

CIBS

ANNUAL REPORT

2023



**CENTER FOR INTEGRATED
BUILDING SYSTEMS**

College of Engineering, Architecture and Technology

MESSAGE FROM THE DIRECTOR

Dear friends,

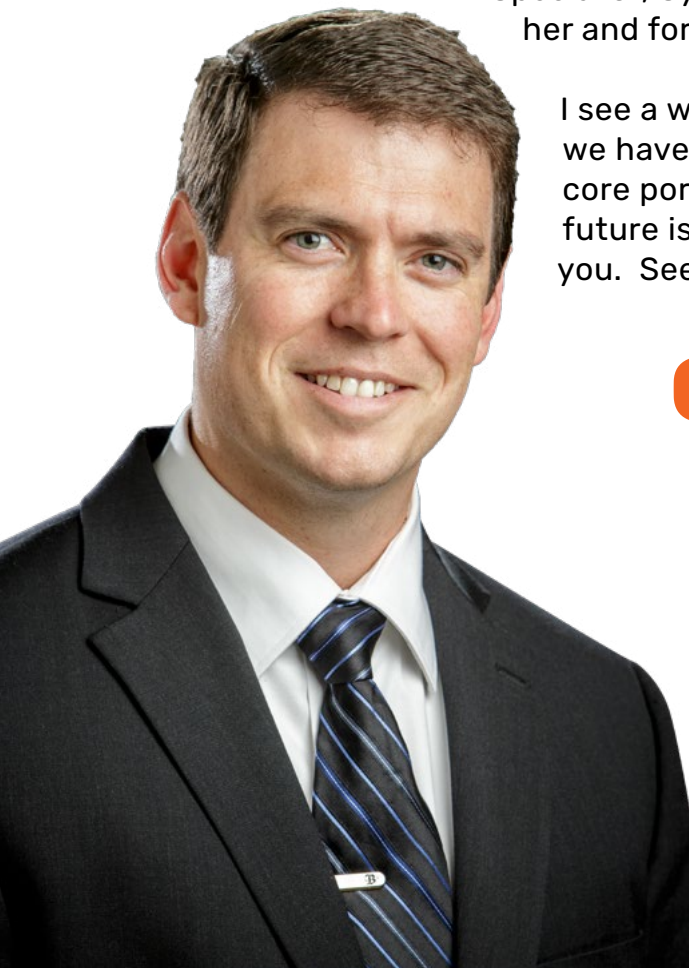
As I was reflecting back on our third year of operation I was starting to see, and feel, the true impact of CIBS. The center is maturing to the level that we are starting to see continued growth in our core areas and outcomes across a wider diversity of activities including, student graduations and outreach. It was another great year for CIBS and I'm excited to share the news with you.

We continued to see the fiscal and technical outcomes at our core grow and generate value across the board. Productivity in research is up **3.25 times over pre-CIBS level** and that has manifest in 24 individual deliverables, 16 pieces of scholarship, and **92 students** exposed to building systems!

On top of our core outcomes we are seeing significant growth in other successes, recognition, and additional participation in the center. Jeff Spitler was awarded the Peter Ritter von Rittinger award, one of the highest honors in our field. We were visited by the US Secretary of Energy, Jennifer Granholm, who spent some time with one of the CIBS capstone teams. We also welcomed two, new, faculty to the CIBS faculty family.

Lastly, we saw wonderful growth and excitement in workforce development and communications. This is due in large part to welcoming our first full-time staff, CIBS Program Specialist, Sydney Klinedinst to the team. I'm excited to welcome her and for her contributions to the center.

I see a wonderful future in store for CIBS. As we start 2024, we have added projects to the portfolio, with ten (10) in the core portfolio and another seven (7) as affiliated projects. The future is very bright and I'm so excited to share it with all of you. See you in Stillwater!



Go Pokes!

A handwritten signature in black ink that reads "Craig R. Bradshaw".

Craig R. Bradshaw

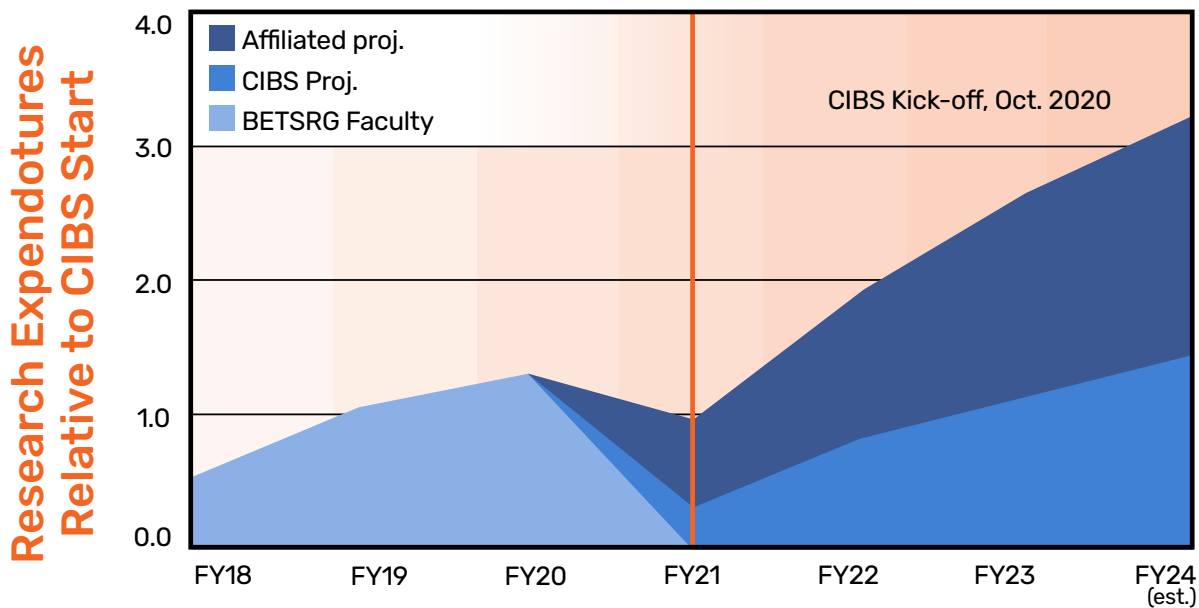
Director, Center for Integrated Building Systems
Carol M. Leonard Fellow | Associate Professor

CIBS PRODUCTIVITY – 2023



The center started its third year, kicking off our six (6) projects (and 6 affiliated projects) and welcoming some new faces to the IAB. Our research portfolio maintained solid productivity growth in most areas. The expenditures data (a general measure of research activity) shows we continue to do more things. It also highlights the huge impact CIBS has had since its inception, increasing research productivity over 3.25 times and over 3x from pre-CIBS levels!

CIBS/Faculty Expenditures over FY



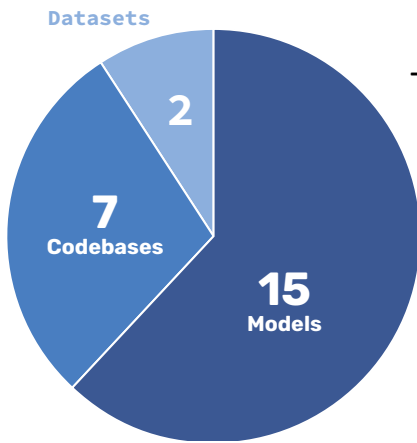
Research Outcomes

This overall increase in productivity has also resulted in outcomes and value for the membership. This includes 24 different deliverables like, for example, the new black box model for unitary heat pumps (1 model and codebase) and accompanying experimental data (1 dataset) that has been shared with the members on our GitHub page. We continue to push for tangible outcomes that our members can use to help their companies.



CIBS PRODUCTIVITY – 2023

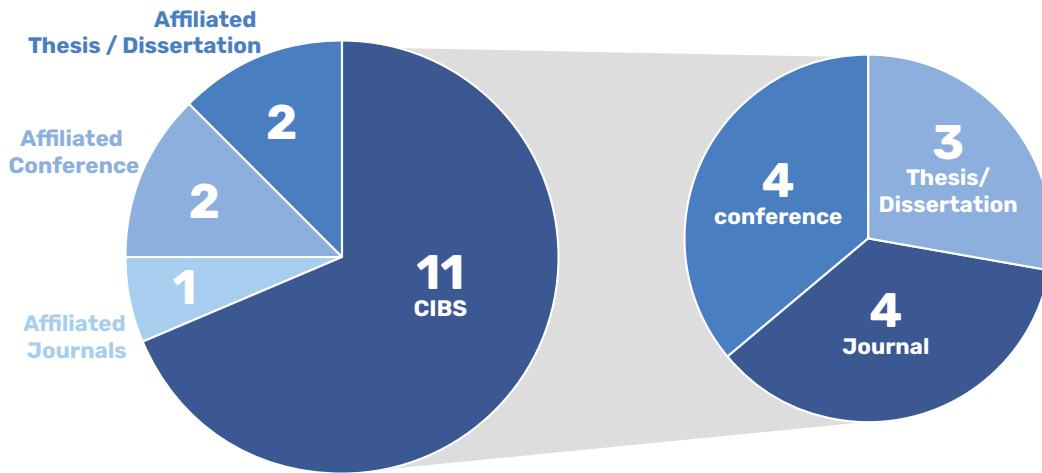
CIBS Deliverables



This has also resulted in a large amount of scholarship (16 pieces total), which reflects general knowledge generation. The center celebrated four (4) PhD and one (1) MS student graduations this year and their dissertations/thesis as well as eleven (11) other pieces of scholarship. You can stay up to date on our scholarship on our website:

<https://ceat.okstate.edu/mae/research/cibs/cibs-research.html>

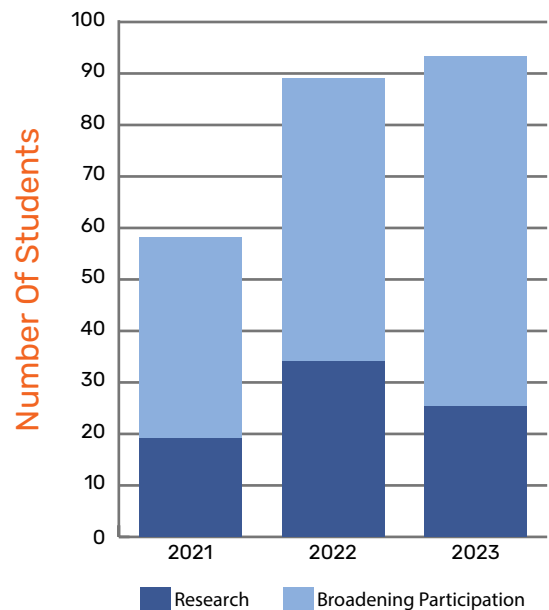
CIBS Scholarship, 2023



Student Engagement and Exposure

We are also able to continue with modest growth in student impact, **impacting 92 total students** in 2023! Considering how many students we have impacted in years past this is a remarkable achievement. This continues to show how important and impactful our broadening participation program is and how many students get influenced by member support.

CIBS Student Impact Over Time



STUDENT SUCCESS AND OTHER ACTIVITIES:

2023 CIBS Graduate Student Graduations



Abraham Lee, PhD (Research Associate at Oak Ridge National Laboratory)
PhD Dissertation Title: An experimentally validated heat exchanger refrigerant charge model and optimization of refrigerant charge for a heat pump



Hyunjin Park, PhD (Post-Doctoral Research Associate at Purdue University) PhD Dissertation Title: Development of design criteria for air mixing and sampling devices for performance testing of HVAC equipment



Mohsin Tanveer, PhD (Thermal Systems Engineer at Trane Technologies)
PhD Dissertation Title: Capacity based performance predictions for positive displacement compressors with low-GWP refrigerants through compressor modeling



Mazharul Islam, PhD (Research Engineer at AAON Inc.) PhD Dissertation Title: Development of a peristaltic compressor and other novel oil-free compressor technologies



Farhan Istiaque, MS (Research Engineer at Trane Technologies) MS Thesis Title: Development and commissioning of a variable capacity experimental infrastructure for a novel three fluid heat exchanger

CIBS Intern Student Graduations



Parker Raney
(Burns and McDonnell)



Madison Holberg
(Hilti)



Ethaniel Tobar
(MS Student at Ecole Centrale de Lyon)

STUDENT SUCCESS AND OTHER ACTIVITIES:

Capstone Projects Supported by CIBS

The center supported three (3) capstone projects in 2023, mentored by Drs. Christian Bach, Jeff Spitler and Craig Bradshaw. They were:

- Zero Energy Tiny Home – 2 teams (Spring 2023 and Fall 2023)
- Thermal Energy Storage (TES) tank design (Spring 2023)

The Zero Energy Tiny Home project even presented their work to the US Secretary of Energy, Jennifer Granholm, and the first Gentlemen, Doug Imhoff, during their visit in the spring of 2023.

Each of these projects supported one of our center research thrusts in 2023 and greatly increased the exposure to our field with students.



Photos: Thermal Solutions Spring 2023 (left) and Tiny House Renewable Energy Demo Spring 2023 (right).



Photos: Secretary of Energy, Jennifer Granholm, visits with CIBS capstone team during her visit at OSU.



Photo: Center Director, Dr. Craig Bradshaw, with CIBS capstone team during the 2023 Senior Design showcase at OSU.

STUDENT SUCCESS AND OTHER ACTIVITIES:

New faculty and staff at the center

Sydney Klinedinst



We are very excited to welcome some new faces to the center. First, we welcomed our first ever CIBS Program Specialist, Sydney Klinedinst, in the summer of 2023. Sydney is responsible for event planning, communications, social media and outreach. She has already made huge contributions to the operations and outward impact of the center, you may have noticed her handiwork on social media already.

Ardi Moftakari and Prem Bikkina



We are also excited to formally welcome two, new, faculty to the center as project leaders for 2024 projects. Dr. Ardi Moftakari joined the faculty of MAE in the fall of 2023. He completed his PhD in 2022 from University of Texas at Austin and spent a year at Penn State as a postdoctoral researcher.



Dr. Prem Bikkina is an Associate Professor in Chemical Engineering at OSU with a background in fundamental microfluidics applied to the oil and gas industry. We are excited to have his skills applied to building systems and participation in a new project.

Peter Ritter Von Rittinger Award – Jeff Spitler

Dr. Jeff Spitler was awarded the IEA Peter Ritter von Rittinger International Heat Pump award. This award is the highest honor in the field of air-conditioning, heat pumps, and refrigeration. The award recognizes advancement in the field with lasting international impact. Dr. Spitler joins a cohort of only 23 other individuals and groups to be bestowed the honor of the award since its inception. Read more:

<https://ceat.okstate.edu/announcements/mae/2023/jeff-spitler-receives-the-international-energy-associations-ritter-von-rittinger-award.html>



Photo: Jeff Spitler receiving the Peter Ritter von Rittinger Award.

STUDENT SUCCESS AND OTHER ACTIVITIES:

The International Refrigeration and Compressor Course (IRCC)

Four (4) CIBS students and Dr. Bradshaw again participated in the IRCC for 2023. The students joined their colleagues from Purdue University, Technical University in Dresden, and University of Applied Sciences in Karlsruhe. Students visited both German universities in May, participating in lectures, lab experiments, and industrial tours and re-convened in August at Purdue for a similar week of activities.

Read more: https://news.okstate.edu/articles/engineering-architecture-technology/2023/osu_students_attend_refrigeration_and_compressor_conference_in_germany_for_exchange_program.html

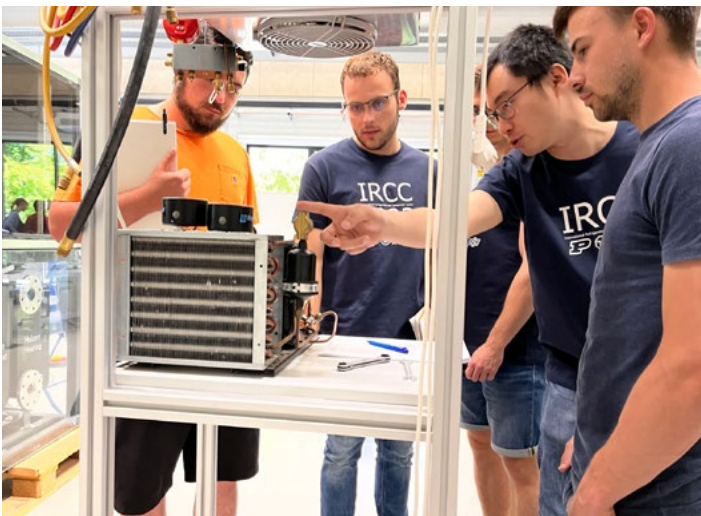


Photo: The laboratory exercise (left) and 2023 IRCC students (right) in Dresden Germany.

Popular Mechanics Article

Dr. Bradshaw was featured as an expert in an article in Popular Mechanics this year on air-conditioning. The article explored the rule of thumb referred to as the 20 degree rule.

Read more : <https://www.popularmechanics.com/technology/a44853531/can-your-air-conditioning-system-cool-your-space-20-degrees/>



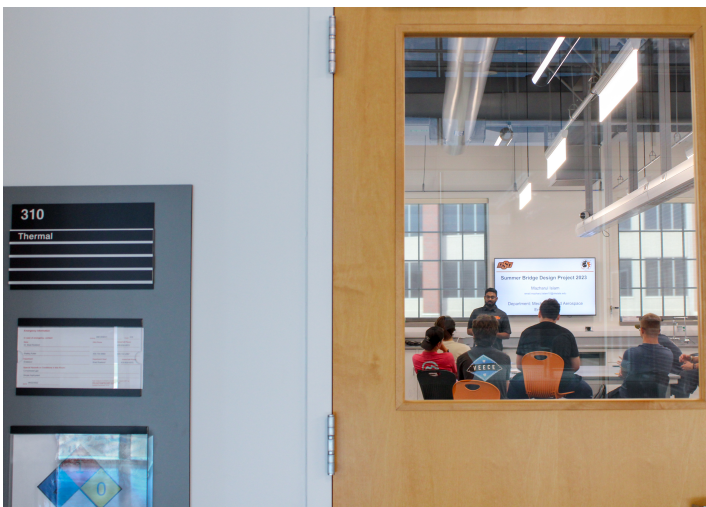
Photo: CIBS Students and Dr. Bradshaw at ASHRAE Winter Conference in Atlanta, February 2023.

STUDENT SUCCESS AND OTHER ACTIVITIES:

Summer Bridge Program



This year, CIBS participated in the college's summer bridge program and designed a short course to create excitement about thermal systems and buildings. Designed by PhD student Mazharul Islam, the course introduced incoming freshman engineering students to the basics of heat transfer and thermodynamics as well as provided some insights into the potential career opportunities in buildings.



Photos: CIBS PhD student Mazharul Islam leads a summer bridge course at OSU on thermal systems.

LOOKING FORWARD TO 2024

At our April IAB meeting the group then sat down and planned our next phase of growth and updated our research strategy for 2023-2025 that included three (3) major thrusts, including 1) Electrification/Decarbonization & integration, 2) Refrigerant diversity and future and 3) Other energy topics. These thrusts will provide a roadmap for us to select projects and was demonstrated in our 2024 project selections.

The first research thrust, overlapped with the expertise at OSU, results in two major areas of research for 2023, a) heat pumps/ components and b) thermal energy storage. The second thrust is omnipresent and finds itself as at least a secondary interest level in most of our 2023 projects. The resulting project list for 2024 includes 10 unique projects. Combined with seven (7) additional affiliated projects this makes 2024 the largest year to date for our research.



1. Decarbonization and Integration

- Heat pump equipment development
- Compression
- Heat exchanger technology
- Thermal energy storage and hydronics

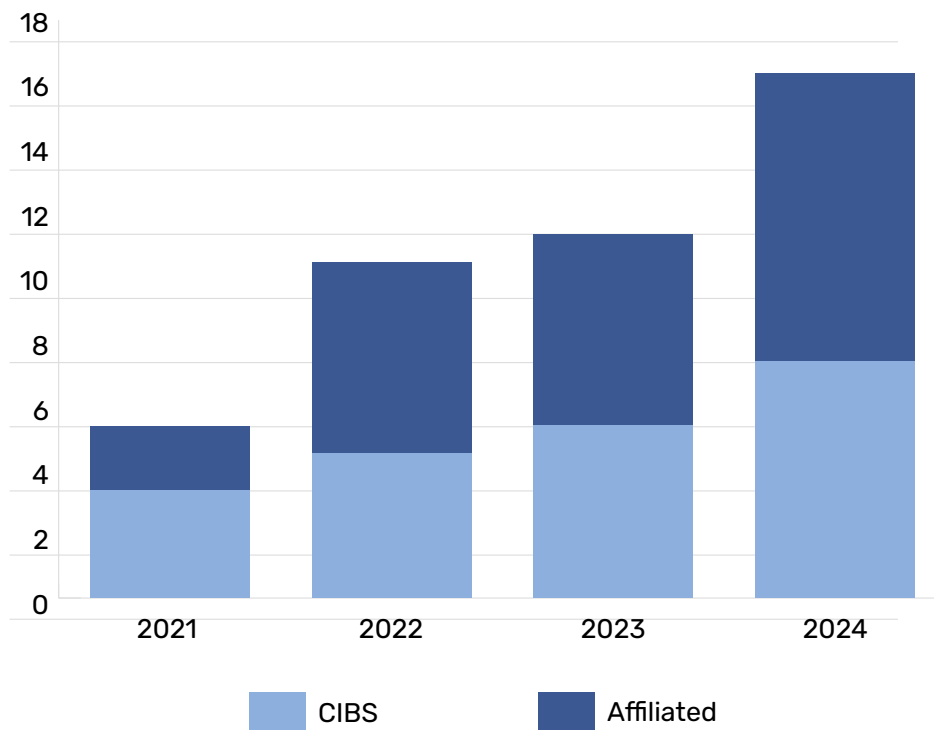
2. Refrigerant Diversity and Future

- Test data on new refrigerants
- Leakage and safety of flammable refrigerants

3. Other Energy Topics

- Industrial heat pumps
- Waste-heat recovery w/HVAC&R equip.




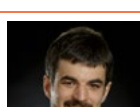
CIBS Projects in Portfolio



CIBS projects in portfolio since inception.

LOOKING FORWARD TO 2024

2024 Project titles and faculty leader

Title	PI
Development of a Vapor Injected and Refrigerant Flexible Semi-Empirical Compressor Model	 Bradshaw
Compressor Technology Evaluation for Heat Pumps using Low-GWP Working Fluids	 Bradshaw
Additional Benefits of Secondary Loop Systems: Thermal Storage and Demand Response	 Spitler
Performance Evaluation of Refrigerants with High Temperature Glide- Measurements and Design Guidelines	 Bach
Solar-powered ultra-low-GWP A3 heat pumps with DC compressors and TES	 Spitler
Reversing Valve Loss and Leakage Models for Low Temperature Heat Pumps	 Bach
Development of Wetting and Non-Wetting Surfaces for Improved Heat Transfer Applications	 Bikkina
Physics-Based Models for Performance Analysis of Refrigerant-To-Water Heat Exchangers in Hydronic Heat Pump Applications	 Mofstakhari
Development of Reduced-order System Models for Next Generation Comfort Cooling Equipment	 Bradshaw
Enabling Thermal Energy Storage to Accommodate Oklahoma Wind Energy – TriCoil as Cost Effective Means for Residential System Integration	 Bach

If you aren't a member, please contact Craig Bradshaw (craig.bradshaw@okstate.edu) to discuss membership so you don't miss out on our events for 2024.

Events for 2024:

March 27-28th, 2024 – Project Update and Center Strategy Meeting – Stillwater, OK

October 9-10th, 2024 – Project Update and Project Selection Meeting – Stillwater, OK

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Contact Us:

<http://cibs.okstate.edu>

cibs@okstate.edu