SAFETY AND GRID SECURITY TIGER TEAM

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LDES Safety and Grid Security Recommendations

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LDES Challenges as Related to Safety and Grid Security

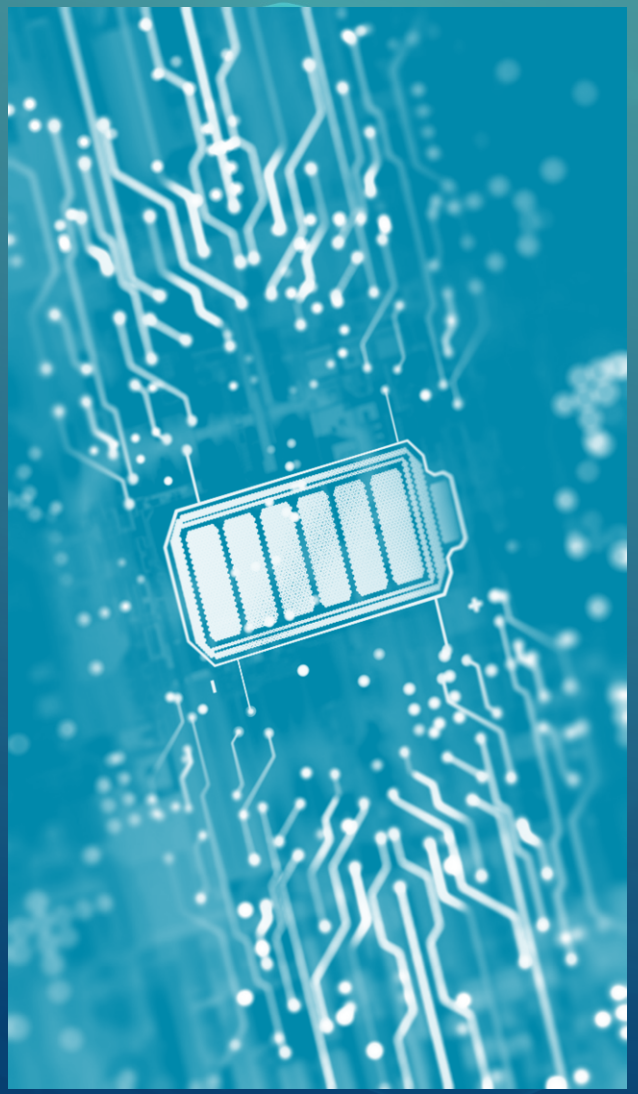
The following two LDES challenges applicable to safety and grid security were identified in DOE LDES Liftoff report: “Pathways to Commercial Liftoff: Long Duration Energy Storage” March 2023.

Identified Challenge #3: The specific needs related to LDES workforce training (i.e., skills and training) are presently not well defined.

Identified Challenge #6: There is presently a lack of resources regarding how to evaluate grid upgrades or expansions that will be necessary to accommodate both new variable renewable generation sites and LDES systems.

Tiger Team reviewed challenges and made recommendations on how to address

Late April/early May was the targeted timeframe for 1st set of draft recommendations



Industry & Lab Representation for Safety and Grid Security

Name	Organization	Role
Steve Willard	EPRI	Safety
Lakshmi Srinivasan	EPRI	Safety
Dr. Davoud Zamani	GridWrap, Inc.	Safety/Security
Eric Ruffel	City Light & Power Engineering, LLC	Security
Alex Dresser	City Light & Power Engineering, LLC	Safety
Karthi Chakaravarty	EarthEn	Safety/Security
Manas Pathak	EarthEn	Safety/Security
Jesse Hoffman	Energy Systems Group LLC	Safety
Daniel Dalpiaz	Infineon Technologies Americas Corp	Safety/Security
Kraig Bockhost	Infineon Technologies Americas Corp	Safety/Security
Steve Baxley	Southern Company	Safety
Kieran Claffey	Southern Company	Safety
Matthew Millard	CapyBara Energy	Industry Advisor/ Safety
Huiyi Jackson	Edison Electric Institute	Safety
Kaitlin Brennan	Edison Electric Institute	Security
Kristine Martz	Edison Electric Institute	Safety
William Pfister	Edison Electric Institute	Safety
Mitch Zafer	Coffman Engineers, Inc.	Safety/Security
Elias Greenbaum	GTA, Inc.	Safety
Pejman Kazempoor	University of Oklahoma	Security
Owais Amin	e-zinc	Safety/Security
Loraine Torres-Castro	Sandia National Laboratory (SNL)	Safety
Chris O'Reilley	Oakridge National Laboratory (ORNL)	Security
Jackie Huynh	Pacific Northwest National Laboratory (PNNL)	Safety

SAFETY CHALLENGES & RECOMMENDATIONS

Challenge 3 & 6: Safety Recommendations

3-1. Recommendation: Develop and implement safety and standards specifically for LDES technologies that can incorporate existing National Fire Protection Association (NFPA) 855, Standard for the Installation of Stationary Energy Storage Systems (2023) and International Fire Code (ICC) 2018. This will ensure that they are efficient and effective for training workforces for current and future LDES technologies.

3-2. Recommendation: Subsea LDES electrolytic hydrogen production and storage systems are the safest approach to gigawatt-scale clean hydrogen. All unit operations needed for subsea electrolytic hydrogen production and storage are already being performed by the workforce of the offshore gas and oil industry, albeit in different contexts. A testing and engineering company should be tasked with constructing a pilot scale system.

3-3. Recommendation: Develop a comprehensive LDES workforce training program that includes specific modules and certifications on the safe installation and maintenance of battery storage cabinets. These modules should emphasize the importance of adequate spacing between cabinets to reduce the risk of DC arch flash, ensure efficient cooling, and facilitate accessibility for maintenance.

6-1. Recommendation: Invest in research and development for advanced, climate-controlled housing for integrated electrolyzer Hydrogen production and storage systems that prioritize safety.

SECURITY CHALLENGES & RECOMMENDATIONS

Challenge 3 & 6: Security Recommendations

3-1. Recommendation: Establish a dedicated working group or task force to develop a comprehensive LDES workforce training program for both operators and security professionals, with strong emphasis on LDES security certification. This program should provide clear guidelines on the necessary skills and training for certifying the workforce to ensure the security of the storage systems and protect the connection to grid-connected power generation resources (e.g., Distributed Energy Resources)

6-1. Recommendation: Prioritize the development of comprehensive guidance through NIST standards that address grid security vulnerabilities such as standards applicable to the LDES system manufacturers/vendors or to those purchasing, implementing, using, maintaining that will be integrated with the grid as part of the LDES systems integration. This is particularly crucial as we transition from a few centralized power generation sites to a multitude of grid-connected renewable power generation and storage systems.

6-2. Recommendation: Develop cybersecurity and physical security guidance documentation for interconnecting LDES with the grid that encompasses a variety of use-case scenarios.

6-3. Recommendation: Develop a Change Configuration Management plan for asset owners/operators specifically for LDES systems. This plan should include a structured process for documenting and tracking software updates and maintenance activities, particularly those related to inverter software changes and updates that impact battery performance.

6-4. Recommendation: Participate in existing or establish efforts to analyze existing NERC Reliability Standards against documented reliability risk to the Bulk Electric System from Battery Energy Storage System (BESS) to determine where regulatory enhancements such as NERC Standards projects, and BES Definition Review, are necessary to reduce security risks. Note that distribution side BESS are not within NERC's jurisdiction and would not be subject to compliance with the NERC CIP Standards.

6-5. Recommendation: Analyze existing interconnection requirements and revise them to include minimum security requirements for BESS.

Next Steps

- Safety and Grid Security Tiger Team developed four additional challenges with recommendations focused on:
  - **Challenge 1:** Addressing the lack of comparative studies on the safety of each LDES type or category and the gaps in the safety testing, etc, in emerging LDES technologies and unique battery chemistries and thermal energy storage. We need a common framework and language to discuss and compare.
  - **Challenge 2:** Safety standards and testing have not been developed yet for emerging technologies, e.g., UL testing.
  - **Challenge 3:** Need to update the codes and standards (NFPA 855, NEC70, IFC, etc.) to consider different types of LDES technologies. Examples of LDES technologies that codes and standards do not consider currently are:
    - Flow Battery: vanadium flow, iron flow battery, zinc aqueous, hydrogen
    - Mechanical storage: Gravity (pump hydro), kinetic (spin)
    - Thermal storage: Molten salt, compressed air
  - **Challenge 4:** Addressing the different safety needs to develop based on the type of LDES such as safety for hydrogen sensors, safety shut-off valve, and different egress, fire suppression systems, and PPE when compared to Li-Ion batteries for specific types of LDES technologies.

Summary

Safety and Grid Security Tiger Team has developed and submitted LDES recommendations for following challenges:

- **Challenge #3**: The specific needs related to LDES workforce training (i.e., skills and training) are presently not well defined.
- Safety: 3
- Security: 1

- **Challenge #6:** There is presently a lack of resources regarding how to evaluate grid upgrades or expansions that will be necessary to accommodate both new variable renewable generation sites and LDES systems.
- Safety: 1
- Security: 5

Submission of four additional challenges and recommendations are to be submitted to LDES Consortium and DOE in September.

THANK YOU!