Session: Evolving Architecture of the 21st Century Grid with Two Way Power Flow

Topic: Planning towards Enhanced Grid Discipline & Grid Reliability in the Power System Operations in South Asian Region

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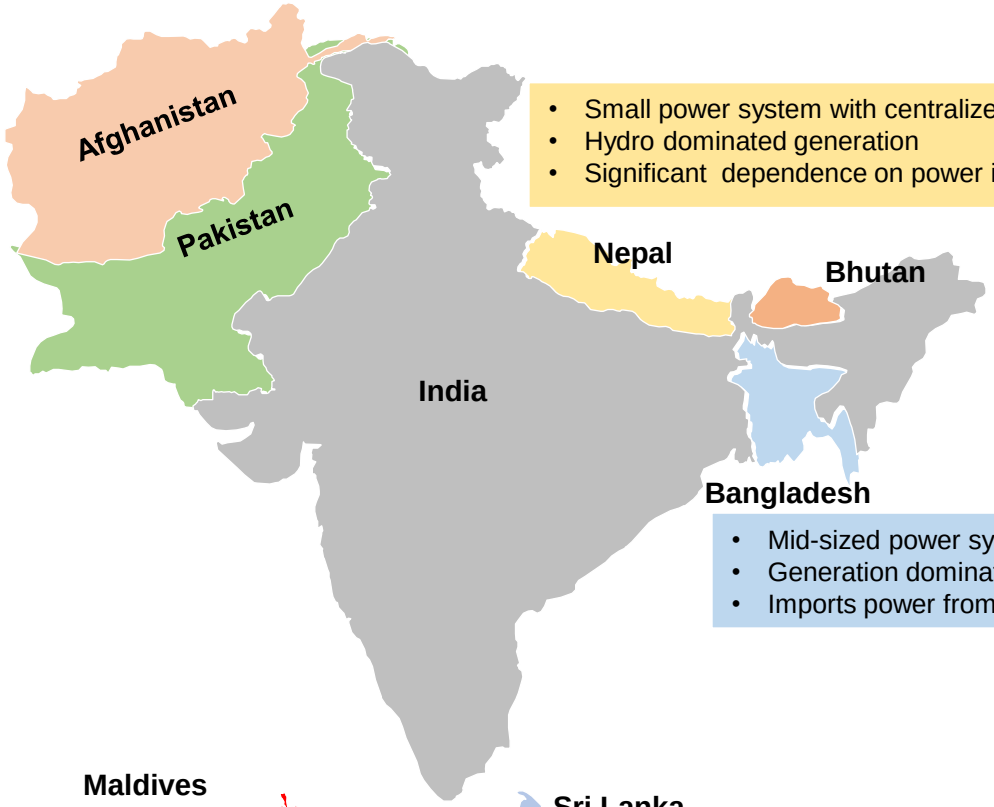
Introduction

Power Systems in South Asian Region (SAR) varies in Size and Operation

- Small power system
- Extensively dependent on power imports

- Mid-sized power system with centralized dispatch
- Fossil fuel dominated Generation

- Very Large power system
- State, regional & national level system operation
- Share of RE has grown rapidly in the past 5 years



- Small power system with centralized dispatch
- Hydro dominated generation
- Significant dependence on power imports

- Small power system with centralized dispatch
- Generation completely hydro based
- Exports power to India

- Mid-sized power system with centralized dispatch
- Generation dominated by oil and gas
- Imports power from India to meet shortfall

- Isolated island level power system with integration challenges & Generation dominated by oil capacity

- Small power system with centralized dispatch
- Generation dominated by fossil fuel and hydropower capacity

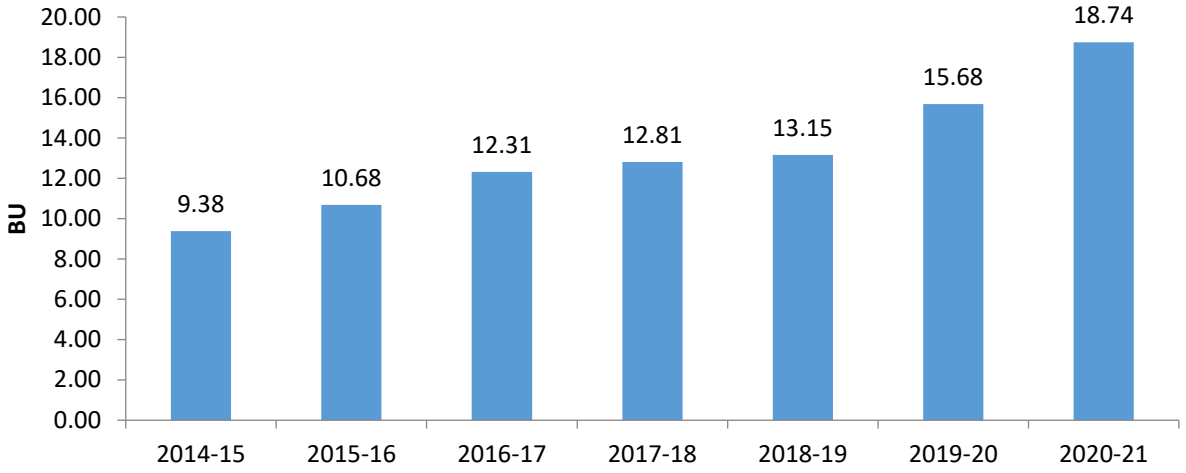
Reference Map should be treated for illustrative purpose only

- **Total Installed Capacity in SAR:** 4,68,735 MW

- **Resource Mix of Countries:** Bangladesh has 51.35% Natural gas based capacity, Bhutan is Hydro Power dominated country, Nepal has 96% of hydro capacity. Pakistan has 63.10% Thermal capacity. Sri Lanka has 50.8% Thermal capacity. Maldives is dependent on Diesel-based capacity and Afghanistan is majorly dependent on imports.

Cross Border Electricity Trade (CBET) in SAR

CBET in BBIN region - BUs (TWh)



- CBET in SAR has seen manifold increase in the last 5 years and is expected to increase further.
- Electricity demand to be further heightened by increase Cross-border Electricity Trade (CBET)

Country	Renewable Energy Installed Capacity (MW)	Peak Demand (MW) in CY21
India	1,05,854	2,00,570
Pakistan	2,147	26,349
Sri Lanka	714	2,717
Bangladesh	779.8	13,792

- 43.8 GW CBET Interconnection Capacity by 2040
- CBET through Power Exchange Platform began in 2021 in India
- CBET push through One Sun One World One Grid, a Green Grids Initiative

Objective

Grid Discipline

Grid discipline refers to the adherence of operating rules, procedures, criteria and guidelines by generator, transmission & distribution companies with the objective to avoid grid failure that may arise due to withdrawal of more power than they are actually entitled to

Grid Reliability

Grid reliability refers to the ability of the system to endure the instability, disturbance, uncontrolled events or unanticipated loss of system components and at the same time provide seamless supply of electricity by taking into account scheduled or unscheduled outages of system components.

Challenges in achieving Grid Discipline & Grid Reliability (GDR)

- **Different** sets of **regulations and technical standards** (i.e., lack of harmonization) across countries involved in CBET.
- **Lack** of adequate **commercial mechanisms** (incentive / penalty) for deviating from norms
- **Different regulatory institutions & regulatory statue** are at varied maturity levels

Objective: To suggest regulatory measures/intervention needed to ensure grid discipline and grid reliability in SAR from the perspective of regional integration.

Key Indicators defining GDR

• Most important parameters for assessment of security and quality of power supply in any grid • Has impact on generator voltage & passive transmission network elements	01 Voltage Variation	• Can occur in power system due to multiple reasons (inadequate supply of reactive power, overloaded/underloaded circuits, etc. • May lead to malfunctioning of equipment
	02 Frequency Variation	
• Designed to measure amount of generation capacity available to meet expected demand in planning horizon and provides indication of the additional capacity available to meet unforeseen - increases in demand, outages and trends	03 Frequency Response	• Measure of interconnection's ability to stabilize frequency immediately following sudden loss of generation or load
	04 Planning Reserve Margin	
	05 Grid Disturbance	• Measured in number of outages and duration of outages
• Count of interruptions over period of time (daily/ weekly/ monthly/ yearly) • Frequency and duration of tripping - indication of performance measured at interconnection level	06 Tripping	
	07 Angular Stability	• Real-time angle difference between nodes, sampled from widely dispersed locations in the power system network and synchronized from common time source of a GPS radio clock, provides SO with an immediate awareness of system strength and stress
• Ability of electricity system to supply aggregate electrical demand of the end-use customers at all times, taking into account scheduled & unscheduled outages of system elements	08 System Adequacy	

Regulatory Gaps identified in South Asian Countries

Bangladesh

- Absence of transmission planning manual
- Inadequate measures in system construction and safety.
- Absence of System Protection Philosophy and third-party protection audits
- Absence of ancillary services market in Bangladesh
- Absence of detailed framework for CBET
- Inadequate regulatory push to regularly assess adequacy of current technology & recommend more effective technology solutions

Bhutan

- Absence of transmission planning manual
- Inadequate measures in system construction and safety.
- Absence of System Protection Philosophy and third-party protection audits
- Bhutan has not capitalised its hydro power resources by offering ancillary services
- Absence of detailed framework for CBET
- Absence of Cyber security standards for critical information infrastructure

Nepal

- Absence of transmission planning criterion
- Inadequate measures in system construction and safety.
- Absence of System Protection Philosophy and third-party protection audits
- Absence of ancillary services mechanism in Nepal
- Absence of detailed penalty mechanism in Grid Code/ Regulations
- No clear mandate to publish information related to power system in public domain

India

- Update Transmission system planning manual with present day system planning techniques
- Resilience of present Regulation for ancillary services is inadequate. Efforts to introduce de-linking of payment from pool account and improving response time for secondary and tertiary services to be made
- Currently no post-despatch analysis is conducted and there is no/ inadequate compensation to generators forced to run below normative parameters
- Grid code lacks adequate provisions to ensure robust cyber security
- RPCs conduct system protection studies and lay down regional system protection standards that are not necessarily standardized.

Regulatory Gaps identified in South Asian Countries

Pakistan

- No mechanism to ensure compliance to system planning standards
- Absence of imbalance settlement mechanism
- Absence of a commercial mechanism/ market for providing ancillary services
- Absence of detailed framework for CBET
- Absence of mechanisms to monitor performance standards of transmission licensee
- Inadequate regulatory push to regularly assess adequacy of current technology to manage grid operations

Sri Lanka

- No mechanism to ensure compliance to system planning standards
- Absence of imbalance settlement mechanism
- Absence of a commercial mechanism/ market for providing ancillary services
- Absence of detailed framework for CBET
- Inadequate performance monitoring indicators
- Inadequate regulatory push to regularly assess adequacy of current technology to manage grid operations

Afghanistan

- Absence of independent electricity regulator and codes
- Absence of planning manual, codes for construction & safety and grid connection
- Absence of ancillary market, imbalance settlement method and CBET framework
- Improvement in ICT and measures for robust monitoring and compliances

Maldives

- Maldives has no Transmission Grid
- Considering possibilities of future interconnections, regulations with respect to System planning, System construction and System operations have to be drafted

Identified Measures to achieve GDR

01	System Planning	Specify a detailed transmission planning criteria to be followed by Transmission Licensee
02	System Construction & Safety	Grid code to have provisions related to system construction and safety like standards for general safety requirements
03	Grid Connection	Lay down detailed procedure for grid connections for users including renewable energy generators. Standardize process
04	System Protection, Commissioning & Testing	Norms to to maintain dynamic stability, prevent, or minimize equipment damage , minimize system outage area, reduce system voltage disturbance and to allow continuous flow of power within emergency rating
05	System Operation	Publish procedure for operational planning, system security, demand management, outage management and partial/complete grid disturbance, define key system performance indicators. Develop Ancillary Service Market
06	Scheduling & Dispatch	Specify framework for co-ordination of CBET with details of identified roles and responsibilities of various stakeholders, standard contracts for export and import of power, grid safety related provisions for CBET.
07	Information & Communication Technology	Push for adoption of advanced technology including Information and Communication Technology (ICT). specify cyber security related aspects to identify critical information infrastructure.
08	Monitoring & Compliance	Lay down provision for periodic publishing of monitoring and compliance reports, system performance reports. Define and mandate capturing information on grid performance indicators for effective reporting of grid reliability

Case Study 1: *Governing framework in EU for GDR*

EU's Governing Framework

Commission Regulation (EU) 2017/1485 of 2 August 2017 established a guideline on electricity transmission system operation (TSO)

Key Dimensions

- *Requirements and principles concerning operational security*
- *Roles and responsibilities for the coordination and data exchange between transmission system operators in close to real-time operation*
- *Requirements on outage coordination*
- *Requirements for scheduling between the TSOs' control areas*
- *Framework for load-frequency control and reserves*
- *Scope of Regional Security Coordinators (RSC).*

Roles & Responsibilities of TSO

- **Develop and implement network operation tools that are relevant for its control area and related to real-time operation and operational planning**
- **Develop and deploy tools and solutions for the prevention and remedy of disturbances**
- **Use services provided by vendors such as re-dispatching, congestion management services, generation reserves and other ancillary services**
- **Comply with incidents classification scale adopted by ENTSO and Monitor the appropriateness of the network operation tools on an annual basis**

Key Takeaways

- The governing regulation **ensures a coordinated operation** of the regional network.
- The regulations also **ensures uniform rules** for the participants for non-discriminatory access to the transmission network for cross-border exchanges in electricity.

Case Study 2: *NERC's Electricity Information Sharing and Analysis Center (E-ISAC)*

Information and communication technology

NERC's Electricity Information Sharing and Analysis Center (E-ISAC) serves as the primary security communications channel and enhances industry's ability to respond cyber & physical threats

Role

- *Gathers, analyzes, and shares cyber and physical threat alerts, warnings, advisories, notices, and vulnerability assessments security information provided by members*
- *Communicates mitigation strategies with stakeholders across sectors;*
- *Serves as a central point of coordination and communication for members.*
- *Coordinates incident management;*
- *Provides an electronic, secure capability for E-ISAC participants to exchange and share information on all threats to defend critical infrastructure;*

Key Takeaways

❖ EISAC indicates the need for seamless flow of information amongst the concerned stakeholders to maintain reliability of such a complex power system

Recommendations

01 A country-wise roadmap covering suggested regulatory interventions for short-term (up to 3 years), medium-term (3-6 years) and long-term (beyond 6 years) would be required.

02 For System Planning, s concerned authority shall prepare Grid Codes in case of its absence

03 For System Construction & Safety, a concerned authority shall conduct a study on international best practices and propose new approaches

04 For Grid Connection, a governing authority shall commence analysis on transmission network and introduce advance tests for HVDC/ FACTs

05 For System protection, testing and commissioning, a concerned authority shall define the protection system philosophy.

06 For Schedule & Despatch, a concerned authority shall facilitate regulations defining the framework for coordination of CBET

07 For ICT, the Regulator or any other competitive authority shall specify cyber security code to identify critical information infrastructure

08 For Monitoring and compliance, a concerned authority shall lay down provision for periodic publishing of monitoring and compliance reports, system performance reports on public domain

Thank You