

DOE Building Technologies Office (BTO): Energy Efficiency R&D

2014 FESC Workshop, Gainesville, Florida, May 12 - 13



U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

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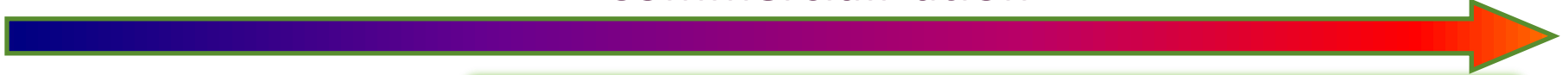
May 12, 2014

Who Supports Energy Efficiency R&D?

**Fundamental
Research**

**First
Commercialization**

**Market
Penetration**



Building Technologies Office

**Emerging
Technologies**

**Commercial
Buildings
Integration
Residential
Buildings
Integration**

**Codes
&
Standards**

ARPA-E

NSF

ONR

DOE Office
of Science

FEMP

ESTCP

GSA Green
Proving Grounds

Energy Efficiency &
Renewable Energy

BTO's Integrated Approach

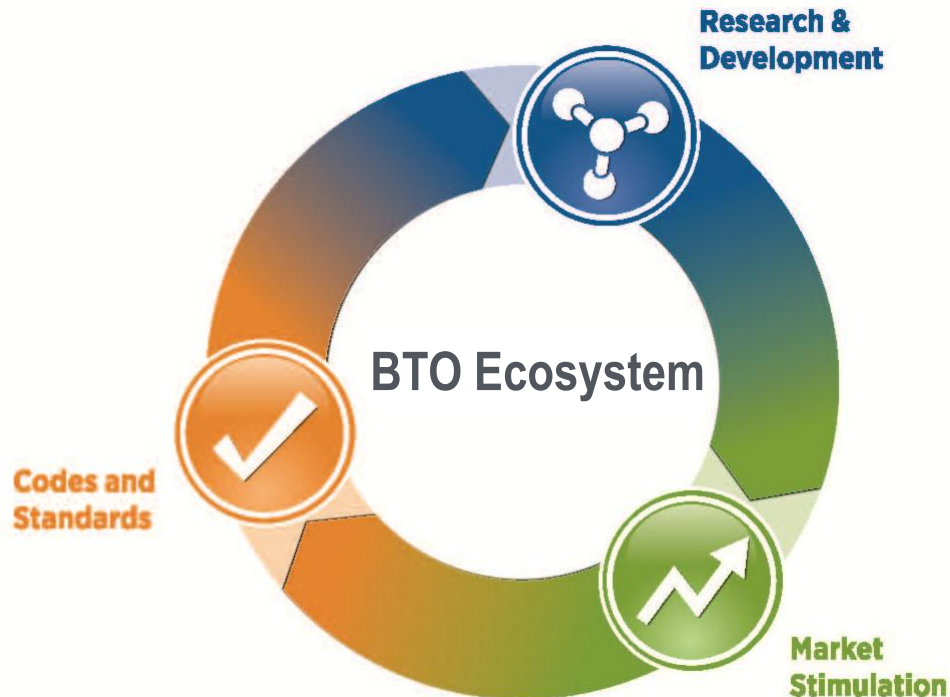
Research & Development



- Develop technology roadmaps
- Prioritize opportunities
- Solicit and select innovative technology solutions
- Collaborate with researchers
- Solve technical barriers and test innovations to prove effectiveness
- Measure and validate energy savings

Market Stimulation

- Identify barriers to speed and scale adoption
- Collaborate with industry partners to improve market adoption
- Increase usage of products & services
- Work through policy, adoption, and financial barriers
- Communicate the importance and value of energy efficiency
- Provide technical assistance and training



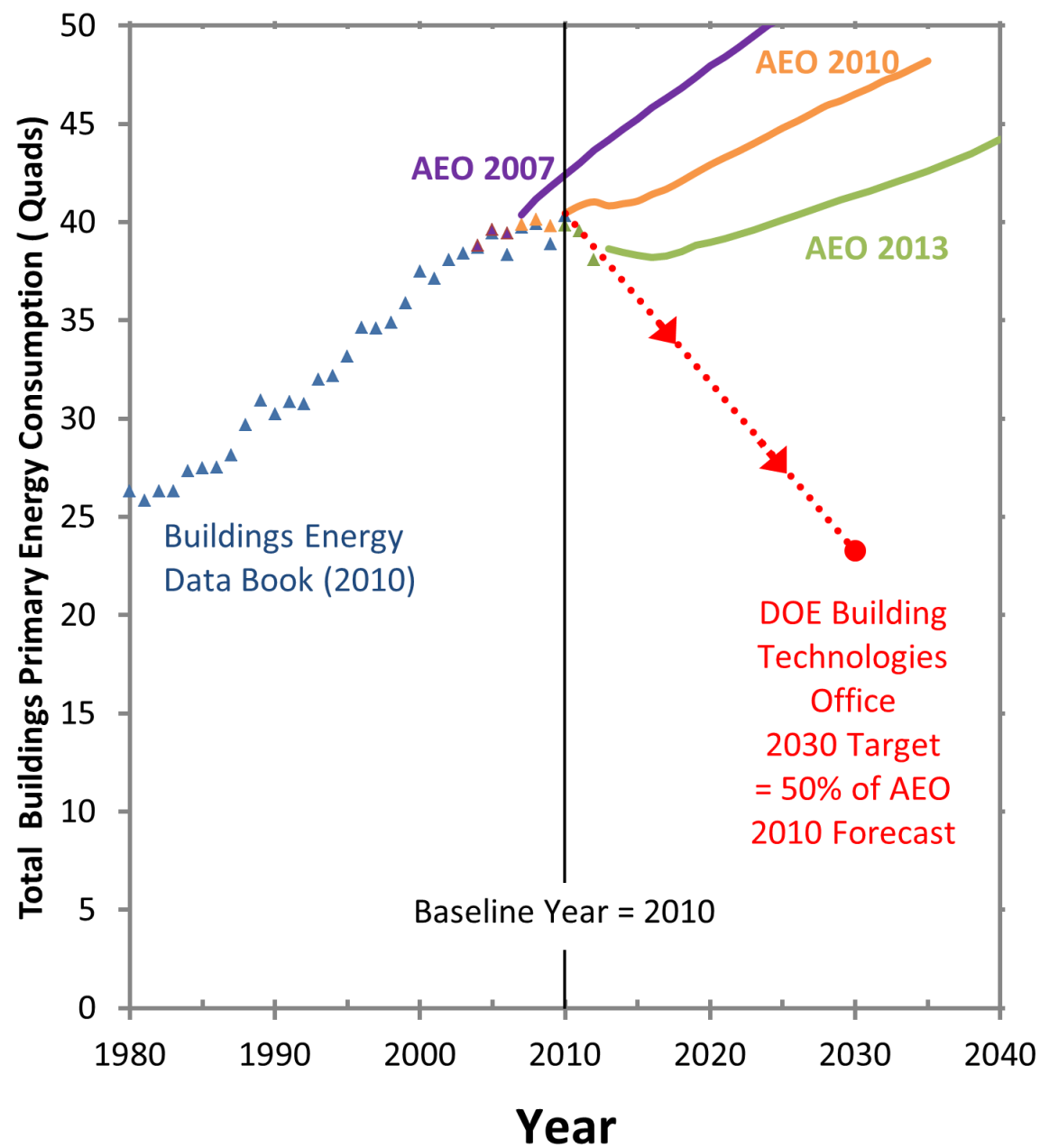
Codes and Standards

- Establish minimum energy use in a transparent public process
- Protect consumer interests
- Reduce market confusion
- Enhance industry competitiveness & profitability
- Expand portfolio of EE appliances & equipment
- Raise the efficiency bar



BTO Goal

Reduce building energy use by 50% in 2030, compared to the “business-as-usual” energy consumption projected by the *2010 Annual Energy Outlook*

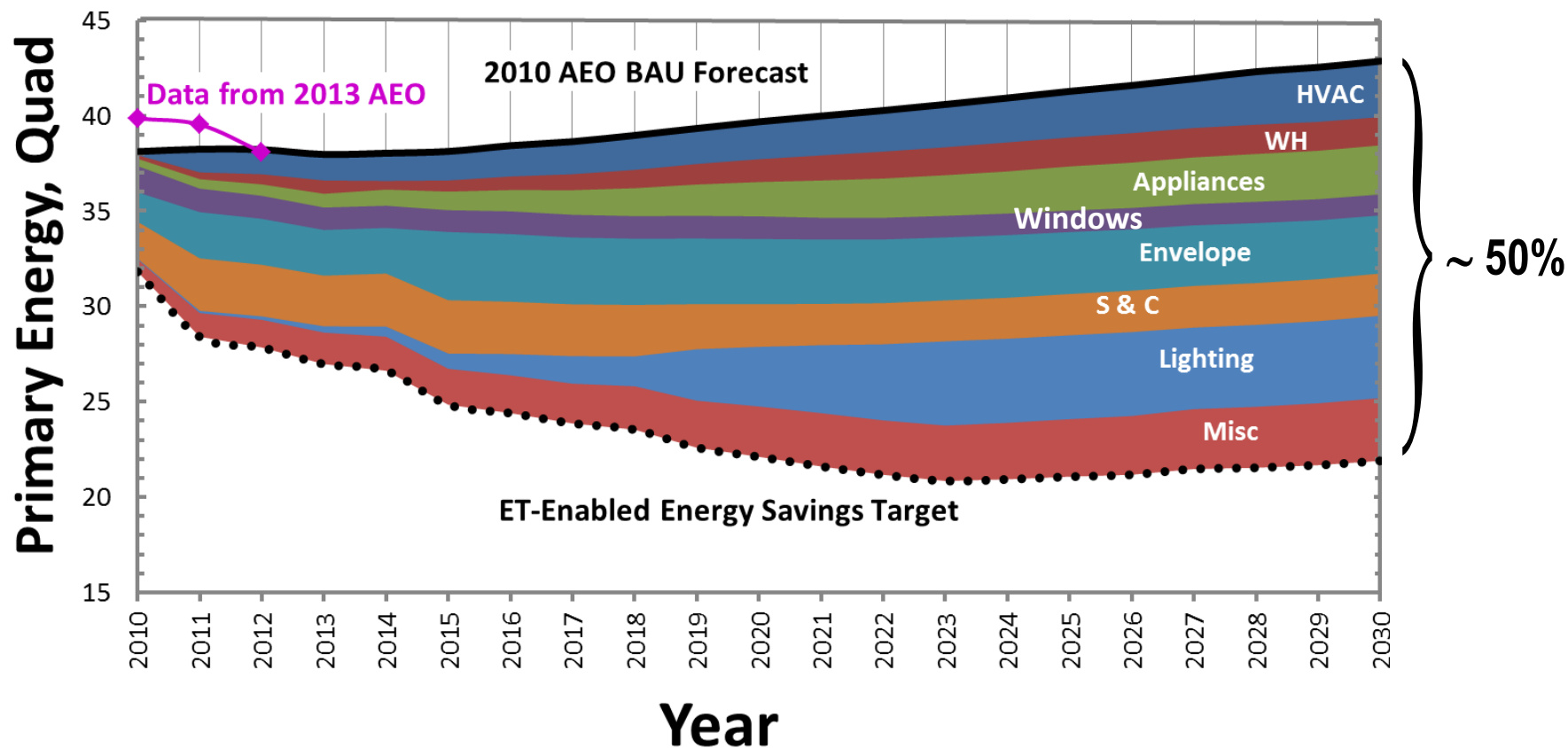


The BTO Prioritization Tool (P-Tool)

The P-Tool provides an objective analytical framework to assess technical and market opportunities of different technologies to allow for side-by-side comparison

- Creates a level field for different technologies to compete
 - Avoid market overlap
 - Account for varying lifetime and different stock turnover
- Identify High Impact Technologies
- Create **performance** and **cost** targets for FOAs/Solicitations
 - “the lighting sector has the economic potential to achieve 70% energy savings by 2030 compared to a 2010 baseline”
- Set an ‘***Uber goal***’ for the program office: “cost effective 50% energy savings by...”
- Avoid SWAG

ET-Enabled Cost-Effective Energy Savings



ET Goal: By 2030, develop technologies enabling 65% energy savings in lighting, 37% in water heating, 34% in windows/envelope, 29% in appliances, 24% in HVAC, and 18% in sensors & controls.

BTO Emerging Technologies: Research Portfolio

Advanced windows

Advanced refrigerator
technology

Building energy
models/calculators

Low global warming
potential
refrigerants

Heating, ventilating,
air conditioning,
water heating, and
working fluids



Solid state
lighting

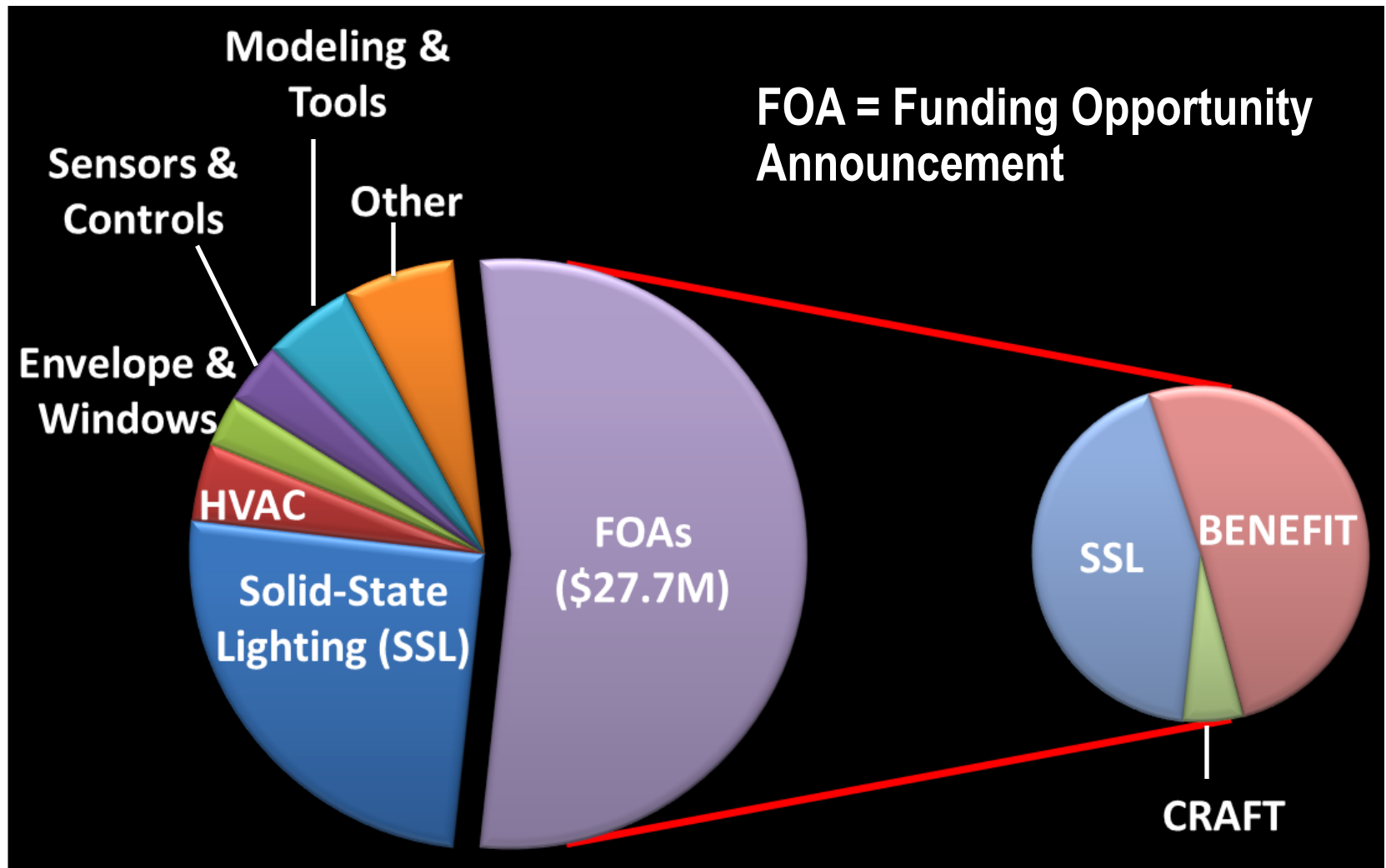
Sensors and
controls

Advanced heat
pump technology:

- Air source heat pumps
- Integrated heat pumps
- Heat exchangers

Building
Envelope: Next
generation
insulation

FY14 Funding for BTO Emerging Technologies (ET)



ET FY14 Budget: \$51.9M

FY14 BTO/ET Funding Opportunity Announcements

CRAFT (Certification and Rating of Attachments for Fenestration Technologies)

- \$1.6M (DE-FOA-0001000)
- Released
- Concept papers due Dec 5, 2013
- Full applications due Feb 5, 2014

Solid-State Lighting Advanced Technology R&D - 2014

- \$12M (DE-FOA-0000973)
- Released Dec 6, 2013
- Concept papers due Jan 8, 2014
- Full applications due Feb 24, 2014

BENEFIT (Building Energy Frontiers & Incubator Technologies)

- \$14M (DE-FOA-0001027)
- Released Feb 4, 2014
- Concept papers due Mar 6, 2014
- Full applications due April 21, 2014

FY14 BENEFIT FOA Topics

Incubator Topics (early stage, off roadmap):

- Topic 1: Open topic for energy-efficiency solutions for residential and commercial buildings
- Topic 2: Innovative sensors & sensor systems

Frontiers Topics (roadmap-driven):

- Topic 3: Advanced energy-efficient clothes dryers
- Topic 4: Highly insulating building envelope components
 - Subtopic a: Visibly transparent building envelope components
 - Subtopic b: Opaque building envelope components

Representative ET-Supported Projects

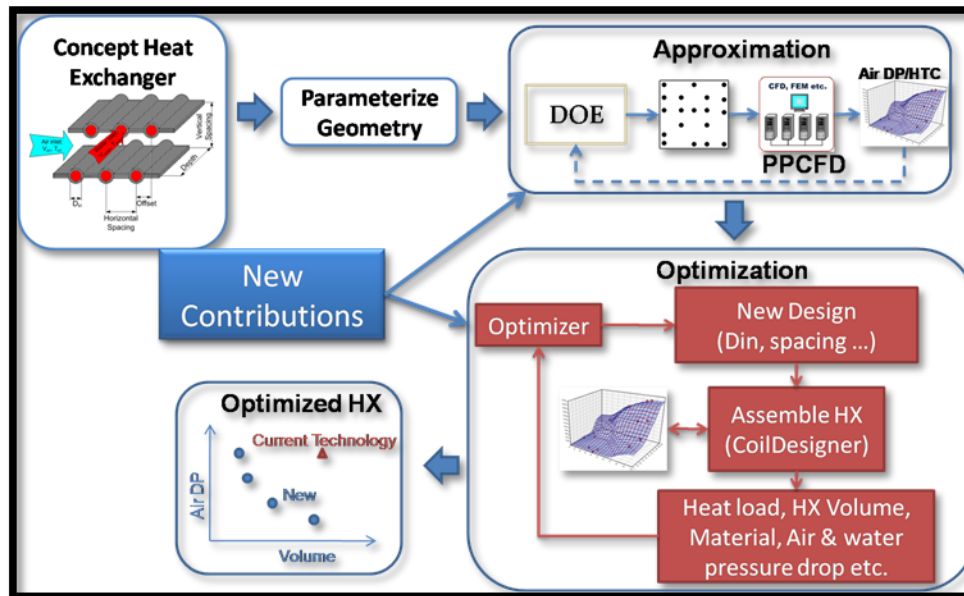
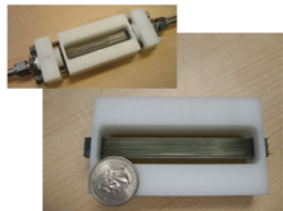
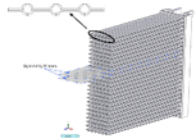
Objectives: Develop miniaturized air-to-refrigerant heat exchangers (HX) for heat pumps (condensers/evaporators), that have **20% less volume and weight** than current state-of-the-art; in production within 5 years

Project Team: University of Maryland, Oak Ridge National Laboratory, Luvata, International Copper Association (ICA)

Impact/Outcome: (1) Raise readiness level for miniaturized HX from TRL3 to TRL6; (2) Accelerate development of novel HX designs to promote compactness and reduced material; (3) Guidelines for design and mass production

Background:

UMD investigated novel HX; successfully tested 100W prototype



Design Optimization Approach

DOE: Design of Experiments

PPCFD: Parallel Parameterized CFD

Timeline:

Project start: 3/2013

Year-1: Identify 3-5 promising designs; finalize materials and mfg. techniques

Year-2: Fabricate and test 1kW HX

Year-3: Fabricate and test 10kW HX

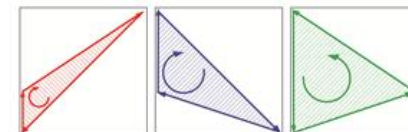
Status: 9 concept HX geometries are being analyzed using the proposed design approach

Company: ThermoLift, Inc.

Project Title: ThermoLift, The Natural Gas Heat Pump and Air Conditioner

DOE Funds: \$750,000 **Cost Share:** 32%

Partners: Oak Ridge National Laboratory, Stony Brook University, National Grid
 NYSERDA (\$482,000), Private Capital (\$1.63M), Commercial Manufacturing Partners



Technology/Approach Summary

- 30-50% performance increase in HVAC/water heating efficiency
- Natural Gas Heat Pump
- Reduced dependence on electricity for cooling
- Air Source heat pump effective in cold climates
- Heating, Cooling and Hot water in one device
- No refrigerants

Technology/Approach Impact

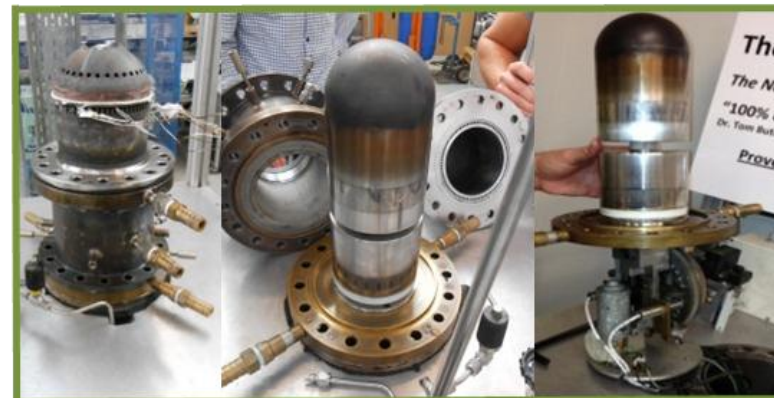
(Quads)*	Commercial	Residential	Total
Total US Energy Consumption	4.94	8.76	13.70
TL-N Potential Energy Savings	1.18	2.72	3.90
TL-N Potential Cost Savings (billions)	\$ 14.45	\$33.78	\$48.24
TL-Potential CO2 Savings (Mtons)	382	554	936

*Quad Savings assuming a 100% market penetration

Proposed Targets

State of the Art and Conventional Systems	ThermoLift Air-Conditioner and Heat Pump System
Systems with heating efficiencies up to 98-99%, expensive, and yield high CO2 emissions/refrigerants	End to end energy heating: 200+% - Heating 150+% - DHW 120+% - Cooling

The ThermoLift Heat Pump is a proven technology with measured data with over 6,500 hours testing



ThermoLift vs. Conventional Heating and Cooling Systems		Power Plant Eff.	Distribution Eff.	End-To-End Efficiency	
				Heating	Cooling
Air Conditioner		36%	90%		117%
Air Source Heat Pump		36%	90%	107%	117%
Boiler/Furnace				82-95%	
Hot Water Heater				65-95%	
TL-P Measured Data		NA	99%	138%	
TL-N	Expected outcome	NA	99%	160-180%	120-140%



2014 Exhibitor/Presenter



Transparent Insulation for Windows

Evacuated components are transparent while providing superior insulation in a flexible structure that can be retrofitted to installed windows.



National Renewable Energy Laboratory
Innovation for Our Energy Future

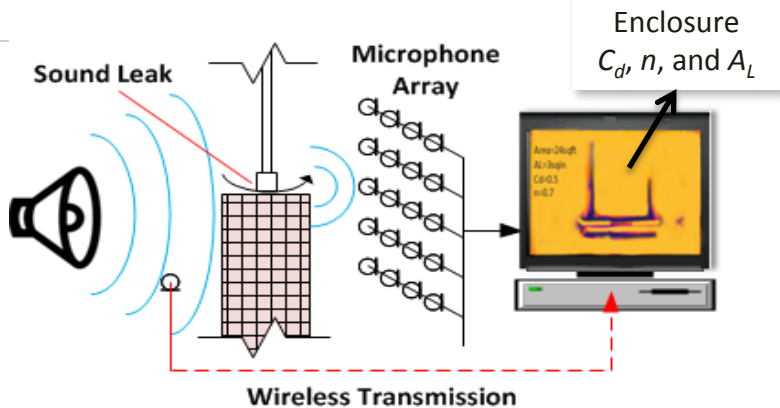
Metric	Proposed Target
R-value	R-20
Cost	<\$1/ft ²
SHGC	0.2-0.8



Acoustic Building Infiltration Measurement System (ABIMS)

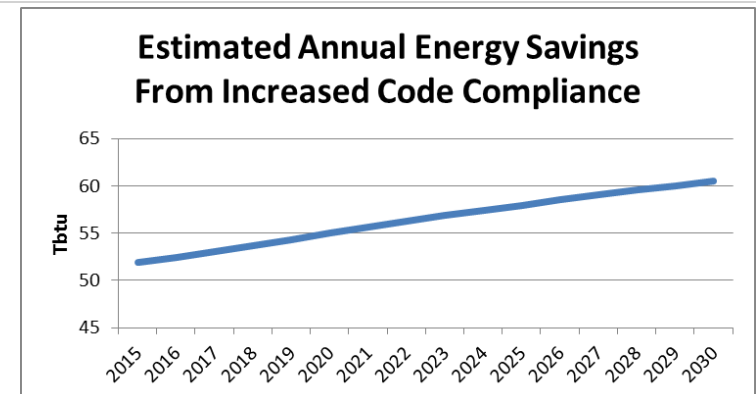
Argonne National Laboratory (Lead)+ Illinois Institute of Technology

- \$650K + 6.5% Cost Share
- Argonne PI: Ralph T Muehleisen
- IIT PI: Ganesh Raman

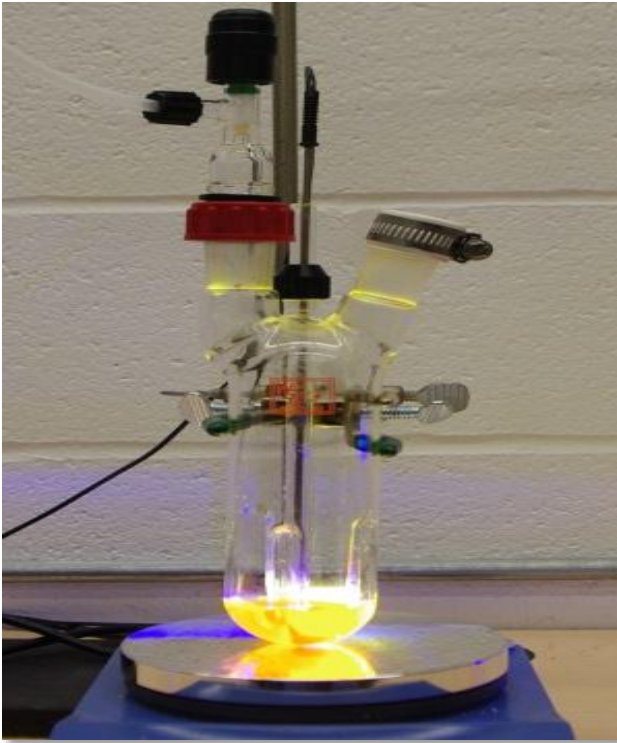


- ABIMS will allow for practical infiltration measurement of buildings of all sizes in various stages of construction
 - Commercial energy code can be changed to require infiltration measurements **increasing compliance**
 - Infiltration problems in existing buildings can be located and quantified **increasing weatherization retrofits**

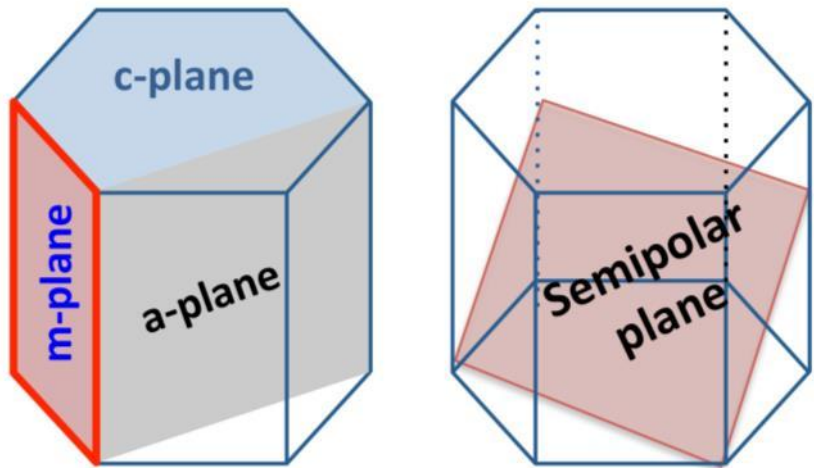
- ABIMS ensonifies the building envelope interior and measures the sound leakage through the envelope.
- The acoustic leakage used to estimate the infiltration properties of the envelope
- ABIMS finds equivalent leakage area, A_L , flow coefficient, C_d , and flow exponent, n , for the area tested



FY13 Solid-State Lighting: R&D Awards Highlights



SUNY/Buffalo developing high-efficiency colloidal quantum dot phosphors



Soraa optimizes use of non-polar and semi-polar substrates

Sensors & Controls: Open Controls Platform for Small/Medium Buildings

2013 FOA awards to CMU, VT, CIEE.

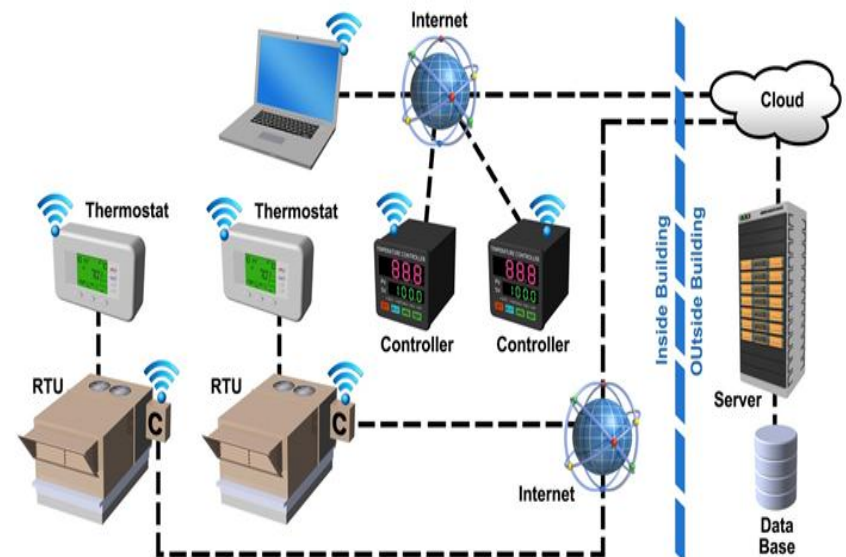
Opportunity: Less than 10% of the buildings in the U.S. use energy saving building automation systems or central controls. Over 90% of the buildings are either small (<5,000 sf) or medium-size (between 5,000 sf and 50,000 sf)

Problem: These buildings currently do not have a cost-effective way to monitor and control their building systems from a central location.

Solution: Development of cost-effective open architecture controls platform for small and medium-sized buildings.

Key Features of platform:

- Open Source
- Open architecture (interoperable)
- Plug and Play
- Auto mapping
- Thermostat, lighting, plug load devices
- Grid ready
- Agent based applications



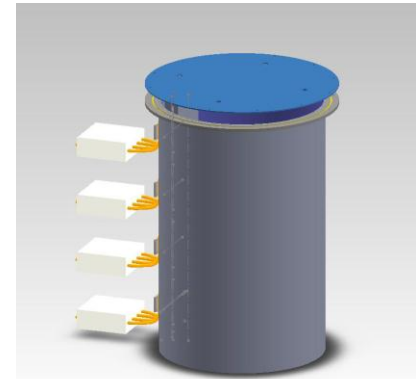
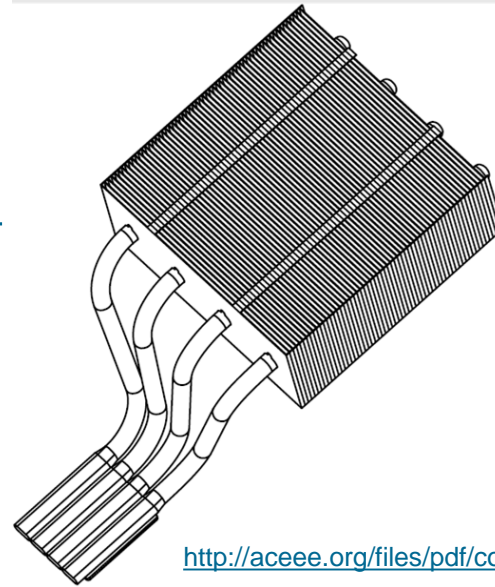
2014 SBIR Phase II Awards in Water Heating Technologies:

Goal: COP = 1.1 at an installed cost of \$500

Sheetak

- Thermoelectric (TE) technology

PI: Dr. Uttam Ghoshal, ghoshal@sheetak.com

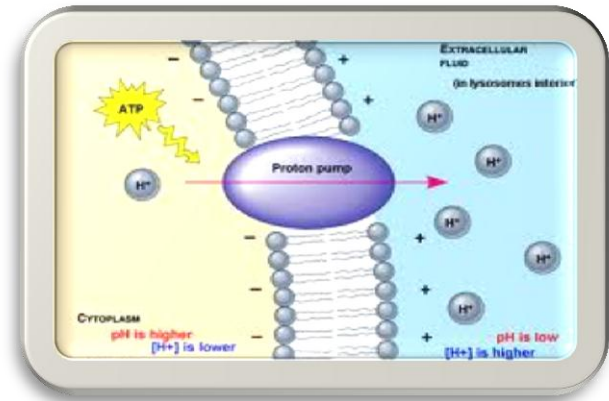


<http://aceee.org/files/pdf/conferences/hwf/2013/7A-pokharna.pdf>

Xergy

- Electro Chemical Compression (ECC) technology

PI: Mr. Bamdad Bahar,
bamdad.bahar@xergyinc.com



<http://aceee.org/files/pdf/conferences/hwf/2013/7A-bahar.pdf>

Both projects are developing full-scale prototypes in Phase II.

Whole-Building Energy Modeling (BEM)

Use cases

- Integrated design of new buildings and retrofits
- Performance-path code compliance (ASHRAE 90.1), green certification (LEED), asset rating (CAS)
- Emerging: continuous commissioning, dynamic control, demand response

Strategy

- Develop state-of-the-art BEM engine (EnergyPlus) and “middleware” (OpenStudio)
- Use permissive open-source licensing to encourage collaboration and commercial use
- Recruit partners to develop end-user applications and engage building professionals
- Support BEM practitioner community with research education, and training

2013 Success

- EnergyPlus V8.0 now in C++, courtesy of new partner Autodesk
- Four new EnergyPlus interfaces in 2013: Simergy, N++, gEnergy, and Sefaira
- OpenStudio ships 1.0 (graphical workflow), 1.1 (parametric analysis), 1.2 (cloud support)
- Xcel Energy launches EDAPT, E+/OS-based design assistance program tracker, BTO working with Xcel to share EDAPT with other utilities
- Concept3D pilots Simuwatt, an E+/OS-based mobile auditing tool
- AEC releases CBECC-Com, an E+/OS-based performance-path compliance engine for Title 24

2014 Goals

- EnergyPlus V9.0 with XML input/output and 2X speedups
- 90% coverage of EnergyPlus HVAC systems and equipment in OpenStudio
- CBECC-Com ruleset for ASHRAE 90.1-2010 for code compliance and LEED
- More third-party applications, plug-ins, users, and building projects!



<http://www.energyplus.gov/>



<http://openstudio.nrel.gov/>

Questions? Comments? Demo requests?
Amir Roth, amir.roth@ee.doe.gov

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BTO Roadmaps and Technical Reports

Technology Roadmaps

- [Windows and Building Envelope R&D Roadmap](#), February 2014
- [Solid-State Lighting Technology Roadmaps](#)

Systems Engineering

- [Building America – Systems Engineering Approach](#)

Technology Evaluations

- [Solid-State Lighting Technical Reports](#)
- [Assessment of the Energy Impacts of Outside Air in the Commercial Sector](#)
- [Challenges and Opportunities to Achieve 50% Energy Savings in Homes](#)

Deployment and Diffusion

- [Better Buildings Challenge Overview](#)
- [Better Buildings Neighborhood Program](#)
- [High Performance Roof top Unit Challenge](#)
- [ENERGY STAR®](#)
- [U.S. Department of Energy Solar Decathlon](#)
- [Guiding Market Introduction of High-Performance SSL Products](#)
- [Home Energy Score](#)

Look for:

- * **Presentations from the FY14 BTO Peer Review**
- * **the BTO Multi-Year Program Plan (2014 – 2020)**

How To Get Involved with BTO

- Get on our email list (<http://www1.eere.energy.gov/buildings/newsletter.html>, and click on “Sign up to receive news and events from BTO”)
- Volunteer to be a reviewer
- Participate in workshops, RFIs (Requests for Information), and the annual program peer review
- Apply for the BTO Post-Doctoral Science & Technology Policy Fellowship (<http://orise.orau.gov/science-education/internships-scholarships-fellowships/description.aspx?JobId=14599>), due March 31, 2014)
- Apply to a FOA (multiple FOAs to be released each year)

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