# Building Technologies

With more than 120 million buildings in the United States consuming approximately 40% of the nation's total primary energy and 75% of its electricity, reducing energy consumption is essential to achieving a sustainable future. Oak Ridge National Laboratory (ORNL) is focused on developing new technologies and tools to enable grid-interactive efficient buildings that provide beneficial impacts to energy security and affordability, resilience, the environment, and the US economy. Public–private partnerships allow ORNL to focus on scientific research while industry focuses on further development and implementation.

***Building Technologies Research and Integration Center** is the only DOE-designated National User Facility devoted to building technologies research and development.*

## Research and Development

**Building envelope materials**—Developing new materials, components, and systems and how these can be integrated via advanced manufacturing techniques to effectively reduce heat, air, and moisture transfer through the building envelope

**Multifunctional equipment integration**—Testing new components, equipment, and systems in realistic environments, such as a research house and flexible research platforms, before market introduction and using computer modeling, visualization, and analytics

**Integrated building performance**—Pursuing advanced sensor and control technologies, advanced building and system energy modeling, energy efficiency optimization, grid interactive controls, communication and automation, and energy-optimized solutions for neighborhoods of the future

**Energy-efficient equipment**—Developing energy-efficient building equipment technologies including heat pumps, heating ventilation and air-conditioning, dehumidifiers, appliances, water heaters, and refrigeration systems

**Energy storage**—Advancing new technologies that integrate energy storage capabilities in equipment and building envelope systems with sensors and controls to reduce, shift, shed, and modulate building loads

**REIMAGINING** thermodynamic processes for efficiency breakthroughs

**CREATING** two to five times greater insulating value per unit thickness

**CUTTING** cost per wireless sensor node by more than 10 times

**FLEXING** building loads for grid resilience without compromising comfort

**AUTOMATING** building energy model generation and calibration

"We are advancing the understanding of buildings from a holistic perspective, specifically in regard to energy efficiency and sustainability."

**Diana Hun,** ***Group Leader, Building Envelope Materials Research***

OAK RIDGE National Laboratory

U.S. DEPARTMENT OF ENERGY

# Recent Impacts

## Building envelope

- Developed an autonomous self-healable and highly adhesive elastomer that self-repairs at ambient conditions and under water
- Created a self-healing barrier film that instantaneously self-repairs punctures and prevents vacuum loss of high R-value vacuum insulation panels
- Developed an anisotropic thermal management system that sheds and tailors cooling and heating loads on demand
- Developed a stable, low-cost salt hydrate phase change material (PCM) using a novel technique for incorporating compressed expanded natural graphite that increases thermal conductivity
- Designed and additively manufactured a self-cooling and heating smart wall, called EMPOWER, that uses sensors and advanced controls to lower peak energy demand

## Building equipment

- Created low-cost ground heat exchangers that use PCMs for geothermal heat pump systems
- Developed a thermoelectric heat pump dishwasher that demonstrated 4.6% less energy consumption and improved the drying rate by 63% compared with a conventional unit
- Developed and demonstrated a separate sensible and latent cooling system that can enable at least 40% energy savings compared with conventional technologies

## Energy-saving tools

- Launched Automatic Building detection and Energy Modeling (AutoBEM) software leveraging scalable data and algorithms to automatically create models of all buildings in an area of interest
- Launched the Building Science Advisor, a web-based expert system that puts guidance on how to achieve highly energy-efficient, moisture-durable wall systems in any climate into the hands of builders
- Developed a computer simulation to more accurately compare energy use on similar weather days for connected neighborhoods to better identify the potential for cost savings
- Developed a website tool that estimates the energy and durability implications of improving the airtightness of building envelopes

## Emerging solutions

- Leading connected communities research and publishing data; results from the Smart Neighborhood in Alabama demonstrate that grid-interactive efficient homes use 44% less energy and 34% less power demand
- Developing a refraction-based building air leak detector to locate and measure flow without stepping inside the building
- Developing an active insulation system that enables the effective use of the thermal storage capacity of building envelopes to reduce, shed, shift, and shape heating and cooling loads
- Developing a gas-driven thermo-vacuum clothes dryer with a 1.5 times higher combined energy factor and capable of a drying time of 5–10 minutes
- Developing a hybrid inverter that provides a universal interface
- Developing a novel compact flooded evaporator that can reduce the total refrigerant charge in the system by 40%
- Creating generalizable and adaptable deep learning techniques to analyze building energy data

**10** R&D 100 Awards

**127** Industry Partners

**27** University Partners

**238** Publications in FY 2020


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