



U.S. Department of Energy
Energy Efficiency and Renewable Energy



Building America Leading the Path to Affordable Net Zero Homes

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U.S. Department of Energy
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What is Building America?

Building America is a national residential systems research test bed sponsored* by the US Department of Energy with the goal of developing marketable designs for homes that produce as much energy as they.

* All building construction and material costs are provided as cost share by industry partners



Program Goals

- Develop designs for homes that produce as much energy as they use by 2020
- Increase comfort and air quality
- Improve quality
- Improve durability and resale value
- Community wide solutions that minimize the environmental impact



Building America's Industry Teams

*Industry
Teams*

Team Members Include:

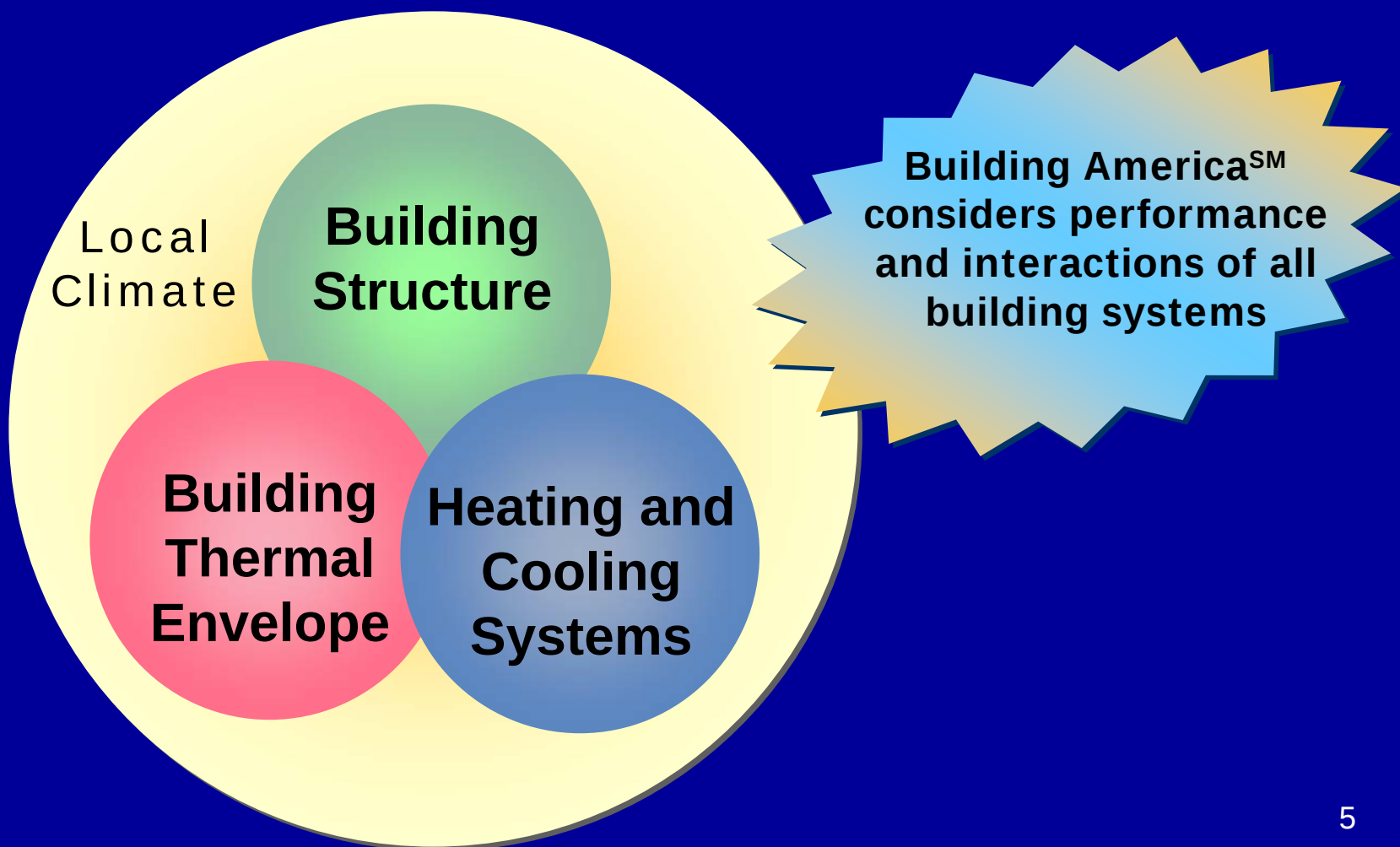
**DOE Building America
System Research**
(www.buildingamerica.gov)

- Material Suppliers
- Designers
- Developers
- Utilities
- Manufacturers
- Lead Builders

Technology Centers

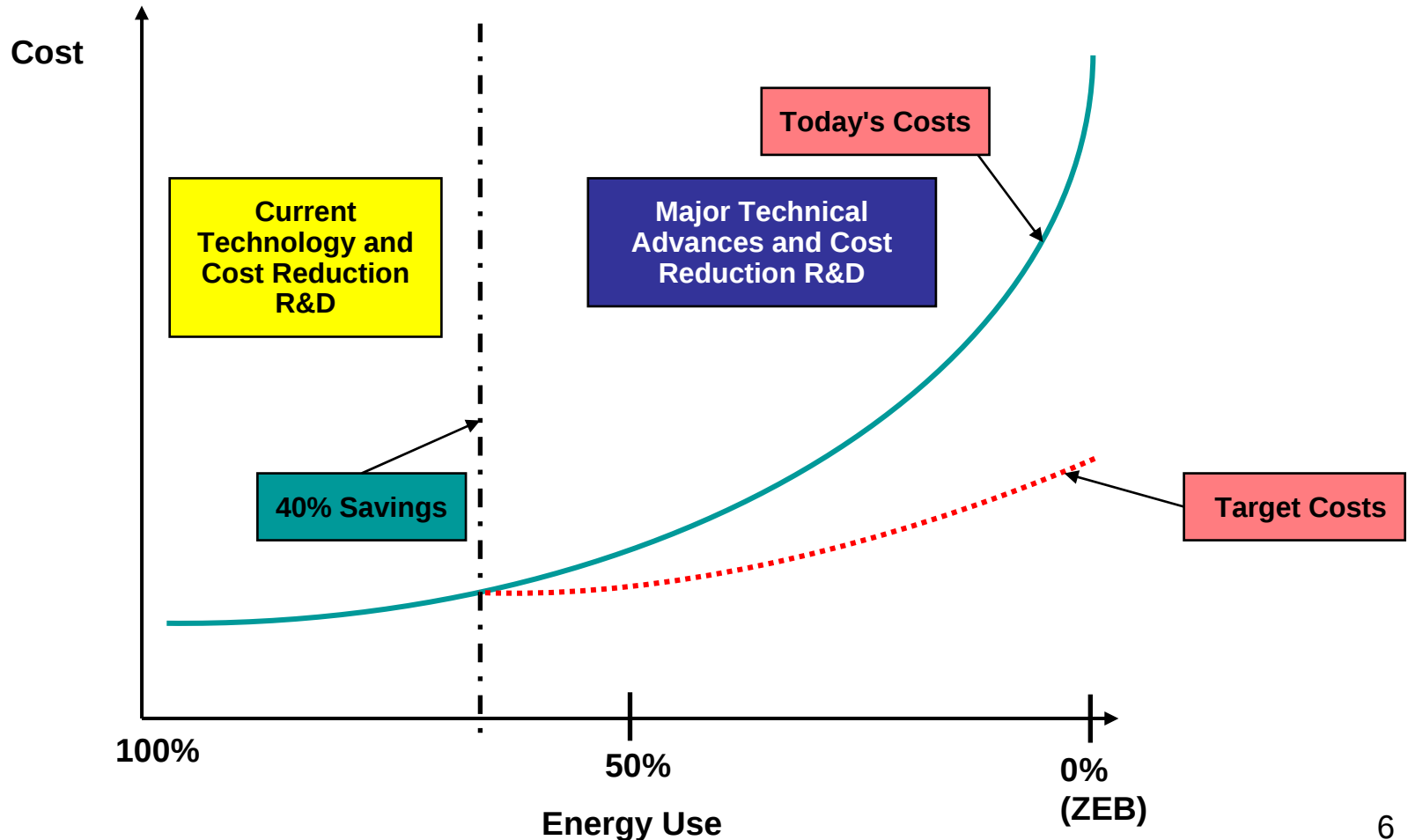


Whole-house Approach



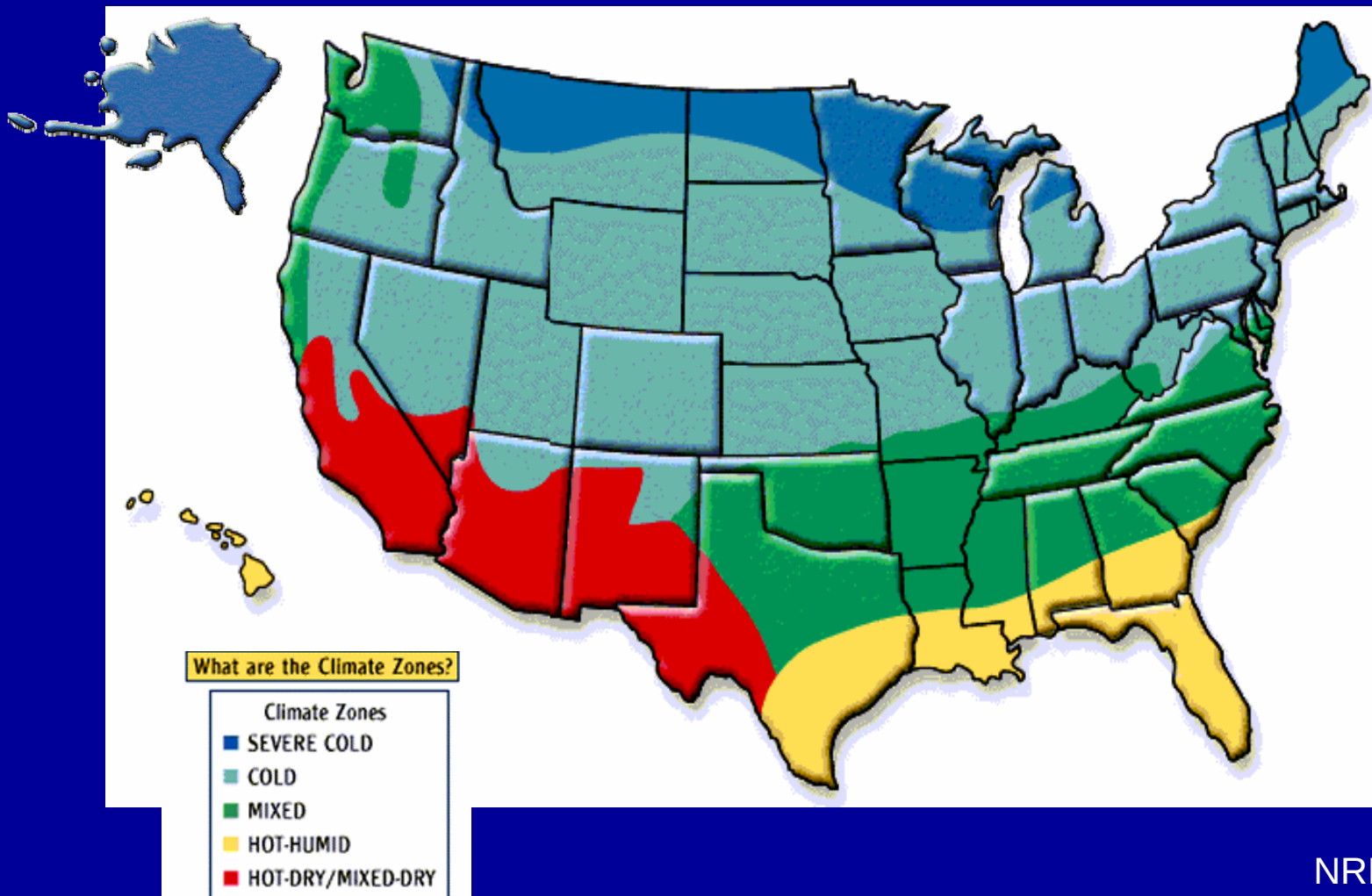


Moving to ZEB will require significant technical advances to meet performance and cost targets





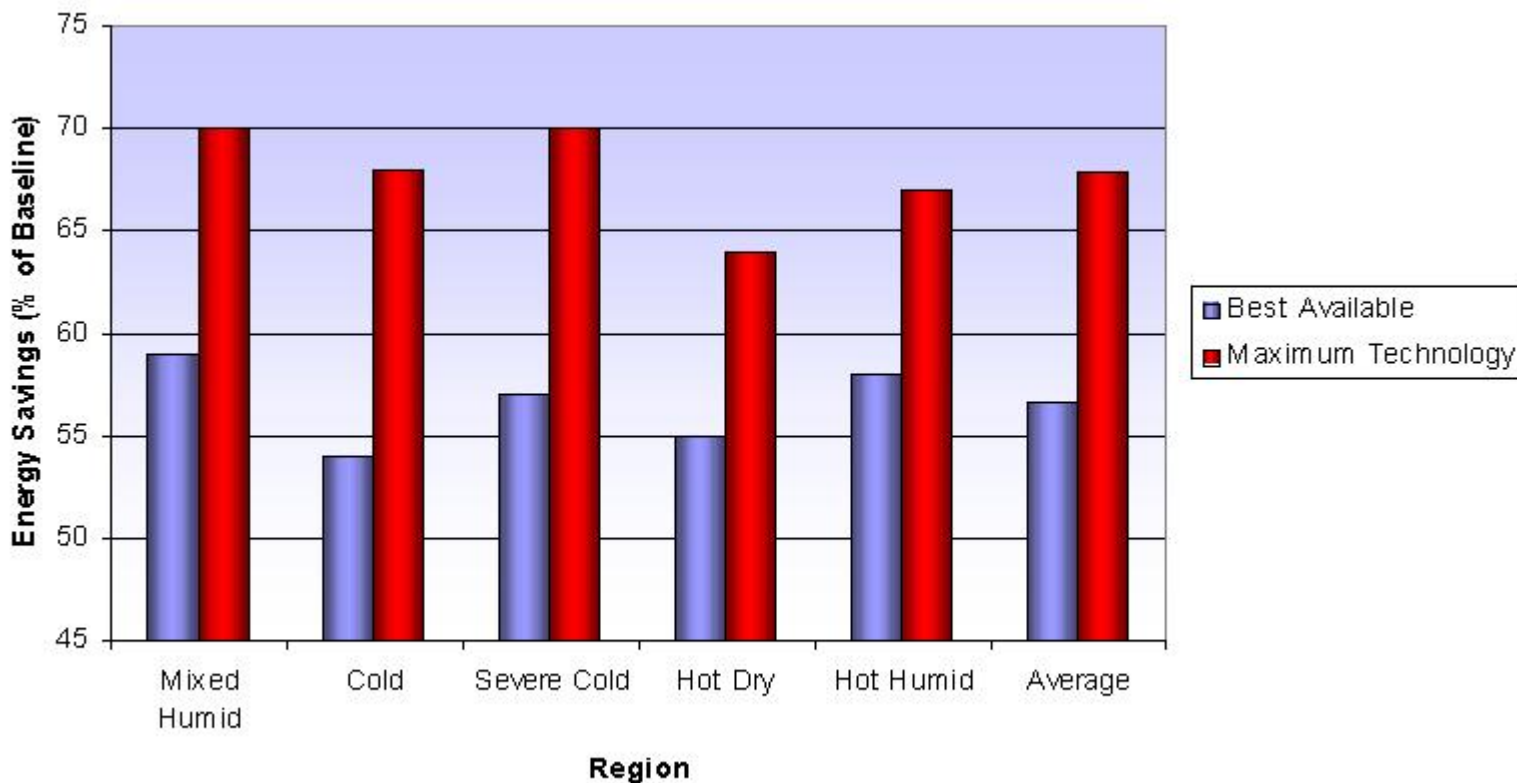
Systems Engineering Research Consider Moisture and Thermal Climate Zones





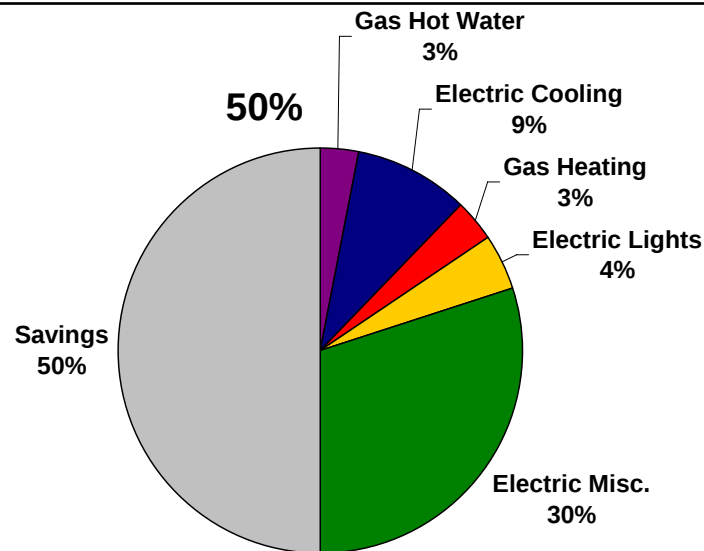
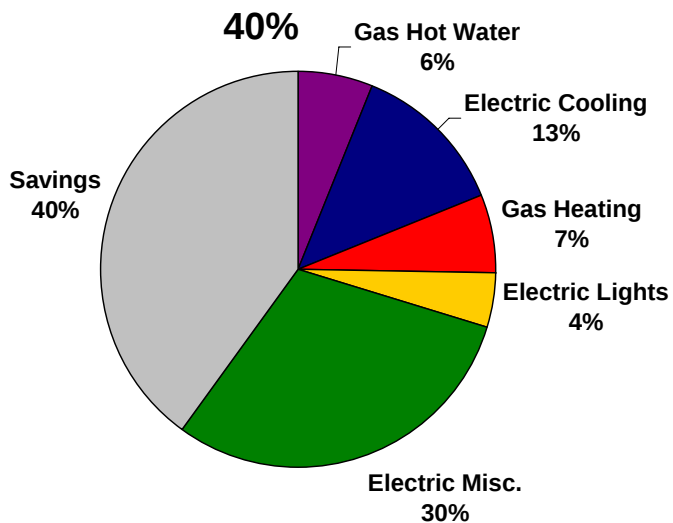
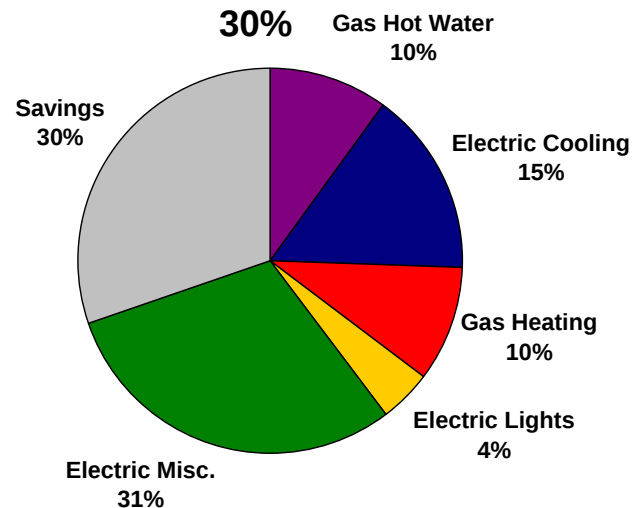
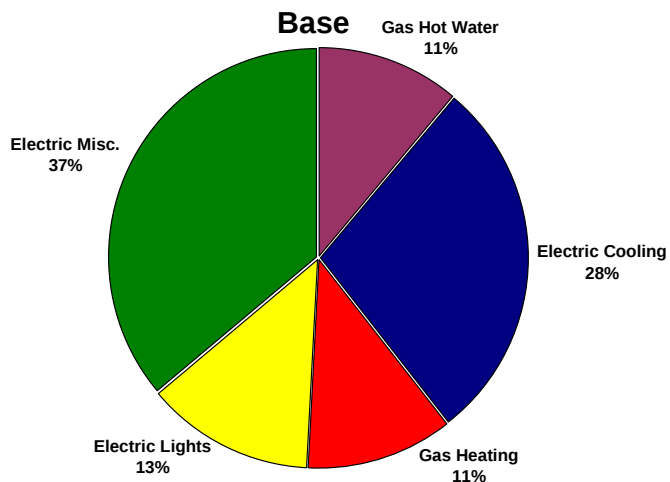
Residential Optimization Model

For all five regions, the average energy reduction attainable was 57% with best available technologies and 68% with maximum technologies.



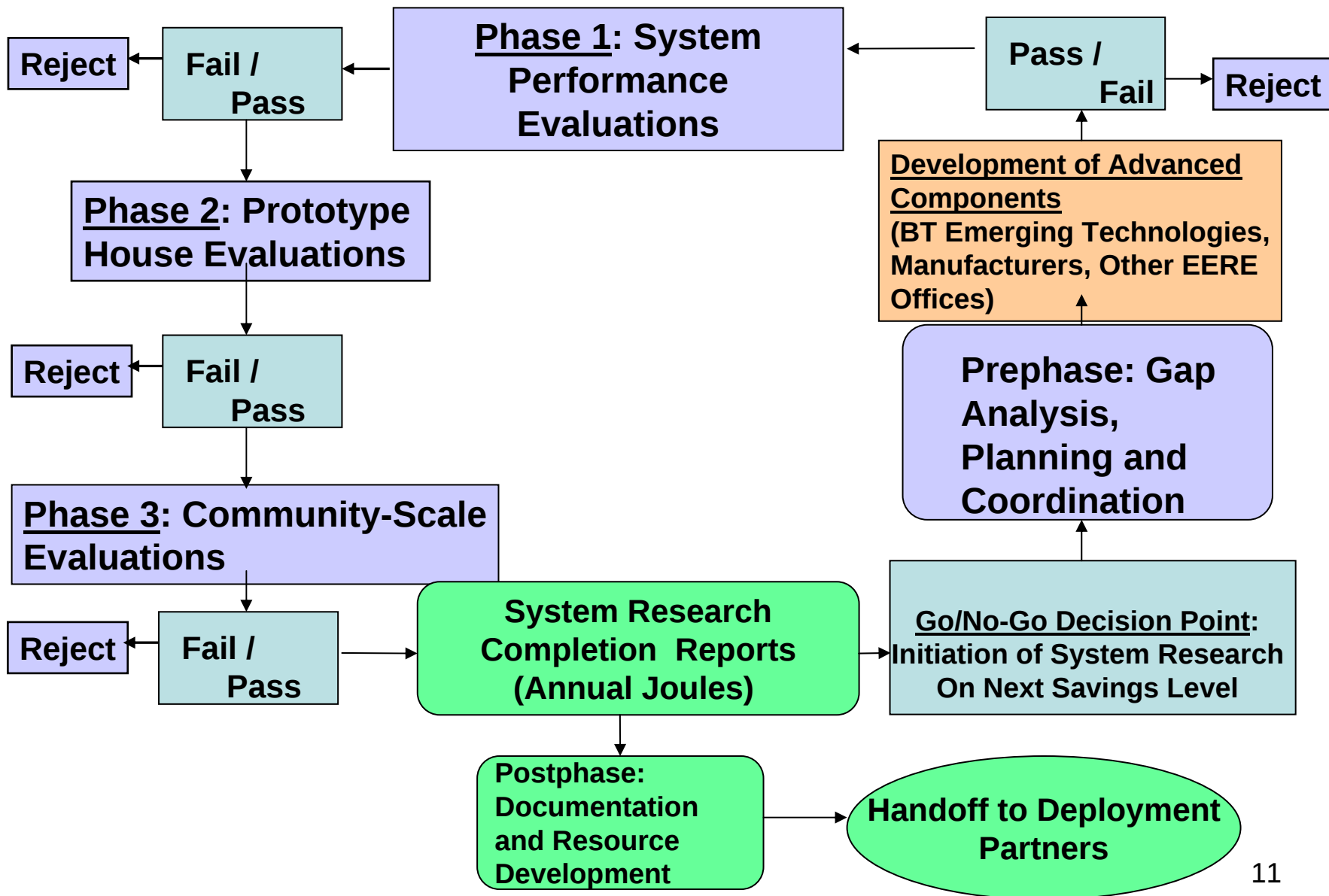


Projected hot humid climate residential energy savings





				
	Current Home	Energy Star Home	2002 ZEH	2020 ZEH
Size (sq ft)	2200	2200	2200	2500
Typical Cost/ Incremental Cost	\$235,000	No Incremental Cost	\$75,000 over comparable conventional costs	\$20,000 over comparable conventional costs
Kwh/day Consumption	58 kwh/day	49 kwh/day	25 kwh/day	15 kwh/day
Renewables	0	0	50% Solar Hot Water 6 KW of PV	100% Solar Hot Water/Space Heating 3-4 KW of PV
Percentage from Grid	100%	100%	30%	0





About 20,000 high performance production homes, but how?

- In general, we focused on:
 - Identifying break points & creating meaningful cost trade-offs
 - Solving builder warranty & liability problems
 - Creating market differentiation
- Applied building science was the engine driving this train



System Trade-offs Summary

- HVAC downsizing (driven by right sizing, simplified ducts, and reduced loads of better windows) “finance” better windows
- Advanced framing lumber savings “finance” increased levels of insulation and air sealing
- These trade-offs are often, but not always, about cost neutral
- For Example:



Building Science Consortium Copper Moon

1,618 sq ft



Features

- Unvented cathedral attic
- Low-E² spectrally selective windows
- Sealed ducts with mechanical ventilation
- Stack framing
- Blown cellulose wall and ceiling insulation

Tucson, Arizona



Cost Summary for Building America Metrics—Copper Moon, Tucson, AZ

Unvented roof	+ \$ 750
NOT installed roof vents	– \$ 500
High performance windows	+ \$ 300
Controlled ventilation system	+ \$ 150
Downsize air conditioner by 2 tons	– \$ 1000
Sealed combustion furnace	+ \$ 400
<i>TOTAL PREMIUM</i>	+ \$ 100



Benefits

Through research, Building America helps builders

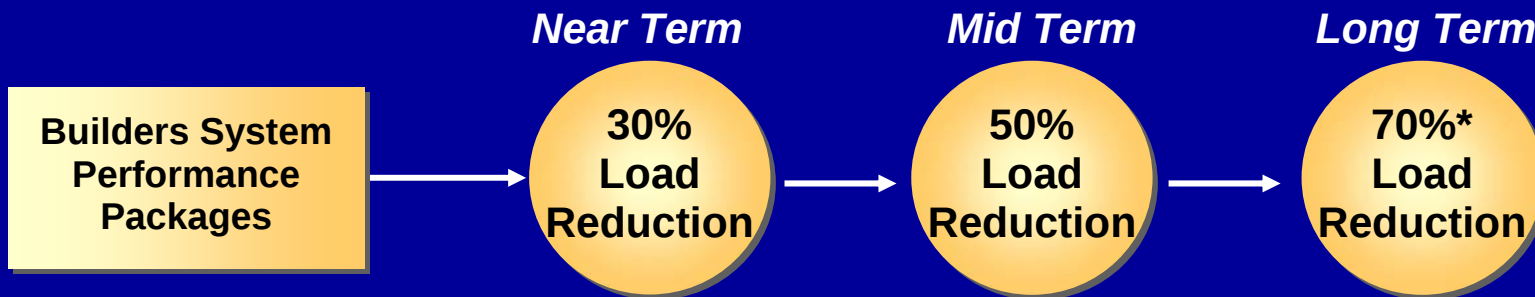
- Lower customers' energy bills
- Improve comfort and indoor air quality
- Reduce construction costs and waste
- Reduce callbacks and warranty claims
- Offer cost-saving building system trade-offs
- Stand out in the marketplace
- Provide new product opportunities
- Learn from other builders



Reduced warranty & liability:

- Relating to comfort (draft stopping, air pressure differentials, tight ducts) that **also saved energy**
- Relating to mold (air pressure differentials, tight ducts) and was the result of:
 - energy conservation (more insulation and tight construction)
 - misplaced/mis-used vapor barriers
 - lack of ventilation
 - lack of water management
- Related to quality (performance metrics and testing) that **also saved energy**
- Related to material efficiency (drywall callbacks) that **also saved energy**

Builders System Performance Packages



**Overall building load*





Resources



Building America
Website

www.BuildingAmerica.
gov

Includes an extensive
document database



- New name: Technology Validation and Market Introduction
- Integrate ENERGY STAR, Rebuild, Codes, Building America, and Energy Smart Schools
- Promote market acceptance of building technologies
- Create and use robust and sustainable partnerships for delivery of BTP programs and products
- State Energy Offices: Vital partners in technology delivery
 - Know State, local, and regional trends and needs
 - Well positioned to spark collaboration across a broad spectrum of partners, including local governments, schools, colleges and universities, business, extension services, utilities, builders, and consumers
 - Cross-program integration at state level
- Next step – strategic thinking and planning



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Congress Building America

- Senate & House concurrent Resolution 5/06/03 to support “Home Ownership Month”
- MOU between RESNET & Habitatat
- Provides opportunity to:
 - Provide low income energy efficient housing
 - Press coverage on energy efficient homes
 - Educate the public
 - Educate Congress



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Figure 1: Front Elevation of the Mixed-Humid Climate House

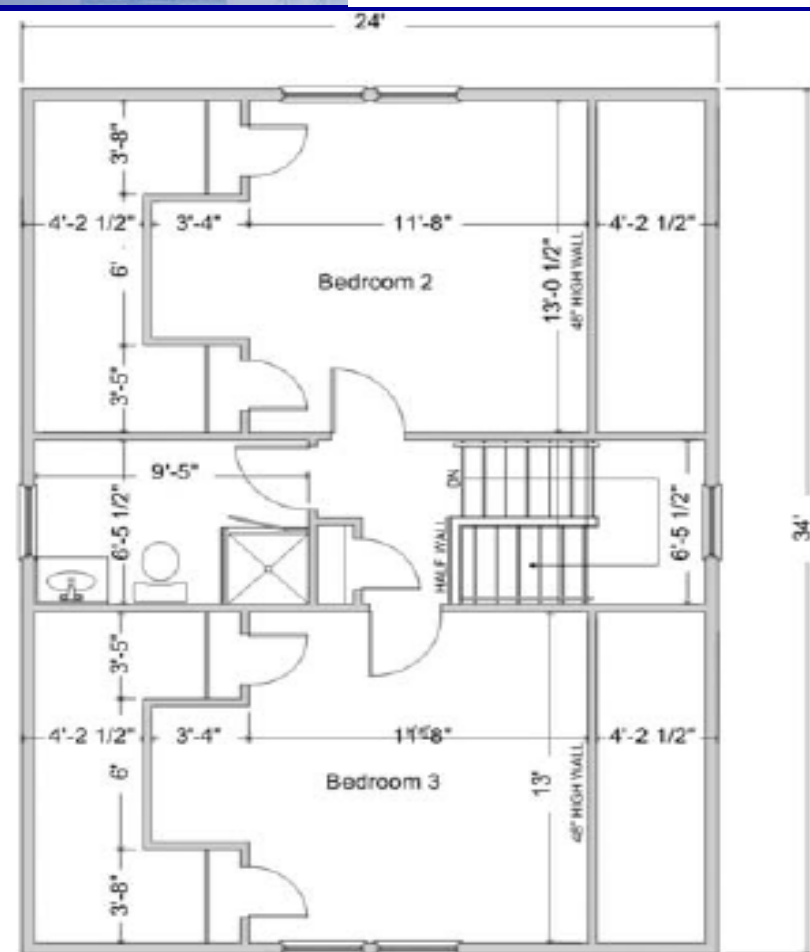


Figure 2: Mixed-Humid floor plans (Right: Ground Floor, Left: Second Floor, crawlspace not shown)



Benchmark

Prototype

Building Enclosure

R-13, 16" oc + R-1 Sheathed Walls

R-19 24" oc + R-5 Sheathed Walls

R-25 Roof Insulation

R-38 Attic / R-35 Cathedral Ceiling

Low E Windows (U=0.58, SHGC=0.58)

Low E Windows (U=0.33, SHGC=0.28)

R-9 Crawlspace Insulation

R-10 Walls on Conditioned Crawl

BM Airtightness (~5"/100 sf)

BSC BA Airtightness (2.5 ins/100 sf)

Mechanical

6.8 HSPF ASHP

8.5 HSPF Air Source Heat Pump

10 SEER A/C System

14 SEER Cooling System

R-5 Ducts 15% Leakage

Ducts in Conditioned Space

0.88 EF Electric Tank Hot Water

0.94 EF Tank Hot Water Heater

ASHRAE 62.2 Exhaust Fan

ASHRAE 62.2 Ventilation by FanCycler

Appliances and Lights

Incandescent Lighting

Fluorescent Lighting

Regular Appliances

ENERGY STAR Appliances



Table 1: Parametric Analysis Results

Parametric Run ID	Description of step	Estimated Individual Cost of change	Estimated Cumulative Cost of change	Total Source Energy Savings (heating, cooling, dhw, lighting, appliances, plug loads)				
				over BA Benchmark ¹	Incremental	Annual energy cost	Simple payback (yr)	Increment payback (yr)
Benchmark		n/a	n/a	n/a	n/a	\$1,288	n/a	n/a
1	Benchmark + Enclosure Upgrades	\$400	\$400	6.0%	6.0%	\$1,210	5	5
2	1 + Mechanical Upgrades	\$1,000	\$1,400	21.9%	16.0%	\$1,000	5	5
3	2 + Lights & Appliances	\$350	\$1,750	27.4%	5.4%	\$929	5	5

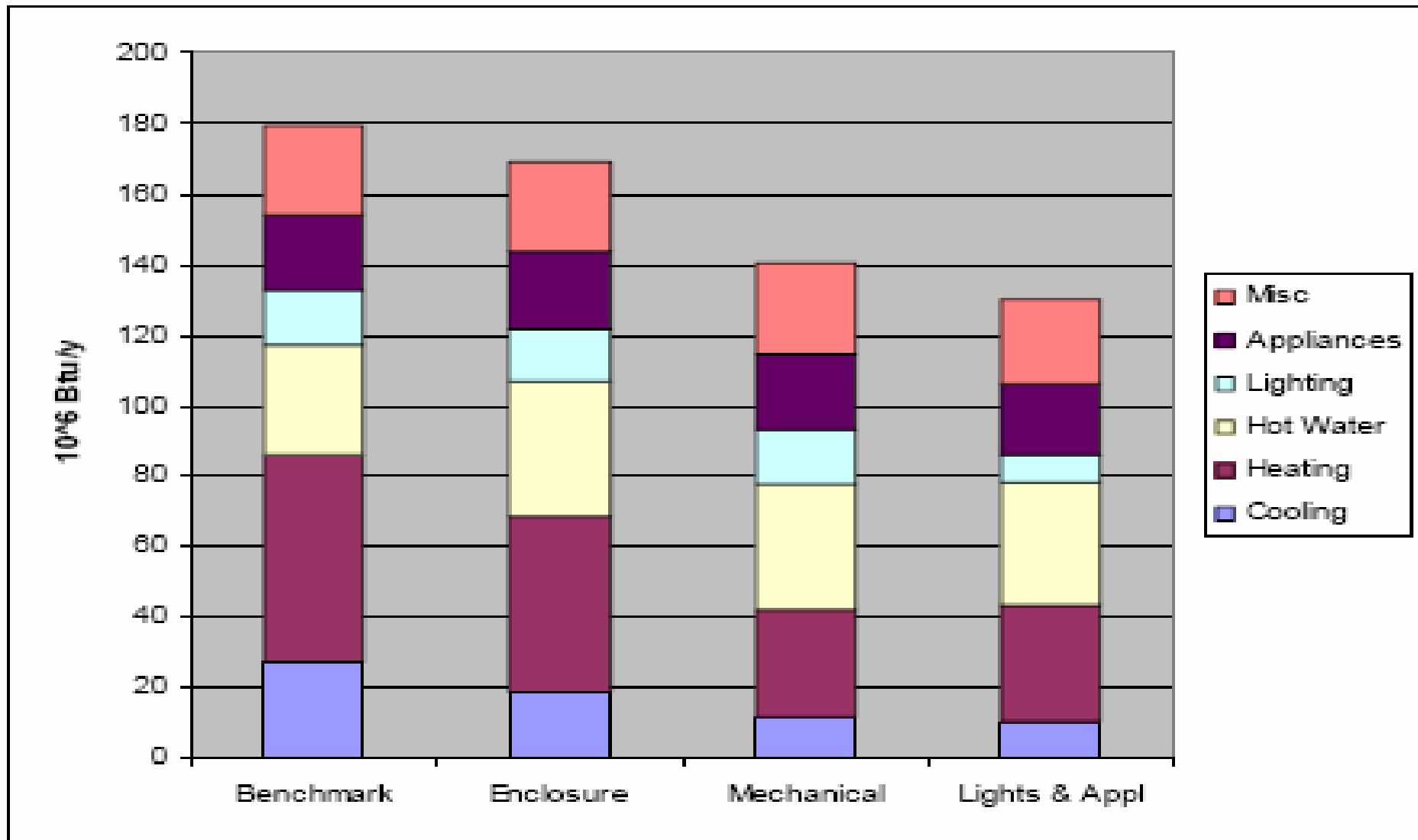


Figure 4: Total Source Energy Consumption Reduction Graph



Outreach Through Educational Institutions

- Universities and Colleges
- Community Colleges
- Trade Schools
- Extension Service
- Professional Associations



Plans For Working with Universities

- Pilot program started 2 years ago
- Focus was on developing centers of excellence for each climate zone
- Summer Institute to develop Curriculum & course material
- Web page to share materials
- Opportunity for raters to participate in field work