

EEBA, Dallas, Sep 27, 2016

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



**The Times, They Are a-Changin’
Keeping Current with Building Science**

Eric Werling
Building America Program Director
Building Technology Office



STEREO
MONO 11 278

THE TIMES THEY ARE A-CHANGIN'

BOB DYLAN

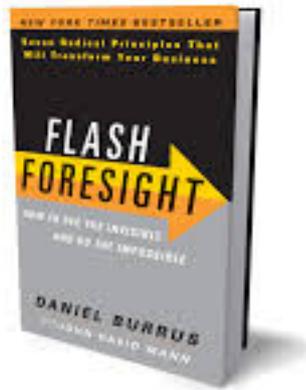
THE LONESOME DEATH OF HATTIE CARROLL
BOOTS OF SPANISH LEATHER
RESTLESS FAREWELL / WITH GOD ON OUR SIDE
THE TIMES THEY ARE A-CHANGIN'
ONLY A PAWN IN THEIR GAME
WHEN THE SHIP COMES IN / ONE TOO MANY MORNINGS
BALLAD OF HOLLIS BROWN / NORTH COUNTRY BLUES



“Accelerating rate of change is certain
as the sun rising in the east...

It’s going to sweep across our landscape
like the technological tsunami it is....

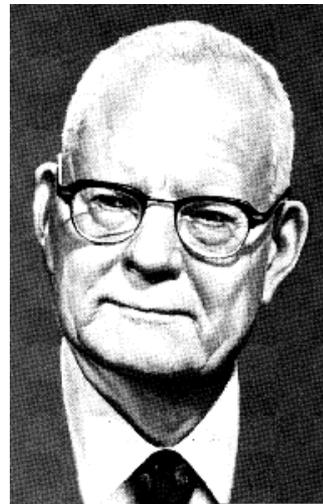
It will disrupt catastrophically
every aspect of every industry...
—*except for those who see it coming.*”



Daniel Burrus, *“Flash Foresight”*

"It is not necessary to change.
Survival is not mandatory."

W. Edwards Deming



Your Buyers Are a Changin'



Some are buying personal fitness meters...



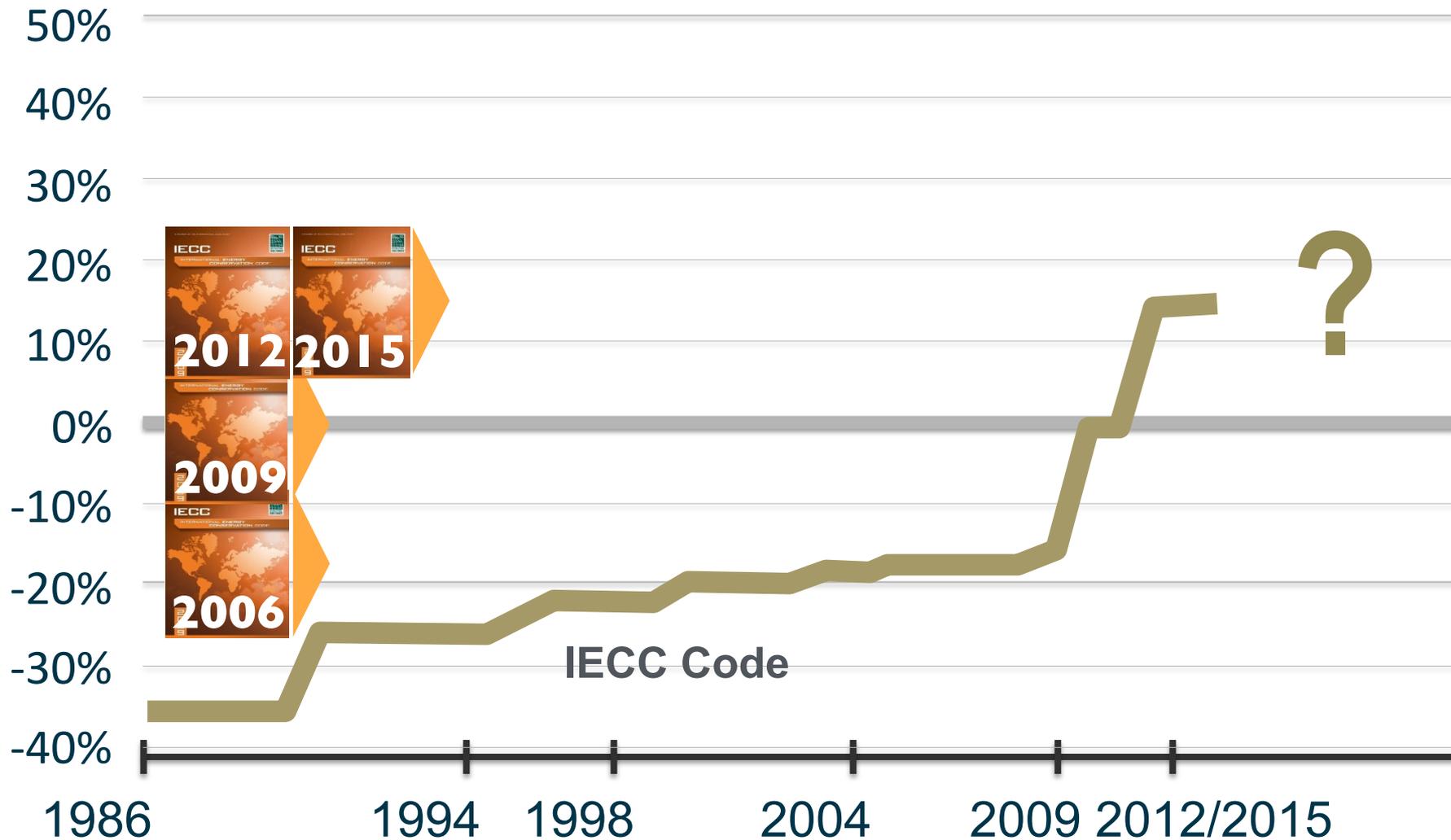
Will they buy home health meters?



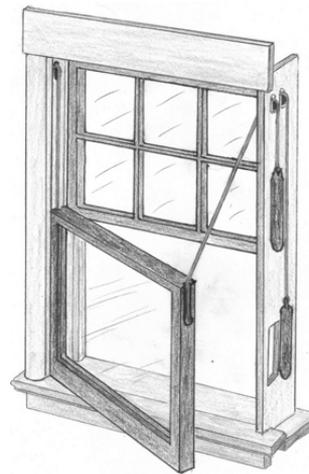
>90% Use the Internet When Buying Homes

The screenshot displays the Zillow website interface for a search in Frisco, TX. The navigation bar includes links for Buy, Rent, Sell, Mortgages, Agent finder, Advice, Home design, and More. The search bar contains 'frisco tx' and filters for Listing Type, ANY PRICE, 0+ BEDS, and MORE (1). The main content area shows a map of Frisco, TX, with numerous red circular markers indicating new homes for sale. A text overlay on the map reads 'Only showing 500 homes. Zoom in, or use filters to narrow your search.' A sidebar on the right features a sponsored advertisement for C21 with the text 'All 4. 3 Years in a Row. Of all the real estate agencies, only C21 can say that. Learn More'. Below the advertisement, the search results are titled 'Frisco TX Single Family Homes' with '900 homes for sale. 11 unmapped.' and options for 'Homes for You', 'Newest', and 'More'. Two property listings are visible, both marked as 'NEW CONSTRUCTION' with prices starting at '\$525,900+' and details like '4 bds • 5 ba • 3,689+ sqft'.

Energy Codes Are a Changin'



Materials Are a Changin'

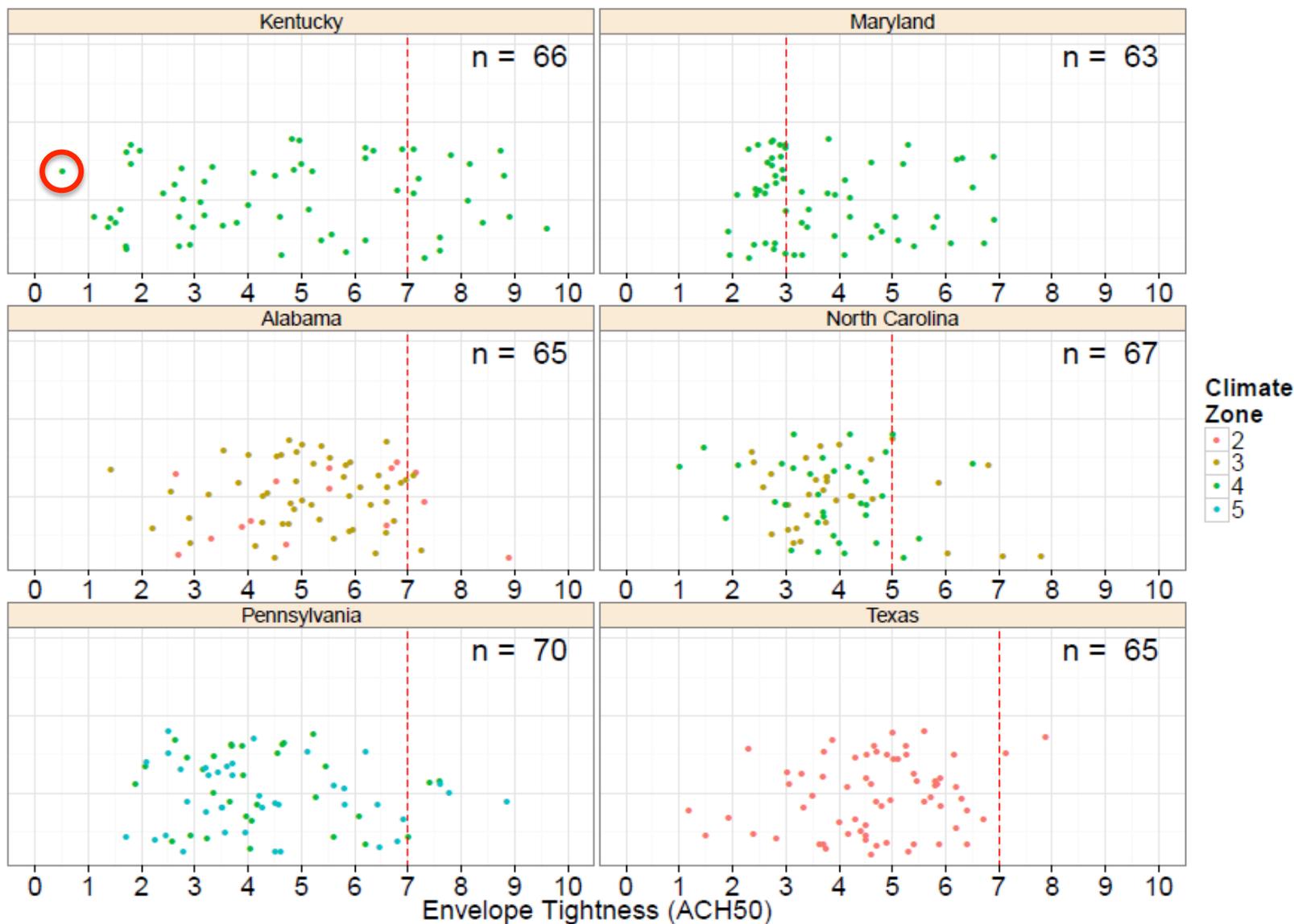


Air-Tightness Is a Changin'

LBNL Air Leakage Database (147,000 homes):

- Mean air-leakage of U.S. homes **>10 ACH50**
- Post-2000 homes have **half** the air-leakage of Pre-1960 homes
- Rated homes (e.g., HERS) have air-leakage **30% lower** than typical homes
- Median reduction from retrofits is 20%-30%

Air Tightness of Average New Homes



Building America Research Can Help You Deal with These Changes ...



1. Moisture Managed High-R Envelopes

- **Less Likely to Get/Stay Wet**

High performance homes with increased insulation, reduced infiltration, reduced risk of condensation, & adequate drying potential inside building assemblies

2. Optimized Low-Load Comfort Solutions

- **Effectively Manage Airflow & Indoor RH for Comfort**

High efficiency comfort systems for homes with low thermal loads, including optimal efficiency, managed air flow and RH control at all part load conditions

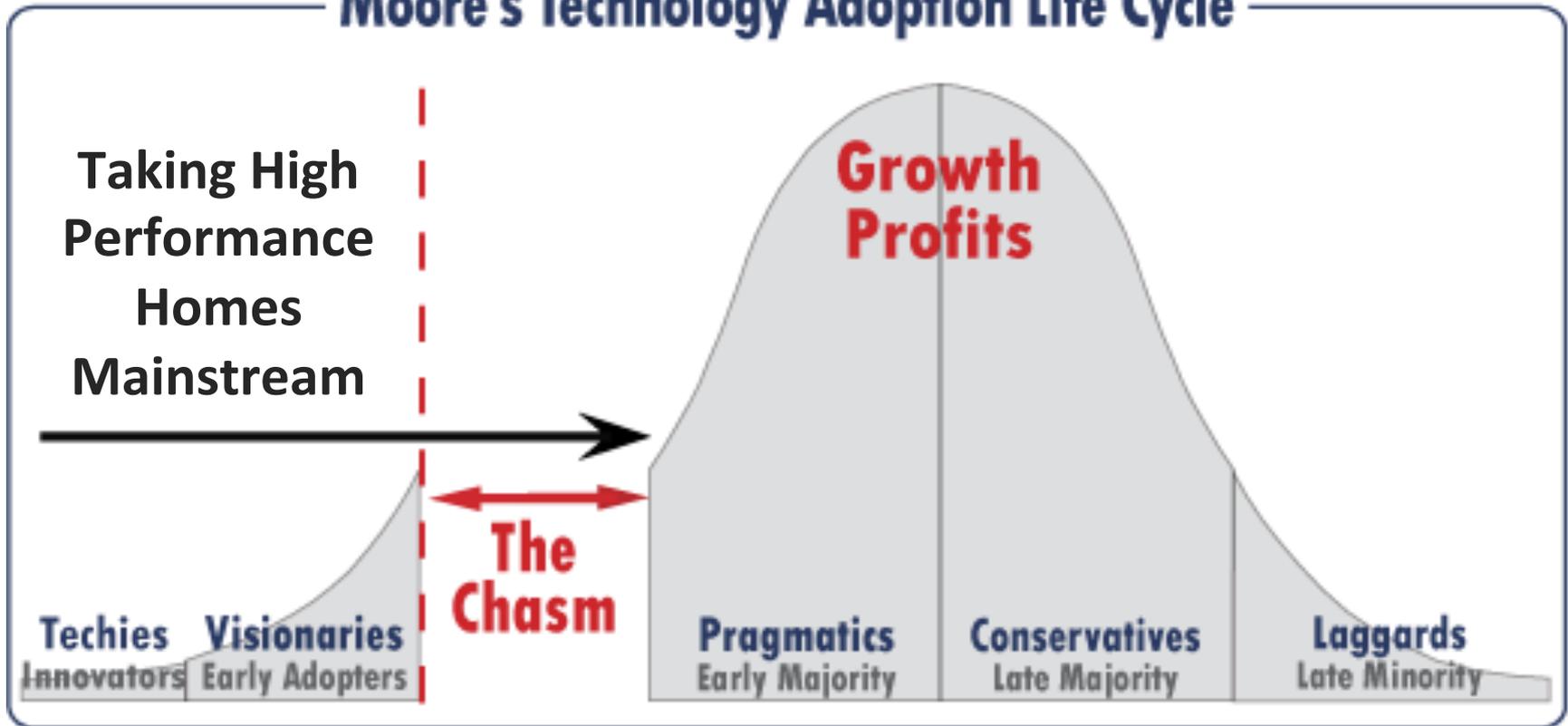
3. Smarter Indoor Air Quality Solutions

- **Control Fresh Air Supply & Contaminant Removal**

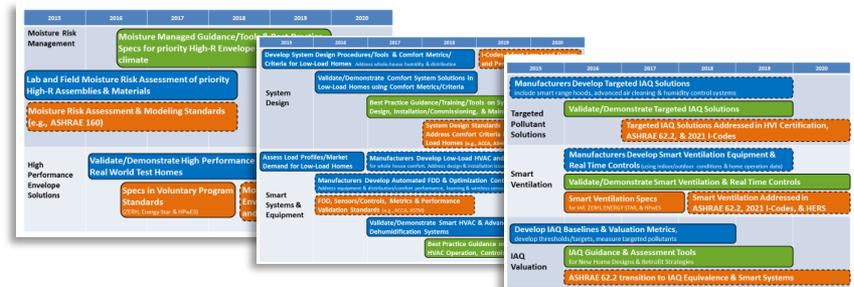
Added tightness with improved source control, dilution, and high efficiency filtration, with little or no energy penalty

Building America and the Innovation Adoption Curve

Moore's Technology Adoption Life Cycle

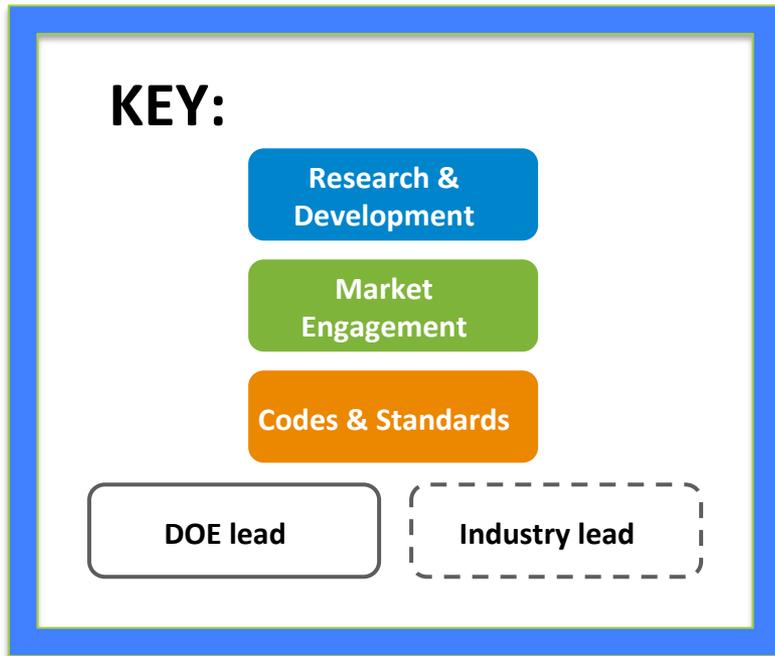


Source: "Crossing the Chasm". Geoffrey Moore, Collins Business Essentials, 2006



Building America Research-to-Market Plan

- Published in November 2015
- Goal is “Standard Practice”
- Manage Risks
- Practical & Profitable Solutions



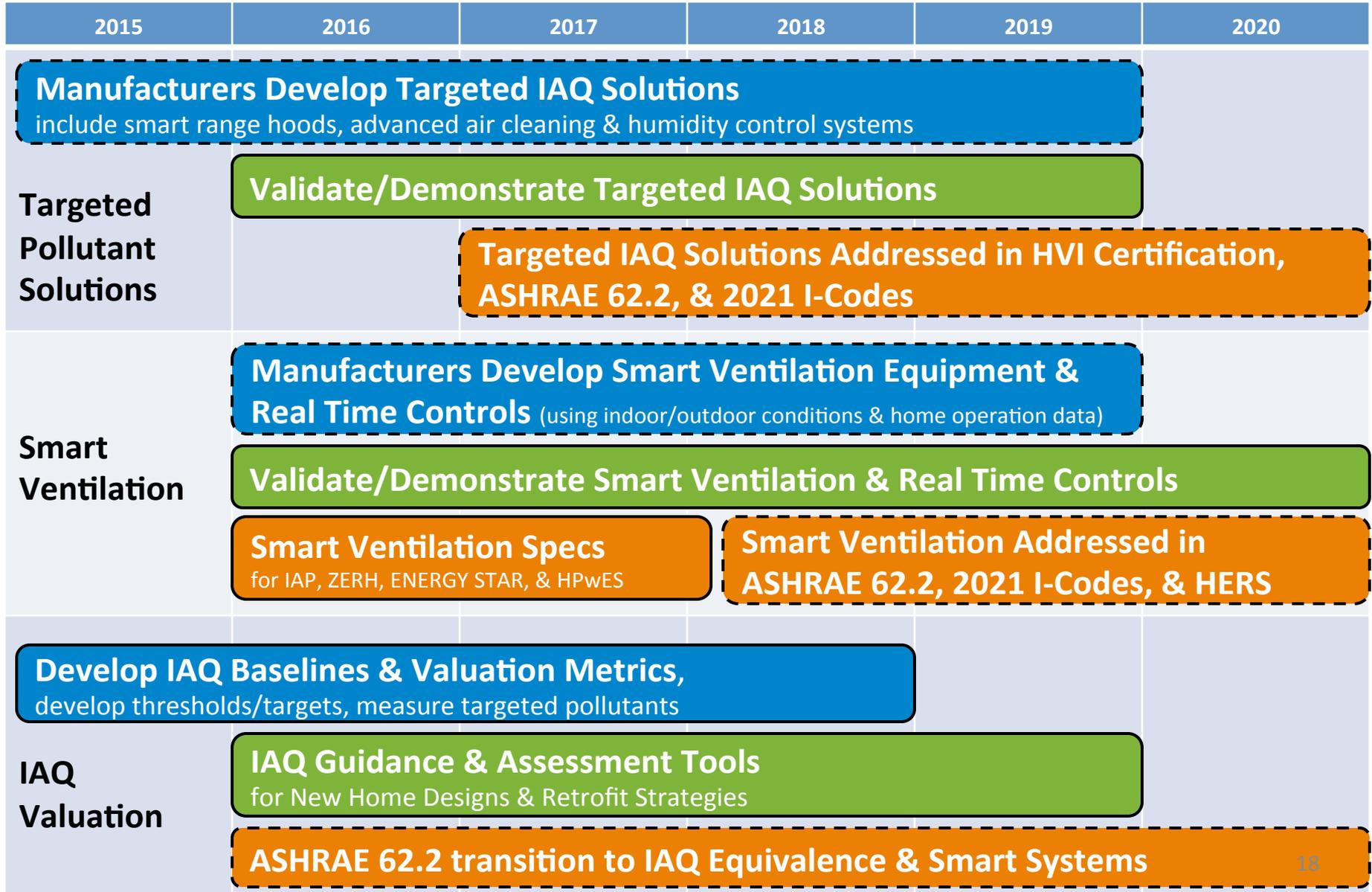
A. High Performance Moisture Managed Envelopes

	2015	2016	2017	2018	2019	2020
Moisture Risk Management		Moisture Managed Guidance/Tools & Best Practice Specs for priority High-R Envelope Systems in each climate				
	Lab and Field Moisture Risk Assessment of priority High-R Assemblies & Materials					
	Moisture Risk Assessment & Modeling Standards (e.g., ASHRAE 160)					
High Performance Envelope Solutions	Validate/Demonstrate High Performance Envelope Specs in Real World Test Homes					
	Specs in Voluntary Program Standards (ZERH, Energy Star & HPwES)			Moisture Managed High-R Envelopes addressed in 2021 IECC and IRC		

B. Optimal Comfort Systems for Low-Load Homes

	2015	2016	2017	2018	2019	2020
System Design	Develop System Design Procedures/Tools & Comfort Metrics/Criteria for Low-Load Homes Address whole-house humidity & distribution			I-Codes Adopt Low-Load Design and Performance Standards		
	Validate/Demonstrate Comfort System Solutions in Low-Load Homes using Comfort Metrics/Criteria					
				Best Practice Guidance/Training/Tools on System Design, Installation/Commissioning, & Maintenance		
				System Design Standards Address Comfort Criteria in Low-Load Homes (e.g., ACCA, ASHRAE)		
Smart Systems & Equipment	Assess Load Profiles/Market Demand for Low-Load Homes		Manufacturers Develop Low-Load HVAC and Dehumidification for whole house comfort. Address design & installation issues			
	Manufacturers Develop Automated FDD & Optimization Controls Address equipment & distribution/comfort performance, learning & wireless sensors/controls					
				FDD, Sensors/Controls, Metrics & Performance Validation Standards (e.g., ACCA, ASTM)		
				Validate/Demonstrate Smart HVAC & Advanced Dehumidification Systems		
				Best Practice Guidance on Automated Smart HVAC Operation, Controls, & Maintenance		

C. Optimal Ventilation & IAQ Solutions



Building America Projects



Improvement RD&D Proj

Building America Project Highlights: High Performance Moisture Managed Envelopes

High Performance Building Envelope Assemblies

Team and Partners	Topic Area
Home Innovation Research Labs, Inc. w/ ACC, NAHB, FPL, VSI, Dow, SIPA, APA, IBHS, DuPont	High Performance Moisture Managed Envelopes (2015)



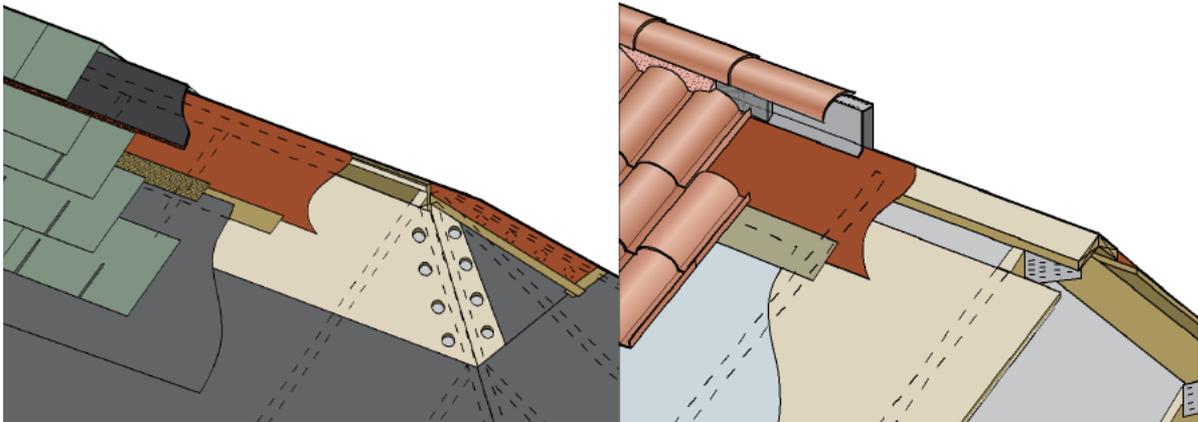
- **Moisture Performance of High-R Wall Systems:** Study moisture performance in high-R walls (>R-20) in 20 occupied high performance homes across different climate zones.
- **Extended Plate and Beam Wall System:** Study the constructability and structural/moisture performance of high-R walls with rigid foam insulation behind the WSP, in the pocket resulting from wall plates one dimension wider than studs.
- **Attic Retrofits Using Nail-Base Insulated Panels:** Study the constructability, energy and moisture performance of an innovative retrofit approach using nail-base insulated panels installed above the existing roof deck.

Success Metrics: Measured and modeled performance of high-R walls and design guidance for all climates. Efficient, durable wall assembly to meet and exceed new IECC targets. HVAC energy savings of 10% or more for sealed attics and cathedral ceilings.

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

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

- Interior vapor control membrane on attics with fibrous insulation.
- Enables affordable insulation solution for attics, bringing the HVAC equipment into the conditioned space.
- New Construction Field Test
- Existing Manufactured Housing Field Test/ Demonstration
- Up to 3 winters of data

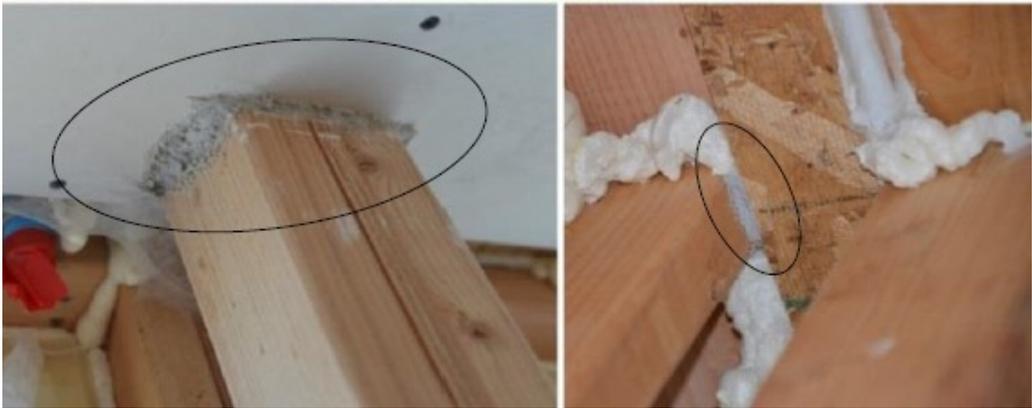


Success Metrics: Assessment & validation of unvented roof construction detail to enable moisture managed fibrous insulation solutions in cold climates, achieving code & above code performance (R-49) at up to 80% material cost reduction, and saving >10% in HVAC energy use.

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 during construction, sealing gaps and cracks in envelope, within a few hours.
- Real time feedback of leakage
- Project will develop the optimal integration of this technology into production homebuilders' practices.

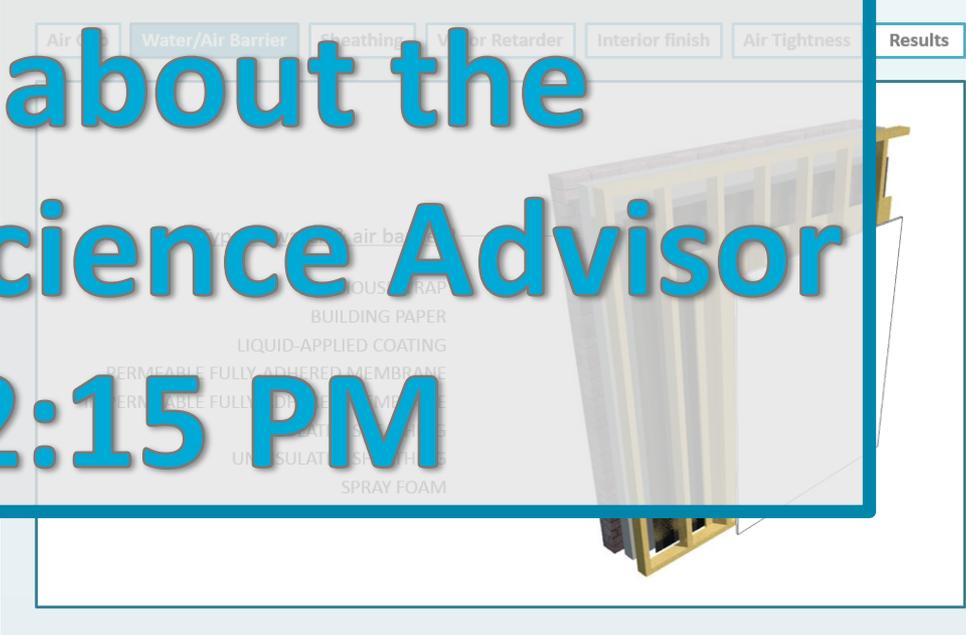


Success Metrics: 20-home study optimizes integration of aerosol envelope sealing in production building process to radically improve QC and significantly reduce labor cost compared to traditional air sealing.

Moisture Managed Wall Expert System

National Lab	Topic Area
Oak Ridge National Laboratory	High Performance Moisture Managed Envelopes

- Decision support tool for builders and designers
- Provides expert advice on high performance envelope system performance from industry's best researchers and building scientists
- Evaluates and compares moisture durability for a wide range of walls
- Presents guidance on proper methods to mitigate risk
- Promotes better-informed and decisions higher confidence regarding high performance wall assemblies



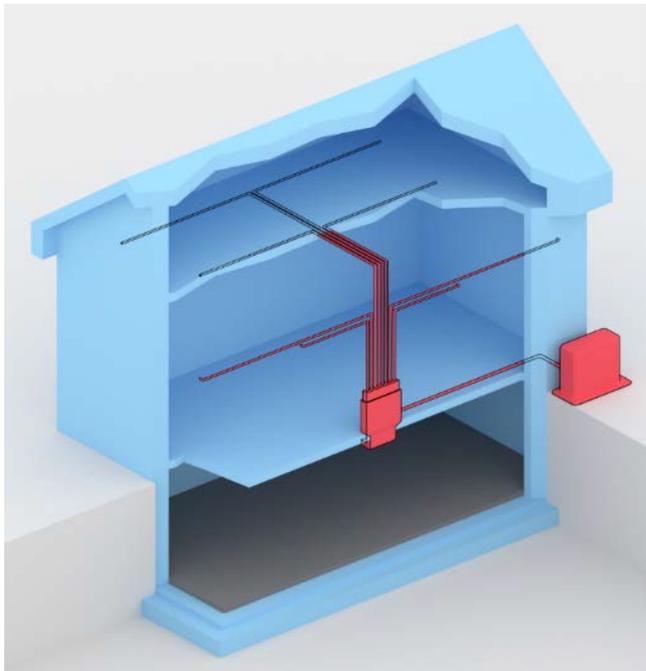
Learn about the Building Science Advisor At 2:15 PM

The screenshot shows a software interface for a wall assembly analysis. At the top, there are tabs for 'Air Barrier', 'Water/Air Barrier', 'Sheathing', 'Vapor Retarder', 'Interior finish', 'Air Tightness', and 'Results'. Below the tabs is a 3D cutaway view of a wall assembly. The layers are labeled as follows from top to bottom: AIR BARRIER, WATER/AIR BARRIER, SHEATHING, LIQUID-APPLIED COATING, PERMEABLE FULLY ADHERED MEMBRANE, PERMEABLE FULLY ADHERED MEMBRANE, INSULATION, and SPRAY FOAM.

Building America Project Highlights: Optimal Comfort Systems for Low-Load Homes

A “Plug-n-Play” Air Delivery System for Low Load Homes & Evaluation of a Residential Thermal Comfort Rating Method

Team and Partners	Topic Area
IBACOS	Optimized Comfort Systems for Low-Load Homes (2015)

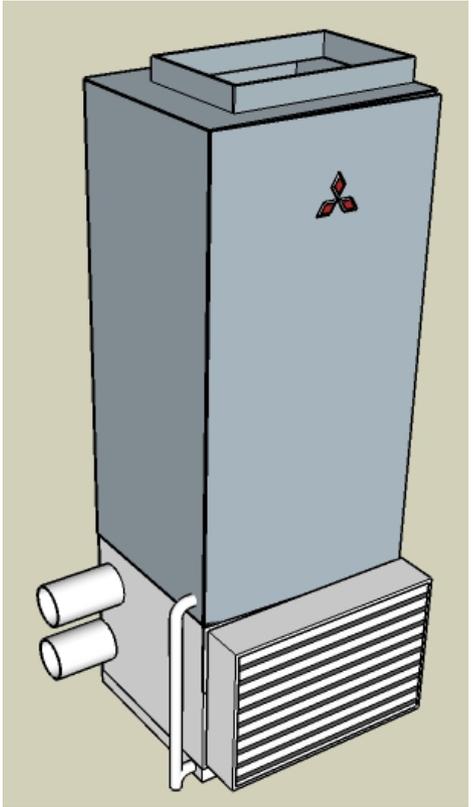


- A simplified small-diameter residential air delivery system as a solution to the air distribution and comfort delivery issues in low-load production-built homes. The system is assembled in a homerun arrangement from a kit of parts with a limited number of components.
- Evaluating need for, and feasibility of, a Thermal Comfort Rating Method (TCRM) to allow builders and homeowners to make value-based decisions about thermal comfort. TCRM is a scaled metric of whole-house comfort delivery, that quantifies a home’s ability to provide thermal comfort under varying conditions and demands.

Success Metrics: System easily integrated within the home’s conditioned space, installed with less error and waste, and offers predictable performance to help provide comfort in low-load homes.

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)

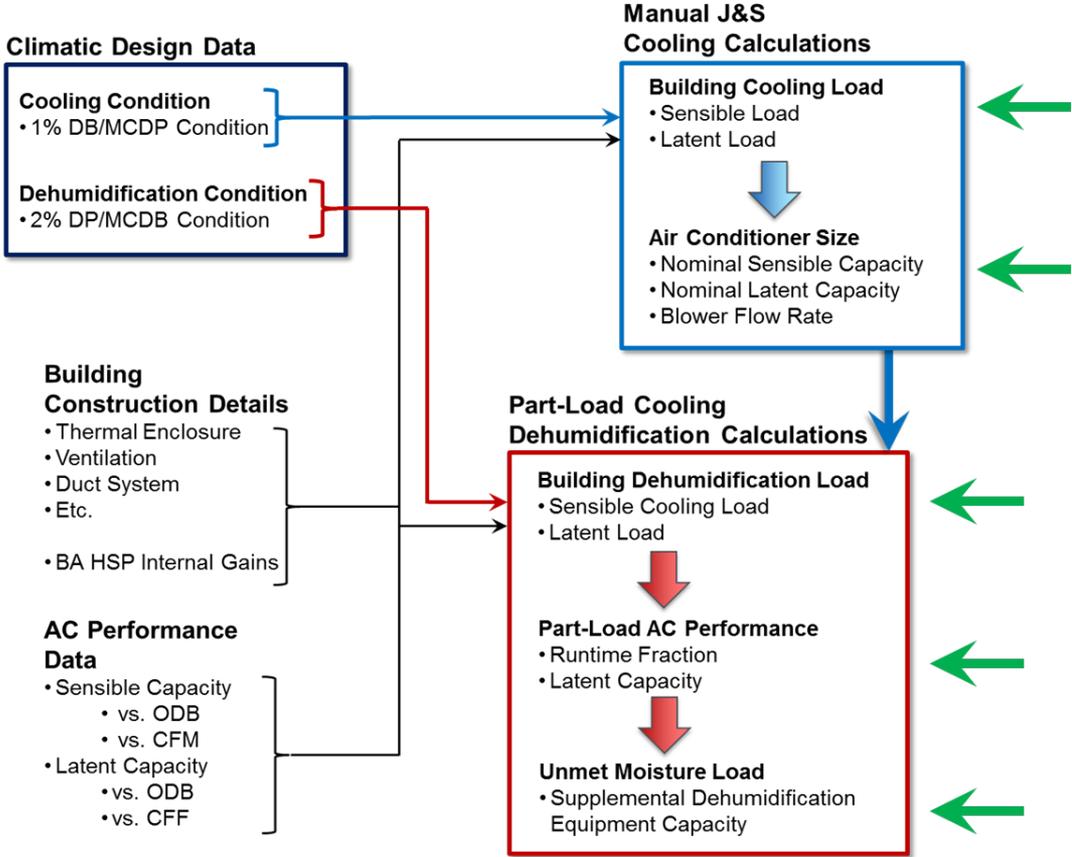


- Development of integrated ERV and heat pump
- Variable speed fans for low energy and high controllability
- Test and demonstrate in unoccupied and occupied homes
- Lower cost and higher performance than typical practice of Central Fan Integrated Supply (CFIS) ventilation

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.

Dehumidification Design and Sizing Procedures

National Lab	Topic Area
National Renewable Energy Laboratory	Optimized Comfort Systems for Low-Load Homes



- Parametric analysis comparing procedure to EnergyPlus annual simulations
 - 3 constructions, 10 cities
- Smaller dehumidifiers than “expected”
- Dehumidifiers met the load 94% of the time
- With an RH setpoint of 55%, indoor RH never exceed 60%

Building America Project Highlights: Optimal Ventilation & IAQ Solutions

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.



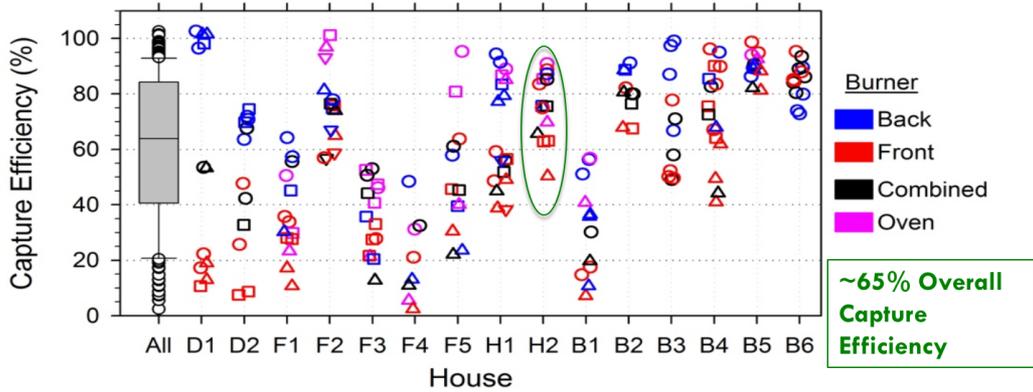
ASTM Range Hood Test Method

National Lab	Topic Area
Lawrence Berkeley National Lab	Optimal Ventilation & IAQ Solutions



- Capture Efficiency: fraction of emitted pollutants removed by hood
- Variety of devices testing in lab and in homes
- Wall-mount, downdraft, and island

$$CE = \frac{C_{exhaust} - C_{chamber}}{C_{exhaust} - C_{ambient}}$$



Performance-Based IAQ and Optimized Ventilation

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

- Develop assessment protocol incorporating low-cost IAQ sensors: PM_{2.5}, CO₂, O₃, formaldehyde, 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



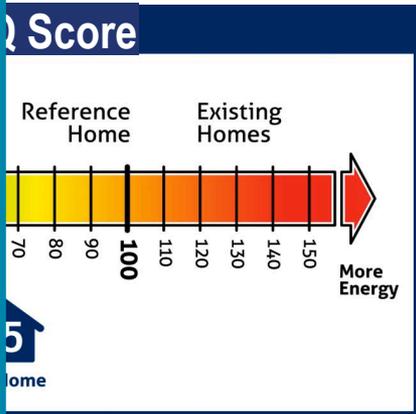
Success Metrics: Develop & validate a performance-based protocol for assessing indoor air quality (IAQ) in homes and inexpensive smart ERV solution that can achieve average annual HVAC energy cost savings of approximately \$100 compared to central fan integrated supply systems, and ~50% reduction of ventilation related latent loads compared to supply or exhaust strategies. Goal is to overcome builder reluctance to air-tightness & ventilation strategies, to enable energy savings from tight construction in hot/humid climates, while reducing IAQ risks and improving comfort.

IAQ Score Development

National Lab	Topic Area
Lawrence Berkeley National Lab	Optimal Ventilation & IAQ Solutions (2016)

- A “score” like a HERS rating for IAQ
 - Asset rating: house characteristics & diagnostic
 - Combine measurements of indoor air quality into single score
- Include system design
 - Filtration, auto air change home's air ventilation control
- Include diagnostics
 - Measure air flows, test air systems
- Include construction materials
- Enables credit for a better home
- Collaboration with RESNET, EPA & many others

Learn about the
IAQ Scoring Tool
At 1:00 PM



Research to Market?

- **Building America Solution Center**
 - for **Designers, Building Professionals, Trainers**
- **Expert Guidance**
 - for **Designers, Building Professionals, Trainers**
- **Guidelines for Building Science Education**
 - for **Education**
- **Codes & Standards Integration (CSI)**
 - for **Building Professionals & Code Officials**
- **Home Improvement Consumer Checklists**
 - for **Homeowners (Coming Soon)**

Questions?

For More Information:

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