

April 7, 2015



# Building America Webinar: Tech-to-Market Roadmaps

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We already know how to  
build Zero Energy Homes



## INGREDIENTS

## DIRECTIONS

## Zero Energy Home

1. Construct Perfect Envelopes
2. Install High Efficiency HVAC, Ventilation, Appliances & Lighting
3. Add PV or Wind Energy
4. Add Conservation to Taste



We Are On the Road to ...

Zero Energy Homes!



“In theory, there is no difference between theory and practice. In practice, there is.”

**Yogi Berra**



# The Road to Zero Energy Homes?

- Probably <500 built to date  
(but who's counting?)
- It still costs more than code
- Infrastructure favors low first cost
- Too risky for most builders
- Workforce is not skilled enough
- Utilities are worried about the grid

More Like a Dirt Road ...



Zero  
Energy  
Homes



Paving the Road to ...



Zero Energy Homes

Energy  
Efficiency



Renewable  
Energy







“If you come to a fork in the road, take it.”  
**Yogi Berra**

Paving the Road to ...

# Zero Energy Homes



Proud Sponsors:



- DOE Energy Efficiency Goal is 50% Savings
  - Relative to 2009 IECC
  - 50% savings target is technically feasible/optimal
  - Focus on technical and market barriers to adoption



- PV Will Cover the Other 50%
  - SunShot Goal: cost competitive PV by 2020
  - Focus on BOS & “Soft Costs”



# Building America Program 5-Year Research-to-Market Plan

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



- Focused on reducing heating & cooling energy use in new & existing homes (highest impact end use)
- RD&D of low-risk, high performance envelopes, optimized HVAC systems, & IAQ solutions
- FY15-17 FOA's: new Building America Industry Teams will demonstrate solutions in real world houses
- New integrated ***Technology-to-Market Roadmaps*** will link research to market to improved industry standards & codes
- Stakeholder Input & Expert Meetings will help refine roadmaps and leverage industry collaboration

- **New Homes Goal**

Demonstrate at scale market-relevant strategies for *new* homes offering savings of 50% or more by 2025

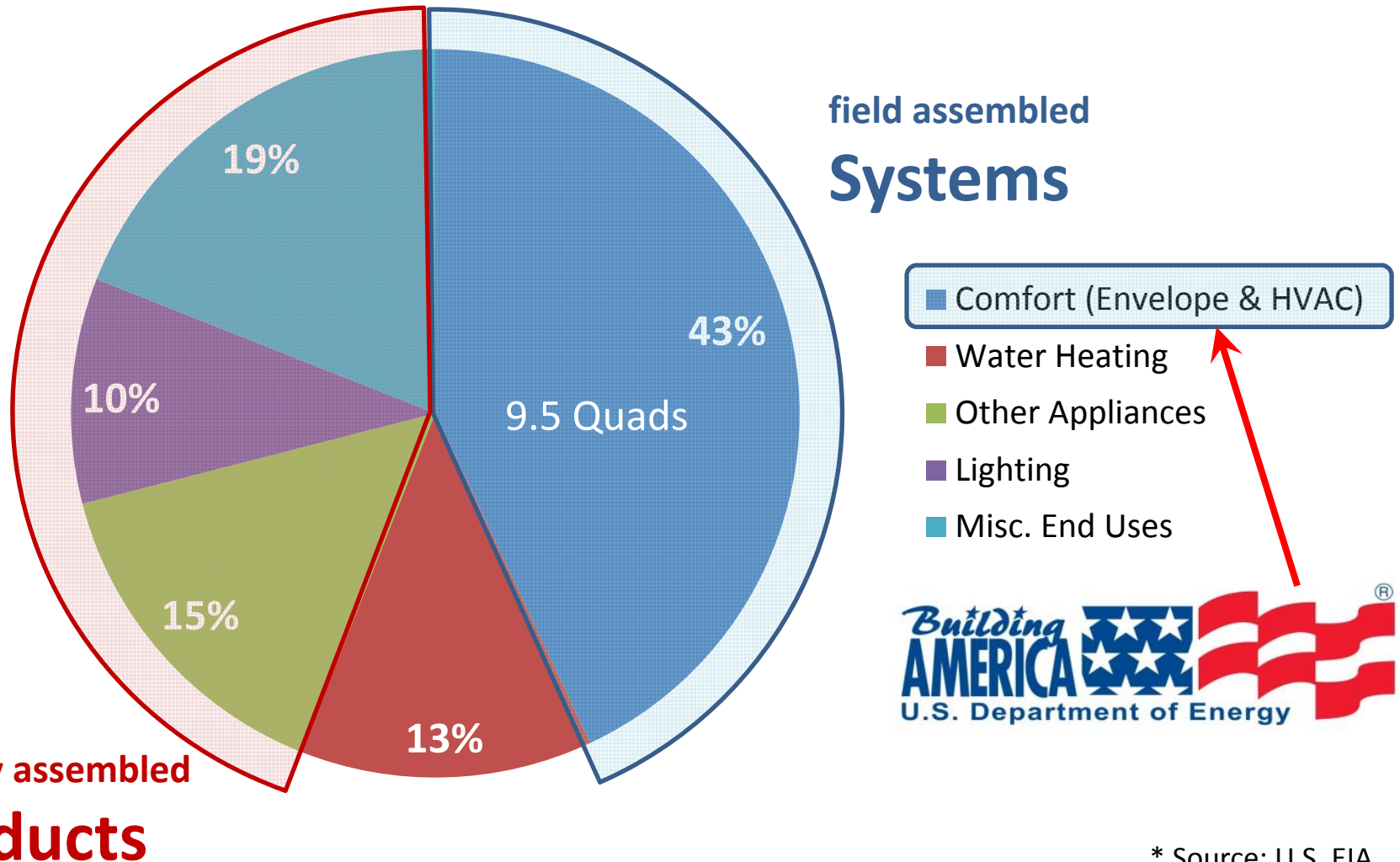
- **Existing Homes Goal**

Demonstrate at scale market-relevant strategies offering existing home savings of:

- 20% or more by 2020
- 25% or more by 2025, and
- 40% or more by 2030

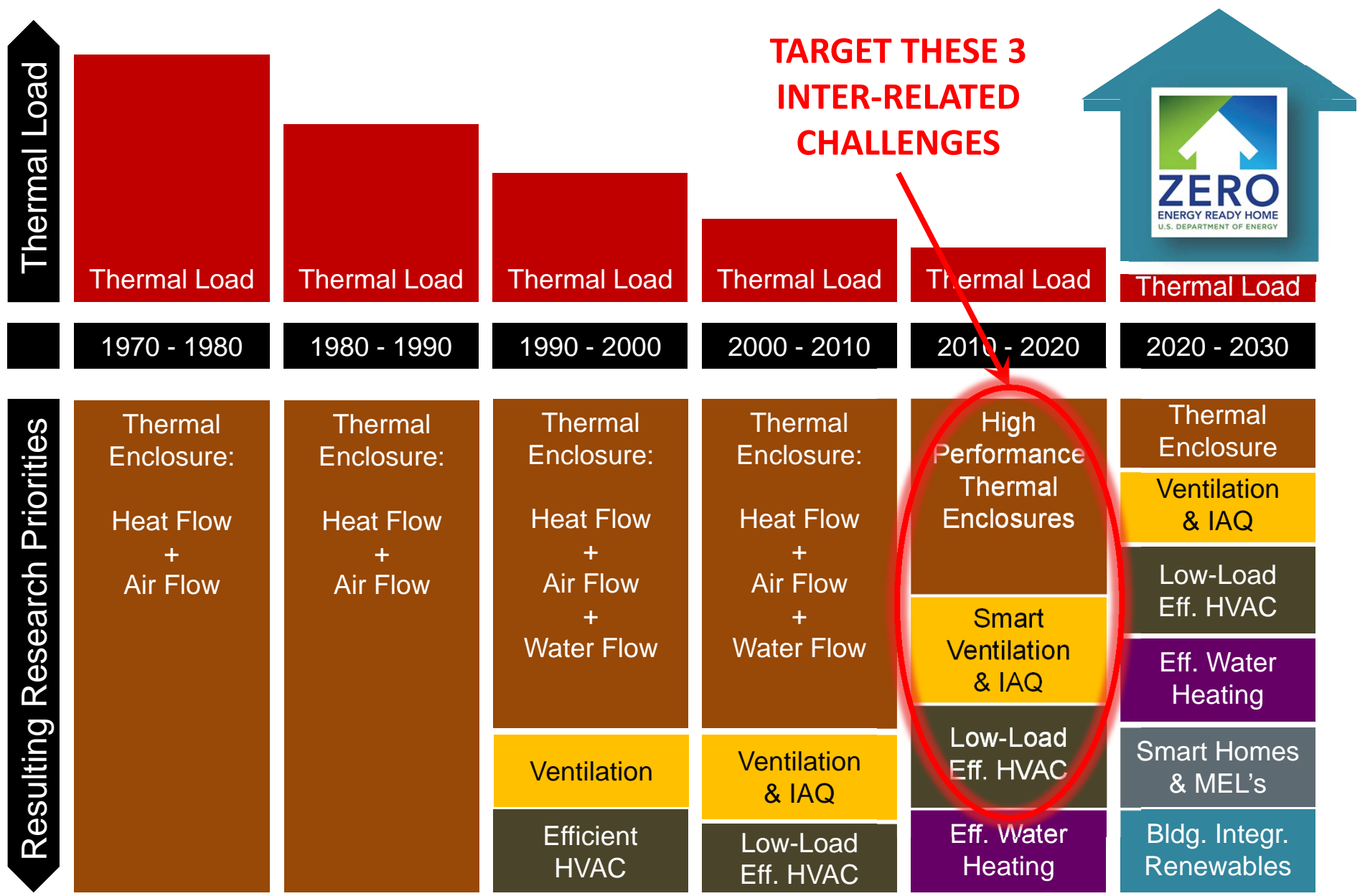


# U.S. Residential Buildings Primary Energy Consumption (22 Quads)\*



\* Source: U.S. EIA

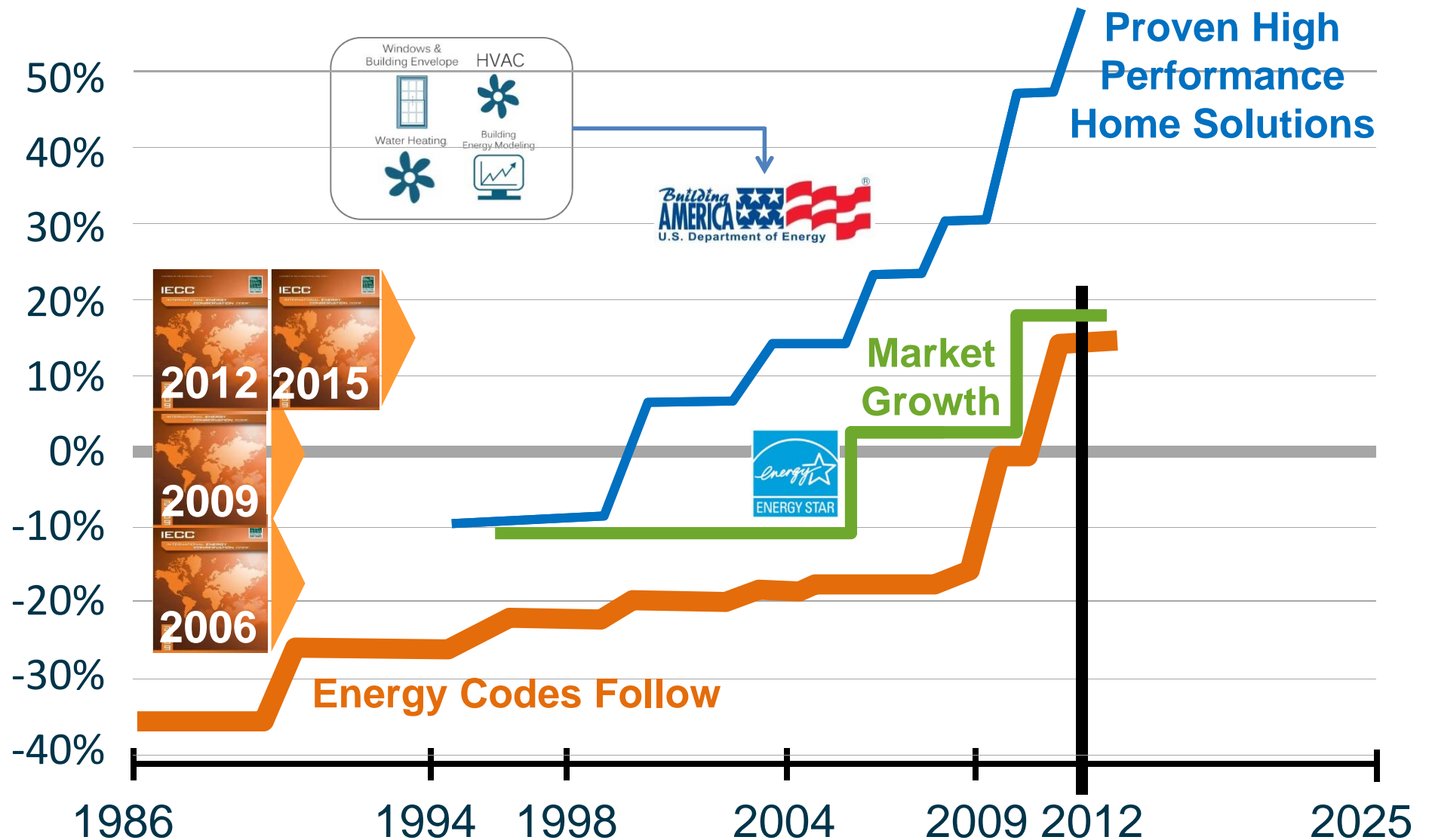
# Building America Technology Roadmap



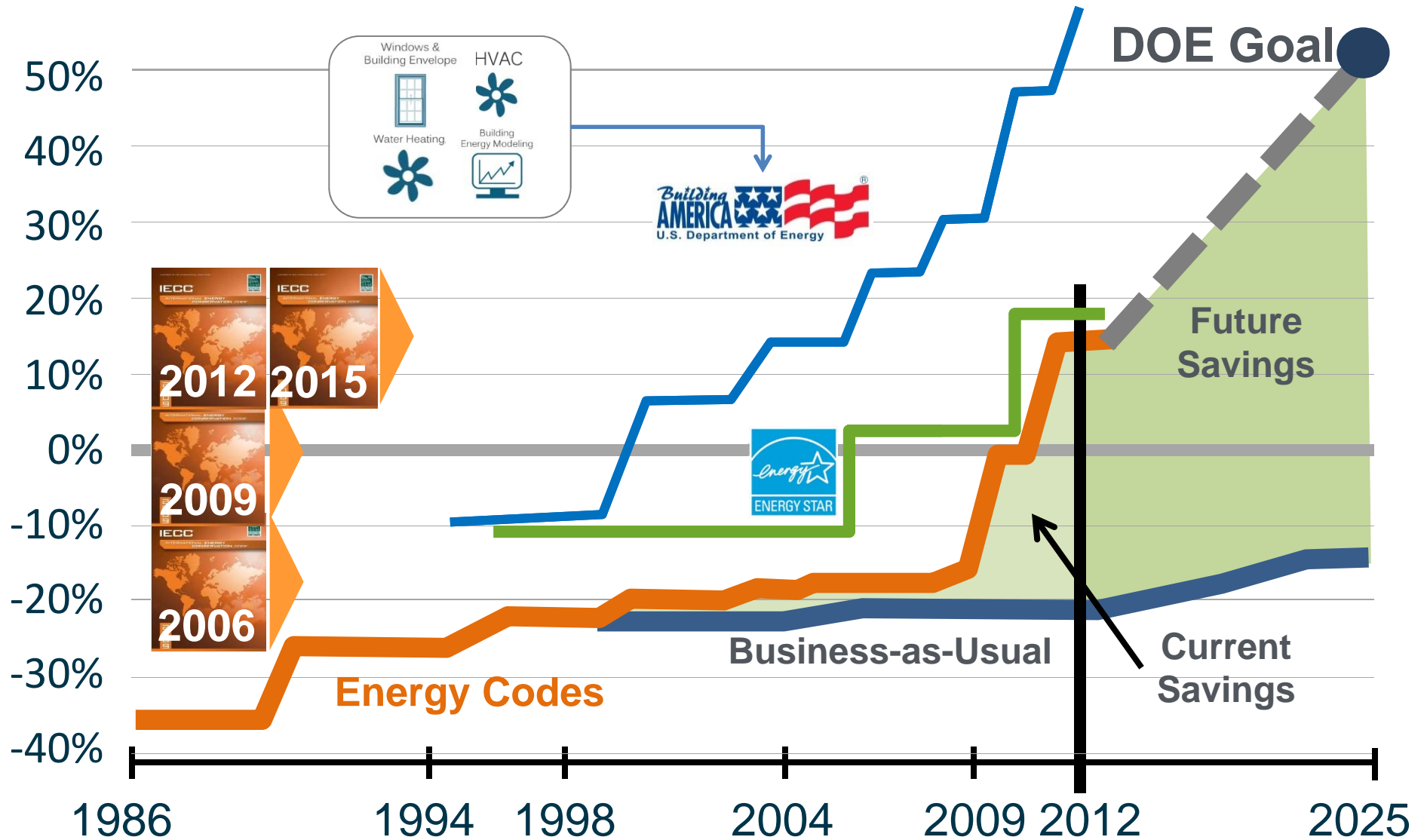
**TARGET THESE 3 INTER-RELATED CHALLENGES**



# Research to Market to Standard Practice

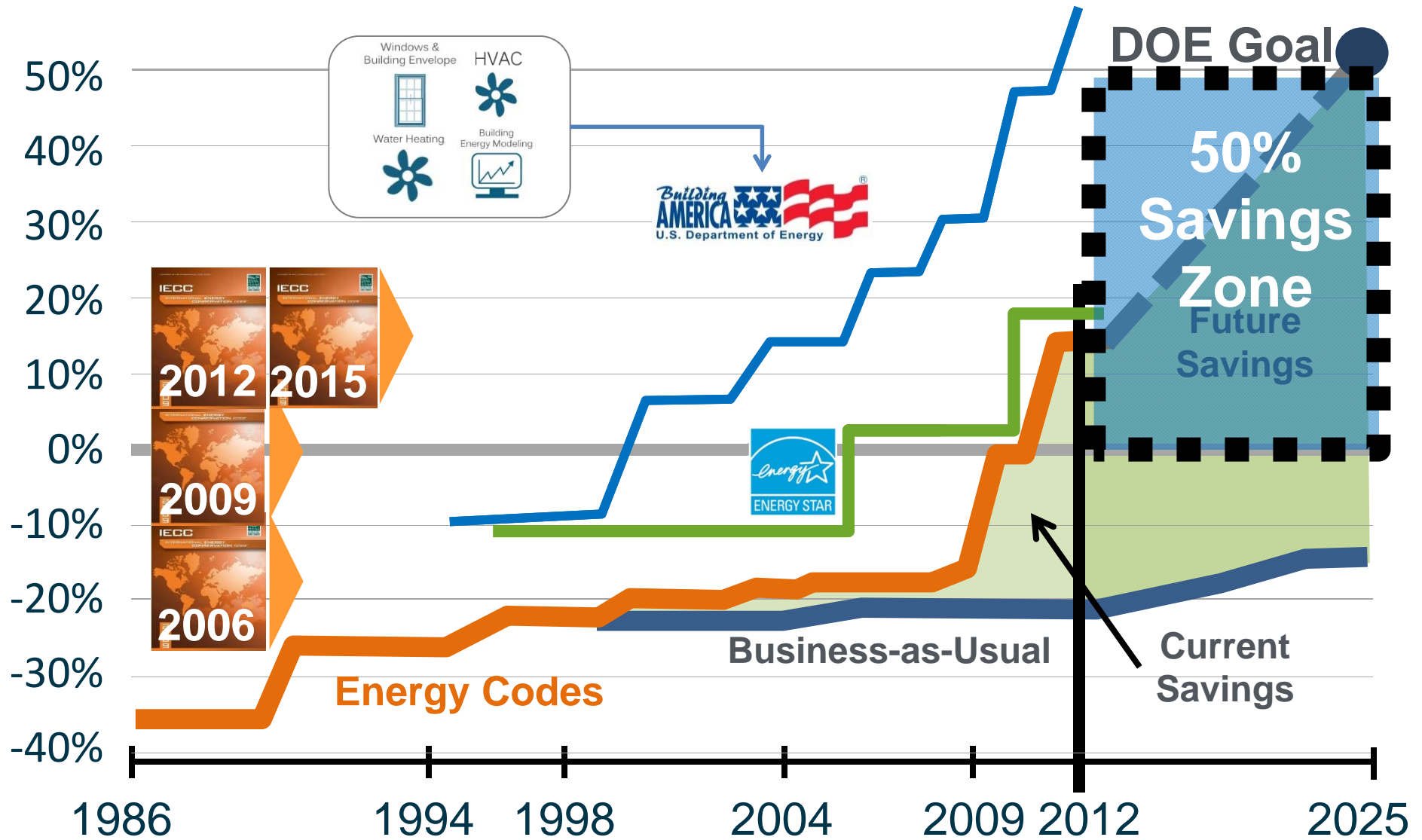


# Current & Future Savings



\* Which ultimately sets the bar for future existing homes infrastructure

# But How Can We Achieve 50% Savings?



\* Which ultimately sets the bar for future existing homes infrastructure

# DOE 50% Savings Scenarios Require...

## More Insulation & Tighter Construction That Can:

- **Cause Envelope Assemblies to Get/Stay Wet**

Increased insulation levels and air tightness can elevate risk of condensation and substantially limit drying potential inside building assemblies

- **Lower Airflow & Increase Indoor RH**

Lower loads reduce air flow, increase relative latent load, extend swing seasons

- **Reduce Fresh Outdoor Air Exchange**

Added air tightness demands improved source control, dilution, and filtration

**If these performance issues are not solved, high efficiency homes will have comfort and durability problems, builders will not go further than current code, and future energy code advancement will be prevented.**

# We Need High Performance Home Solutions!

## Energy Efficient New and Existing Homes with ...

### Moisture Managed High-R Envelopes

- Are Less Likely to Get/Stay Wet

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

### 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

### 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



# 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:

- Codes and 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

## KEY:

Research & Development

Market Engagement

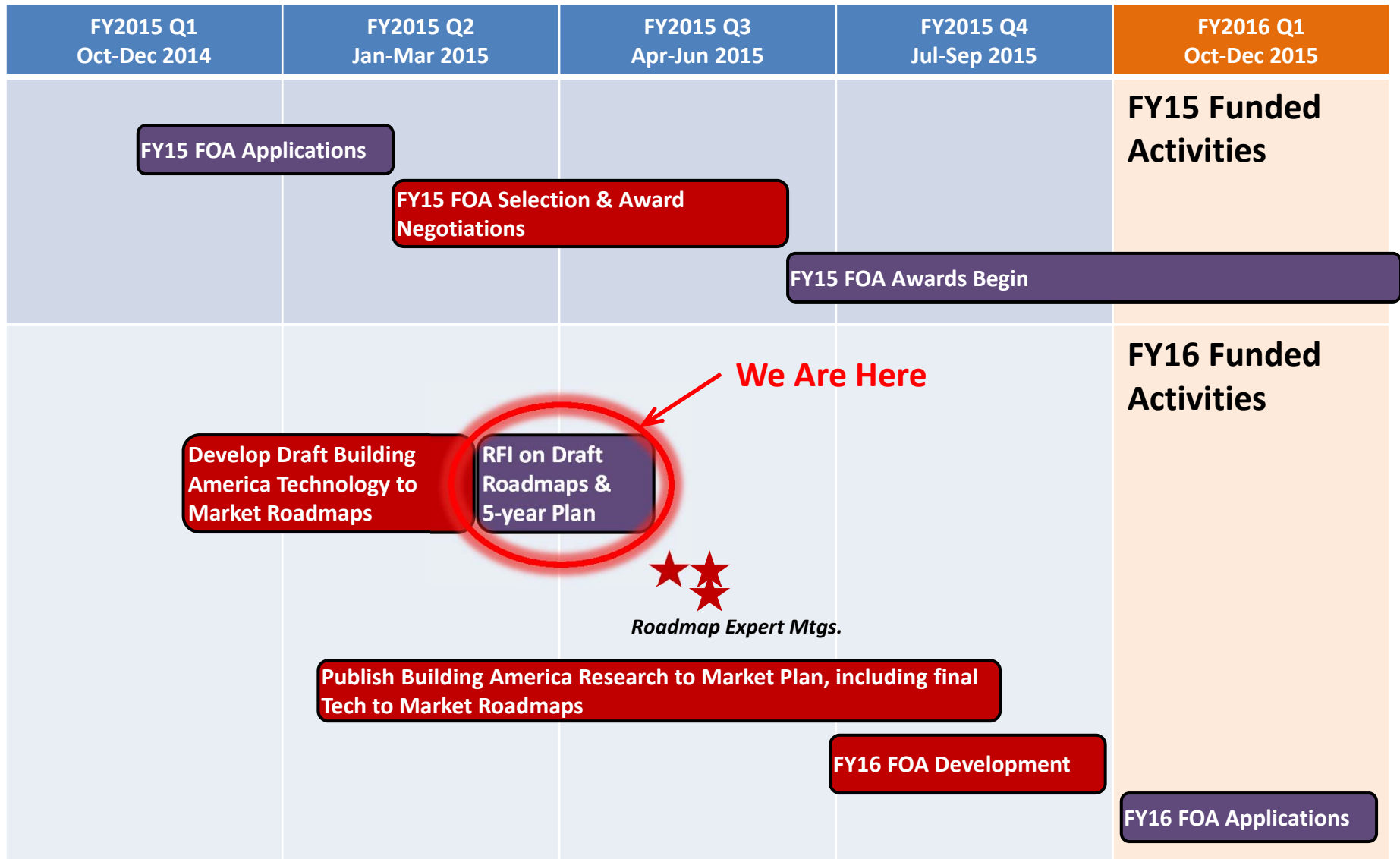
Codes & Standards

DOE lead

Industry lead



# Building America FY16 Planning Timeline



# Building America Planned FOA Schedule (subject to appropriations)

	FY2015				FY2016				FY2017				FY2018				FY2019			
Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
NREL contract down select (FY15 bridge-funding)	\$ High-R																			
	\$ Comfort																			
	\$ IAQ																			
	FOA15			FY15 FOA Award #1																
				FY15 FOA Award #2, etc.																
					FOA16			FY16 FOA Award #1												
				FY16 FOA Award #2																
				FY16 FOA Award #3, etc.																
									FOA17			FY17 FOA Award #1								
								FY17 FOA Award #2												
								FY17 FOA Award #3, etc.												

**Notes:**

1. All FOA's are fully funded up front
2. No. of awards each year will depend on award negotiations and budget.

## A. HIGH PERFORMANCE, MOISTURE MANAGED ENVELOPE SOLUTIONS

High-R assemblies are the largest potential home energy saving measures (heating & cooling loads are nearly 50% of home energy use). But high-R without assured performance increases moisture risk. Current solutions are expensive or unfamiliar to industry and some solutions are limited by IRC code barriers (fire, structural).

### JUSTIFICATION - EVIDENCE

- **Codes Group request** - based on DOE discussions with key IECC stakeholders about major perceived risk of increased R-values in IECC
- **Building America Envelope Standing Technical Committee & Expert Meeting Reports** identify moisture risk in High-R walls as highest technical priority
- **HIRL test hut study (2013)** of 9 IECC 2012 compliant assemblies shows risk of high moisture content in OSB (Zone 4)
- **ORNL test hut study (2013)** of 8 air-tight assemblies with IECC 2012 insulation indicates risk of mold on sheathing (Zone 5)
- **BSC hygrothermal simulation study (2013)** of 8 High-R wall assemblies with defects indicate risk of high moisture content in sheathing (Zones 2-7)
- **Anecdotal evidence of failures, based on expert experience**

High  
Performance  
Thermal  
Enclosures

## A. HIGH PERFORMANCE, MOISTURE MANAGED ENVELOPE SOLUTIONS



## INTEGRATED ROADMAPS

- I. Envelope System Moisture Risk Management
- II. High Performance Envelope Solutions

### Roadmap Objectives:

- Codes and standard practice as endpoints
- Tools & guidance to help industry manage risks & minimize problems of adoption for high performance envelopes
- Address optimal performance, cost-effectiveness, & buildability
- Address codes & standard barriers to adoption of high performance envelope systems in new and existing homes



## B. OPTIMAL COMFORT SYSTEMS FOR LOW LOAD HOMES

Installed performance of HVAC systems, especially distribution system effects and latent performance, is typically sub-optimal, which is a critical risk in low-load homes; duct system & RH optimization are not “owned” by manufacturers or required by codes/standards, & current solutions are labor intensive and/or expensive.

### JUSTIFICATION - EVIDENCE

- **Codes Group request** - based on DOE discussions with key IECC stakeholders about major perceived risk of comfort problems in tighter homes (IECC 2012/2015)
- **Building America Space Conditioning Standing Technical Committee & Expert Meeting Reports** identify air distribution issues, high relative humidity, and equipment sizing problems affecting comfort in low load homes as highest technical priority
- **IBACOS study/report** investigated most promising efficient HVAC solutions for low load houses and found significant comfort risks related to latent performance and distribution effectiveness.
- **Various other reports (studies & roadmaps)**
- **Anecdotal evidence of failures, based on expert experience**

Low-Load  
Eff. HVAC

## B. OPTIMAL COMFORT SYSTEMS FOR LOW LOAD HOMES



### INTEGRATED ROADMAPS

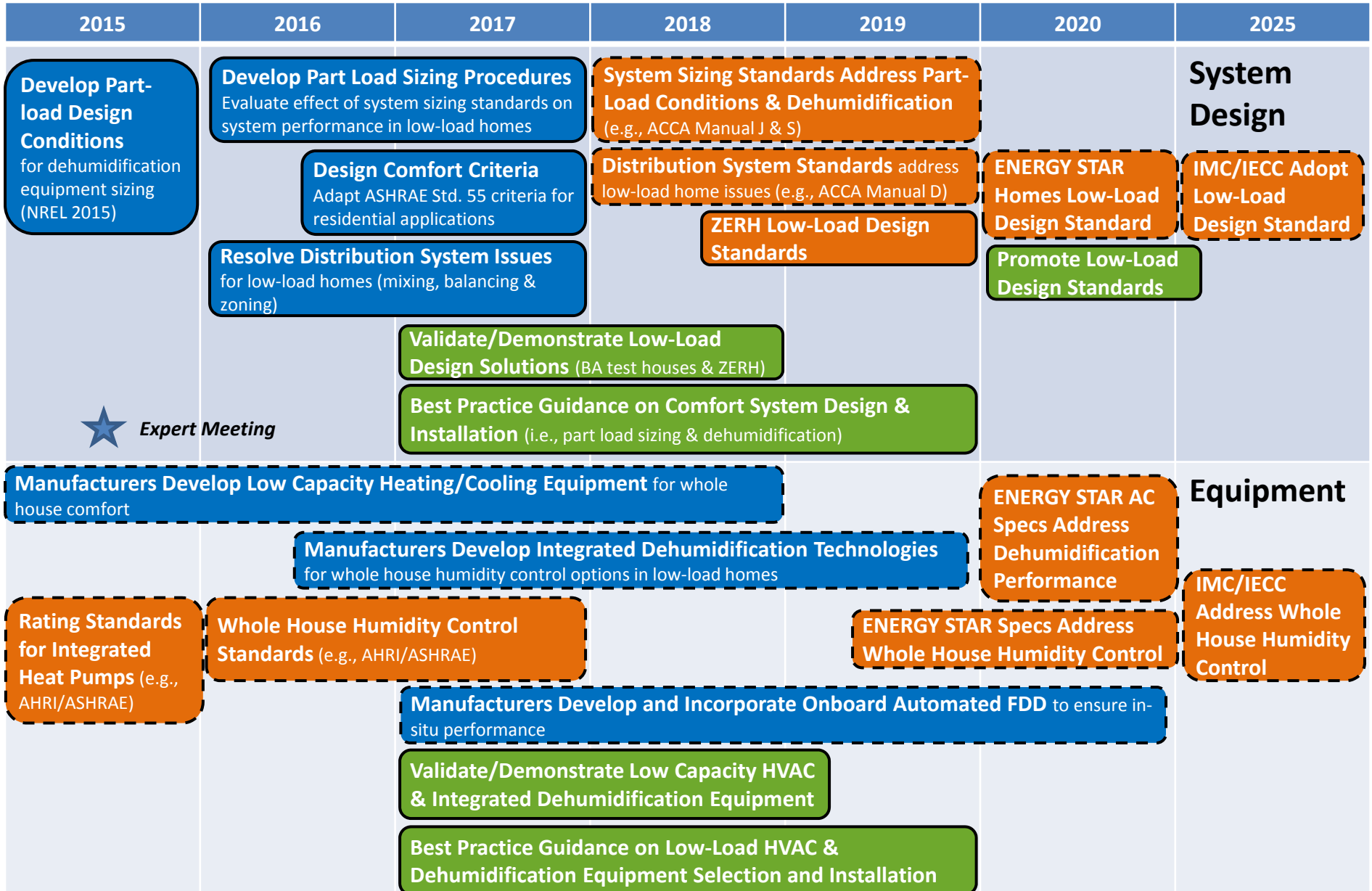
- I. Optimal HVAC System Design Standards
- II. HVAC Equipment Gaps for Low Load Homes

#### Roadmap Objectives:

- Industry Standards, Codes & New Technologies as Endpoints
- Priority Issues/Barriers to Address:
  - High performance HVAC system solutions needed for low load homes
  - HVAC system standards don't adequately address indoor RH and airflow
  - HVAC system design, installation and maintenance faults lead to 20-70% system degradation
  - Current state of the art design standards rarely used & labor intensive
  - HVAC performance measurement technology limited and expensive

# Building America Technology-to-Market Roadmap

## Optimal Comfort Systems for Low-Load Homes





## C. OPTIMAL VENTILATION SYSTEMS & IAQ SOLUTIONS FOR LOW LOAD HOMES

Basic ventilation has become standard in some areas, but current solutions are limited (climate, controls, sources, costs) & standards do not help optimize either IAQ or energy performance; significant IAQ risks remain, especially in low-load homes & envelope retrofits.

### JUSTIFICATION - EVIDENCE

- **Codes Group request** - based on DOE discussions with key IECC stakeholders about major perceived risk of IAQ problems in tight houses (IECC 2012/2015)
- **Building America Space Conditioning Standing Technical Committee & Expert Meeting Reports** identify IAQ in efficient air-tight houses as high technical priority
- **U.S.EPA** (Indoor Environments Division) documents identify increased health risks due to indoor pollutant exposures (2 to 5 times), associated with air-tight homes & homes without adequate ventilation and/or pollutant source control measures
- **ASHRAE Standard 62.2**, Guideline 24, and other documents identify IAQ risks and best practices for acceptable IAQ; however, these practices are not widely or fully adopted/enforced in codes due to cost, education, and standards limitations
- **Significant evidence that IAQ issues increase financial risk due to construction defect litigation**; expert estimates range from \$1 billion and above industry wide, but accurate estimates are not available due to confidentiality issues.
- **Anecdotal evidence of failures, based on expert experience**

## C. OPTIMAL VENTILATION SYSTEMS & IAQ SOLUTIONS FOR LOW LOAD HOMES



### INTEGRATED ROADMAPS

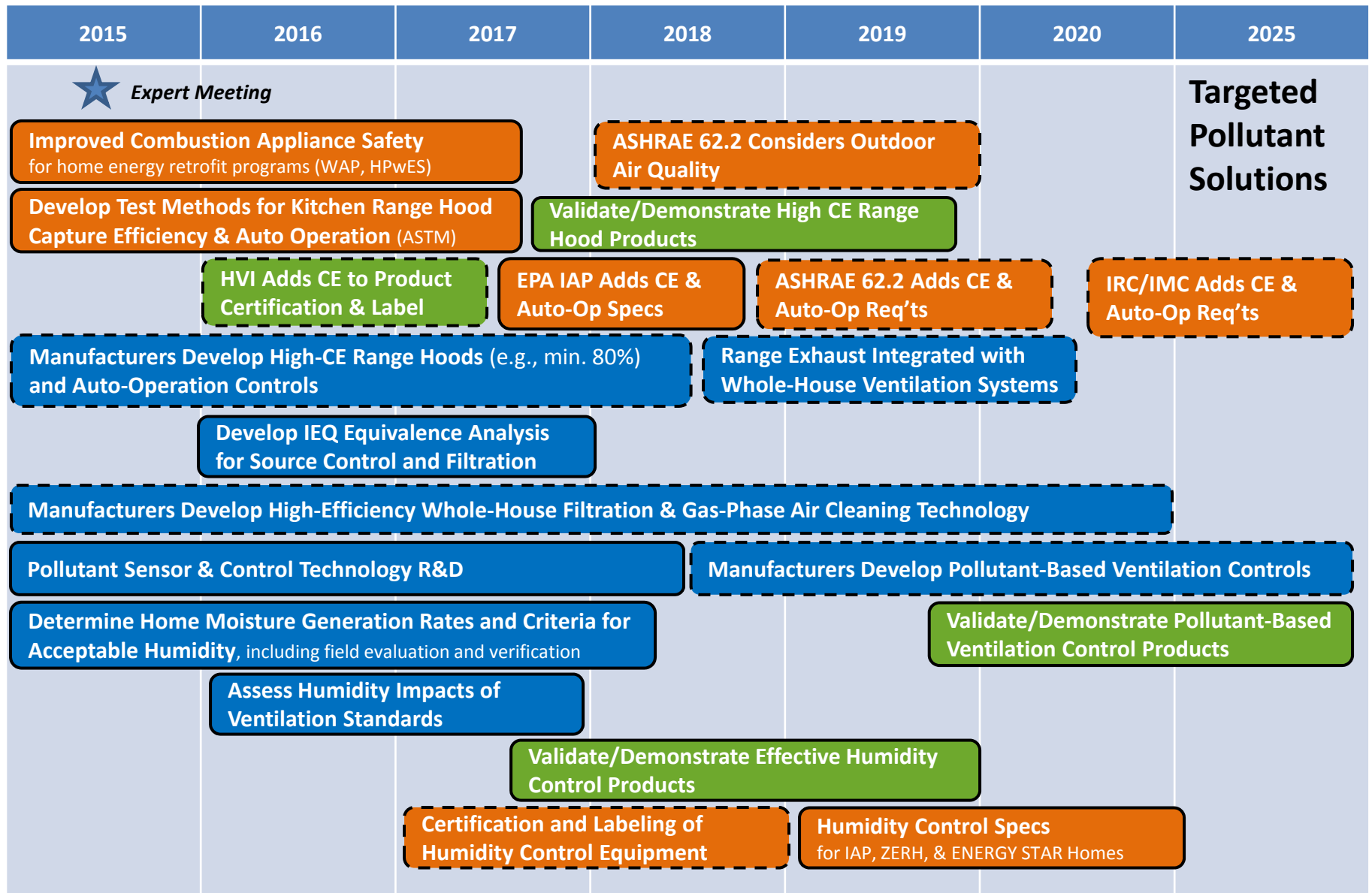
- I. Targeted Pollutants/Non-Dilution Solutions
- II. Smart Ventilation Technology Solutions
- III. IAQ Valuation & Equivalence in Standards

#### Roadmap Objectives:

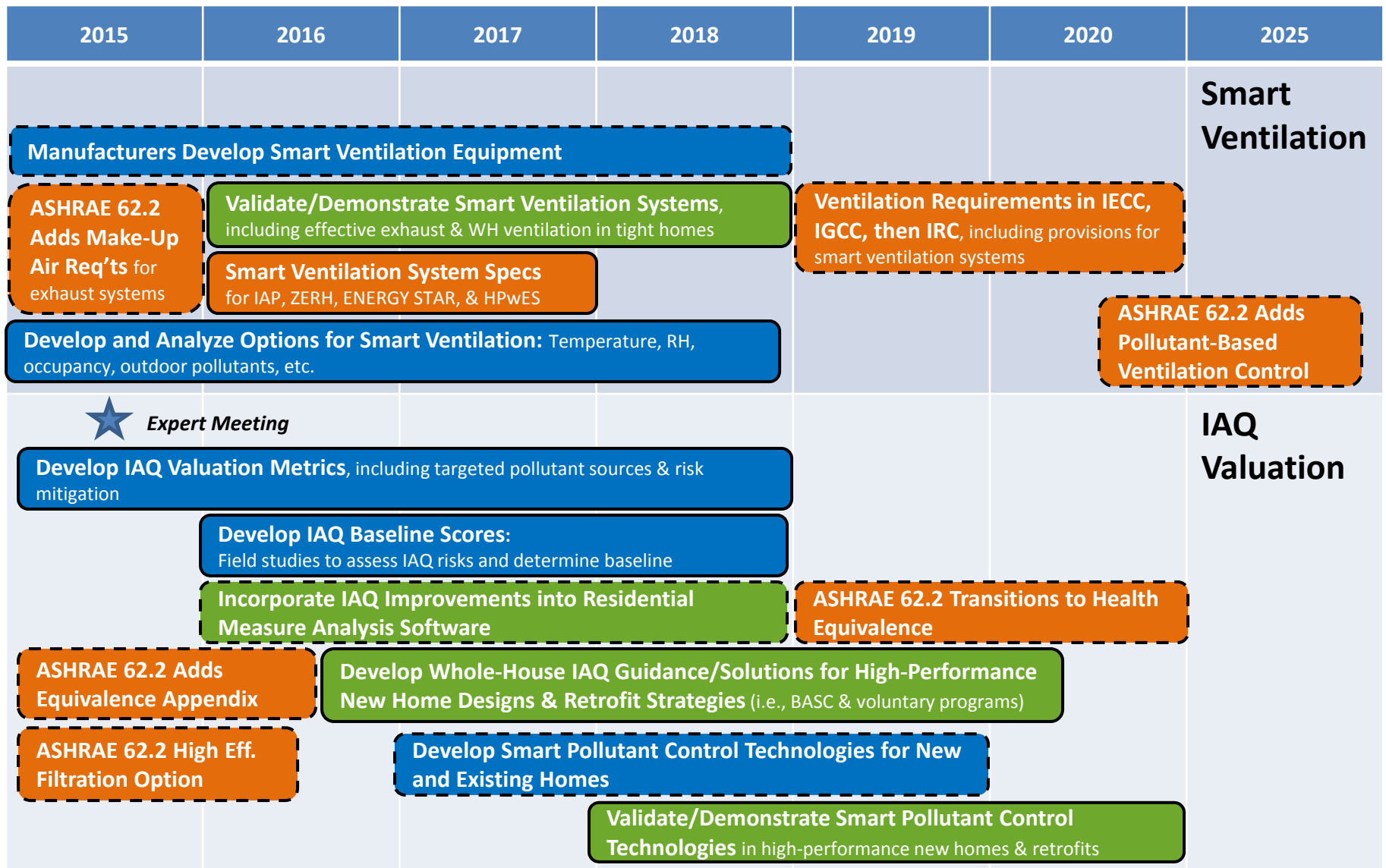
- Industry Standards, Codes & New Technologies as Endpoints
- Priority Issues to Address:
  - Health effects of PM2.5 exposure is high, while control technologies & standards are missing/limited (i.e., kitchen range hoods & advanced filtration)
  - Current state of the art ventilation technologies limited in flexibility for energy & DR management, do not adequately address RH & airflow, and are expensive
  - Combustion safety testing standards are expensive & can lead to both false negatives & false positives for health risks
  - Industry ventilation standard limited in flexibility, doesn't adequately address sources, RH & airflow, and is not universally adopted by building codes

# Building America Technology-to-Market Roadmap

## Optimal Ventilation & IAQ Solutions



# Building America Technology-to-Market Roadmap Optimal Ventilation & IAQ Solutions



- **General Comments:**
  - Missing critical technical challenges?
  - Suggestions for roadmap implementation?
- **Comments on the 3 Roadmaps:**
  - Missing critical research, market, or codes & standards needs?
  - Roadmap sequence/timing realistic & logical?
  - Industry organizations critical to success? How to engage them?
  - Other suggestions for improvement?

EERE Exchange FOA #:

**DE-FOA-0001326**

Request for Information: Building America Program Technology-to-Market Roadmaps

Comment period closes:

**5 PM (ET) on April 30<sup>th</sup>, 2015**

Submit comments to:

**[BuildingAmericaRFI@ee.doe.gov](mailto:BuildingAmericaRFI@ee.doe.gov)**

Questions?

# Thank You

**For More Information:**

**[eric.werling@ee.doe.gov](mailto:eric.werling@ee.doe.gov)**

