

PNNL-ACT-10123

Transactive Campus Energy Systems: An R&D Testbed for Renewables, Integration, Efficiency, and Grid Services (CRADA 356 / Amendment 1)

Final Report

June 2022

S Katipamula
RG Lutes
R Kini
S Huang

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor Battelle Memorial Institute, nor any of their employees, makes **any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.** Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or Battelle Memorial Institute. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

PACIFIC NORTHWEST NATIONAL LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC05-76RL01830

Printed in the United States of America

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information,
P.O. Box 62, Oak Ridge, TN 37831-0062;
ph: (865) 576-8401
fax: (865) 576-5728
email: reports@adonis.osti.gov

Available to the public from the National Technical Information Service
5301 Shawnee Rd., Alexandria, VA 22312
ph: (800) 553-NTIS (6847)
email: orders@ntis.gov <<https://www.ntis.gov/about>>
Online ordering: <http://www.ntis.gov>

Transactive Campus Energy Systems: An R&D Testbed for Renewables, Integration, Efficiency, and Grid Services (CRADA 356 / Amendment 1)

Final Report

June 2022

S Katipamula
RG Lutes
R Kini
S Huang

Prepared for
the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99354

Cooperative Research and Development Agreement (CRADA) Final Report

Report Date: June 30, 2022

In accordance with Requirements set forth in the terms of the CRADA, this document is the CRADA Final Report, including a list of Subject Inventions, to be provided to PNNL Information Release who will forward to the DOE Office of Scientific and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

Parties to the Agreement: U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL) and the Washington State Department of Commerce (Commerce) through the Clean Energy Fund (CEF).

CRADA number: 356 / Amendment 1

CRADA Title: Transactive Campus Energy Systems: An R&D Testbed for Renewables, Integration, Efficiency, and Grid Services

Responsible Technical Contact at DOE Lab: Srinivas Katipamula

Name and Email Address of POC at Company: Angela LaSalle

DOE Program Office: Office of Energy (OE) and the Office of Energy Efficiency and Renewable Energy (EERE).

Joint Work Statement Funding Table showing DOE funding commitment:

Task	Commerce RD&D - Funds	DOE Match - Funds	Total Budget
Task 9: Battery Energy Storage System (BESS)	\$210,000	\$300,000	\$510,000
Milestone 9A	\$0	\$0	\$0
Milestone 9B	\$0	\$0	\$0
Milestone 9C	\$210,000	\$90,000	\$300,000
Milestone 9D	\$0	\$0	\$0
Milestone 9E	\$0	\$0	\$0
Milestone 9F	\$0	\$150,000	\$150,000
Milestone 9G	\$0	\$30,000	\$30,000
Milestone 9H	\$0	\$30,000	\$30,000
Milestone 9I	\$0	\$0	\$0

Executive Summary

Transactive energy refers to the combination of economic and control techniques to improve grid reliability and efficiency. The fundamental purpose of transactive energy management is to seamlessly coordinate the operation of large numbers of new intelligent assets—such as distributed solar, energy storage and responsive building loads—to provide the flexibility needed to operate the power grid reliably and at minimum cost, particularly one filled with intermittent renewable generation such as the Pacific Northwest. It addresses the key challenge of providing smooth, stable, and predictable “control” of these assets, even though most are neither owned nor directly controlled by the power grid.

The Clean Energy and Transactive Campus (CETC) work described in this report was done as part of Amendment 1 to Campus Cooperative Research and Development Agreement (CRADA) 356, the Transactive Campus CRADA with the Washington State Department of Commerce (Commerce) between the U.S. Department of Energy’s (DOE’s), Pacific Northwest National Laboratory (PNNL) and the Commerce through the Clean Energy Fund (CEF). The original project team consisted of PNNL, the University of Washington (UW) and Washington State University (WSU), to connect the PNNL, UW, and WSU campuses to construct and operate the testbed as both a regional flexibility resource and as a platform for research and development (R&D) for buildings/grid integration. Building on the foundational transactive system established by the Pacific Northwest Smart Grid Demonstration (PNWSGD), the purpose of the project was to construct the testbed as both a regional flexibility resource and as a platform for R&D on buildings/grid integration and information-based energy efficiency. The testbed supports the integration of renewables and other regional needs, using the flexibility provided by building loads, energy storage, and smart inverters for batteries and photovoltaic (PV) solar systems, at four physical scales: multiple campuses, campus, microgrid and building.

This report provides a summary of the work performed under the amended CRADA to procure install and commission a battery energy storage system (BESS).

Summary of Research Results

As part of this CRADA effort, a 125 kW/250 kWh Li-Ion BESS was procured and installed in 2022 at PNNL's Systems Engineering Building (SEB), an office and laboratory structure fitted with sensors that enable evaluation of building control ideas and technologies. The BESS was funded by the Department of Commerce's Clean Energy Funds. It will be used to conduct research and development on how building integrated BESS can provide grid services to support grid reliability when there is significant penetration of renewable energy.

Following tasks were successfully completed as part of this work: 1) site engineering: BESS requirements and detailed engineering design was completed, 2) procuring BESS: after competitive procurements process, PNNL selected Northern Reliability Inc. (NRI, now part of Kore Power) to supply the BESS, install and commissioning it on site, 3) installation and construction: PNNL facilities and operations staff prepared the site, hired a local subcontractor to prepare the site and install all the infrastructure to integrate the BESS to SEB, 4) system integration and commissioning: NRI with support from PNNL F&O staff, completed the integration of the BESS with the building and conducted factory commissioning tests; PNNL R&D staff conducted further commissioning tests to ensure we are able to conduct all the planned R&D activities.

The installed battery can provide power to the SEB for several hours on one charge, and it can be tested as an individual storage resource or in conjunction with other SEB capabilities. For instance, the battery is adjacent and connected to PNNL's thermal energy storage system (TESS). Several research activities are planned to learn most effective and efficient methods for using the battery and the TESS—together and separately—to show how storage devices can charge at times when electricity is cheaper and then provide an alternate energy source for a building when prices, due to increased demand on the grid, are higher. In all cases, researchers are striving to create storage methodologies and solutions that concurrently assure building functionality and occupant comfort.



As part of this project no invention disclosures or patents were filed, and no publications resulted for this work either.

Pacific Northwest National Laboratory

902 Battelle Boulevard
P.O. Box 999
Richland, WA 99354
1-888-375-PNNL (7665)

www.pnnl.gov