Emerging Technologies for Building Applications

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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November 18, 2016

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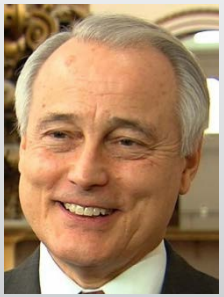
Technology Managers



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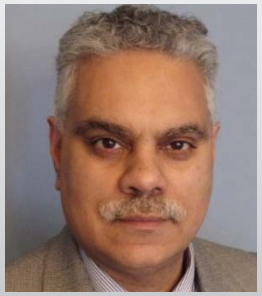

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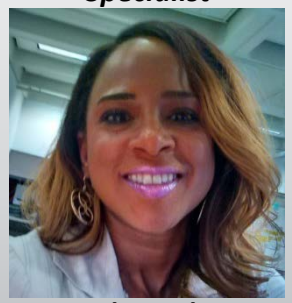

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Who Supports Energy Efficiency R&D (Federal)?

Building Technologies Office

Emerging Technologies

Commercial Buildings Integration

Residential Buildings Integration

Codes & Standards

ARPA-E

NSF

DOE Office of Science

ONR

FEMP

ESTCP

GSA Green Proving Grounds

BTO's Emerging Technologies (ET) Program

HVAC, Water Heating, & Appliances

Windows & Building Envelope

Lighting

Building Energy Modeling

Sensors & Controls

Buildings to Grid

http://energy.gov/eere/buildings/emerging-technologies

Emerging Technologies Program Logic Model


Updated Dec. 2015

OBJECTIVE	ACTIVITIES	KEY OUTPUT	SHORT-TERM OUTCOME	MID-TERM OUTCOME	LONG-TERM OUTCOME
Develop next-gen tech	Next-gen tech & component R&D	Next-gen prototypes	Performance goals met	Private sector R&D	Advanced tech and tools in market on a national scale
Improve near-term tech	Cost reduction R&D	Reduced cost prototypes	Validated products	Adopted products	
	Demonstrate pre-commercial technologies	Validated demo results			
Provide modeling tools	Update and validate key tools	Widely used modeling tools	Adopted tools	Wide use	

EXTERNAL INFLUENCES

- DOE Budget
- Spin-off Products
- Market Incentives
- Legislation / Regulation
- Energy Prices
- Private R&D

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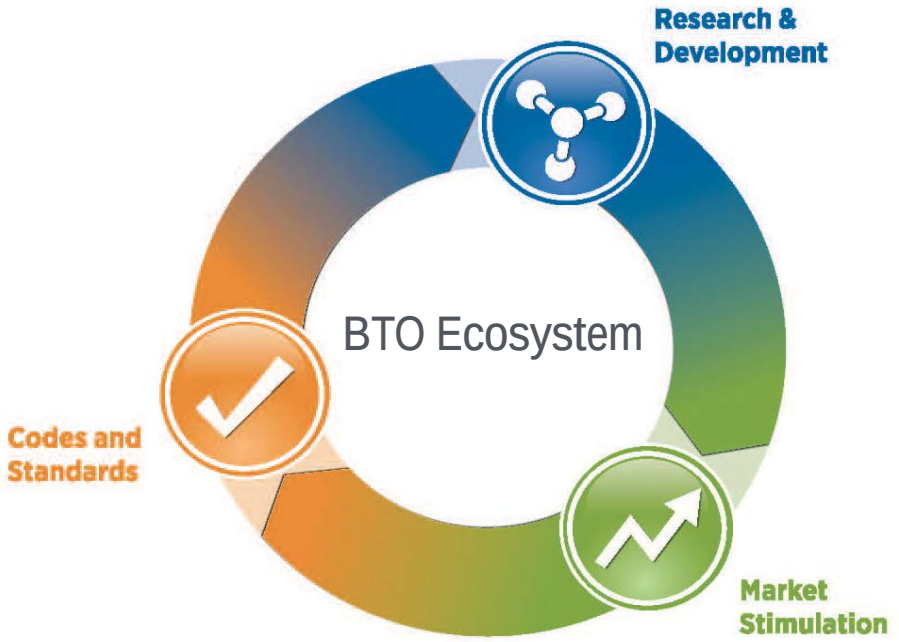
BTO's Integrated Approach

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

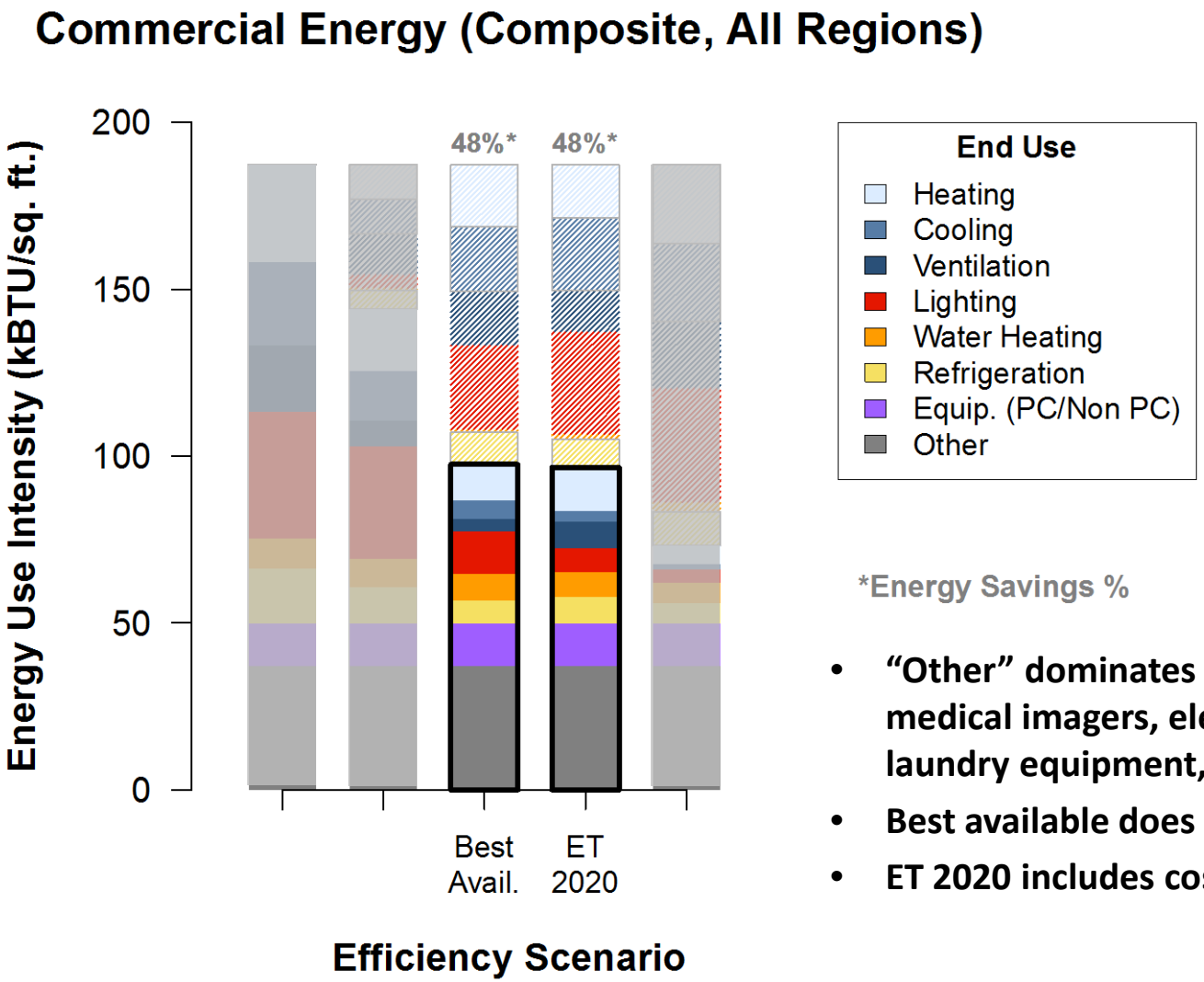
- Identify barriers to speed and scale adoption
- Collaborate with industry partners to improve market adoption
- Increase usage of products & services
- Work through policy, adoption, and financial barriers
- Communicate the importance and value of energy efficiency
- Provide technical assistance and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

Achieving ET Program Goals Requires Cost Reductions



- **"Other" dominates in future: Transformers, medical imagers, elevators, escalators, pumps, laundry equipment, pumps, fume hoods, CHP, etc.**
- **Best available does not consider cost**
- **ET 2020 includes cost effectiveness**

ET 2020 – ET Multi-year Program Plan Targets for 2020

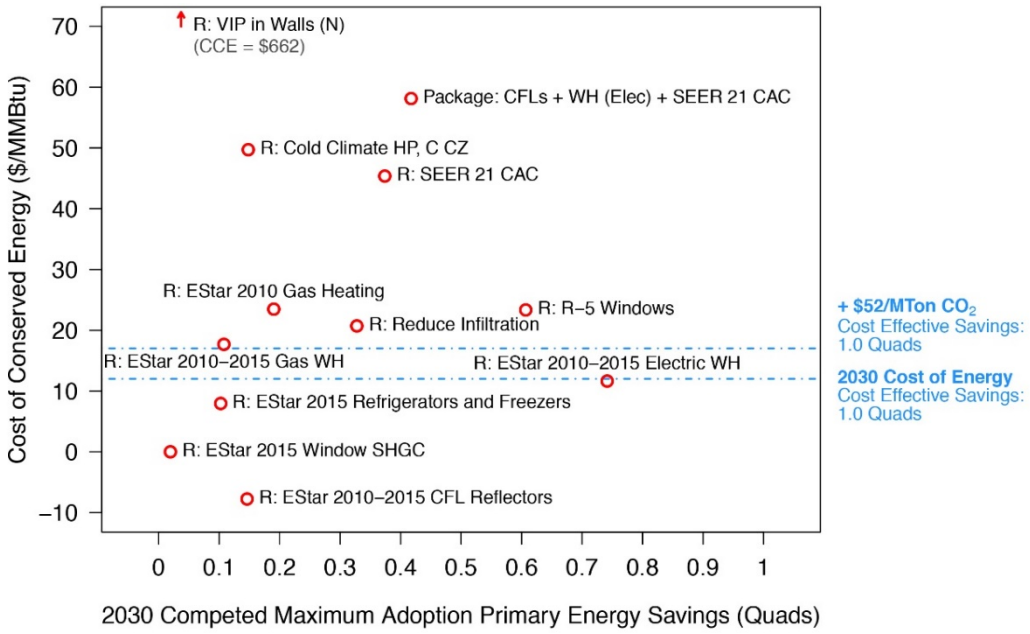
Scout: A Building Energy Efficiency Impact Analysis Tool

Objective:

Evaluate the national energy and CO_2 reduction impacts of a diverse portfolio of building energy efficiency measures on a level playing field

Key features

- Baseline energy use and building stock dynamics from EIA data
- Measure performance inputs from building energy models
- Energy, cost, and CO_2 impacts by measure and aggregated
- Open source; available on GitHub



Scout can be used to assess the cost-effective savings potential of a portfolio of energy efficient measures.

ET Funding Mechanisms

Funding Opportunity Announcements (FOAs):

- **BENEFIT (Building Energy Frontiers and Innovation Technologies)**
  - Rotates among non-SSL topics
  - Early stage and later stage R&D; often includes “open” topic
  - FY17 notice of intent and teaming list released
- **Solid State Lighting (SSL) Advanced Technology R&D**
  - Concept papers were due Nov. 14; full application due Jan. 10

Opportunities for Small Business:

- **Small Business Innovation Research (SBIR)**
  - Topics issued Oct. 31: solar building energy storage management, geothermal heat pumps, window cost and performance, SSL, and indoor air quality
  - Letters of intent due Dec. 19
- **Small Business Vouchers (SBV)**

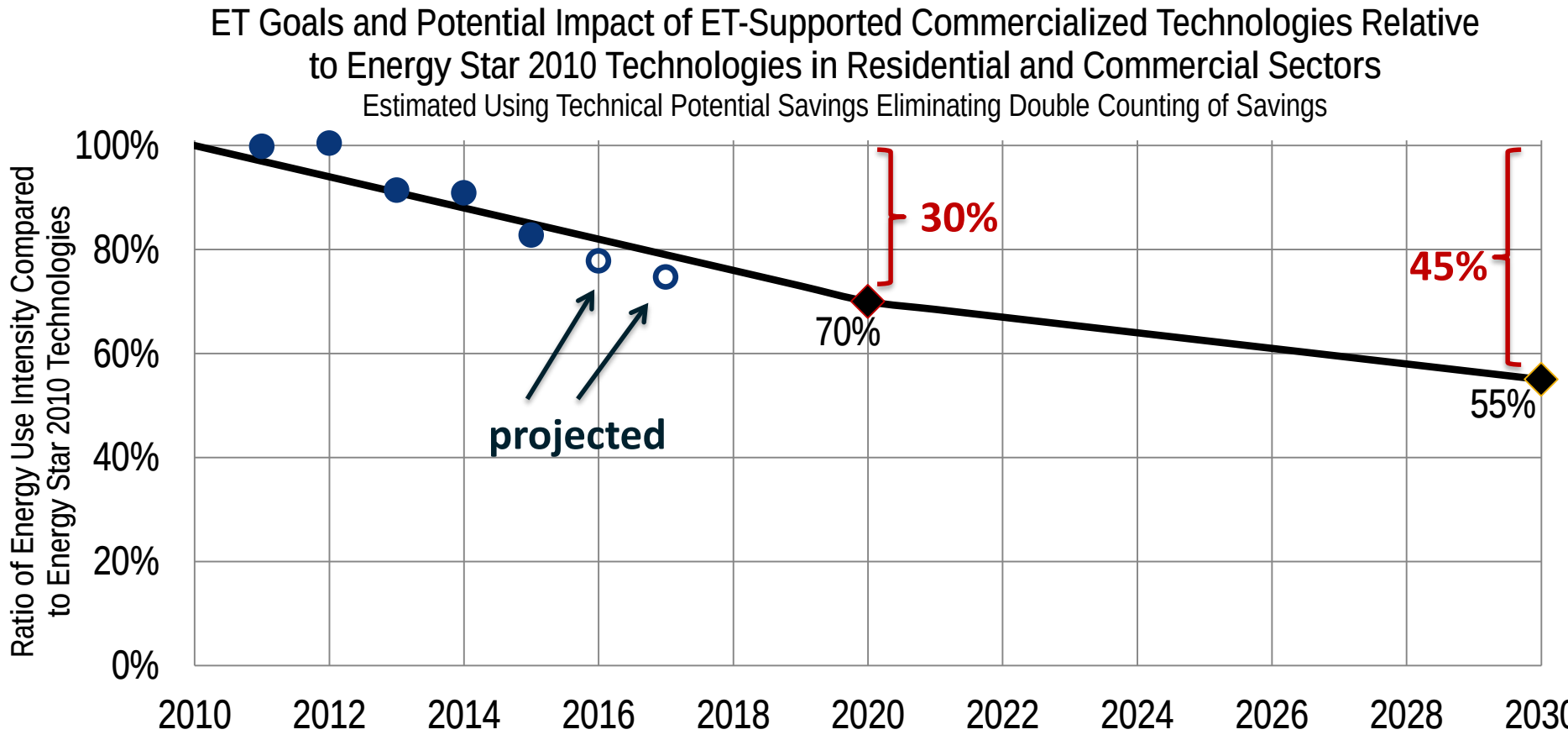
Open Innovation Prizes

- **Catalyst (software solutions; joint with SunShot)**
- **JUMP (5 lab open innovation platform joint with RBI & CBI)**

Direct Laboratory Funding:

- **Laboratory Calls (competed by sub-program)**

Progress Towards Aggregate Energy Savings Goals



As a result of ET-sponsored research, cost-effective technologies will be introduced into the marketplace by 2020 that will be capable of reducing a building's energy use by 30% relative to 2010 cost effective technologies, and 45% by 2030.

[BTO Multi Year Program Plan]

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Buildings RD&D Opportunities in the 2015 QTR

Building thermal comfort and appliances	▪ Materials that facilitate deep retrofits (e.g., thin insulating materials) ▪ Low/no-GWP heat pump systems ▪ Improved tools for diagnosing heat flows over the lifetime of a building ▪ Clear metrics for the performance of building shells for heat and air flows
Lighting	▪ Test procedures for reliably determining the expected lifetime of commercial LED and OLED products ▪ Understanding why LED efficiency decreases at high power densities ▪ High efficiency green LEDs ▪ Efficient quantum dot materials ▪ Advanced sensors and controls for lighting ▪ Glazing with tunable optical properties ▪ Efficient, durable, low-cost OLEDs ▪ Lower cost retrofit solutions for lighting fixtures
Electronics and miscellaneous building energy loads	▪ More efficient circuitry (hardware and software) ▪ More flexible power management (hardware and software) ▪ Standardized communications protocols ▪ Wide-band-gap semiconductors for power supplies
Systems-level opportunities	▪ Accurate, reliable, low installed cost sensors ▪ Energy harvesting to power wireless sensors and controls ▪ Improved control systems (cybersecurity, install/commissioning) ▪ Control algorithms to automatically optimize building system performance ▪ Open-source software modules supporting interoperability ▪ Easy-to-use, fast, accurate software tools to design and operate buildings ▪ Co-simulation modeling with a widely used interface standard ▪ Decision science research incorporating personal information security ▪ Components and systems that allow building devices to share waste heat

Source: *2015 DOE Quadrennial Technology Review (QTR)*

FY17: Potential Topics of Interest

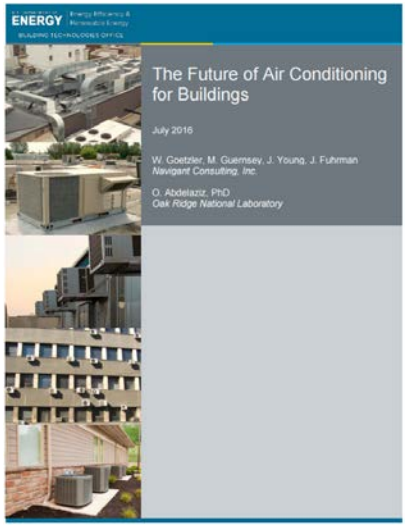
- **Solid-State Lighting (SSL)**
  - Updated SSL R&D Plan was just released
- **Advanced HVAC&R**
  - Two workshops last fall (at ASME IMECE and ASHRAE Headquarters)
  - Recent Request for Information (RFI)
- **Advanced Controls for Miscellaneous Electric Loads (MELs) energy reductions**
  - Workshop last summer in San Francisco
  - Recent Request for Information (RFI)
- **Open Topic**
  - Early-stage “Innovations”
  - Pre-commercialization “Transitions”

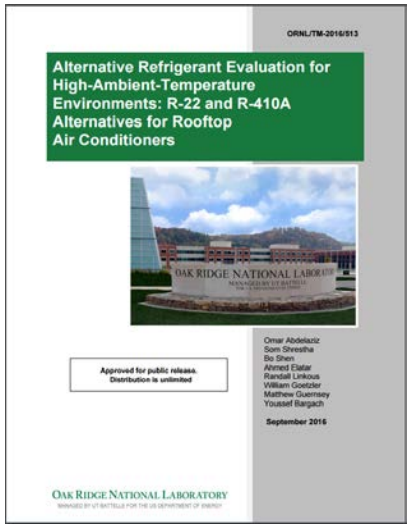
Phasing Down HFCs

- The Future of Air Conditioning Report documents air conditioning's explosive growth worldwide:
  - Documents current landscape trends and possible solutions

- The ORNL High-Ambient Temperatures Report tested low-GWP alternative refrigerants in rooftop air conditioners under high temperature conditioners:
  - Found several viable low-GWP alternative refrigerants as replacements for common HFCs

- In October 2016, the global community committed to the Kigali Agreement, an amendment to the Montreal Protocol to phase down HFCs.





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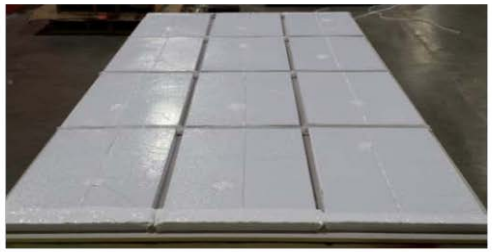
Electrochemical Compression

Performer: Xergy, Inc.

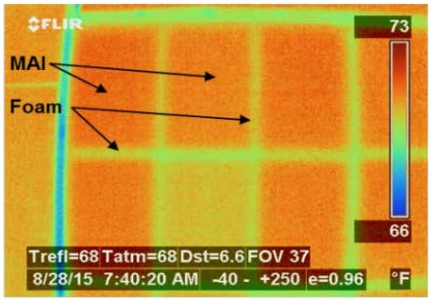
- Zero-GWP cooling fluid (water, hydrogen, or other refrigerant)
- Uses an external voltage to pump a refrigerant across a membrane
- A platform technology with numerous potential applications:
  - Water heaters, HVAC, dehumidifiers, fuel cells, desalination
- Successes:
  - Prototype hybrid water heater being developed by GE Appliances
  - Demonstrated refrigeration cycle with metal hydride heat exchanger for HVAC applications

Modified Atmosphere Insulation Composite Boards

- Combination of Modified Atmosphere Insulation (MAI) panels, a low-cost alternative to vacuum insulation, and polyisocyanurate
- Two applications: wall sheathing and commercial roof retrofits
- First prototype achieved R-10.8/inch (goal is R-12/inch)
- Energy savings potential of 1,319 TBtu



Modified Atmosphere Insulation (MAI) panels on high-density (HD) foam substrate



Foam application on manufacturing line

Finished composite insulation boards

OAK RIDGE National Laboratory

NanoPore

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Building Energy Management Open Source Software Development

Project Goal:

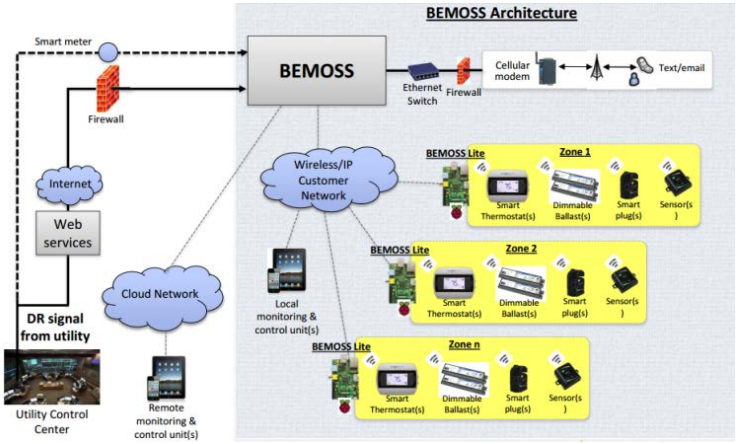
Develop a, plug and play open source open architecture control system that improves energy efficiency, optimizes electricity usage, and. improves the comfort for small and medium-sized buildings

Solution:

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

Key Features of platform:

- Open Source (first application to be built on DOE-developed open execution platform, VOLTTRON)
- Open architecture (interoperable)
- Plug and Play
- Automated mapping
- Thermostat, lighting, plug load devices
- Grid ready
- Agent based applications



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How To Get Involved with BTO/ET

- **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")
- **Attend the annual BTO Peer Review**
  March 12-16, 2017
- **Provide feedback on draft roadmaps:**
  soon ones on Sensors & Controls and Building Energy Modeling
- **Volunteer to be a reviewer**
  (send CV to BTOreviewer@ee.doe.gov)
- **Postdoctoral Fellow opportunities**

http://energy.gov/eere/buildings/building-technologies-office