National Micro-CHP Technology Pathways Workshop

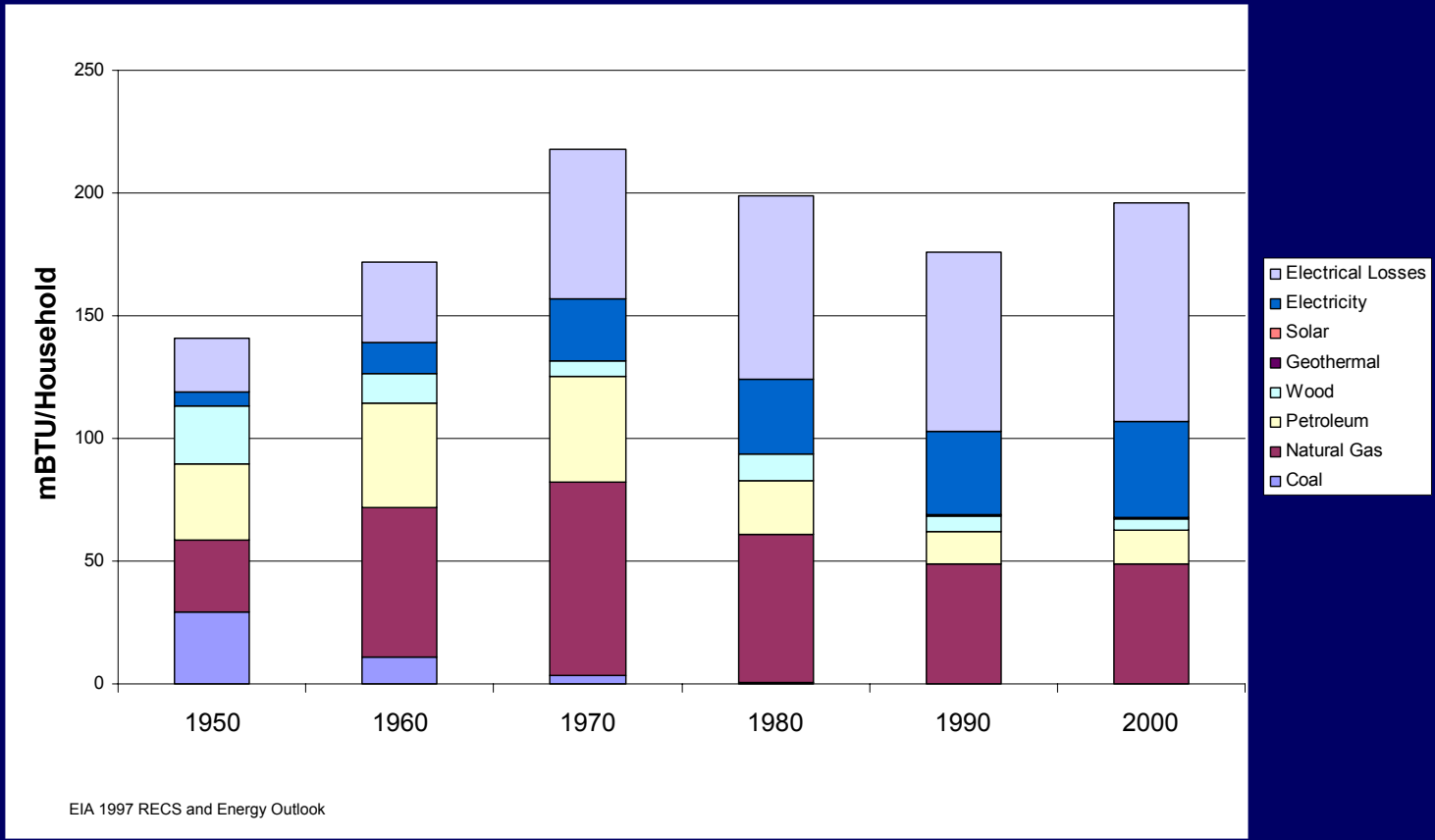
Energy Innovations in America's Housing

US DOE Building Technology Program

Dr. Ren Anderson
NREL

Building AMERICA
U.S. Department of Energy

US residential energy use appears to be increasing for the first time since 1970



What is Building America?

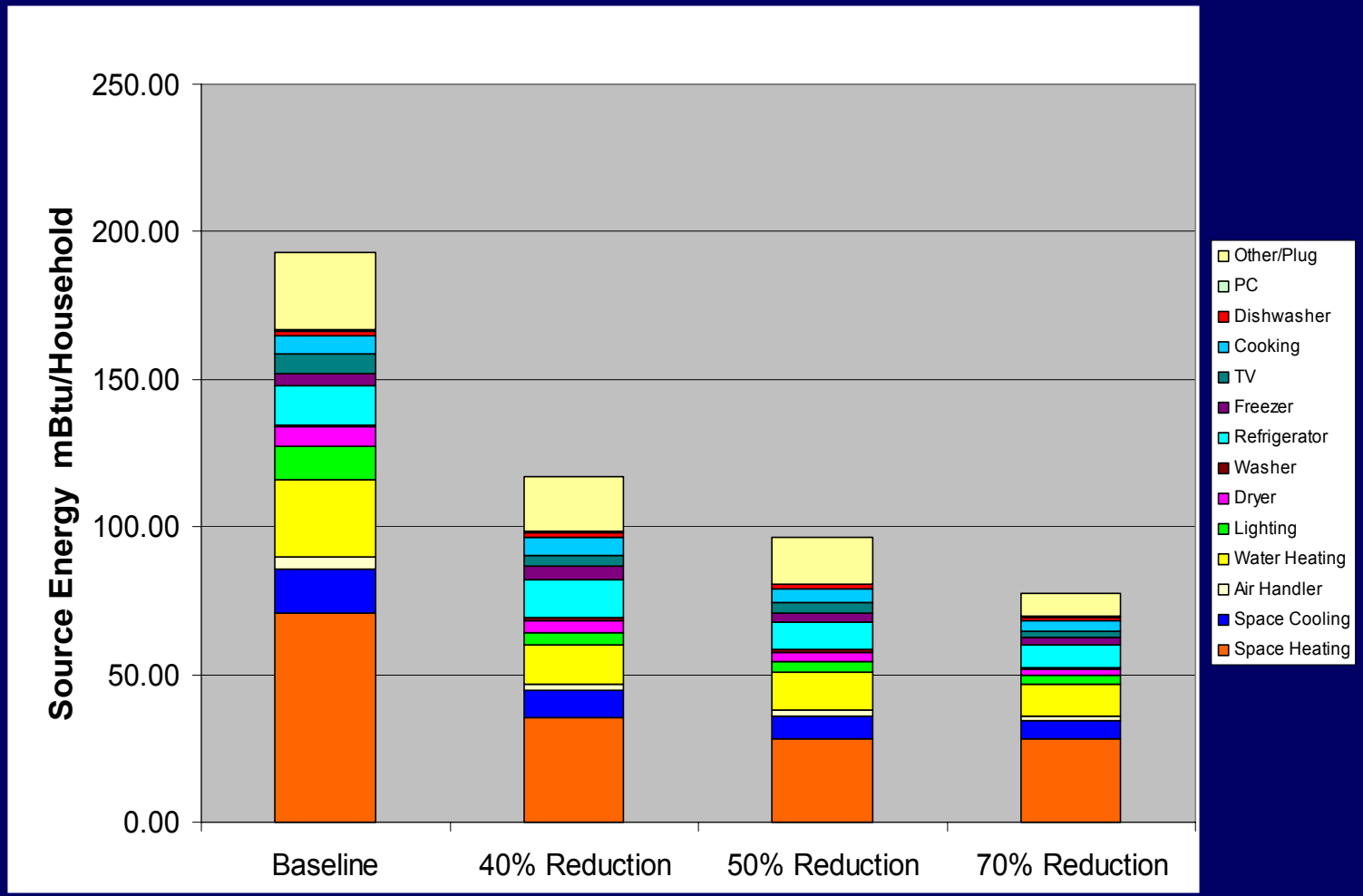
Building America is a residential systems research test bed sponsored* by the US Department of Energy

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

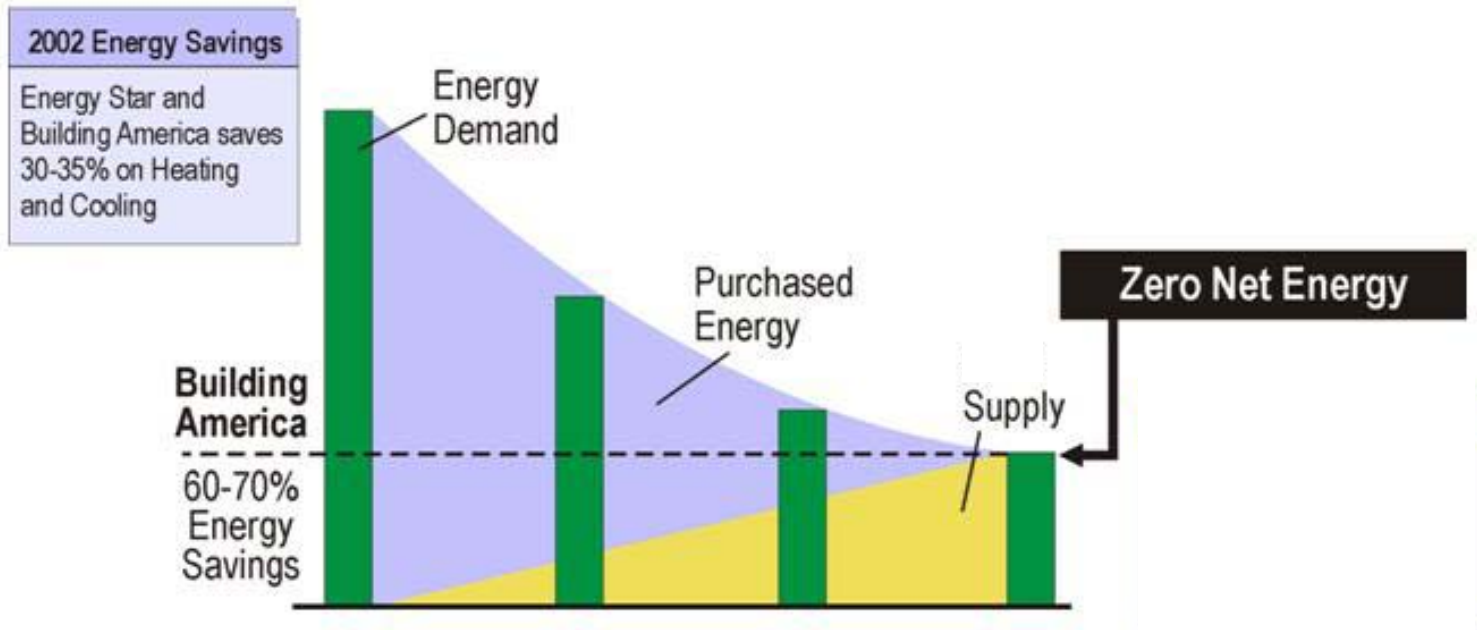
Building America R&D Goals

- Support upstream system engineering research required to achieve 40%-70% energy savings using production building techniques
- Integrate onsite electric power and heat recovery systems
- Transfer energy system innovations to community-scale developments

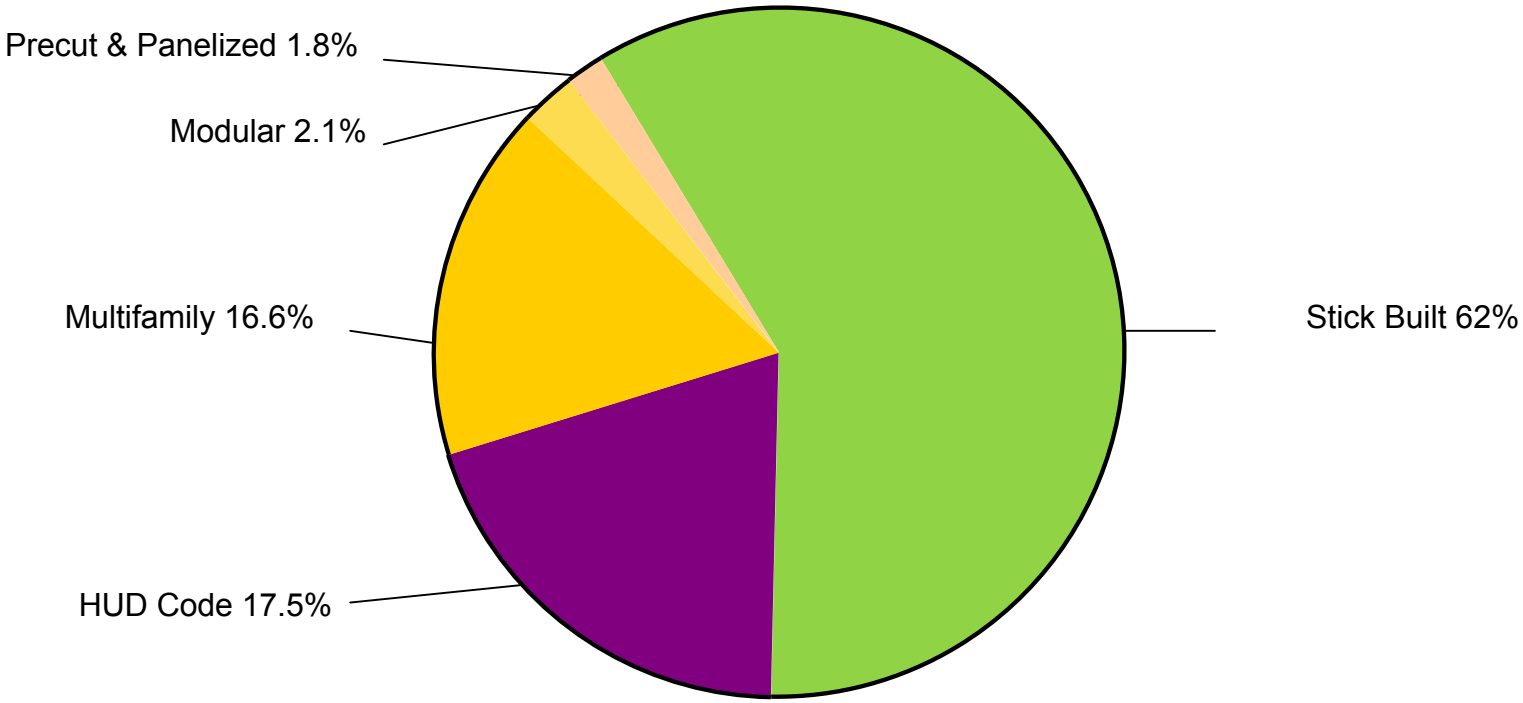
Building America Energy Efficiency Targets



Building America Onsite Energy Supply Target



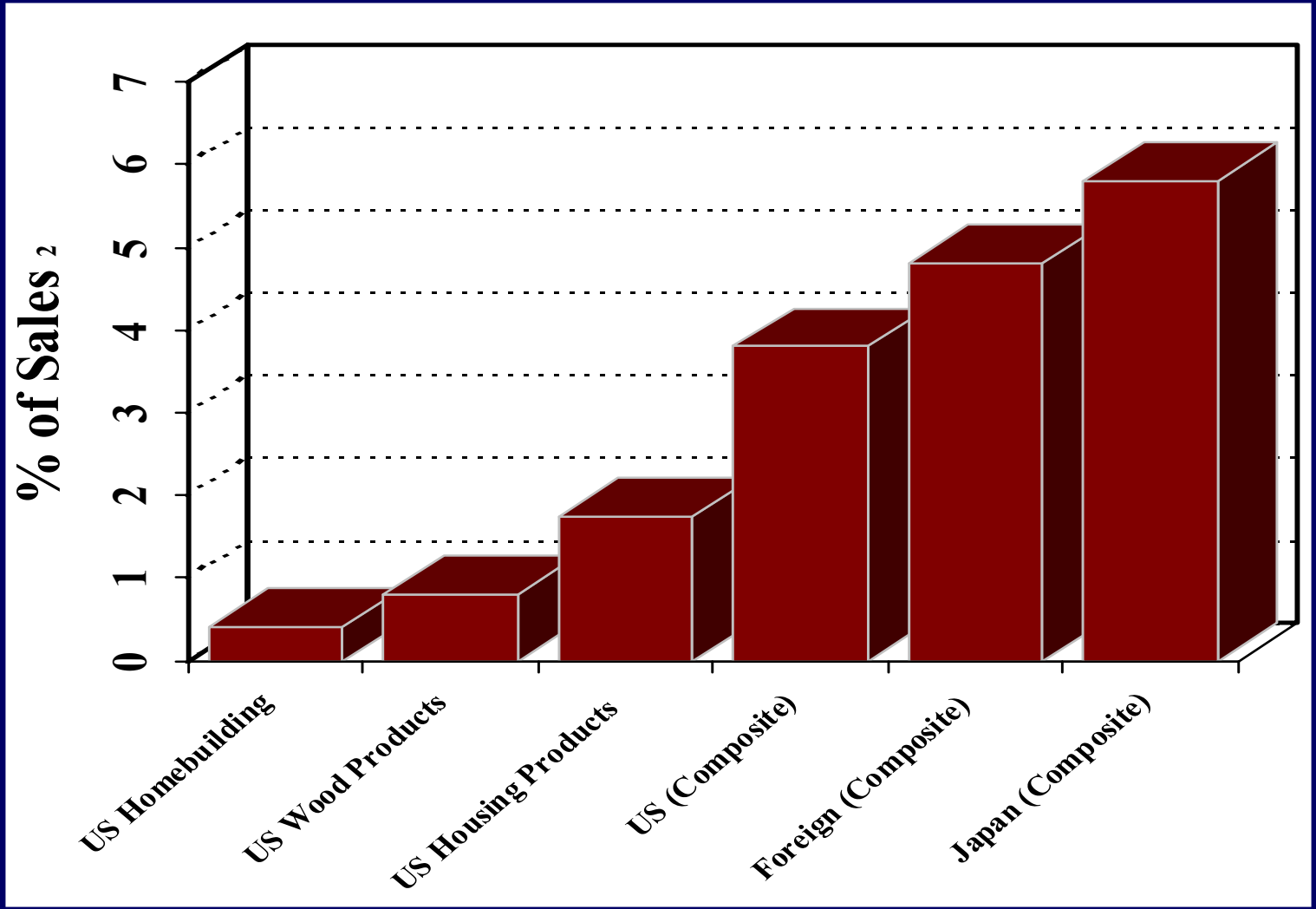
The bad news:
The US homebuilding industry includes a large number of contractors and suppliers



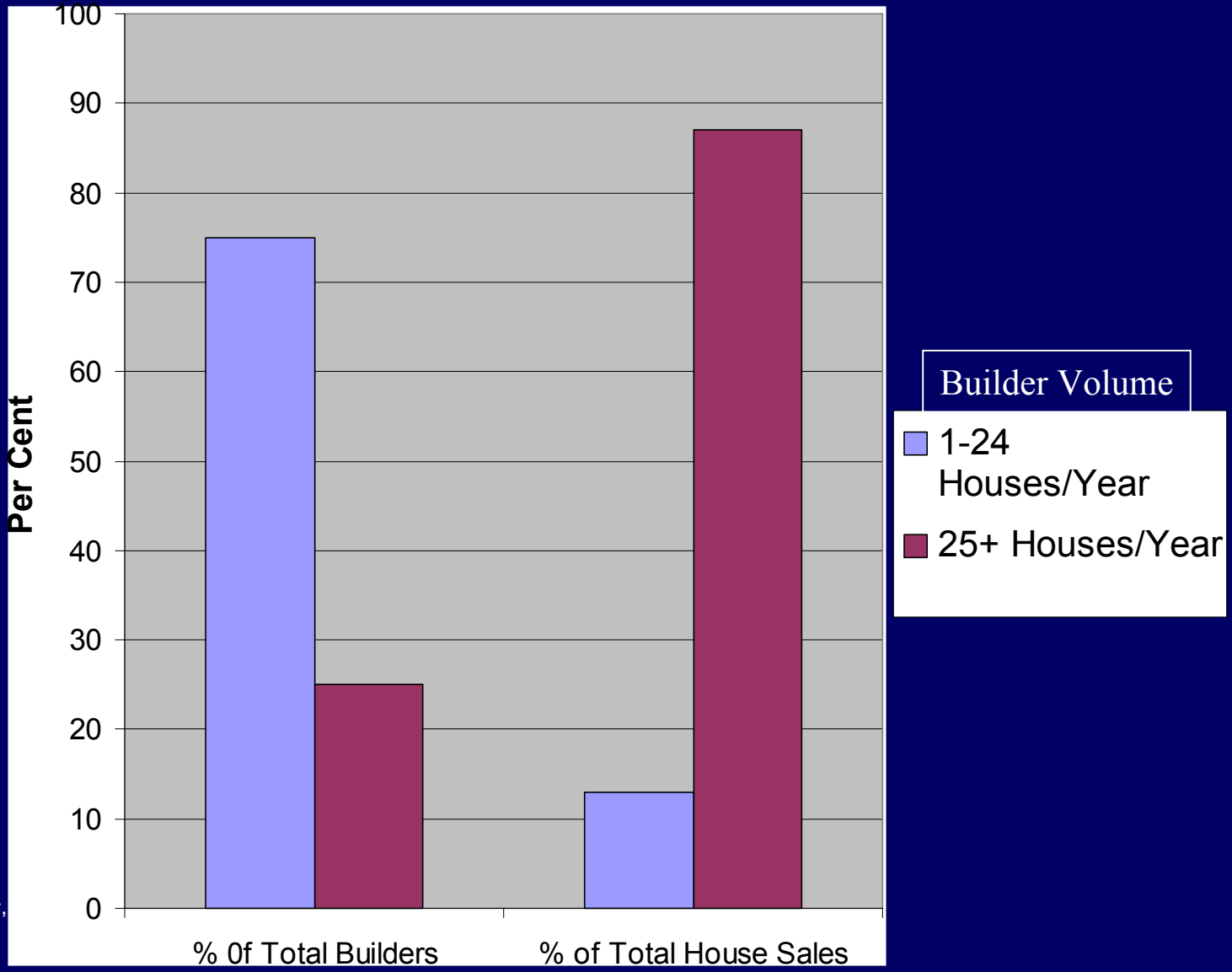
Total Number of New Houses = 1,984,000

Sources: http://www.census.gov/pub/const/mhs/shipment.txt
http://www.census.gov/prod/www/abs/c25.html

The US homebuilding industry invests 0.25% of sales in research compared to $3.8% for all market sectors (Business Week R&D Scoreboard, June 28, 1993)

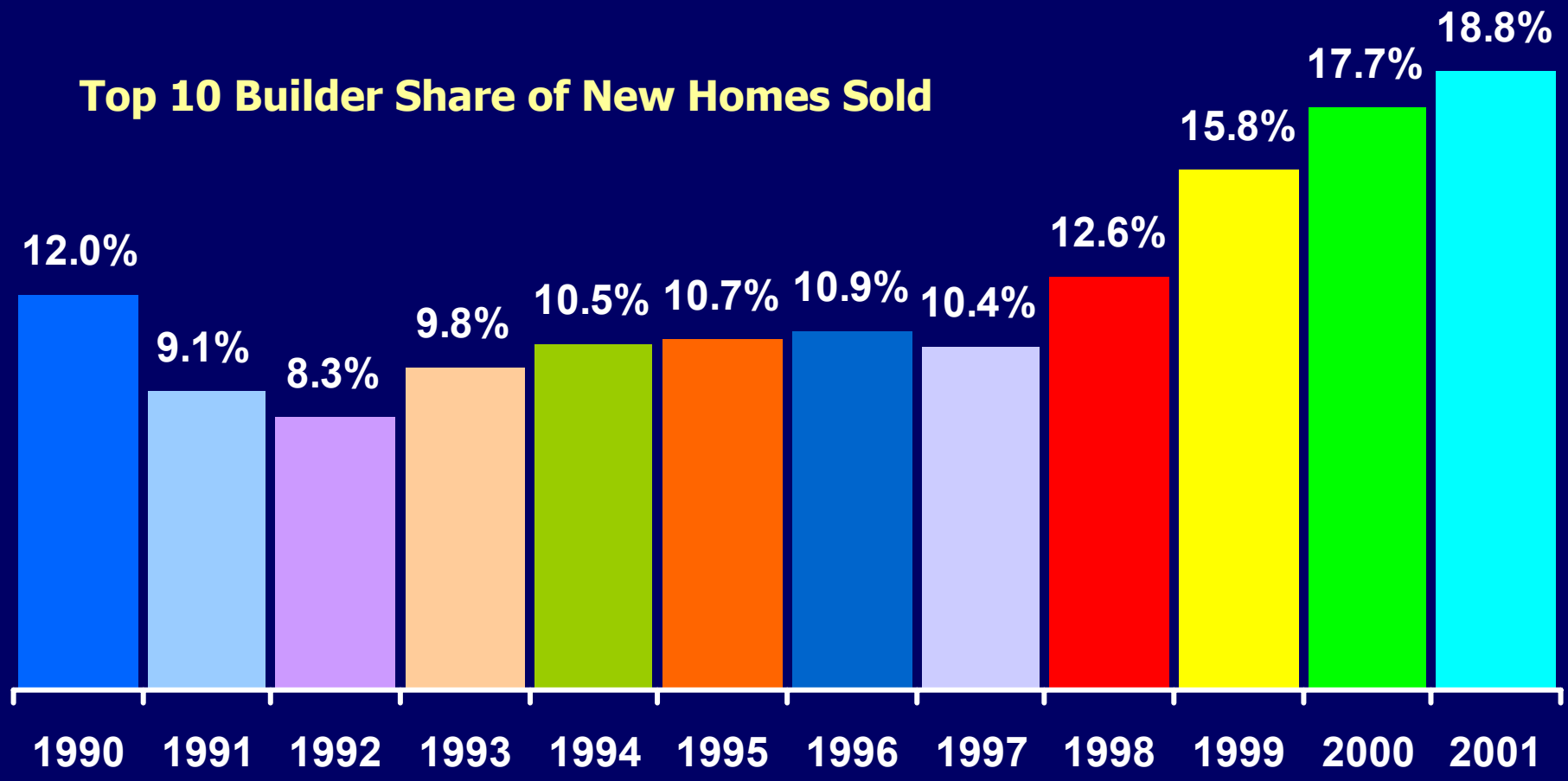


The good news:
The "80/20" rule applies to US Homebuilding:
25% of builders account for 87% of homes



NAHB, *Housing Economics*, June, 1990, p. 6

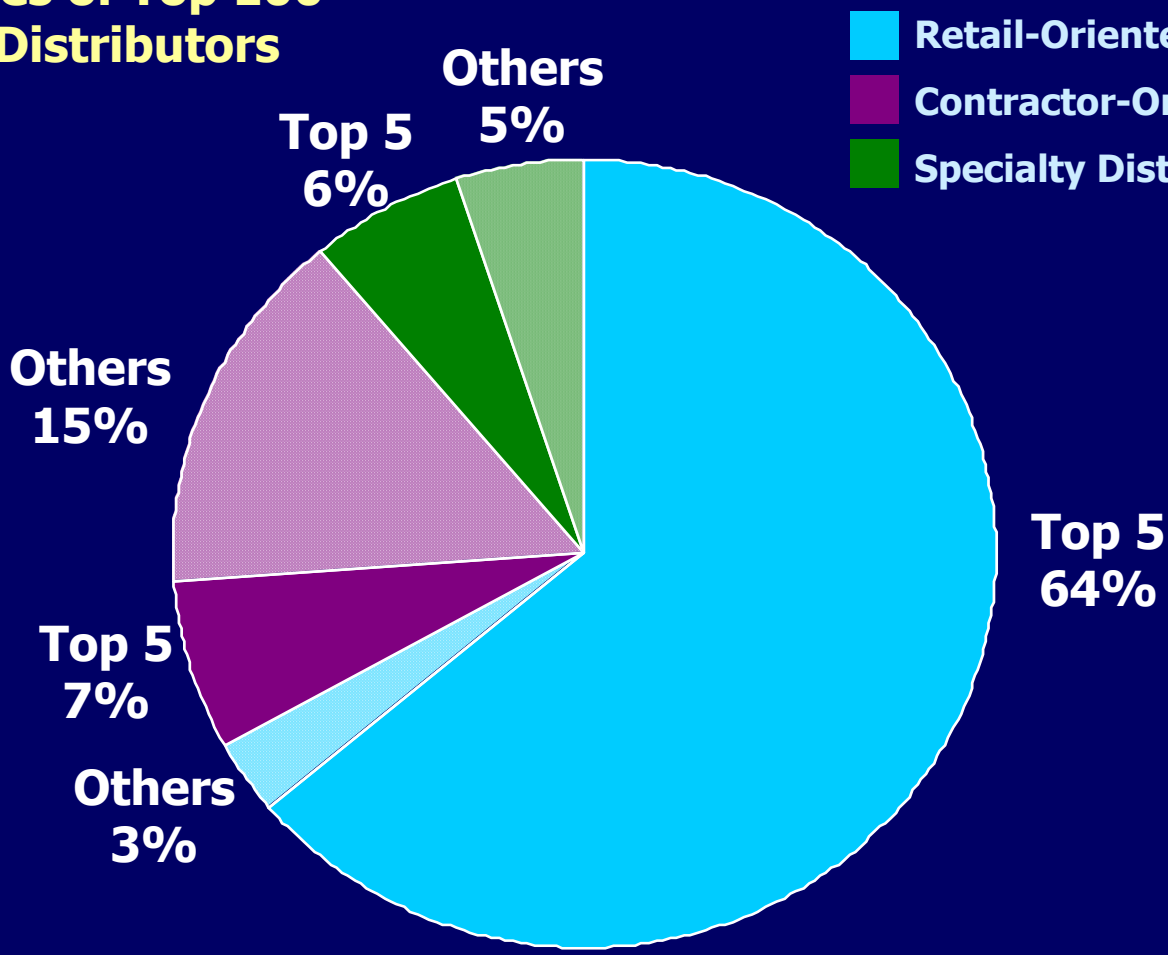
Consolidation Within Homebuilding Has Intensified



Note: Excludes homes built under contract.
Sources: Professional Builder Magazine and US Department of Commerce.

Retail Distribution of Building and Home Improvement Products Is Highly Concentrated

Percent of Sales of Top 100 Residential Distributors



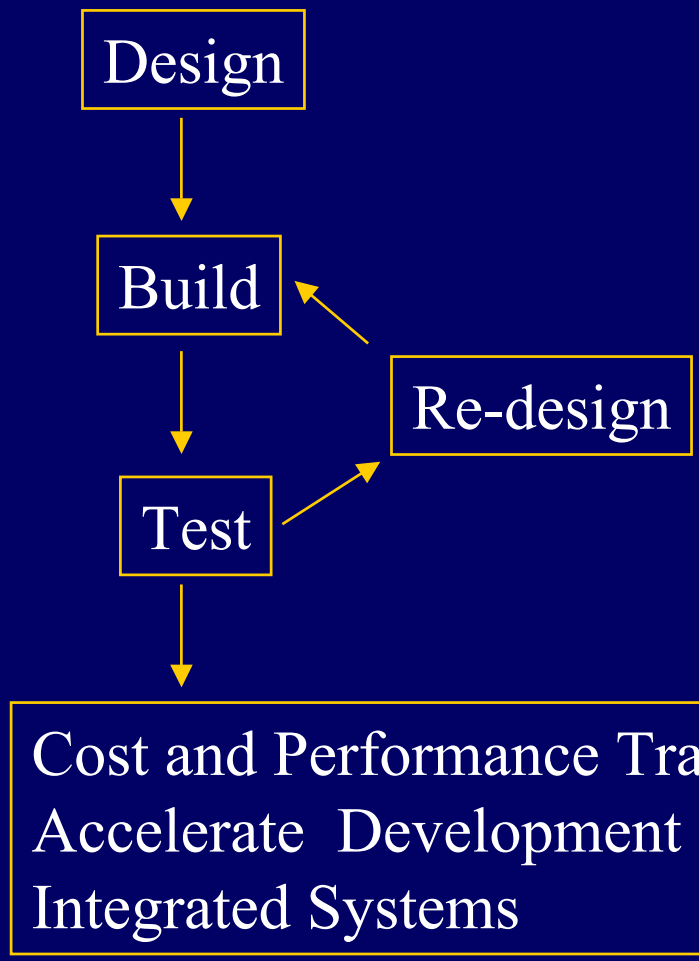
Source: Chain Store Guide: Home Center Operators and Hardware Chains, 2002.

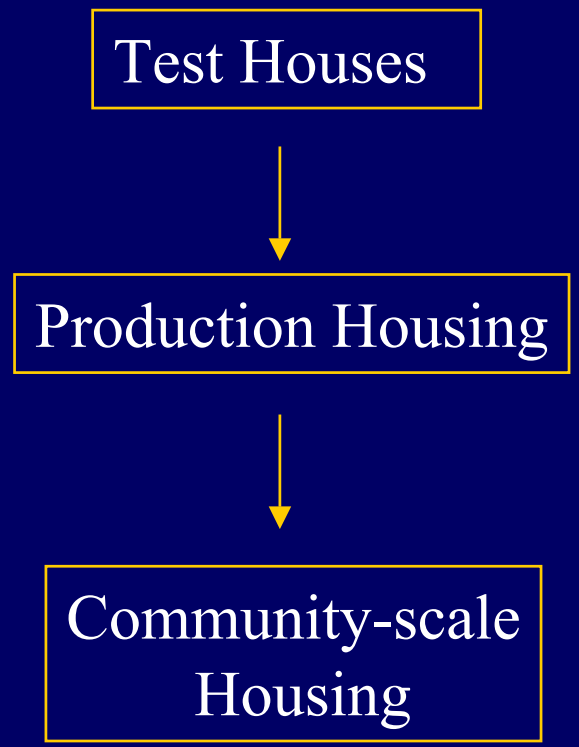
Building America's Industry Teams

Team Members Include:

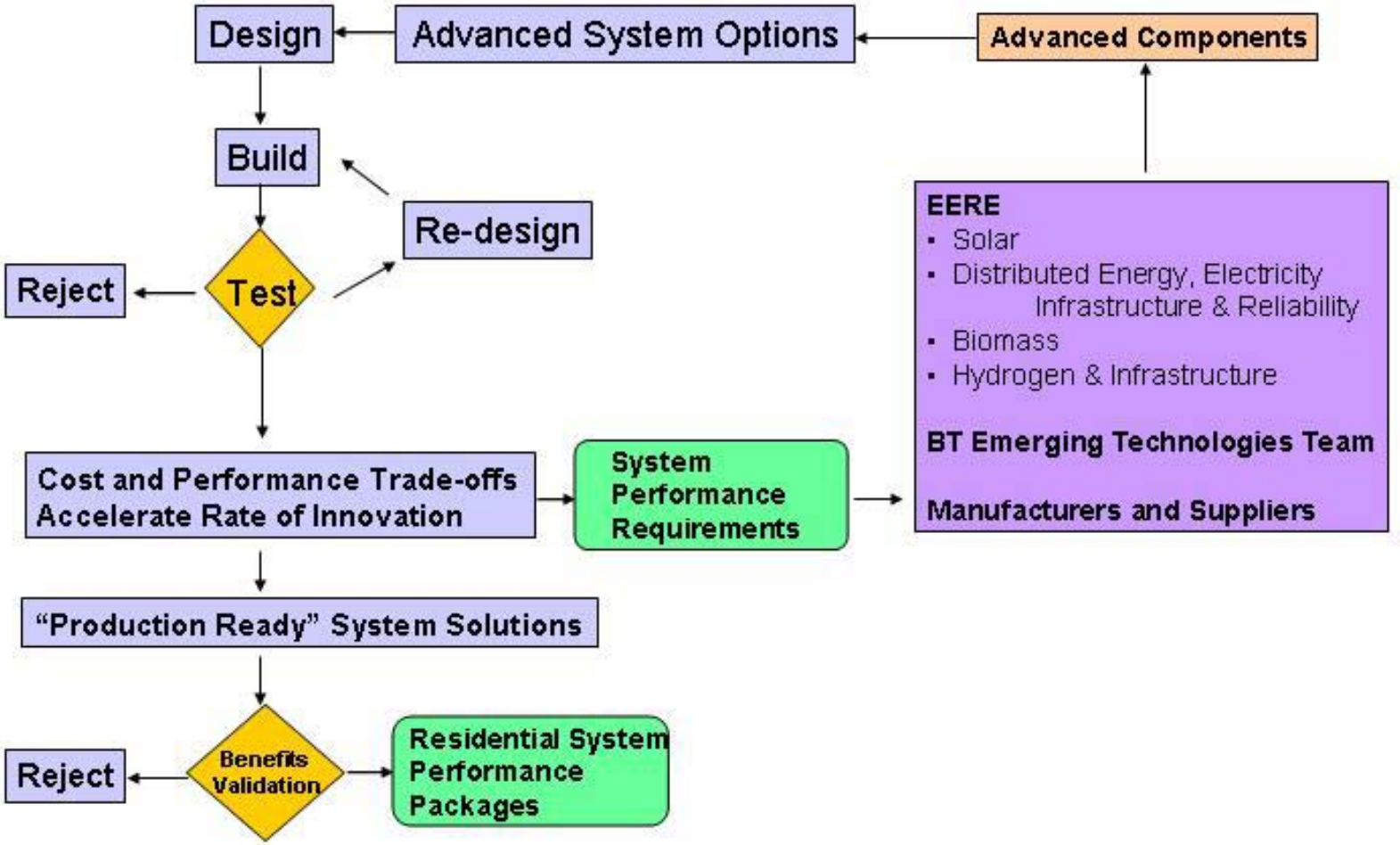
- Lead Builders
- Material Suppliers
- Designers
- Developers
- Utilities
- Manufacturers

Systems Engineering Approach





Inputs and outputs from system engineering process

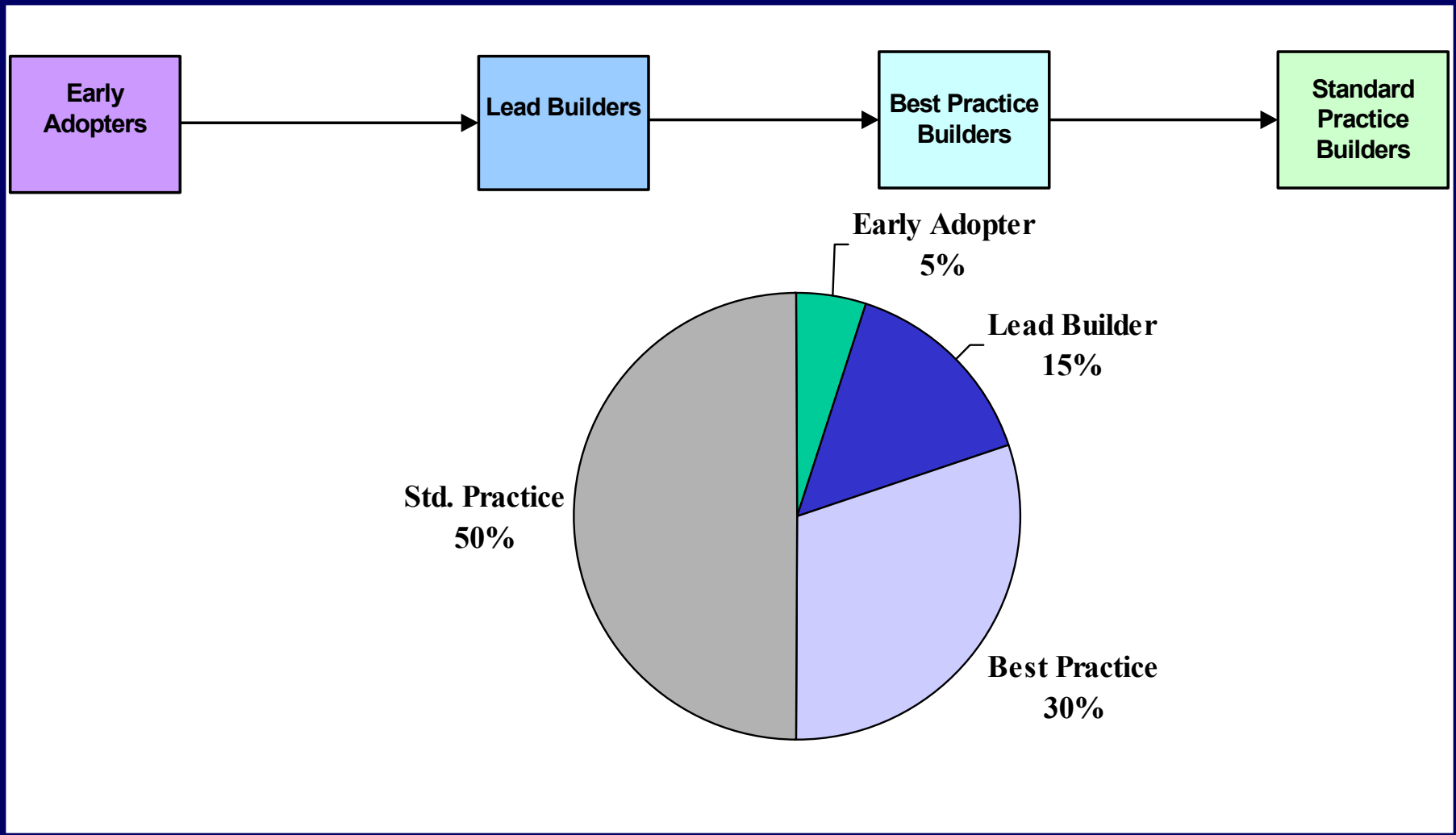


Key Challenge for Residential Building Innovations

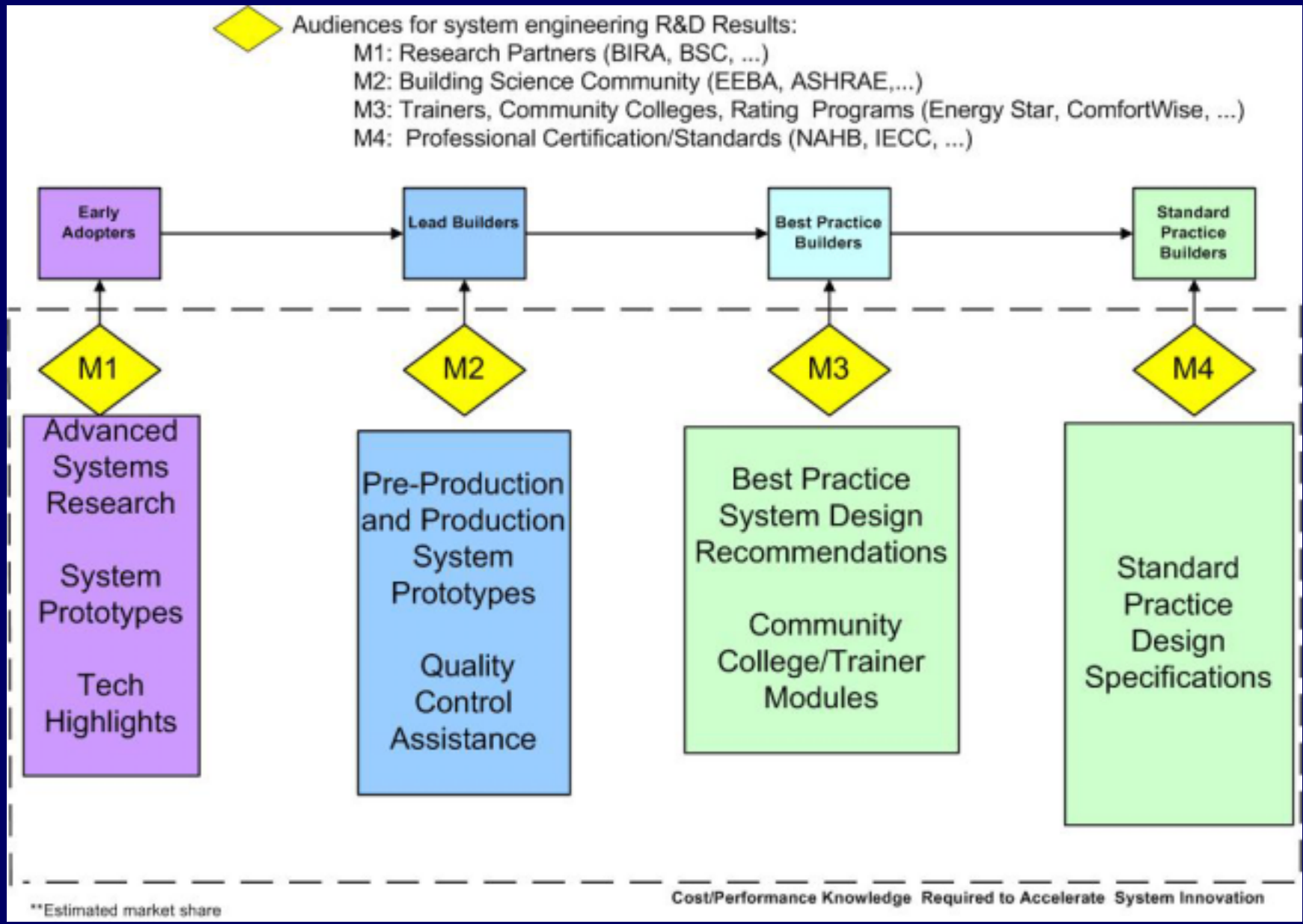
Transition of innovative systems from niche markets into broad markets requires "bomb proof" integration

Stages of system development

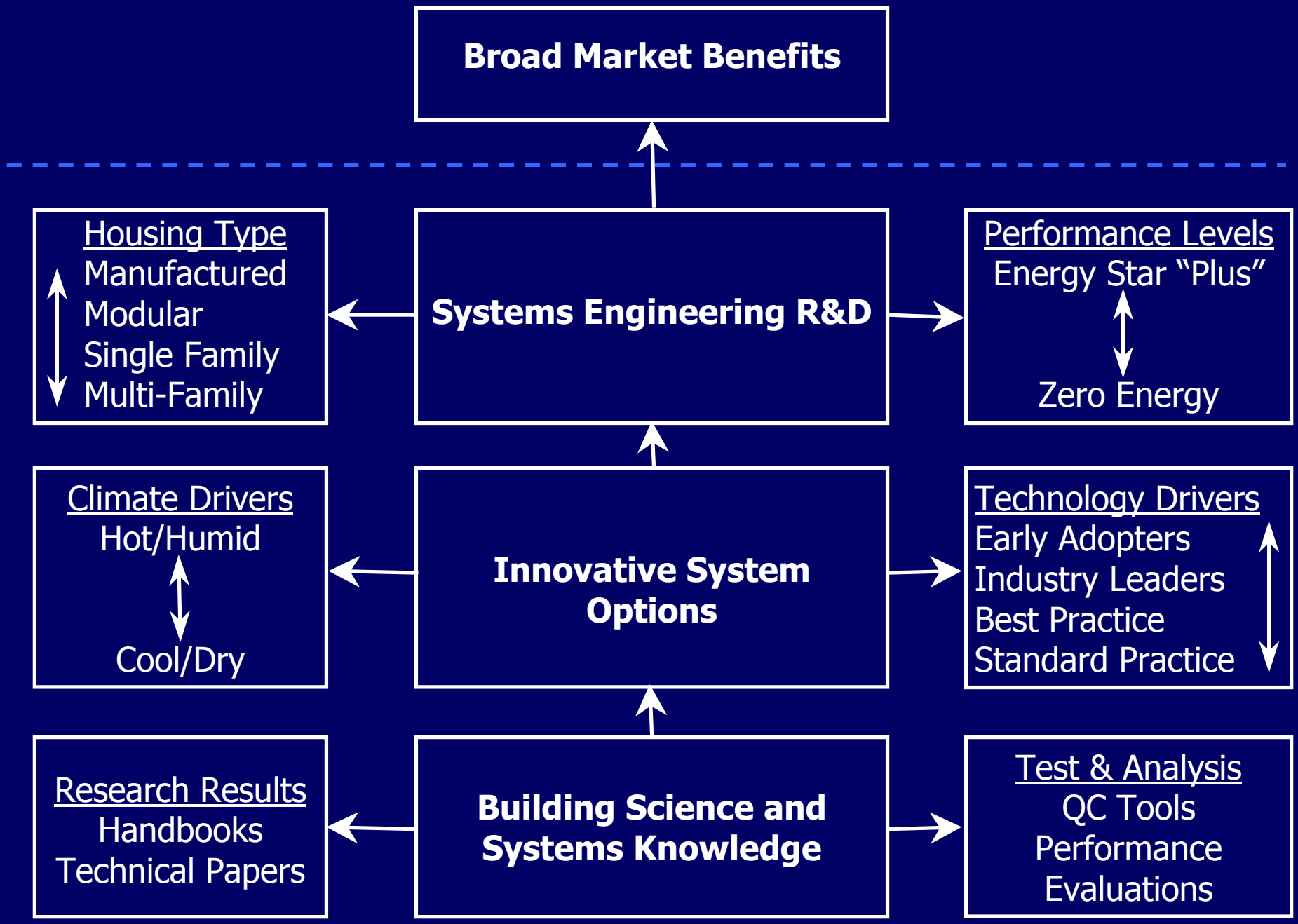
Types of residential technology adopters

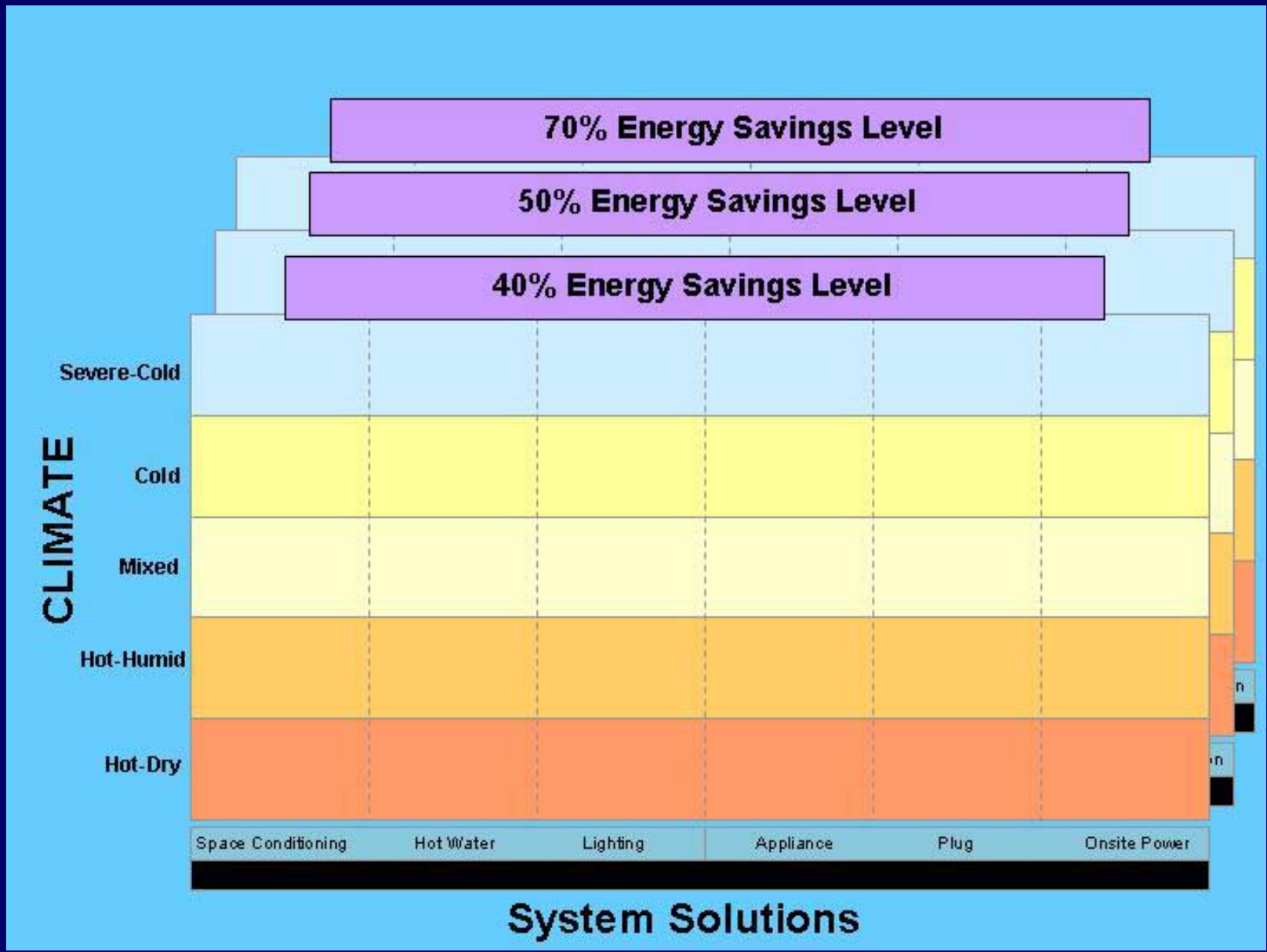


Technology adopter support needs

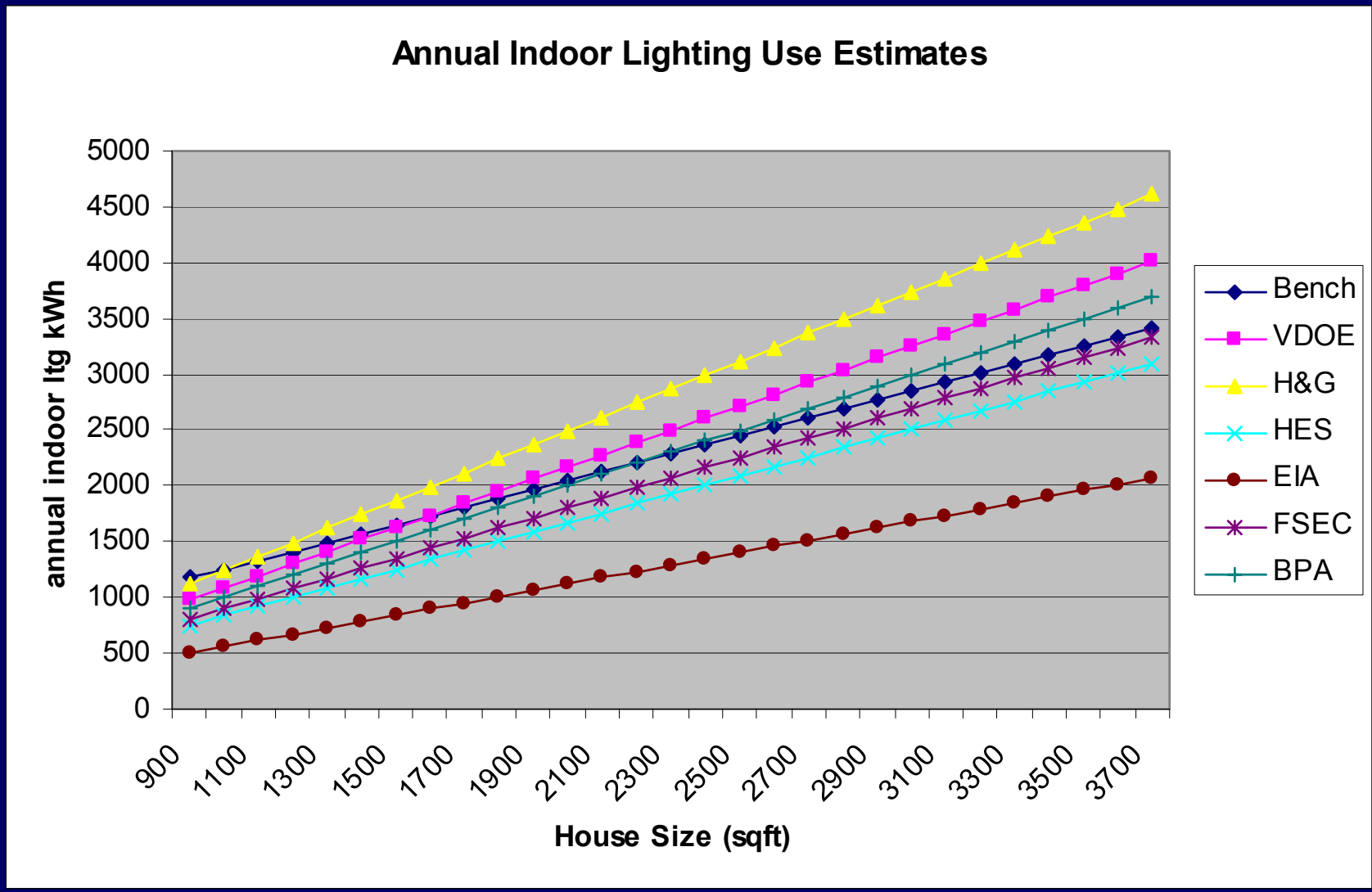


Building America Research Targets




70% Energy Savings Level
50% Energy Savings Level
40% Energy Savings Level
CLIMATE
Severe-Cold
Cold
Mixed
Hot-Humid
Hot-Dry
Space Conditioning
Hot Water
Lighting
Appliance
Plug
Onsite Power
System Solutions

How much energy is saved?:
Building America Research Benchmark house definition



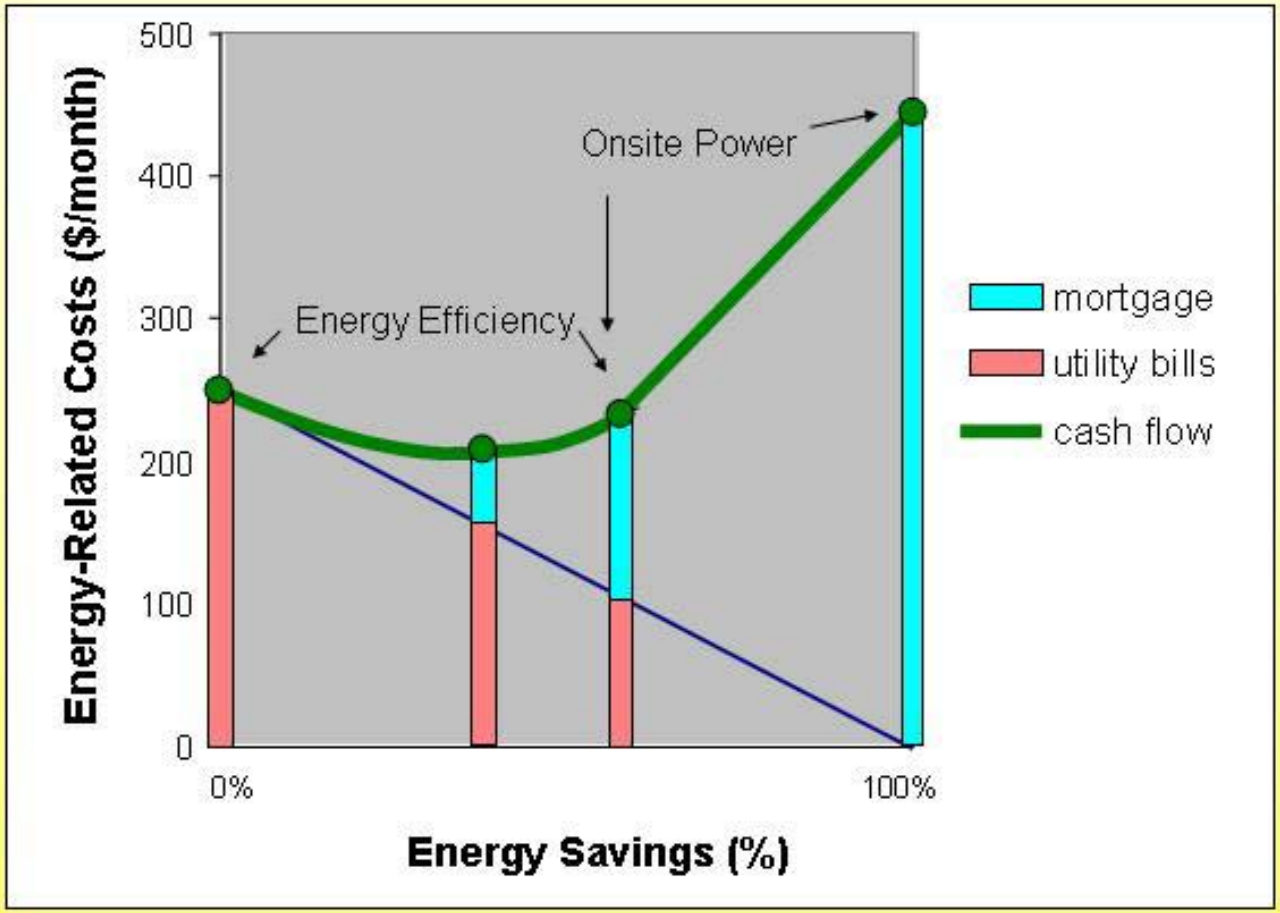
How much energy is saved?: Site energy analysis

	Annual Site Energy							
	BA Benchmark		**Region Standard**		**Builder Standard**		**BA Prototype**	
End-Use	kWh	therms	kWh	therms	kWh	therms	kWh	therms
Space Heating	7986	0	11286	0	11286	0	4397	0
Space Cooling	2061	0	2432	0	2432	0	902	0
DHW	4837	0	4838	0	4838	0	1351	0
Lighting	3110		3110		3110		1204	
Appliances + Plug	7646	0	7646	0	7646	0	7436	0
OA Ventilation	202		400		400		400	
Total Usage	25842	0	29712	0	29712	0	15690	0
Site Generation	0	0	0	0	0	0	7402	0
Net Energy Use	25842	0	29712	0	29712	0	8289	0

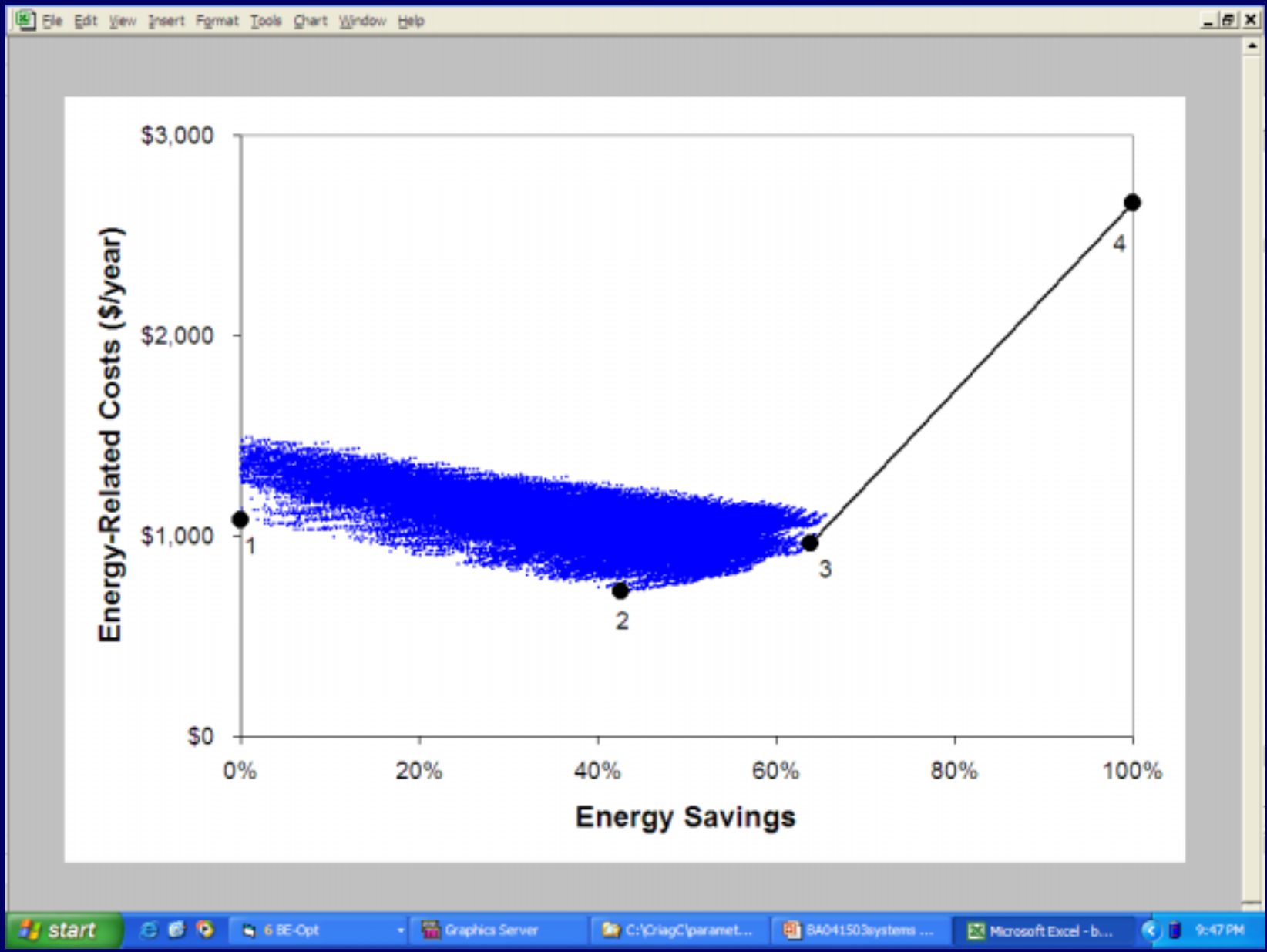
How much energy is saved?: Source energy analysis

	Estimated Annual Source Energy				Source Energy Savings					
					Percent of End-Use			Percent of Total		
End-Use	**Benchmark** MBTU/yr	**Region** MBTU/yr	**Builder** MBTU/yr	**Proto** MBTU/yr	**BA** Base	**Reg** Base	**Bldr** Base	**BA** Base	**Reg** Base	**Bldr** Base
Space Heating	82	116	116	45	**45%**	61%	61%	**14%**	23%	23%
Space Cooling	21	25	25	9	**56%**	63%	63%	**4%**	5%	5%
DHW	50	50	50	14	**72%**	72%	72%	**13%**	12%	12%
Lighting	32	32	32	12	**61%**	61%	61%	**7%**	6%	6%
Appliances + Plug	78	78	78	76	**3%**	3%	3%	**1%**	1%	1%
OA Ventilation	2	4	4	4	**-98%**	0%	0%	**-1%**	0%	0%
Total Usage	265	304	304	161	**39%**	47%	47%	**39%**	47%	47%
Site Generation	0	0	0	-76				29%	25%	25%
Net Energy Use	265	304	304	85	68%	72%	72%	68%	72%	72%

Residential Systems Optimization Studies (NREL 2003)

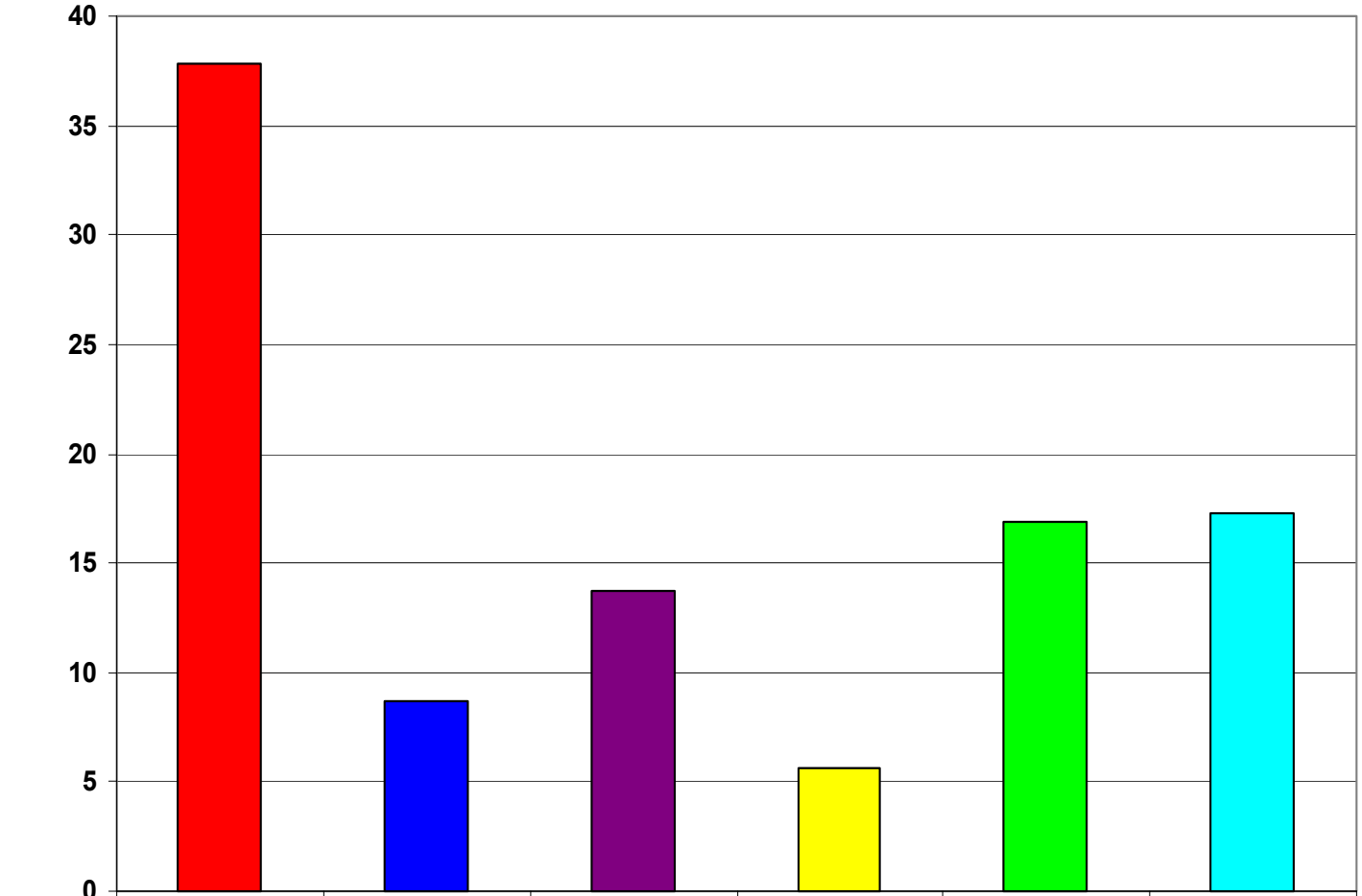


Results of detailed parametric evaluation to determine most cost effective system combinations (NREL 2003)



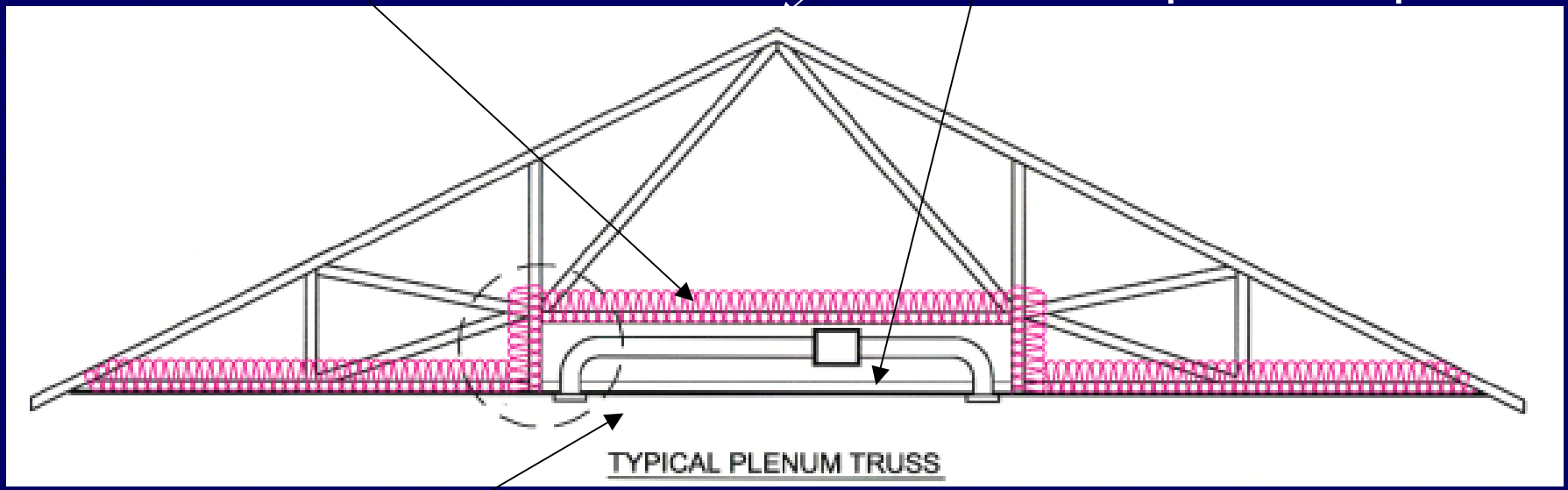
Current Residential Energy Use

(Source Energy- Average New House - EIA 1998 Energy Outlook Calculator)



	Space Heating	Space Cooling	Water Heating	Lighting	Appliances	Plug
Percent	38	9	14	6	17	17

Duct Sealing Systems



Duct Plenum Trusses

Foundation Insulation Systems

Drainage Planes/Window Sealing

Building America Research Results

Over 20,000 homes have participated in Building America research projects

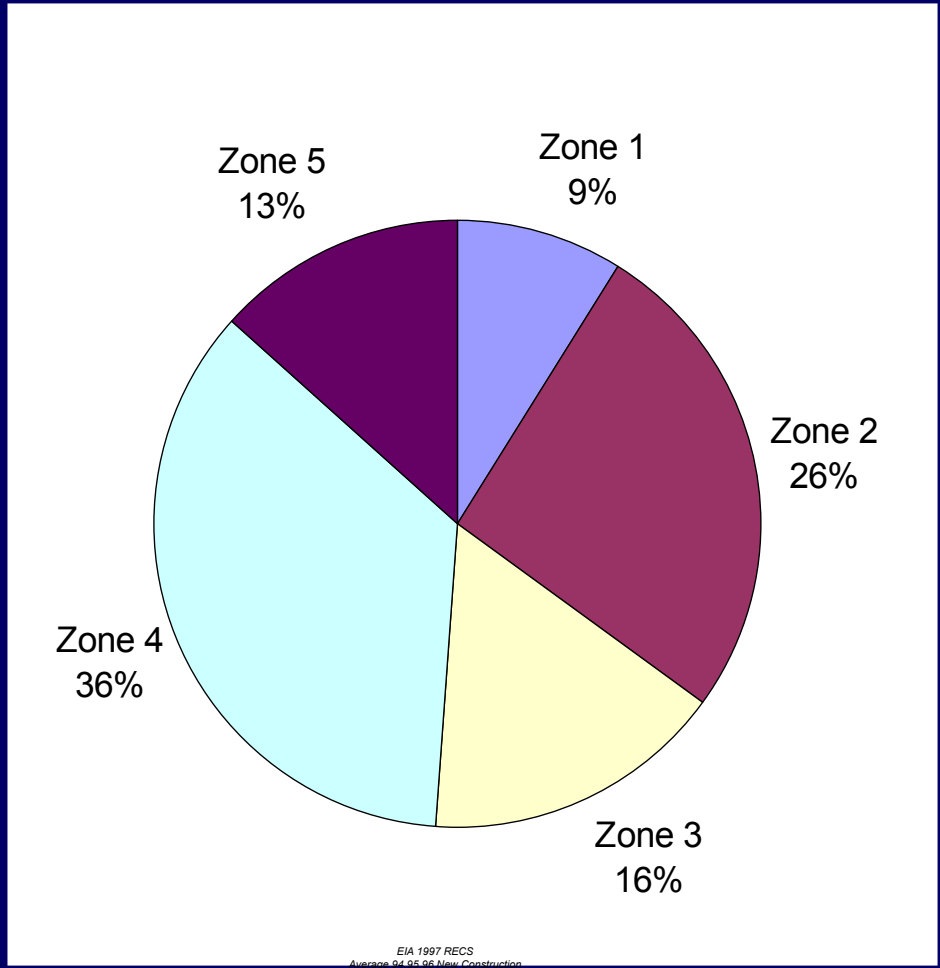
Cost/benefit trade-offs improve whole building performance without increasing overall cost

- Reduced utility bills
- Healthy, comfortable homes
- Accelerated adoption of new technologies
- Reduced warranty and callback issues

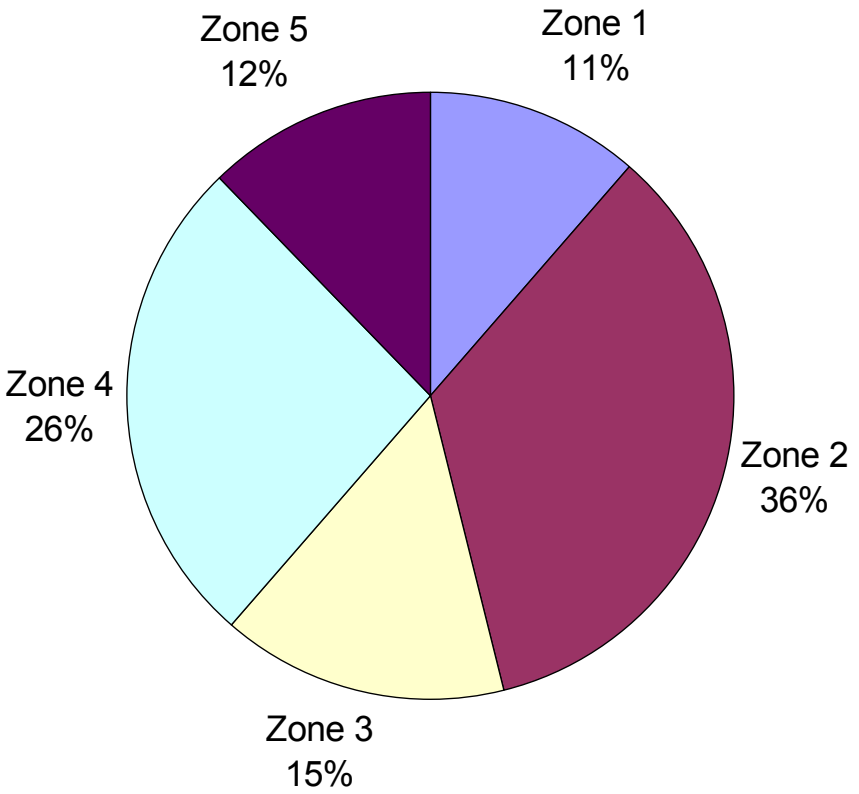
www.buildingamerica.gov

Building AMERICA
U.S. Department of Energy

“Sunbelt” Dominates Housing Starts



“Rustbelt” Shares Growth in Residential Energy Use

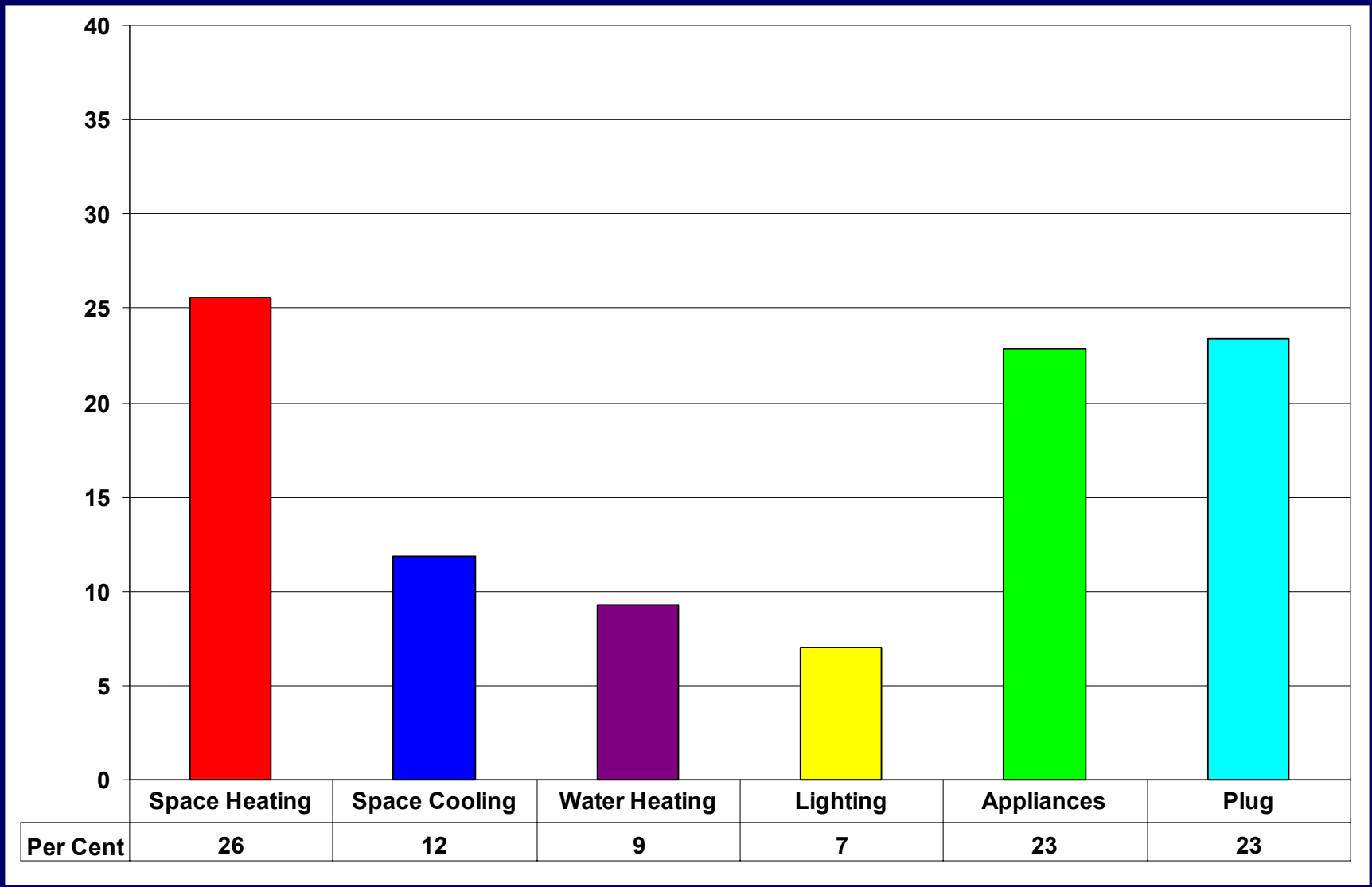


EIA 1997 RECS
Average 94,95,96 New Construction
Site energy

Coldest zones (1&2) account for 47% of energy growth, Warmest Zones (4&5) account for 38% of energy growth

Future Residential Energy Use

(Source Energy)



	Space Heating	Space Cooling	Water Heating	Lighting	Appliances	Plug
Per Cent	26	12	9	7	23	23

Table 4. Residential Team Milestone Summary (v5-draft)

May 20, 2003

	2003	2004	2005	2006	2007	2008	2009	2010
KEY ACTIVITIES AND MILESTONES								
I. 20% Energy Savings: Existing Homes								
Develop system retrofit strategies that reduce total energy use in existing homes by 20%								
Initiate system retrofit pilot studies to evaluate best approaches to 20% total energy savings goal								
Initiate expanded field studies focusing on most promising system retrofit approaches, including multifamily								
Expand research partnerships with system-based community-scale retrofit pilots								
Complete system retrofit pilots for single family and multifamily homes								
Initiate system retrofit pilots targeting manufactured homes								
Complete development of system retrofit strategies that reduce total energy use by 20%								
Complete technical guidebooks for community-scale home retrofit strategies								
II. 30% Energy Savings: New and Existing Homes								
Complete research on new homes that reduce space conditioning and hot water energy by 30%.								
Complete knowledge base for new residential homes that produce 30% space conditioning and hot water savings.								
Complete fact sheets and handbooks for new homes that deliver 30% energy savings								
Conduct research to develop system retrofits that reduce total energy use in existing homes by 30% .								
Initiate system retrofit pilot studies to evaluate best approaches to 30% total energy savings goal								
Initiate pilot studies: system retrofits for affordable housing								
Initiate pilot studies: system retrofits for manufactured housing								
Case studies report: system retrofit strategies that reduce energy use in existing homes by 30%								
III. 50% Energy Savings: New Homes								
Design and test research houses that have the goal of producing total energy efficiency savings of at least 40%.								
Initiate the design and test of research houses that have the goal of producing total energy efficiency savings of at least 40%.								
Case studies report: Initial results from research houses that produce total energy efficiency savings of at least 40%.								
Develop initial fact sheets and design handbooks for homes in one climate zone that deliver 40% efficiency savings.								
Complete fact sheets and design handbooks for homes that deliver total energy efficiency savings of 40%.								
Design and test research houses with onsite renewable energy systems that reduce utility bill by an additional 10%								
Initiate design and test of research houses that reduce utility bills by an additional 10% using renewable energy								
Case studies report: Initial results from supply 10% of benchmark load using renewable energy								
Develop initial fact sheets in one climate zone for renewable energy systems that supply 10% of basecase energy..								
Complete fact sheets and design guides for homes that use renewable energy systems to supply 10% of load								
IV. 75% Energy Savings: New Homes								
Conduct research on the most promising advanced systems for total energy efficiency savings of 50% in new homes.								
Initiate the evaluation of advanced systems required to produce total energy efficiency savings of 50% in new homes.								
Technology update: System requirements for total energy efficiency savings of 50% in new homes.								

Note: All energy savings percentages on this table are measured relative to the BT residential research benchmark house definition.