



# Building Technologies Program

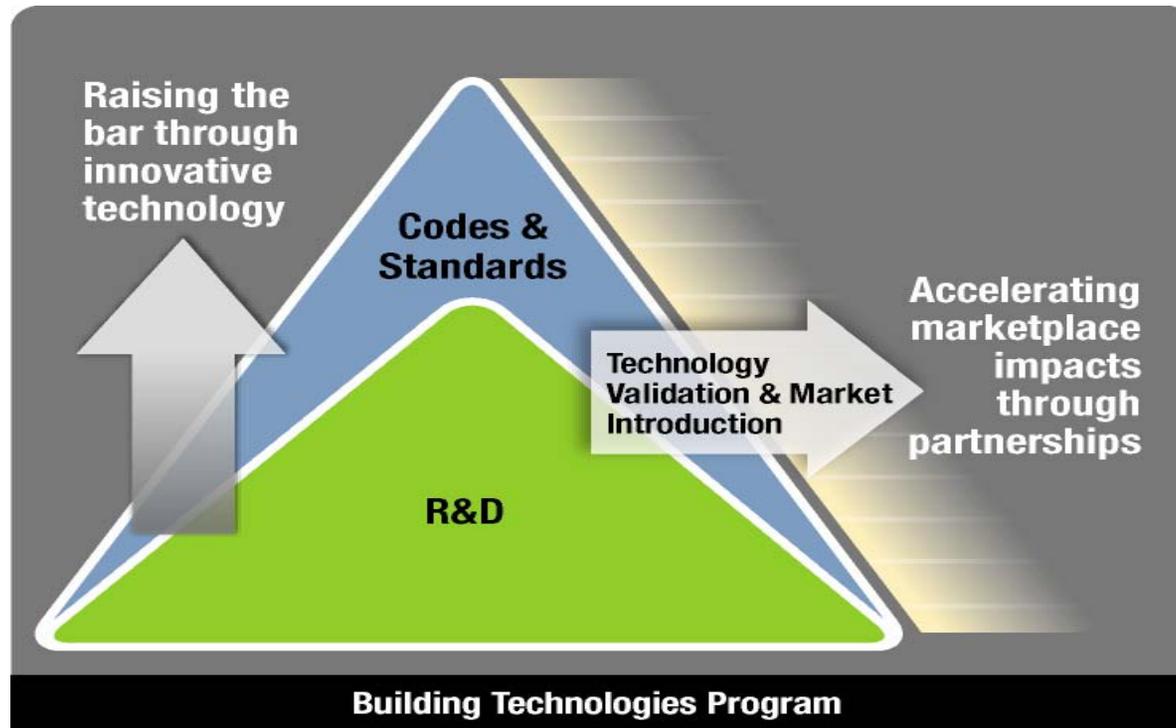
Jerry Dion  
Acting Program Manager  
Building Technologies Program

State Energy Advisory Board Meeting

October 17, 2007

The Buildings Technologies Program researches and deploys new technologies to make homes and commercial buildings more affordable, energy efficient, and better performing

Energy Efficiency & Renewable Energy

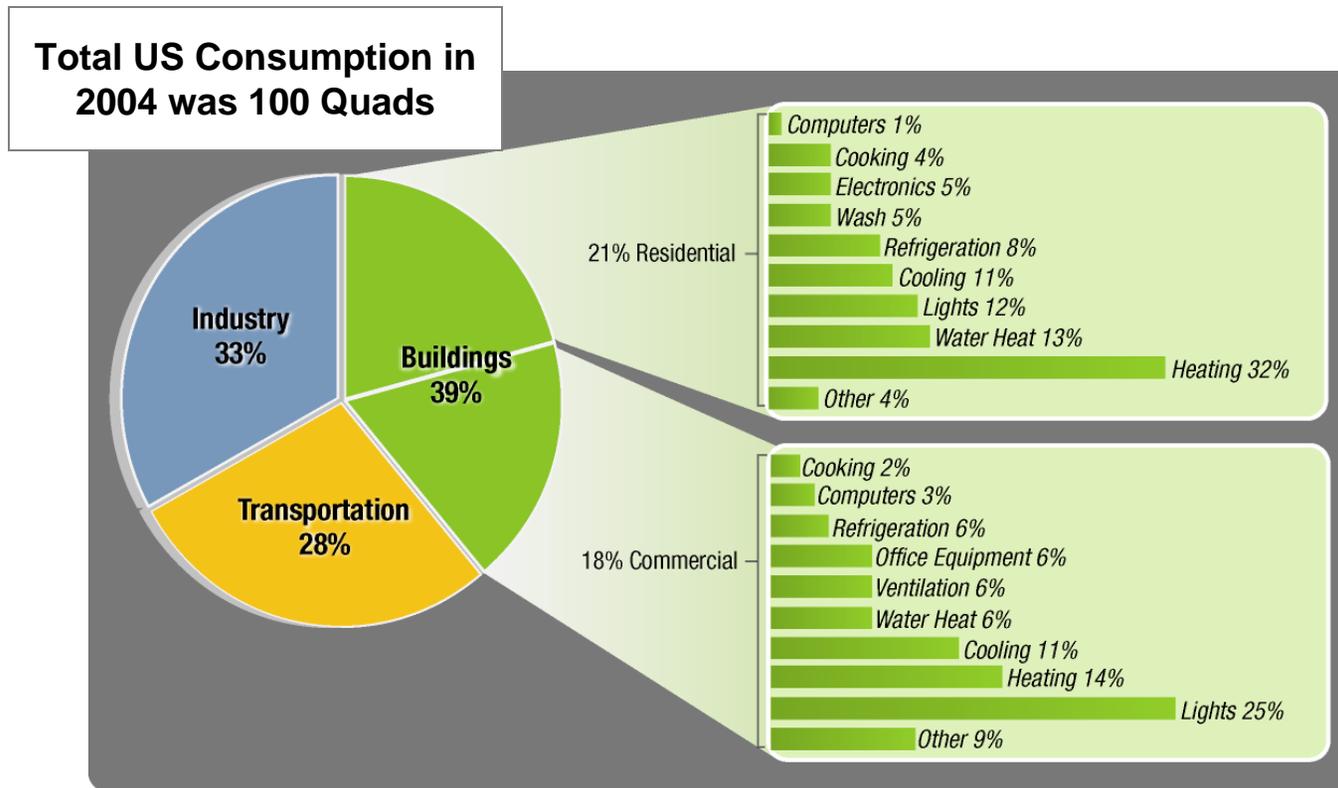


The investment in Buildings R&D yielded an ROI of 15:1 from 1978 to 2000

"Energy Research at DOE: Was it Worth It", NRC 2001, Tables 3.1

Buildings sector accounts for 39% of US energy, 71% of electricity, 55% of Natural Gas, and 38% of carbon, 19% of NOx, and 52% of SO<sub>2</sub> emissions.

Energy Efficiency & Renewable Energy



Building Sector construction and renovation accounts for 9% of GDP and employs 8 million people. Energy utility bills total \$325B each year.

Source: *Buildings Energy Data Book*, September 2006, Tables 1.1.3, 1.1.6, 3.1.1, 3.3.1, 4.1.5, 5.1.2, 5.3.1

# Buildings Technologies Program employs three complementary strategies to achieve its mission

Energy Efficiency & Renewable Energy



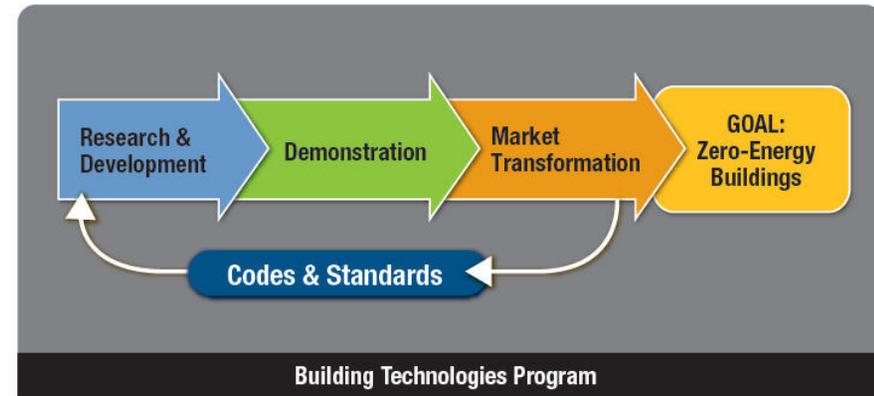
## ➤ R&D

- Whole Building Integration
- Component, Equipment, and Materials

## ➤ Appliance Standards

## ➤ Market Transformation

- Energy Star
- Building Energy Codes



*A net-zero energy building is a grid-connected residential or commercial building that, over the course of a year, produces with renewable sources as much energy as it consumes*

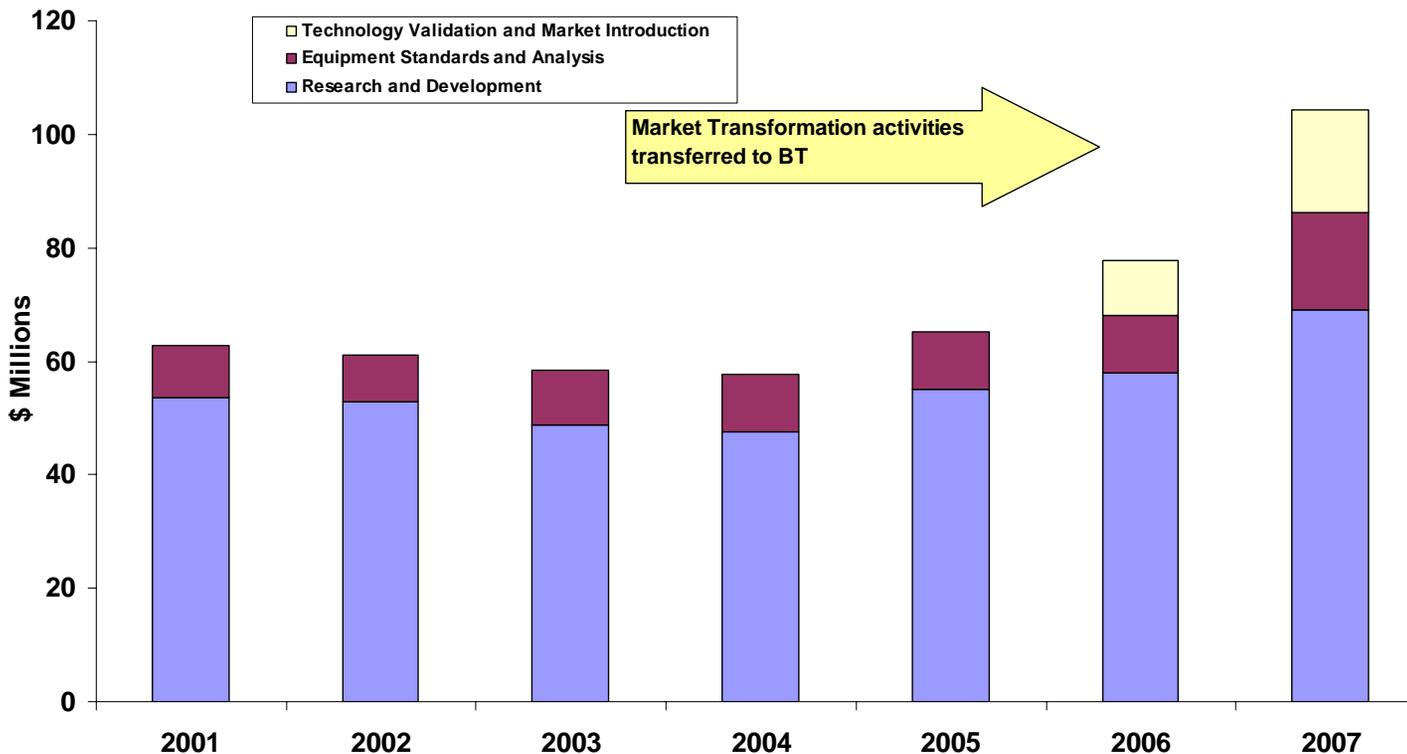
An integrated and aggressive Buildings Program is required to achieve Zero Energy Homes by 2020, and Commercial Buildings by 2025

Buildings Technologies R&D expenditures over the past 7 years demonstrate a consistent commitment to developing leading edge technologies

Energy Efficiency & Renewable Energy



Building Technologies R&D Budget



Building Program continues to evolve to address opportunities, e.g. Solid State Lighting Initiative

Source: U.S. DOE

# Building Technologies Program

Energy Efficiency & Renewable Energy



## U.S. Market

- 40% of all energy is consumed by buildings
- 2 million new homes built each year; could be 30% more efficient at no extra cost over the life of the home
- Green building movement small, but growing

## Accomplishments

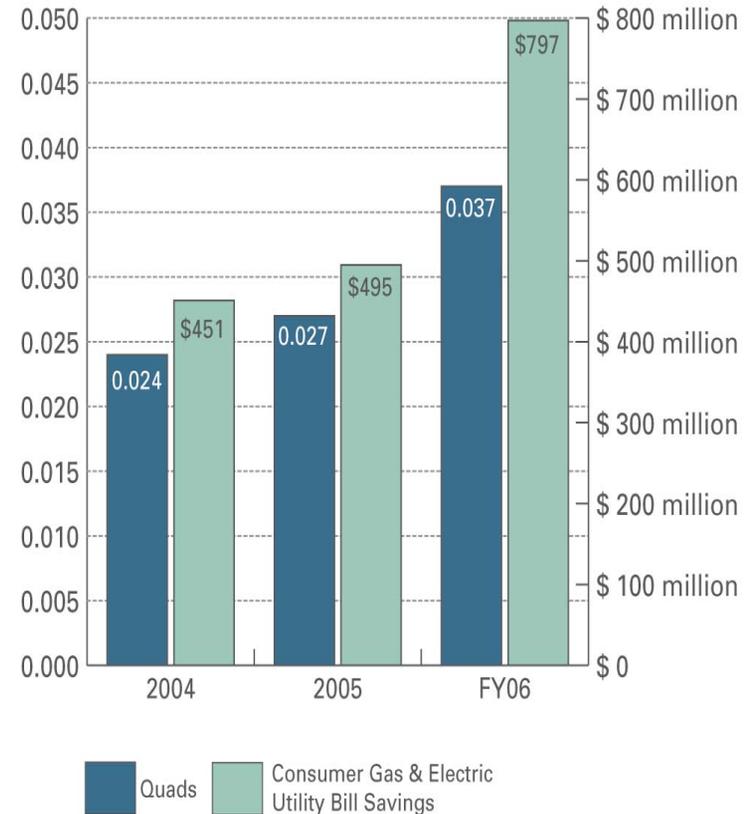
- Pioneered compact fluorescent light bulbs
- SSL breakthrough: World record for the efficacy of a production, market available Light Emitting Diode Lamp white light (85 lumens/watt)
- Technologies for new homes to be 30% more efficient in all climate zones
- Appliance standards savings through 2005: over \$50 Billion; 10 Quads; and nearly 200 million metric tonnes carbon

## Current Program Activities

- Accelerate Appliance Standards Rulemakings
- Buildings R&D leading to zero-energy buildings
- Solid State Lighting R&D
- Promote Adoption of Improved Building Codes

## Example: Energy Star Annual Savings

Annual Savings of All DOE Products



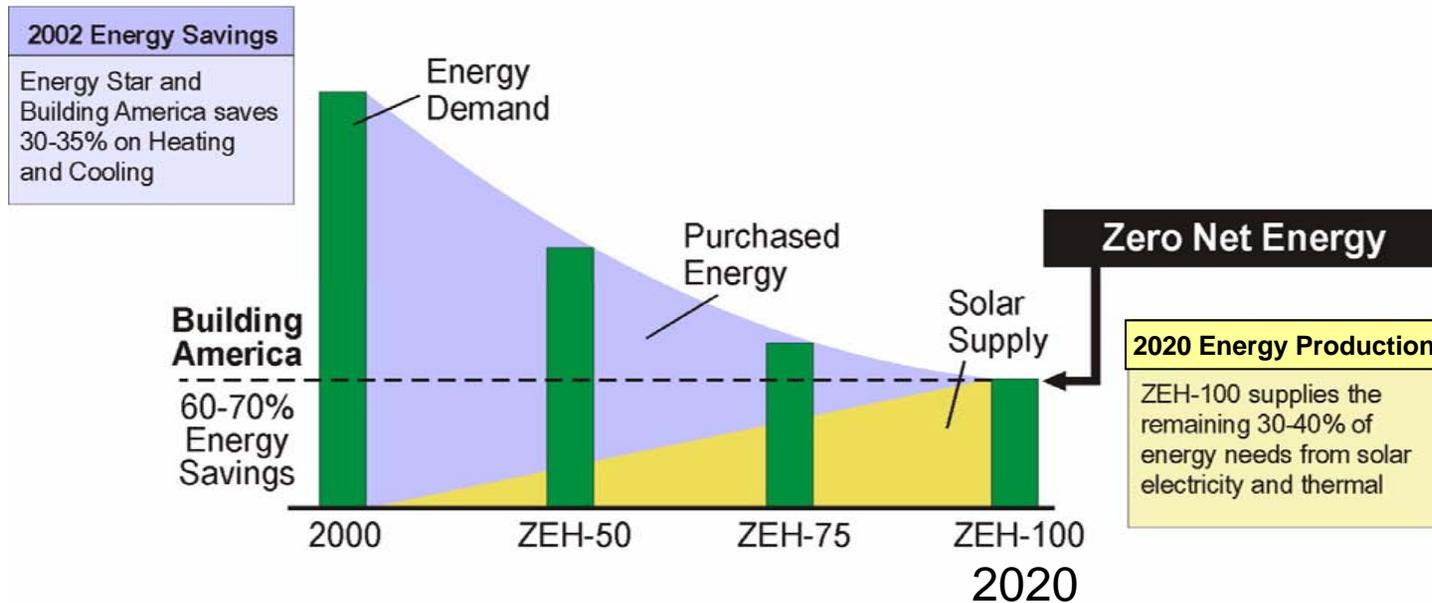
| FY2006 Adjusted Approp | FY2007 Request | FY2007 CR Appropriation | FY2008 Request |
|------------------------|----------------|-------------------------|----------------|
| \$68.2M                | \$77.3M        | \$104.3M                | \$86.5M        |

# Building America Program is marching towards ZEH for All Americans

Energy Efficiency & Renewable Energy



## Zero Energy Homes

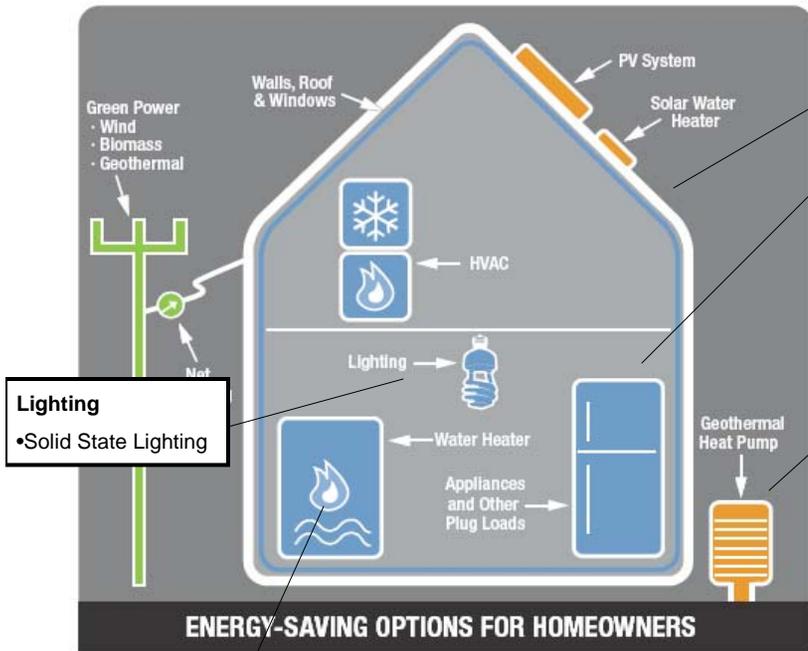


**ZEH-100 Saves 100% of Traditional Household Energy Use**

Ultimate goal is a Zero Energy Home using cost effective tools, techniques and integrated technologies, systems and designs for buildings that generate and use energy so efficiently that buildings are capable of generating as much energy as they consume.

# Building America Program is marching towards ZEH for All Americans

Energy Efficiency & Renewable Energy



**Thermal Envelope**

- High R Walls and Roofs (60-70%)

**Windows**

- R-10 Dynamic Super Window (70-80%)

**Appliances and Other Plug Loads**

- Whole House Energy Control Standard
- Other Misc. Electric Savings (40-50%)

**Space Conditioning and Refrigeration**

- Integrated, low capacity heat pump. (60-70%)

**Lighting**

- Solid State Lighting

**Domestic Hot Water**

- Integration, low capacity heat pump (60-70%)

| Future Zero-Energy Home in Mixed Humid Climate |   |                  |
|--|---|------------------|
|  | Percent Energy Offset (vs. Conventional Home)                         | Incremental Cost |
| Energy Use                                     | Reduction (using State-of-the-Art Design and Efficiency Technologies) | -52%             |
|  | Reduction (from Accelerated Efficiency Research)                      | -15%             |
|  | Avoided due to Solar PV   | -33%             |
|  | <b>Total</b>  | <b>-100%</b>     |
| Associated Costs (\$/yr)                       | Incremental Annual Mortgage Costs                                     | + \$1,855        |
|  | Incremental Annual Utility Bills                                      | - \$2,022        |
|  | <b>Total</b>  | <b>- \$167</b>   |

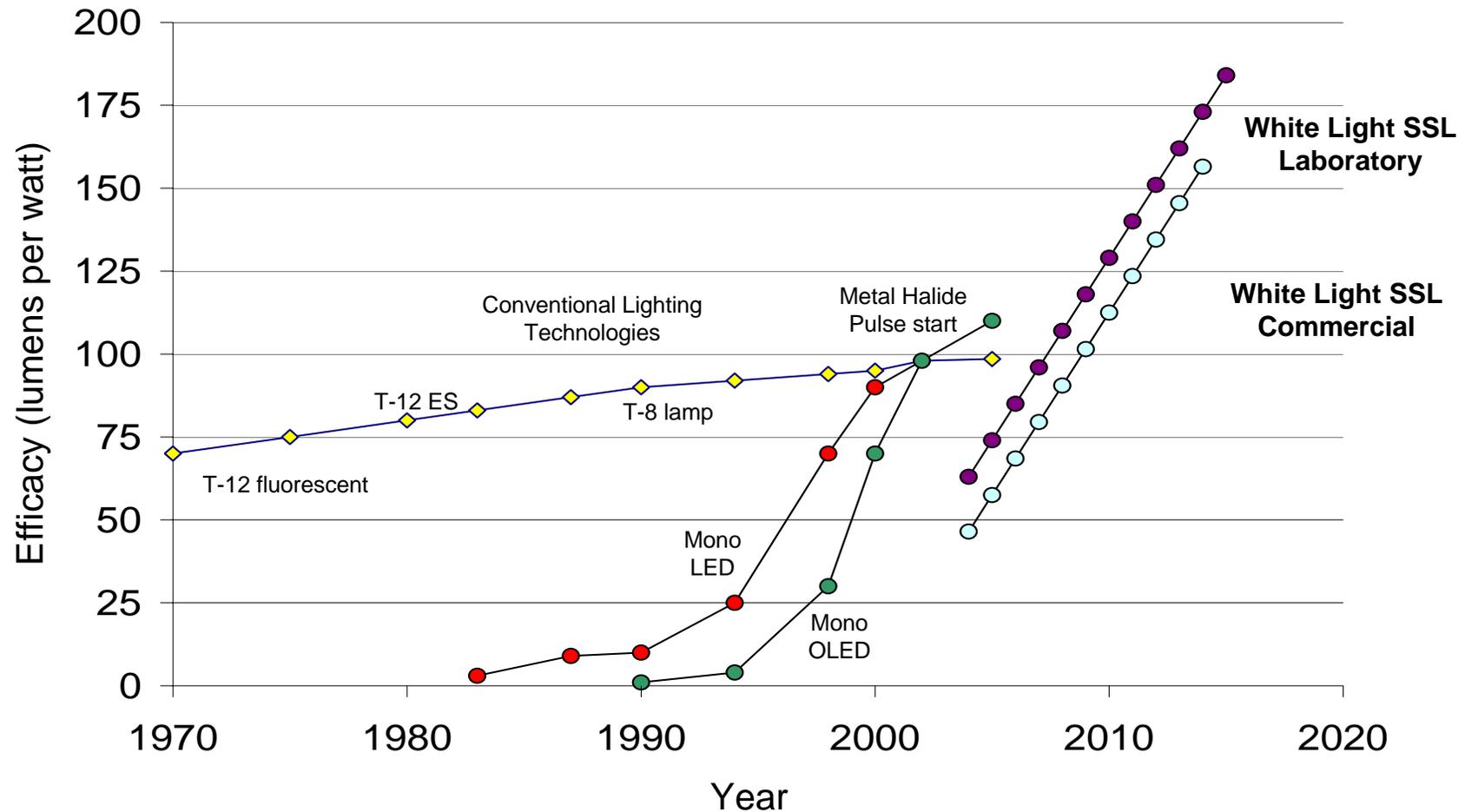
|            |   |              |                   |
|------------|---|--------------|-------------------|
| Energy Use | Reduction (using State-of-the-Art Design and Efficiency Technologies) | -52%         | + \$16,883        |
|            | Reduction (from Accelerated Efficiency Research)                      | -15%         |                   |
|            | Avoided due to Solar PV   | -33%         | + \$16,500        |
|            | <b>Total</b>  | <b>-100%</b> | <b>+ \$33,383</b> |

|                          |                                   |                |
|--------------------------|-----------------------------------|----------------|
| Associated Costs (\$/yr) | Incremental Annual Mortgage Costs | + \$1,855      |
|                          | Incremental Annual Utility Bills  | - \$2,022      |
|                          | <b>Total</b>                      | <b>- \$167</b> |

ZEH homes available now at high cost and only some climates. Goal is to make available to all Americans through technology breakthroughs and cost reduction.

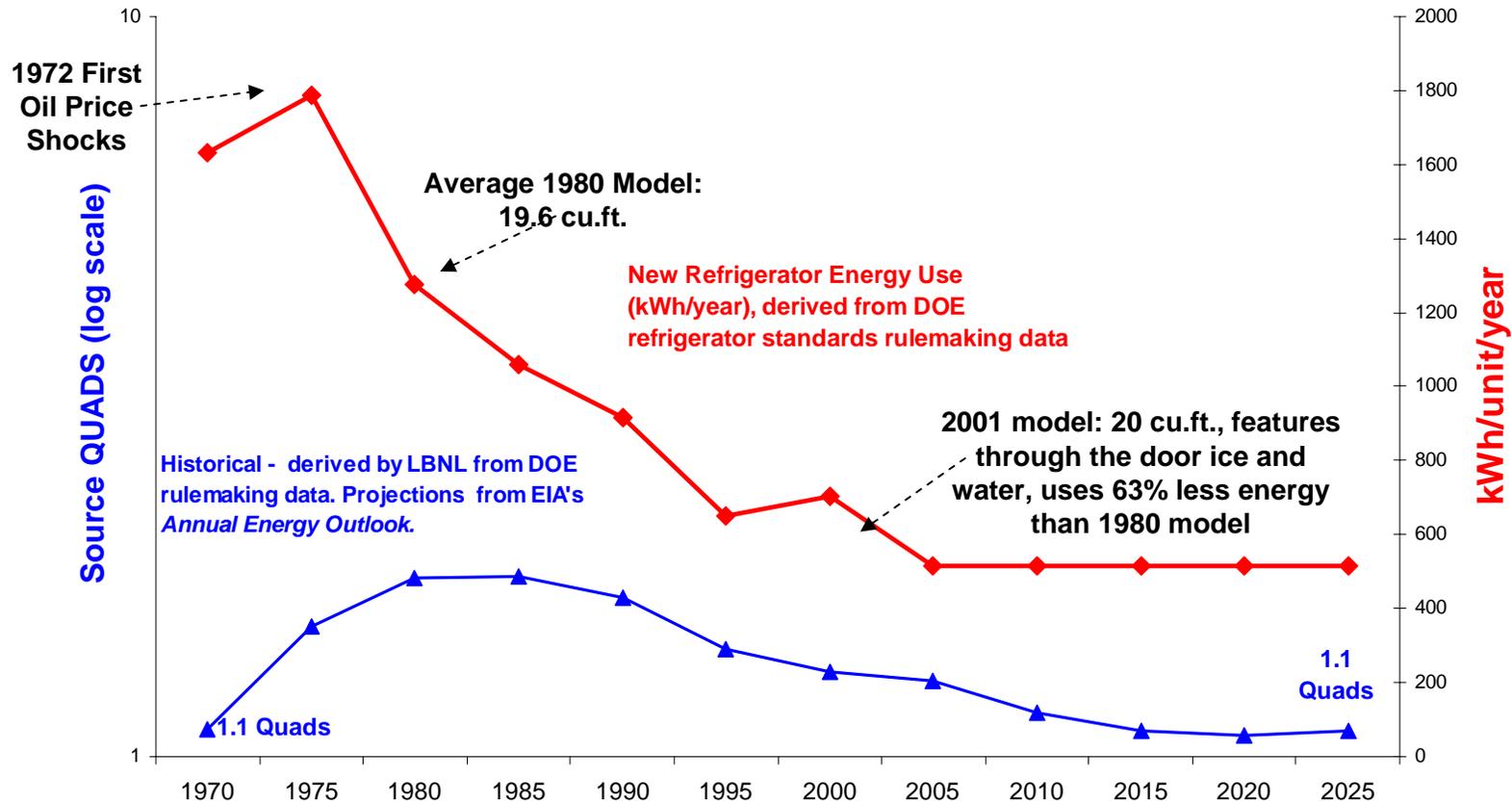


## Accelerated R&D for White Light SSL



*SSL Laboratory and Commercial Curves, revised April 2007*

# Past Successes have resulted in large and sustained savings



Advanced Refrigeration "...one of the last half-century's more remarkable technological achievements in the energy field: a reduction of more than two-thirds in the average electricity consumption over 25 years, even as average unit sizes increased, performance improved,...DOE was an early and effective leader, ..." ("Energy Research at DOE: Was it Worth It", NRC 2001, page 96)

# Market Transformation: Energy Star

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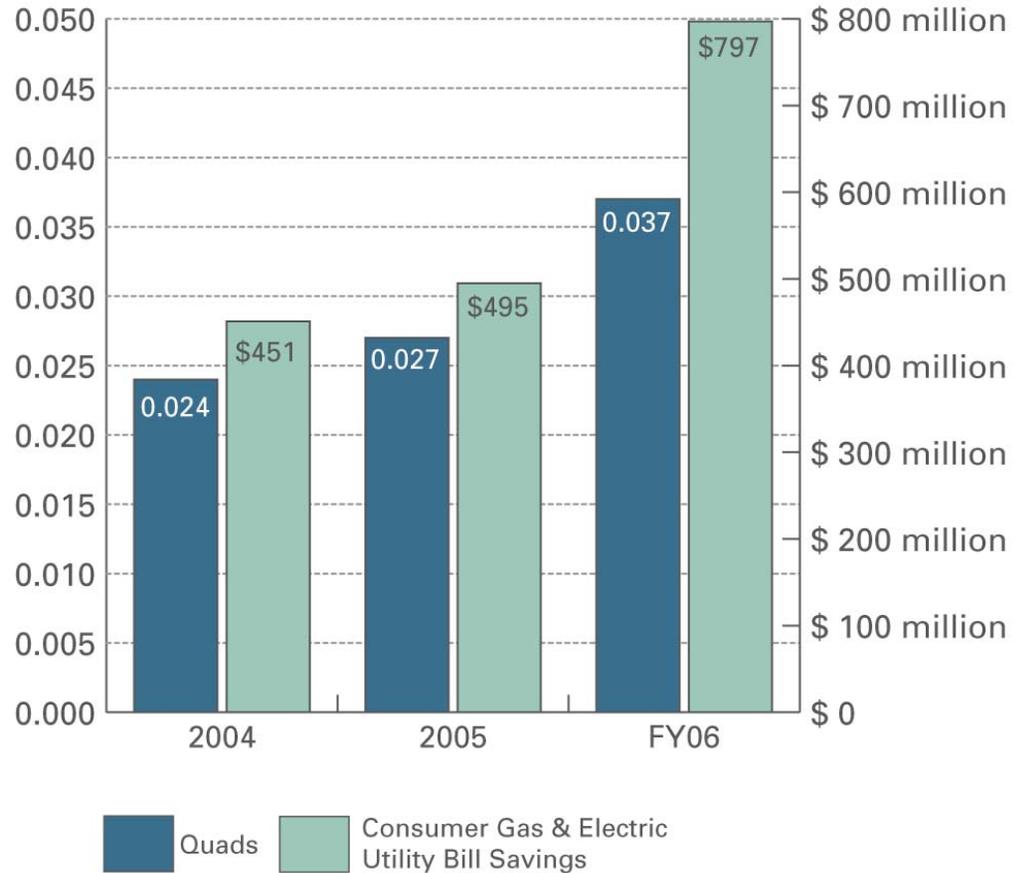
## DOE Products

- Clothes Washers
- Dishwashers
- Refrigerators
- Room A/C
- CFLs
- Windows

## Emerging

- SSL
- Advanced Tech Water Heaters
- Packaged Terminal A/C

Annual Savings of All DOE Products



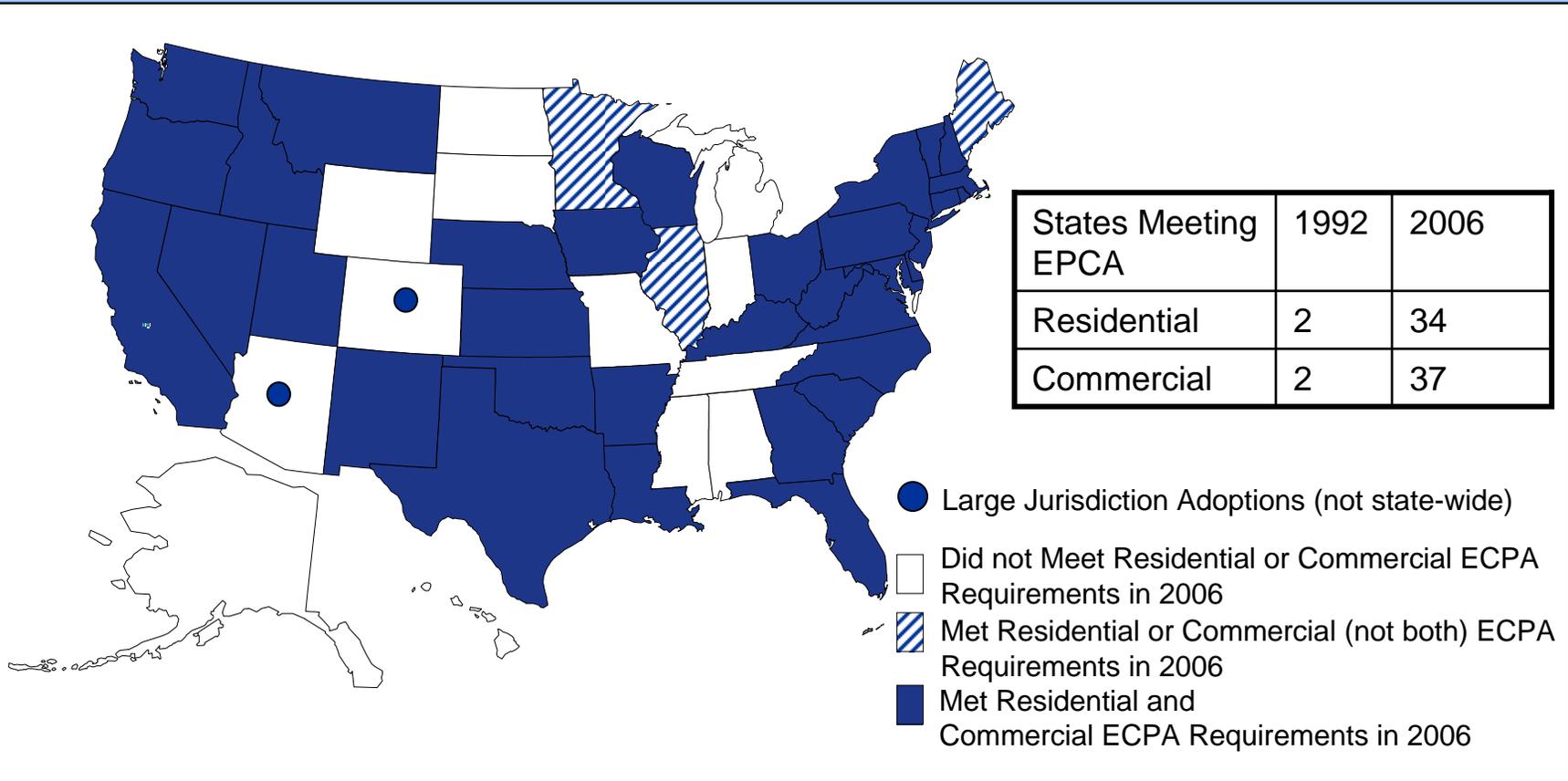
DOE Energy Star beginning to encompass advanced technology... Issued a solid state lighting specification for minimum efficiency

Improved energy codes allow new technologies & better practices. DOE provides technical assistance to states to implement and enforce new codes.

Energy Efficiency & Renewable Energy



### Building Codes by State



**Building Standards evolve as cost and performance of technologies improve over time. Cumulative source energy and avoided carbon savings since 1992 total 0.7 quads and 11 MMTCE, respectively**

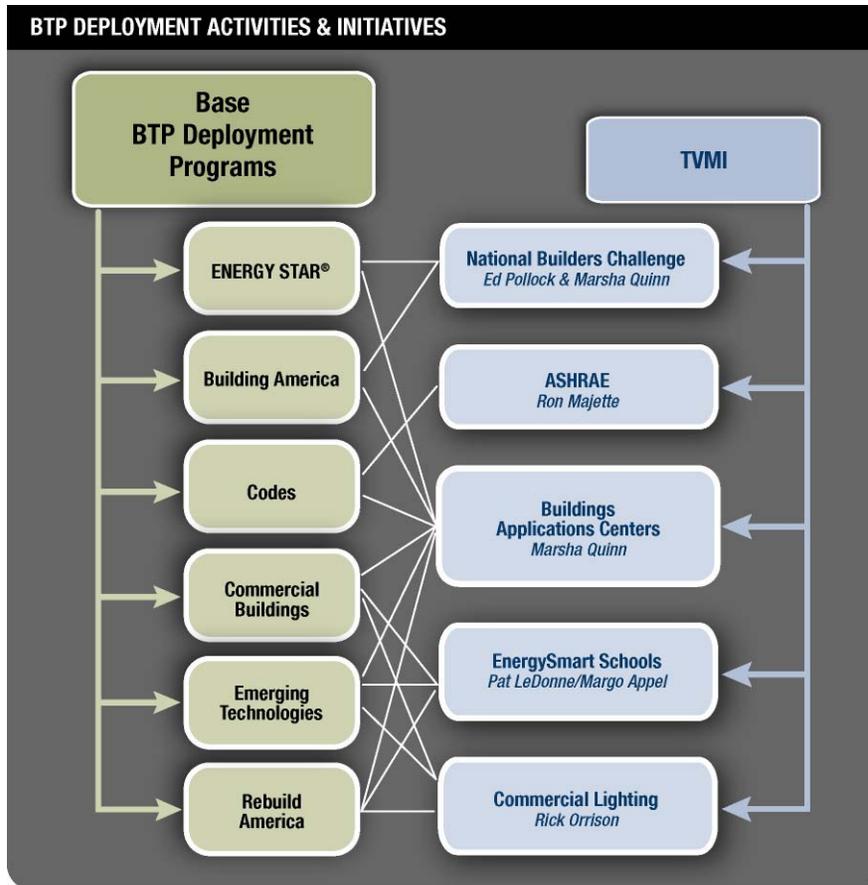


Building Energy Codes is the vehicle to overcome regulatory barriers to new and emerging technologies, broaden use of feasible and cost effective technologies, and provides RD&D off ramp.

- Legislatively mandated to support upgrading of building industry Model Energy Codes:
  - Support incrementally upgrading building industry Model Energy Codes
  - Determine whether upgraded model codes would improve energy efficiency in buildings and publish in *Federal Register*
  - Provide financial and technical assistance to States
  - Develop Federal Building Energy Code (move to FEMP July 2006)



Building Technologies' five new deployment initiatives build upon base activities.



- **National Builders Challenge** will construct over 3.7 million homes between 2007 and 2020.

- **ASHRAE** will accelerate the adoption of the 30% upgraded codes in 3 years.

- **Buildings Application Centers** create a permanent sustainable presence to transfer regionally-focused efficient building protocols and information.

- **Energy Smart Schools** builds 700 new schools at 50% better than code, energy savings and improves 2,800 existing schools by 30%.

- **Commercial Lighting** improves over 5 billion square feet of office space by 30%.

Past standards have addressed significant end-uses.  
Congress has expanded coverage to other end-uses

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### Appliance Standards Developed and Issued by DOE (1987 through 2006)

- Residential Refrigerators (**twice**)
- Room Air Conditioners (residential)
- Residential Central AC & HP
- Residential Water Heaters
- Small Furnaces, <45 kBtu/hr (residential)
- Residential Dishwashers
- Residential Clothes Washers (**twice**)
- Residential Clothes Dryers
- Electric Ranges and Ovens (residential)
- Fluorescent Lamp Ballasts (commercial)
- \*Commercial Warm Air Furnaces
- \*Commercial Water-Cooled AC/Water-Source HP
- \*Commercial Water Heaters

Congress put into place a schedule for Appliance Standards Rulemakings in 1987 (12 standards in 19 years)

\* DOE Adopted ASHRAE 90.1 as revised in Oct. 1999.

### Appliance Standards that DOE Must Issue between January 2007 and June 2011

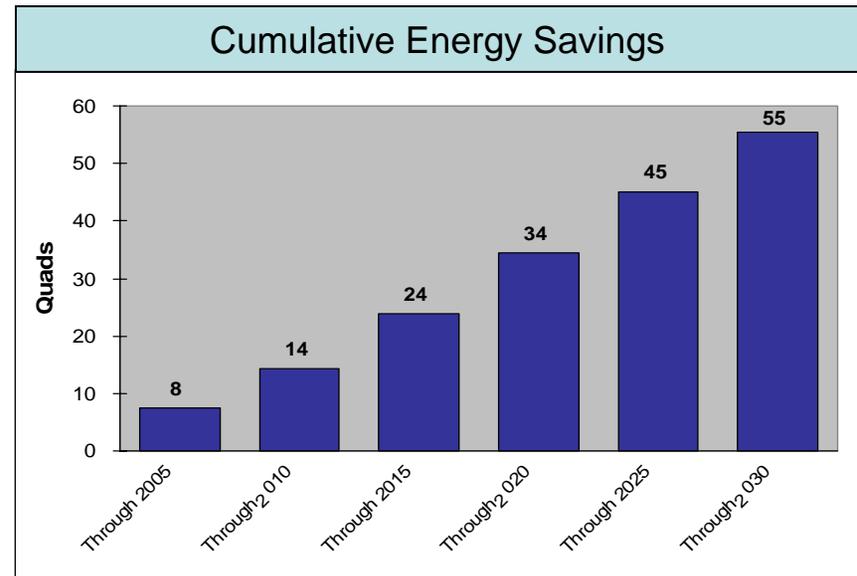
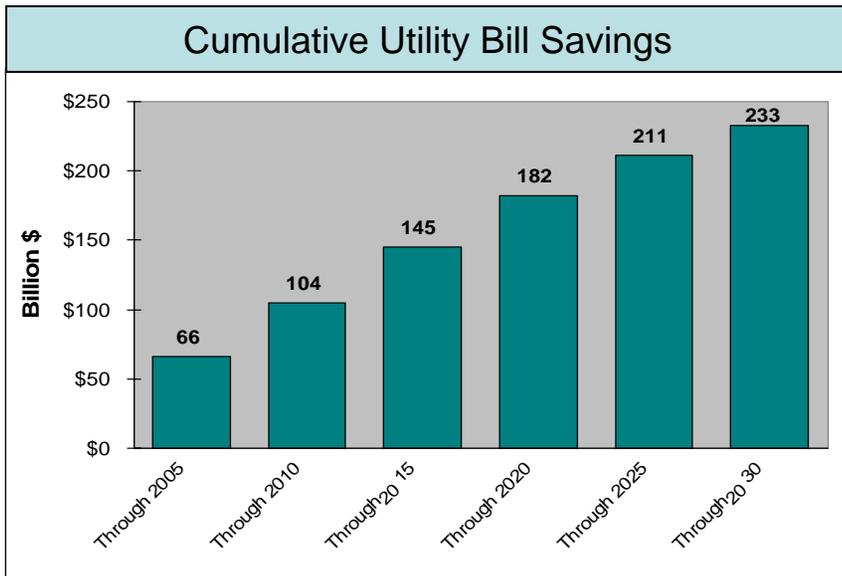
- Residential Furnaces and Boilers
- Mobile Home Furnaces
- Small Furnaces, <45 kBtu/hr (residential)
- Residential Water Heaters
- Direct Heating Equipment (residential)
- Pool Heaters (residential)
- Distribution Transformers, MV Dry and Liquid-Immersed (commercial)
- Electric Motors (1-200 HP) (commercial)
- Small Electric Motors (<1 HP) (commercial)
- Incandescent Reflector Lamps
- Fluorescent Lamps
- Incandescent General Service Lamps
- Fluorescent Lamp Ballasts (commercial)
- Residential Dishwashers
- Gas and Electric Ranges and Ovens and Microwave Ovens (residential)
- Residential Clothes Dryers
- Room Air Conditioners (residential)
- Packaged Terminal Air Conditioners and Heat Pumps
- Residential Central Air Conditioners and Heat Pumps
- Ceiling Fan Light Kits (complete)\*\*
- Residential Dehumidifiers\*\*
- Commercial Clothes Washers\*\*
- Beverage Vending Machines (commercial)\*\*
- Commercial Refrigeration Products\*\*

List does not include products with standards prescribed by EPACT 2005, if DOE does not have to develop subsequent standards. If the August 2008 determination for battery chargers and external power supplies is positive, a final rule will be issued by August 2011. Also, the HID lamp determination is scheduled for June 2010.

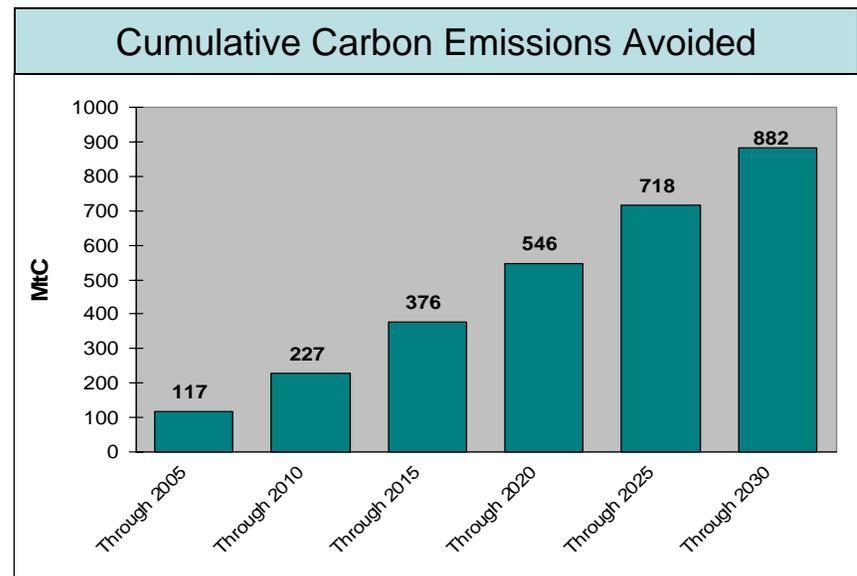
In response to EPACT 2005 and the consent decree, working on 20 new rulemakings, which will add to the above savings

# Appliance Standards already enacted will result in cumulative energy savings of 55 Quads through 2030

Energy Efficiency & Renewable Energy



“The importance of standards pulling technological innovation in buildings...cannot be exaggerated. Often DOE research has been used to provide a proper basis for standards (NRC, 2001)





Building Technologies has some new activities in FY08:

- Commercial Buildings
  - Initiate a new strategy of large scale public-private partnerships with the retail, office and school building segments
  - Engage numerous national building owners in consortia to develop, build, and demonstrate highly efficient prototypical designs that are at least 50 percent more efficient than current designs
  - Provide research to fill technology gaps identified with the consortia, help the consortia implement volume purchase agreements for high efficiency technologies, and other activities to drive energy efficiency into these market segments.
- Residential Buildings
  - Transfer of the Solar Heating and Cooling System and Solar Decathlon activities from the Solar Program to BT.



# Backup Slides

Energy Efficiency &  
Renewable Energy



|                                     | FY 2006<br>Current<br>Approp | FY 2007<br>Request | FY 2007<br>Continuing<br>Resolution | FY 2008<br>Request | FY 2008<br>House Mark | FY 2008<br>Senate<br>Mark |
|-------------------------------------|------------------------------|--------------------|-------------------------------------|--------------------|-----------------------|---------------------------|
| Biomass and Biorefinery Systems R&D | 89,776                       | 149,687            | 199,687                             | 179,263            | 250,000               | 244,000                   |
| Building Technologies               | 68,190                       | 77,329             | 104,329                             | 86,456             | 146,456               | 137,000                   |
| Federal Energy Management Program   | 18,974                       | 16,906             | 19,480                              | 16,791             | 27,000                | 23,000                    |
| Geothermal Technology               | 22,762                       | -                  | 5,000                               | -                  | 44,258                | 25,000                    |
| Hydrogen Technology                 | 153,451                      | 195,801            | 193,551                             | 213,000            | 194,000               | 228,000                   |
| Hydropower                          | 495                          | -                  | -                                   | -                  | 22,000                | 2,000                     |
| Industrial Technologies             | 55,856                       | 45,563             | 56,563                              | 45,998             | 57,000                | 57,000                    |
| Solar Energy                        | 81,791                       | 148,372            | 159,372                             | 148,304            | 200,000               | 180,000                   |
| Vehicle Technologies                | 178,351                      | 166,024            | 188,024                             | 176,138            | 235,441               | 230,000                   |
| Activities                          | 316,866                      | 225,031            | 281,731                             | 204,904            | 314,947               | 398,575                   |
| Wind Energy                         | 38,333                       | 43,819             | 49,319                              | 40,069             | 57,500                | 57,500                    |
| Facilities and Infrastructure       | 26,052                       | 5,935              | 107,035                             | 6,982              | 195,699               | 6,982                     |
| Program Support                     | 13,321                       | 10,930             | 10,930                              | 13,281             | 18,930                | 13,481                    |
| Program Direction                   | 101,868                      | 91,024             | 99,264                              | 105,013            | 110,013               | 105,013                   |
| Use of Prior Year Balances          | -3,339                       | -                  | -                                   | -                  | -                     | -                         |
| <b>TOTAL EERE</b>                   | <b>1,162,747</b>             | <b>1,176,421</b>   | <b>1,474,285</b>                    | <b>1,236,199</b>   | <b>1,873,244</b>      | <b>1,707,551</b>          |



| Building Technologies                            | FY 2007<br>Current<br>Appropriation | FY 2008<br>Request | FY 2008<br>House Mark | FY 2008<br>Senate Mark |
|--|-------------------------------------|--------------------|-----------------------|------------------------|
| Residential Buildings Integration                | 17,270                              | 19,700             | 19,700                | 27,000                 |
| Commercial Buildings Integration                 | 8,699                               | 7,000              | 7,000                 | 17,000                 |
| Emerging Technologies                            | 41,840                              | 32,756             | 52,756                | 41,000                 |
| Technology Validation and Market<br>Introduction | 18,249                              | 13,361             | 43,361                | 32,000                 |
| Equipment Standards and Analysis                 | 16,925                              | 13,639             | 23,639                | 20,000                 |
| <b>Total, Building Technologies</b>              | <b>102,983</b>                      | <b>86,456</b>      | <b>146,456</b>        | <b>137,000</b>         |

FY 2007 CR Incremental Funding \$27,000,000

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Renewable Energy



### Highlights:

- Solid State Lighting (\$10,000,000)
- Appliance Standards (\$5,000,000)
- Energy Efficient Reconstruction (\$2,000,000)
- Commercial Zero-Energy buildings (\$3,000,000)
- Energy Star (\$3,000,000)
- Energy Building Code (\$3,000,000)
- EnergySmart Schools and Hospitals (\$3,000,000)
- Asia Pacific (-\$2,000,000)

### Progress:

- Solid State Lighting - three solicitations totaling \$15,000,000
- Energy Star –DOE hosted an advanced technologies (photovoltaics, small wind, and fuel cells) workshop to initiate dialogue with industry stakeholders (April 26, 2007)
- Energy Building Code- MOU signed with ASHRAE to make codes 30% better than Standard 90.1-2004

## Major Solicitations in 2007/2008

Energy Efficiency &  
Renewable Energy



- Building America Energy Efficient Housing Partnerships
- Energy Efficient Building Technologies Application Centers
- Solid State Lighting - Core Research - Round 4
- Solid State Lighting - Product Development - Round 4