Energy Storage in South Asia

Understanding the Role of Grid-Connected Energy Storage in South Asia's Power Sector Transformation

National Renewable Energy Laboratory

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Today's Presenters

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Agenda

- Overview of NREL’s work in South Asia
- Context for Energy Storage Potential
- Policy and Regulatory Considerations for Energy Storage
- Technical and Economic Potential for Energy Storage
- Conclusions

NREL South Asia Program

GTG
USAID-MOP

Conclusion: India's grid can balance the 175 GW of RE

Tools: Detailed operations model of India
High fidelity weather data (maps.nrel.gov/rede-india)

Cross-Border Electricity Trade in South Asia

Conclusions: Increased cross-border electricity trade (CBET) has regional and individual country benefits
Increased RE capacity could increase opportunities for CBET

Tools: Detailed operations model of South Asia region
CBET regulatory roadmaps for Nepal, Bangladesh, India

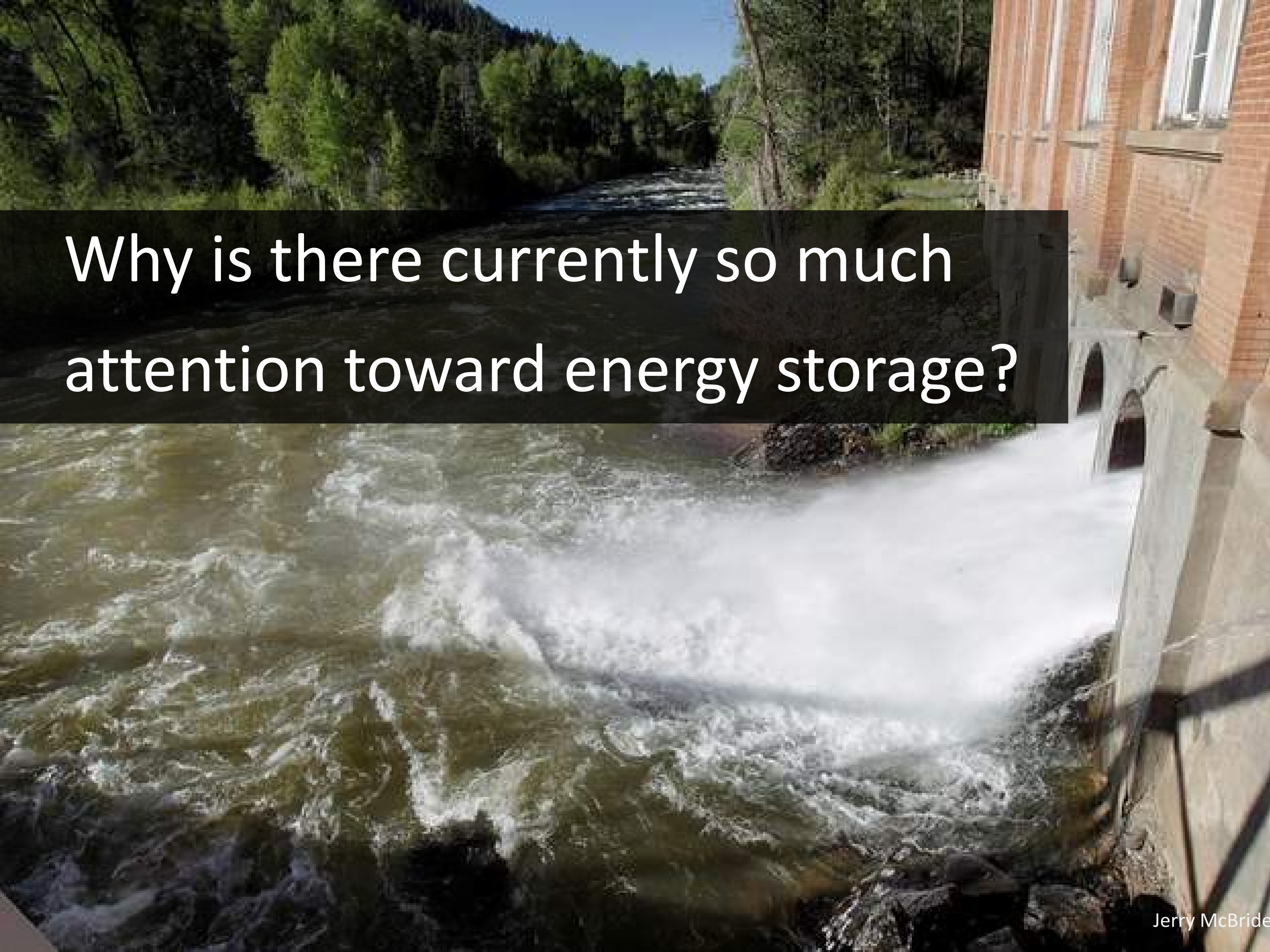
Planning and Operations Studies

Ongoing:

- Least-cost capacity expansion planning in India
- Operations in 2030 (targets for RE changing fast…)
- Working with India's states to plan for high RE futures

Energy Storage in South Asia

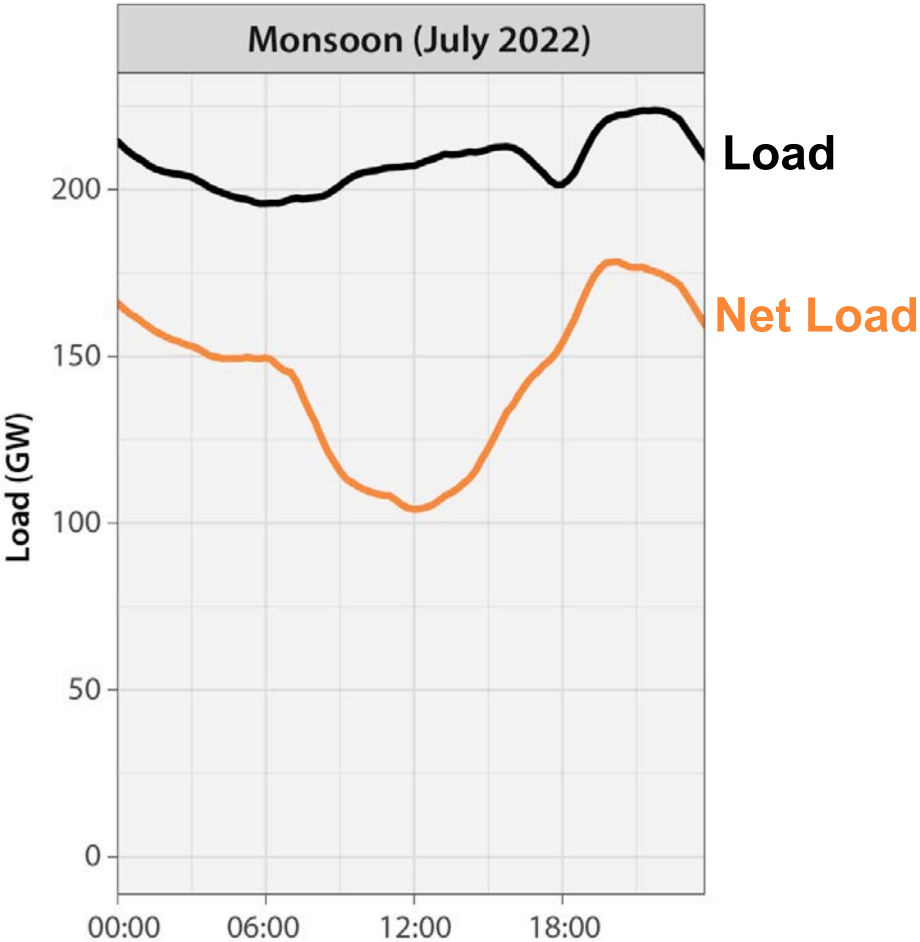
Context

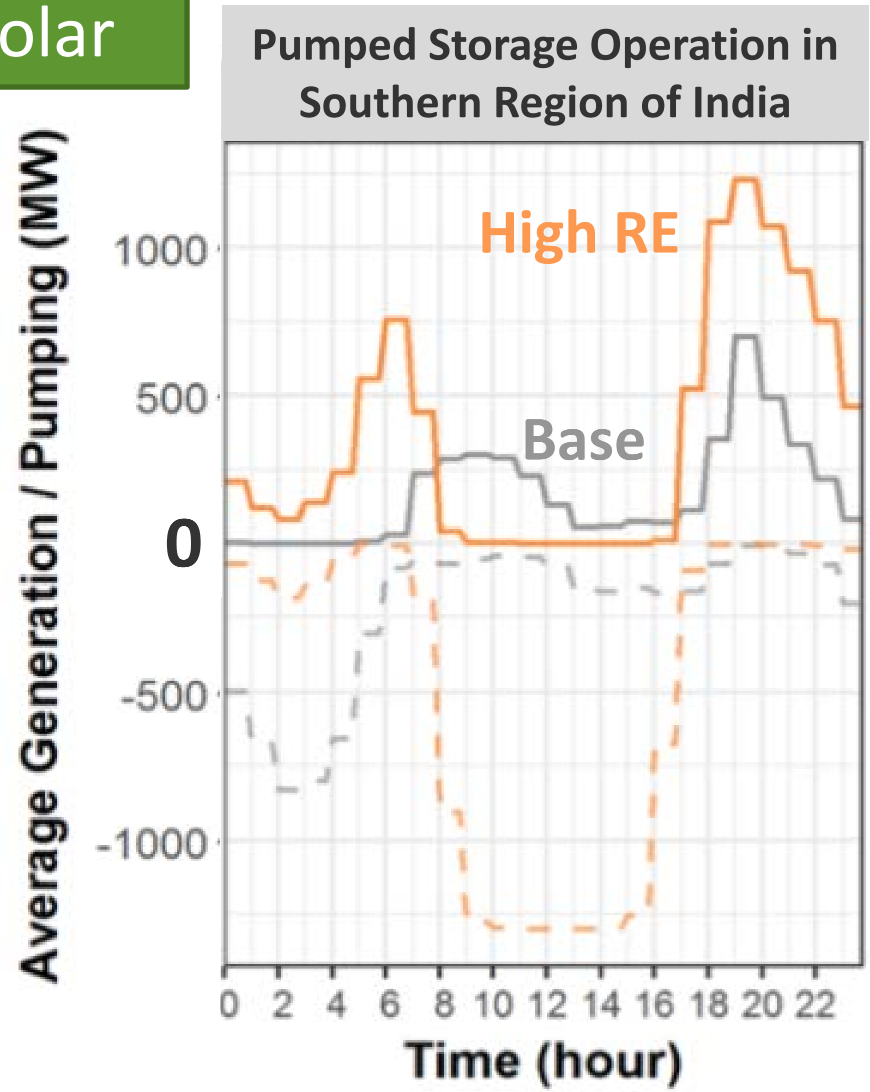

Why is there currently so much attention toward energy storage?
Jerry McBride

Grids are transforming to higher levels of RE

Example from Greening the Grid Study:

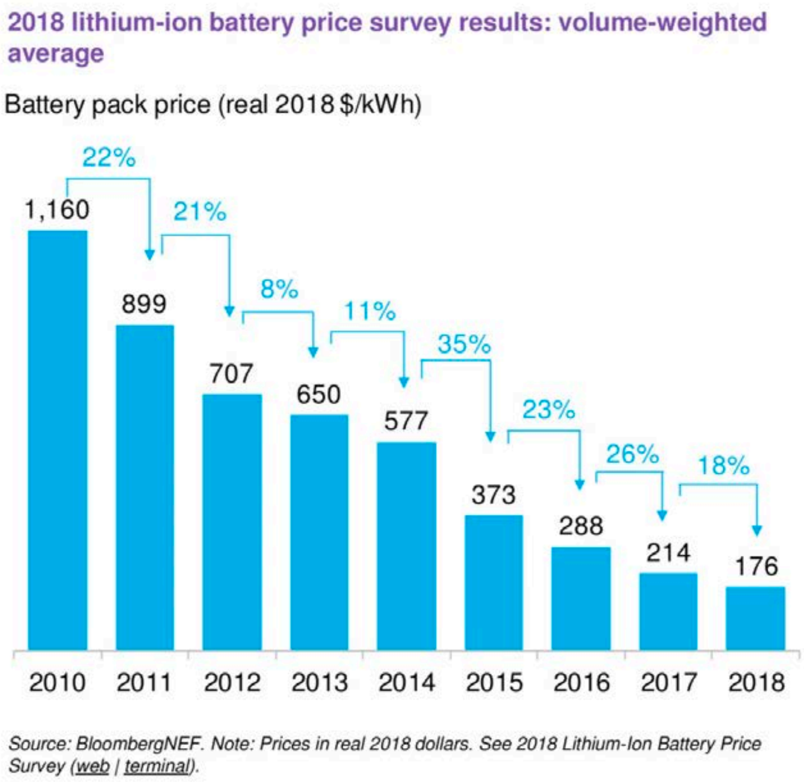
22% generation from wind and solar

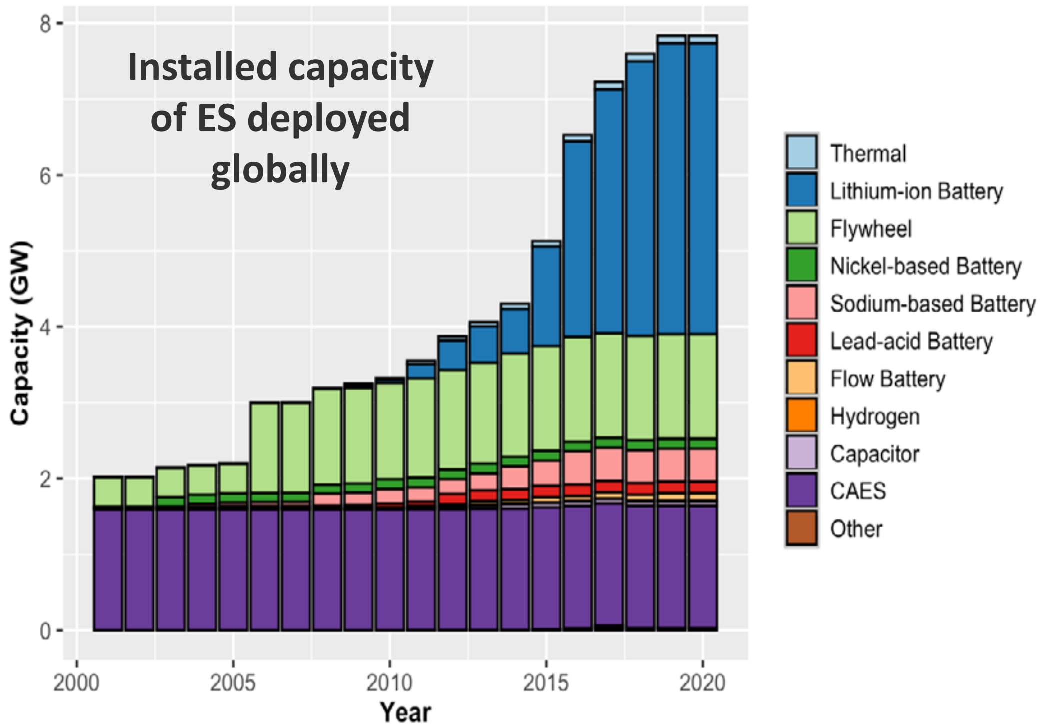




GTG, 2017 (https://www.nrel.gov/docs/fy17osti/68530.pdf)

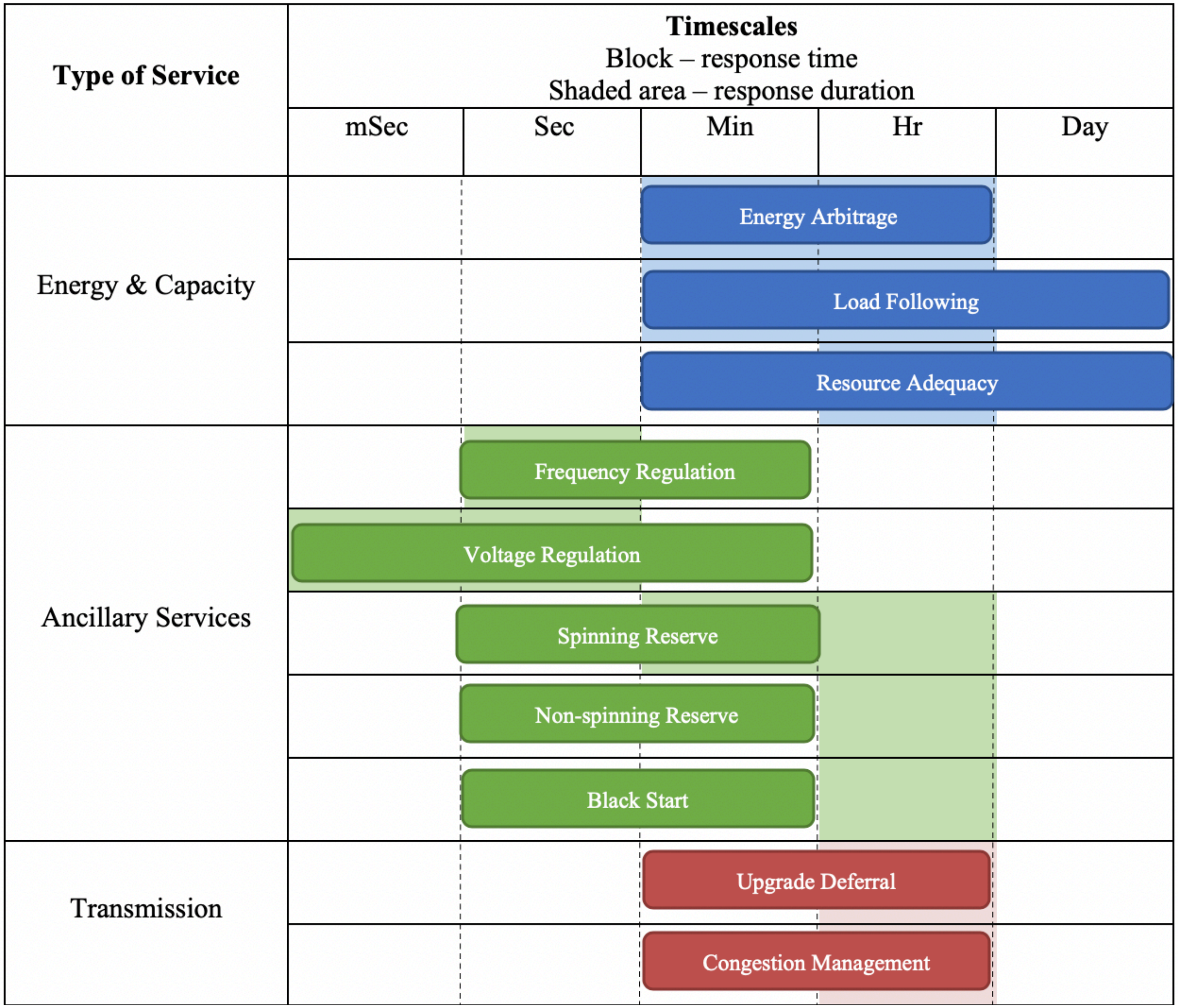
Costs are declining





* excluding pumped hydro (DOE 2020, EIA 2020)

Energy storage has many potential applications



Source: BNEF 2019; CEA 2020; CERC 2017; GIZ 2015; ICF 2019; IEA 2020; IESA 2019 Rose et al. 2020

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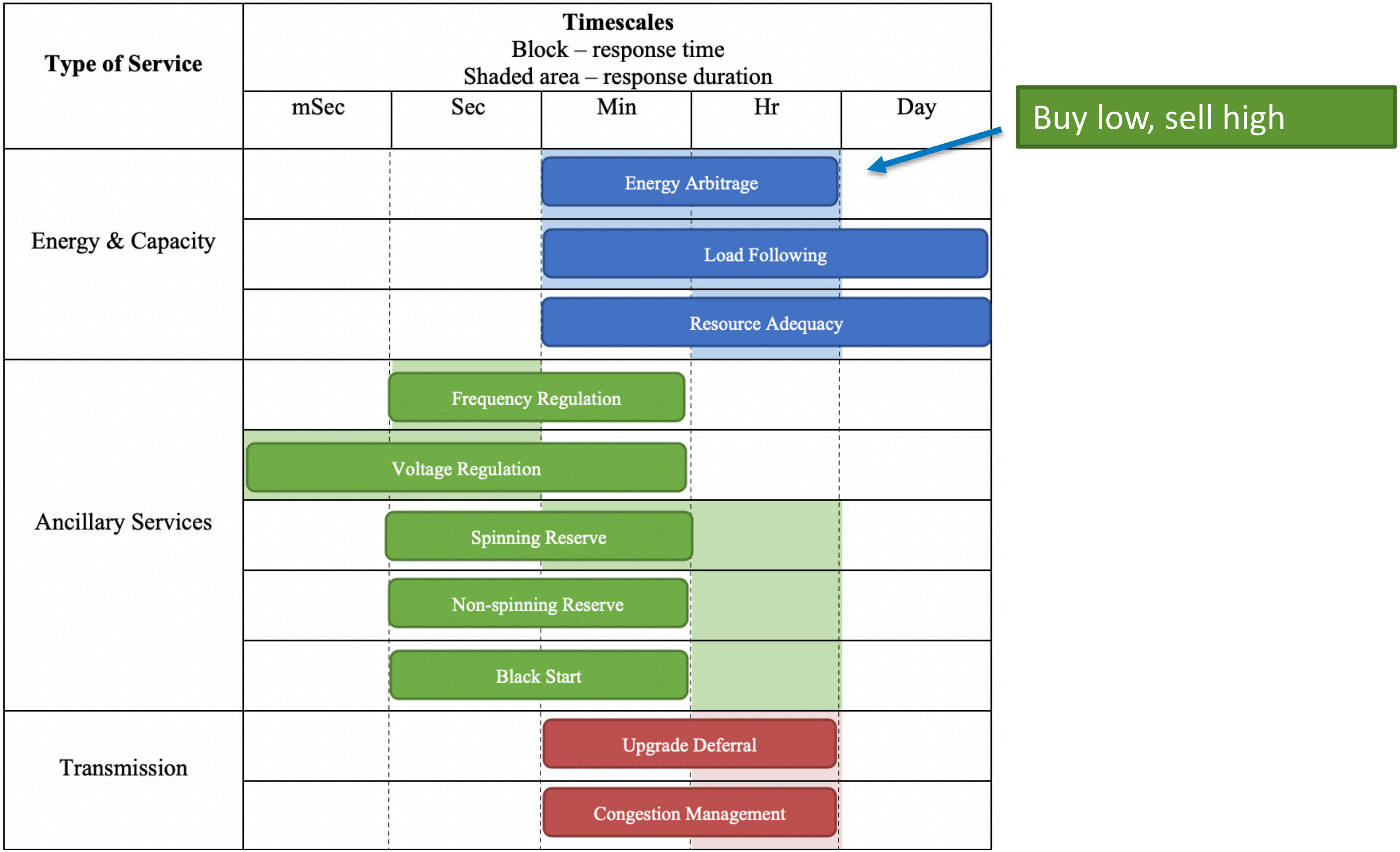

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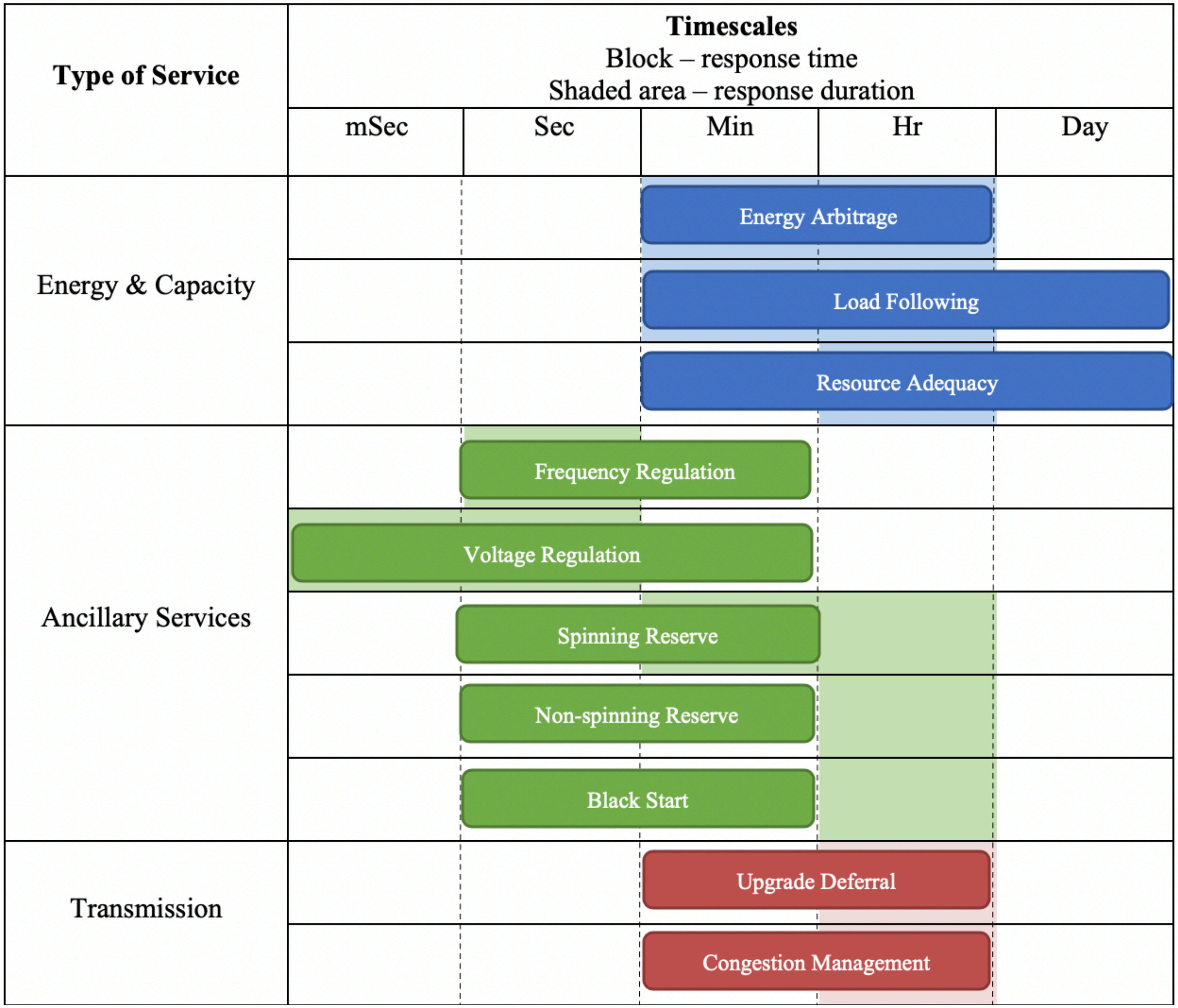

Be available when you are REALLY needed (e.g., peak demand or other high-risk times)

Source: BNEF 2019; CEA 2020; CERC 2017; GIZ 2015; ICF 2019; IEA 2020; IESA 2019 Rose et al. 2020

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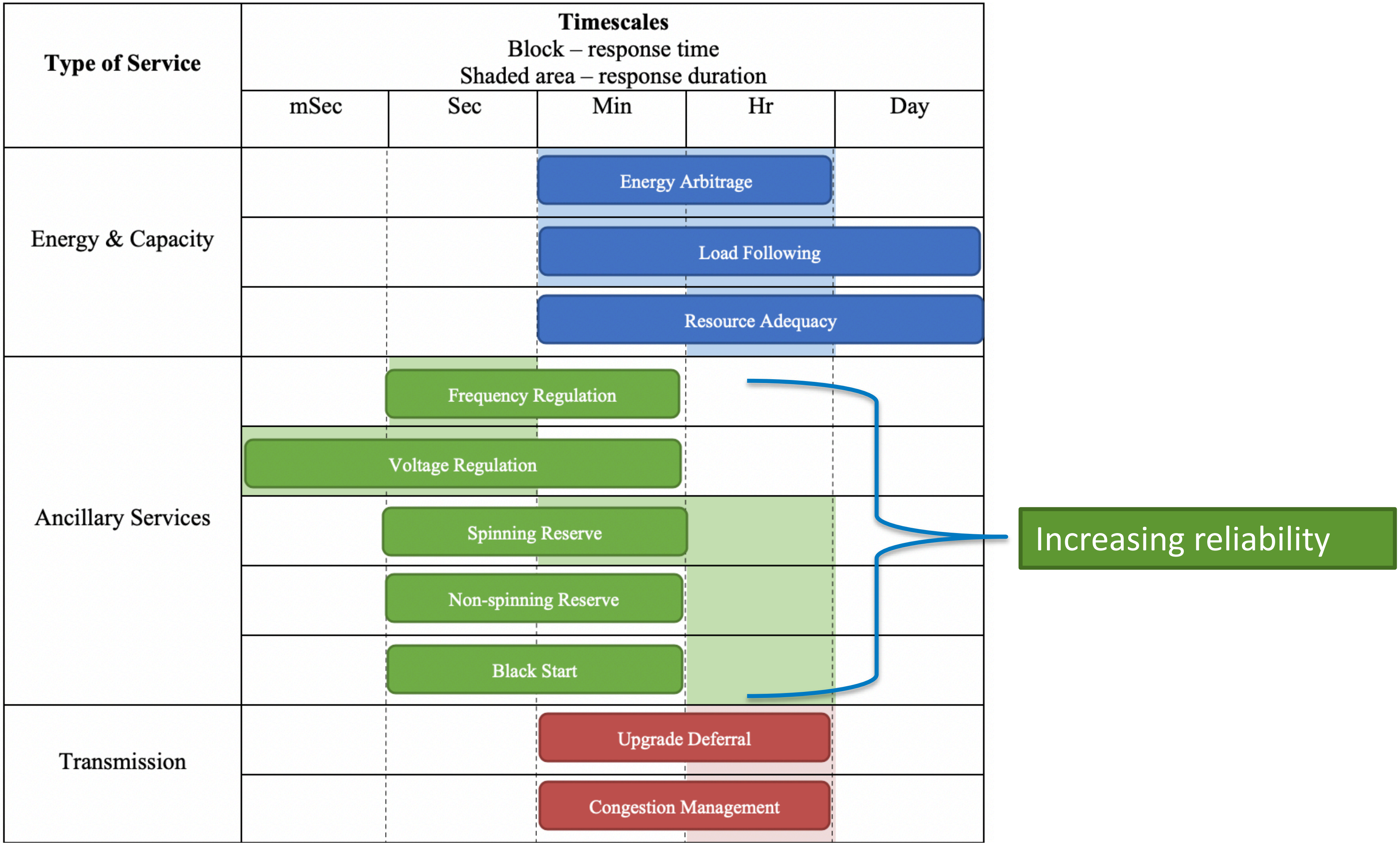

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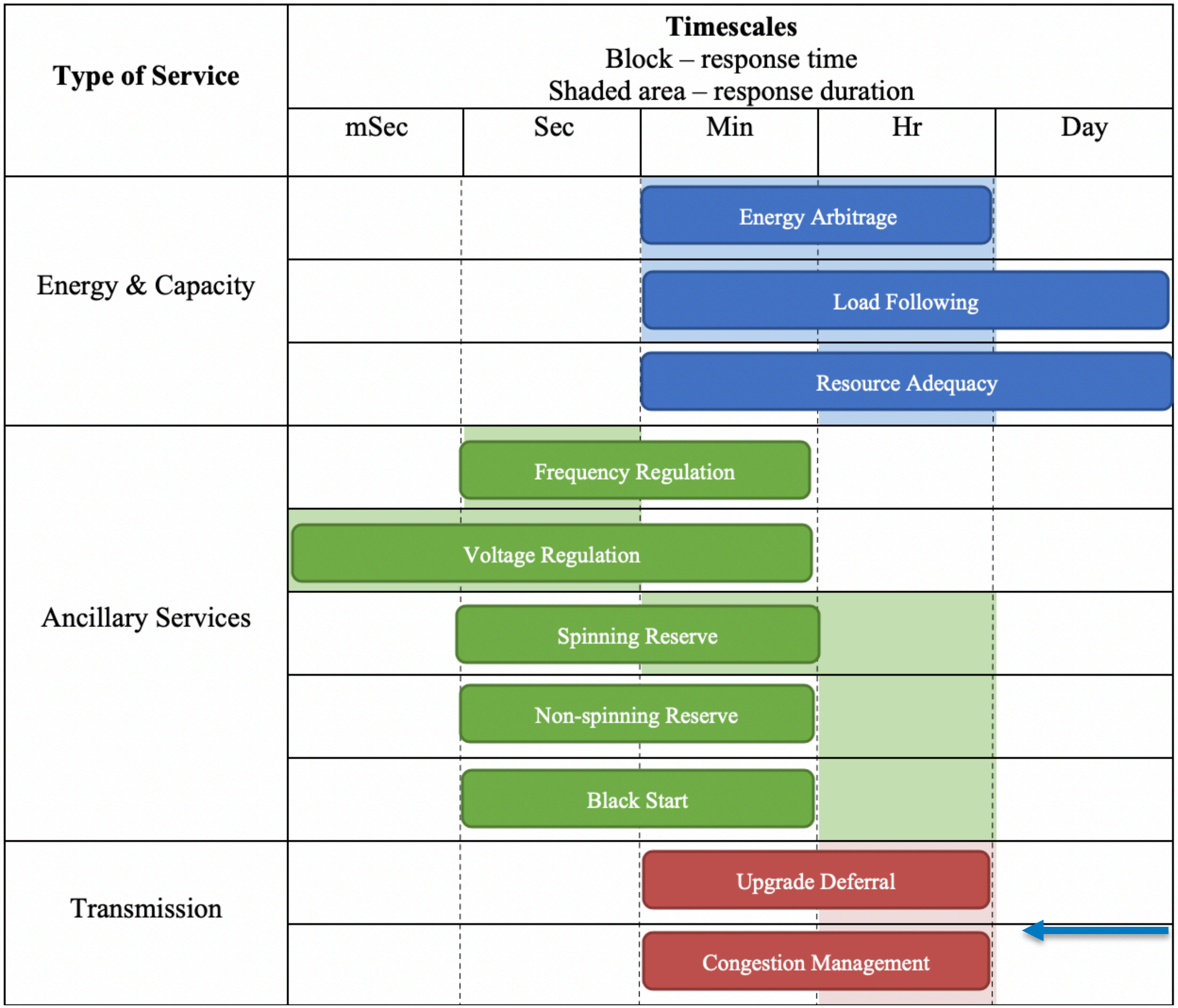

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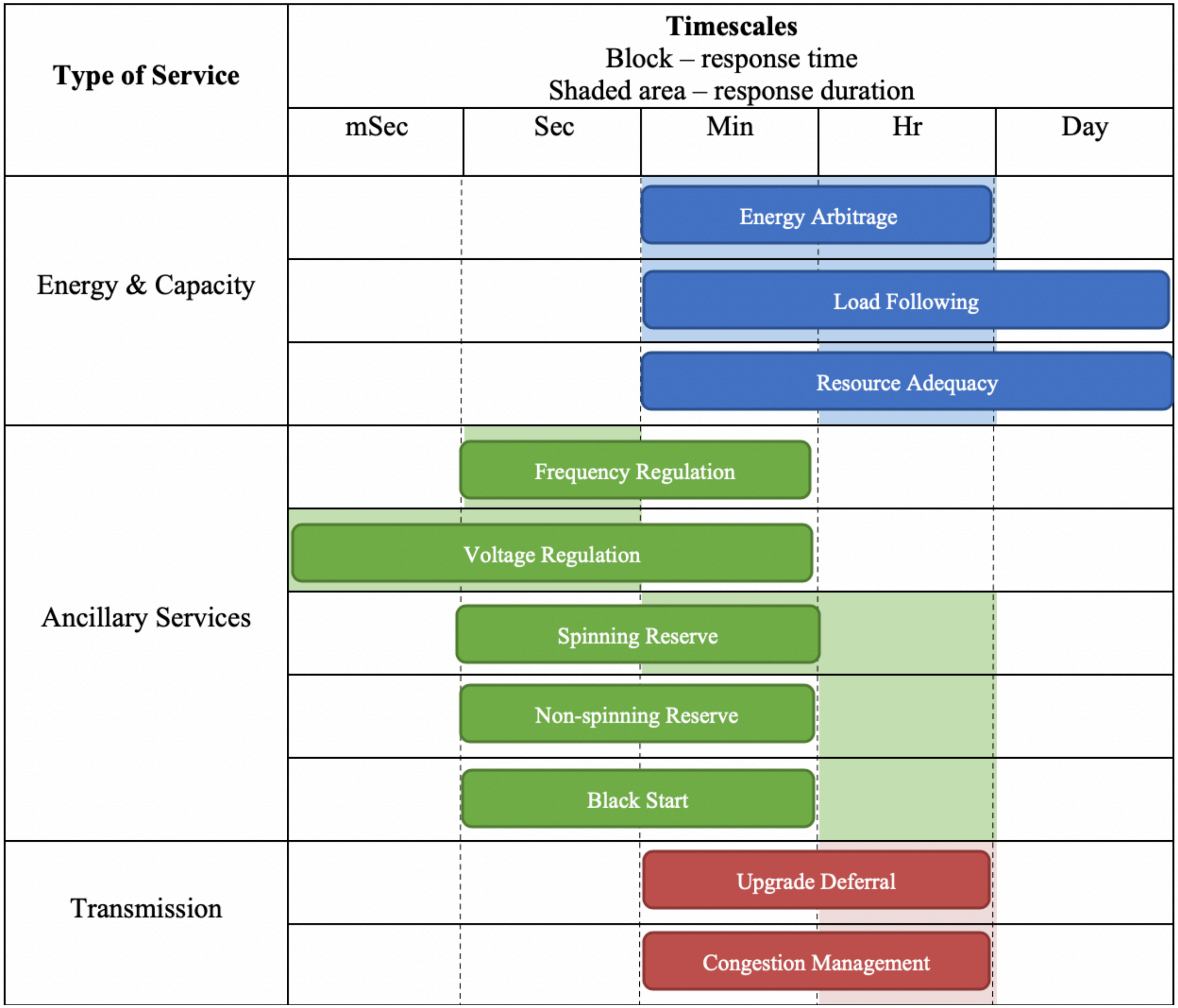
Decreased risk for very big investments in time and money

Energy storage has many potential applications



Source: BNEF 2019; CEA 2020; CERC 2017; GIZ 2015; ICF 2019; IEA 2020; IESA 2019 Rose et al. 2020

These opportunities will evolve as grids evolve

Growing interest in energy storage in South Asia

How big are these opportunities and what can countries do to realize their benefits?

Source: BNEF 2019; CEA 2020; CERC 2017; GIZ 2015; ICF 2019; IEA 2020; IESA 2019 Rose et al. 2020

Energy storage – what we already know

- Energy storage (ES) can increase the flexibility of the grid.
- ES can complement variable renewables, but new investments in ES are not necessarily needed to integrate large amounts of renewable energy (e.g., GTG study for India).
- ES has many potential applications for the grid. A primary challenge is in properly valuing them through regulations and markets.
- Planning for ES requires a systems-level approach, in part because ES value is sensitive to other changes on the grid such as solar growth or fuel prices.

What is the focus of this project?

- Grid-connected ES that is "utility-scale" (greater than 1 MW)
- ES that is interconnected to the bulk power system (voltages > 100 kV)
- Hydro reservoir storage is considered; however the outcomes are more focused on ES that can "charge"
  - E.g., pumped hydro, batteries, etc.

Key Contributions

Understanding the opportunities for South Asia's energy storage market

- Assessments of **existing and potential policy and regulatory** barriers for energy storage in South Asia

- **Data-driven analysis** on the technical, economic, and policy drivers for energy storage in a rapidly evolving region

Our Approach to Assessing Storage Opportunities in South Asia

Regulation and Policy Insights

Promote supportive policy and regulatory environments with targeted analysis and insights

Forward Looking

Empower development of sustainable, affordable, reliable power systems by looking at mid- and long-term decision impacts

Technology Agnostic

Evaluate a range of technologies to understand the systems-level impacts and opportunities for power system advancements

Timeline for Project

Today

Oct 2020

Energy Storage Readiness Assessment for India

Dec 2020

Long-Term Planning for South Asia's Grid – Understanding Drivers for Energy Storage Growth

June 2021

Energy Storage Readiness Assessments for Bangladesh and Nepal

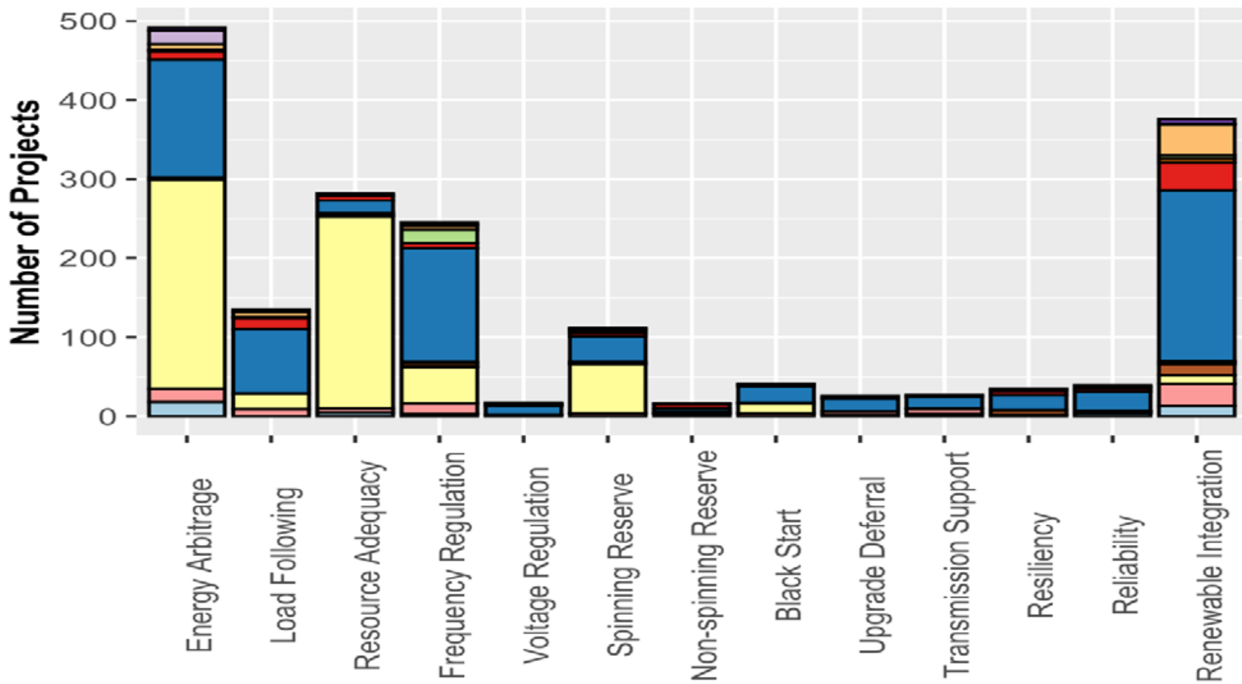
Applications and Operational Value of Energy Storage for India, Nepal, and Bangladesh

Engaging policymakers, regulators, developers, researchers, and utilities across the South Asia region to guide key objectives

Energy Storage Policy and Regulatory Considerations for South Asia

What is storage used for in practice?

Data from existing storage projects shows that projects are designed to serve multiple needs and access multiple revenue streams.



Energy storage presents a new kind of grid asset

The unique features of ES raise new questions for policymakers and regulators

What

Potential applications cut across generation, transmission, and distribution functions

Who

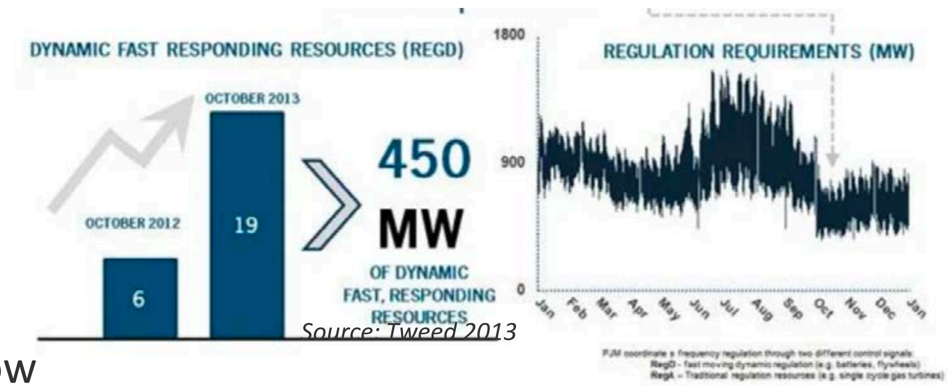
Structural reforms governing the power sector may prevent investments in sectors that benefit from ES

How

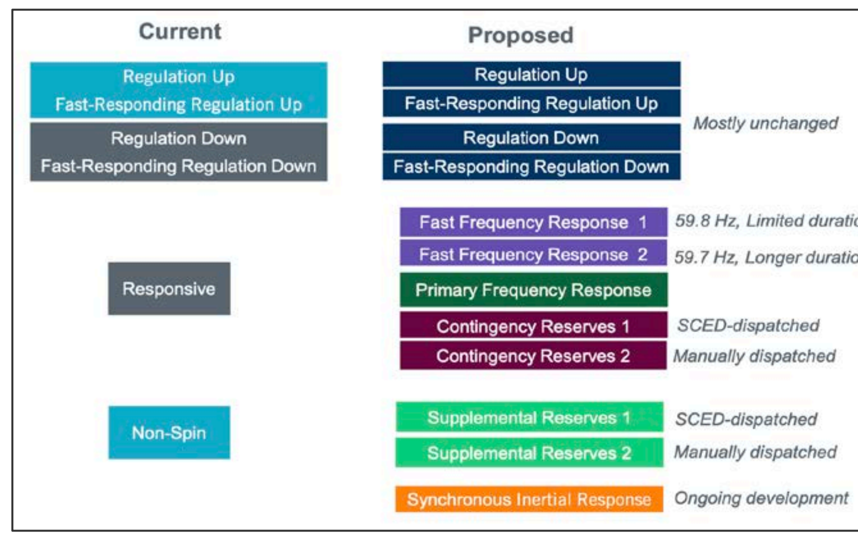
Existing planning and operational practices are not designed to capture the value and limitations of many ES technologies

How are these issues being addressed in practice?

- NYISO creates a new category of “ES resource” able to provide services across multiple sectors and compensation mechanisms
- Policymakers in Texas amend rules to allow utilities to own ES assets
- Innovative tariff design triples fast-moving resources available for frequency regulation in PJM Interconnection
- ERCOT proposed changes to ancillary services to better capture system needs



Source: Tweed 2013

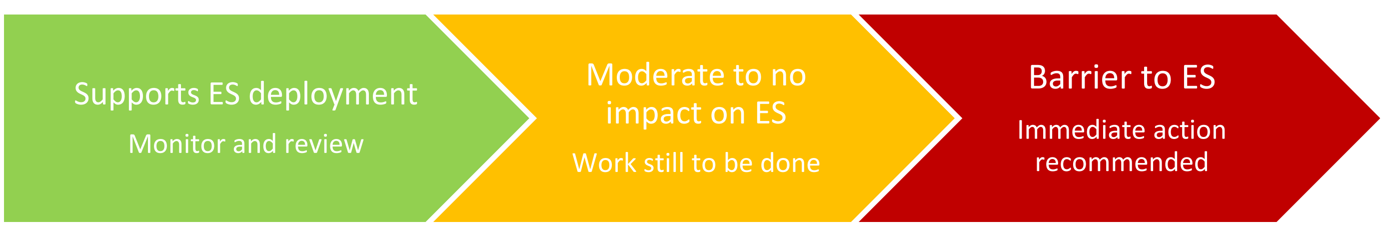


Source: ERCOT 2016

What enables energy storage deployment and operation?

Energy Storage Readiness Assessment

Topic	Sub-topic
System Characteristics	Decreasing load factor in electricity demand
	Inadequate ancillary services
	Inadequate or costly supply options during peak demand periods
	Increasing levels of transmission congestion
	Network upgrades with low anticipated utilization
	Low flexibility in the generation mix
	Increasing VRE curtailment
Policy	ES included in energy policy and master plan
	Energy strategy promotes operational flexibility
	Support organized knowledge sharing and delivery for scale up and replication
	Capacity or energy targets for ES deployment
	Domestic industrial policy
	Targeted support to early adopters
Regulation	ES able to compete with other grid assets to provide multiple services
	ES able to receive revenue for providing multiple services
	Interconnection processes give ES the right to interconnect and obtains transmission service
	Utilities and third-party providers allowed to make storage investments
	Electricity services charges reflect value of and increase price transparency for energy services
	Operating requirements for fast-responding assets
	Promotion of high-quality standardized technologies through safety standards for ES technologies



Energy Storage Readiness Assessment

The goal of the Readiness Assessment is to allow policymakers and regulators to quickly gauge how well existing policy and regulatory frameworks support ES investments and operation.

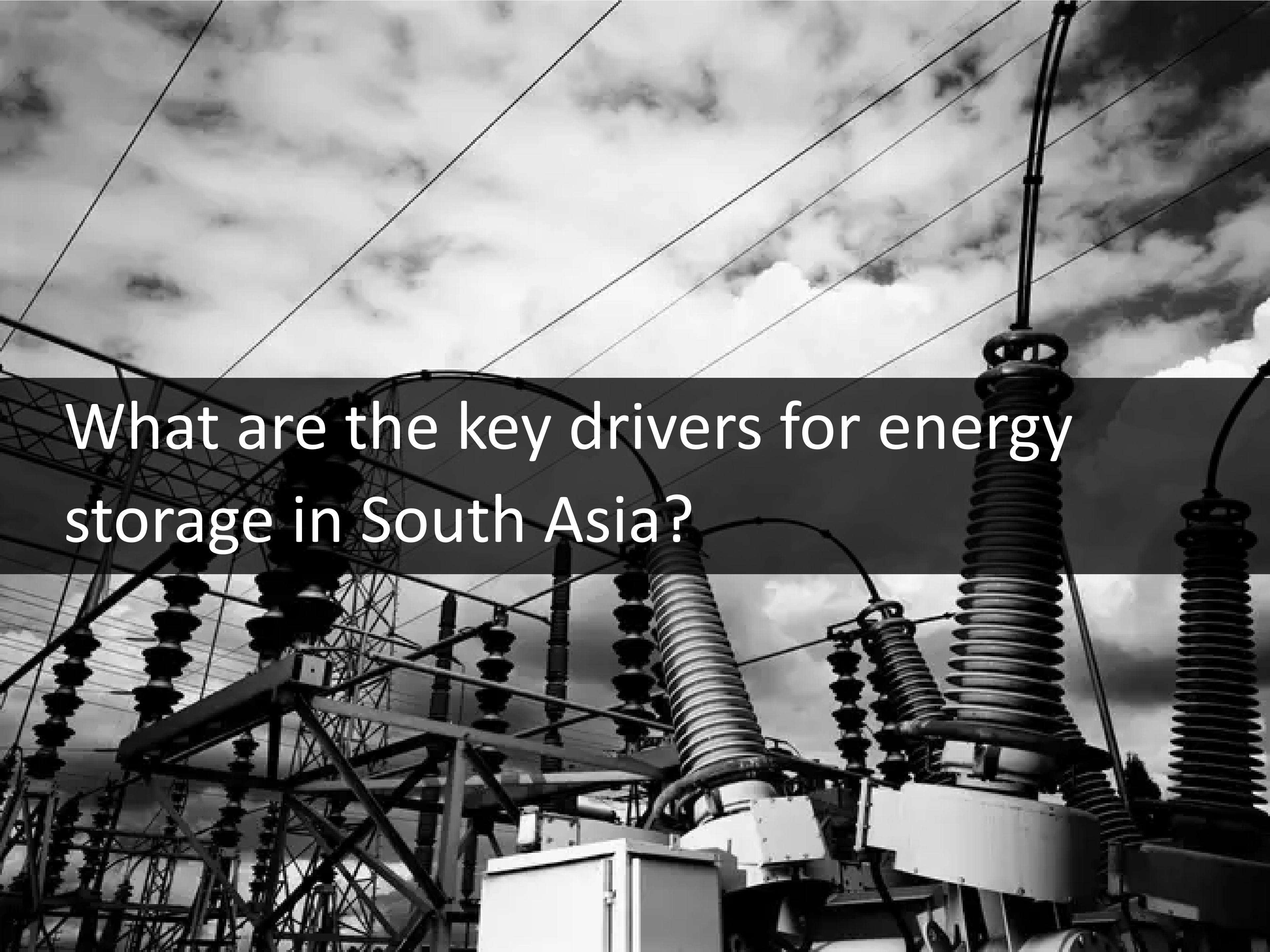
The Readiness Assessment can:

- Identify priority focus areas as policymakers and regulators develop the appropriate suite of policies, programs, and regulations
- Be applied in any jurisdiction regardless of its governance, regulatory, or market structure

The Readiness Assessment CANNOT:

- Recommend specific policy or regulatory solutions
- Inform whether ES is the best solution among other technical and non-technical interventions to meet system needs

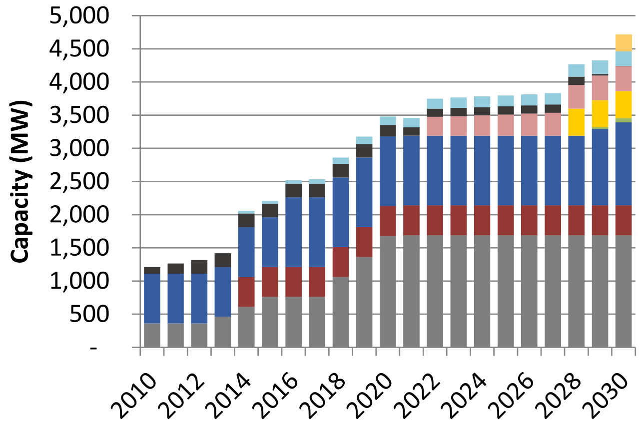
Technical and Economic Potential for Energy Storage in South Asia


What are the key drivers for energy storage in South Asia?

Different ES questions require integrated models

Timeframe: years / hours

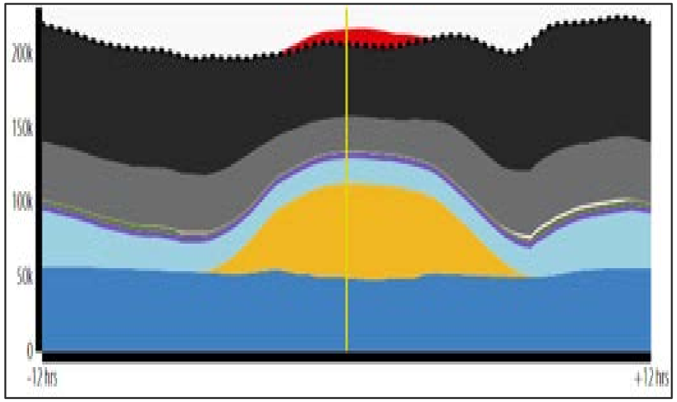
Detail: system / unit



Capacity expansion planning

- Where and when is ES cost-effective?
- How do changes in system costs impact ES investments?
- How do investment opportunities change over time?

Production cost modeling



- Which ES services provide the greatest value to the system?
- How can ES help with RE balancing and reducing curtailment?
- What operational strategies can maximize the value of ES to the grid?

Challenges of valuing ES technologies

Cost-benefit of value stacking becomes more complex

- Use for one application may exclude others
- Uncertainty in load growth, RE targets, and technology costs

Timeframes become more important

- Seasonal vs. intraday services
- Managing state of charge

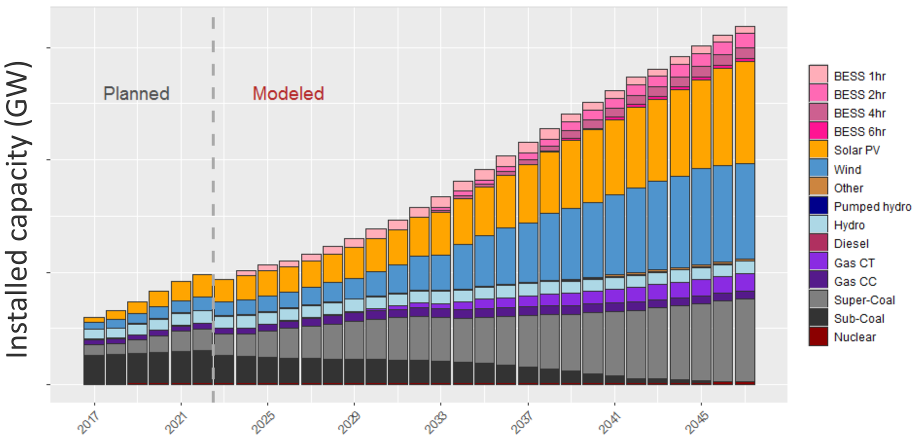
Coordination required to maximize value of energy-limited resource

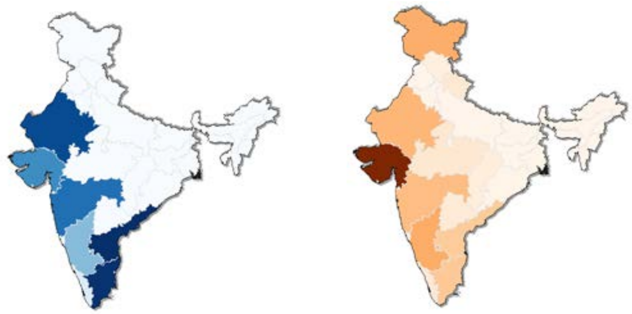
- Power vs. energy requirements for different applications
- Need low cost power for charging

Advanced planning models capture ES technologies and performance

Regional Energy Deployment System (ReEDS) India: Open-access tool for mid- and long-term capacity expansion

Example results





Key Features

- Multi-duration storage
- Capacity credit for storage
- Energy arbitrage value
- Operating reserve value
- Reduced curtailment value
- Augur hourly operational module

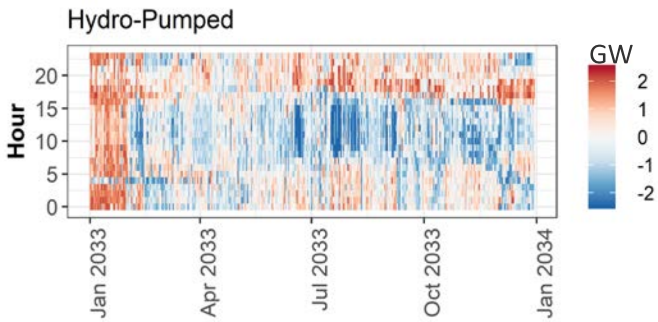
ReEDS finds the mix of generation, transmission, and storage technologies that meet anticipated requirements of the electric sector at least cost

Detailed representation of energy storage operations

Production cost modeling with unit commitment and economic dispatch simulation using PLEXOS

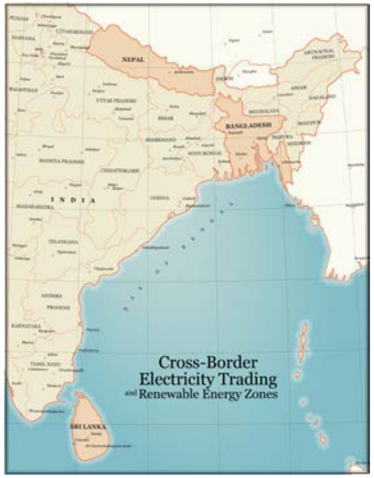
Key Features

- State-of-charge management
- Energy arbitrage value
- Ancillary services provision
- Scenario-based transmission deferral
- Re-dispatch due to RE forecast errors



Modeling regional operations

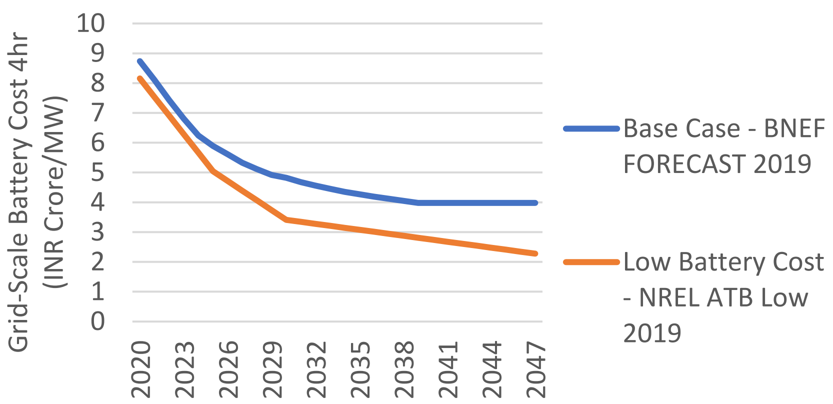
- Using existing plans for ES in Nepal, Bangladesh, and Bhutan.
- Different scenarios of ES growth, operations, and market interactions.
- Represent the value of ES technologies for different SA countries.



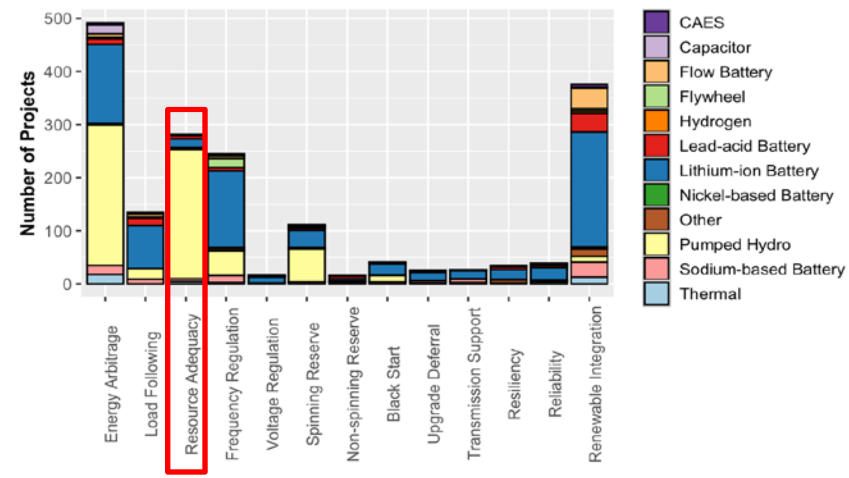
PLEXOS identifies the operational values of ES across timescales

Scenario analysis identifies drivers for ES value

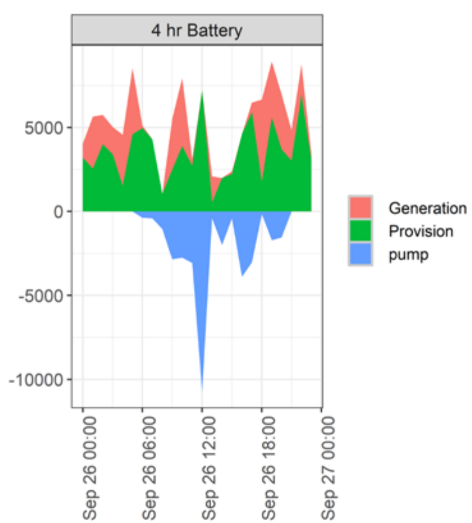
Impacts of cost uncertainty



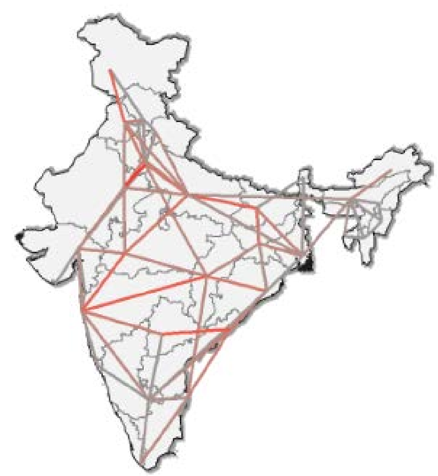
Impacts of market participation rules



Impacts of operating practices



Transmission congestion and utilization

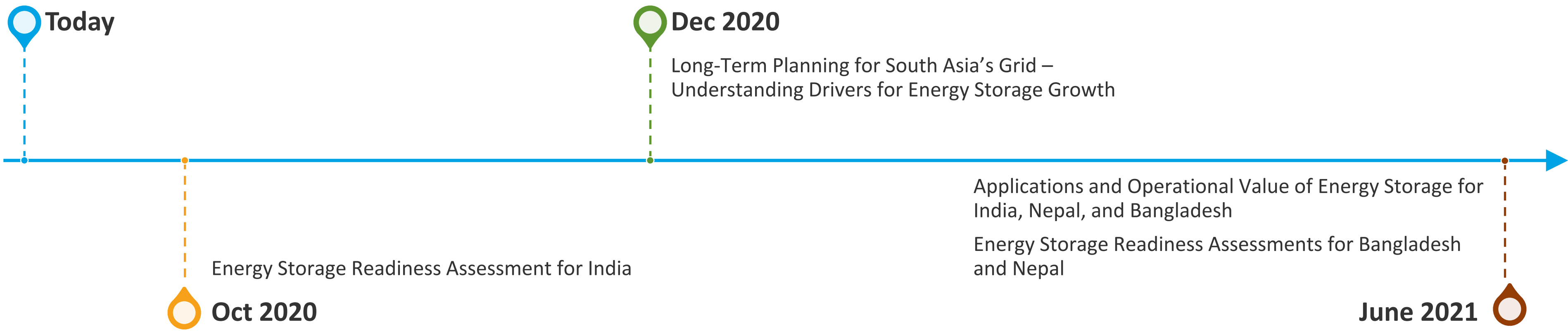


Conclusions

Key Outcomes

- Regulatory readiness assessments
  - Detailed review of how a country can incentivize ES

- Understanding the key techno-economic drivers
  - Long-term horizon to understand the system changes that drive ES investment
    - Including policy and regulatory environments
  - Operational value to validate short timeframe opportunities for ES



How does this work benefit stakeholders?

Policymakers & Regulators

- Priority focus areas for policy and regulatory development
- Data-driven insights of the role and opportunities for ES
- Quantitative assessment of policy and regulatory impacts on ES models

Operators and Planners

- Strategies to maximize value of ES to the grid
- Feasible pathways for system development
- Advanced open-access planning tools (India specific)

Private Sector

- Investment opportunities
- Risk factors that may impact these opportunities

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Questions

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