



OAK RIDGE NATIONAL LABORATORY

Building Technologies

With more than 130 million buildings in the United States consuming approximately 40% of the nation's total primary energy and 75% of its electricity, reducing energy consumption and embodied carbon in building materials 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 benefit energy security, 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 commercialization.



Building Technologies Research and Integration Center is the only US Department of Energy (DOE)-designated National User Facility devoted to building technologies research and development. The 60,000 ft² campus includes the flagship MAXLAB, a multipurpose laboratory to advance the energy efficiency and durability of building envelopes, equipment, and materials.

Research and Development

Energy-efficient equipment—Developing energy-efficient building equipment technologies, including heat pumps, HVAC, dehumidifiers, appliances, water heaters, and refrigeration systems

Building envelope materials—Developing new low-carbon materials and integrating them into advanced manufacturing techniques to effectively reduce heat, air, and moisture transfer through the building envelope and decrease embodied carbon in buildings

Multifunctional equipment integration—Testing new components, equipment, and systems in realistic environments (e.g., research house, flexible research platforms) before market introduction; using computer modeling, visualization, and analytics to develop integration technologies

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 storage—Advancing the development and integration of materials, building envelopes, equipment, sensors, and controls into optimized systems that reduce energy use and peak demand while maintaining occupant comfort



DEVELOPING
novel low-carbon
construction materials



CREATING
direct-air carbon
capture technologies



DEPLOYING
equipment for net-zero
energy and low-carbon
neighborhoods



IMPLEMENTING
environmentally friendly
refrigerant innovations



IMPROVING
access to clean energy
tools for all communities



“We have to investigate other materials that don’t use cement but form a product similar to concrete. We know what we need to do, and we have the capability here at ORNL to really make an impact immediately on the carbon emissions.”

—Building Envelope Research Group Materials Scientist **Denise Antunes da Silva**

Recent Impacts

Building Envelope

- Developed and demonstrated in a large-scale trial a new concrete mix that has 15% lower embodied energy, reduces by 40% the amount of concrete needed in precast insulated panels, and doubles the production capacity of precast plants without capital investment
- Created an R&D 100 Award-winning novel autonomous self-healing sealant that self-repairs at ambient conditions and under water
- Developed and demonstrated in a natural exposure test facility a novel thermally anisotropic building envelope system that diverts heat or cold away from the envelope storage in a thermal energy storage system for use on demand
- Invented a high-performance concrete mix for precast wythes that received a US patent

Building Equipment

- Collaborated with one of the nation's largest refrigeration unit suppliers to validate a refrigeration solution to address the ultracold last-mile distribution challenge for COVID-19 vaccines
- Demonstrated an integrated cold-climate heat pump that reached the highest combined Energy Efficiency Ratio, heating a 50-gallon water tank within a half hour
- Created an R&D 100 Award-winning ultraclean condensing gas furnace that utilizes monolithic acidic gas reduction to remove more than 99.9% of acidic gases and other emissions from furnaces
- Licensed and patented stable salt hydrate-based thermal energy storage materials

Sustainable Tools

- Developed a digital tool that simulates the energy profile of every building in America to provide homeowners, utilities, and companies a quick method for determining energy use and cost-effective retrofits that can reduce energy and carbon emissions
- Featured in the International Facility Management Association journal for recognizing 14 commercial buildings that meet the DOE Better Buildings Envelope Campaign goals
- Developed computational fluid dynamics models of a typical supermarket to evaluate the potential for COVID-laden particle distribution in a variety of scenarios
- Launched the [Building Science Advisor](#), an online tool that helps building designers mitigate moisture risk in building envelopes

Demonstration Results

- Instrumented a cross-laminated timber (CLT) hotel in South Carolina to study energy and peak demand reduction caused by the CLT's thermal mass and completed blower door testing, demonstrating that the structure greatly exceeded performance criteria for building airtightness
- In collaboration with the University of Tennessee, Knoxville; the Knoxville Community Development Corporation; and industry partners, demonstrated a cost-effective, modular, exterior panel retrofit solution on 12 low-income single-family attached duplexes and on advanced HVAC equipment and controls in one small commercial site
- Designed a carbon capture platform for incorporation into existing HVAC units on commercial and residential buildings

13

R&D 100
Awards

125+

Industry
Partners

54

University
Partners

236

Publications
in FY 2022



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