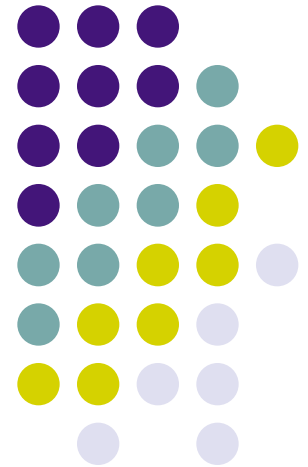


Energy Conservation

A Major Part of the Solution to
Energy Generation and
Global Warming

Dennis Silverman

U. C. Irvine Physics and Astronomy

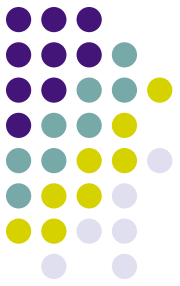




Why Us (U.S.)?

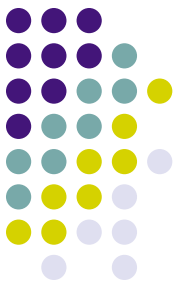
- With 5% of the world's population, the U.S. uses 26% of the world's energy.
- A U.S. resident consumes 12,000 kWh of electricity a year, nine times the world's avg.
- The average American household emits 23,000 pounds of CO₂ annually.
- Two billion people in the world do not have electricity.
- Just using off the shelf technology we could cut the cost of heating, cooling, and lighting our homes and workplaces by up to 80%.

Electric Energy Conservation in the Home



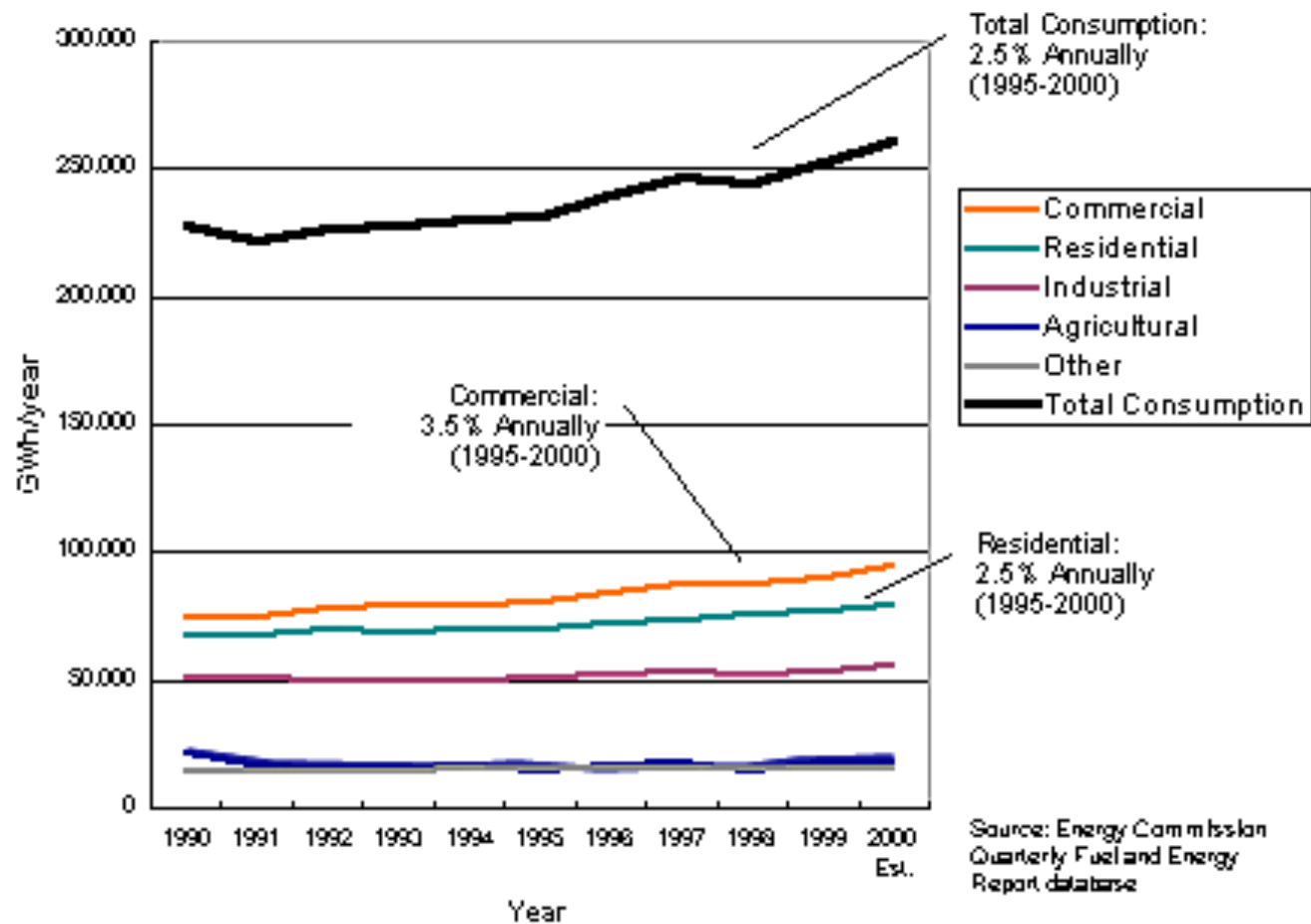
- Art Rosenfeld, Former Commissioner of the California Energy Commission, and pioneer of the [Environmental Energy Technologies Division of the Lawrence Berkeley National Lab](#)
- Some slides from his aide, John Wilson



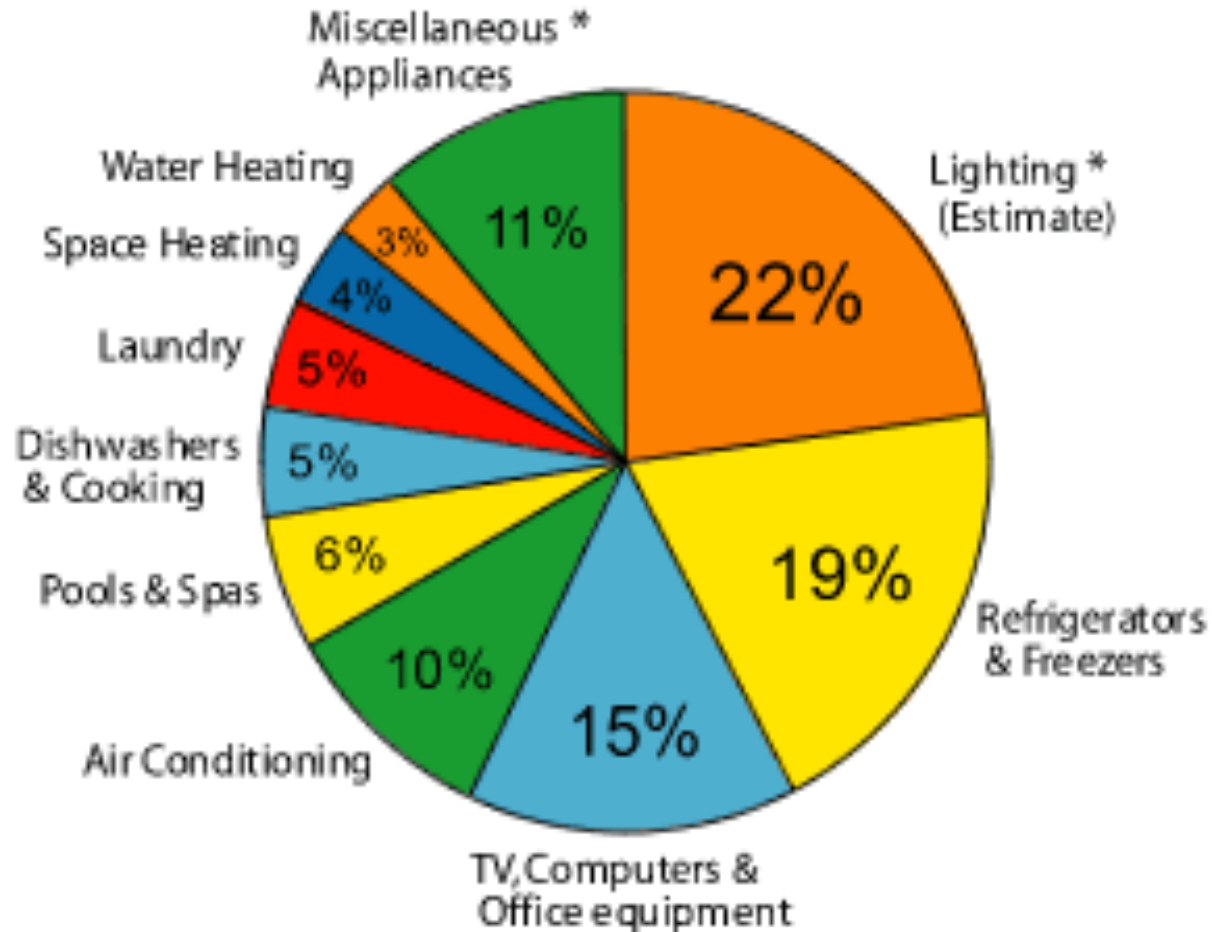
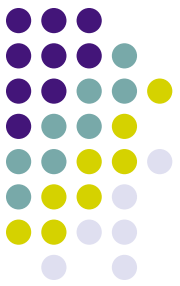


California Electricity Consumption

California Electricity Consumption by Sector (GWh)

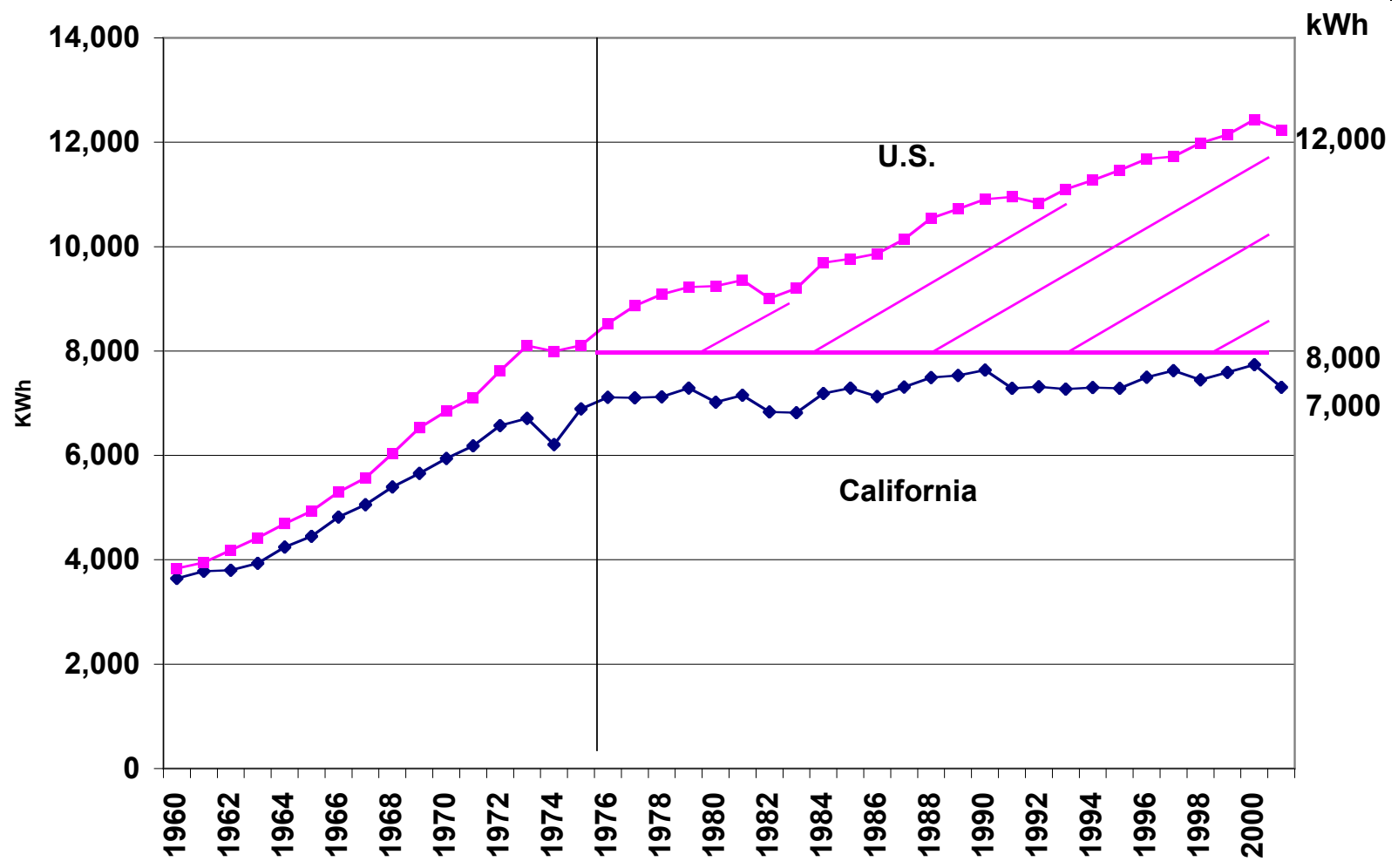


Annual Electricity Use Per California Household (5,914 kWh per household)

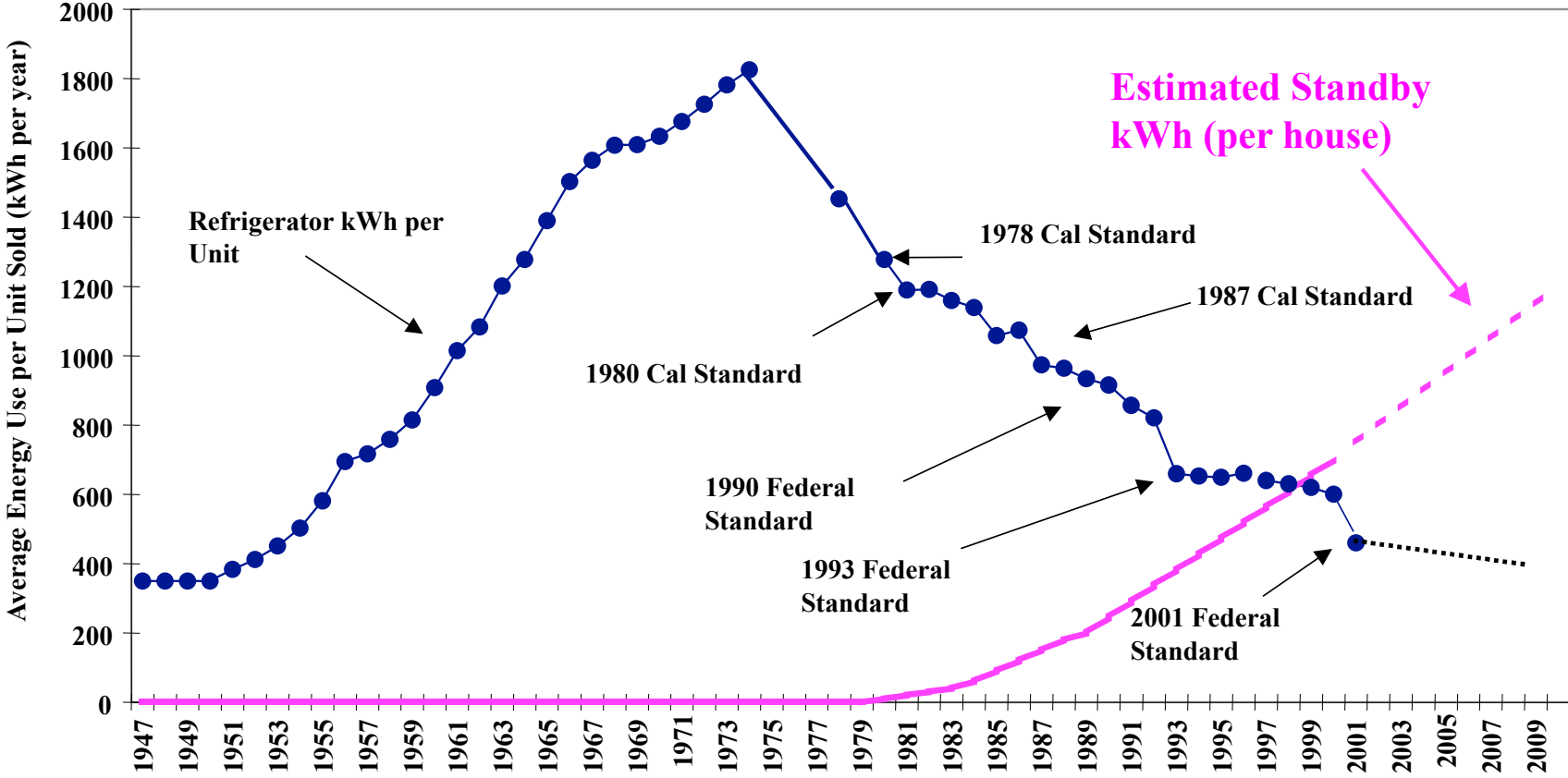




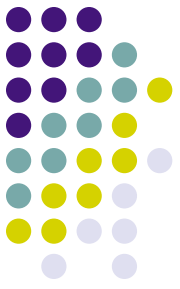
Total Electricity Use, per capita, 1960 - 2001



Average Energy Use per Refrigerator, 1947 to 2009

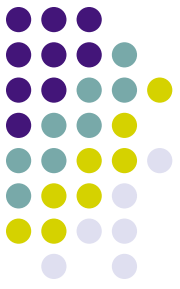


Conservation Economic Savings



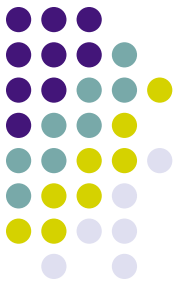
- If California electricity use had kept growing at the US rate, kWh/person would have been 50% higher
- California electric bill in 2004 ~\$32 Billion...
- so we've avoided ~\$16 B/yr of electricity bills.
- Net saving (accounting for cost of conservation measures and programs) is ~\$12 B/year, or about \$1,000/family/yr.
- Avoids 18 million tons per year of Carbon
- **Appliance standards save ~\$3B/year (1/4)**

Lighting



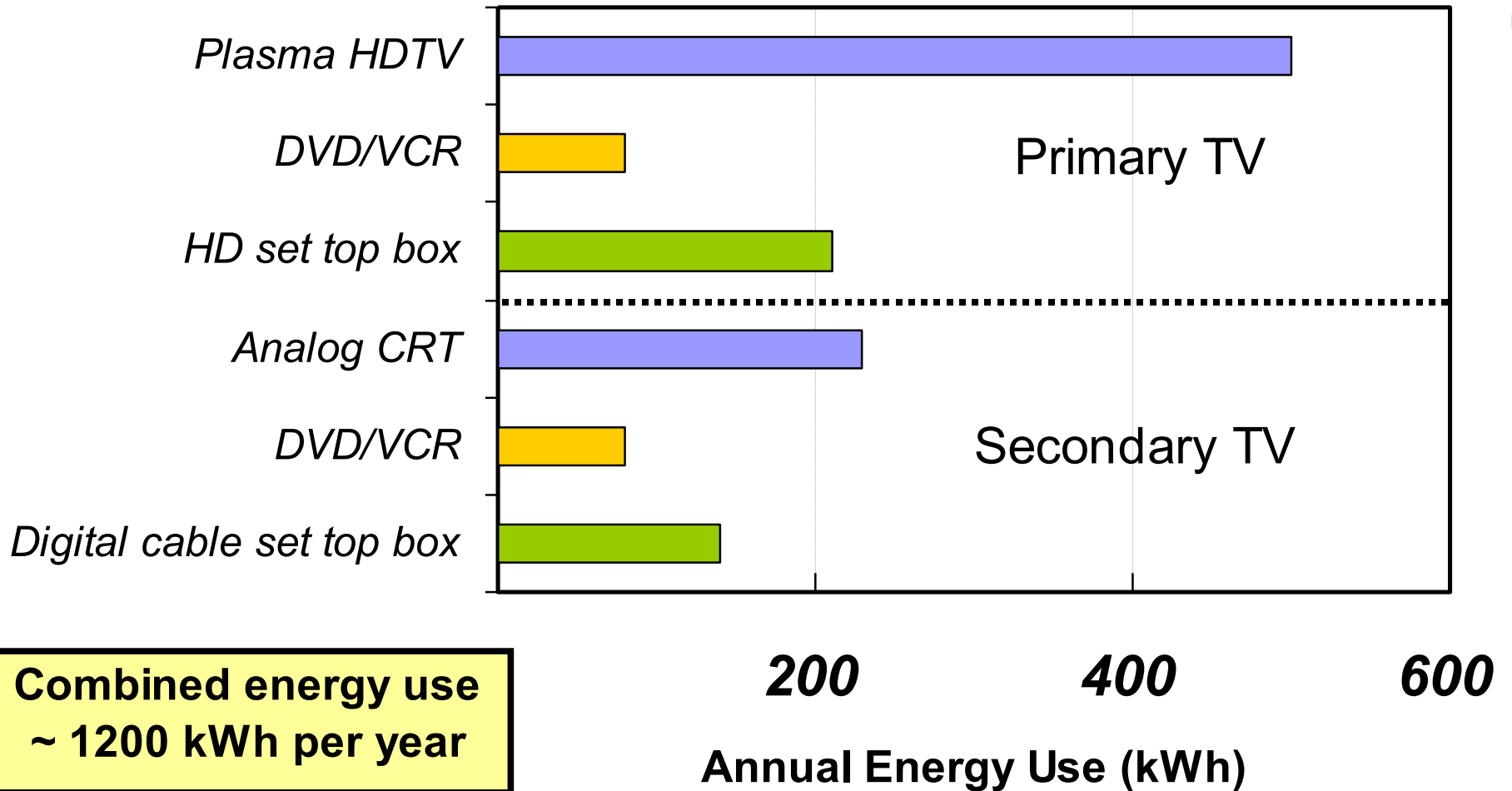
- Compact Fluorescents or Long Fluorescents using plasma discharges use only 1/4 of the energy and heat of incandescent lights, which derive their light from heating filaments hot enough to emit visible light.
- If every home changed their five most used lights, they would save \$60 per year in costs.
- This would also be equal to 21 power plants.
- The fluorescents also last up to 10 times as long.
- Replacing one bulb means 1,000 pounds less CO2 emitted over the compact fluorescent's lifetime.
- Traffic signal LEDs use 90% less energy and last 10 years rather than 2 years.
- Lloyd Levine, Chair of the California Assembly's Utility and Commerce Committee, has proposed the "How Many Legislators does it take to Change a Light Bulb Act" to ban incandescent bulbs by 2012.
- Australia has just passed a law to ban incandescent bulbs by 2009.

Compact Fluorescent Bulbs: Do the Math for California

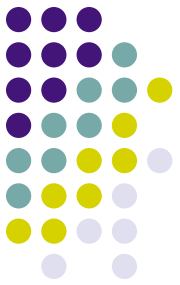


- Allocate a 125 watt equivalent bulb for sufficient lighting for each person. Each 125 watt equivalent CFL uses only 30 watts.
- (Incandescent bulbs only use 5% of their energy for light).
- They will use 30 watts per person and save $125-30=95$ watts over incandescent bulbs.
- Multiply by 30,000,000 Californians, saves 3 gigawatts of power capacity.
- 3 gigawatts is more than 10% of the nighttime load.
- That is equivalent to about three nuclear power plants at one gigawatt each.
- The cost of this is currently $\$1.70/\text{person} \times 30 \text{ million people}$ is \$50 million.
- This is equivalent to buying each nuclear power plant for \$17 million, rather than \$2 billion or more each at current cost estimates.

Household Energy Use for Entertainment Electronics



NRDC, "Tuning in to Energy Efficiency: Prospects for Saving Energy in Televisions," January 2005.



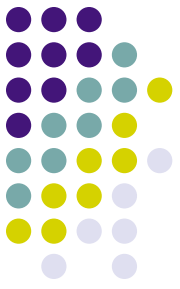
“Zero energy” new homes

- Goals:
 - 70% less electricity => down to ~2,000 kWh/yr
 - 1 kW on peak
- Electronics are a problem!
 - 1,200 kWh/ yr for TVs, etc.
 - 100-200 W for standby
- TV Power
 - Plasma TV (50”) 400 W (Panasonic 200+ W)
 - Rear Projection TV (60”) 200 W
 - Large CRT (34”) 200 W
 - LCD (32”) 100 W



Home Energy Conservation

- [Department of Energy: Energy Efficiency and Renewable Energy](#)
- Central resource for the following slides on home energy technology
- We only select some topics of interest
- Other sources
 - [California Consumer Energy Center](#)
 - [California “Flex Your Power”](#)

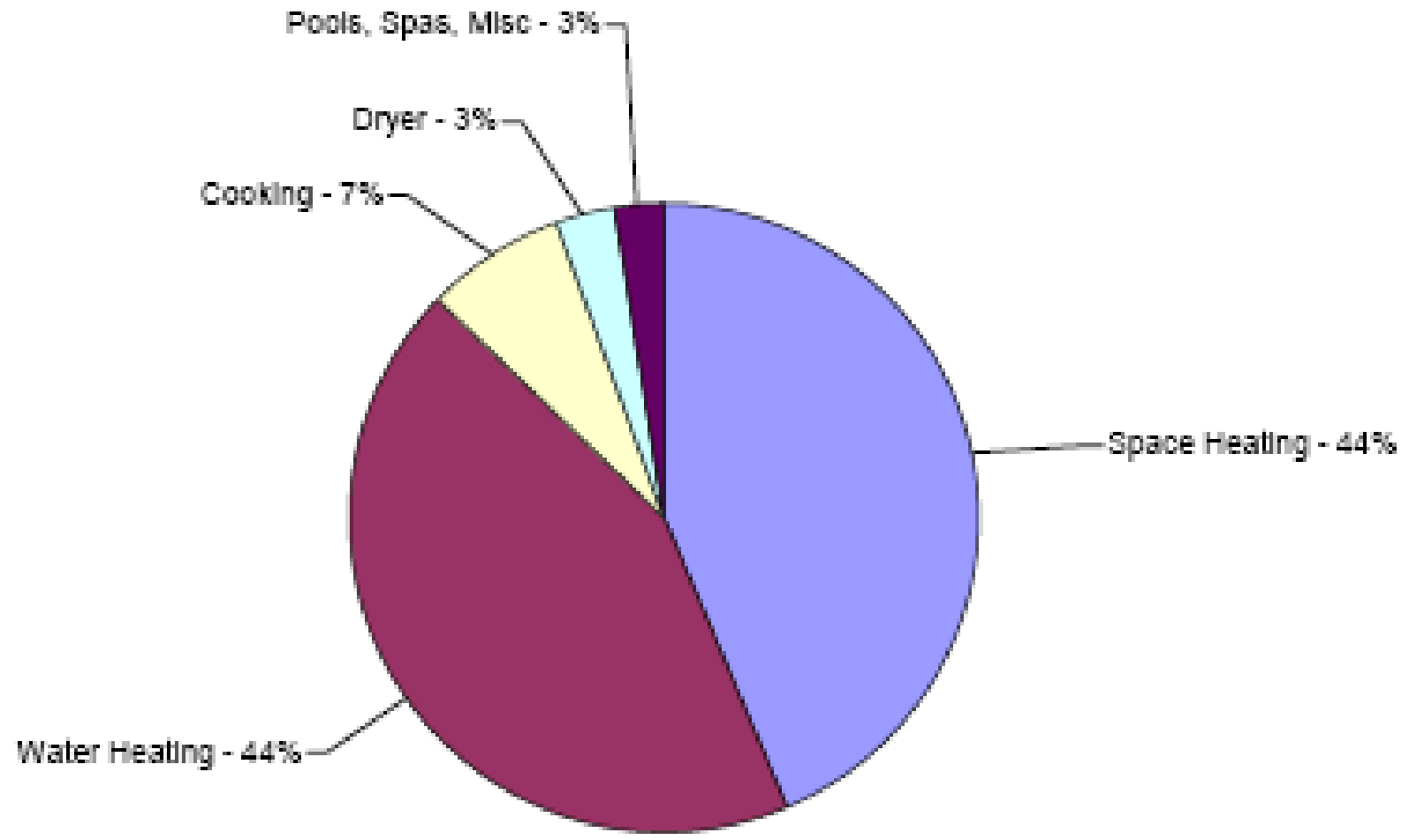


Heating and Cooling in the Home

- Accounts for 45% of energy bill or \$1,000 per year
- HVAC – Heating, Ventilating and Air Conditioning
- SEER efficiency rating of AC
- Before 1992, typically 6.0
- After 1992 required 10.0
- Jan. 2006, required minimum 13.0



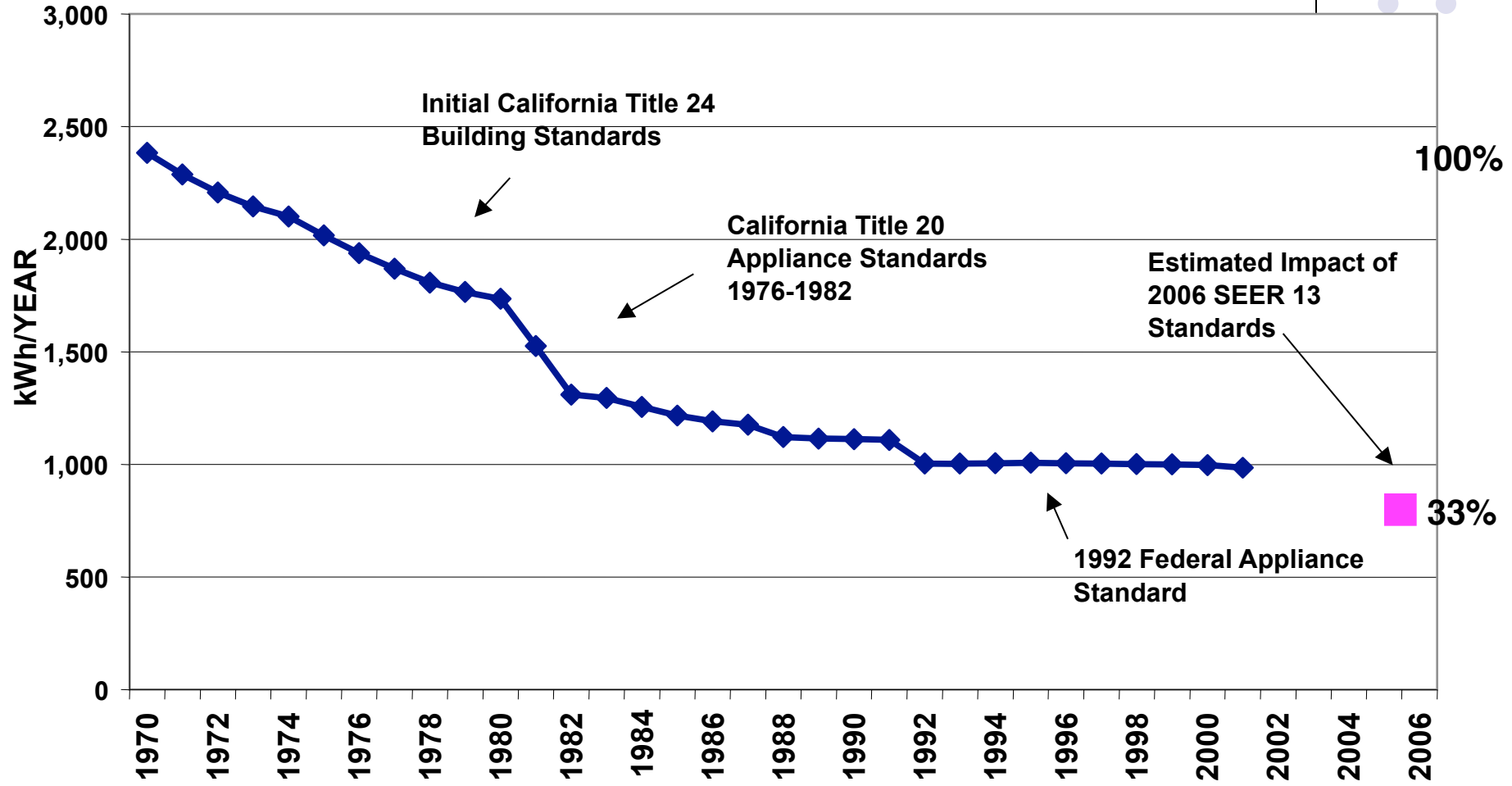
Statewide Gas Energy Use



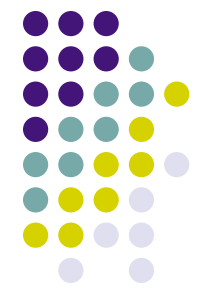


Annual Usage of Air Conditioning in New Homes in California

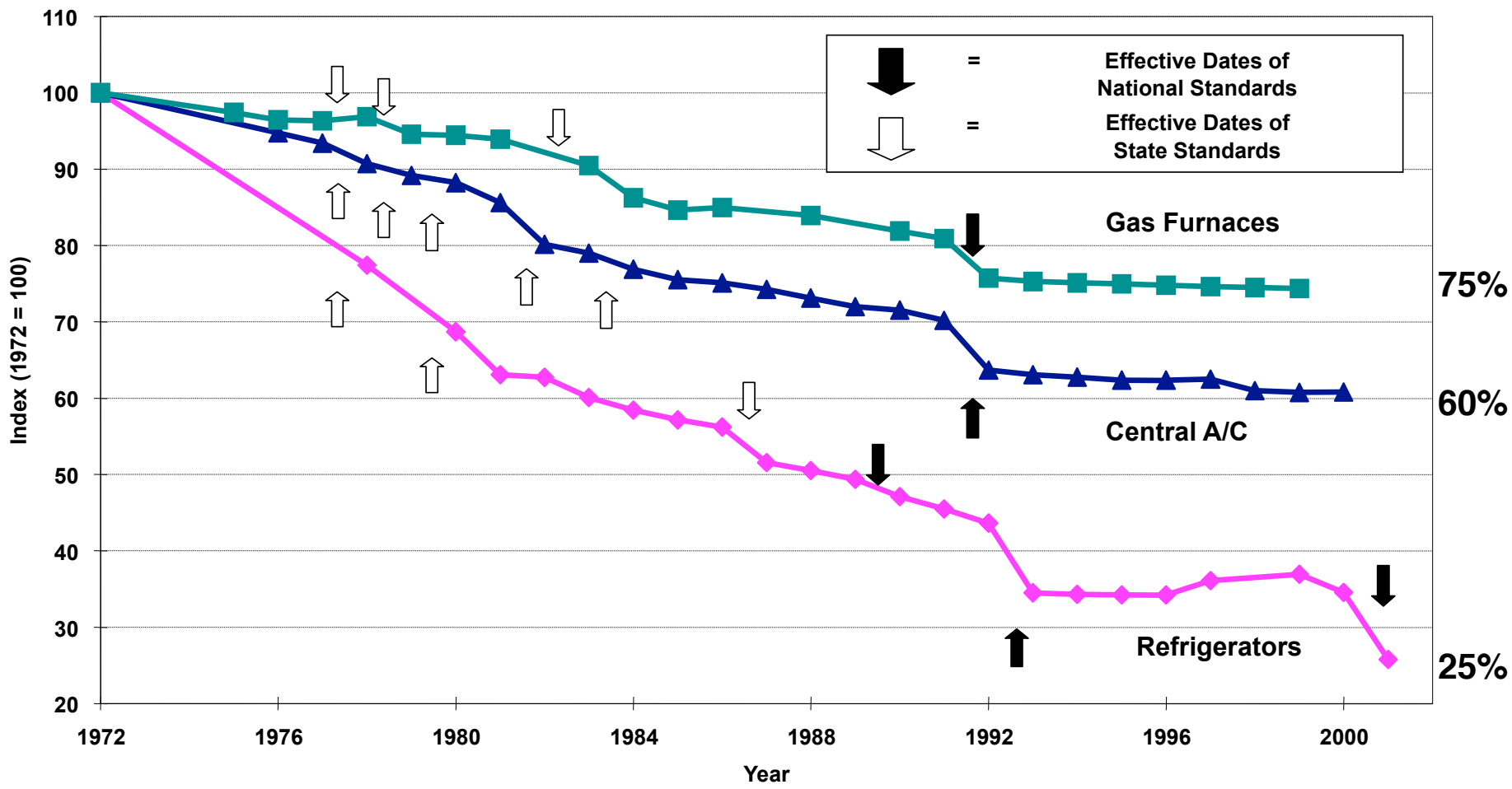
Annual drop averages 4% per year



Source: CEC Demand Analysis Office



Impact of Standards on Efficiency of 3 Appliances



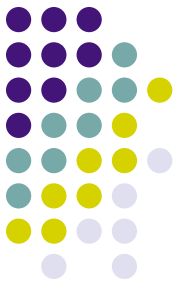
Source: S. Nadel, ACEEE, in ECEEE 2003 Summer Study, www.eceee.org



Setback Thermostats

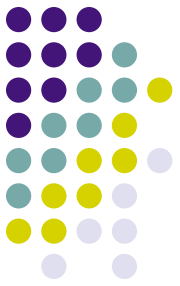
- Program to lower temperature setting at night and if gone on weekdays.
- Required in California
- Winter suggested: 55° at night, 68° when at home
- Summer suggested: 85° when gone, 78° when at home
- 20 to 75% energy savings

Solar Water Heating



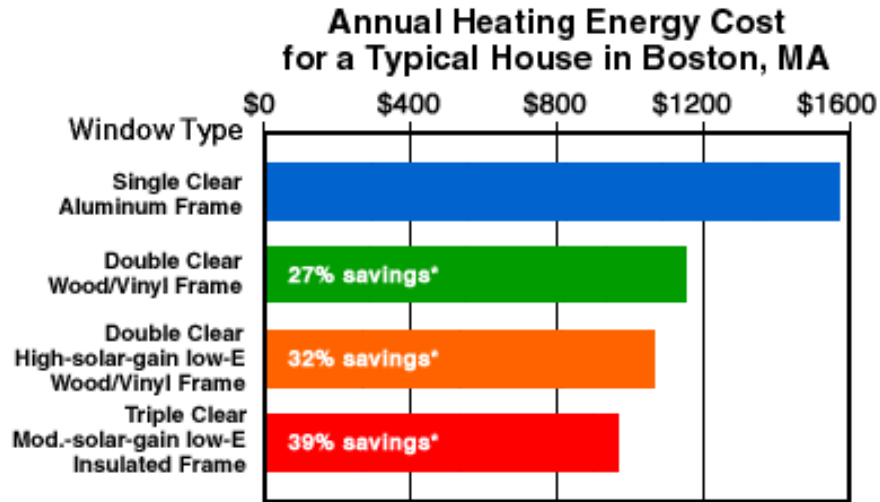
- Water heating uses 14-25% of energy use
- Solar water heating replaces the need for 2/3 of conventional water heating.
- Virtually all homes in Greece and Israel (700,000) use solar water heating. Japan has over 4 million units.
- The US over a million, with most systems in Florida and California, and Hawaii has 80,000.
- Each saves 1.5 to 2.5 tons of CO₂ a year.
- Typical cost is \$3,000 for 50 square feet.
- DOE is trying to lower this to \$1,000 to \$1500.
- Energy saved would be about 3,000 kWh per year per household
- DOE would like to have 3 million new units by 2030.
- Current payback is 10-13 years (solar lobby says 4-8 years), whereas for 50% market penetration, 5-6 years is needed.

Building energy efficiency

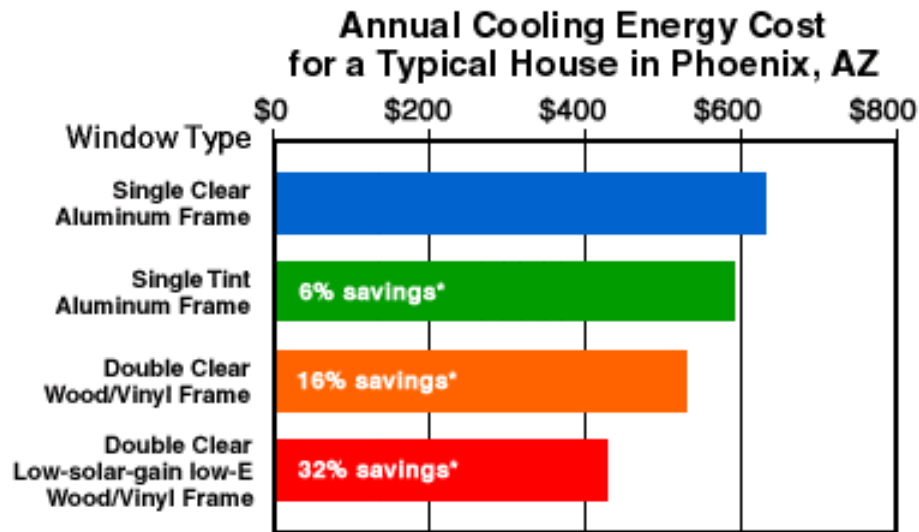


- Structural Insulated Panels are 4-8 inches thick and are foam filled. They can be faced with drywall and plywood. They give R-4 to R-8 per inch of thickness.
- Insulation includes batts and rolls, loose fill (blown in), rigid and reflective.
- Cool Roofs: white reflective roofs on a summer's day lower roof temperature from 150-190° F to 100-120° F. Saves 20% on air conditioning costs.

Window Efficiency

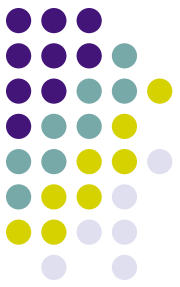


*Compared to the same 2000 sq. ft. house with clear single glazing in an aluminum frame.



*Compared to the same 2000 sq. ft. house with clear single glazing in an aluminum frame.

Estimated savings for a typical home from replacing single pane with ENERGY STAR qualified windows are significant in all regions of the country, ranging from \$125 to \$340 a year.



Energy Intensity or energy/\$GDP

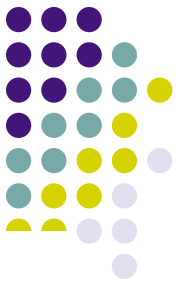
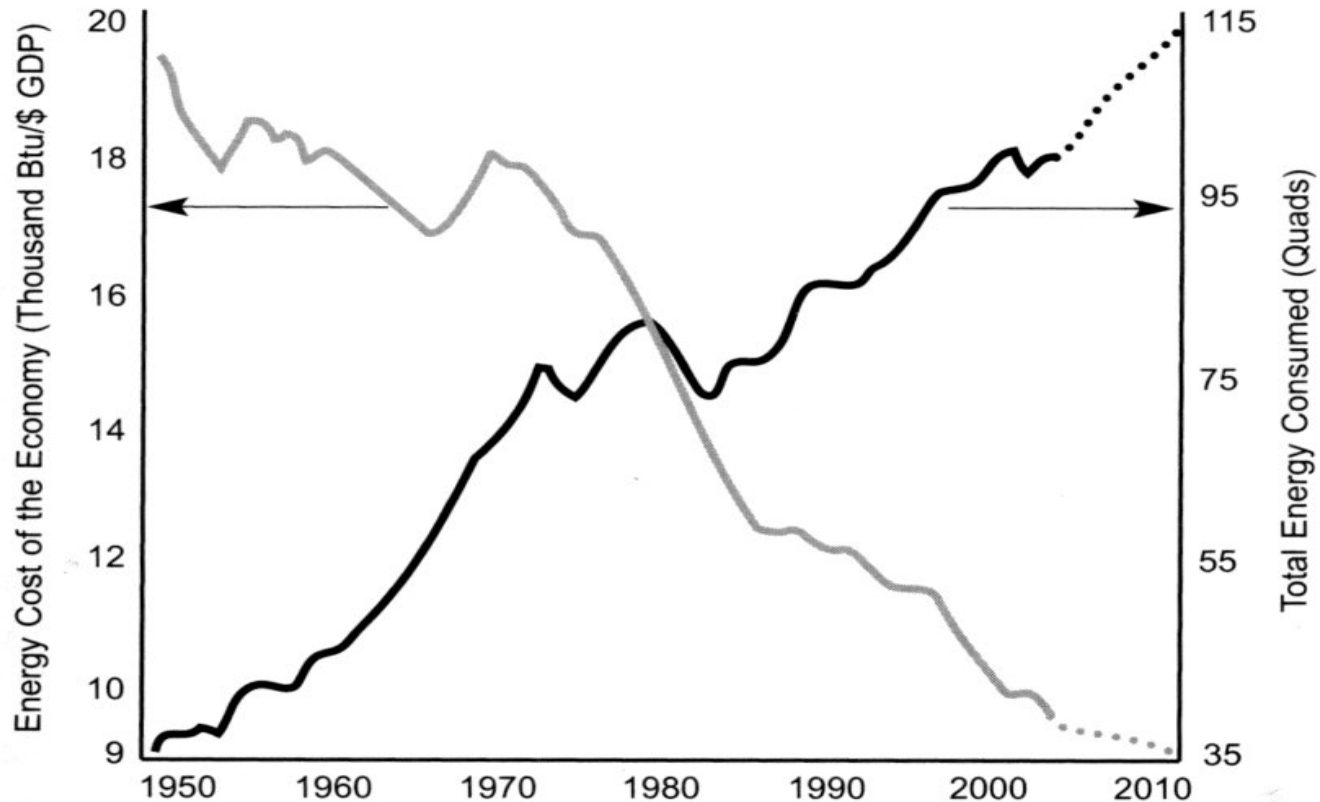


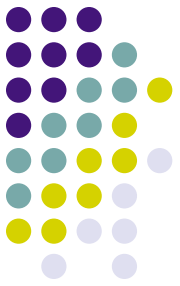
FIGURE 7.2 Energy Cost of the U.S. Economy versus Total Consumption



Source: EIA, *Annual Energy Review 2003* and *Annual Energy Outlook 2004*; Bureau of Economic Analysis.

The U.S. economy as a whole is twice as energy-efficient today as it was in 1950—the amount of fuel needed to produce \$1 of GDP has been cut in half. But total energy consumption has almost tripled. As they grew more efficient, we built more steam power plants, jet turbines, and car engines, light bulbs, electric motors, air conditioners, and computers, and used them more heavily—and total energy consumption went up.

Energy conserving potential by sector



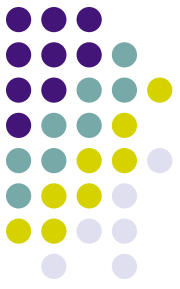
- Industries: 4-8%
- Residential: 10-30%, except lighting at 50%
- Commercial / Public heating and cooling: 50%
- Transportation: 10 – 20%

Additional Advantages of Energy Conservation



- Less need to secure oil and natural gas overseas with attendant military and civilian casualties while costing hundreds of billions of dollars
- Fewer power plants and liquid natural gas ports are needed
- Less air pollution
- Less drilling for oil in Alaska and near national parks
- Less global warming and attendant environmental destruction

Conclusions on Energy Conservation



- Energy conservation has saved the need for many power plants and fuel imports.
- It has also avoided CO₂ and environmental pollution.
- Energy conservation research is only funded at \$306 million this year at DOE, which is low considering the massive amounts of energy production that are being saved by conservation.
- **Regulations on efficiency work, but voluntary efforts lag far behind.**
- Much has been done, but much more can be done
- In this new era of global warming and high energy costs and energy shortages, the public must be informed and politicians sought who are sensitive to these issues.