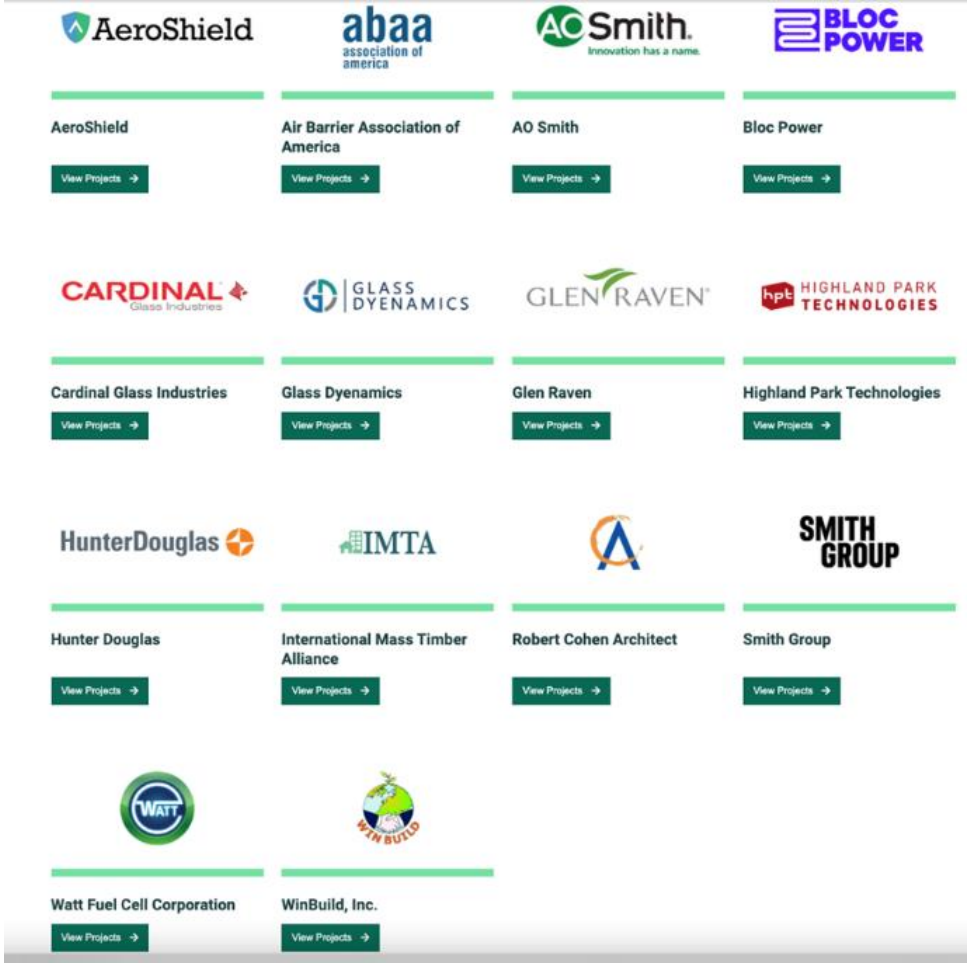
2024 PROJECT PEER REVIEW

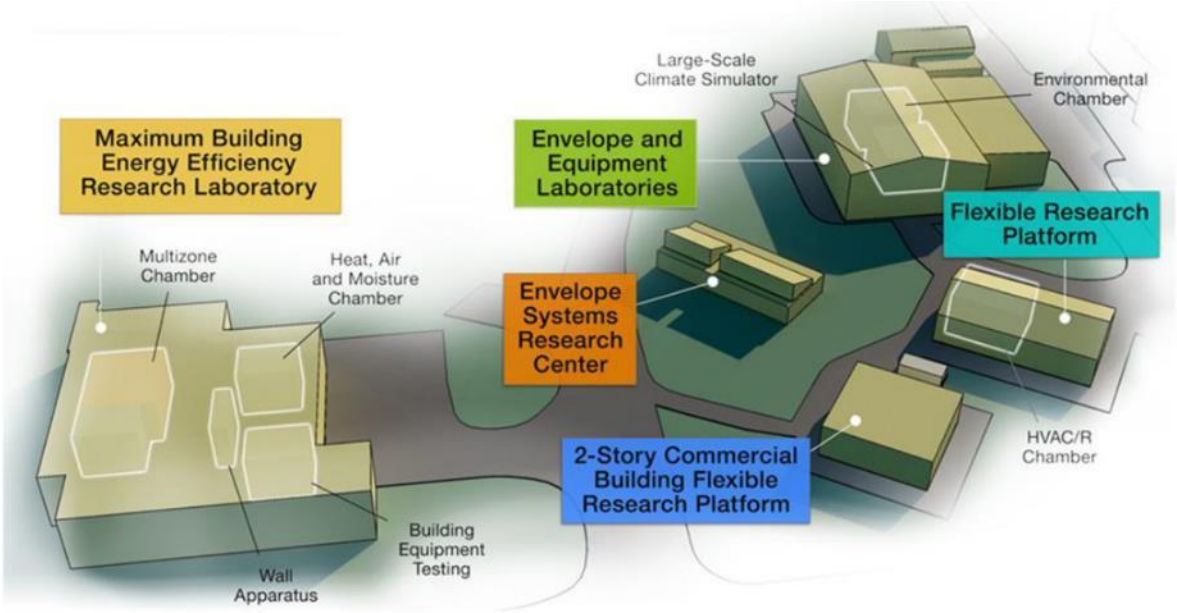
U.S. DEPARTMENT OF ENERGY
BUILDING TECHNOLOGIES OFFICE

BTO Peer Review: BTRIC Technical Collaboration Program

Companies leverage ORNL building technologies research capabilities to address climate mitigation goals



BTRIC Technical Collaboration Program



Oak Ridge National Laboratory
Melissa Lapsa, Building Technologies Program Manager
lapsamv@ornl.gov
WBS: 03.02.02.78

OAK RIDGE National Laboratory | BUILDING TECHNOLOGIES RESEARCH AND INTEGRATION CENTER

Project Summary

OBJECTIVE, OUTCOME, AND IMPACT

Technical Collaboration projects create opportunities for companies to develop innovative building technologies by leveraging the facilities, capabilities, and expertise at ORNL's Building Technologies Research and Integration Center (BTRIC) to address the DOE BTO mission.



TEAM AND PARTNERS

PIs from across BTRIC: 22 researchers
Industry partners: 45 companies
Tech Collab Manager: Melissa Lapsa
BTRIC Researchers Support: Linda Severs and Jason Schmidt

STATS

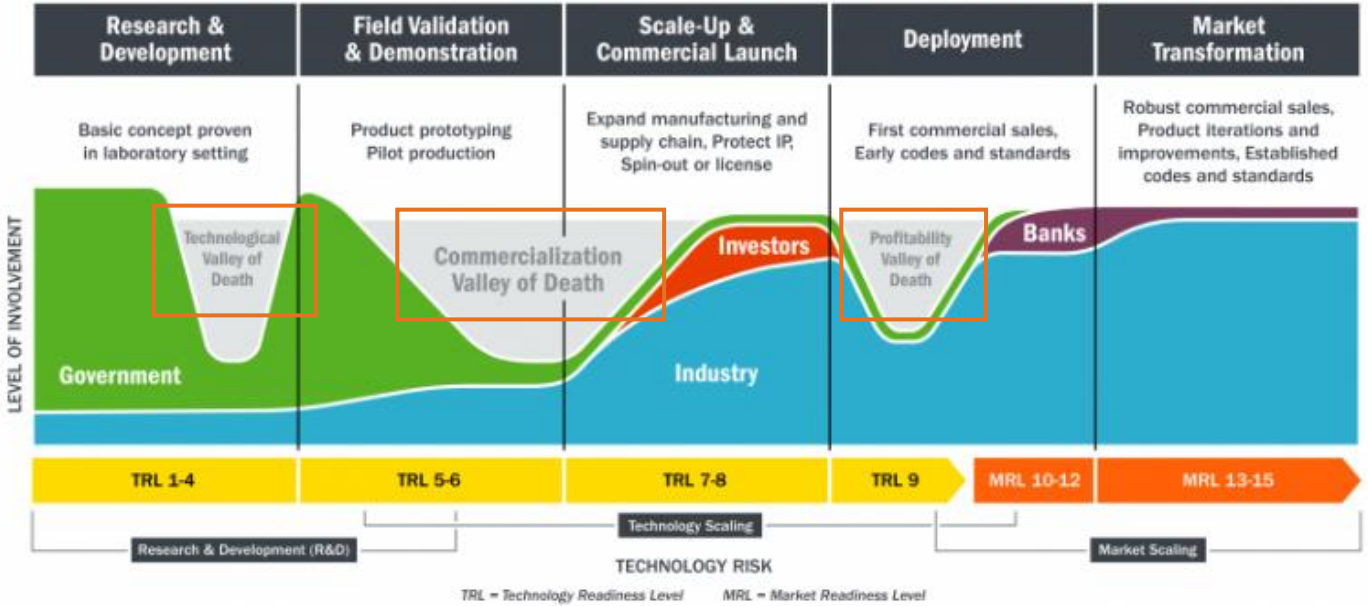
Performance Period: FY21–FY24
DOE Budget: $1.2M/FY
Cost Share: 20% in project phase 1, 50% in project phase 2
Milestone 1: Quarterly review
Milestone 2: Final reports

Problem

The United States is the leading country by the number of tech startups (75,056 start-ups (1)).

Tech startups face significant challenges:

- Attracting and retaining talent (2)
- Funding
  - 58% of start-up have less than $25,000 during initial phases (1)
- Challenge of scaling (3)
- Product development (4)
- Identifying partnerships and collaboration (5)



https://www.energy.gov/eere/buildings/technology-market (6)

(1) Minaev, A. (2024, May 30). *Startup statistics (2023): 35 important facts and Trends*. FirstSiteGuide.
(2) Nash, J. (2024, August 13). *Council post: Overcoming the biggest challenges to hiring staff for startups and scaleups*. Forbes.
(3) Vidal, I. C. (2023, September 25). *Early-stage start-ups challenges: Scaling: Deloitte UK*. Deloitte United Kingdom.
(4) Venkataramanan, A. (2023, May 16). *Product management for startups: Navigating the challenges of early-stage product development*. LinkedIn.
(5) Fallon, N. (2024, May 7). *Challenges your tech startup will face*. Business News Daily.
(6) Technology-to-market | Department of Energy. Technology to Market. (2022). https://www.energy.gov/eere/buildings/technology-market.

Alignment and Impact

Technical Collaboration Program utilizes the DOE-designated National User Facility, the Building Technologies Research and Integration Center (BTRIC) to provide opportunities for companies to further develop innovative building technologies to address DOE's National Buildings Blueprint and Climate Mitigation Goals.

ORNL receives cost-shared proposals from industry to assess technologies that can contribute to increasing building energy efficiency, reducing U.S. building emissions, prioritizing affordability, equity and resilience.





Technology areas of interest:

HVAC, water heating, and appliances

Windows and building envelope

Building energy modeling

Sensors and controls

Grid-edge technologies




Advanced building construction

Residential building integration

Commercial building integration

Thermal energy storage



Alignment and Impact

Electrification Strategies, LLC → Reduces peak demand for grid resilience by preheating water during periods of low demand

Mackinac → High-impact, affordable window retrofit increases building energy efficiency and reduces emissions, especially in older homes with inefficient single- or double-pane windows

CRRC COOL ROOF RATING COUNCIL → Cool surfaces reduce peak demand in all climate zones; prioritizes equity in poorly insulated older homes

TRANE → Accelerates on-site emission reductions by capturing CO_2 from gas-fired equipment exhaust streams

AeroShield → Provides ultra-clear insulating aerogel to increase energy efficiency and reduce peak demand in refrigeration equipment

Approach

Submission process

- Opportunity for proposals is publicly posted in Federal Business Opportunities
- Announcements are issued annually and remain open for 12 months
- Collaborations are short term (12–15 months)
- Industry provides minimum 20% of total funding
- Downselection by ORNL buildings program management team
- Final selection by DOE BTO Technology Managers



Approach

Current Approach: Currently, several years of research, development, and demonstration are required for new equipment to reach the market. Many smaller companies lack skills and resources to develop products and overcome “valley of death.”

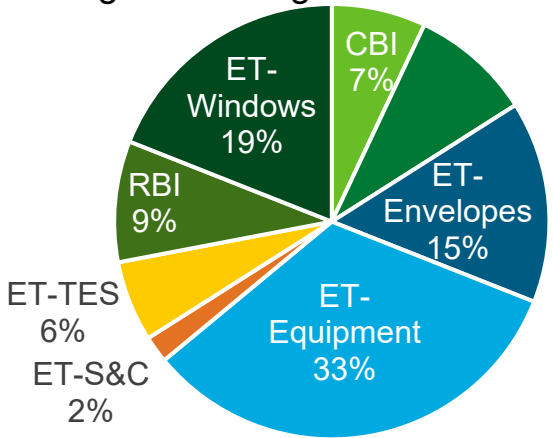
Innovation: By linking industry partners with expertise and laboratory facilities at BTRIC, companies (especially smaller ones) can accelerate innovations for efficient, low-carbon, affordable, and resilient building solutions.

Impact: The program enables investigation of sustainable and resilient building technologies on a faster schedule by channeling national lab resources to supplement industry talent and facilities.

Results include shorter time to market and faster deployment of technologies that reduce energy and emissions.

Technology areas of interest

- Equipment: HVAC, water heating, and appliances
- Windows
- Building envelope
- Building energy modeling
- Residential building integration
- Commercial building integration
- Thermal energy storage
- Sensors & Controls: for grid-edge technologies



Approach

30 – September – 2024

R1 is Round 1 (FY21), R2 is Round 2 (FY22), R3 is Round 3 (FY23), R4 is Round 4 (FY24), P1 is Phase 1, P2 is Phase 2

ET-Equipment (18)

Aeroshield (R1 P1) (R3 P2)
AO Smith (R1 P1) (R2 P2)
BAC (R3 P1)
Carnot (R2 P1)
ClimateMaster (R4 P1)
Daikin (R3 P1)
Emerson (R1 P1)
Lennox (R4 P1)
Rheem (R1 P1) (R2 P2)
Spark (R1 P1)
Taylor (R2 P1)
Trane (R2 P1)
Watt (R1 P1)
Molecule Works (R4 P1)
CoilPod (R4 P1)

ET-Envelopes (8)

Bosch (R4 P1)
Certainteed (R1 P1)
GoLab (R2 P1)
HP (R2 P1)
Imerys (R2 P1)
IMTA (R1 P1)
Polyceed (R3 P2)
Rise (R4 P1)

R1 -19 P1s
R2 -11 P1s, 3 P2s
R3- 6 P1s, 3 P2s
R4 – 11 P1s, 1 P2

Total: 54 Tech Collabs

ET-TES (3)

Emanant (R2 P1)
Shift Thermal (R4 P1)
Electrification Strategies (R2 P1)

ET-S&C (1)

Winbuild (R1 P1)

ET-BEM (5)

BlocPower (R2 P1) (R4 P2)
Cardinal Glass (R1 P1)
MAA (R4 P1)
SmithGroup (R1 P1)

RBI (4)

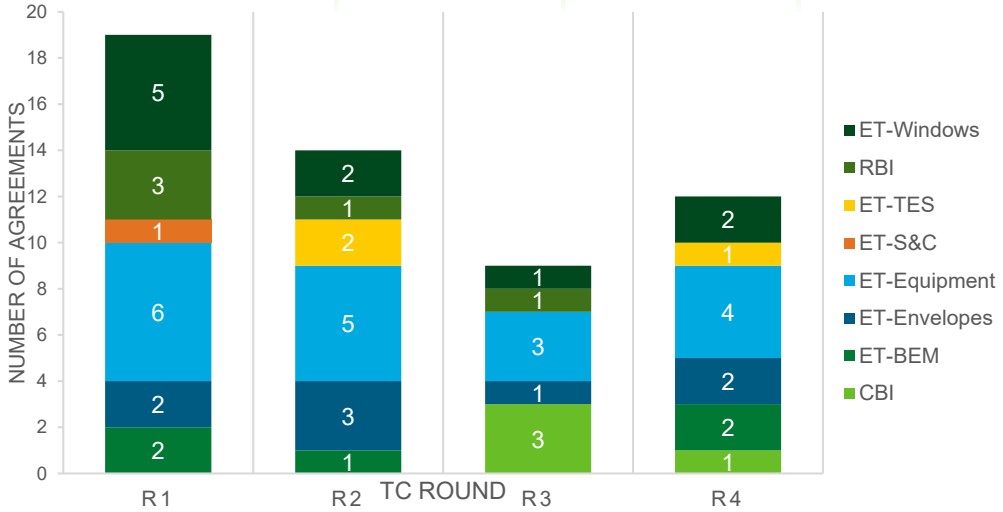
ABAA (R1 P1) x 2
Clayton (R1 P1) (R3 P2)
CRRC (R2 P1)

CBI (4)

AO Smith (R4 P1)
Global Medical (R3 P1)
Hydronic Shell (R3 P1)
Dalrada (R3 P1)

Windows (10)

AERC (R3 P1)
Pankow (R4 P1)
FTI (R4 P1)
GlenRaven (R1 P1)
HunterDouglas (R1 P1)
Mackinac (R1 P1) (R2 P2)
Polyceed (R1 P1)
RCA (R1 P1)
Wonderworks (R2 P1)



Approach

Barriers, technical challenges, and project risks

- Inherent project risks and intellectual property concerns, addressed by → ORNL Strategic Partnership agreements process
- Unexpected challenges or delays within project, addressed by → Careful communication and tracking through no-cost extension process
- Coordination and tracking of proposal process, addressed by → Organized, professional project specialists at ORNL

Approach

- ORNL BTRIC has had excellent success in meeting milestones and goals in past and current projects by establishing good communication and planning at project initiation and in follow-on activities
- Going forward, ORNL will work more closely with industry partners to provide help navigating the CRADA process and with delays in using SAM.gov (unfamiliar to many small companies)
- In FY24, a new website was stood up to provide a short summary and link to the Tech Collab project final report. We also continued (from FY23) gathering input on future successes from completed projects.



CARNOT COMPRESSION (small company):

"…the CRADA work allowed us to rule out two device design philosophies (resulting in a later pivot toward a third design approach), as well as to confirm that commercial CFD software tools do not correctly represent our system, saving us from investing in the corresponding licenses (typically between $7,000 and $40,000 per year…)."

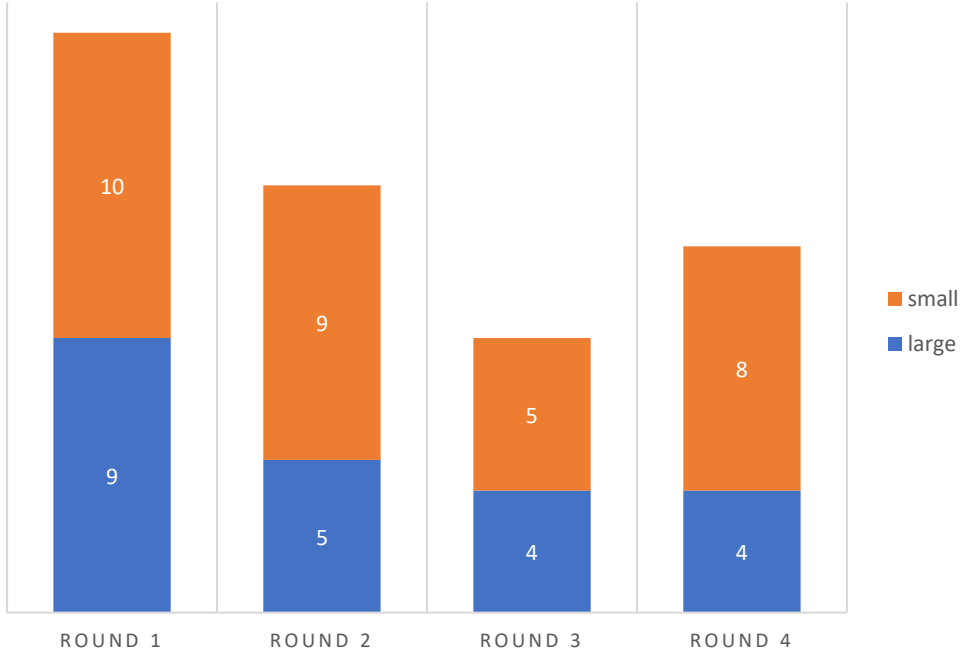
Progress and Future Work

Small business or non-profit: 59%
Large business: 41%

Partnerships benefit small, non-profit, and large businesses

We will continue to:

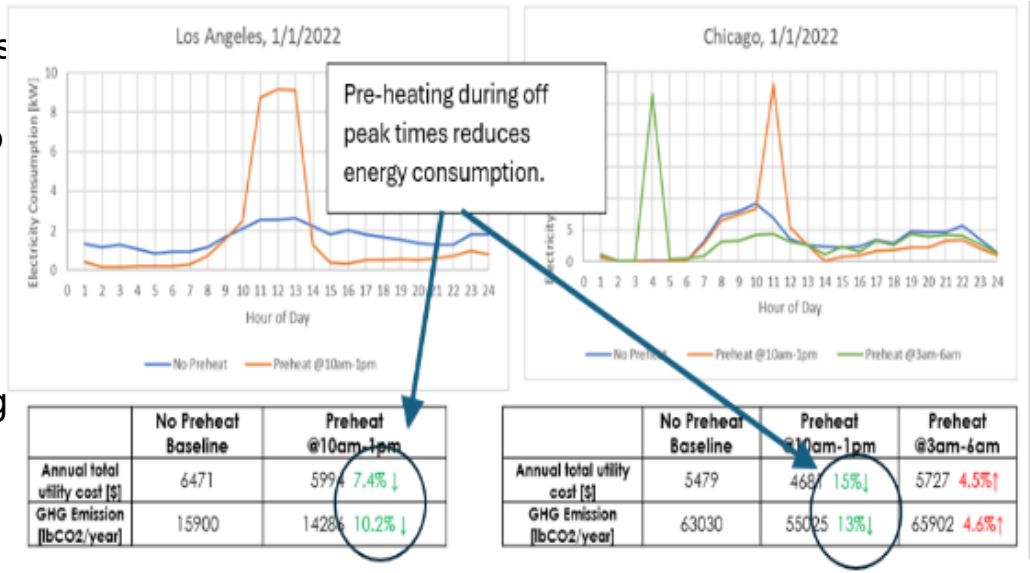
- prioritize proposals from small businesses
- promote results of the collaborations
- gather success stories from partners after the projects concludes



Progress and Future Work

Electrification Strategies, LLC

- A Technical Collaboration with Electrification Strategies proved that controlled preheating of heat pump water heaters reduces peak demand, which lowers energy costs and reduces emissions
  - By preheating when energy costs are lowest, the water heater acts like a thermal battery to discharge hot water when energy costs are higher
  - Load shifting can coincide with renewable energy production to reduce emissions
  - Aligns with National Buildings Blueprint by increasing energy efficiency and transforming the grid edge to deliver increased resilience and affordability
- Future work: Joint efforts with Steffes, a water heater OEM, developing scalable models that can be applied across various types of multifamily housing units



	No Preheat Baseline	Preheat @10am-1pm
Annual total utility cost [$]	6471	599[illegible] 7.4%↓
GHG Emission [lbCO2/year]	15900	1428[illegible] 10.2%↓

	No Preheat Baseline	Preheat @10am-1pm	Preheat @3am-6am
Annual total utility cost [$]	5479	468[illegible] 15%↓	5727 4.5%↑
GHG Emission [lbCO2/year]	63030	55025 13%↓	65902 4.6%↑

Progress and Future Work

Mackinac

- A Technical Collaboration project with Mackinac developed a frame assembly that optimized thermal performance of an interior, secondary window attachment
  - Iterative process yielded R-value improvements R-2.1→R-5.9
  - Major impact: 19 billion ft^2 of existing windows, 40% single-pane glass, 47 million homes with single glazing, 46 million with double-pane clear (1)
  - Aligns with equity and affordability aspects of National Buildings Blueprint because product can meet needs of older homes with inefficient windows where total window replacement would be expensive
- Future work: Phase 2 Technical Collaboration deploying the tech in ORNL FRP-2



(1) Cort (2013) and DOE-EIA

(1) Cort, KA, Low-E Storm Windows: Market Assessment and Pathways to Market Transformation, Pacific Northwest National Laboratory, PNNL:-22565, 2013.

Progress and Future Work

A Technical Collaboration project with the Cool Roof Rating Council highlighted relationship between building color and energy savings, giving insight into optimal deployment of reflective roofs and walls

- Peak demand is reduced significantly in all climate zones by deploying reflective roofs and walls
- Aligns with National Buildings Blueprint goals for affordability because a small investment in changing building color can reduce peak demand across all building sectors

- Future work: Create web-based tool to estimate cost savings associated with peak demand reductions

For a stand-alone commercial retail building...

Climate Zone	No Wall IECC 2006 Roof		No Wall IECC 2021 Roof		IECC 2021 Wall and Roof	
	Energy Savings, $	Demand Savings, $	Energy Savings, $	Demand Savings, $	Energy Savings, $	Demand Savings, $
2	$2,106	$1,704	$1,666	$1,303	$1,110	$875
4	$200	$1,272	$75	$899	$351	$561
6	-$532	$589	-$493	$470	-$98	$248

Hotter climate has biggest benefit

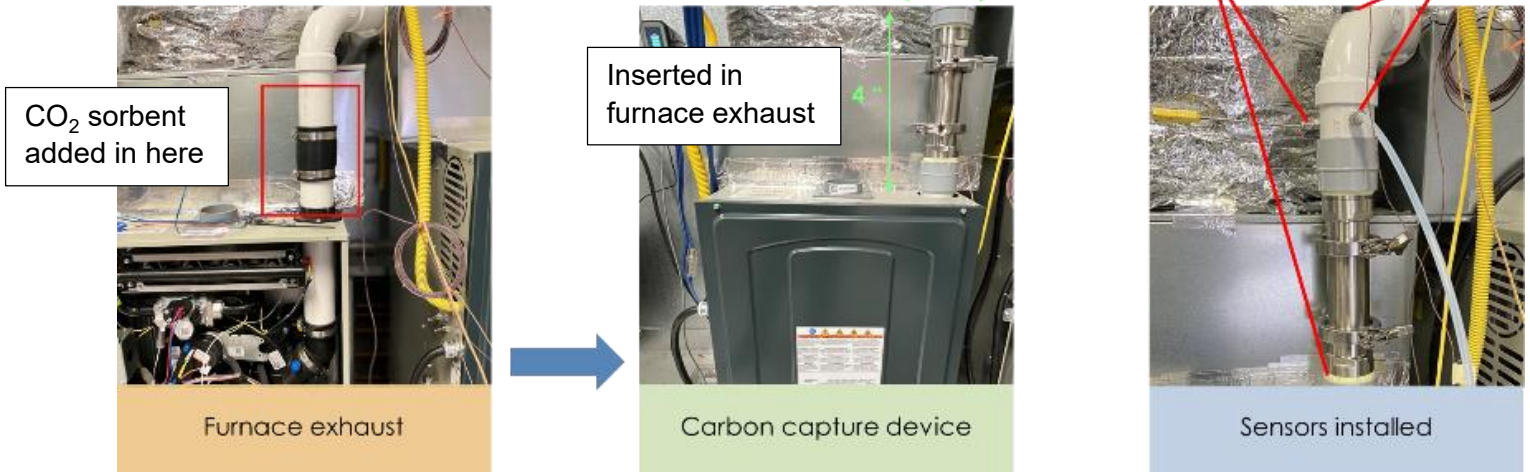
Cold climate insulated buildings will benefit also

Progress and Future Work

A Technical Collaboration project with Trane promises to reduce emissions from gas-fired furnaces and boilers

- CO_2 sorbent added in line with exhaust lines
- Alignment with National Buildings Blueprint: Direct reductions of CO_2 make strides toward net-zero emissions economy

- Future work: Potential for 20% CO_2 reduction in exhaust stream; CO_2 can be reused in other industries (e.g., syngas, polymers, supercritical CO_2)



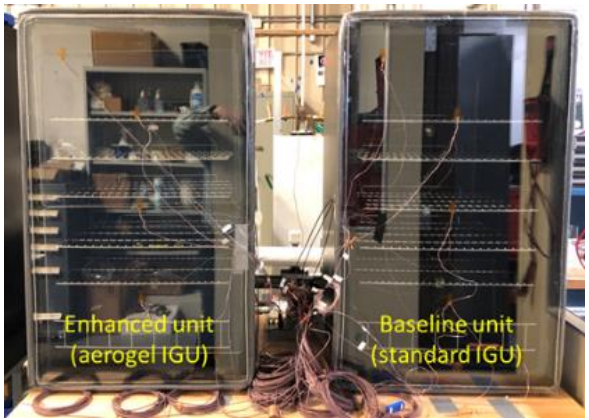
Progress and Future Work

AeroShield

A Technical Collaboration project with Aeroshield proved that ultra-clear, insulating aerogels can increase energy efficiency of freezer and refrigerator glass doors

- Provide start-up company with proof-of-concept to attract investors

- Alignment with National Building Blueprint: increase energy efficiency and reduce peak demand in refrigeration equipment
- Future work: Phase 2 Technical Collaboration to produce and test larger-scale specimens



AeroShield · Jun 25

AeroShield Materials Selected for $14.5M ARPA-E Award to Manufacture Cutting-Edge Energy Efficient Technology for the Built Environment

Boston, MA – June 25, 2024 – AeroShield Materials, an MIT spin out developing cutting-edge technology for energy efficiency applications in the built environment, announced today it was selected to receive an Advanced Research Projects Agency-Energy (ARPA-E) Seeding Critical Advances for Leading Energy technologies with Untapped Potential (SCALEUP) award. This award provides new funding to previous ARPA-E awardees that are determined to have a viable road to market. AeroShield is set to receive $14.5M to scale the


Mahabir Bhandari


Niraj Kunwar


Emishaw Iffa


Andre Desjarlais

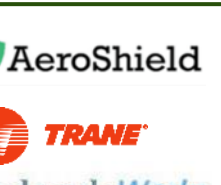

Philip Boudreaux


Mikael Salonvaara


Denise Antunes da Silva


Anthony Aldykiewicz


Bill Eckman


Kashif Nawaz


Steve Kowalski


Jian Sun


Praveen Cheekatamarla


Jamie Lian


Joshua New


Piljae Im


Xioabing Liu


Kyle Gluesenkamp


Yiyuan Qiao


Zhenning Li


Vishaldeep Sharma


Bo Shen

Thank you

Oak Ridge National Laboratory and Industry Partners

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Buildings Program Manager
lapsamv@ornl.gov

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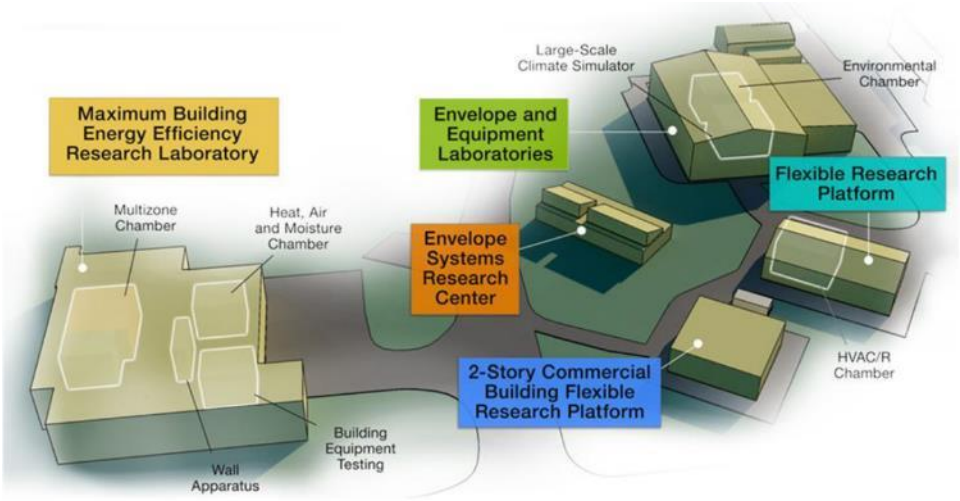


The **Building Technologies Research and Integration Center (BTRIC)** at ORNL has supported DOE BTO since 1993. BTRIC is comprised of more than 60,000 square feet of lab facilities conducting RD&D to develop affordable, efficient, and resilient buildings while reducing their greenhouse gas emissions 65% by 2035 and 90% by 2050.

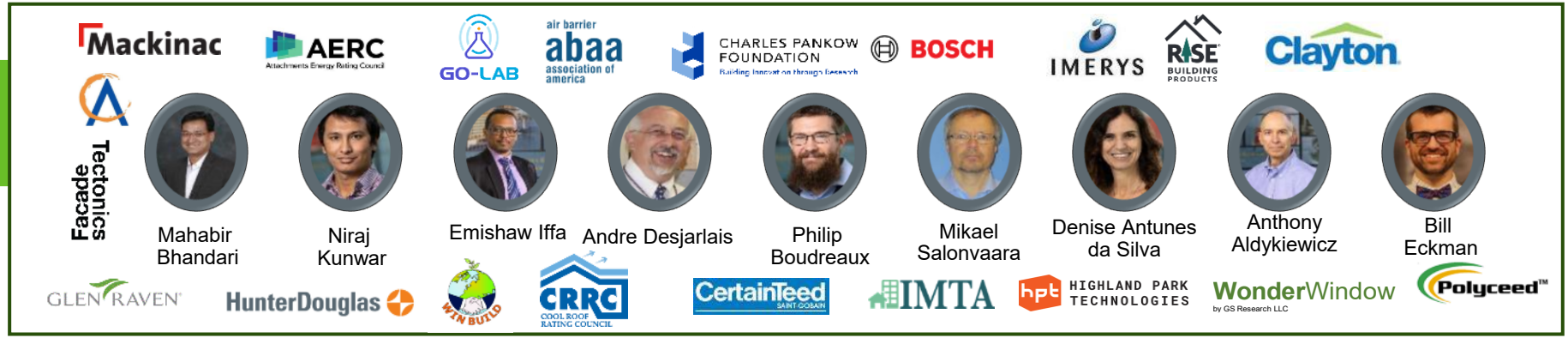
Scientific and Economic Results
139 publications in FY24
85 industry partners
18 university partners
16 R&D 100 awards
64 active CRADAs

BTRIC is a DOE-Designated National User Facility

Reference Slides

Project Execution

	FY2023				FY2024				FY2025			
Planned budget	$1.2M				$1.2M				$1.2M			
Spent budget	$1.2M				$1.4M							
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Past Work												
Q1 Milestone: Quarterly report	◆				◆				◆			
Q2 Milestone: Quarterly report		◆				◆				◆		
Q2 Milestone: Call for proposals		◆				◆				◆		
Q3 Milestone: Quarterly report			◆				◆				◆	
Q4 Milestone: Quarterly report				◆				◆				◆


Mackinac
AERC
GO-LAB
air barrier
abaa
association of america
CHARLES PANKOW FOUNDATION
BOSCH
IMERYS
RISE BUILDING PRODUCTS
Clayton
Facade Tectonics
Mahabir Bhandari
Niraj Kunwar
Emishaw Iffa
Andre Desjarlais
Philip Boudreaux
Mikael Salonvaara
Denise Antunes da Silva
Anthony Aldykiewicz
Bill Eckman
GLEN RAVEN
HunterDouglas
WIN BUILD
CRRC
COOL ROOF RATING COUNCIL
CertainTeed
IMTA
hpt HIGHLAND PARK TECHNOLOGIES
WonderWindow
by GS Research LLC
Polyceed


AeroShield
AO Smith
Innovation has a name.
CARNOT COMPRESSION
Dalrada Corporation
SPARK THERMIONICS
COILPOD
TRANE
MoleculeWorks
WATT
BALTIMORE AIRCOIL COMPANY
Kashif Nawaz
Steve Kowalski
Jian Sun
Praveen Cheekatamarla


GLOBAL MEDICAL REIT
CARDINAL Glass Industries
BLOC POWER
MAA
SMITH GROUP
Jamie Lian
Joshua New


HYDRONIC SHELL TECHNOLOGIES
Piljae Im
EMANANT


ClimateMaster
COPELAND
formerly Emerson
SHIFT THERMAL
Xioabing Liu
Kyle Gluesenkamp
Yiyuan Qiao


Rheem
TAYLOR
DAIKIN
LENNOX
Zhenning Li
Vishaldeep Sharma
Bo Shen
Electrification Strategies, LLC

Team



Melissa Lapsa

Building Technologies Program Manager

ORNL



Jason Schmidt

Collaborations Technical Project Specialist

ORNL BTRIC



Linda Severs

Project Management Specialist

ORNL BTRIC