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

Building America Roadmap to High Performance Homes

Building Technology Office
U.S. Department of Energy

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EERE's National Mission

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Mission: To create American leadership in the global transition to a clean energy economy

1) High-Impact Research, Development, and Demonstration to **Make Clean Energy** as **Affordable and Convenient** as Traditional Forms of Energy

2) **Breaking Down Barriers** to Market Entry

Why It Matters to America

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- Winning the most important **global economic development race** of the 21st century
- Creating **jobs** through American innovation
- Enhancing **energy security** by reducing our dependence on foreign oil and gas
- **Saving money** by cutting energy costs for American families and businesses
- **Protecting health & safety** by mitigating the impact of energy production on air quality and climate

High Impact in Everything We Do

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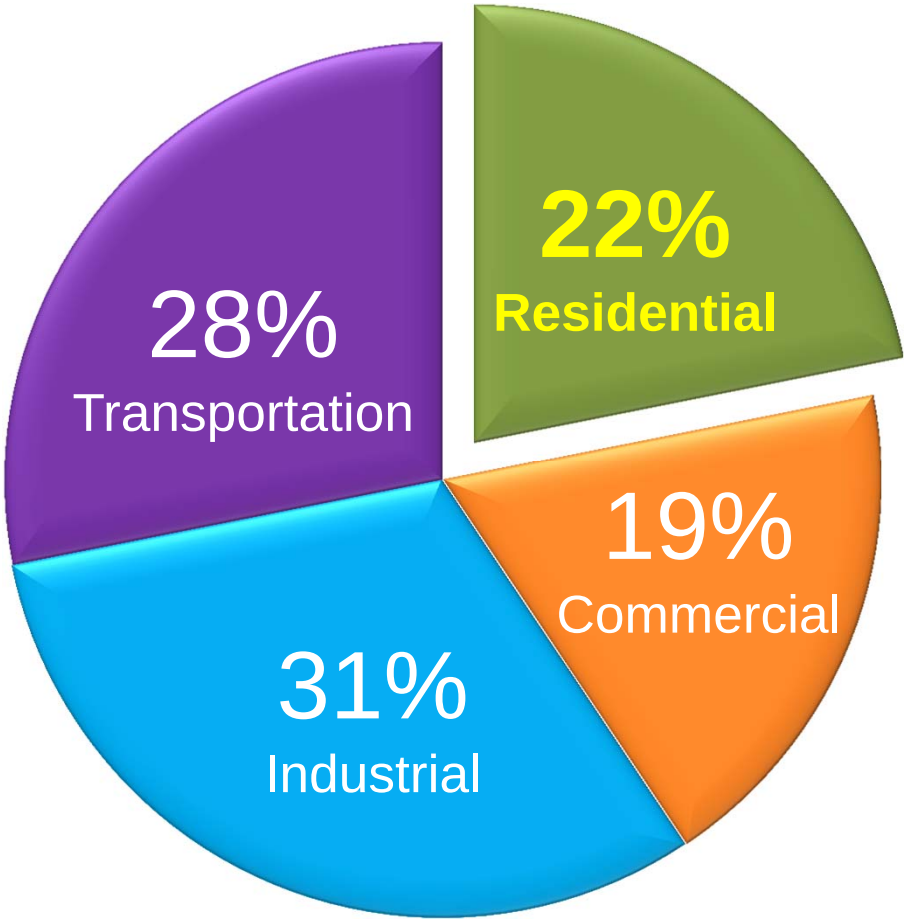
The 5 EERE Core Questions:

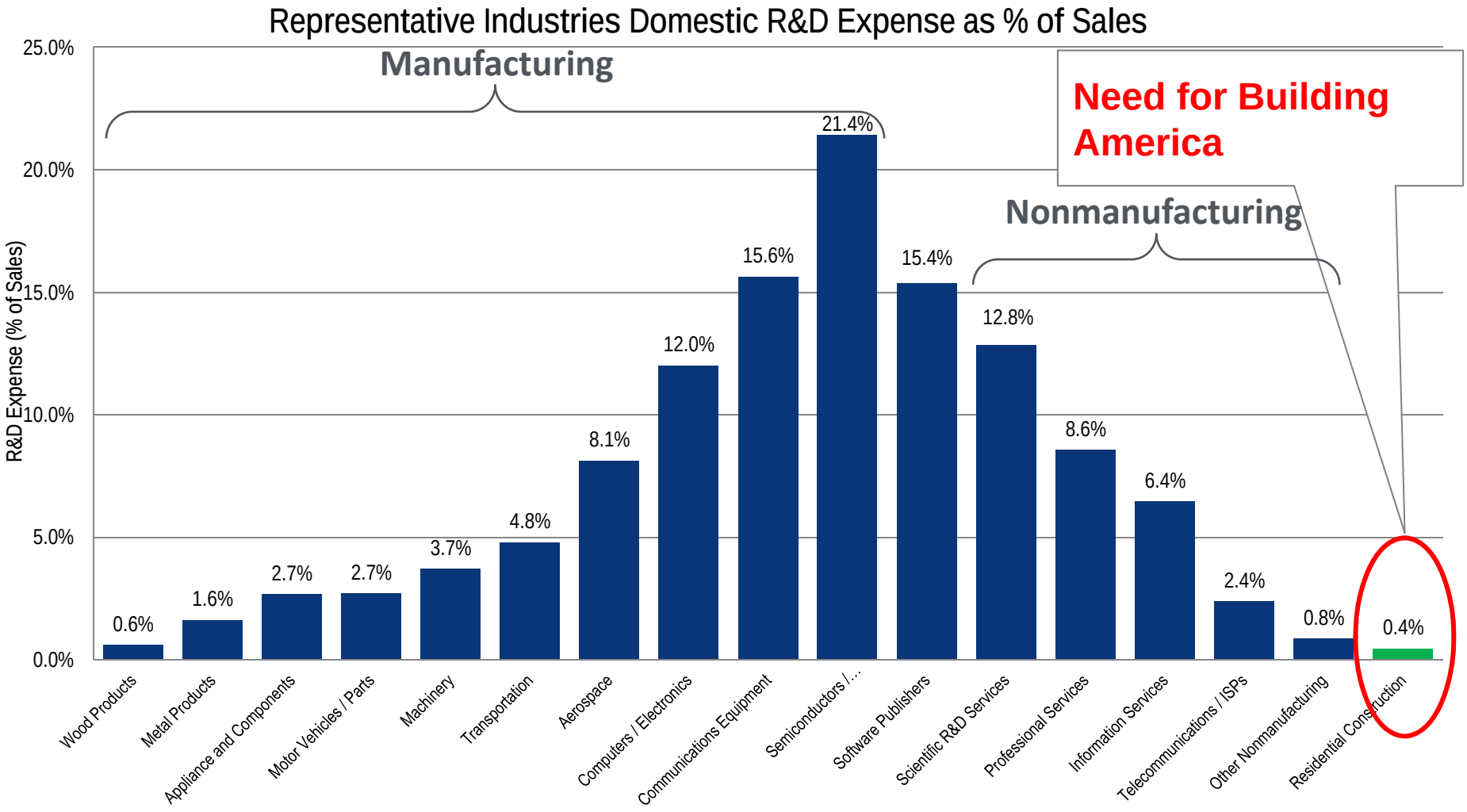
1. **HIGH IMPACT**: Is this a high-impact problem?
2. **ADDITIONALITY**: Will the EERE funding make a large difference relative to what the private sector (or other funding entities) are already doing?
3. **OPENNESS**: Have we made sure to focus on the broad problem we are trying to solve and be open to new ideas, new approaches, and new performers?
4. **ENDURING U.S. ECONOMIC BENEFIT**: How will this EERE funding result in enduring economic benefit to the United States?
5. **PROPER GOVERNMENT ROLE**: Why is what we are doing a proper high-impact role of government vs. something best left to the private sector to address on its own?

Residential Energy Use Significant



U.S. Energy Consumption

Industry Underinvests in R&D



Source: National Science Foundation/Division of Science Resources Statistics, Business R&D and Innovation Survey: 2008

Home Energy Economic Impa(N3

~$2,200: Average Annual Household Energy Bill

>113,000,000: DOE Housing Units in America

>$240 Billion: Amount spent on home utility bills per year.

if we make our houses 50% more efficient

>$120 Billion: Available to the economy

N3 Benefit Discussion

= 1100 x 116 million x 0.1 = $1276000000

If 1% of homes reach this level of energy consumption reduciton each year, then something around a benefit of $63 to $1 (consumer savings vs
funding, need to account for cost of improvements as well)
NCI, 1/24/2013

High-Performance Home Opportunity

- 100 Million Homes:
- Jobs (millions of U.S. housing jobs)
- Energy Independence (NZE Homes use No foreign energy)
- Clean Air & Healthier Households (we spend >60% indoors)

But Budgets Are Tight…

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And Expectations Are High…

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How Can We Ensure Success?

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What Does Success Look Like?

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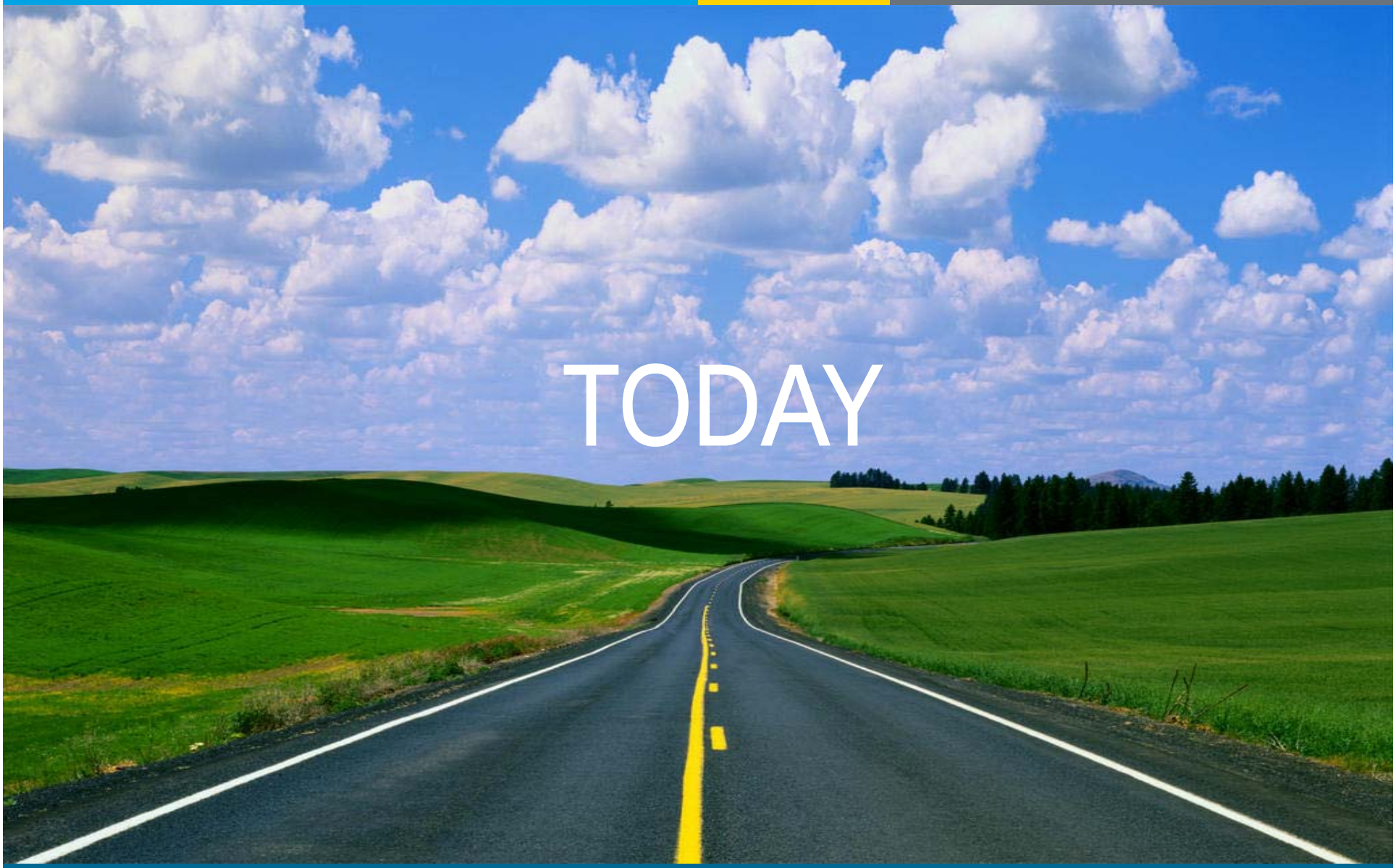

Success So Far

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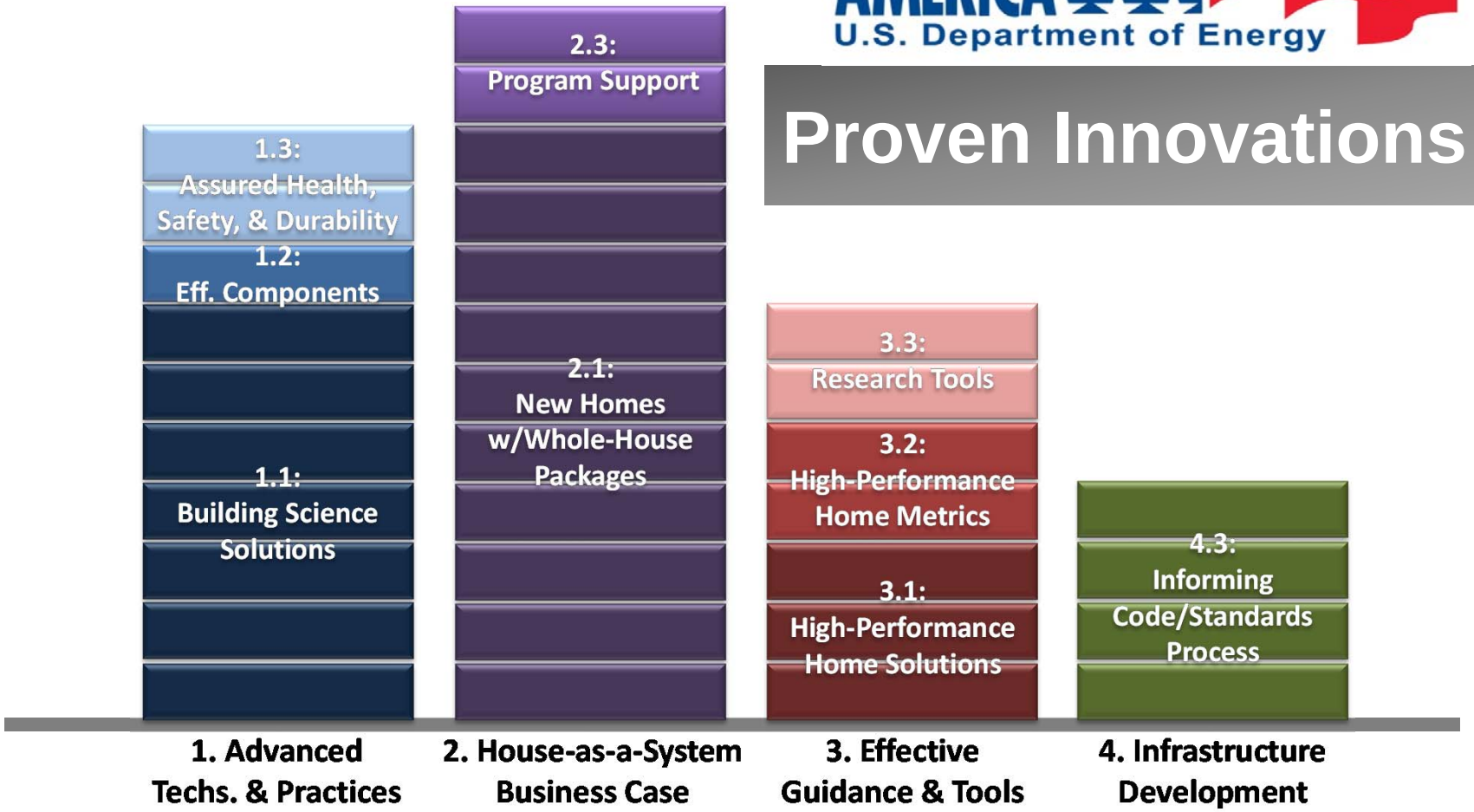
Building AMERICA® U.S. Department of Energy

Proven Innovations:



Success So Far

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32 Top Innovation Profiles:

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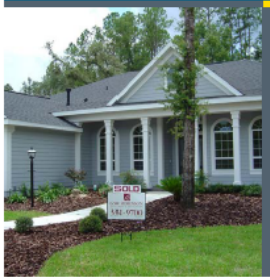
BUILDING TECHNOLOGIES PROGRAM



BUILDING AMERICA TOP INNOVATIONS 'HALL OF FAME' PROFILE

INNOVATIONS CATEGORY:
2. House-as-a-System Business Case
2.3 Program Support

ENERGY STAR for Homes Support

GW Robinson, a production home builder in Gainesville, Florida, worked with Building America to build all 290 units at its Cobblefield development to ENERGY STAR criteria. The builder was one of several featured in a series of guides produced by Building America to help builders achieve ENERGY STAR with climate-appropriate energy-efficiency measures (Baechler et al. 2004-06).

ENERGY STAR for Homes performance metrics gave evidence of a profound impact on our nation's housing: in 2011 alone 30% of builders (8,500 builder partners) built over 1.3 million ENERGY STAR homes that delivered $23 billion in energy cost savings and avoided 210 million tons of green-house emissions. Strong technical underpinnings from Building America have been critical to this success.

BUILDING AMERICA TOP INNOVATIONS

Recognizing Top Innovations in Building Science – The U.S. Department of Energy's Building America program was started in 1995 to provide research and development to the residential new construction and remodeling industry. As a national center for world-class research, Building America funds integrated research in market-ready technology solutions through collaborative partnerships between building and remodeling industry leaders, nationally recognized building scientists, and the national laboratories. Building America Top Innovation Awards recognize those projects that have had a profound or transforming impact on the new and retrofit housing industries on the road to high-performance homes.

ENERGY STAR for Homes, with critical support from DOE's Building America program, has been transformative, leading the U.S. housing industry to high-performance homes and driving the development of a national Home Energy Rating System (HERS) infrastructure.

ENERGY STAR is a joint program of the U.S. Environmental Protection Agency (EPA) and DOE, helping U.S. citizens save money and protect the environment through energy-efficient products and practices. Through ENERGY STAR for New Homes, the DOE and EPA have worked to increase the energy efficiency of the nation's new homes (EPA 2012a). More than 127,000 new homes earned the ENERGY STAR in 2011, bringing the total number of certified homes to more than 1.3 million (EPA 2012a).

ENERGY STAR for new homes was first offered late in 1995. At that time, the ENERGY STAR guidelines targeted "low-hanging fruit," improvements such as high-performance windows, improved air sealing, tightly sealed ducts, and efficient heating and cooling equipment. Homes qualified to ENERGY STAR for Homes Version 1 were 30% more efficient than a home built to the 1993 Model Energy Code (MEC). These initial guidelines stayed in effect for 10 years, with some regional modifications to reflect more rigorous local codes or construction practices (EPA 2012a).

The development of a national Home Energy Rating System infrastructure was a major by-product of ENERGY STAR for Homes during the initial Version 1 specification phase. When EPA first introduced ENERGY STAR for homes, the HERS industry had just started and was not ready to support a national program. The Building America Program stepped in to fill this critical gap with much needed technical support by deploying research teams to work directly with the nation's leading builders to develop energy-efficiency innovations. These teams successfully engaged hundreds of builders to join ENERGY STAR for Homes. This early support proved to be the critical jump start needed to build ENERGY STAR's initial momentum while allowing the HERS industry time to mature. Thus, Building America and ENERGY STAR dovetailed perfectly to help transform the building industry to energy-efficient building practices (EPA 2005).

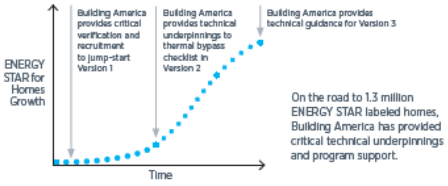
In 2006, EPA developed more stringent guidelines (ENERGY STAR Version 2). The updated guidelines added a Thermal Bypass Checklist, right-sized HVAC systems, and use of efficient lighting and appliances. These guidelines were substantially derived

BUILDING AMERICA TOP INNOVATIONS 'HALL OF FAME' PROFILE

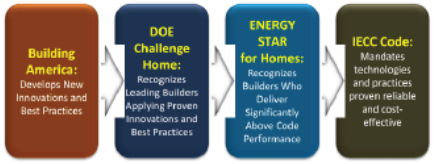
from best practices advocated by Building America. They became effective on January 1, 2007, and the Thermal Bypass Checklist soon after was substantially adopted in the 2009 International Energy Conservation Code (IECC).

In response to increasing code requirements and improving construction practices, EPA released a third-generation of guidelines (ENERGY STAR for Homes Version 3) that took full effect on July 1, 2012. Homes built to ENERGY STAR for Homes Version 3 are approximately 15% more efficient than those built to the 2009 IECC. More importantly, these latest specifications ensure comprehensive building science with detailed checklists substantially informed by Building America research. In addition, DOE is teaming with EPA by making the vast expertise of Building America research teams available for ongoing guidance on the wide array of technical issues and questions required to maintain these specifications.

In October 2010, DOE began developing the 2012 specifications for the DOE Challenge Home in coordination with EPA. The goal was to fully align the old Builders Challenge program with ENERGY STAR for Homes to ensure a unified federal government voice and process for promoting advanced building science. DOE envisions the effort as an opportunity to "road-test building science measures targeted for the next new homes specification" while providing an opportunity to "promulgate technologies and best practices successfully established in their Building America research program" (EPA 2010).



On the road to 1.3 million ENERGY STAR labeled homes, Building America has provided critical technical underpinnings and program support.



Building America, DOE Challenge Home, and ENERGY STAR for Homes are examples of how "good government" programs can work together as a system, creating a highly effective market transformation process that culminates in code adoption of new innovations.

ENERGY STAR HOMES

More than 1.3 million homes nationwide have earned the ENERGY STAR label, as of March 2012.

REFERENCES

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DOE Building Technologies Program
www.buildings.gov

Building America Solutions Center
www.buildingamerica.gov/solutionscenter

PNNL-SA-90561 November 2012

Building America U.S. Department of Energy
www.BuildingAmerica.gov

Market Transformation Success

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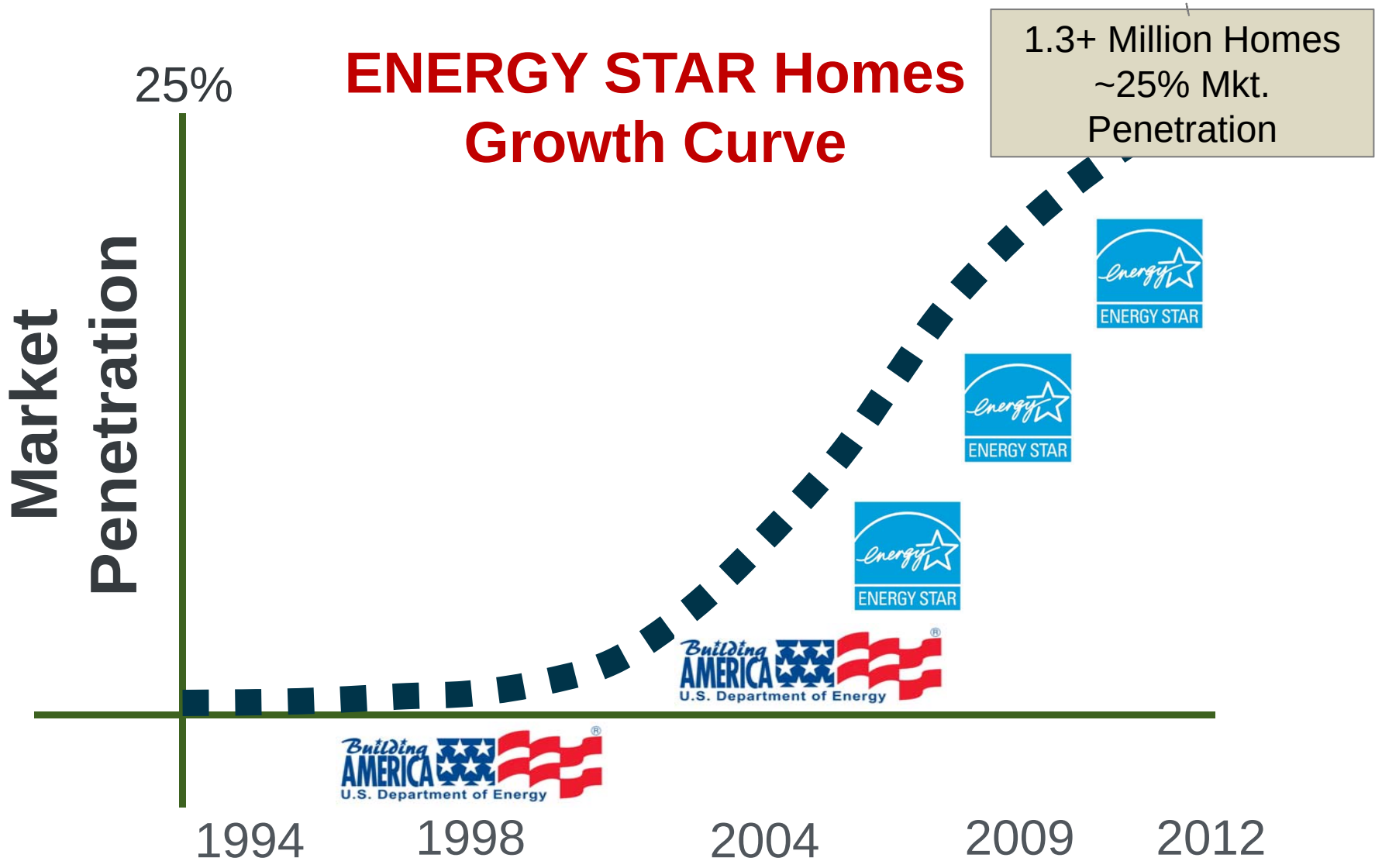

Market Transformation Success

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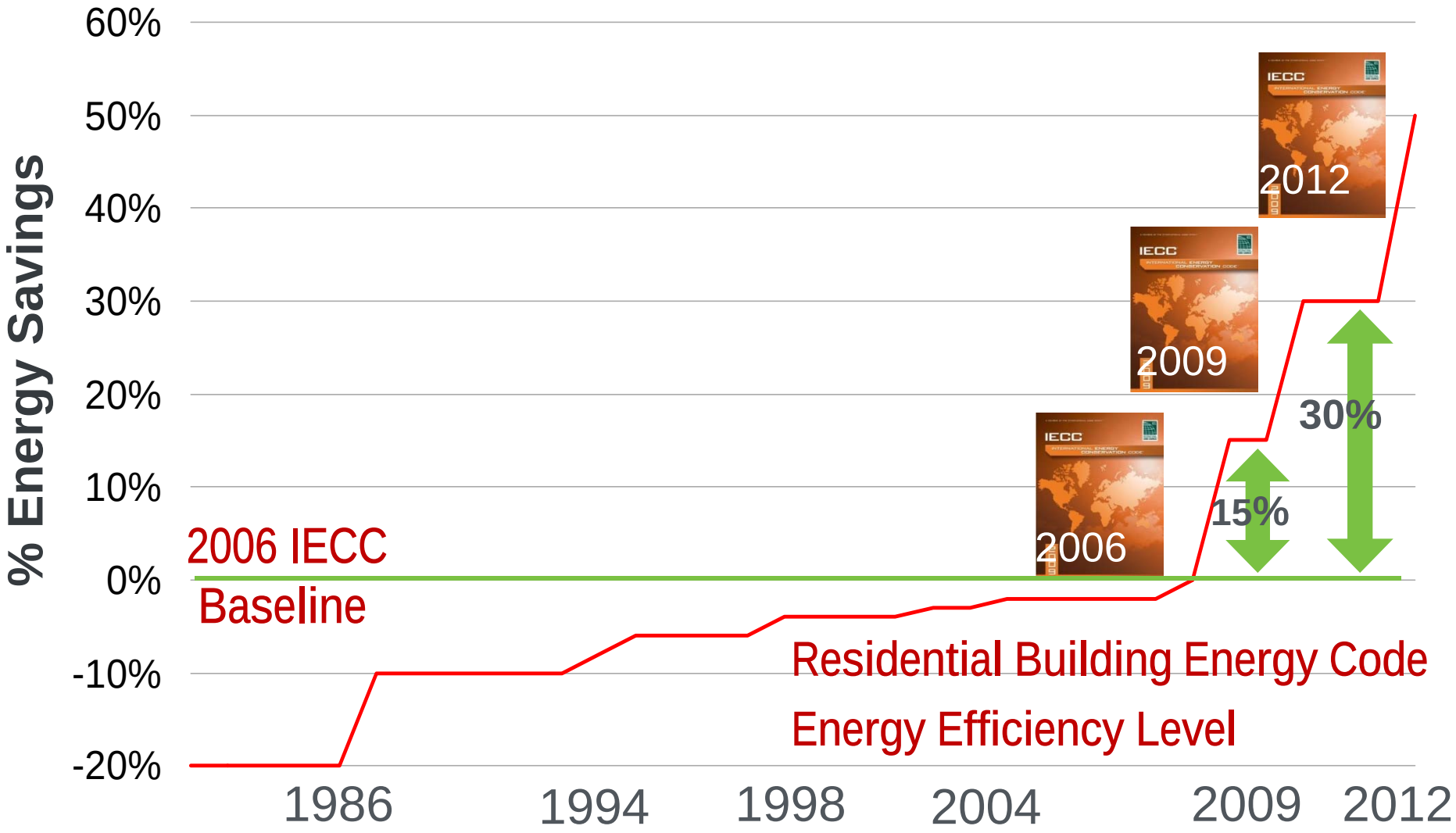

Market Transformation Success

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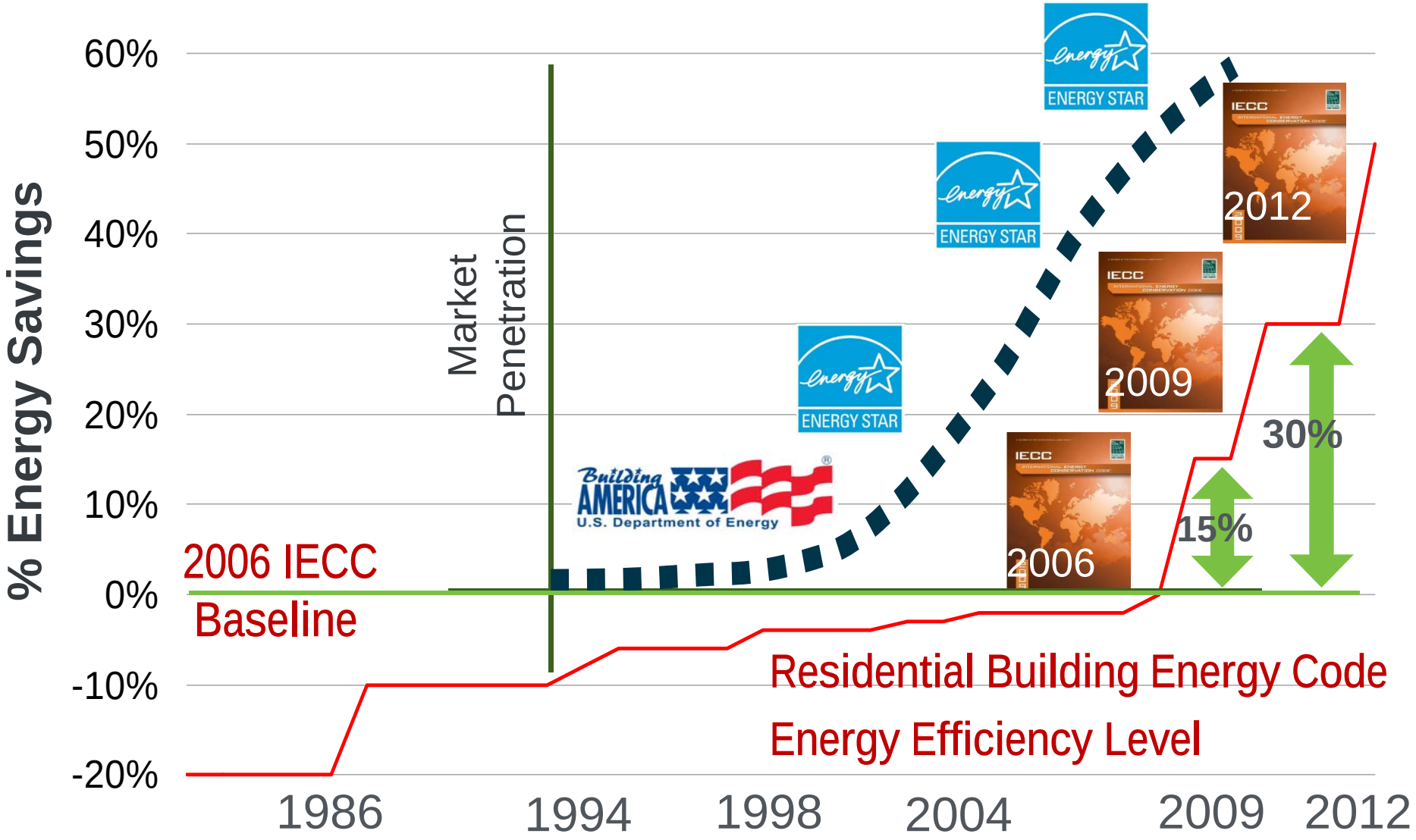

Market Transformation

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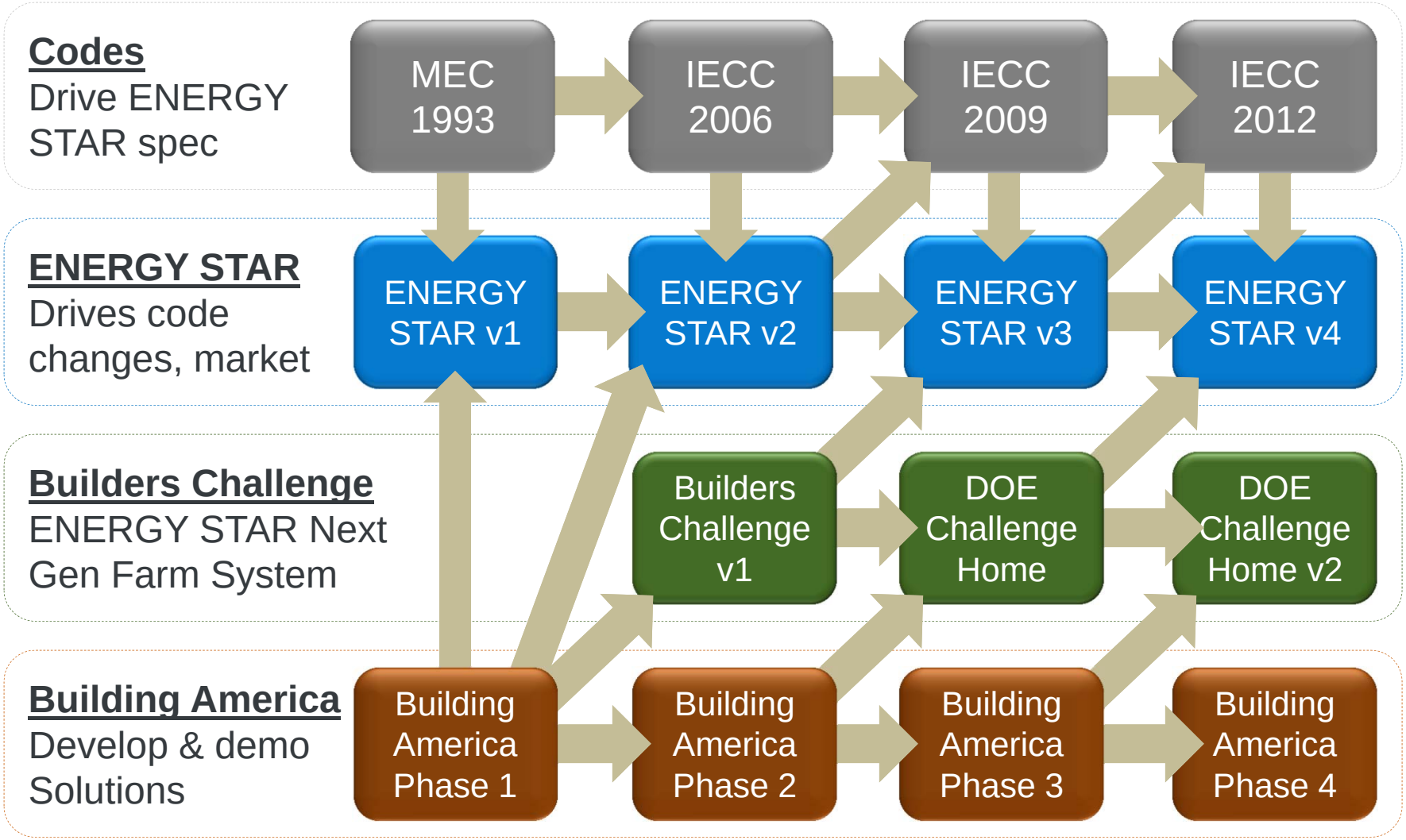

Progress Toward the 50% Goal

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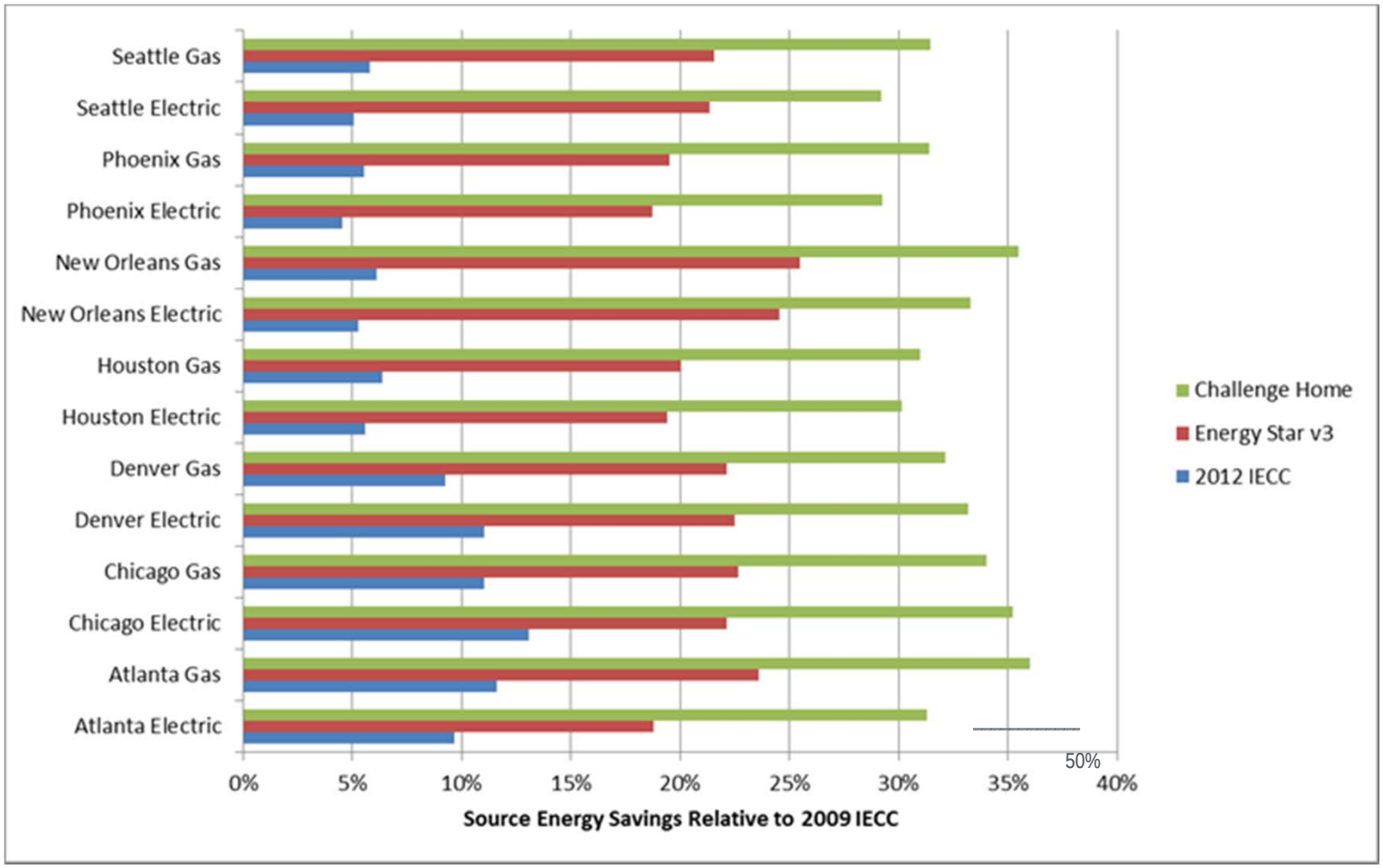
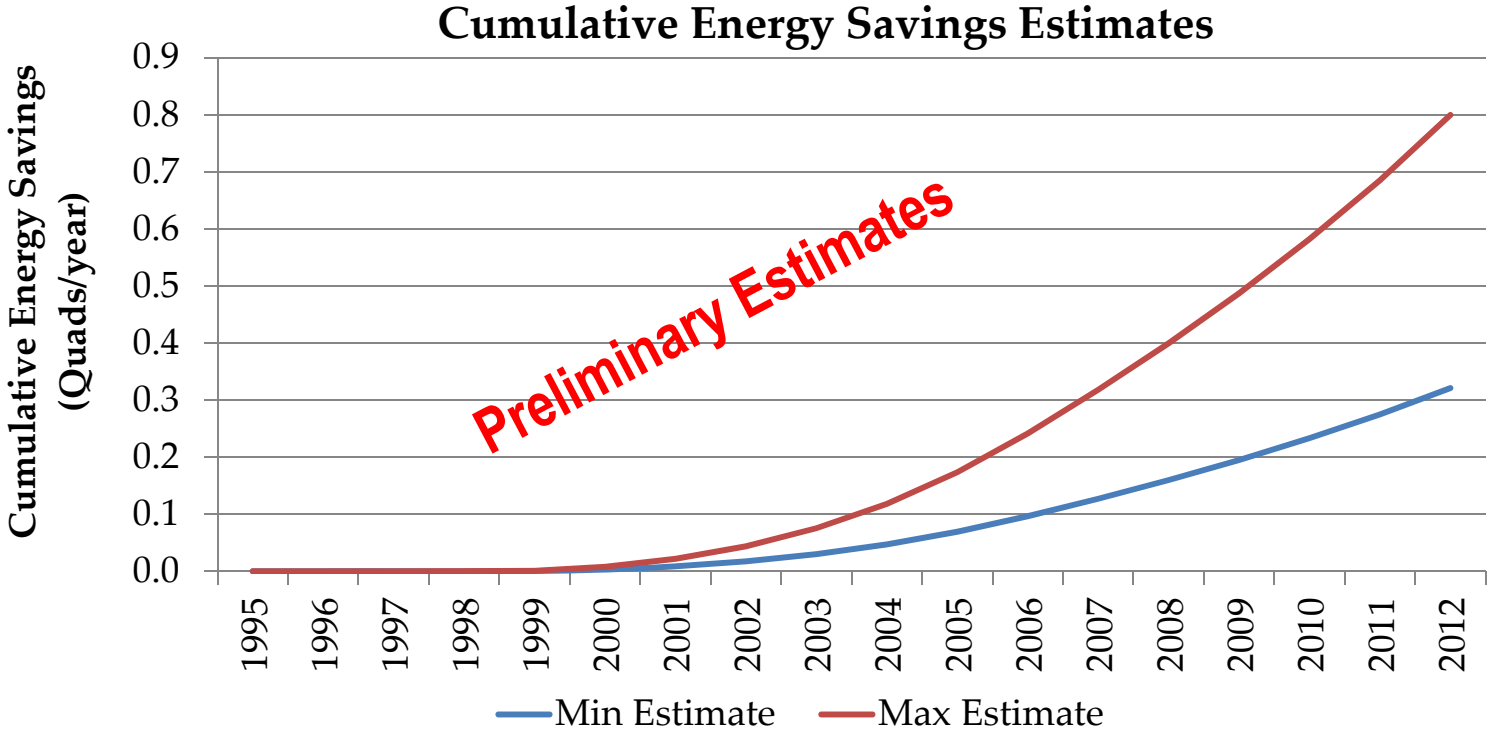
Goal: ***50% energy savings in new and existing homes****.*



Program Impact To Date

Since 1995, Building America Innovations have resulted in approximately 0.32-0.80 quads of cumulative energy savings for U.S. homeowners and continue to grow each year (new construction market impacts only).



These energy savings correspond to a cumulative utility cost savings of approximately $6.3-$15.8 Billion.*

* Based on 1990-2015 estimates from 2011Building Energy Data Book, Table 2.3.1

How Much is That?

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- That's $30 to $70 per $1 invested
- It's 10 to 20 Coal Fired Power Plants
- A Year's worth of Power for Pennsylvania homes

What Does Success Look Like?

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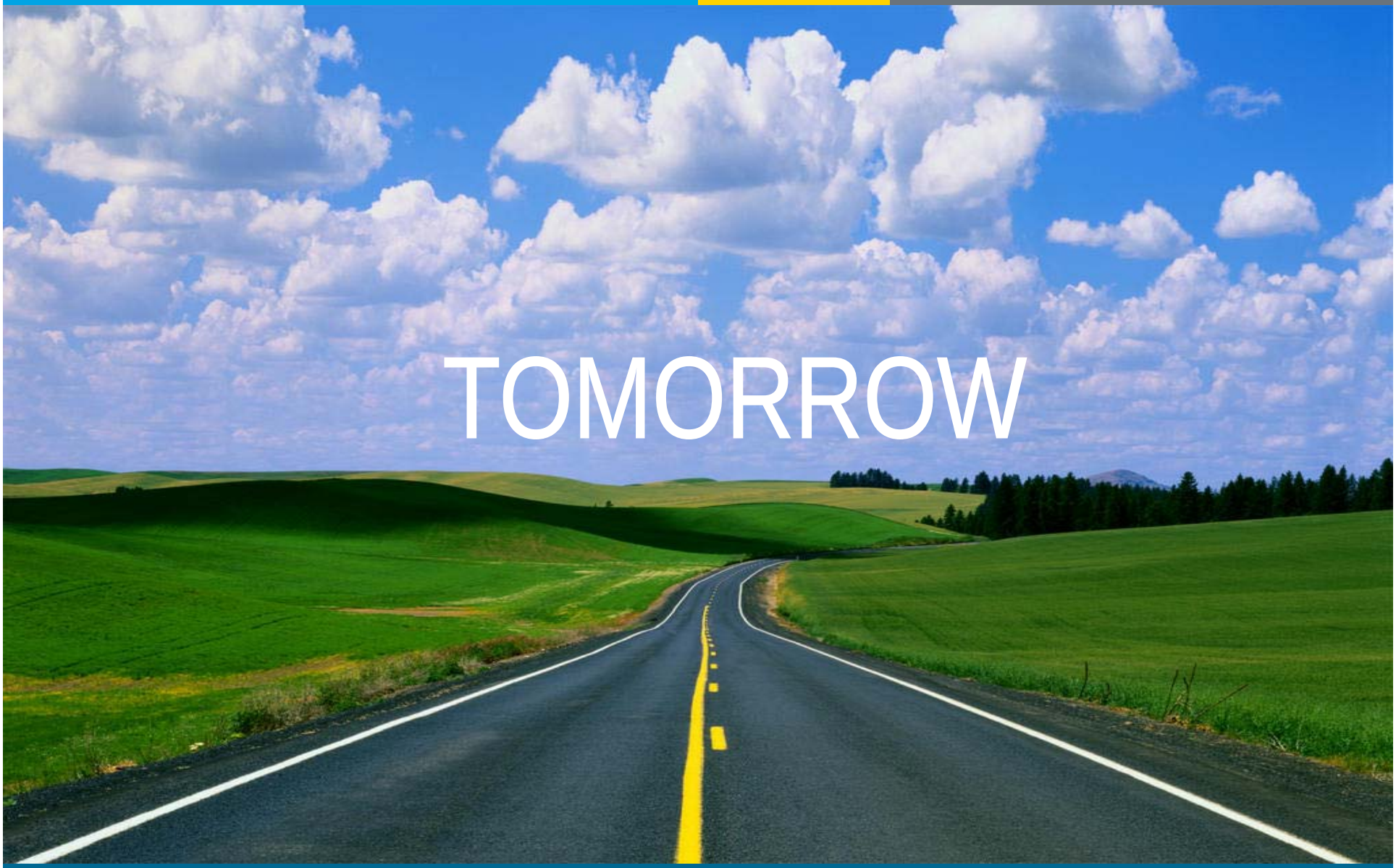
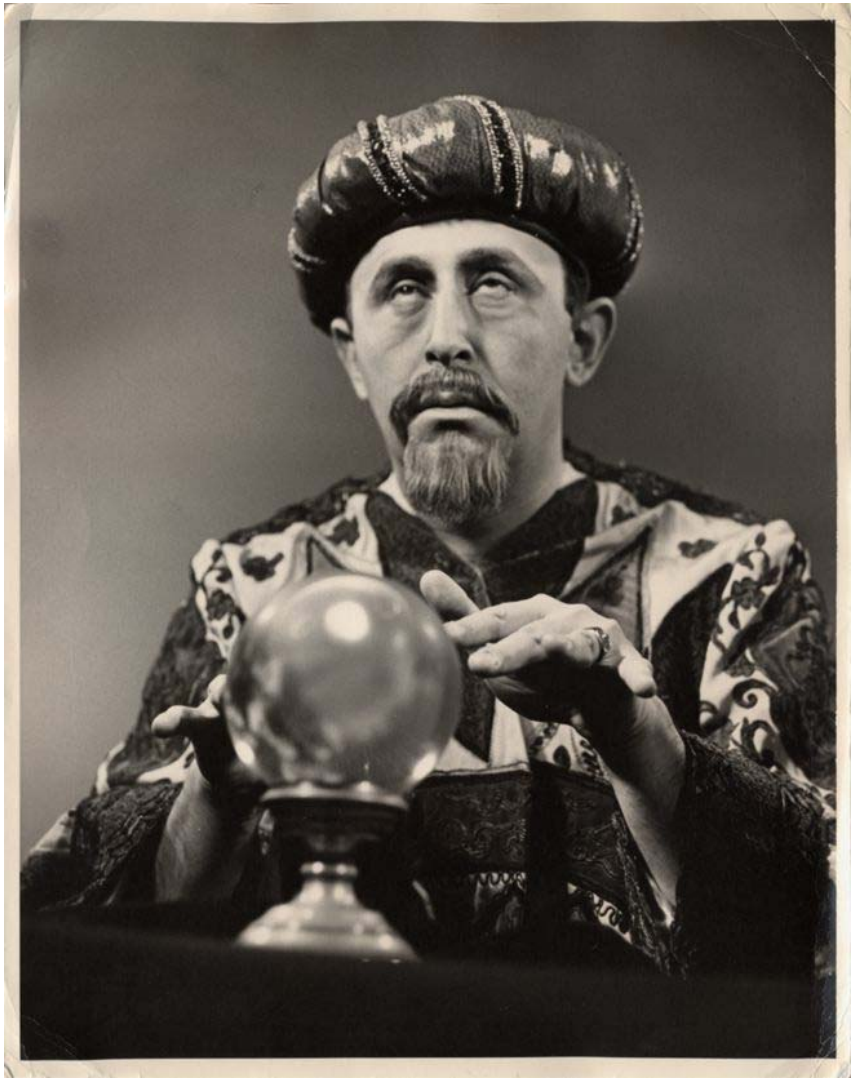


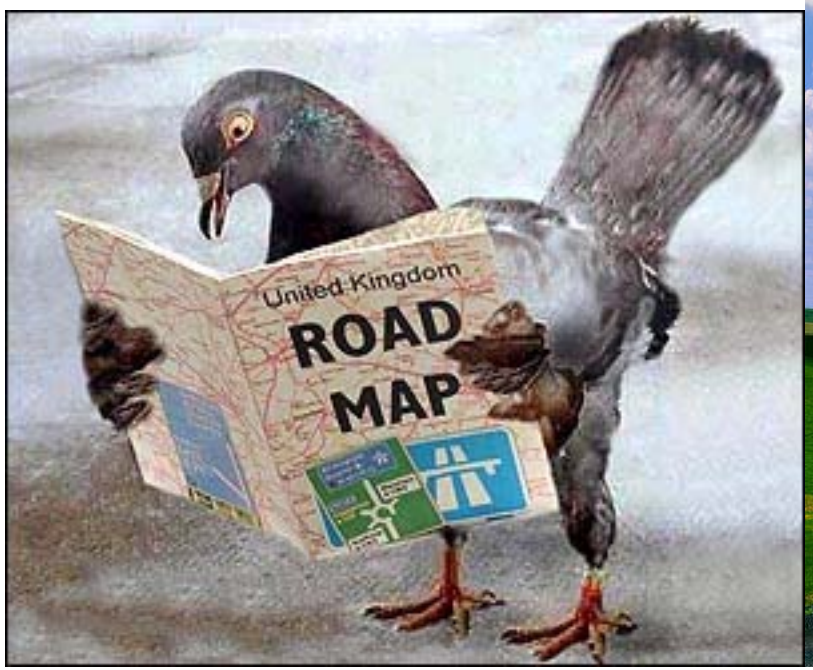
What Does Success Look Like?

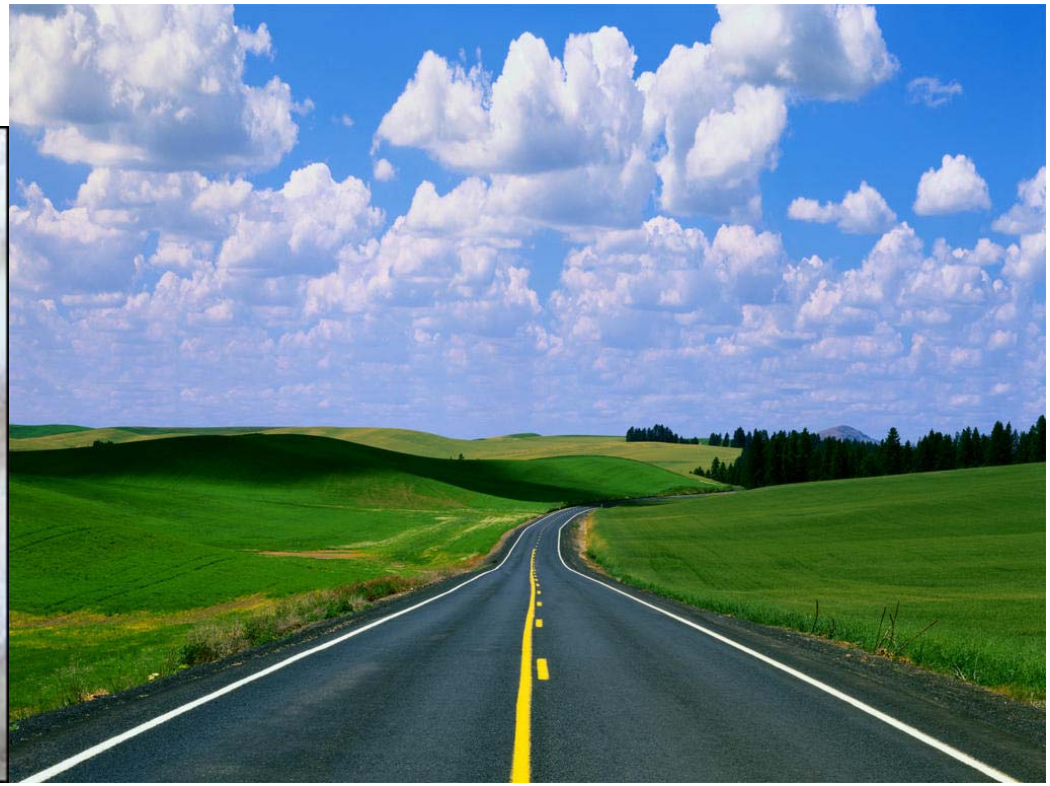


- **Net Zero Homes** become common place
- Americans pay for **Preventative Maintenance** for their Homes
- **Home Asset Management** businesses emerge
- **"House Doctor"** businesses emerge
- All housing **Trades offer Energy Efficiency** services
- Builders offer extended **Warranties** (>30 years)

How Do We Get There?

With a **Roadmap?**





Technology Roadmaps…

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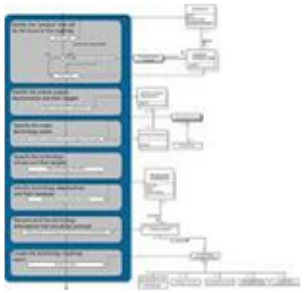
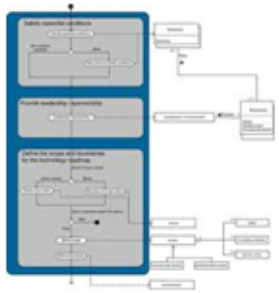
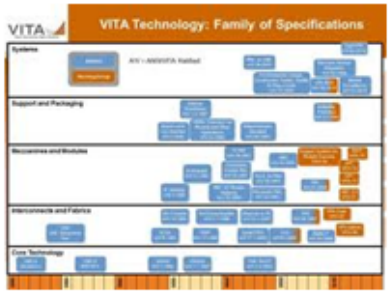
+You Search Images Maps Play YouTube News Gmail Drive Calendar More

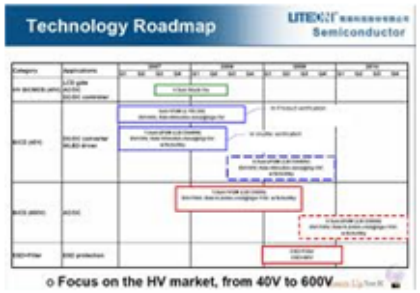
Google technology roadmaps

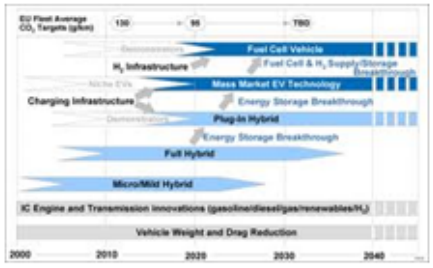
Web Images Maps Shopping More Search tools

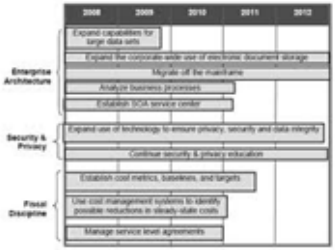


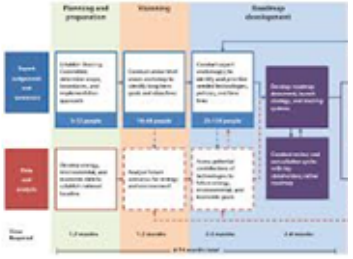


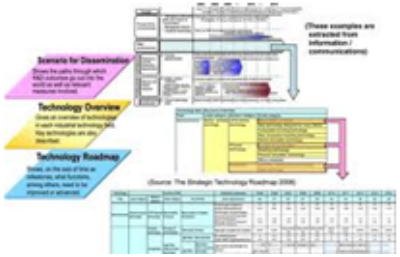


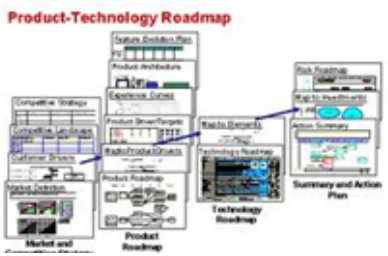


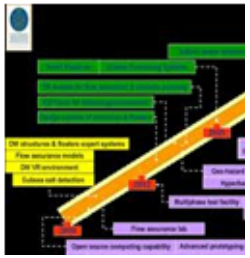




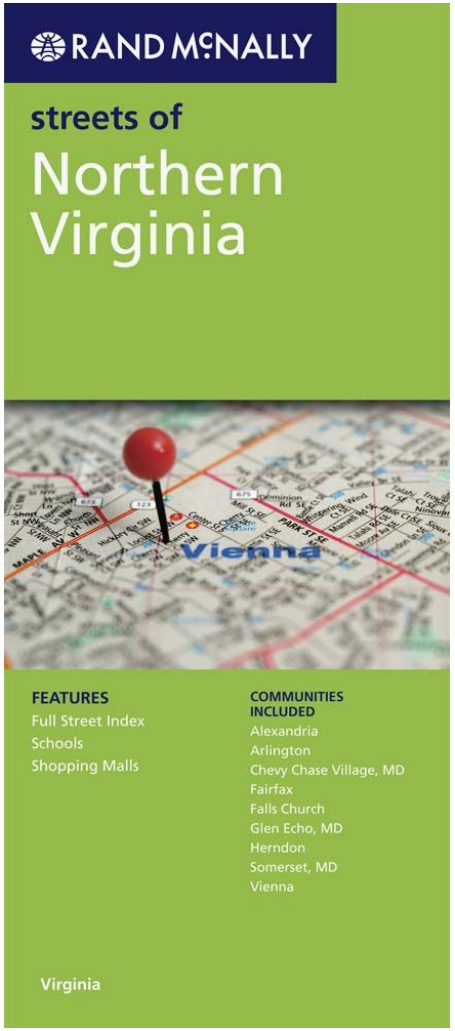








We Need a Roadmap? Really?



Remember these?

I prefer my GPS…

Meet Nancy Navigator

Five easy steps to reach your destination…

1. Type in Destination

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Today I headed to Denver

Tomorrow we're headed for Net Zero Energy Homes!

To Get to NZE Ready Homes…

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1. High Efficiency

- Thermal Enclosure (“Envelope”)
- Low-Load HVAC
- Efficient Components

2. High Performance

- Comfort
- Health
- Durability
- Renewable Readiness/Integration
- Water Conservation
- Disaster Resistance

Building America Destination

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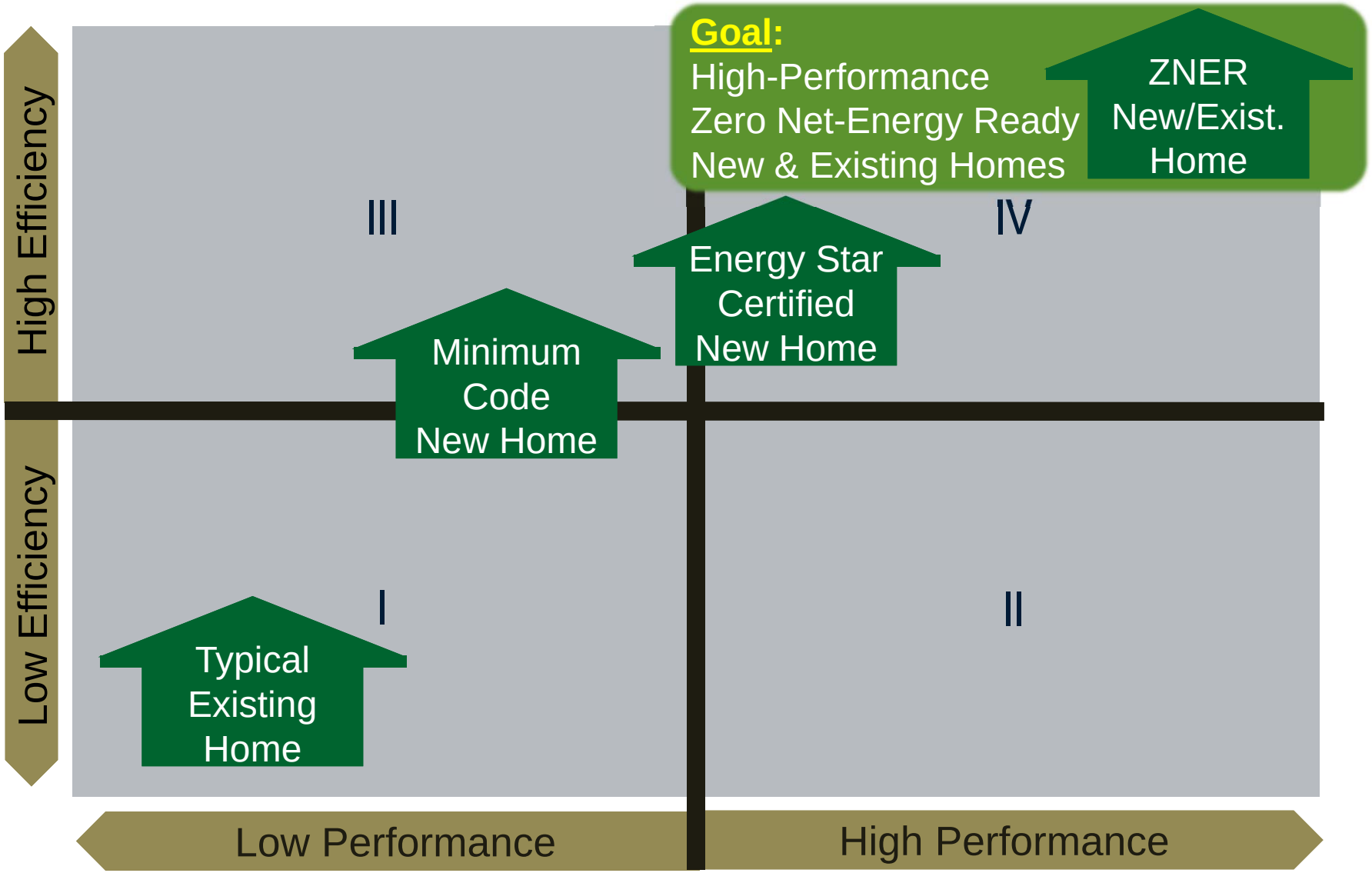
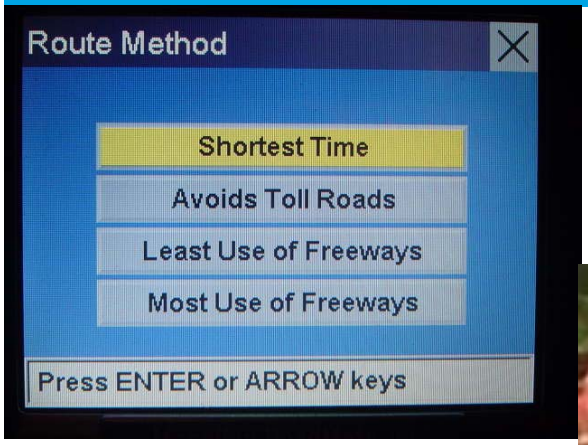


2. Choose Preferred Route



Shortest Time, Avoid Tolls…

Building America Technology Path

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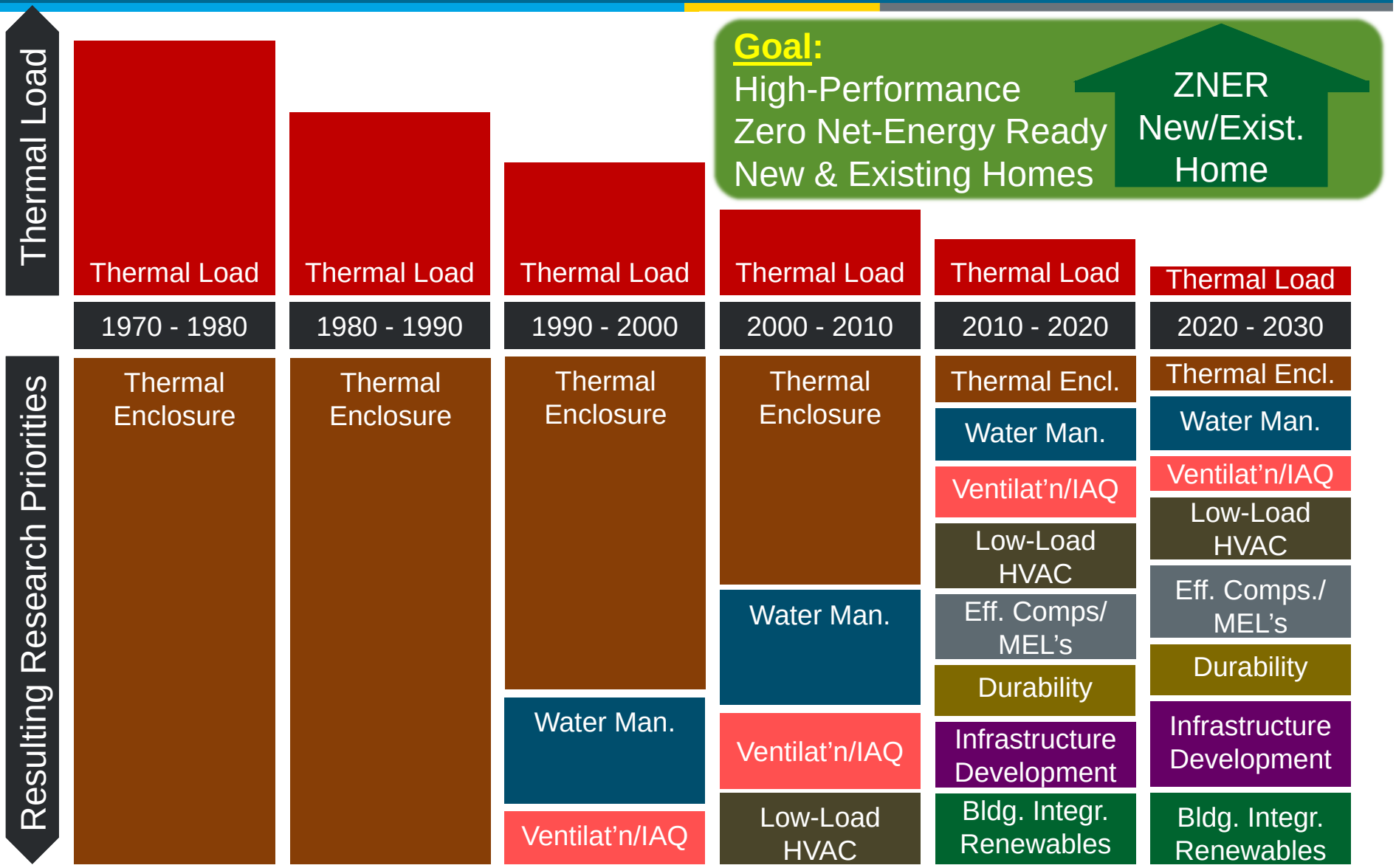

World Class Building Systems Research

Building America Solution Center
BASC.energy.gov

At Your Fingertips!

http://www1.eere.energy.gov/buildings/residential/ba_solution_center.html

3. Follow Directions

"Proceed to Highlighted Route…"

Building America Innovations Fill Critical Market Gaps

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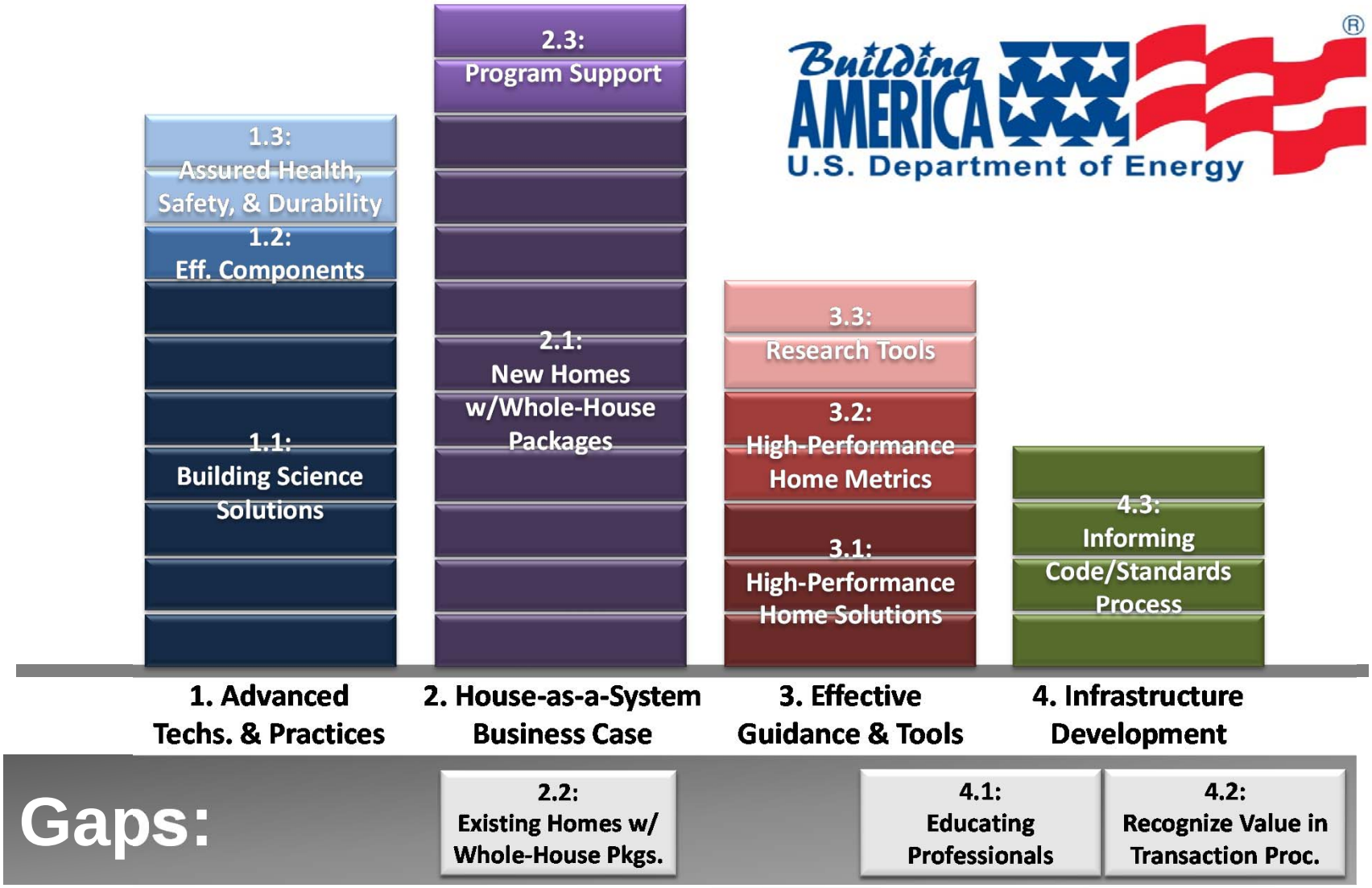
- **Lower cost** efficient technologies & systems
- **Lower risk** of system failures (moisture, durability)
- **Easier installation** methods/systems (fewer steps, fewer materials, less training)
- **Easier performance measurement** methods/systems (fewer steps, less training, higher error tolerance)

Major Remaining Gaps



4. Re-route if Necessary

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"Recalculating…"

Changing Course

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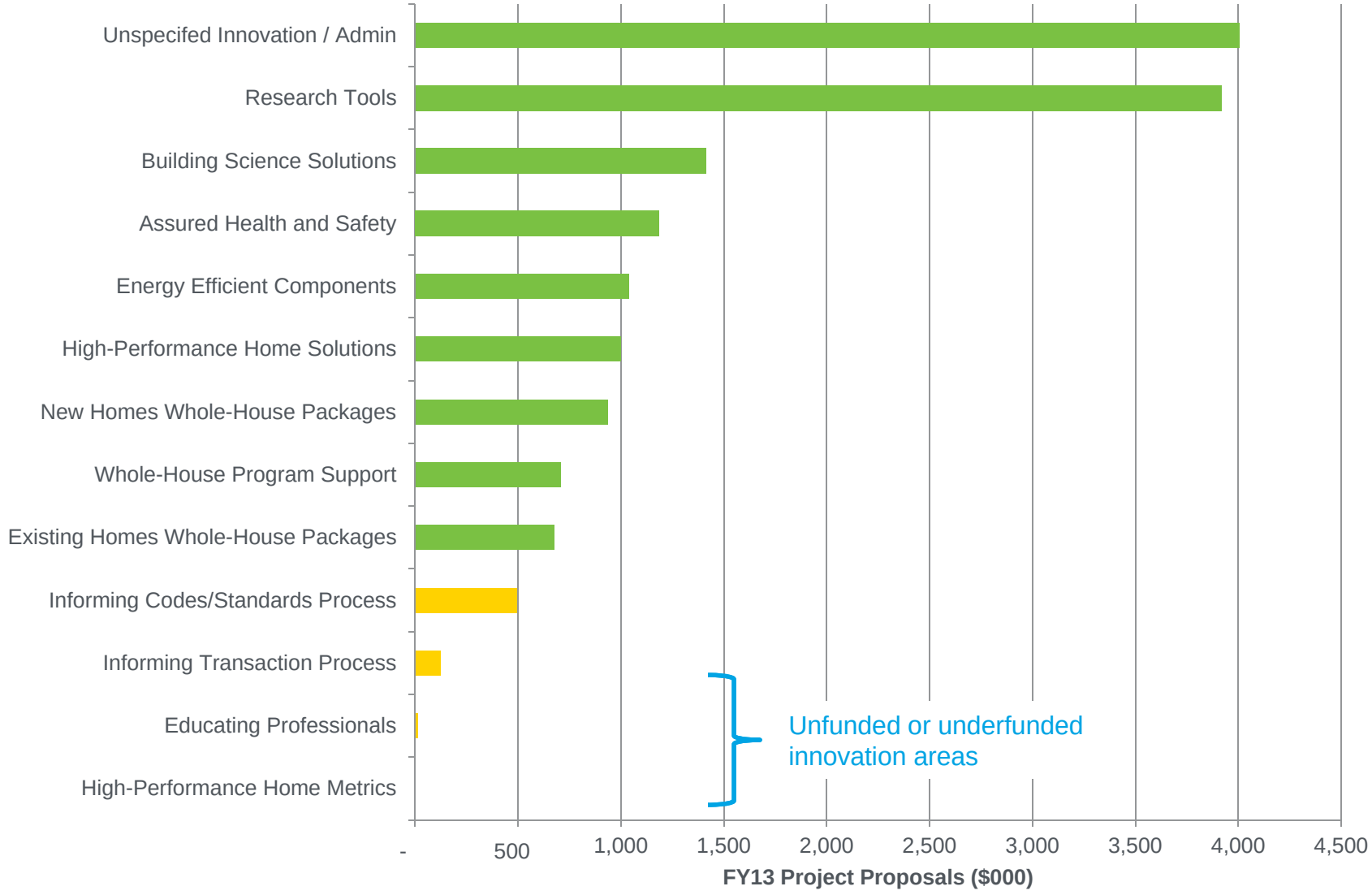

The Biggest Roadblock Ahead?

How to Retrofit 100,000,000 Existing Homes?

Building America Innovation Example

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

Ducts in Conditioned Space:

Building America provided proven solutions for locating ducts in conditioned space that are being adopted by builders across the country.

- ~8 – 15% savings on air conditioning bills
- 1,000's of homes

Residential Integration Example: Market Solutions

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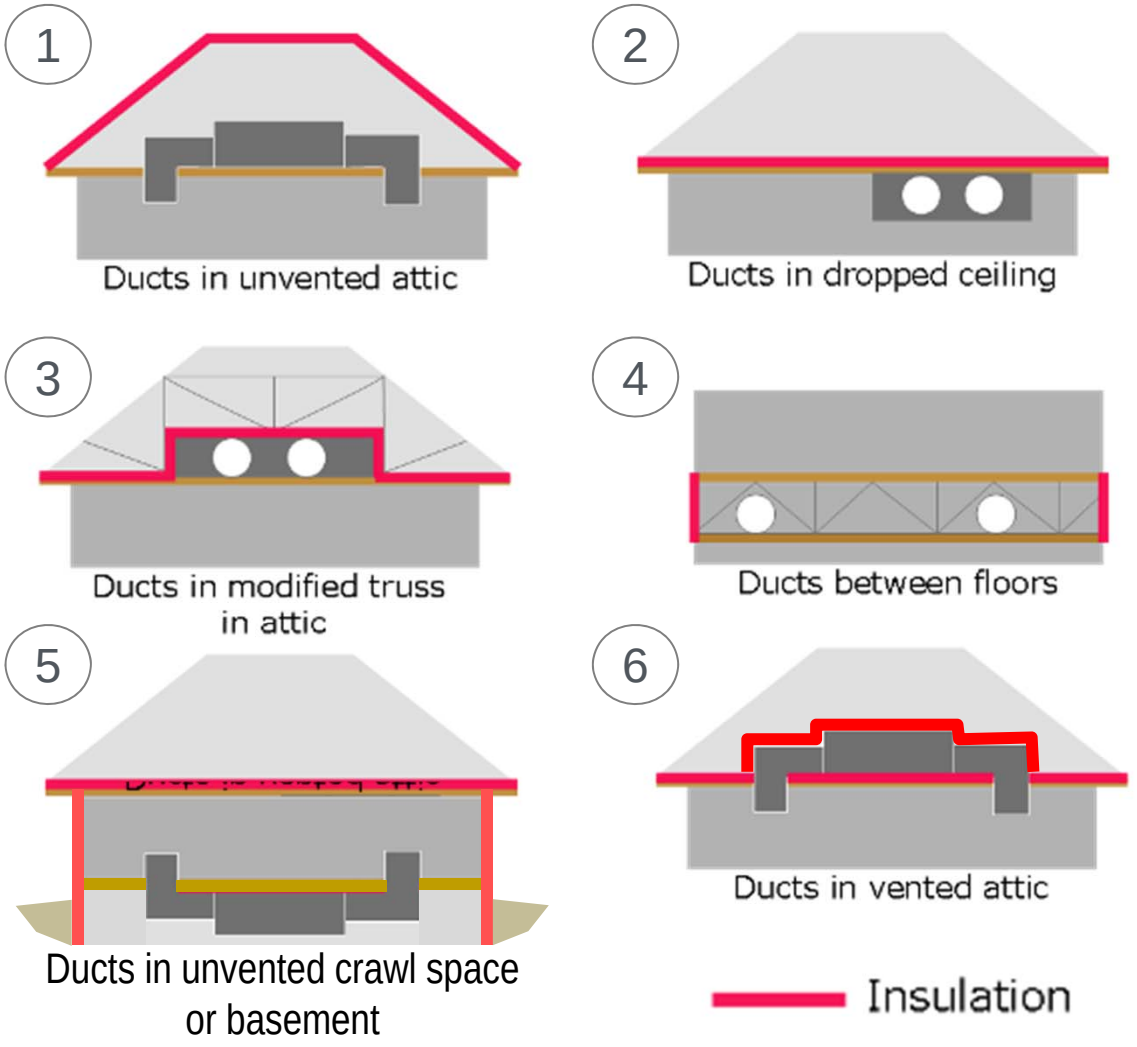
Ducts in Conditioned Space:

Building America developed and demonstrated 6 different cost-effective solutions for locating ducts inside conditioned space. All are being adopted by builders across the country.



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What's Next?

Figure 20. Ductwork well-sealed to sheetrock with ccSPF

Figure 21. Rigid insulation inserted under ductwork to serve as a substrate and provide insulating value

Figure 22. Varying thickness of ccSPF and interference from cross bracing

Figure 23. Varying application thicknesses shown on rectangular (left) and round (right) ducts

Question for You:

How can our work help achieve **Lower Installation Costs, Lower Business Risks, and Easier Performance Measurement?**

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