Translating Energy Efficiency Technologies into the Home

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To Home Energy Management Technology Forum
and Technical Roundtable, SCAQMD

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eetd.lbl.gov/EA.html

INSTITUTIONAL INTRODUCTION

- **LBNL is the first DOE national laboratory (1931)**
  - **Research in all scientific disciplines; team-based**
  - **Current focus on solving the energy/carbon problem**
  - **Ca 3600 persons, $400M/a**
- **Environmental Energy Technologies Division (EETD) started in 1973**
  - **Energy, technologies and analysis of systems/policies**
  - **End-use orientation, especially buildings, industry, and electricity sectors**
  - **Ca 400 persons, $50M/a**
- **Energy Analysis Department (EAD) since 1973**
  - **Ca 100 persons, $15-20M/a**

OUTLINE

- **Overview of buildings sector**
  - Energy use, GHG emissions
  - Expenditures
  - End uses (appliances, equipment and lighting)
- **Example of energy efficiency success: refrigerators**
- **Potential for energy efficiency technology in buildings**
  - Energy savings
  - Costs of conserved energy
- **Market effects of policies** (topics for discussion)
  - Energy labels and standards
  - Public and private R&D
  - Private investment (“Clean Tech”)
  - California AB32
  - National (and global) carbon policy

Buildings and expenditures

- Buildings include (US):
  - **Residential:** 116 million households in 2007
    - 169 billion square feet
  - **Commercial:** 77 billion square feet
    - Office, retail, education, warehouse, lodging, service, public assembly, health care, food

- **Expenditures:** 70 % of construction, 40% of energy
  - New construction: $780 B/yr (>7 million employees)
  - Renovation: $390 B/yr (>1 million contractors)
  - Energy: $370 B/yr
  - Total expenditures: ca. $4000/capita/year

Energy Consumption by U.S. Buildings

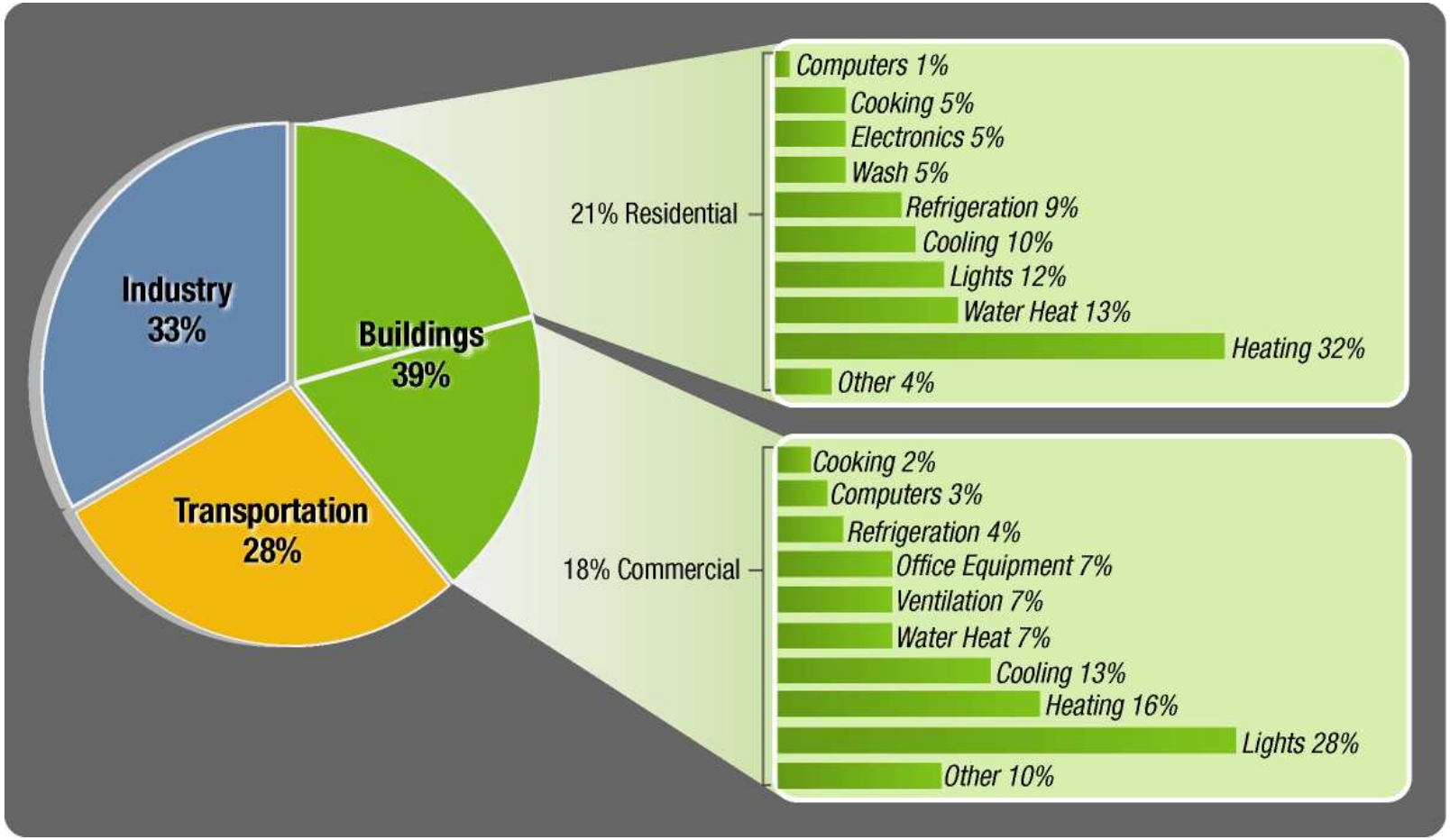
- 71% of U.S. electricity consumption
- 54% of U.S. natural gas consumption
- 39% of U.S. carbon dioxide emissions

U.S. buildings are responsible for more CO_2 emissions than any country in the world except China & US

Buildings' Energy Consumption by End Use

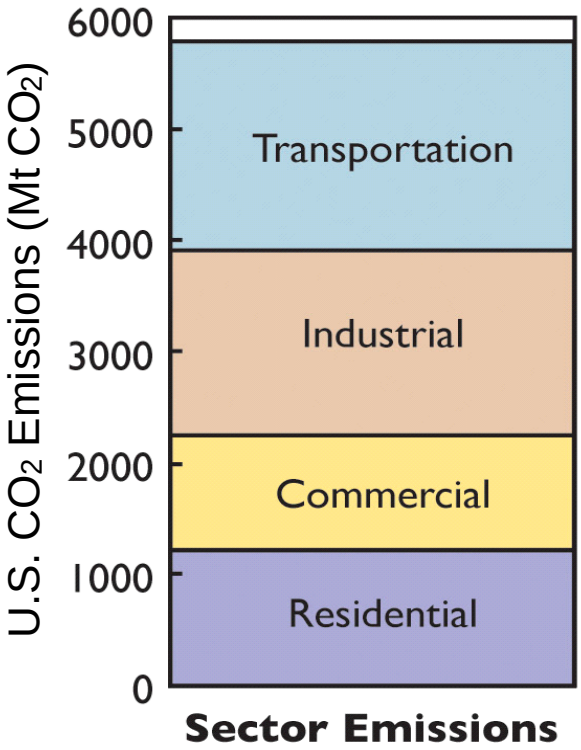
Buildings consume 39% of total U.S. primary energy

- ***71% of electricity and 54% of natural gas***

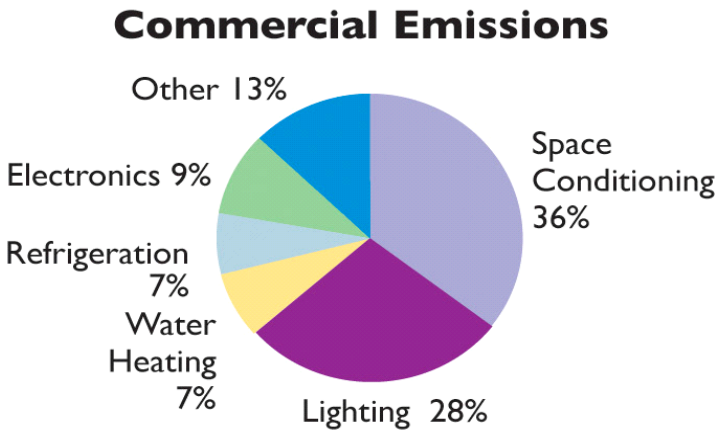


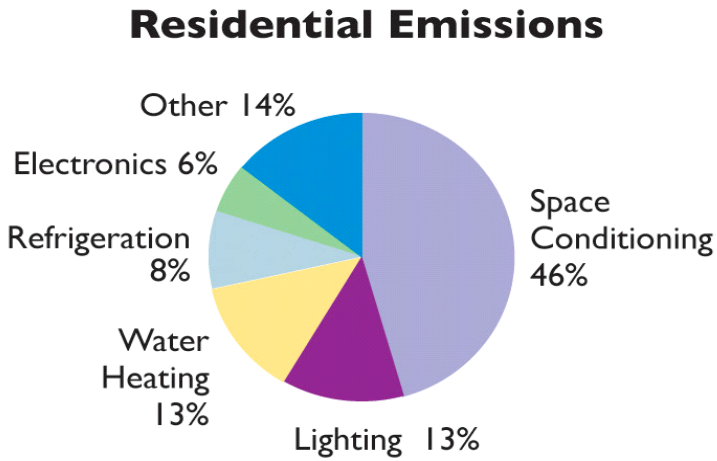
U.S. CO_2 Emissions

By Sector

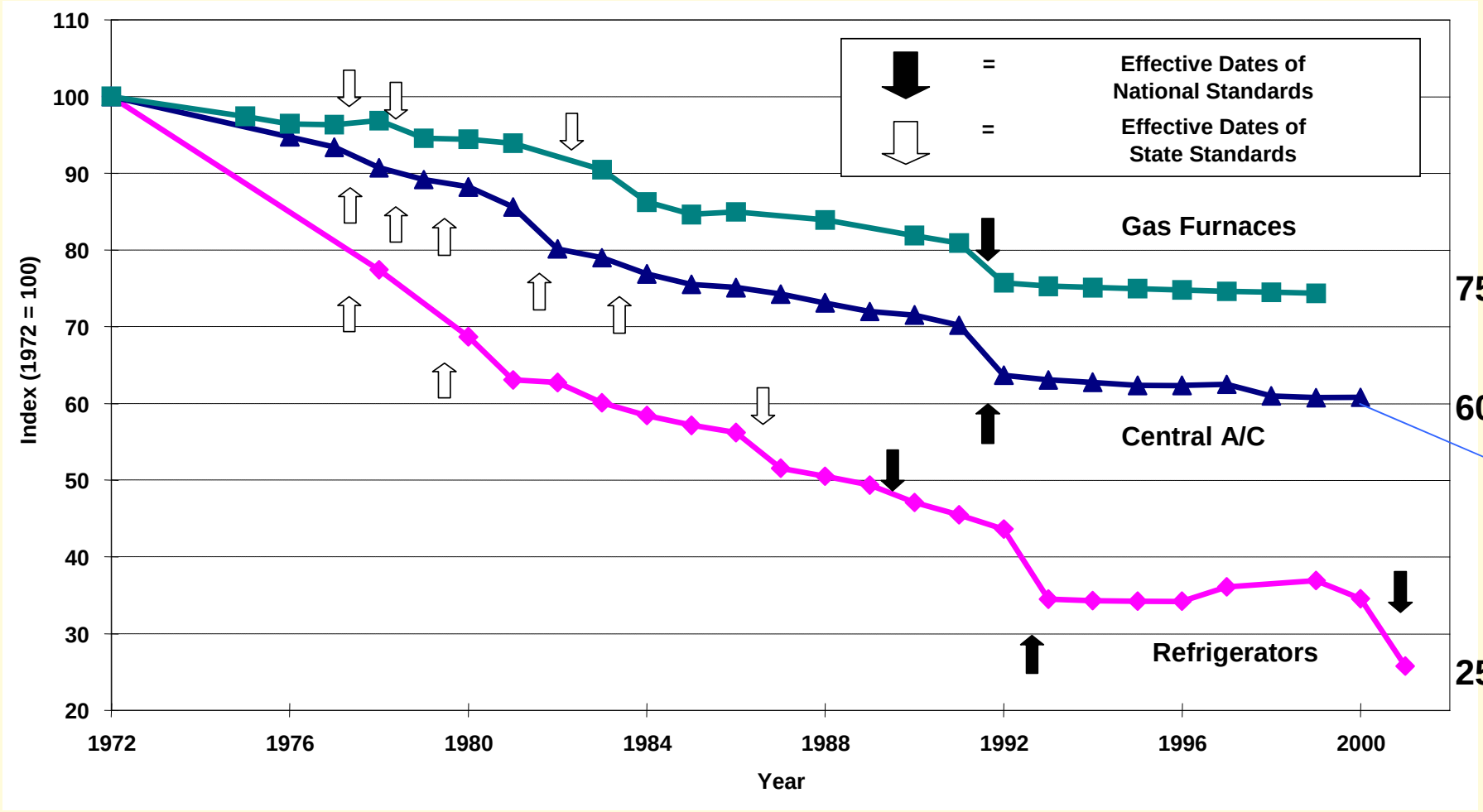


By End Use



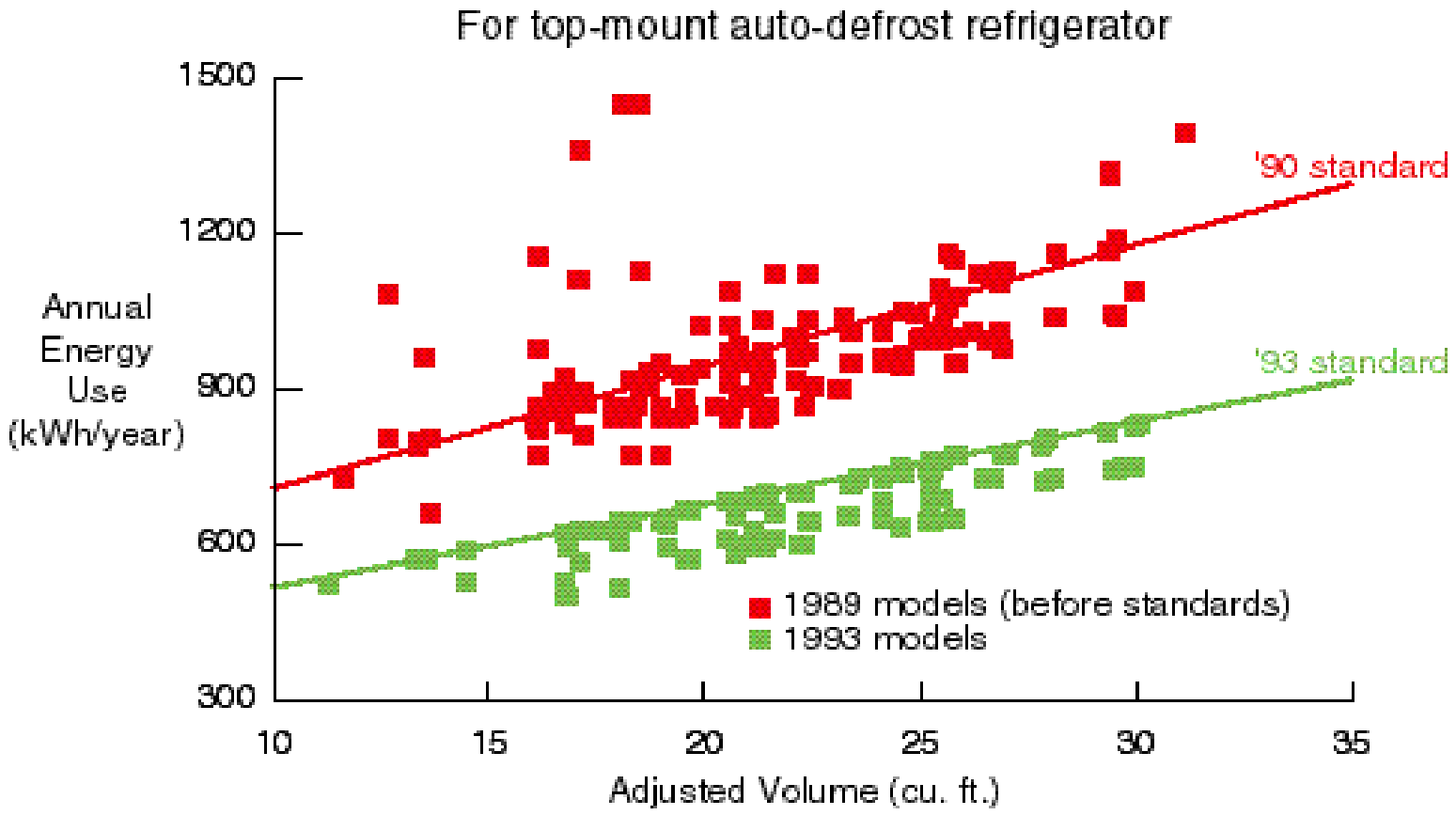


Impact of Standards on Efficiency of 3 Appliances

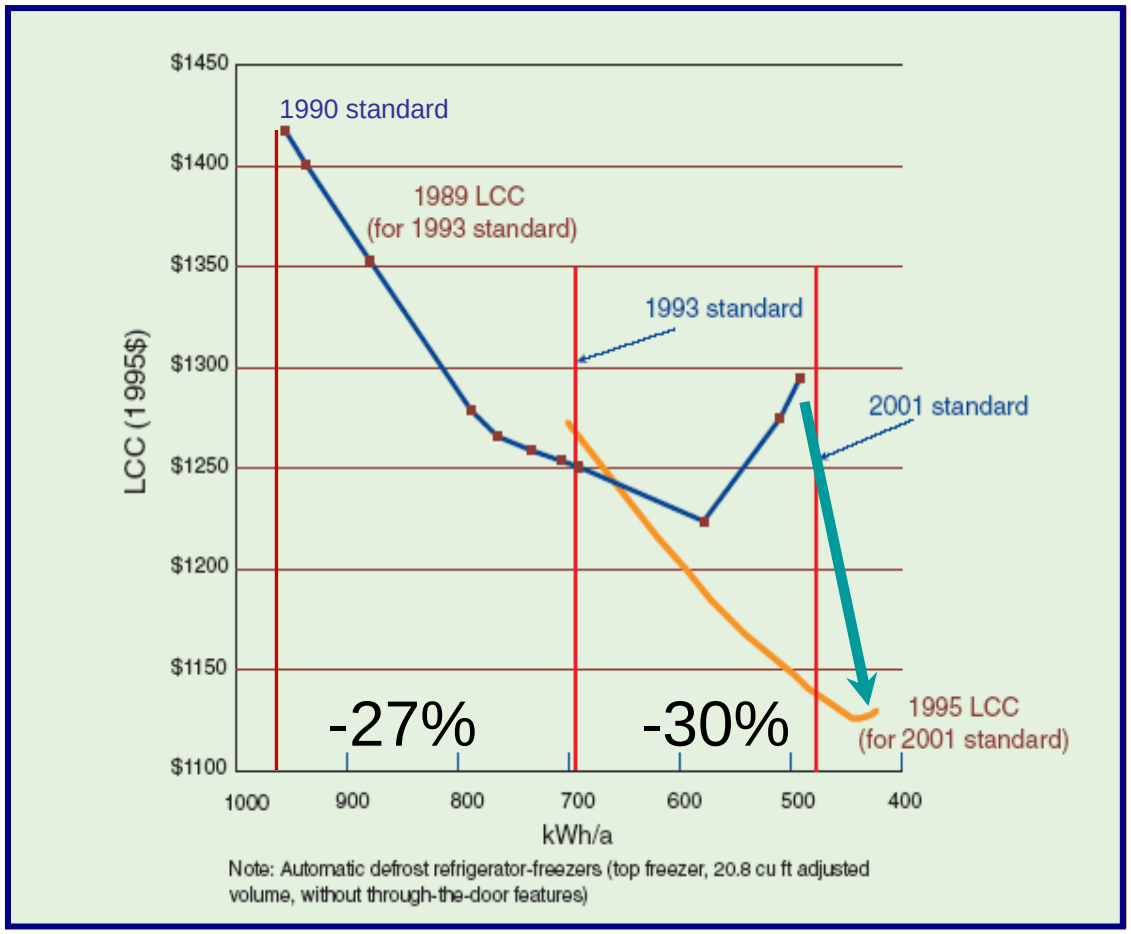


Source: S. Nadel, ACEEE, in ECEEE 2003 Summer Study, www.eceee.org

Appliance Standards Achieve Deployment of Energy-Efficient Technologies



Low-Hanging Energy-Efficiency is a Renewable Resource



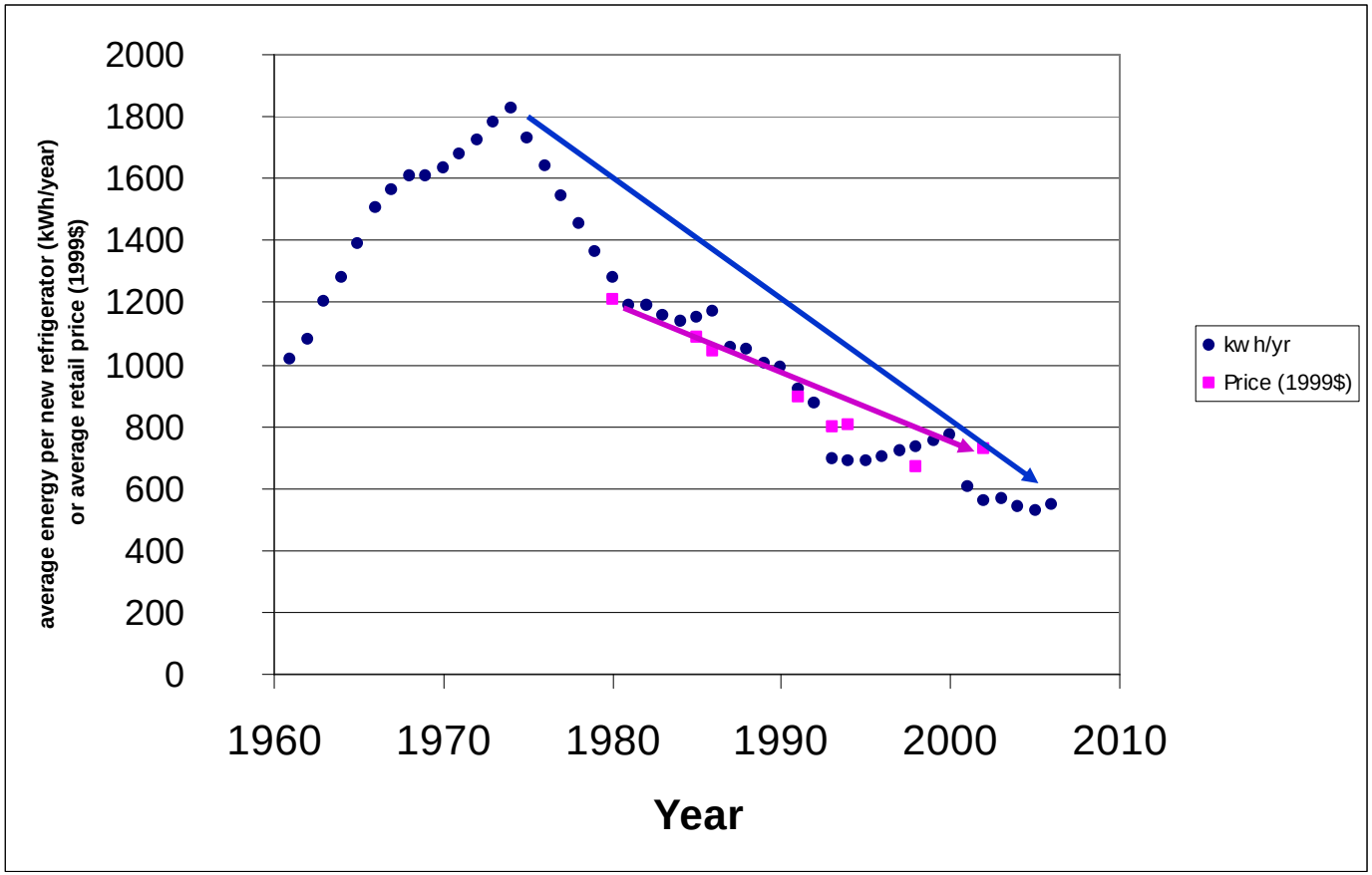
The maximum technology kWh/a in refrigerators changed 14% in 6 years - from 495 kWh/a (1989) to 425 kWh/a (1995) –

and became cheaper to manufacture.

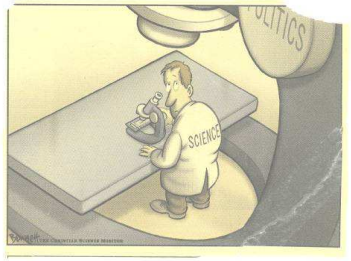
Average standards, % change, effective date:
690 kWh/a, -27%, 1993
475 kWh/a, -30%, 2001

US New Refrigerator kWh/year Declined 70%

Annual Drop from 1974 to 2001 = 4% Per Year (average)

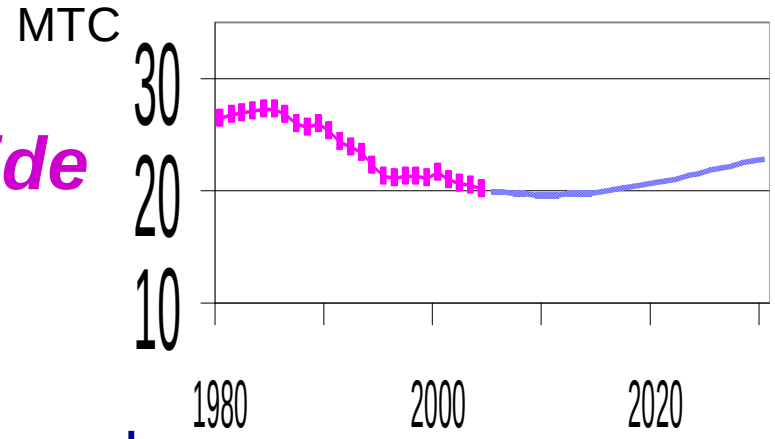


Real retail price in 2002 is 40% lower than in 1980



Why Is this Example Important?

- Unit energy consumption per new refrigerator decreased 70% in about 30 years



- Absolute amount of energy consumption – ***and carbon dioxide emissions*** – for household refrigeration decreased

- Technology and policy together saved energy
  - Average retail prices declined

- Lessons learned can be applied to other energy technologies and services

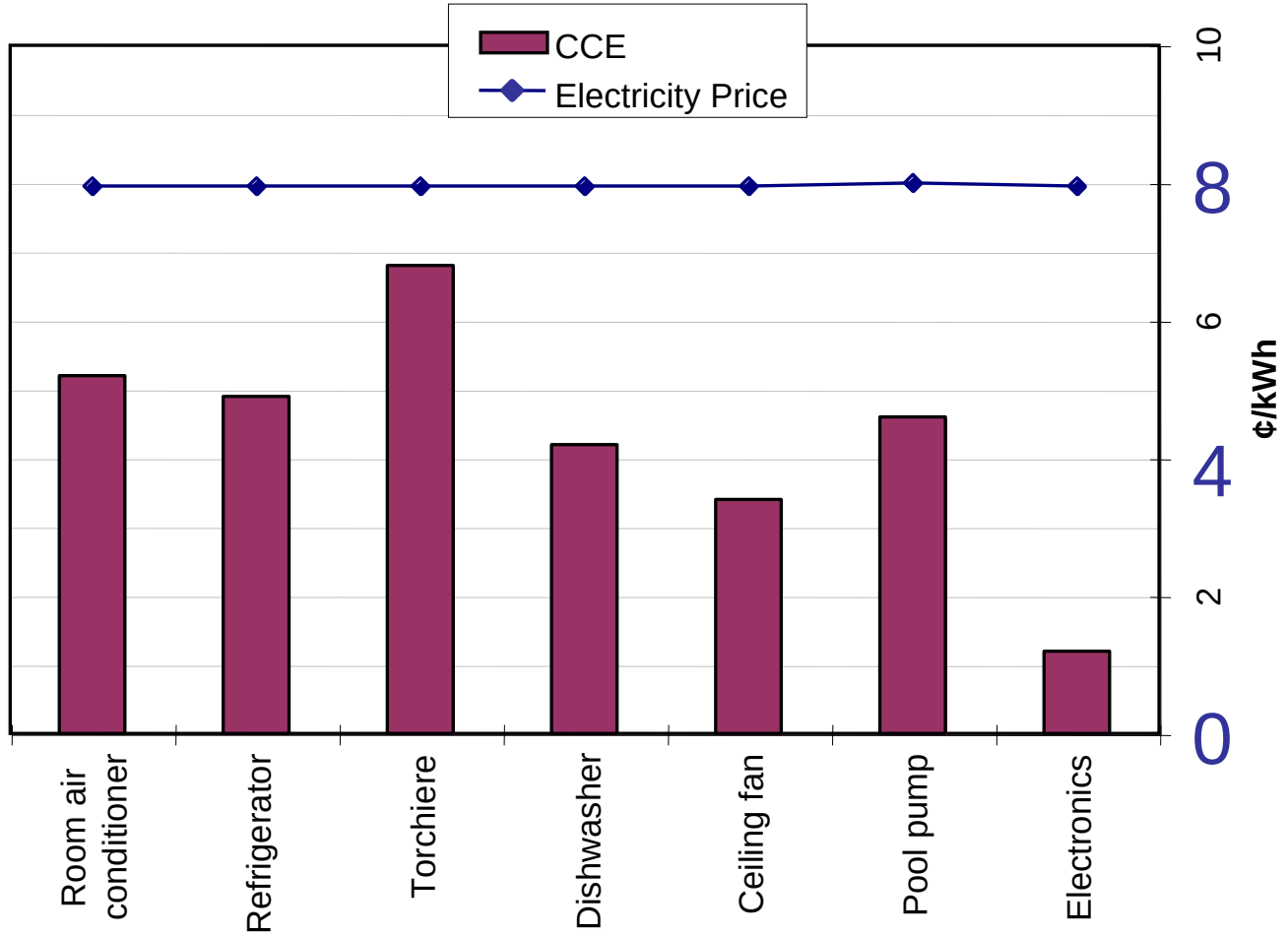
National Estimates of Cost-Effective Energy Efficiency Continue to Identify Large Potential

Estimate	Source
20% Reduction by 2020-2025 compared to BAU	**Five National Labs – Scenario for a Clean Energy Future – 2000**
23% Reduction by 2025 compared to BAU	**American Solar Energy Society - 2007**

NEW OPPORTUNITY !

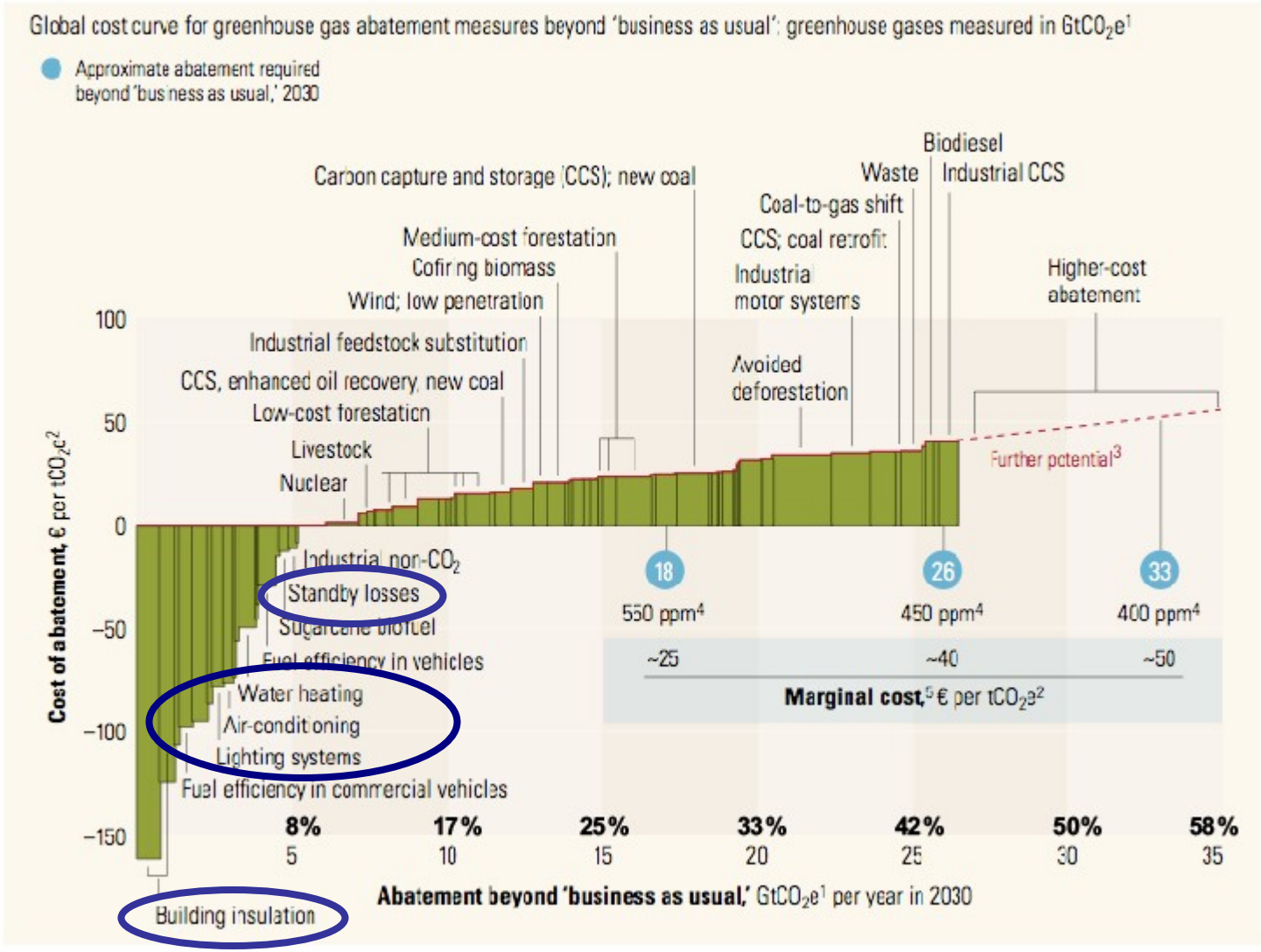
- **California's Water-Energy Relationship, 2005 found new potential electricity savings from water conservation**
  - Equivalent to current three-year plan for CA utilities
  - Est. cost per kWh about 50% lower than electric plan

Cost of Conserved Energy (CCE) is Lower Than Electricity Price for Many Energy Efficiency Increases (Residential, 2010)



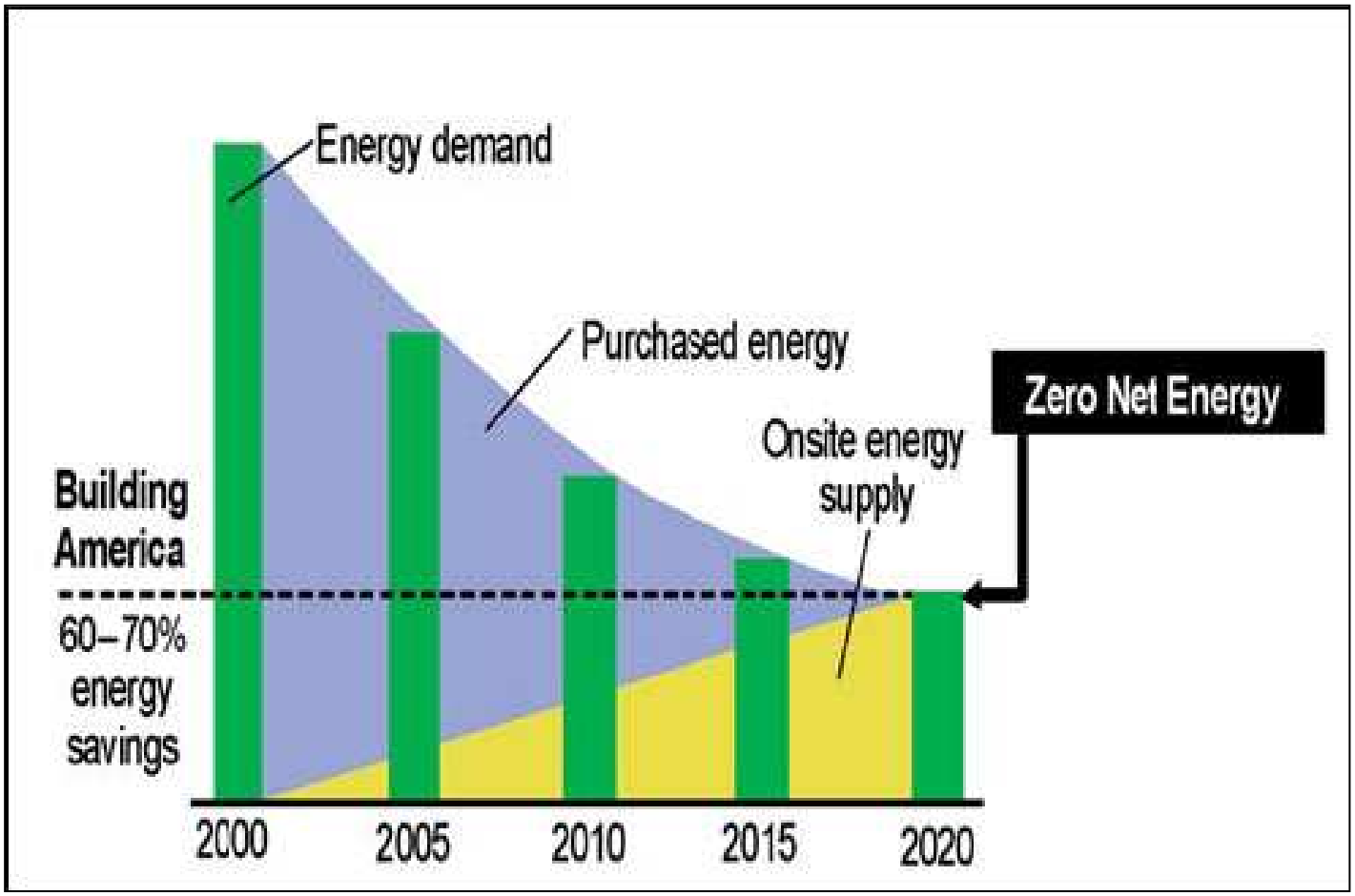
Source: National Commission on Energy Policy, 2004

EE reduces carbon and saves money



Source: McKinsey Global Institute, 2007

Efficiency and carbon-neutral supply are complements



Whole Building Approach (with PV) Can Save More Than Just Equipment Improvements

- Can build a 2592 ft2 home in Sacramento at incremental cost of about 5% above code to achieve:
  - zero peak cooling demand
  - reduce annual heating energy 70%
  - reduce annual cooling energy by 60% and
  - reduce total source energy use by 60%

Size matters

Source: Ren Anderson, C Christensen, S Horowitz, "Program Design Analysis using BEopt Building Energy Optimization Software: Defining a Technology Pathway Leading to New Homes with Zero Peak Cooling Demand" (Preprint Conference Paper NREL/CP-550-39827), May 2006

Additional Savings from Systems

- *Demand response* incorporates price signals to deliver automatic reductions
- *Digital networks* can maximize comfort and utility while minimizing energy
- *Combined heat and power* can improve efficiency and reduce peak
- Neighborhood systems (e.g., *district heating/cooling*)
- *Micro-grids* provide local power, desired quality
- Efficient *data centers* (electricity and cooling)

Conclusions

- Energy efficiency has proven itself for thirty years
  - Technologically feasible
  - Economically justified
- Low-hanging energy efficiency is a renewable resource
  - Replacing appliances, equipment, lighting
  - New buildings
- Challenge: retrofitting existing buildings