

**Near-Term Solutions for  
Mitigation of Carbon Dioxide  
CARB Symposium  
March 5, 2007**

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<http://www.energy.ca.gov/commission/commissioners/rosenfeld.html>

or just **Google “Art Rosenfeld”**

# The Economist

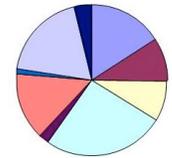
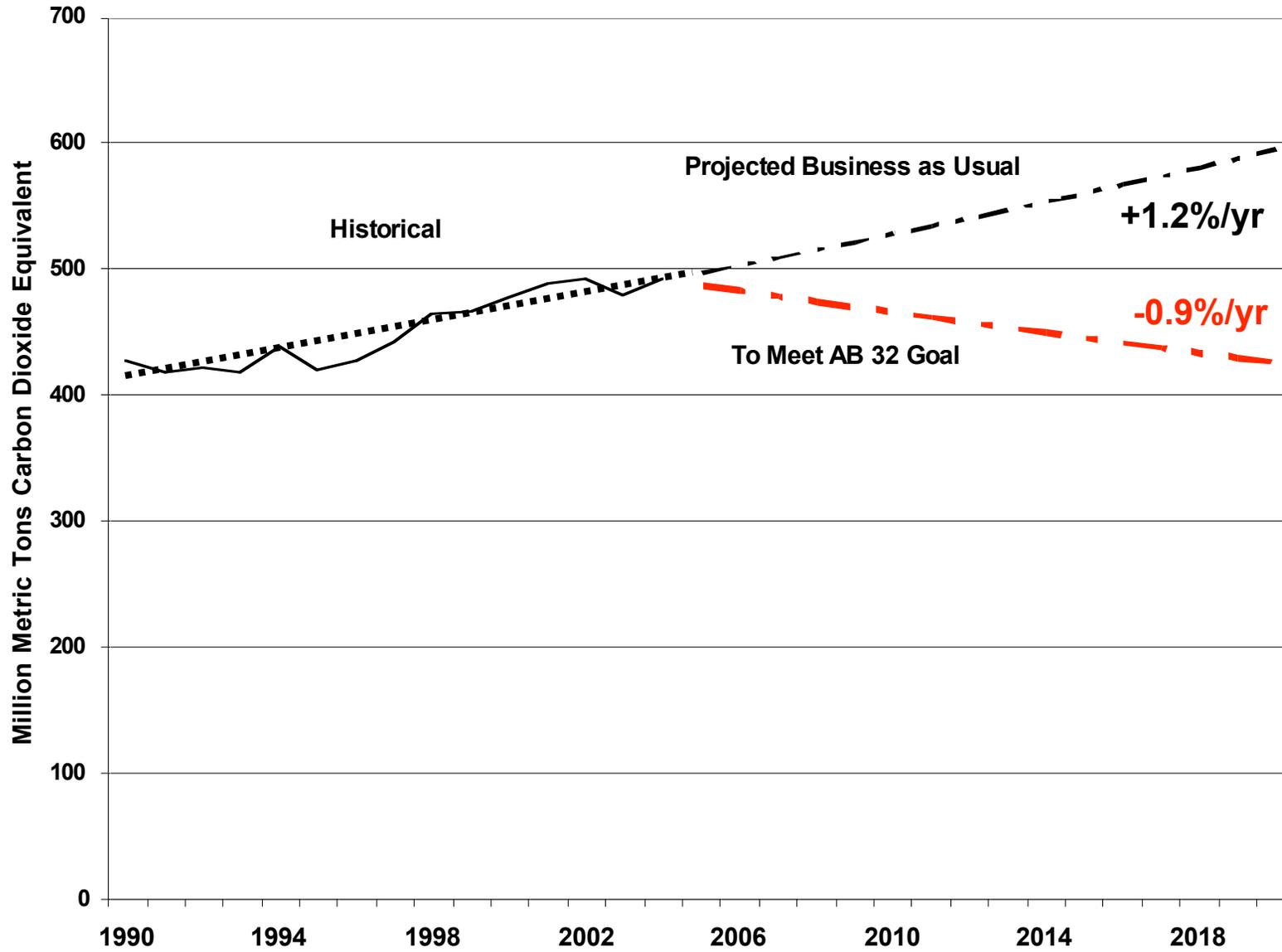
JANUARY 27TH - FEBRUARY 2ND 2009 [www.economist.com](http://www.economist.com)

Shake-up in Big Pharma  
China's space blast  
Europe's rotating slump  
Serbia's encouraging election  
Hating Hillary Clinton

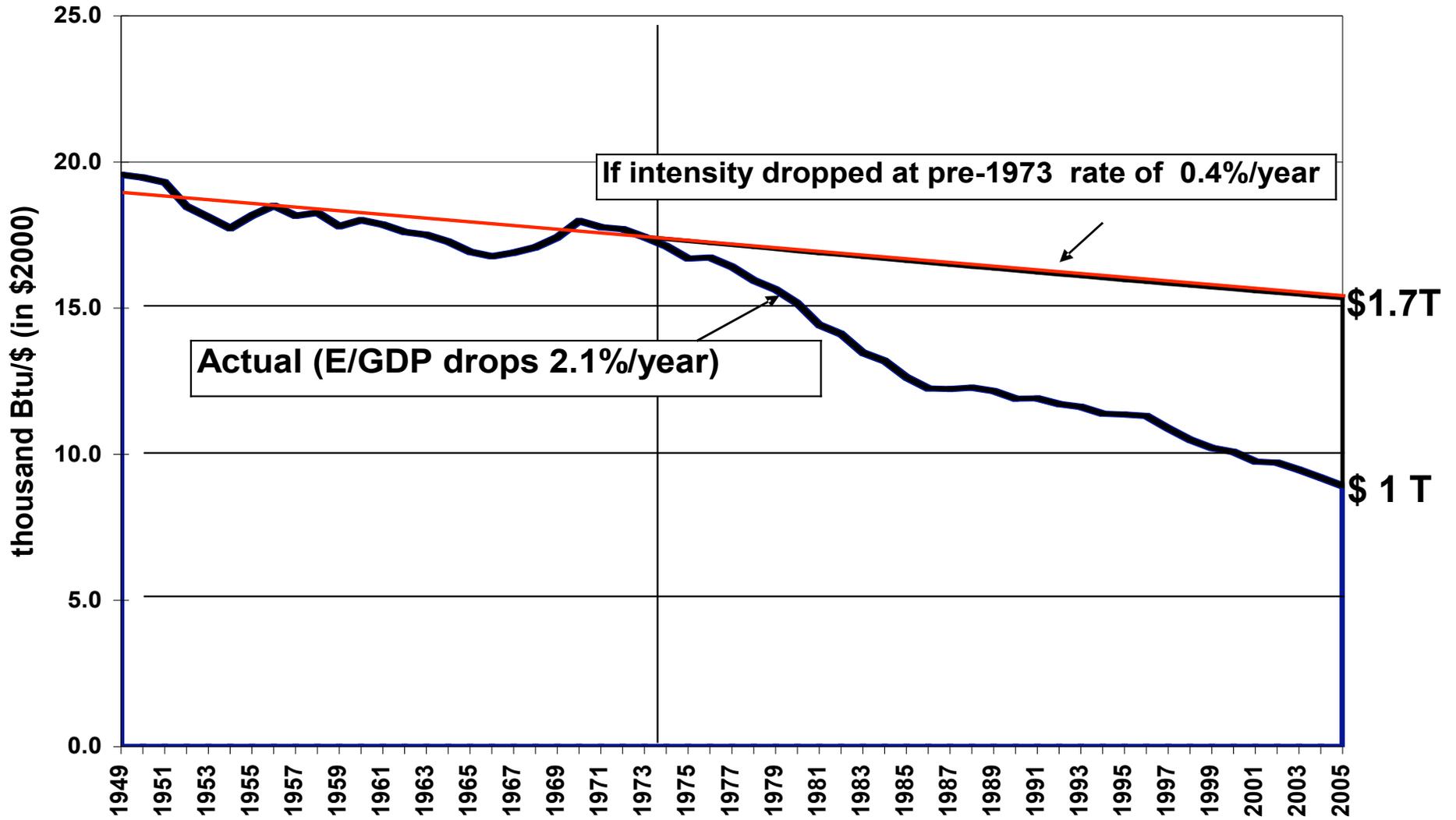


## The greening of America

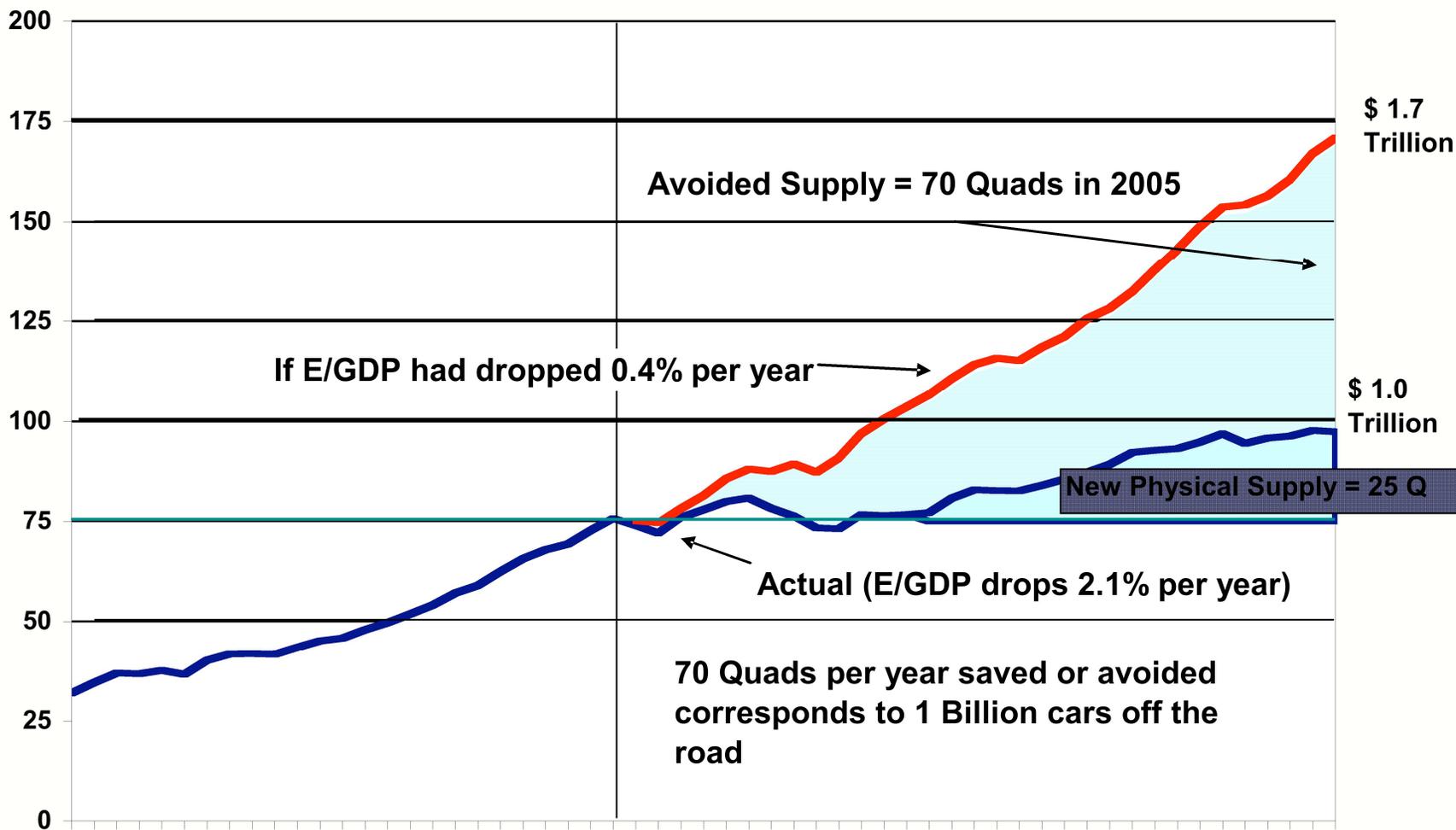
# CO2 Emissions in California: Historical and Projected



# Energy Intensity in the United States 1949 - 2005



# Energy Consumption in the United States 1949 - 2005



## Environmental Equivalent of Avoiding 70 Quads

- ◆ 70 Quads = 33 Mbod (Million barrels of oil per day)  
= 40% of World oil production of 80 Mbod
- ◆ 70 Quads = 1 Billion cars off the road, impressive since there are only 600 million cars on the road

# How Much of The Savings Come from Efficiency?

- ◆ Easiest to tease out is cars
  - In the early 1970s, only 14 miles per gallons
  - Now about 21 miles per gallon
  - If still at 14 mpg, we'd consume **75 billion gallons more** and pay **\$225 Billion more** at 2006 prices
  - But we still pay **\$450 Billion per year**
  - If California wins the "Pavley" suit, and it is implemented nationwide, we'll save **another \$150 Billion per year**
- ◆ Commercial Aviation improvements save another **\$50 Billion per year**
- ◆ Appliances and Buildings are more complex
  - We must sort out true efficiency gains vs. structural changes (from smokestack to service economy).

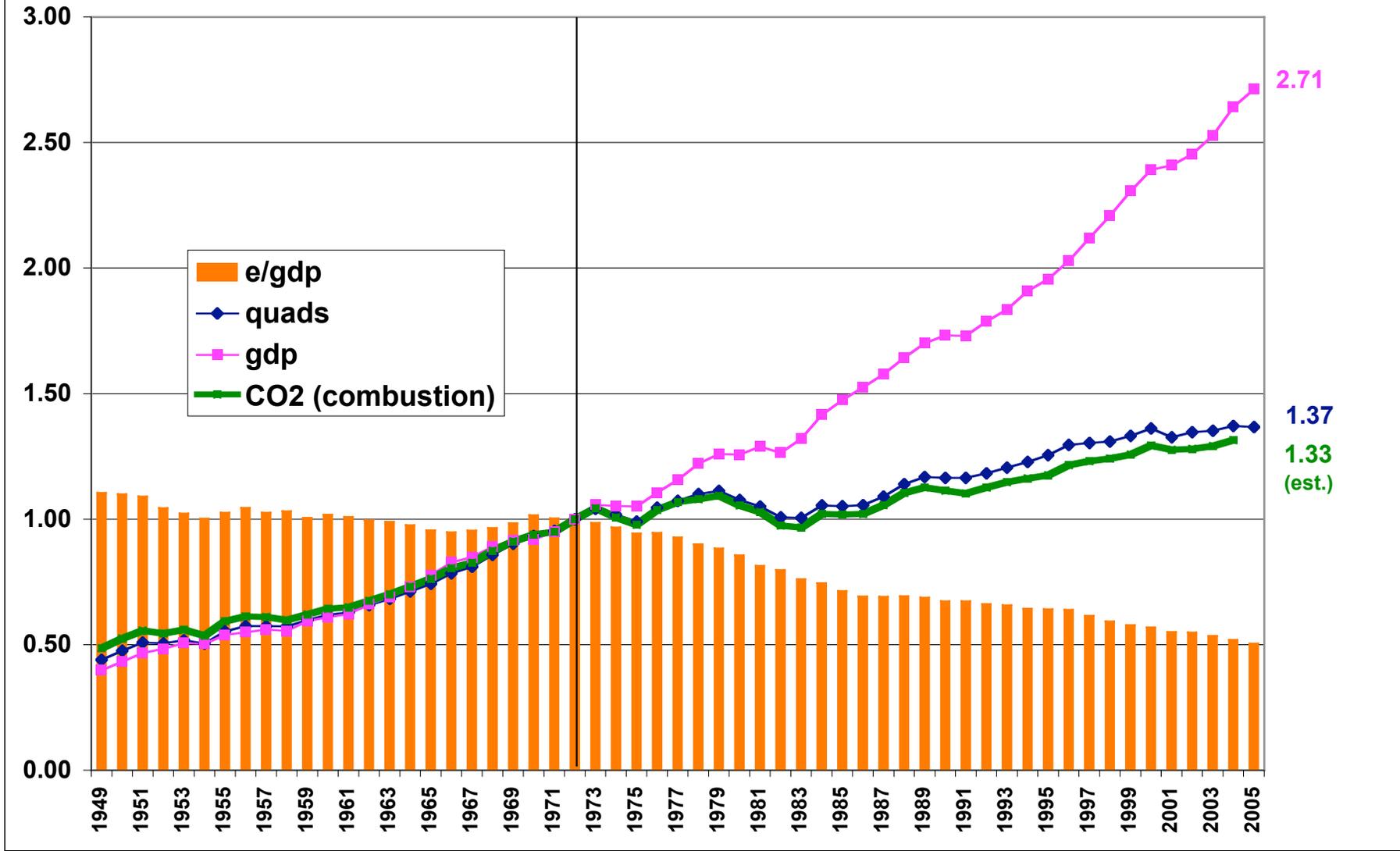
## How Much of The Savings Come from Efficiency (cont'd)?

- ◆ Some examples of estimated savings in 2006 based on 1974 efficiencies minus 2006 efficiencies

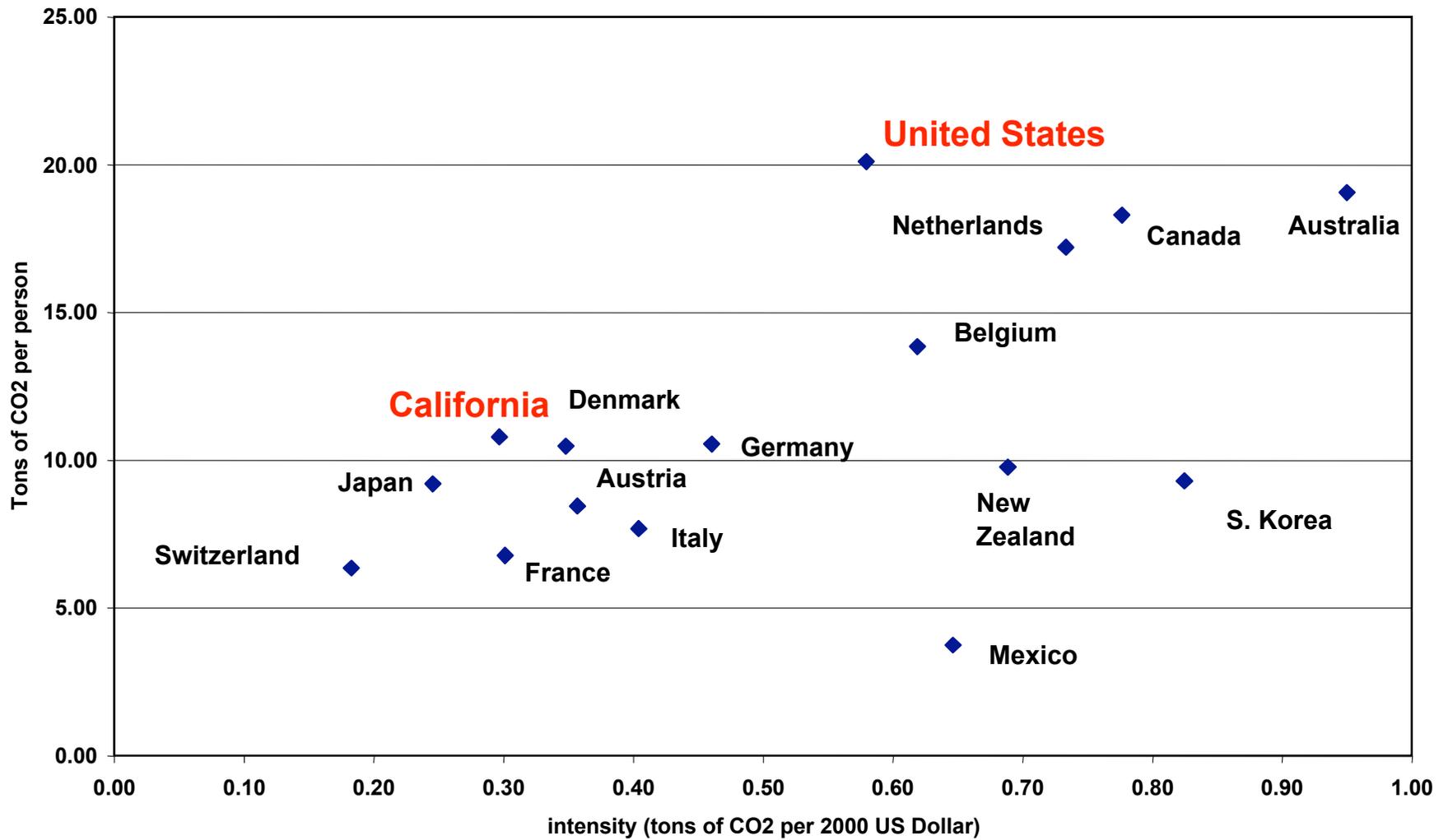
	Billion \$
Space Heating	40
Air Conditioning	30
Refrigerators	15
Fluorescent Tube Lamps	5
Compact Fluorescent Lamps	5
<b>Total</b>	<b>95</b>

- ◆ Beginning in 2007 in California, reduction of “vampire” or stand-by losses
  - This will save \$10 Billion when finally implemented, nation-wide
- ◆ Out of a total **\$700 Billion**, a crude summary is that 1/3 is structural, 1/3 is from transportation, and 1/3 from buildings and industry.

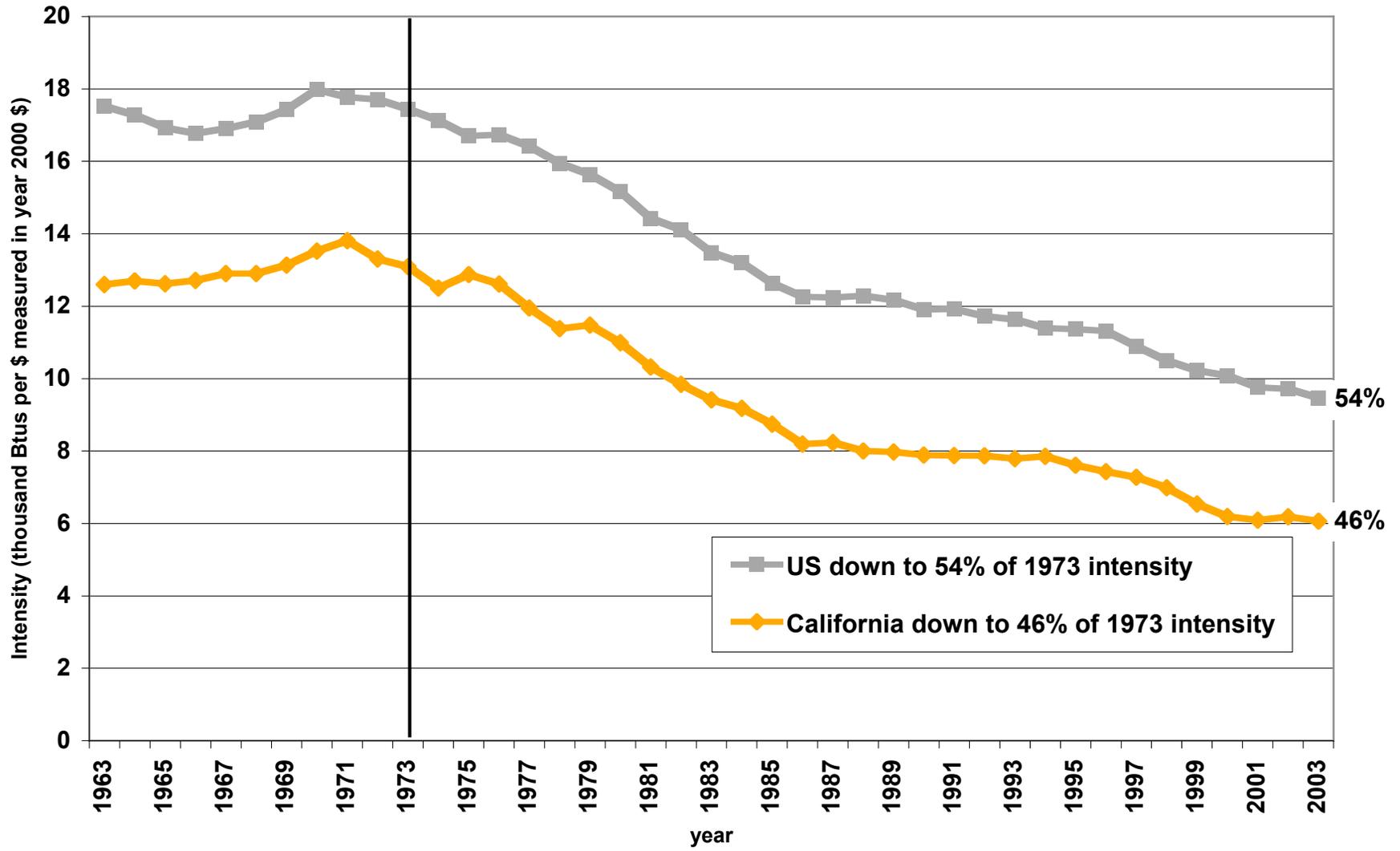
Index (1972 = 1.00) of U.S. Energy Use, GDP, Energy Intensity and Carbon Dioxide  
 last 10-year CO2 growth = 1.3% per year



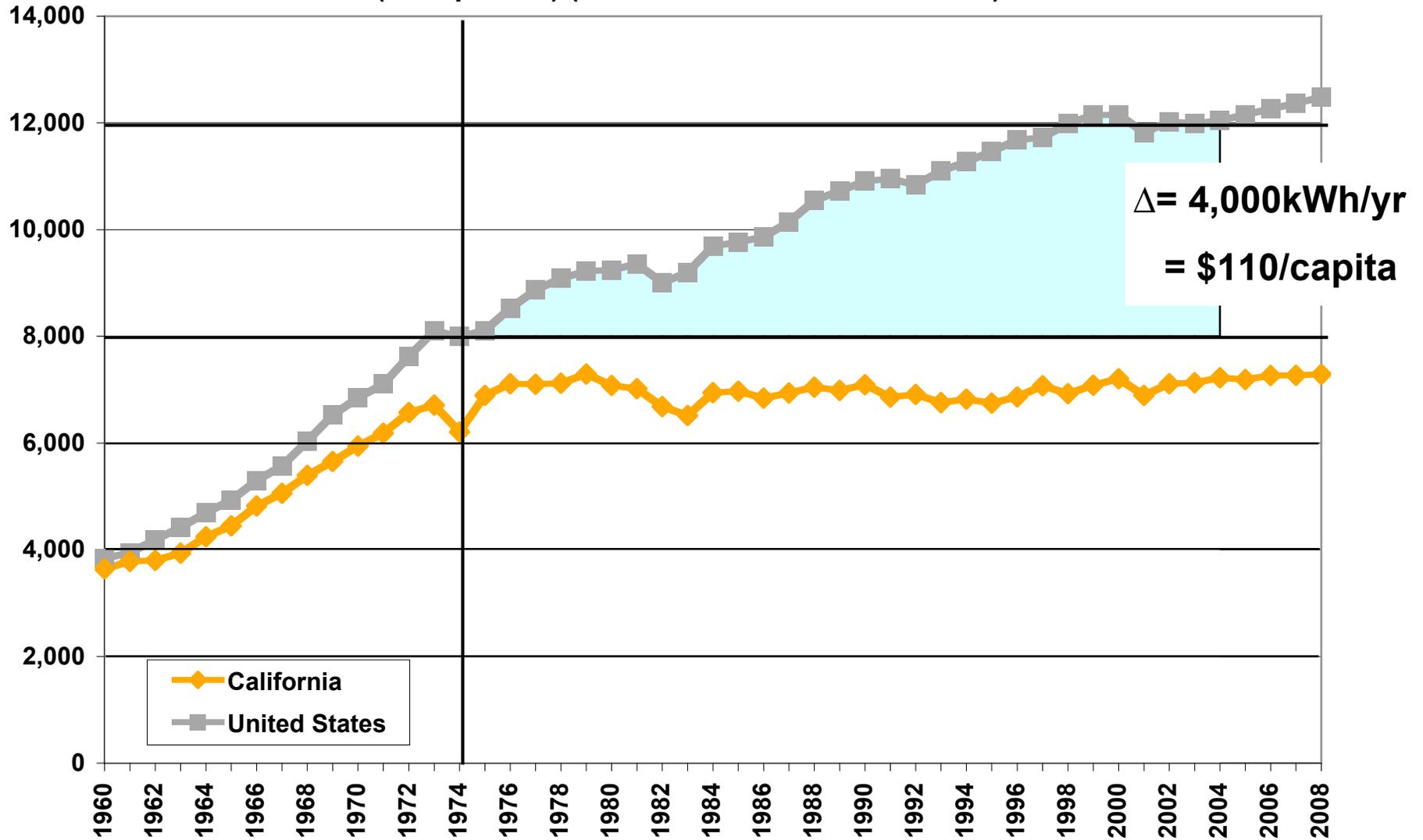
Carbon Dioxide Intensity and Per Capita CO2 Emissions -- 2001  
(Fossil Fuel Combustion Only)



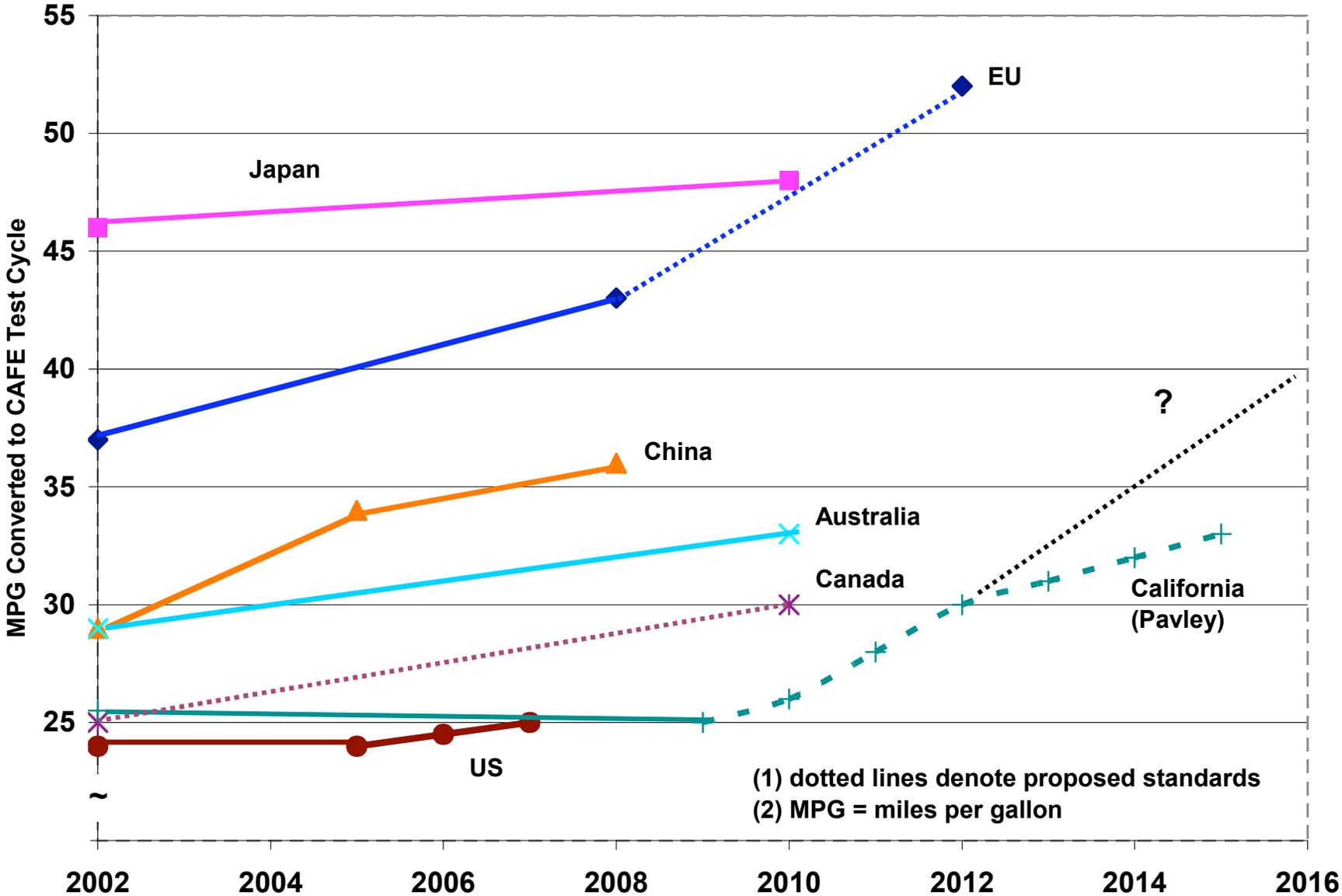
### Energy Intensity -- California and the United States



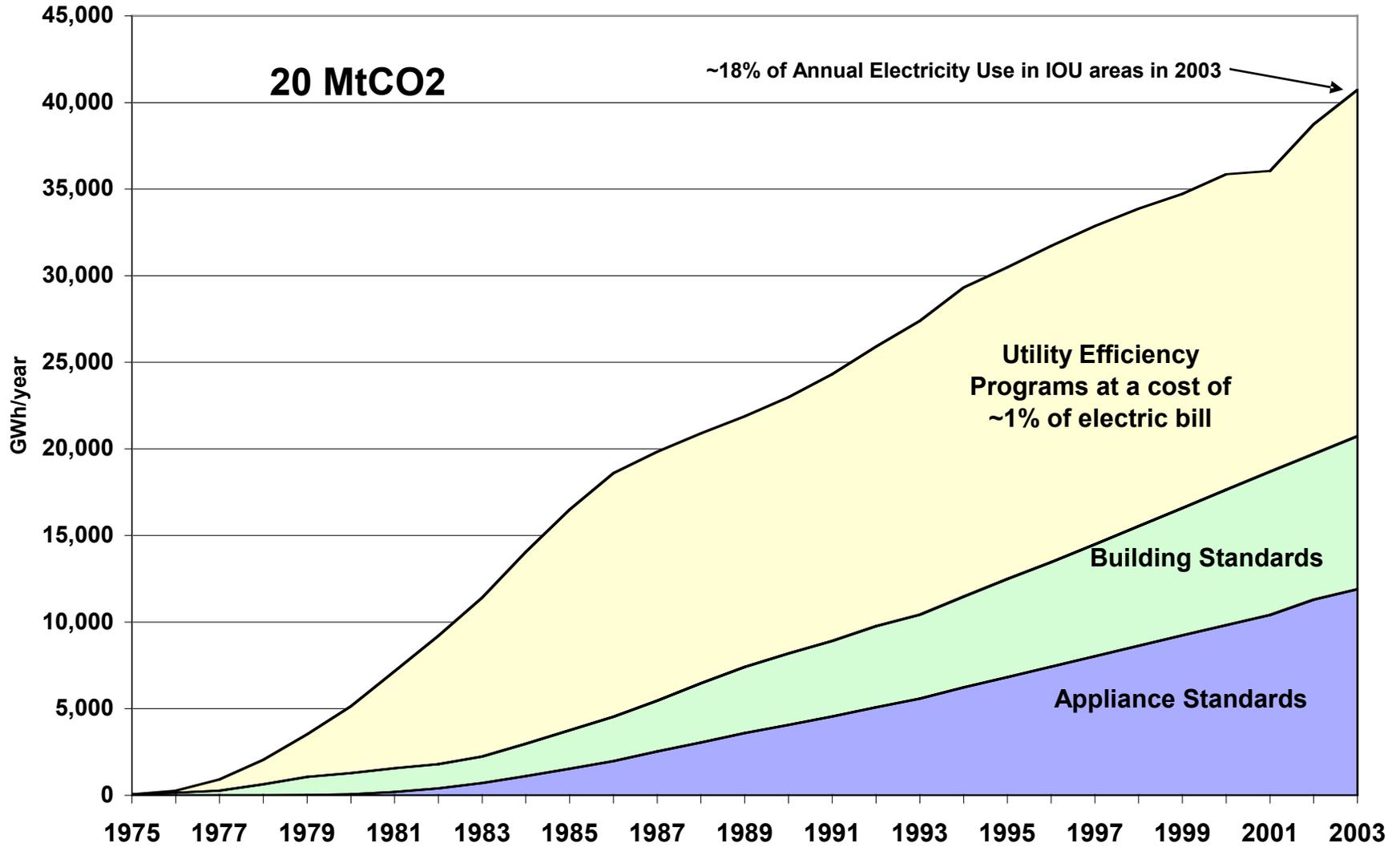
Per Capita Electricity Sales (not including self-generation)  
 (kWh/person) (2005 to 2008 are forecast data)



# Comparison of Fuel Economy – Passenger Vehicles



## Annual Energy Savings from Efficiency Programs and Standards

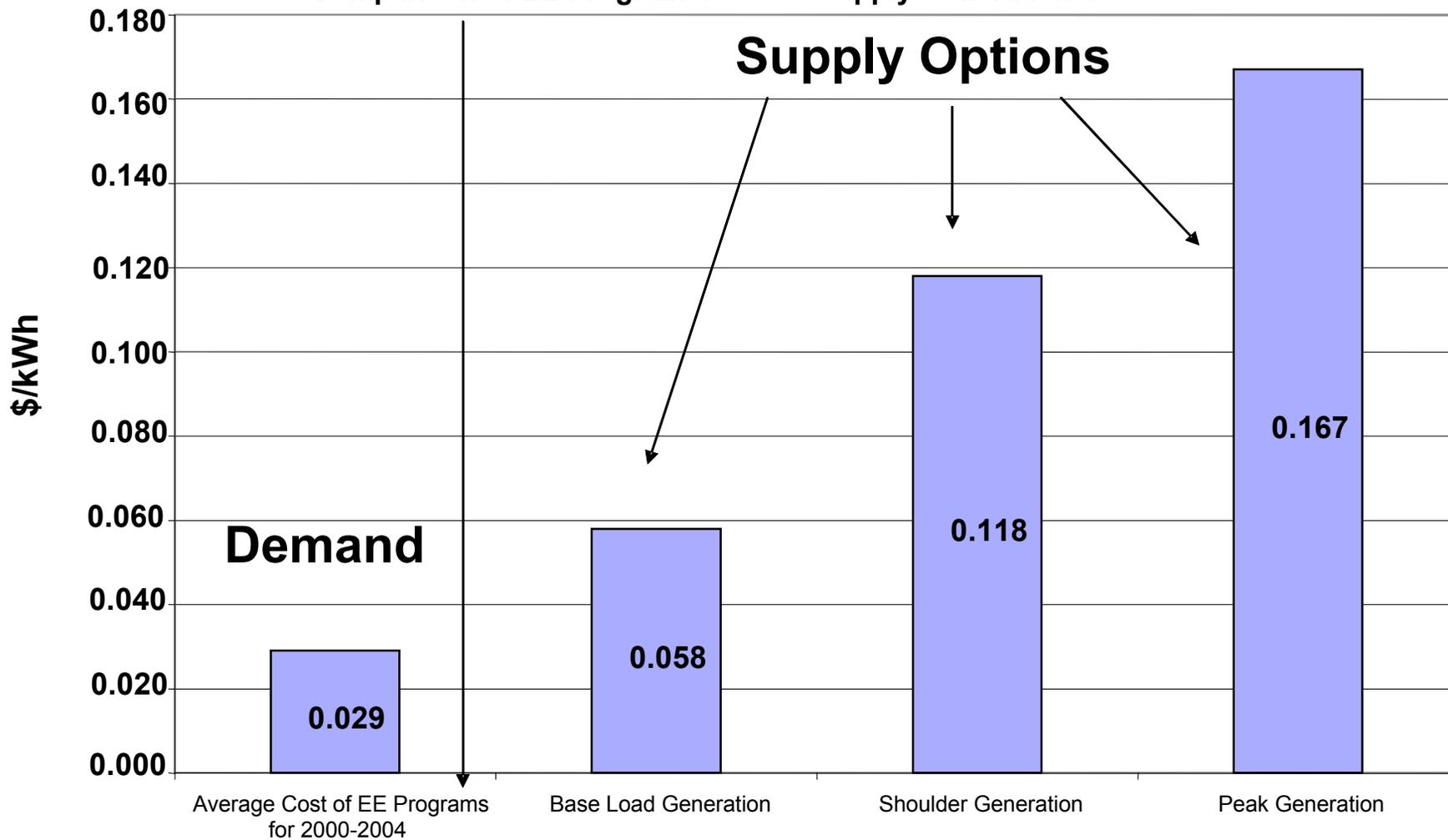


# California Must Expand CEC Staff for Standards

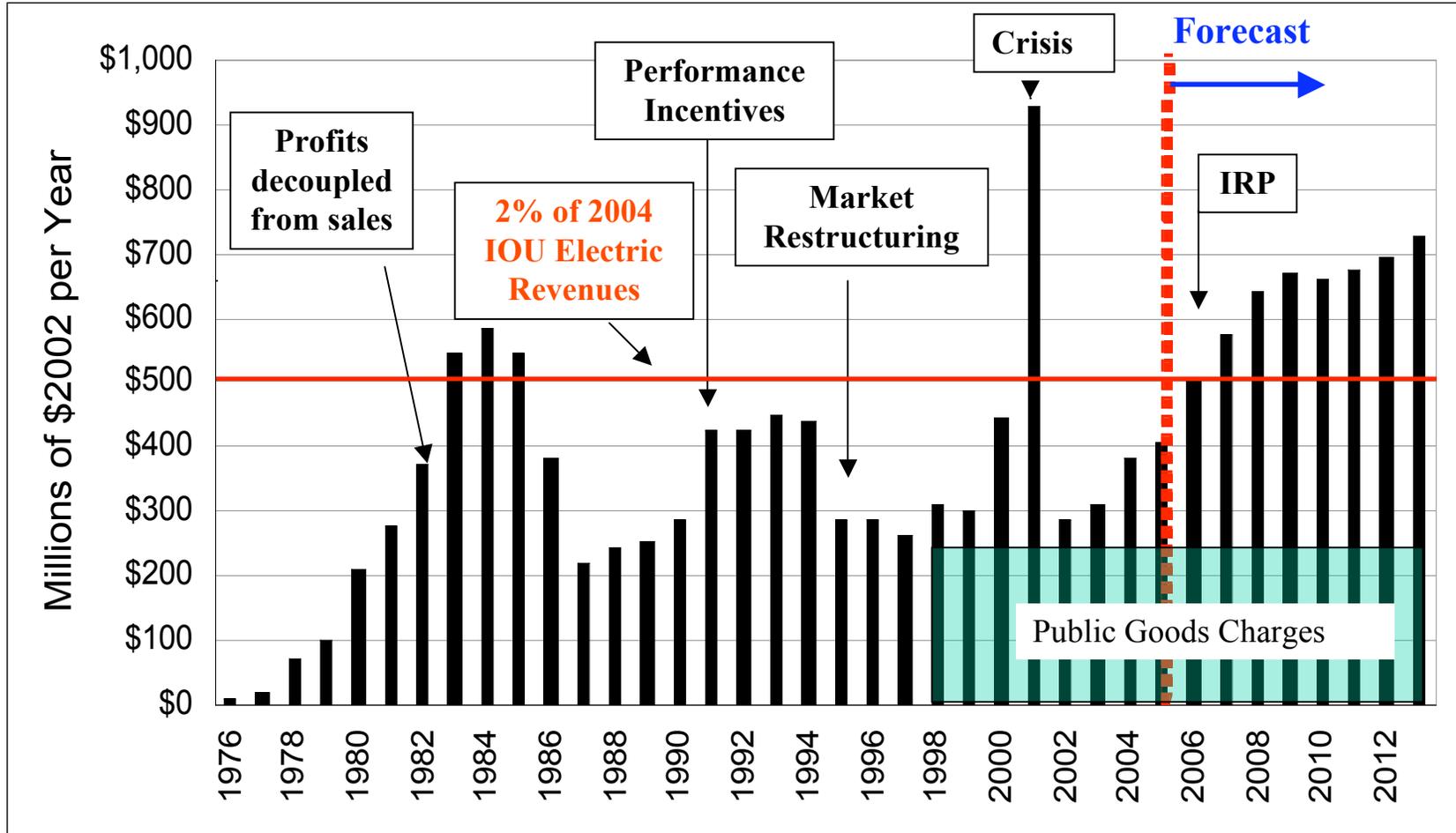
California spends ~\$1B/year on EE and Renewables to reduce electricity use by ~1%/year,

But CEC Standards Office has only 14 staff (\$2M/year) to accelerate building and appliance standards, and thus reduce use by ~1/2%/year.

Figure 8  
Comparison of EE Program Costs to Supply Generation Costs



# California IOU's Investment in Energy Efficiency

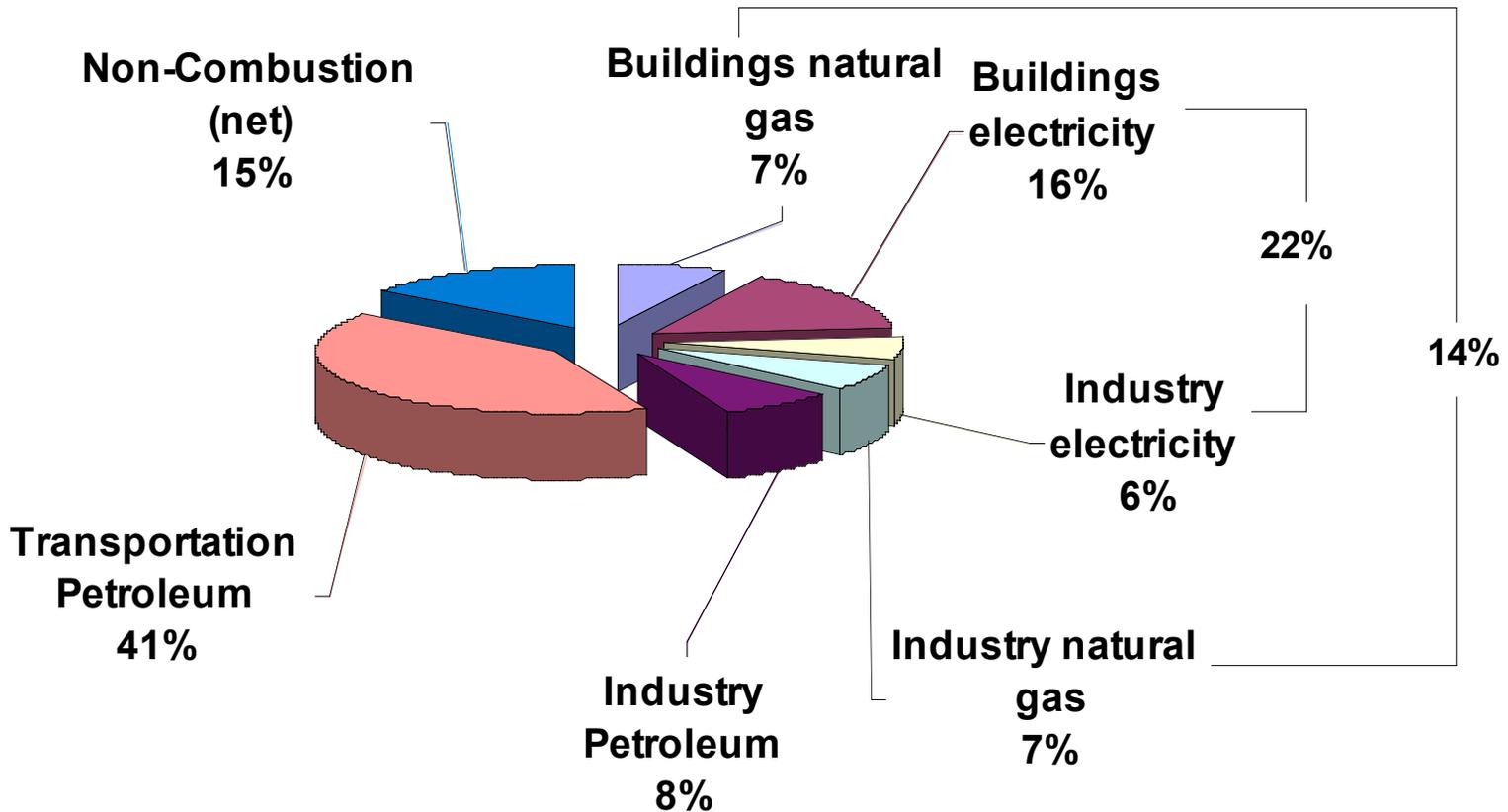


## What about Public Utilities – the Other 25% ?

- ◆ Existing law already requires that IOU electric and gas utilities regulated by the CPUC shall:
  1. Meet resource needs through all available energy efficiency and demand reduction resources that are cost-effective, reliable, and feasible and
  2. Set energy efficiency goals
  
- ◆ AB 2021 (Levine, 2006) now requires that **Public Utilities** shall follow similar programs and goals, supervised by the CEC

# Emissions of CO2 in California by End Use in 2004

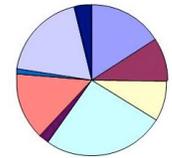
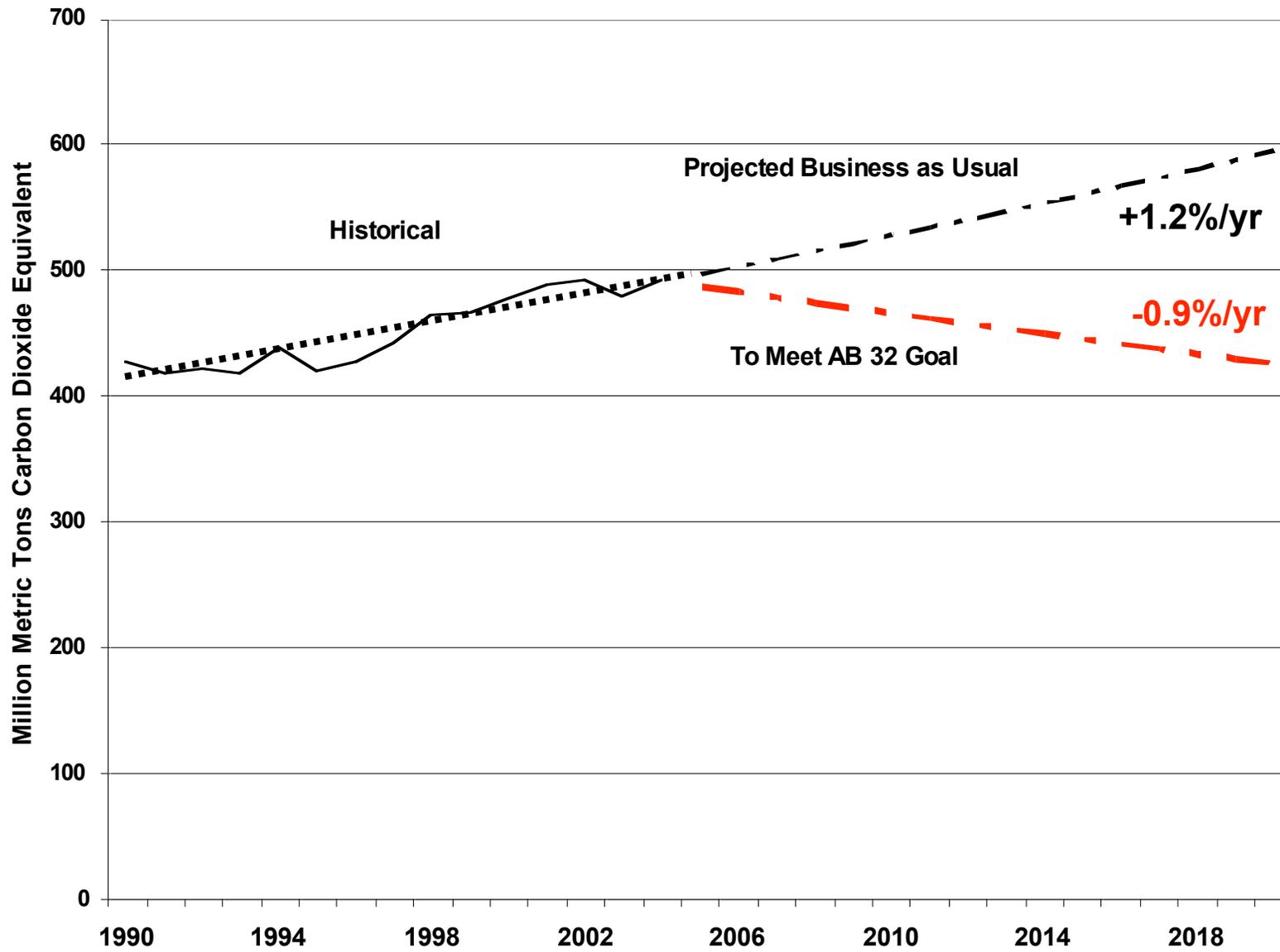
Total Emissions = 490 Million metric tons CO2 equivalent



Source: Energy Efficiency in California and the United States -- Chang, Rosenfeld, McAuliffe

<http://www.energy.ca.gov/2007publications/CEC-999-2007-007/CEC-999-2007-007.PDF>

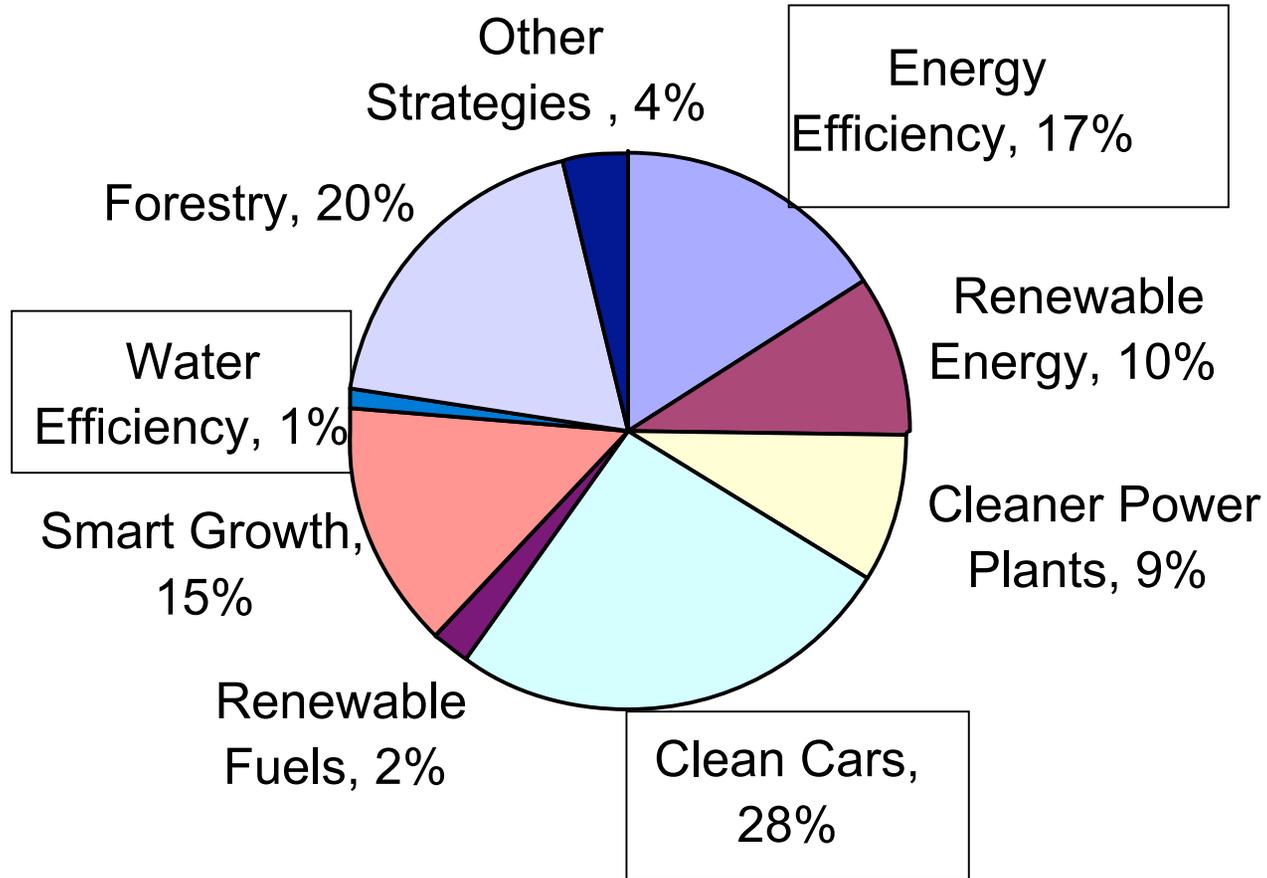
# CO2 Emissions in California: Historical and Projected



## Strategies for Meeting California's CO2 Goals in 2020

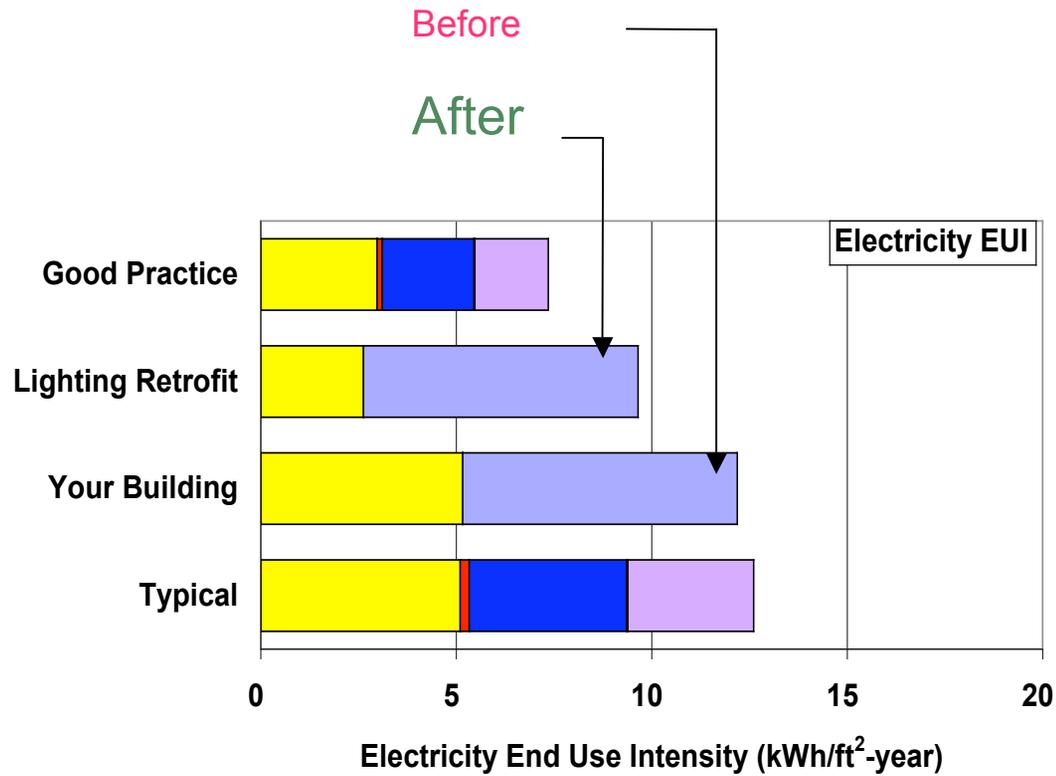
Total Reductions = 174 Million metric Tons CO2 equivalent

i.e. 30% of projected 2020 Business As Usual CO2 emissions



## 2011 Energy Efficiency Goals for the IOUs

- ◆ CPUC OIR to implement 2009-2011 energy efficiency goals
  - Portfolio development over the next few months
  - Should support “significant, bold progress toward measurable market penetration goals”
  - Proposed new measures:
    1. Conversion of general purpose lighting to high efficiency by 2017
    2. A specific % of **residential** construction to exceed 2008 Title 24 by 35% and thereby set new levels for Title 24 updates in 2011
    3. A specific % of existing **commercial** building to improve energy efficiency by 20% (through **benchmarking**)
    4. A specific penetration of 80%-efficient gas water heaters (SEGWHAI) by 2011 and beyond



# Title 20 Appliance Standards

- ◆ Lighting
  - 5% improvement in incandescent lamps already underway
  - Eventually, a fleet average of all lighting, measured in lumens/watt
    - Moving toward very limited use of incandescent bulbs and T-12s
- ◆ Reductions in Stand-by losses also underway
  - Currently running 10% of residential use
- ◆ Clothes washers. In CA, 29% of electr & 30% of nat gas → water.
  - Less water use leads to reduced energy use
  - Department of Energy is considering California petition for waiver of rather weak federal standard

## Title 24 – Building Standards

- ◆ White roofs already required in T-24 2005 for ‘flat’ roofs
- ◆ Cool **colored** roofs will be required in 2008 updates
  - Possible utility incentive programs to go beyond colored roof all the way to white
- ◆ California Solar Initiative. Don’t put expensive PV on a new home which is optimized for relatively cheap grid electricity.
  - Rebates will require that new homes beat Title 24 by at least 15%

# Public Interest Energy Research

- ◆ Cool colored paints
  - Not only for use in roofs
  - But, also on cars
    - Reduce fuel use by 2% (of ~100 MtCO<sub>2</sub> for gasoline)
    - Can reduce first costs by reducing AC system size
- ◆ Working with the EPA to deliver a “benchmark” tools for non-residential buildings called ‘Energy Star Portfolio Manager’
  - Hand over to utilities for implementation
- ◆ Hot Dry Air Conditioning Standards
  - Break up US into three AC climate zones
  - At no cost, could improve EER up to 20%
  - Legislation or a waiver is needed though
- ◆ Super Efficient Gas Hot Water Heater Appliance Initiative-SEGWHAI
  - Will save >20%

## From Cool Color Roofs to Cool Color Cars

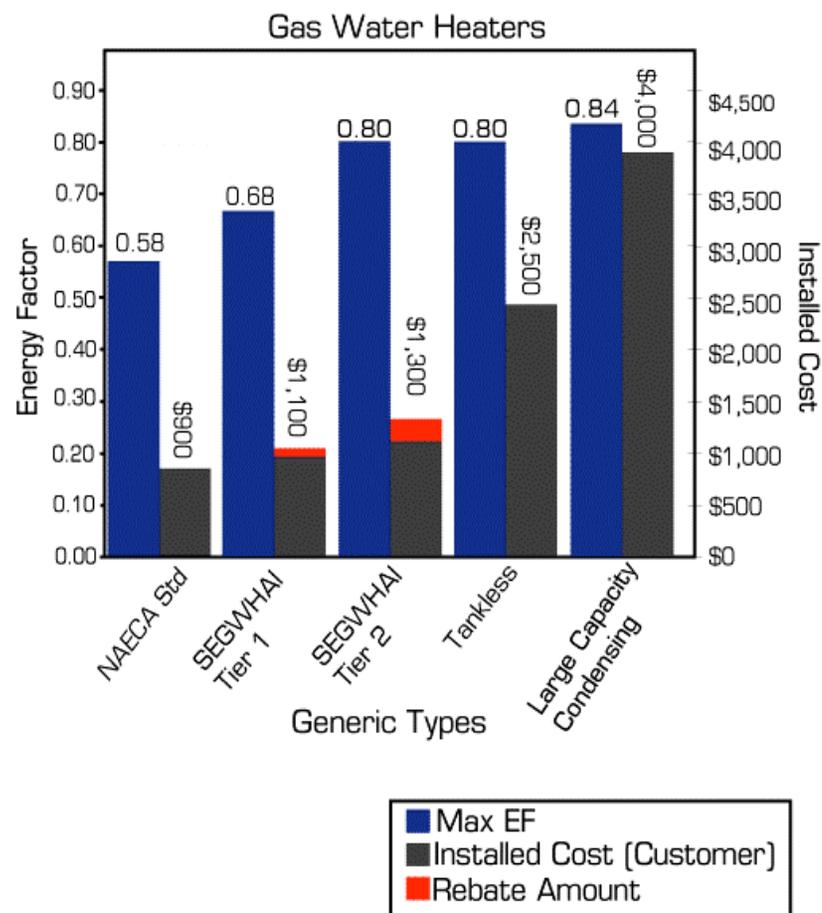


- ◆ Toyota experiment (surface temperature 10C = 18F cooler)
- ◆ Ford and Fiat are also working on the technology

# SEGWHAI

Super Efficient Gas Water Heating Appliance Initiative

- ◆ Replacement Gas Storage Water Heater
  - Conventional technology: simple but antiquated design that wastes energy
  - 85% of water heater sales are replacement units, 60% of these are **emergency** replacements
  - Current advanced technologies not appropriate for replacement market
- ◆ SEGWHAI Goals:
  - 30% increase in efficiency
  - 70% decrease in NO<sub>x</sub>
  - Cost effective market price, pay back less than 5 years
  - Equivalent to standard water heaters for the customer and installing plumber



# SEGWHAI

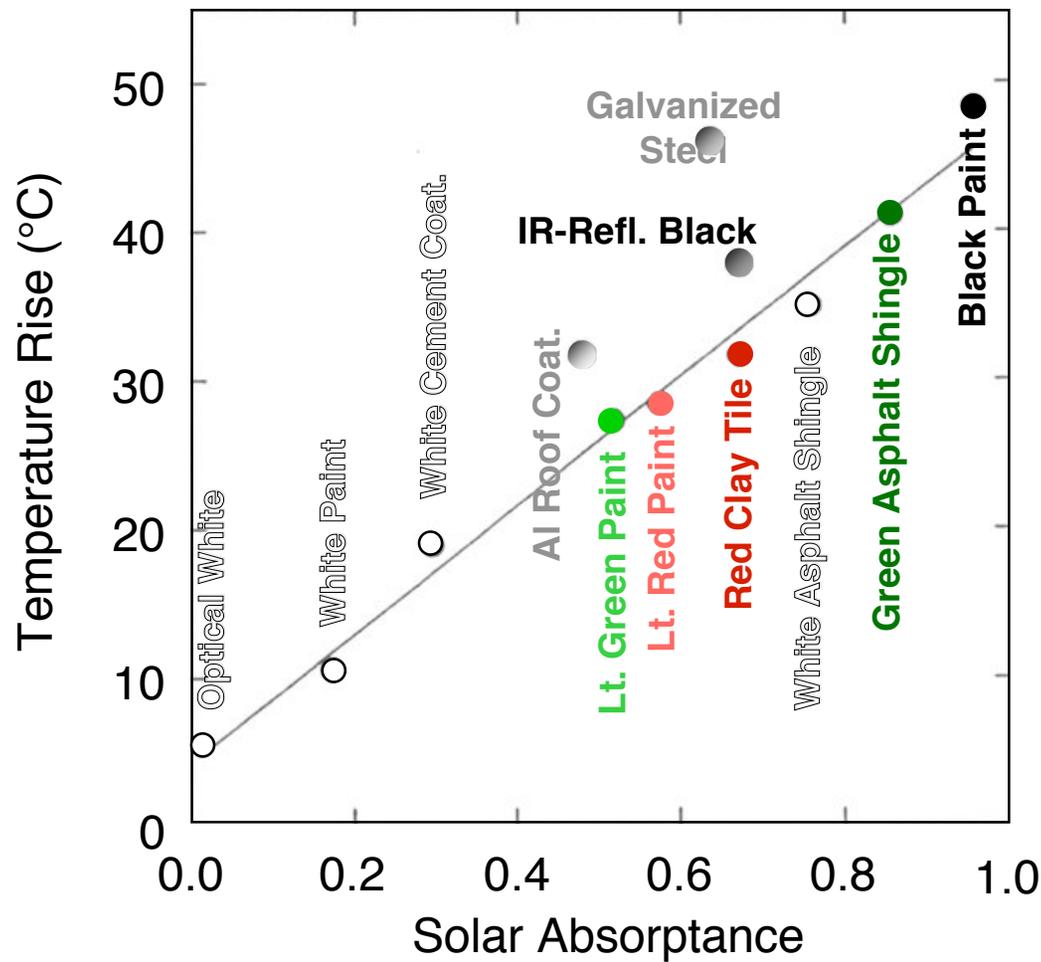
Super Efficient Gas Water Heating Appliance Initiative

## Benefits to California

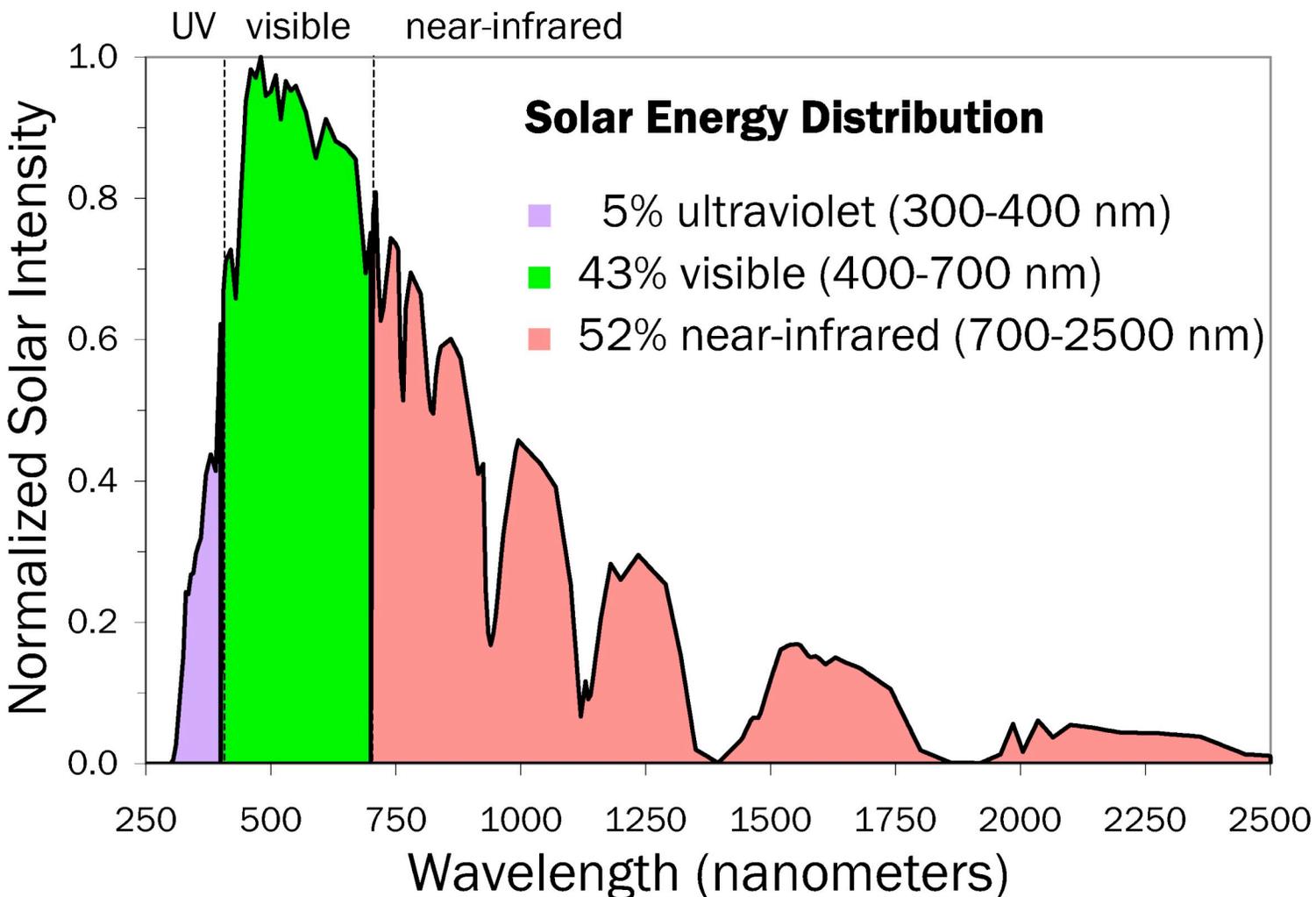
- ◆ Savings per water heater (over the equipment lifetime):
  - 400 - 700 therms
  - 2.4 – 4.1 metric tons CO<sub>2</sub>
  - 13 pounds of NO<sub>x</sub>
- ◆ If 50% of existing water heaters in CA are replaced w/ SEGWHAI Tier 1 units:
  - \$154 M in natural gas costs saved each year
  - **900,000 metric tons of CO<sub>2</sub>** avoided each year
  - 5 M pounds of NO<sub>x</sub> avoided each year
- ◆ These emission reductions are valued at more than \$30M per year

# Temperature Rise of Various Materials in Sunlight

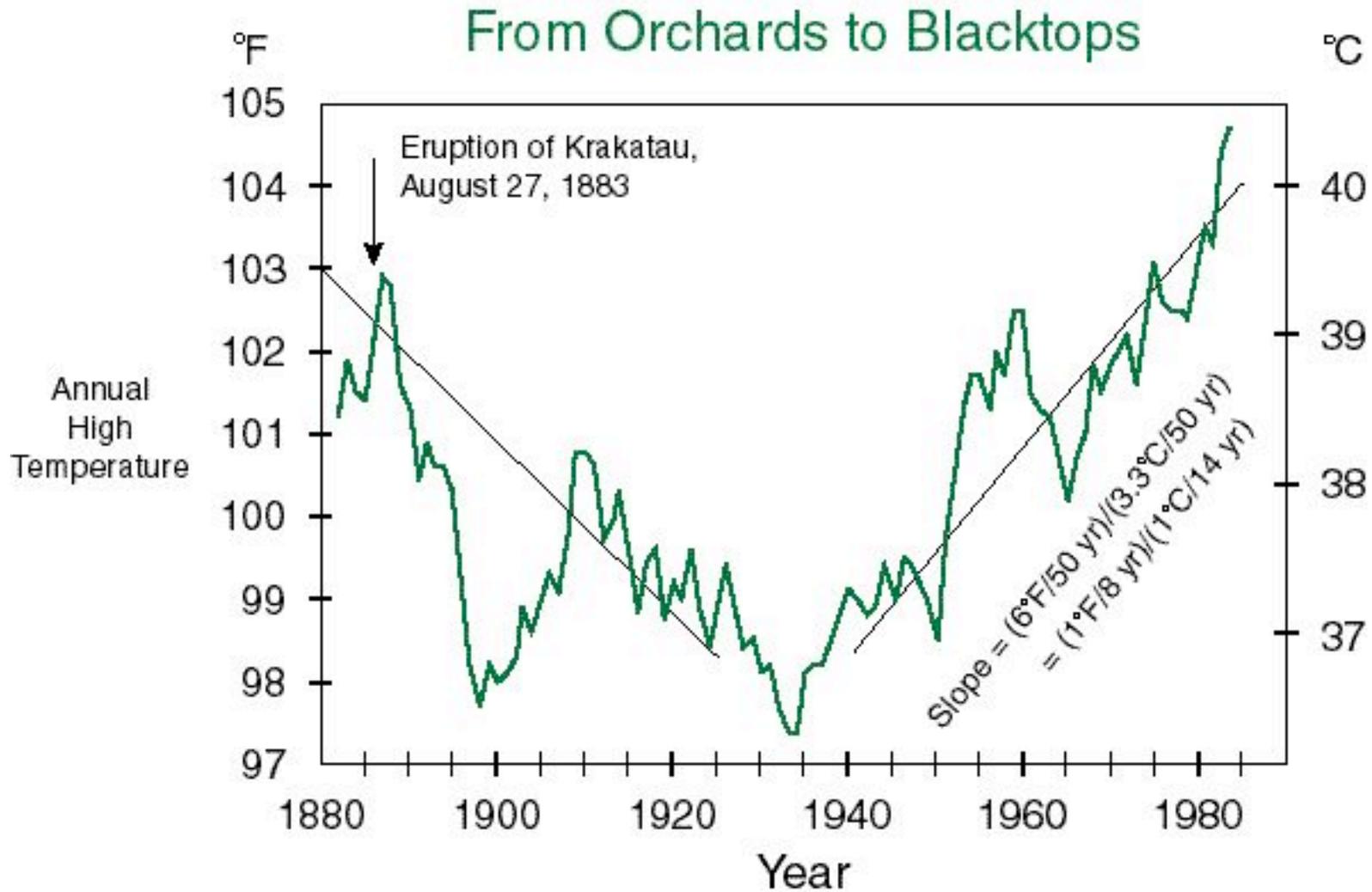
Dr. Hashem Akbari, LBNL Heat Island Group



# Cool Colors Reflect Invisible Near-Infrared Sunlight



# Temperature Trends in Downtown Los Angeles



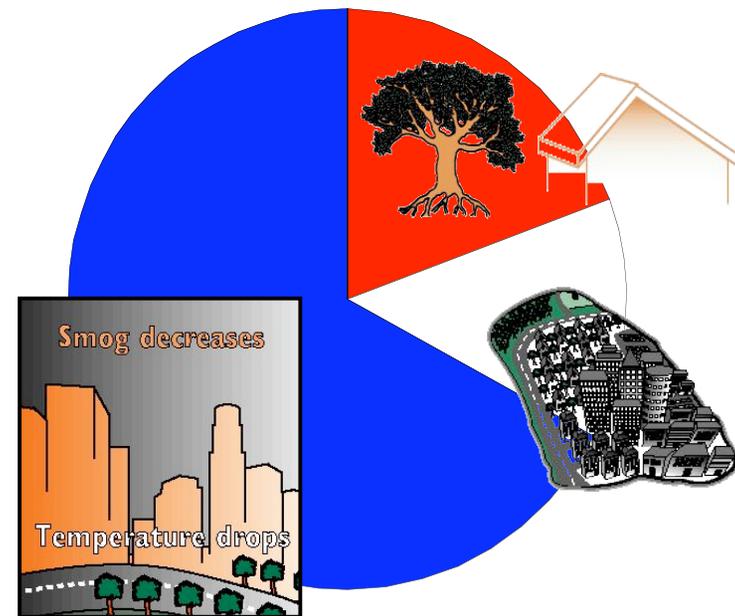
## Potential Savings in LA

### ◆ Savings for Los Angeles

- Direct, \$200M/year
- Indirect, \$140M/year

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- Smog, \$360M/year
- CO<sub>2</sub>, ~2 MtCO<sub>2</sub>/year



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- ◆ This talk available on my web page

- ◆ Just Google

“Art Rosenfeld”