Pacific Northwest
NATIONAL LABORATORY
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Making the Buildings-Grid Connection

Homes and buildings represent untapped potential for optimizing energy savings and increasing power grid reliability.

America puts a lot of energy into its buildings. With approximately 120 million homes and more than 5 million commercial buildings, the majority of the nation's electricity—upwards of 70 percent—is used to keep structures heated, cooled, lighted, and functioning. This rate of consumption is expected to continue into the future. At the same time, continuing advances in efficient and "smart" technologies, and onsite renewable energy are changing the way power is used in homes, offices and industries across the country.

In this evolving environment, Pacific Northwest National Laboratory researchers support the U.S. Department of Energy's vision for advanced controls for buildings, where sensors, control systems and other technologies work together to manage energy use. PNNL's development of tools and techniques to coordinate electricity generation and consumption onsite—or "behind the meter"—is expanding the definition of connected buildings and ultimately yielding enhancements in efficiency and costs, while reducing impacts on the nation's electrical grid.

Powerful Capabilities and Contributions

PNNL's pioneering work in demand-response— or "smart grid"—research and development, showed early indications of the clear value of responsive loads. Initial projects, such as the Olympic Peninsula Gridwise® Demonstration Project in 2006 and the Pacific Northwest Smart Grid Demonstration Project (2010-2015), clearly indicated the essential contribution of buildings controls toward a responsive grid of the future.

With deep roots in smart grid research and application development, PNNL's expertise covers a range of key disciplines, including:

- transactive control
- building control systems
- data analytics and modeling
- energy storage
- cybersecurity.

These capabilities anchor PNNL's buildings-grid research for two DOE offices—the Office of Electricity Delivery and Energy Reliability and the Office of Energy Efficiency and Renewable Energy. PNNL also collaborates with other national laboratories, industry and academia to help advance the buildings-grid agenda.

PNNL partners with the U.S. Department of Energy and others to strengthen connections and increase efficiencies between the nation's building stock and the power grid.

U.S. DEPARTMENT OF ENERGY

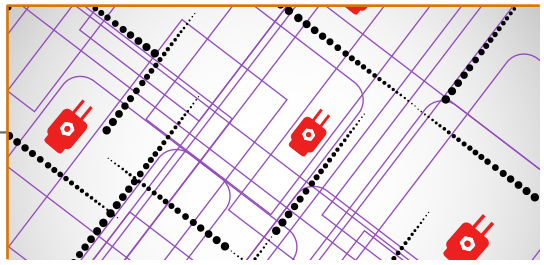
Transitioning to Transactive Control and Coordination

A critical component of buildings-grid concepts, PNNL pioneered the idea of transactive control in the 1990s. Transactive control is a system of signals representing electricity costs and power needs, exchanged seamlessly, via two-way communication, across the power system. The concept has been successfully tested in several demonstration projects. Other recent examples of PNNL progress in advanced building controls include:

2013

VOLTTRON™ — Developed by PNNL, this distributed control and sensing software platform has emerged as a key buildings-grid technology. VOLTTRON™ manages transactions between building systems, such as rooftop heating and cooling units, and the power grid.

2013

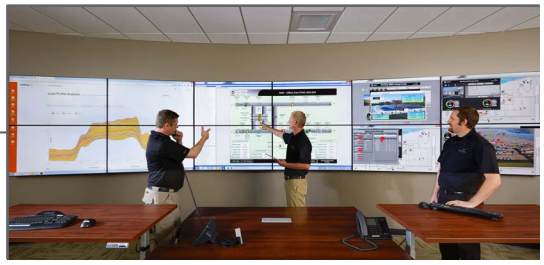


Transactional Network Project — Led by PNNL and funded by DOE, researchers designed and tested a platform to support energy, operational and financial transactions with networked entities.

2014 -15

Transaction-Based Building Controls Framework, Volume 1 (2014) **and Volume 2** (2015) — Authored by PNNL, these foundational reports outline a structure for mutually-beneficial and cost-effective market-based transactions between multiple players across different domains.

2015



Connected Campus Project — In fall 2015, PNNL, the University of Washington, and Washington State University kicked off a unique three-campus demo of transaction-based energy management. The $4.5 million project is supported by Washington's Clean Energy Fund and DOE. As the project's nerve center, PNNL's new **Building Operations Control Center** monitors and manages energy use information at the three locations.

About PNNL

Interdisciplinary teams at Pacific Northwest National Laboratory address many of America's most pressing issues in energy, the environment and national security through advances in basic and applied science. Founded in 1965, PNNL employs 4,400 staff and has an annual budget of nearly $1 billion. It is managed by Battelle for the U.S. Department of Energy's Office of Science.

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