Building America Technical Update Meeting

July 24-26, 2012

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

Building America Top Innovations

SAM RASHKIN
Chief Architect
Building Technologies Program
July 26, 2012

Words to Live By

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

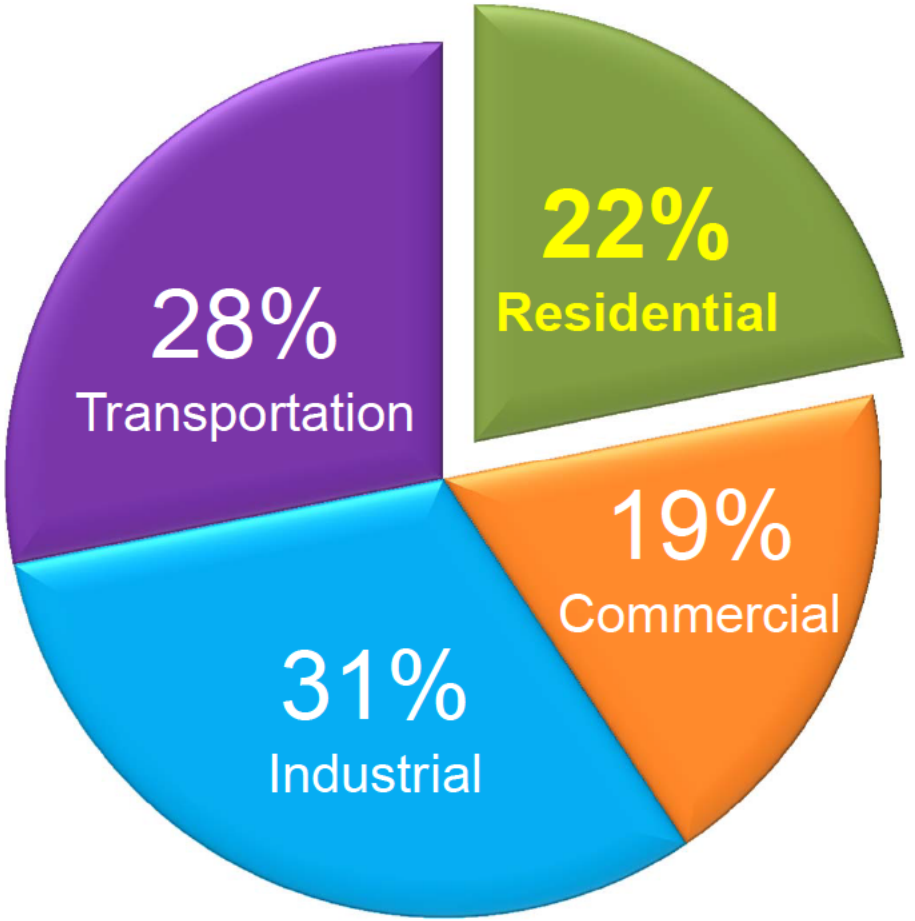
"Your job is to make me look good"

David Lee

Why Building America Innovations

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

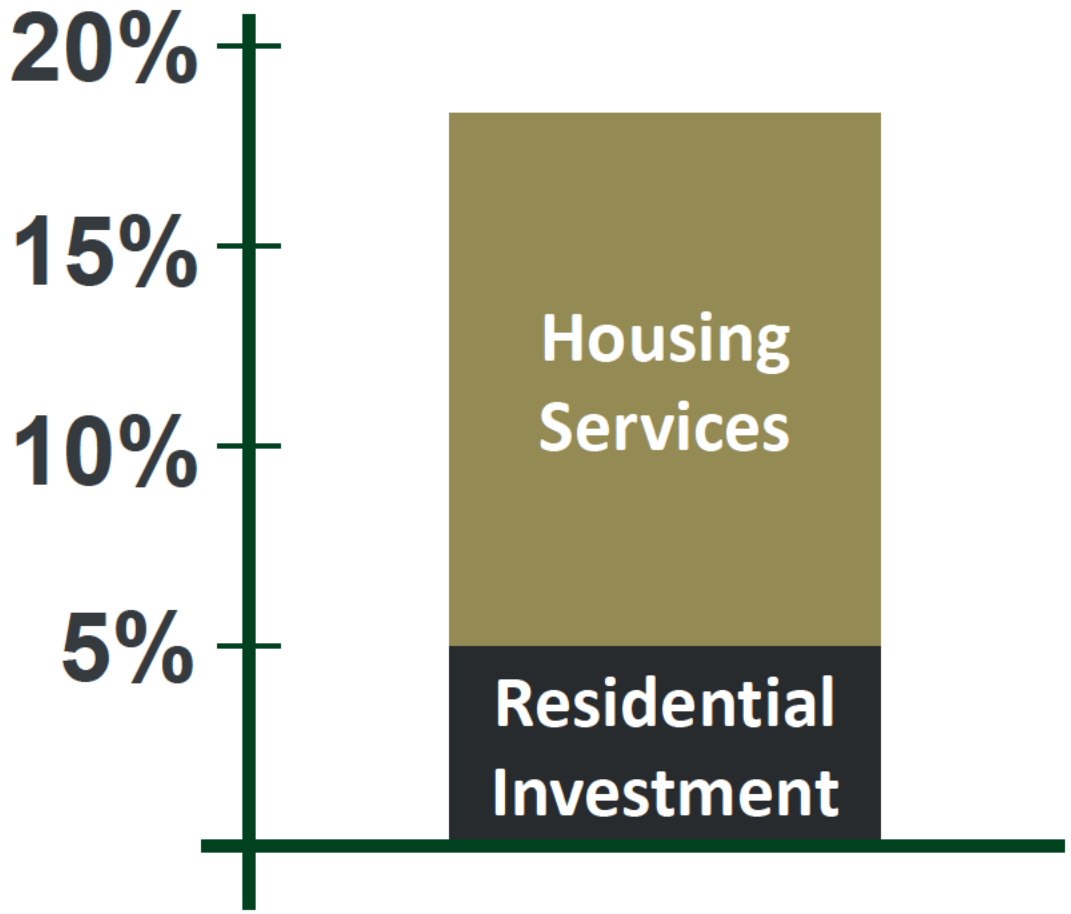
Residential Sector Accounts for more than 20% of all U.S. Energy Consumption



U.S. Energy Consumption

Why Building America Innovations

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

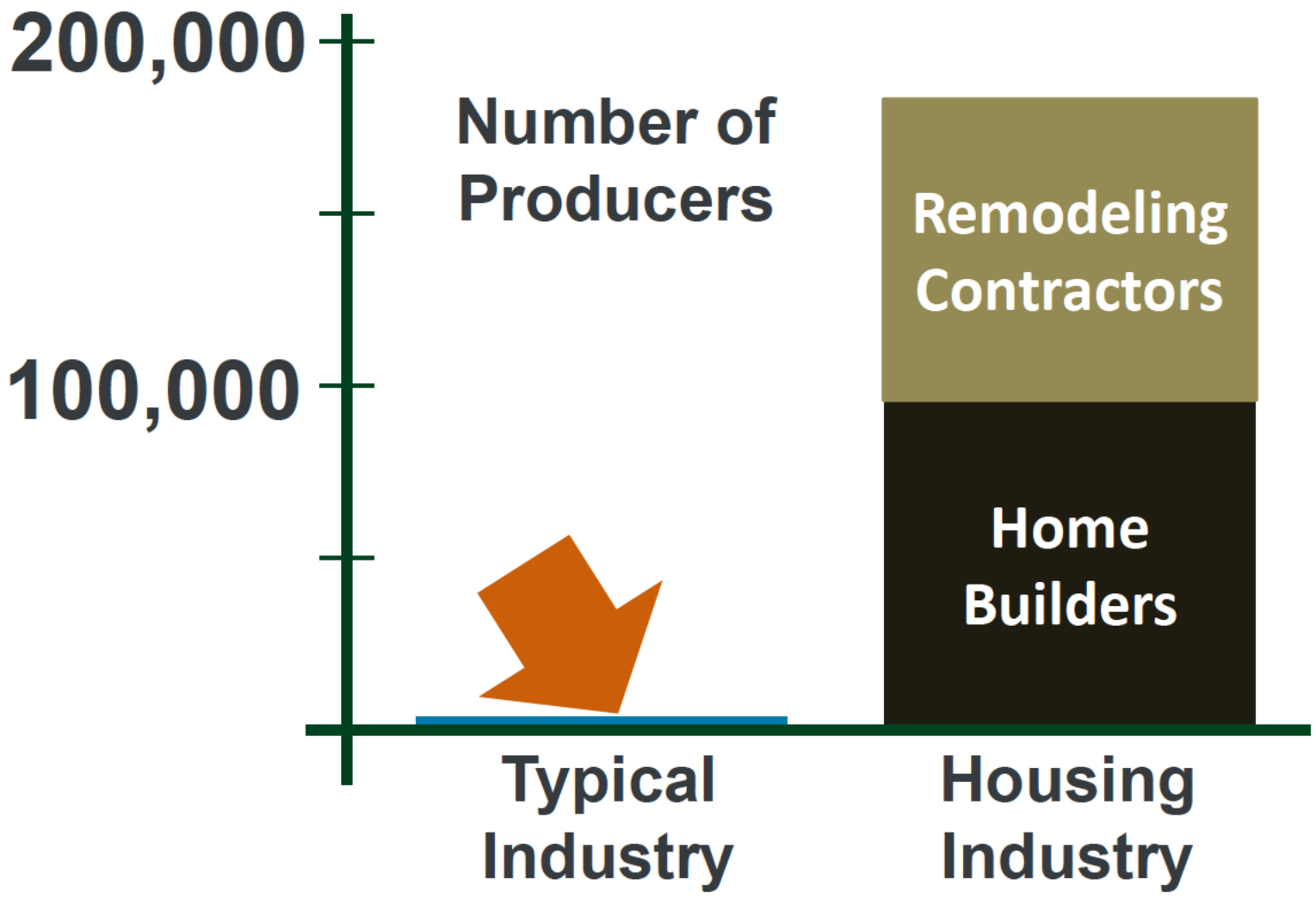


Housing Sector Percent of GNP

Source: NAHB data through Q1 2012

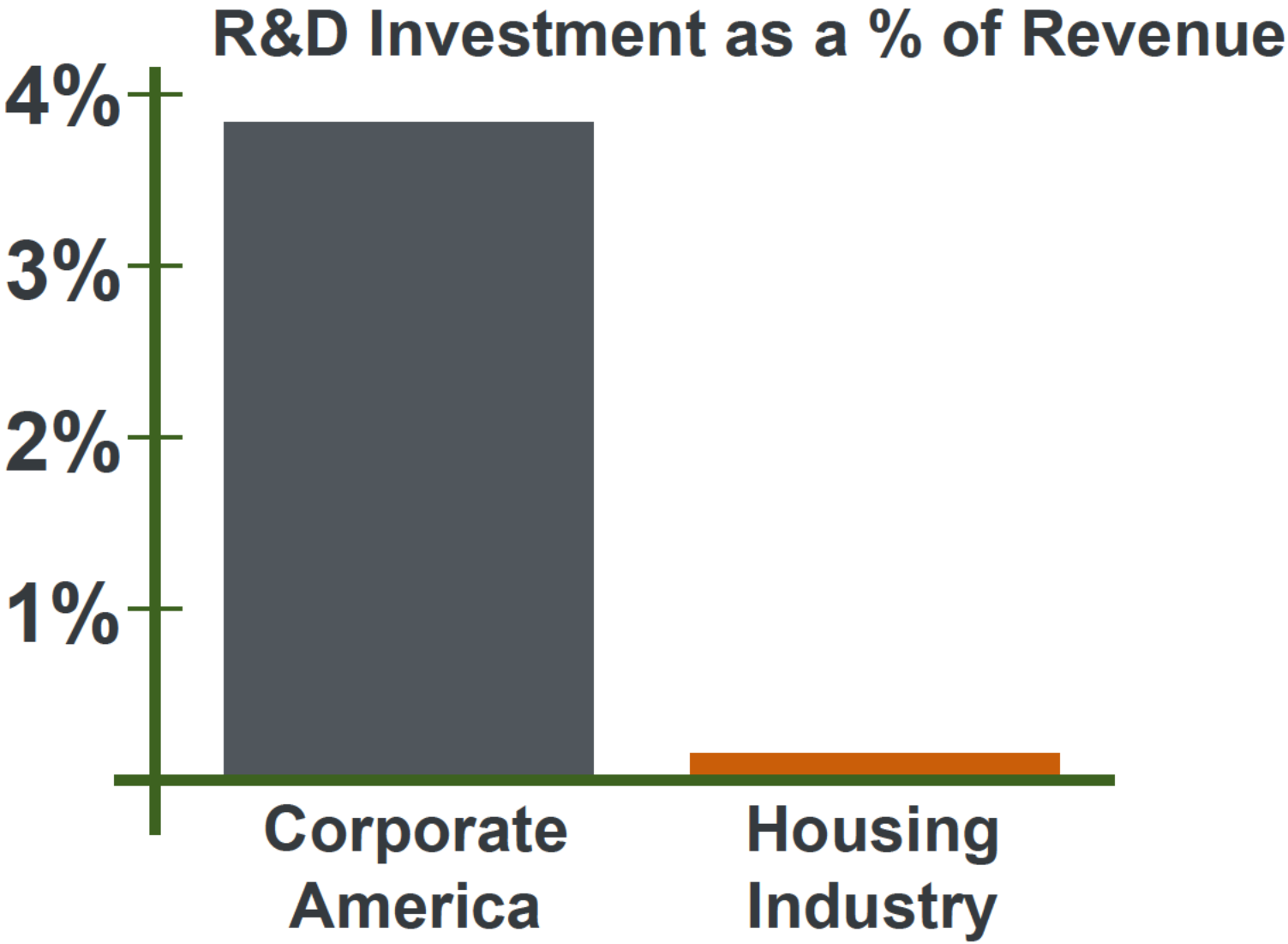
Why Building America Innovations

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



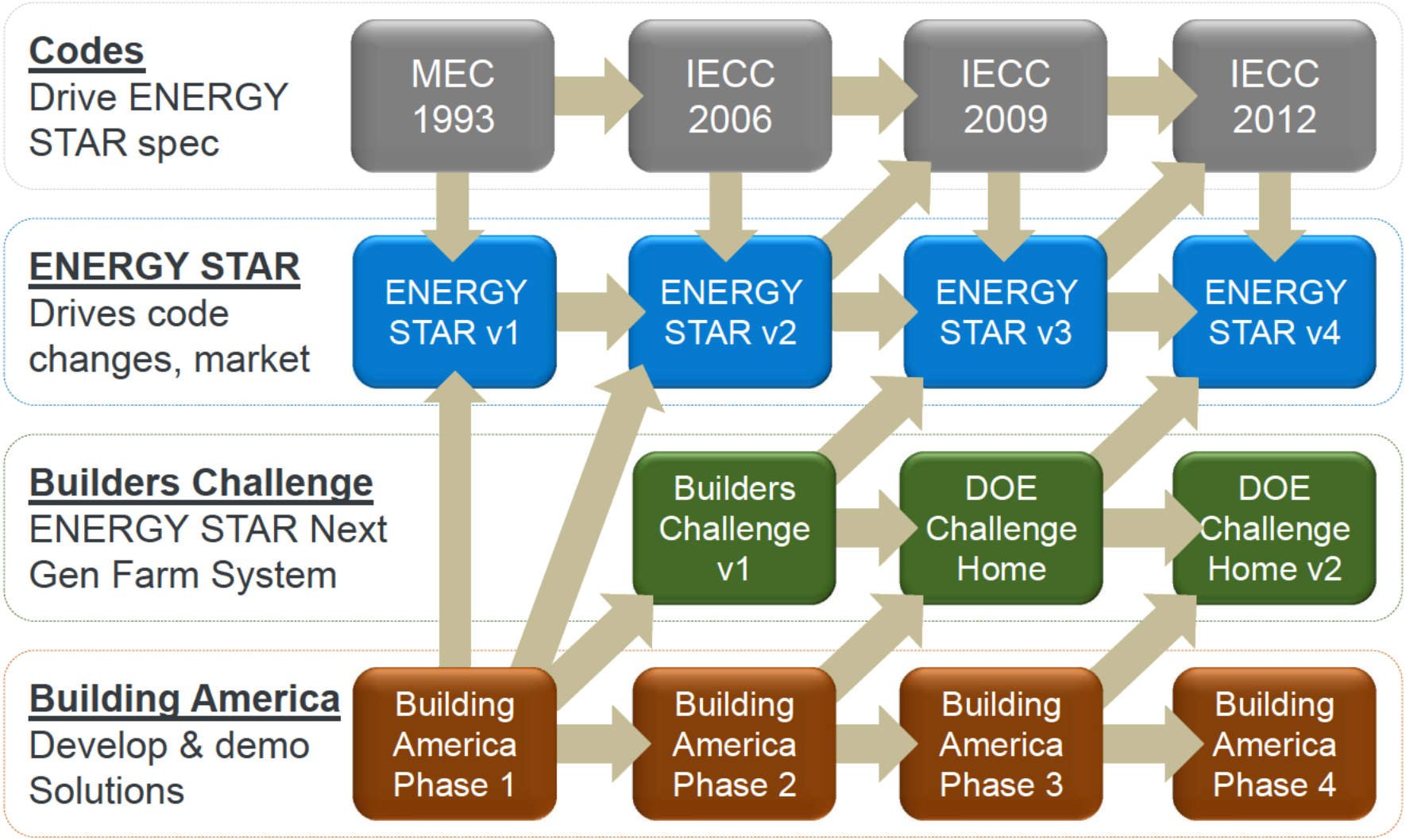
Why Building America Innovations

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



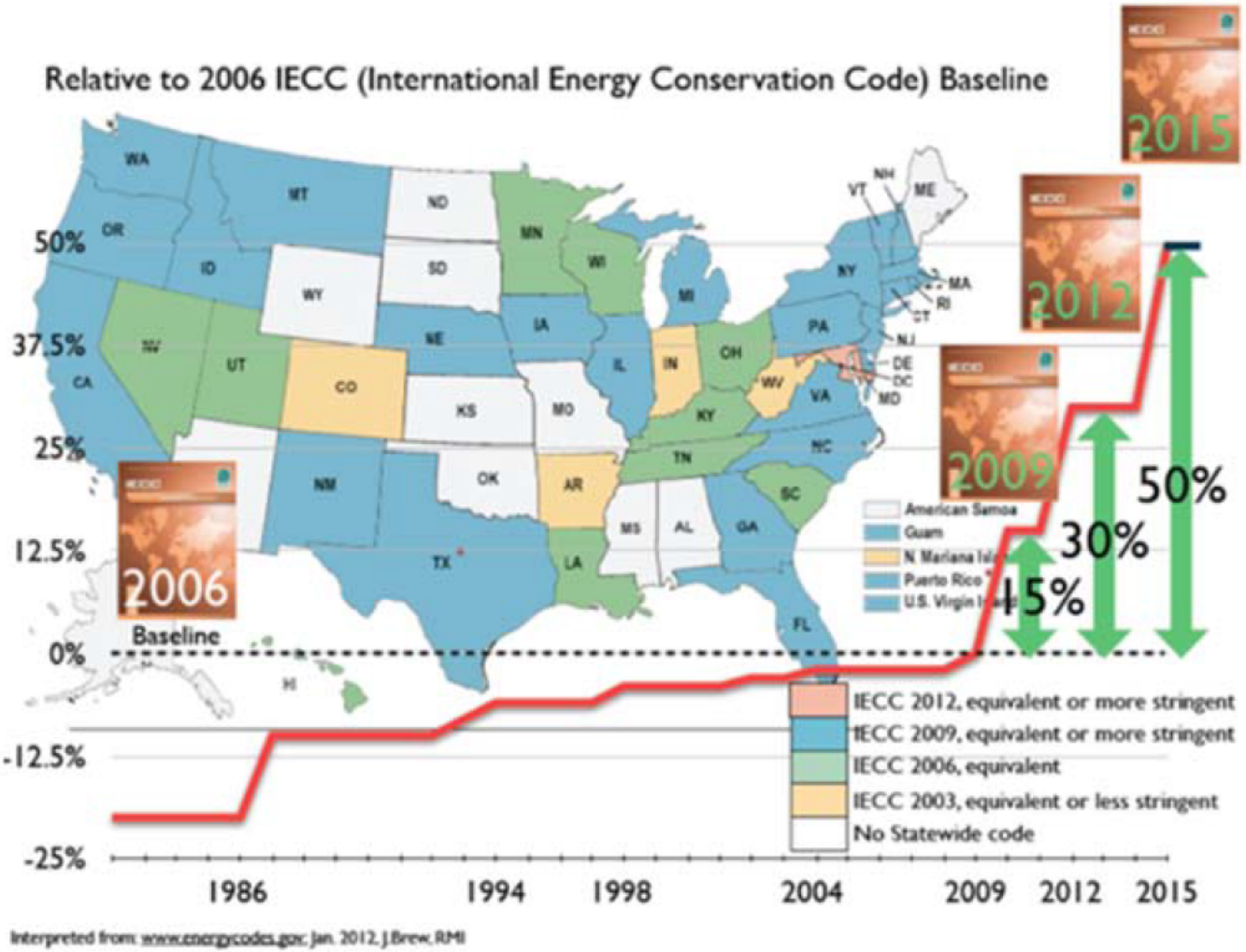
Why Building America Innovations

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



Why Building America Innovations

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

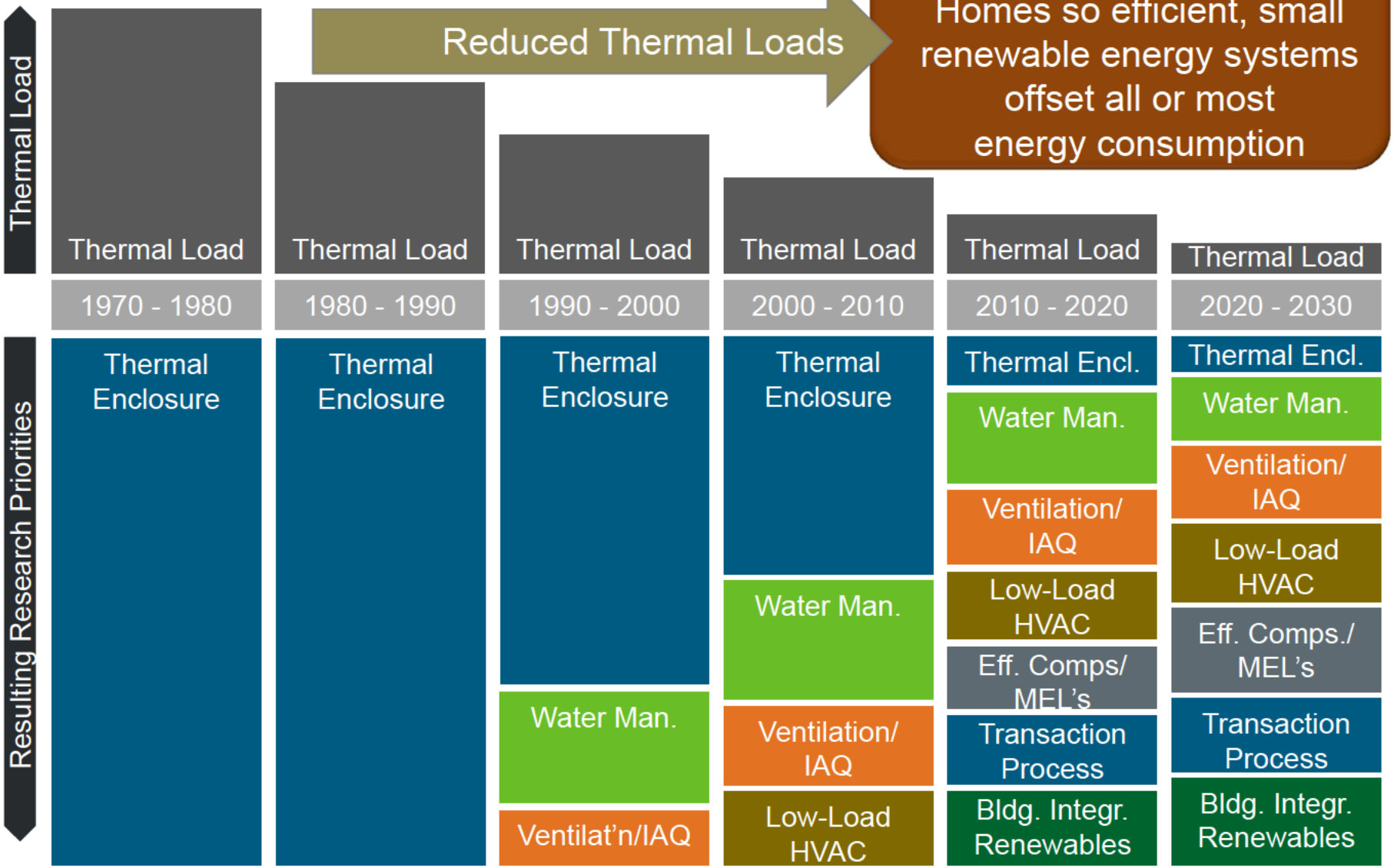


Building America Strategy

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

Goal:
Homes so efficient, small renewable energy systems offset all or most energy consumption

Reduced Thermal Loads



Building America Top Innovations 'Hall of Fame' Process

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

- Determine Criteria

Building America Top Innovations 'Hall of Fame' Criteria

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

- Building America Played a Primary Role
- Significant Real or Potential Impact:
  - Solving Critical Problem
    or
  - Capturing Significant Opportunity

Building America Top Innovations 'Hall of Fame' Process

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

- Determine Criteria
- Solicit Nominations

Building America Top Innovations 'Hall of Fame' Process

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

- Determine Criteria
- Solicit Nominations
- Research Past Documents

Building America Top Innovations 'Hall of Fame' Process

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

- Determine Criteria
- Solicit Nominations
- Research Past Documents
- Compile Complete List of BA Innovations

Building America Top Innovations 'Hall of Fame' Process

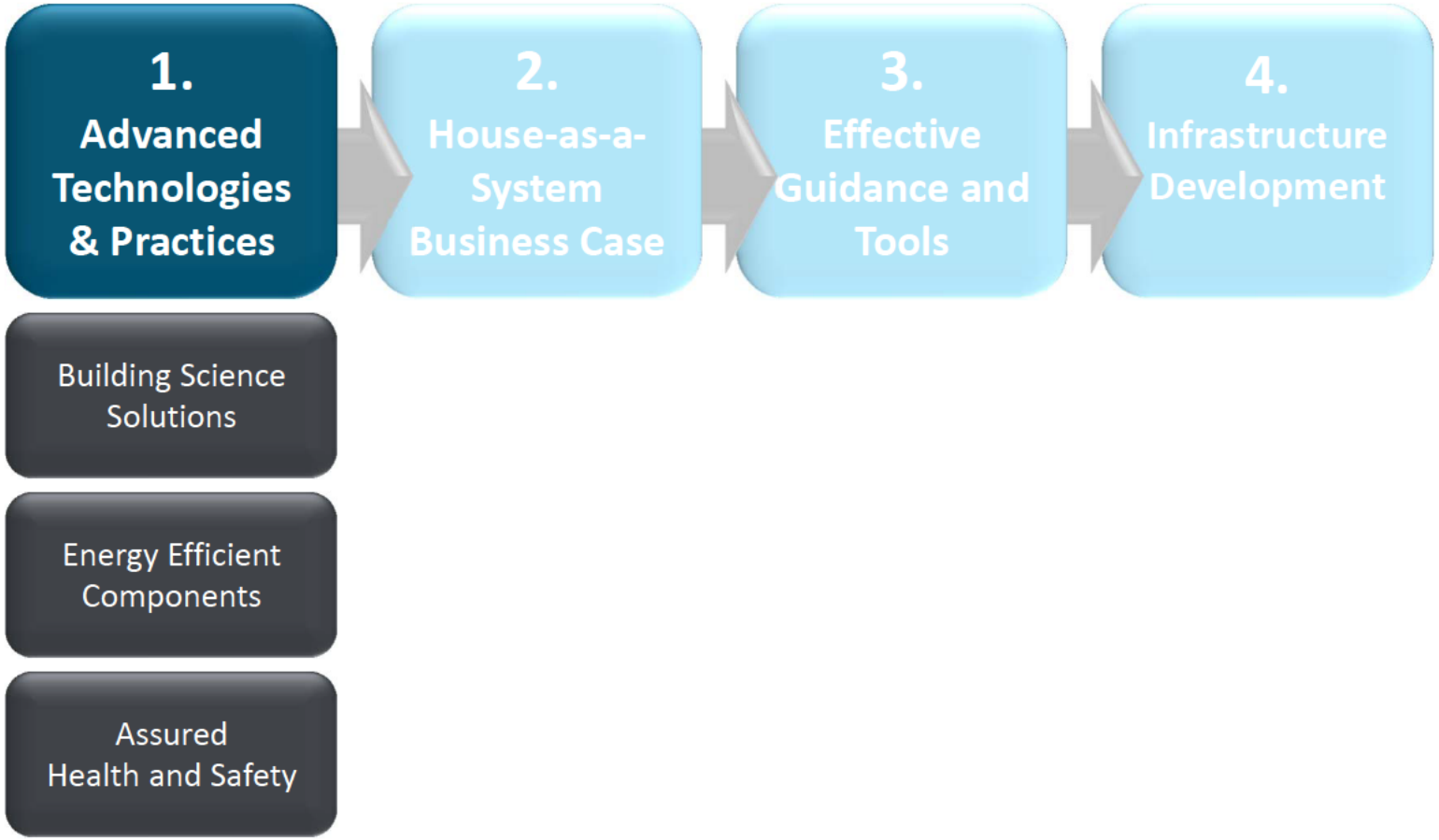
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- Determine Criteria
- Solicit Nominations
- Research Past Documents
- Compile Complete List of BA Innovations
- Identify Story (Innovations Categories)

Top Innovations Story

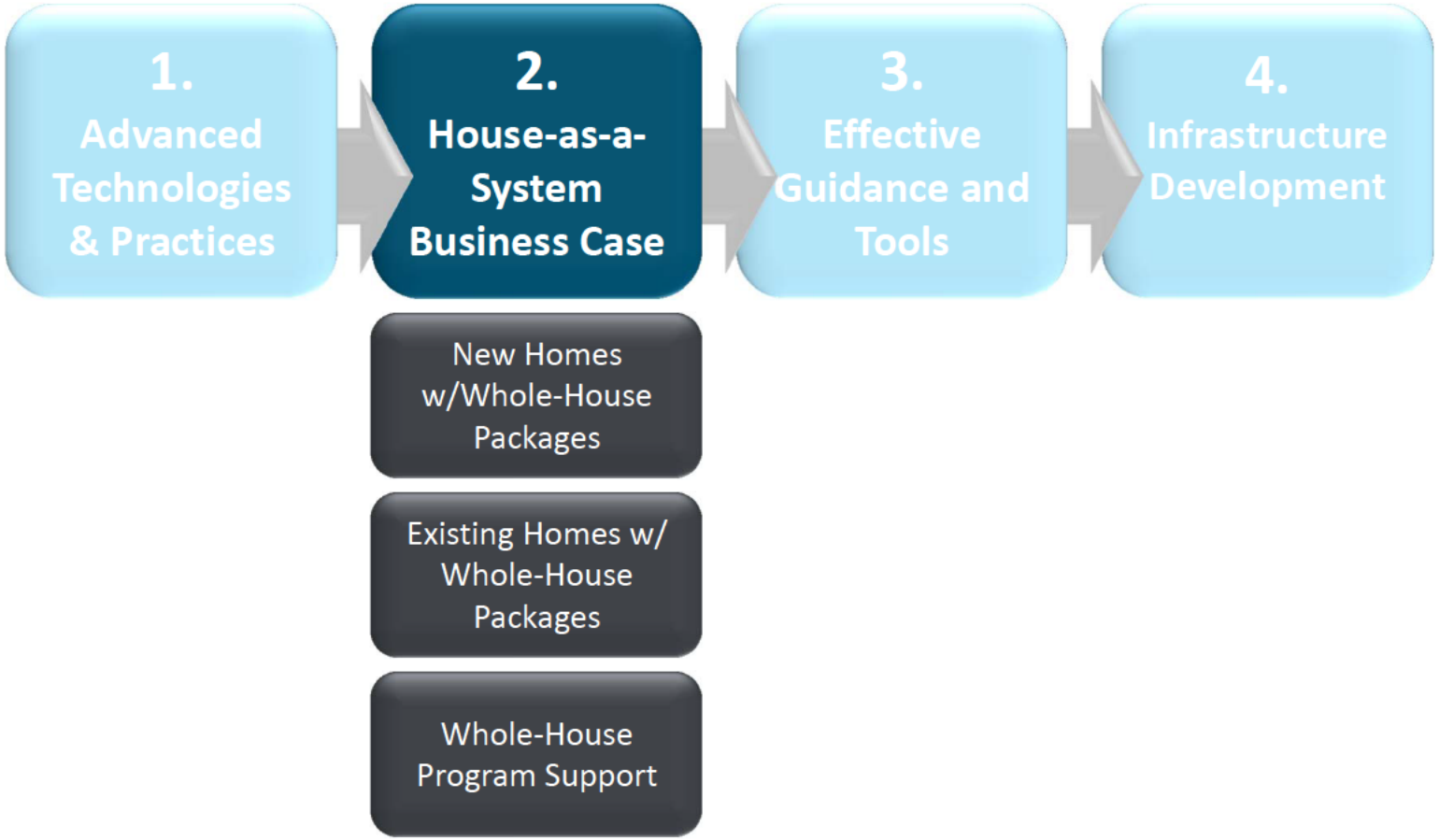
Top Innovations Story

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

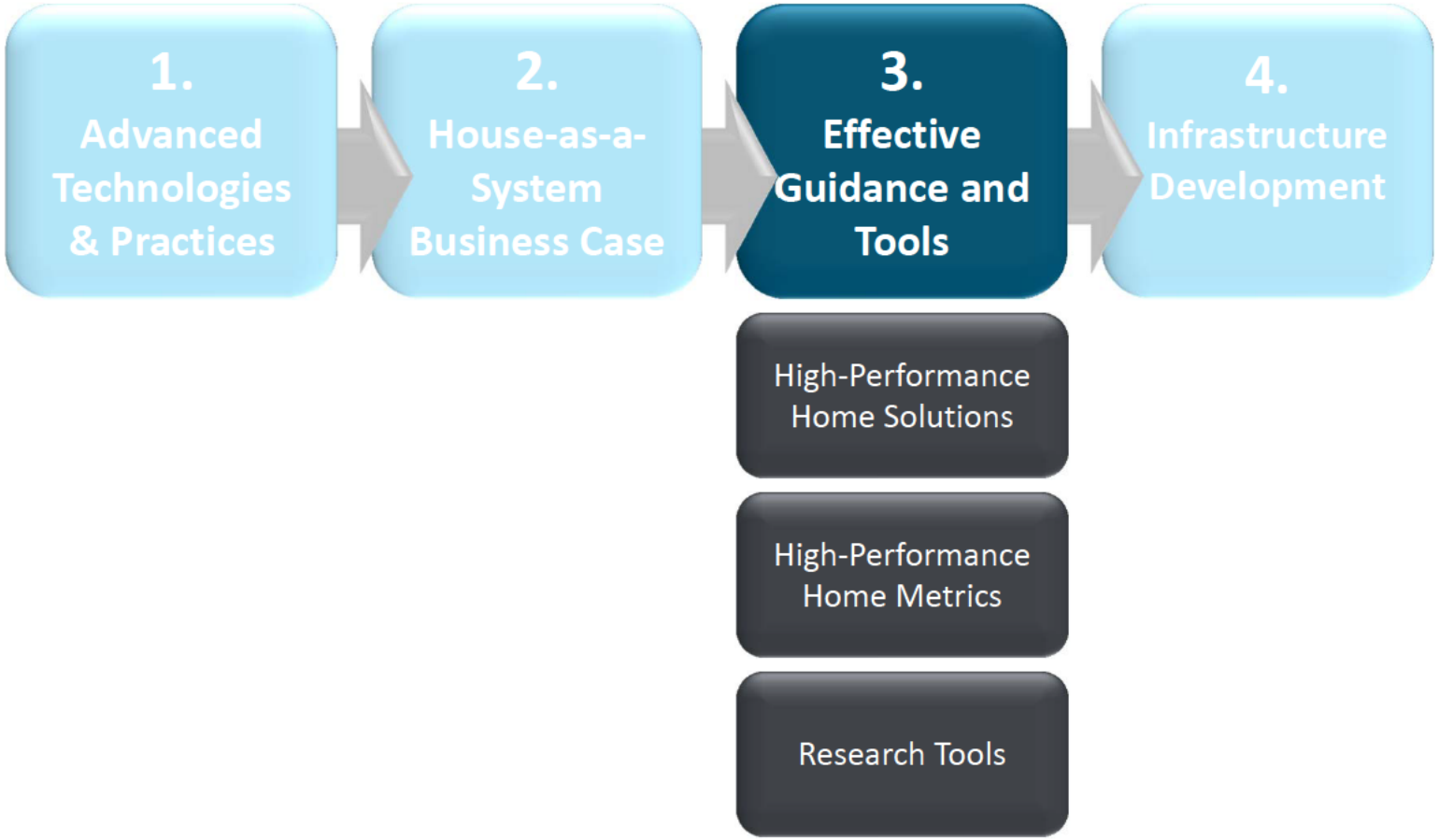


Top Innovations Story

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

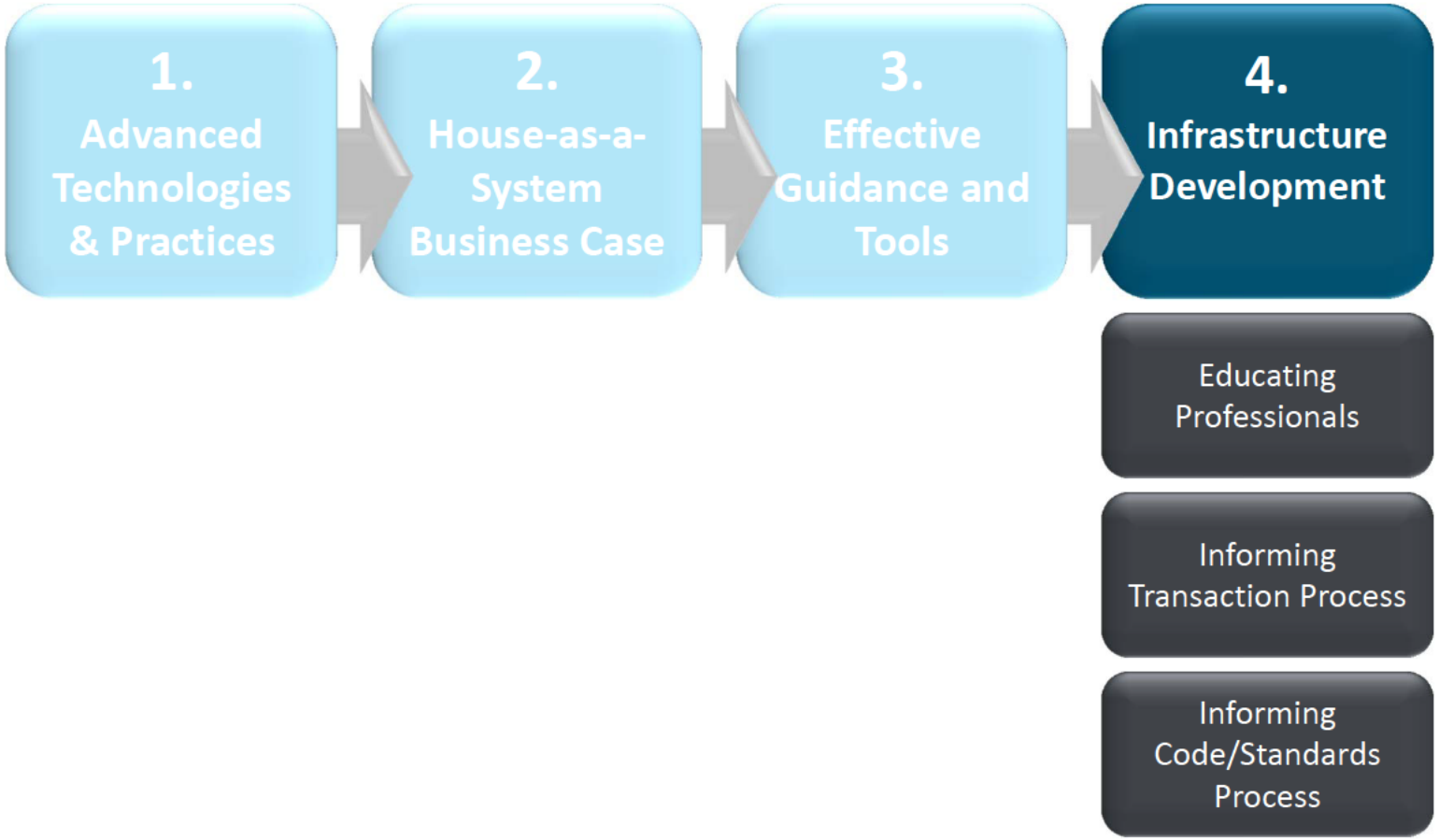


Top Innovations Story



Top Innovations Story

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



Top Innovations Story

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

Building America Top Innovations 'Hall of Fame' Process

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

- Determine Criteria
- Solicit Nominations
- Research Past Documents
- Compile Complete List of BA Innovations
- Identify Story (Innovations Categories)
- Sort Nominations

Building America Top Innovations 'Hall of Fame' Process

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

- Determine Criteria
- Solicit Nominations
- Research Past Documents
- Compile Complete List of BA Innovations
- Identify Story (Innovations Categories)
- Sort Nominations
- Select 'Hall of Fame' Innovations per Criteria

Building America Top Innovations 'Hall of Fame'

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

- Central Fan Integrated Supply Ventilation
- Simple Ventilation Systems
- Outside Air Ventilation Controller
- Tankless Gas Water Heater Performance
- Basement Insulation Systems
- Advanced Framing Systems
- Unvented Conditioned Attics
- Unvented Conditioned Crawl Spaces
- High –R Walls
- HVAC Simplified Duct Distribution
- Ducts in Conditioned Space

Building America Top Innovations 'Hall of Fame'

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

2. House-as-a-System Business Case

- ENERGY STAR for Homes support
- DOE Challenge Home

- Cost Performance Trade-Offs
- Reduced Call-Backs
- High-Performance Affordable Housing (HFH)
- Reduced Peak Demand (Premier Gardens)
- Affordable HP w/Ducts in Condit. Sp. (Artistic)
- Supply Chain for HP (Pulte, Las Vegas)
- HP in Hot-Humid Climate (Tommy Williams)
- HP w/o Increased Cost (Pulte, Phoenix)
- Community Scale HP – (Pulte, Tucson)
- Net Zero w/Quick Sale (Grupe, Sacramento)

Building America Top Innovations 'Hall of Fame'

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

- BeOPT
- Model Simulating Real DHW Use
- Energy Efficient Measures Data Base
- House Simulation Protocols (BA Benchmark)
- EEBA Builder Guides
- EEBA Water Management Guide
- Attic Air Sealing Guidelines

Building America Top Innovations 'Hall of Fame'

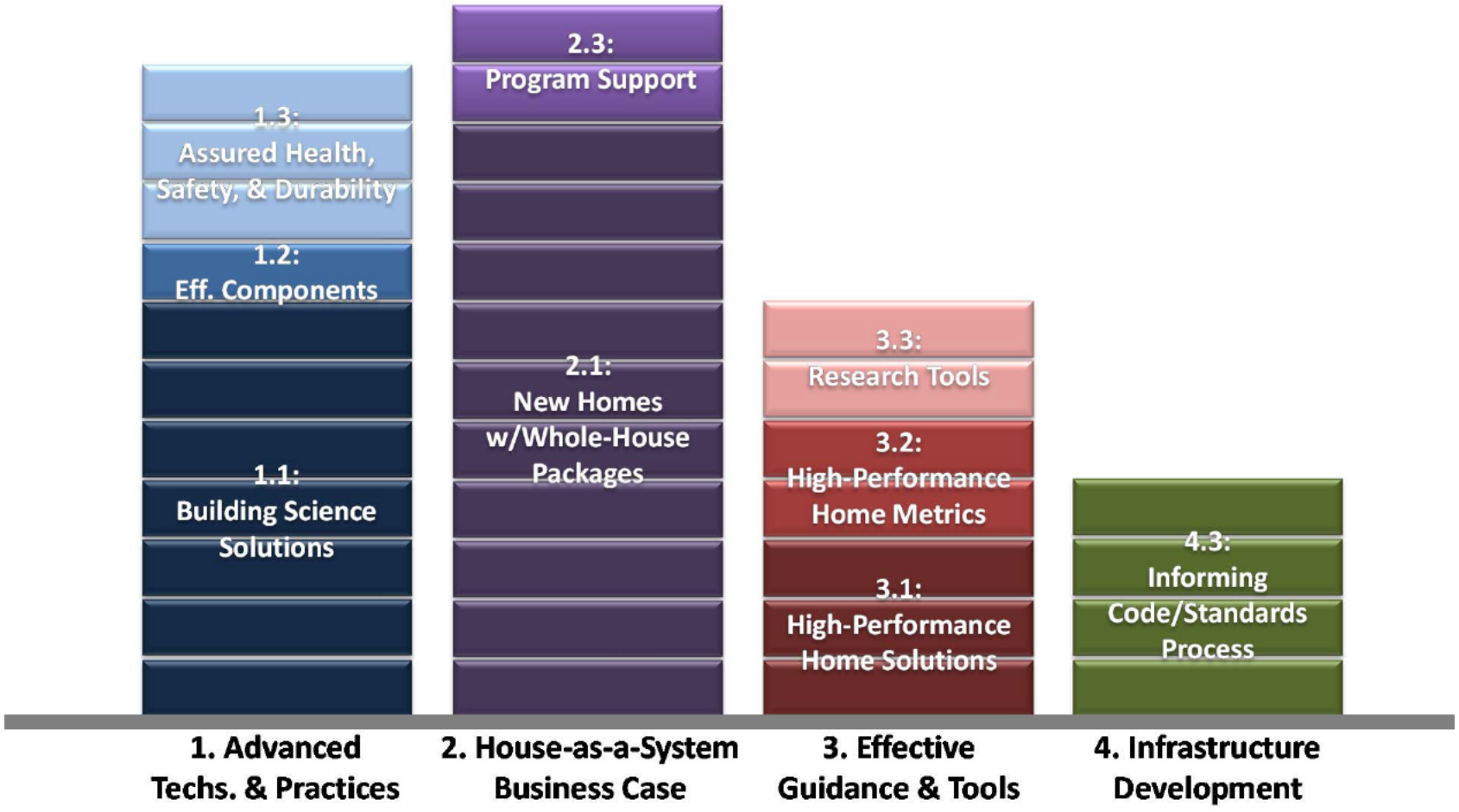
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

4. Infrastructure Development

- Building Science Based Climate Maps
- Vapor Retarder Classification
- Unvented Crawl Space I-Code Adoption
- Thermal Bypass Air Barriers in 2009 IECC

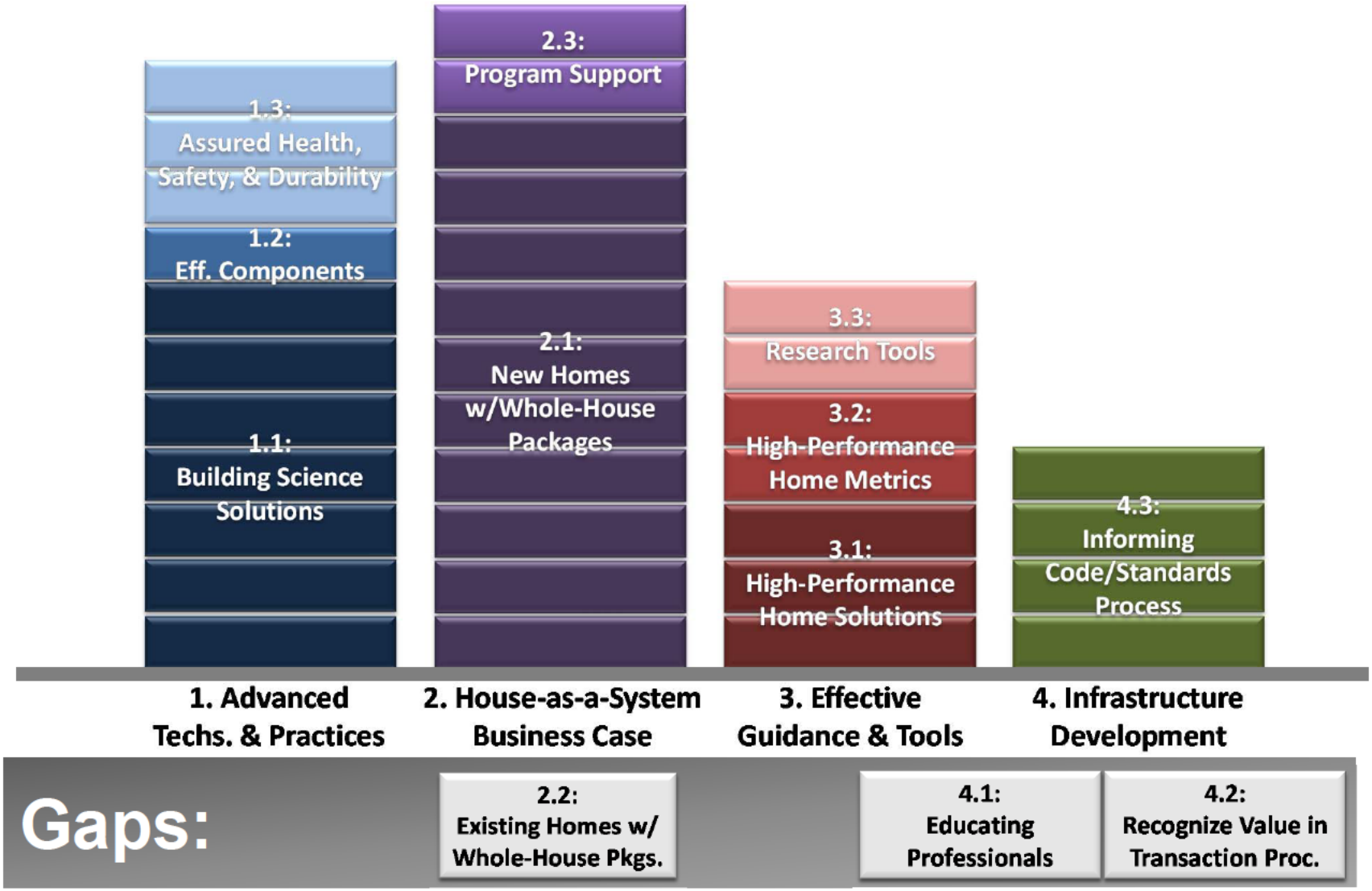
Building America Top Innovations 'Hall of Fame'

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



Building America Top Innovations 'Hall of Fame'

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



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

BUILDING TECHNOLOGIES PROGRAM

BUILDING AMERICA TOP INNOVATIONS 'HALL OF FAME' PROFILE

INNOVATIONS CATEGORY:
2. House-as-a-System Solutions
2.1 New Homes with Whole-House Packages

Reduced Peak Demand:

Premier Homes, Premier Gardens, CA

The 95 homes in Premier Gardens are equipped with photovoltaic panels that take advantage of solar energy to offset peak power loads during the hottest part of the day.

Building America's research partner ConSol worked with SMUD to analyze utility billing data and monitoring data in this project that was one of several Building America researchers have conducted involving photovoltaics.

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.

Solar photovoltaics are an attractive option for utilities because they can reduce reliance on other forms of energy and especially because they can reduce peak demand. They produce the most power on sunny summer afternoons when homes in sunny locales have the highest demand for air conditioning. Photovoltaics have been a part of several research projects conducted by the U.S. Department of Energy's Building America and its research partners. In 2007, Building America produced a best practice guide for builders, Solar Thermal & Photovoltaic Systems, that includes case studies of 13 of these projects. One case study describes Premier Homes, who worked with Building America and the Sacramento Municipal Utility District (SMUD) on a large solar home project in Sacramento, California.

In 2004, two energy-efficient neighborhoods in Rancho Cordoba, California, were built side-by-side and monitored for electricity use by the Sacramento Municipal Utility District (SMUD). The two sets of homes were nearly identical in size and price, and both exceeded the California Title 24 energy cooling requirements by as much as 30%. However, only one set of homes, known as Premier Gardens, was equipped with solar photovoltaic panels to generate electricity.

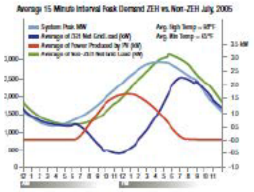
During the course of a year, the 95 solar-equipped houses, built by Premier Homes of Sacramento, drew an average of 13% less power from the grid than the 98 homes in the other neighborhood. The more impressive fact is this: In July 2005, the area's hottest July on record, the solar-equipped homes had a peak energy demand that was 75% lower than their neighbors'. Reducing peak energy demand can reduce the likelihood of rolling blackouts when summer temperatures soar. It's also attractive for customers who pay more for electricity during peak demand times.

Premier Homes worked with the U.S. Department of Energy's Building America program to develop an energy efficiency package for the homes in Premier Gardens. ConSol, a Building America research partner, performed energy analyses to determine the most cost-effective components.

"The ability of solar to level out air conditioning-driven peak demand makes it a desirable investment for utilities and for consumers."

Bruce Baccei, ConSol

BUILDING AMERICA TOP INNOVATIONS 'HALL OF FAME' PROFILE



In July 2005, outdoor temperatures reached 98°F and air conditioners ran full force, yet the solar-equipped homes' net electricity demand (dark blue) actually dropped during the hottest part of the day. The red line shows the average power being produced by the solar systems in Premier Gardens. In contrast, the power demand of the neighboring, energy-efficient community (green) and the average system demand (light blue) rose steadily during the day.

Premier Homes chose photovoltaic tiles that lie on the roof shingle-fashion and blend in with the concrete roofing tiles.

"The first step in designing a near zero-energy home is to significantly reduce the home's overall energy use," said Rob Hammon of ConSol. "This enables the home builder to install a smaller, less expensive PV system to meet the home's electrical needs."

When both neighborhoods were completed, SMUD monitored the homes and collected three sets of data. It tracked the electric bills of all 193 homes, tracked electric consumption in 15-minute intervals in 18 homes in each neighborhood, and tracked solar power production in the 18 Premier Gardens homes. ConSol analyzed the data.

In July 2005, outdoor temperatures reached 98°F and air-conditioners ran full-force, yet the solar-equipped homes' demand for power actually dropped during the hottest part of the day (see graphic).

"The ability of solar to level out air conditioning-driven peak demand makes it a desirable investment for utilities and for consumers," said Bruce Baccei of ConSol.

Overall, the solar panels produced about 10% more power than expected. Each home's 2.2-kW photovoltaic system produced about 3,330 kWh during the 12 months studied, about half the average consumption of each household (7,007 kWh). Premier Homes chose to install photovoltaic tiles that are similar in dimension to cement roof tiles. The PV tiles lay on the roof shingle-fashion to blend with the roofing.

The homes' other energy-efficient features include a tankless, on-demand water heater, a 91% AFUE furnace, and a correctly sized SEER 14 air conditioner. Ducts are tightly sealed and buried in the R-38 attic insulation. The high-efficiency windows are vinyl-framed and spectrally selective. Walls are insulated on the inside with R-13 batts and sheathed on the outside with 1-inch rigid foam insulation instead of house wrap.

The entire energy efficiency package, including solar tiles, cost $10,000 to $15,000, but financial incentives from SMUD helped keep the solar systems cost-effective for homebuyers. SMUD contributed about $7,000 per home toward the cost of each PV system. Premier Homes offset the remaining cost by including fewer high-end aesthetic features, such as granite countertops, so the homes would sell at a price comparable to the neighboring homes.

Premier Homes offered photovoltaics as a standard feature on several developments after Premier Gardens was completed. SMUD continues to conduct research and demonstration projects for energy efficiency.

KEY ENERGY-EFFICIENCY MEASURES

Envelope:
- Attic: R-38 insulation
- Walls: R-13 batt insulation , plus 1-inch rigid foam exterior sheathing insulation
- Windows: Vinyl-framed, spectrally selective (U=0.33-0.37, SHGC=0.32-0.35)

HVAC:
- Furnace: 0.91 AFUE gas
- Air conditioner: SEER 14
- Ducts: R-4 insulation, duct-blaster tested, buried in attic insulation

Solar, Lighting:
- Photovoltaic system: 2-kW GE Energy AC
- Water Heater: Tankless, on-demand
- Lighting: 100% CFLs

REFERENCES

Baechler MC, TL Gilbride, KA Ruiz, HE Steward, and PM Love. 2007. *Building America Best Practices Series, Volume 6: High-Performance Home Technologies: Solar Thermal & Photovoltaic Systems.* NREL/TP-550-41085; PNNL-16362, Prepared by Pacific Northwest National Laboratory for the U.S. Department of Energy. http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/41085.pdf

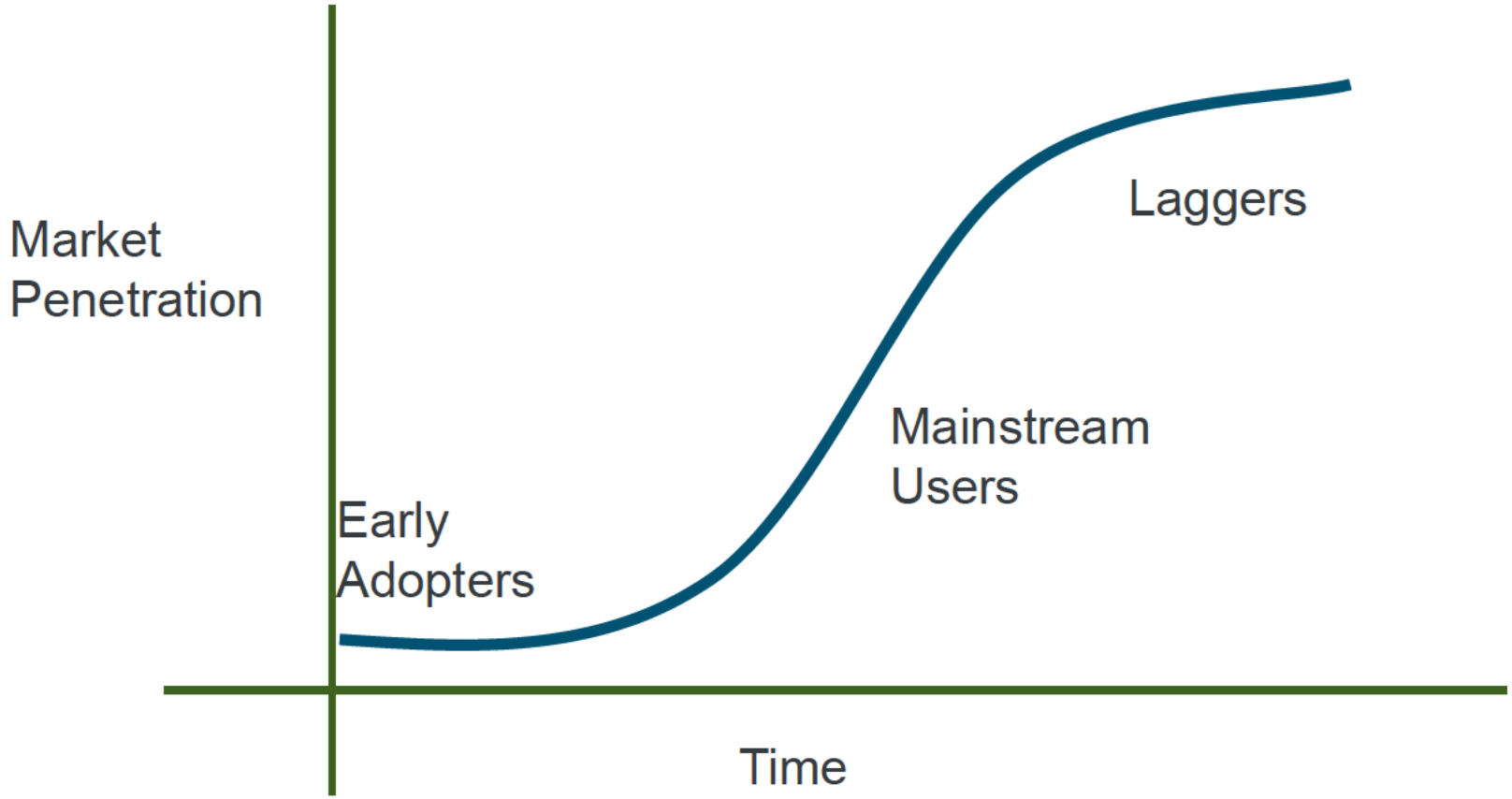
U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy

DOE Building Technologies programs
www.buildings.gov
Building America Solutions Center
www.buildingamerica.gov/solutionscenter

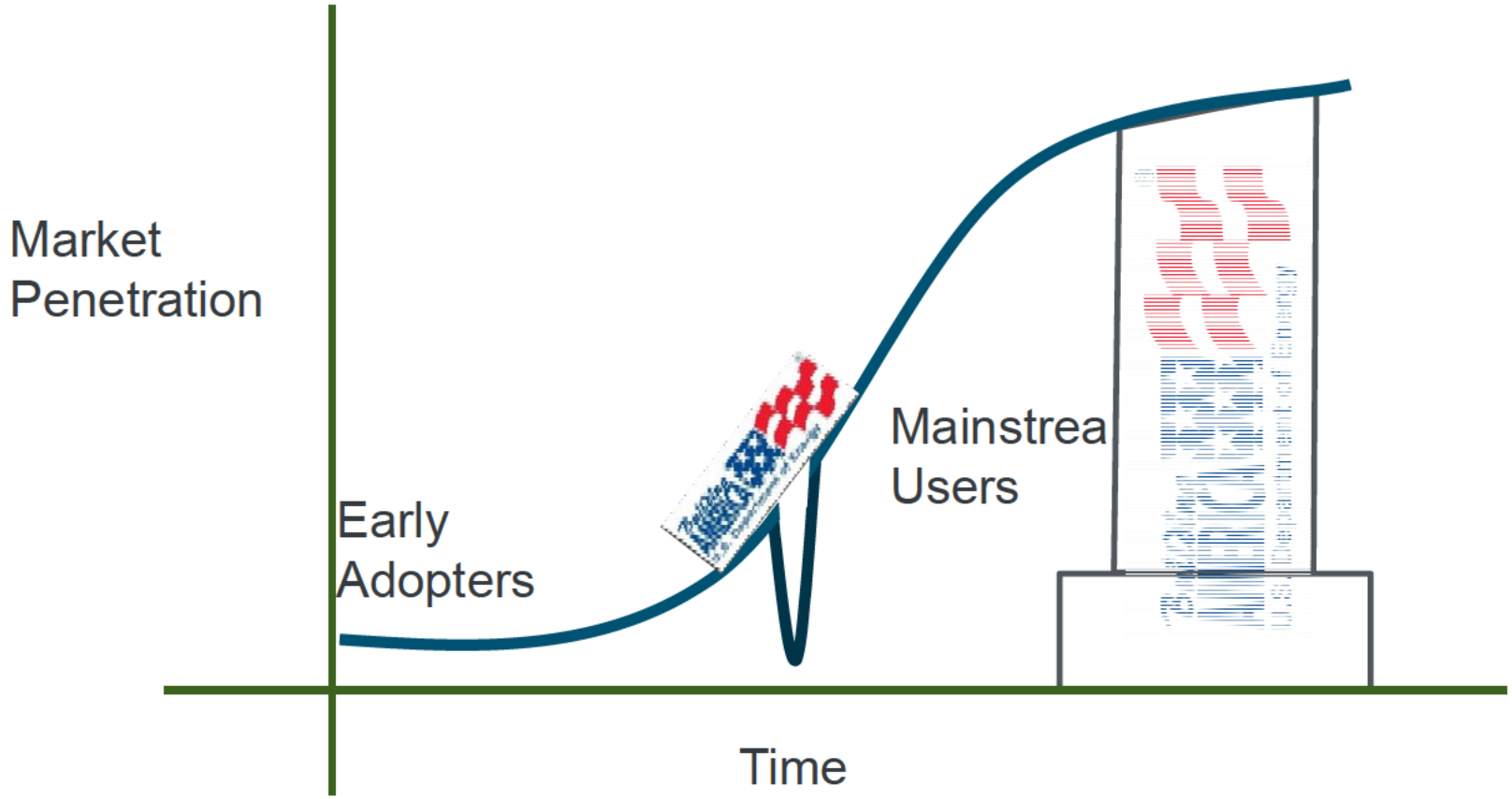
PNNL-SA-XXXXX DRAFT July 2012

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

ENERGY STAR for Homes Support



ENERGY STAR for Homes Support



Solar Decathlon Venue:

- DOE Challenge Home
- Home Performance with ENERGY STAR
- Building Science Educator of the Year
- **Building America Top Innovation of the Year**

Solar Decathlon 2011

- 2 billion media impressions
- 250 articles in 150 publications
- 500 television interviews
- 300 media check-ins onsite
- 6 million web site page views
- 600,000 YouTube channel views
- 350,000 house visits by public

Final Word on Top Innovations…

Building America is a critical research initiative for the housing industry that has yielded transformative innovations…

It's time to tell that story consistently and effectively.

Thank You

Questions?

For More Information:

http://www1.eere.energy.gov/buildings/challenge/

e-mail Contact:

builderschallenge@newportpartnersllc.com