

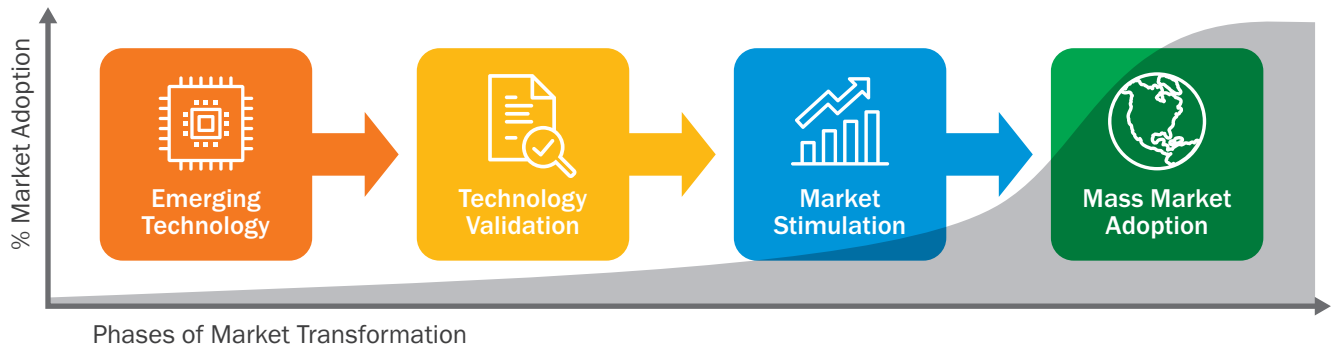
Building Energy Efficiency and Decarbonization Technology Deployment and Market Transformation

@ PNNL



Technology deployment and market transformation capabilities at Pacific Northwest National Laboratory (PNNL) play a key role in accelerating the adoption of technologies and practices to improve energy efficiency and reduce greenhouse gas emissions throughout the energy system.

PNNL helps stakeholders understand and address the technical and market challenges and issues associated with new clean energy technologies for commercial and residential buildings and accelerate their adoption in the marketplace.



Technology Validation and Testing

When promising, emerging clean building energy technologies approach early commercial readiness, PNNL supports the validation of their market viability, quantifies their benefits, and identifies barriers to technology adoption.

Laboratory and field validation studies provide objective evaluation of technologies before they are broadly deployed. These evaluations help identify benefits, challenges, and improvement opportunities to pave the way and lessen the risk for product developers and future adopters.

PNNL maintains and operates several controlled test facilities that enable performance validation of technologies and systems to help answer critical questions related to technology development and market readiness. These include **chambers** for high-precision testing of heating, ventilation, and air conditioning systems and appliances in a simulated environment; **research homes** dedicated to testing building technologies including windows, heat pumps, and connected appliances under varied conditions; and **laboratories used to test and develop innovative lighting** and building control system concepts and technologies.

Often informed by laboratory results, PNNL applies extensive capabilities in designing technology field studies and measurement and verification plans to assess the performance of promising new technologies and systems in real-world settings, from public- and private-sector residential and commercial buildings and campuses to industrial settings. This includes technologies to improve energy and water efficiency and enhance energy system security, resilience, and equity.

Quantitative and qualitative field validation results include equipment performance, occupant or operator feedback, and cost/payback information to support the unbiased body of knowledge associated with a technology's technical and market readiness.

PNNL experts also lead observational research studies in "living labs" and "human-centered research" to understand the motivations to purchase efficient building components and the processes associated with installing, configuring, using, and maintaining emerging technologies. These studies help find and resolve pressure points, aiming to improve performance and increase adoption rates to maximize a technology's energy savings potential.

Market Stimulation and Mass Market Adoption Support

Once technologies are validated, PNNL takes multiple approaches to stimulate early market adoption of technologies throughout the energy system and to encourage deployment at scale. Collaborating with government and industry leaders, PNNL designs and delivers initiatives that address technology and market barriers, support technology adoption, track progress, and lock in energy savings and carbon emission reductions.



SUCCESS STORY

High-Efficiency Rooftop Units

From 2011–2019, PNNL worked closely with a wide range of partners on behalf of the Department of Energy (DOE) to catalyze technology innovation and transform the market to higher-efficiency rooftop units (RTUs), saving U.S. businesses an estimated \$50 billion on their utility bills.

This work included launching a challenge for manufacturers to develop RTUs with 30–50% higher efficiency compared to existing units, followed by field demonstrations to validate performance. The Advanced RTU Campaign, beginning in 2014, supported owners/operators in replacing older RTUs with high-efficiency RTUs. Early campaign feedback motivated adjustments to associated rebate structures in 2015. That same year, DOE announced a new minimum RTU efficiency standard informed by the success of both the challenge and the campaign and negotiated with market stakeholders. The new standard represented the largest savings of any efficiency standard in history.

To help speed technology adoption, PNNL designs and delivers public–private sector deployment initiatives including **technology campaigns, challenges, prizes**, and accelerators that target specific technology and system solutions to overcome market barriers. PNNL provides technical support, resources, and recognition to industry leaders who adopt technologies.

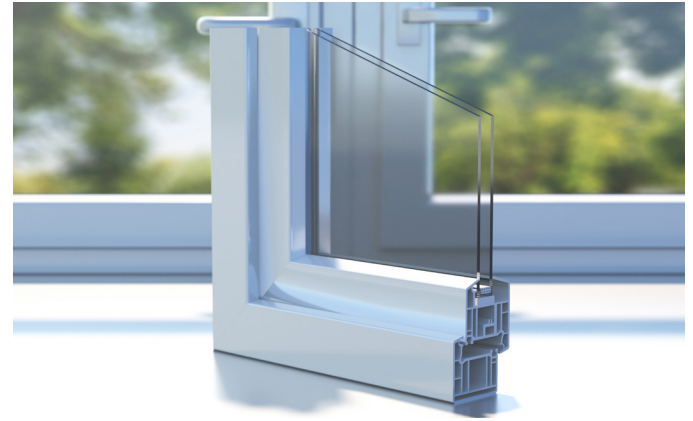
Public and private sector partnerships are crucial to helping identify, develop, and implement new energy technology opportunities and practices. To this end, PNNL works closely with industry, utilities, trade and professional associations, state and local governments, and building owners/operators.

Once proven to have market viability, PNNL further supports full-scale technology deployment and adoption, including through the following:

- Working with utilities to identify opportunities that can be linked with their energy-efficiency incentive programs.
- Collaborating with voluntary programs (e.g., LEED, the WELL Building Standard) that support green, healthy, resilient, and energy-efficient buildings.
- Partnering with other government agencies like the U.S. General Services Administration and Department of Defense to field explore and demonstrate promising technologies.
- Supporting their incorporation into **building codes** and standards to lock in long-term savings and benefits.
- Informing the design and delivery of market-based programs, including DOE prize and challenge projects. These projects are founded on extensive technical and market analysis to detect and address product shortcomings that could hinder adoption.
- Providing support for training a qualified workforce to manufacture, operate, and maintain impactful technologies to support market sustainability. This includes secondary science, technology, engineering, and mathematics education, college and university partnerships, and training programs for existing professionals.



Regency Centers received recognition from the LEEP Campaign for high-efficiency LED parking lot lighting at its Santa Ana, CA location. (Image courtesy of Regency Centers)



SUCCESS STORY | COMMERCIAL

High-Efficiency Parking Lighting Systems

High-efficiency LED parking lighting is between 30% and 80% more efficient compared to traditional lighting and emerged as one of the first applications where LED technology was technically viable and cost effective.

Beginning in 2013, PNNL managed the Lighting Energy Efficiency in Parking (LEEP) Campaign, which provided a suite of tools and resources including field validation results to assist 183 LEEP participants in upgrading to or installing energy-efficient lighting and control systems in 560 million square feet of parking facilities. This effort yielded energy savings of 0.2 terawatt hours annually and \$24 million in electricity costs.

The DOE work supported by this technology campaign resulted in a performance specification for parking lot lighting, and campaign data was used to inform an energy code proposal for the 2016 version of ANSI/ASHRAE/IES Standard 90.1.

SUCCESS STORY | RESIDENTIAL

Modern Low-E Storm Windows and Insulating Panels

DOE is currently investing in efforts to increase market awareness and deployment of modern low-emissivity (low-e) storm windows and insulating panels through the PNNL-managed Storm Window and Insulating Panel (SWIP) Campaign.

As part of this effort, SWIP Campaign team members worked with the software development team at Oak Ridge National Laboratory that manages the Weatherization Assistant energy auditing tool to add low-e storm windows to the list of measures in the new web-based version of the tool. Weatherization agencies across the United States use Weatherization Assistant to determine which energy-efficiency measures to install in low-income, underserved households. Now, they can accurately assess the cost-effectiveness of low-e storm windows and consider installing them to improve comfort and energy efficiency in homes they serve.

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About PNNL

Pacific Northwest National Laboratory advances the frontiers of knowledge, taking on some of the world's greatest science and technology challenges. Distinctive strengths in chemistry, Earth sciences, biology, and data science are central to our scientific discovery mission. PNNL's research lays a foundation for innovations that advance sustainable energy through decarbonization and energy storage and enhance national security through nuclear materials and threat analyses.