



“ORNL is a sweet spot where I can do fundamental and applied research and have a foot in both worlds.”

Joshua New,  
Computer Scientist



## Innovations in Building Technologies

Buildings consume 40% of the nation’s primary energy and 74% of its electricity. Thus, more energy efficient buildings are a priority for improving the nation’s energy productivity and grid resilience. American companies are competing for global leadership in the manufacture and sale of building components and materials, and their success is vital to the nation’s economic health. Public-private partnerships allow Oak Ridge National Laboratory (ORNL) to tackle basic research while industry focuses on later stage research and development and implementation.

### Research and Development

ORNL’s building technologies research focuses on reducing energy use and increasing grid resilience through the following.

- Reimagining thermodynamic processes of HVAC, refrigeration and water-heating systems, and appliances, including concepts for natural gas-fired systems
- Developing modeling, advanced materials, design, and prefabrication techniques for building envelopes
- Leveraging advanced materials and manufacturing for sensors and transactive controls
- Creating building energy modeling innovation using high-performance computing and big data

*The energy efficient ultrasonic dryer developed at ORNL extracts moisture with high frequency vibrations.*



**REIMAGINING** thermodynamic processes for efficiency breakthroughs



**CREATING** 2 to 5x greater insulating value per unit thickness



**CUTTING** cost per wireless sensor node by >10x



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



**AUTOMATING** building energy model generation and calibration

## Recent Impacts

### Building Envelope

- World's most respected hygrothermal models for understanding the flow of heat, air, and moisture through building envelope assemblies and moisture-durability thresholds.
- A spray-on water-based building envelope air sealant that is 4 times faster to install, is fast setting, can be applied in most weather, and spans 0.25-inch gaps without backing materials.
- 3D-printed molds for the architectural precast concrete industry, enabling many more castings per mold, reduced production time, and built-in energy-saving features.

### Building Equipment

- ORNL research findings contributed to 190 nations agreeing to phase down hydrofluorocarbon (HFC) refrigerants, creating a large energy saving opportunity.
- Non-HFC, nonflammable refrigerant that can be dropped into existing supermarket refrigeration hardware and boost efficiency 10%.
- New supermarket refrigeration hardware optimized for the CO<sub>2</sub> refrigerant, which uses up to 25% less energy.

### System/Building Integration

- The Roof Savings Calculator, a web-based tool for evaluating efficiency upgrades at time of roof replacement, which easily integrates with roofing contractor quotation systems for industry-wide adoption.
- The Building Science Advisor, a web-based expert system that puts into the hands of builders guidance on how to achieve highly energy-efficient, moisture-durable wall systems in any climate.

### Emerging Early Stage Breakthroughs

- Progress to date has shown that thermoelectric-based heat pump (HP) clothes dryers can match performance of best-in-market HP dryers at much lower cost.
- Although further off, ultrasonic clothes dryers that shake rather than evaporate moisture from fabric could double or triple efficiency.
- Refrigerators/freezers based on the magnetocaloric effect can boost efficiency 25% over traditional units.
- A transactive controller capable of networking an arbitrary number of building loads to enable grid load flattening without compromising comfort.

## Building Technologies Research and Integration Center



*The Maximum Building Energy Efficiency Research Laboratory is the flagship facility of BTRIC, which is the only DOE-designated National User Facility devoted to building technologies research and development.*

**10** R&D 100 Awards

**126** Industry Partners

**18** University Partners

**43** Active Strategic Partnerships

**22** Active Cooperative R&D Agreements

**175** Publications in FY 2017

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