U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Research and Development Opportunities for HVAC, Water Heating, and Refrigeration Applications

BTO Peer Review

Emerging Technologies Strategy Overviews

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October 21, 2024

Introduction to special section

Today's Session

Hear our latest thinking now (and later)

Ask questions

Share your feedback

Listen for more from BTO, on strategies

The mission

The Building Technologies Office (BTO) conducts research, development, and demonstration activities to accelerate the adoption of technologies and techniques that enable high-performing, affordable buildings that meet Americans' need for resiliency and health while also supporting a reliable energy system.

90%

The amount of time people spend in buildings.

74%

Amount of electricity consumed by buildings.

$374 billion

Amount spent on energy costs annually.

BTO RD&D Activities Support America

- Energy Efficiency
- Energy Affordability
- Innovation
- Industrial Competitiveness
- Infrastructure
- Energy Reliability and National Security
- Resilience
- Indoor Environment and Health

A practical, inclusive definition of innovation

The Heilmeier Questions:

01 Problem

Stated without jargon

02 Impact

If you succeed, what changes and who cares?

03 Status

How is it done today?

04 Proposal

What is the new approach, why will it succeed, and what will the output be?

05 Midterm checks

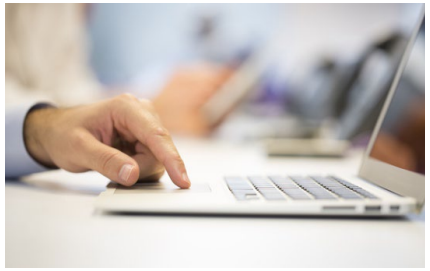
How will we know we're on the right track?

06 How much does it cost?

How long will it take? What are the risks?

Innovation for building technology is broad

It includes R&D for product development, testing, and validation. But also!



Market transformation

Partnership models

Service delivery modes

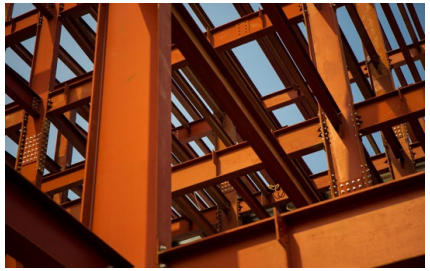
Value chain

Contractors

Trades

Specifiers

Reps



Supply chain

Materials

Components

System integration

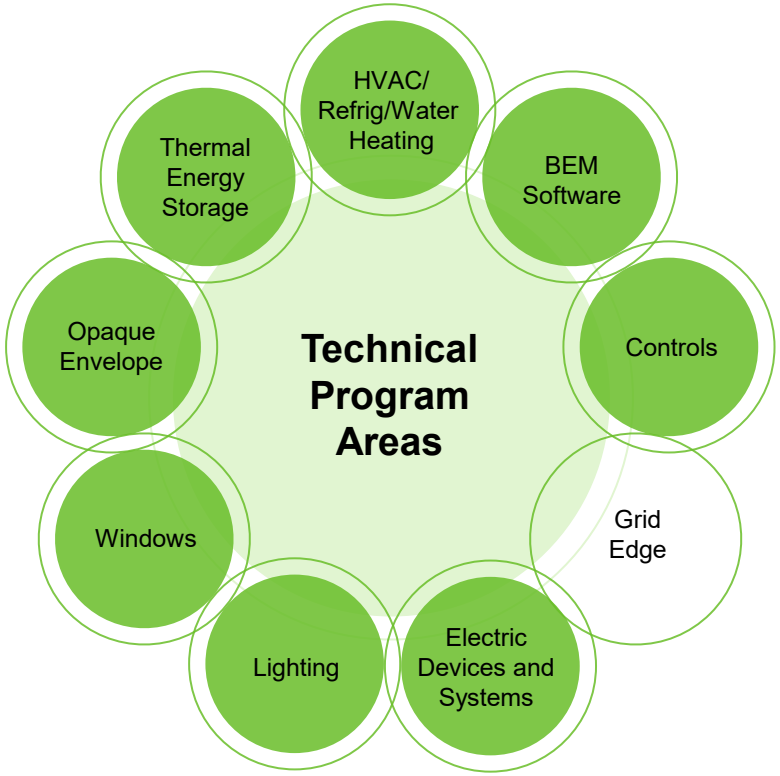
Logistics

Serendipity

Partnerships

Alignment

What does this strategy mean for DOE's applied R&D for buildings?



Reduce first costs

Make it easy

Deliver performance that matters

Ask, who's missing that we need?

Welcome and Agenda

Overview

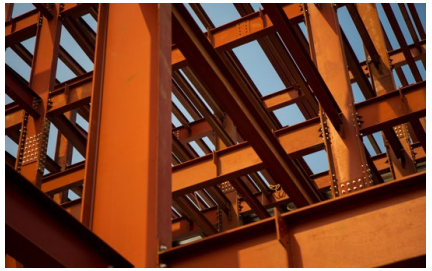
- The ET heating, ventilation, and air conditioning (HVAC), water heating, and refrigeration Peer Review, includes:
  - 42 Project Presentations – Rooms Washington A & B
  - 25 Posters during the Poster Sessions

Agenda

- Introduction to the HVAC, Water Heating, and Refrigeration ET Program Area
- Technology and Market Deployment Barriers and RD&D Solutions
- Areas for Stakeholder Engagement

Vision

Our innovations for HVAC, water heating, & refrigeration will enable:



Reduced up-front costs

by 50%, all-in

by 2035

Barriers and Solutions

Barriers

- Cold climate heat pump performance and upfront / operational costs
- Refrigerant leak detection, repair, and reclamation
- Limited information on safety and performance of A3 hydrocarbon refrigerants
- Improve non-vapor-compression (NVC) solutions
- Utility infrastructure challenges
- Lack of trained workforce and available training

Solutions

Technology Development

- Engaging across the stakeholder value chain to increase development of new technologies
- Advancing HP solutions for current and future building stock (e.g., cold climate, high temperature options, load shifting)
- Developing R&D for high performance systems and solid-state, thermal, and mechanical NVC systems

Market Readiness and Scaling

- A3 hydrocarbon refrigerant risk assessments and other research related to codes and standards
- Refrigerant leak mitigation and sensor development
- Lifecycle cost analyses

Partnerships and Technology Demonstrations

- Research initiatives, manufacturer partnerships to develop 120V options
- Supporting technology demonstration pilots and case studies

Note: this is not an exhaustive list of all barriers and solutions

BTO Emerging Technology Role

BTO and its partners have explored and supported the development, market introduction, and deployment of high efficiency and low carbon HVAC&R technologies.

Research and Development

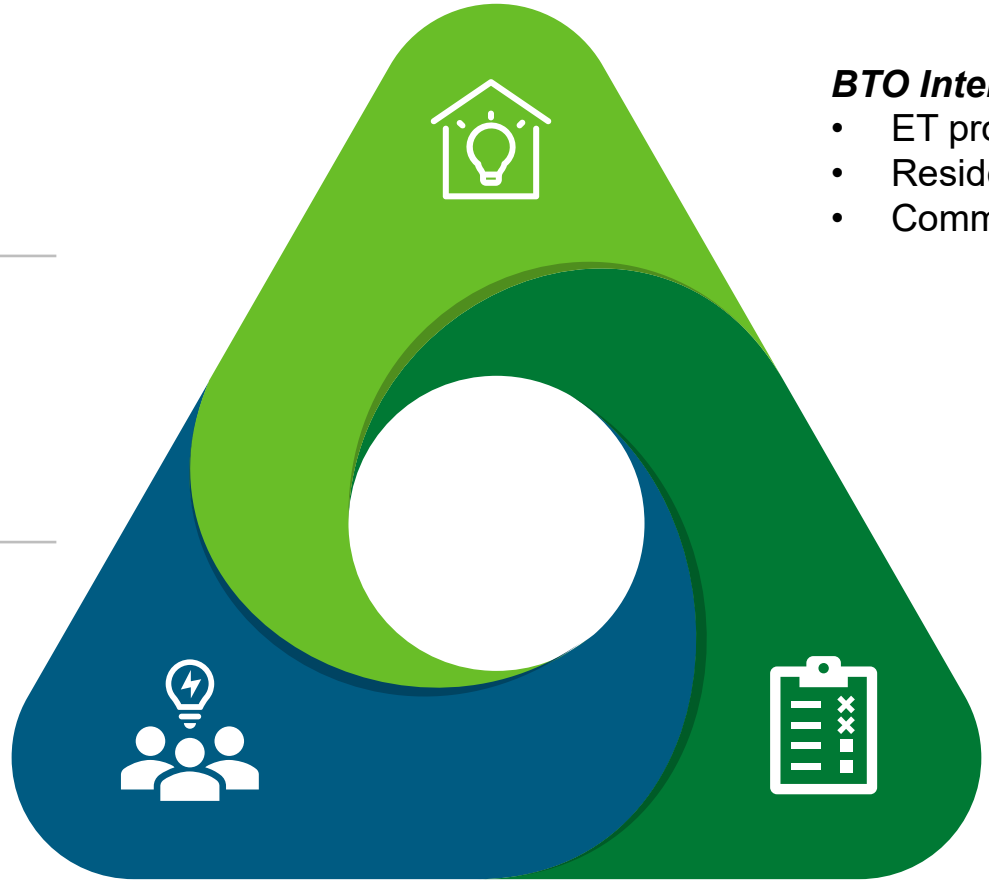
Equipment, systems, components, refrigerants, sensors, and controls

Demonstration and Deployment

Laboratory and field testing, and promotion with early adopters, incentive programs, and other leaders

Industry Collaboration

Convening experts across different stakeholder groups to support collaborative initiatives

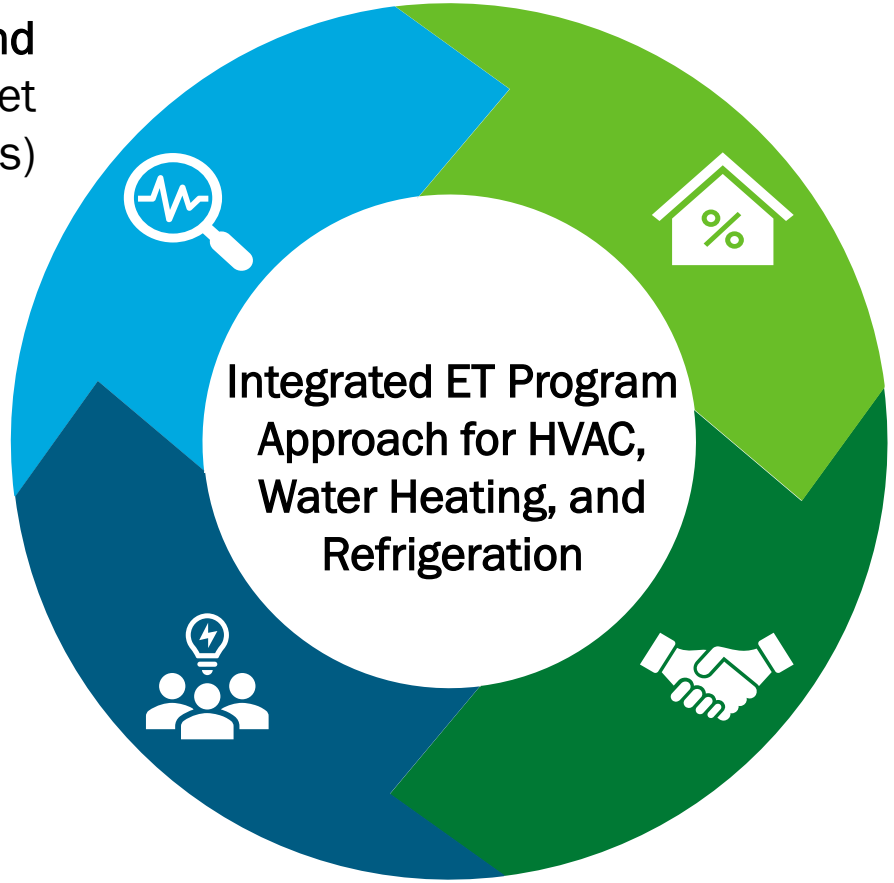


BTO Internal Collaboration

- ET program areas
- Residential Buildings Integration
- Commercial Buildings Integration

Integrated Approach – Bringing It All Together

Evaluate Technical, Market, and Policy Drivers and Goals (Market Characterization Analyses)



Develop Analytical Tools that Support Characterization of Current Building Stock (ResStock, ComStock, RECS*, CBECS**, etc.) and Future Analyses

Obtain Industry Stakeholder Input (Conferences, Workshops, 1-1 Discussions, Emerging Technologies Collaborative for Buildings [ETCB])

Perform Collaborative RD&D with Industry Partners (e.g., cooperative research and development agreements (CRADAs), Challenges & Campaigns, demonstrations at federal facilities, deployment initiatives)

*RECS= Residential Energy Consumption Survey
**CBECS= Commercial Building Energy Consumption Survey

Key Industry Engagement Activities and Timeline: 2024

Completed / In Process

- ASHRAE / AHR Expo Coffee Chat: January 22
- ACEEE HAHW Forum: March 12–13
- ACCA Coffee Chat: March 14
- EPRI Refrigerants Workshop (HVAC): April 1–2
- UMD Refrigerants Workshop (CRE, WH, HVAC): May 1–2
- DOE National Energy Codes Conference: May 6–8
- High Performance Refrigerant Working Group Meetings: Ongoing
- BTO Peer Review: October 21–24
- Individual discussions with stakeholders.

Energy Efficiency

High Performance Refrigerants

Workforce Challenges

Cost Optimization

HVAC Events

Cold-climate HPs

HPs using ultra-low GWP refrigerants

High temperature HPs

Efficient and modular HPs

Event	Time
Cold Climate Heat Pump using Vapor Compression Cycle Cascaded with a Thermoelectric Heat Pump *Sreenidhi Krishanamoorthy, EPRI*	Monday morning
Reduced Cost Heat Pump Space and Water Heating in Cold Climates *Iain Walker, LBL*	Monday afternoon
Residential Cold Climate Heat Pump Field Validation and Market Transformation *Vrushali Mendon, PNNL*	Tuesday afternoon
High-Efficiency Air-Source Multi-Stage Cold-Climate Integrated Heat Pump *Bo Shen, ORNL*	Wednesday afternoon
Detailed Air Source Heat Pump Evaluation for Very Cold Climates *Jeff Munk, NREL*	Wednesday afternoon
Next Generation Low Cost Direct-Expansion Heat Pumps *Zhenning Li, ORNL*	Thursday morning

Event	Time
High Temperature Combination Heat Pumps - FY22 Lab Call *Nelson James, NREL*	Monday afternoon
High Temperature Heat Pump for Commercial Space and Water Heating *Kashif Nawaz, ORNL*	Wednesday afternoon
GEB by ME: Grid-interactive Efficient Buildings by Modular Design of Plug-and-play Equipment *Kyle Gluesenkamp, ORNL, Michael Poplawski, PNNL, Multi-lab*	Tuesday afternoon
Super-Efficient Air-Conditioning Unit *Jeff Premer, Baryon Inc.*	Wednesday morning
Commercial Space Cooling/Direct Air Capture System with Waste Heat Utilization *Steve Kowalski, ORNL*	Wednesday afternoon
Seamlessly Fuel-Flexible Heat Pump *Steve Kowalski, ORNL*	Wednesday afternoon

Note: Some events are repeated under multiple categories, when applicable.

Water Heating Events

High Performance refrigerants

Low cost HPWHs

Energy storage and low power options

High temperature HPWHs

Event	Time
Low Charge Heat Pump Water Heater Using Propane *Bo Shen, ORNL*	Monday afternoon
MaxTech HPWH *Kashif Nawaz, ORNL*	Monday afternoon
Cost compression for multifamily heat pump water heaters - FY22 Lab Call *Joseph Rendall, ORNL*	Monday afternoon
Reduced Cost Heat Pump Space and Water Heating in Cold Climates *Iain Walker, LBL*	Monday afternoon
120V heat pump water heating *Kyle Gluesenkamp, ORNL*	Monday afternoon
Flexible HPWH with embedded energy storage (CRADA AOS) *Jian Sun, ORNL*	Monday afternoon
High Temperature Heat Pump for Commercial Space and Water Heating *Kashif Nawaz, ORNL*	Wednesday afternoon

Note: Some events are repeated under multiple categories, when applicable.

Cross-Program Collaboration within BTO

- Residential Buildings Integration (RBI)
  - Field Validation Partnerships of HPs and HPWHs
  - Tuesday morning and afternoon

- Commercial Buildings Integration (CBI)
  - Commercial Building Heat Pump Accelerator: Cold Climate HP Rooftop Unit Technology Challenge
  - Thursday midday

Questions

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