SARI/EI Study on Harmonization of grid codes, operating procedures and standards to facilitate/promote cross border electricity trade in the south Asia region: Status Update and Way Forward

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SAARC Perspective Workshop on the Past, Present and Future of High Voltage DC (HVDC) Power Transmission

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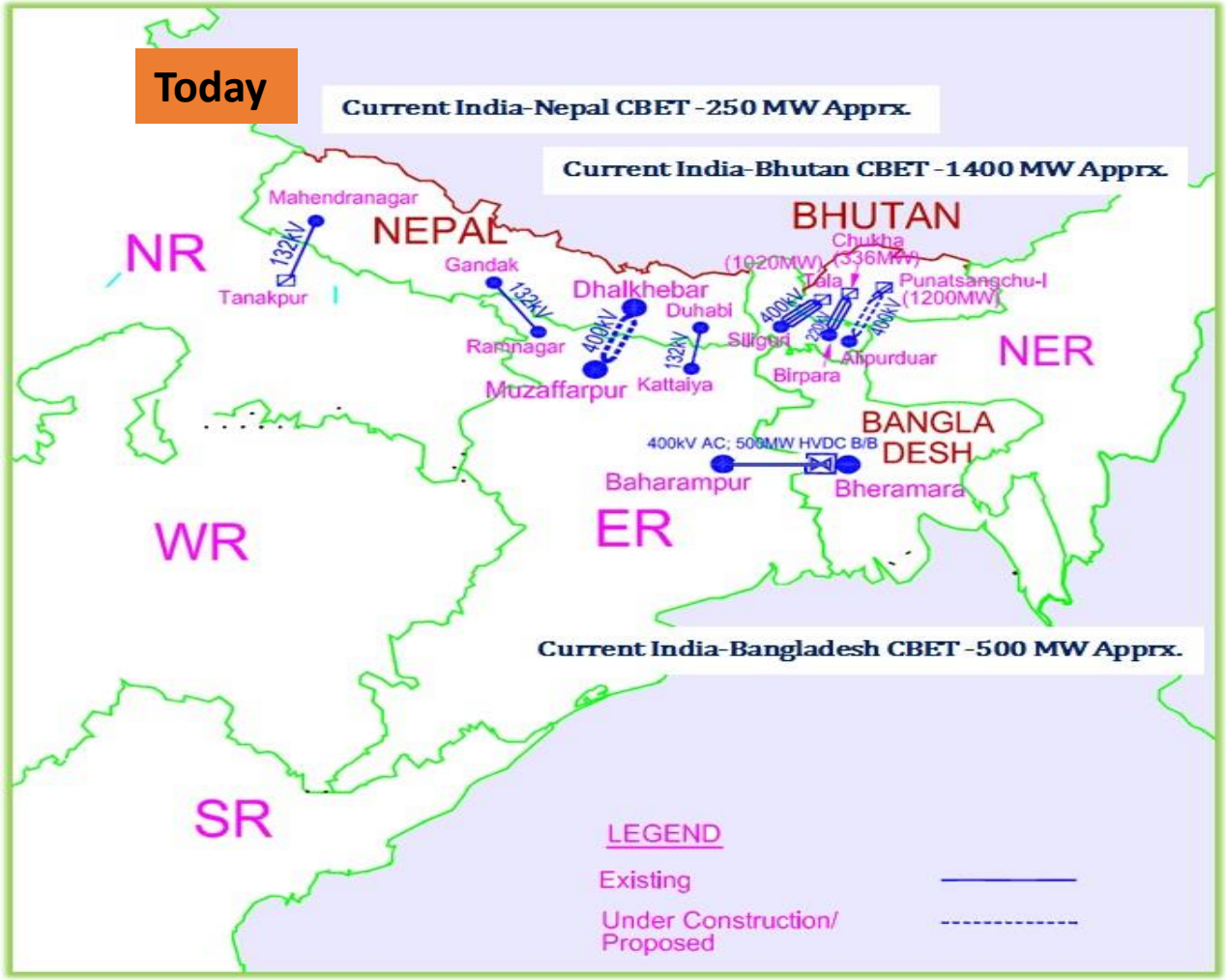
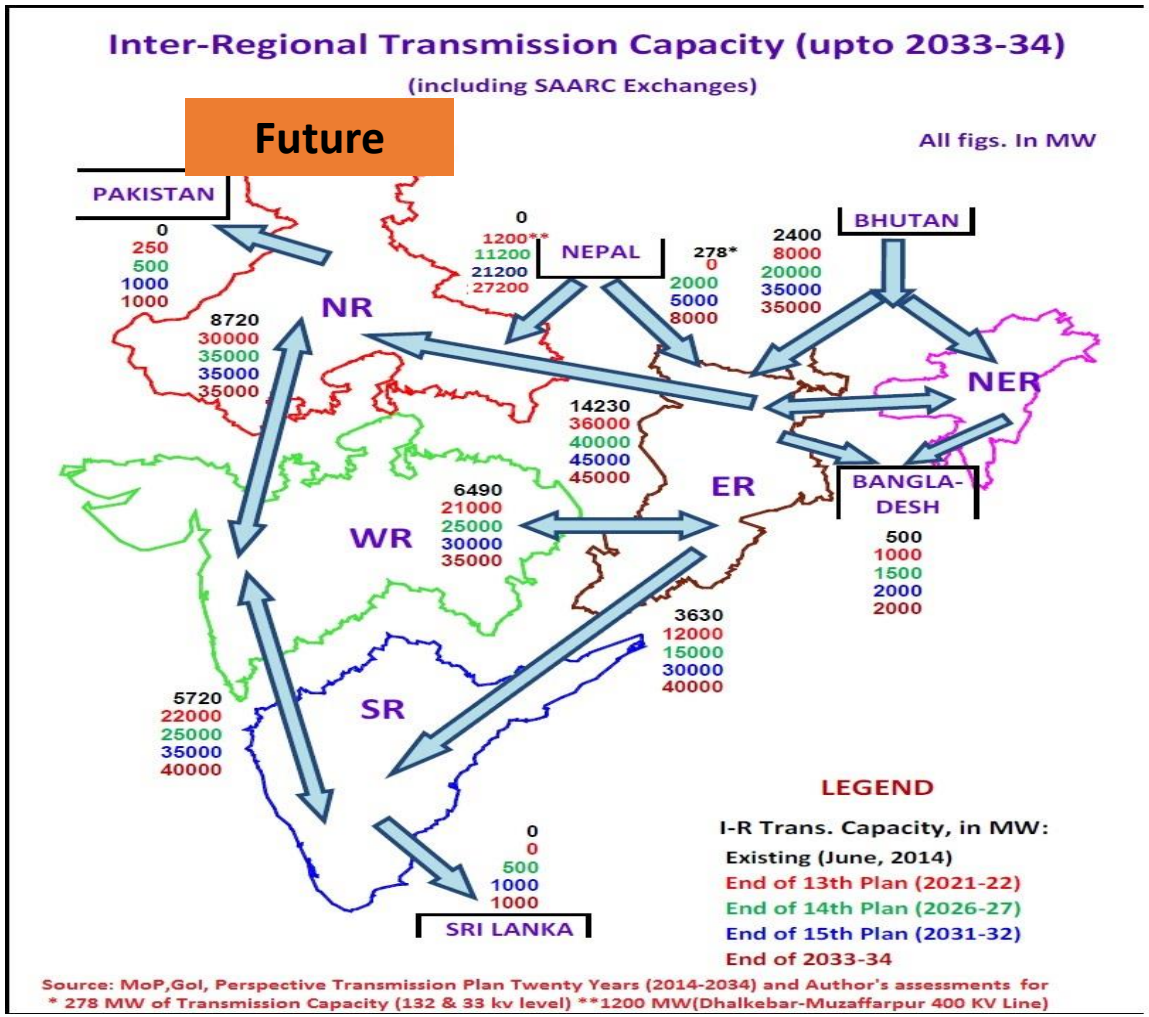
Presentation Outline

- Back Ground
- Scope of Work
- Project Methodology
- International Experience Review
- Way Forward : Overall Approach for Grid Code Harmonization/Coordination in South Asia
- Way Forward: Development of Framework Guidelines.

Background : What is the CBET Vision ?

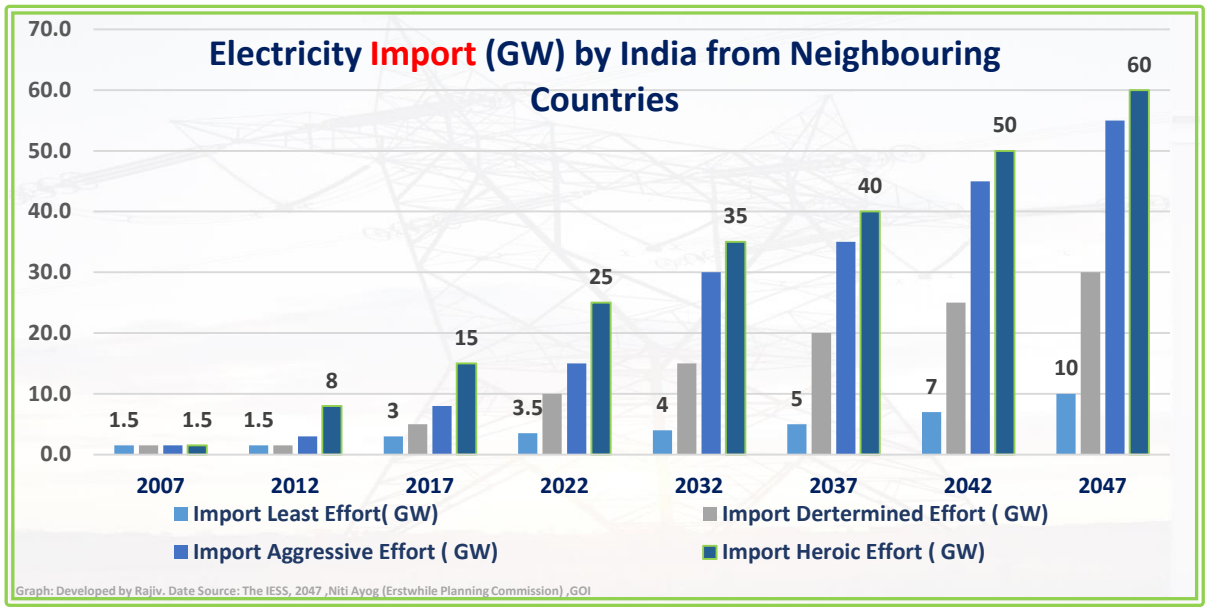


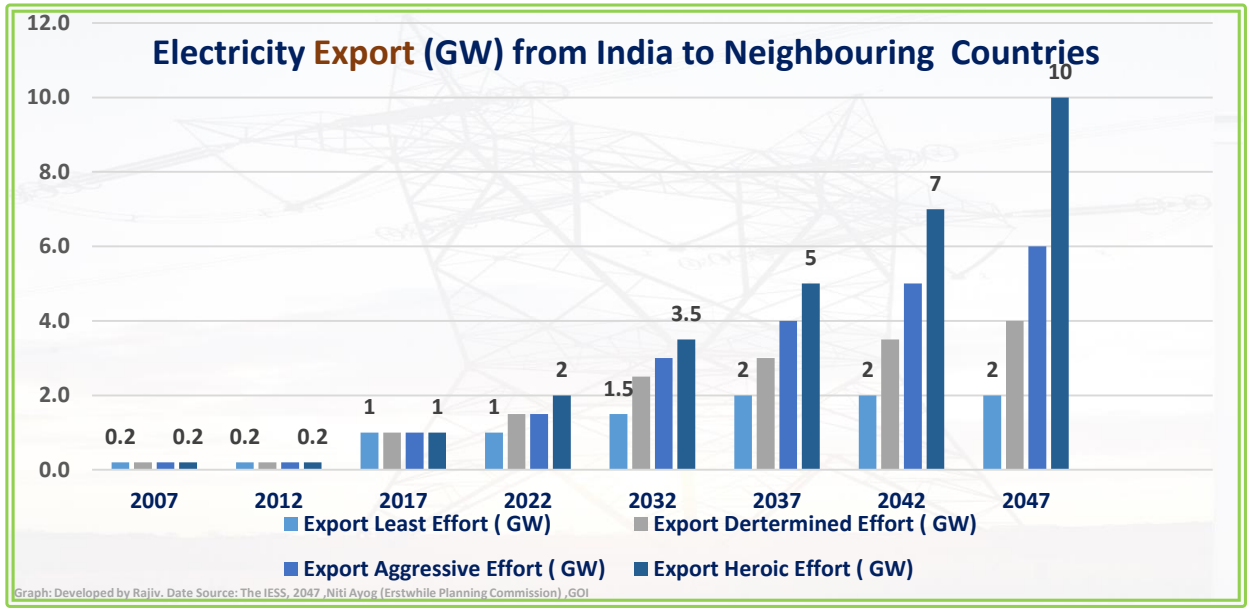


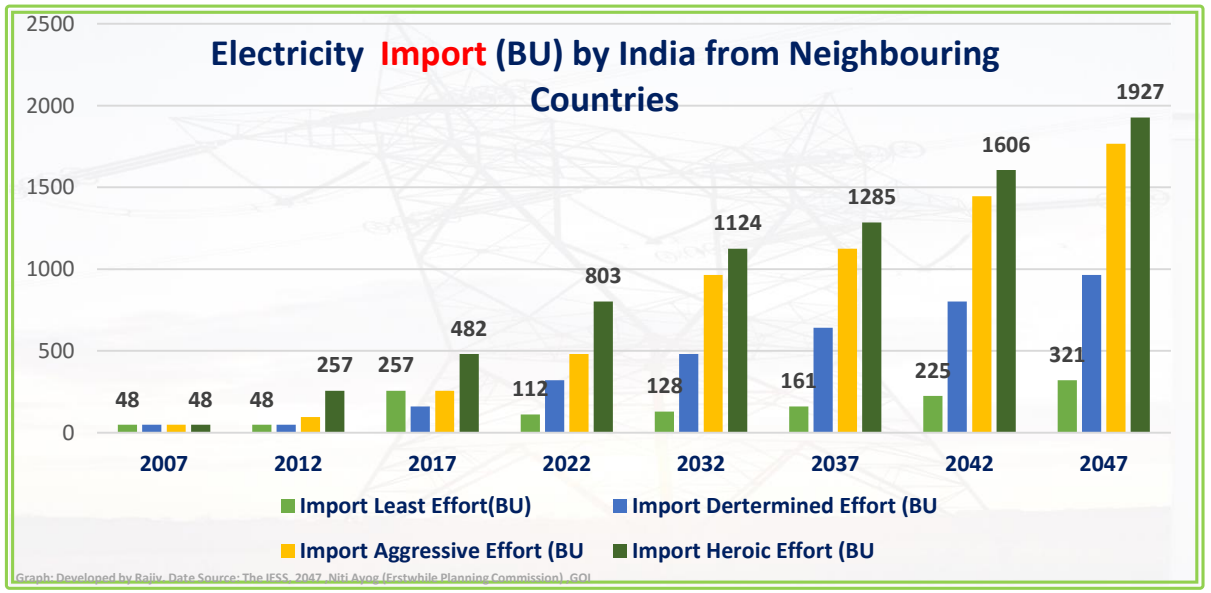
Significant Transmission System Interconnection (Both AC and DC) are being Planned and Proposed.

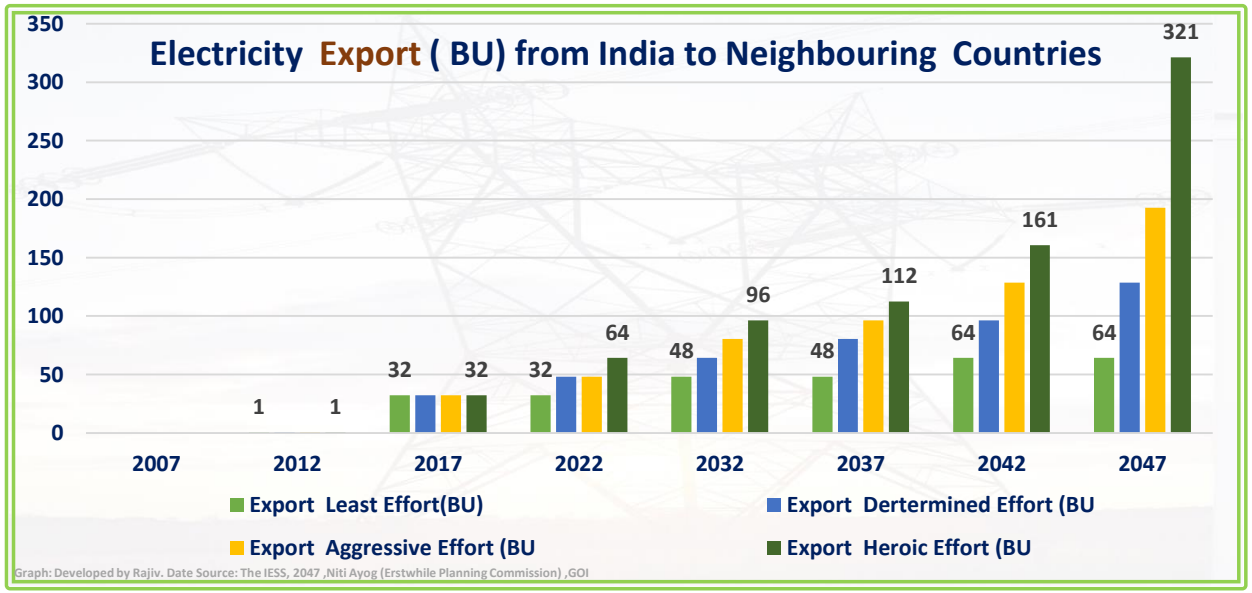
Bangladesh is in the process of Planning to Import around Apprx. 6000 MW by 2034 (PMSP 2015-JICA Presentation,4th June,2015)

India: Cross Border Electricity Trade Export and Import by India from Neighbouring Countries









Source: The IESS, 2047 ,Niti Ayog (Erstwhile Planning Commission) ,GOI

Background : Need for Harmonization for Safe, Reliable and stable operation of the Interconnected Power system

- With Such High Level of Cross Border Interconnection being envisaged, it is obvious that for safe, reliable and stable operation of the interconnected transmission system, the various technical aspects of grid codes, operating procedures and standards needs to be harmonized/coordinated.
- Harmonization means adjustment of differences & inconsistencies among measurements, methods, procedures, schedules, specifications of systems to make them uniform or mutually compatible.
- Compatibility has to be there depending on the type of interconnection.
- In case of a synchronous interconnection, voltage, basic insulation strength, nominal frequency and protection scheme must match.
- In case of asynchronous interconnection though may require less level of harmonization, the tripping of HVDC terminal would itself can constitute a disturbance in terms of loss of load or loss of supply.

Scope of Work : Objectives

Review of the Grid Codes of the respective South Asia nations covering procedures/ codes/standards such as Power system operating procedures, protection code, metering code, connection code, planning code, system security, demand estimation systems, outage planning, recovery procedures etc.

Identify relevant provisions in each of the above documents operating procedures/ Grid codes and standards that have the potential to impact “cross border electricity trade”;

Suggest possible measures with necessary changes to be made in each of the above of the respective SA countries to facilitate/promote optimal and economic “cross border electricity trade only” in the South Asia region.

SARI/EI Task Force-2 Study on Harmonization of grid codes, operating procedures and standards to facilitate/promote cross border electricity trade in the south Asia region: Status

- SARI/EI Task Force-2 is currently carrying out the Study on Harmonization of grid codes, operating procedures and standards to facilitate/promote cross border electricity trade in the South Asia Region.
- M/s PRDC,Bangalore is the conducting the study.
- Methodology and approach has been finalized by Members .
- Preliminary Review of the Grid Codes and Gap Analysis has been conducted.
- Overall Appaorch for harmonization of Grid Codes for SA has been envisaged.
- International best practices to be analyzed and reviewed.
- Need to develop comprehensive framework guidelines along with Draft Codes.

Study Methodology

Phase I
1. Project Inception

- 1.1 Project Kick-off
- 1.2 Work Plan Preparation
- 1.3 PreliminaryData Mapping and Gap Analysis
- 1.4 Inception Report generation
- 1.5 TF/IRADe Meeting

Phase II
2. Project Interim Analysis

- 2.1 Project related Data Collection
- 2.2 Power Transmission Standards Review
- 2.3 Standards Gap Analysis
- 2.4 Organizational Structure Review
- 2.5 TF Meeting

Phase III
3. Impact Assessment & Regional Grid Code Creation(Now Framework Guidelines will be prepared as suggested by members)

- 3.1 Review of international grid codes on cross border trading
- 3.2 Impact Analysis of Grid Codes & Operating Procedures
- 3.3 Draft Interim Report
- 3.4 Comments from TF members
- 3.5 Recommendation for CBET supportive Framework Guidelines
- 3.6 Draft Final Report

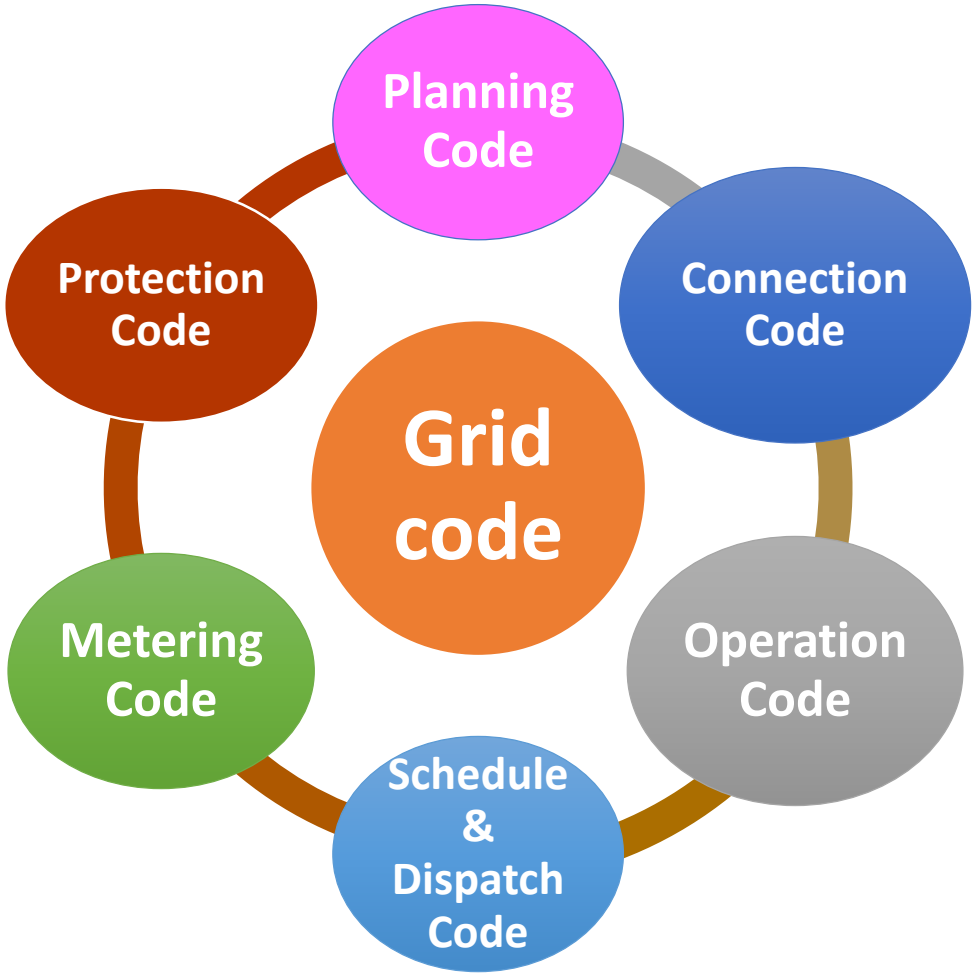
Phase IV
4. TF Workshop & Final Report Submission

- 4.1 Final TF Workshop
- 4.2 Final Report Submission
- 4.3 Identification of Training Requirements to ensure proper implementation Framework Guidelines

Grid Code

Grid Code details the rules, procedures, guidelines, criteria and responsibilities to be complied with by the users, owners and operators of the transmission system of a country.

Grid codes are approved by a regulatory body or government in exercise of powers conferred to it under the relevant electricity act/legislation.



For interconnecting two grid systems, underlying principles of individual systems planning and operational framework has to be understood and harmonise the relevant rules in a limited manner purely for purpose of facilitating cross border interconnection and trading only.

Grid Codes , Regulatory Institutional Framework Reviewed

Country	Grid code document	Electricity Sector Regulatory
Afghanistan	NA	
Bangladesh	Grid Code, 2012	Bangladesh Electricity Regulatory Commission (BERC)
Bhutan	Grid Code 2008 (Reprint 2011)	Bhutan Electricity Authority (BEA)
India	Grid code 2010 (Amendment 2014)	Central Electricity Regulatory Commission (CERC) , State Electricity Regulatory Commissions (SERC) for each state
Maldives	NA	Maldives Energy Authority
Nepal	NA Grid code 2005	Department of Electricity Development
Pakistan	Grid Code, 2005	National Electric Power Regulatory Authority (NEPRA)
Sri Lanka	Grid Code, 2014	Public Utilities Commission (PUC)

WAY FORWARD

Way Forward

International practices on cross border trading

- Impact analysis for cross border trade of SA countries considering International practices on border flows

Formulation of Guidelines / harmonized Grid code for SA nations

- Guidelines /codes with reference to cross border trading while maintaining country specific grid codes for internal power system planning & operation.

Way Forward: Overall Approach for Grid Code Harmonization/Coordination in South Asia

Framework Guidelines

Development of Framework guidelines on the identified Areas (contains explanatory statement along with draft code for each identified areas)

Cross Border Grid code

Development of codes based on Framework guidelines by the relevant authorities

Agreement & Operationalization of code

International Experience Review

International Experiences Review: Network Codes as per ENTSO-e

Grid Connection Related Codes

- Requirement for Generators
- Demand Connection code
- HVDC Connection code

System Operation Related Codes

- Operational Security Network
- Operational Planning and Scheduling
- Load Frequency Control and Reserves
- Operational Procedures in an Emergency

Market Related Codes

- Capacity Allocation and Congestion Management
- Forward Capacity Allocation
- Balancing Network code

Development of Framework Guidelines

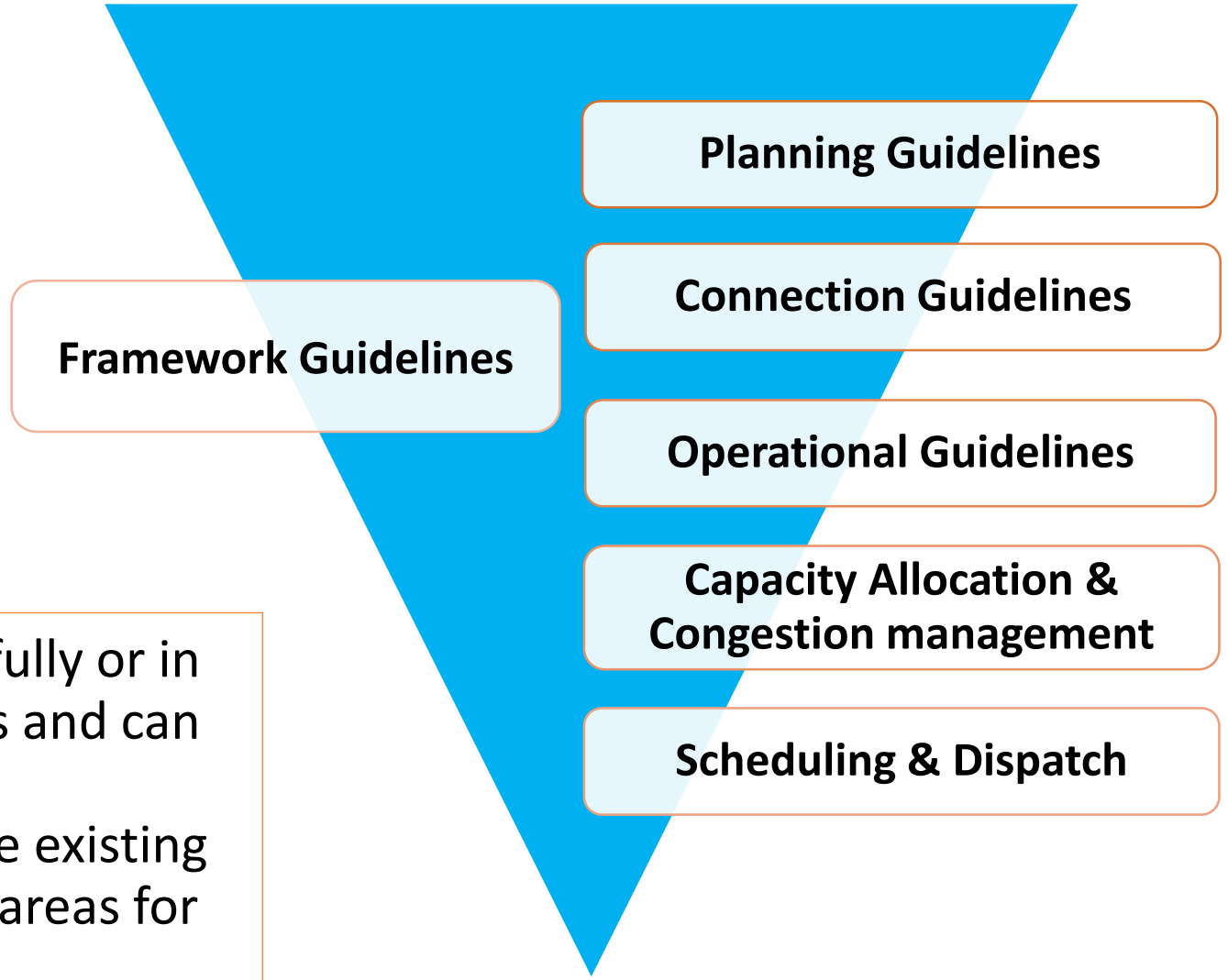
Development of Framework Guidelines

The Framework Guidelines will be comprehensive in nature and shall contain

Impact analysis	**Explanatory statement**	**Implementation Provisions**	**Draft code**

The proposed framework shall not be intended to replace the existing national grid codes for non-cross border issues but to harmonise/Coordinate the critical issues concerning cross border trade.

Way Forward- Identified Areas for Framework Guidelines



The draft code can be adopted fully or in parts by the relevant authorities and can form the basis for harmonising/Coordination of the existing national codes in the identified areas for CBT.

Way Forward- Identified Areas for Framework Guidelines and It's Linkage with SAARC Framework Agreement for Energy (Electricity) Cooperation (SFAEC).

The planning guidelines will be prepared in line with overall intent of the Article 7 of the SAARC Framework Agreement for Energy (Electricity) Cooperation (SFAEC).

The connection guidelines would be in line with the overall intent of the Article 8, Article 9 and Article 10 of the SFAEC.

The guideline on system operation and capacity allocation and congestion management will be prepared in line with overall intent of the article 11 and article 12 of SFAEC respectively.

Framework Guidelines for Planning Guidelines

Feasible Cross Border Interconnections

Interconnection	Countries
AC interconnection: 400 kV and above	Between India & Bhutan, India & Nepal, India and Bangladesh ; Between Pakistan- Afghanistan
AC Interconnection of 220kV and below (on radial mode)	Between India & Bhutan, India & Nepal, India & Bangladesh ; Between Pakistan & Afghanistan ;
HVDC back to back	Between India and Bangladesh Between India & Pakistan
HVDC Bi-Pole with underground cable / Overhead transmission	Between India & Sri Lanka; Between Sri Lanka & Maldives (at a later date due considerations on economics);

Planning guidelines would contain planning guidelines in line with overall intent of the Article 7 of the SAARC Framework Agreement for Energy Cooperation (Electricity).

Guidelines for Planning Code

Master Plan

Master Plan shall be prepared for cross border trading considering 400 kV and above network between connected countries for next 10 or 20 years and revalidated every two/three year

The master plan can be for bi-lateral transaction or multilateral transactions

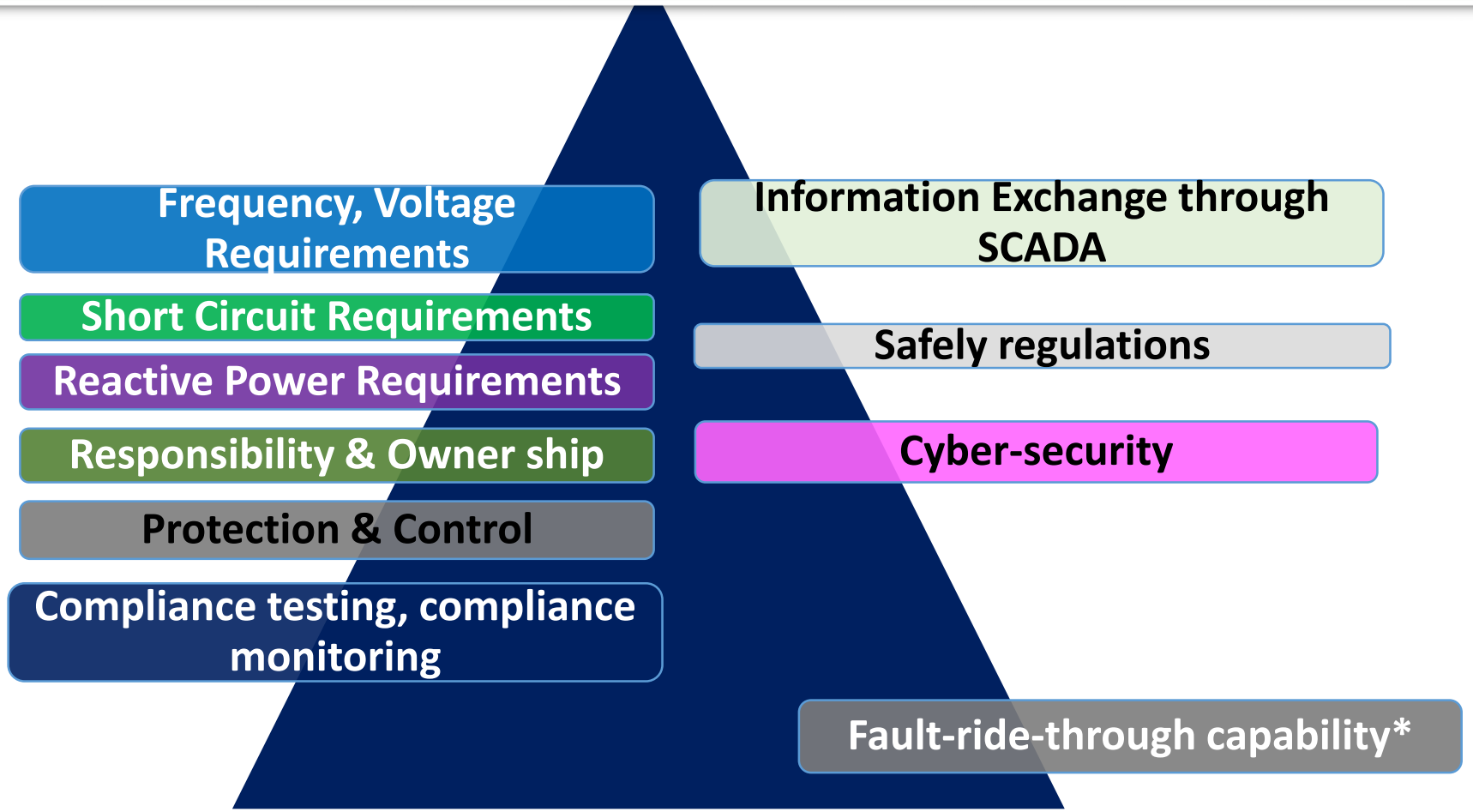
The master plan (both generation & Transmission) also shall include feasibility studies for future years with various possible scenarios.

The planning guidelines shall consider the following

- Transmission system capability of withstanding loss of most severe single system infeed
- Transient Stability Limits
- Accounting for renewables in planning
- Reactive Power planning

Framework Guidelines: Connection Guidelines

The following technical requirements shall be considered while making for cross border connection code



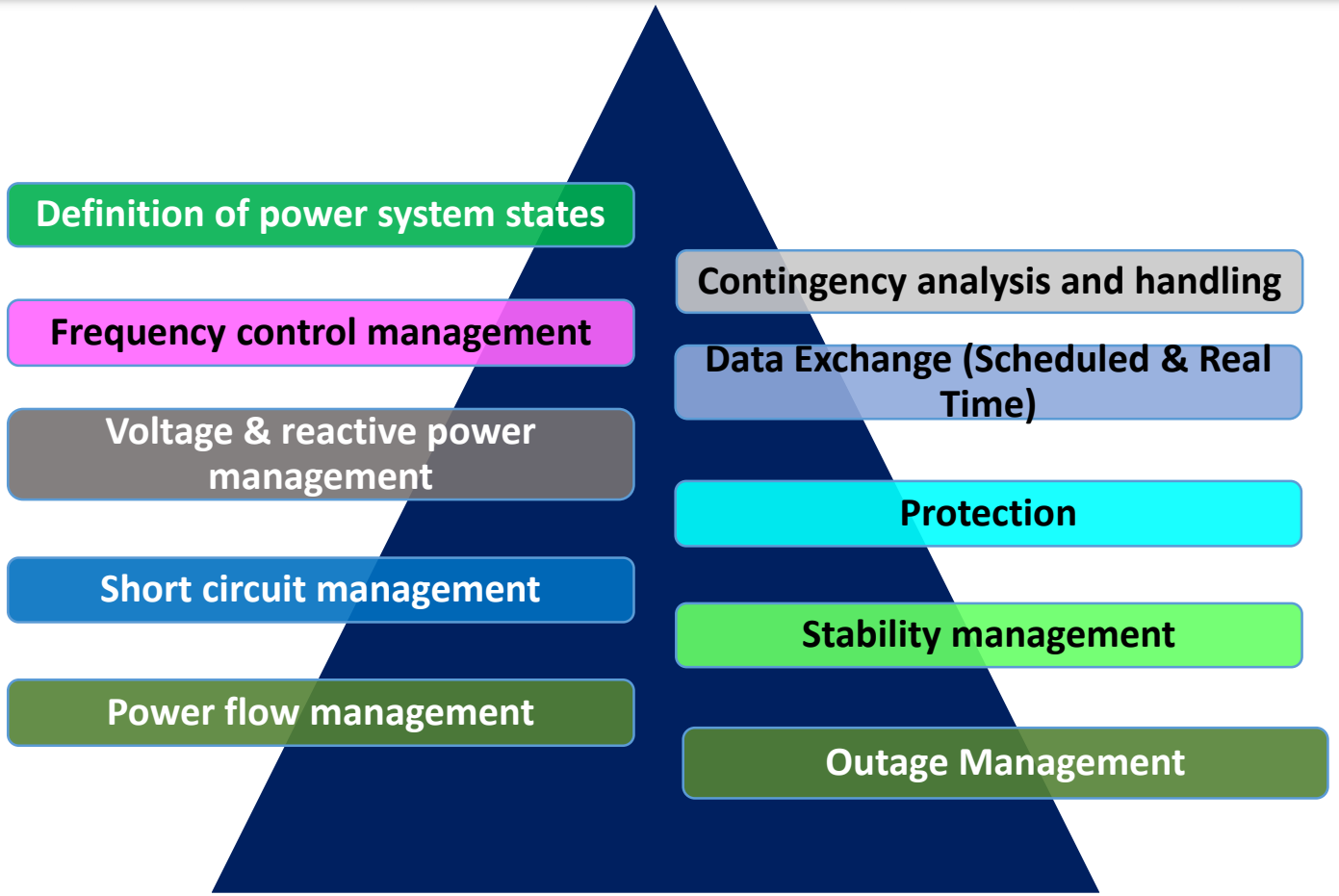
Way Forward: Operational Guidelines

The following aspects shall be considered while making guidelines for Operation of cross border trading.

- Outage Planning (Annually/Monthly/Weekly)
- Operational Security Analysis
- Frequency control and handling of Reserves
- Emergency operational procedures

Way Forward: Operational Guidelines

The following technical aspects shall be considered while making for Operational Code



Way Forward: Capacity Allocation & Congestion Management

The purpose of cross border Capacity Allocation & Congestion management guidelines is to enable non-discriminatory access to the respective transmission grids for purpose of cross border trade in line with Article 12 of SAARC Framework Agreement for Energy Cooperation (Electricity).

60 to 70% of the trading capacity shall be from long-term contracts and remaining from short term.

All countries shall facilitate the network for cross border trading and shall not be constrained by any type congestions

Way Forward: Capacity Allocation & Congestion Management

The following aspects shall be considered while making guidelines for cross border Capacity Allocation & Congestion management.

- **Each country shall provide ATC and TTC for specific cross border transmission paths for long term and short term trading.**
- **Capacity calculation methodology considering reliability margin, contingency, local system changes etc.**
- **Coordinated curtailments on long term allocations**
- **Capacity allocations for day ahead and intra day operations**
- **Congestion relieving mechanisms**

Way Forward: Guidelines for scheduling & Dispatch

The following aspects shall be considered while making guidelines & Code for scheduling & Dispatch

- Establishment of scheduling processes
- Provision of information to other country system operators
- Day ahead scheduling procedure
- Intra day scheduling/revision procedure
- Sharing of information on schedules with other trading countries
- Standardized Scheduling intervals (15 min)

The commercial framework for Deviation settlement is not part of Technical guidelines

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Thank You

Technical Info

Country	Permissible Frequency Band (Hz)
Afghanistan	NA
Bangladesh	49.0 – 51.0 Hz
Bhutan	49.5 – 50.5 Hz
India	49.9 – 50.05 Hz
Maldives	49.5 – 50.5 Hz
Nepal	48.75 – 51.25 Hz
Pakistan	49.4 – 50.5 Hz
Sri Lanka	49.5 – 50.5 Hz

Country	Transmission Voltage Levels (kV)	Permissible Deviation
Afghanistan	220, 110	NA
Bangladesh	400, 230	+/- 5%
Bhutan	400, 220	+/- 5%
India	765, 400 220,	+/- 5%; +/-10%;
Maldives	33, 11	+/- 10%
Nepal	220, 132,	+/- 10%
Pakistan	500, 220	+/- 10%
Sri Lanka	220,132	+/- 5%; +/- 10%

Acceptable Voltage Deviations are similar but the permitted frequency deviation is different- Need to harmonize for synchronous Croos Border interconnection

Grid Code: Gap Analysis of SA countries

Gap Analysis of SA countries : Planning Code

Planning code specifies

- The data information to be provided by all entities and various criteria to be adopted for Grid Planning
- Planning responsibilities of various entities in electricity sector.

Activity	Responsibility Authority	Country
Transmission planning activities	Transmission Licensee	Bhutan (BPC), Bangladesh (PGCB), India-(CEA/CTU/STU), Pakistan (NTDC), Sri Lanka (CEB)
	Grid owner	Nepal
Generation and Transmission Perspective Plan	Transmission Licensee	Pakistan, Sri Lanka, Nepal
	System Planner & transmission licensee	Bangladesh
	Ministry & System Operator (Dept. of hydro power & power system)	Bhutan
	CEA	India

System master plan for each Cross border link– Deca
Plan with phased implementation.

Respective Transmission Agencies plan / coordinated transmission planning or Separately Agency?

Gap Analysis of SA countries : Planning Code

Criteria	Country	Remarks
'N-1' contingency criteria for AC lines	All SA countries	In India, outage of a D/C 220 kV or 132 kV line is also considered as 'N-1' outage. It also considers 'N-1-1' criteria.
'N-1' contingency criteria for HVDC	India	HVDC Back-to-Back Station or HVDC Bi-Pole line
Dynamic Stability	All SA countries	Among other SA nations, Bangladesh, India and Pakistan specify that system shall survive a permanent three phase to ground fault on EHV lines with a fault clearance time of 100 ms. India grid code specifies many other disturbances also in detail for assessing system stability.
'N-1-1' stability	India	For critical elements.
Generator loss	India and Sri Lanka	System shall survive the loss the largest/critical generating unit.

Contingency criteria : N-1 for HVDC and AC Radial Mode operation

N-1-1 for AC inter-connection and Transmission system with independent corridors

Gap Analysis of SA countries : Planning Code

Criteria	Country	Remarks
Information Confidentiality	India	Nodal agencies shall provide the information to the public through various means of communications including internet.
	Other SA nations	Confidentiality of the user information made available to licensee shall be maintained
Interconnection Transmission Planning	Bhutan	Generating stations and concerned agencies in neighboring countries shall discuss and review
	India	It is understood that the mechanism used for inter-state planning shall be used
	Other SA nations	Not specified

Information and Communication protocol?

Information confidentiality or available on Public Domain?

Gap Analysis of SA countries : Planning Code

Except India, grid codes of all other SA nations specify the same voltage variation limits for both planning and operation stages. (For India: refer CEA's manual on transmission planning).

Country	Voltage – Normal		Voltage - Emergency conditions
	Planning Studies	Operational conditions	
Nepal, Bhutan, Bangladesh	+/- 5%		+/- 10%
Sri Lanka	+/- 5% for 132 kV, +/-10% for 220 kV		+/- 10% for 132 kV, +/-10% for 220 kV
Pakistan	+/- 5% for 500 kV, 220 kV		+/- 10% for 500 kV, 220 kV
India	+/- 2%→ 765 kV; +/- 3% → 400 kV; +/- 5% to 7% for below 220 kV	+/- 5% for 400 kV, 765 kV; +/- 10% for below 220 kV	+/- 5% for 400 kV, 765 kV; +/- 10% for below 220 kV

Voltage Deviations shall be in the same range for interconnection → **For EHV (above 400kV) +/-5%**

Gap Analysis of SA countries : Connection Code

Connection code specifies a minimum of technical, design and operational plant criteria to be complied with by the existing connected user and prospective users.

Activity	Responsible Authority	Country
Site Responsibility Schedule (SRS) for each connection point to be prepared by	Licensee	Bangladesh
	Transmission &Generation licensee	Bhutan
	Substation/Connection Site Owner	India
	Grid Owner	Nepal
	NTDC and Generation licensee	Pakistan
	transmission licensee and Users	Sri Lanka
Schedule of Transmission Assets: Submission of annual schedule of Assets to concerted authorities	Transmission Licensee	Bhutan, India, Sri Lanka

Transmission Licensee is responsible for SRS and Schedule

Transmission licensee in all SA countries and CTU in India ?

Gap Analysis of SA countries : Connection Code

Criteria	Country	Remarks
Reactive Power Compensation	All SA countries	All the grid codes specify that users shall not depend on the grid for reactive power and shall install facilities for maintaining power factor.
Generators shall be capable of operating at	Bangladesh	0.8 (lagging) to 0.95 (leading)
	India	0.9 (lagging) to 0.95 (leading)
	Nepal, Sri Lanka	0.85 (lagging) to 0.95 (leading)
	Pakistan	0.8 (lagging) to 0.9 (leading)
Distribution licensees shall maintain a power factor	India, Pakistan	within 0.95 at the connection point
	Nepal	within 0.8 (lagging) and 0.95 (leading)

Generators must comply with respective country regulation & Reactive power Limits only for AC interconnection

0.97 lead and lag at the point of interconnection within permissible voltage deviation

Gap Analysis of SA countries : Connection Code

Criteria	Country	Remarks
Data Communication & System Recording Facilities	All SA countries	▪ All the grid codes specify that the users and licensees shall provide and maintain voice and data communication facilities. ▪ Grid codes of Bhutan, India and Pakistan specify recording instruments shall be provided by users and licensees
Cyber Security	India	All utilities in India shall have in place, a cyber-security framework to identify the critical cyber assets and protect them so as to support reliable operation of the grid
International Inter-connection	**Bhutan**	by Agency assigned by the Ministry
	Bangladesh	by the licensee in consultation with the Commission and Ministry
	India	by the CTU in consultation with the CEA and the Ministry.

Cyber Security, Data communication and system recording facilities be mandated ?

Gap Analysis of SA countries : Metering Code

Metering code specifies the type, standards, ownership, location, accuracy class etc. and responsibilities of the generating companies/licensees and transmission and distribution licensees.

Country	Metering type	Standards	Ownership
Bangladesh	Generation, Transmission & Distribution meters for operational & commercial metering.	Bangladesh Standards/ relevant IEC	Operation metering owned by Generator/Transmission licensee. Commercial metering owned by Transmission licensee.
Bhutan	Energy Meters for Accounting purposes	Bhutan Standard	Licensee in whose premises meter is present.
India	Interface meters, Consumer meters, Energy Accounting & audit meters. All are of static type.	BIS. If not then IEC/BS	Interface meters and Consumer meters owned by Transmission licensees. Energy Accounting & audit meters owned by generating company/licensee.

Gap Analysis of SA countries : Metering Code

Country	Metering type	Standards	Ownership
Nepal	Operational metering & Bi-directional Energy meters for accounting.	Relevant IEC	Generating plants and Grid owner shall own their respective meters.
Pakistan	Revenue Metering	Relevant IEC	Grid users shall install and Own the revenue meters.
Sri Lanka	Static Energy & Demand meters. Also, revenue metering if required.	Relevant IEC	Grid users supply the meters. Transmission licensee responsible for Installing and owning them.

All meters for interconnection shall be owned by govt. Transmission Licensee/CTU

Energy Accounting and Audit functions - Coordinating mechanism (i.e, Bi-lateral) or separate agency?

Gap Analysis of SA countries : Metering Code

All grid codes specify that Metering point shall be at point of interconnection wherever possible.

Grid codes of Bhutan, Pakistan & Sri Lanka specify energy meters for billing shall be

- At HV side of Generator transformer
- At LV side of Power transformers at Grid substations

Indian grid code specifies that

- Interface meters shall be provided on
  - Transmission interconnection points of open access customers for billing purposes.
  - all outgoing feeders at a generating station,
  - one end of lines between substations under same licensee, both sides of the line between substations of different licensees and HV side of ICTs.

Gap Analysis of SA countries : Metering Code

Accuracy Class of Meters	• **0.2 class - specified in all grid codes.**
Meter Data Processing	• **Provision to transfer the meter readings at transmission connection point to remote location through data communication channels.** • **Meter data is processed by respective system operators/responsible agencies.**
Access	• **All the grid codes specify that the owner of the premises where, the meter is installed shall provide access to the authorized representative(s) of the licensee for installation, testing, commissioning, reading and recording and maintenance of meters.**
Procedures for testing & calibration and to manage Meter failures & Discrepancies	• **specified in all the grid codes.**

0.2 Accuracy class and above Guidelines can be followed for SA Cross Border trade

Gap Analysis of SA countries : Protection Code

Protection code specifies criteria or standards to be complied with by the grid protection schemes & also specifies the responsibilities of the concerned entities.

Country	Authority to prepare & review protection plan	Ownership
Bangladesh	Transmission Licensee	Users & Transmission licensee
Bhutan	System Coordination Committee	Users & Transmission licensee
India	RPC Secretariat, Protection Coordination Sub-Committee	Users, Transmission licensees & System Operator
Nepal	Grid Owner (NEA)	Users & Grid owner
Pakistan	NTDC	Users & NTDC
Sri Lanka	Transmission Licensee (CEB)	Users & Transmission licensee

Respective agency can be vested to prepare and review protection plan or need for co-ordination forum?

Gap Analysis of SA countries : Protection Code

Protection Scheme	Remarks
Back Up protection	Specified by all countries except Bhutan.
Circuit Breaker fail protection	Specified by all countries except Bhutan.
Bus Bar Protection	Specified by Bangladesh, India & Pakistan grid codes.
System Protection Schemes	Specified by only Bhutan & India grid codes. To protect from voltage collapse, cascade tripping and tripping of important corridors.
Generator protection	In India, all generators above 100 MW, shall have two independent sets of main protection schemes and a backup protection scheme. Other nations specify one main & one back up protection scheme.
Transmission Line protection	Each transmission line shall be provided with two sets of distance protection schemes and a backup scheme in Bangladesh, India & Pakistan. In Nepal, a minimum of one distance protection scheme and a backup scheme shall be provided. Sri Lanka & Bhutan do not specify transmission line protection scheme
Disturbance logging facilities	Disturbance recording & event logging facilities along with time synchronization facility for global common time reference shall be provided in India & Pakistan.

Gap Analysis of SA countries : Operation Code

Operating States:

- Only Bhutan grid code specifies the criteria for classifying an operating state as either Normal/Alert/Emergency.
- Pakistan grid code specifies 'N-1' contingency as emergency state.
- Other SA nations specify different security limits for Normal & Emergency conditions but they don't define the criteria for classifying "Emergency conditions".
- Indian grid code does not specify security limits for emergency conditions

	Bangladesh	Bhutan	India	Nepal	Pakistan	Sri Lanka
Voltage Variation	Normal: ±5% Emergency: ±10%	Normal: ±5% Alert: ±10%	Normal: ±5% for 400 kV, 765 kV ±10% for 220 kV & below.	Normal: ±5% Emergency: ±10%	Normal: 8% and -5% . Emergency: ±10%	Normal: ±5% for 132 kV, ±10% for 220 kV. Emergency: ±10%
Operating Frequency Variation	49 Hz to 51 Hz	Normal: 49.5 Hz to 50.5 Hz Alert: 49 Hz to 51Hz but above Normal range.	49.9 Hz to 50.05 Hz	48.75 – 51.25 Hz	49.8 Hz to 50.2 Hz	49.5 Hz to 50.5 Hz

Gap Analysis of SA countries : Operation Code

Operational Requirements of Generators

	Governor Action		AVR	PSS
Bangladesh	Yes. But Unit type, rating and droop details not given.	Free Governor Mode	Yes	-
Bhutan	Yes. Every Hydro unit above 10 MW. Droop: 3% to 10%.	Free Governor Mode	Yes. Every Hydro above 10 MW.	-
India	Yes. Every Thermal unit above 200 MW and Hydro above 10 MW. Droop: 3% to 6%. Dead band ± 0.03 Hz.	Restricted Governor Mode (no time delay allowed).	Yes. Every generator above 50 MW.	If installed, a plan prepared by CTU/RPC is followed for the tuning of the same.
Nepal	Only those units that form frequency regulating reserve.	Free Governor Mode	Yes	-
Pakistan	Yes. Every thermal unit above 100 MW and reservoir based generators.	Free Governor Mode	Yes.	-
Sri Lanka	Yes. Droop : 3% to 5%. Dead band ± 0.05 Hz.	Free Governor Mode	Yes.	-

Generators should follow the respective Operational Requirement of the Country of location

Gap Analysis of SA countries : Operation Code

Criteria	Country	Remarks
Generation Reserves	All SA nations except India	A part of installed generation capacity should constitute operational reserves
	India, Bhutan	All thermal generating units of 200 MW (India) and above and all hydro units of 10 MW and above (India & Bhutan) operating at or up to 100% of their Maximum Continuous Rating (MCR) shall be capable of instantaneously picking up to 105% and 110% of their MCR, respectively, when frequency falls suddenly.
Generation Ramping Up/Down rate	All SA nations	Ramping rate limits of the generator units should be considered while giving dispatch instructions to them.
	Bangladesh, Nepal	When frequency goes below 49 Hz/49.5 Hz or above 51 Hz/ 50.5 Hz, concerned generators shall ramp up/down at 2% per 0.1 Hz frequency deviation.
	Bhutan, India	The supplementary frequency control shall be 1% per minute or as per manufacturer's limits. However, during frequency going below 49.7 Hz, load pick-up shall be at a faster rate.

Gap Analysis of SA countries : Operation Code

Criteria	Country	Remarks
Special Requirements for Solar/Wind Generators	India	system operator shall treat Solar/Wind generators as “MUST RUN” stations and shall make all efforts to evacuate Solar & Wind power except when grid security/reliability is compromised.
Short term Demand Estimation for Operational Purposes	Bangladesh, Nepal, Pakistan , Sri Lanka	by Transmission licensees
	Bhutan	by System Operator and Distribution licensees
	India	Demand Forecast by SLDC’s Wind Energy Forecasting shall be considered while estimating the active and reactive power requirement.

Guide lines for activation of additional generation or reserves for changes in cross border flows

Gap Analysis of SA countries : Operation Code

Demand Management

Criteria	Country	Remarks
Demand Management	All SA countries	▪ System Operator & Distribution licensees shall provide arrangements for demand reduction during insufficient generating capacity/congestion/other operating problems. ▪ During under frequency conditions, the System Operator shall give demand control instructions to distribution licensees to reduce their drawl from the grid. ▪ India & Bhutan specify demand control during inadequate import from external interconnections too.

Respective authority needs to adhere to demand management control without effecting grid security

Gap Analysis of SA countries : Operation Code

Criteria	Country	Remarks
Demand Management	India	▪ Indian Grid code specifies, during normal frequency conditions also, demand management shall be carried out such that the over drawl/under-injection of each control area shall not exceed 12% of scheduled value or 150 MW, whichever is lower during each 15 minute time block. ▪ In India, each inter control area transmission line is assigned a Available Transfer Capability (ATC), Total Transfer Capability (TTC) and Transmission Reliability Margin (TRM) by the Transmission Licensee (CTU). CTU gives a warning to the entities involved if the line flow exceeds ATC and then applies congestion charges over and above Unscheduled Interchange charges if it exceeds TTC.

Common guidelines for capacity allocation for long term access and short term access with mandated ATC and TTC for cross border links and between countries?

Gap Analysis of SA countries : Operation Code

Operational Liaison

Criteria	Country	Remarks
Operational Liaison	Bhutan, India, Pakistan	▪ The procedure for Operational Liaison which is provisions for quick exchange of information in relation to events which had/will have an effect on the grid/user system. ▪ Before any operation is carried out by System operator, it shall inform the grid user, whose system shall/may have experience an operational affect and also give details of the operation. The vice-versa i.e. grid user informing the system operator also is applicable.

Guidelines for data communications under emergency conditions

Gap Analysis of SA countries : Operation Code

Load Shedding Schemes

Country	Automatic Load Shedding	Under frequency relays	df/dt relays	Demand Response	Grouping arrangements of Feeders/loads for Shedding
Bangladesh	Yes	Yes	-	-	Distribution Utilities shall provide estimates of discrete blocks of load that may be shed with the details of the arrangements.
Bhutan	Yes	If System operator requires	-	-	Distribution licensees shall provide details of arrangements of demand into discrete blocks to system operator.
India	Yes	Yes	Yes	Yes	Interruptible loads shall be categorised into four non-overlapping groups, scheduled, unscheduled, through under frequency/df/dt relays and through System Protection Schemes

Gap Analysis of SA countries : Operation Code

Country	Automatic Load Shedding	Under frequency relays	df/dt relays	Demand Response	Grouping arrangements of Feeders/loads for Shedding
Nepal	Yes	Yes	-	-	Distributor/HV Consumer shall split the demand into discrete MW blocks as specified by system operator.
Pakistan	Yes	Yes	-	-	System Operator shall provide automatic load shedding groups and the amount of load to be shed
Sri Lanka	Yes	Yes	-	-	Distribution details provide details Identifying feeders as essential and non-essential loads with non-essential loads further categorized in the order of priority.

Cross border Grid code would not specify load management excep in case of special protection to limit the power flow in AC interconnection

Gap Analysis of SA countries : Operation Code

Outage Planning

All grid codes specify procedures to prepare a coordinated generation and transmission outage schedule for the year ahead considering load-generation balance and operating conditions.

Country	Responsible for Final Outage Plan	Submission of Outage Plan by grid users	Release of Final Outage Plan	Review of Outage Plan
Bangladesh	Transmission Licensee	March 31	May 31	Monthly
Bhutan	System Operator	December 1	December 31	Monthly/Quarterly
India	RPC Secretariat	November 30	January 31	Monthly/Quarterly
Nepal	System Operator	Mid March	Mid May	3 year rolling plan
Pakistan	NTDC		April 30	Quarterly
Sri Lanka	Transmission Licensee	November 30	December 31	Monthly

Guide lines for outage management and information sharing between countries –Bi-lateral or SA co-ordination forum?

Annual, monthly, weekly, and daily basis

Gap Analysis of SA countries : Operation Code

Recovery Procedures & Event Information

Criteria	Country	Remarks
Recovery Procedures	All SA countries	All grid codes have laid down provisions for recovering the system from a total/partial Black Out.
	Bangladesh	Responsible by NLDC & Transmission licensee
	Bhutan, Pakistan	Responsible by System Operator
	Sri Lanka	Responsible by Transmission licensee
	India	RLDC's
Event Information	Bangladesh, Bhutan, India, Pakistan	Specify the incidents to be reported, the reporting route to be followed and information to be supplied to ensure consistent approach to the reporting of incidents/events.

Guidelines for recovery procedure under failure of cross border lines by respective system operators

All countries connected through AC and DC

Gap Analysis of SA countries : Scheduling and Dispatch Code

Schedule & Dispatch code specifies the Demarcation of Scheduling & Dispatch responsibilities among System Operator, Transmission licensees, Grid Users and other entities involved in Electricity Sector.

Task	Bangladesh	Bhutan	India	Nepal	Pakistan	Sri Lanka
Generation Dispatch	Centralized	Centralized	De-centralized	Centralized	Centralized	Centralized
Drawl/ Injection Dispatch	-	Distribution licensees & cross-border transfer to India	De-centralized. Shall be done by RLDCs	-	-	-
Nodal Agency	System Operator	System Operator	ISGS by RLDC. Intra state by SLDCs.	System Operator	System Operator	System Operator

Gap Analysis of SA countries : Scheduling and Dispatch Code

Scheduling Procedure

Task	Bangladesh	Bhutan	India	Nepal	Pakistan	Sri Lanka
Capability Declaration	Before 12 noon	0930 hrs	0800 hrs	Before 12 noon	1000 hrs	Before 12 noon
Drawl declaration	-	0930 hrs	1500 hrs	-	-	-
Dispatch Schedule Informed	1700 hrs	1800 hrs	1800 hrs	1600 hrs	1700 hrs	1500 hrs
Time blocks	1 hour	1 hour	15 minute	1 hour	Half hour	1 hour

Common Guidelines for scheduling and dispatch for cross border flows?

To adopt common time reference – Indian Standard Time

Common Settlement period – 15 minutes

Gap Analysis of SA countries : Scheduling and Dispatch Code

- Pakistan and India grid codes specify that for generators which work with different fuels, availability shall be declared with respect to each fuel type.
- Only Indian grid code has provided methodology for re-scheduling wind and solar plants on a three hourly basis.
- Indian grid code specifies that the hydro generators are expected to respond to frequency & inflow fluctuations. Hence they are free to deviate from the schedule and shall be compensated for the difference in energy on the 4th day. Other grid codes do not specify the same.
- All grid codes specify that reactive power drawl from grid is discouraged. Only Indian grid code specifies VAR drawl charges for discouraging the same.
- In India, hydro generating units of capacity 50 MW and above shall be capable of operation in synchronous condenser mode. The quantum of absorption/injection of reactive power shall be instructed by the appropriate load dispatch centre.

Gap Analysis of SA countries : Scheduling and Dispatch Code

Indian grid code has laid down regulations:

- CERC (Deviation Settlement Mechanism & related matters) regulations, 2014: Establishes a mechanism for charging the control areas for deviating from the scheduled drawl/injection.
- CERC (Power Market) Regulations 2010 and CERC (Open Access in inter- State Transmission) Regulations, 2008 establish procedures for scheduling collective transactions i.e. buyers and sellers of power to participate in power trade through Power Exchange(s).
- CERC (Sharing of Inter State Transmission Charges and Losses) Regulations, 2010 specify mechanism for sharing transmission charges and losses among designated transmission customers.

Other grid codes have not specified mechanisms for Deviation Settlement, Operating a Power Exchanges, Relieving Congestion etc.

Deviation settlement not to form part of Technical guidelines

Way Forward: Capacity Allocation & Congestion Management

The following aspects shall be considered while making guidelines for cross border Capacity Allocation & Congestion management.

- Each country shall provide ATC and TTC for specific cross border transmission paths for long term and short term trading.
- Capacity calculation methodology considering reliability margin, contingency, local system changes etc.
- Coordinated curtailments on long term allocations
- Capacity allocations for day ahead and intra day operations
- Congestion relieving mechanisms

Introduction : SOUTH ASIA

In South Asia, cross-border links for electricity trade have been established between India-Bhutan, India-Nepal, Bangladesh-India, Pakistan-Iran etc., and many more have been planned.

The first major interconnection between Bhutan and India was commissioned in 1984 with 220kV interconnection between Chukha (Bhutan)-Birpara (India/West Bengal). This was followed by 400kV interconnection with two 400kV, double circuit Tala (Bhutan) – Siliguri (West Bengal) lines.

The Bangladesh and India interconnection was agreed in 2009 with 500MW cross-border link and commissioned in October 2013. By 2017 end, its capacity is planned to be doubled to 1000MW.

400 kV Muzaffarpur (India)-Dhalkebar (Nepal) double circuit line is under construction and is likely to be completed by 2015 end.

Introduction : Benefits of Cross Border Electricity Trading

By interconnecting systems with different load curves and diversity, overall load factor improves and generating capacity is efficiently utilized.

The feasibility of a cross-border interconnection is a function of a large number of factors such as:

Social acceptability	Security of transmission corridor
Political decision	Economic viability
Financing of interconnection	Technical feasibility of interconnection
Long-term PPA or agreement on market coupling	Acceptability of commercial terms & conditions
Satisfactory dispute resolution mechanism	Feasibility of integrated grid operation

It can facilitate large scale integration of renewable energy which reduces dependency on fossil fuels and also diversifies energy supply.