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

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Building America

Quarterly Team Project Update

May 9, 2017

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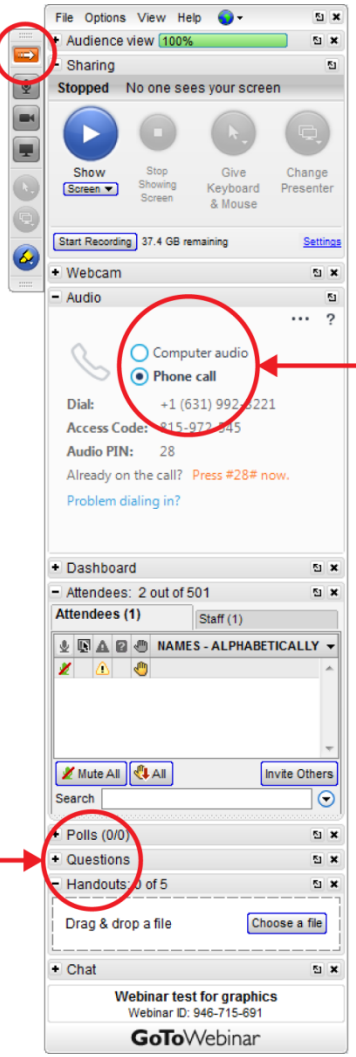
Open and close your control panel



Submit text questions

2 Audio Options:
Use telephone to dial into the call

OR

Use your computer's microphone & speakers ("VoIP")*

**If you are using the Mic and Speakers (VoIP) option, please make sure your computer has a microphone and it is enabled.*

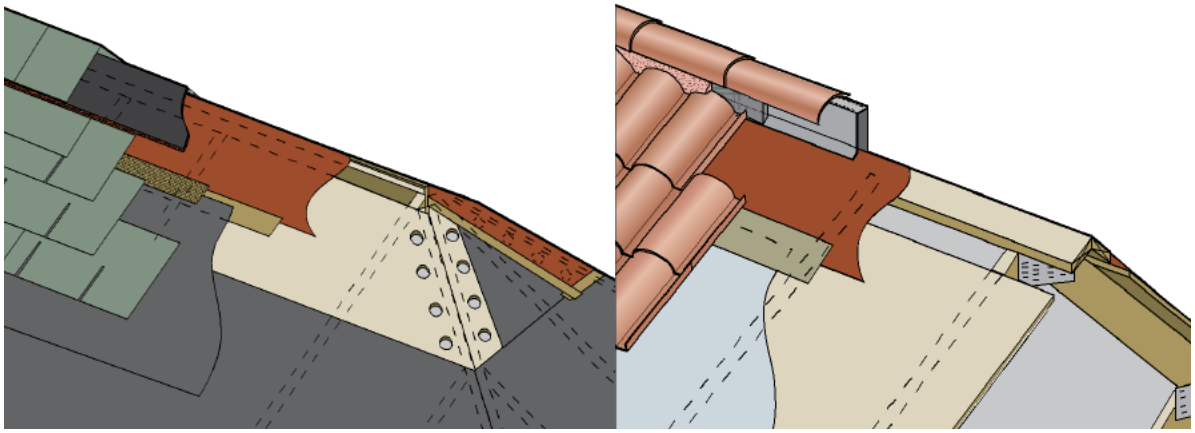
Up Next…

bsc Building Science Corporation

Monitoring of Unvented Roofs with Diffusion Vents and Interior Vapor Control in a Cold Climate

Team and Partners	Topic Area
Building Science Corporation w/ NAIMA, Nu-Wool, DuPont, Owens Corning, Cosella-Dörken, K. Hovnanian Homes	High Performance Moisture Managed Envelopes (2016)

- Field testing of attics with fibrous insulation at roofline (conditioned attic).
- Enables affordable insulation solution for attics, bringing the HVAC equipment into the conditioned space.
- Testing interior vapor control membranes, vapor diffusion ridge vent
- New Construction Field Test
- Existing Manufactured Housing Field Test/ Demonstration
- Up to 3 winters of data



Success Metrics: Assessment & validation of unvented roof construction detail, to enable moisture-managed fibrous insulation solutions in cold climates, achieving code & above code performance (R-49) at up to 80% material cost reduction, and saving >10% in HVAC energy use.

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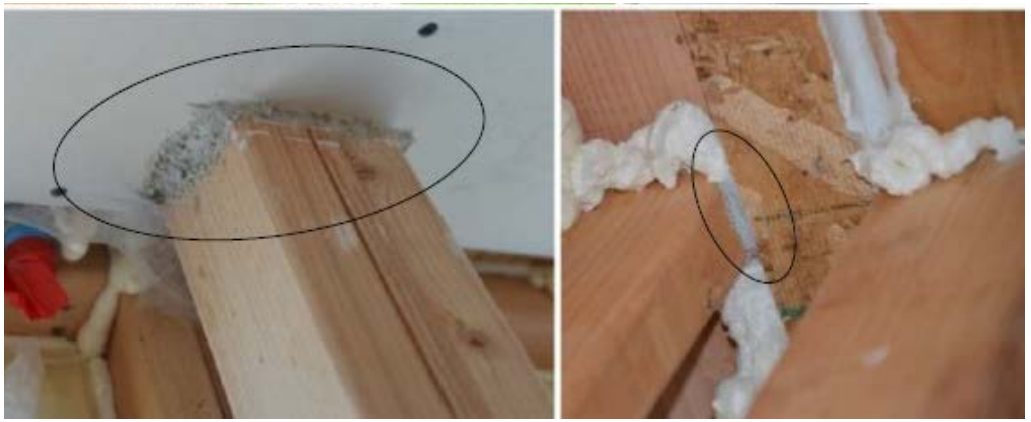
Up Next…

cee
Center for Energy and Environment

Aerosol Sealing in New Construction

Team and Partners	Topic Area
Center for Energy and Environment w/ UC Davis WCEC, Building Knowledge, Aeroseal LLC, UMN Cold Climate Housing Program	High Performance Moisture Managed Envelopes (2016)

- Aerosol sealing method (a successful duct sealing solution) applied to whole house envelope sealing.
- Sealant particles dispersed in pressurized house, sealing envelope gaps up to 3/8” wide, within 60 to 90 minutes.
- Real time feedback of leakage
- Project will develop the optimal integration of this technology into production homebuilders’ practices.



Success Metrics: 20-home study optimizes integration of aerosol envelope sealing in production building process to radically improve QC and significantly reduce labor cost compared to traditional air sealing.

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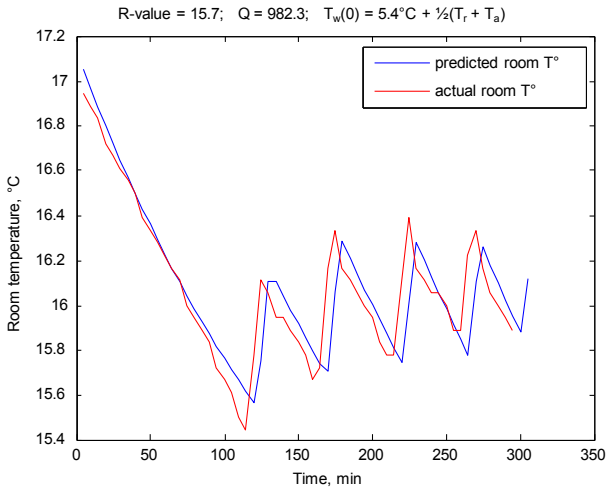
Up Next…

Fraunhofer

Physics-based Interval Data Models to Automate and Scale Home Energy Performance Evaluations – May 2017 Update

Team and Partners	Topic Area
Fraunhofer USA, Inc. with Eversource, National Grid, Holyoke Gas & Electric	Performance Measurement (2016)

Develop a highly scalable tool that automatically and remotely analyzes communicating thermostat (CT) and interval meter data to identify household-specific retrofit opportunities to reduce heating energy consumption, quantify expected retrofit energy savings, and validate post-retrofit energy performance.



Success Metrics: Develop & validate approach that correctly identifies households with the target retrofit opportunities with 1) at least 75% classification accuracy and 2) +/-25% accuracy in predicting retrofit energy savings, to significantly increase the uptake of the target retrofit measures while reducing program recruitment costs per retrofit project. Success metrics include doubling the rate of onsite energy audits in partner utility programs for the target households identified by the tool.

Project Approach and Progress

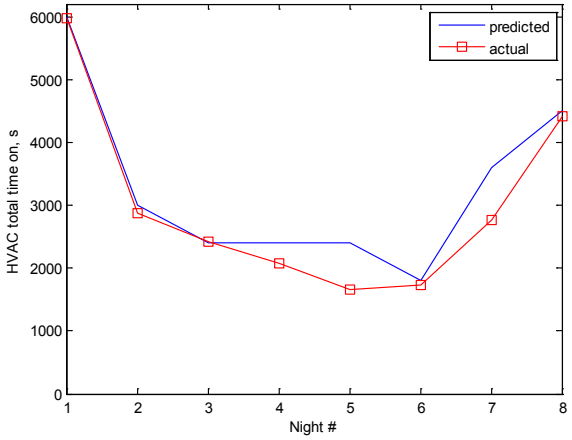
- Develop coarse-grained gray-box models
  - Connect CT data & home thermal parameters
- Leverage existing and new utility data
  - ~80 homes: CT data, home assessments, interval gas and electric meter data
  - Several hundred homes: CT data + home energy evaluations
- Apply to homes/systems of increasing application complexity over project life
  - Regular gas furnaces to condensing boilers
  - Single-zone to multi-zone homes
- Apply Machine Learning to increase accuracy
- Use models to:
  - Estimate home thermal parameters
  - Characterize home-specific classes of retrofit opportunities (e.g., insulation upgrade)
  - Predict home-specific retrofit energy savings

Data Acquisition Progress Update: Obtained Human Subjects approval from CDOEIRB in April

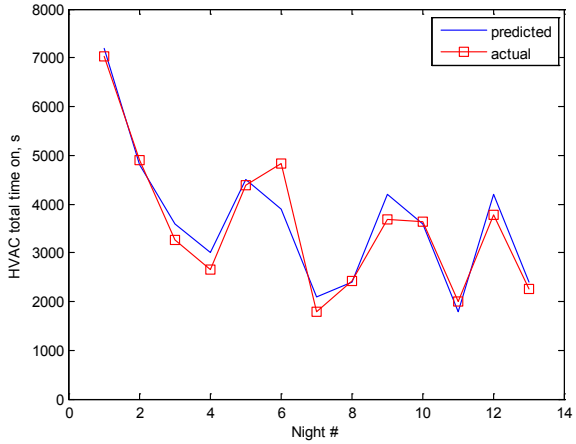
- ~3.5-month process
- Delayed data sharing and field deployment

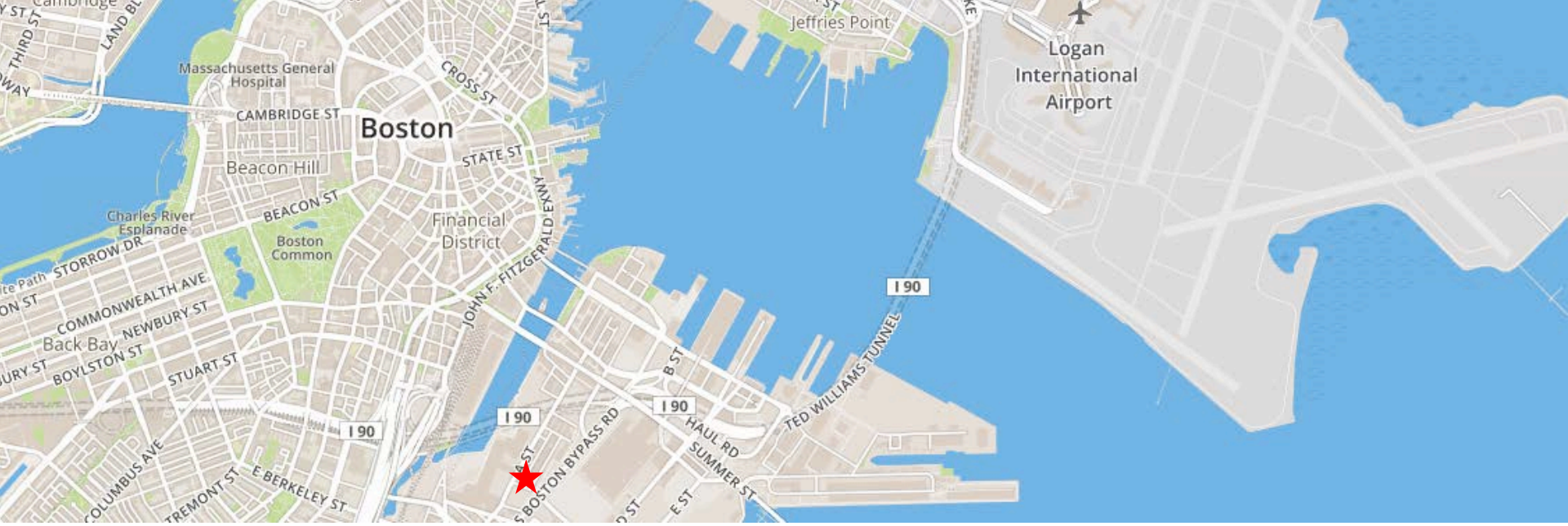
Technical Progress Update: Initial testing of furnace runtime prediction accuracy within ±25% accuracy target.

March :
12.6% error



April:
8.5% error





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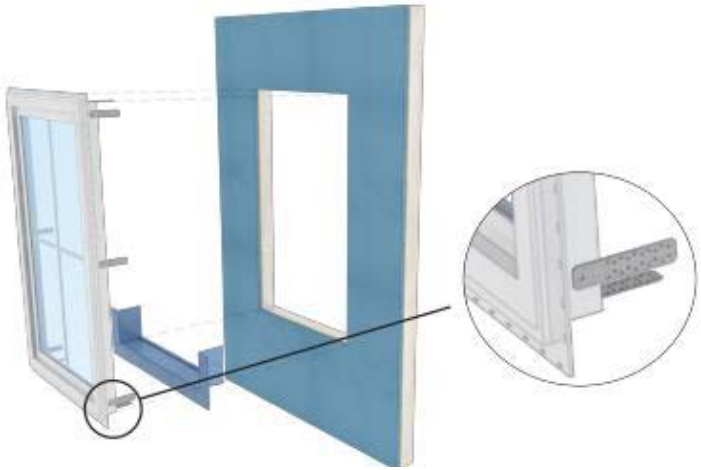
Up Next…

Home Innovation RESEARCH LABS™

Home Innovation RESEARCH LABS

Structural Support of Windows in Walls with Continuous Insulation

Partners	Topic Area
Home Innovation Research Labs, Inc. American Chemistry Council American Architectural Manufacturers Association	Topic 1: High Performance Moisture Managed Envelopes (2016)



- Identify code compliant solutions for window installation in walls with continuous insulation (CI)
- Evaluate the structural performance of walls with windows of varying shapes and sizes, insulation thicknesses, and installation methods.

Success Metrics: Structural performance validation of window installation methods for walls with continuous insulation will provide data & justification for additional methods to be included in industry (AAMA) guidance & IRC code provisions. Results will enable increased use of continuous insulation, which is highly effective at raising overall R-value, eliminating thermal bridging, and mitigating moisture issues.

Up Next…

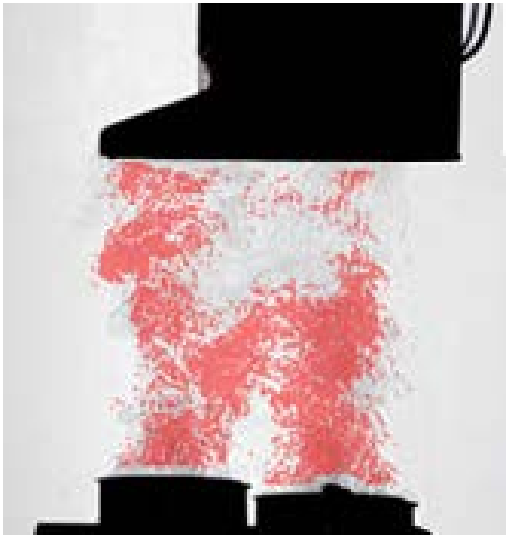
NP

Newport Partners L.L.C.

Development of the Industry's First Smart Range Hood

Team and Partners	Topic Area
Newport Partners w/ Broan-NuTone	Optimal Ventilation & IAQ Solutions (2016)

- Kitchens are the primary source of the most harmful pollutants generated in the home.
- Kitchen range hoods are seldom used and can be ineffective.
- Develop a Smart Range Hood that senses pollutants, with automatic operation.
- Improve residential IAQ, extend lives, and save billions of dollars in health-related costs annually.



Success Metrics: "Smart" range hood developed & validated that is very quiet (≤ 1 sone), up to 5 times more efficient than ENERGY STAR, and near 100% capture efficiency, at a target price point competitive with the intermediate market. Enables tighter homes, ZERH specs, & better IAQ by addressing major indoor pollutant source.

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Up Next…

Southface

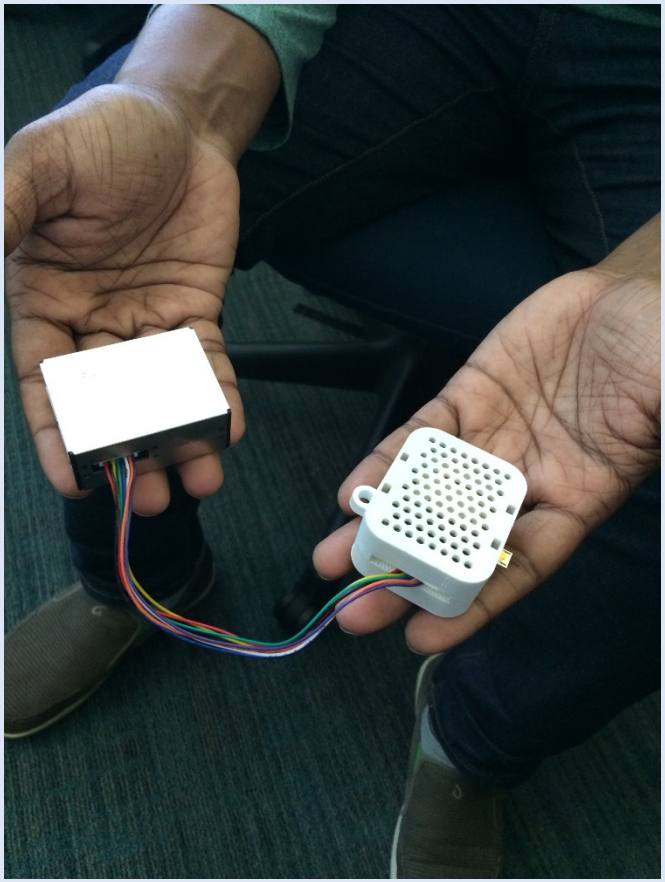
Performance-Based IAQ and Optimized Ventilation

Team and Partners	Topic Area
Southface Energy Institute w/ Underwriters Laboratory, Beazer Homes, Illinois Sustainable Technology Center, Venmar, Kerley Family Homes	Optimal Ventilation & IAQ Solutions (2016)

- Develop assessment protocol incorporating low-cost IAQ sensors: PM2.5, CO_2, O_3, TVOC, and radon sensors
- Benchmark IAQ metrics in new and existing homes
- Smart ERV field tests in real-world homes to evaluate impact on IAQ and energy consumption
- Pilot LBNL-developed IAQ Score in test homes

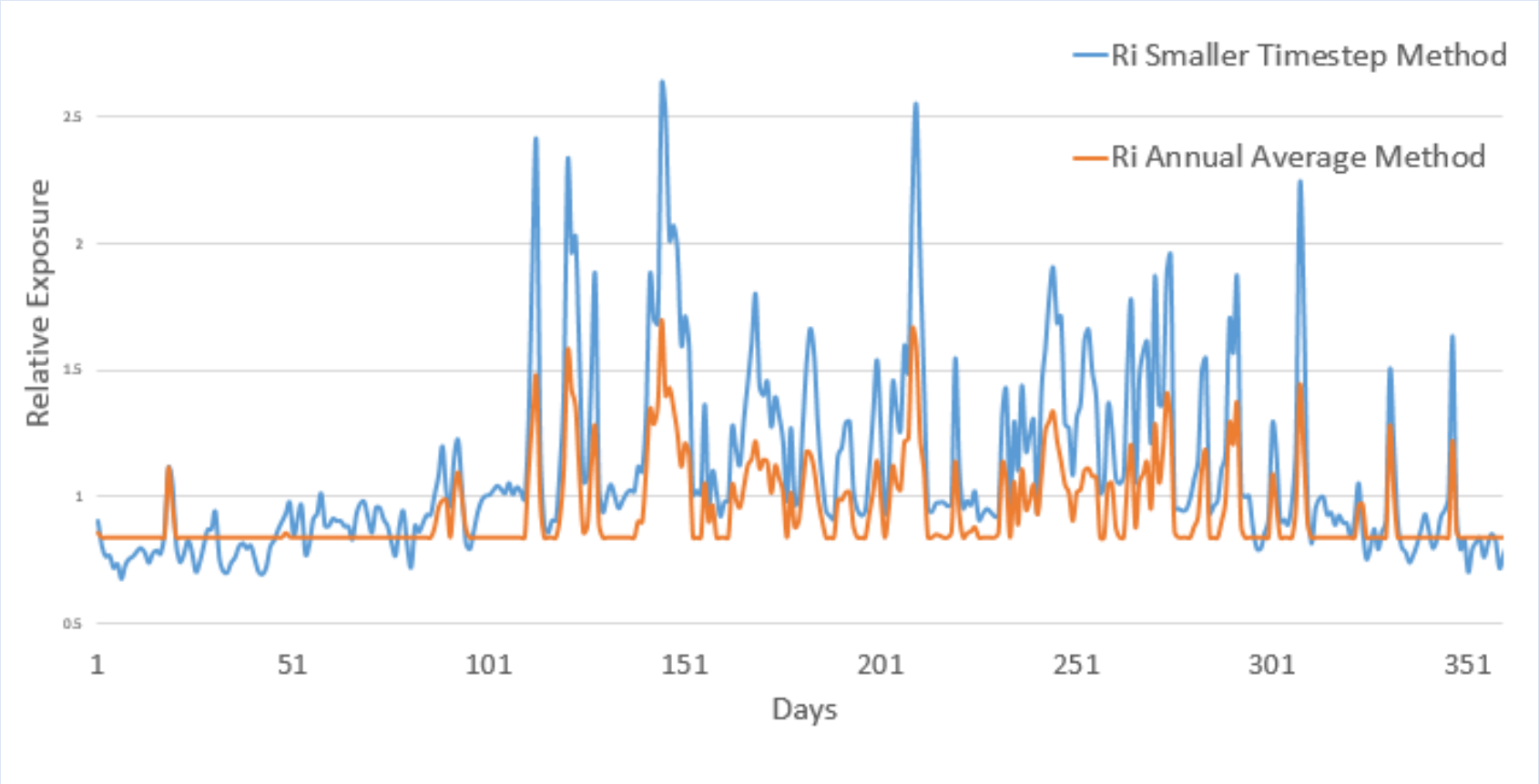
Success Metrics: Develop & validate a performance-based protocol for assessing indoor air quality (IAQ) in homes and inexpensive smart ERV solution that can achieve average annual HVAC energy cost savings of approximately $100 compared to central fan integrated supply systems, and ~50% reduction of ventilation related latent loads compared to supply or exhaust strategies.

Sensors



T/RH, CO_2, $PM_{2.5}$, PM_{10}

ASHRAE 62.2-2016



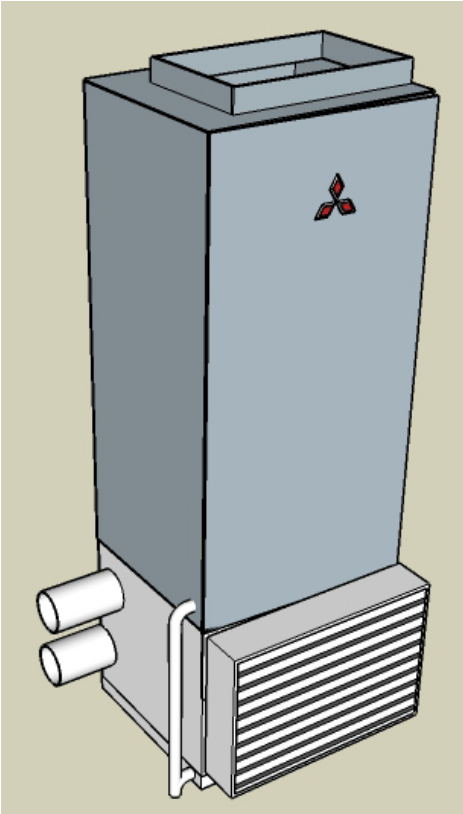
Up Next…

Steven Winter Associates, Inc.

Improving the Built Environment Since 1972

Ventilation Integrated Comfort System (VICS)

Team and Partners	Topic Area
Steven Winter Associates, Inc. w/ Mitsubishi	Optimal Comfort Systems and Optimal Ventilation & IAQ Solutions (2016)



- Development of integrated E/HRV and heat pump
- Variable speed fans for low energy and high controllability
- Test and demonstrate in unoccupied and occupied homes
- Lower cost and better performance than most balanced, heat recovery ventilation options.

Success Metrics: Develop, validate, & demonstrate VICS, to reduce up-front cost $1,000-$2,000 compared to separate E/HRV. Save 400-800 kWh/year compared to exhaust only ventilation. Enables balanced ventilation, better IAQ, & RH control in tight homes at lower cost.

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Up Next…

UNIVERSITY OF MINNESOTA

Affordable, Solid Panel “Perfect Wall" System

Team and Partners	Topic Area
NorthernSTAR **University of Minnesota**	**Topic 1: Moisture Risk Management and High-Performance Envelope Systems**

Research Project Update – Quarter 3

- Developed 2 complete MonoPath house designs for bids
- Completed energy & moisture modeling
- Trained one envelope contractor for solid panel construction
  - 2nd contractor will be trained this spring
- Partners acquired 8 lots for building starts in the next 2 months
- Bringing on a new building partner
  - City of Minneapolis wants to develop a method for delivery and financing of affordable housing on the lots they own
  - This method could be replicated in other urban areas

RENDERING

PROJECT RENDERING

Partners:

MonoPath
Twin Cities Habitat
Urban Homeworks
City of Minneapolis
Building Knowledge, Inc
Thrive, Denver
Unico
Huber Engineered Woods

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Up Next…

FLORIDA SOLAR ENERGY CENTER®

A Research Institute of the University of Central Florida

Variable Capacity Comfort Systems for Low Load Homes

Team and Partners	Topic Area
University of Central Florida **Florida Solar Energy Center**	Optimized Comfort Systems for Low-Load Homes (2015)

Success Metrics: 5-10% space conditioning energy savings in current DOE Zero Energy Ready Homes while maintaining or enhancing comfort.

- Validate system approaches for energy efficient management of temperature and relative humidity in low load homes in humid climates.
- Lab test of inverter driven heat pump with small duct high velocity distribution.
- Field tests of ducted mini-split and ductless multi-splits.
- Potential for better RH control via ability to vary compressor speed, refrigerant flow, and coil air flow.
- Select strategies present opportunities to reduce/eliminate duct losses.
- Investigating distribution of comfort throughout the homes.

Smart Mechanical Ventilation System Control

Team and Partners	Topic Area
University of Central Florida **Florida Solar Energy Center**	Optimal Ventilation and IAQ Solutions (2015)

- Optimize mechanical ventilation in response to variable risk factors.
- Lab test of system controlled by algorithm varying flow real time proportional to outdoor temperature and relative humidity (Florida)
- Field test of system delivering 2 levels of flow in response to 1) outdoor temperature and 2) occupancy (Washington)
- Field test of hybrid supply/exhaust system involving CFIS with variable capacity mini-split.

Success Metrics: 5-10% space conditioning energy savings in current DOE Zero Energy Ready Homes while maintaining IAQ equivalency.

Up Next…

The Levy Partnership

Integrated Design: A High Performance Solution for Affordable Housing

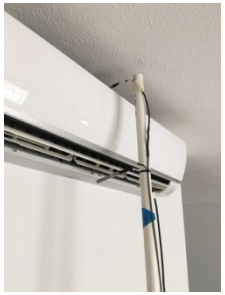
Team and Partners	Topic Area
The Levy Partnership, Inc.	Envelope, Comfort, and IAQ (2015)

- Develop a high performance Integrated Design for affordable housing (Habitat for Humanity and factory-built)
- Combine a high performance enclosure, ductless mini-split heat pump, transfer fans and ventilation
- Monitor 3 test homes, occupied and unoccupied, for 1 year+
- TRNSYS and BEopt models calibrated to field data

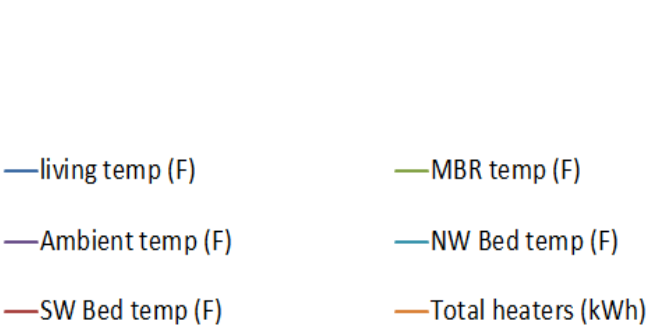
Success Metrics: Reduce space conditioning energy use by 50% relative to IECC 2009 in Habitat and factory built homes in mixed-humid and cold climates

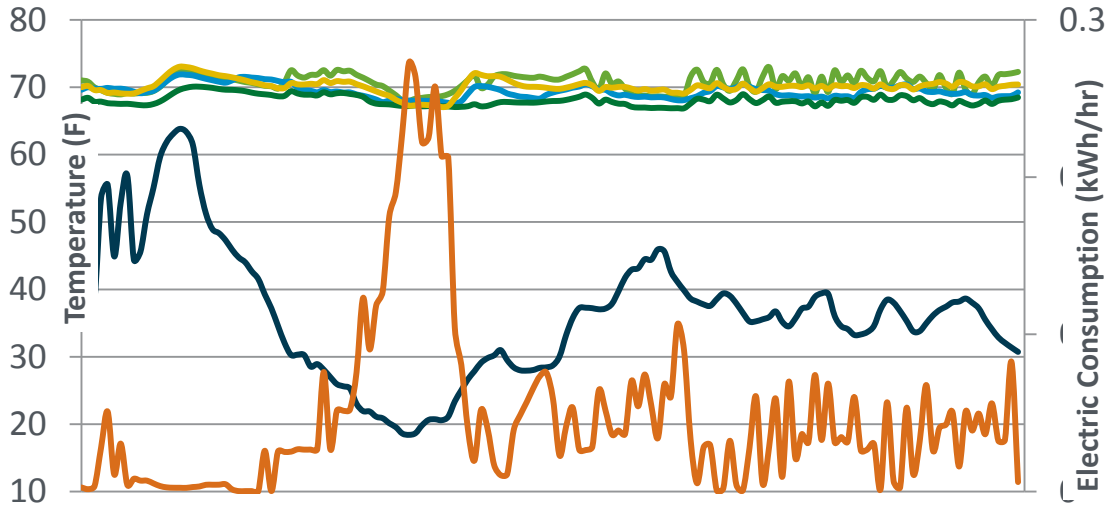
Some Lessons Learned

- Transfer fans can mix the temperatures well - 100+ cfm per room is needed
- Backup heat in bedrooms: 15% site energy
- RH, as expected is an issue for low-load homes
- VRF heat pumps may remove less moisture than non-VRF AC because they run at lower capacities and don't condense as much moisture when operating
- Solutions may include new heat pump features, more precise equipment sizing and/or supplemental dehumidification







ARIES Collaborative

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Up Next…

gti

GAS TECHNOLOGY INSTITUTE

Energy Savings with Acceptable IAQ through Improved Air Flow Control

Team and Partners	Topic Area
Gas Technology Institute, University of Illinois, Midwest Energy Efficiency Alliance, Chitwood Energy Management, National Center for Healthy Housing	Optimal Ventilation & IAQ Solutions (2015)

- This project will develop an integrated assessment that will measure the impact of controlled HVAC duct losses, infiltration, and ventilation options on IAQ and energy savings.
- Field tests of 20 control homes and 20 treatment homes, conducted in cooperation with field practitioners.
- Multiple IAQ measurements including CO2, radon, formaldehyde, humidity
- Guidance for delivering residential retrofits including both good IAQ and maximum energy savings.

Success Metrics: Through systematic management of airflows, provide improved energy savings with the same IAQ or improved IAQ with the same energy savings.

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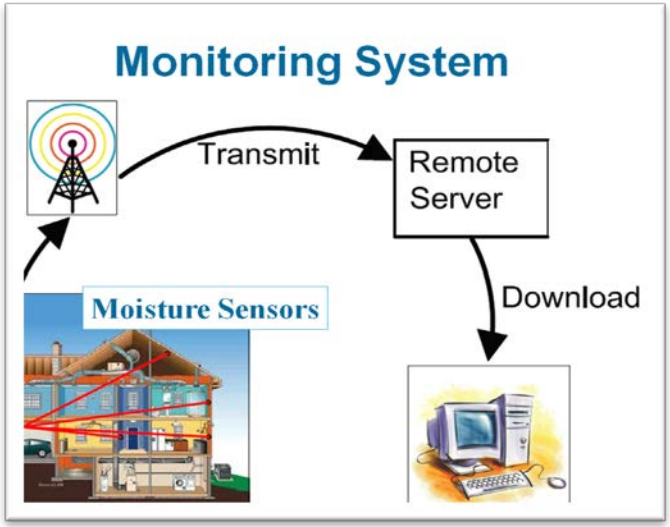
Up Next…

Home Innovation RESEARCH LABS™

Moisture Performance of High-R Wall Systems

Team and Partners	Topic Area
Home Innovation Research Labs w/ American Chemistry Council, NAHB, USDA Forest Products Lab, VSI	High Performance Moisture Managed Building Envelopes (2015)



Goal: Study moisture performance of high-R walls (>R-20) in occupied high performance homes across different climate zones. Improve builders' confidence and facilitate transition to high-R walls.

Success Metrics: Measured and modeled performance of high-R walls and design guidance to ensure durability of high performance walls.

Extended Plate and Beam (EP&B) Wall System

Team and Partners	Topic Area
Home Innovation Research Labs, Inc. w/ American Chemistry Council, Forest Products Laboratory, The Dow Chemical Company, Builder Partners: Arn McIntyre Construction, Kevin L. Smith Construction	High Performance Moisture Managed Envelopes (2015)

Goal: Study the constructability and structural/moisture performance of high-R walls with rigid foam insulation interior to the wood structural sheathing

Success Metrics: Efficient, cost-effective, durable wall assembly to meet and exceed new IECC targets

Attic Retrofits Using Nail-Base Insulated Panels

Team and Partners	Topic Area
Home Innovation Research Labs, Inc. w/ SIPA, ACC, APA, Dow, DuPont, Owens Corning	High Performance Moisture Managed Building Envelopes (2015)

Purpose: Develop and demonstrate a roof/attic energy retrofit solution using retrofit panels for existing homes where traditional attic insulation approaches are not effective or feasible.

Success metrics: Heating and cooling energy savings of at least 10%; improved comfort; monitored data that confirms acceptable moisture levels.

Up Next…

Discussion Topics

Up Next…

March All Team Meeting

Next Steps

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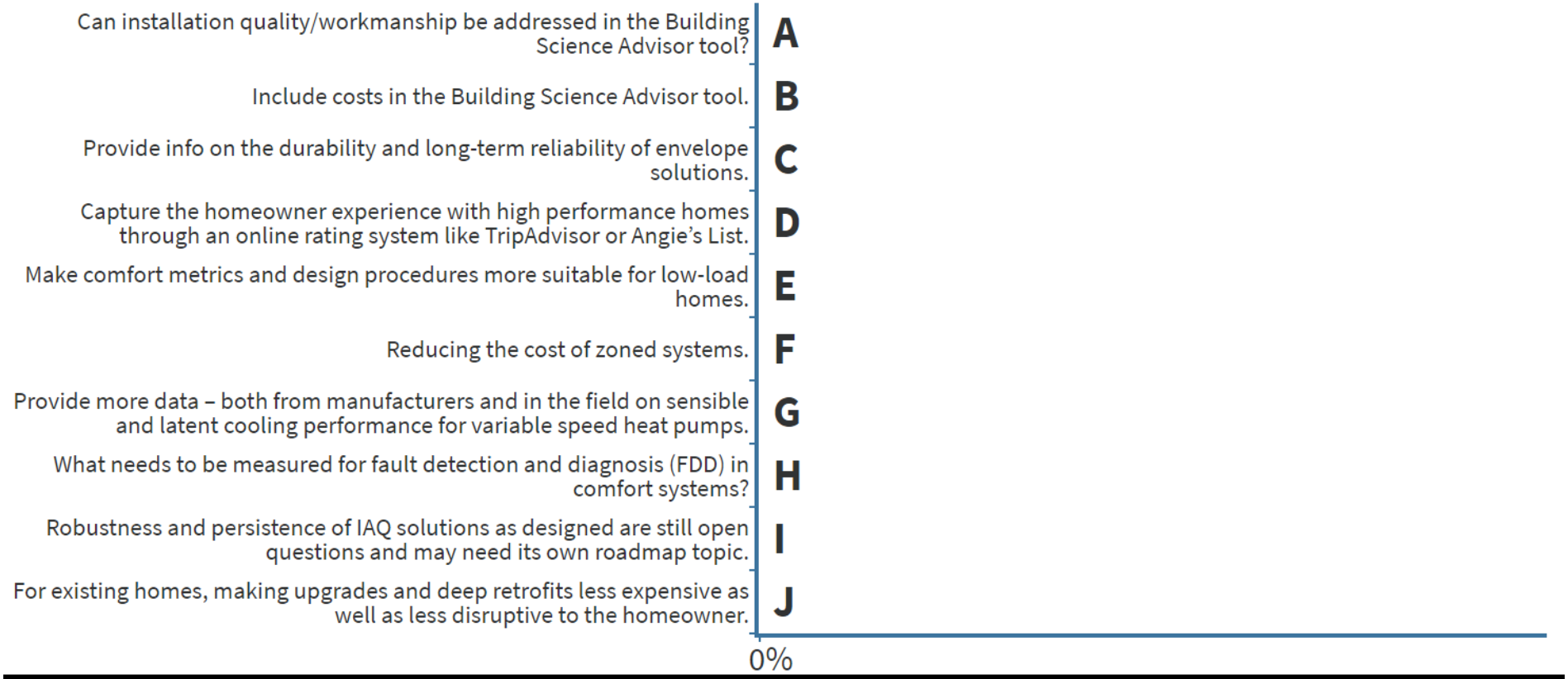
Select the top three topics you find most important.

Respond at **PollEv.com/doeba** Text **DOEBA** to **22333** once to join, then **A, B, C, D, E...**



Poll Everywhere

Up Next…

Building Science Advisor

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Up Next…

Existing Homes Roadmaps

Building America Integrated Roadmaps for Existing Homes

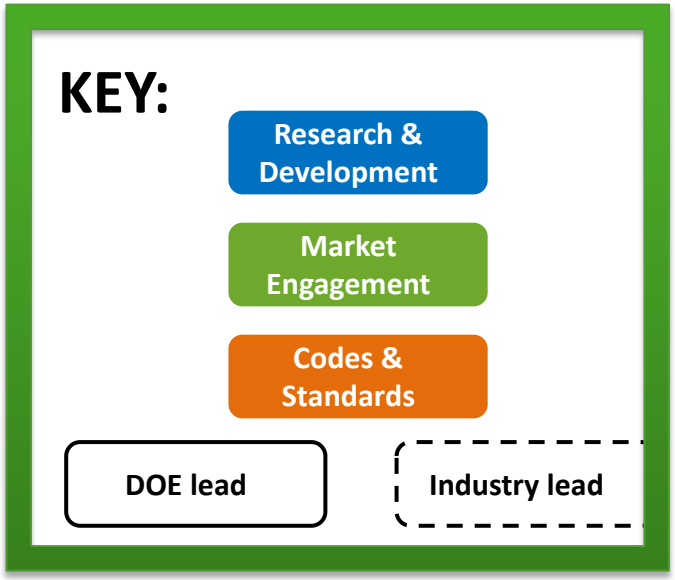
A. Envelope Upgrade Solutions for Existing Homes

B. Optimal Comfort System Performance in Existing Homes

C. Reliable Performance Measurement

Overall Roadmap Objectives:

- Standard Practice as endpoints
- Manage risks to minimize problems of adoption
- Address optimal performance & cost-effectiveness
- Solutions must be practical & profitable for home improvement contractors and consumers



A. Envelope Upgrade Solutions for Existing Homes

2018	2019	2020	2021	2022	2023

Lab & Field Moisture Risk Assessment of Priority Envelope Upgrade Materials & Practices

Thermal Envelope Upgrade Solutions

- **Validate Envelope Insulation Upgrades in Real World Test Homes**
- **Specs in Voluntary Program Standards**
- **Guidance/Tools & Best Practice Specs for Envelope Upgrades in Each Climate**

- **Develop and Validate Infiltration Solutions for Existing Homes**
- **Guidance & Best Practices for Infiltration Solutions in Existing Homes**

Air Infiltration and IAQ Solutions

- **Manufacturers Develop Targeted IAQ Solutions**
  including advanced air cleaning & humidity control systems
- **Validate Targeted IAQ Solutions**
  for existing homes
- **Specs in Voluntary Programs**
  Advanced filtration & smart ventilation
- **Guidance/Tools & Best Practice Specs for IAQ Solutions in Existing Homes**

B. Optimal Comfort System Performance in Existing Homes

2018	2019	2020	2021	2022	2023

Validate/Demonstrate Comfort System Solutions in Existing Homes including distribution and dehumidification

Best Practice Guidance on Comfort System Solutions in Existing Homes

FDD, Sensors/Controls Metrics & Communication Standards

Innovative Systems and Equipment

Develop & Validate Smart, AFDD & Optimization
Sensors, controls, learning algorithms for maintenance & operation

Best Practice Guidance on Automated HVAC Operation, Controls & Maintenance

Installation Tools and Methods

Develop Baselines and Metrics for Installation & Retrocommissioning

Best Practice Guidance/Training on Installation & Retrocommissioning

Develop Smart Tools for Quality Installation & RCx

Validate/Demonstrate Smart Tools for Quality Installation & RCx

Best Practice Guidance & Training on Smart Tools for QI & RCx

B. Optimal Comfort System Performance in Existing Homes

Validate/Demonstrate Comfort System Solutions in Existing Homes including distribution and dehumidification

Best Practice Guidance on Comfort System Solutions in Existing Homes

- Equipment replacement strategies that are compatible with existing distribution systems and achieve proper distribution and comfort in reduced-load existing homes.
- Innovative distribution systems that are easily installed in existing homes and minimize or eliminate distribution system losses.
- Innovative dehumidification equipment and approaches (add-on or integrated) for whole-house humidity control in existing homes.

B. Optimal Comfort System Performance in Existing Homes

FDD, Sensors/Controls Metrics & Communication Standards

Develop & Validate Smart, AFDD & Optimization
Sensors, controls, learning algorithms for maintenance & operation

Best Practice Guidance on Automated HVAC Operation, Controls & Maintenance

- Incorporating smart HVAC sensors and controls as add-ons to existing equipment or onboard replacement equipment
- Monitoring existing systems to predict wear-out and avoid emergency replacement
- What other FDD/Smart Control needs are specific to existing homes?

B. Optimal Comfort System Performance in Existing Homes

Develop Baselines and Metrics for Installation & Retrocommissioning

Best Practice Guidance/Training on Installation & Retrocommissioning

- Installed performance of systems with both existing and new components (e.g., Condensing unit is replaced, while existing evap coil, AHU, furnace, and ducts remain)
- Best practice installation techniques to minimize installation costs and improve the likelihood of achieving expected performance.
- Quantify the potential energy savings, comfort improvement, and increased equipment lifespan associated with commissioning new HVAC systems in existing homes and retro-commissioning existing HVAC systems?
- What other gaps in QI are specific to existing homes?

B. Optimal Comfort System Performance in Existing Homes

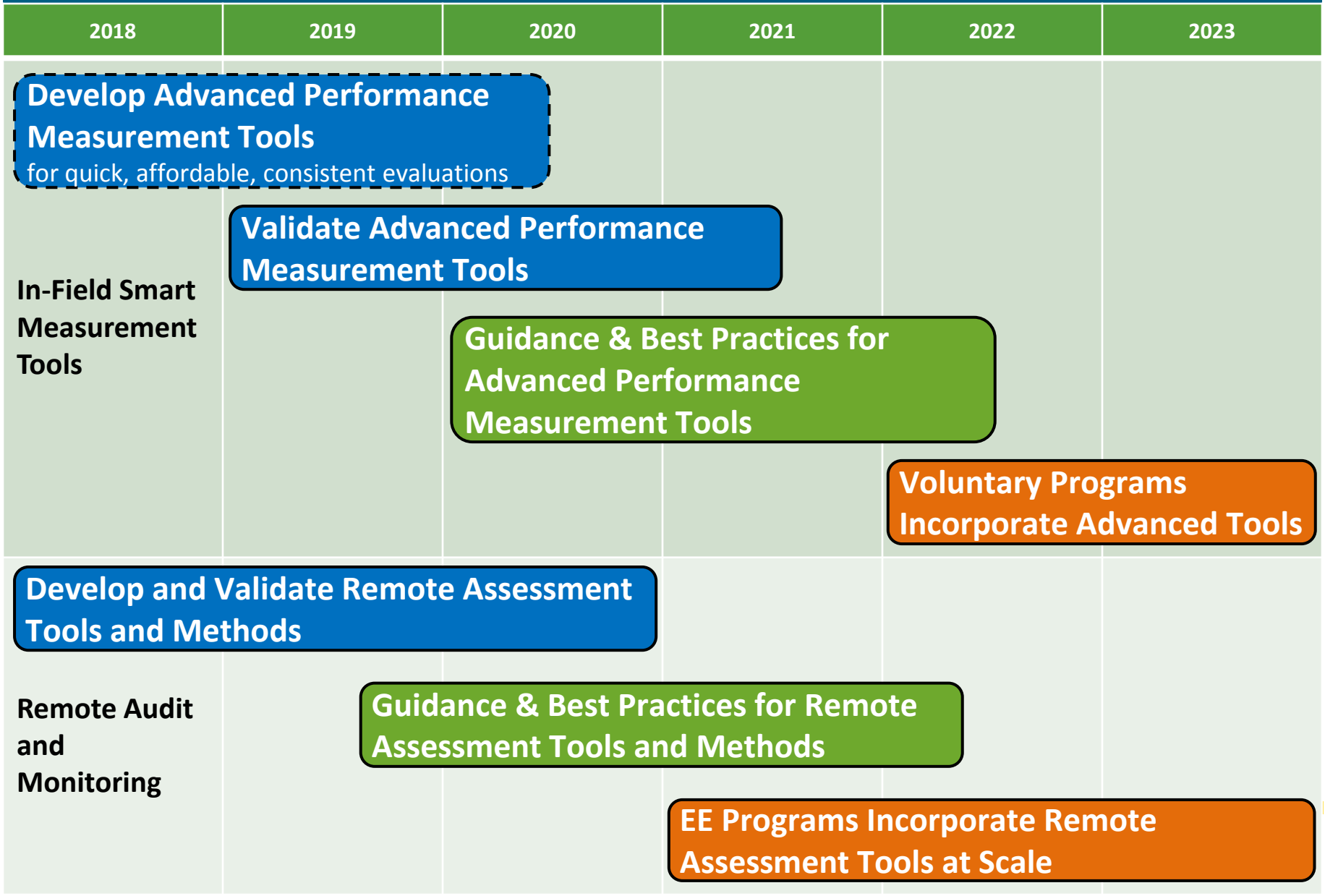
Develop Smart Tools for Quality Installation & RCx

Validate/Demonstrate Smart Tools for Quality Installation & RCx

Best Practice Guidance & Training on Smart Tools for QI & RCx

- What technical or research gaps related to smart tools are specific to existing homes?

C. Reliable Performance Measurement



C. Reliable Performance Measurement: In-Field Tools

Develop Advanced Performance Measurement Tools
for quick, affordable, consistent evaluations

Validate Advanced Performance Measurement Tools

Guidance & Best Practices for Advanced Performance Measurement Tools

Voluntary Programs Incorporate Advanced Tools

- What technologies are needed to enable quick, affordable, and consistent evaluations of existing homes?
- What could be automated to reduce cost, labor, and HPC error?
- Measurement tools that help HPCs develop expertise.

C. Reliable Performance Measurement: Remote Assessment Tools

Develop and Validate Remote Assessment Tools and Methods

Guidance & Best Practices for Remote Assessment Tools and Methods

EE Programs Incorporate Remote Assessment Tools at Scale

- Non-invasive, cost-effective and accurate remote assessment tools to identify opportunities for significant energy savings and/or verify improved performance.
- What research or technology advancements are needed to enable this?
- Privacy concerns?

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Thank you!