A GUIDE TO ESIC:

THE ENERGY STORAGE INTEGRATION COUNCIL

Engagement guide for a technical community developing publicly-available references and tools for the integration of energy storage

FEBURARY 2023
3002024265

OVERVIEW

The Electric Power Research Institute (EPRI) established the Energy Storage Integration Council (ESIC) to advance the deployment and integration of energy storage systems through open, technical collaboration. For nearly 10 years, EPRI convenes and coordinates ESIC's working groups and strategic sessions in order to publish documents and online resources.

Energy storage is among the fastest-growing segments of the electric power industry, with U.S. annual deployment projected to increase from 3,509 MW in 2021 to more than 12,000 MW by 2026[1]. Development and change in energy storage are accelerating, initially driven by declining costs, propelled by widening use of renewable and distributed energy resources, deep decarbonization goals, mandates, and incentives. Technologies continue to advance rapidly, particularly with respect to safety, grid integration capabilities, monitoring and system analytics. Although lithium ion battery energy storage currently dominates by the number of deployments, there is a recent and renewed interest in emerging, non-lithium technology advancements, aiming to provide longer duration and operate longer lifecycles.

As a result, gaps in best practices and streamlined procedures have emerged in the industry, driving the need for an accurate and common understanding of how to deploy storage to meet the exponentially increasing demand.

ESIC's open, technical forum facilitates discussion among utilities, storage developers, researchers, regulators, and others to address technical and operational issues associated with deploying energy storage systems. Council participants work together through meetings, webcasts, and teleconferences to identify areas of common interests and concerns, and to share deployment experience.

ESIC collects, develops, publishes, and shares information on leading practices that support effective energy storage integration through a variety of guides and tools.

ESIC guides considerations of multi-faceted strategies and requirements for energy storage to provide value to the grid, while maintaining safety and reliability.

1. U.S. Energy Storage Monitor: 2021 Year in Review Full Report. Wood Mackenzie / American Clean Power, March 2022.

HOW ESIC WORKS

ESIC's participants collaborate to steer and shape the council's activities, with support and guidance provided by EPRI's research staff. EPRI hosts ESIC, provides coordinating and supporting communications among participants, and publishes ESIC's guides, templates, and tools. EPRI also coordinates ESIC's support of related endeavors such as DER-VET™, a free, publicly accessible, open-source platform for calculating, understanding, and optimizing the value of distributed energy resources including energy storage.

ESIC is organized into three working groups:

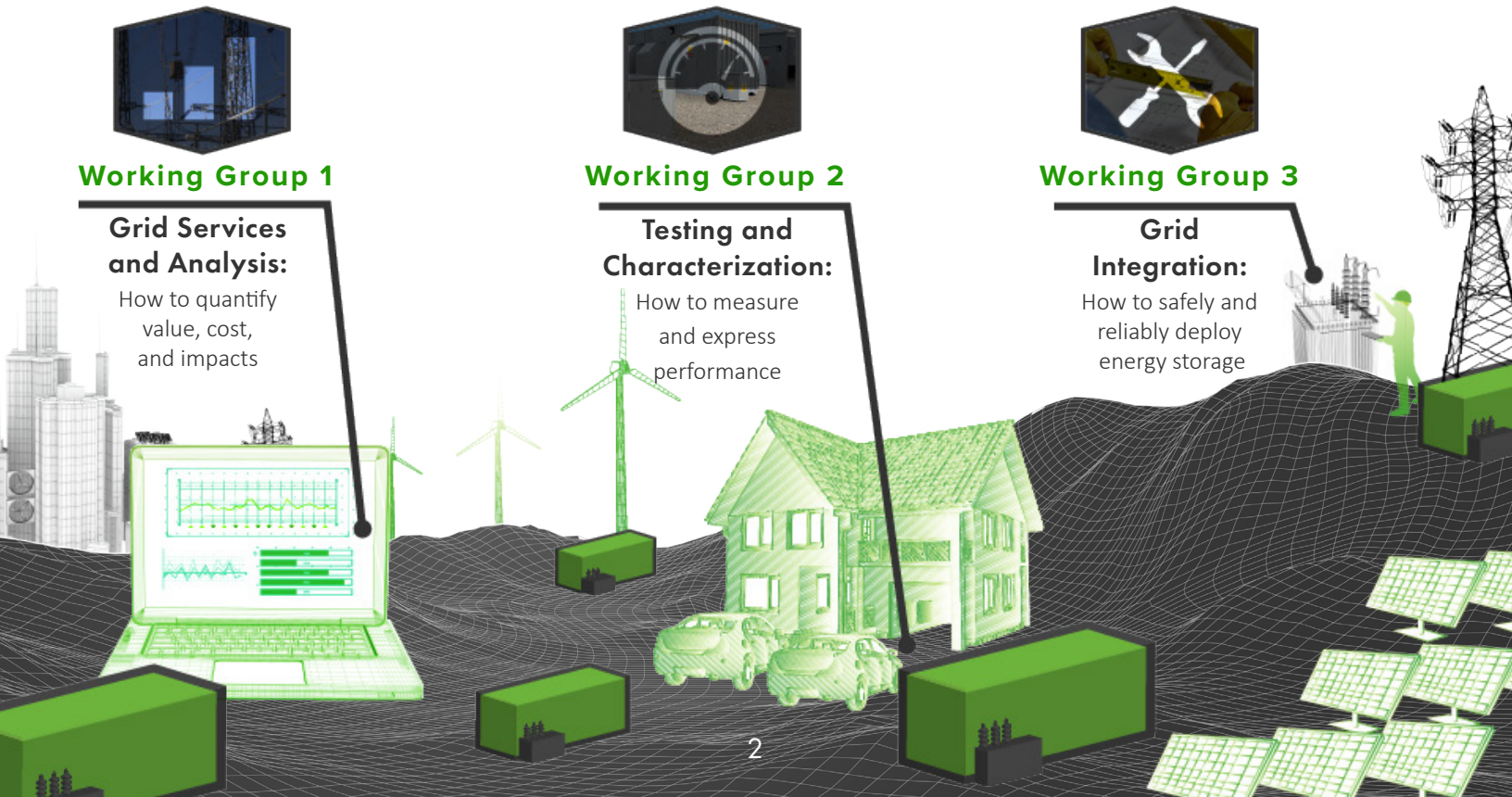
The Grid Services and Analysis Working Group (WG1) determines the requirements of energy storage with respect to grid needs and value. It develops guidelines and definitions for evaluating energy storage system value and power system impacts.

The Testing and Characterization Working Group (WG2) characterizes and standardizes technical parameters of fully-integrated energy storage products and technologies with respect to utility requirements. It works to improve industry standards for energy storage by developing common metrics and data guidelines, and establishing performance standards and test protocols.

The Grid Integration Working Group (WG3) provides practical guidance for implementing energy storage in the field through the project lifecycle.

Task forces within each working group focus on tasks specific to the production of new guides and templates and on reviewing and updating products and publications.

ESIC
ENERGY STORAGE
INTEGRATION COUNCIL



ESIC's Collaborative Process

Figure 1 illustrates ESIC's working process:

- Identify strategic gaps in understanding of technical requirements for energy storage systems, along with current deployment concerns.
- Define work products or ideas to address the gaps. These can include handbooks, guidelines, software, webcasts, or others.
- Task forces work collaboratively and tactically with ESIC to develop tools and guidelines. These are reviewed, published and distributed to provide common understanding among utilities, solution providers, and other stakeholders.
- Work products are updated as new information becomes available or industry needs arise.

Figure 1. The ESIC Process

HOW ESIC STAKEHOLDERS REALIZE BENEFIT

Utilities and Grid Operators

Utilities and grid operators are engaged on the front lines of energy storage deployment and integration. Investor-owned utilities, electric cooperatives, municipally owned utilities, public power utilities, independent system operators, and regional transmission organizations participate to gain access to leading practices that can help improve communication to reduce "soft costs" in integrating energy storage projects. ESIC products aid utilities and grid operators in clearly specifying, testing, commissioning, and evaluating safety approaches. Further, ESIC participation affords opportunities for utility and grid operators to engage in a wider stakeholder community.

Suppliers

Equipment and service suppliers are central to the ESIC stakeholder community. These include manufacturers, integrators, controls developers, and turnkey storage system providers. Some suppliers participate in working groups to gain insights into utility perspectives of the storage market, providing a fuller understanding of utility needs and operations. Given the diverse technology offerings, suppliers' insights are valued in developing common terminology, definitions, and procedures for characterizing various storage options, and incorporate best practices for commissioning. With increased focus on emerging technologies, ESIC creates opportunities for suppliers to provide input to ensure technology evaluation is being conducted on a consistent basis. Alignment between suppliers and utilities through the use of ESIC's resource library helps avoid costs and schedule delay associated with conflicting specifications or unclear scope. The guides and templates can equip them to formulate accurate, reliable bids and offer a tailored portfolio of services covering a storage project's lifecycle.

Public Agencies

ESIC's mission aligns with diverse missions of public agencies, including regulatory bodies, and publicly-funded research centers. Because such agencies work in the public interest, ESIC's open, collaborative research can serve them in carrying out their mission or charter. ESIC can serve as a public platform to disseminate research findings to a broader audience. ESIC's resource library is publicly available to serve various purposes. From costs-benefit evaluations to implementation, ESIC resources can be used to inform the public about the benefits and challenges of energy storage. Through ESIC, public agencies can interact with other stakeholders in the energy storage sector.

Regulators

Regulators bring a keen interest in issues in energy storage as it relates to providing customers with safe, reliable, affordable and equitable energy. Many Public Utilities Commissions across the U.S have set mandates or targets for public utilities to install energy storage, responding in part to the consequences of renewable energy's growing portion of the energy portfolio. Although states' mandates and priorities may differ, increasingly, energy storage is a key element in electric resource planning. ESIC provides regulators a point of reference on use cases and applications of energy storage. Participation also provides benchmarks of storage valuations across regions and, as such, can be instrumental in policy analysis and resource planning portfolios. Regulators can use ESIC's guidelines in evaluating utility procurement processes by providing context and standard language. ESIC materials and forums also provide publicly available data to inform transparent rulemaking and ratemaking.

Research Organizations

ESIC collaborates with national laboratories, academia, and industry researchers to target relevant areas for study. ESIC guides, templates, tools, and reports provide common methodologies and nomenclature to facilitate effective data sharing and communication among diverse organizations and interests. ESIC's shared approach equips researchers to compare results and collaborate more effectively. ESIC's Energy Storage Data Guidelines, Safety Guide, and Commissioning Guide were co-published as a collaborative effort of EPRI and national laboratories.

Standards Developing Organizations (SDOs)

Standards are essential for energy storage today, making these organizations important both as ESIC stakeholders and contributors. Standards for many aspects of energy storage, such as inverters and safety, continue to be developed. By participating in ESIC working groups, SDOs gain insights into diverse stakeholders' challenges and can better understand where new standards are needed and how existing standards should be refined.

The Public

ESIC provides an open forum, making the public integral to the broad group of stakeholders. ESIC resources are available to inform any interested individual or organization regarding the benefits and value of energy storage and its integration with utility distribution systems. The public has ready and free access to the latest insights into the applications and benefits of energy storage and how it can foster a safer, reliable, affordable, and equitable energy.

LAYERS OF ENGAGEMENT

Established in 2013, ESIC has grown to over 2,600 participants with multiple layers of possible engagement. Depending on expertise and interest level, participants can attend face-to-face general meetings, working group update webcasts, and task force meeting webcasts. All in-person and virtual meetings are open to the public and are free to attend.

General Meetings

Semi-annual general meetings are open to all, typically in conjunction with another industry gathering or conference. The focus is strategic – identifying gaps and how ESIC can address them. EPRI staff lead discussions of ESIC's work, and participant groups focus on strategic topics, which the group brainstorms ways of how to proceed. Participants contribute to decisions on work priorities, outlining ideas, and use their experience and perspectives to guide product development.

Working Group and Task Force Meetings

Each working group meets as needed. These webcasts discuss recent events, provide updates on work in progress on a group of related Task Forces, and solicit feedback in prioritizing new efforts. Task Forces meet more frequently in smaller groups and drive the development of the products, from framing the products, to writing and reviewing drafts.

Knowledge Sharing

ESIC hosts educational and information sharing webcasts. These cover various topics on integrating energy storage and are avenues for different publicly available information to disseminate through the energy storage industry. Knowledge sharing webcasts provide lessons learned and leading practices from demonstrations and deployments.

"EPRI ESIC provides an excellent collaborative forum for energy storage stakeholders, including safety, utilities, developers, system providers, manufacturers, recyclers, regulators, and researchers. The energy storage industry and deployment base have grown significantly during the past several years and correspondingly, EPRI ESIC has kept up with this growth by increasing its attention on safety, codes & standards, decommissioning, and recycling. The EPRI ESIC collaboration approach and publications benefit the industry by providing valuable products developed by experts from multiple stakeholders."

— ***Kevin Fok***
Director of Service,
LG Energy Solution Vertech

PUBLISHED RESOURCES

How ESIC Develops and Updates its Resources

ESIC currently offers seventeen guides, templates, and tools to support storage deployment through the entire ESS project lifecycle, from planning to end-of-life. ESIC also facilitates a forum for the use of a web-based software system developed by EPRI. Each product is subject to ongoing review by ESIC participants and updated to reflect industry developments, experience, and research. New products are launched as ESIC participants collectively identify and prioritize gaps in knowledge or resources for storage integration. Selected ESIC products are highlighted in this Guide and all available through ESIC's website (www.epri.com/esic).

ESIC Energy Storage Implementation Guide

This guide is a practical reference covering the complete lifecycle of a grid-connected energy storage system, from planning and deployment to operations and maintenance, and ultimately to decommissioning. This overarching reference covers how other ESIC products and publicly available resources can be used in each stage of an ESS project. It also focuses on implementing current leading practices for integrating energy storage systems and includes comprehensive references and links to publicly available resources. Figure 2 illustrates the example of the major steps in a storage project from planning through decommissioning. While utilities may be the guide's primary beneficiaries, storage suppliers, regulators, and other stakeholders can use it to understand the scope and complexity of storage integration and train newer team members who are not familiar with energy storage integration.

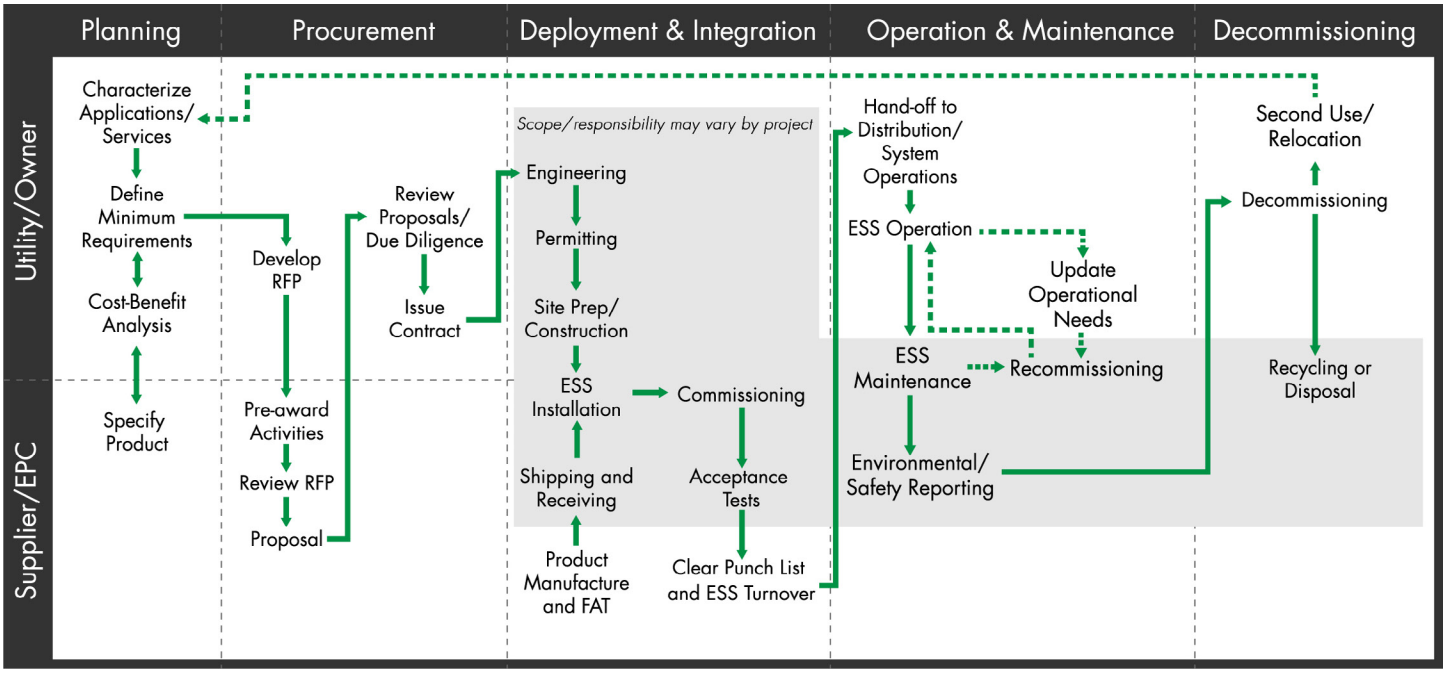


Figure 2. Energy Storage Project Lifecycle Process

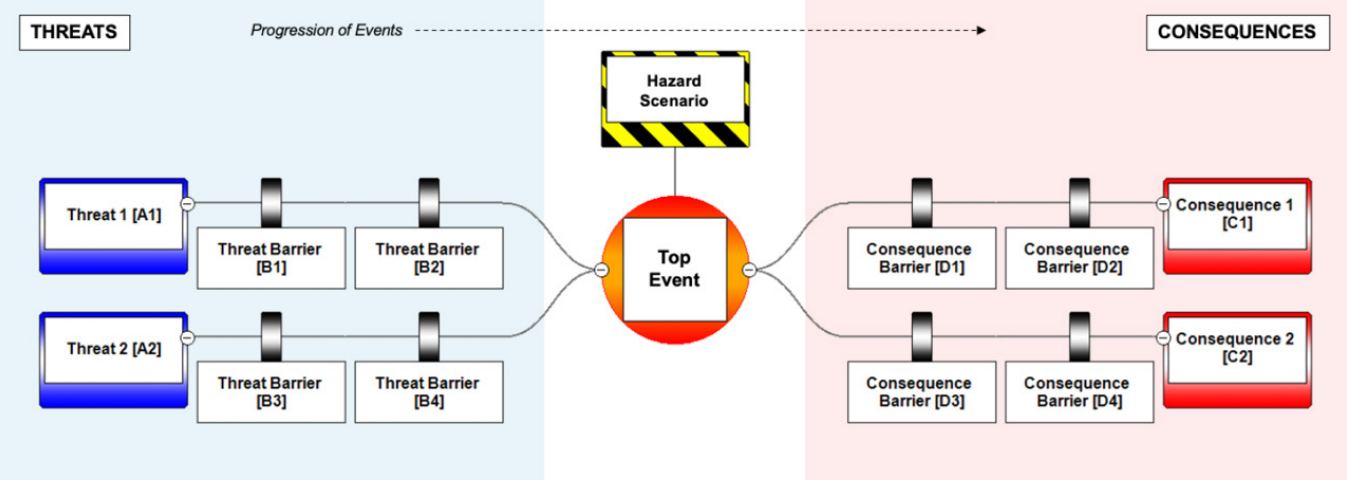


Figure 3. Bowtie Hazard Mitigation Analysis Framework

ESIC Energy Storage Reference Fire Hazard Mitigation Analysis

Following a series of energy storage fire-related incidents in 2018 and 2019, ESIC re-engaged its Safety Task Force to identify current industry gaps and challenges related to safety. After finding there was a general lack of transparency and thorough understanding in various safety offerings and mitigation strategies, the task force of industry experts developed a set of reference hazard mitigation analyses. A "bowtie" framework was used to show failure modes, what threats could lead to that failure, consequences of the failure, and mitigation methods to prevent the failure or minimize the impact. Project engineers, technology developers, and authorities having jurisdiction can utilize these reference analyses to communicate safety approaches and understand risks. The framework was used by EPRI and its members to perform reviews of fielded systems, and findings from those projects were incorporated into the latest version in ESIC.

ESIC Energy Storage Test Manual

ESIC's Energy Storage Test Manual presents specific, detailed, reproducible test procedures for utilities, research laboratories, and other testing entities when evaluating energy storage systems. Given the variety of energy storage technologies and their diverse applications, it can be challenging to consistently characterize ESS performance and functionality. This manual establishes consistent sets of characteristics and terminology so that a variety of devices, technologies, and functions can be compared objectively at testing facilities and in the field. The most recent update contains a test regime specifically designed for testing a system during operation to minimize downtime and maximize output results, and DC-coupled solar plus storage test procedures.

The test manual has been adapted for procurement solicitations and contracting as to the test method for system acceptance and performance guarantees. Including clearly defined test procedures, measurement points, and calculations of performance metrics up front allow owners and suppliers to align on expectations.

"The EPRI ESIC Energy Storage Test Manual provides a standardized Test Protocol that has been developed with input from multiple Utilities and Industry experts. Duke Energy has adopted the Test Manual as the accepted method to evaluate the performance of multiple non-Lithium energy storage technologies, including Nickel-Hydrogen, Zinc Bromine, Flow, Hydrogen and others. Duke and EPRI also collaboratively developed DC-coupled solar plus storage test protocols which were shared with the ESIC community to help align on industry approaches to DC-coupled solar plus storage system acceptance."

— ***Tom Fenimore***
Director of Emerging Technology Office at Duke Energy

Electrical Energy Storage Data Submission Guidelines

Access to relevant data for performance verification and reliability assessments is needed throughout the life of a project, especially where storage is assuming a critical role in supporting the grid. This guide helps to define data requirements including a points list, data quality and transmission, sensor accuracy, alarm management, and data responsibility. This guide provides information to standard making bodies as well as tracking emerging standards related to data. Data is critical for making operational decisions, identifying indicators for maintenance activities, and incorporating into asset management strategies. A companion excel-based data optimization tool is being developed to inform on data needs and potential export limitations.

ESIC Energy Storage Commissioning Guide

This guide provides utilities and suppliers with a practical, high-level understanding of the requirements for commissioning energy storage and establishes practical approaches for deploying projects safely and reliably. The guide defines the roles, responsibilities, and tests involved in initial commissioning, recommissioning during the life of the project and decommissioning. It includes commissioning-related considerations with a flow chart for each stage of a project.. This guide can be used to support the development of project-specific commissioning plans and checklists. Expected to be published in 2023, a newer version will incorporate the latest codes and standards and more recent lessons learned.

ESIC Energy Storage Request for Proposal Guide

This guide provides an introduction to structuring an energy storage project request for proposal (RFP). It describes an RFP's essential components, the information that should be provided to vendors, and the materials to be requested from vendors in their proposals. It promotes clear communication of project requirements for both issuers and suppliers which aims to ensure the system meets its desired objectives and reduce lifecycle costs. Following the guidelines creates a path to standardized storage RFPs, making their evaluation more transparent and efficient. The guide includes specific materials, such as a bidder qualification form, a division of responsibility matrix that can be used to delineate roles and responsibilities clearly, and a glossary of key technical terminology.

"EPRI ESIC has provided a valuable venue for vetting and disseminating US Department of Energy (DOE) funded grid storage research and development products. In Pacific Northwest National Laboratory's case, EPRI ESIC has provided feedback that improved PNNL's Energy Storage Protocol report. And in turn, ESIC has incorporated portions of the PNNL ES Protocol's content into ESIC's own Testing references. Our collaboration with ESIC is a stellar example of effective 'private public' partnership.

The EPRI ESIC community includes several electric utilities leading the nation's evaluation, deployment and integration of grid energy storage. The information and experience exchange between this community and the DOE funded National Laboratories is accelerating the efficient and effective addition of modern grid storage as a critical additional clean energy enabling asset. As adoption of grid storage continues to grow, our exchange of information and experience will remain a critical contributor to removing barriers to grid storage success across the public and private sectors of the power industry."

— ***Vince Sprenkle***
Sr. Advisor Energy Storage, Pacific Northwest National Laboratory (PNNL)

ESIC Energy Storage Cost Template and Tool

This tool can be used to organize the full set of cost line items for a distributed energy storage project, from development through decommissioning. Its interactive spreadsheet includes fields for one-time, upfront project costs, recurring annual or periodic costs, and end-of-life costs. In using the template, planners have a complete list of cost line items for soliciting bids for a new system. Likewise, suppliers of systems or components can use the template to prepare clear, complete offers.

The template functions both as a data file and an active cost estimation tool. Once specifications and cost data are entered, the template will calculate a total cost of ownership for energy storage using a conventional pro forma cash flow approach. Consistent use of the template for different projects can provide relative/comparative total costs.

ESIC Energy Storage Technical Specification Template

The diversity of energy storage products drives the need for standardized specifications for an energy storage system. This need is shared by procurement departments, distribution planning engineers, SCADA and telecommunications engineers, operators, and protection engineers. ESIC working group participants developed standardized lists of technical characteristics that need to be defined for a given storage project.

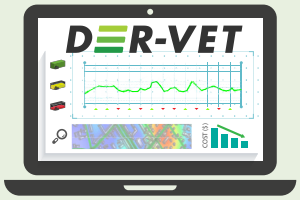
The template offers consistent terminology for both the project and performance characteristics. Planners can use it to communicate requirements to suppliers while developing a clearer understanding of the supplier's products. The template facilitates and simplifies information exchanges among utility planners, suppliers, customers, and regulators involved in planning new energy storage facilities.

ESIC Operations and Maintenance Tracking Tool

Proper O&M data gathering enables forensics and data analytics on availability, reliability, and potentially component or design issues. To support this data gathering, ESIC developed an excel-based tool to document O&M reliability issues and tasks to support reliability tracking. It provides tables of component and sub-components and a list of other inputs needed for consistent categorization of maintenance activities. EPRI has used the tool directly to log O&M activities for a demonstration project or it could be used as a reference for integrating into a separate tracking tool. This tools also helps communicate and align with suppliers on reporting expectations.

ESIC Energy Storage Incident Gathering and Reporting List

This product serves as a questionnaire to facilitate uniform and robust data gathering for safety related incidents that enables improved post-incident evaluation. It provides support for identification of common failure modes and characteristics of an incident, which aims to lead to guidance that could eliminate or reduce the impact of similar incidents in the future. The list can be used by system owners, first responders, and integrators for pre-incident preparation and to support incident root cause analysis.



- **Web-hosted software evaluates energy storage and distributed energy resources economics for customer and utility applications.**
- **Design, locate, and operate energy storage projects with optimization and simulation engine.**
- **Free public access, made possible with funding from California Energy Commission.**

DER-VET™

DER-VET™ provides a free, publicly accessible, open-source platform for calculating, understanding, and optimizing the value of distributed energy resources (DER) based on their technical merits and constraints. An extension of EPRI's StorageVET® tool, DER-VET supports site-specific assessments of energy storage and additional DER technologies—including solar, wind, demand response, electric vehicle charging, internal combustion engines, and combined heat and power—in different configurations, such as microgrids. It uses load and other data to determine optimal size, duration, and other characteristics for maximizing benefits based on site conditions and the value that can be extracted from targeted use cases including grid services, resilience objectives, bill management savings, and more.. Customers, developers, utilities, and regulators across the industry can apply this tool to inform project-level decisions based on sound technical understanding and unbiased cost-performance data. A DER-VET task force meets monthly to discuss tool development, get user feedback, and prioritize future tool enhancements.

Common Functions for Smart Inverters

Now in its fourth edition, Common Functions for Smart Inverters serves the utility industry as a standards-setting document for smart inverter functions and as a tool to support uniformity and interoperability across smart inverter protocols. EPRI led its development, which included contributions from more than 600 industry stakeholders. For the recent revision, ESIC provided industry input on functionality and identified gaps and areas for improvement with respect to energy storage systems. As a result, findings in the report are incorporated in all smart inverter standards and specifications including DNP3, SEP2, IEC 61850, SunSpec, and MESA, as well as grid codes globally. These guidelines have provided input to standards organizations and activities, including the National Institute of Standards and Technology and the International Electrotechnical Commission.

HOW TO PARTICIPATE

ESIC is an open forum. Published documents and tools are readily available to the public at no charge, with no special permissions required. All of the resources can be accessed at www.epri.com/esic.

To become an ESIC participant, visit ESIC's website to register, or email esic@epri.com. All ESIC participants receive direct notification of ESIC agenda items and meetings and may elect to take part in any of the activities described here.

To engage in specific Task Forces, email esic@epri.com to inquire about the latest active Task Forces, where participants can provide input, ideas and feedback to specific ESIC products or activities.

Contacts:

Peggy Ip, ESIC Manager, pip@epri.com

Caleb Cooper, Lead Support Engineer, ccooper@epri.com

Erin Minear, Program Manager, eminear@epri.com

Administrative Support, esic@epri.com

ESIC PRODUCTS

- A Guide to ESIC: The Energy Storage Integration Council
- ESIC Energy Storage Implementation Guide
- Summary of Energy Storage Control Performance Metrics
- ESIC Energy Storage Operation and Maintenance Tracking Tool
- ESIC Energy Storage Reference Fire Hazard Mitigation Analysis
- ESIC Energy Storage Safety Incident Gathering and Reporting List
- ESIC Energy Storage Test Manual
- Electrical Energy Storage Data Submission Guidelines
- ESIC Energy Storage Commissioning Guide
- StorageVET & DER-VET supporting documentation
- Energy Storage System Taxonomy of Operating Behaviors
- ESIC Energy Storage Request for Proposal Guide
- ESIC Energy Storage Technical Specification Template
- ESIC Energy Storage Cost Template and Tool
- Energy Storage Safety: 2016
- ESIC Energy Storage Modeling Bibliography
- Common Functions for Smart Inverters: 4th Edition

For the latest ESIC products go to www.epri.com/esic

EPRI

3420 Hillview Avenue, Palo Alto, California 94304-1338 USA • 800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com

3002024265