"a confederation of trade associations, regional and sectoral chambers of commerce and industry, bilateral business councils and employer organisations in Sri Lanka"

WHITE PAPER ON ENERGY STORAGE SAFETY IN SRI LANKA'S ENERGY TRANSITION

Executive Summary

Sri Lanka is entering a decisive phase in its energy transition, with renewable energy and energy storage systems positioned at the center of national policy and private sector investment. The National Energy Policy of Sri Lanka laid the foundation for this transition, emphasizing stability, security, affordability, and sustainability. While this policy remains the strategic baseline, it needs to update frameworks to reflect new technologies and risks.

The Ceylon Chamber of Commerce recently organized an event on Energy Transition of Sri Lanka brought together government officials, regulators, developers, and technology providers, private sector to discuss both the opportunities and the risks of this transformation. The recurring theme was safety. According to the Sri Lanka Sustainable Energy Authority, while energy storage systems are essential to balance intermittent renewable supply, electrochemical storage such as lithium-ion batteries must be evaluated for safety and environmental impacts[1]. Furthermore, The Public Utilities Commission of Sri Lanka (PUCSL) has issued technical guidelines on stand-alone and backup power systems, identifying hazards and prescribing risk management measures for battery energy storage systems. Sri Lanka's energy transition is being driven by the national objective of achieving 70% renewable electricity generation by 2030. As the share of variable renewable energy sources such as solar and wind increases, energy storage systems (ESS) will become essential for maintaining grid stability, balancing supply and demand, improving system flexibility, and enabling higher levels of renewable energy integration. The successful deployment of ESS will therefore require appropriate regulatory, technical, and safety frameworks to ensure reliable operation, protect public confidence, and support long-term energy security.

This paper argues that energy storage safety is the foundation of successful deployment. In addition to technical safety considerations, stakeholders highlighted the importance of market regulatory and quality-assurance frameworks in enabling the safe deployment of energy storage systems. Attention is required on renewable energy tariff certainty, battery storage incentives, approved-product certification, independent testing requirements, and supplier accountability mechanisms. Together,

[1] https://www.energy.gov.lk/en/renewable-energy/technological-frontiers

these measures can strengthen investor confidence, improve consumer protection, and support Sri Lanka's transition towards a more renewable and resilient electricity system.

Background

The session, convened by the Chamber of Commerce, brought together a diverse group of stakeholders, including representatives from the Ministry of Energy, the Public Utilities Commission of Sri Lanka (PUCSL), private sector developers, and technology providers. The opening remarks underscored the strategic importance of grid stability, decarbonization, and Sri Lanka's international commitments. Presentations drew on global experiences with energy storage, examined business models such as self-consumption, diesel displacement, time-of-use arbitrage, distribution deferral and emphasized the critical role of planning and safety.

Panel discussions highlighted several pressing concerns, including the need for regulatory clarity, mechanisms to ensure developer payment security, and investment in workforce training. The overall tone of the session was simultaneously ambitious and pragmatic: stakeholders acknowledged the urgency of deploying storage to stabilize the grid and reduce reliance on imported fuels, while also recognizing that without clear safety standards and institutional support, accelerated deployment could introduce new risks.

Why Energy Storage Safety Matters

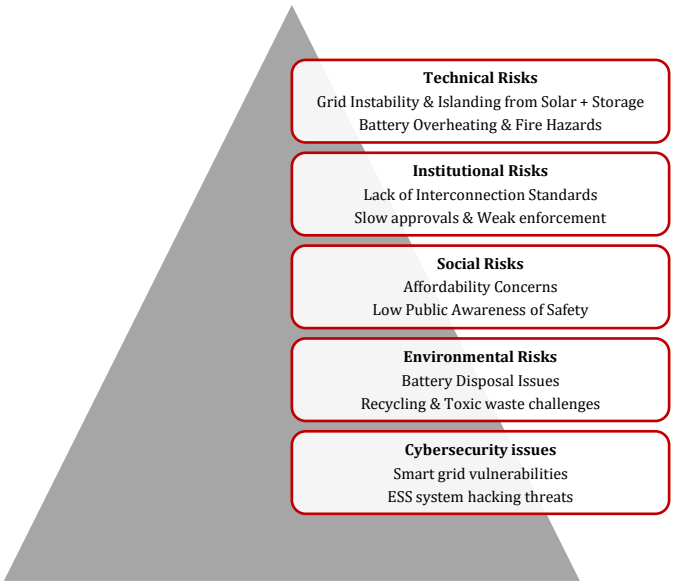
Energy storage systems are indispensable for balancing renewable generation, yet they introduce new technical, social, and environmental challenges. Safety ensures technical reliability by preventing outages, fires, and equipment damage. It protects workers by ensuring installers, linemen, and first responders that are trained to handle battery thermal runaway incidents. It builds community trust by reducing resistance to new projects and reassuring the public that risks are managed. Finally, it strengthens investor confidence by reducing financial uncertainty through clear standards and insurance mechanisms. As the global energy transition accelerates, safety has emerged as a defining concern for the energy storage industry. The rapid growth of installations worldwide expected to exceed 500 GWh by 2030 has been accompanied by a rise in battery-related incidents, underscoring the need for robust standards and oversight. Establishing a culture of safety is therefore not only a technical requirement but also a strategic imperative for sustainable deployment.

Risks Identified

Sri Lanka's energy storage sector faces a complex mix of challenges across five dimensions. Technically, the grid is exposed to instability and islanding risks from behind-the-meter solar combined with storage, alongside overheating and fire hazards in batteries. Institutionally, the absence of clear interconnection standards, slow approval processes, weak enforcement, and limited quality-assurance mechanisms undermine reliability and investor confidence. Stakeholders also highlighted uncertainty regarding long-term renewable energy tariff structures and the absence of dedicated compensation mechanisms for battery energy storage services. While solar generation can access established payment mechanisms, battery storage currently lacks a clear framework for monetizing services such as frequency regulation, peak-demand reduction, reserve capacity, and

renewable-energy firming. This may constrain investment in technologies that are increasingly necessary to support higher levels of renewable energy integration. Market reform to establish an ancillary service market becomes essential to provide a conducive environment in monetizing the values of BESS in power market. Socially, affordability concerns and limited public awareness of battery energy storage safety could slow adoption. Environmentally, the disposal and recycling of batteries present long-term sustainability challenges as volumes increase. Cybersecurity risks also loom large, with vulnerabilities in smart grid and ESS control systems that could be exploited if not addressed. Internationally, cybersecurity for industrial control systems is increasingly guided by the IEC 62443[2] series, which provides a risk-based framework for securing operational technology and critical infrastructure.

Energy Storage Risks in Sri Lanka



Recent developments illustrate how these risks manifest in practice. The 2025 nationwide blackout was linked to rooftop solar inverters, highlighting technical vulnerabilities in grid stability. Engineering forums in 2026 warned of battery overheating and thermal runaway in pilot storage projects, underscoring safety concerns. At the institutional level, PUCSL's consultations revealed delays in approvals, tariff disputes, and weak enforcement, which erode investor confidence. Socially, proposed time-of-use tariffs raised affordability concerns, while unqualified installations using non-compliant equipment have created hazards and reduced public trust. Environmentally, Sri Lanka generates 175 million kg of e-waste annually, with limited recycling capacity for lithium-ion batteries despite new EV disposal laws mandating Extended Producer Responsibility. Finally, as smart meters and distributed control systems are introduced, cybersecurity vulnerabilities pose emerging risks to grid stability and critical infrastructure.

[2] https://www.isa.org/standards-and-publications/isa-standards/isa-iec-62443-series-of-standards

Energy Storage Risk Landscape: Global vs. Sri Lanka

Risk Category	Global Context	Sri Lanka Incidents / Gaps
Technical	Fires, thermal runaway, and grid instability reported in US, China, South Korea (2021–2025).	PUCSL's 2025 blackout inquiry noted rooftop solar inverters destabilizing the grid. IESL forums (2026) warned of battery overheating and DC arc faults in pilot BESS projects.
Institutional	Countries adopt interconnection codes, certification, and safety audits.	Sri Lanka lacks clear interconnection standards; PUCSL consultations (2025) highlighted slow approvals, tariff disputes, and weak enforcement of rooftop solar compliance.
Social	Public resistance to storage projects after fire incidents in New York and Seoul.	Affordability concerns raised in PUCSL tariff hearings; many rooftop solar systems installed by unqualified personnel using non-compliant equipment, eroding public trust.
Environmental	Recycling hubs in EU/US handle lithium-ion waste; Basel Convention governs transboundary movement.	Sri Lanka generates 175 million kg of e-waste annually (Central Environmental Authority, 2025). No local lithium recycling; reliance on export hubs. EV disposal law (2026) mandates Extended Producer Responsibility, but enforcement capacity remains limited.
Cybersecurity	ESS hacking incidents in US and Europe exposed vulnerabilities in smart grid control systems.	Sri Lanka's smart meter pilots (2025–2026) flagged risks of billing manipulation and dispatch interference. No national cybersecurity certification for ESS or smart grid systems.
Product Quality & Certification	Many countries maintain approved-products registries, installer accreditation systems, and independent performance testing programs. Countries such as Australia and Thailand maintain approved-product registries, certification standards, installer accreditation schemes, and independent testing requirements to ensure the safety and performance of solar and energy storage equipment	No national approved-products framework, independent verification mechanism, or installer accreditation system currently exists for energy storage technologies.

International Best Practices

Global experience offers valuable lessons. China has emphasized national planning and mandatory participation of storage in grid services. The European Union and the United Kingdom have developed safety codes, subsidies, and market integration mechanisms. The Philippines has implemented large-scale PV plus ESS projects with strict commissioning standards, while the United States has tied tax credits to compliance with safety and performance standards. These examples demonstrate that safety frameworks can accelerate deployment by reducing risks and building confidence among all stakeholders.

Internationally, several jurisdictions complement safety regulations with quality-assurance frameworks. Australia maintains approved-product lists covering batteries, inverters, and solar equipment, while participation in certain government programs requires compliance with recognized standards. Such approaches improve consumer protection, strengthen accountability, and reduce risks associated with poor-quality equipment entering the market.

Increasingly, jurisdictions are adopting internationally recognized standards for energy storage deployment. The IEC 62933[3] series have emerged as a key reference for battery energy storage system safety, testing, and performance requirements. Several countries have adapted these standards to local grid conditions. For example, Singapore has adopted a modified application of IEC 62933-5-1, incorporating additional grid protection requirements, including restrictions on back feed current during High Voltage Ride Through (HVRT) events. Such examples demonstrate how international standards can be localized while maintaining globally recognized safety and reliability principles.

Implementation Plan and Recommendations

Having identified the technical, institutional, social, environmental, and cybersecurity risks associated with energy storage in Sri Lanka, a structured response is required. International best practices provide useful guidance, but Sri Lanka must adapt these principles to its own grid realities, regulatory institutions, and socio-economic context. The following recommendations outline priority actions to establish a strong safety framework that can support the country's energy transition while protecting communities, workers, and investors.

[3] https://webstore.iec.ch/en/publication/64642

Recommendations

1. Embed safety and quality across the lifecycle

- Mandate certified installers and periodic inspections by Public Utilities Commission of Sri Lanka (PUCSL) and Sustainable Energy Authority (SEA).
- Require compliance testing for imported batteries and inverters before market entry.
- Introduce safety audits during construction and operation phases of BESS projects.
- Establish national cybersecurity standards for smart meters, ESS controllers, and grid management systems, drawing on internationally recognized frameworks such as the IEC 62443 series.

2. Strengthening technological capacity and collaboration

- Establish joint research programs between Sri Lankan universities, Institute of Engineers of Sri Lanka (IESL), and industry to address inverter compliance, battery thermal management, and fire suppression.
- Support pilot projects that test international best practices under Sri Lankan grid conditions.
- Develop training modules for engineers, firefighters, and first responders on battery incident management.

3. Improve governance and regulatory frameworks

- Introduce clear interconnection codes for solar rooftop and storage.
- Streamline approval processes to reduce delays and improve transparency.
- Integrate quantitative safety assessments into licensing, linked to insurance mechanisms.
- Prioritize the development or update of grid codes and technical interconnection requirements in parallel with, or ahead of, energy-storage market mechanisms to ensure that technical performance, safety, and interoperability requirements are clearly defined before market participation rules are finalized.
- Strengthening enforcement capacity by resourcing PUCSL and SEA with technical staff and monitoring tools.
- Establish predefined emergency procurement and deployment protocols that may be activated during clearly defined electricity supply shortages, grid contingencies, or energy-security events.
- Any expedited allocation, procurement, or tariff mechanisms should be transparent, time-bound, and narrowly limited to emergency conditions. Such measures should not replace normal competitive procurement and planning processes.

4. Market and Quality Assurance Measures for Energy Storage Deployment

- Strengthen renewable energy tariff certainty to support long-term investment and project financing.
- Introduce dedicated incentives for battery energy storage systems (BESS) to recognize services such as peak shaving, reserve capacity, and grid support.

- Establish a national approved-products registry for batteries, inverters, and energy storage equipment.
- Implement independent testing and performance verification requirements for solar and storage technologies.
- Introduce installer accreditation and supplier accountability requirements to improve safety and consumer protection.
- Establish emergency deployment mechanisms for defined grid reliability or energy security events.

5. Promote collaborative governance and international alignment

- Encourage industry self-regulation through codes of practice and voluntary safety certification.
- Engage in regional cooperation with South Asia to harmonize standards and share lessons.
- Align with international safety certification programs to reassure investors and ensure credibility.

6. Address environmental sustainability of Storage Systems

- Develop a national framework for safe battery disposal and recycling, leveraging Extended Producer Responsibility (EPR) for EV and stationary storage batteries.
- Explore second-life applications for retired batteries in microgrids and community storage.
- Partner with regional recycling hubs under the Basel Convention[4] to manage hazardous waste responsibly.

7. Enhance cybersecurity resilience

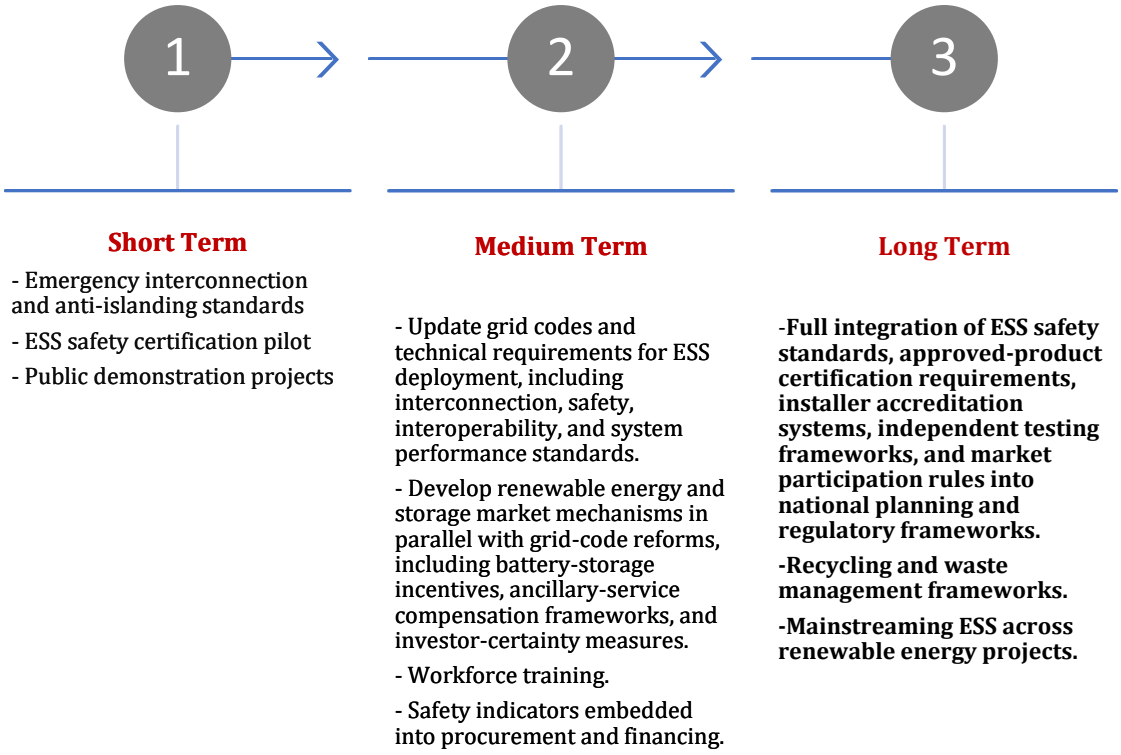
- Establish national cybersecurity standards for smart meters, ESS controllers, and grid management systems.
- Require periodic penetration testing of utility control systems.
- Train utility staff in cyber incident response and coordinate with Sri Lanka CERT for monitoring.

8. Build public awareness and affordability mechanisms

- Launch awareness campaigns on safe installation and handling of storage systems.
- Provide targeted subsidies or concessional financing for compliant systems to improve affordability.
- Encourage community-based storage pilots to demonstrate safety and build trust.

[4] https://www.basel.int/

Implementation Plan



Sri Lanka should adopt a phased approach to energy storage safety. In the short term, emergency interconnection and anti-islanding standards should be issued, a national ESS safety certification pilot should be launched, and one or two public demonstration projects should be funded with transparent monitoring. In the medium term, storage should be integrated into market mechanisms such as frequency regulation and peak shaving, workforce training should be scaled up, and safety indicators should be embedded into procurement and financing. In the long term, national planning and grid codes should be aligned with ESS safety standards, recycling and waste management frameworks should be developed, and safety should be mainstreamed into all renewable energy projects.

Conclusion

Energy storage safety extends beyond technology standards alone. It is equally influenced by the quality of equipment entering the market, the competence of installers and operators, the availability of independent testing and certification mechanisms, and the regulatory and investment frameworks that support deployment. Effective tariff structures, battery-storage incentives, approved-product schemes, and mandatory testing requirements should therefore be regarded as integral elements of a comprehensive national energy storage strategy. Together, these measures create an ecosystem that encourages responsible investment, promotes public confidence, and ensures that energy storage

systems perform safely and reliably throughout their operational life. As Sri Lanka accelerates its transition toward a cleaner and more renewable-based power system, energy storage will play a central role in maintaining grid stability, resilience, and energy security. However, realizing these benefits requires a parallel commitment to safety, quality assurance, and technical competence. By establishing clear standards, strengthening workforce training, and implementing robust monitoring and compliance mechanisms, Sri Lanka can create the conditions for sustainable large-scale deployment. In this context, safety should not be viewed as a regulatory burden or a constraint on growth; rather, it is the foundation that enables the confidence, reliability, and investment needed to scale energy storage successfully.