

International HVAC&R Research Collaboration through IEA & IIR



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Project Summary

Objective and outcome

- Objectives of this cross-cutting government function:
 - Maintain collaborative contacts with the International Energy Agency (IEA) Heat Pump Technologies (HPT) Technology Collaboration Program (TCP) and International Institute of Refrigeration (IIR)
 - Engage participants in technology development of core interest to DOE/BTO
- The US is a world leader in scientific research and engineering, including building energy efficiency and heat pump research.
 - Vital that DOE/BTO and ORNL engage actively with building equipment R&D organizations in Europe, Asia, and globally
 - Obtain insight on the latest HVAC&R/WH technology developments of core interest to BTO/ET and US HVAC/R industry partners, directed toward improved building equipment energy efficiency.



Team and Partners

- International Energy Agency Heat Pumping Technologies Program (IEA-HPT)
 - 18 member countries: Europe, Asia, North America
- US National Team (USNT) for the IEA-HPT
 - Approximately 20 high-level members from the US HVAC&R industry
- International Institute of Refrigeration (IIR)
 - 59 member countries
- US National Committee (USNC) for the IIR
 - Approximately 30 members from leading US HVAC&R industry, research institutes and universities

Stats

Performance Period: 10/01/2022 – 09/30/2025

DOE budget: \$1,770k

FY23 Milestone 1: Submit draft final report for Annex 53 to the IEA Technology Collaboration Program on Heat Pumping Technologies

Fyt23 Milestone 2: Organize US teams and initiate work for new Annex projects 1) HPs in Positive Energy Districts, and/or 2) HPs integrated with energy storage (aka Comfort and Climate Box 2) for hot/humid climates


FY23 Milestone 3: Finish all event planning and conduct 2023 IEA Heat Pump Conference

Problem

- US industry competitiveness:
 - One of BTO's key focus areas:
 - Maintain/grow US-based manufacturing jobs (via US-owned companies or US-based manufacturing presence of foreign-owned companies)
 - Major challenge given increasingly global nature of building energy service equipment business/industry
 - Understanding offshore competitive “threats” is vital
 - Keep BTO informed of latest R&D innovations
- How do you do that? Continuous, robust engagement with industry, academic, and public-sector HVAC/R peers around the globe is essential!
 - This crosscutting project designed to facilitate understanding of overseas developments
 - Convenient platform for BTO and US HVAC/R stakeholders to interact with foreign colleagues/peers via IEA-HPT and USNC/IIR activities

Alignment and Impact

- IEA/HPT Benefit: “Heads up” understanding of up-to-date international developments in traditional vapor compression heat pump and AC, alternative refrigerants, and alternative non-traditional heating/cooling cycle technologies in Europe and Asia.
- USNC/IIR Benefit: Early access to the latest results of R&D activities into the basic sciences underlying current vapor compression-based heat pump and AC technologies and exciting new non-traditional cooling technologies.
- DOE/BTO and ORNL membership in the IEA/HPT and IIR programs permits bilateral or multilateral collaboration between US organizations and counterparts in Europe and Asia without need obtain individual governmental agreements each time a project is launched.



Increase building energy efficiency
Reduce onsite energy use intensity in buildings 30% by 2035 and 45% by 2050, compared to 2005

Accelerate building electrification
Reduce onsite fossil -based CO₂ emissions in buildings 25% by 2035 and 75% by 2050, compared to 2005

Transform the grid edge at buildings
Increase building demand flexibility potential 3X by 2050, compared to 2020, to enable a net-zero grid, reduce grid edge infrastructure costs, and improve resilience.

Approach

U.S. participation in IEA HPT and IIR:

- **U.S. National Team (USNT) for the IEA HPT TCP**
 - Includes senior representatives of major U.S. HVAC/R manufacturers, research organizations, utilities and manufacturer and professional organizations.
 - ORNL serves as the coordinating agency for the USNT on behalf of BTO and provides secretariat services including an official web site (<https://usnt.ornl.gov/>).
- **U.S. National Committee for the IIR (USNC/IIR)**
 - Coordinates US participation in IIR activities.
 - Both DOE/BTO and ORNL are members and ORNL staff have chaired the USNC on several occasions.
 - USNC/IIR consists of leading university, lab, and industry researchers.



Approach

IEA-HPT (<http://heatpumpingtechnologies.org/>)

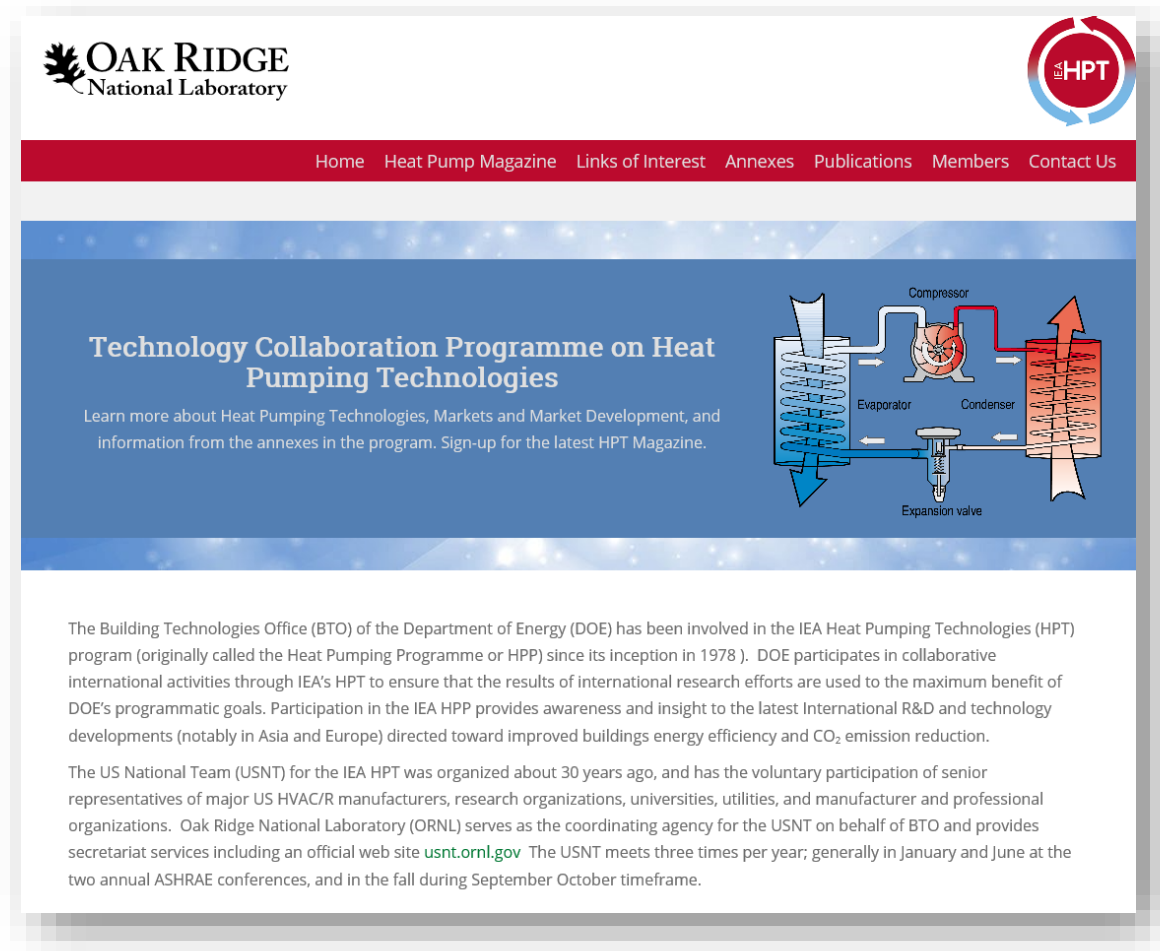
- One of several Technology Collaboration Programs (TCP)
- Tony Bouza; official US delegate to HPT
- 18 member countries: Austria, Belgium, Canada, China, Czech Republic, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, South Korea, Sweden, Switzerland, United States, and United Kingdom.
- Hi-quality periodical publication, HPT Magazine (2-3 times/yr.)
 - Latest news & RD&D reports
- Triennial Heat pump Conference series (since 1984)
 - Preeminent international event for heat pump technologies, markets, and policy initiatives.
 - 2014, in Montréal (Tony Bouza chaired international organizing committee).
 - 2017, in Rotterdam.
 - 2020, held in South Korea and virtually.
 - 2023, to be held in Chicago, IL.
- International collaborative RD&D projects (aka Annexes)



Approach

USNT for IEA-HPT: <https://usnt.ornl.gov/>

- US National Team (USNT), 20+ members, all key HVAC&R community leaders from industry, associations, utilities, & universities.
- Helps guide DOE participation; review of Annex proposals and HPT work plans, members contribute to selected Annexes.
 - 63 official Annexes since inception; US participated in 43, led 9.

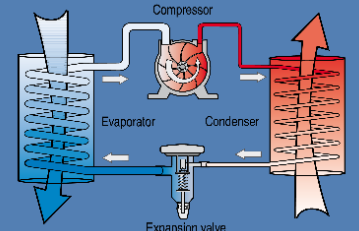


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Home Heat Pump Magazine Links of Interest Annexes Publications Members Contact Us

Technology Collaboration Programme on Heat Pumping Technologies

Learn more about Heat Pumping Technologies, Markets and Market Development, and information from the annexes in the program. Sign-up for the latest HPT Magazine.



The Building Technologies Office (BTO) of the Department of Energy (DOE) has been involved in the IEA Heat Pumping Technologies (HPT) program (originally called the Heat Pumping Programme or HPP) since its inception in 1978). DOE participates in collaborative international activities through IEA's HPT to ensure that the results of international research efforts are used to the maximum benefit of DOE's programmatic goals. Participation in the IEA HPP provides awareness and insight to the latest International R&D and technology developments (notably in Asia and Europe) directed toward improved buildings energy efficiency and CO₂ emission reduction.

The US National Team (USNT) for the IEA HPT was organized about 30 years ago, and has the voluntary participation of senior representatives of major US HVAC/R manufacturers, research organizations, universities, utilities, and manufacturer and professional organizations. Oak Ridge National Laboratory (ORNL) serves as the coordinating agency for the USNT on behalf of BTO and provides secretariat services including an official web site usnt.ornl.gov. The USNT meets three times per year; generally in January and June at the two annual ASHRAE conferences, and in the fall during September-October timeframe.

Approach

IIR (<http://www.iifir.org>)

- Intergovernmental association: focus on advancement of basic sciences (early stage R&D) underpinning all refrigeration-related fields
 - 59 member countries (includes all IEA-HPT members)
 - Activities grouped under ten Commissions
 - Sponsors major quadrennial conference, International Congress of Refrigeration (ICR); historically has attracted ~1000 attendees
 - International Journal of Refrigeration (IJR), highest impact factor journal in refrigeration (4.14 in 2023)



Approach

- USNC/IIR:
 - Guides US participation in IIR, nominates US members for IIR commissions.
 - Sponsors Refrigeration & Air-Conditioning (R&AC) Short in conjunction with Purdue International R&AC Conference (<https://engineering.purdue.edu/Herrick/conferences>).
 - Refrigeration Short Course 1: Ejector Design for Vapor Compression Systems
 - Refrigeration Short Course 2: Update on Flammable Refrigerants
 - Chair/organizer Dr. William Murphy, Prof. Emeritus, Univ. of KY, USNC/IIR member



2022 (26th) International Compressor Engineering Conference
2022 (19th) International Refrigeration and Air Conditioning Conference
2022 (7th) International High Performance Buildings Conference

Progress and Future Work

- **USNC/IIR**

- Eckhard Groll (Purdue Univ) is President of IIR Commission B “Thermodynamics, Equipment and Systems”
- Yunho Hwang (Univ MD) is chair of Commission B1, “Thermodynamics and Transfer Processes”
- Brian Fricke (ORNL) is US delegate to the IIR Executive Committee
- ASHRAE and NIST contribute to USNC/IIR costs

- **USNT IEA-HPT**

- Members attend meetings 2-3 times per year at their own expense
- Members participate in IEA-HPT Annex activities:
 - Annex 52, “Long-term performance of commercial GSHP systems”; US team lead by Jeff Spitler (OSU)
 - Annex 53, “Advanced cooling/Refrigeration Technology Development” Reinhard Radermacher (UMD) and Brian Fricke (ORNL) serving as Operating Agents
 - Annex 54, “Heat Pump Systems with Low GWP Refrigerants”; Yunho Hwang (UMD) serving as Operating Agent
 - Annex 55, “Comfort and Climate Box”
 - Annex 58, “High Temperature Heat Pumps”; US participating, Kashif Nawaz (ORNL)
 - Annex 60, “Retrofit Heat Pump Systems in Large Non-Domestic Buildings”; US participating (EPRI)

Progress and Future Work

- Planning of the 14th IEA Heat Pump Conference (15-18 May 2023, Chicago)
 - US National Team is organizing the conference
 - 188 conference papers received
 - Conference Program
 - Workshops (Monday)
 - Opening Session and Plenary Speakers (Tuesday)
 - Technical Sessions (Tuesday - Thursday)
 - Reception following Workshops (Monday)
 - Banquet and Awards (Wednesday)
 - Closing Ceremony (Thursday)
 - Technical Tour: GTI Energy (Wednesday)
 - ExCo Meeting (Friday)
 - Plenary session
 - Two sessions, six speakers:
 - Policy
 - Technical
 - Sponsorship
 - A.O. Smith, Rheem, Carrier, Daikin, Trane, Johnson Controls, Nortek, Emerson, Heatcraft, Honeywell, Chemours, Koura, Ziehl-Abegg
 - Canmet/NRC Canada, Korean National Committee, Germany, Japan
 - Air-Conditioning, Heating and Refrigeration Institute (AHRI), American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), Electric Power Research Institute (EPRI), GTI Energy



Progress and Future Work

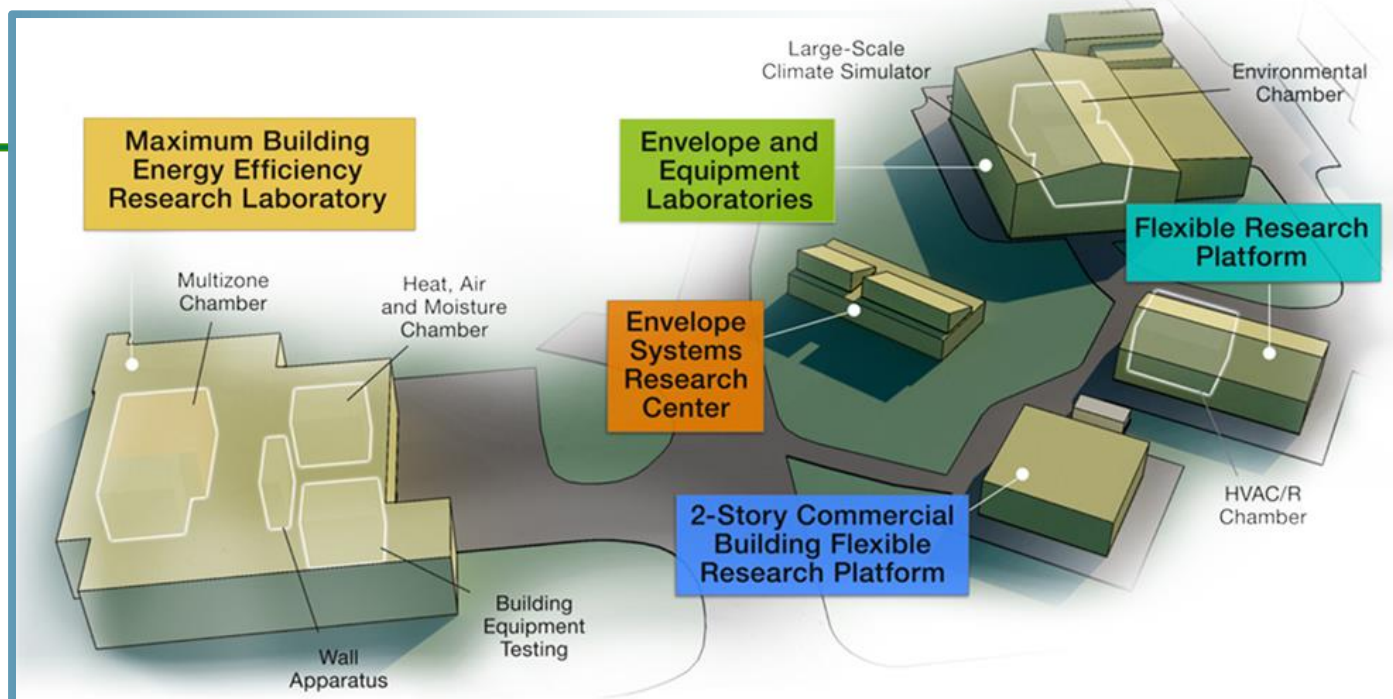
- Continuous robust engagement with HVAC/R, WH, Appliance community peers in EU and Asia will remain important so long as HVAC/R, WH, and Appliances R&D remains important to BTO portfolio.
 - ORNL will continue to facilitate BTO’s activities through the USNT and USNC/IIR.
- Future planned IEA-HPT and IIR activities include:
 - Submit Annex proposal on “Comfort Climate Box for Warm and Humid Climates”
 - Follow-on activity of Annex 55, “Comfort and Climate Box”
 - USA to serve as operating agent with interest to participate by Austria, Korea, Japan, India, Brazil, Turkey and Spain.
 - Focus: Integrate heat pumps with thermal storage; provide effective, affordable cooling and dehumidification
 - Participate in 2023 IIR International Congress of Refrigeration (ICR)
 - Plan/develop the 2024 Purdue short course

Thank you

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ORNL's Building Technologies Research and Integration Center (BTRIC) has supported DOE BTO since 1993. BTRIC is comprised of 60,000+ ft² of lab facilities conducting RD&D to support the DOE mission to equitably transition America to a carbon pollution-free electricity sector by 2035 and carbon free economy by 2050.

Scientific and Economic Results

236 publications in FY22

125 industry partners

54 university partners

13 R&D 100 awards

52 active CRADAs

*BTRIC is a
DOE-Designated
National User Facility*

REFERENCE SLIDES

Project Execution

	FY2023				FY2024				FY2025			
Planned budget	\$630k				\$570k				\$570k			
Spent budget												
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Past Work												
Q2 Milestone: IEA Heat Pump Conference paper review		◆										
Q2 Milestone: New IEA-HPT Annex proposal submission		◆										
Q3 Milestone: Complete organization and conduct 2023 IEA Heat Pump Conference												
Q4 Milestone: Submit draft final report for Annex 53												

Team

ORNL BTRIC's Building Equipment Research (BER) team is tasked with overseeing the HVAC&R related IEA and IIR activities for DOE/BTO.

Team members include:

- Brian Fricke: PI, USNT chair, US delegate to IIR Management Committee, Chair of the National Organizing Committees for the 2023 IEA Heat Pump Conference
- Melissa Lapsa: Manager of the ORNL Building Technologies Program, coordinator of IEA activities, chaired National Organizing Committee for the 2005 IEA Heat Pump Conference

