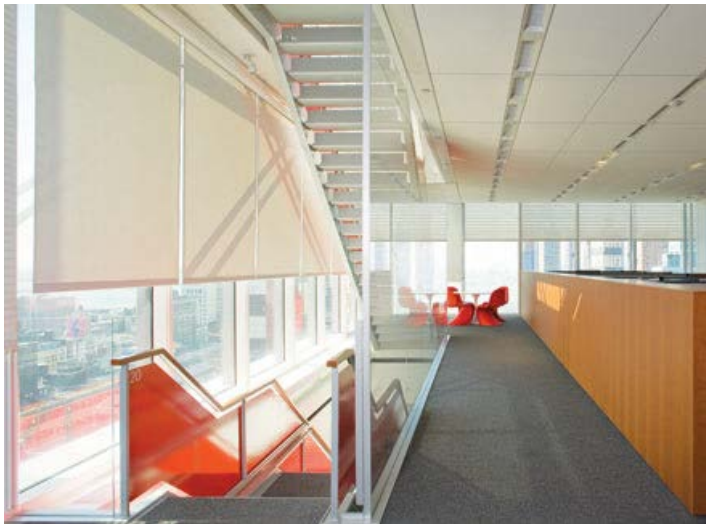


# Developing the High Impact Technology Priority List

## 2017 Building Technologies Office Peer Review



Images courtesy CREE, True Manufacturing, A.O. Smith, Bernstein Associates, Cambridge Engineering, Alliance Laundry Systems, NREL

# Project Summary

## Timeline:

Start date: December 2013

Planned end date: TBD (annual go/no-go)

## Key Milestones

1. Initial tech sweep completed; Sept 2016
2. HIT Matrix Completed; Oct 2016
3. Coordinated Workshops; Nov/Dec 2016
4. Workshop Report;
5. Finalize HIT list; Feb/March 2017

## Budget:

Total DOE \$ to date: ~\$636k (7/14 – 3/17)

Includes work on HIT process development support, HIT list development and update, deployment plan development, and CBI fact book updates

Total future DOE \$: \$TBD

## Key Partners:

BBA Members	Building Owners
Equipment OEMs	Trade Associations
National Labs	Professional Societies
Research Organizations	Utilities

## Project Goal:

Identify and prioritize more than 400 different energy efficiency measures. Prioritization is conducted through a transparent and collaborative process and feeds into multi-year program planning goals of demonstration and adoption.

# Purpose and Objectives

**Problem Statement:** Prioritization of technology offerings in the commercial building sector for potential CBI investment is difficult due to the sector's diverse, fragmented group of owners and tenants, numerous assorted building systems, and highly varied building types and markets.

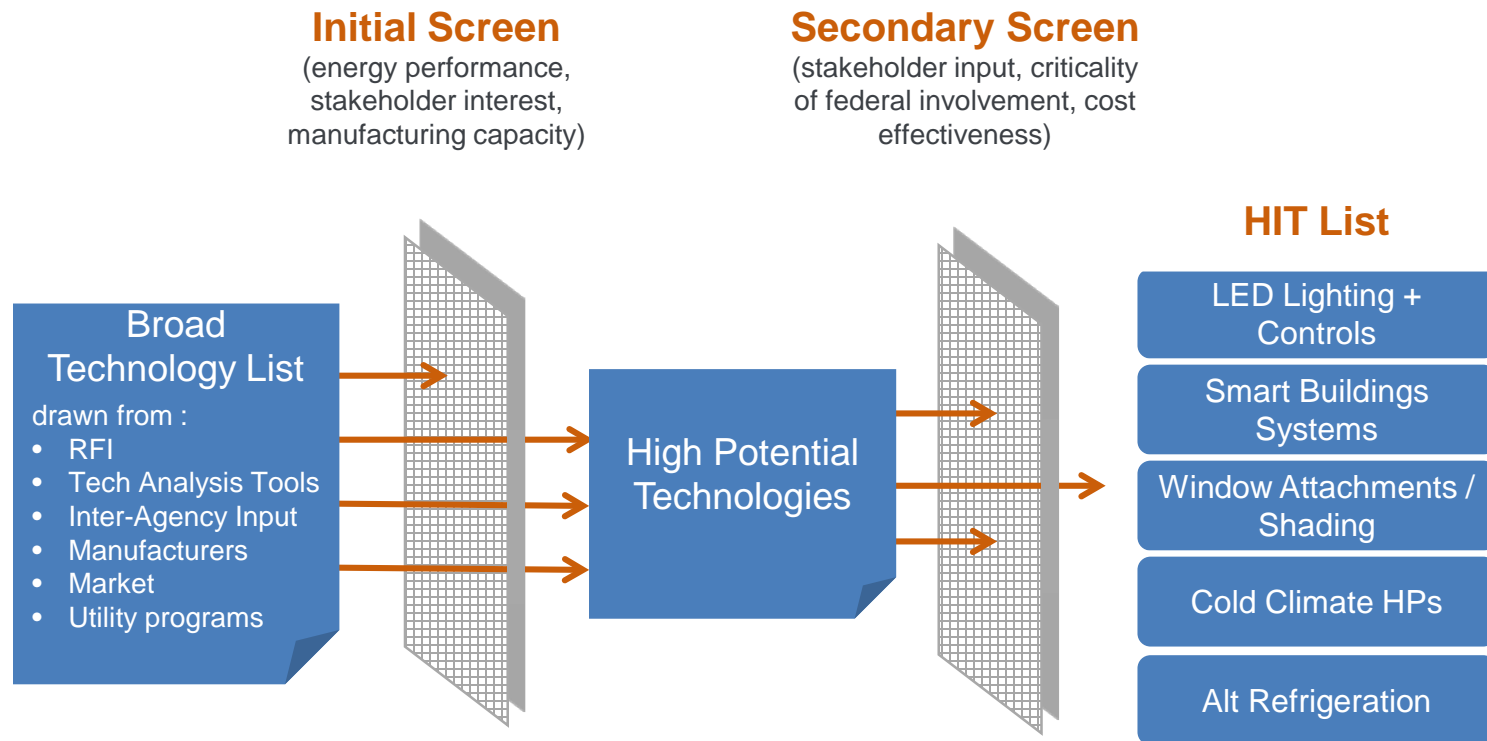
**Goal:** The High Impact Technology (HIT) List is designed to identify and prioritize cost-effective, underutilized, energy-efficient technologies so that BTO can focus resource development and deployment activities within the commercial buildings sector.

**Target Market and Audience:** We deploy HITs through partnerships with the commercial buildings industry via the Better Buildings Alliance (BBA), federal leaders, regional non-profits, and efficiency organizations, encompassing all 5.5 million commercial buildings (18 quads/yr. of primary energy)\*

\*Data source: <https://energy.gov/sites/prod/files/2016/02/f29/BTO%20Multi-Year%20Program%20Plan%20-%20Final.pdf>

# Approach

Identify HITs through a rigorous prioritization process; characterize HITs based on their stage in the product life cycle; develop appropriate resources, and evaluate the most appropriate and effective deployment activities.



Deployment prioritization also enables partners to focus on market-ready, high potential technologies in a shifting landscape with multiple, complicated choices.

# Approach (cont.)

1. Gather measures and rank to develop HIT Matrix: P-Tool/Scout, RFI, Tech Sweep
2. Refine Matrix: Workshop Series with Industry Partners

Measure Description											Other Locations of the Measure						
Number	Data Quality (As of Feb 2016)	HIT Matrix Short-hand Name	P-tool Brief Description	P-Tool Full Description	Additional Description	Sector	Category	P-Tool End Use	Technology Area	ROB, RET, NEW	Relevant BBA Team	HIT Matrix 2-23-2016	OYP Additions List 7-1-2016	Most current P-tool version (v7.23)	P-Tool Units	P-tool Efficiency Operation	
837	Good	RENOVATE System Window Retrofit	C: RENO VATE Window [E]	Commercial, new, patented, retrofit window technology which hermetically seals a factory-manufactured insulated glass unit (IGU) to the interior surface of a single-view, Inc. (VI), with assistance from BTO (as part of the American Recovery and Reinvestment Act), developed dynamic glass based on electrochromic	Commercial	Building Envelope	Building	Envelope	RET	TBD	Y	Y	Y	Energy Savings (%)	0.84		
108	Good	Dynamic Tinted Glass	C: View Dynamic Glass [E]	View, Inc. (VI), with assistance from BTO (as part of the American Recovery and Reinvestment Act), developed dynamic glass based on electrochromic	Commercial	Building Envelope	HVAC	Envelope	RET, NEW	TBD	N	Y	Y	Energy Savings (%)	0.45		
381	Good	Cool Roofs, Hot CZ, 0.75 SR	C: Cool Roofs, 0.75 SR, H1 & C: BE MOSS (x100,000SF)	Deploy advanced Building Envelope	Commercial	Building Envelope	HVAC	Envelope	ROB, NEW, RET	Space Conditioning	Y	Y	Y	Energy Savings (%)	0.23		
1011	Good	Building energy management and information systems	C: BE MOSS (x100,000SF)	Move to include rooftop	Commercial	Whole Building	All End Uses	EMIS	RET, NEW	TBD	N	Y	Y	Energy Savings (%)	0.30		
90	Good	Proper AC Sizing	C: Right sized AC	Advanced Rooftop Unit (RTU) (DOE CRADA TARGET)	Commercial	HVAC - Cooling	Cooling	HVAC	?	Space Conditioning	N	Y	Y	Energy Savings (%)	0.13		
814	Good	Advanced RTU	C: Adv. RTU (IEER 22+)	Advanced Rooftop Unit (RTU) (DOE CRADA TARGET)	Commercial	HVAC - Cooling	Cooling	HVAC	ROB, NEW	Space Conditioning	Y	N	Y	IEER	22.00		
3	Good	CEE Split and Single-package AC Specifications	C: CBI CEE Tier 2 RTU	SSR, The Consortium for Energy	Commercial	HVAC - Cooling	Cooling	HVAC	ROB, NEW	Space Conditioning	N	Y	Y	IEER	13.80		
31	Good	BHME Heat & Moisture Exchange	C: BHME Heat & Moisture	Building integrated heat and moisture exchange; a membrane-based air-air exchanger integrated into modular wall panels	Commercial	HVAC - Cooling	Cooling	HVAC	RET, NEW	Space Conditioning	N	Y	Y	Energy Savings (%)	0.23		
94	Good	Cold Storage, Large Chillers	C: Cold Storage for Large Chillers	Demonstrate and deploy	Commercial	HVAC - Cooling	Cooling	HVAC	ROB, NEW, RET	Space Conditioning	N	Y	Y	Energy Savings (%)	0.05		
562	Good	Hot-dry A/C	C: Hot-dry A/C (IMD/H2 CZ)	Research, demonstrate, and deploy climate optimized hot-dry A/C in commercial buildings. (To assure adequate dehumidification in most climates, the evaporator	Commercial	HVAC - Cooling	Cooling	HVAC	ROB, NEW, RET	Space Conditioning	Y	Y	Y	Energy Savings (%)	0.20		
945	Good	Separate sensible and Latent Heat Controls for RTUs	C: Latent Heat Controls	Develop and evaluate techniques for separate sensible and latent control for rooftop A/C units and ASHPs. Air-conditioning systems remove both sensible	Commercial	HVAC - Cooling	Cooling	HVAC	ROB, NEW	Space Conditioning	Y	N	Y	Energy Savings (%)	0.30		
564	Good	Magnetic Bearing Var Speed Chillers	C: Magnetic Bearing Variable	Demonstrate and deploy	Commercial	HVAC - Cooling	Cooling	HVAC	ROB, NEW	Space Conditioning	N	Y	Y	kWh/ton cooling	0.50		
804	Good	Cold Climate HP	C: Cold Climate HP (C CZ)	Develop techniques to raise heat pump performance at low-ambient temperature, consider elimination of defrost (or frost buildup) and backup heat sources to	Commercial	HVAC - Heating	Heating/Cooling/Heating	HVAC	ROB, NEW	Space Conditioning	Y	N	Y	Energy Savings (%)	0.58		
612	Good	Max tech furnace & radiator	C: Max tech furnaces	Encourage retro-commissioning of commercial buildings for all buildings (only HVAC is considered, and assumes no new equipment costs)	Commercial	HVAC - Heating	Heating	HVAC	ROB, NEW	Space Conditioning	Y	Y	Y	AFUE	0.98		
105	Good	HVAC Retro-commissioning	C: Retro-commissioning	Encourage retro-commissioning of commercial buildings for all buildings (only HVAC is considered, and assumes no new equipment costs)	Commercial	HVAC - Heating & Cooling	HVAC	HVAC	RET	Space Conditioning	Y	Y	Y	Energy Savings (%)	0.16		
723	Good	Packaged HVAC controls	C: Packaged HVAC Controls	Packaged HVAC controls for existing buildings (economizer, multi-speed fan and capacity control, demand control ventilation) SAME AS ADVANCED DIGITAL	Commercial	HVAC - Heating & Cooling	HVAC	HVAC	RET	Space Conditioning	Y	Y	Y	Energy Savings (%)	0.57		
720	Good	Outside-Air Damper AFDD	C: Outside-Air Damper AFDD	Outside air damper automated fault detection and diagnostics (AFDD)	Commercial	HVAC - Heating & Cooling	Heating & Cooling	HVAC	ROB, NEW, RET	Space Conditioning	Y	Y	Y	Energy Savings (%)	0.10		
721	Good	RTU automated fault detection and diagnostics	C: RTU AFDD	Rooftop Unit (RTU) fault detection and diagnostics	Commercial	HVAC - Heating & Cooling	Heating & Cooling	HVAC	ROB, NEW	Space Conditioning	Y	Y	Y	Energy Savings (%)	0.09		
872	Good	RTU control retrofit (DCV+Econ+VSD+other)	C: RTU Control Retrofit	Develop and deploy a controller pack to RTU accompanied by a gas furnace for demand controlled ventilation and upgrade to a digital economizer with differential	Commercial	HVAC - Heating & Cooling	Heating & Cooling	HVAC	RET	Space Conditioning	Y	Y	Y	Energy Savings (%)	0.34		
123	Good	Predictive thermostats	C: Predictive Thermostats	Demonstrate and deploy predictive thermostat in all commercial buildings	Commercial	HVAC - Heating & Cooling	Heating & Cooling	HVAC	ROB, NEW, RET	Space Conditioning	Y	Y	Y	Energy Savings (%)	0.10		
NEV	Good	Occupant comfort feedback apps	NOT IN PTOOL	Apps like Comfy that allow users to directly provide input on comfort levels as input for managing HVAC controls	Other	HVAC - Heating & Cooling	#N/A	HVAC	ROB, NEW	Space Conditioning	N	N	N	NOT IN PTOOL	NOT IN PTOOL		
NEV	Good	Energy Recovery Ventilation in Commercial Buildings	NOT IN PTOOL	Engine Driven Heat Pump, commercial buildings	Other	HVAC - Heating & Cooling	#N/A	HVAC	RET, NEW	Space Conditioning	N	N	N	NOT IN PTOOL	NOT IN PTOOL		
680	Good	Engine Driven HP (FS to gas)	C: Engine Driven HP (FS to gas)	Engine Driven Heat Pump, commercial buildings	Commercial	HVAC - Heating & Cooling	Heating & Cooling	HVAC	ROB, NEW	Space Conditioning	Y	Y	Y	Energy Savings (%)	-0.25		
682	Good	Dual source HP (FS only)	C: Dual source HP, all except C	Demonstrate and deploy dual source heat pumps in commercial buildings in non-coldest climates	Commercial	HVAC - Heating & Cooling	Heating & Cooling	HVAC	ROB, NEW	Space Conditioning	Y	Y	Y	Energy Savings (%)	79%		
NEV	Good	Absorption based HP	#N/A	#N/A	Commercial	HVAC - Heating & Cooling	#N/A	HVAC						heating			
NEV	Good	Commercial / Industrial Fans and Blowers	NOT IN PTOOL	Fans and blowers used for ventilation in commercial and industrial buildings	Other	HVAC - Ventilation	#N/A	HVAC	ROB, NEW	Space Conditioning	Y	N	N	NOT IN PTOOL	NOT IN PTOOL		
12	Good	Modulating Kitchen Ventilation	C: CBI Demand Control Kitchen	Removal of gas contaminants from indoor air as a practical substitute for outside air ventilation. FD 100 award winner in 2016. CBI - Amy Jiron's	Commercial	HVAC - Ventilation	HVAC	HVAC	ROB, NEW, RET	Food Service/Space	N	Y	Y	Energy Savings (%)	0.47		
NEV	Good	EnVey Systems HVAC Load Reduction (HLE)	NOT IN PTOOL	Removal of gas contaminants from indoor air as a practical substitute for outside air ventilation. FD 100 award winner in 2016. CBI - Amy Jiron's	Commercial	HVAC - Ventilation	Ventilation	HVAC	RET, NEW	HVAC	N	N	N	NOT IN PTOOL	NOT IN PTOOL		
162	Good	Standardized VAV Ventilation	C: Move from CAV to VAV	Demonstrate and deploy demand control ventilation in all commercial buildings	Commercial	HVAC - Ventilation	HVAC	HVAC	ROB, NEW	Space Conditioning	N	Y	Y	Energy Savings (%)	0.25		
141	Good	Demand Control Ventilation	C: DCV	Demonstrate and deploy demand control ventilation in all commercial buildings	Commercial	HVAC - Ventilation	Ventilation	HVAC	ROB, NEW, RET	Space Conditioning	Y	Y	Y	Energy Savings (%)	0.20		
437	Good	Ozone laundry systems for multi-load clothes washers	C: Multi-load C/W	Implement ozone laundry systems as a retrofit that dissolve ozone in cold water to reduce hot water usage in any multi-load/washer-extractor clothes washers	Commercial	Laundry	Washing & Drying	Laundry	ROB, NEW, RET	TBD	Y	Y	Y	Energy Savings (%)	0.65		
444	Good	Clothes dryer exhaust heat recovery	C: CD Exhaust Heat Recovery	Deploy economical heat exchanger in existing commercial standard capacity	Commercial	Laundry	Washing & Drying	Laundry	ROB, NEW	TBD	Y	Y	Y	Energy Savings (%)	0.45		
470	Good	Low-Temperature Detergent in Commercial	C: Multi-load		Commercial	Laundry	Washing & Drying	Laundry	ROB, NEW, RET	TBD	N	Y	Y	Energy Savings (%)	0.20		
Instructions 2016 Tech Matrix Reference Fields 2015 Water Tech Matrix AEO 2016 Data NC Data											: < > >>						

Instructions

2016 Tech Matrix

Reference Fields

2015 Water Tech Matrix

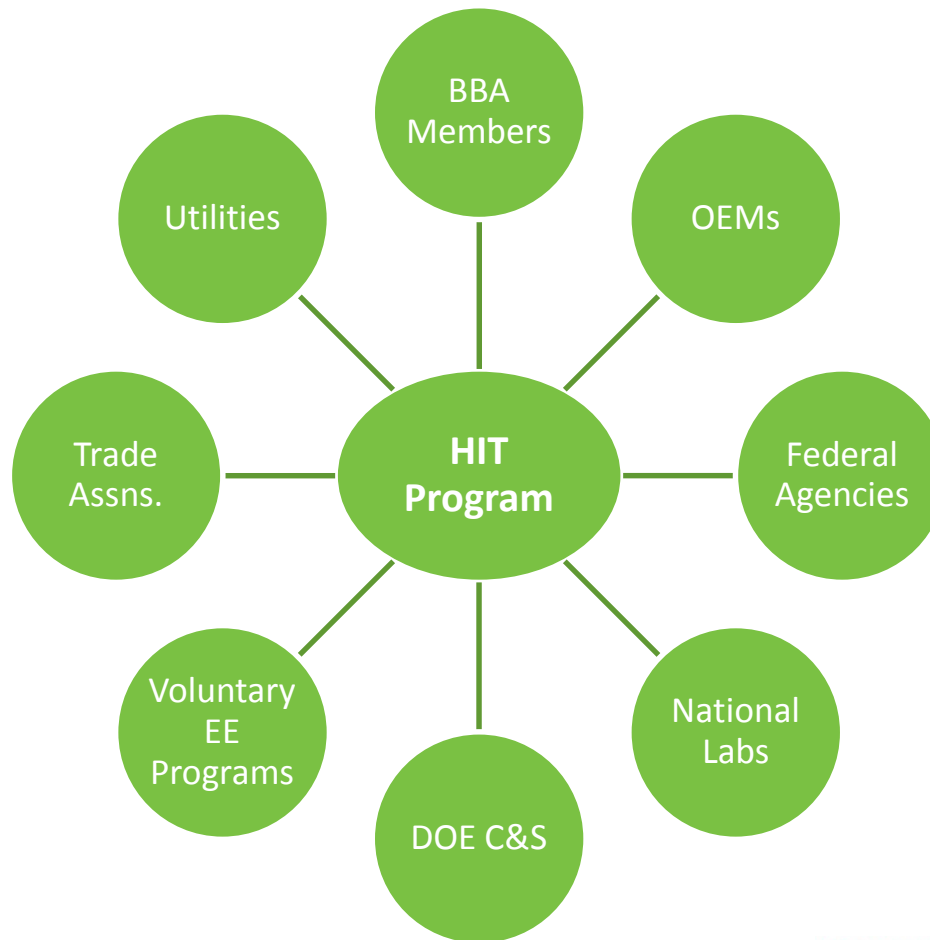
AEO 2016 Data

NC Data

+

# Project Integration and Collaboration

The HIT program is built upon two-way communication with a diverse set of collaborators to generate ideas for the program, which then creates data and deployment tools for stakeholders.



# Progress

The **HIT Matrix** helps us identify new market-ready technologies

- Includes technologies developed through work by the BTO Emerging Technologies team (P-Tool)
- Technology-specific and national energy savings potential values
- In total, over **450 measures** to evaluate
- Two screens for: 1) energy savings opportunity and deployment readiness; and 2) market factors

**Peer Workshops** provide perspective on market factors and feedback on priority technologies identified in the Matrix

- Academia, Federal Agencies, Utility, Regional Energy Organizations
- 17 unique organizations and 20 individuals participated in 2016
- RFI open for input by building owners/end-users and technology vendors

**Third annual** identification + evaluation + prioritization to produce the HIT List.



# 2017 HIT Matrix - New Construction Spotlight

- A few candidate HIT measures are particularly well suited to high-performance, net-zero-energy new construction.
- To be a target for new construction, measures must have substantially better cost-effectiveness in new construction than in retrofit (others are evaluated directly in the HIT matrix)
- Among 2017 HIT candidates, the following are top candidates for new construction projects (post first screen) that are worthy of additional consideration:

HVAC	Advanced heat pumps (including geothermal/wastewater/greywater-source heat pumps and cold climate heat pumps)
	Modulating kitchen ventilation
	BIHME heat & moisture exchange
	Thermal storage, large chillers

Water Heat	Drain-water waste heat recovery
	Heat-recovery RTU for water preheating

Light	Personal lighting controls
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Whole Bldg	Building energy/automation systems and controls
	Dry-type distribution transformers (premium efficiency + right sizing)

Envelope	Modified atmospheric insulation panels (MAI)
	Vacuum insulated panels (VIP)
	Dynamic tinted glass



# 2017 HIT Matrix - New Construction Spotlight

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**We are seeking feedback on 12 candidate technologies**

For each technology, tell us:

- *How valuable could the technology be in helping achieve program goals for new construction?*
- *How appropriate is the technology for investment by DOE/BTO?*

# New Construction Spotlight (1 of 5)

Measure Name	End Use	Savings Potential (Tbtu/yr)	Description
Vacuum insulated panels (VIP)	Envelope	370	Insulating panels comprised of a vacuum surrounded by membrane walls that prevent air from entering the vacuum. Approximately 35% unit energy savings.
Modified atmospheric insulation panels (MAI)	Envelope	370	Offers similar performance as VIPs at a 40% reduced cost. The MAI vacuum is created by condensation of steam, a cheaper and faster process than in VIPs.
Dynamic tinted glass	Envelope	270	A multi-layer, electrochromic, coating on the inner surface of the outer pane in a double-pane IGU. The tint of the pane is proportional to the voltage applied across the glass. Approximately 45% unit energy savings.

**MAI**

#### COVER - FOIL BAG

Function:  
to prevent deserting of gas  
and moisture into the panel

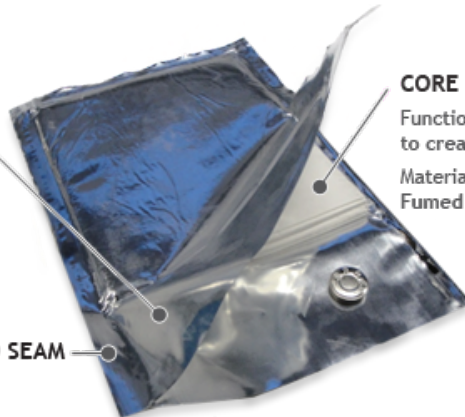
Materials:  
hight barrier multilayer film

#### CORE

Function:  
to create shape and to channel heat wave

Materials:  
Fumed Silica, glass fiber

HEAT SEALED SEAM



#### Legend

Primary Energy  
Technical Savings  
Potential

>300 TBtu

100-300 TBtu

50-100 TBtu

Photo source: <http://vipa-international.com/vacuum-insulation-panels;>

# New Construction Spotlight (2 of 5)

Measure Name	End Use	Savings Potential (Tbtu/yr)	Description
Modulating kitchen ventilation	HVAC	186	Demand control kitchen ventilation to modulate the speed of kitchen ventilation relative to the cooking activity based on temperature, optical, or IR sensors. Approximately 47% unit energy savings.
Advanced heat pumps	HVAC	750	Alternative heat pump systems including geothermal, wastewater, greywater-source, and cold climate heat pumps. Approximately 30% unit energy savings (up to 79% in dual source HPs).

## Advanced Heat Pumps



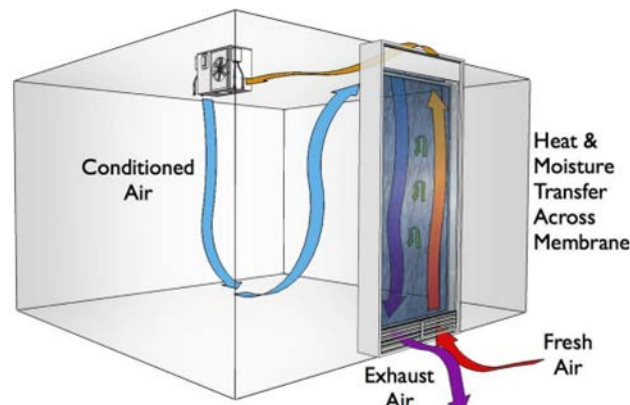
<b>Legend</b> Primary Energy Technical Savings Potential	>300 TBtu
	100-300 TBtu
	50-100 TBtu

Photo source: <http://iceghp.com/natural-gas-heat-pump-technology/>

# New Construction Spotlight (3 of 5)

Measure Name	End Use	Savings Potential (Tbtu/yr)	Description
Thermal storage, large chillers	HVAC	80	Cold storage for large chillers that enables load shifting and can save energy by reducing the system size in systems with a large discrepancy between peak and regular hours. Approximately 5% unit energy savings.
Energy Recovery Ventilation (ERV) Panels	HVAC	150	Modular wall panel, replacing standard envelope, with a membrane based air-air exchanger that provides energy recovery ventilation. Also known as Building Integrated Heat & Moisture Exchange. Approximately 30% unit energy savings.

## ERV panels



Legend Primary Energy Technical Savings Potential	>300 TBtu
	100-300 TBtu
	50-100 TBtu

Photo source: <https://energy.gov/eere/buildings/>

# New Construction Spotlight (4 of 5)

Measure Name	End Use	Savings Potential (Tbtu/yr)	Description
Drain-water waste heat recovery	Water Heating	226	Deploy wastewater heat recovery systems in commercial buildings to capture wastewater heat and use it to preheat freshwater. Approximately 30% unit energy savings.
Heat-recovery RTU for water preheating	Water Heating	40	A packaged RTU that recovers heat from the refrigerant and uses it to pre-heat water prior to the water heater. Incoming water is pre-heated to up to 125 F and stored in an insulated storage tank. Approximately 45% unit energy savings.

## Heat-Recovery RTU for water pre-heating



Photo source: <http://www.rheem.com/h2ac/>

<b>Legend</b> Primary Energy Technical Savings Potential	>300 TBtu
	100-300 TBtu
	50-100 TBtu

# New Construction Spotlight (5 of 5)

Measure Name	End Use	Savings Potential (Tbtu/yr)	Description
Building energy/automation systems and control	Bldg	1,300	Building energy management and automation systems including but not limited to electrical metering, XXXX Approximately 20% unit energy savings.
Dry-type distribution transformers (premium efficiency + right sizing)	Bldg	305	Oversized dry-type distribution transformers are frequently oversized to account for load growth, leaving DTs to operate and inefficient utilization levels. Approximately 20% unit energy savings.

Measure Name	End Use	Savings Potential (Tbtu/yr)	Description
Personal lighting controls	Lighting	440	Occupant control of individual light levels, often includes occupancy and/or daylight sensors. Approximately 36% unit energy savings.

<b>Legend</b>	>300 TBtu
Primary Energy	100-300 TBtu
Technical Savings	50-100 TBtu
Potential	

# Next Steps and Future Plans

## HIT List Refresh:

- Collect inputs from RFI and other sources
- Prioritize
- Collect stakeholder feedback
- Select HITs for focus

We evaluate and update each year to reflect evolving market conditions and advances in technology.

## Deployment Plan and Resource Development:

- Evaluate existing resources, gaps, barriers and potential partners
- Determine most effective deployment channels

## Select & Execute Deployment:

- Campaigns
- Strategic Partnerships
- Better Buildings Technology Solutions Teams

Upcoming  
tasks



# REFERENCE SLIDES

# Project Budget

**Project Budget:** See table below

**Variances:** None.

**Cost to Date:** See table below

**Additional Funding:** None.

Budget History					
Start to FY2016 (past)		FY2017 to Jan 2017 (current)		FY2018 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
\$570,000	N.A.	\$66,000	N.A.	TBD	N.A.

Budget values include work on HIT process development support, HIT list development and update, deployment plan development, and CBI fact book updates

# Project Plan and Schedule

	FY16		FY17									
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
✓ Initial tech sweep	◆											
✓ HIT Matrix update			◆									
✓ First screen results				◆								
✓ Stakeholder workshops				◆◆◆◆◆								
✓ Second screen results						◆						
Finalize HIT list								◆				
Deployment plan												◆

◆ Key Milestone