



ENERGY TECHNOLOGY INTEGRATION TEAM Residential Building Energy Efficiency Capability Area

The **Energy Technology Integration Team** is part of the Energy Policy & Economics (EP&E) Group at the Pacific Northwest National Laboratory (PNNL). Our team, along with experts across PNNL, helps clients understand and address the challenges and issues associated with the development, adoption, and deployment of new technologies, resulting in faster and stronger market acceptance. This brochure highlights the solutions, services, and results delivered by the team in support of Residential Building Efficiency.

The team's work in support of Residential Building Energy Efficiency provides customers with expertise in the areas of technology development and testing, impact assessments, software development, thermal and energy modeling, and best practice guidance for the building industry and utility program designers.

RECENT IMPACTFUL RESULTS

Building America Program

Our staff support the U.S. Department of Energy's Building America program by conducting residential building science research and facilitating the dissemination of program findings from the entire program as best practices for the home building industry. Visit: BASC.energy.gov.

Staff have developed:

- The Building America Solution Center to provide the building industry with easy access to the Building America Program's wealth of building science research results.
- Climate-specific guides and climate-optimized packages of energy-efficiency measures for new home builders.
- Retrofit guides for home performance contractors on topics such as insulation, HVAC, and air sealing upgrades.
- Guidance to help code officials and builders adopt innovative construction practices. Code Compliance Briefs help with technology validation, conducting plan reviews, and field inspections. The Briefs help builders and code officials establish common expectations for innovative construction technologies and practices.



Through the Building America Solution Center, PNNL staff disseminate DOE-funded building science research results that are helping the U.S. home building industry achieve zero energy ready homes.



PNNL staff leading Lab Home research: Josh McIntosh, Katie Cort and Cheryn Metzger.

PNNL Lab Homes

The PNNL Lab homes are a matched pair of homes with a full suite of simulated occupant, lighting, and appliance loads. Typically, a baseline technology is deployed in the baseline home, and an advanced technology is placed in the experimental home. The differences in energy use and temperature distributions measured between the homes are directly related to the advanced technology. The PNNL Lab Homes Team has studied the energy savings, demand response, and grid integration potential of building envelope components, HVAC equipment, HVAC controls, transactive controls, load monitoring sensors, and water heaters. Recent topics include cellular shades and a transactive control strategy for thermostats. Visit: <http://LabHomes.pnnl.gov>.

Heat Pump Water Heaters Technology Validation

- Heat pump water heaters (HPWHs) provide up to 60% energy savings in comparison to electric resistance water heaters. PNNL conducted field research as part of the largest-ever HPWH pilot study in collaboration with Bonneville Power Administration (BPA), the Northwest Energy Efficiency Alliance (NEEA), Portland General Electric, and other Northwest utilities. This research demonstrated potential savings and peak load management capabilities and tested two-way communication systems.
- In addition, PNNL worked with manufacturers, NEEA, and utilities across the nation to identify the greatest HPWH performance potential, to resolve supply chain barriers to market adoption, and to increase consumer awareness of this technology. Visit <https://rpse.energy.gov/tech-solutions/hpwh>.

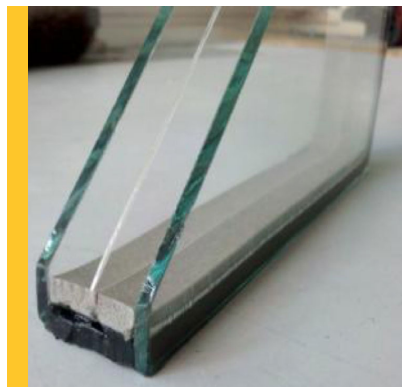
NEW PROJECTS UNDERWAY

Connected Houses

PNNL is developing and testing an in-home load coordination and optimization platform based on transactive controls to integrate energy efficiency (EE) and demand response (DR) in the residential sector. The traditional DR program has low participation rates because utilities directly control home devices based on grid needs and with little knowledge of customer preferences and priorities. The developed solution package (including connected hardware devices, secured software solutions, and advanced control strategies) will enable existing homes to provide grid services while balancing comfort and savings for residents. This project is expected to quantify and verify EE and DR benefits of connected homes and explore how existing homes can be updated to be grid-interactive and efficient. Results are expected in late 2019.

Thin Triple-Pane Windows

PNNL is leading a three-year study in partnership with Lawrence Berkeley National Laboratory to validate the performance of the latest technology in highly insulated windows. The project includes an evaluation of the performance of newly developed thin triple-pane, krypton-filled high-R windows in the PNNL Lab Homes and field studies in multiple climate zones and building types. The project will measure the energy performance of high-R windows in real-world settings and investigate installation practices in the field. These findings will inform manufacturers seeking new product lines, home builders, utility programs, weatherization programs, ENERGY STAR product specification development, rating organizations, and future code development for this latest generation of high-R windows. Results are expected in the fall of 2020.



The new thin triple-pane can work as a “drop-in replacement” for conventional double-pane insulating glass units, while improving performance to R5-R7 insulating levels (code-level double-panes have ~R-3 insulating levels).

Innovative Approaches to Insulating Walls in Existing Homes

Many older homes have walls with little or no existing insulation. Finding cost-effective ways to increase the insulation levels that don't cause moisture problems in the walls and don't cause major disruptions to building occupants is the topic of a three-year study recently undertaken by EP&E staff. Laboratory studies completed in partnership with the University of Minnesota will be conducted on innovative installation practices, thermal performance, and moisture performance. Results are expected in September 2021.

Field Study of Non-Intrusive Load Monitoring Technology

PNNL is conducting a pilot study on non-intrusive load monitoring (NILM) equipment on behalf of the Energy Information Administration. The objective of this study is to understand the first cost, installation, communication, and disaggregation performance of NILM equipment. The pilot study results are expected in spring 2020.

Ductless Mini-Splits

This project will test methods to control ductless mini-split systems that are installed in existing homes with existing central HVAC systems or existing zoned systems. Data from utilities in the northeast and northwest are showing these systems are not saving as much energy as anticipated (even in the heating season) because the central systems are running more than they should. This project will use EnergyPlus modeling and the PNNL Lab Homes to test and validate up to six control strategies to cost effectively save up to 50% more HVAC energy than they are currently saving in the field. The project is co-funded by NEEA, BPA, Silicon Valley Power, and the American Public Powers Association. Results are expected in April 2020.

Indoor Air Quality Field Study in Occupied New U.S. Homes: Cold and Marine Climates

This project, funded by the DOE's Residential Buildings Program, aims to determine the relationship between air tightness/air leakage, air flow, and indoor air quality in homes. The project will study this relationship in 32 new (post 2013) homes in both the marine and cold climate zones using both low-cost and research-grade equipment that measures PM2.5, semivolatile organic compounds, formaldehyde, radon, temperature and humidity. Results are expected in March 2020.

KEY CONTRIBUTORS to the Residential Building Efficiency focus area include:



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Residential Building Efficiency

Our team consists of engineers, scientists, analysts, and code specialists with experience in residential buildings research. This cross-cutting team excels at everything from R&D to deployment. We specialize in integrating all of these factors for a successful project. <http://epe.pnnl.gov>

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