Energy Efficiency &
Renewable Energy

Driving for Net-Zero Energy

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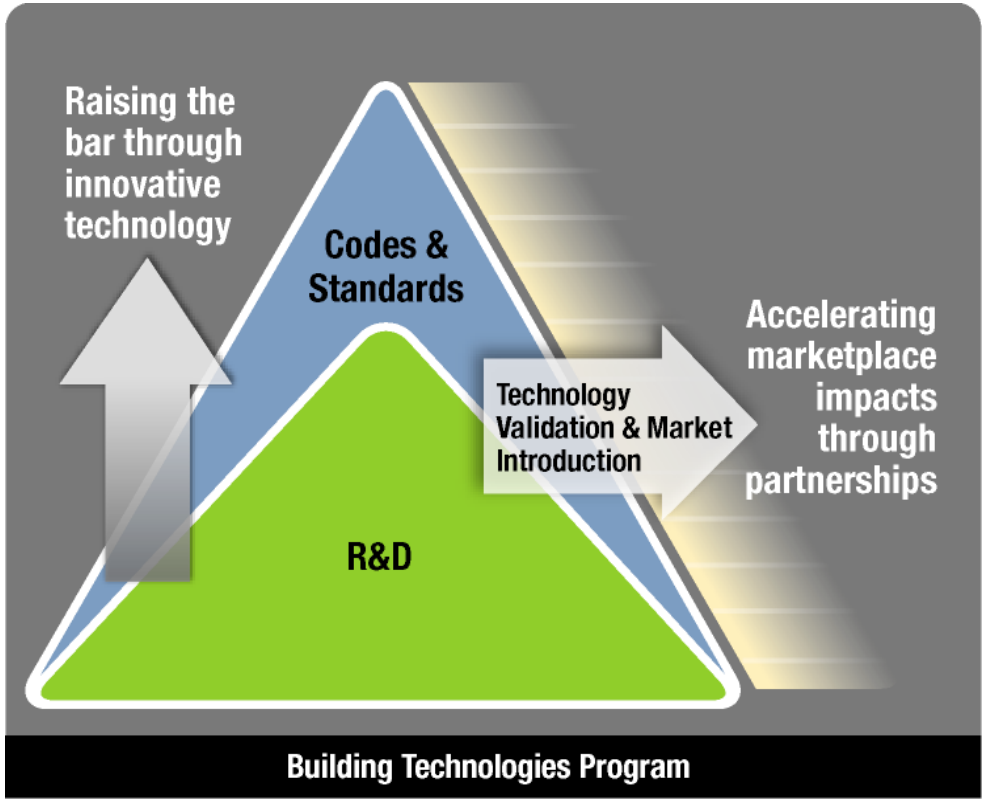
DOE Office of Energy Efficiency and Renewable Energy

May 15, 2008
Net Zero Energy High Performance Green Buildings Workshop
Subcommittee on Buildings Technology Research and Development

DOE Buildings Strategy

Energy Efficiency &
Renewable Energy



Targets:

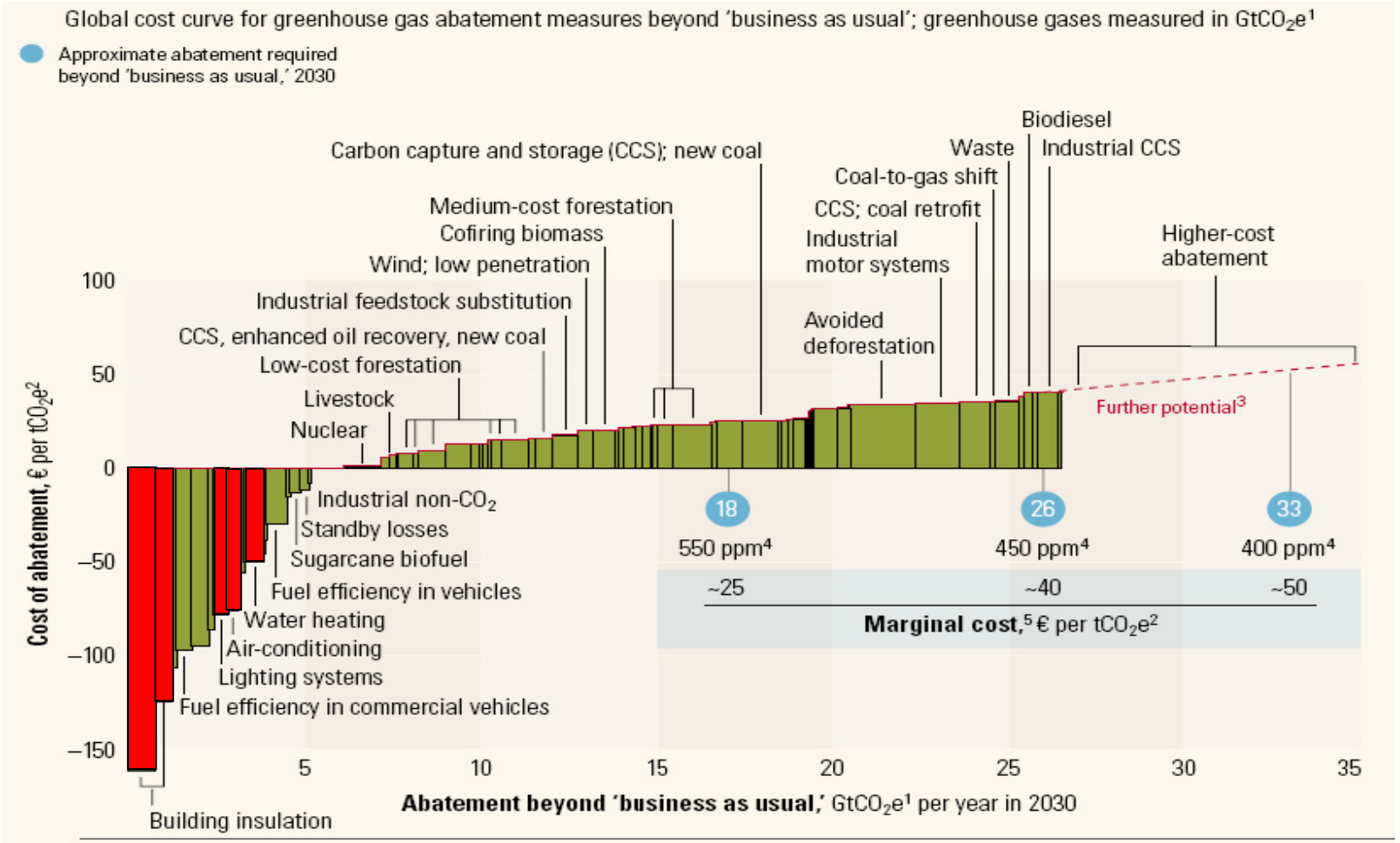
Affordable net-zero energy residential buildings (by 2020) and commercial buildings (by 2025)

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

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

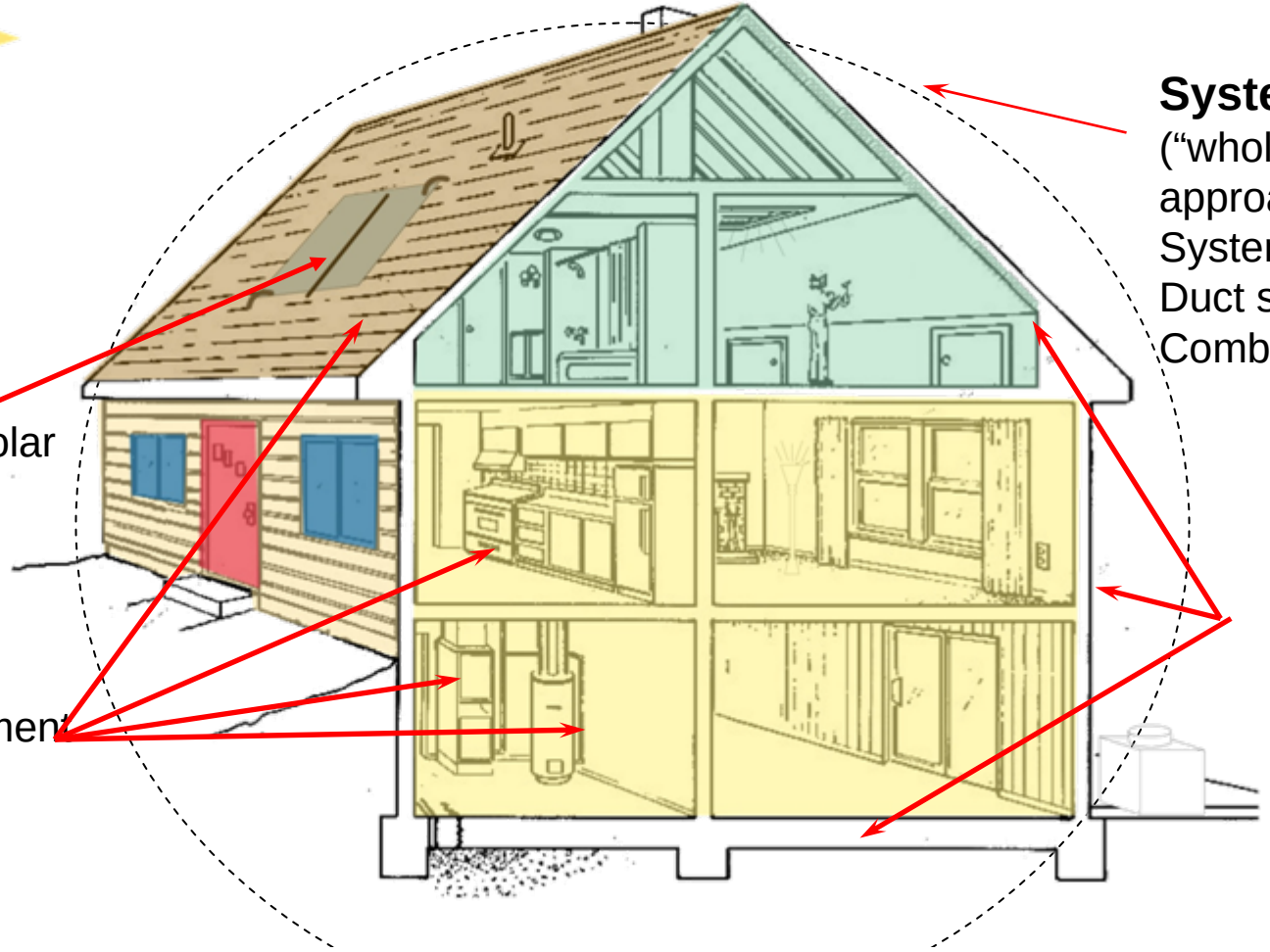
Low/No-Cost Carbon Reduction Options

Energy Efficiency & Renewable Energy



[1] $GtCO_2e$ = gigaton of carbon dioxide equivalent; "business as usual" based on emissions growth driven mainly by increasing demand for energy and transport around the world and by tropical deforestation.
[2] tCO_2e = ton of carbon dioxide equivalent.
[3] Measures costing more than €40 a ton were not the focus of this study.
[4] Atmospheric concentration of all greenhouse gases recalculated into CO_2 equivalents; ppm = parts per million.
[5] Marginal cost of avoiding emissions of 1 ton of CO_2 equivalents in each abatement demand scenario.

Source: McKinsey Global Institute, 2007



Renewable Energy
Photovoltaics
Fuel Cells, Solar Hot Water,
Geothermal

Equipment
HVAC equipment
Lights
Appliances

Systems
("whole-house" approach)
System Integration
Duct sealing
Combustion testing

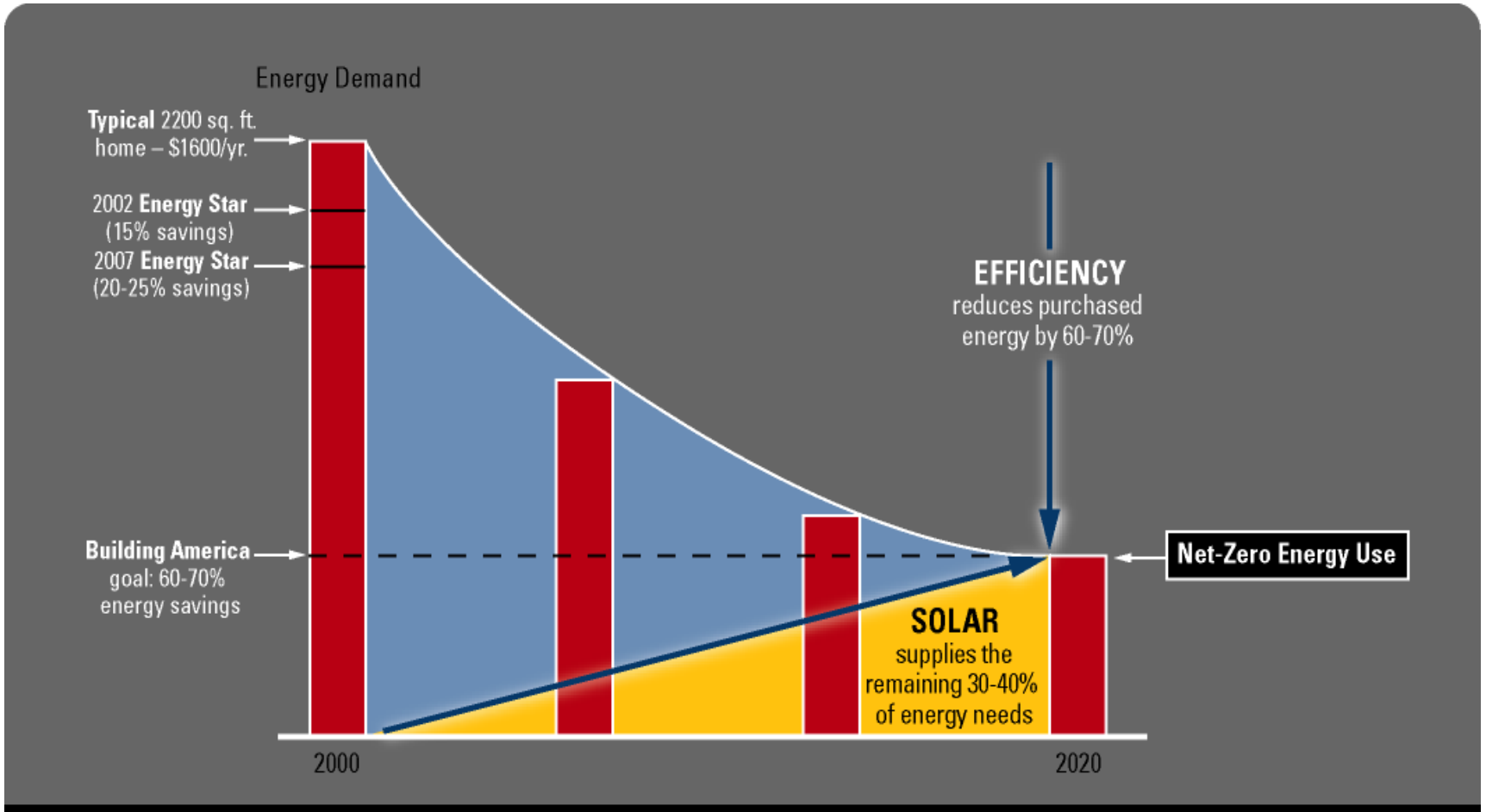
Building Envelope
Insulation,
Windows,
Walls, Floors
Air sealing

Reduce total building energy use by 60–70 percent

Highly efficient, cost-effective lighting technologies, air sealing advanced windows, appliances and space heating and cooling technologies.

Pathway to Net-Zero Energy Homes

Energy Efficiency & Renewable Energy



Pathway to Net-Zero Energy Home

Commercial Building Integration

Energy Efficiency & Renewable Energy

Lighting/Windows

Cooling/Heating

Materials

Photovoltaics

Putting the right Materials, Components, Systems, and Controls together to Reduce Energy Use by 60-70%

Controls

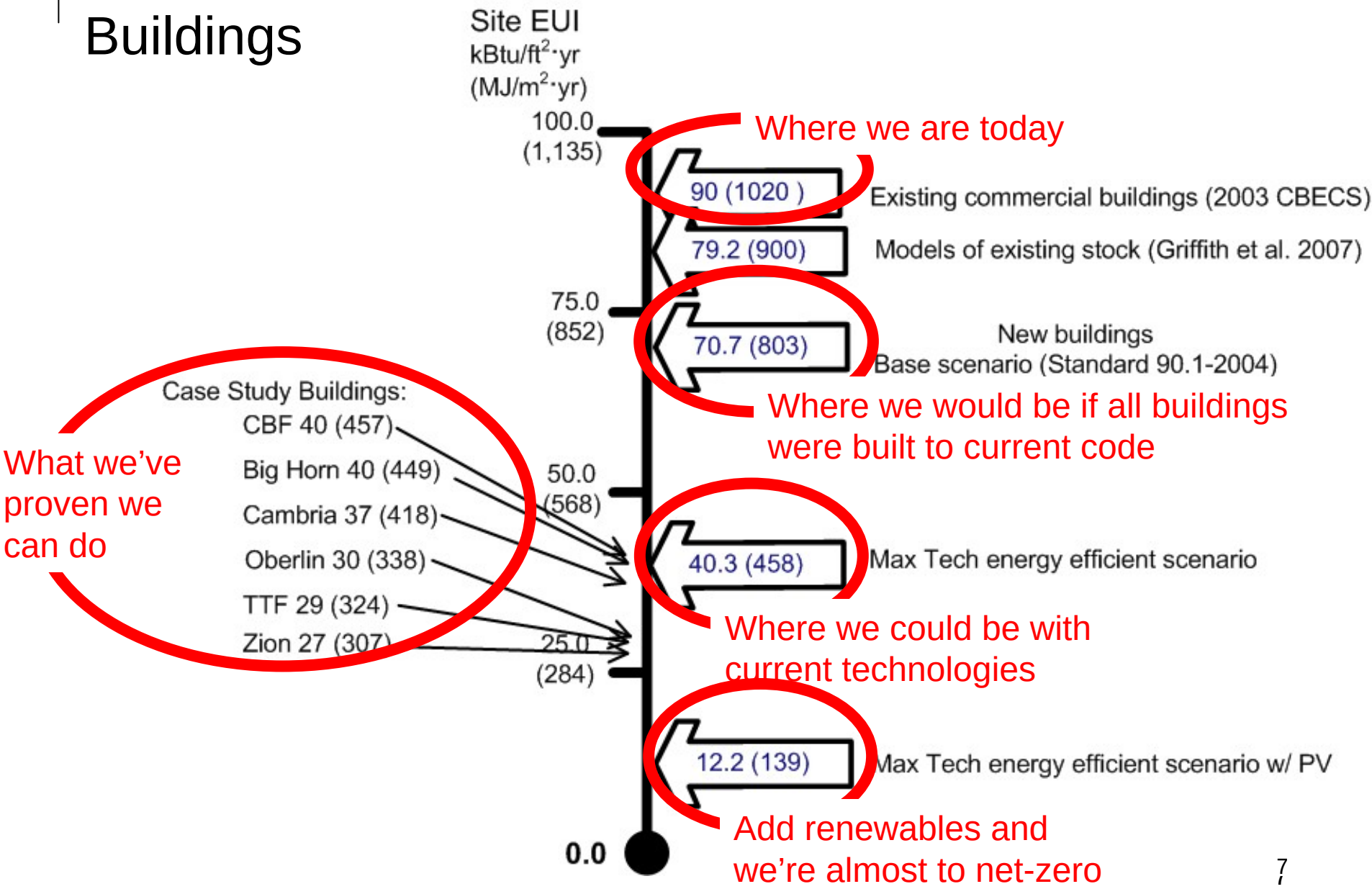
Equipment

Fuel Cell

Air Quality

Great Potential in Commercial Buildings

Energy Efficiency & Renewable Energy



Going Forward: Commercial Building Strategy

Energy Efficiency & Renewable Energy

- National Energy Alliances
  - Strategic alliances with businesses and organizations for targeted building types/market sectors
  - Baseline and share best practices
  - Participate in volume purchases for equipment to pull suppliers to higher levels of efficiency and reduce cost
  - Planning 4 alliances
    - Retailer
    - Commercial Real Estate (Offices, REITs, Finance, Lodging)
    - Institutional (including K-12, Colleges and Universities, State and Local Government, Hospitals and Healthcare)
    - Commercial Building Industry Alliance (utility, associations, NGOs, manufacturers)
  - Voluntary Effort
    - Building owners and operators
    - Design and construction firms
    - Standards bodies
    - NGOs and other energy advocates
  - Charter members of Retailer Energy Alliance in place and effort launched in February 2008
  - Launch of other alliances to follow later in 2008-2009.

- National Accounts
  - Work directly with market leaders to optimize current standard design for increasing levels of efficiency and build, monitor, replicate, and share with National Energy Alliances

- Building Package Research and Development
  - DOE sponsored development of advanced design guide products, building decision tools, and technology option sets to support realization of 50% and better buildings

Resources

Energy Efficiency & Renewable Energy

- eere.energy.gov
- energystar.gov
- energysavers.gov
- highperformancebuildings.gov
- buildingamerica.gov
- buildingamerica.gov/challenge

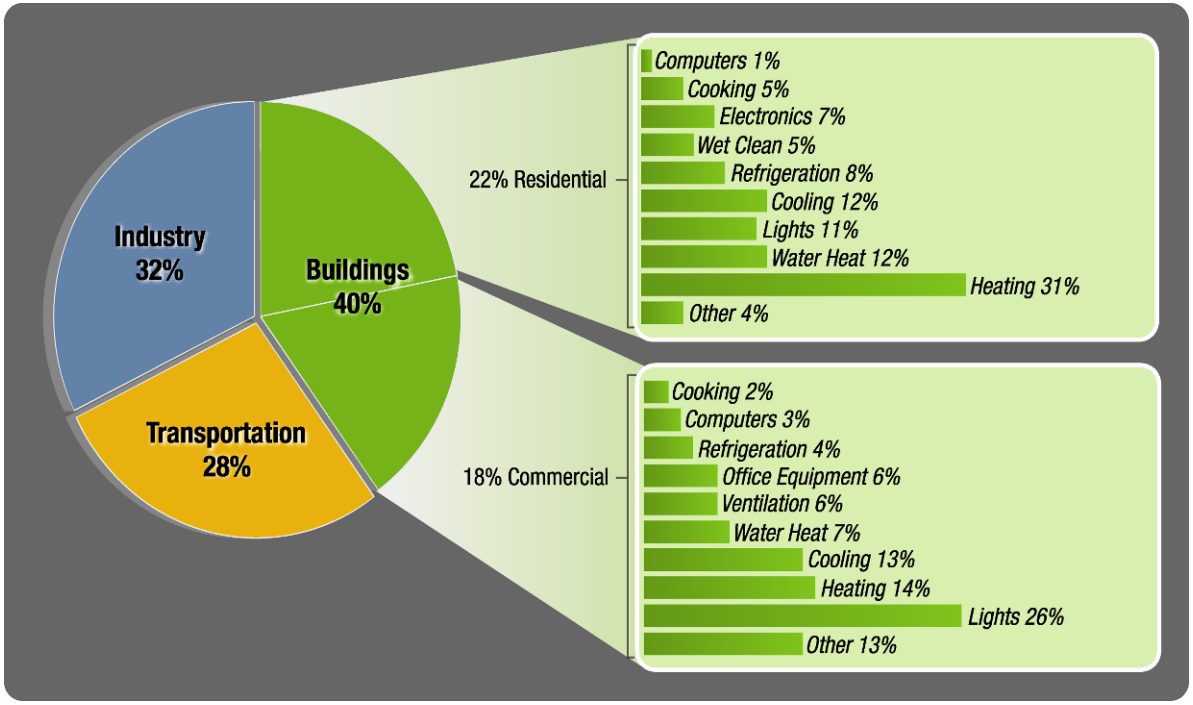
Background Slides not used

Why Buildings?

Energy Efficiency & Renewable Energy

Buildings account for about 40% of US energy, 72% of electricity, 55% of natural gas, 39% of carbon, 19% of NOx, and 52% of SO_2 emissions

Total US consumption in 2005 was 100 Quads



Construction and renovation accounts for 9% of GDP and employs 8 million.
Energy utility bills total $370B each year.

Source: *Buildings Energy Data Book*, September 2007, Tables 1.1.3, 1.1.6, 3.1.1, 3.3.1, 4.1.5, 5.1.2, 5.3.1

DOE Buildings R&D: Driving Toward Net-Zero Energy Buildings

Energy Efficiency & Renewable Energy

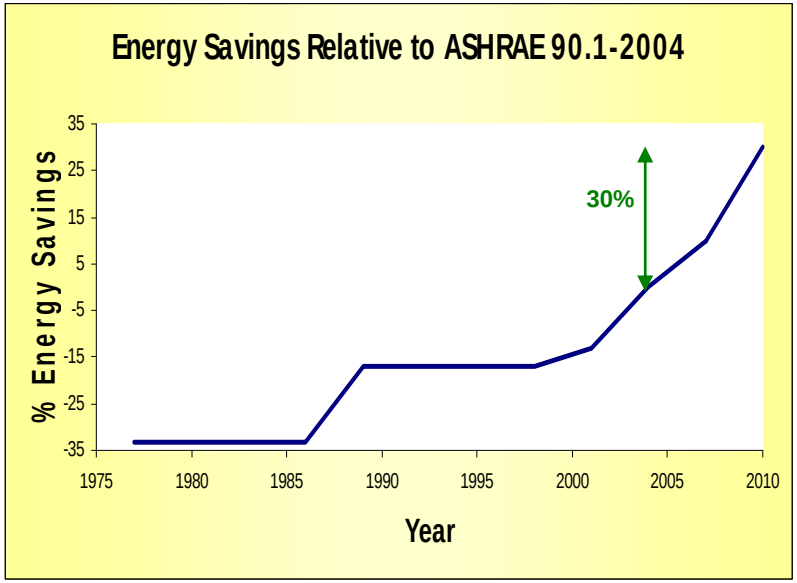
Grid-connected buildings that:

- *Use 60% to 70% less energy than conventional counterparts*
- *And, over the course of a year, produce with renewable sources as much energy as they consume*

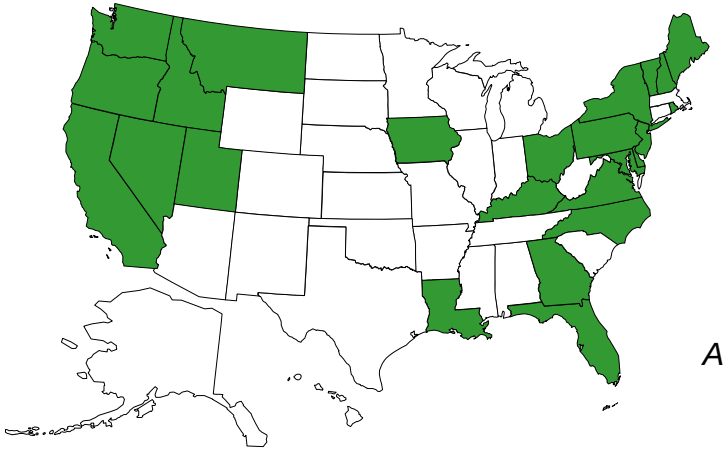
Commercial Building Codes

Energy Efficiency & Renewable Energy

- Goals FY08, FY09: DOE and ASHRAE will continue to work toward their 30% savings goal.
- BECP will work with ASHRAE to develop a performance-based approach for Standard 90.1 (ASHRAE linked criteria idea).
- BECP expects additional requests from ASHRAE for support improving Standard 90.1.



DOE is working with ASHRAE to achieve 30% more energy efficiency relative to Standard 90.1-2004 by 2010.

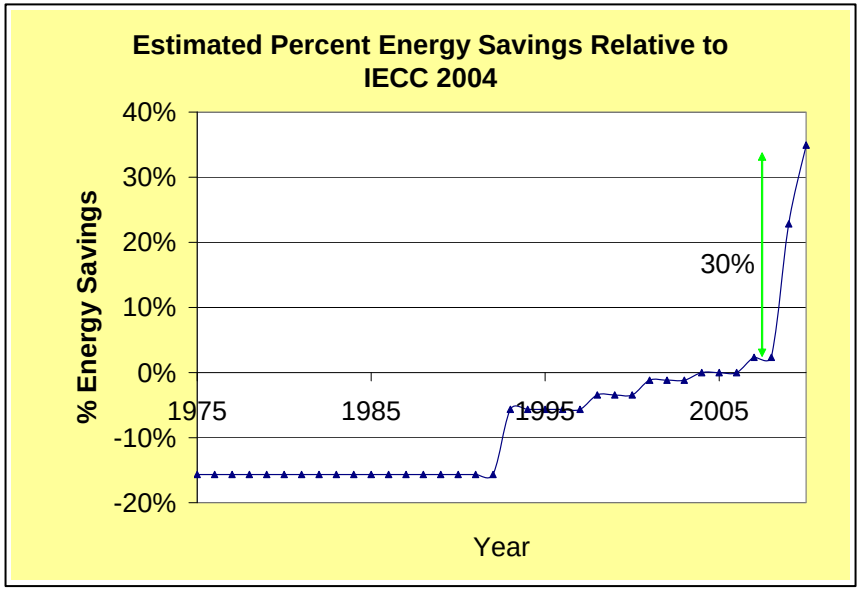


A long road ahead: many states (white) do not meet ASHRAE Standard 90.1-2004.

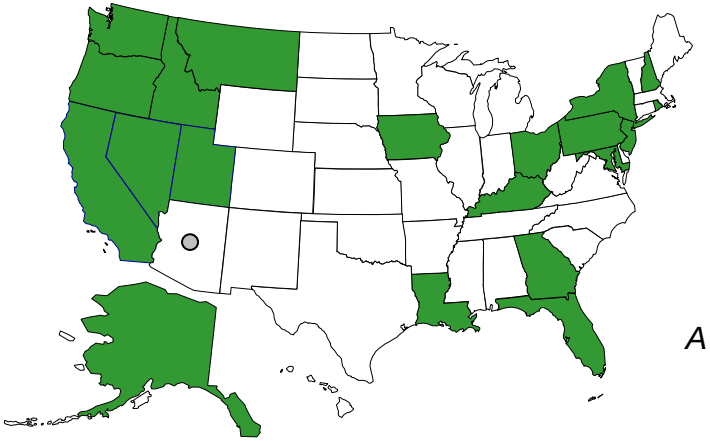
Residential Building Codes

Energy Efficiency & Renewable Energy

- Future Goals (FY08, FY09)
  - Advance residential energy code by 30%.
    - Appliance Standards preemption likely to prevent.
  - DOE will work with all interested parties, including the two current coalitions, to promote efficient, usable, adoptable, and enforceable improvements to the IECC.
  - To the extent the IECC fails to meet the 30% goal, DOE will work with the same parties to develop a separate specification that does.



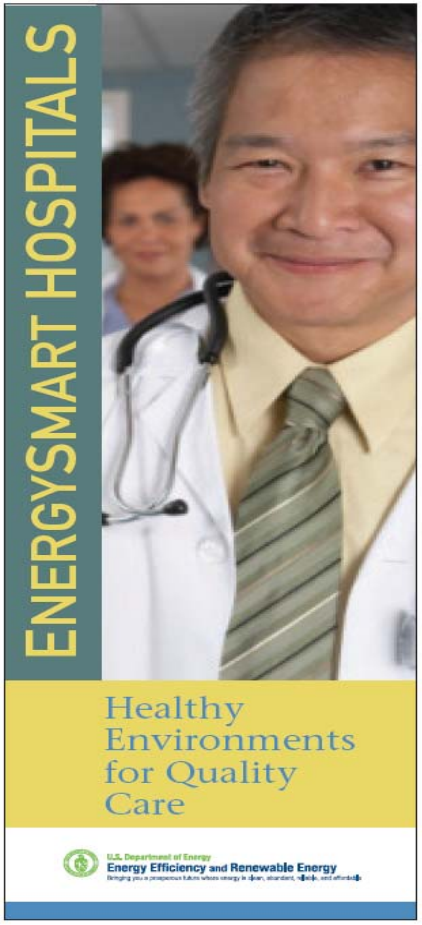
DOE (EERE) is committed to advancing the residential energy code by 30%

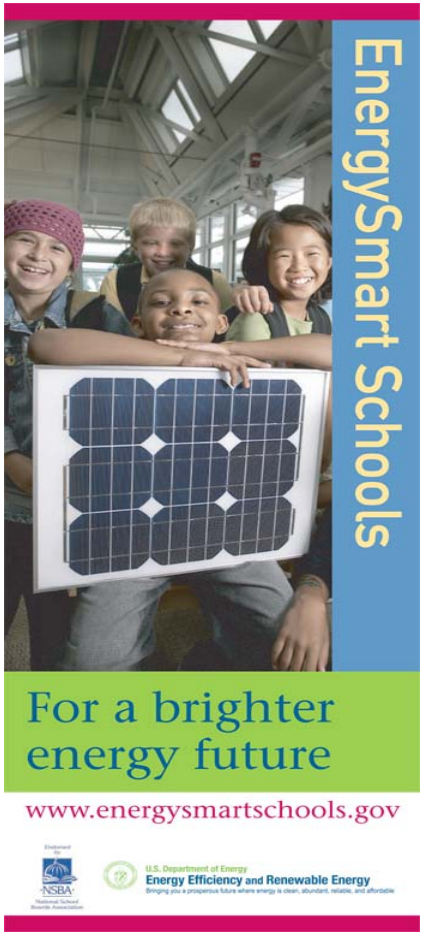


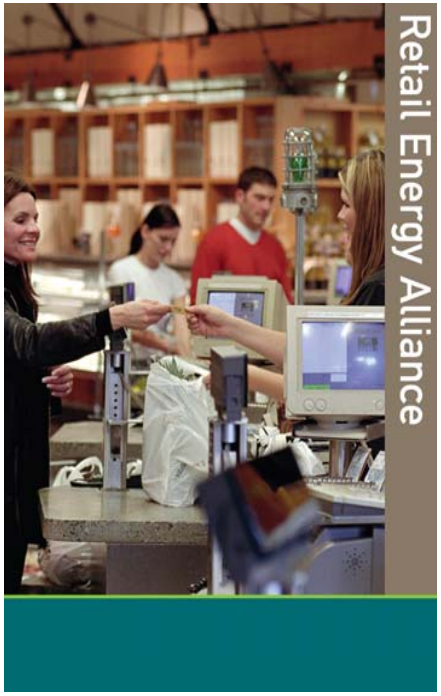
A long road ahead: many states (white) <u>do not</u> meet the 2006 IECC.

Targeted Outreach to Decision Makers

Energy Efficiency & Renewable Energy







EnergySmart Schools

EnergySmart Hospitals

Commercial Buildings Energy Alliances

Application Centers

Zero Net Energy Commercial Buildings Initiative

Energy Efficiency & Renewable Energy

Objectives [EISA 2007 SEC. 422(c)]

- Develop and disseminate technologies, practices, and policies for the development and establishment of zero net energy commercial buildings for
  - Any commercial building newly constructed in the US by 2030
  - 50 percent of US building stock by 2040
  - All US commercial buildings by 2050

Scope [EISA 2007 SEC. 422(d)]

- Conduct R&D
- Conduct pilot programs and demonstration projects
- Conduct deployment, dissemination, and technical assistance
- Develop training materials and courses
- Develop and disseminate public education materials
- Support code-setting organizations and State and local governments
- Develop strategies for overcoming split incentives
- Develop improved means of measurement and verification

Goal of Zero Net Energy Use for All Commercial Buildings by 2050

Energy Efficiency & Renewable Energy

- Zero Net Energy Commercial Buildings Initiative
  - Design, construct, and operate high-performance commercial buildings that: [EISA 2007 SEC. 422(a)(3)]
    - Require greatly reduced energy
    - Meet balance of energy from sources that do not produce greenhouse gases
    - Result in no net emissions of greenhouse gases
    - Are economically viable.
- And Produce High-Performance "Green" Buildings that: [SEC. 401(13)]
  - Reduce energy, water, and material resource use
  - Improve indoor environmental quality
  - Reduce negative impacts on the environment
  - Increase the use of environmentally preferable products
  - Increase reuse and recycling opportunities
  - Integrates systems in the building
  - Reduces the environmental and energy impacts of transportation
  - Considers indoor and outdoor effects of building on human health and environment

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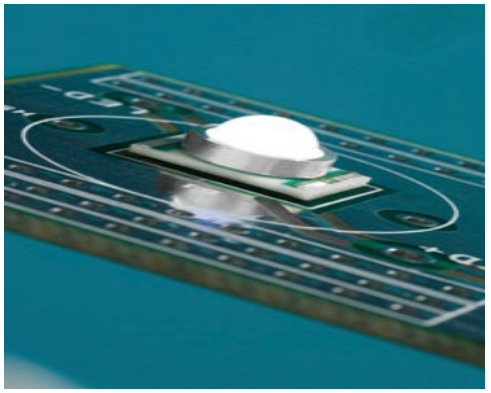
Technical Challenges of ZEB

Energy Efficiency & Renewable Energy

Technical Challenges	
Technology	•Solid State Lighting – double efficiency of current best fluorescent lamps •30-50% reduction in Hot Water Energy Use via Next Generation Equipment and Distribution •50% reduction in Heating and Cooling Energy Use via Next Generation HVAC Systems •Low cost PV & Solar Thermal (with improved peak efficiency via integrated heat recovery) •Dynamic, High R Windows and Tight, Self Drying High R Walls •20-30% Reduction in Miscellaneous Electric Loads
Systems	•Optimizing cost and performance of technologies above, and creating tools for builders to use •Integrating renewable energy sources with building components and systems •Integrated ability to respond to high price/electric grid stress automatically •Maintain or improve indoor air quality, decrease maintenance costs, increase durability and quality



Cree XLamp® and EZBright Chip

U.S. Department of Energy

EnergySmart Home Scale℠

Estimated annual energy usage:
Electric (kWh) 7728
Natural gas (Therms) 237

Estimated average monthly energy bill:
$104

Building America
U.S. Department of Energy
Research Toward Zero Energy Homes

AD Builder

123 Main Street, Gainesville, FL
Rating conducted June 8, 2007

http://www.buildingamerica.gov/challenge

Commercial Building Successes: 30% Improvement Guides

Energy Efficiency & Renewable Energy

- Advanced Energy Design Guides
  - Intended to go “above code” to design buildings 30% more efficient than standard
  - Small Office Buildings
  - Small Retail Buildings
  - K-12 School Buildings
  - Warehouses
  - Highway Lodging and Small Healthcare Buildings (under development)

R&D Platform for Affordable Zero Energy Buildings

Energy Efficiency & Renewable Energy

- Whole-building design and controls
- Increased efficiency of all plug loads and subsystems
- Integration of renewable onsite technologies (solar power and heating, storage, etc.) to meet remaining energy needs

Envelope
Phase change material enhanced thermal insulation
Climatically tuned weather resistive barriers
Thermochromatic roof systems

HVAC
Air-source integrated heat pump
Ground-source integrated heat pump
High efficiency electric water heating

Windows
Highly insulating windows
Dynamic solar control

Lighting
Solid state lighting (SSL)
Buildings Systems Engineering
Building Simulation Modeling

Our Challenge

Energy Efficiency &
Renewable Energy

- Strong DOE commitment to collaborate with all Federal partners and buildings community
- Many provisions in law call us to action … in line with powerful market forces
- How can we work together to:
  - Rapidly accelerate progress toward net zero?
  - Target the vast set of existing buildings more effectively?