

Battery Storage Fire Safety Research at EPRI

European Fire Safety Week
Dec 1st, 2021

Dirk Long, PE, PMP

Senior Technical Leader

Electric Power Research Institute (EPRI)

Energy Storage and Distributed Generation



www.epri.com

© 2021 Electric Power Research Institute, Inc. All rights reserved.



Energy Storage Deployment is Parabolically Increasing



Source: U.S. Energy Storage Monitor (ESA/Wood MacKenzie), US Storage Deployments (Q1 2018 – Q4 2019)

100 GW

Energy Storage Association vision for 2030 cumulative U.S. deployment

ESA "100x30 Vision"

Recent Energy Storage System Fires: Incident Database

Location	Capacity (MWh)	Capacity (MW)	Application	Event Date	System Age (yr)	Source
US, HI, Kuhuku	10.0	15.0	Wind Integration	4/22/2011	1.0	Hawaii Free Press
Japan, Ibaraki Prefecture	unknown	unknown	unknown	9/21/2011	unknown	NGK
US, WA, Port Angeles	unknown	unknown	Energy Shifting	7/3/2013	unknown	Peninsula Daily News
US, WI, Franklin, S&C	unknown	unknown	unknown	8/10/2016	0.0	S&C
Korea	1.5	unknown	Wind Integration	8/2/2017	0.0	MOTIE Investigation, June 2019
Belgium, Engie	unknown	6.0	Frequency Regulation	11/11/2017	unknown	GTM
Korea	8.6	unknown	Frequency Regulation	5/2/2018	1.8	MOTIE Investigation, June 2019
Korea	14.0	unknown	Wind Integration	6/2/2018	2.4	MOTIE Investigation, June 2019
Korea	19.0	unknown	Solar Integration	6/15/2018	0.5	MOTIE Investigation, June 2019
Korea	9.7	unknown	Wind Integration	7/21/2018	1.6	MOTIE Investigation, June 2019
Korea	18.0	unknown	Demand Charge Mgmt	7/28/2018	0.0	MOTIE Investigation, June 2019
Korea	6.0	unknown	Solar Integration	9/1/2018	0.7	MOTIE Investigation, June 2019
Korea	6.0	unknown	Solar Integration	9/7/2018	0.0	MOTIE Investigation, June 2019
Korea	0.2	unknown	Solar Integration	9/14/2018	4.0	MOTIE Investigation, June 2019
Korea	17.7	unknown	Frequency Regulation	10/18/2018	2.6	MOTIE Investigation, June 2019
Korea	3.7	unknown	Solar Integration	11/12/2018	0.8	MOTIE Investigation, June 2019
Korea	1.2	unknown	Solar Integration	11/12/2018	0.9	MOTIE Investigation, June 2019
Korea	4.2	unknown	Solar Integration	11/21/2018	0.9	MOTIE Investigation, June 2019
Korea	1.3	unknown	Solar Integration	11/21/2018	0.6	MOTIE Investigation, June 2019
Korea	9.3	unknown	Demand Charge Mgmt	12/17/2018	1.0	MOTIE Investigation, June 2019
Korea	2.7	unknown	Solar Integration	12/22/2018	1.0	MOTIE Investigation, June 2019
Korea	3.3	unknown	Demand Charge Mgmt	1/14/2019	0.8	MOTIE Investigation, June 2019
Korea	5.2	unknown	Solar Integration	1/14/2019	1.2	MOTIE Investigation, June 2019
Korea	2.5	unknown	Solar Integration	1/15/2019	0.8	MOTIE Investigation, June 2019
Korea	46.8	unknown	Demand Charge Mgmt	1/21/2019	0.6	MOTIE Investigation, June 2019
US, OR, Powin	unknown	unknown	n/a	4/11/2019	unknown	The Oregonian
US, AZ, APS	2.0	2.0	Volt Reg., PQ, Solar int.	4/19/2019	2.0	APS
Korea	3.7	unknown	Solar Integration	5/4/2019	2.3	MOTIE Investigation, June 2019
Korea	1.0	unknown	Solar Integration	5/26/2019	1.0	MOTIE Investigation, June 2019
Korea	3.0	unknown	Solar Integration	7/12/2019	0.6	MOTIE Investigation, June 2019

Over 42 Known Incidents

https://storagewiki.epri.com/index.php/BESS_Failure_Event_Database

EPRI Collaborative Project to Understand and Close Gaps

Battery Storage Fire Prevention and Mitigation
Two-phase Project

Expert Collaboration

Top-Down

Bottoms-Up

Site-Specific Hazard Assessment

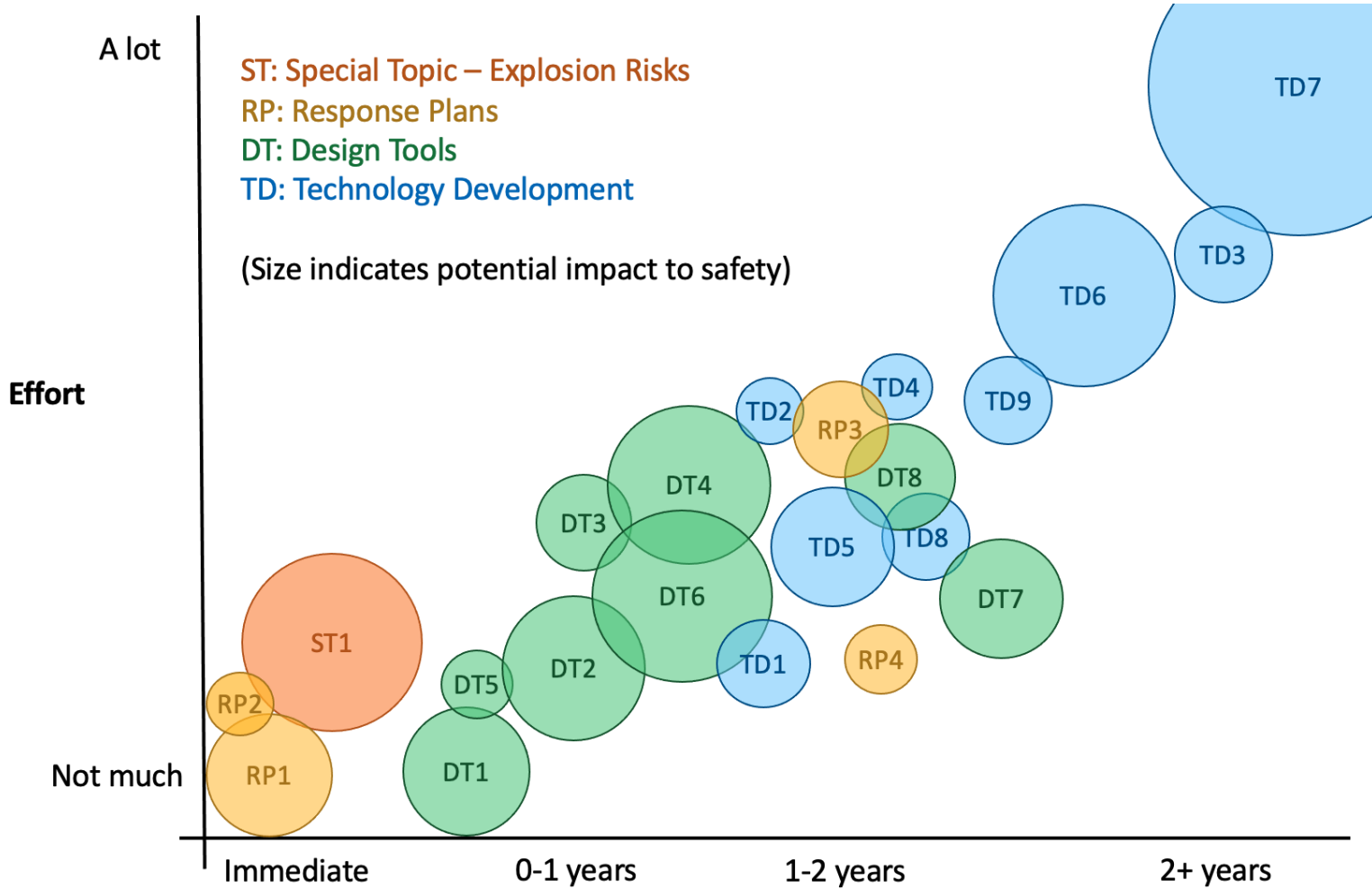
Strategic Roadmap

**Project
life cycle
safety
toolkit**

Phase I

Phase II

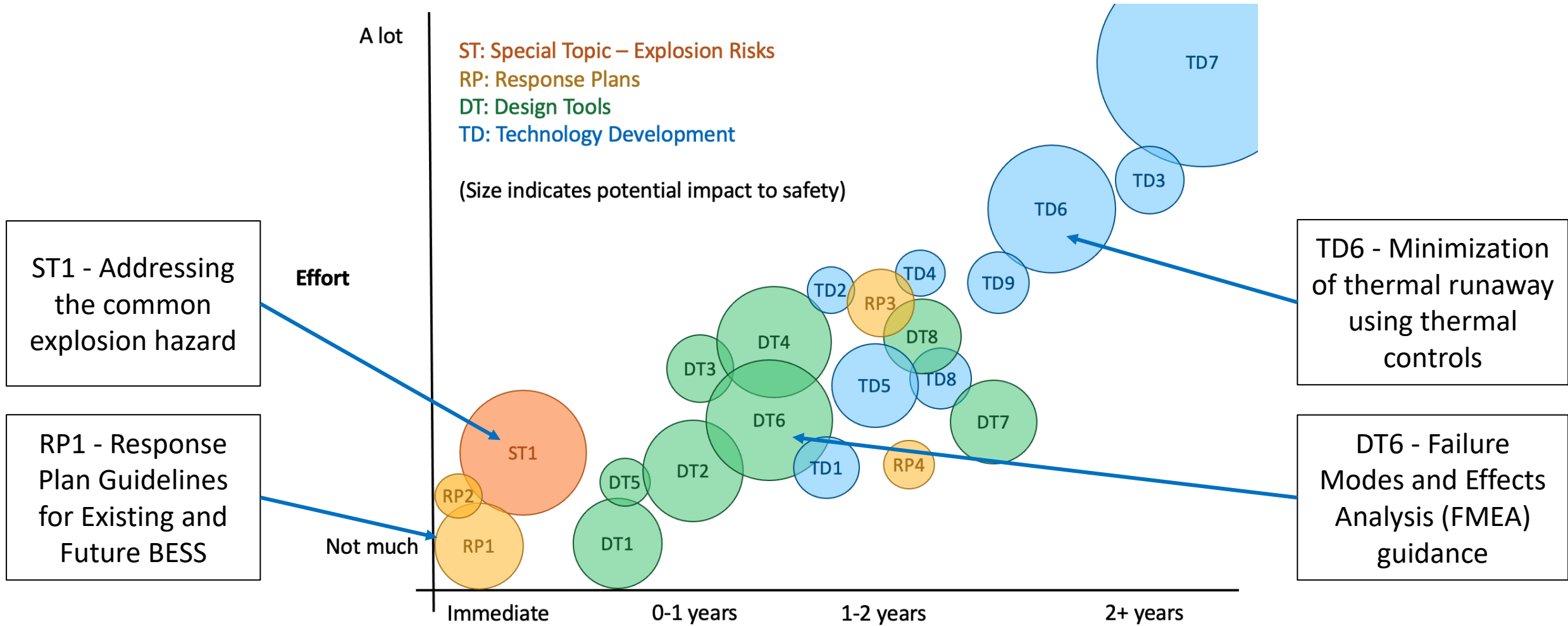
Phase I Output – Battery Storage Fire Safety Roadmap



22 topics defined for future research

<https://www.epri.com/research/products/000000003002022540>

Phase I Output – Battery Storage Fire Safety Roadmap



22 topics defined for future research

<https://www.epri.com/research/products/000000003002022540>

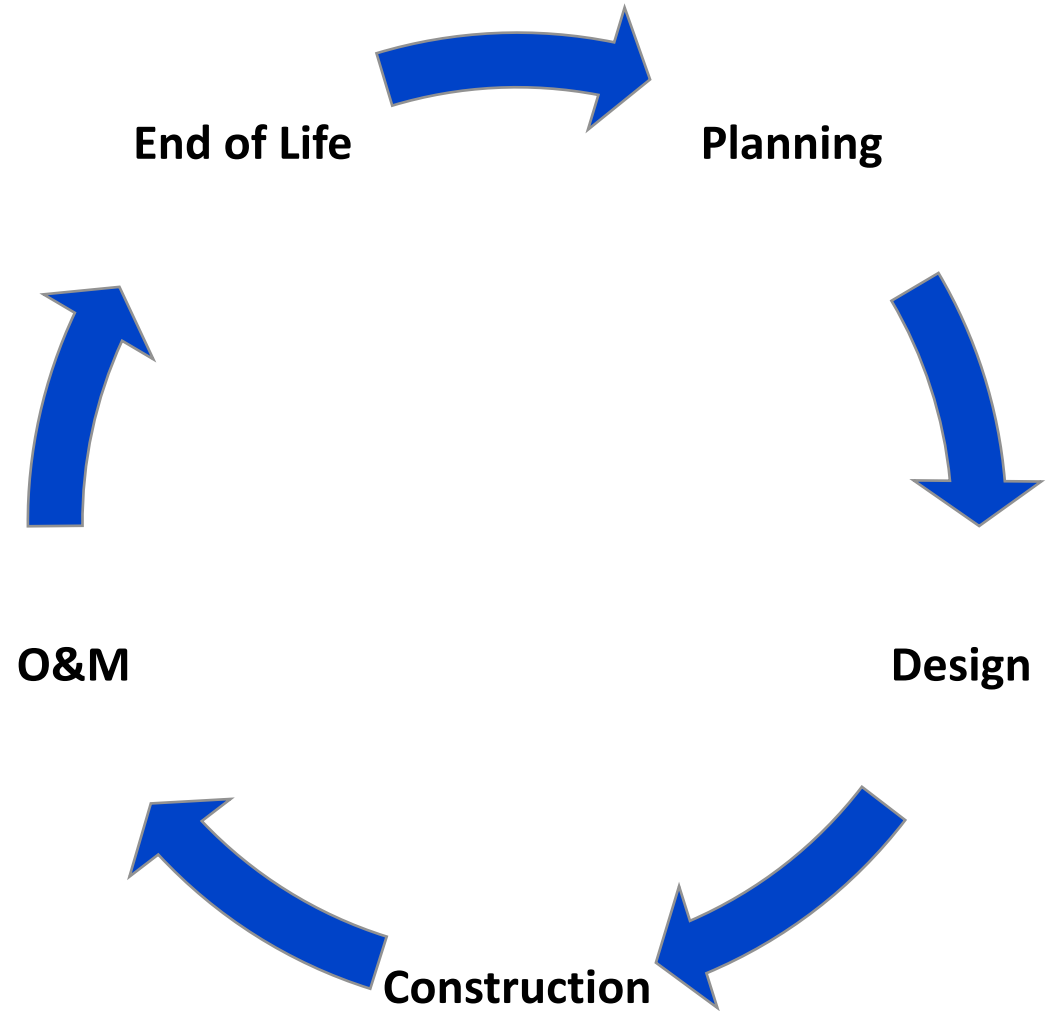
Project Life Cycle Safety Toolkit

Types of Resources

- Prioritized testing & data collection
- Whitepapers and research summaries
- Calculators and tools
- Spec templates and references
- Analysis/methodology input guidance

Example Approach

- Identify: Battery Fire Safety Roadmap ([link](#))
- Educate: Explosion hazard whitepaper ([link](#))
- Enable: Explosion hazard calculator ([link](#))



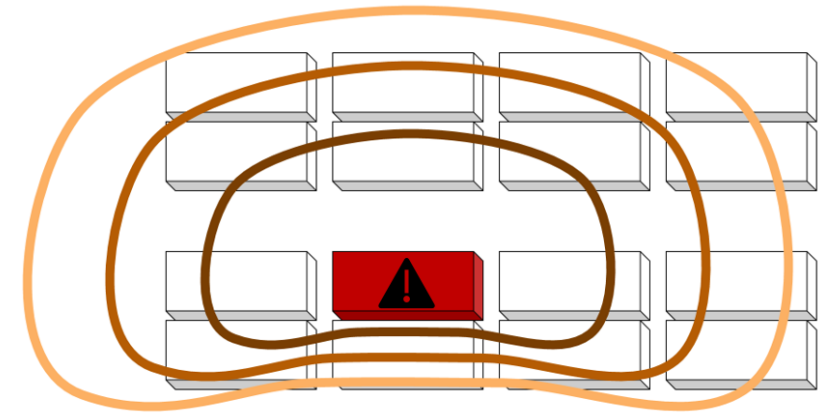
Battery Energy Storage Fire Prevention and Mitigation: Phase II

OBJECTIVES AND SCOPE

- Guide safe energy storage system design, operations, and community engagement
- Implement models and templates to inform ESS planning and operations
- Study planned and operational energy storage site safety retrofit, design, and incident response cost tradeoffs

VALUE

- Strategies to mitigate fire, explosion, and environmental hazards created by energy storage thermal runaway
- Amplified efforts leveraging public funding
- Expert engagement from across ESS industry



DETAILS	CONTACT
<p>Duration 2 years</p> <p>Price Collaborators: \$60,000 Site Hosts: \$100,000 (varies by custom scope)</p>	<p>Dirk Long +1 (720) 925-1439 DLong@EPRI.com</p> <p>Stephanie Shaw +1 (650) 391-8203 SShaw@EPRI.com</p>
Funding may be spread over 2021-2023	

Develop Energy Storage Project Life Cycle Safety Toolkit to Guide Energy Storage Design, Procurement, Planning, and Incident Response

Current EPRI Battery Safety Resources (Initial Toolkit)

Title	Year Published	Availability	Link
EPRI BESS Failure Event Database	Maintained current	Public	Storage Wiki
Battery Storage Fire Safety Roadmap	2021	Public	3002021077
Battery Energy Storage Fire Prevention and Mitigation Project – Phase I Final Report	2021	EPRI Project Participants	3002021077
Lessons Learned: Lithium Ion Battery Storage Fire Prevention and Mitigation - 2021	2021	Public	3002021208
Battery Storage Explosion Hazard Calculator	2021	EPRI Project Participants	3002021076
BESS Explosion Hazards Whitepaper	2021	Public	3002022706
Energy Storage Integration Council (ESIC) Energy Storage Reference Fire Hazard Mitigation Analysis	2019 original release 2021 update pending	Public	3002017136
Lithium Ion Battery Thermal Runaway Propagation and Emissions Analysis	2021	EPRI Members (TI)	3002021644
BESS – Augmented Reality Maintenance and Safety (AMRAS) demonstration	Forthcoming 2021	EPRI Project Participants	TBD
Design Trade Study Method for Battery Energy Storage Fire Prevention and Mitigation	2020	EPRI Project Participants	3002020573
EPRI Lithium Ion Battery Module Burn Testing	2020	EPRI Members (TI)	3002020241
ESIC Energy Storage Safety Incident Gathering and Reporting List	2019	Public	3002017241

A blue-tinted photograph of four people (three men and one woman) in professional attire, smiling and looking towards the camera. The woman in the center is wearing a white hard hat. The background is a solid blue color.

Together...Shaping the Future of Electricity

Dirk Long, PE, PMP

Senior Technical Leader

Electric Power Research Institute (EPRI)

Energy Storage and Distributed Generation

dlong@epri.com

(720) 925-1439