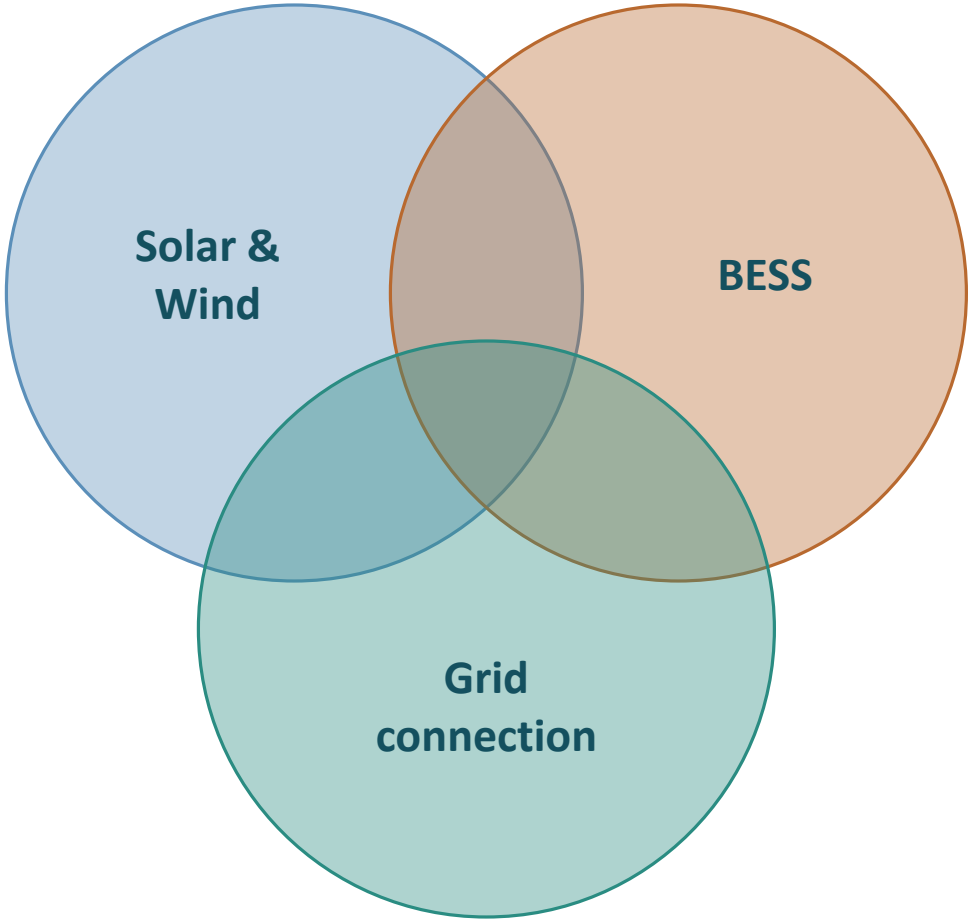
SAARC ENERGY CENTRE · WEBINAR PRG-281/2026/PETREN

Regulatory Frameworks for Variable Renewable Energy, Battery Energy Storage and Grid Interconnections in SAARC Countries

From Renewable Energy Growth to Regulatory Readiness

Imtiaz Ahmad
Independent System and Market Operator (ISMO), Pakistan
24 November 2026



Regulatory framework at the centre

Session storyline: from the trend to the rules

WHY: THE TREND AND ITS CHALLENGES

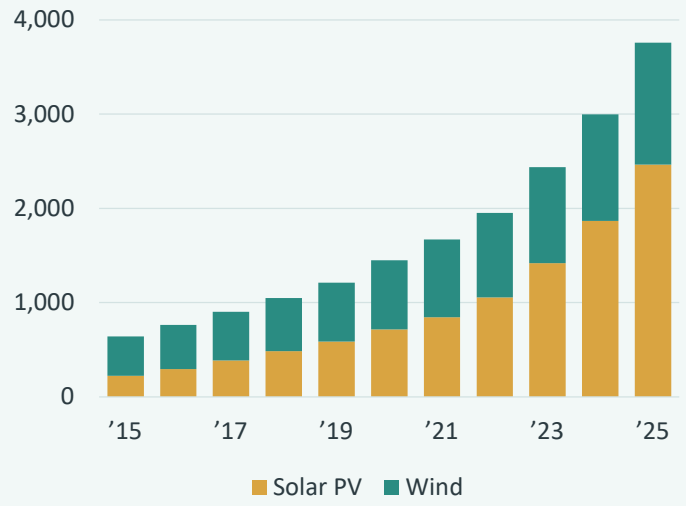
WHAT: THE REGULATORY RESPONSE

1. VRE growth
2. System challenges
3. BESS response
4. Regulatory framework
5. Pakistan: VRE and grid connection
6. BESS framework: India case
7. SAARC status and way forward

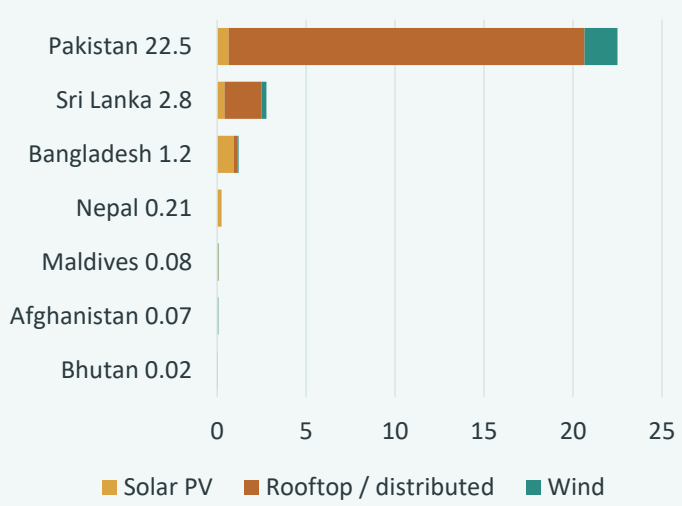
Each part builds on the last: trend, challenge, solution, rules, case studies, regional picture

VRE and BESS are scaling fast, worldwide and in South Asia

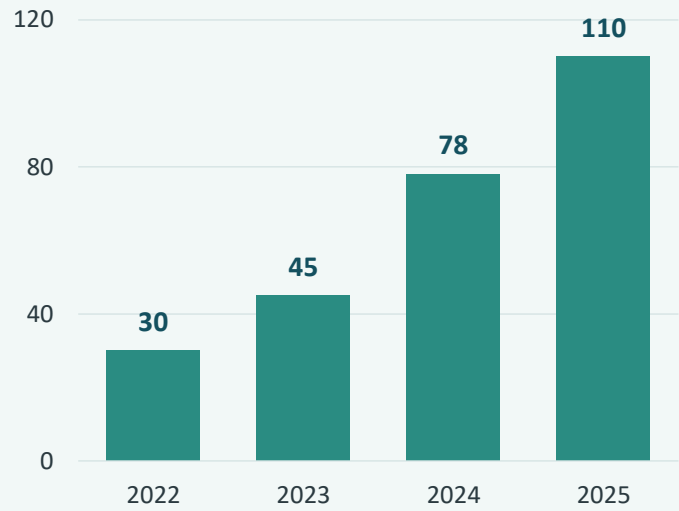
Global solar PV and wind capacity (GW)



South Asia VRE excl. India (GW, 2025)



Global BESS annual additions (GW)



≈3.8 TW
solar PV + wind installed, 2025 (≈6× since 2015)

>75%
of ≈800 GW renewable additions in 2025 were solar PV

≈190 GW
India VRE, more than all other Member States combined

≈3.7×
growth in annual BESS additions, 2022 to 2025

−70%
Li-ion battery pack price, 2015 to 2025

Sources: IRENA, Renewable Capacity Statistics 2026; IEA, Global Energy Review 2026; BloombergNEF (indicative). Cumulative capacity, rounded. Pakistan distributed solar: ISMO estimate. South Asia chart excludes India (≈135 GW solar, ≈54 GW wind). To be verified nationally.

Rising VRE penetration challenges operation, stability and security

Operation

- Minimum demand and curtailment
- Steep evening ramps
- Forecast uncertainty
- Higher reserve needs

Stability

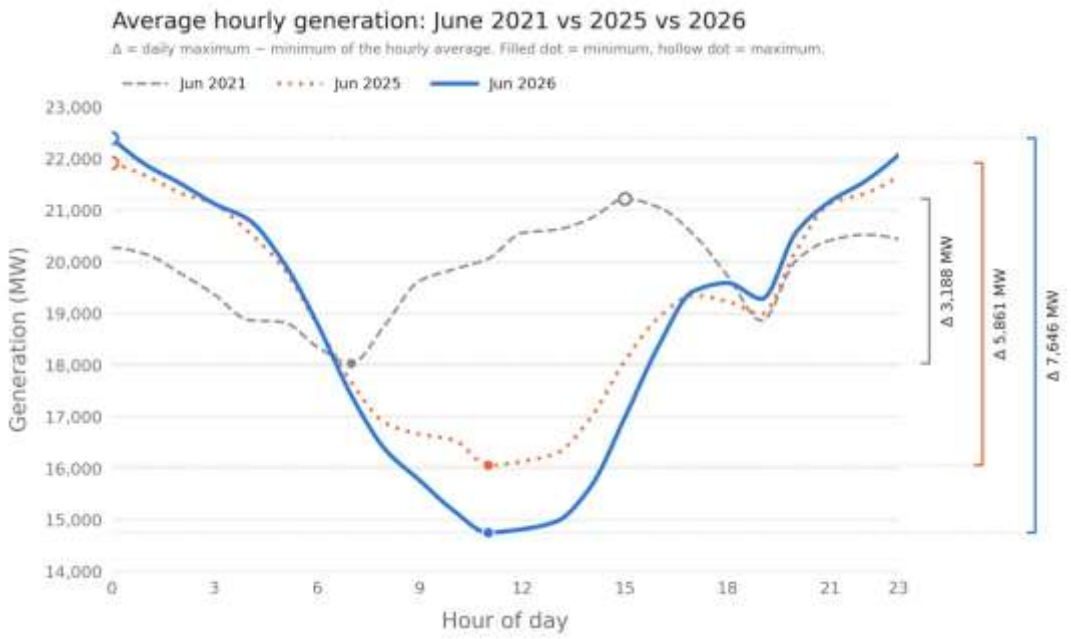
- Lower system inertia
- Frequency control
- Voltage and reactive support

Security

- Limited visibility of distributed solar
- Evening-peak adequacy
- Restoration after disturbances
- Cyber-security of inverter fleets

Higher penetration calls for more flexibility, stronger technical rules and better visibility

Duck curve and distributed solar are tightening operation



1. **Minimum demand and unit commitment**
   Midday net demand ~4–5 GW lower; plant minimums force shutdowns
2. **Steep evening ramp**
   Solar fades as demand peaks; faster, sustained ramping needed
3. **Low inertia and frequency risk**
   Fewer synchronous units online weakens inertia and response
4. **Limited flexibility and curtailment**
   Min-load, start-up and ramp limits lead to solar curtailment

Distributed solar adds: Limited visibility | Forecast uncertainty | Rising reserve needs | Feeder-level effects | Control and dispatch gap

System need: lower plant minimums, faster response, more synchronous support and flexible resources

Source: ISMO system-operation analysis of hourly demand and generation profiles (2021–2026); midday demand about 4–5 GW below 2021 with evening level broadly unchanged.

BESS is the practical enabler of higher VRE integration

SYSTEM CHALLENGE	BESS SERVICE	HOW IT HELPS
Midday surplus, minimum demand	Energy time-shift	Store midday solar; discharge in the evening
Steep evening ramp	Peak capacity	Adds adequacy; reduces peak thermal commitment
Low inertia, frequency risk	Fast frequency response	Injects or absorbs power in milliseconds
Congestion and curtailment	Congestion management	Relieves constrained network locations
Voltage variability	Voltage support	Reactive power in charge, discharge and standby
Restoration after disturbance	Black-start and islanding	Supports restoration where designed

Source: IEA, Global Energy Review 2026; ISMO system-operation analysis; SEC webinar working material.

BESS is emerging across SAARC, at very different stages

India

Scaling

14.54 GWh

5.32 GW operational (CEA, Sep 2026); 78.96 GWh under construction and a substantial awarded / tender pipeline.

Pakistan

Pilots and planning

1,000 MW / 2,000 MWh

ADB-supported transmission-level project proposed; separate 20 MW pilot and 10% co-located BESS requirement in wheeling auction.

Sri Lanka

Operating

10 MW / 40 MWh

First grid-scale BESS commissioned in 2026; wider programme includes 130 MW / 520 MWh across 13 facilities.

Maldives

Programme

20.6 MWh

Reported POISED deployment across 97 islands, alongside solar PV and hybrid diesel-renewable systems.

Bangladesh

Early development

26 MWh

BESS component of proposed 130 MW Sonagazi solar project; ADB advisory pipeline expanded to six solar-plus-storage projects.

Nepal and Bhutan

Planning

Hydro + solar

Storage linked to renewable integration and hydropower flexibility; no comparable commissioned utility-BESS capacity verified.

The trend is clear: regulation must now keep pace with technology

VRE growth + **BESS deployment rising, cost falling** → **Regulatory framework: the enabler**

WHAT CLEAR RULES DO

Lower financial barriers

Clear rules reduce risk premiums and cost of capital

Create market conditions

Revenue and access rules make projects bankable

Reduce technical uncertainty

Connection rules tell developers what to build

Protect system security

Grid codes keep the system stable as VRE grows

CONSEQUENCES OF A POLICY GAP

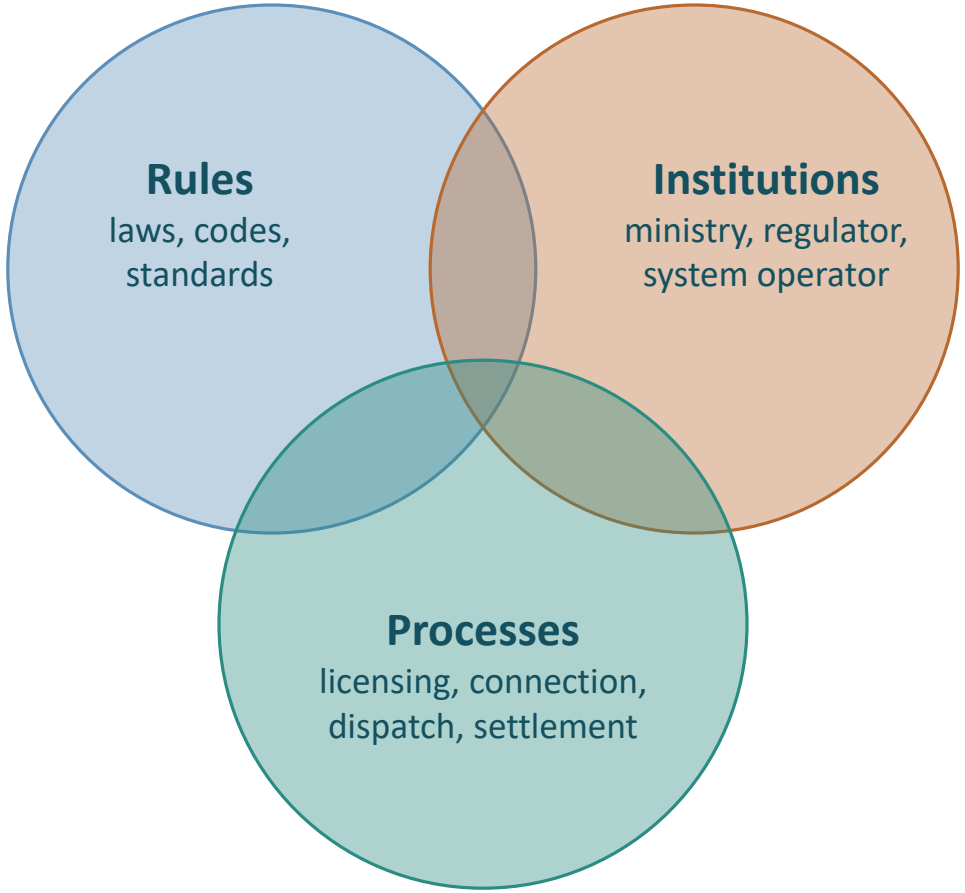
- Curtailment
- Higher cost of capital
- System instability
- Duck-curve stress
- Stranded assets

Source: SAARC Energy Centre, Webinar Concept Note PRG-281/2026/PETREN; SEC webinar working material.

What is a regulatory framework?

DEFINITION

The laws, policies, regulations, technical codes and market rules, together with the institutions that apply them, that determine how generation, storage and networks are licensed, connected, operated and paid.



- **Enable investment**
- **Secure operation**
- **Fair treatment of all users**

Source: author's working definition for this session; SAARC Energy Centre, Webinar Concept Note PRG-281/2026/PETREN.

A comprehensive framework spans six layers

LAYER	WHAT IT COVERS	PAKISTAN	INDIA
Legal	Electricity laws, regulatory authority, institutional mandates	**NEPRA Act 1997**	**Electricity Act 2003**
Policy	RE targets, storage ambitions, national priorities	**National Electricity Policy 2021**	**National RE targets**
Regulatory	Licensing, tariffs, procurement, market participation	**NEPRA licensing rules**	**CERC regulations**
Technical	Grid codes, interconnection standards, performance	**Grid Code 2023**	**IEGC 2023; CEA standards**
Operational	Forecasting, scheduling, dispatch, balancing, ancillary services	**Grid Code 2023**	**Grid-India procedures**
Market	Energy trading, storage compensation, flexibility services	**Market Commercial Code 2025**	**CERC market rules**

Source: NEPRA Act 1997 (Pakistan); Electricity Act 2003 (India); Grid Code 2023 (Pakistan); IEGC 2023 and CEA standards (India); Market Commercial Code 2025 (Pakistan); CERC regulations. Examples indicative.

Grid connection rules bridge policy and secure operation

1 Application

Technology, capacity, location and connection point

2 Network studies

Load flow, short-circuit, voltage, stability, protection

3 Grid-code compliance

Active/reactive power, ride-through, frequency response

4 Protection and telemetry

Coordination, SCADA and communication interfaces

5 Testing and commissioning

Plant tests, model validation, compliance verification

6 Ongoing monitoring

Performance, dispatch and periodic compliance assessment

Without clear interconnection rules, VRE and BESS add risk rather than flexibility to the system

Source: NEPRA Grid Code 2023 (Connection Code); SEC webinar working material.

Pakistan's VRE framework: six building blocks

Policy and legal

NEPRA Act 1997; ARE Policy 2019; National Electricity Policy 2021

Licensing and tariffs

Generation Licensing Rules 2000; Tariff Standards and Procedure Rules 1998

Grid connectivity

Renewable Generation Interconnection Regulations 2015; Grid Code 2023

Technical compliance

Voltage and frequency, reactive power, fault ride-through, protection

System operation

Forecasting, scheduling, dispatch; Market Commercial Code 2025

Distributed solar

NEPRA Prosumer Regulations 2026; prosumer arrangements

AREAS REQUIRING FURTHER STRENGTHENING

- VRE forecasting and scheduling
- Inverter-based frequency response
- Ancillary services and compensation
- Operational reserves and flexibility
- Distributed solar visibility
- Compliance and performance verification

Source: NEPRA Act 1997; ARE Policy 2019; National Electricity Policy 2021; National Electricity Plan 2023–27; Grid Code 2023; NEPRA regulations; Market Commercial Code 2025. Verify latest amendments.

Grid Code 2023: the technical rulebook

CM — Code Management
Governance, amendments, exemptions

PC — Planning Code
System planning, data, security

CC — Connection Code
Technical design and performance

OC — Operation Code
Real-time and short-term rules

SDC — Scheduling and Dispatch
Economic dispatch, AGC, ancillary services

PCC — Protection and Control
Protection principles and standards

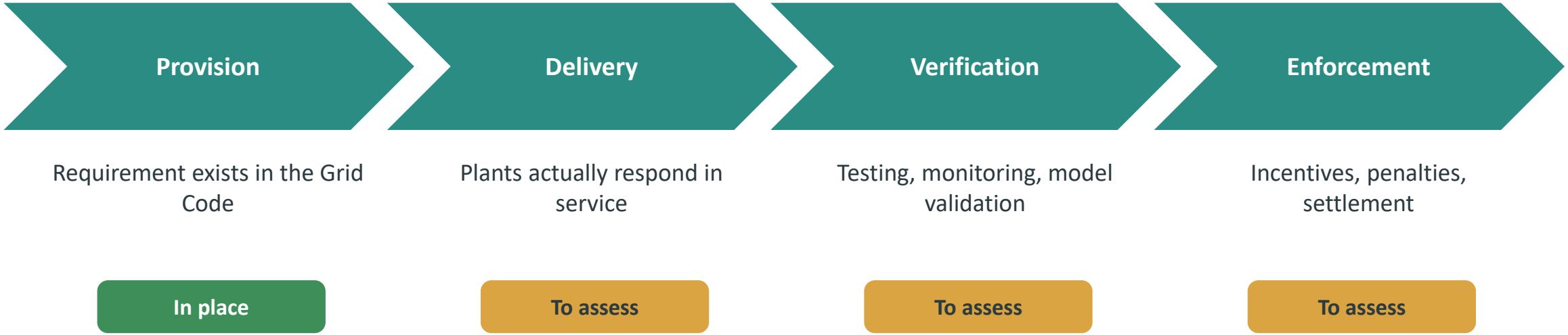
MC — Metering Code
Metering at connection points

DRC — Data Registration
Unified data exchange

Grid Code review at least every three years, so provisions can evolve with VRE and BESS penetration

Source: NEPRA, Grid Code 2023 (approved under Section 23H of the NEPRA Act; supersedes Grid Code 2005).

From provision to performance: the implementation test



Practical example: frequency response
Provisions exist for solar, wind and storage. The questions are whether plants actually deliver the response, and whether delivery is verified.

Source: NEPRA Grid Code 2023 (CC 6.3, CC 11); author assessment for discussion. Provision, delivery and verification of frequency response from wind and solar should be assessed in each system.

BESS needs distinct regulatory treatment from wind and solar

Wind / solar		BESS
Wind / solar resource	**Primary energy source**	Stored electrical energy
Normally injects	**Power direction**	Charges and discharges
Weather-dependent	**Availability**	Depends on state of charge and limits
Resource availability	**Energy limitation**	MWh capacity and duration
Limited by resource	**Dispatchability**	Controllable within constraints
Primarily generation	**Grid role**	Load, generation, storage and grid service

Source: SEC webinar working material; ISMO system-operation perspective.

A BESS regulatory framework must address ten areas

1 — Legal classification
Storage as a distinct asset class

2 — Licensing
Standalone and co-located pathways

3 — Ownership
Utility, private and third-party models

4 — Grid connection
Bidirectional connection, protection, control

5 — Operation
Charging, discharging, dispatch, SoC

6 — Ancillary services
Frequency, reserves, regulation

7 — Market participation
Energy trading and market access

8 — Tariff and compensation
Charging costs, revenues, service payments

9 — Safety and performance
Efficiency, degradation, testing, safety

10 — Planning and operation
Centralised and distributed models

Storage should be recognised as a flexible grid resource providing multiple services, not only as a generation asset

Source: SEC webinar working material; CERC and Ministry of Power (India) storage regulations and guidelines; NEPRA Grid Code 2023.

Pakistan today: strong on connection, still developing on storage

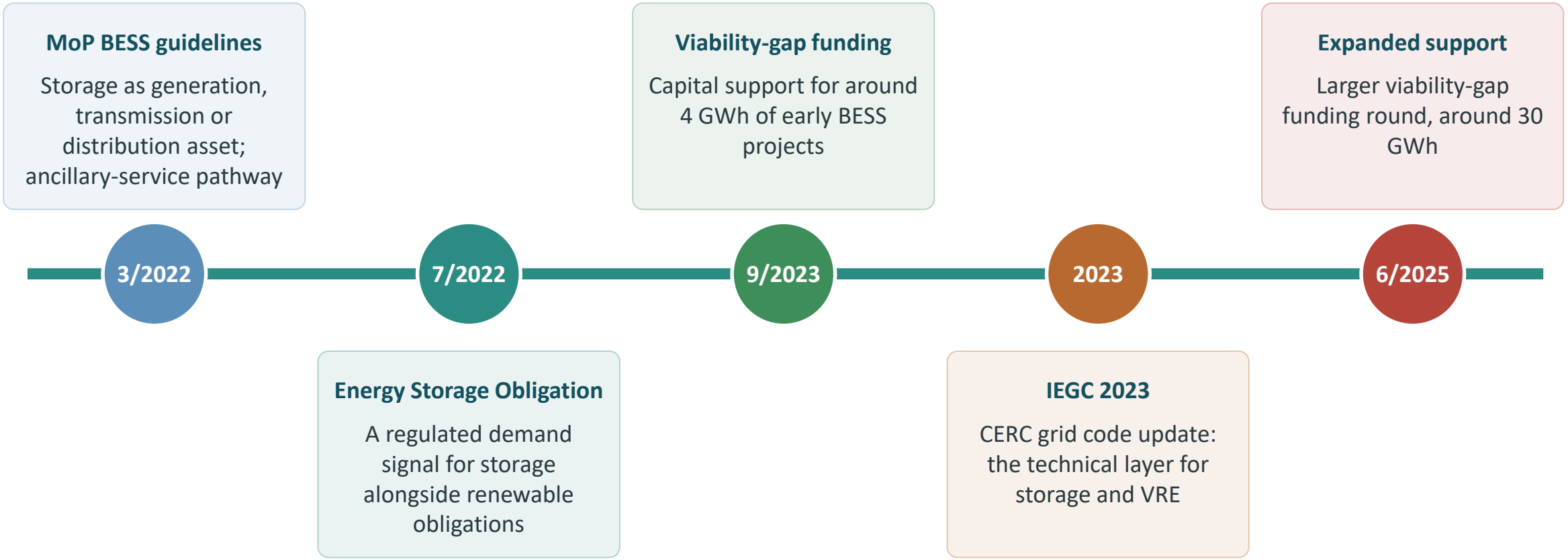
Connection process	Strong	Clear process, defined timelines
Technical performance (SWE)	Strong	LVRT/HVRT, Q capability, control modes
ESU classification and licensing	Partial	ESU scoped; standalone path evolving
Market for flexibility	Partial	Services listed; settlement via MCC
Distribution / embedded BESS	Gap	Code is transmission-centric
Microgrids and islanding	Gap	Limited islanding and black-start rules
Data and forecasting	Partial	Forecast accuracy duties to strengthen
Cybersecurity for BESS	Emerging	Limited BESS-specific guidance

Where storage appears in the Grid Code 2023

- Energy Storage Units are Code Participants (CM 3)
- Solar, wind and storage grouped as SWE (CC 6.3)
- Reactive capability shown for BESS (CC 6.3.4)
- Frequency response and synthetic inertia from ESU (CC 11)

Source: NEPRA, Grid Code 2023: CM 3 (scope), CC 6.3, CC 6.3.3(d), CC 6.3.4 / Figure CC 3, CC 11, planning data; author assessment for discussion and validation.

India as the BESS case study: a policy ladder since 2022



Source: Ministry of Power (India) BESS guidelines, Energy Storage Obligation and viability-gap funding schemes; CERC / IEGC 2023. Dates and scale indicative; verify current provisions.

India and Pakistan side by side: what can be adapted

	India	Pakistan
Asset classification	Storage as generation, transmission or distribution asset	ESU scoped in the Grid Code; standalone path evolving
Demand signal	Energy Storage Obligation	Co-located BESS in wheeling auctions (≥10% of firm capacity)
Financial support	Viability-gap funding for early projects	Pilots under assessment (ADB-supported study)
Procurement	Competitive tenders, standalone and RE-linked	IGCEP treats storage as a flexibility resource
Ancillary services	Defined pathway for storage participation	Services listed; settlement depends on market rules

Source: Ministry of Power (India) BESS guidelines; CERC; NEPRA Grid Code 2023; NEPRA wheeling-auction decision; IGCEP 2025–35; ADB TA-10195; author assessment.

Regional lessons: one storage model does not fit every grid

Bangladesh and Sri Lanka

Net metering and net accounting show the need for clear export valuation and planned evolution of prosumer rules

Maldives

Storage is essential for diesel displacement; hybrid-system standards and bankable contracts are critical

Bhutan and Nepal

Hydro systems need storage and solar for seasonal balancing; inverter-based resource provisions are the priority

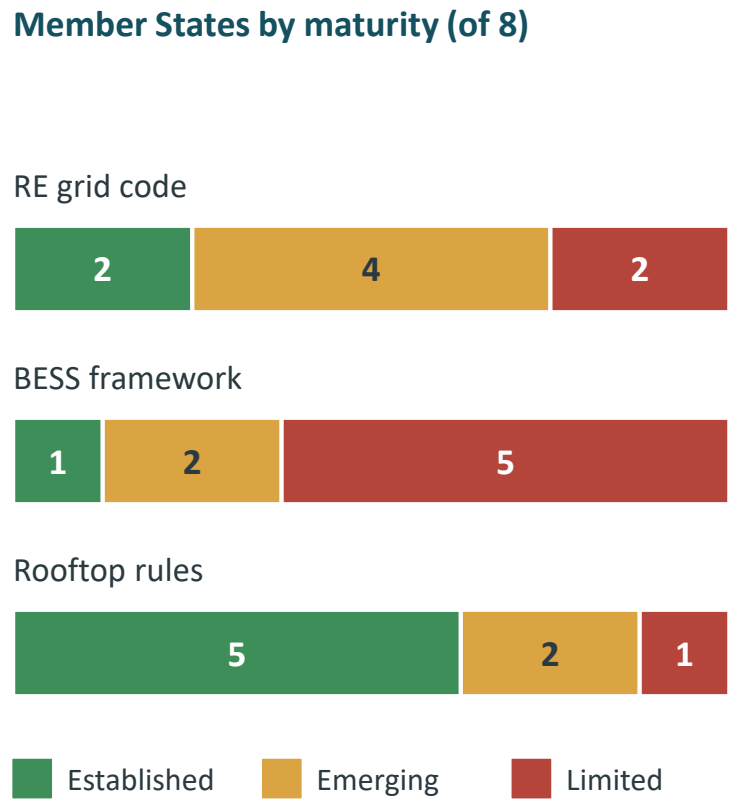
Common message

Island, distribution and transmission-connected BESS have different technical and commercial needs

Source: SEC webinar working material; national net-metering schemes of Bangladesh and Sri Lanka; Maldives island programmes; Nepal and Bhutan hydropower systems.

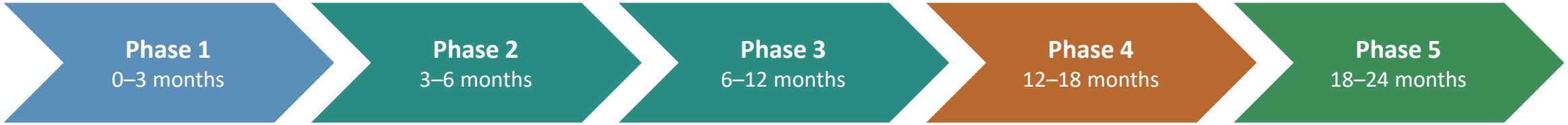
Regulatory framework status across SAARC Member States

Country	Regulator	RE grid code	BESS framework	Rooftop rules
India	CERC / SERCs	Established	Established	Established
Pakistan	NEPRA	Established	Emerging	Established
Bangladesh	BERC	Emerging	Limited	Established
Sri Lanka	PUCSL	Emerging	Limited	Established
Nepal	ERC	Emerging	Limited	Emerging
Bhutan	BEA	Emerging	Limited	Emerging
Maldives	URA	Limited	Emerging	Established
Afghanistan	—	Limited	Limited	Limited



Source: author assessment for regional dialogue; to be validated with national experts and current legislation. Afghanistan arrangements require particular care.

A phased roadmap for regulatory readiness



Gap assessment	Technical framework	Market framework	Consultation and pilots	Implementation and review
Review laws, grid codes, market rules, mandates	Connection, telemetry, control, testing	BESS dispatch, ancillary services, settlement	Stakeholder consultation and pilot projects	Monitor, refine and scale

Track A: strengthen VRE arrangements
Compliance and testing · forecasting and scheduling · inverter-based resource performance · transparent curtailment

Track B: develop the BESS framework
Legal classification and licensing · bidirectional connection · SoC-aware dispatch · ancillary-service settlement

Source: author proposal for discussion; phasing indicative and to be adapted to national circumstances.

Key takeaways

1 The constraint is increasingly policy and regulation, not technology

Cost declines have moved the bottleneck to rules, grid access and market design

2 Most SAARC countries have VRE foundations; depth varies

High penetration needs continuous review and verification

3 BESS needs its own legal and commercial identity

Classification, licensing, SoC-aware operation and market access are the largest gaps

4 Use categories and proportionate obligations

Transmission, distribution and behind-the-meter storage differ

5 Predictability lowers the cost of capital

Stable rules and transparent interconnection accelerate investment

6 Regional cooperation multiplies the benefit

SEC as a platform for peer learning, harmonised standards and capacity building

Source: synthesis of the presentation.

From deployment ambition to regulatory readiness

The objective is not simply to install more renewable capacity or batteries, but to develop power systems in which they can operate reliably, efficiently and commercially within clear regulatory frameworks.

Thank you · Questions and regional dialogue welcome

ANNEX

References

Global and regional data

- IEA, Global Energy Review 2026
- IRENA, Renewable Capacity Statistics 2016–2026
- BloombergNEF and similar battery price analyses (indicative)
- Draft National Energy Storage Policy, Pakistan (citing Ember and customs data)
- SAARC Energy Centre, Webinar Concept Note PRG-281/2026/PETREN
- SAARC Framework Agreement for Energy Cooperation (Electricity), 2014
- ISMO system-operation analysis and hourly profiles, 2021–2026

Pakistan

- NEPRA Act 1997; Grid Code 2023
- ARE Policy 2019; National Electricity Policy 2021; National Electricity Plan 2023–27
- Interconnection Regulations 2015; Prosumer Regulations 2026
- Market Commercial Code 2025; IGCEP 2025–35
- ADB TA-10195 BESS feasibility study

India, other Member States, international

- Electricity Act 2003; CERC regulations; IEGC 2023; CEA standards; GNA Regulations 2022
- Ministry of Power BESS guidelines; Energy Storage Obligation; viability-gap funding
- BERC Act 2003; Sri Lanka Electricity Act and Grid Code; Nepal and Bhutan Electricity Acts
- FERC Orders 841, 2222, 2023; EU Regulation 2016/631; AEMO; NESO

Instruments and figures should be verified against current notifications before publication.