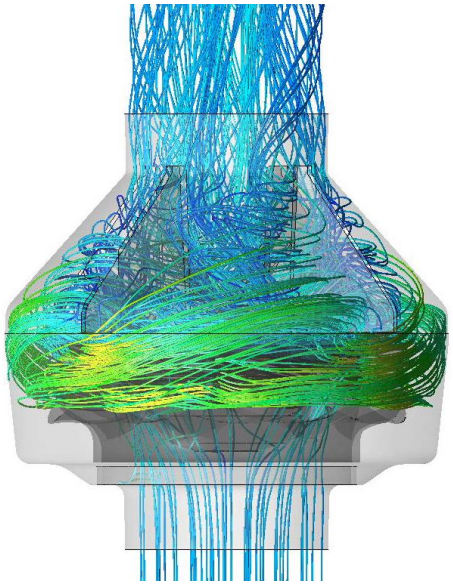
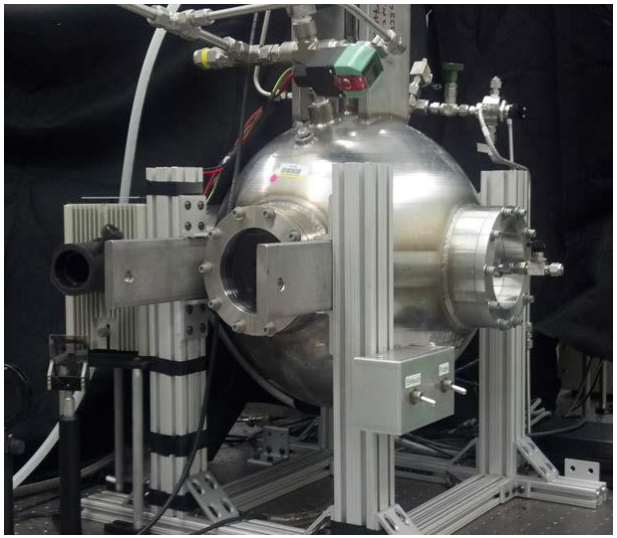
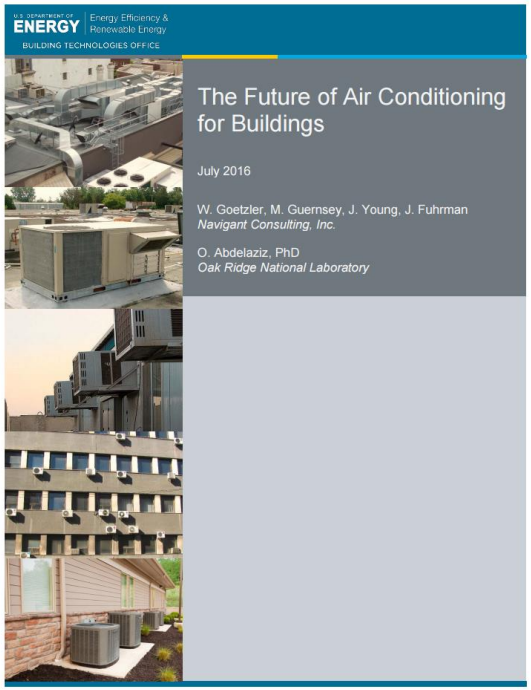
U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Emerging Technologies: HVAC, WH and Appliance BTO Peer Review 2018







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March 30 - May 2, 2018

HVAC, Water Heating and Appliance R&D

BTO's ultimate goal is to reduce the average energy use per square foot of all U.S. buildings by 50% from 2010 levels. Emerging Technologies Program's goal is to enable the development of cost-effective technologies capable of reducing a building's energy use per square foot by 45% by 2030, relative to 2010 high-efficiency technologies.

HVAC/WH/Appliances goals require by 2020 that the potential energy use intensity (EUI) for:

- *HVAC would be 60% lower*
- *WH would be 25% lower*
- *Appliances would be 15% lower*
- *All relative to 2010 energy-efficient baseline*

Two-pronged approach to accelerate the development of new technologies:

1) Accelerate the development of near term technologies that have the potential to save significant amount of energy (including cost reduction activities, bending the cost curve)
2) Accelerate the development of the next generation of technologies that have the potential of "leapfrogging" existing technologies by pursuing entirely new approaches (including crosscutting efforts)

The goal is to develop technologies that save energy and reduce our environment burden while introducing them in the simplest application first, highest probability of success.

U.S. DOE HVAC&R Strategy, *Efficiency first*

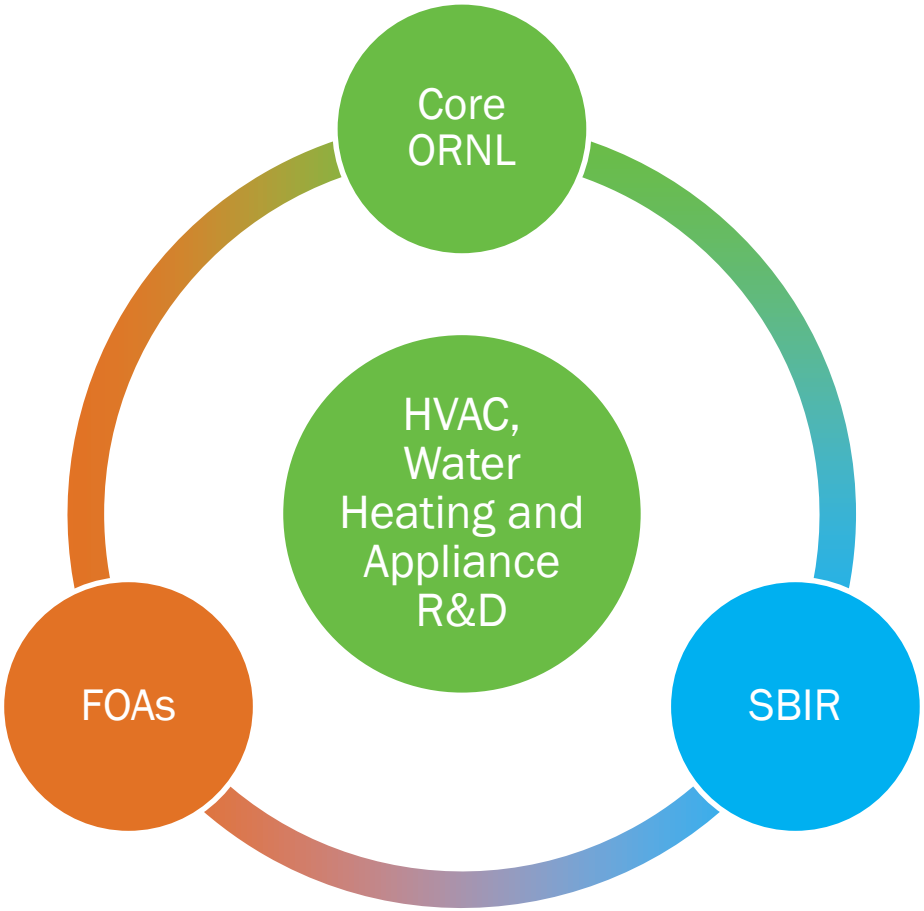
DOE's ultimate goal is to develop the next-generation technologies that 'leapfrog' existing technologies and result in dramatically improved energy efficiency.

- **Short Term:** Develop and evaluate alternative refrigerants, including flammability characterization and hot climate performance *(energy savings via today's technologies).*

- **Mid Term:** Develop systems that can handle next generation refrigerants *(energy savings via tomorrow's technologies).*

- **Long Term:** Develop non-vapor compression systems that use zero-GWP refrigerants (energy savings via next generation technologies).

HVAC, Water Heating and Appliance R&D



BTO Strategy: Short Term, energy savings via today's technologies

Focus Areas	Outcomes
Thermodynamic and HVAC system analysis of alternative low-GWP refrigerant replacements for R-410A, including toxicity, flammability, cycle COP, etc.	Through modeling, determined possible low-GWP refrigerant alternatives
Development of low-GWP alternative refrigerants	Commercialized a HFO replacement refrigerant for supermarket refrigeration
Development of a transcritical CO_2 supermarket refrigeration system	Commercialized a low-GWP, CO2-based supermarket refrigeration system
Experimental testing of low-GWP alternatives for R-22 and R-410A in mini-split air conditioners under high ambient temperature conditions	Proved low-GWP alternative refrigerants can perform well under extremely high ambient temperature conditions (up to 55°C)
Experimental testing of low-GWP alternatives for R-22 and R-410A in rooftop units (RTUs) under high ambient temperature conditions	Report Published
Evaluation of flammable refrigerants characterization and test methods (NIST), and charge limits (ORNL)	Work started

BTO Strategy: Mid-Term, energy savings via tomorrow's technologies

Focus Areas	Description
CO_2 heat pump water heaters	• Replacing existing R-134a heat pump water heater with low-GWP CO_2 heat pump water heater
Absorption and Adsorption heat pump water heaters	• Use non-toxic working fluids with zero-GWP • Significantly boost water heater efficiency by transferring heat to the water from fuel and ambient air
Advanced compressors suitable for low-GWP refrigerants	• Compressors that will be able to handle low-GWP refrigerants
Low-GWP heat pumps using natural refrigerants	• Developing air source heat pump for commercial applications—can operate in cold and hot climates

Develop non-vapor-compression solutions, including:

Focus Areas	Description
Magnetocaloric systems	• Developing a magnetocaloric refrigerator and air conditioner
Electrocaloric systems	• Electrocaloric systems require an electric field, rather than a magnetic field, to achieve cooling • An electrocaloric air conditioner is being developed
Thermoelectric systems	• Developing heat pump water heaters and clothes dryers
Electrochemical compression	• Electrochemical compression is like an inverse fuel cell, in that compression requires no moving parts • Developing a heat pump water heater and HVAC system
Thermoelastic cooling	• Air conditioner that works by stretching and compressing a material.
Membrane-based systems	• Can remove water vapor, and so is particularly good for high latent loads.

Program: Core + FOAs + SBIR

CORE

AOP: Critical to the program

2008-Present

FOA

Advanced Energy Efficient Building Technologies, DE-FOA-0000115 (June 29, 2009)

2009

- Research Focus: HVAC, Water Heating and Appliances: Cold Climate, Low-GWP, Refrigerant, Non-vapor compression, and Clothes Dryers

FOA

Energy Savings through Improved Mechanical Systems and Building Envelope Technologies, DE-FOA-0000621 (March 7, 2012)

2012

- High performance air source cold climate heat pumps
- Alternative space-heating systems
- Next generation heat exchangers for electric vapor-compression heat pumps and air conditioners

Program: Core + FOAs

FOA

2013

Building Technologies Innovations Program, DE-FOA-0000823 (March 5, 2013)

- Open Topic: Natural refrigerant air-sourced heat pump, cold-climate applications, heat exchangers and natural gas heat pump and heat engine.

FOA

2014

Building Energy Efficiency Frontiers & Incubators Technologies (BENEFIT) – 2014, DE-FOA-0001027 (Feb 4, 2014)

- Open Topic: Membrane-based absorption to cool and dehumidify (WH, IHP and non-vapor compression), heat exchanger research, and motors
- Frontier Topic: Advanced energy efficient clothes dryers (electric and gas): innovative electrostatic precipitator, thermoelectric heat pumping and ultrasonic technology

Program: Core + FOAs

FOA

2014

Building Energy Efficiency Frontiers and Innovation Technologies (BENEFIT)-2015, DE-FOA-0001166 (Oct 9, 2014)

- Innovation: Non-vapor compression HVAC technologies
- Frontiers: Advanced vapor compression HVAC technologies

FOA

2015

Building Energy Efficiency Frontiers and Innovation Technologies (BENEFIT)-2016, DE-FOA-0001383 (Dec 15, 2015)

- Innovation: HVAC&R Materials Joining Technologies

FOA

2016

Buildings Energy Efficiency Frontiers & Innovation Technologies (BENEFIT) – 2017, DE-FOA-0001632 (Nov 30, 2016)

- Topic 1: Open Topic for Energy Efficiency Solutions for Residential and Commercial Buildings – Early-stage (starting TRL 2-3)
- Topic 2: Advanced HVAC&R Research and Development, FRONTIERS section (starting TRL 4-5)
- Topic 4: Open Topic for Energy Efficiency Solutions for Residential and Commercial Buildings – Pre-Commercial Stage, SCALE-UP section (starting TRL 6-7)

BENEFIT 2017 Projects (HVAC&R)

Six HVAC&R projects selected:

- Stone Mountain Technologies Inc. (Johnson City, Tennessee) will validate and analyze a gas-fired absorption heat pump that uses an ammonia-water absorption cycle.
- University of Maryland (College Park, Maryland) will develop the next-generation reduced charge air-to-refrigerant heat exchangers using non-round tubes.
- Arkema Inc. (King of Prussia, Pennsylvania) will develop formulations and additive materials that can mitigate the flammability of A2L refrigerant blends.
- Xergy (Harrington, Delaware) will investigate electrochemical compression technology combined with ionic liquid desiccant technology to improve latent and sensible heat loads in air-conditioning systems.
- United Technologies Research Center (East Hartford, Connecticut) will develop and validate a high-efficiency compressor based roof-top air-conditioning system that uses a sustainable, nontoxic, nonflammable, and high-efficiency refrigerant.
- Oak Ridge National Laboratory (ORNL) (Oak Ridge, Tennessee) will investigate a novel dehumidification process to avoid the excessive energy utilized by conventional approaches, through high frequency mechanical vibration of ultrasonic transducers to “eject” adsorbed water.

Monday, March 30th 2018 (FOA)

- 2:00-2:30: **Optimized Thermal Systems, Inc.**, Advanced Serpentine Heat Exchangers
- 2:30-3:00: **Trane**, Improved Braze Joint Quality Through use of Enhanced Surface Technologies
- 3:00-3:30: **UMD College Park** - Design and Manufacturing of High Performance, Reduced Charge Heat Exchangers *NOT REVIEWED*

- 4:00-4:30: **UTRC**, Advanced Vapor Compression
- 4:30-5:00: **UTRC**, High-efficiency Low Global-Warming Potential (GWP) Packaged Rooftop System *NOT REVIEWED*

Tuesday, May 1st 2018 (ORNL)

- 11:00-11:30: **ORNL**, Adhesive Bonding of Aluminum and Copper in HVAC&R Applications
- 11:30-12:00: **ORNL**, Innovative, Low-Cost Ground Heat Exchanger (GHX) for Geothermal Heat Pump Systems
- 12:00-12:30: **ORNL**, HVAC&R Research Collaboration through IEA (and IIR activities)

- 1:30-2:00: **ORNL,** Novel Solar Absorption Cooling System to Reduce Peak Loads
- 2:00-2:30: **ORNL**, Peel & Stick Sensor for Refrigerant Leak Detection
- 2:30-3:00: **ORNL**, Design/Optimization of Heat/Mass Exchangers (HMX) using Membrane Technologies
- 3:00-3:30: **ORNL,** Fuel Cell Cooling, Heating, and Power (CHP)

- 4:00-4:30: **ORNL**, Validate Performance of Existing Pre-Commercial Gas-Fired Equipment
- 4:30-5:00: **ORNL**, Residential Gas-fired Cost-effective Triple-state Sorption Heat Pump

Wednesday, May 2ndst 2018 (SBIR, ORNL)

- 8:30-9:00: **Xergy**, Advanced Hybrid Water Heater using Electrochemical Compressor [SBIR]
- 9:00-9:30: **Mechanical Solutions**, Development of an Innovative, High-Efficiency Radon Fan [SBIR]
- 9:30-10:00: **ORNL**, Mechanical Dehumidification Using High-Frequency Ultrasonic Vibration
- 10:00-10:30: **ORNL**, Magnetocaloric Refrigerator (CRADA – GE)

- 11:00-11:30: **ORNL**, Thermoelectric Clothes Dryer (CRADA- SAMSUNG America)
- 11:30-12:00: **ORNL**, Radiation Defrosting Technique

Thank You and Contact Info…

The HVAC/Water Heating/Appliance subprogram develops cost effective, energy efficient technologies.

http://energy.gov/eere/buildings/hvac-water-heating-and-appliances

My Contact Info:

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