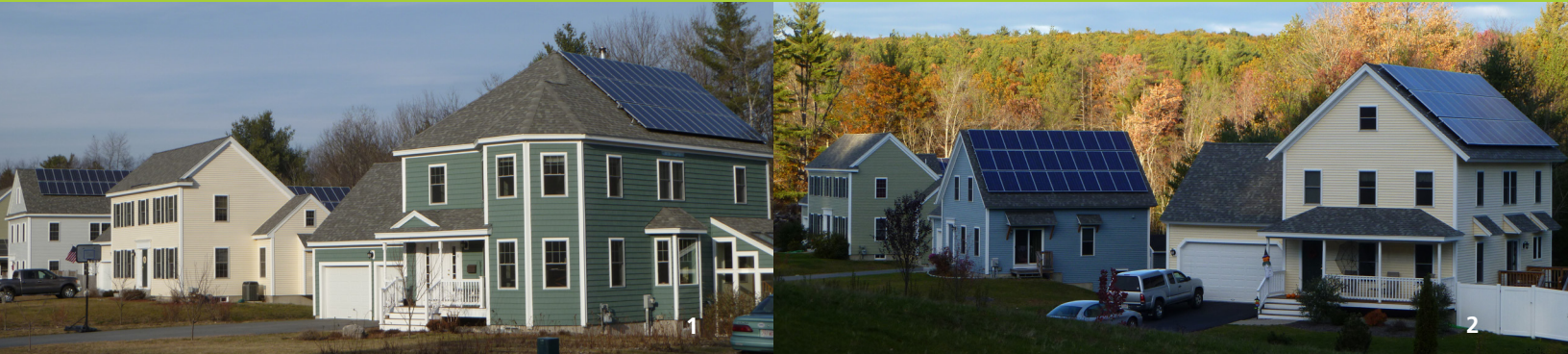


# ENERGY STORAGE INTEGRATION LAB



1 & 2 *Connected homes of the future will incorporate rooftop solar, energy storage, smart loads and electric vehicle charging stations.*

## Fraunhofer Center for Sustainable Energy Systems CSE

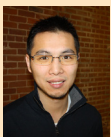
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## Standardized Assessment of Residential Energy Storage

The Fraunhofer Center for Sustainable Energy Systems CSE, in Boston, MA, has developed the Standardized ESS Test (SET) Initiative, a comprehensive framework for characterizing residential energy storage systems. The SET framework answers critical questions that go beyond traditional UL safety testing. For example:

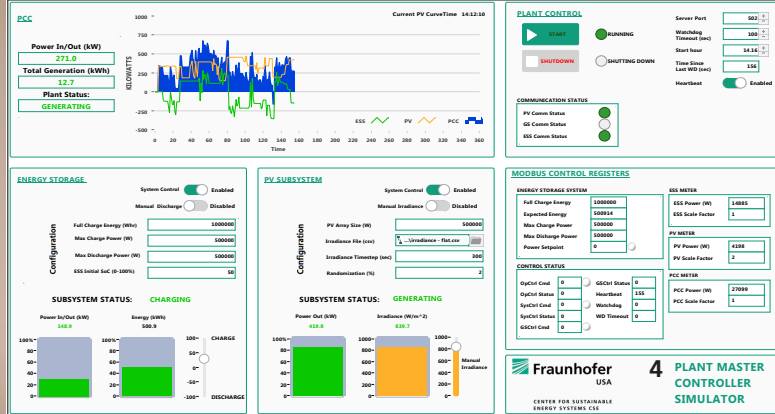
- How does the product perform given real-world duty cycles and applications?
- What degree of control and access does the product offer?
- How is customer data used and protected?
- What safety standards does the product meet, and are these appropriate?

## Energy Storage Integration Lab

Fraunhofer's Energy Storage Integration (ESI) Lab offers a flexible platform for evaluating the performance of energy storage systems in residential and light-commercial applications. The ESI lab simulates a "connected home" of the future, including rooftop solar, energy storage, smart loads, and electric vehicle charging. It is fully configurable for characterization of Distributed Energy Resources (DERs), e.g., Energy Storage Systems, Solar PV, Inverters, etc., under various test conditions and use cases:

- Readily integrates battery systems from multiple manufacturers, compatible with a range of technologies and topologies

Stakeholder	Value Proposition
Distribution Utilities	<ul style="list-style-type: none"> <li>• Assess integration of ESS with system operations</li> <li>• Inform customers, support incentive programs</li> <li>• Feed critical acceptance criteria back to market</li> </ul>
Vendors	<ul style="list-style-type: none"> <li>• Performance Benchmarking</li> <li>• Product differentiation supported by 3rd party Assessment</li> </ul>
Installers, Aggregators, Consumer Advocacy	<ul style="list-style-type: none"> <li>• Quantify value proposition for end-users</li> <li>• Assess business-critical differentiators (e.g., ease of install, application-specific performance criteria)</li> </ul>
State and Municipal Governments	<ul style="list-style-type: none"> <li>• Support incentive programs, inform end-users</li> </ul>



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- Islanding or Grid Connected Operation: 12 kW / 31.5 kVA reactive grid simulator enables testing of grid-connected or islanded systems
- Renewable generation: Up to 30 kW simulated solar / 3 kW live rooftop solar
- Loads: 12 kW / 31.5 kVA reactive programmable load bank, with expandable to incorporate real loads
- Electric Vehicle charging
- Test environment allows for full Instrumentation, control, and visualization of power flow

### Preparing for a Post Net-Metering World

Driven in large measure by the increasing penetration of small distributed solar generation, the deployment of residential energy storage systems in the United States is expected to grow from 1 MW today to 600 MW by 2022. As is already the case in Germany, the US regulatory regime is likely to migrate over this time frame from one dominated by net-metered electricity rates, which allow customers to export electricity on to the power distribution system at or near price-parity with retail rates, to a regulatory

regime that incentivizes self-consumption or provision of grid-facing services.

In anticipation of this growth, the number of residential storage systems on offer in the US market has exploded, doubling even in the last twelve months. While these products are governed by a well-defined suite of test standards aimed at safety, there is no commonly accepted method for characterizing real-world performance of Residential ESSs. As such, end-users have no ability to understand differences between competing products, and high-quality vendors lack the ability to differentiate themselves from lower quality competitors. Based on German experience in the more mature residential ESS market, this lack of transparency leads to wide variance in the quality, reliability, safety, and overall value proposition of products on offer.

### About Fraunhofer CSE

The Fraunhofer USA Center for Sustainable Energy Systems (CSE) is an applied research and development laboratory dedicated to building tomorrow's energy future today. Our staff's expertise in solar photovoltaics, smart energy-efficient buildings, and

### 3 Battery System Testing at Fraunhofer's Energy Storage Integration Lab

### 4 Fraunhofer CSE's real-time Solar + Storage Plant Simulator

grid technologies provides a platform for deeply integrating distributed energy resources through collaborative R&D with private companies, government entities, and academic institutions. Fraunhofer CSE is one of seven centers of Fraunhofer USA, a 501(c)(3) non-profit contract R&D organization, a subsidiary of Fraunhofer-Gesellschaft, Europe's largest contract R&D organization.

### Acknowledgements

Funding for this lab was provided, in part, by the Massachusetts Clean Energy Center (MassCEC).



Test Categories	Assessment Topics	Performance Indicators
Applications	Renewables Firming, PV Smoothing, Peak Shaving, Volt/Var Support, Frequency Regulation, etc.	Efficiency, Capacity, Response Time & Ramp Rate, etc.
Communications & Controls	Protocols, Standards, Security	Compliance, Reliability, Suitability, Accessibility, etc.
Installation & Commissioning	Installation, Configuration, Acceptance Testing	Part Count, Labor, Qualification Requirements
Safety	Codes & Standards	Compliance, Suitability
Value Proposition	Initial Investment, O&M, Value Streams	Lifetime Operating Costs & Benefits

Test Matrix of the Standardized ESS Test (SET) Initiative highlighting the assessment topics and associated performance indicators