



Nova Analysis Final Technical Report

Jeff Maguire

National Renewable Energy Laboratory

**NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
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Contract No. DE-AC36-08GO28308

Technical Report
NREL/TP-5500-85663
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Suggested Citation

Maguire, Jeff. 2024. *Nova Analysis Final Technical Report*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5500-85663.
<https://www.nrel.gov/docs/fy24osti/85663.pdf>.

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This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Solar Energy Technologies Office. The views expressed herein do not necessarily represent the views of the DOE or the U.S. Government.

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Preface

a. Federal Agency	Department of Energy	
b. Award Number	DE-EE00034160	
c. Project Title	Project Title	
d. Recipient Organization	<i>Nova Analysis: Valuing the Contribution of Solar to Grid-interactive Efficient Homes</i>	
e. Project Period	<i>Start:</i> 05/01/2020	<i>End:</i> 03/31/23
f. Principal Investigator (PI)	Jeff Maguire Researcher Jeff.maguire@nrel.gov 978-857-8461	
g. Business Contact (BC)	Kristen Ardani Program Lead Kristen.ardani@nrel.gov 303-384-6461	
h. Certifying Official (if different from the PI or BC)	Name Title Email address Phone number	

Acknowledgement

This material is based upon work supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under DE-EE00034160.

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1 Project Summary

As the adoption of solar plus storage technology is rapidly increasing, there is a need for a more holistic view of homes adopting them. In homes, both energy efficiency (EE) upgrades and DERs provide value not just to the homeowner, but to utilities and even society at large through emissions. Traditionally, EE and DERs are separate sectors, which makes it difficult to understand the co-benefits of their adoption. To address this, we created a novel workflow of tools that allows for a complete analysis of both efficiency and DERs. We also looked at a suite of metrics designed to capture the different benefits provided to different stakeholders, demonstrated with multiple sets of field data. A final report demonstrates the potential of the simulation workflow by simulating hundreds of buildings spread across the U.S. and demonstrating how a variety of factors affect the optimal sizing of DERs along with several other key metrics including energy, utility bills, emissions, and average resilience hours.

2 Project Objectives and Outcomes

The goals for this project were to develop stakeholder-facing products, a detailed methodology for calculating metrics. Two separate final reports, covering how metrics can be applied to measured data and a semi-national simulation study of interaction across multiple metrics of EE and DERs. An additional goal was to spread the metrics with help from the TAG. New Buildings Institute did substantial outreach on behalf of NREL, helping to promote this project to a key stakeholders through email and promoting a final webinar for the project. The workflow has also been developed and demonstrated and could easily be repeated for analysis of additional scenarios. The goal is also to open source the workflow making it available to all interested parties. Most of the tools are open source already, with OCHRE expected to become open source later this year.

The key challenge this project faced is staff turnover. This project went through multiple changes in principle investigator as well as gaining and losing multiple key performers throughout the project. These changes in staffing led to more time needing to be spent on getting staff up to speed and managing the project. The plan was extended through multiple no cost time extensions to accommodate this, but all of the original milestones were able to be delivered. The workflow developed here can be utilized in any future studies of these technology combinations and will be made available. TAG members have expressed interest in using part or all of this workflow for their own analysis. This has led to some ongoing conversations about how these new tools can support a utility in planning efforts as well as pieces of the workflow being leveraged in multiple DOE Connected Communities projects. Additionally, one of the key metrics from this project, average resilience hours, is currently being added to the OS-HPXML workflow that supports HERS raters, potentially making this metric available to that community for homes with storage.

3 Full List of Milestones

(See next page.)

Year #	Task #	Milestone	Milestone Name/Description	Planned End Date	Milestone Type: Annual or Quarterly
1	1	1	Establishment of a Technical Advisory Group of at least 8-10 members	5/29/2020	Quarterly
1	1	2	Needs Assessment completed for the Technical Advisory Group which identifies the primary technical and conceptual stakeholder needs for the quantifying and communicating the value of GEB-solar homes.	6/30/2020	Quarterly
1	1	3	Completed a Long-term Stakeholder Engagement Strategy with assistance from TAG that outlines primary stakeholder needs, most-effective opportunities for disseminating project outcomes and the plan for doing so.	4/30/2021	Quarterly
1	2	1	Common project terminology regarding valuing and measuring GEB-solar homes needed to describe the analysis workflow for the internal project team completed and agreed upon with internal stakeholders (SETO and TAG).	6/30/2020	Quarterly
1	2	2	The analysis approach for the first phase, Expanding the Toolbox, including the case studies, have been agreed upon by the project team with input from the TAG.	7/30/2020	Quarterly
2	2	1	Draft Report for SETO review on the results from the Expanding the Toolbox phase, includes Key Metrics, Methods and Case Study Results	4/30/2021	Quarterly
1	3	1	Data partnerships finalized for the Metrics at Home task	4/30/2021	Quarterly
2	3	1	Analysis approach for the Metrics at Home analysis completed and presented to the TAG, including status update on data collection and preparation for the Metrics at Home.	4/9/2021	Quarterly
1	3	2	Jasper Valley sonnen dataset obtained and cleaned, and plan for analysis provided to SETO.	7/31/2020	Quarterly
2	3	2	Draft technical report based on analysis and modeling of the performance of systems in sonnen Jasper Valley dataset	9/30/2021	Quarterly
2	3	3	Model enhancements to REopt based on analysis of Mandalay dataset	4/30/2021	Quarterly
2	3	4	Draft technical report for the results of the Metrics at Home application and assessment of metrics for real world homes.	9/30/2022	Annual
2	3	5	Analysis approach for the Metrics at Scale phase of the project on testing metrics at a semi-national scale completed and presented to the TAG.	5/31/2022	Quarterly
2	3	6	Completed a draft technical report on the Metrics at Scale semi-national analysis and findings	9/30/2022	Annual
2	3	7	Develop two summary products relevant to high-value stakeholders on the Metrics at Home and Metrics at Scale efforts	9/30/2022	Annual
2	4	1	Draft technical report based on analysis and modeling of system installation costs in the Mandalay dataset	9/30/2021	Annual

4 Path Forward

The workflow developed in this project is designed to be able to support multiple other future projects. This could include more national scale modeling at a higher granularity, including multifamily buildings, to get a more detailed understanding of how these technologies interact and to get to a more statistically representative sample of the U.S. building stock. This could include analysis looking at specifically at the differences, challenges, and opportunities for low and middle income (LMI) communities. The workflow can also be leveraged to aid in the design of a smart community, being able to provide valuable insight into how solar and storage together with flexible loads can provide value to both the homeowners and the grid.

One of the key tools developed in this project, OCHRE, has also become of interest to several external stakeholders as well as growing to support multiple projects beyond this one, including several DOE Connected Communities proposals. OCHRE will be open sourced later this year in a beta release that will allow interested stakeholders access to the tool as well as detailed usage instructions. The overall workflow developed here, which connects multiple NREL developed tools, can then also be open sourced.

Two final technical reports are currently in the publication process at NREL, with release likely in the next month.

5 Inventions, Patents, Publications, and Other Results

Publications:

- “Savings in Action: Lessons from Observed and Modeled Residential Solar Plus Storage Systems” Full Report **OSTI ID 1884300**
- “Savings in Action: Lessons from Observed and Modeled Residential Solar Plus Storage Systems” Fact Sheet. **OSTI ID 1879454**
- “Metrics and Analytical Frameworks for Valuing Energy Efficiency and Distributed Energy Resources in the Built Environment” Conference Paper **OSTI ID 1710148**
- “Nova Analysis: Wholistically Valuing the Contributions of Residential Efficiency, Solar, Storage, and Flexible Loads” Technical Report, **currently in publication process**
- Savings in Action: Lessons Learned from a Vermont Community with Solar Plus Storage” Technical Report, **currently in publication process**

Software:

- Improvements to REopt were made as part of this project, including linking this tool to OCHRE and other software tools.
- Substantial improvements were made to OCHRE to make it suitable for this project. OCHRE is planned to be open sourced later this year and is currently being leveraged by more than a dozen other projects at NREL.

New networks and collaboration:

- Portland General Electric: PGE has expressed interest in OCHRE and hope to use it to help them with their planning efforts. Discussion is still ongoing.
- New Buildings Institute: Helped to publicize the results of this project once completed. Lots of good discussions and potential future collaborations in this area.

6 Project Team

List all project participants and their individual roles.

Monisha Shah: Project lead, initial PI

Dylan Cutler: REopt developer, 2nd PI

Emma Elgqvist: REopt developer, 3rd PI

Jeff Maguire: OCHRE developer, 4th and final PI

Michael Blonsky: OCHRE developer and simulation lead

Sugi Ramaraj: OCHRE developer

Sean Ericson: REopt development and analysis

Amanda Farthing: REopt development and analysis of field data

Indu Manogaran: REopt user and analysis of field data

Robin Burton: TAG management

Kenny Gruchallah: Graphics support