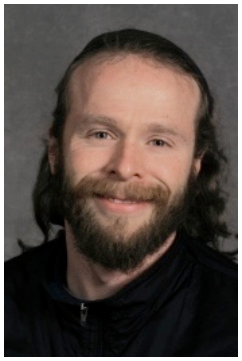
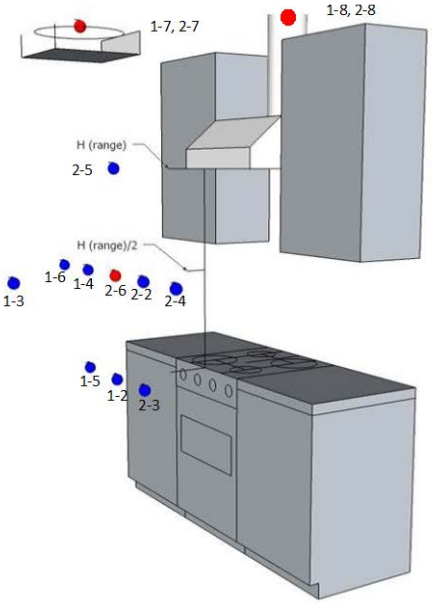
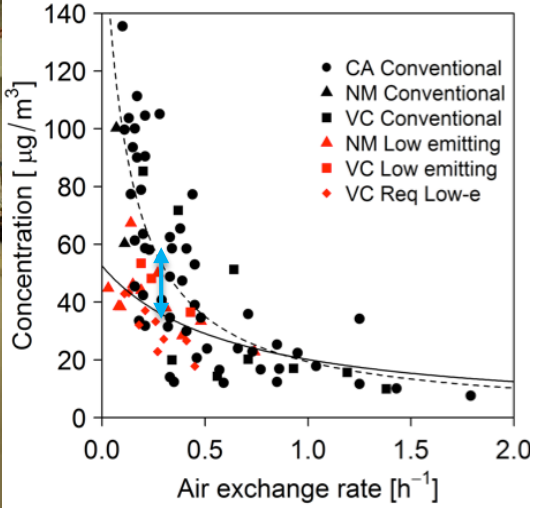
Healthy Efficient Homes Research & Standards

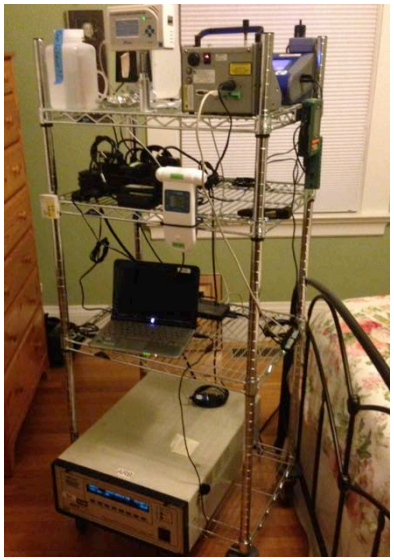
2017 Building Technologies Office Peer Review







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Lawrence Berkeley National Laboratory

Project Summary

Timeline:

Start date: FY16

Planned end date: FY18

Key Milestones (FY17: Month/Year)

1. Report on downdraft / island hood test 12/16
2. Plan for national IAQ study (->FOA) 12/16
3. Report occupancy-based ventilation 5/17
4. Report low-cost IAQ monitor evaluation 9/17
5. Beta version of IAQ score 9/17

Budget:

Total Project $ to Date:

- DOE: $1.8m Mar17; $2.6m end FY17
- Cost Share: $2.7m through FY17

Total Project $:

- DOE: $3.9m
- Cost Share: $3.8m

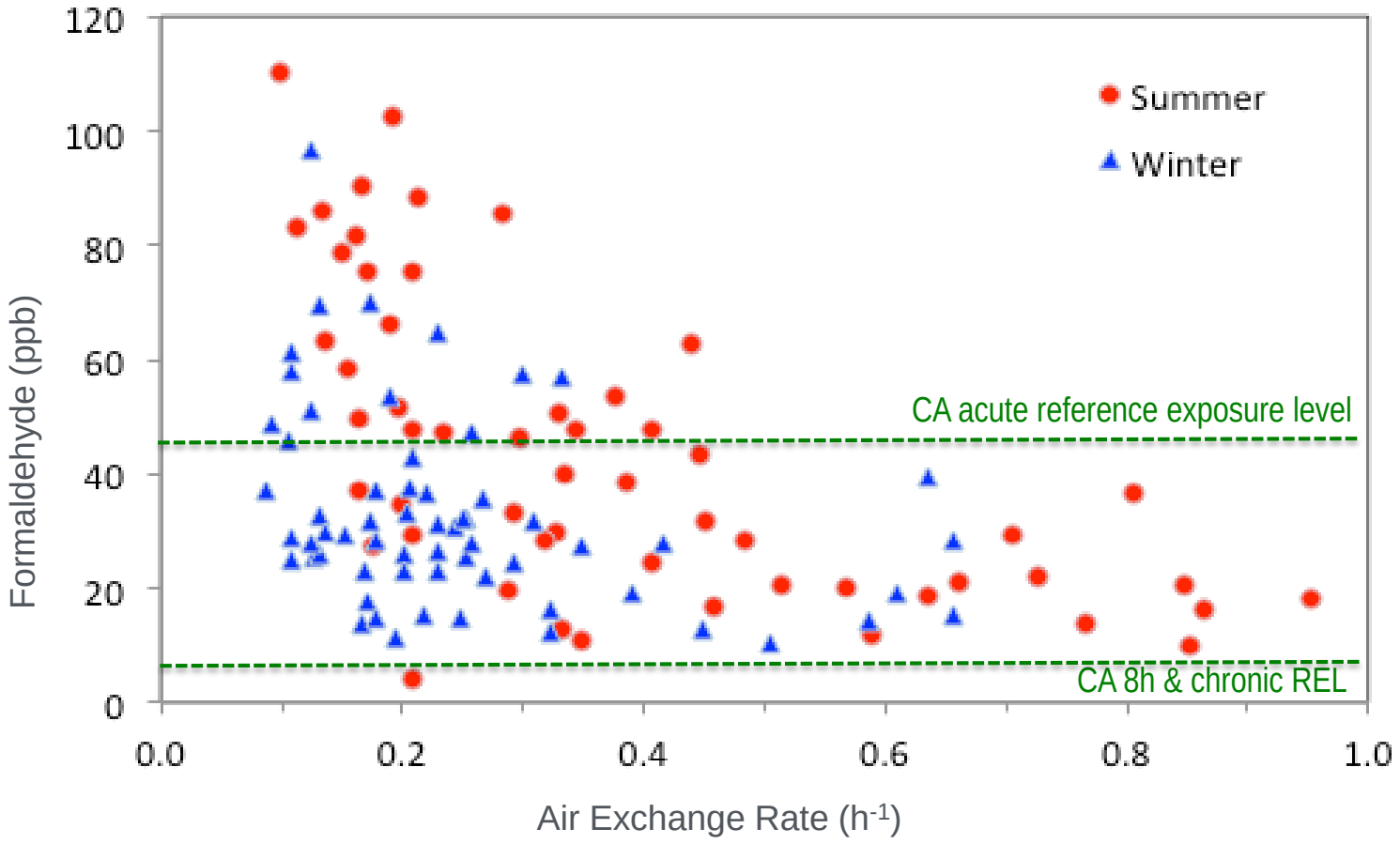
Key Partners:

ASHRAE	Air Infil. & Ventilation Ctr
ASTM	Cal Air Resources Board
EPA & HUD	Cal Energy Commission
HUD	Home Ventilating Inst.
RESNET	GTI, PG&E, SoCalGas
Aeroco	Assoc. Energy Affordability

Project Outcome:

This project will produce innovative technologies, industry guidance and codes and standards that ensure good indoor air quality (IAQ) in homes. This will remove barriers concerning IAQ while reducing the energy cost of IAQ, and allow the building industry to achieve the 40% energy savings in existing homes and 60% reductions in new homes targeted in the MYPP.

Problem: Pollutants elevated in tight homes w/o ventilation



Results from California New Home Study*

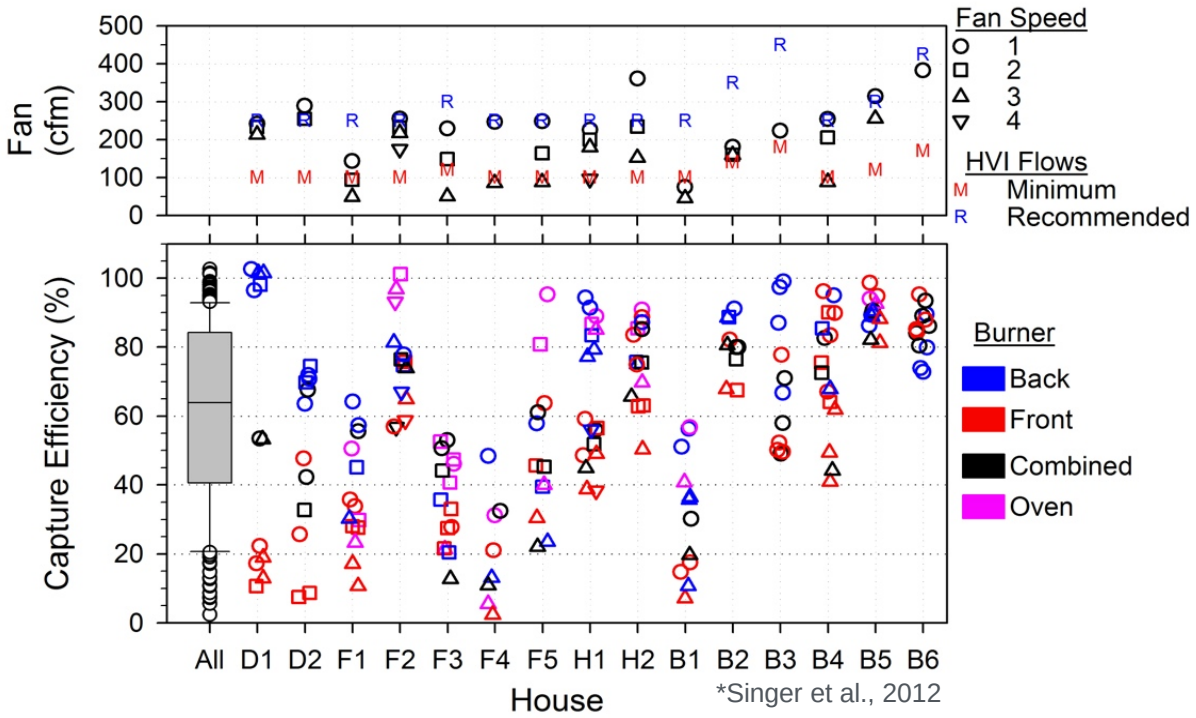
Built in 2002-5
Msd in 2006-7
N=108

*Offermann, California Energy Commission Report CEC-500-2009-085

Problem: Ventilation requirements may be insufficient

Standard	Fraction of people exposed above std.	Estimated # impacted in California	Estimated # impacted across U.S.
CO, 1-h CAAQS	9%	1.7M	10M
NO_2, 1-h NAAQS	62%	12M	66M

Based on simulations of 6634 SoCal homes. Typical Week in Winter. (Logue et al., 2014)



*Singer et al., 2012

- Kitchen ventilation not required by many states
- ASHRAE 62.2 standard requires 100 cfm & 3 sone
- Many hoods ineffective; no way to know
- Most people unaware of the hazard

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Purpose and Objectives

Problem Statement:
Concerns about indoor air quality (IAQ) and moisture problems are a market barrier for airtight efficient homes. Interest in improving health through IAQ is a motivator for retrofits that reduce energy. Industry needs guidance supported by research & demonstrations.

Target Market:
New homes and homes undergoing renovation/retrofit.

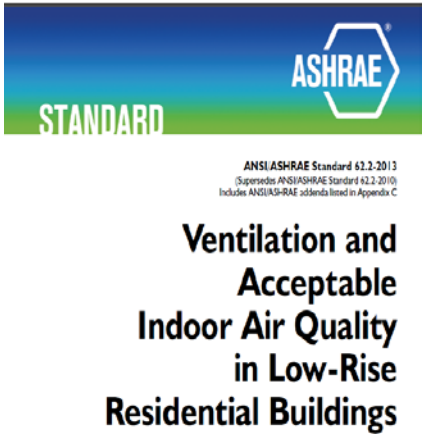
Audiences:
Designers, builders, contractors, utility programs, code authorities, public health & housing agencies, ventilation and IAQ equipment manufacturers.

Goal is to enable air sealing to reduce heating and cooling energy of residential stock by 15-30% (0.7–1.4 quads).

Purpose and Objectives

Impact of Project:

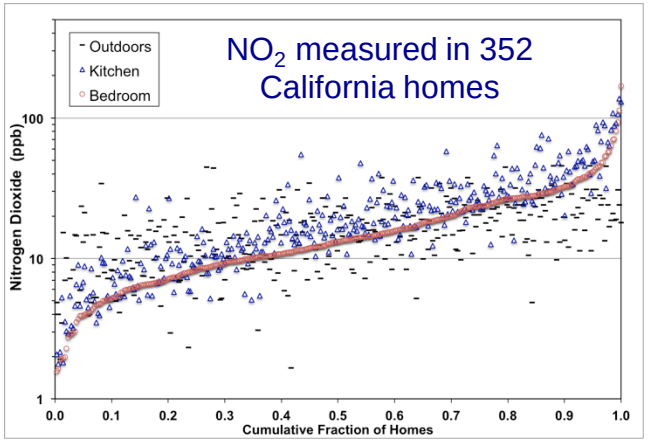
1. Products are peer-reviewed papers, technical reports and presentations guiding practice, standards, codes, and product development.
2. Progress measured by adoption of efficient & healthy home designs, innovative products and technologies, and appropriate standards
3. Success is zero-energy ready new homes and deeply retrofitted existing homes without adverse IAQ and health impacts.



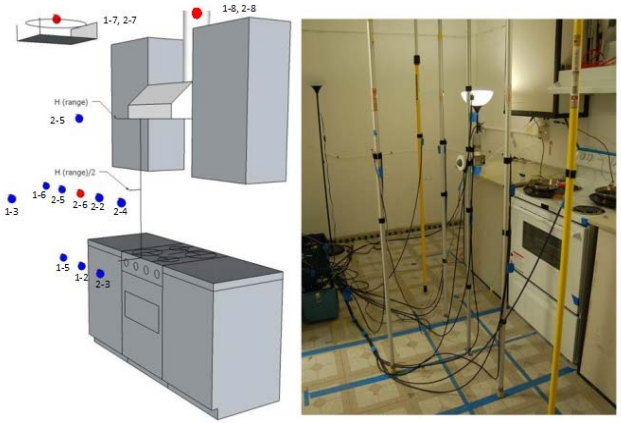
Approach – R&D Methods

Laboratory experiments

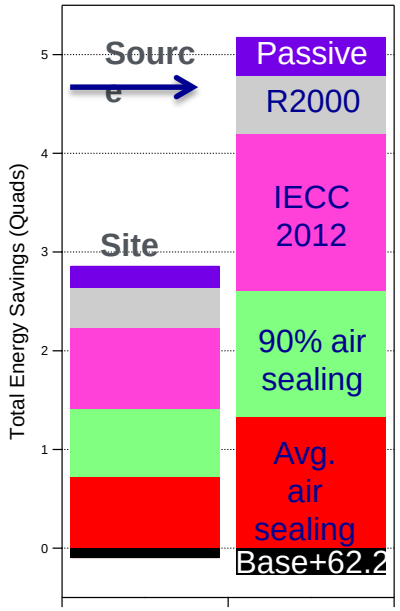
Surveys and data collection



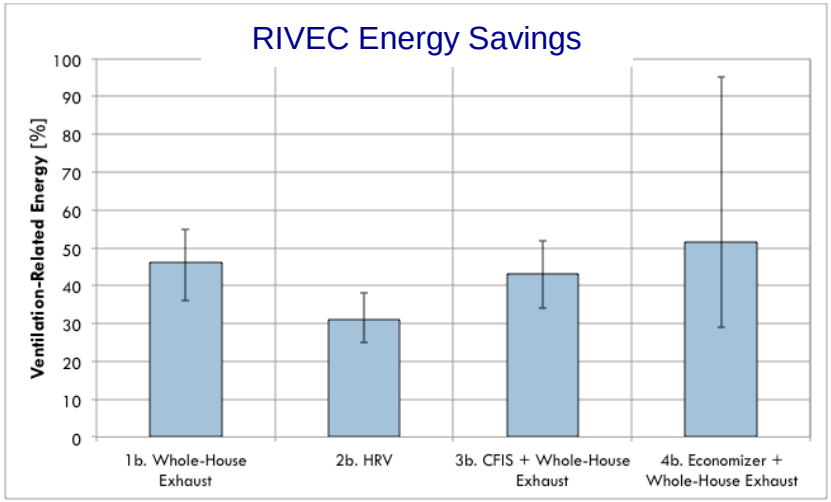
Test method development & demos



Controlled experiments in homes



Analysis & Simulations



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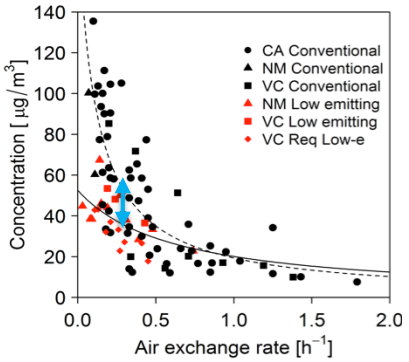
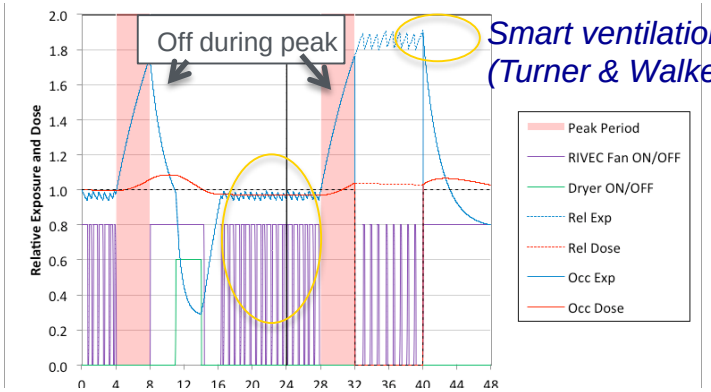
Approach – Key Issues from Tech to Market Roadmap

- **Targeted pollutant solutions:** source reduction & task ventilation to reduce general dilution ventilation.



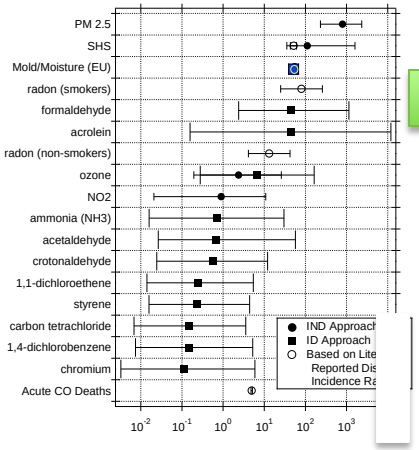
Formaldehyde 42% lower in homes built with low emitting materials (Hult et al. 2014)

- **Smart ventilation technologies** that reduce energy and peak loads. Sensors and controls to integrate all ventilation equipment for optimal energy and IAQ.



Smart ventilation savings (Turner & Walker, 2013)

- **IAQ valuation** methods to standardize assessment, prioritize measures and inform buyers of high performance homes.



A-

HEALTH: 85
MOISTURE: 95
IRRITANTS: 92

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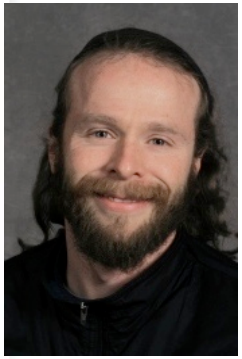
Approach – Distinctive Characteristics

1. *Experienced team with expertise in residential energy, ventilation, and IAQ science and methodologies.*
2. *Building science principles and rigorous research methods.*
3. *Appropriate methodologies to achieve technical innovations*.
4. *Strong industry connections*.


Iain Walker


Brett Singer


Rengie Chan


Woody Delp

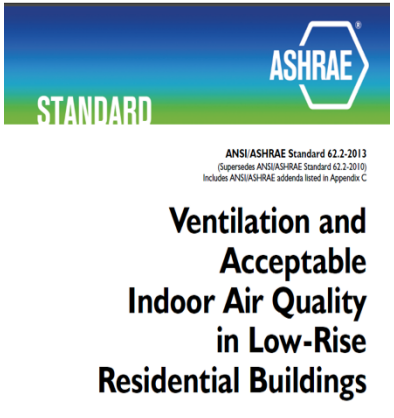

Spencer Dutton


Brennan Less


Max Sherman

Progress and Accomplishments FY16–FY17

- Standard diagnostics for home energy ratings (RESNET 380)
- Increased flexibility in ASHRAE 62.2, enabling smart ventilation innovations
- Developed smart ventilation controls to reduce moisture risks in humid climates
- Test for range hood effectiveness to inform buyers and incentivize product quality
- Designed national study to assess IAQ in homes with/out mechanical ventilation



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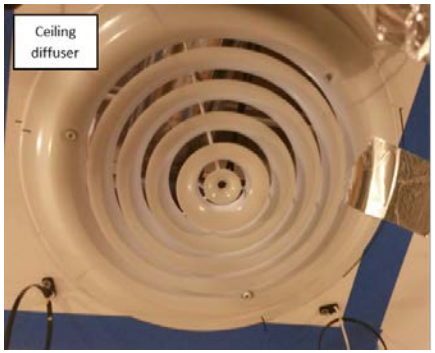
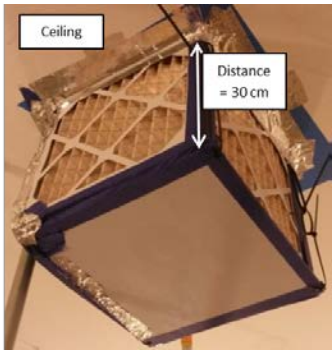
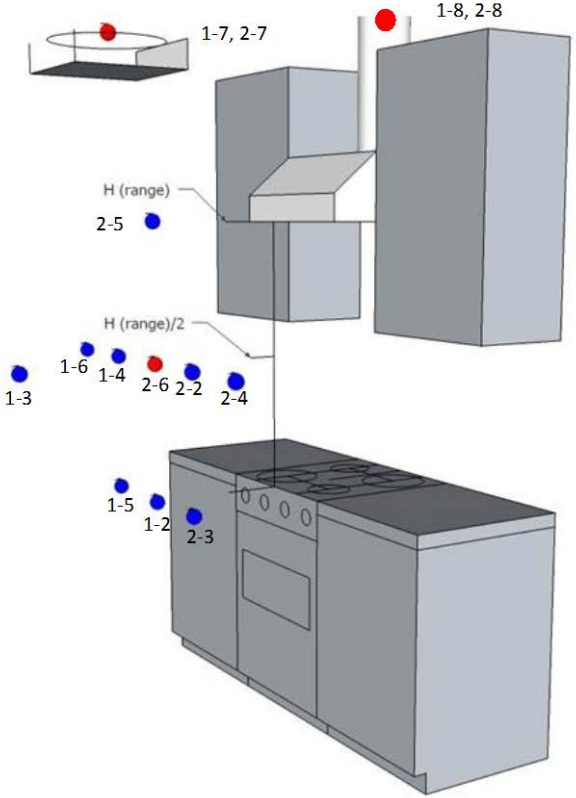
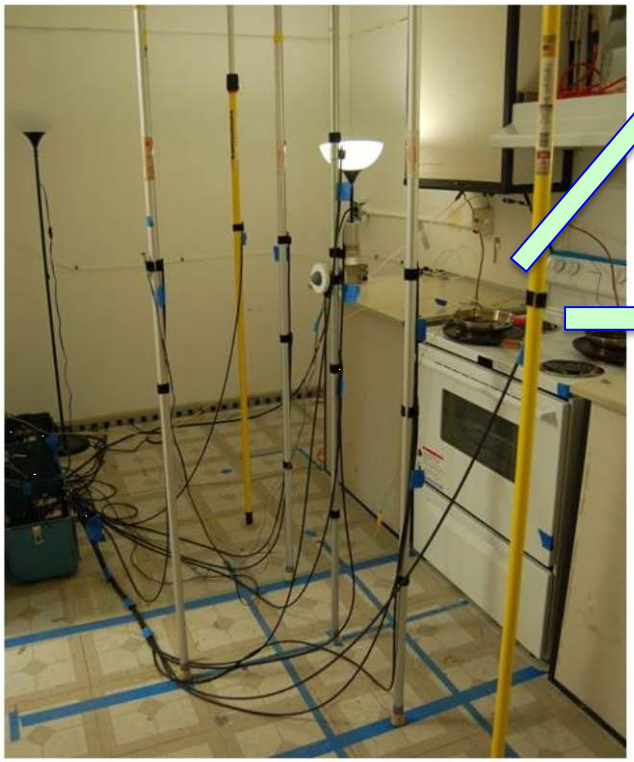
Finalized Range Hood Test Method

Inlet designed for consistent airflow





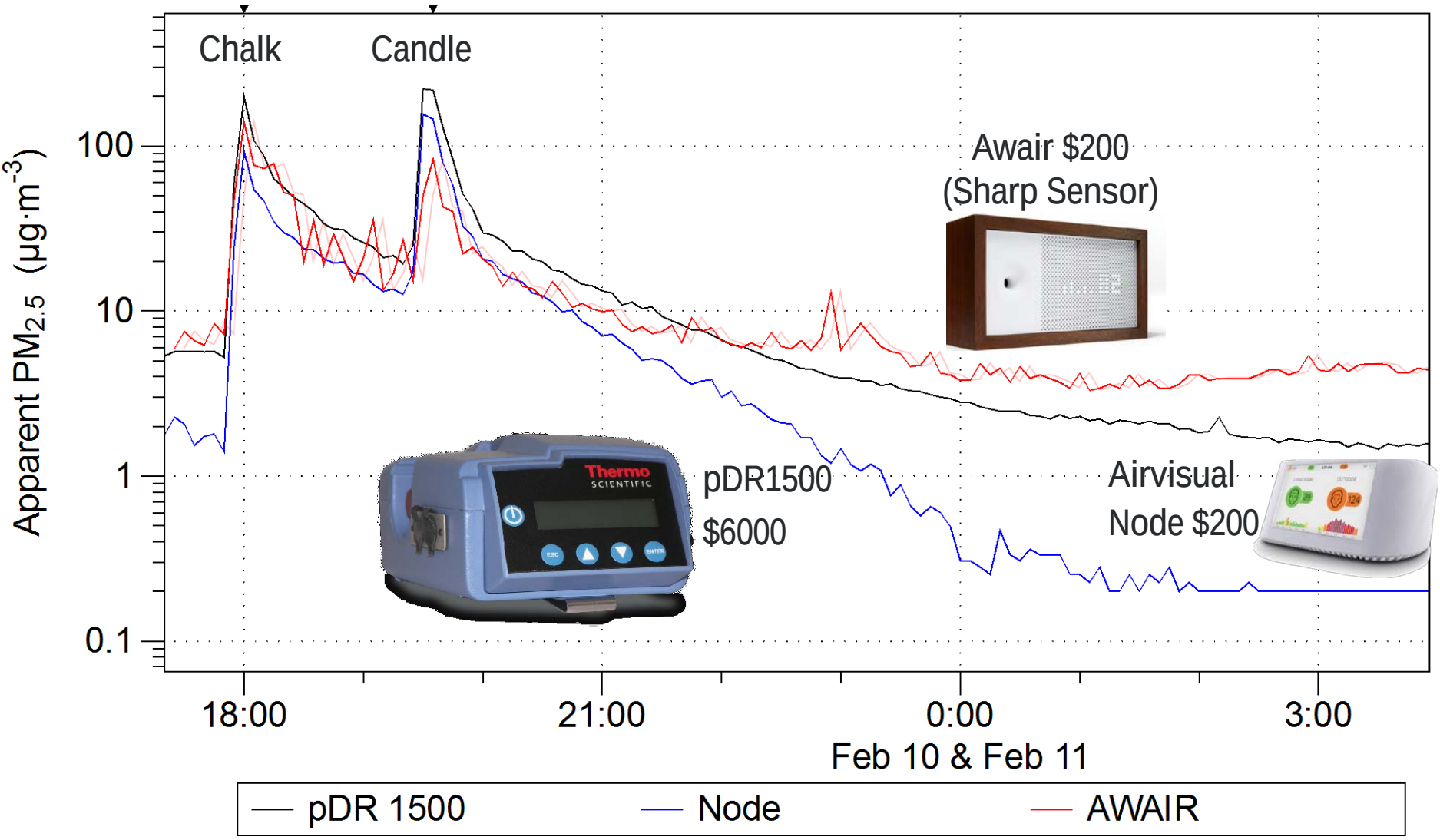




Emitters designed for repeatable distribution

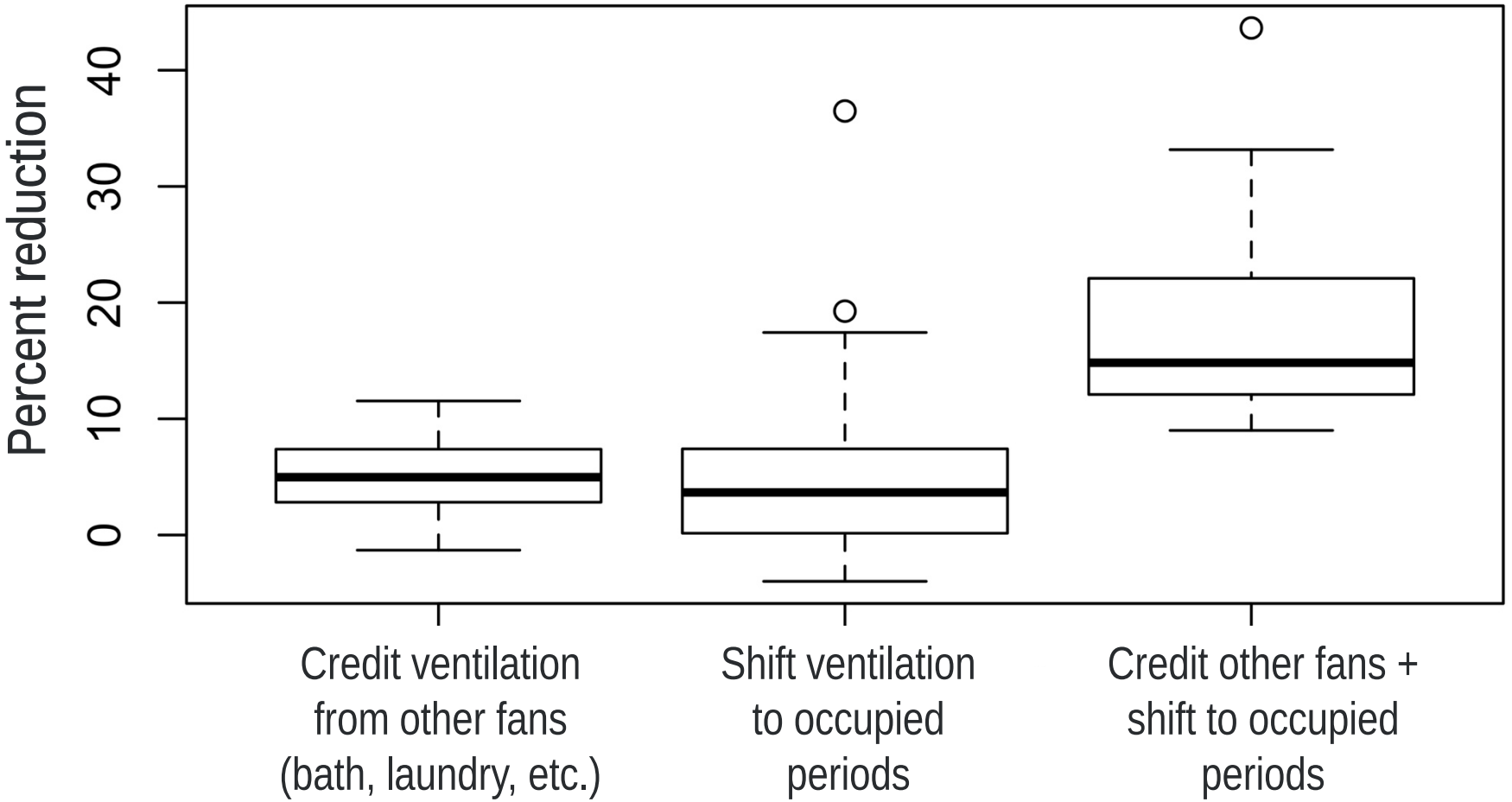
Low-Cost IAQ Sensor and Monitor Evaluations

- Focus evaluation on detection and quantification of indoor sources.
- Evaluate with simulated sources in lab and in homes over time.



Progress on Smart Ventilation

Annual reduction in ventilation load (%), based on simulations across US climate zones. Top of box is 75th percentile. Bottom is 25th percentile.



Progress and Accomplishments

Market Impact:

- RESNET standards advance performance in ~40% of all new homes.
- ASHRAE 62.2 protects IAQ in all DOE weatherization homes plus many retrofits and new homes throughout the US.
- HEH findings support smart ventilation technology development and use of home IAQ monitoring devices.
- Expanded recognition of importance of kitchen exhaust ventilation. Standard test expected to spur product labeling and improvements.

Lessons Learned:

- Long path to approved standard, even with consensus on goal.
- Adoption of new products and practices can depend more on marketing and perception than performance or even cost.

Partners, Subcontractors, and Collaborators

Industry

Quality Standards

Utilities and Related

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Communications

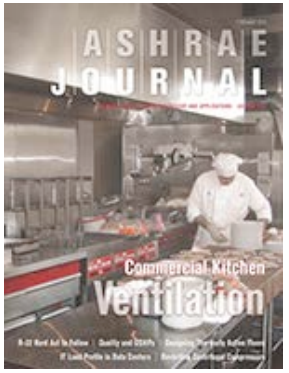
Scientific Journals

ehp ENVIRONMENTAL HEALTH PERSPECTIVES

Environmental Science & Technology

INDOOR AIR
International Journal of Indoor Environment and Health

Practitioner Journals



Presentations to Industry & Practitioners

ASHRAE

EEBA

Home Performance Coalition

INDOOR AIR QUALITY ASSOCIATION

PHIUS
Passive House Institute US

RESNET
RESIDENTIAL ENERGY SERVICES NETWORK

FORUM ON DRY CLIMATE
HOME PERFORMANCE

International Society of Indoor Air Quality and Climate

AIVC Air Infiltration and Ventilation Centre

12TH REHVA WORLD CONGRESS CLIMA2016

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Next Steps and Future Plans

Next Steps:

- Expert input to develop draft IAQ scoring tool
- Continue to develop smart ventilation algorithms. Support industry to incorporate into homes.
- Performance testing -> guidance on home IAQ monitoring devices
- Develop / verify test method for downdraft and island range hoods
- New home IAQ study conducted by competitively selected team(s)

Future Plans:

- Metrics, test methods for automatic and recirculating range hoods.
- Pilot and finalize IAQ scoring tool and related resources.
- Tech support to realize smart ventilation benefits

REFERENCE SLIDES

Project Budget

Project Budget: Level funding at $1.3m/year
Variances: No variances from planned budget
Cost to Date: $1.8m through Mar17; $2.6m projected thru FY17 (DOE portion)
Additional Funding (programmatic cost-share):

- EPA/HUD support for HEH Program $300K/y
- CEC: Healthy Efficient New Gas Homes (FY15–FY18): $1.25m
- CEC: Moisture Performance of Sealed Attics (FY15–FY18): $1m
- CEC: Smart Ventilation in Advanced California Homes (FY16–FY19): $1.5 m
- CEC: Effective Kitchen Ventilation in Zero Net Energy Homes (Pending): $1m

Budget History					
FY 2016 (past)		FY 2017 (current)		FY2019 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$1.3m	$1.2m	$1.3m	$1.5m	$1.3m	$1.3m

*CEC = California Energy Commission

Project Plan and Schedule

- Go/no-go decision point: move on to island and downdraft range hood test development only if draft test method for wall mount hoods is complete
- Future work: complete ASTM test methods for range hood capture efficiency and register flow measurement, develop IAQ score, study IAQ sensors, develop smart ventilation control strategies

Project Schedule

Project Start: **FY16**

Projected End: **FY18**

Completed Work

Active Task (in progress work)

Milestone/Deliverable (Originally Planned)

Milestone/Deliverable (Actual)

Task	FY2016 Q1 (Oct-Dec)	FY2016 Q2 (Jan-Mar)	FY2016 Q3 (Apr-Jun)	FY2016 Q4 (Jul-Sep)	FY2017 Q1 (Oct-Dec)	FY2017 Q2 (Jan-Mar)	FY2017 Q3 (Apr-Jun)	FY2017 Q4 (Jul-Sep)	FY2018 Q1 (Oct-Dec)	FY2018 Q2 (Jan-Mar)	FY2018 Q3 (Apr-Jun)	FY2018 Q4 (Jul-Sep)
Scientific guidance & technical support to BA program and stakeholders; national IAQ study	◆	◆	◆	◆	◆	◆	◆	◆				
C&SI: ASTM range hood method, RESNET 380, ASHRAE 62.2, CA T24, etc.		◆			◆							
Smart ventilation: temp control, occupancy control, aux fan credits, eval low-cost monitors			◆				◆	◆				
Filtration and air cleaning: Add PM to housing population model; emissions database						◆		◆	?	?	?	?
Kitchen vent: develop tests for wall mt, island, downdrft, auto, recirculating hoods					◆	◆		◆				
IAQ valuation / IAQ score / health cost analysis tools					◆			◆				
Technical support to Building America teams (FOA awardees)					◆			◆				