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## Towards Zero Energy Homes

T06: Six Case Studies

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## Who We Are

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## Building America

The U.S. Department of Energy's Building America Program is reengineering the American home for energy efficiency and affordability. Building America works with the residential building industry to develop and implement innovative building processes and technologies – innovations that save builders and homeowners millions of dollars in construction and energy costs. This industry-led, cost-shared partnership program uses a systems engineering approach to reduce energy use, utility bills, construction time, and construction waste.

For more information, visit our website at:  
www.buildingamerica.gov



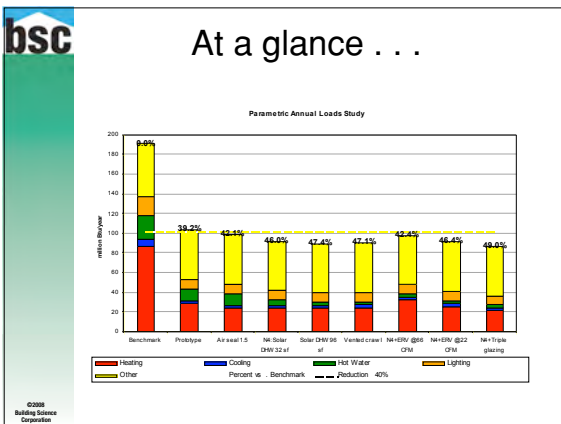
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## Objectives for this morning

- Report on progress “towards zero”
- Forecast next steps
- Share our approach to learning

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## Six Case Studies

1. Bedford, MA — Single-family New Construction
2. Concord, MA — Single-family Renovation
3. Bedford, MA — Single-family Renovation
4. Cleveland, OH — Multi-family New Construction
5. Aspen, CO — Multi-family New Construction
6. Uxbridge, MA — Multi-family New Construction

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**INTRODUCTION –  
TOWARD ZERO ENERGY**

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## What is a “Zero Energy” Home?

A Net Zero Energy Building is  
 “a residential or commercial building with greatly reduced needs for energy through efficiency gains, with the balance of energy needs supplied by renewable technologies”  
 -DOE Building Technologies Program

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## Why go “Towards Zero Energy”?

For Homeowners:

- Lower energy bills and maintenance costs
- More money for things other than energy
- Healthier, more comfortable, more durable homes

For Everyone Else:

- Wise use of resources through energy savings
- Greater energy security through the use of domestic resources
- A healthier environment through reduced emissions

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## The Impact of US Buildings

**Total Energy Consumption by Sector, 2001**

Sector	Percentage
Industrial	34%
Transportation	27%
Residential	21%
Commercial	18%

Source: Energy Information Administration, Annual Energy Review, 2001 data - [www.eia.doe.gov/emeu/aer](http://www.eia.doe.gov/emeu/aer)

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## Contribution to Climate Change

**Carbon Dioxide Emissions from Energy Consumption by Sector, 2001**

Sector	Percentage
Transportation	32%
Industrial	30%
Residential	20%
Commercial	18%

Source: Energy Information Administration, Annual Energy Review, 2001 data - [www.eia.doe.gov/emeu/aer](http://www.eia.doe.gov/emeu/aer)

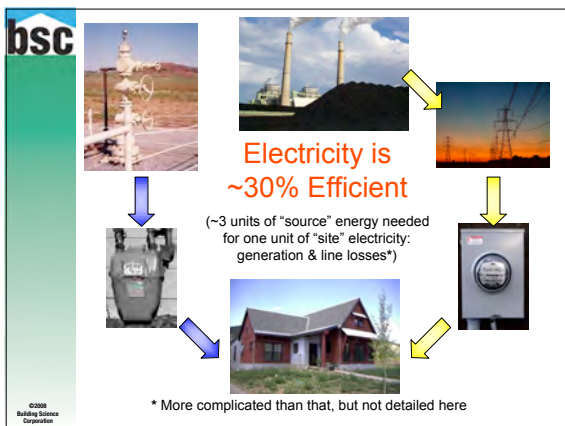
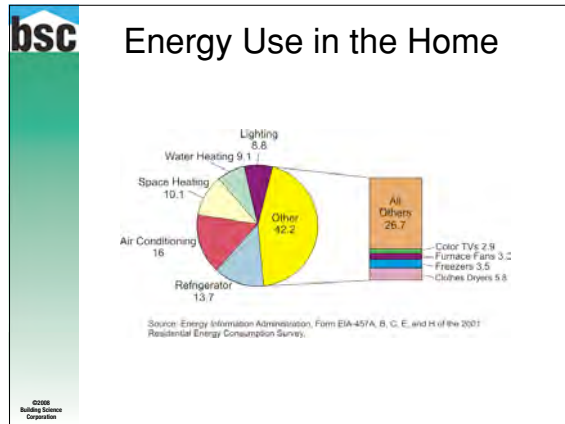
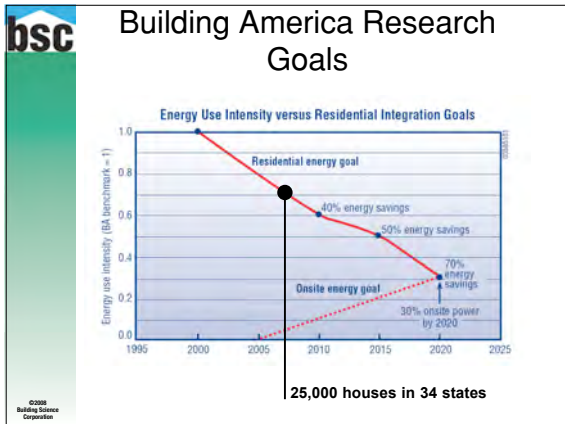
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## Buildings and the Environment

- Largest single global industry
- Hence, buildings consume resources
  - Lots of materials
  - Lots of energy
  - Lots of money
  - Pollute, displace, and destroy habitats
- Last a long time: A “durable good”
  - Running shoe (1 yr), car (10 yr), bldg (100yr?)
- Hence - more careful long-term design
  - i.e. societal involvement is justified

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### Site and Source Energy

Two different energy "yardsticks"

Site is "what you measure at the meter" (electricity, gas)

Source (or "primary energy") is more complicated

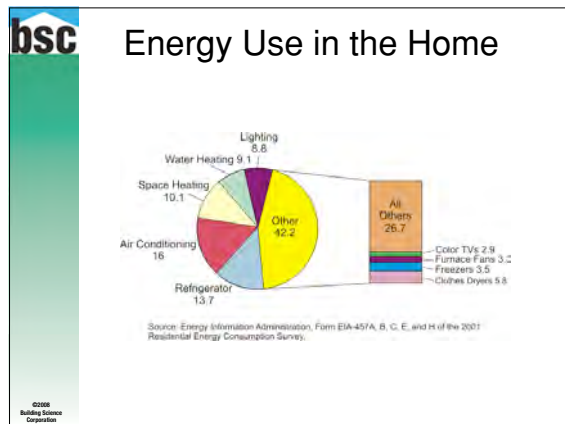
- Where the energy originally comes from
- "Source energy is a measure that accounts for the energy consumed on site and the energy consumed during **generation** and **transmission** in supplying energy to the site."

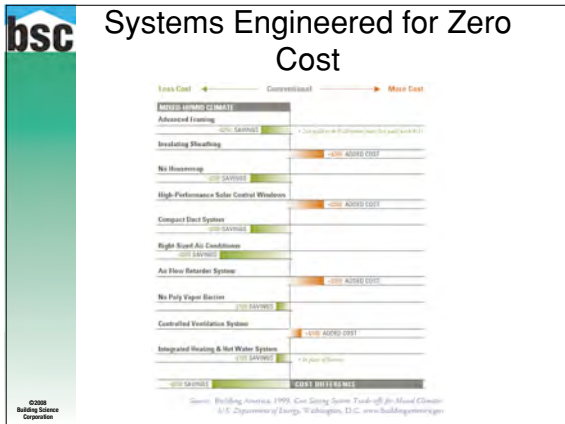
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### So:

- Heating your house with light bulbs is 100% efficient (site energy)
- But it's actually ~30% efficient (source energy)

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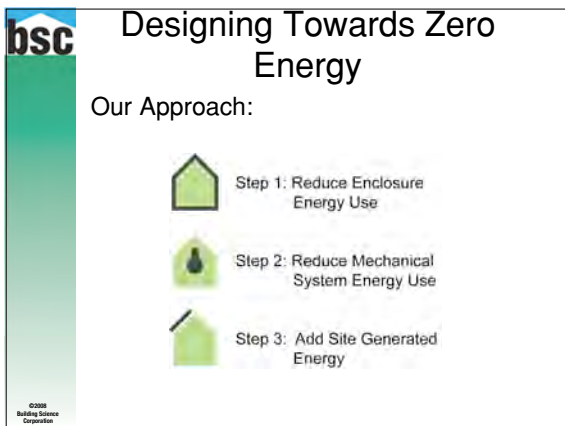


### Looking long term . . .

MIXED-HUMID CLIMATE CASE STUDY HOUSE  
Richmond, VA

STEP 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	Incremental	Annual Energy Cost	Simple Payback (yr)	Incremental Payback (yr)
0 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 Above + Mechanical Upgrades	\$1,000	\$1,400	21.9%	16.0%	\$1,000	5	5
3 Above + Lights & Appliances	\$350	\$1,750	27.4%	5.4%	\$929	5	5
4a 3 + 17 EER, 4 COP GSHP	\$6,000	\$7,750	33.3%	6.0%	\$851	18	77
4b 3 + 40 sq ft SHW	\$3,700	\$5,450	38.5%	11.1%	\$765	10	23
4c 3 + 2kW PV	\$10,000	\$11,750	41.7%	14.3%	\$758	22	58
5 All Strategies	\$19,700	\$21,450	58.8%	31.4%	\$516	28	48

- Balance initial investment with long-term savings
- Add technology in a cost-effective manner



- ### Designing Towards Zero Energy
- Top ten elements in the design of high performance homes:
1. Design for comfort with as little added energy as possible
  2. Build tight
  3. Ventilate
  4. Use more insulation
  5. Provide for durability by controlling moisture
  6. Design a roof that is sloped to the south
  7. Use the most efficient equipment the project can afford
  8. Use efficient lighting, appliances; match to occupant needs

- ### What we are finding . . .
- 40% easy (even for production builders)
  - 50% is getting expensive
  - MEL are becoming larger
  - PV is making more sense in \$/Btu
- Forecast:
- Single-family – 50% enclosure, 50% on-site
  - Multi-family – 30% enclosure, 70% on-site

### 1: SINGLE-FAMILY - BEDFORD, MA