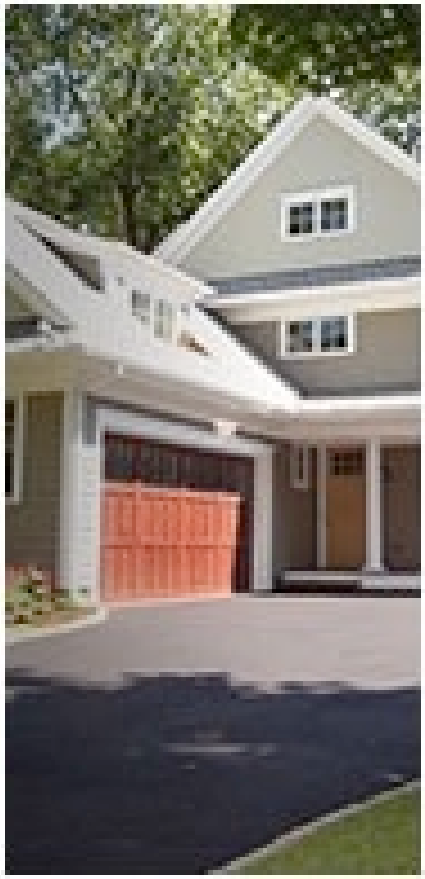
RESNET: Scottsdale, AZ, March 1st, 2016

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



# Building America's Top 3 Building Science Challenges

**ERIC WERLING**
Building America Program Director
Building Technology Office

# The Early Days of Flight


Speed: ~100 mph
Range: ~100 miles
Payload: 100 lbs. mail

Open cockpit

Small Payload

Risky

# The Modern Aviation Era

Speed: 550 mph
Range: 9,500 miles
Payload: 380 + 85 tons

Quality & Performance =
Comfort, Value, Reliability, Efficiency

# The Early Days of Housing


Airtightness: >10 ach50
HERS Index: >120
IAQ: Central Heat

# The Modern Housing Era

Airtightness: <2 ach50
HERS Index: <60
IAQ: Indoor airPLUS

**Quality & Performance = Value, Comfort, Reliability, Efficiency**

# A Definition of Quality ...

**(A)** When people and organizations focus primarily on quality, defined by the following ratio,

$$\text{Quality} = \frac{\text{Results of work efforts}}{\text{Total costs}}$$

quality tends to increase and costs fall over time.

**(B)** However, when people and organizations focus primarily on *costs*, costs tend to rise and quality declines over time.

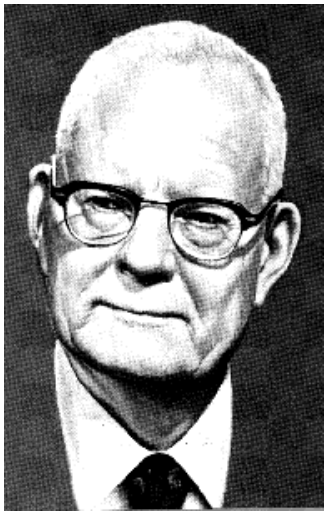
**W. Edwards Deming**

# Another bit of wisdom …

(from the same dead guy)

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

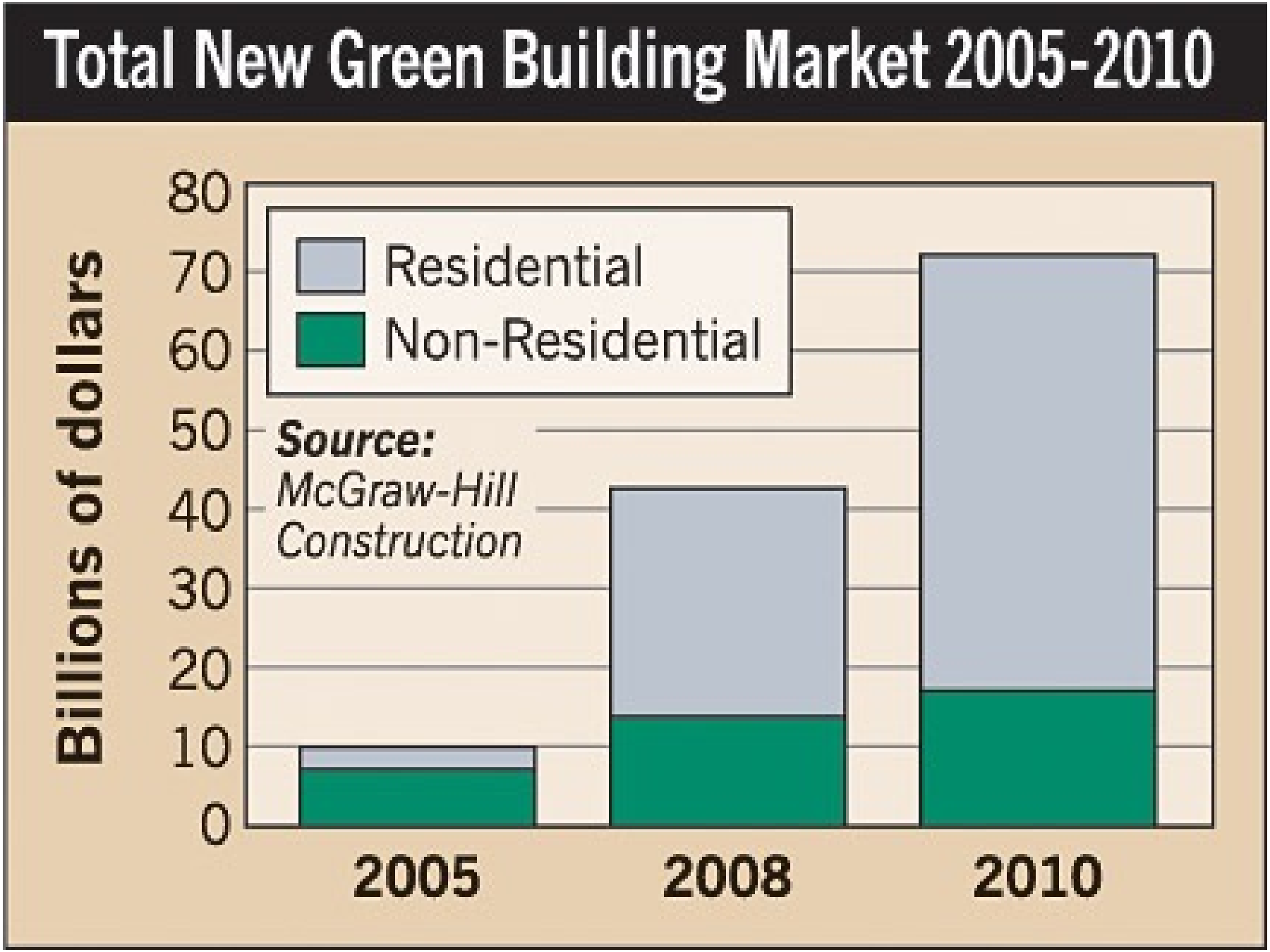
**W. Edwards Deming**



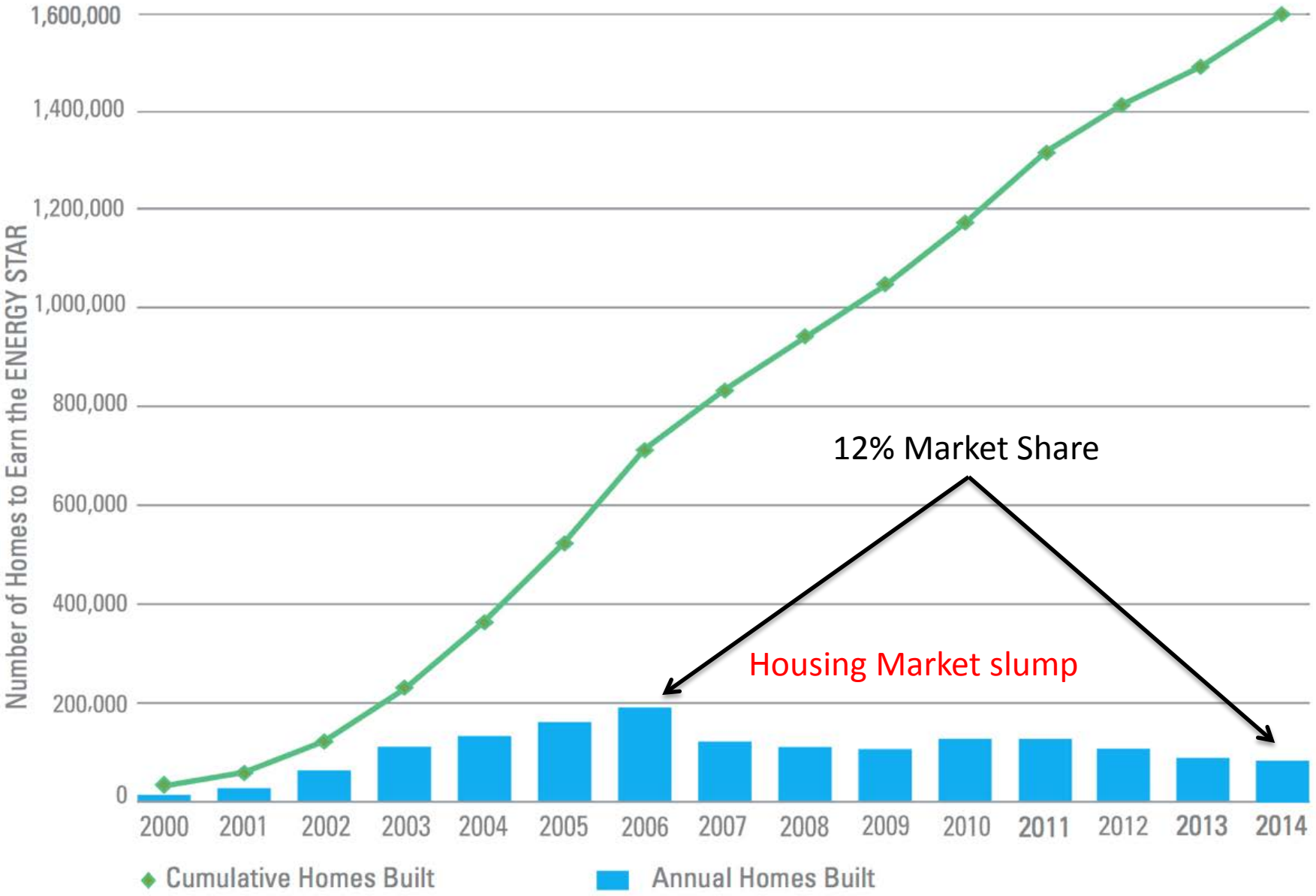
# Modern Housing Trends

# 1. Homes Are “Greener”

# Total New Green Building Market 2005-2010



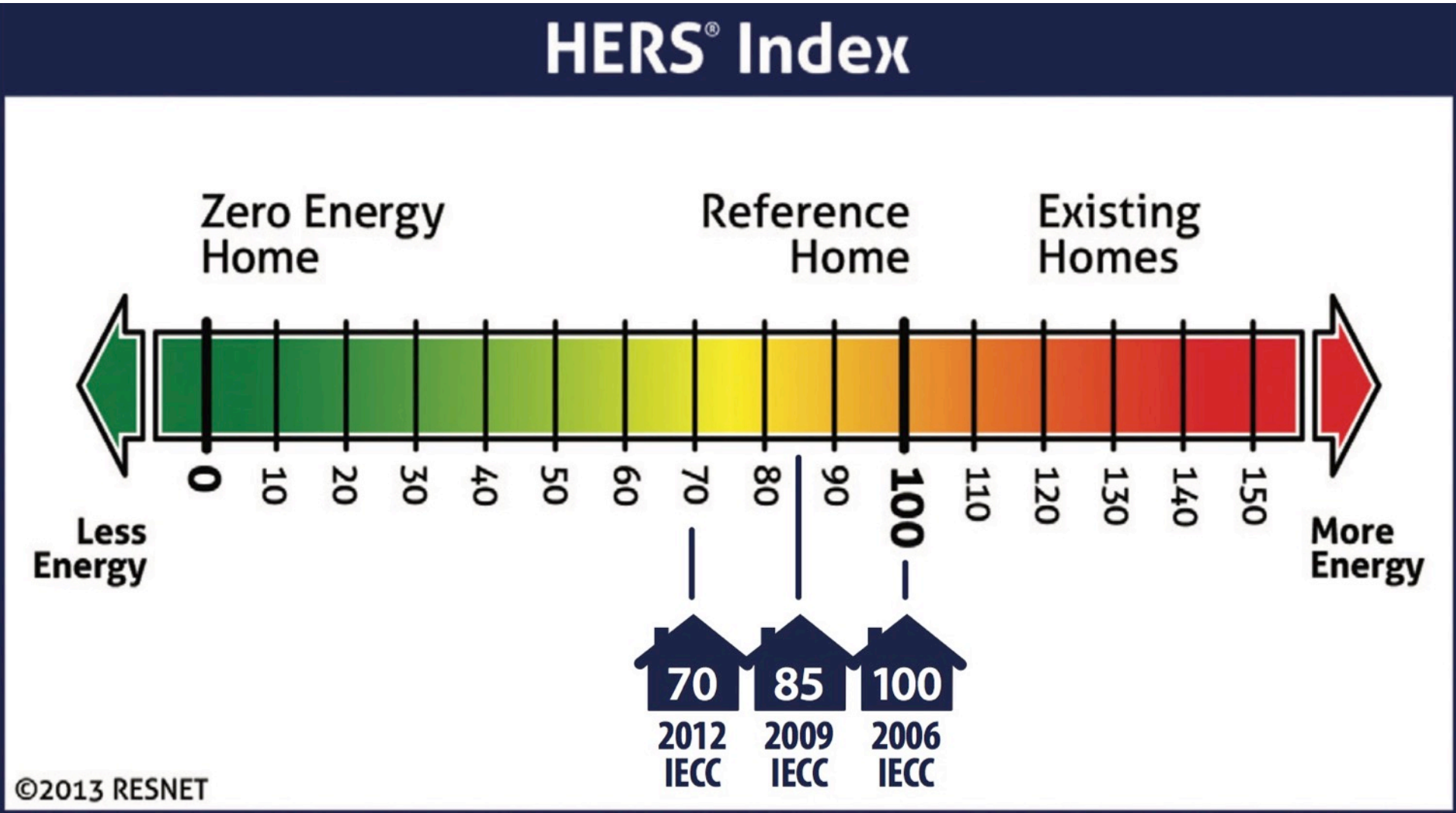
# Fig. 3. Nearly 1.6 Million Homes Nationwide Have Earned the ENERGY STAR Label



Modern Housing Trends

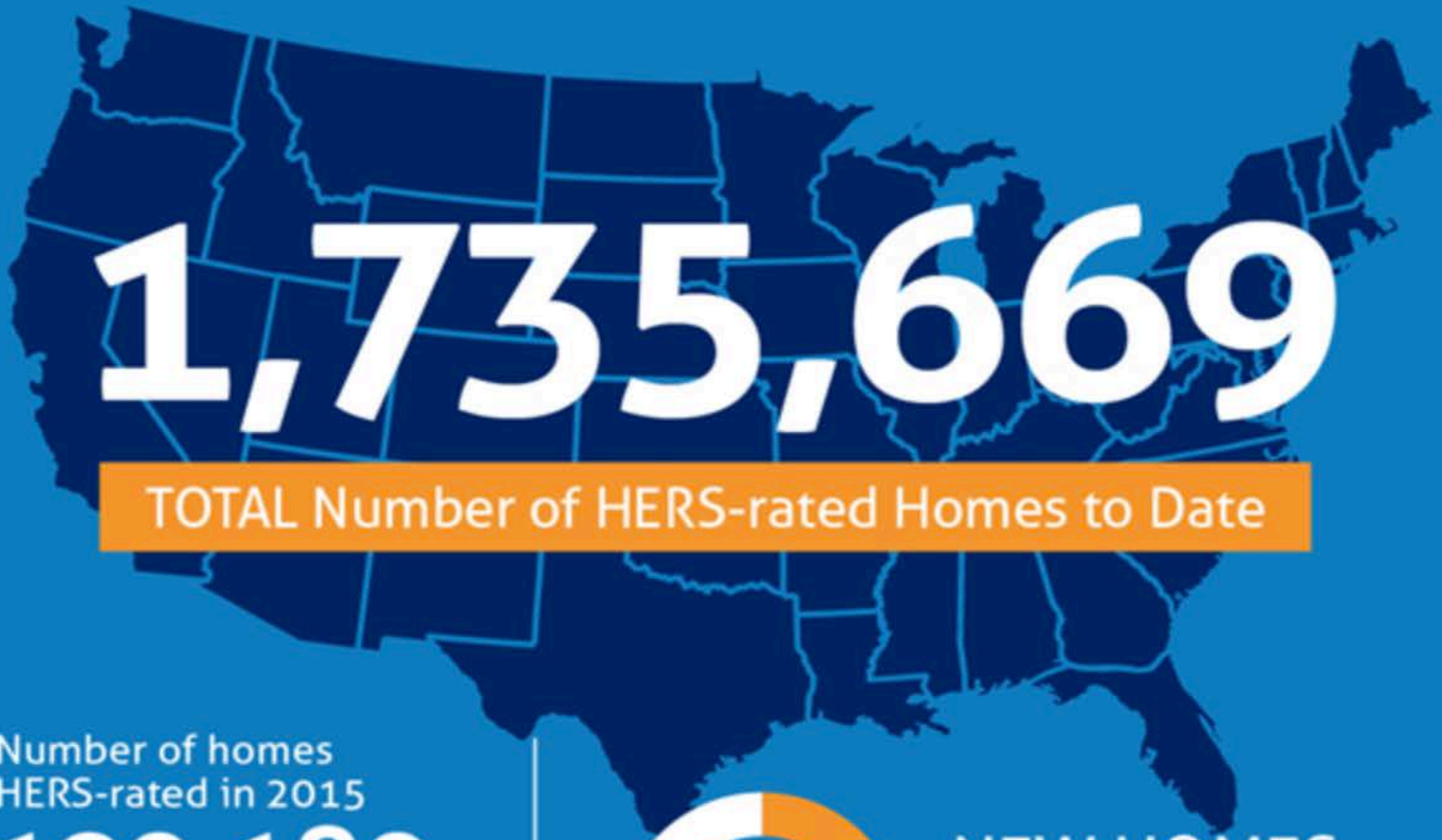
# 2. Home Energy Efficiency Is Being Measured

# It's official:
# **ANSI/RESNET Standard 301-2014**



RESNET®
RESIDENTIAL ENERGY SERVICES NETWORK

# 2015 Annual Report



# 1,735,669

TOTAL Number of HERS-rated Homes to Date

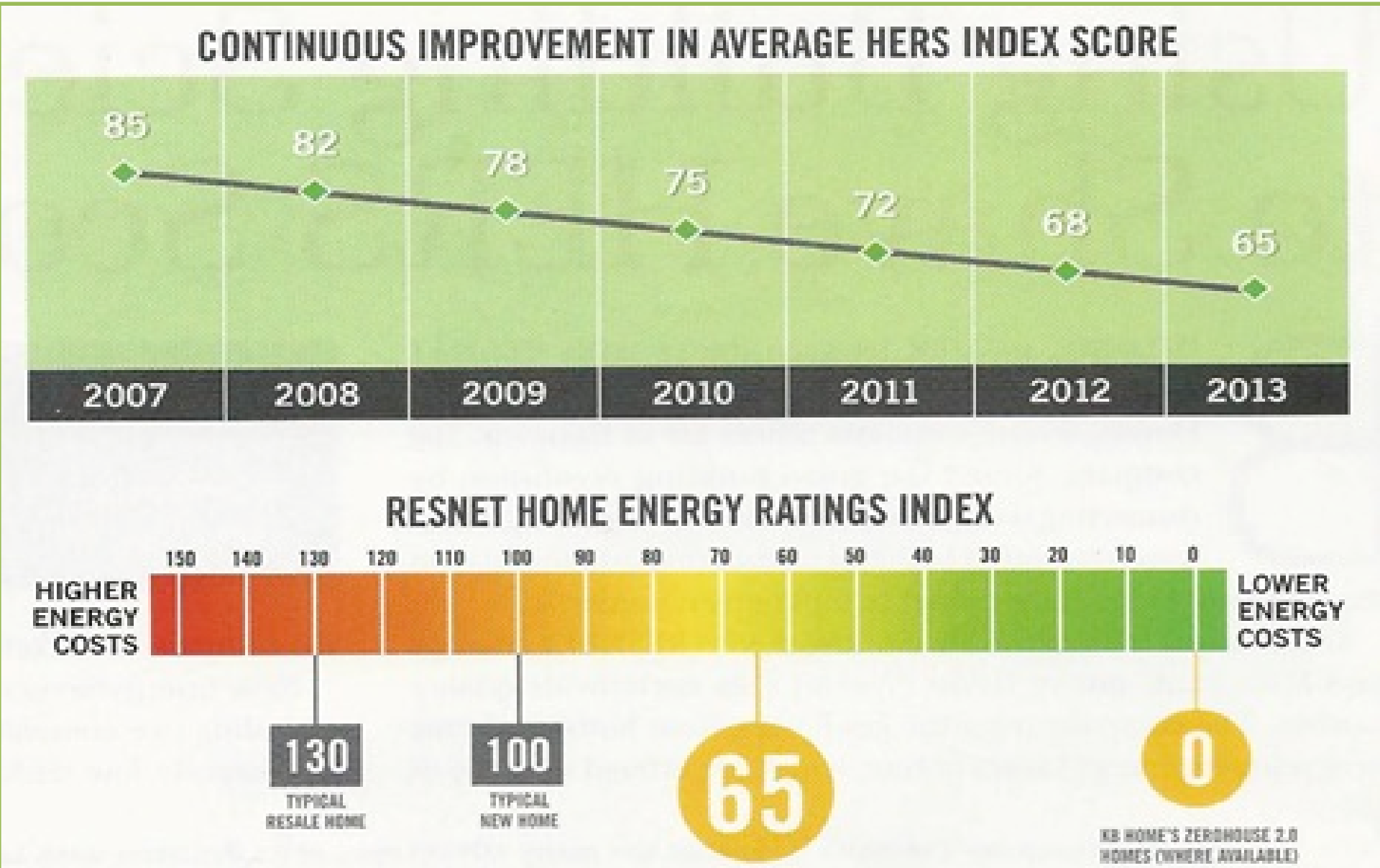
Number of homes HERS-rated in 2015

**190,180**

**30%** increase from 2014


NEW HOMES sold in the US are HERS-rated

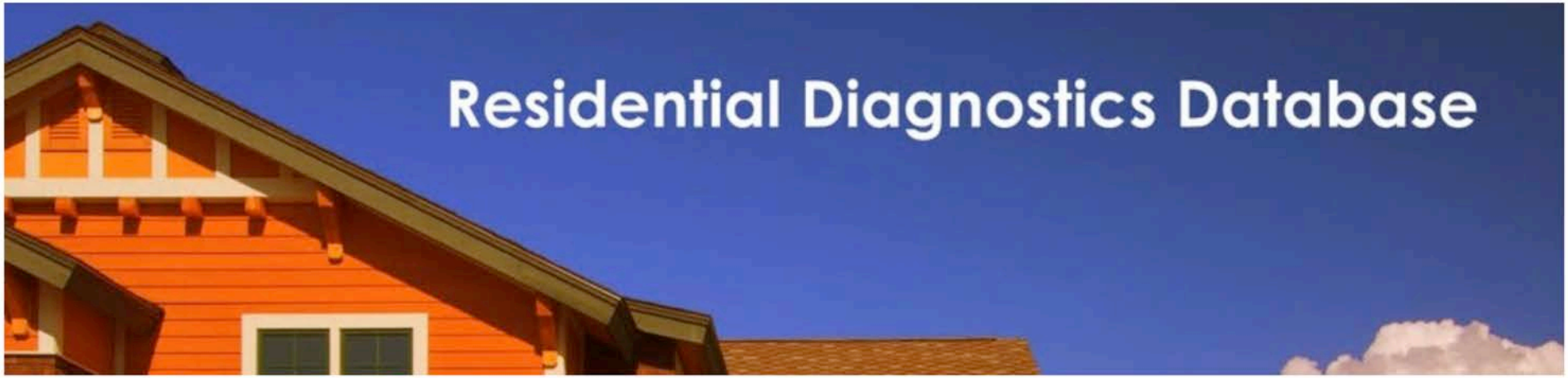
# Builders use it …



# HERS Scores keep improving …

# Modern Housing Trends

# 3. Homes are Getting Tighter

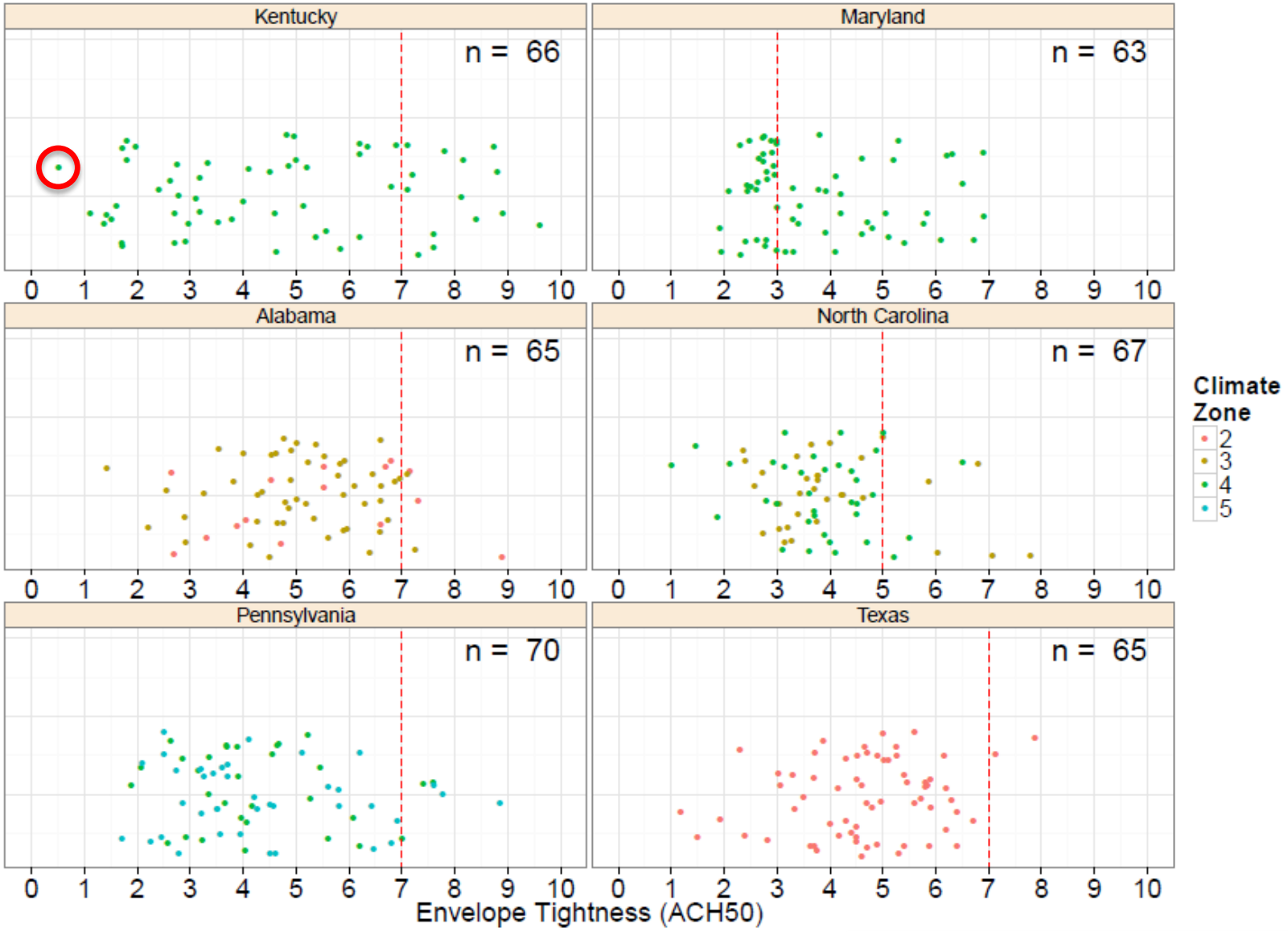





**CONCLUSIONS:**

- Mean air-leakage of U.S. homes **>10 ACH50 (147,000 house measurements)**
- 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

# Envelope Tightness (from DOE Code Study)



# The Next Housing Trend

# 4. Building ~~Science~~

The Next Housing Trend

# 4. Building Engineering

(based on building science!)

# Building America's Top 3 Building Science Challenges for High Performance Homes:

Solutions for New and Existing Homes with …

## 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

# Smarter, Healthier Homes

**Live better.**

**Work better.**

**Last better.**

Brought to you by a

# Smarter, Healthier Housing Industry

Brought to you by

Building AMERICA U.S. Department of Energy

RESNET® RESIDENTIAL ENERGY SERVICES NETWORK

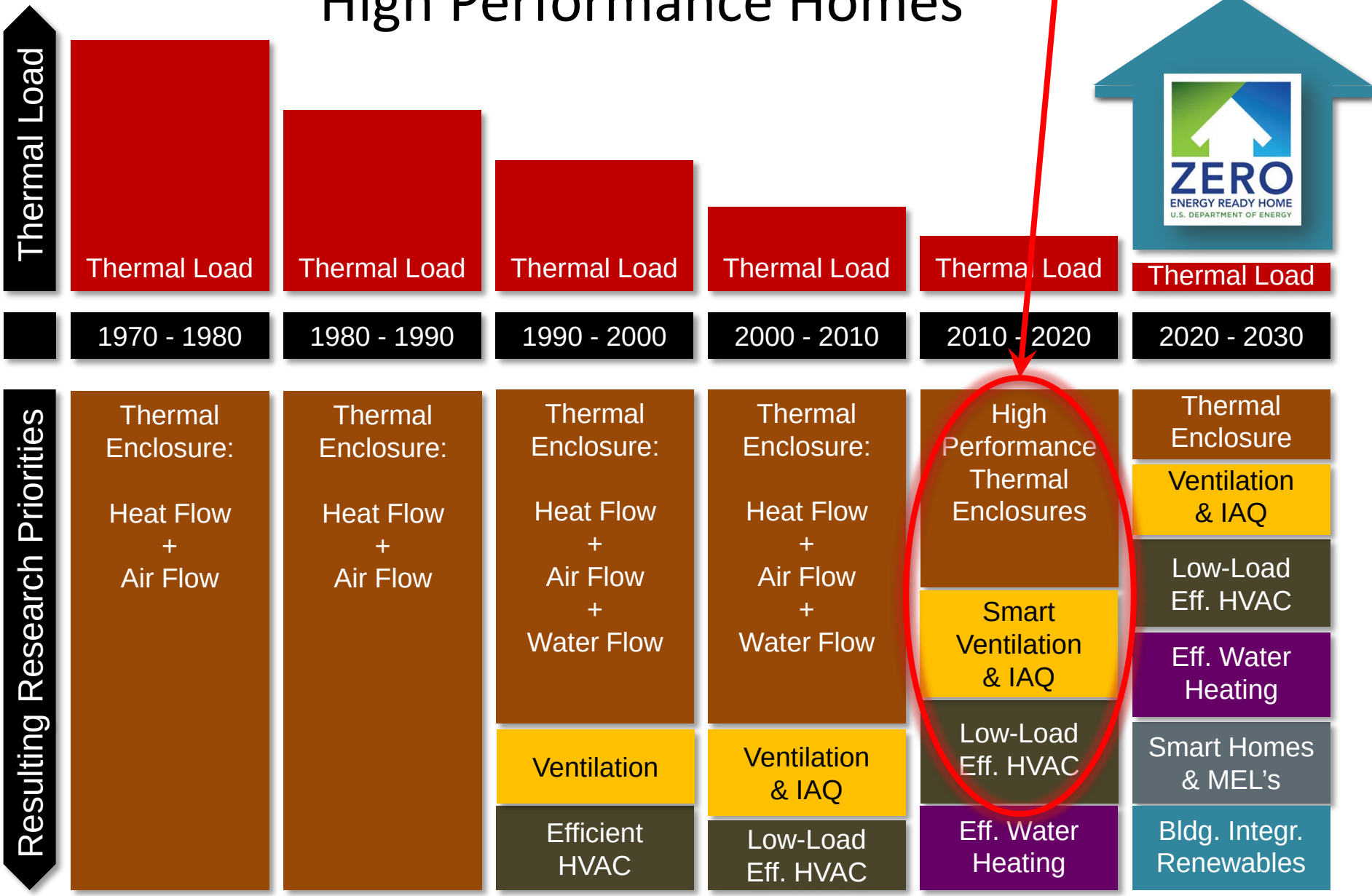
energy ENERGY STAR

EPA Indoor airPLUS

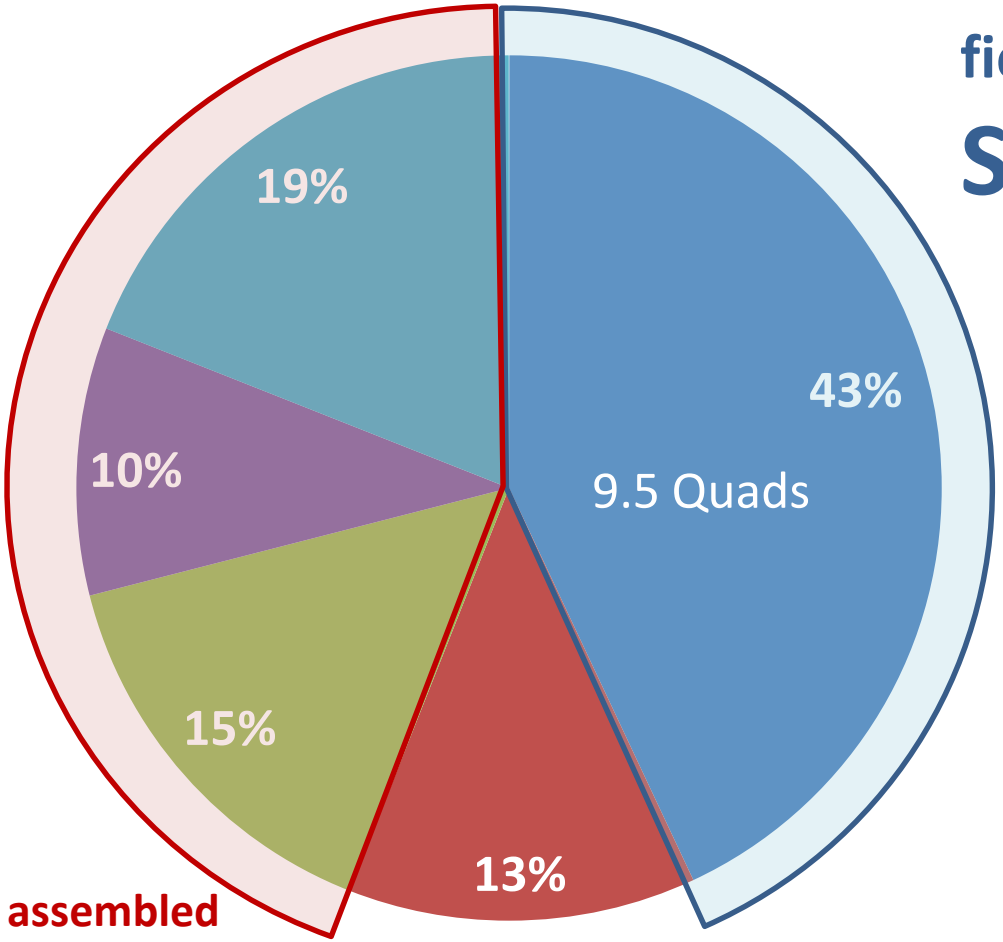
ZERO ENERGY READY HOME U.S. DEPARTMENT OF ENERGY

# U.S. DOE Building America
# **Research to Market Plan**

# Building America's Top 3 Challenges for High Performance Homes



# U.S. Residential Buildings
# Primary Energy Consumption (22 Quads)*




**field assembled**

## Systems

- Comfort (Envelope & HVAC)
- Water Heating
- Other Appliances
- Lighting
- Misc. End Uses

Building AMERICA
U.S. Department of Energy

**Goal: 50% Savings**

**factory assembled**

## Products

* Source: U.S. EIA

Now available for your reading pleasure!

[Download]


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

# Building America Research-to-Market Plan

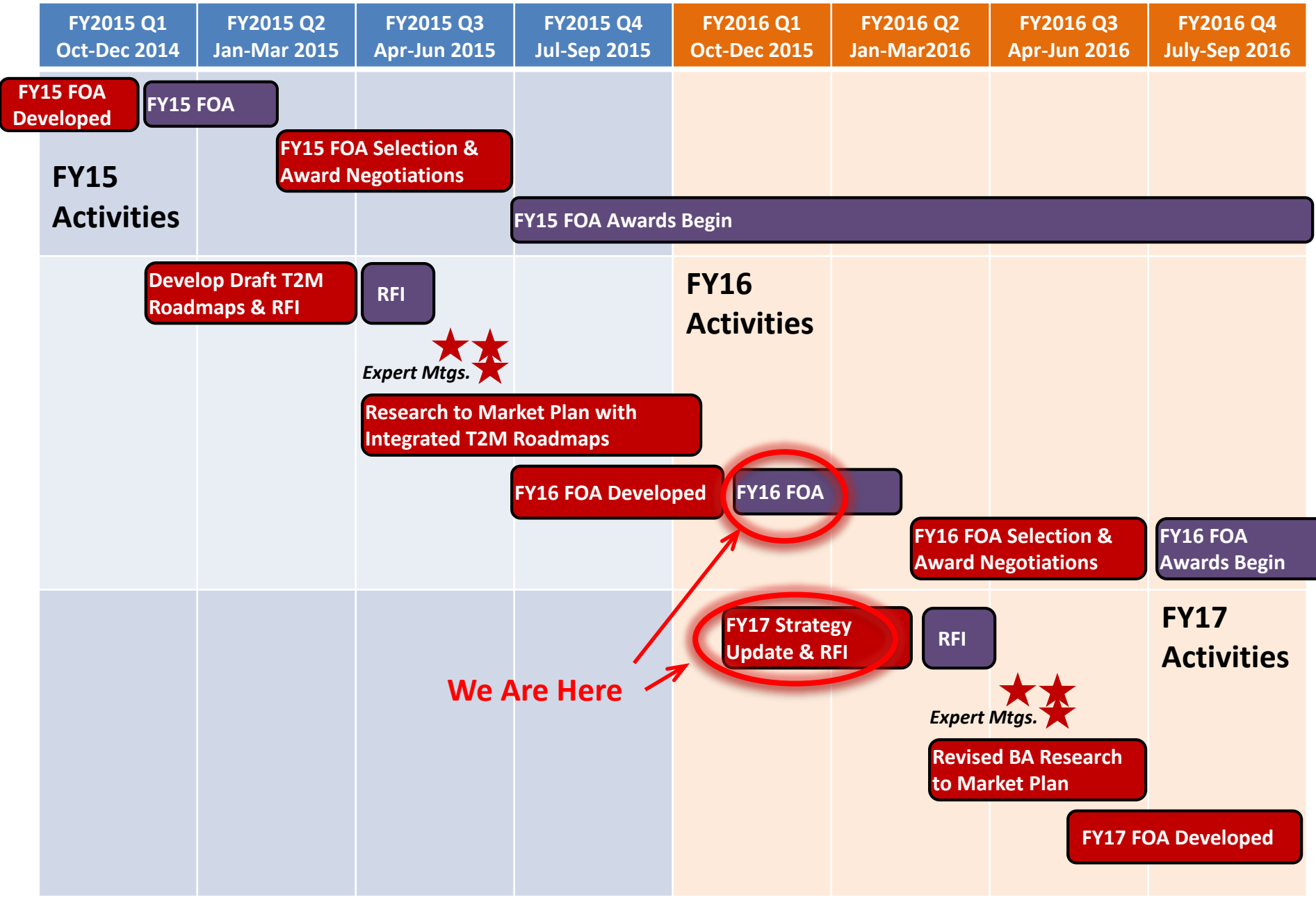
November 2015

**Prepared by Confluence Communications and Energetics Incorporated for:**
The Building America Program
Residential Buildings Integration
Building Technologies Office
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

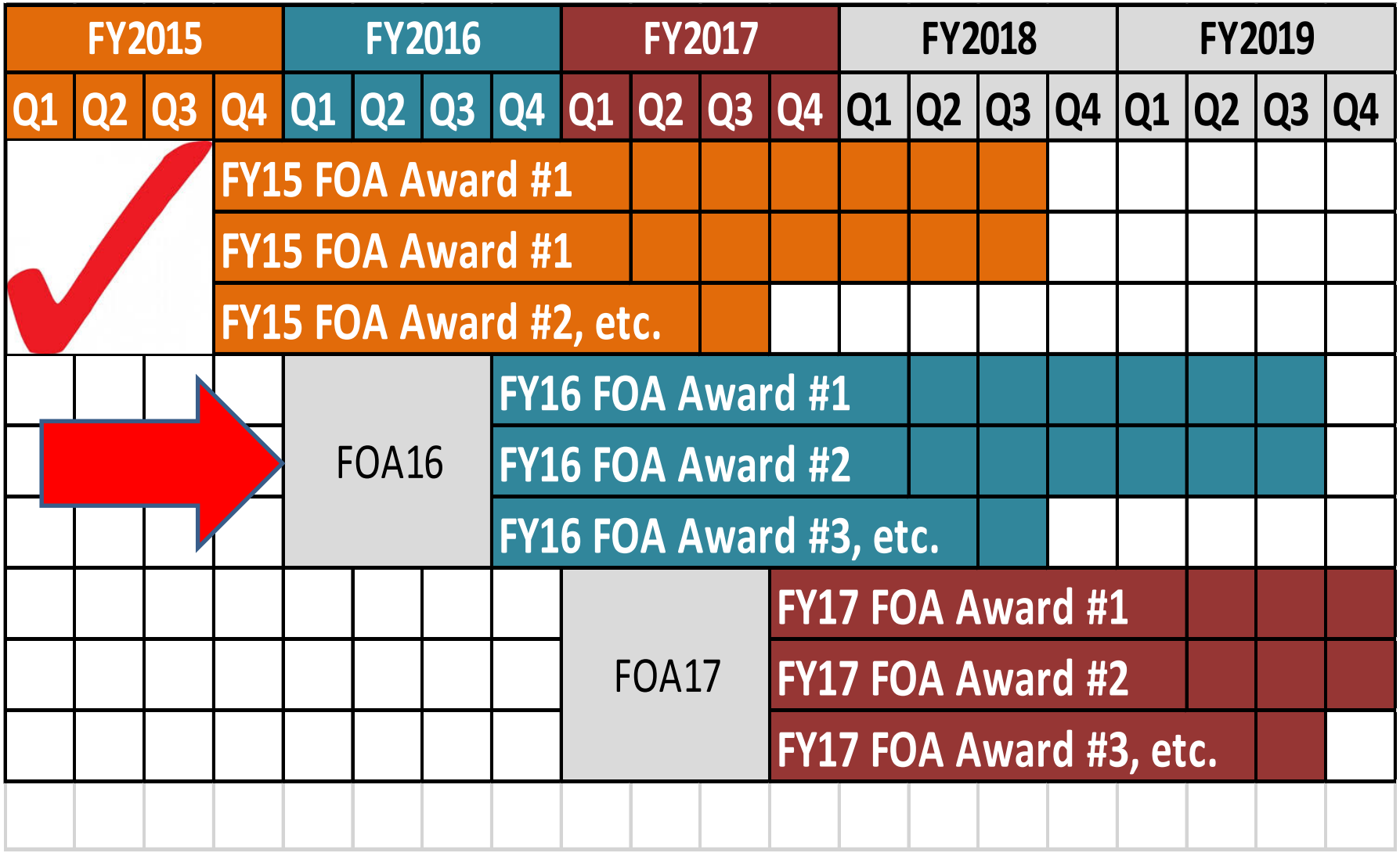
**Project Manager and Technical Editor:**
Eric Werling
Building America Program Director

Building America
U.S. Department of Energy

# Building America FY15-17 Planning Timeline



# Building America Planned 3-Year FOA Schedule (subject to appropriations)



# Building America Integrated Roadmaps

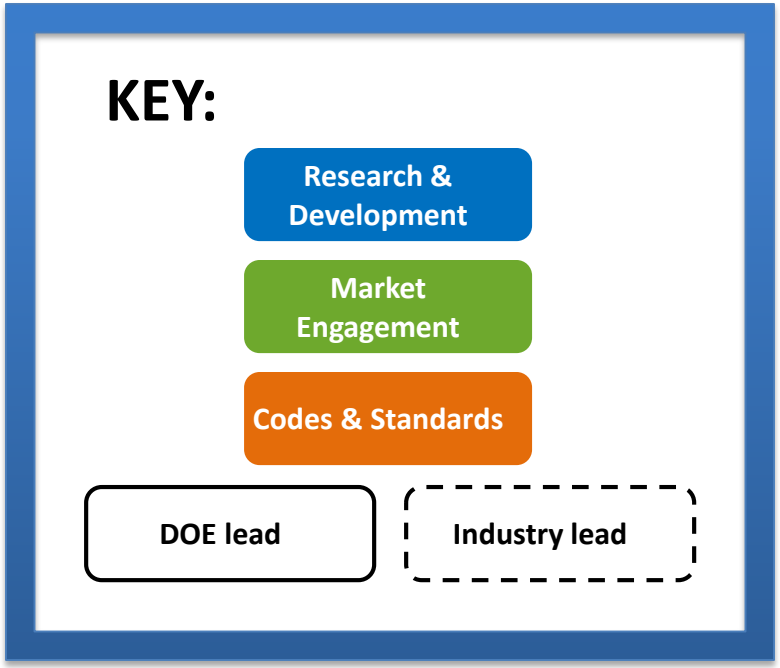
A. High Performance, Moisture Managed Envelope Systems

B. Optimal Comfort Systems for Low Load Homes

C. Optimal Ventilation Systems and IAQ Solutions for Low Load Homes

**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 builders and home improvement contractors

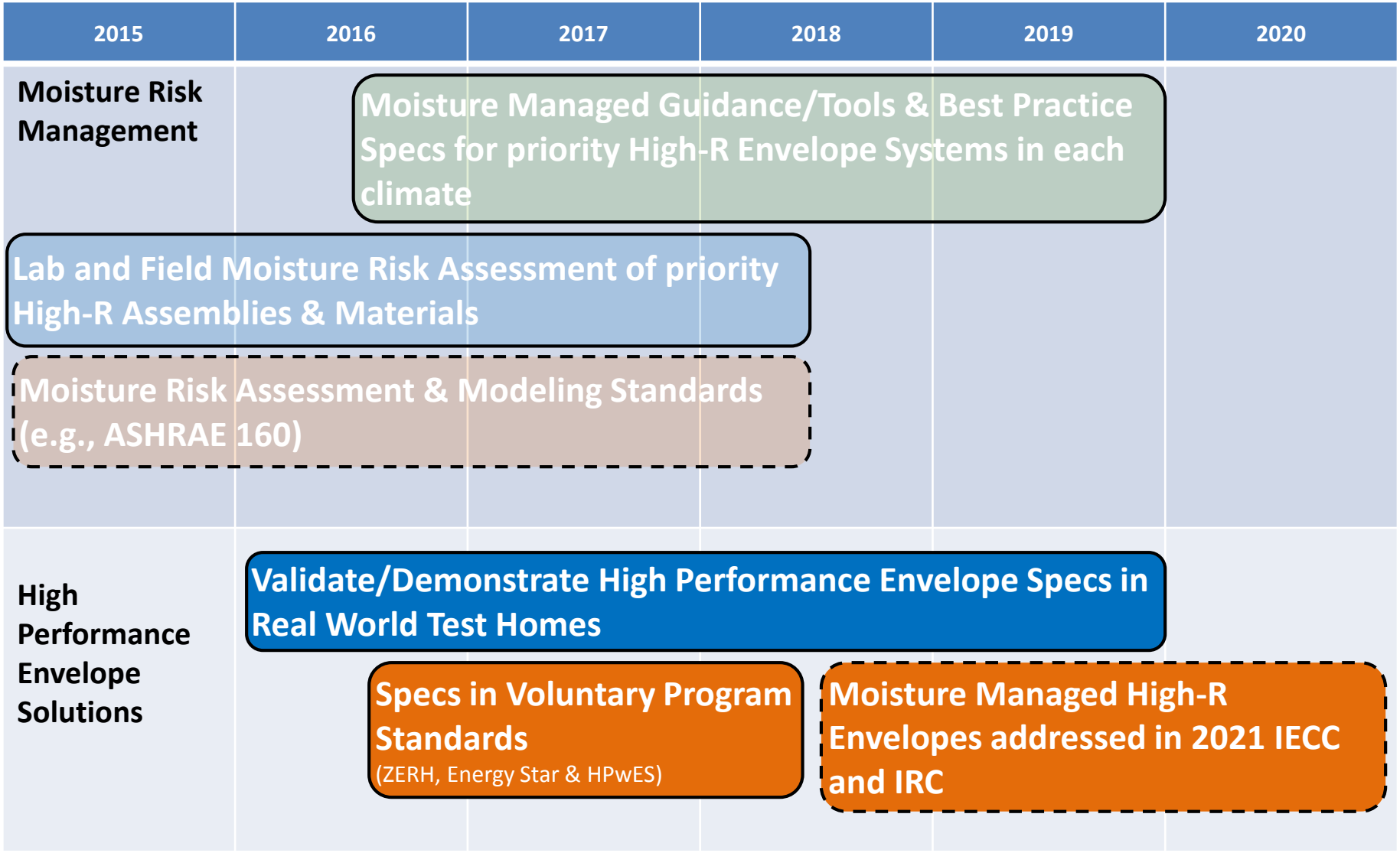


# A. Moisture Managed High Performance Envelopes

# 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** | |

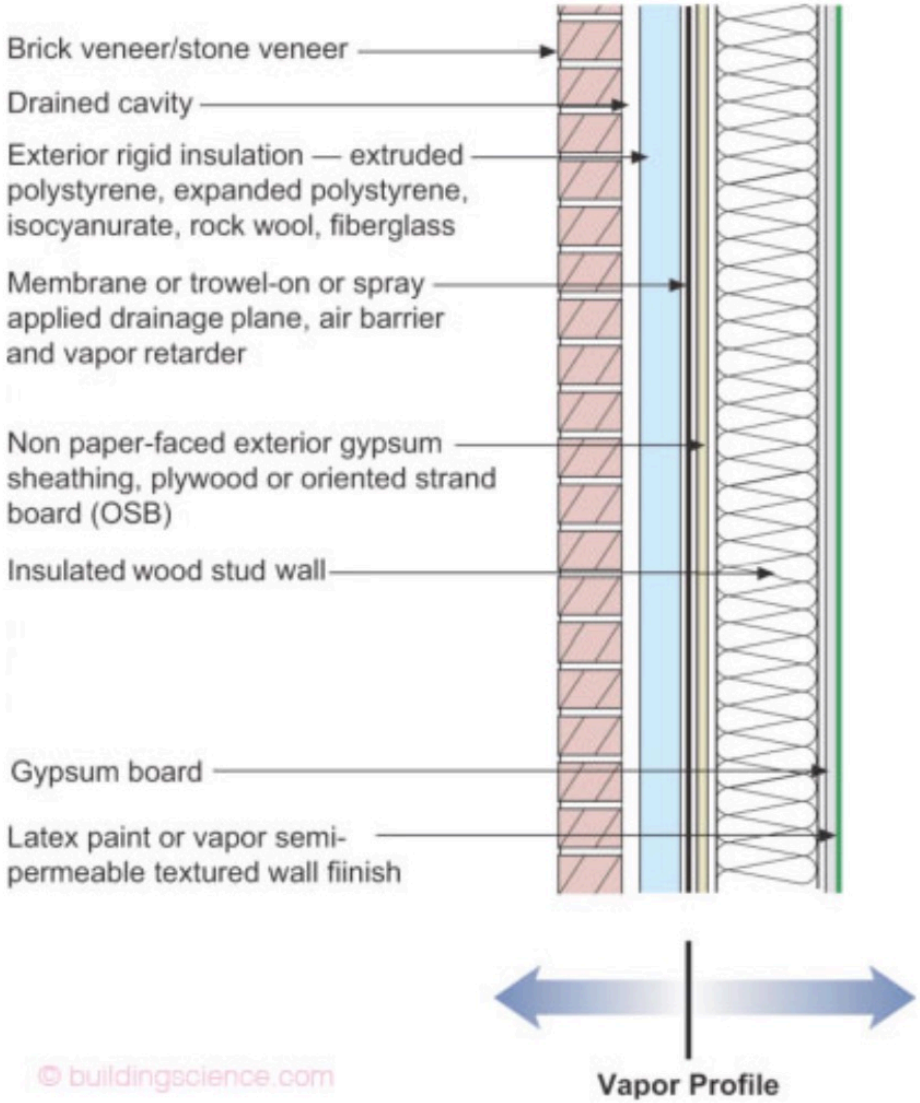
# A. High Performance Moisture Managed Envelopes



# The Perfect Wall

## 4 control layers:

- rain control
- air control
- vapor control
- thermal control




"The Residential Wall"
The best residential wall we know how to construct. Not cheap. Works almost everywhere – except in extreme cold climates where we would not insulate within the wood structural frame.

# But nobody's Perfect, right?

(except maybe Joe)

- What if you leave out a control layer (or combine control layers)?
- What if a control layer is on the wrong side?
- What if installation is not perfect?
- What if people move in and start taking showers?

It gets complicated…

# Maybe we need Expert advice?

Wouldn't it be great if …

**there was an App …**

**with an expert inside?!**

# 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) | | | | |
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| | | Specs in Voluntary Program Standards (ZERH, Energy Star & HPwES) | | Moisture Managed High-R Envelopes addressed in 2021 IECC and IRC | |

# Why Moisture Management? Why Now?

1. Innovative building materials (gypsum board, OSB) have changed how envelopes behave
2. Proliferation of central air conditioning has changed the thermal conditions inside homes
3. Houses are getting tighter with more insulation

# Moisture Risk Management

- Fear of greater moisture risk due to uncertainty about moisture & drying
- Moisture problems are costly
- Many variables affect these risks
- Some variables are outside our control …

PAGE A12 The Olympian

Business

EDITOR: FRIEDA BUSH (news@theolympian.com): 754-5403

MARKETS IN BRIEF

10,727.19 80.61 DOW

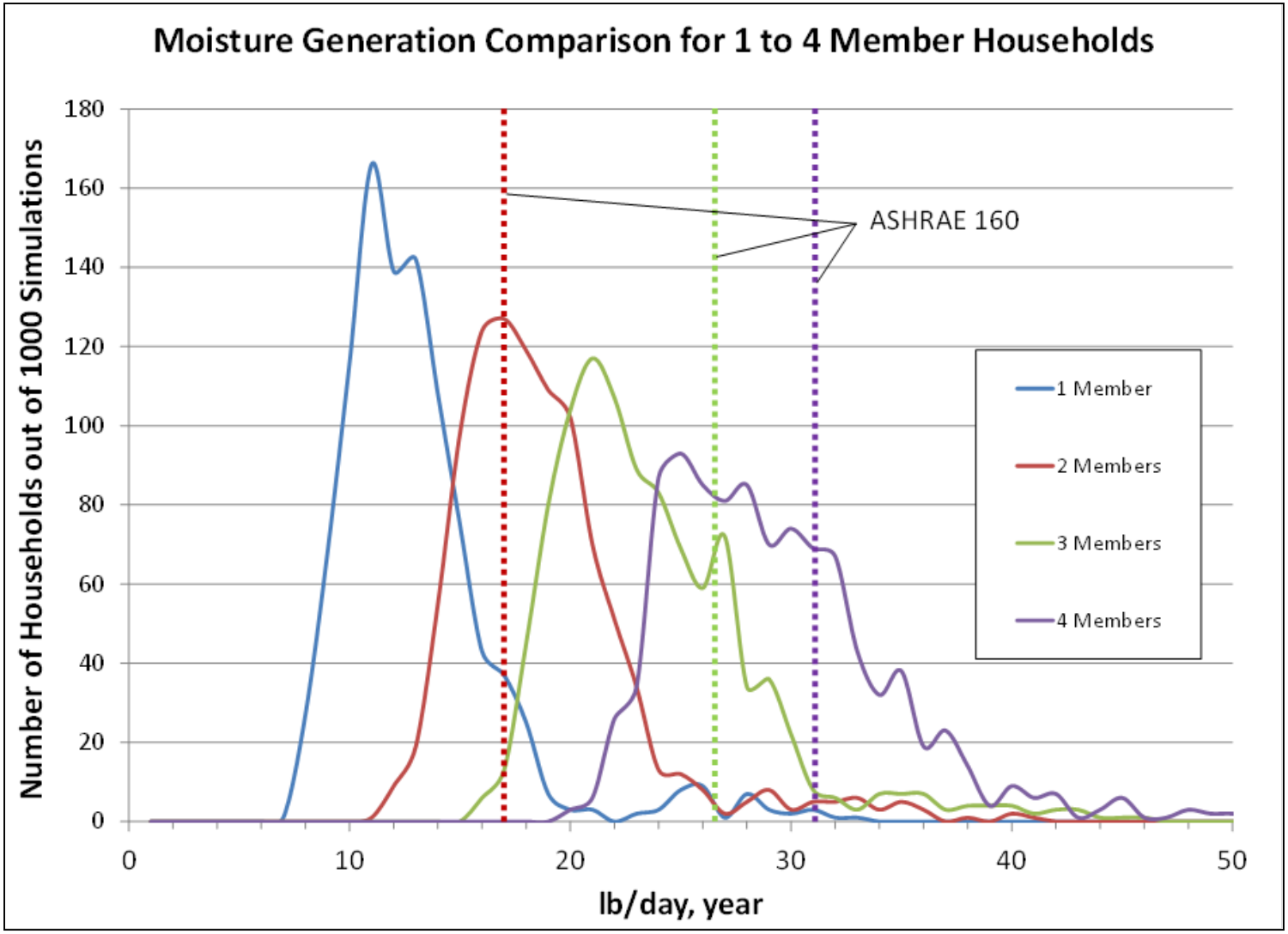
3956.42 -23.87

[redacted]nakes offer in defective siding lawsuit

# Moisture Management Design Parameters

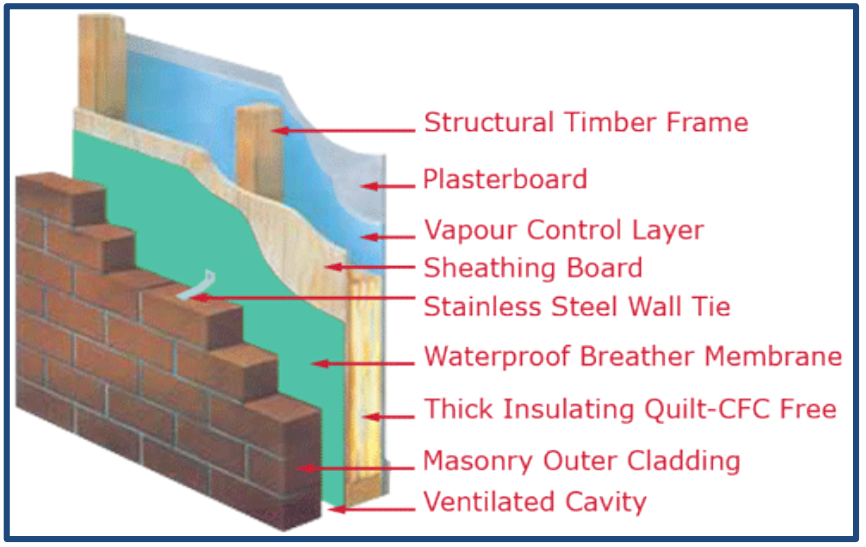
- **Moisture Loads:**
  - Climate
  - Bulk water leakage
  - Internal building moisture loads (people!)
  - Initial construction moisture

# Probabilistic distribution of interior moisture sources



# Moisture Management Design Parameters

- **Envelope Design:**
  - Air tightness
  - Interior vapor control
  - Insulation permeance
  - Water resistive barrier permeance
  - Exterior sheathing permeance
  - Cladding type and color



# Lab and Field Moisture Assessment

- Test parameters that impact moisture durability
- Examine effects of moisture sources, including air leakage, through a combination of simulations and laboratory tests
- Calibrate hygrothermal simulation tool (WUFI) to better model the effects of air leakage in wall assemblies
- Calibrate model with laboratory and field tests

# Modeling software modified...

**construction details**

**orientation**

**inclination**

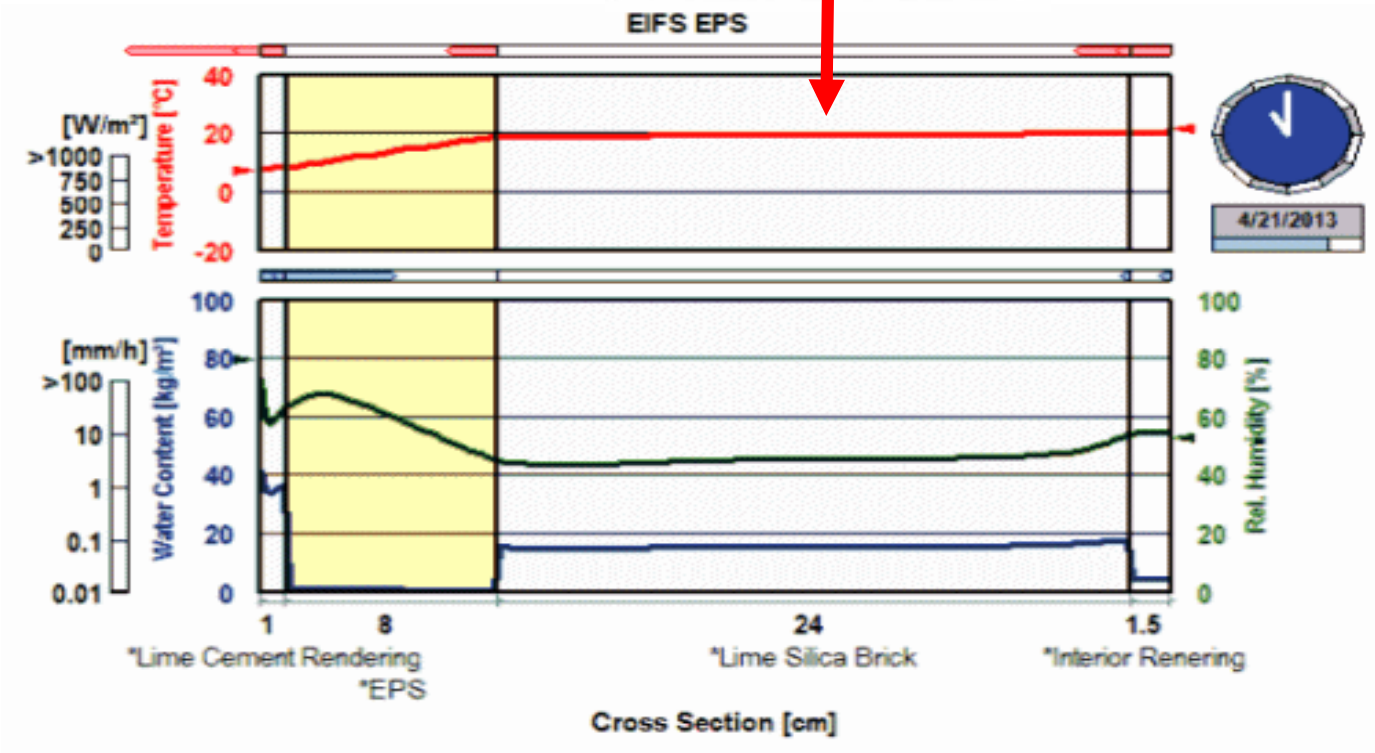
**initial conditions**

**material properties**

**climate conditions**

$$\frac{\partial w}{\partial \phi}\cdot\frac{\partial \phi}{\partial t}=\nabla\cdot\left(D_\phi\nabla\phi+\delta_p\nabla\left(\phi\ p_{sat}\right)\right)$$

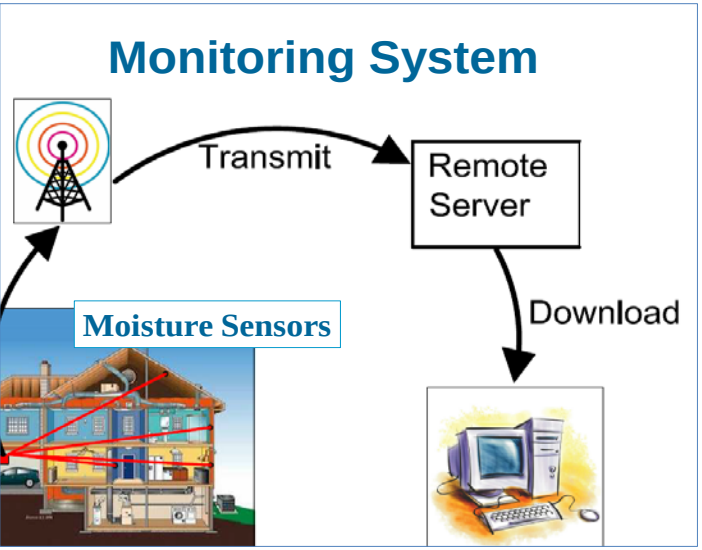
$$\frac{\partial H}{\partial T}\cdot\frac{\partial T}{\partial t}=\nabla\cdot\left(\lambda\nabla T\right)+h_v\nabla\cdot\left(\delta_p\nabla\left(\phi\ p_{sat}\right)\right)$$




# Building America Field Testing Project

## Moisture Performance of High-R Wall Systems

# Moisture Performance of High-R Wall Systems




## Summary

Home Innovation will monitor and analyze the moisture performance of High-R wall systems across various climate zones. The research will address concerns and develop solutions related to long-term moisture performance in High-R walls.

## Goals

1. Demonstrate moisture performance of well-designed high performance walls.
2. Identify wall systems with marginal performance and develop solutions that introduce an added factor of safety.
3. Develop a set of design criteria and code change proposals that ensure durability of high performance walls.

**TEAM**

Vladimir Kochkin

Nay Shah

Team: Home Innovation Research Labs

**Partners**: American Chemistry Council, NAHB, USDA Forest Products Lab, VSI

## Impact

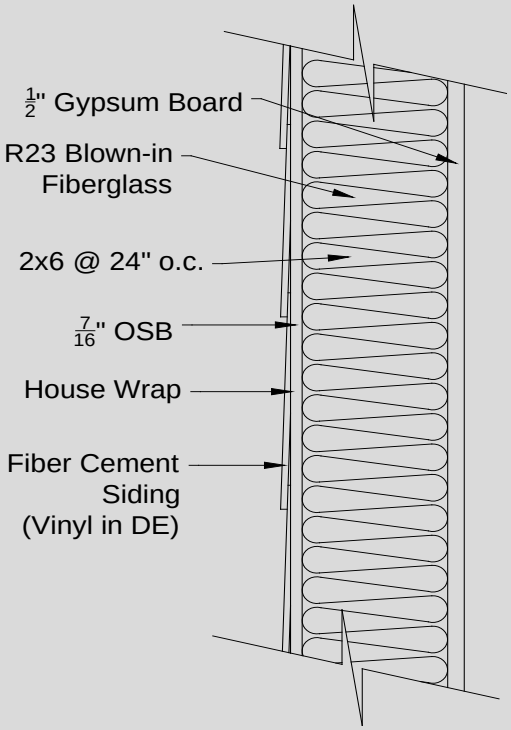
Removing barriers to the adoption of High-R wall systems for low-load homes by providing new design guidance, code requirements and specific durable wall solutions

## Key Idea/Takeaway

1. Increase the adoption of High-R walls.
2. A library of data for durable wall systems.
3. Improved code provisions that are up to date with the latest High-R wall technologies.

# Moisture Performance of High-R Wall Systems


Sensor Calibration on OSB




Wall Configuration

## Completed Tasks

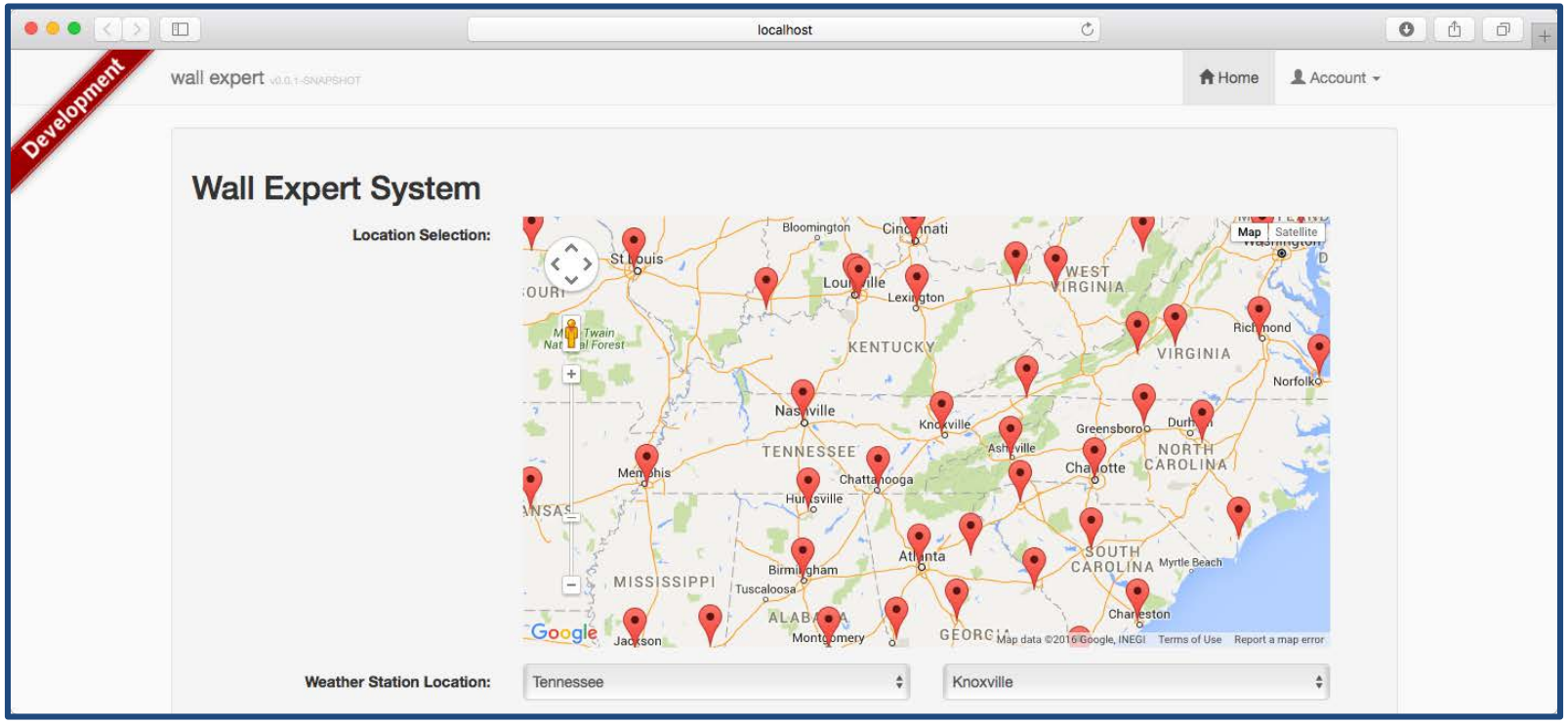
- Submission of draft Research Plan
- Submission of draft Field Measurement Method
- Established an Advisory Group (AG)
- Moisture sensor calibration study
- Announcement of the project at IBS

## Next Steps

- Finalize prioritized library of wall systems by AG
- Share calibration data results
- Ramp up Builder Recruitment

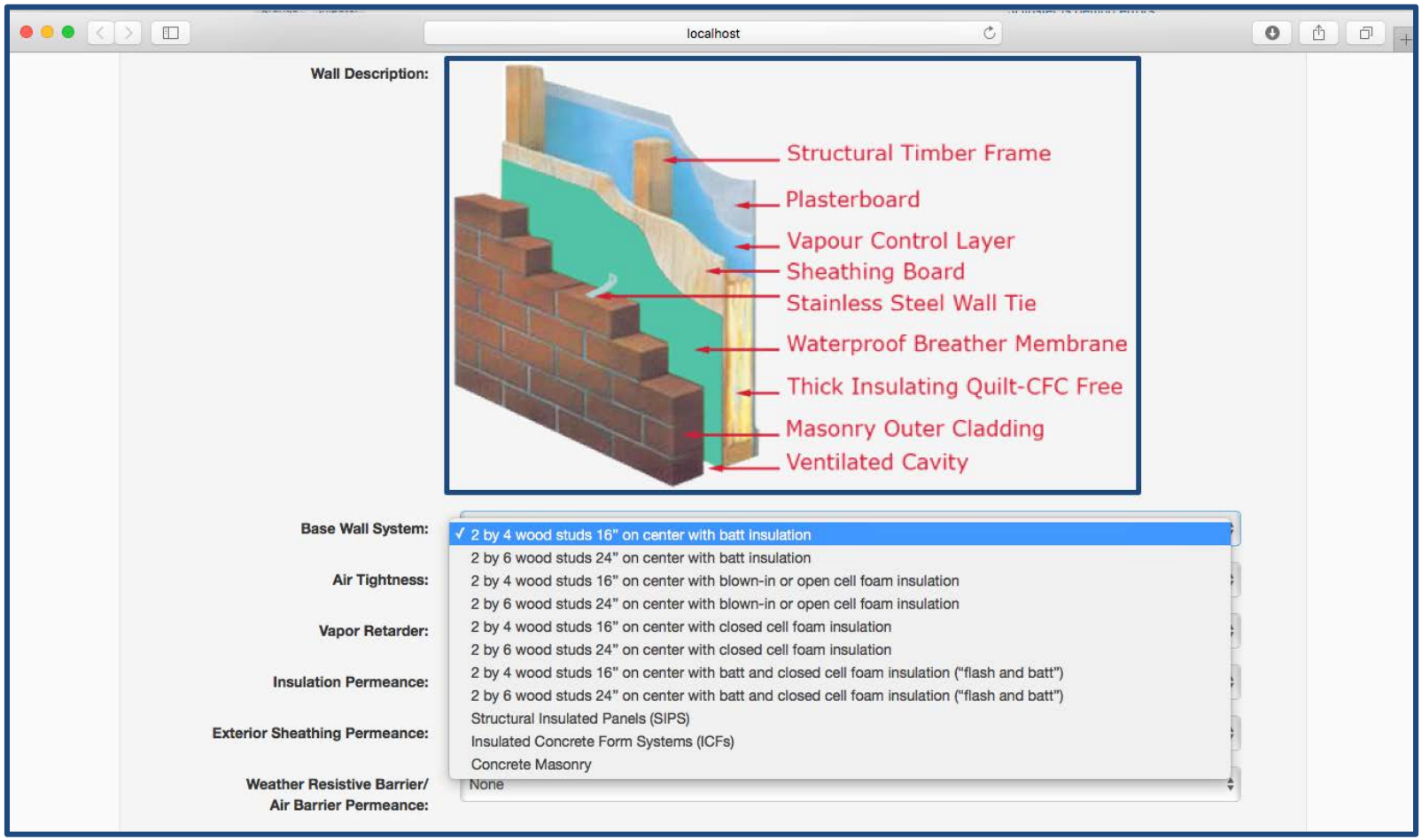
# Building America Moisture Management Expert System CONCEPT

# Proposed expert system development



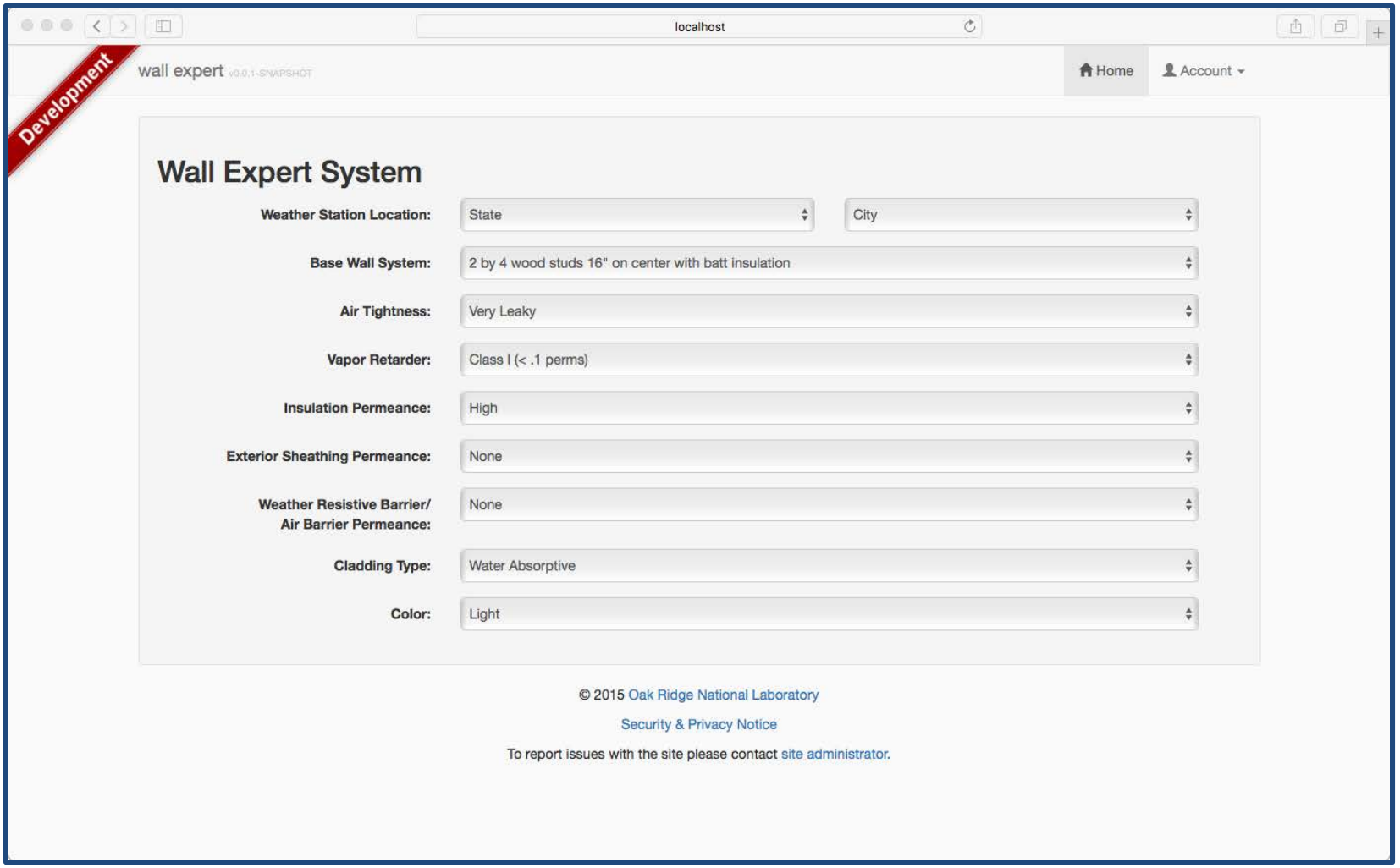

- Select building location from map.

# Proposed expert system development




- Select base wall system.

# Proposed expert system development




- Answer questions about wall components

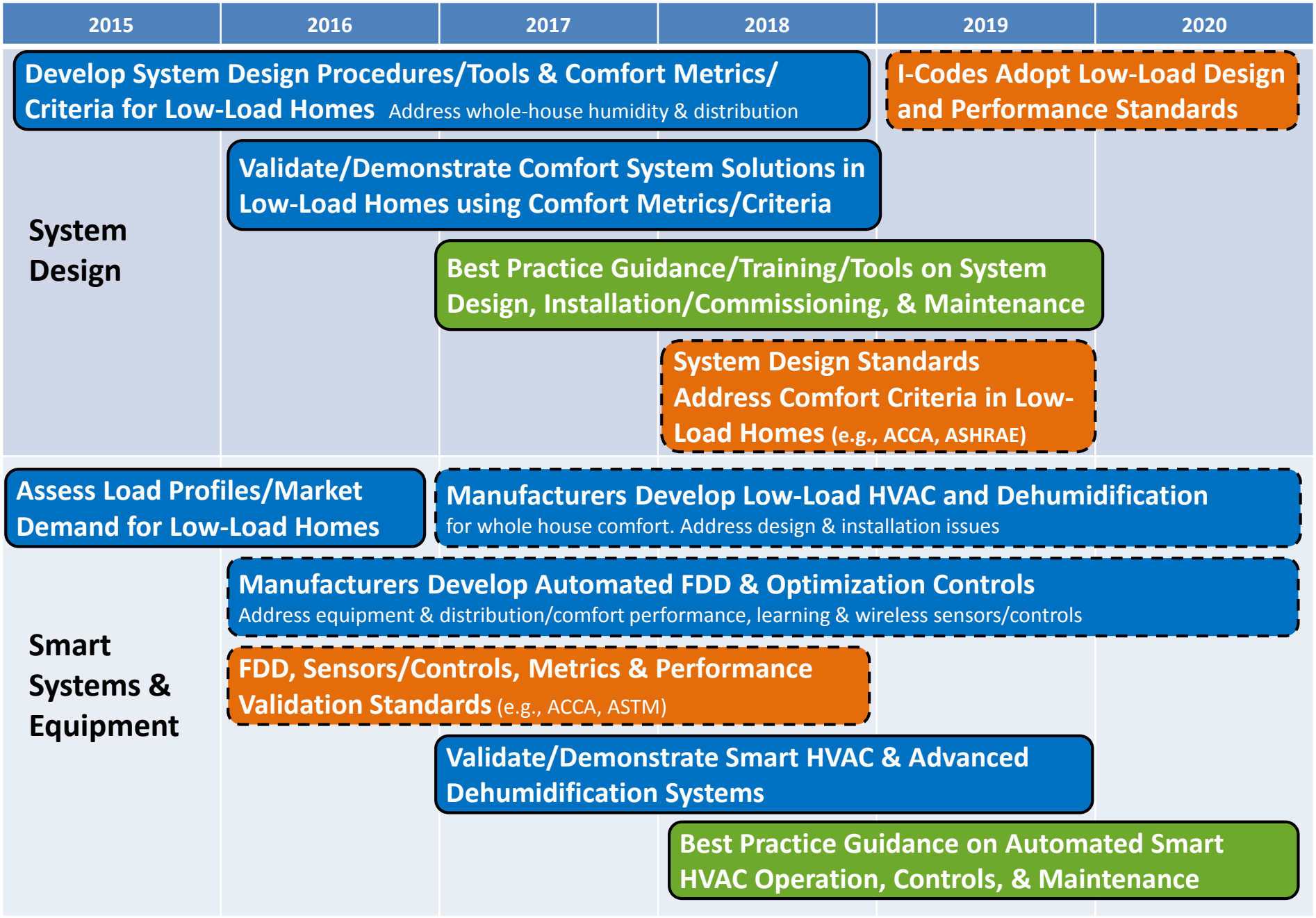
# Proposed expert system development

- **Ongoing tasks**
  - Add “help” menu for wall component selections
  - Complete “results” page
  - Develop list of wall systems that are known to perform well (expert meeting planned for April 2016)
  - Develop wall system graphics
  - Continue to develop database of simulation results

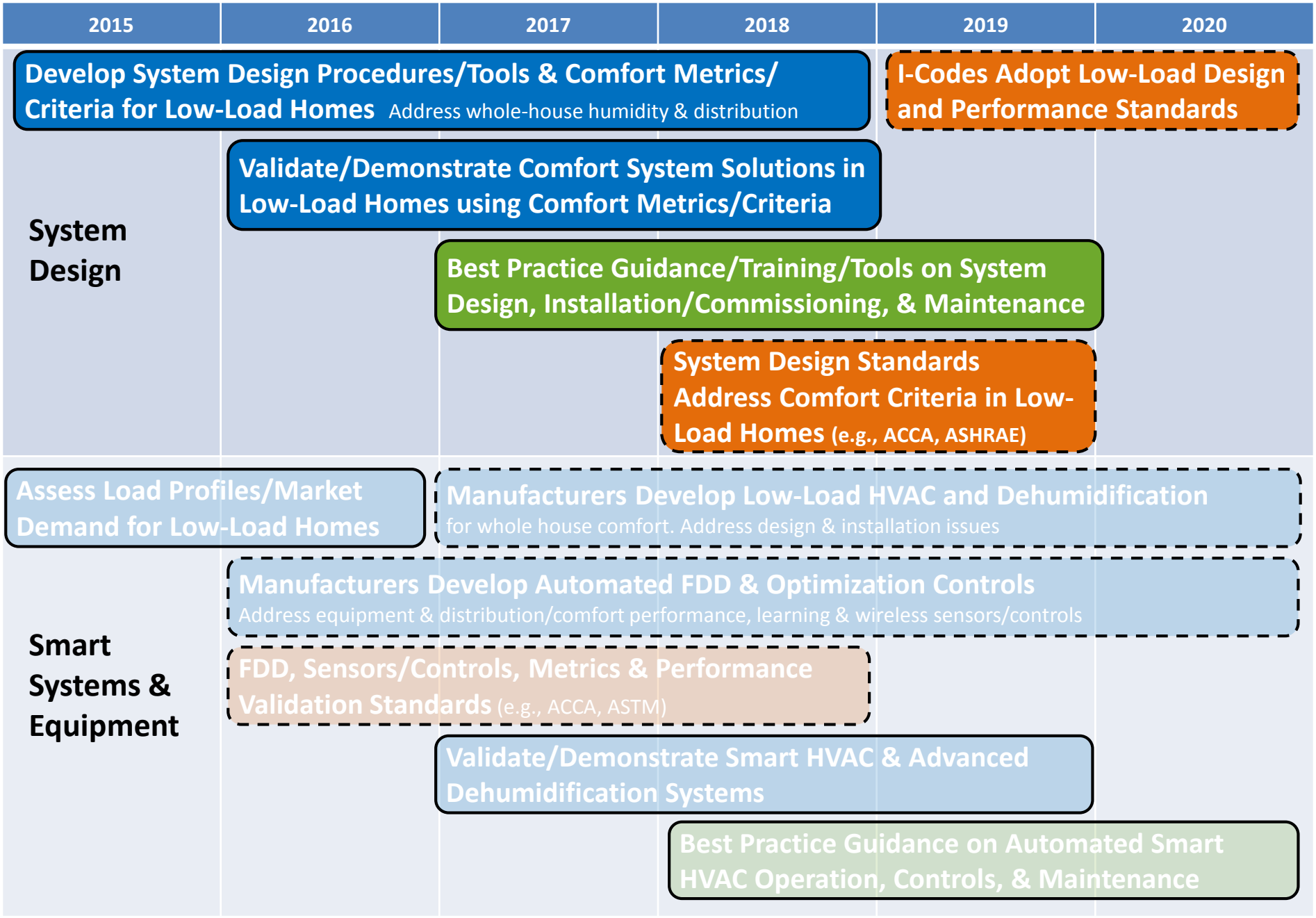
- **Beta version ready in late 2016**

# B. Optimal Comfort for Low-Load Homes

# B. Optimal Comfort Systems for Low-Load Homes



# B. Optimal Comfort Systems for Low-Load Homes



# HVAC Loads Are Changing

**Legacy Practice**

- Ducts in attic
- Code thermal enclosure
- Only limited exhaust ventilation included
- Standard appliances and lighting

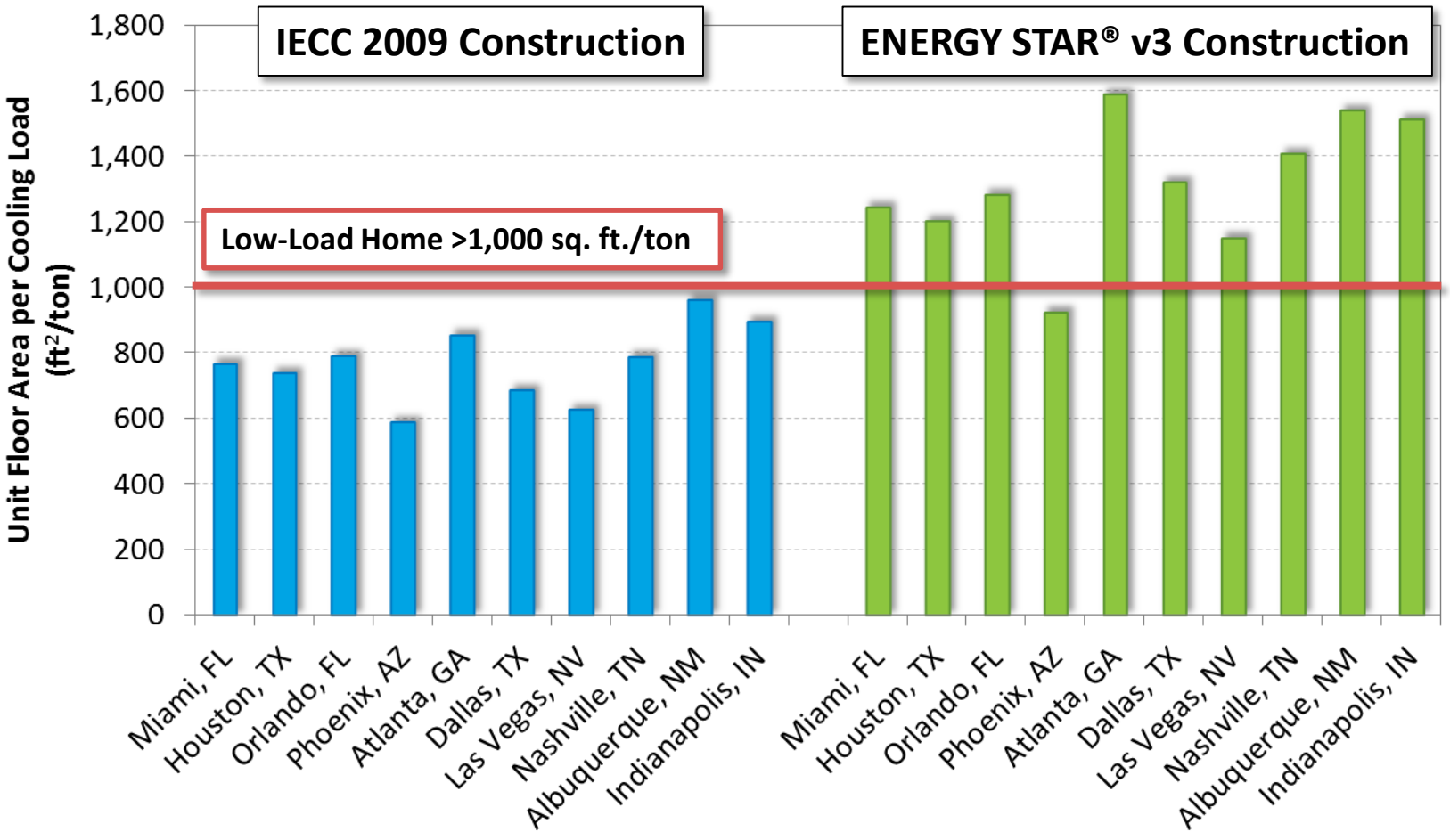
**400 → 1,000 sq. ft. per ton of cooling**

**High Performance Homes**

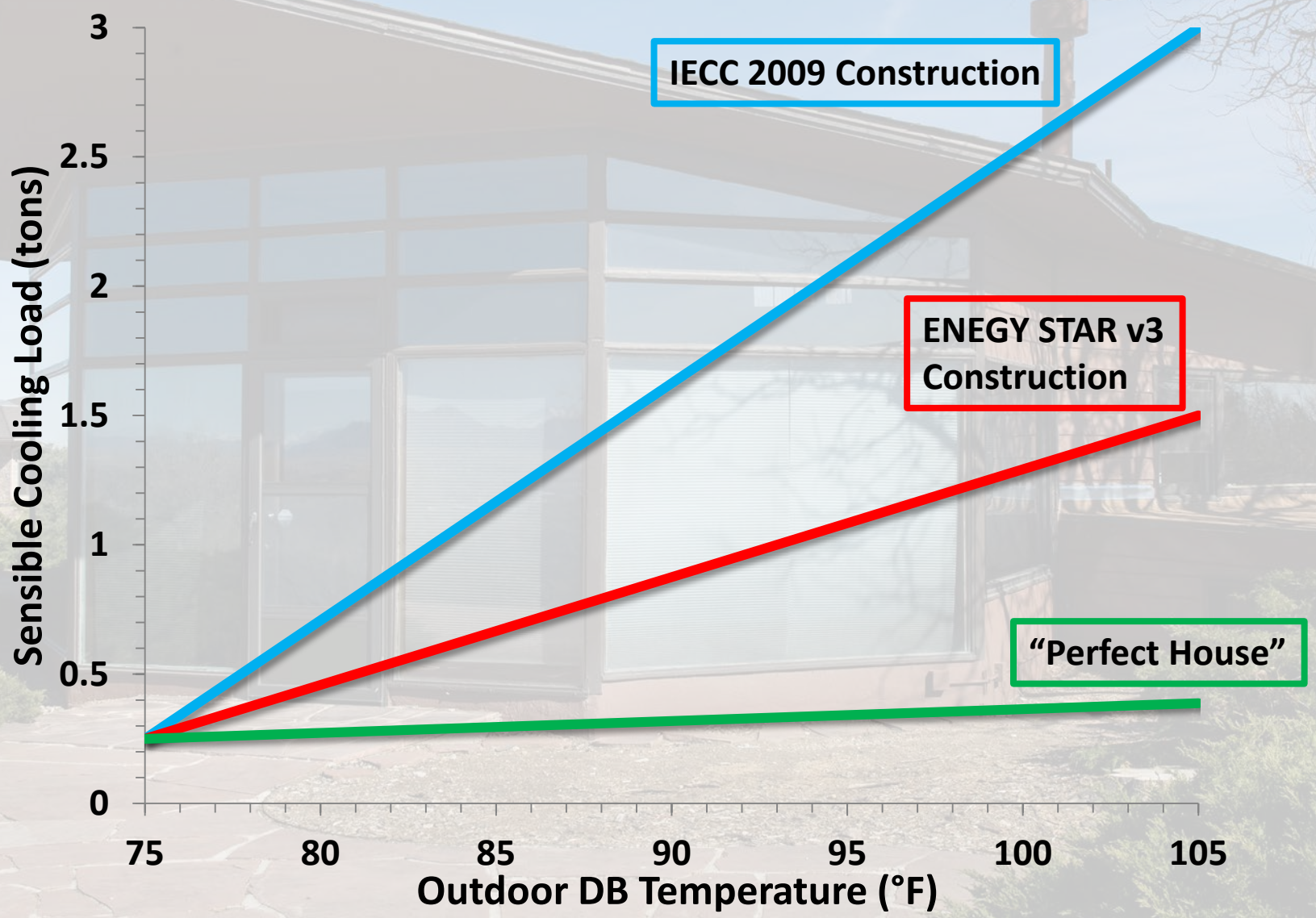
- Ducts in conditioned space
- High-R thermal enclosure
- Air tight construction requires mechanical ventilation
- ENERGY STAR appliances and lighting

**1,200 → 2,000 sq. ft. per ton of cooling**

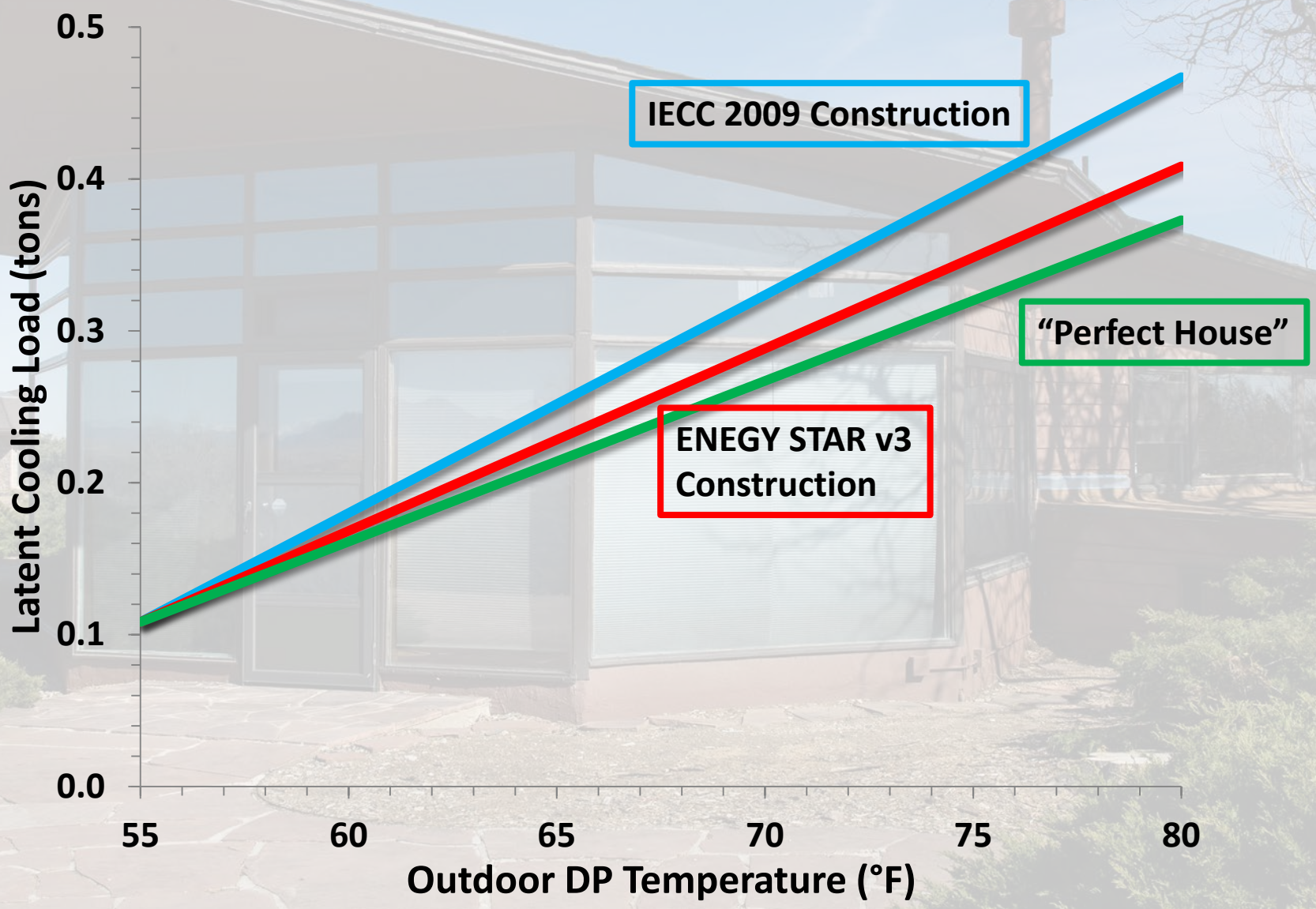
# Normalized Cooling Loads



# Low-Load Homes Behave Differently



# Low-Load Homes Behave Differently

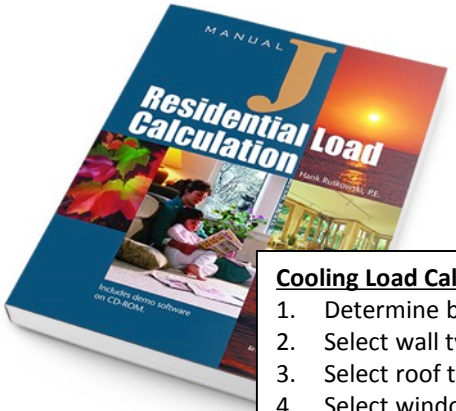


# Comfort Issues to Address in Low-Load Homes

- **Part-load cooling humidity control**
  - Conventional equipment operation and selection procedures limit latent capacity
- **Room air flow and mixing**
  - Lower room sensible loads require less delivered air
- **Temperature non-uniformity**
  - Low-load homes can have large variation in room cooling loads due to local solar and internal gains
  - Single thermostat results in over- and under-conditioning of spaces

# Selecting Dehumidification Equipment

Calculate building loads using 1% DB temperature




**Cooling Load Calculations**

1. Determine building size…
2. Select wall types…
3. Select roof types…
4. Select window types…
5. Select ducts…

Select the equipment

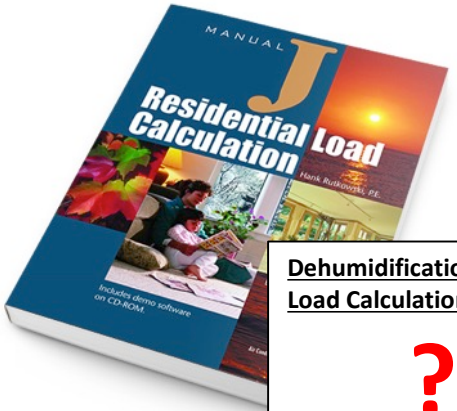

COOLING CAPACITY - XP14-024 with

Outdoor Air

| Entering Wet Bulb Temperature | Total Air Volume | | 85°F (29°C) Total Cooling Capacity | | Comp Motor kW Input | Sensible To Total Ratio (S/T) Dry Bulb | | | 95°F (35°C) Total Cooling Capacity | | Comp Motor kW Input | Sensible Ratio Dry |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | cfm | L/s | kBtuh | kW | | 75°F 24°C | 80°F 27°C | 85°F 29°C | kBtuh | kW | | 75°F 24°C |
| 63°F (17°C) | 670 | 315 | 23.4 | 6.9 | 1.35 | .75 | .89 | 1.00 | 22.2 | 6.5 | 1.54 | .77 |
| | 820 | 385 | 24.4 | 7.2 | 1.36 | .80 | .96 | 1.00 | 23.2 | 6.8 | 1.55 | .82 |
| | 820 | 385 | 24.4 | 7.2 | 1.36 | .80 | .96 | 1.00 | 23.2 | 6.8 | 1.55 | .82 |
| 67°F (19°C) | 670 | 315 | 24.8 | 7.3 | 1.36 | .59 | .72 | .85 | 23.6 | 6.9 | 1.55 | .60 |
| | 820 | 385 | 25.8 | 7.6 | 1.36 | .62 | .78 | .92 | 24.6 | 7.2 | 1.56 | .63 |
| | 820 | 385 | 25.8 | 7.6 | 1.36 | .62 | .78 | .92 | 24.6 | 7.2 | 1.56 | .63 |
| 71°F (22°C) | 670 | 315 | 26.2 | 7.7 | 1.37 | .45 | .58 | .70 | 24.8 | 7.3 | 1.56 | .45 |
| | 820 | 385 | 27.2 | 8.0 | 1.37 | .46 | .61 | .75 | 25.8 | 7.6 | 1.57 | .47 |
| | 820 | 385 | 27.2 | 8.0 | 1.37 | .46 | .61 | .75 | 25.8 | 7.6 | 1.57 | .47 |

Install the equipment

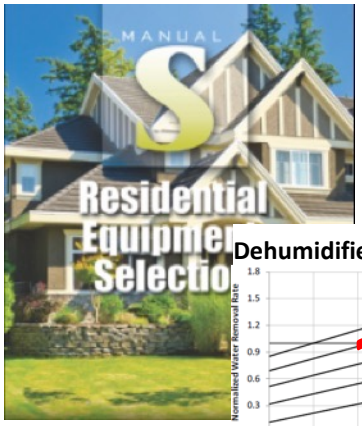
Calculate building loads using ?% DP temperature



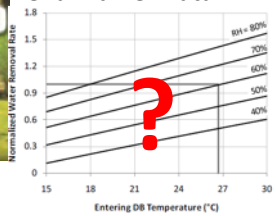

**Dehumidification Load Calculations**

?

Select the equipment



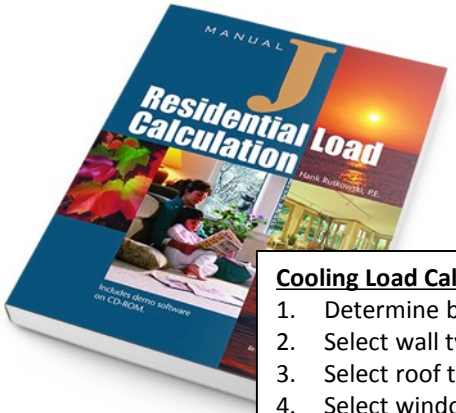

**Dehumidifier Data**




Install the equipment

# Selecting Dehumidification Equipment

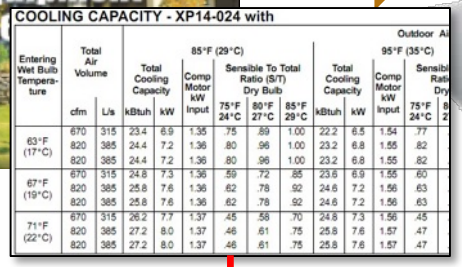
Calculate building loads using 1% DB temperature




**Cooling Load Calculations**

1. Determine building size…
2. Select wall types…
3. Select roof types…
4. Select window types…
5. Select ducts…

Select the equipment

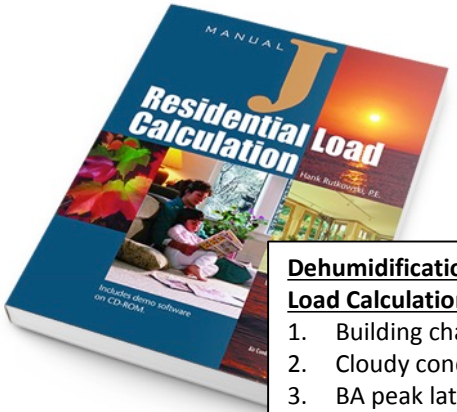



COOLING CAPACITY - XP14-024 with

| Entering Wet Bulb Temperature | Total Air Volume cfm | Total Air Volume L/s | 85°F (29°C) Total Cooling Capacity kBtuh | 85°F (29°C) Total Cooling Capacity kW | Comp Motor kW Input | Sensible To Total Ratio (S/T) Dry Bulb 75°F 24°C | 80°F 27°C | 85°F 29°C | 95°F (35°C) Total Cooling Capacity kBtuh | 95°F (35°C) Total Cooling Capacity kW | Comp Motor kW Input | Sensible Ratio Dry 75°F 24°C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 63°F (17°C) | 670 | 315 | 23.4 | 6.9 | 1.35 | .75 | .89 | 1.00 | 22.2 | 6.5 | 1.54 | .77 |
| | 820 | 385 | 24.4 | 7.2 | 1.36 | .80 | .96 | 1.00 | 23.2 | 6.8 | 1.55 | .82 |
| | 820 | 385 | 24.4 | 7.2 | 1.36 | .80 | .96 | 1.00 | 23.2 | 6.8 | 1.55 | .82 |
| 67°F (19°C) | 670 | 315 | 24.8 | 7.3 | 1.36 | .59 | .72 | .85 | 23.6 | 6.9 | 1.55 | .60 |
| | 820 | 385 | 25.8 | 7.6 | 1.36 | .62 | .78 | .92 | 24.6 | 7.2 | 1.56 | .63 |
| | 820 | 385 | 25.8 | 7.6 | 1.36 | .62 | .78 | .92 | 24.6 | 7.2 | 1.56 | .63 |
| 71°F (22°C) | 670 | 315 | 26.2 | 7.7 | 1.37 | .45 | .58 | .70 | 24.8 | 7.3 | 1.56 | .45 |
| | 820 | 385 | 27.2 | 8.0 | 1.37 | .46 | .61 | .75 | 25.8 | 7.6 | 1.57 | .47 |
| | 820 | 385 | 27.2 | 8.0 | 1.37 | .46 | .61 | .75 | 25.8 | 7.6 | 1.57 | .47 |

Install the equipment

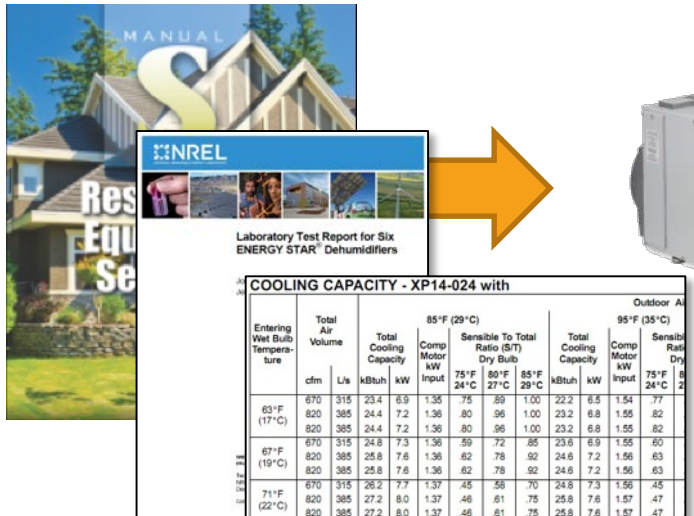
Calculate building loads using **2**% DP temperature




**Dehumidification Load Calculations**

1. Building characteristics…
2. Cloudy conditions…
3. BA peak latent internal gains…
4. Etc…

Select the equipment

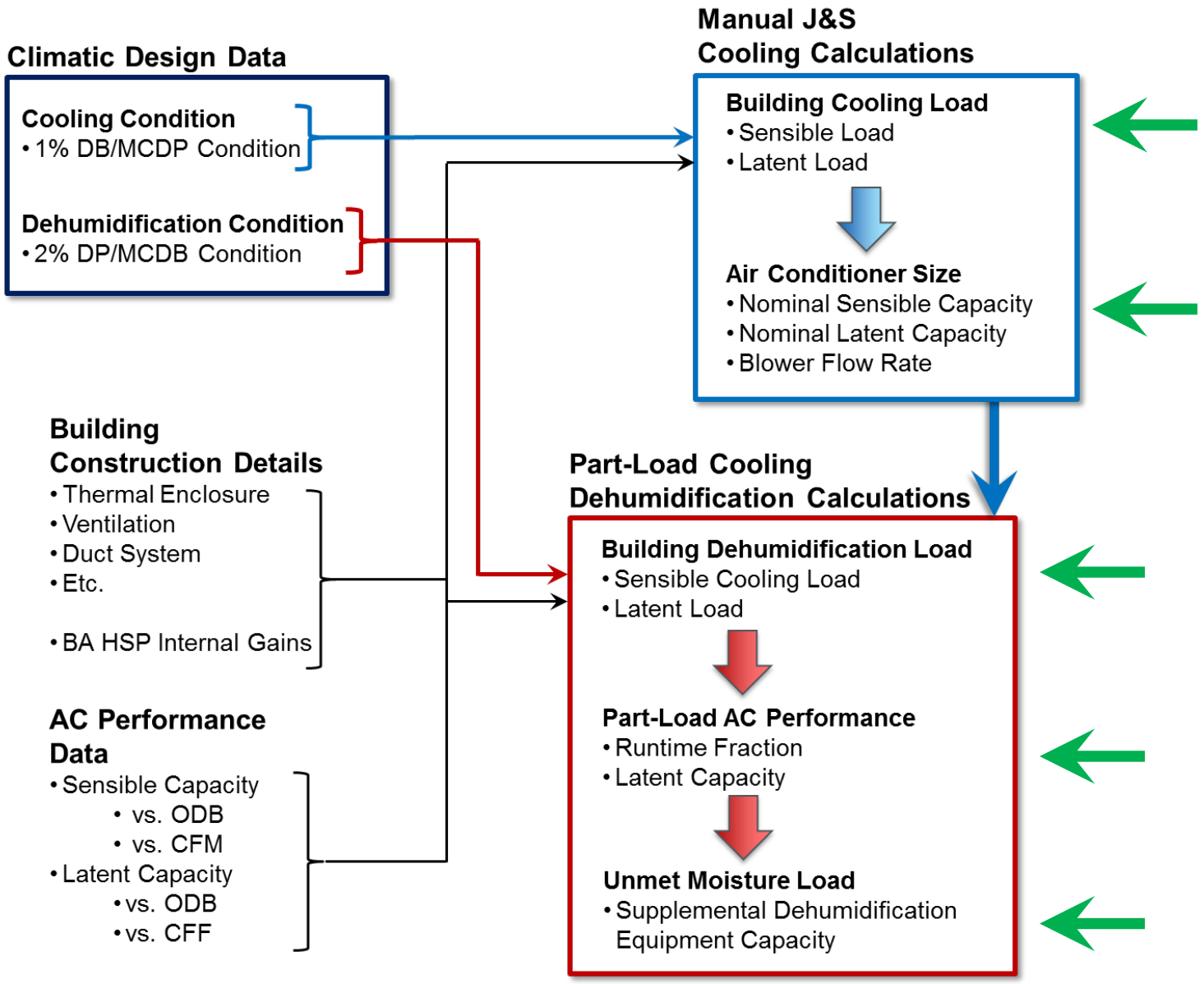



COOLING CAPACITY - XP14-024 with

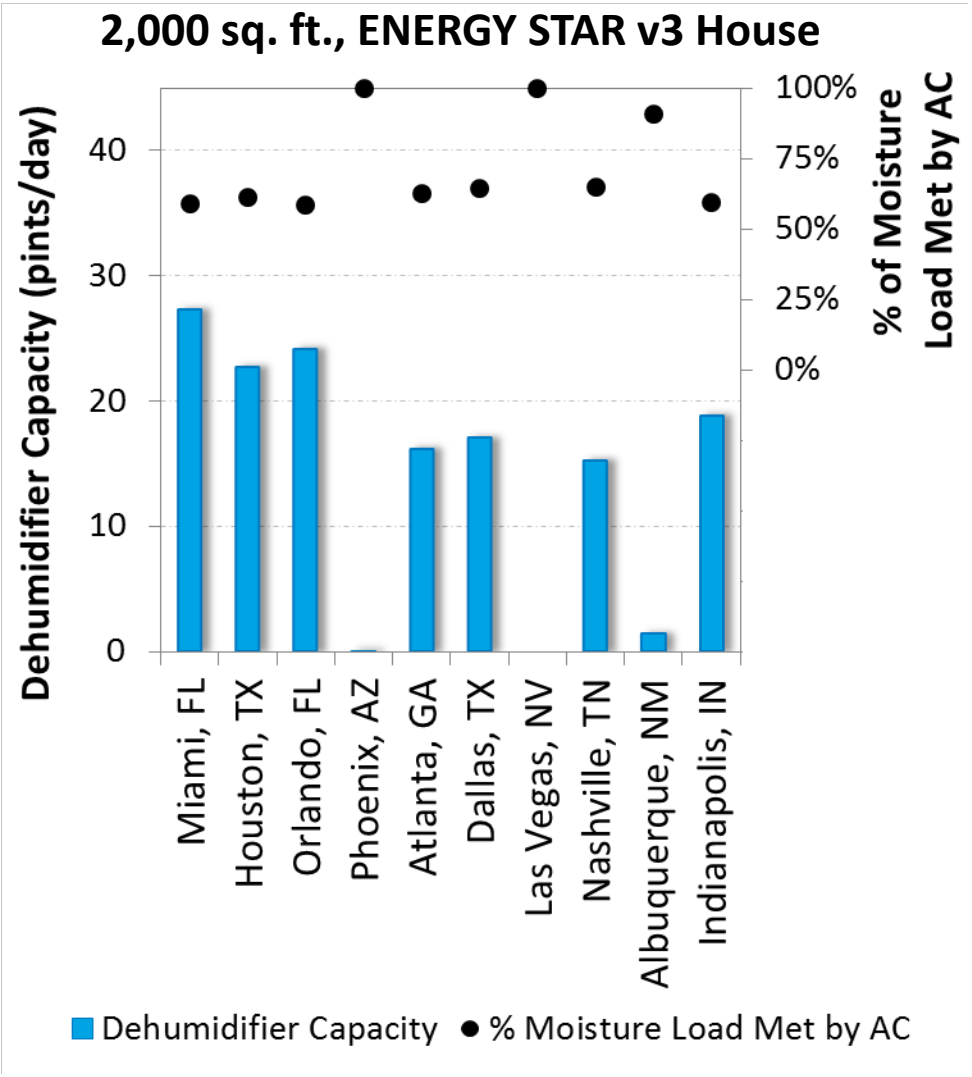
| Entering Wet Bulb Temperature | Total Air Volume cfm | Total Air Volume L/s | 85°F (29°C) Total Cooling Capacity kBtuh | 85°F (29°C) Total Cooling Capacity kW | Comp Motor kW Input | Sensible To Total Ratio (S/T) Dry Bulb 75°F 24°C | 80°F 27°C | 85°F 29°C | 95°F (35°C) Total Cooling Capacity kBtuh | 95°F (35°C) Total Cooling Capacity kW | Comp Motor kW Input | Sensible Ratio Dry 75°F 24°C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 63°F (17°C) | 670 | 315 | 23.4 | 6.9 | 1.35 | .75 | .89 | 1.00 | 22.2 | 6.5 | 1.54 | .77 |
| | 820 | 385 | 24.4 | 7.2 | 1.36 | .80 | .96 | 1.00 | 23.2 | 6.8 | 1.55 | .82 |
| | 820 | 385 | 24.4 | 7.2 | 1.36 | .80 | .96 | 1.00 | 23.2 | 6.8 | 1.55 | .82 |
| 67°F (19°C) | 670 | 315 | 24.8 | 7.3 | 1.36 | .59 | .72 | .85 | 23.6 | 6.9 | 1.55 | .60 |
| | 820 | 385 | 25.8 | 7.6 | 1.36 | .62 | .78 | .92 | 24.6 | 7.2 | 1.56 | .63 |
| | 820 | 385 | 25.8 | 7.6 | 1.36 | .62 | .78 | .92 | 24.6 | 7.2 | 1.56 | .63 |
| 71°F (22°C) | 670 | 315 | 26.2 | 7.7 | 1.37 | .45 | .58 | .70 | 24.8 | 7.3 | 1.56 | .45 |
| | 820 | 385 | 27.2 | 8.0 | 1.37 | .46 | .61 | .75 | 25.8 | 7.6 | 1.57 | .47 |
| | 820 | 385 | 27.2 | 8.0 | 1.37 | .46 | .61 | .75 | 25.8 | 7.6 | 1.57 | .47 |

Install the equipment

# Dehumidification Load Calculation

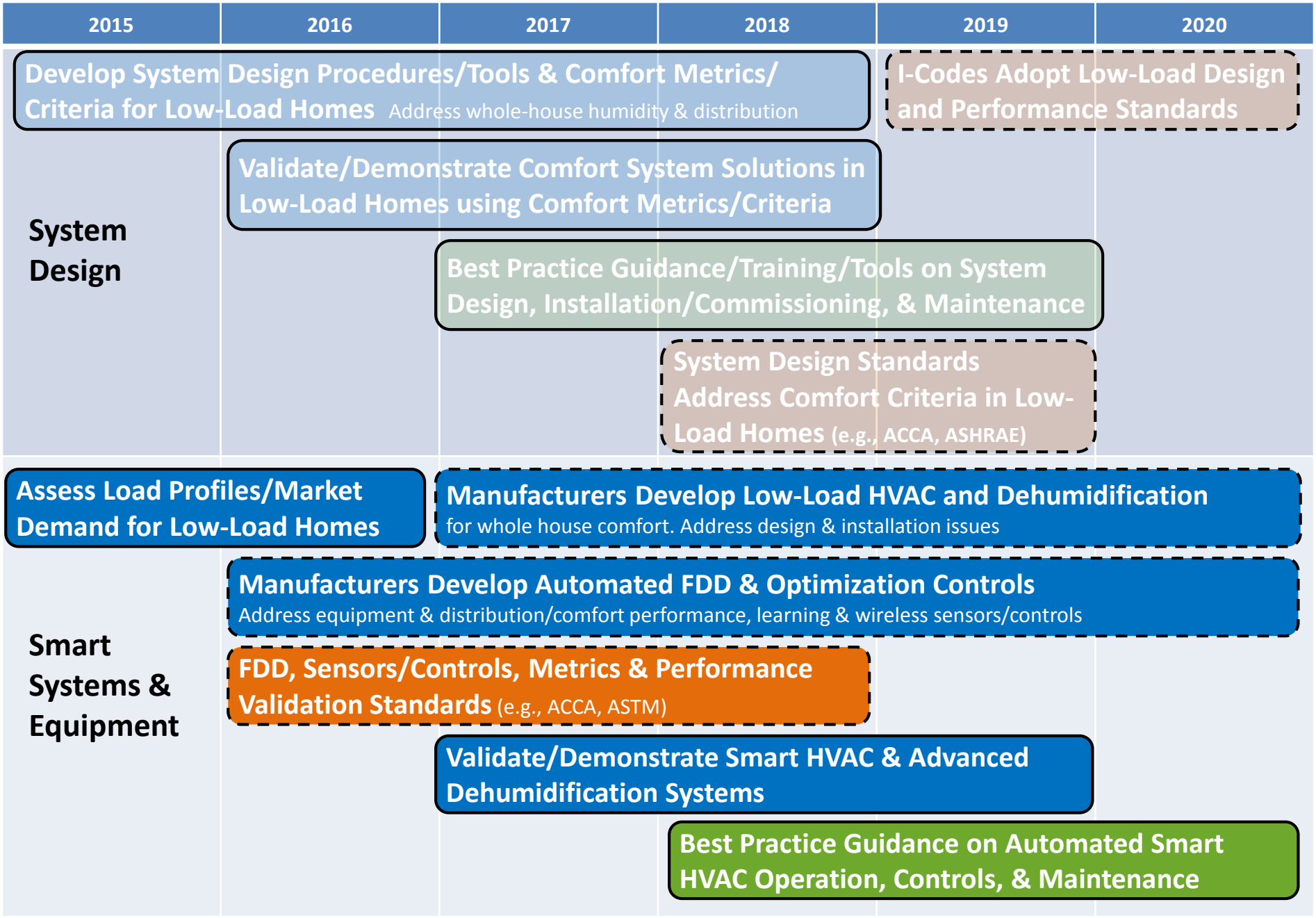


# Selecting Dehumidification Equipment

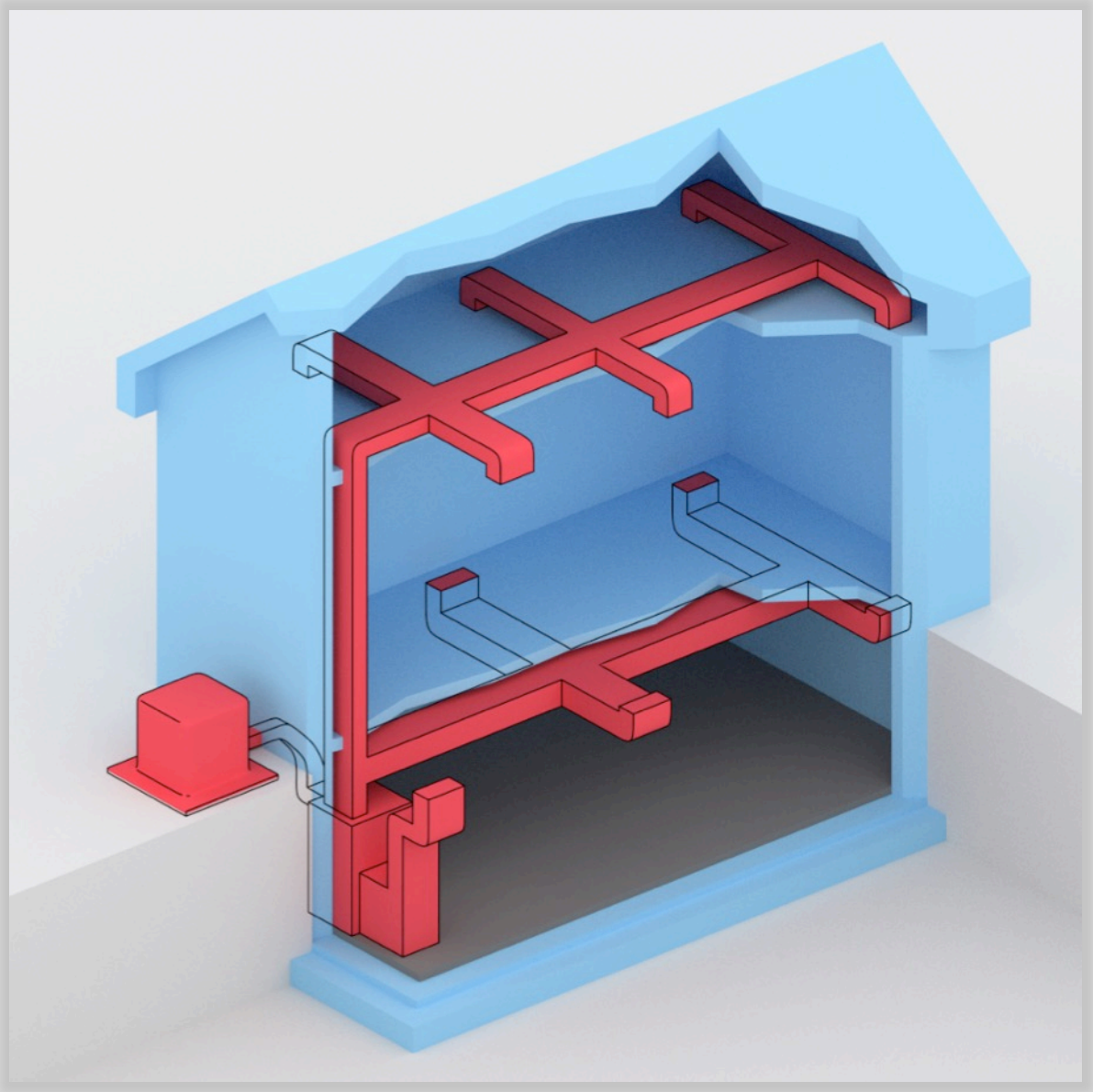



- **Parametric analysis comparing procedure to EnergyPlus annual simulations**
  - 3 constructions, 10 cities
- **Smaller dehumidifiers than "expected"**
- **Dehumidifiers met the load 94% of the time**
- **With an RH setpoint of 55%, indoor RH never exceed 60%**

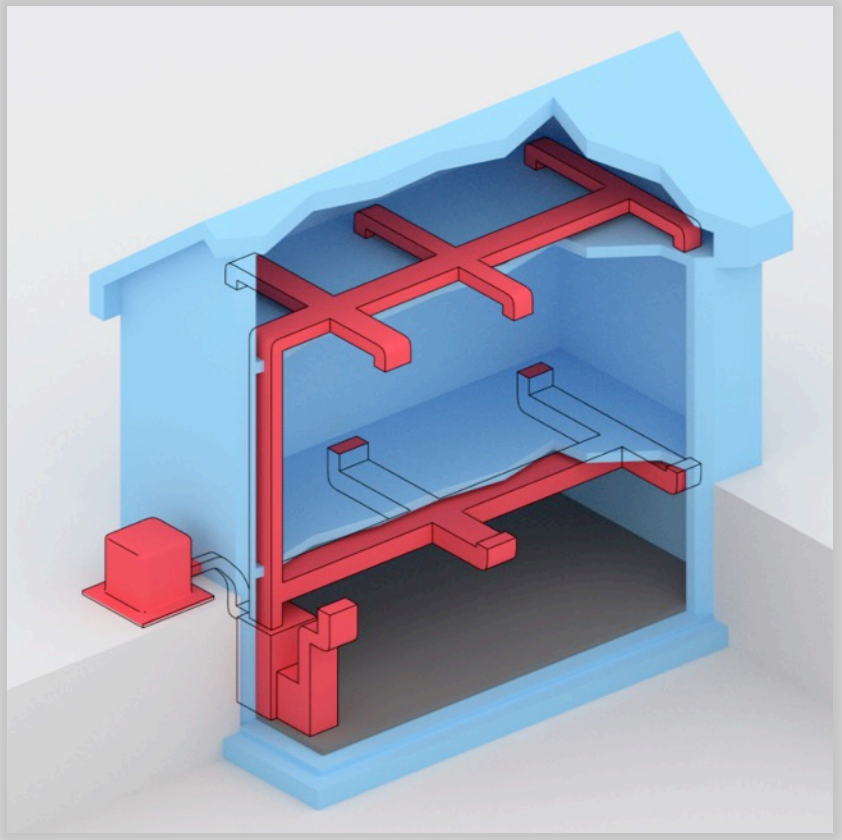
# B. Optimal Comfort Systems for Low-Load Homes

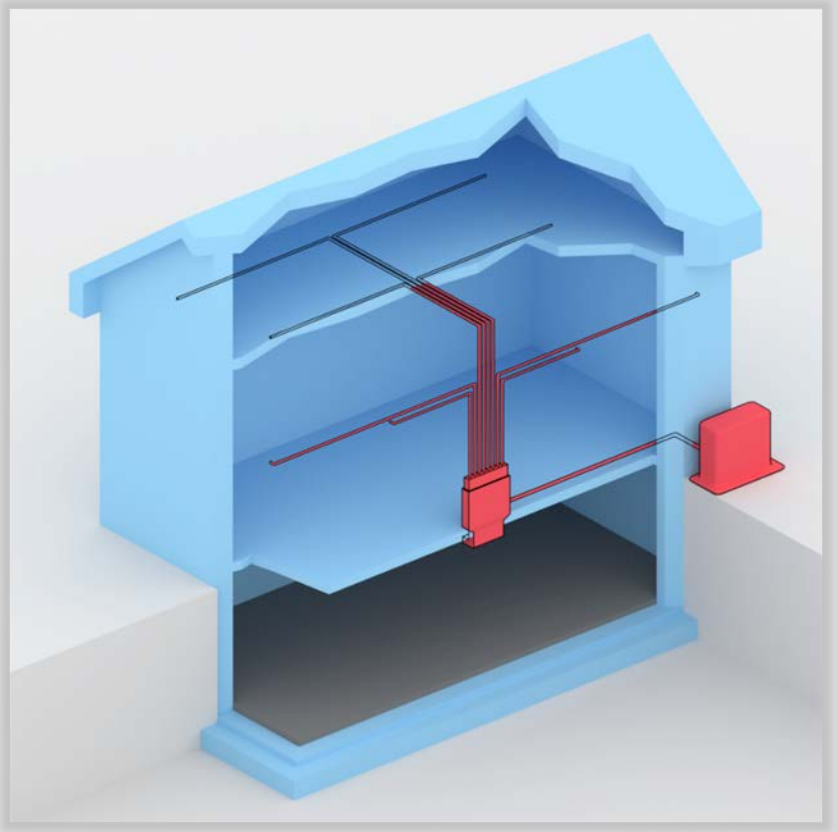


# They Keep Putting Ducts in Attics…

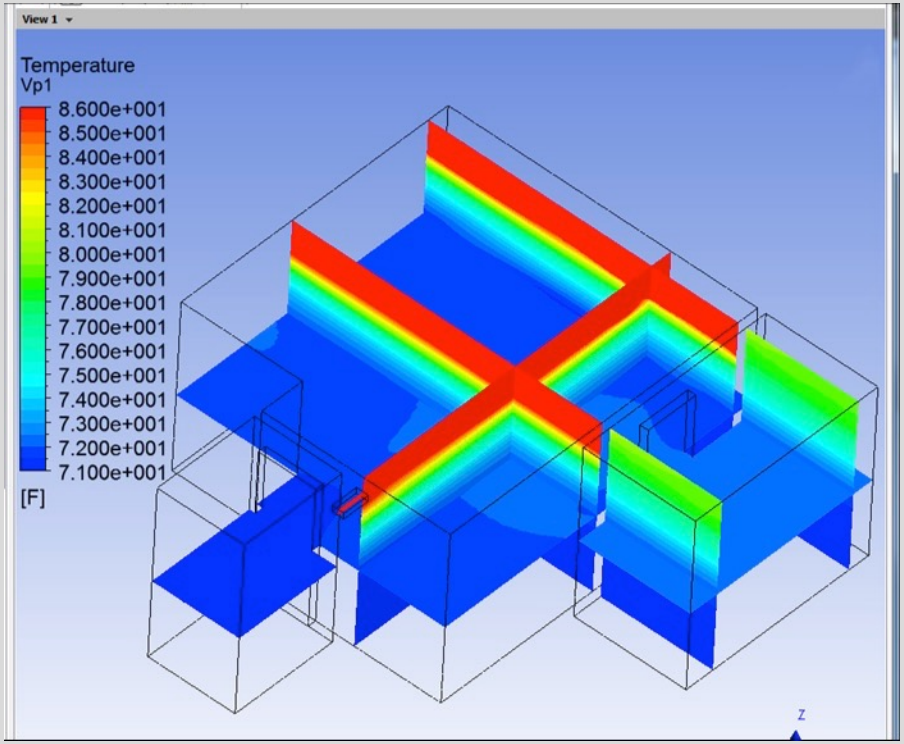


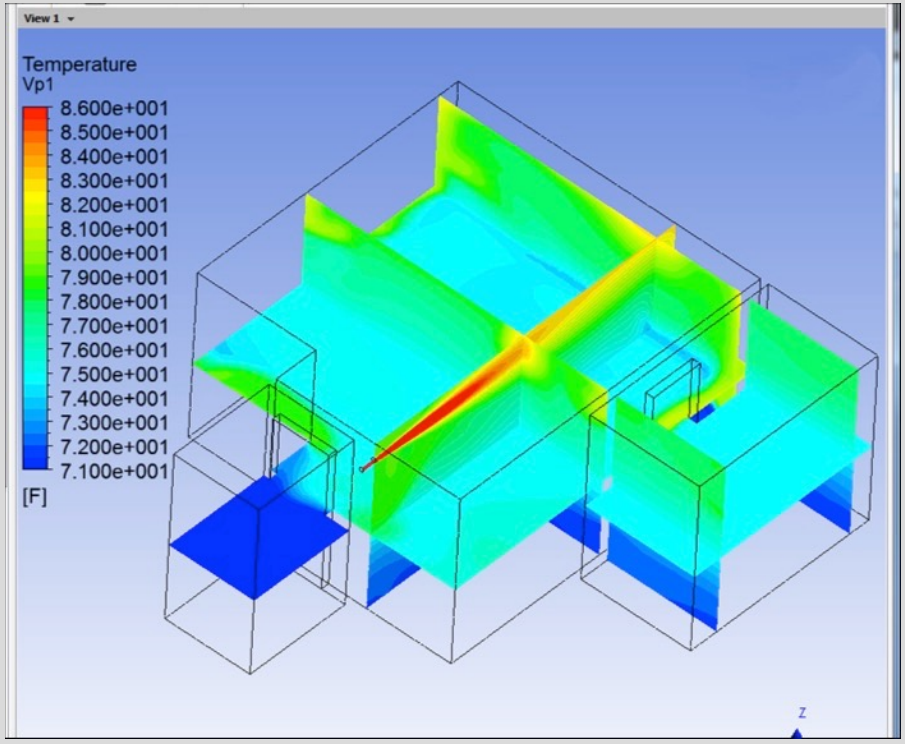
# If We Could Just Make Ducts Smaller…



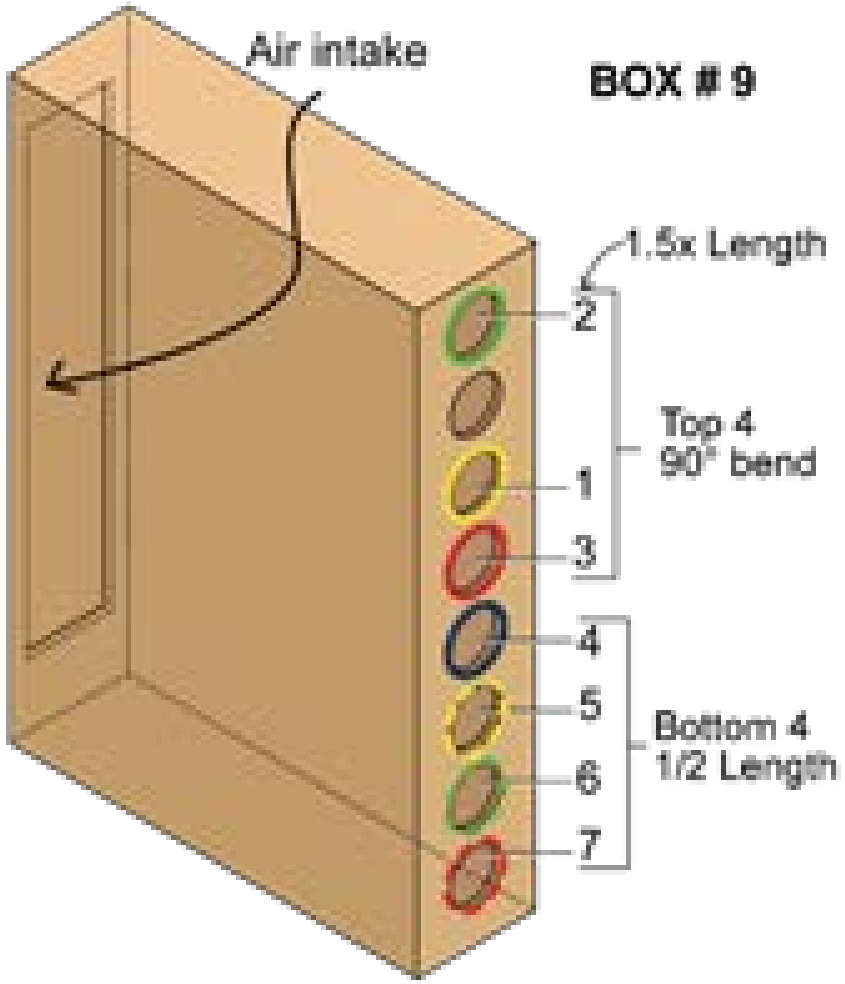


# “Plug-n-Play” Duct System



# “Plug-n-Play” Duct System Prototype



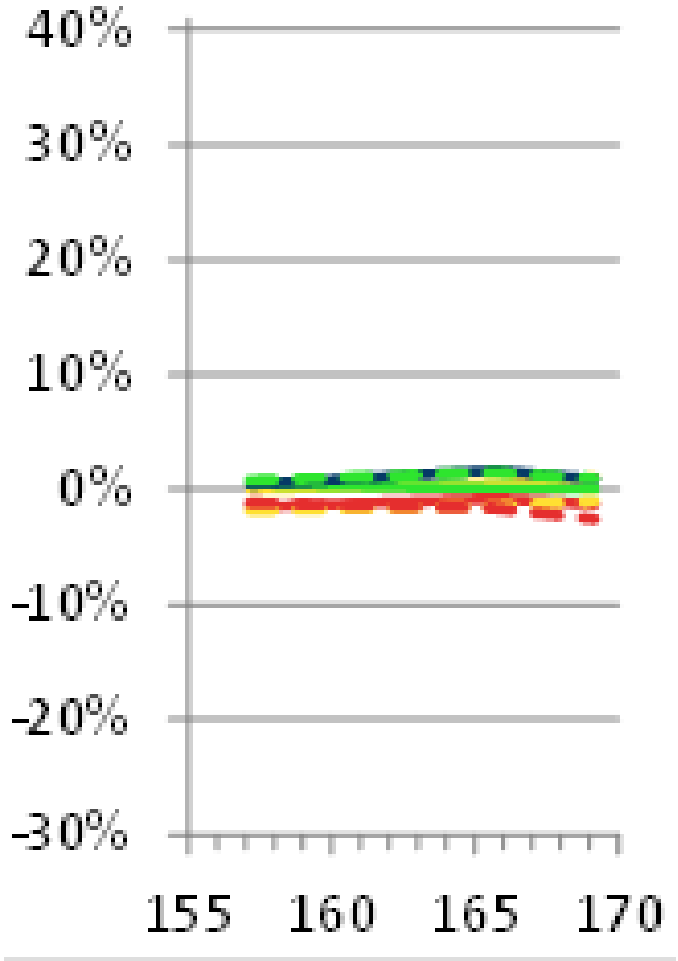




*Figure 1: CFM and deviation in airflow*

# “Plug-n-Play” Duct System Prototype

# "Intelligent" HVAC Technology Development Framework (DRAFT)

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

| Classes | Commissioning | Maintenance | Operations |
|---|---|---|---|
| Sensors and Smart Sensors | Digital thermometer with thermocouple probes, multi-meter, infrared temperature gun, thero-hygrometer, thermal-imaging temperature gun (not common) | Digital thermometer with thermocouple probes, multi-meter, infrared temperature gun, thero-hygrometer, thermal-imaging temperature gun (not common) | Temperature sensors, occupancy sensors, humidity sensors |
| Intelligent Sensing Devices | iManifold | Comfort Guard | Sensors with smartphone apps, Smart thermostat add-on, e.g, Nest dropcam, Ecobee remote temperature sensor |
| Controllers and Actuators | | | Standard fixed or binay (open/closed) dampers, constant speed fans |
| Intelligent Controllers and Actuators | | Scheduled alerts to change the air filter | Ecovent, variable speed fans, multi-stage units such as INFINITY 18VS heat pump 25VNA8 |
| Integrated Sensors & Controls | Automatic refrigerant charging using analog pressure indicators | Filterscan (can also go in intelligent sensing devices) | Analog and programmable thermostats such as Lux TX9600TS, Honeywell RTH2300B1012, Hunter Universal 7-Day |
| Intelligent Integrated Sensors & Controls | Automatic refrigerant charging using digital gauge sets, e.g., Mastercool 99661-A Digital Manifold Gauge Set (not highly intelligent) | Fault detection and diagnostic tools such as HVAC Service Assistant | Advanced thermostats such as NEST, Ecobee, Lennox iComfort, Carrier Infinity Touch |

# C. Optimal Ventilation and IAQ Solutions

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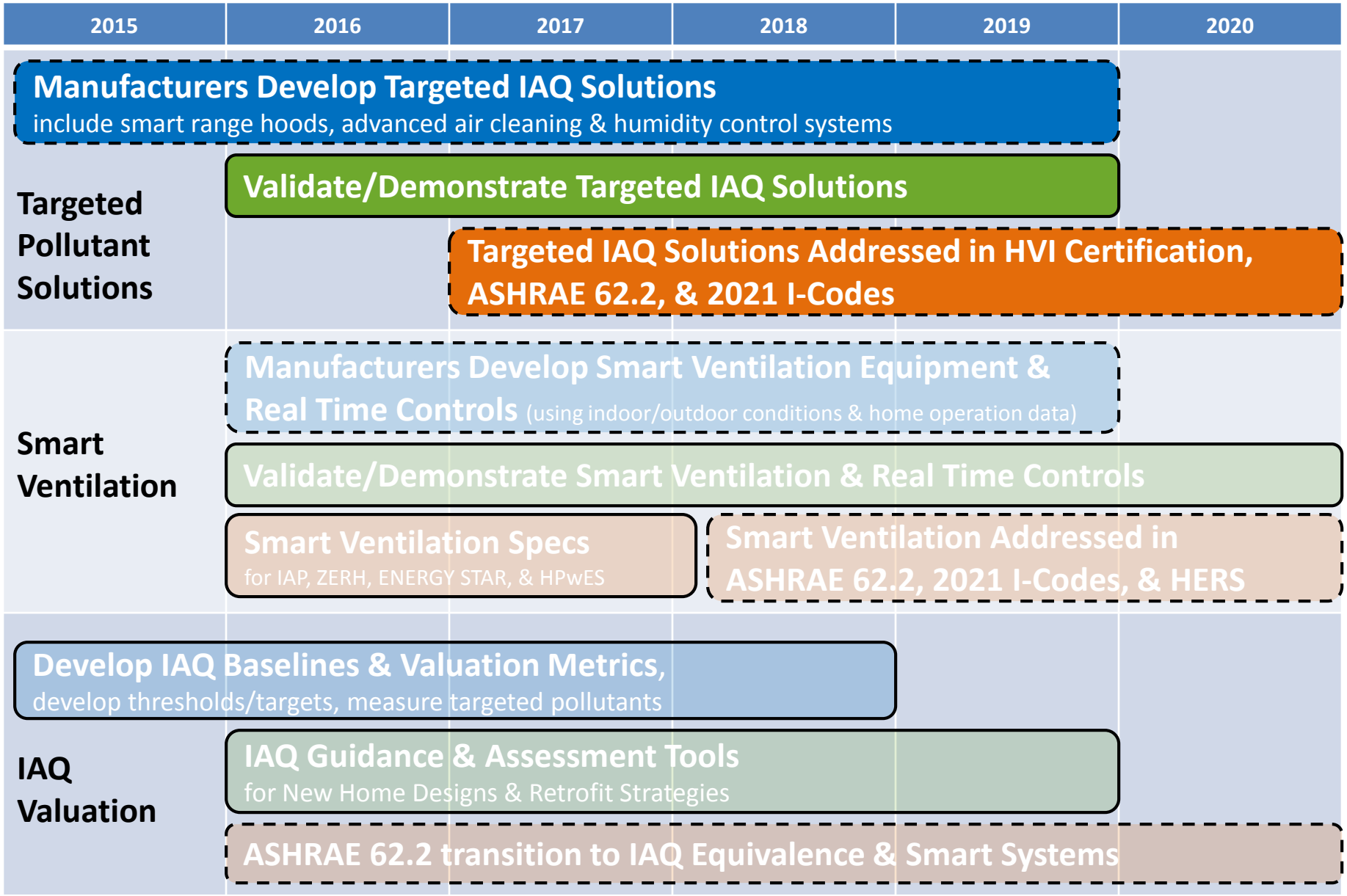


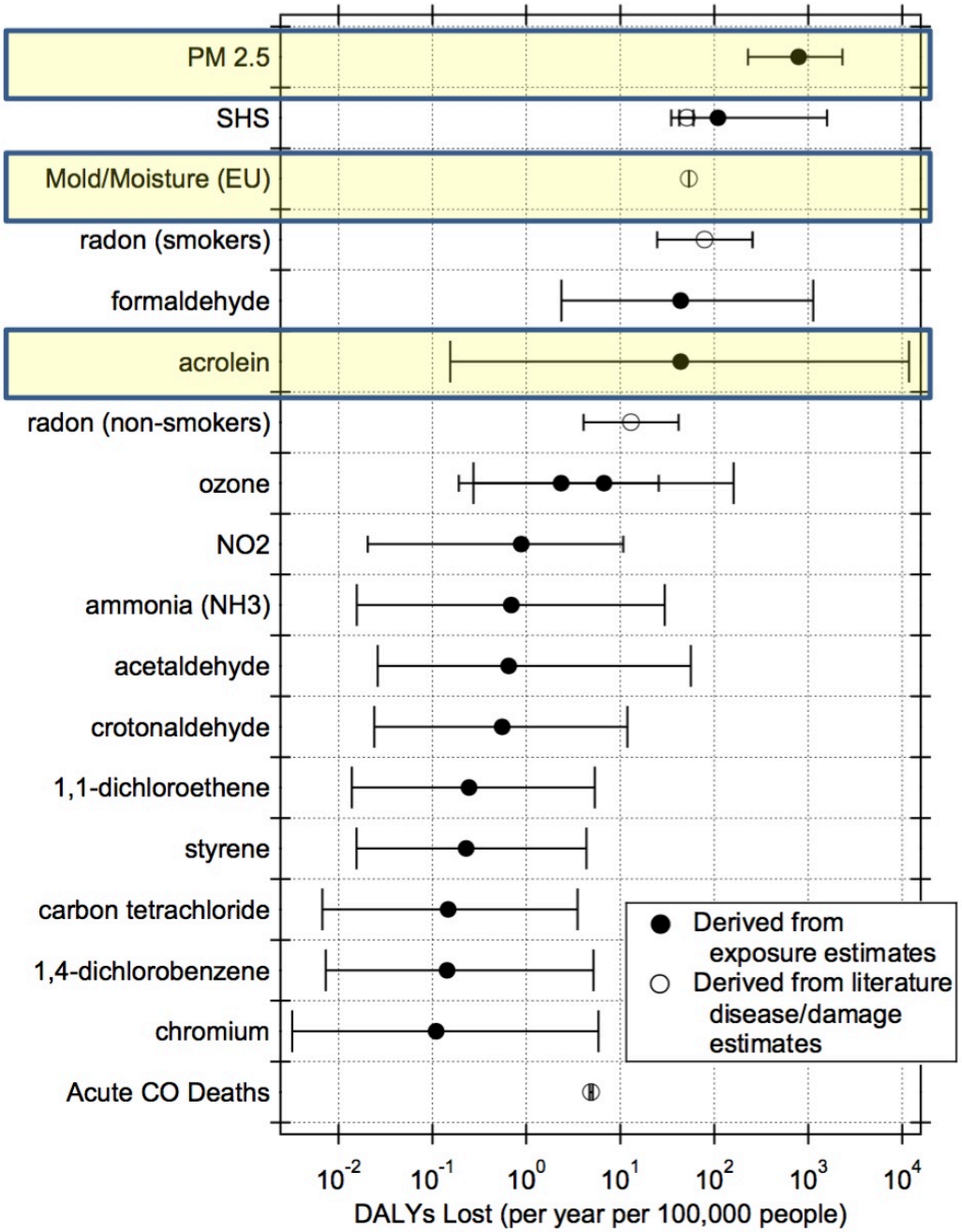
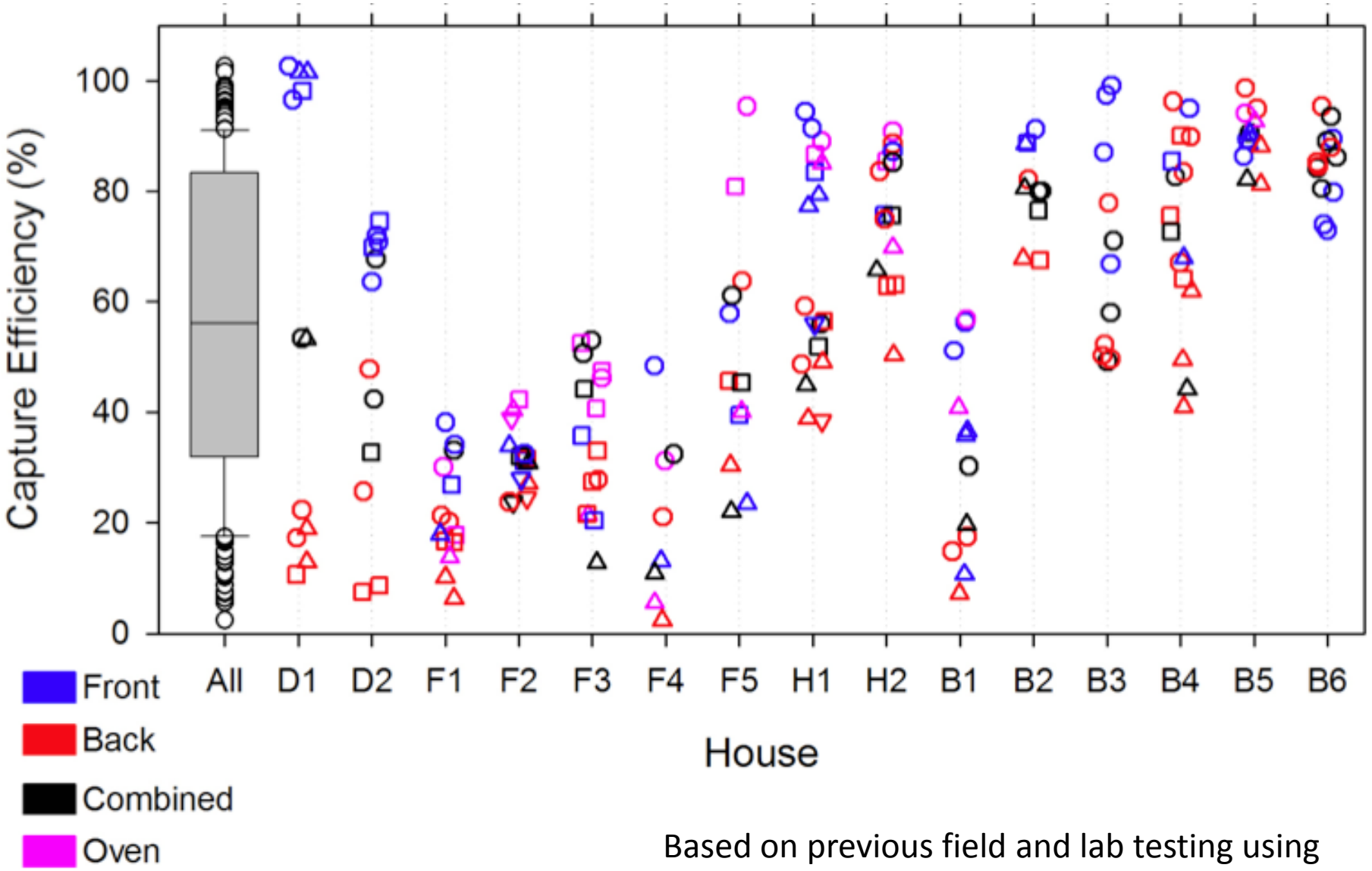



Figure 8. Estimated disability life years lost per 100,000 people per year due to chronic (long-term) exposure to indoor air pollutants[34]

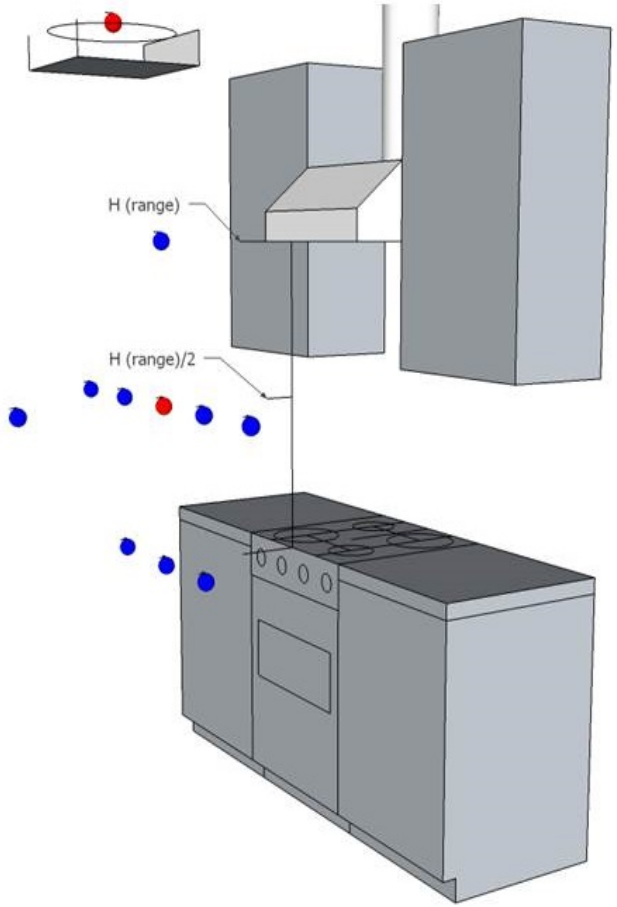
# Range Hood Standard Development

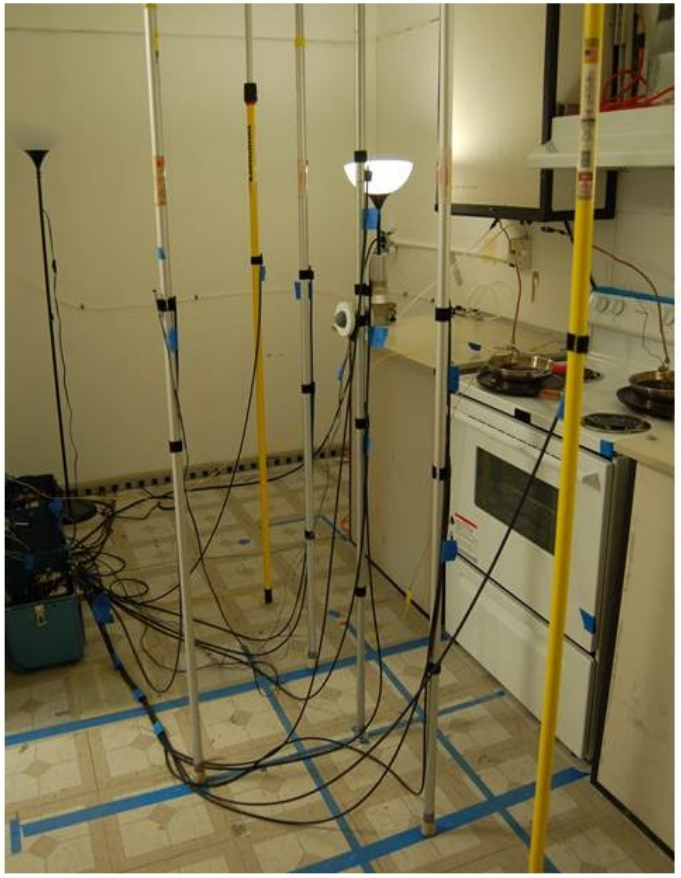



Based on previous field and lab testing using Tracer gas ($CO_2$ from gas burners directly)

# Range Hood Standard Development

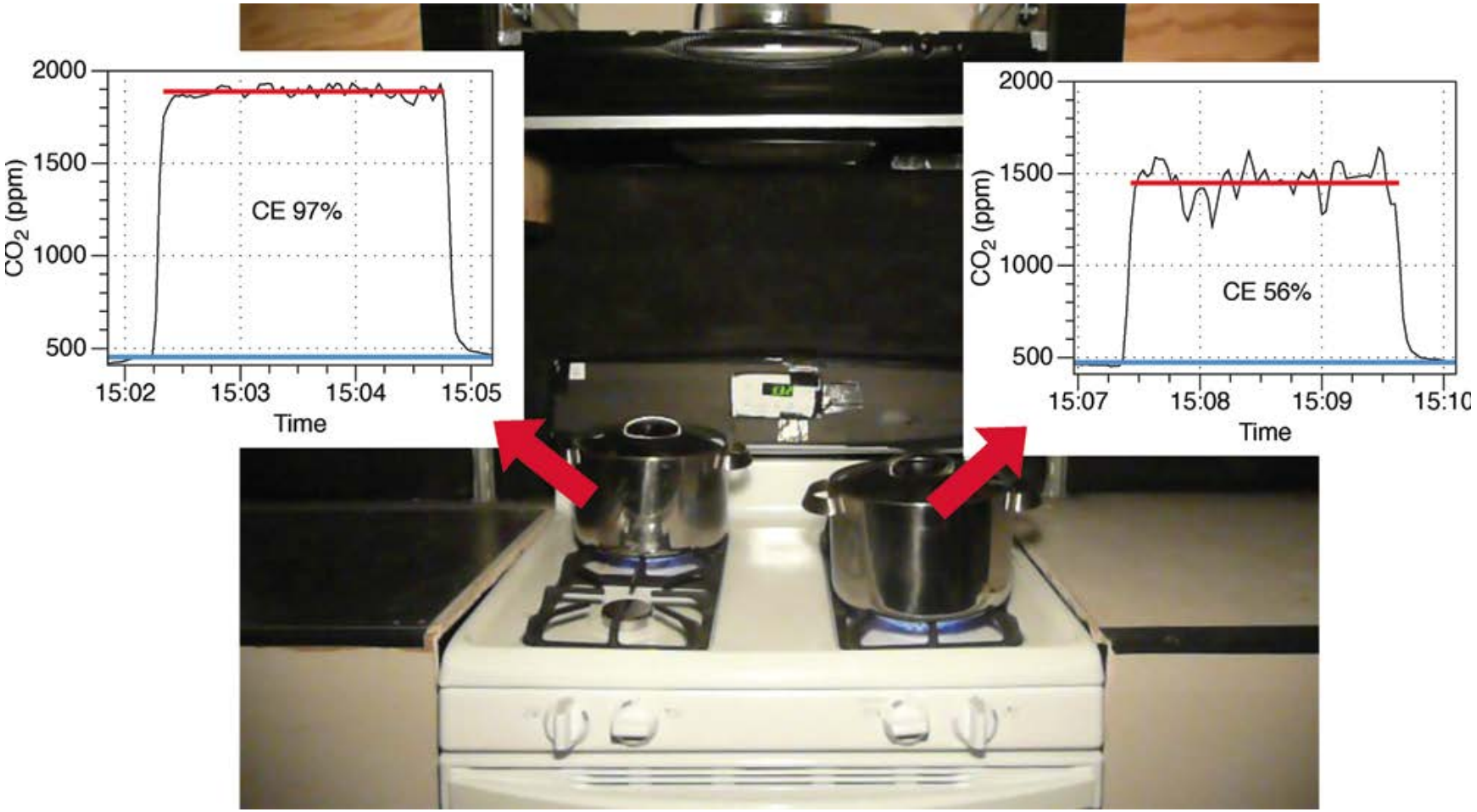
Evaluated multiple sample points to find the “right” place to sample



# Range Hood Standard Development

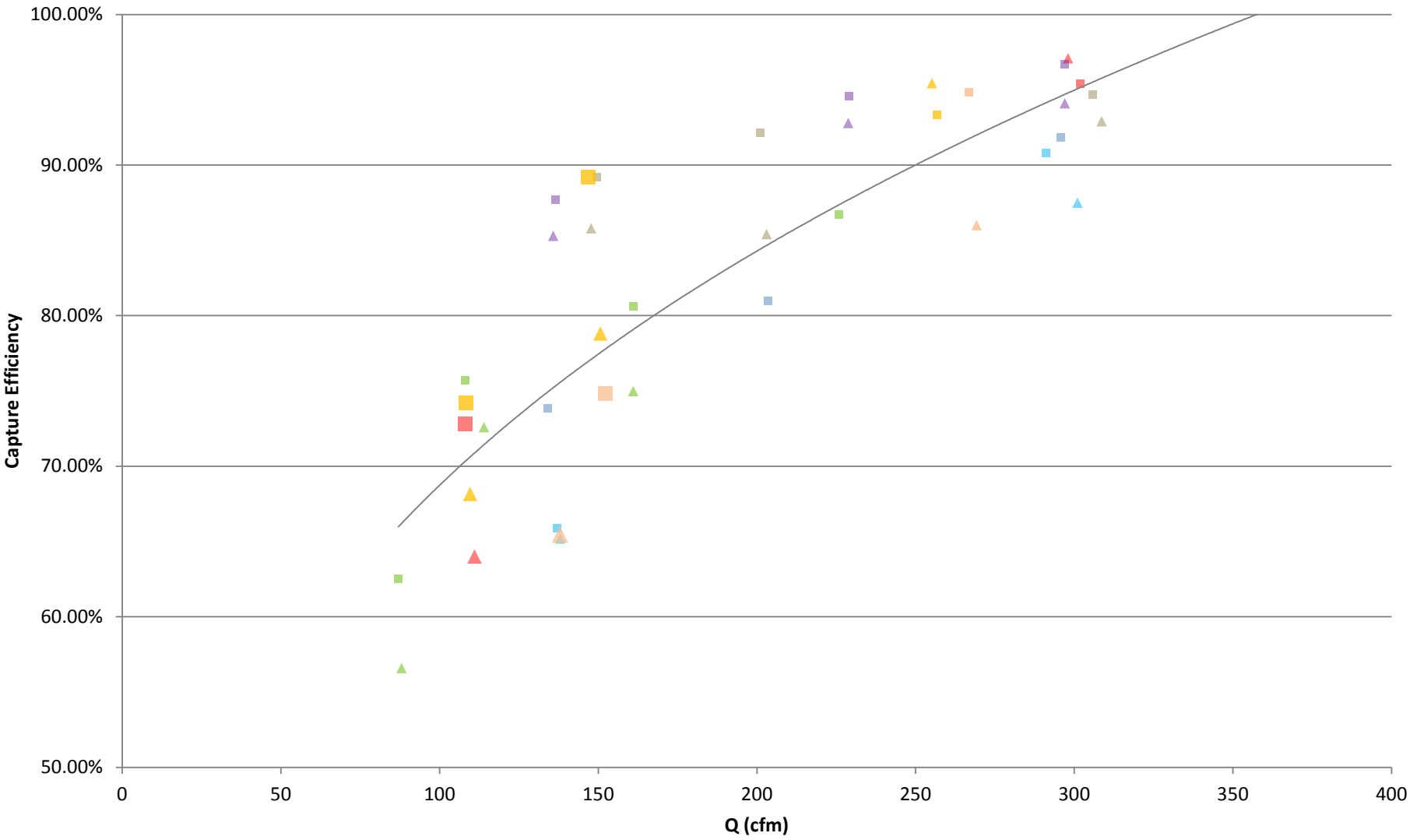
Front and rear capture different: but most cooking on the front:
Should we test front and back or front only???



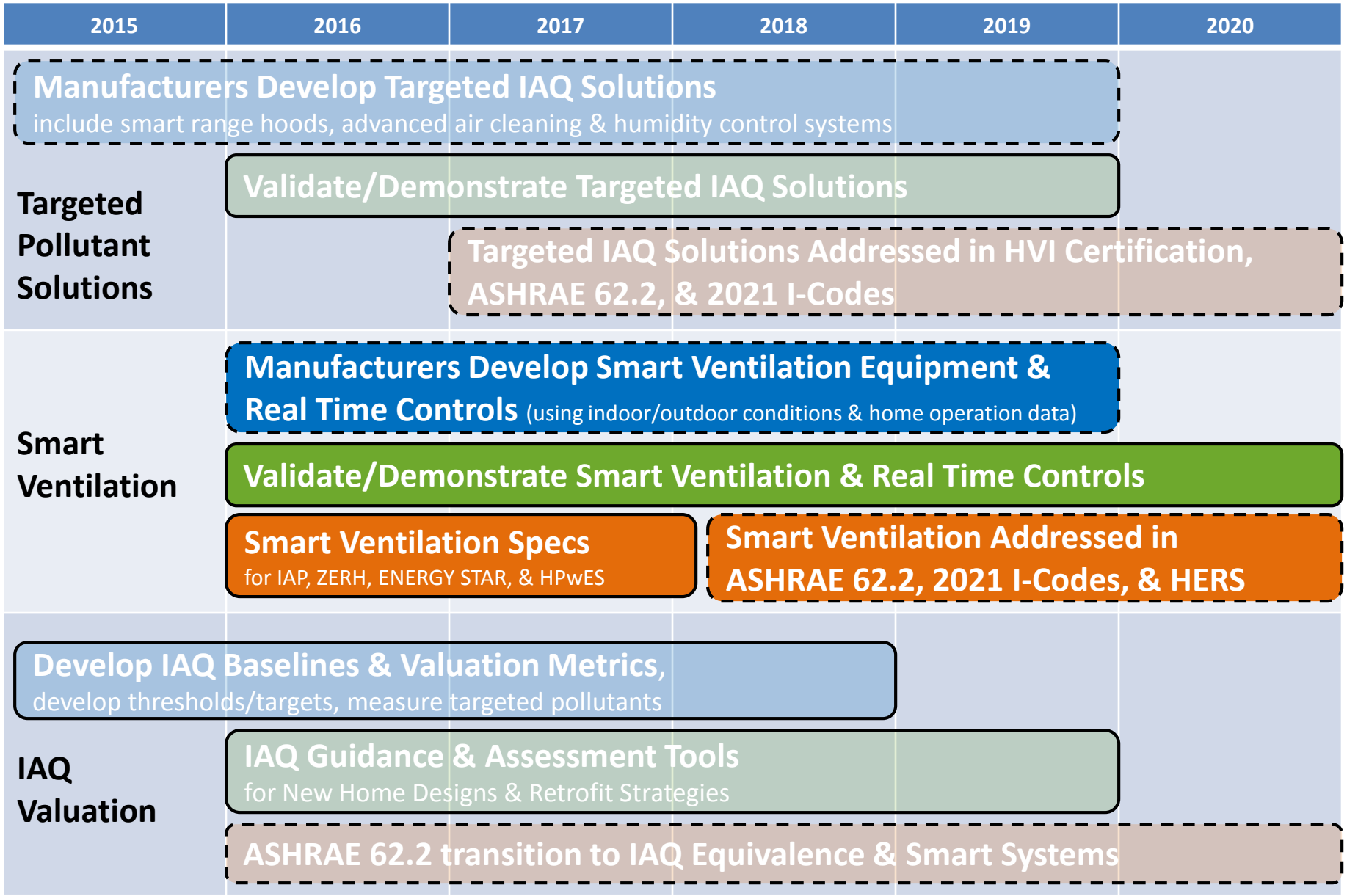

Delp & Singer 2012 ES&T

# Range Hood Standard Development

## Example Results: 8 hoods at different speeds



# C. Optimal Ventilation & IAQ Solutions



Building AMERICA
U.S. Department of Energy
Partnership for Improved Residential Construction
BA-PIRC

# Multi-Parameter Smart Ventilation System

*D. Parker, D. Chasar, C. Withers, E. Martin*

*Florida Solar Energy Center*
*January 2016*

FSEC *A Research Institute of the University of Central Florida*

# Smart Ventilation Algorithm

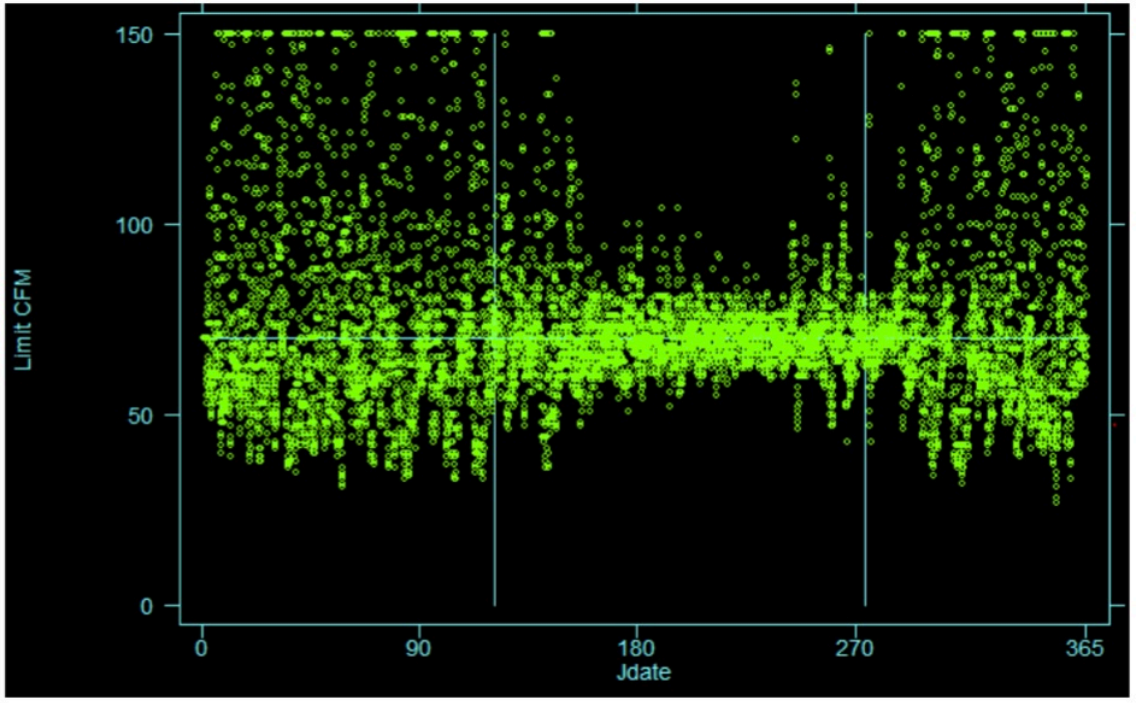
- Algorithm Basis:  meet Standard 62-2 over 24 hrs
- Minimize sensible & latent loads: modulate fan flow
- Last 24 hours & current hour to determine fan flow
- Seeks to minimize sum of square deviation from multiple targets: temperature, W (absolute moisture), peak window
- Customizable time step; can potentially use broadband weather data & fixed interior targets so sensors not required
- Weights can be added to multiple parameters used to optimize flows

FSEC

Building America U.S. Department of Energy Partnership for Improved Residential Construction BA-PIRC

# Dynamic Variation of Vent Rate

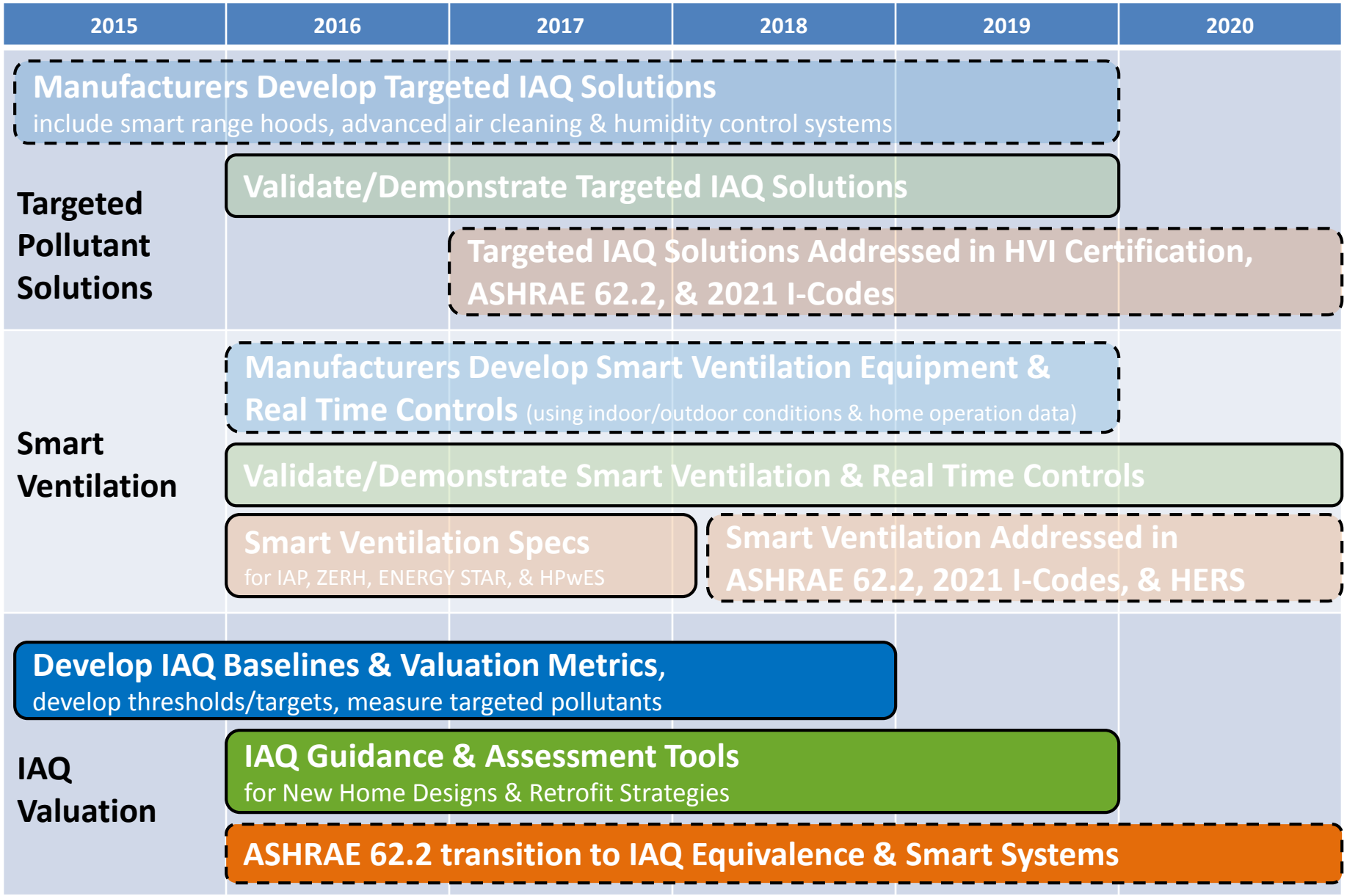
- Rather than using average profile, dynamically calculate at each time step using weather data
- Still hit the target
- Target: 70 cfm, hourly flow variation over year; avg. ~75 cfm




FSEC

Building America U.S. Department of Energy
Partnership for Improved Residential Construction
BA-PIRC

# C. Optimal Ventilation & IAQ Solutions



# Questions?

## For More Information:

eric.werling@ee.doe.gov