Challenges and Opportunities in Energy Storage – EPRI Perspective

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Lakshmi Srinivasan
Sr. Technical Leader, Energy Storage
Electric Power Research Institute (EPRI)
Lsrinivasan@EPRI.com

EPRI Energy Storage Roadmap: Vision for 2025



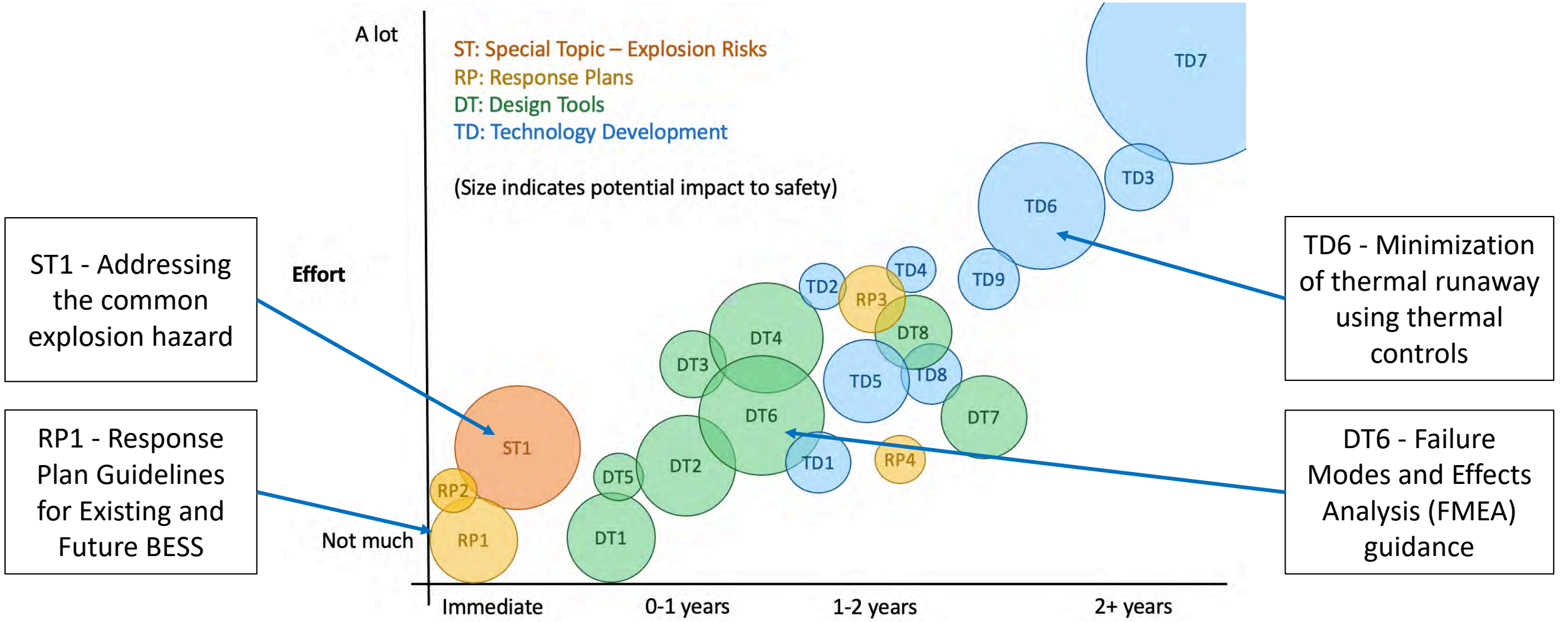


SAFETY	ELECTRICITY RELIABILITY	ECONOMICS	ENVIRONMENTAL RESPONSIBILITY	INNOVATION
Safety practices established	Energy storage asset reliability characterized and enhanced	Planning and operational modeling validated and applied	Reduced emissions with energy storage applications	Cross-industry disruption awareness and integration
Asset hazards characterized and minimized	Energy storage controls integrated and interoperable	Multi-use applications enabled	Sustainable life cycle implemented	Future workforce available and trained
Community resilience and public safety applications viable	Energy storage integrated into grid planning and portfolio management	Total cost of ownership reduced	End-of-life impacts minimized	Technology advancements accelerated

Source: 3002019722

EPRI's energy storage roadmap guides research and collaboration

Battery Storage Fire Safety Roadmap



ST1 - Addressing the common explosion hazard

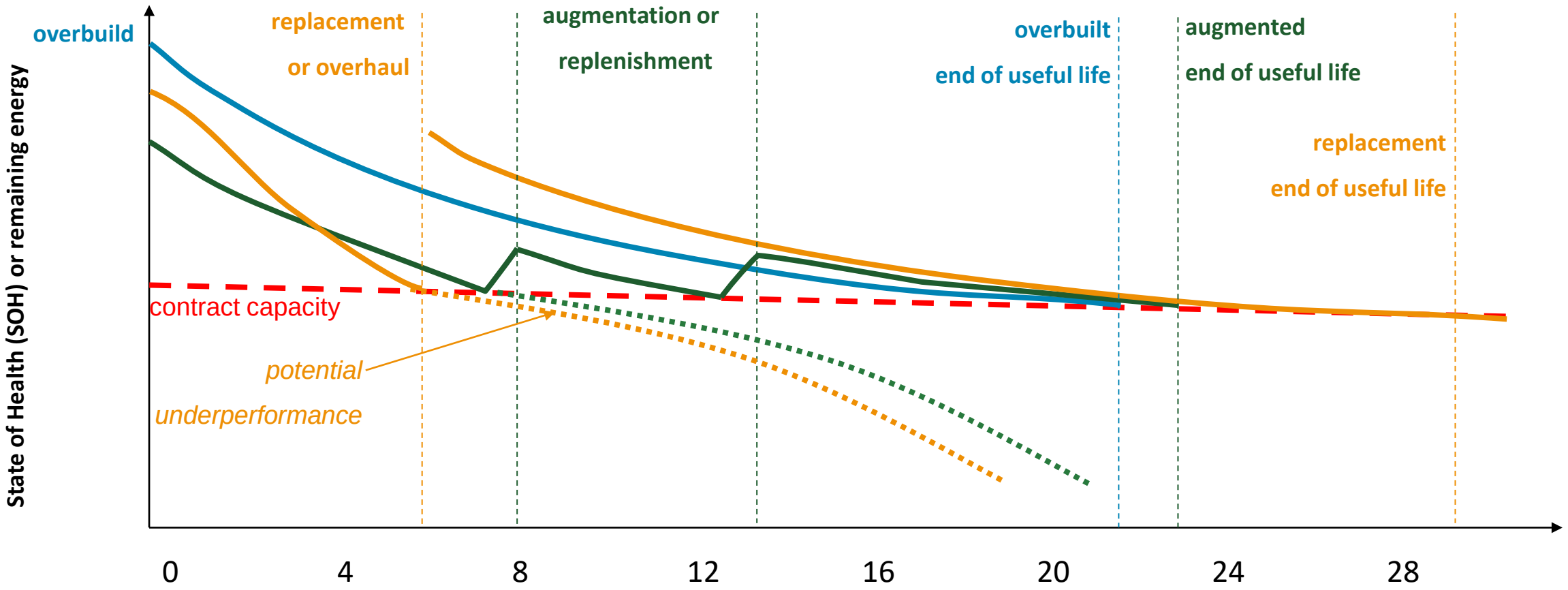
RP1 - Response Plan Guidelines for Existing and Future BESS

TD6 - Minimization of thermal runaway using thermal controls

DT6 - Failure Modes and Effects Analysis (FMEA) guidance

Battery Storage Fire Safety Roadmap: https://www.epri.com/research/products/000000003002022540
BESS Failure Event Database: https://storagewiki.epri.com/index.php/BESS_Failure_Event_Database

Reliability: Maximizing Uptime and Managing Degradation



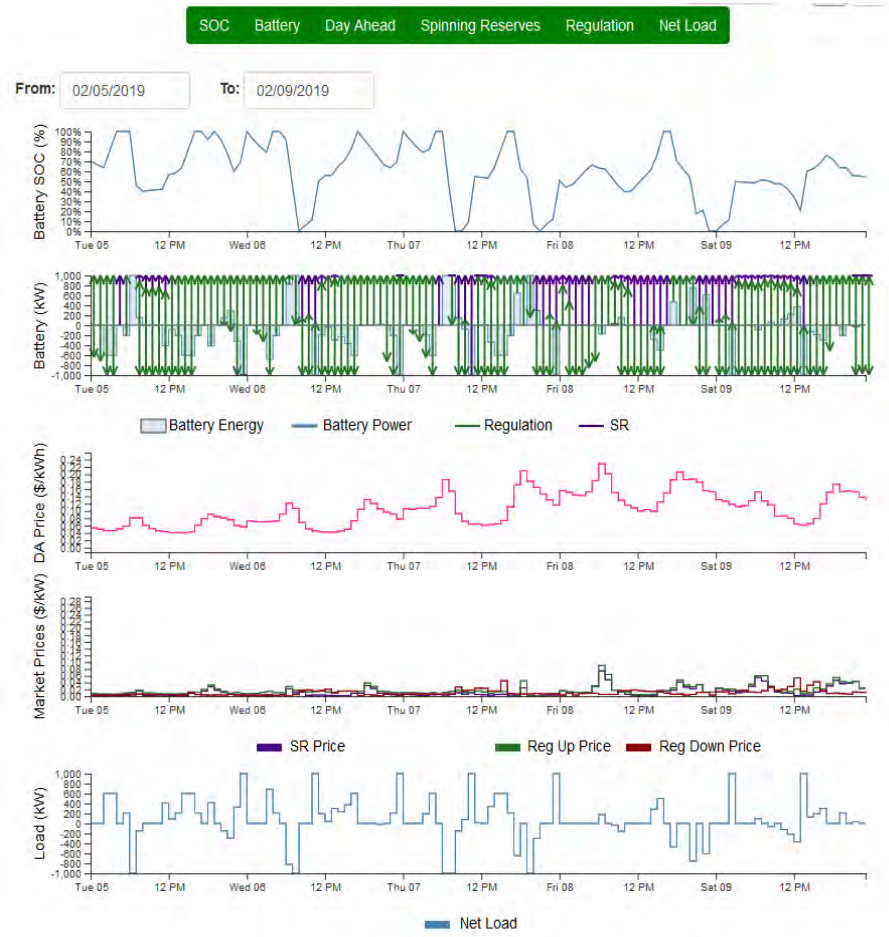
Note: *Figure is intended to be illustrative, not to scale.*

Field data is building but takes time and is not uniformly available

Read more: EPRI Journal "Energy Storage to Count On": https://eprijournal.com/energy-storage-to-count-on/

Economics: Modeling and Valuation Challenges

- **Policy:** Market rules and regulations are evolving
- **Planning/Forecasting:** Futures impacted by decarbonization and renewable and storage deployment levels
- **Site-specific:** General values are difficult
- **Sizing:** Power and energy sizing optimization is complex and dependent on many factors
- **Operations:** Optimizing operations requires reconciling a range of application and technological constraints



StorageVET®/DER-VET® Open Source Optimization and Simulation Software: www.der-vet.com
"Energy Storage Analysis: Finding, Designing, Operating Projects" Whitepaper: https://www.epri.com/research/products/000000003002014064

Environmental Responsibility: Energy Storage Life Cycle Issues

Sustainability of Lithium ion Battery Supply Chain3002019811

Composition and Environmental Fate of Battery Fire Air Emissions and Water Releases

GHG and Air Quality Benefits of Low Carbon Distributed Generation and Energy Storage

Decommissioning Guidelines, Plans and Costs 3002006911; 3002020594

Module Recycling Options and Reuse Feasibility

Tracking Global Environmental Policy and Regulatory Developments

Innovation: Emerging Energy Storage Technologies and Applications

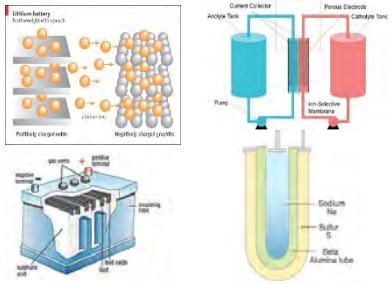
Emerging drive for longer duration (>4 hour) storage to meet decarbonization goals

When and how much long duration energy storage is needed?

What technologies may meet those needs?

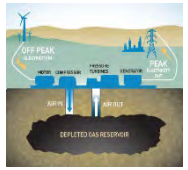
Electrochemical ("Batteries")

Lithium ion
Lead acid
Sodium-beta
Flow batteries
…and more

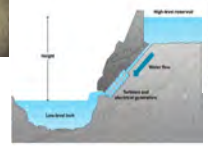


Electromechanical

Compressed Air (CAES)



Pumped Hydro

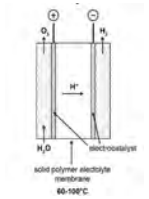


Flywheel

Source: Stornetic

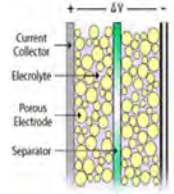
Chemical

Hydrogen, Synthetic Fuels

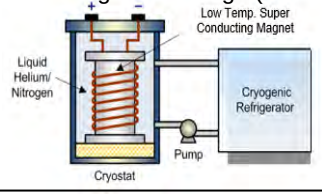


Electrical

Capacitors

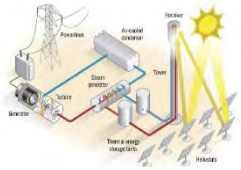


Superconducting magnetic storage (SMES)



Thermal

Molten salt, concrete, sand



Source: American Public Power Association

DOE Long-Duration Energy Storage Workshop
March 9-10, 2021

"BIG" Energy Storage: Priorities and Pathways to Long-Duration Energy Storage

Notice
Proposal for the Longer Duration Energy Storage Demonstration innovation competition
Updated 28 May 2021

Source: uk.gov

CESA PRESS RELEASE

California Needs up to 55 Gigawatts of Long Duration Energy Storage by 2045 to Meet Climate Targets and Maintain Reliable Electric Sector

Industry Technical Forum and Publicly Available Tools

ESIC
ENERGY STORAGE INTEGRATION COUNCIL

A forum advancing the integration of energy storage systems through open, technical collaboration

Publicly Available ESIC Resources

- Energy Storage **Implementation** Guide
- **StorageVET, DER-VET** and Supporting Documentation
- Energy Storage **Cost** Template and Tool
- Energy Storage **Modeling** Bibliography
- Energy Storage **Technical Specification** Template
- Electrical Energy Storage **Data Submission** Guidelines
- Energy Storage **Request for Proposal** Guide
- Energy Storage **Safety** Guidelines
- Energy Storage Reference **Fire Hazard Mitigation Analysis**
- Energy Storage **Safety Incident Gathering and Reporting List**
- Energy Storage **Test Manual**
- Energy Storage **Commissioning** Guide
- Energy Storage **Operations and Maintenance Tracker**
- **Common Functions** for Smart Inverters V4

Publicly Available ESIC Resources: www.epri.com/esic

ESIC Stakeholders

Email esic@epri.com to join the 2400+ industry collaborators

Summary of Key Challenges

- Energy storage is a flexible asset that is not easily categorized
- Energy storage deployment is rapidly increasing
  - Focus on workforce, safety, reliability, and economics is critical
- Lithium ion batteries are dominant technology today
  - Safety and environmental issues deserve continued attention
  - New, low-cost long duration storage appears important to meet decarbonization goals

Energy storage policy, markets, and technology continue to evolve quickly and are deeply connected