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Integrated Research and Action for Development
IRADe

SOUTH ASIA REGIONAL INITIATIVE FOR ENERGY INTGRATION (SARI/EI)

Key Findings of the Study

on

Regional Regulatory Guidelines

&

Harmonization of Grid Codes, Operating Procedures, Standards for promoting Cross Border Electricity Trade in South Asia Region

Second Meeting of the SAARC Energy Regulators

08-09 February,2016

Colombo, Sri Lanka

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South Asia Regional Initiative for Energy Integration (SARI/EI)

- **SARI/E is a long standing program of USAID started in the year 2000.**

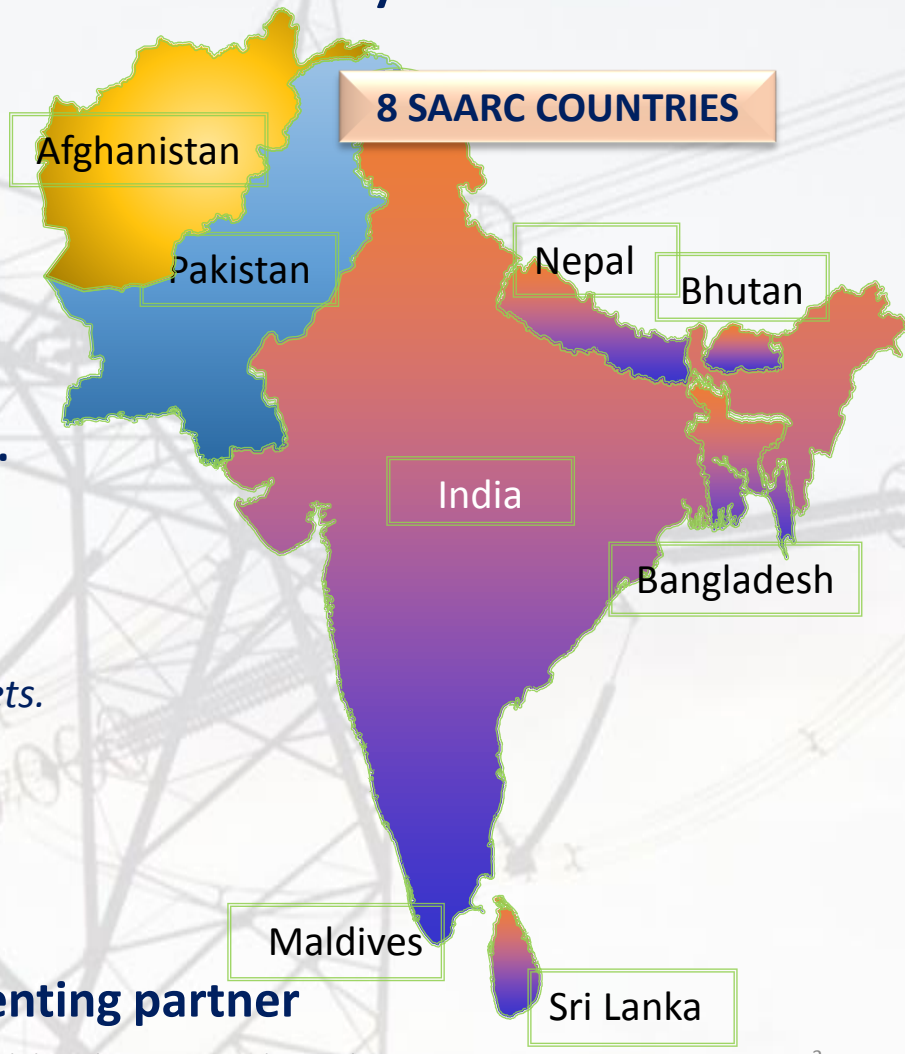
- **Program has consistently strived to address energy security in South Asia by focusing**
  1) Cross Border Energy Trade
  2) Energy Market Formation and
  3) Regional Clean Energy Development.

- **SARI/EI–Phase IV (2012-2017): Key Outcomes.**
  Three Key Development Outcomes:
  1. *Coordinate policy, legal and regulatory issues.*
  2. *Advance transmission interconnections.*
  3. *Establish South Asia Regional Electricity Markets.*

- **First Three Year of the Program is Completed.**

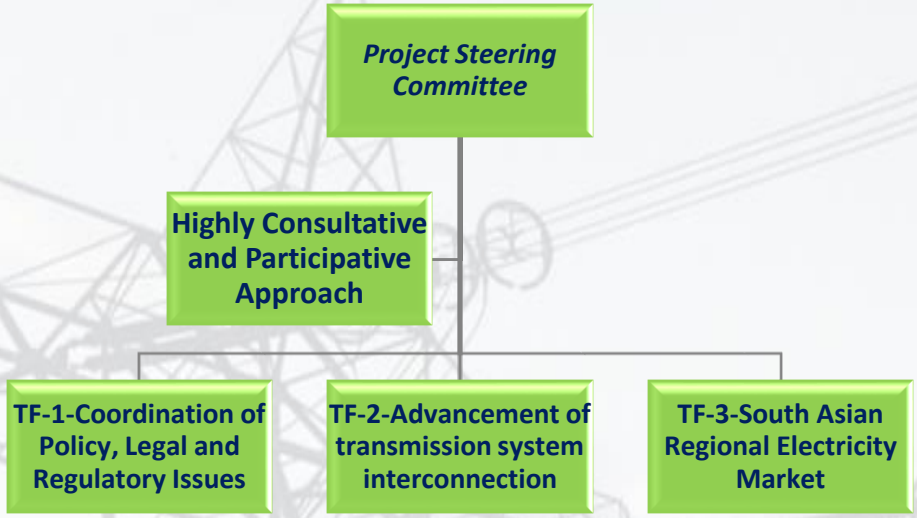
- **Demand Driven 'Bottom Up' Approach**

- **IRADe, a regional organization, is implementing partner**



SARI/EI Framework

- **Project Steering Committee (PSC)** is the apex body of the program and provides overall strategic directions.
- PSC members consist of government nominated **Senior level officials from the country governments, SAARC, ADB, Independent Energy Experts/Diplomats.**
- Task Force Members are represented by **government nominated members from Regulatory Technical , market related institution of each SA countries.**

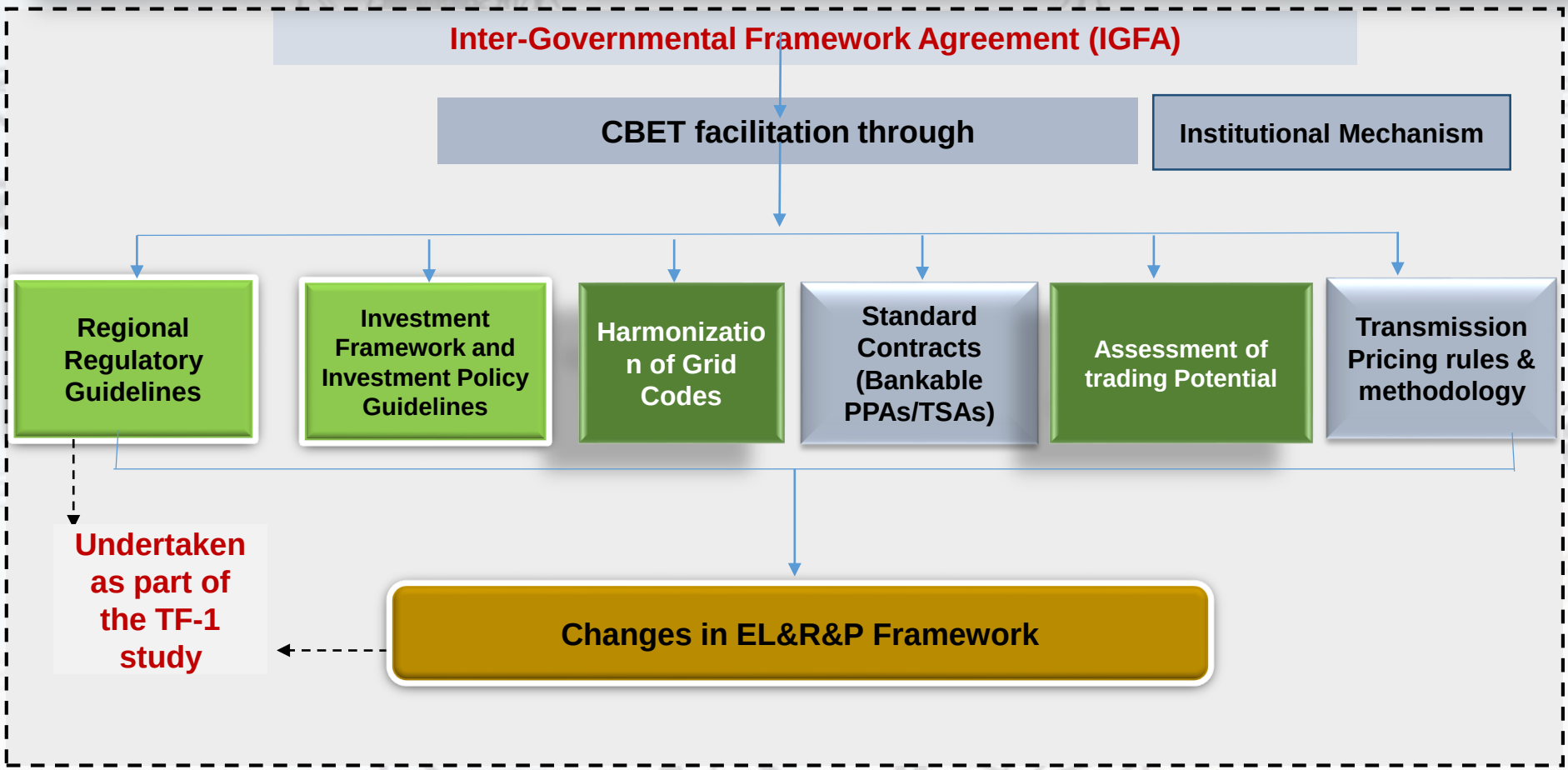


- **TF1: Coordination of Policy, Legal and Regulatory issues**

- **TF-2: Advancement of transmission system interconnection**

- **TF 3: South Asian Regional Electricity Market**

Overall Framework for development of CBET in South Asia

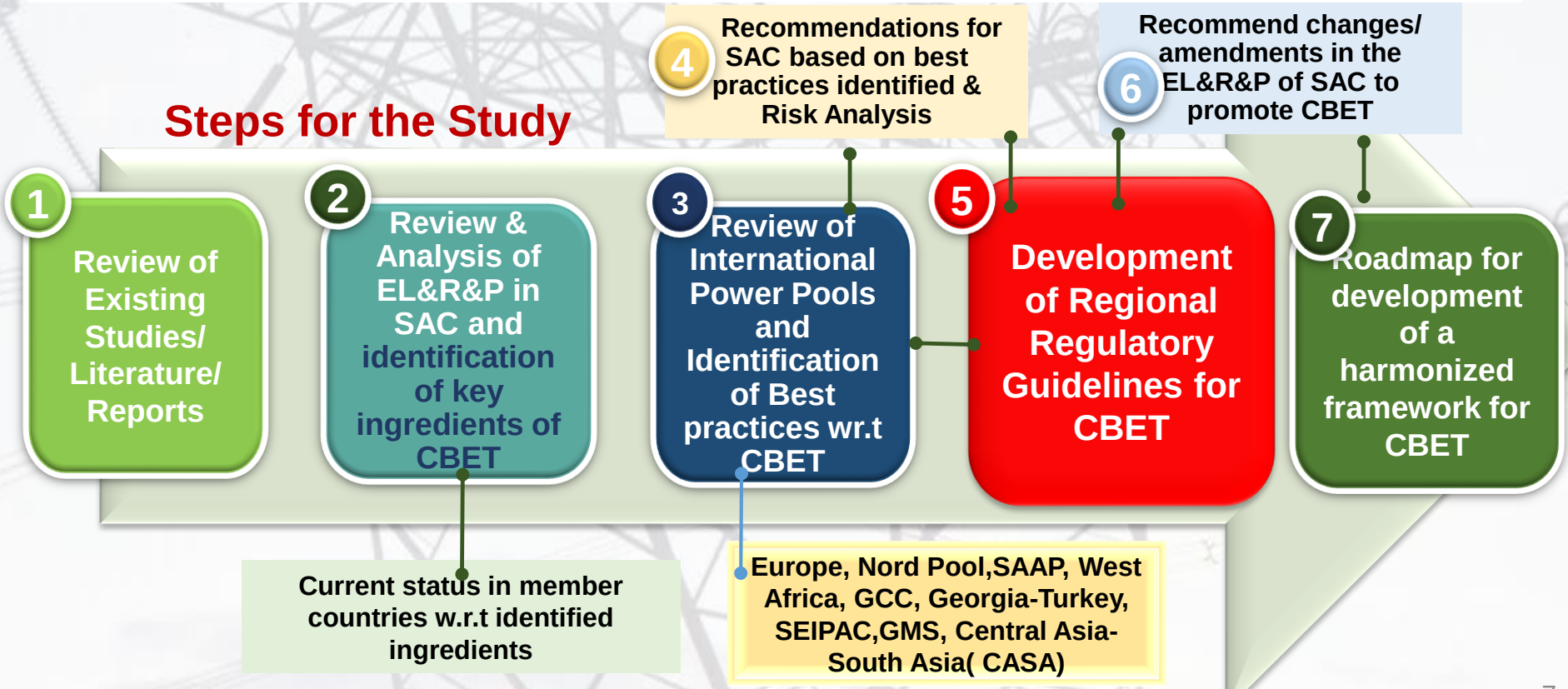


Regional Regulatory Guidelines for promoting Cross Border Electricity Trade in South Asia Region

Background and Approach of the Regional Regulatory Guidelines

Background-*Regional Regulatory Guidelines* *is one of the outcome of the TF-1 study on Review of Electricity Laws, Policies and Regulatory framework of SAC to identify critical requirements of CBET and recommend changes/amendments therein for consideration of the SA countries*

Steps for the Study



International Review : Key Challenges and risk for CBET

Key Challenges

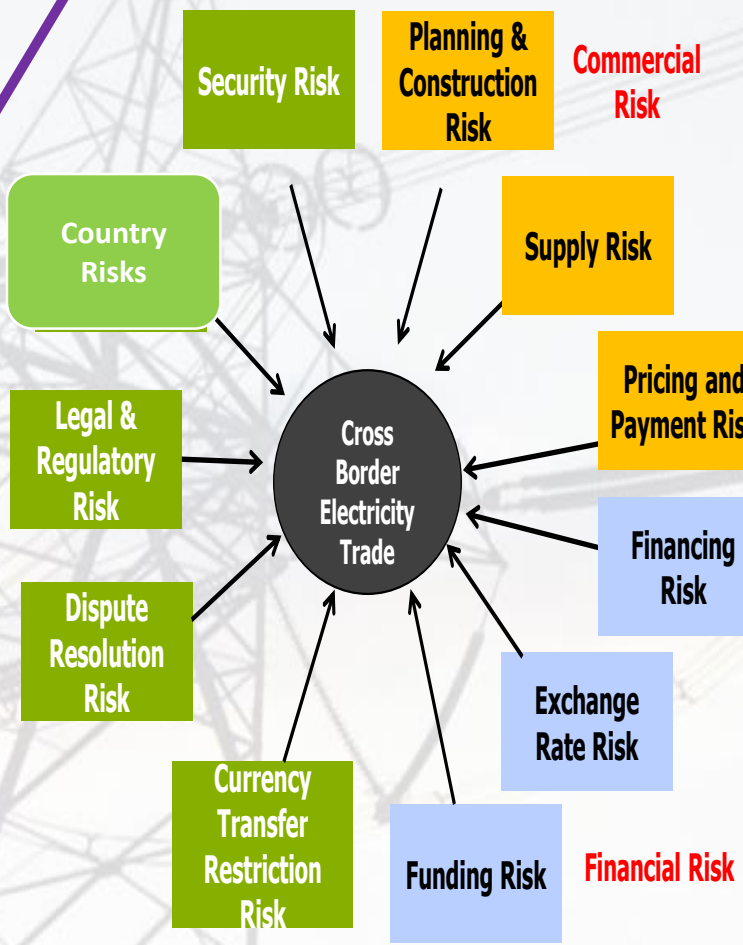
1. Political Conesus : Regional Cooperation and Recognition of CBET/Trade in the National Policy, Law
2. Government Commitment & Policy Coordination
3. Financial Challenges, Investment , Financial Viability
4. Mechanism of Inter-connection
5. Market form of Trade
6. Regional Cooperation on Regulatory and Contractual Aspects
7. Open Access in Transmission
8. Transmission Charges/Pricing
9. Transmission Plan
10. Commercial Mechanisms to Settle Imbalances
11. Dispute Resolution

Regional Power System/ at Initial Stages

Regional Power System at in Transition and Mature Stages

Motivation behind these challenge is to address the typical Risks in Cross-Border Projects.

What are the Risk?



Regional Regulatory Guidelines

- **Context**
- **Preamble**
- **Purpose of Guidelines**
- **Summary of Guidelines**
  - *G1: Licensing for cross border trading*
  - *G2: Open access to transmission network*
  - *G3: Transmission pricing regime*
  - *G4: Transmission planning*
  - *G5: Imbalance settlement mechanism*
  - *G6: Harmonization of Codes*
  - *G7: Dispute Resolution*
  - *G8: Duties and tax regimes*
- **Implementation of Guidelines**

Context of Regional Regulatory Guidelines

Context of the guidelines

- CBET in the region is largely on bilateral basis and is limited
- This is set to change with several new transmission interconnections being proposed that will enable greater integration of power systems in member countries
- Harmonization/coordination of EL&R&P framework is a critical requirement
- The agreements/guidelines needs to recognize the diversity in countries
- Be compatible with respective country's EL&P&R framework

Existence of political will and consensus is evident from the IGFA

The **SAARC Inter-Governmental Framework Agreement (IGFA) for Energy Cooperation**, signed by Foreign Ministers of the eight member states **provides a strong basis for ensuring consistency in certain identified areas** of trade as follows

- *Article 4 (Duties & Taxes)*
- *Article11 (System Operation and Settlement Mechanism)*
- *Article 12 (Transmission Access)*
- *Article 15 (Regulatory Mechanisms)*

It is important to provide actionability to the Articles by defining them into operating rules and common guidelines w.r.t CBET transactions

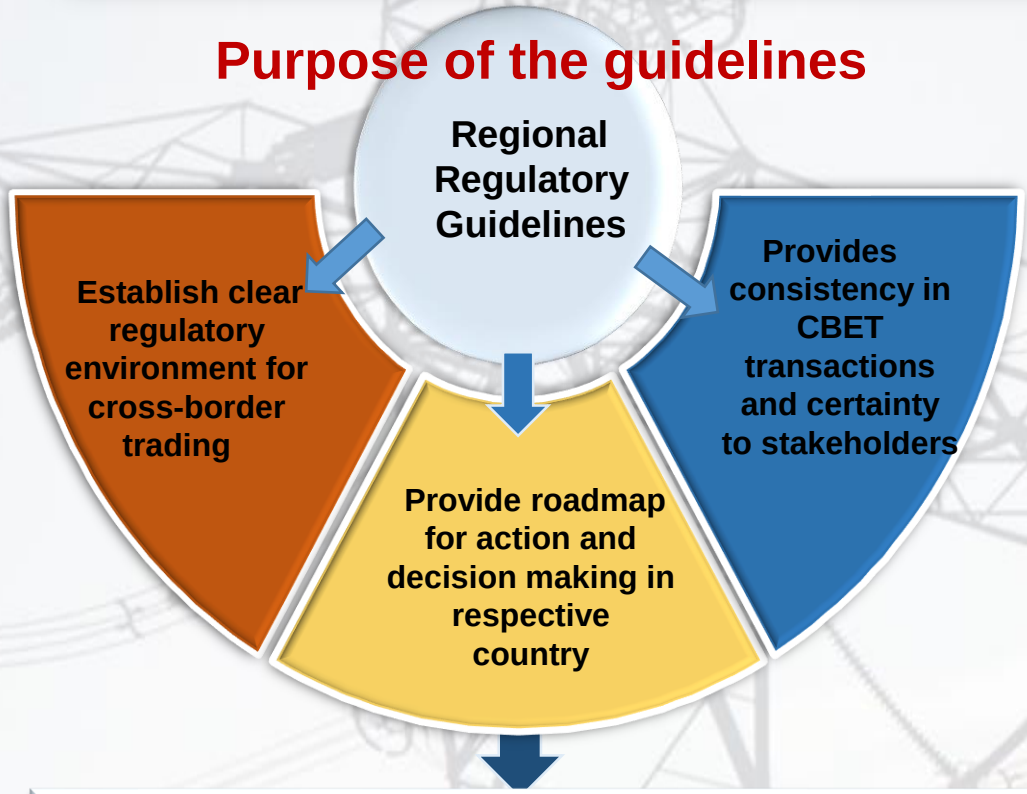
The guidelines are based on the review of the existing CBET transactions and the existing laws, policies and regulations and review of international experience of various power pools

Preamble to the Regional Regulatory Guidelines

- *These regulatory guidelines apply to CBET among the South Asian countries.*
- *These guidelines are **non-binding in nature and are aimed to provide national regulators of SAC with a consistent set of guidelines** applicable to CBET*
- *The **guidelines deal only with limited areas where need for such common guidelines has been felt** by the SAC and are not meant to be comprehensively dealing with all matters related to CBET. **For all other purpose, respective national regulations, rules and guidelines shall apply**.*
- ***Appropriate Institutional Mechanism is required for facilitating and working towards enabling the guidelines and facilitating the required changes** to be made in the national regulatory framework. Such entity shall work in close coordination with the National Energy/Electricity Regulators and SAARC for the same. Study has proposed a Forum i.e South Asia Forum of Electricity **SAFER for the Coordination, and facilitate the implementation of the RRGs.***
- *In countries where regulators do not exist, the responsibilities shall rest with relevant ministry and/or empowered entity .*

Purpose of Regional Regulatory Guidelines

Purpose of the guidelines



The flexible nature of the guidelines and focus on specific aspects of CBET, would permit both the guidelines and the national regulatory framework to co-exist for a reasonable period of time.

Specific aspects requiring consensus through common operating principles

1. ***Licensing for cross border trading***
2. ***Open access to Tx network***
3. ***Transmission pricing regime***
4. ***Transmission planning***
5. ***Imbalance settlement mechanism***
6. ***Harmonization of Codes***
7. ***Dispute Resolution***
8. ***Duties and tax regimes***

Brief Summary of Regional Regulatory Guidelines

1 **Licensing for CBET: (***Important Regulatory Tool for Trading)*

- *Recognition of Trading as a* ***separate licensed business activity***
- *Grant of license for CBET* ***through a well defined process***
- ***License requirements*** *and the underlying rules/limitations*

2 **Open access to transmission system:** *(Competitive Market)*

- ***Setting of fair rules and procedures*** *for non-discriminatory open access*
- ***Modification/amendment of applicable regulations and gradually legally binding provisions***
- *Defining* ***application process, eligibility criteria, priority order*** *and nodal agency for OA*

3 **Transmission Pricing: (***cost reflective & efficient)*

- *Transmission pricing mechanism based on a* ***country's requirement and acceptability***
- *Setting up* ***principles and mechanism for determination of economically efficient transmission pricing regime*** *and gradually adopting methods based on the concept of location specific pricing*
- *Adoption of* ***tariff framework in respective country power system through enabling regulations***

4 **Imbalance Settlement:** *(transparent common procedure)*

- *Member Countries to* ***develop a common set of procedures for Imbalance Settlement for*** *CBET transactions*
- *This will include* ***preparation of scheduling, dispatch, energy accounting and settlement procedures*** *for both AC-AC & AC-DC interconnections in the region*

Brief Summary of Regional Regulatory Guidelines

5 **Transmission Planning:** *(coordinated Regional Planning)*

- ***Development of a regional coordination forum of National Transmission Utilities*** *to coordinate between Member Countries on transmission planning aspects*
- ***Development of a database of information that enables coordination*** *and cooperation towards transmission planning*
- ***National Transmission Plans*** *to also* ***include details of cross border transmission lines*** *(specifically for CBET) & associated infrastructure*
- *Sharing of the national transmission plan at the regional level and progress towards* ***developing a regional level master plan***

6 **Harmonization of codes:** *(safe and reliable regional integrated system operation)*

- ***Harmonization*** *through* ***formulation of guidelines on technical standards for interconnection of power systems*** *on aspects related to voltage standards, frequency tolerance, thermal limits etc.*
- ***Sharing of technical characteristics and system specific data*** *among the member countries*
- ***Rules on metering standards, communication technologies****, Protection Schemes etc.*

7 **Taxes & Duties:** *(for fostering investment and removing trade barriers)*

- *Countries to* ***gradually move towards a zero tax regime***

8 **Dispute Resolution:** *(transparent and fair legal framework)*

- *Dispute Resolution process should primarily be in accordance with the* ***agreements or through amicable settlement***
- ***Referring the disputes to the SAARC Arbitration Council in case the member countries are unable to resolve disputes*** *through amicable settlement*

International Best Practices

ACER
Agency for the Cooperation of Energy Regulators

ACER in European Union

Issues non-binding opinions and recommendations to national energy regulators, transmission system operators

- Fosters cooperation among European energy regulators,
- Ensures market integration and harmonisation of regulatory frameworks.
- Formulates Framework Guidelines related to regulation on System operation, connection and capacity allocation etc. leads to network codes.
- Harmonization of Transmission tariff

RPTCC
(Regional Power Trade Coordination Committee)

RPTCC in Greater Mekong Subregion

High level body **responsible for coordinating and guiding the market development**

- *Specifying **basic rules and guidelines for power trading** among Parties*
- *Providing **recommendation for the overall policy** and day-to-day management of regional power trade;*

RERA
Regional Electricity Regulators Association of Southern Africa

RERA in Southern Africa (SAAP)

Responsible for Cooperation on regulatory & contractual aspects through common set of regulatory guidelines

- **Regional Guidelines for regulating cross-border power trading.**
- ***Making Compatible regulatory decisions***
- ***Approving cross-border agreements** in transit countries*
- ***Promoting transparency in the regulation** of cross-border trading*

ECOWAS Regional Electricity Regulatory Authority (ERERA) in West Africa.

Ensure the regulation of interstate electricity exchanges and to give appropriate support to national regulatory bodies or entities of the Member States.

- *Framework for cross Border Electricity trade.*
- ***Regulatory coordination and harmonization of regulations.***
- *Various regulation and guidelines related to the system operation, transmission tariff etc.*

Harmonization of Grid Codes, Operating Procedures, Standards for promoting Cross Border Electricity Trade in South Asia Region

Why Harmonization of Grid Codes ?

- As different power systems of SA country are required to be interconnected for the purpose of CBET, it is important various technical aspects of grid codes, operating procedures and standards needs to be harmonized/coordinated for safe, reliable and stable operation of the interconnected system.
- Harmonization means adjustment of differences & inconsistencies among measurements, methods, procedures, schedules, specifications of systems to make them uniform or mutually compatible.
- Compatibility depends on the type of interconnection.
- In case of a synchronous interconnection, voltage, basic insulation strength, nominal frequency and protection scheme etc. are important.
- In case of asynchronous interconnection may require less level of harmonization.

Brief Scope of Work

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.

Gap Analysis and to 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" and ;

International experience and impact and to develop framework guidelines along with draft codes for SA region.

Study Methodology

Phase I
1. Project Inception

- 1.1 Project Kick-off
- 1.2 Work Plan Preparation
- 1.3 Preliminary Data Mapping, Comparison of South Asian Grid Codes 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 are being prepared)

- 3.1 Review of international grid codes on cross border trading
- 3.2 Impact Analysis of Grid Codes & Operating Procedures with respect to the International Review.
- 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. Workshop & Final Report Submission

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

Linkages with the SAARC Framework Agreement for Energy (Electricity) Cooperation

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

The connection guidelines would be in line with the overall intent of the Article 8, Article 9 and Article 10 of the SAARC Framework Agreement for Energy (Electricity) Cooperation .

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 SAARC Framework Agreement for Energy (Electricity) Cooperation .

SAARC
South Asian Association for Regional Cooperation
Framework Agreement for Energy (Electricity) Cooperation (SFAEC)

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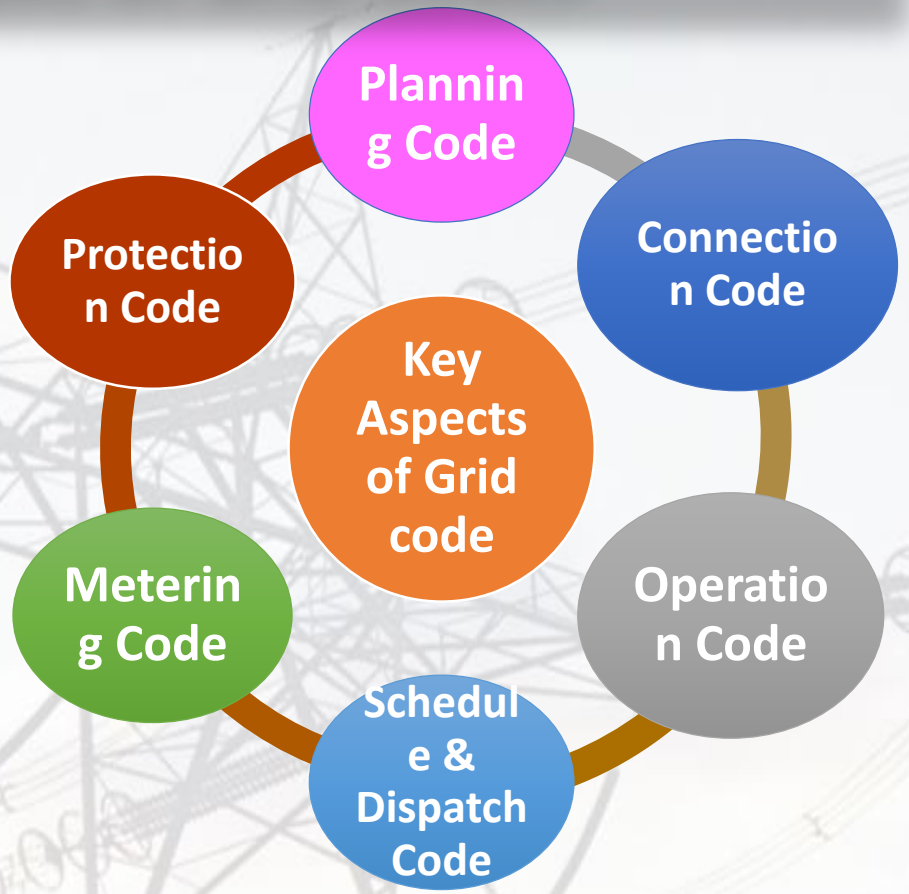
Review and Analysis of Grid Codes

- 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
- Review of Grid Codes Gap analysis was carried out across six key aspect of grid code i.e. Planning , Connection, Operation ,Metering ,Protection and scheduling & despatch.



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 in SA Region

Country	Grid code document	Electricity Sector Regulator
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	Grid code 2005	Department of Electricity Development/Ministry of Energy
Pakistan	Grid Code, 2005 and subsequent amendments	National Electric Power Regulatory Authority (NEPRA)
Sri Lanka	Grid Code, 2014	Public Utilities Commission (PUC)

Review of Grid Codes -Gap analysis : Key Findings (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%	+/- 5%	+/- 10%
Sri Lanka	+/- 5% for 132 kV, +/-10% for 220 kV	+/- 5% for 132 kV, +/-10% for 220 kV	+/- 10% for 132 kV, +/-10% for 220 kV
Pakistan	+/- 5% for 500 kV, 220 kV	+/- 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

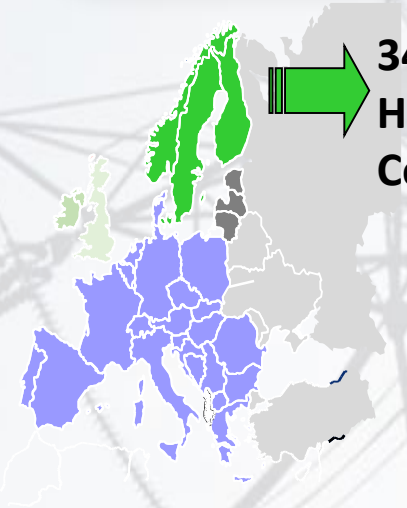
For EHV (above 400kV) +/-5%

Some of the Key Findings

1. At the cross border point of Interconnection, acceptable range of operating voltages shall be ± 5% for 400 kV and above transmission voltage levels.
2. All the connected equipment shall withstand the voltage variation of ±10%.
3. Each country has different frequency limits which needs to be harmonized for CBET interconnections, frequency band of operation of synchronised interconnection preferably should be within 49.9 Hz to 50.05 Hz.
4. All the connecting equipment shall withstand the 49 to 51 Hz and for limited duration beyond the specified limits.
5. Reactive Power: Participating generators must comply with respective country's regulation. Reactive power flow through cross border AC links shall be limited to 0.97 lead/lag at PCC.
6. Accuracy Class of Meters: 0.2 Accuracy class and above Guidelines can be followed for SA Cross Border trade.
7. Each country has different time blocks, preferably scheduling block for cross border transaction may be of 15 minutes duration.
8. Special protection mechanism to take care of deficiency in the system and single pole outage of HVDC links.

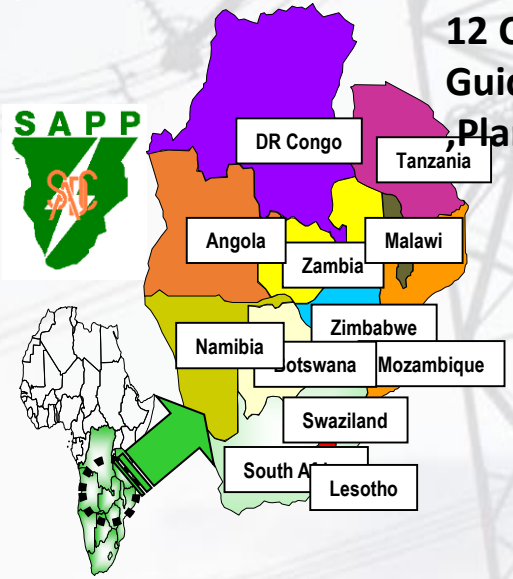
International experience Review and Impact Analysis

International Experience Review and Impact Analysis



34 European Countries : ENTSOe

Have developed Framework Guidelines(FG) and Network Codes across key areas: Connection, Operational (Operational Security , Planning ,Scheduling ,L/F Control & Reserve),Market Codes(CA and Congestion Management, Electricity Balancing)



12 Countries:
Guidelines on Operation ,Planning and Environment

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

NERC's area of responsibility spans the continental United States, Canada, and the northern portion of Baja California, Mexico.

Developed Various Standards related to Reliability Operation

International experience Review and Impact Analysis was carried out across a) Planning Code b) Connection Code c) Operation Code d) Metering Code

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International Experience - Transmission Planning Process and Criteria

European Grid Code/ENTSOe.

- TSO is responsible for planning,Upto 30 years ahead planning term –(categorized as mid, long & very long term)
- Contingencies listed and classified as Normal, Exceptional and Out Of Range.
- All TSOs are obligated to serve under an 'N-1' principle which is developed with the goal of preventing propagation of an incident.

NERC-Regulations/Standards

- Planning coordinator performs resource adequacy analysis.
- Apart from following year, studies carried out for up to 10 years(categorized as near and long term)
- Contingencies are classified as Normal, events resulting in single element loss, events resulting in multiple elements loss, extreme events resulting in single element removal or cascading outage.

SAPP Rules/Criteria, Grid Code

- Utility publishes the 5 year ahead Transmission System.
- Normal and N-1 contingency studies performed to assess reliability.
- Individual members develop criteria ensuring system security and reactive compensation.

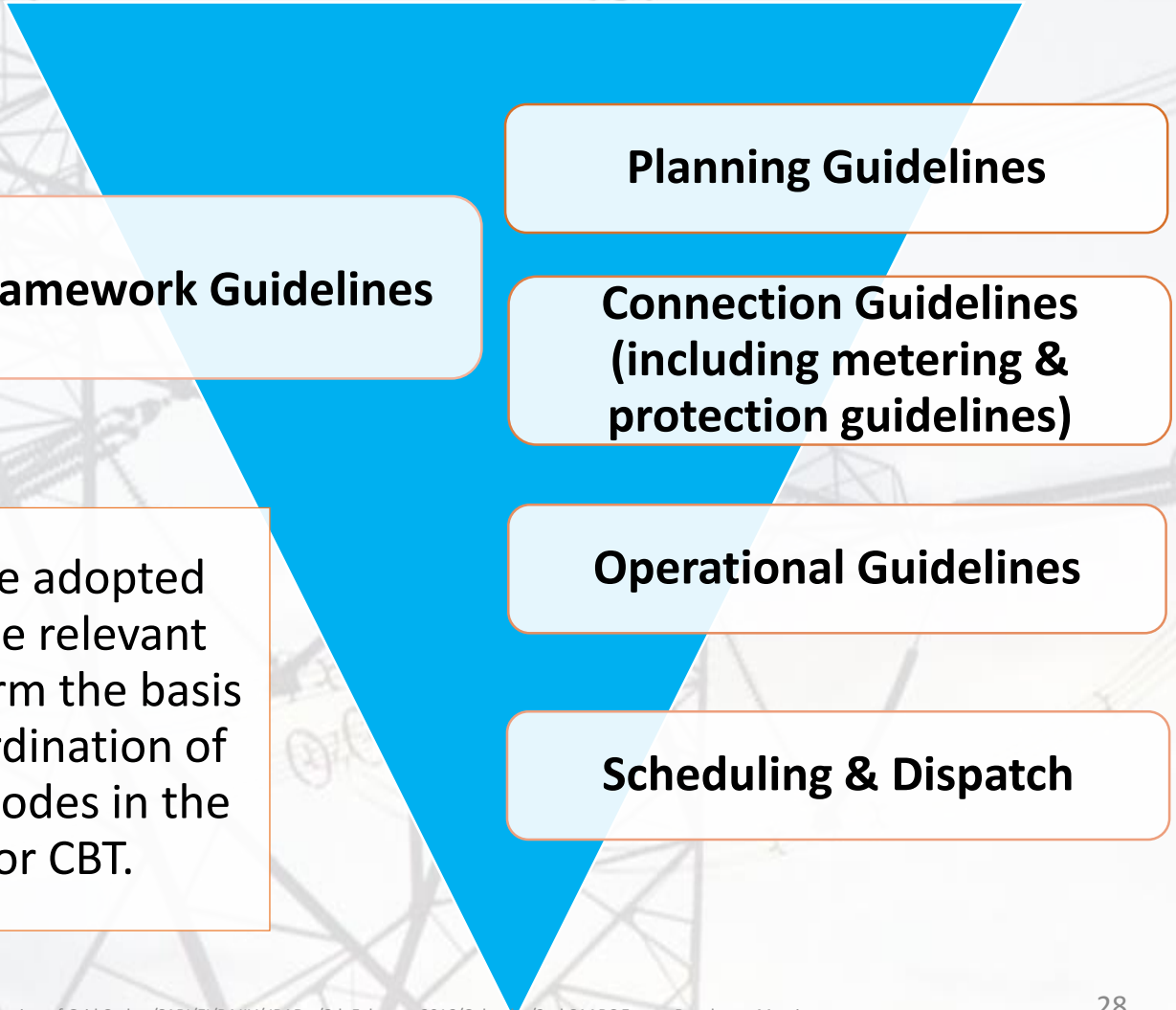
South Asian Countries' Grid Code

- Either a planning authority or the operator prepares the plan.
- Different time horizon followed by different countries ranging from 1 to 20 years.
- Normal and N-1 contingencies are applicable. N-1-1 also included in India. LFA, SCS, TRS studies are used for planning.

Recommendations:

1. It is critical to have a coordinating institutional mechanism.
2. Road map with Master Plan covering the next 10 years .
3. System modelling and running studies for security assessment and Contingency studies for both Asynchronous and Synchronous connections.

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: Development of Framework Guidelines

The Framework Guidelines will be comprehensive in nature and shall contain

Impact analysis	Explanatory statement	Draft code	Implementation Provisions

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.

Guidelines for Planning Code

It provides for the supply of information and stipulates the various criteria to be adopted for planning and development studies

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 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.

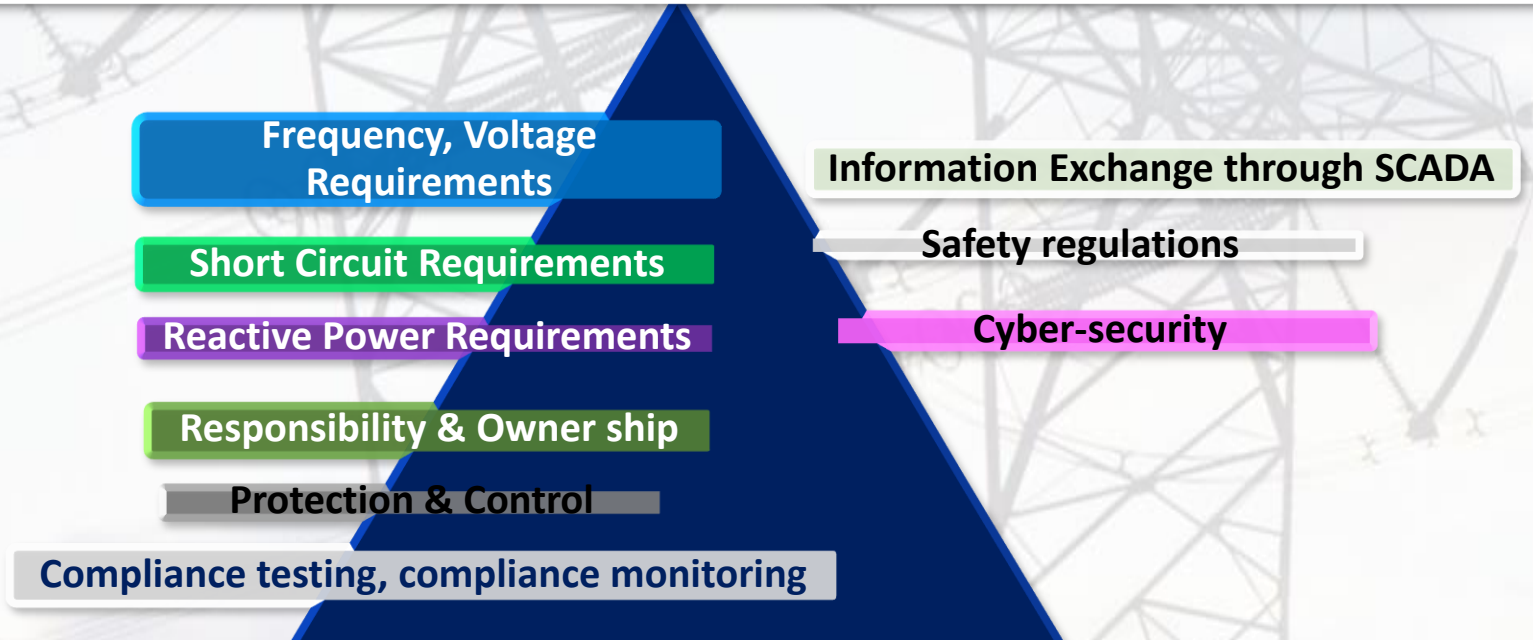
The planning guidelines considers the following

- ✓ Planning Philosophy
- ✓ Transmission Planning Criterion
- ✓ Transmission Reliability Criteria
- ✓ Planning Margins etc.
- ✓ 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

- It specifies a minimum of technical, design and operational plant criteria to be compiled with by the existing and prospective users.
- It includes the meter placement, compliance of meters according to standards in terms of accuracy levels, accessibility of the meters, maintenance responsibility of meters etc.,
- It covers the general protection guidelines to be followed for the generator, transmission licensees.

The following technical requirements has been considered while making for cross border connection code



Operational Guidelines

It contains details for high level operational procedures for example demand control, operational planning and data provision etc.

The following aspects has been 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

The following technical aspects has been considered while making for Operational Code

- Contingency analysis and handling
- Frequency control management
- Data Exchange (Scheduled & Real Time)
- Voltage & reactive power management
- Protection
- Short circuit management
- Stability management
- Power flow management
- Outage Management

Guidelines for scheduling & Dispatch

It describes the procedures to be adopted for Scheduling and despatch of generation and allocation of power drawl

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

- Frame 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

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

Implementation Philosophy -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

Implementation Philosophy –International Experience-Need of Institutional Mechanism

entsoe
Reliable Sustainable Connected

European Union
ENTSO-E's responsibilities in enhancing the cooperation between its 41 member TSOs across the EU to assist in the development of a pan-European electricity transmission network

- Developed the Network codes on on System operation, connection and capacity allocation etc.
- System Development Committee
- System Operation Committee.
- Market Committee
- 'Research Development Committee

SAPP

Southern African Power Pool
Aim to provide the least cost, environmentally friendly and affordable energy and increase accessibility to rural communities.
It is a Inter-Utility organisation established through Inter-Utility MOU

- *Operational Subcommittee*
- *Planning Subcommittee*
- *Environment Subcommittee*
- *SAPP Operating Guidelines*
- *DAM Book of Rules*
- *DAM legal Agreement*

pjm

PJM is a regional transmission organization (RTO) that coordinates the movement of wholesale electricity in all or parts of 13 states and the District of Columbia.

- ***Operating Agreement***
- ***Operating Committee (OC)***
- ***Planning Committee (PC)***
- ***Market Implementation Committee (MIC)***
- ***Markets and Reliability Committee (MRC)***
- ***Various other sub committees and task forces.***
- ***Consolidated Transmission Owners Agreement***

West African Power Pool

West Africa Power Pool:
Integrate the operations of national power systems into a unified regional electricity market.
Inter Utility Organisation, encompasses all WAPP Utility Members(26)

- Engineering and Operating Committee (**EOC**)
- Strategic Planning and Environmental Committee (**SPEC**)
- Operation manual of the WAAP
- Regional Market Rules for the WAPP
- Transmission Tariff Methodology WAPP
- 2012-2015 WAPP Business Plan

Way Forward

- Interim report on Framework guidelines is under review and finalization. The final report of the Study is expected to be concluded by April/May 2016.

- The study as well as the International Experiences (ACER, RERA, CEER, RPTCC, ENTSOe, SAAP, WAPP, GMS) shows that integration of power systems are sustained through strong institutional mechanism in the area of regulatory coordination, integrated system planning, operation, System protection and design etc.

- **For Coordination of Regulations**: Institutionalization of the Process through creation of South Asia Forum of Electricity Regulators (SAFER) OR any other appropriate Association/ Forum/ Working Group etc. for coordination of regulations in the region is critical. First Meeting of SAARC Energy Regulators have also endorsed the same.

- **For Coordination of integrated system planning, operation etc.** : Institutionalization of the Process through creation of South Asia Forum of Transmission Utility (SAFTU) OR any other appropriate Association/ Forum/ Working Group etc. for coordination of integrated system planning and operation in the region is also critical.

Thanks

Implementation of Regional Regulatory Guidelines

The proposed regional regulatory guidelines shall be implemented in a phased manner

Stage 1: Endorsement of Guidelines by National Regulators	Stage 2: Identification of changes/ amendments in National Regulations	Stage 3: Notification of new orders and changes/ amendment w.r.t CBET	Stage 4: Regional Regulatory Guidelines updated and adopted for CBET
Guidelines proposed will be in the **form of a non-binding framework guiding CBET**. Gradually a **legal status will be accorded** to the Guidelines.	National Regulators/ Empowered entities shall identify changes required in the national regulations	National Regulations or the proposed regional regulatory **guidelines will be updated or modified to ensure consistency**	Regular updation and improvement in guidelines Adoption by **National Governments giving a Legal status** **Becomes binding on all CBET transactions**
Proposed Guidelines will be **flexible with limited focus only on specific aspects of CBET**	**Changes proposed as part of this study are also referred** for making necessary amendments	Regional Regulatory Guidelines will be updated **basis other studies undertaken in the due course**	

The above steps will require consensus building and hence will need to be facilitated through a strong sponsor. The study proposes South Asia Forum of Electricity Regulators (SAFER) to manage this process or any other appropriate institutional mechanism.

Review of Grid Codes -Gap analysis : Key Summary on 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
Information Confidentiality	India: Nodal agencies shall provide the information to the public through various means of communications including internet. Other SA countries : Confidentiality of the user information made available to licensee shall be maintained.	

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

For CBET Planning : Respective Transmission Agencies plan /coordinated transmission planning/Planning Committee

Information confidentiality or available on Public Domain.

Review of Grid Codes -Gap analysis : Key Summary on Planning Code

Criteria	Country	Remarks
'N-1' contingency criteria for AC lines	All SA countries	In India, outage of single circuit at 400 kV and 765 kV levels and outage of double circuit at 132 kV and 220 kV levels is considered as 'N-1' outage whereas in other grid codes, at all transmission voltage levels, outage of single circuit is considered. N-2 criterion is applied to important load centres.
'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 system stability.**
Generator loss	India and Sri Lanka	**System shall survive the loss the largest/critical generating unit.**

Contingency criteria : In the synchronous interconnection, the criteria of N-1 or N-1-1 contingency shall be defined and adopted

Draft Planning Guidelines: Transmission Planning Criterion

The nominal frequency shall be 50 Hz. The steady state operational frequency limits shall be +0.05 Hz to -0.1 Hz. The instantaneous frequency limits shall be ± 0.8 Hz for the synchronously interconnected systems.

The temporary over voltage limits due to sudden load rejection shall be:

- 765 kV system 1.4 p.u. peak phase to neutral and 500 kV & 400 kV system 1.5 p.u. peak phase to neutral

The switching over voltage limits shall be:

- 765 kV system 1.9 p.u. peak phase to neutral
- 500 kV & 400 kV system 2.5 p.u. peak phase to neutral

Minimum short-circuit currents shall be assessed in bus-bars where a HVDC installation is connected. Short circuit ratio (SCR) at the converter terminals shall be greater than 3.

Planned maximum sub-transient short circuit fault levels shall not be greater than 80% of equipment ratings.

The line to earth voltage during single line to earth faults should not rise above 80% of the rated line to line voltage.

Draft Planning Guidelines: Transmission Reliability Criteria

Criteria for system with no contingency ('N-0')

- For the planning purpose all the equipment's shall remain within their normal thermal loadings and voltage ratings.
- The angular separation between adjacent buses shall not exceed 30 degree
- Voltage step resulting from capacitor/reactor switching shall not exceed 3.0%.

Criteria for single contingency ('N-1')

- All the equipment's in the transmission system shall remain within their normal thermal and voltage ratings after a disturbance involving loss of any one of the following elements , but without load shedding / rescheduling of generation:
  - Outage of a 400 kV single circuit,
  - Outage of a 400 kV single circuit with fixed series capacitor (FSC),
  - Outage of an Inter-Connecting Transformer (ICT),
  - Outage of a 765 kV single circuit,
  - Outage of one pole of HVDC bi-pole
- The angular separation between adjacent buses under ('N-1') conditions shall be permitted up to 30 degree
- The system shall be capable of withstanding the loss of most severe single system infeed without loss of stability.

Draft Planning Guidelines: Planning Margins

The new transmission additions required for cross-border transmission may be planned keeping a margin of 15% in the thermal loading limits of lines and transformers.

At the planning stage, a margin of about ±3% may be kept in the voltage limits and thus the voltages under load flow studies (for 'N-0' and 'N-1' steady-state conditions only) may be maintained within the limits given below:

- For 765 kV level, a maximum of 788 kV and a minimum of 742 kV
- For 500 kV level, a maximum of 515 kV and a minimum of 485 kV
- For 400 kV level, a maximum of 412 kV and a minimum of 388 kV

In planning studies all the transformers may be kept at nominal taps and On Load Tap Changer (OLTC) may not be considered. The effect of the taps shall be kept as operational margin

For the purpose of load flow studies at planning stage, the nuclear generating units shall normally not run at leading power factor. To keep some margin at planning stage, the reactive power limits (Qmax and Qmin) for generator buses may be taken as:

- Thermal Units: Qmax = 40% of Pmax, and Qmin = (-) 10% of Pmax
- Nuclear Units: Qmax = 40% of Pmax, and Qmin = (-) 0% of Pmax
- Hydro Units: Qmax = 50% of Pmax, and Qmin = (-) 20% of Pmax

Draft Planning Guidelines: Additional Planning Guidelines

Reactive Power Compensation Studies

- Requirement of reactive power compensation (static and/or dynamic) shall be assessed through appropriate studies for cross border transactions. This compensation shall be provided by the respective entities within a country and import of reactive power shall be avoided to the extent possible.

Cross-Border Sub-station planning criteria

- The maximum short-circuit level on any new substation bus shall not exceed 80% of the rated short circuit capacity of the substation equipment's.
- Rating of the various substation equipment's shall be such that they do not limit the loading limits of connected transmission lines.
- Effort shall be made to explore possibility of planning a new substation instead of adding transformer capacity at an existing substation. The maximum transformer capacity for different voltage levels shall be:
  - ***For 765 kV, 6000 MVA***
  - ***For 500 kV & 400 kV, 1500 MVA***
- While augmenting the transformation capacity at an existing substation or planning a new substation the fault level of the substation shall also be kept in view. If the fault level is low, the voltage stability studies shall be carried out.
- Size and number of interconnecting transformers (ICTs) shall be planned in such a way that the outage of any single unit would not over load the remaining ICT(s) or the underlying system.

Draft Operational Guidelines: System Security Aspects

Adequate operating reserves (Primary/Secondary/Tertiary) shall be made available for use during contingency conditions and large demand variation conditions in case of synchronous interconnection. The cross border links shall facilitate in the primary reserve process. However, it is desirable that the adequate control is established to restore the power flow to the scheduled level within a block period.

Each regional head shall provide and maintain adequate and reliable communication facility internally and with other heads to ensure exchange of data/information necessary to maintain reliability and security of the grid. Wherever possible, redundancy and alternate path shall be maintained for communication along important routes.

The system security limits shall be fixed as shown in Table

	Normal	Alert	Emergency
Voltage (400, 500 & 765 kV)	± 5%	± 5%	± 10%
Frequency – for synchronously interconnected system	Nominal: 50Hz Steady state limits: +0.05Hz to -0.1Hz Instantaneous limits: ± 0.8Hz	Exceeds steady state limits for upto 10 mins	Exceeds steady state limits for >10 mins up to 20 mins
Equipment loading	Within Limits	Within Limits	Exceeds limits of short term overload

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Guidelines for Planning Code

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 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 considers 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

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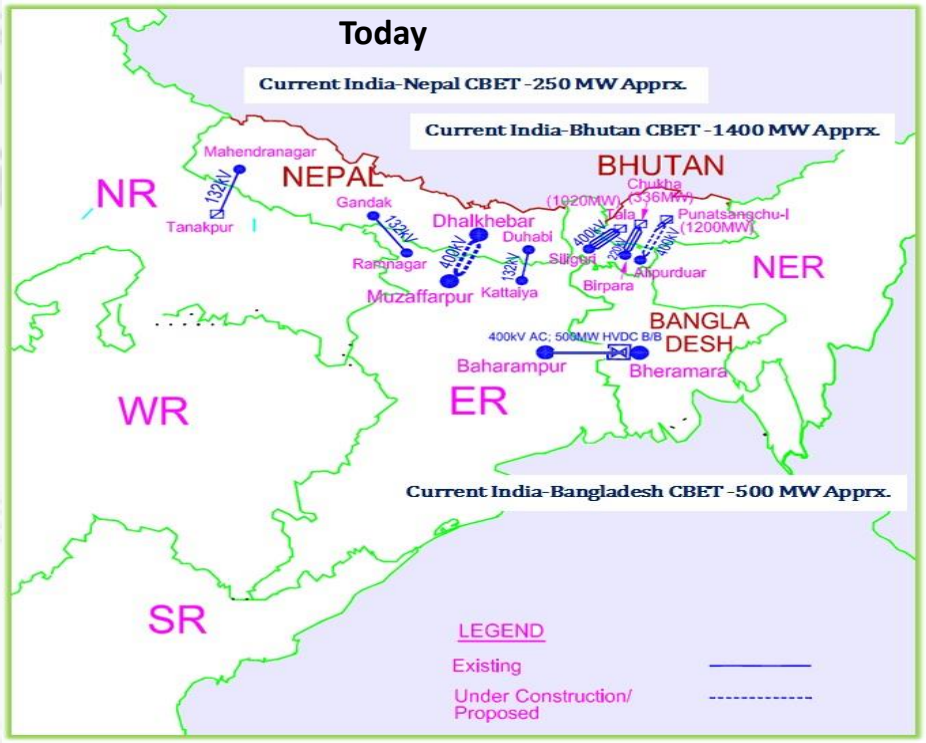
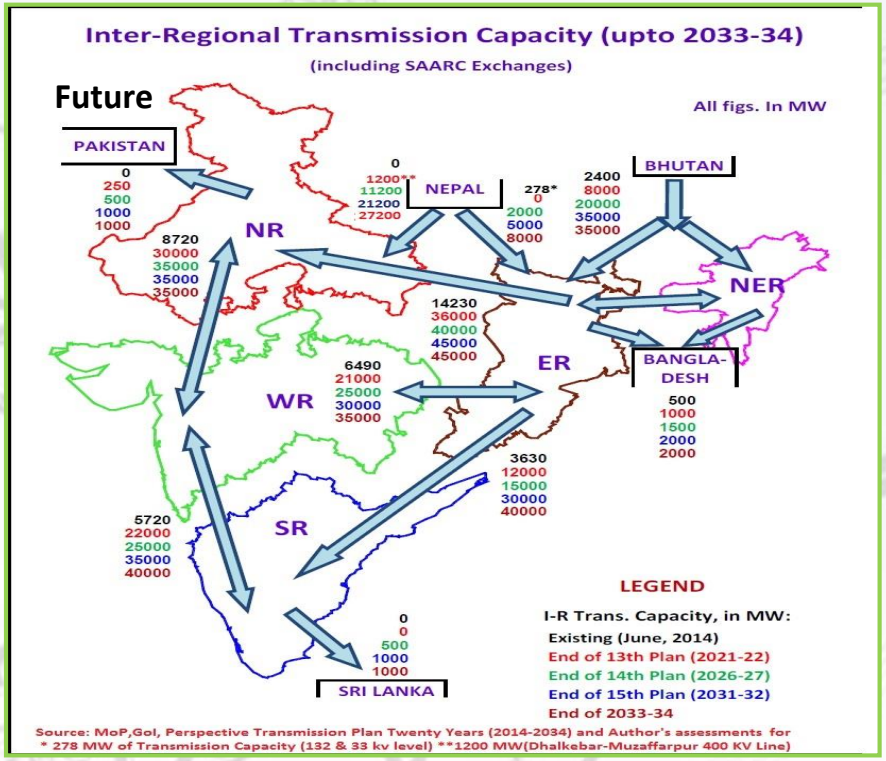
Background : What is the CBET Vision ?





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)

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(Frequency sensitive mode) 49.5-50.5 (Tolerance Frequency band) 49.4-50.5(Load sheading threshold and contingency frequency band)	49.5 Hz to 50.5 Hz

Brie of the Draft Guidelines

Planning Guidelines

- It provides for the supply of information and stipulates the various criteria to be adopted for planning and development studies

Connection Guidelines

- It specifies a minimum of technical, design and operational plant criteria to be compiled with by the existing and prospective users.
- It includes the meter placement, compliance of meters according to standards in terms of accuracy levels, accessibility of the meters, maintenance responsibility of meters etc.,
- It covers the general protection guidelines to be followed for the generator, transmission licensees.

Operation Guidelines

- It contains details for high level operational procedures for example demand control, operational planning and data provision

Schedule and despatch Guidelines

- It describes the procedures to be adopted for Scheduling and despatch of generation and allocation of power drawl

Draft Planning Guidelines

Draft Planning Guidelines: Objective & Applicability

OBJECTIVE

- To specify the principles, procedures and criteria which shall be used in the planning and development of the cross border interconnections,
- To promote co-ordination amongst all participants in any proposed development of the cross border interconnections,
- To provide methodology and information exchange amongst participants in the planning and development of the cross border interconnections;
- It covers **Planning Philosophy,,Transmission Planning Criterion, Transmission Reliability Criteria, Planning Margins etc.**

APPLICABILITY

- Planning guidelines shall apply to Planning agencies, Transmission utilities and other entities involved in the developing or using of the cross border interconnections.

Planning Guidelines: Planning Philosophy

The Master Plan shall form basis for the planning the interconnected network among member countries.

The Master Plan shall be formulated with the planning horizon of at least 10 years and reviewed every alternative year.

As the cross-border interconnection is expected to cater for the long term requirements of member countries, sufficient forecasting of demand and generation shall be carried out.

From practical considerations the load variations over the year shall be considered as under:

- Annual Peak Load
- Seasonal variation in Peak Loads for Winter, Summer and Monsoon
- Seasonal Light Load (for Light Load scenario, motor load of pumped storage plants shall be considered)

Reactive power plays a critical role in EHV transmission system management and hence forecast of reactive power demand on a system-wide basis is as important as active power forecast.

The load-generation scenarios shall be worked out so as to reflect in a pragmatic manner due to typical daily and seasonal variations in load demand and generation availability which impact the cross border power flow.