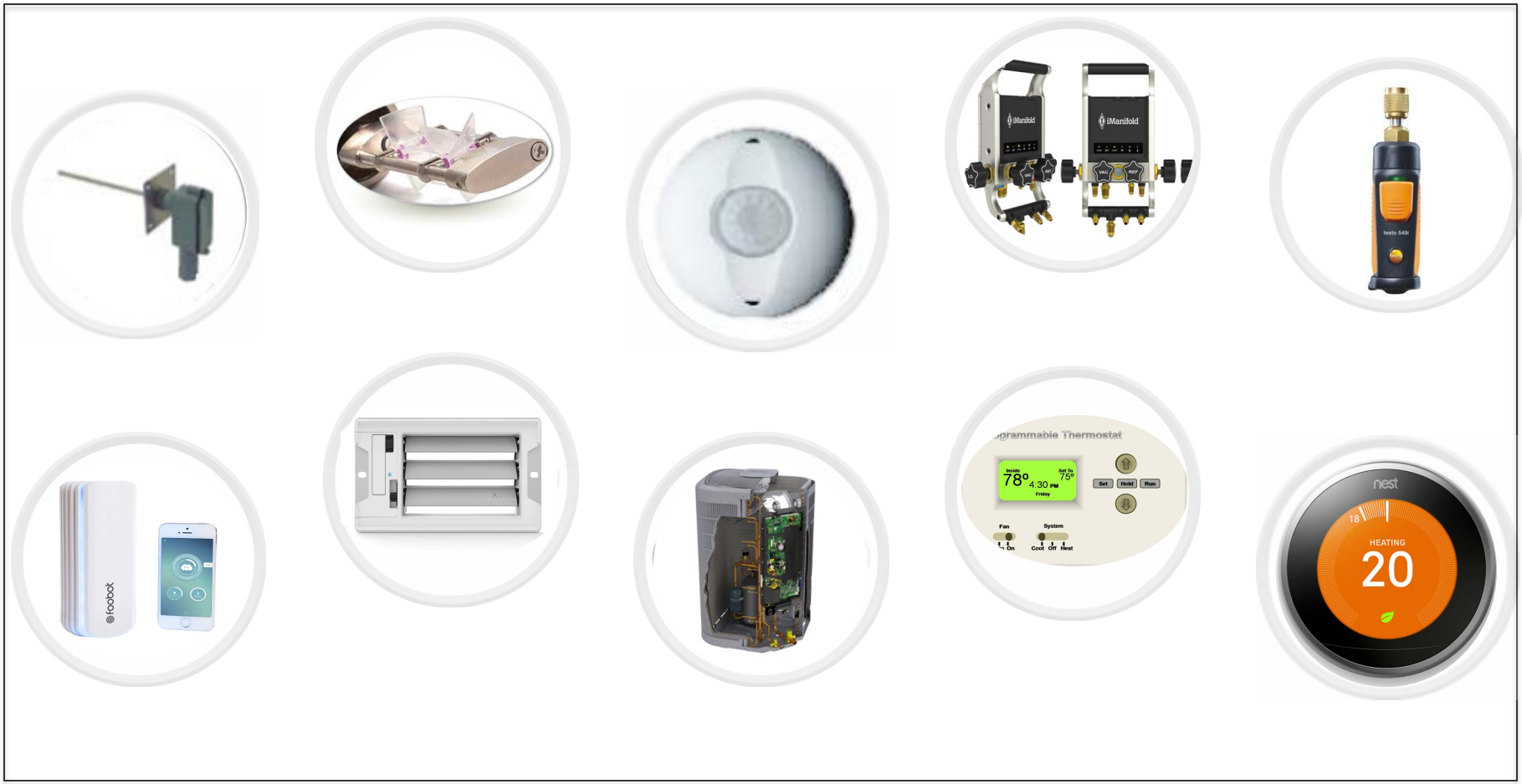
Intelligent Residential Comfort Control Applications

2017 Building Technologies Office Peer Review



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

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Project Summary

Timeline:

Start date: 10/1/2015

Planned end date: 9/30/2018

Key Milestones

1. Internal DOE draft of literature review, inventory, and taxonomy; 12/31/2016 (under review)
2. BTO coordination and review of control technologies and deploymentt activities; 9/30/2017
3. Plans for deployment activities based on industry engagement; 12/29/2017

Budget:

Total Project $ to Date:

- DOE: $180,000
- Cost Share: $0

Total Project $:

- DOE: $300,000
- Cost Share: $0

Key Partners: None at this time

Project Outcome:

Short term: market characterization and engagement.

Mid term: Advanced controls could deliver all of the savings to meet BA goal of an individual technology that provides 10% heating and cooling savings by 2020.

Long term: 43% of residential energy consumption, or 9.5 Quads, goes to heating and cooling comfort. Advanced controls can save up to 50% - assume 30%. A penetration rate of 50% by 2030 would result in a savings of nearly 1.4 Quads.

Purpose and Objectives

Problem Statement: Sensors and controls market is broad and disjointed:

- Construction industry - low RD&D, high risk perception, poor system integration
- HVAC - split between controls developers and HVAC equipment manufacturers and distribution channels
- Consumer electronics – proprietary platforms with limited energy and DR functionality

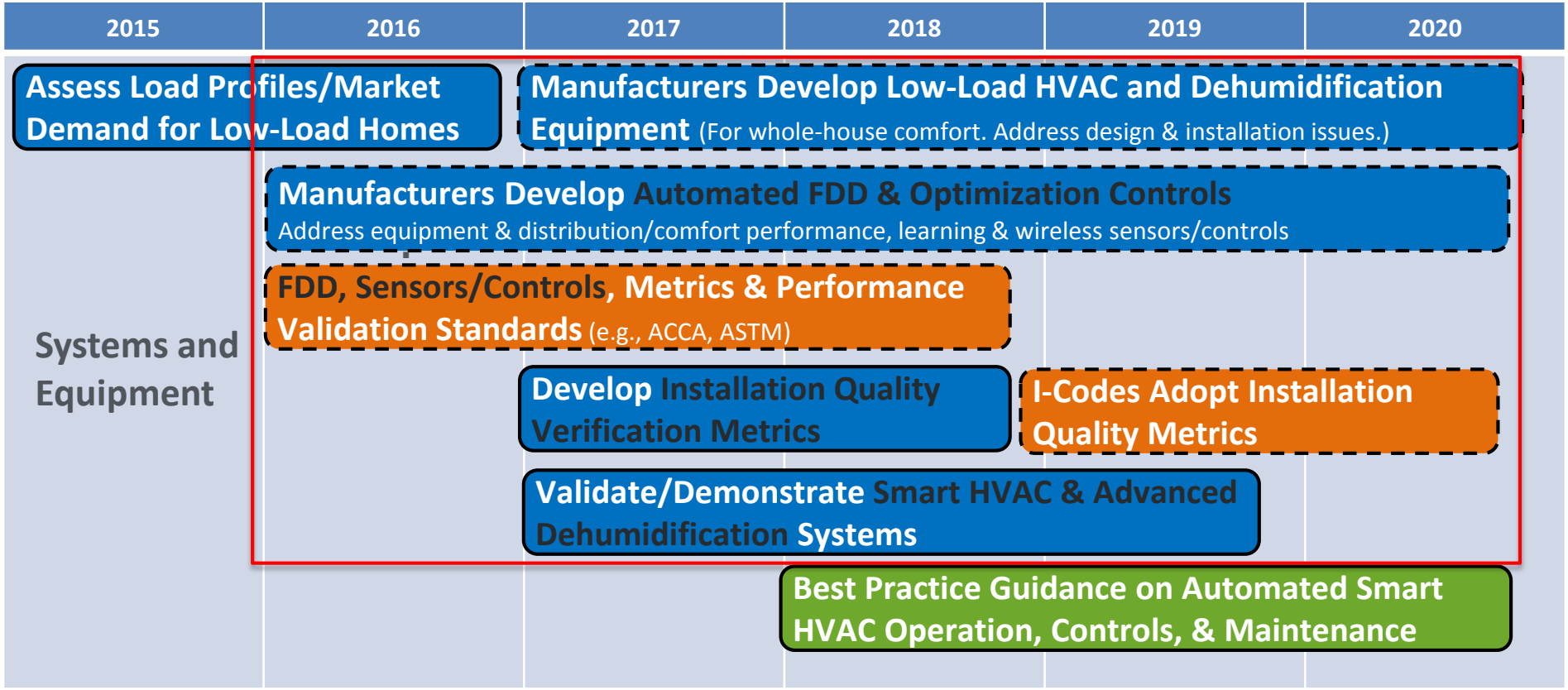
There is a need for capturing the current market and understanding impacts of potential paths forward.

Target Market and Audience: DOE staff and contractors, HVAC manufacturers, sensor and control manufacturers, utilities and program implementers.

Impact of Project: Advanced controls can save up to 50% - assume 30%. A penetration rate of 50% by 2030 would result in a savings of nearly 1.4 Quads. Advanced controls could deliver all of the savings to meet BA goal of an individual technology that provides 10% heating and cooling savings by 2020.

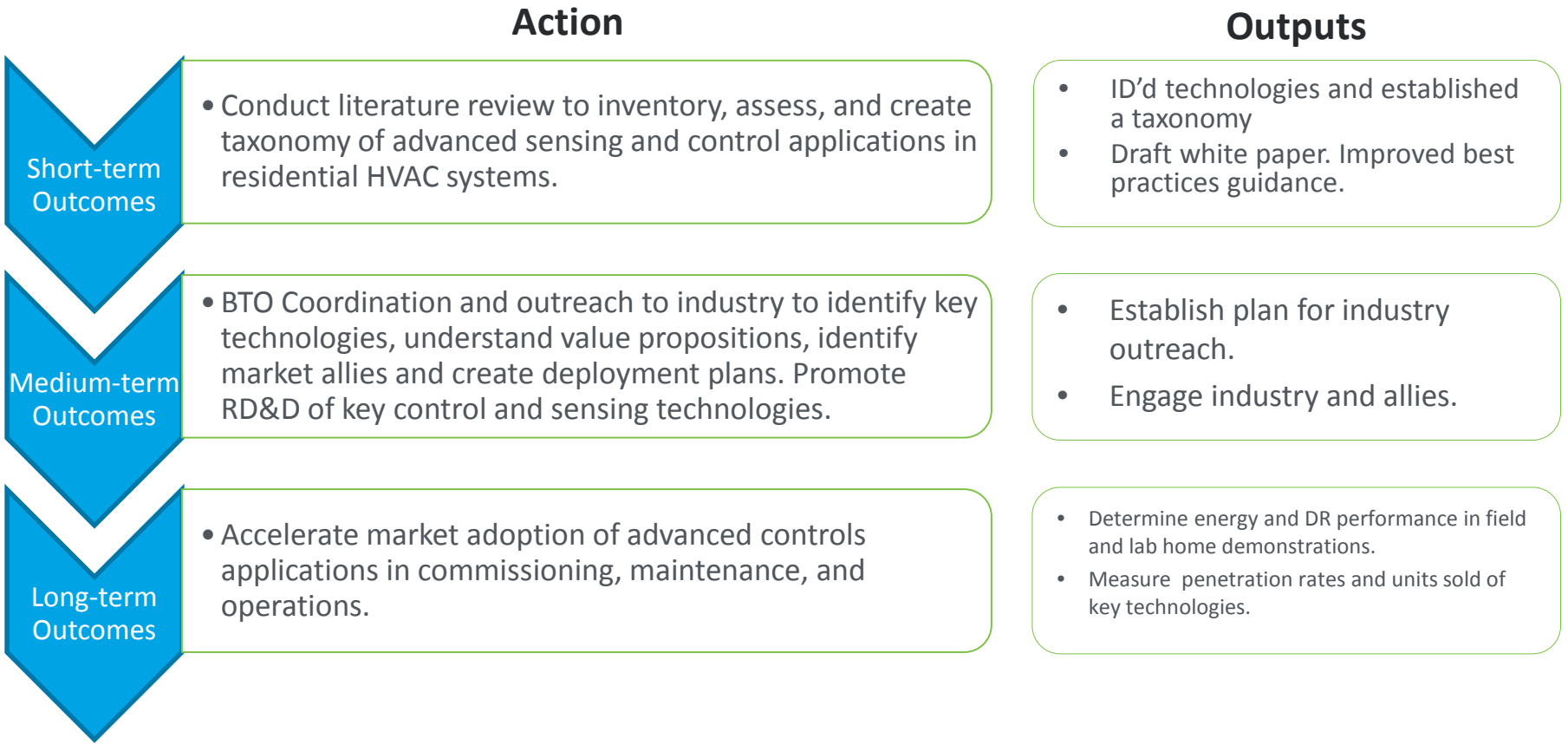
Approach: Support Building America T2M Roadmap

Optimal Comfort Systems for Low-Load Homes



Approach

Approach: Support Building America Research to Market Roadmap and the BTO MYPP



Approach

Key Issues: Without a concise synopsis of the state of the market, and the potential paths forward, development will continue to be disjointed and full savings potential will not be realized.

Distinctive Characteristics:

- Addresses opportunities in both new and existing homes.
- Provides options using existing supply chain.
- Approaching the challenge from a high level and a detailed sensor and controls level using various staff expertise.

Progress and Accomplishments

Accomplishments: Draft market characterization complete.

- Characterizes the state-of-art for HVAC technologies and applications, both at component and system levels.
- Identifies advanced applications that can be applied in commissioning, maintenance, and operations for residential HVAC systems.
- Literature reviewed to evaluate the impact of these applications at the national level.

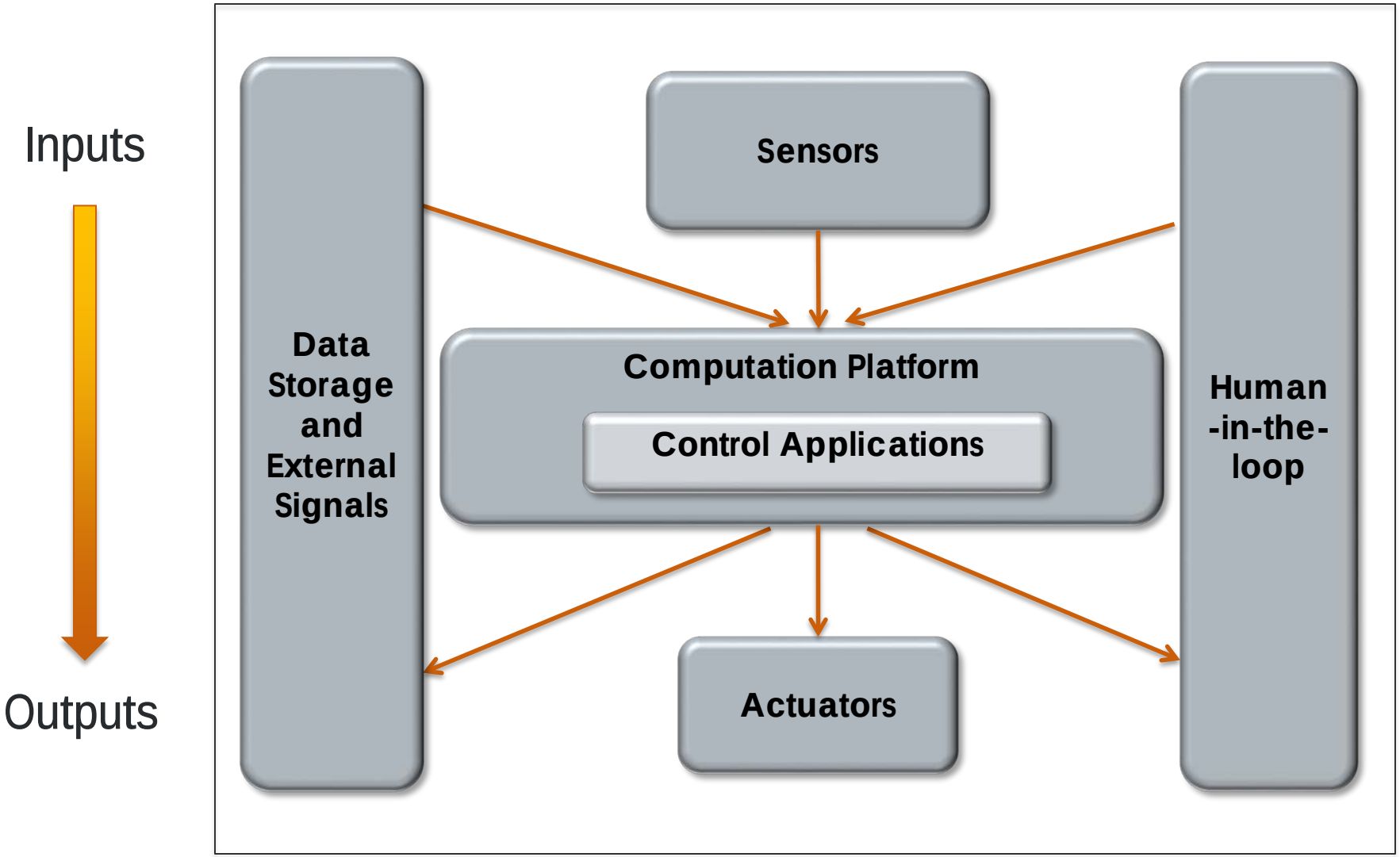
Market Impact: Planned stakeholder engagement

Awards/Recognition: Project has not received any awards.

Lessons Learned:

- The market is moving quickly and cannot be monitored passively. The pace of change is likely to create perceived risk with HVAC service providers and the building industry.
- Cyber security cannot be ignored.
- The industry division between HVAC manufacturers and control developers will require outreach and engagement to bridge the gap.

Interaction of Components in an HVAC Control System



Advanced Commissioning Applications

APPLICATION	Verifying Basic Functionality	Duct Leakage and Air Flow	Refrigerant Charge
BENEFIT OF ADVANCEMENT	• Increase customer satisfaction and avoid call-backs • Energy savings • Save time and labor in field	• Save time and labor in field • Save costs by using the same sensors in multiple applications • Save energy and improve comfort	• Avoid call-backs and equipment damage • Save time and labor in field • Record of proper charging for QC and customer • Reduces poor workmanship
STATE OF THE ART	• Visual inspections and manual data collection • Hand written notes	• Gel based sealant using pressure to fill small holes • Temporary gauge with static pressure probes • Local data collection	• Data collection from temporary sensors • Cloud data transfer and storage • Manifold to charge or check refrigerant level
ADVANCED	• Low cost, integrated temperature sensors, current transducers • Compatibility/ communication between all related components	• Low cost, integrated pressure/airflow rate sensors • Automatic adjustment of variable speed motor • Compatibility communication between all related components	• Low cost, integrated temperature, pressure, and humidity sensors • Compatibility/ communication between all related components

Advanced Maintenance Applications

APPLICATION	Verifying Basic Functionality	Refrigerant Level	Air Filter Replacement	Less Common Faults
BENEFIT OF ADVANCEMENT	• Increase customer satisfaction • Save time and labor in field • Reduce technician visit • Extend system life	• Avoid performance degradation • Save time and labor in field • Save energy and improve comfort • Reduce technician visits	• Avoid performance degradation • Avoid redundancy of sensor installation • Improve IAQ	• Avoid equipment damage • Save time and labor in field
STATE OF THE ART	• Prompted by occupant compliant • Visual inspections • Manual data collection and manual changes • Hand written notes	• Manifold to charge or check refrigerant level • Temporarily installed sensors • Some cloud data storage available	• Permanent pressure sensors as separate product • Notification to homeowner	• Real-time system performance monitoring • Expensive and labor intensive
ADVANCED	• Low cost, integrated temperature sensors and current transducers • Compatibility /communication between all components	• Low cost, integrated refrigerant sensors • Compatibility/ communication between all related components	• Low cost, integrated air pressure sensors • Compatibility/ communication between all related components	• Low cost sensors (many kinds) • Compatibility/ communication between all related components

Advanced Operation Applications

APPLICATION	Comfort	Energy Savings	Grid Power Management
BENEFIT OF ADVANCEMENT	• Increased comfort, health and indoor air quality • Automatic adjustment based on IAQ data • Responds to conditions of multiple locations	• Avoid unnecessary energy use and cost	• Provide grid services: Peak shaving, load shifting, etc.
STATE OF THE ART	• Smart thermostats • Smart ventilation • Whole house (de)humidification	• Automatic night ventilation, set backs • Wireless control of room dampers • Smart phone GPS integration into smart thermostat	• Aggregated data collection and reporting to utilities • Some traditional demand response programs
ADVANCED	• Compatibility/ communication between all related components • User-friendly hardware/software interface • Low cost, accurate occupancy sensors	• Compatibility/ communication between all related components • Improved user interface and occupant sensors	• Compatibility/ communication between single home and aggregated data collection and storage

Project Integration and Collaboration

Project Integration: Internal socialization at BTO.

Partners, Subcontractors, and Collaborators: Pooling knowledge from controls group at PNNL, RBI and ET staff and subcontractors.

Communications: Some stakeholder feedback has been obtained at ASHRAE conferences, Home Performance Conferences, and RESNET Conferences.

Next Steps and Future Plans

Next Steps and Future Plans: Industry and market engagement is a critical next step that must be planned and implemented.

REFERENCE SLIDES

Project Budget

Project Budget: Outline the project budget and history.
Variances: No variances to date
Cost to Date: 90%.
Additional Funding: No other additional funding at this point.

Budget History					
Insert Start Date – FY 2016 (past)		FY 2017 (current)		FY 2018 – 2030 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
100K	0	100K	0	TBD	0

Project Plan and Schedule

Describe the project plan including:

- Project original initiation date & Project planned completion date
- Schedule and Milestones
- Explanation for slipped milestones and slips in schedule
- Go/no-go decision points
- Current and future work