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A STANDARDIZED TEST PROTOCOL FOR EVALUATING RESIDENTIAL ENERGY STORAGE SYSTEMS

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INTRODUCTION

- Deployment of Residential Energy Storage Systems (R-ESS) are expected to grow to 600MW by 2022
- Number of R-ESS systems on offer in the US market doubled in past 12-18mo
- No commonly accepted method to characterize real world performance
- The more mature R-ESS market in Germany indicates the lack of transparency can result in a wide variance in quality, reliability, safety, and overall value proposition

LOOKING BEYOND THE SPEC SHEET

- Characterizes R-ESS across a number of dimensions that extends beyond traditional standards:
  - Application-specific testing over anticipated conditions
  - Assessment of device control and communication
  - Characterization of balance-of-system and soft costs
  - Estimates of initial and lifetime costs of ownership. safety, and overall value proposition

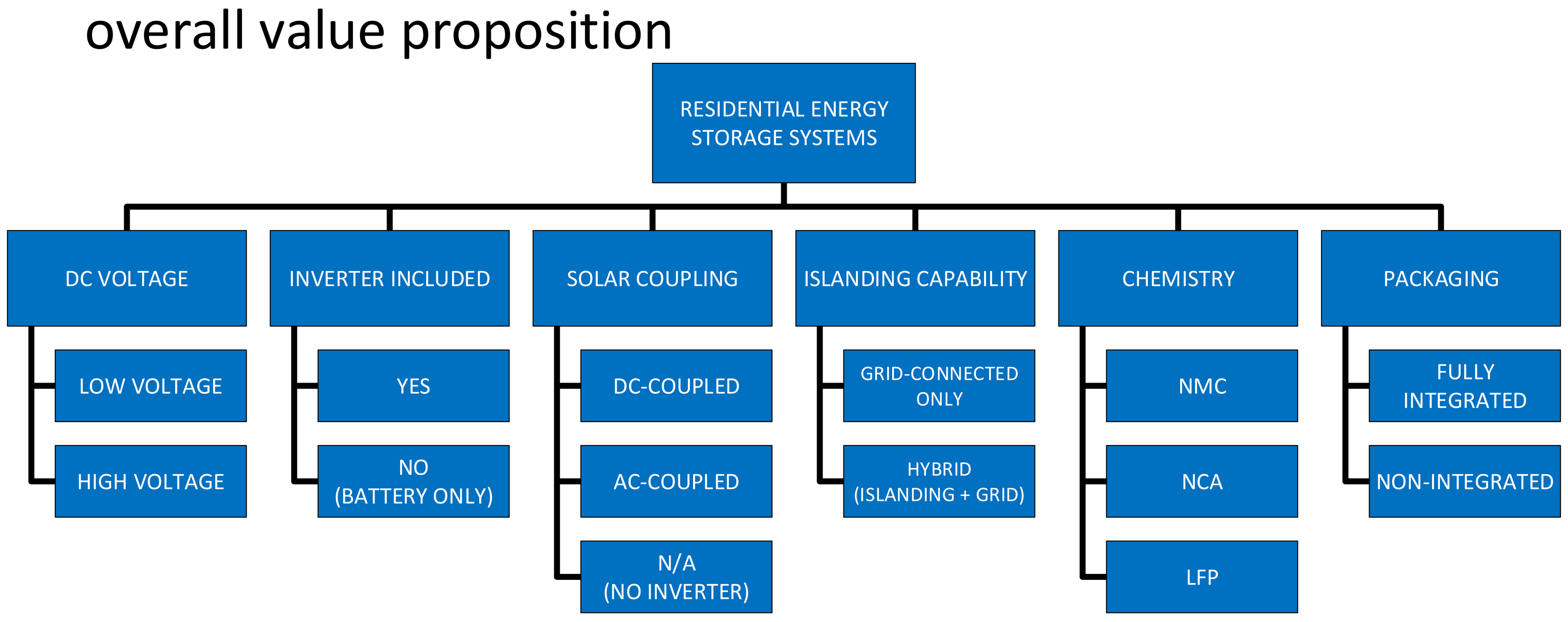


Figure 1: A taxonomy for characterizing Residential Energy Storage System Topologies

IDENTIFYING GAPS

Category	Gap
Safety	Lack of transparency with respect to standards compliance, confusion as to applicability of standards.
AHJ Acceptance	Training of inspectors, fire code officials. Harmonization of requirements across jurisdictions. Maturation of NEC and ESS standards.
System Specifications and Reference Performance	Lack of consistency in defining ESS specifications and nameplate performance
Application Performance	No widely accepted method and no information available with respect to application-specific performance under real-world operating conditions
Communication and Control	Widely varying degrees of methods and availability for access to data and control throughout the interoperability stack. No framework for categorizing these distinctions, lack of clarity as capability of specific products, and lack of data related to efficacy of advertised functions.
Installation and Commissioning	Lack of transparency as to the impact of system architecture, concept of operations, and implementation on the installation and commissioning process.
Value Proposition	Availability of accessible data and/or toolsets to evaluate the combined impact of equipment cost, installation cost, performance, and value-add on context-specific value proposition.

Table 1: Summary of Gaps in R-ESS Standards Landscape

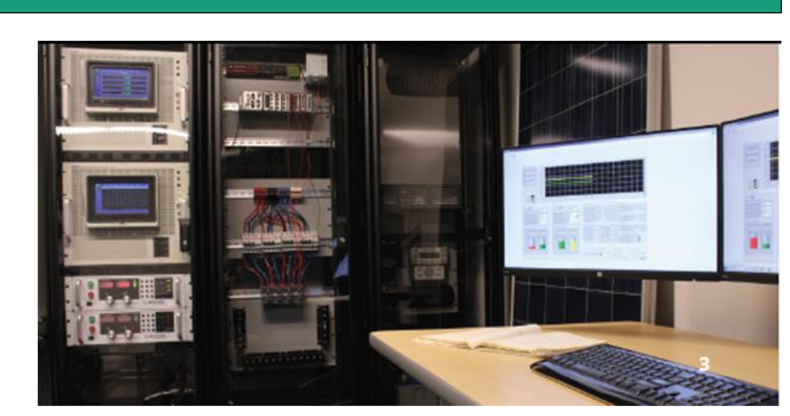
FRAUNHOFER STANDARDIZED ESS TEST PROTOCOL

- Fraunhofer's Standarized ESS Test (SET) protocol for assessing residential energy storage systems is intended to supplement traditional NRTL testing by addressing a subset of the gaps that coincide with Fraunhofer's core competencies

Topic	Assessment Scope	Performance Indicators
Safety	Assessment of applicable standards, verification of compliance with applicable standards through inspection	Documentation of NRTL Compliance
Device Specifications	Verification of nameplate characteristics using normalized reporting format and scope through inspection	Specific and absolute size, weight, and cost. Topology, supported applications, cycle life. Packaging, environmental ratings, thermal requirements
Reference Performance	Evaluation of nameplate ESS performance through laboratory test consistent with IEEE 1679	Rated power, RTE at rated power, energy capacity, response time, ramp rate, standby power use
Duty-Cycle Performance	Application-specific test over representative duty cycle specific to the intended application and use. Follows PNNL methodology, optionally supplemented with characterization of ESS device components (per BVES), and with introduction of representative environmental conditions	RTE, SOC excursion, capacity stability, and reference signal tracking
Communication and Control	Assessment of: - Local device-to-device communication and control , - Local Human-Machine Interface, - Remote communications and control through inspection, test, and analysis	Level of access to data and control functions, reliability, interoperability, efficacy of control functions, response to loss of signal, performance of data acquisition, security
Installation and Commissioning	Analysis of installation materials, process, and labor requirements; Evaluation of regulatory process Demonstration of install under typical conditions, Optional field trial / time & motion analysis of installation	Installation and commissioning time, labor qualification, part count, design flexibility
Techno-Economic Assessment	Analysis of initial investment, O&M, and potential value streams	Normalized lifetime operating costs and benefits

Table 1: Fraunhofer SET Protocol Overview

ENERGY STORAGE INTEGRATION LAB



- Fraunhofer CSE's Energy Storage Integration (ESI) Lab was built to test various performance indicators of the SET Protocol
- It is an isolated grid environment in which devices such as Energy Storage, Inverters, Micro-grid controllers, and other Distributed Energy Resource (DER) assets can be tested in a real-world environment

FUTURE

- Collaboration with various Energy Storage System providers is under way to undergo evaluation using SET Protocol
- Several R-ESS units are currently being evaluated
- Currently in collaboration with utilities and other stakeholders to identify additional gaps
- Summary report on the initial findings in the first round of testing to exhibit the real world variances between systems
- Build the path towards a standardized protocol to allow for a label for Energy Storage Systems similar to Energy Star Labels or EPA Fuel Economy Labels