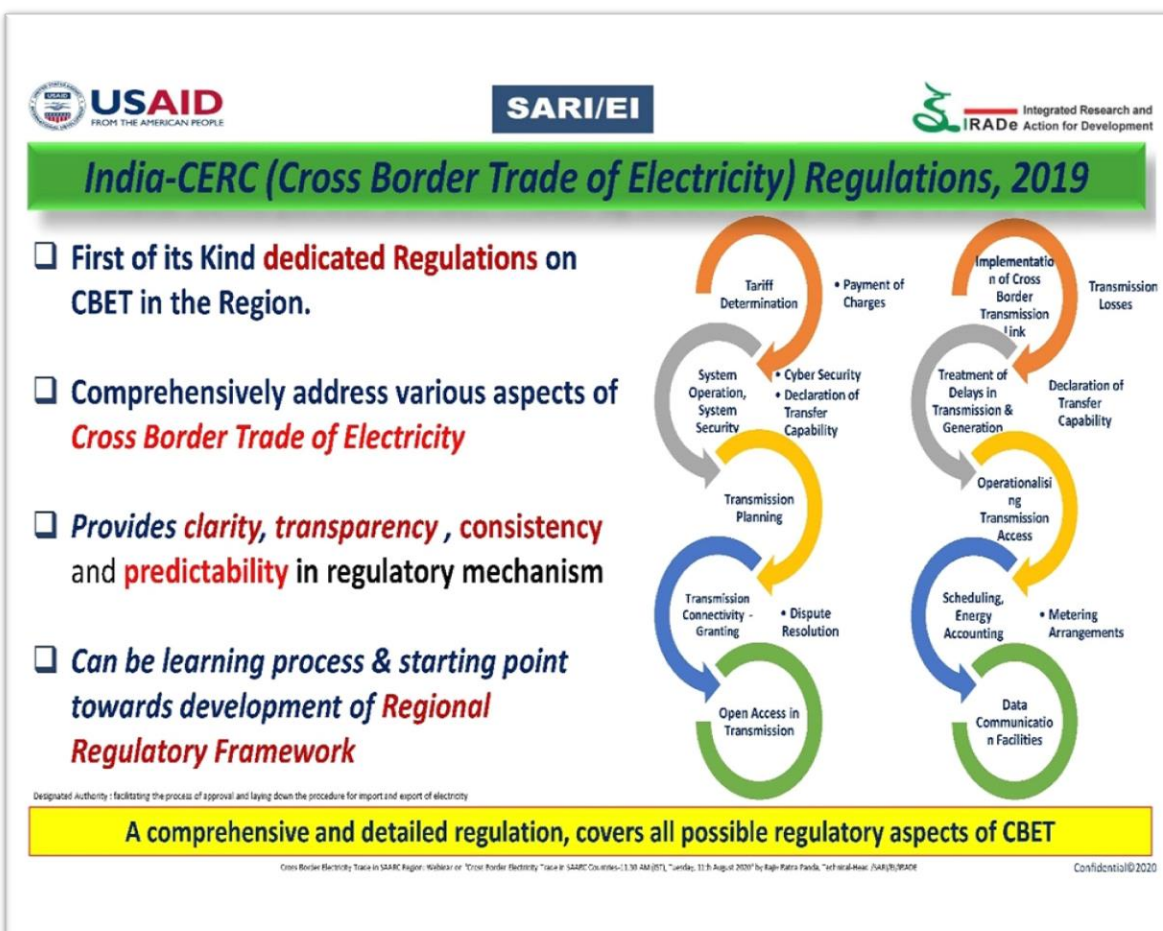
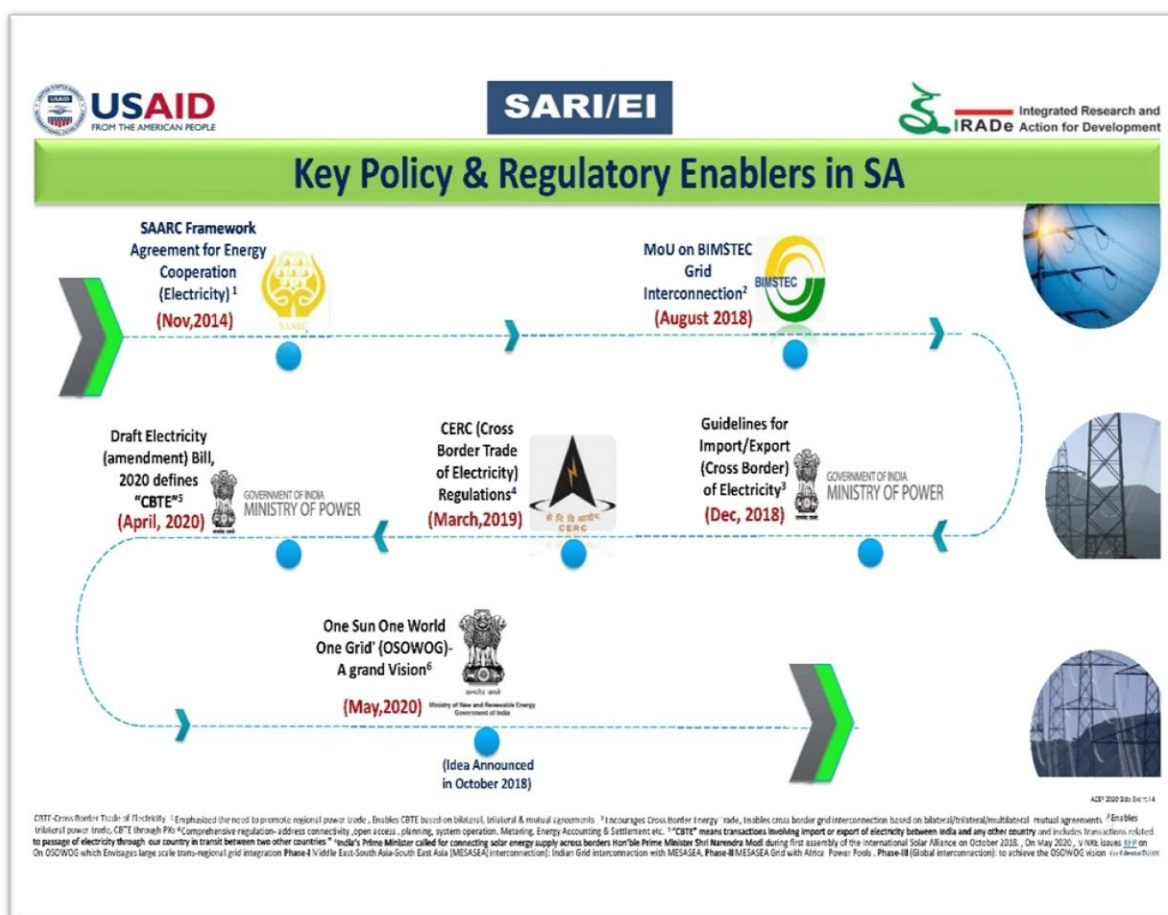
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²Source: [World Bank Study](#)

[illegible]







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SARI/EI Initiatives




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Deepening Energy Cooperation & Accelerating CBET: SARI/EI Initiatives



Harmonisation of legal, Policy framework, Common Regulatory Roadmap **(CRP)**



Coordinated Regional Generation & Transmission Master Plan **(CRGTMP)**



Model Regional Framework for Trilateral & Multilateral Power Trade **(MRFTMPT)**



Common Operating Standards, Common Minimum Grid Code **(CMGC)**



Power Exchange Platform for CBET **(SARPEX)**



Framework-Regional Ancillary Service Market **(FRASM)**



Potential for Natural Gas Trade Potential **(NSTP)**



South Asia Energy Knowledge Resource Database **(SAEKRD)**

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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)

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*Conclusion
and
Way
forward*



Conclusion







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Conclusion and Way forward

Focusing on **Complementary Regulatory framework** development for CBET in each SA countries.

Need to **strengthen the process** of Policy & Regulatory Harmonisation.

Implementation of various inter-governmental agreements (bilateral, trilateral, multilateral).

Regional System Planning- Generation and Transmission **Master Plan**.

De-Risking CBET infrastructure Projects; enhancing **bankability** of projects; Investment mobilisation.

Focusing on **power market development** including **ancillary service market**.

Institutionalizing the Process of CBET-SAFER, SAFTU, SAFSO, SAFEM, SAFEI.

Deepening CBET leads to **Clean Energy Transition and Sustainability**, Climate Change **Mitigation**.

Strengthening **Institutional Capacity**.

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It always seems
impossible until it's done.

Nelson Mandela

Thank You

Contact: rajivratnapanda@irade.org
rajivratnapanda@gmail.com
<https://sari-energy.org/>
<https://www.irade.org/>

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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.

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Evolution of Cross Border Electricity Trade (CBET) in South Asia

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History of evolution of Energy Cooperation, CBET- Key Policy & Regulatory Development



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



⁴ 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. "FIXED ACQUIS" shall mean the energy scheduling hours between 11:00 AM and 12:00 PM, and between 1:00 PM and 2:00 PM, (including) 18:00 hrs to 24:00 hrs of the same day. Further purpose of scheduling is to allow connection from 00:00 hrs and end of 24:00 hrs, in 15-minute intervals.

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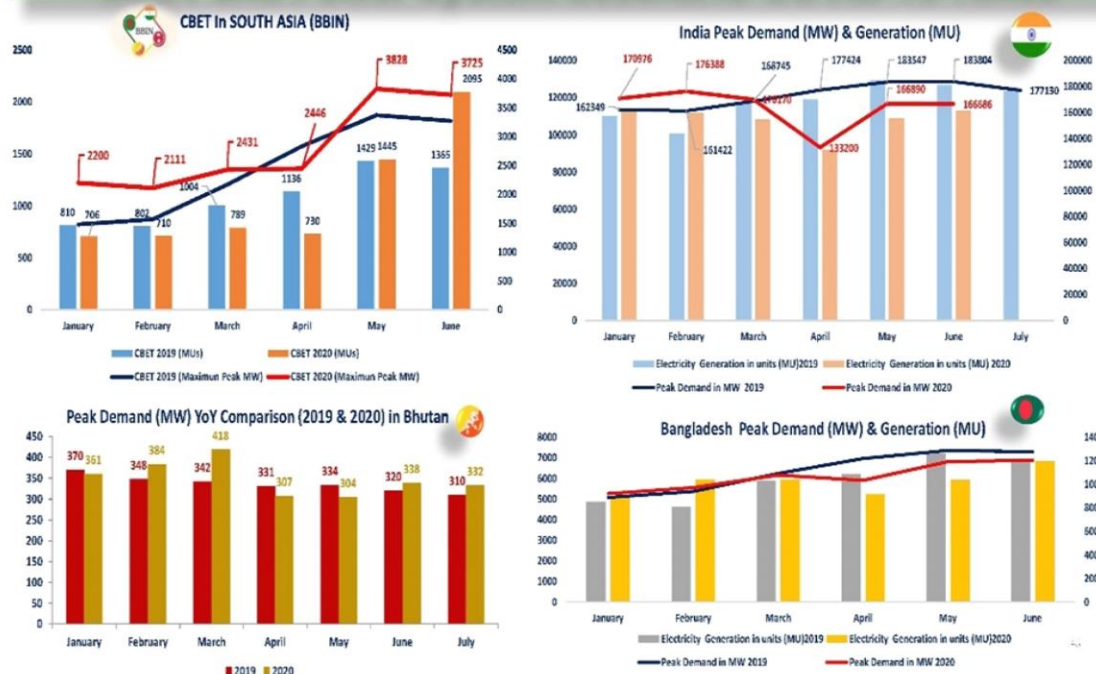
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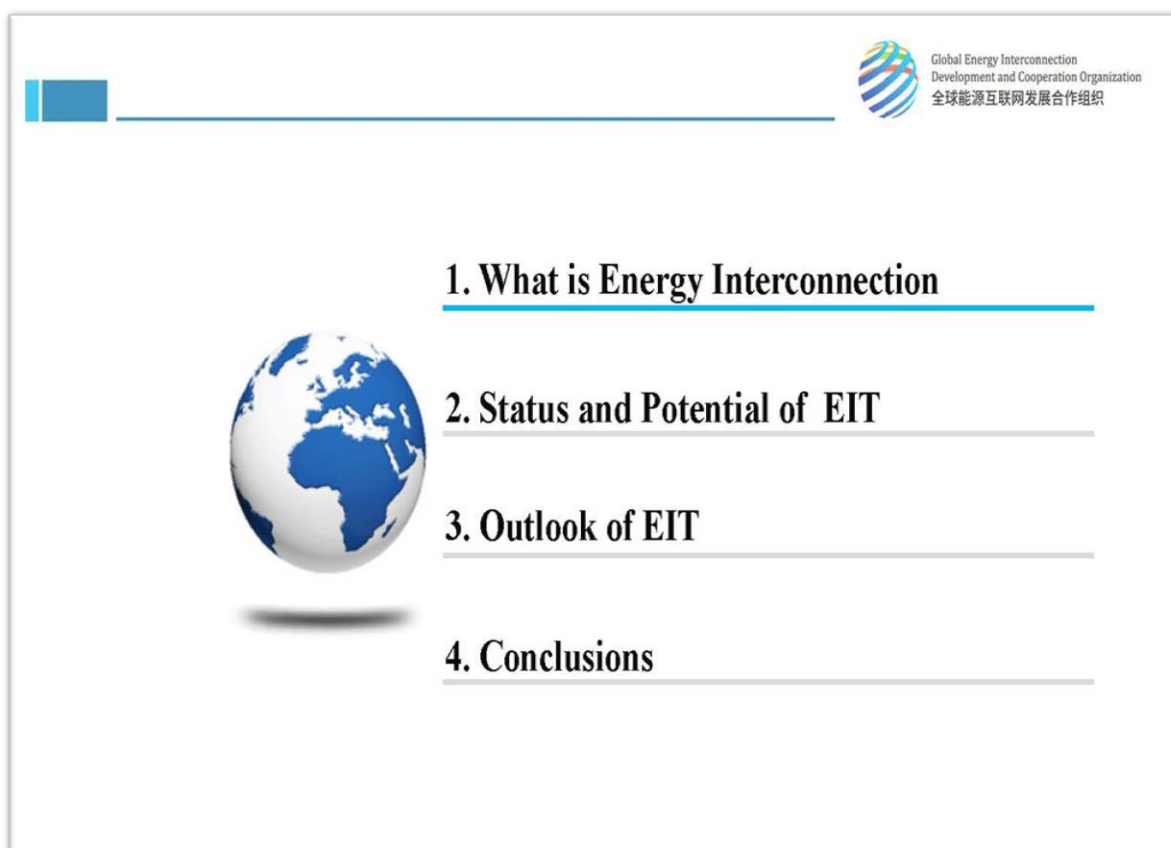
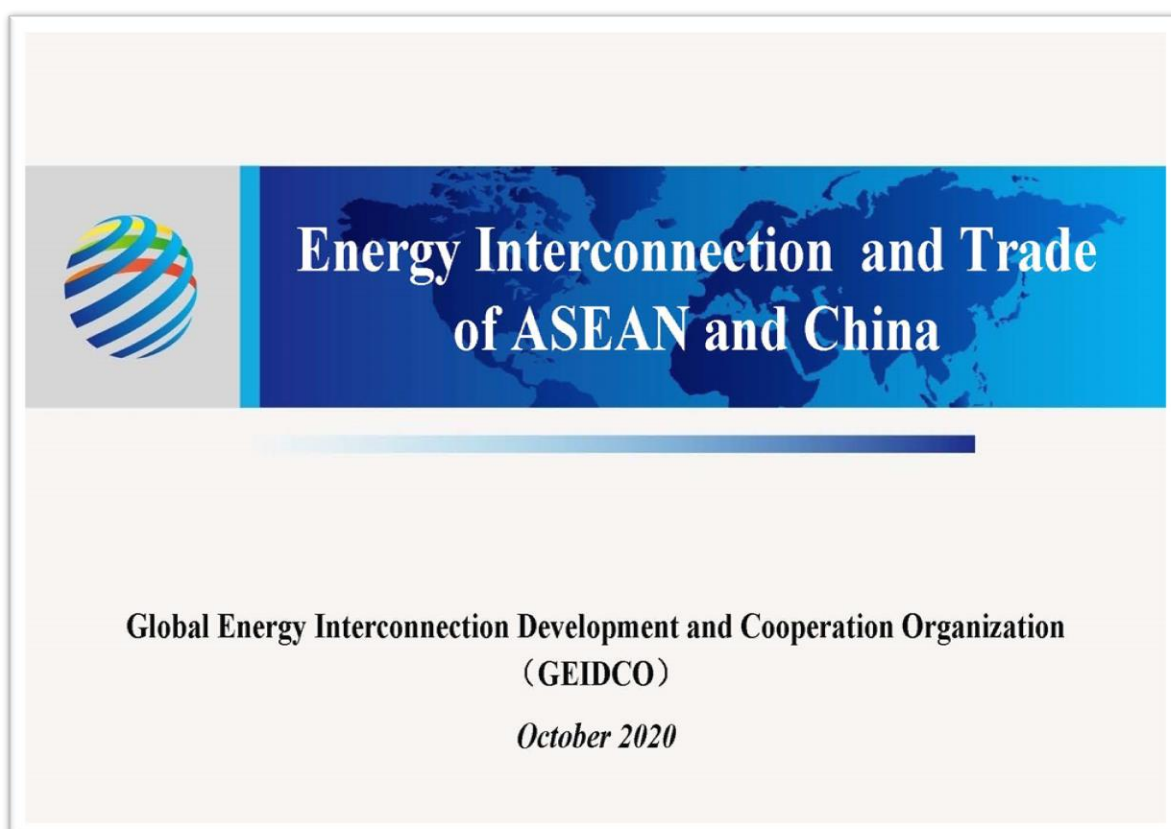


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CBET and Power System Secenario-COVID-19 Times



6. **“Energy Interconnection and Trade of ASEAN and China”** by Dr. Jiang Han
Research Fellow, Global Energy Interconnection Development and Cooperation
Organisation (GEIDCO), China.



1.1 Global Trend



Global sustainable development faces severe problems.



In June 2019, CO₂ concentration was **415** ppm. The average global temperature in 2018 is already about **1.1** °C higher than that before the industrial revolution.



PM2.5 in **64%** cities of the world's exceed the standard. **7** million people die from air pollution every year. **2** billion people short of water.



Coal reserves can be mined for only **130** years, and oil, gas for just **50** years. Soil conditions have deteriorated and forest cover has declined significantly.



730 million people below the international poverty line. Sub-Saharan's GDP per capita is **4%** of OECD's. **840** million people have no access to electricity. **3** billion people depend on firewood for energy.

2

1.2 What is Energy Interconnection



The Energy Interconnection will provide systematic solutions for addressing climate change and realizing sustainable development of world economy, society and environment.

Global Energy Interconnection is a platform for the application of advanced technologies such as smart grid, UHV power transmission, and clean energy, and promoting the large-scale development, deployment and utilization of clean energy globally.



Clean Replacement

Replace fossil fuels with clean energy such as hydropower, solar and wind energy.



Electricity Replacement

Replace coal, oil, gas and firewood with electricity generated from clean energy.



One Increase

Increase in the proportion of electric energy in final energy consumption by 1%.



One Restore

Fossil energy will be used as traditional industrial raw materials.



One Conversion

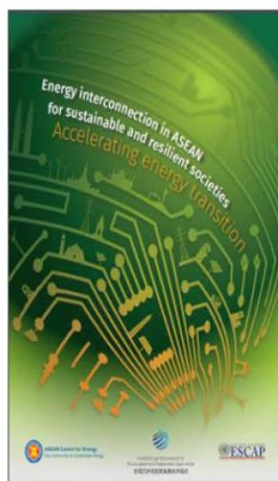
CO₂, water will be converted to fuels and raw materials such as hydrogen, methane through the electricity.

3

1.3 Research Findings



- Energy interconnection in ASEAN for sustainable and resilient societies: Accelerating energy transition
- Global Energy Interconnection Research Report Series



4



1. What is Energy Interconnection

2. Status and Potential of EIT

3. Outlook of EIT

4. Conclusions

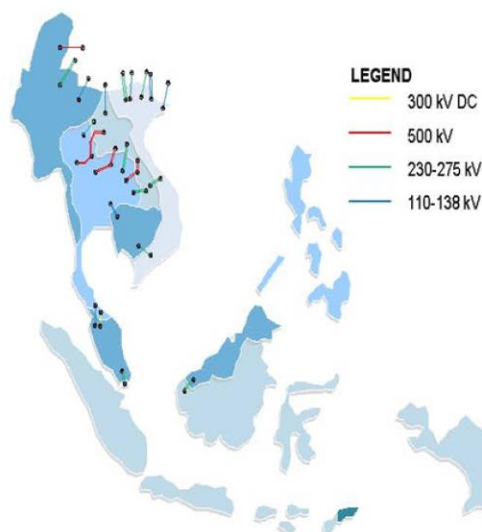


2.1 Current Status of Energy Interconnection and Trade



Global Energy Interconnection
Development and Cooperation Organization
全球能源互联网发展合作组织

- Cross-border power trade is at a modest level.
- In 2016, the power trade reached a total amount of 5.2 GW, which is equivalent to 2.5 per cent of the total installed capacity 2015. In 2017, power trade increased to 5.5 GW, equivalent to approximately 2.7 per cent of total installed capacity.
- ASEAN has exchanged a cumulative 51.7 TWh electricity with Yunnan and Guangxi provinces in China by the end of 2017.
- Only 7 of the existing cross-border transmission lines are at the 500 kV level. The other transmission lines are 230 kV, 110 kV and below.



Current status of the energy
interconnection in Southeast Asia

6

2.2 Drivers and Challenges



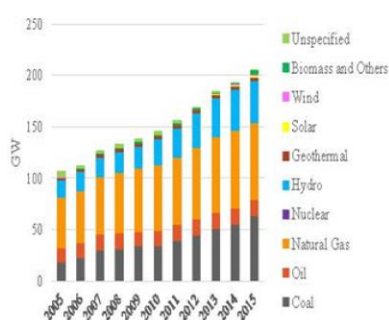
Global Energy Interconnection
Development and Cooperation Organization
全球能源互联网发展合作组织

■ Drivers

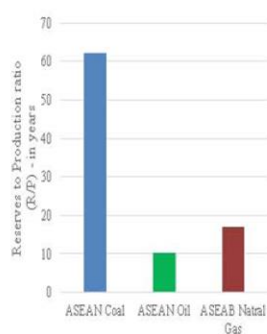
- ✓ Economy continues to grow rapidly
- ✓ Industrial Structure upgrade
- ✓ Abundant Clean Energy Resources

■ Challenges

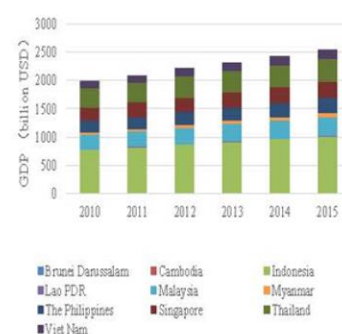
- ✓ Fossil fuels are running out
- ✓ Environment issues become increasingly severe
- ✓ Geographic and temporal mismatches



Trend of generating capacity
in Southeast Asia



Ratio of reserves to production
in Southeast Asia



GDP growing trend in 10 Southeast Asian
Countries

7

2.3 Principle



■ Coordinate Development of Clean Energy & Power Grid

- ✓ Overall planning of power supplies shall be made to optimize generation allocation, promote intensive development of power supplies.

■ Coordinate Markets at Supply & Demand Sides

- ✓ Coordinate export scale and local electricity demand at the supply side and import scale and local generation at the demand side to ensure the electricity is transmittable and receivable.

■ Coordinate Regional & Cross-regional Interconnection

- ✓ It is advised to accelerate the construction and development of regional power grid, establish power grid interconnection among ASEAN, China and South Asia to meet the needs of electricity complementation and expand the scope of clean energy consumption.

8

2.4 Layout & Development of Clean Energy

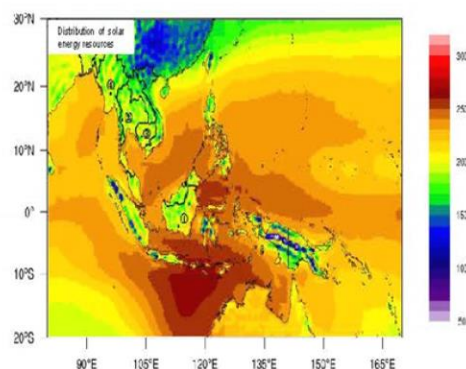


- **Abundant Clean Energy.** The solar irradiation intensity is 200~250 W/m². The average wind speed in coastal areas of Myanmar, Thailand, Viet Nam and the Philippines can reach 8~11 m/s. Hydro energy resource is mainly distributed in Irrawaddy, Salween, Mekong, and Kalimantan.

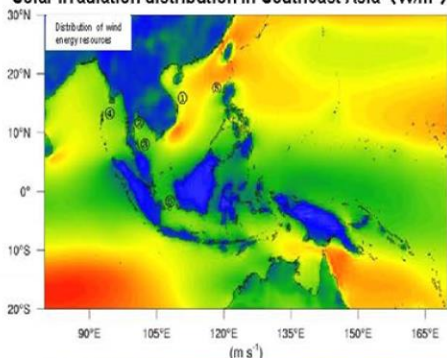
- **Coordination of centralized and distributed development.**



Diagram of clean energy bases distribution in Southeast Asia



Solar irradiation distribution in Southeast Asia (W/m²)



Wind speed distribution in Southeast Asia

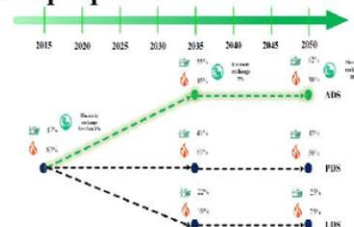
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2.5 Scenarios of EIT

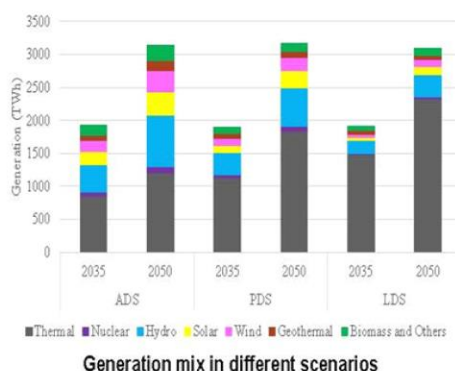


■ Three clean energy development scenarios are proposed

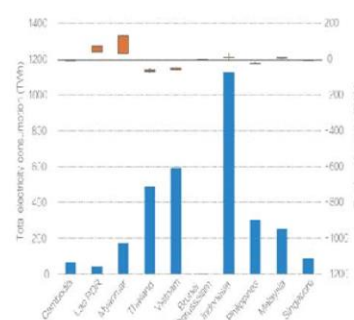
- ✓ Accelerated Development Scenario (ADS)
- ✓ Progressive Development Scenario (PDS)
- ✓ Low-speed Development Scenario (LDS)



Roadmap of Southeast Asia Energy Interconnection development



Generation mix in different scenarios



Balance in 2050

10

2.6 Potential of Energy Interconnection and Trade



- Across the region, Southeast Asia, together with China and South Asia, will achieve multi-energy complementation and solve the seasonal variation of power supplies.
- Within ASEAN, the power is transmitted from north to south in CLMTV. In the BIMPS, the power is transmitted from center to rim.
- ✓ In 2035, countries will preliminarily build a regional power grid in Southeast Asia through bilateral and multilateral interconnection.
- ✓ In 2050, the ASEAN power grid will become the hub connecting China and South Asia.



Diagram of regional electricity exchange

11



1. What is Energy Interconnection

2. Status and Potential of EIT

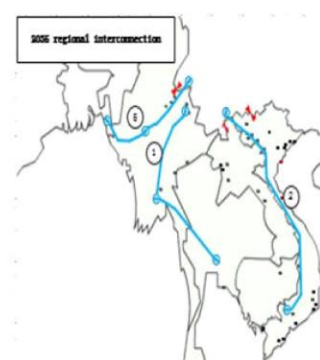
3. Outlook of EIT

4. Conclusions

3.1 Interconnection Scheme

■ In 2035

- ✓ **Within ASEAN:** In CLMTV, a 500 kV synchronous AC grid could be built covering Myanmar, Lao PDR, Viet Nam and Thailand. BIMPS will form three synchronous power grids,.
- ✓ **Across the region:** **To the north**, Southeast Asia connects with Yunnan, China with 3 back-to-back DC projects. By constructing Yunnan-Ho Chi Minh DC transmission project, the electricity demand in the south Viet Nam will be met. **To the west**, it connects with South Asia by a China-Myanmar-Bangladesh DC transmission project.



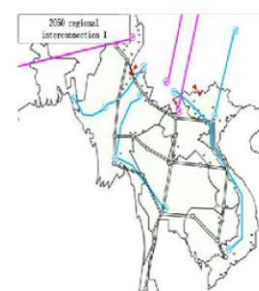
2035 regional interconnection

3.1 Interconnection Scheme



■ In 2050, across the region

- ✓ **Southeast Asia-China:** build a Zhengzhou, China-Phongsali, Lao PDR ± 800 kV UHVDC transmission project and a Liupanshui, China-Hanoi, Viet Nam ± 660 kV HVDC transmission project to exchange power with China.
- ✓ **Southeast Asia-South Asia:** a Myanmar-India ± 800 kV UHVDC transmission line is proposed to send electricity to load centers in central and eastern India.



■ In 2050, within ASEAN

- ✓ **CLMTV, Option 1:** could construct a 1000 kV UHV backbone grid with three horizontal and three vertical corridors. **Option 2:** a ± 800 kV flexible DC backbone grid with the structure of two loops could be formed in Myanmar, Lao PDR and Thailand.
- ✓ **BIMPS** maintain three synchronous power grids. On Kalimantan island, a 500 kV grid could be built, with the construction of 6 transmission projects sending clean energy to the surrounding load centers.

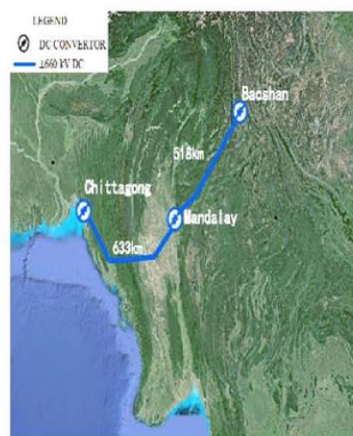


2050 regional interconnection 2 14

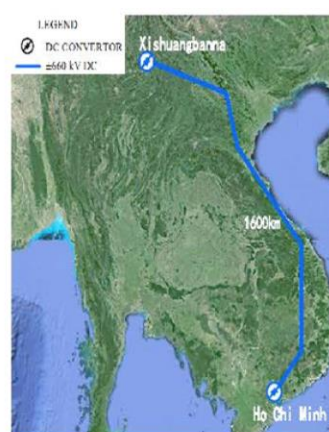
3.2 Recommended Pilot Projects



- **China-Myanmar-Bangladesh Interconnection Project:** ± 660 kV three-terminal DC with a capacity of 4 GW,
- **China-Viet Nam Interconnection Project:** ± 660 kV DC with a capacity of 4 GW.



CMB Interconnection Project



China-Viet Nam Interconnection Project



1. What is Energy Interconnection

2. Status and Potential of EIT

3. Outlook of EIT

4. Conclusions

Conclusions

Energy and electricity cooperation is the core for the regional cooperation and clean development of this area. The key of cooperation is to establish the **energy interconnection**. In specific, the first emphasize should be laid on replacing the traditional **energy development mode** relying on fossil fuel and local balance by a new mode focusing on clean energy and wide-area optimal allocation. Other important contents to ensure the **energy security** and **sustainable development** in the area include the construction of large-scale **clean energy bases**, the establishment of a **strong interconnected grid**, and the **clean development and transition** in the countries.

The region is of great value and prospect, and its implementation is necessary for the region. To achieve that, the **consensus** must be reached among the stakeholders and their efforts must be concentrated on enhancing the **policy-making coordination** and improving the **mechanism for bilateral and multilateral cooperation**. To be specific, a **regional electricity market** should be built, **innovations** should be made in investing and financing aspects, and the **pilot projects** of clean energy utilization and grid interconnection should be implemented in the near future.

*Make joint efforts for innovative development, and create a
beautiful future together*

