

**Near-Term Solutions for
Mitigation of Carbon Dioxide
CARB Symposium
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**Arthur H. Rosenfeld, Commissioner
California Energy Commission
(916) 654-4930
ARosenfe@Energy.State.CA.US**

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

or just **Google “Art Rosenfeld”**

The Economist

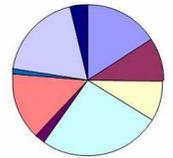
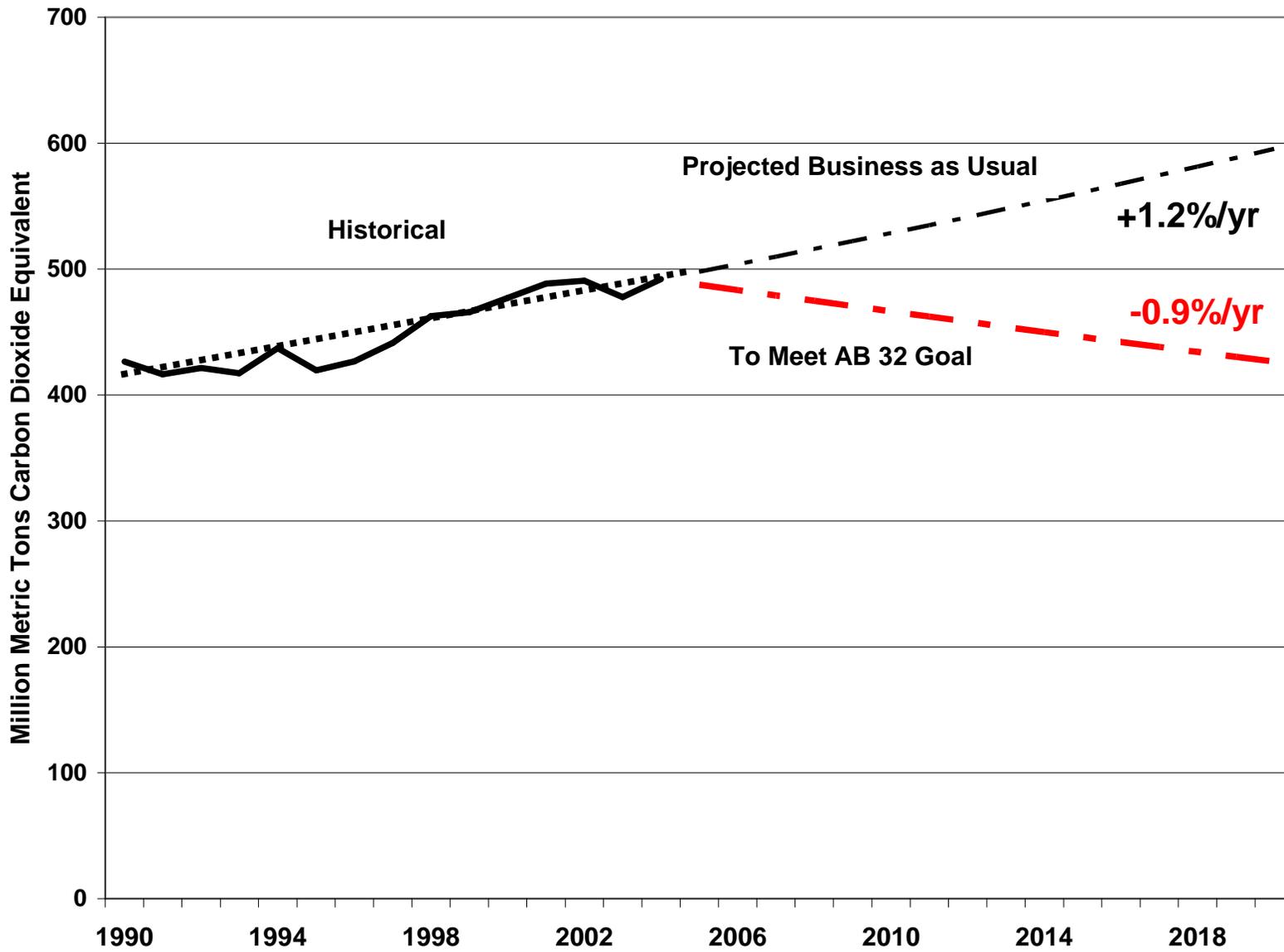
JANUARY 27TH-FEBRUARY 2ND 2008 www.economist.com

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

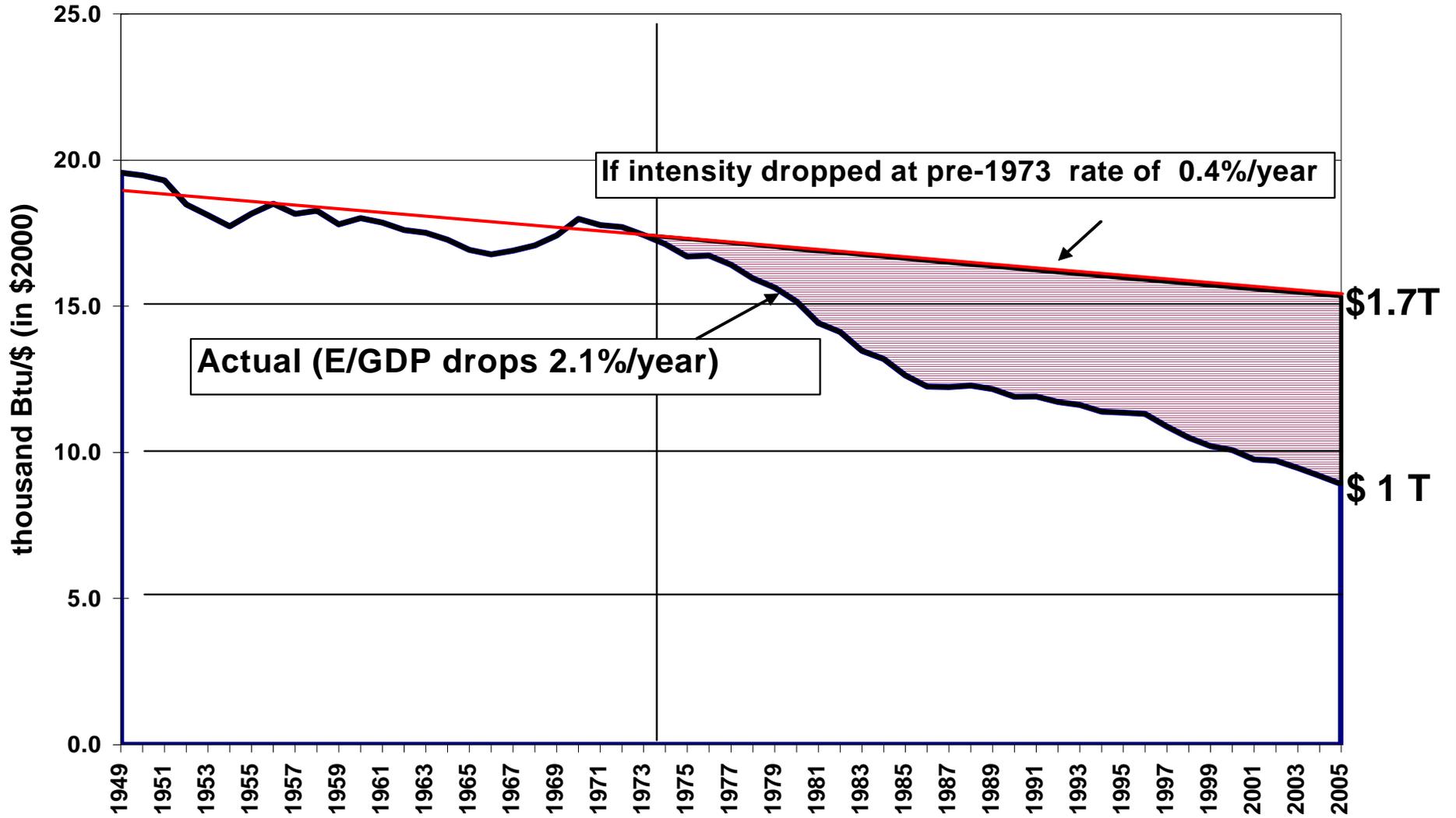


The greening of America

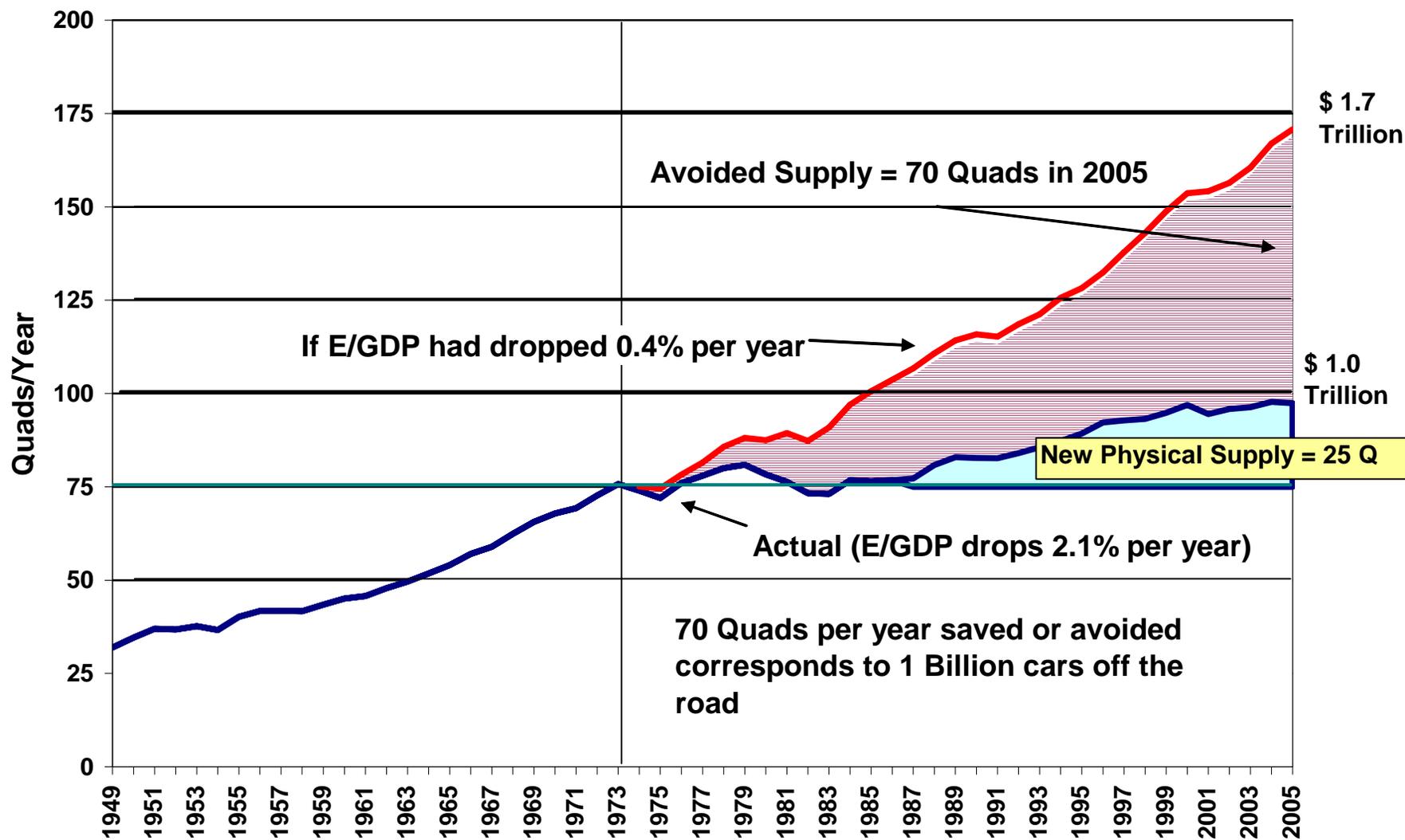
CO2 Emissions in California: Historical and Projected



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).

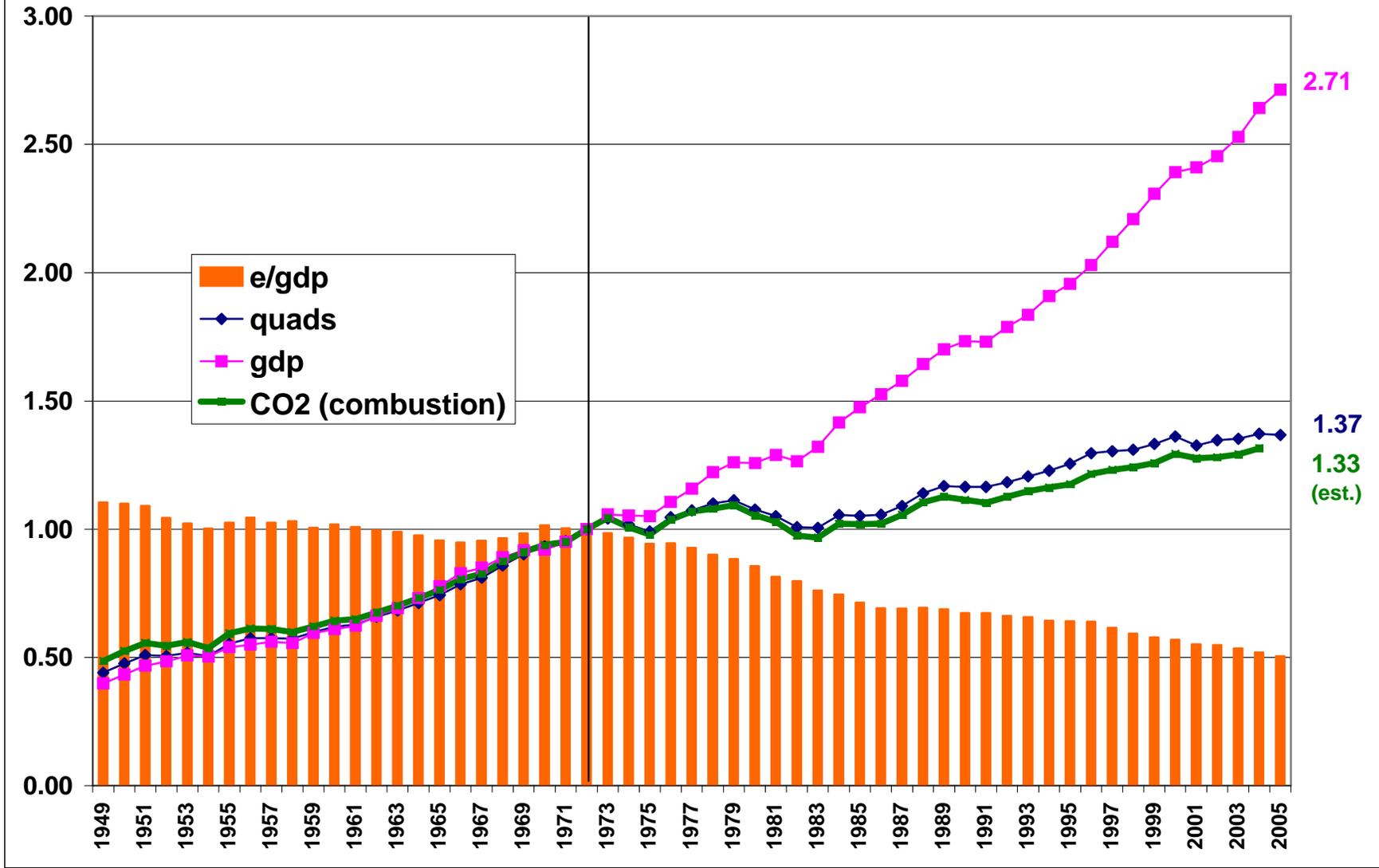
How Much of The Savings Come from Efficiency (cont'd)?

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

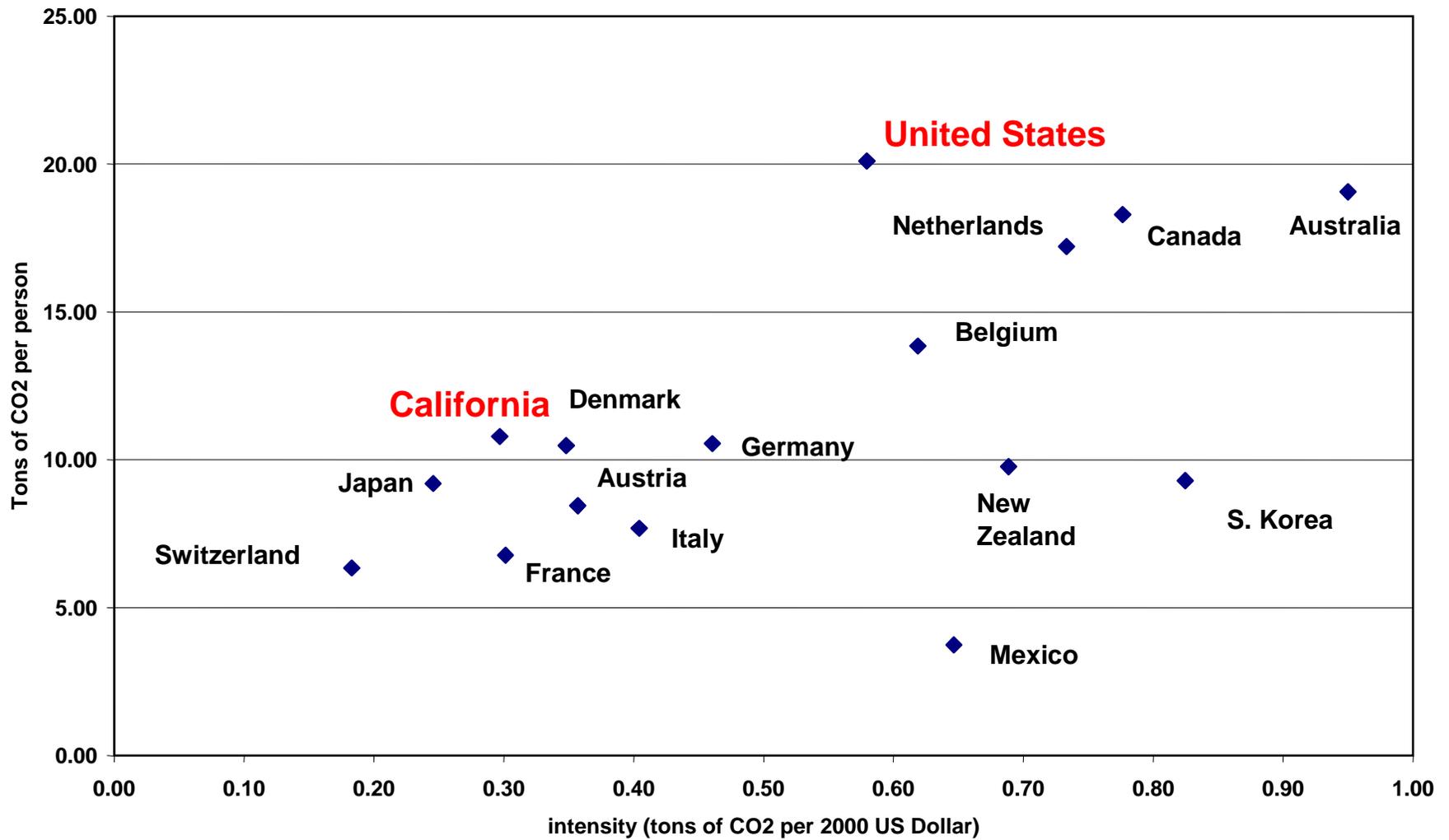
	Billion \$
Space Heating	40
Air Conditioning	30
Refrigerators	15
Fluorescent Tube Lamps	5
Compact Fluorescent Lamps	5
Total	95

- ◆ 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.

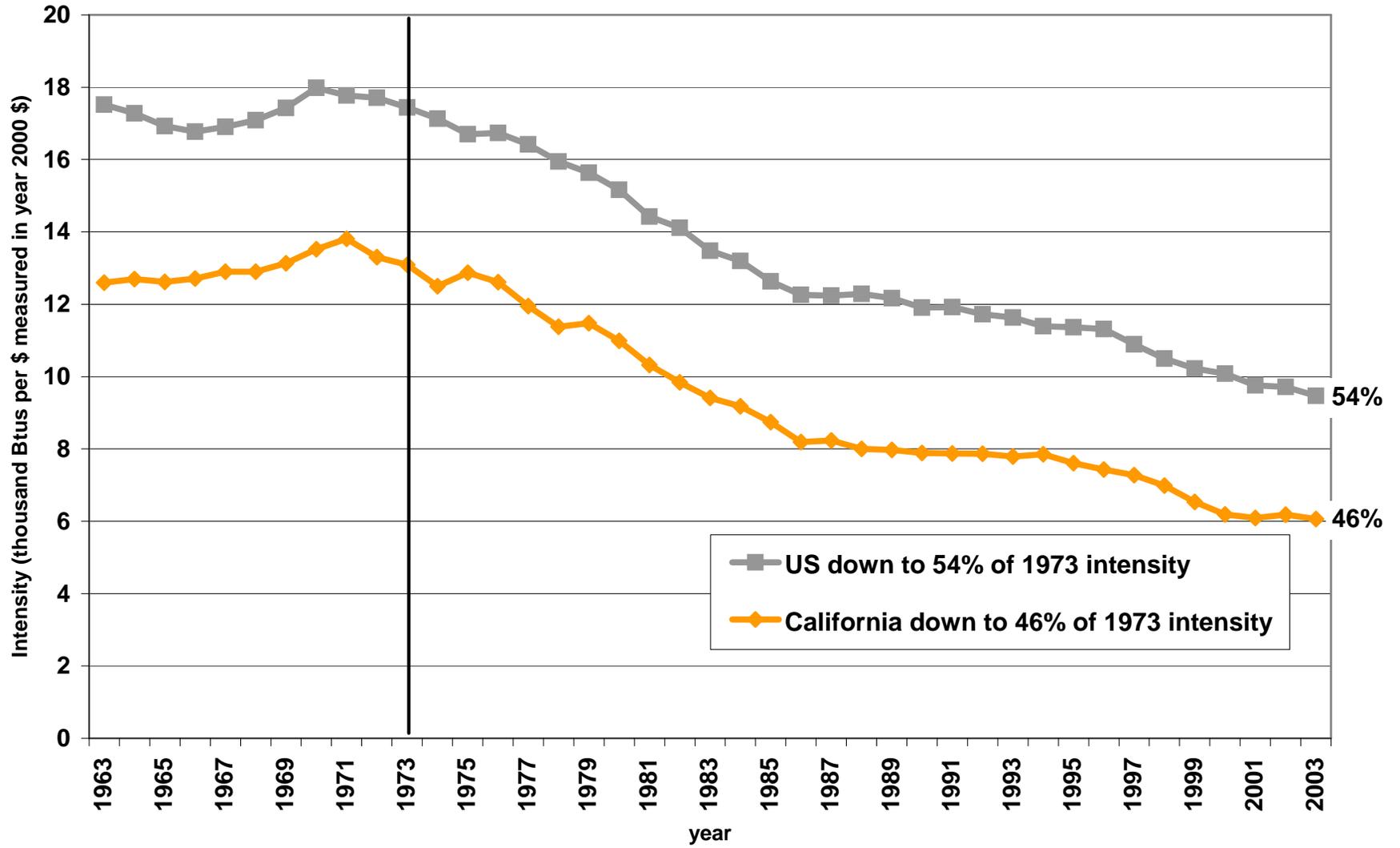
Index (1972 = 1.00) of U.S. Energy Use, GDP, Energy Intensity and Carbon Dioxide
 last 10-year CO2 growth = 1.3% per year



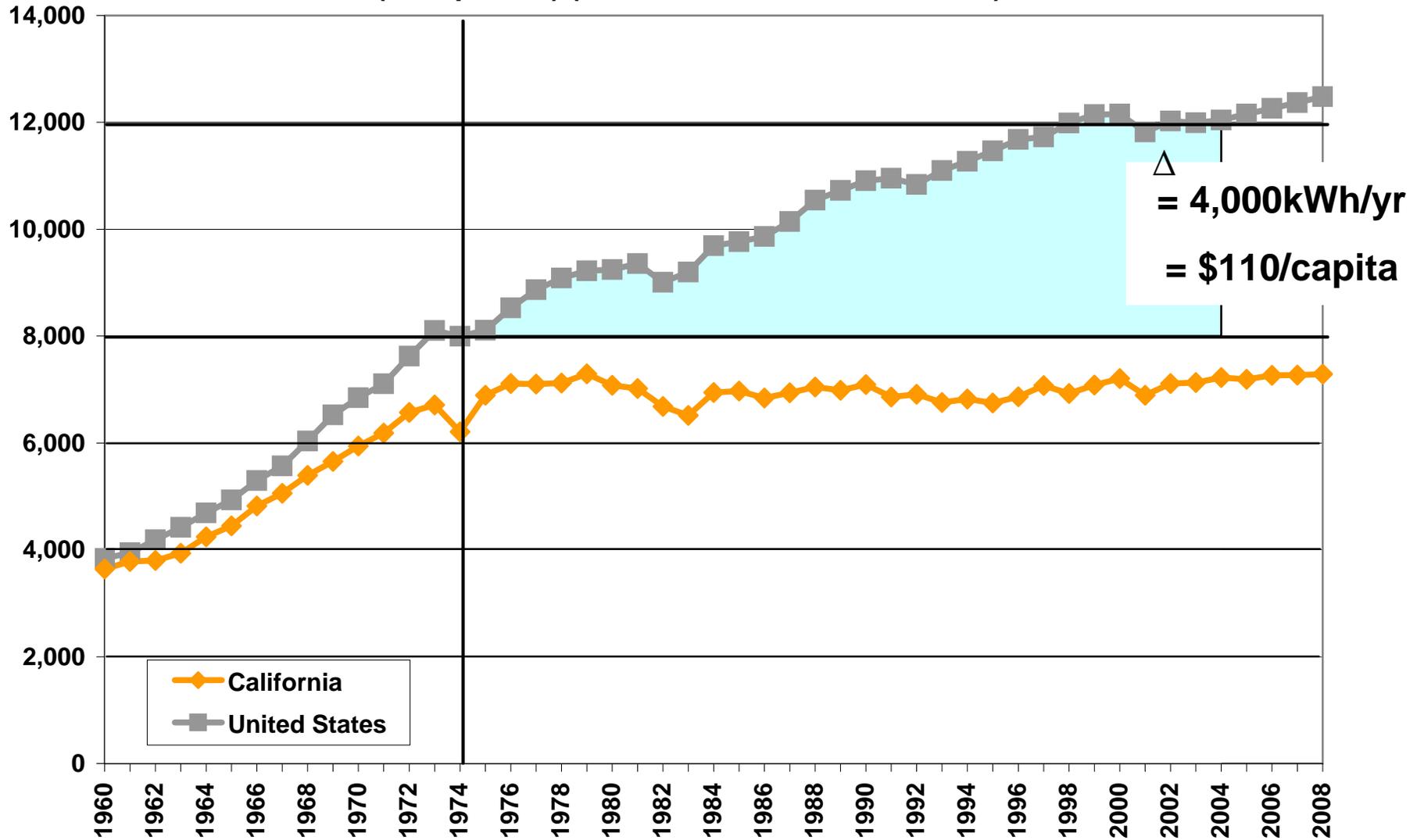
Carbon Dioxide Intensity and Per Capita CO2 Emissions -- 2001
(Fossil Fuel Combustion Only)



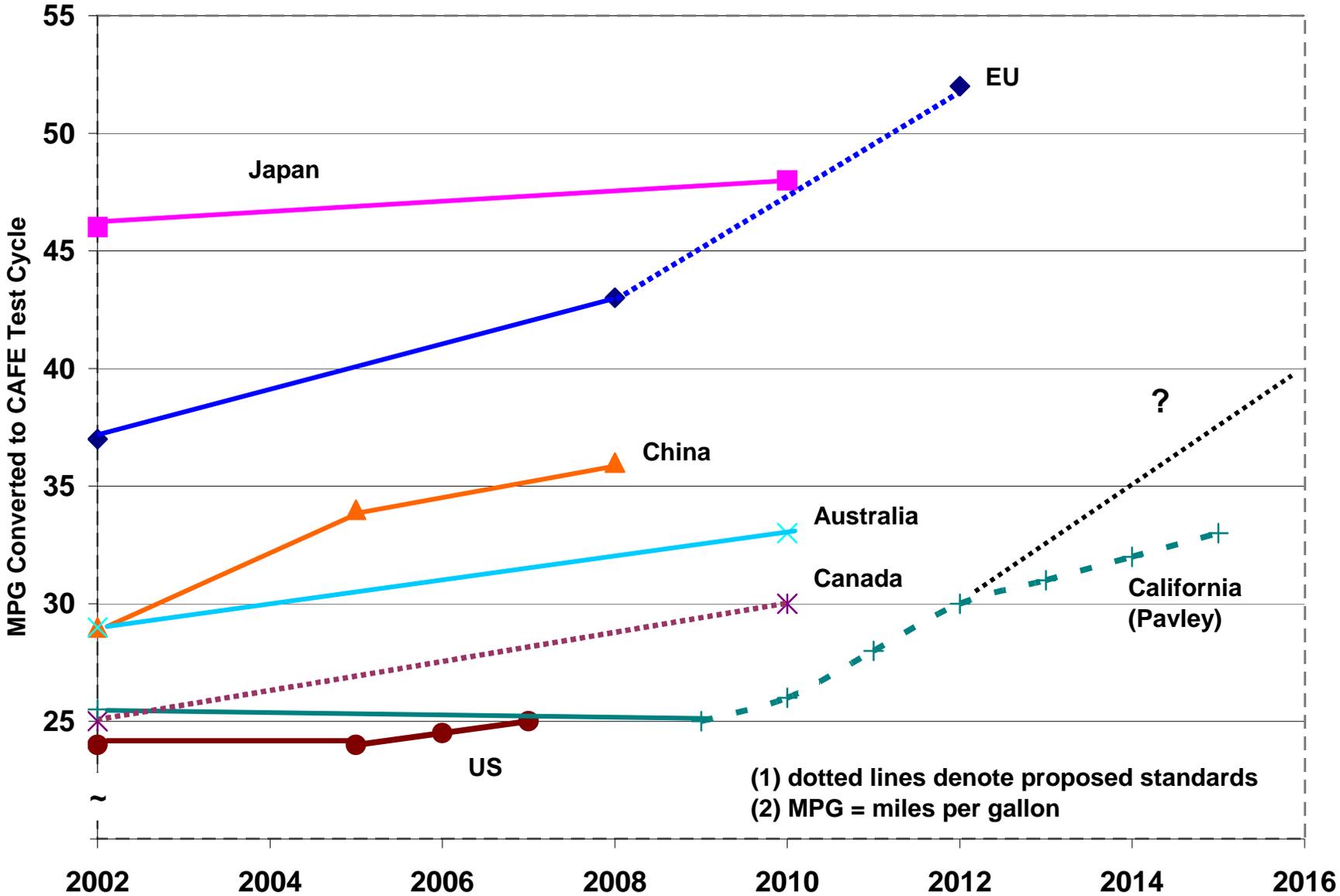
Energy Intensity -- California and the United States



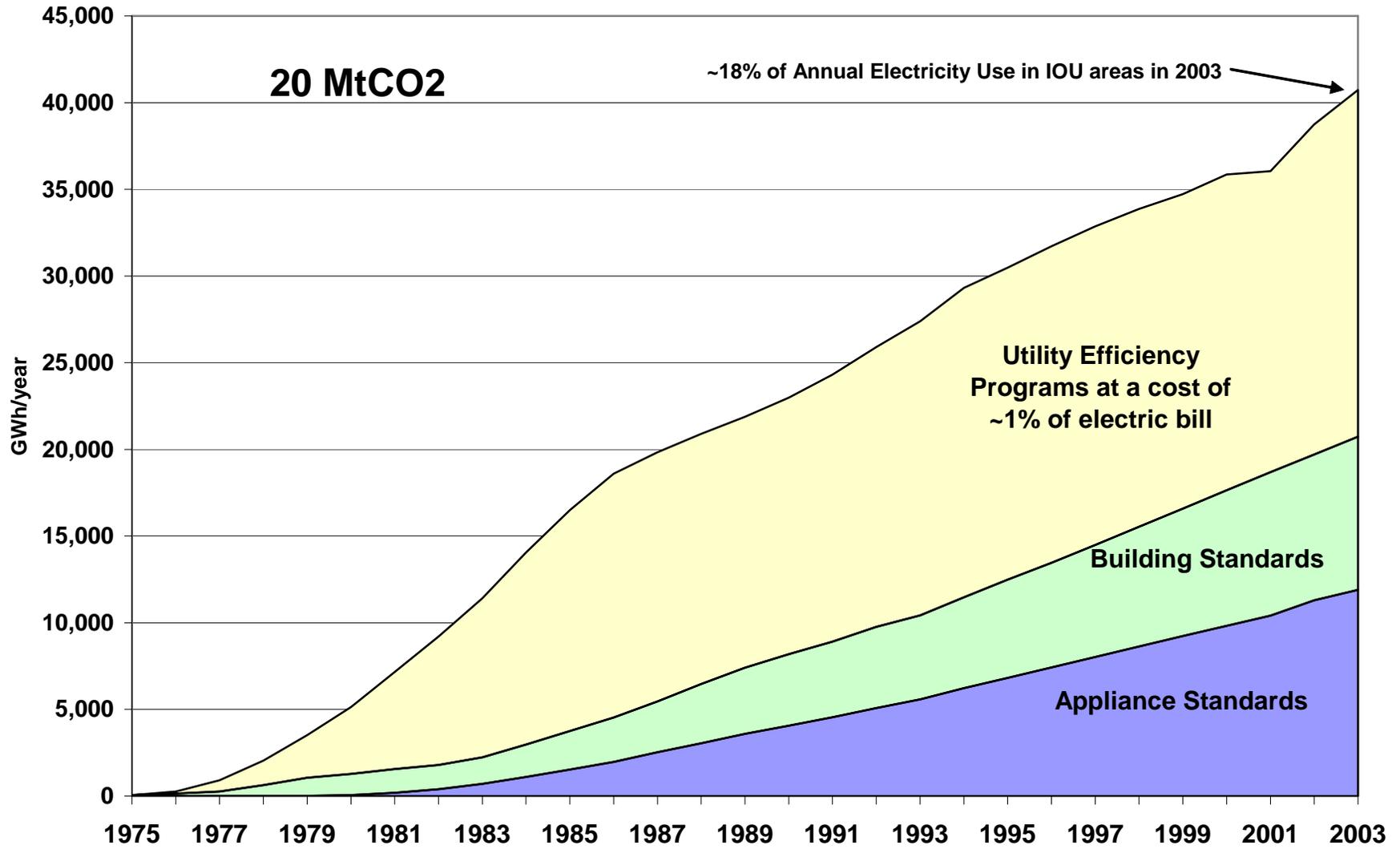
Per Capita Electricity Sales (not including self-generation)
(kWh/person) (2005 to 2008 are forecast data)



Comparison of Fuel Economy – Passenger Vehicles



Annual Energy Savings from Efficiency Programs and Standards

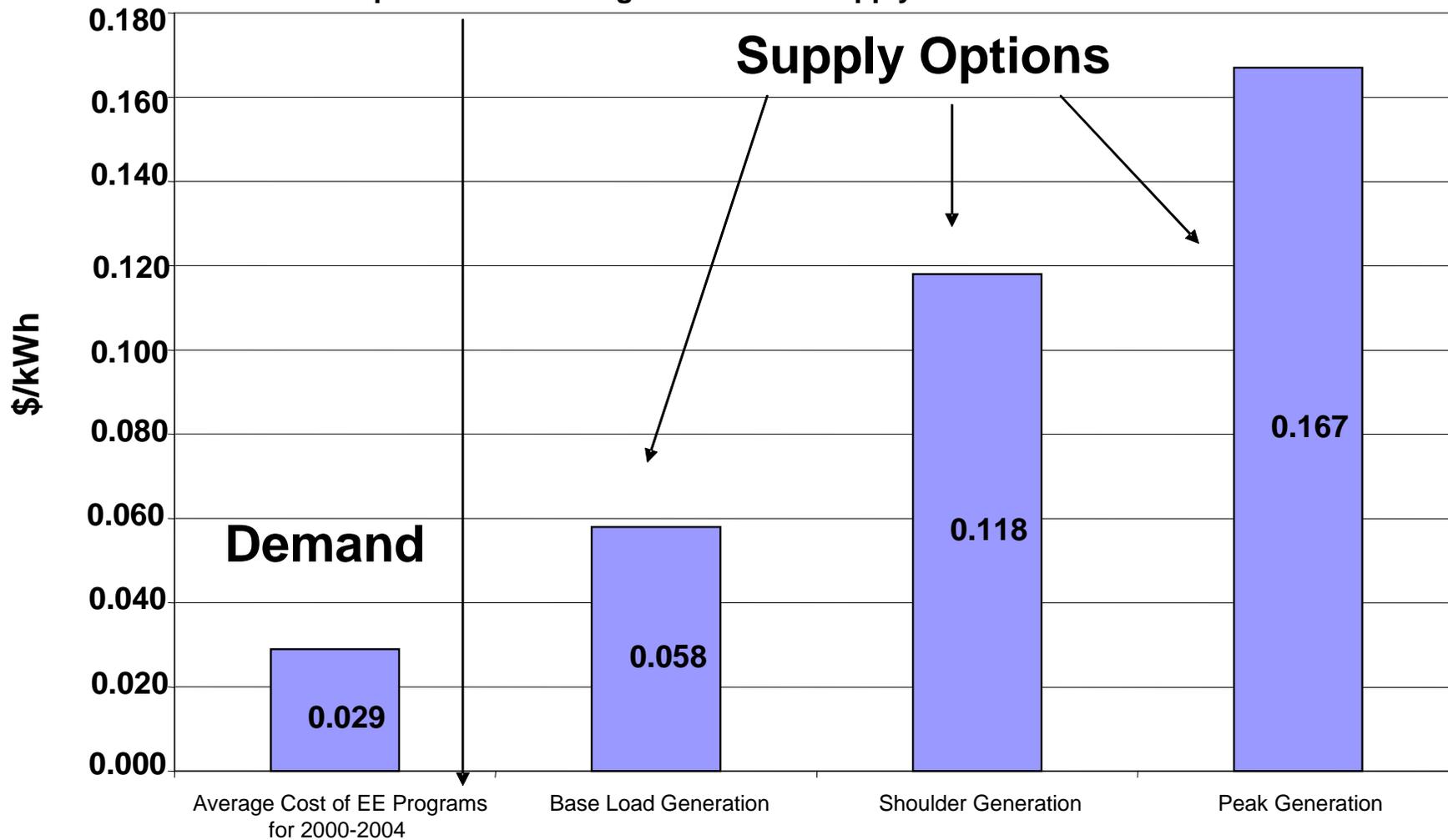


California Must Expand CEC Staff for Standards

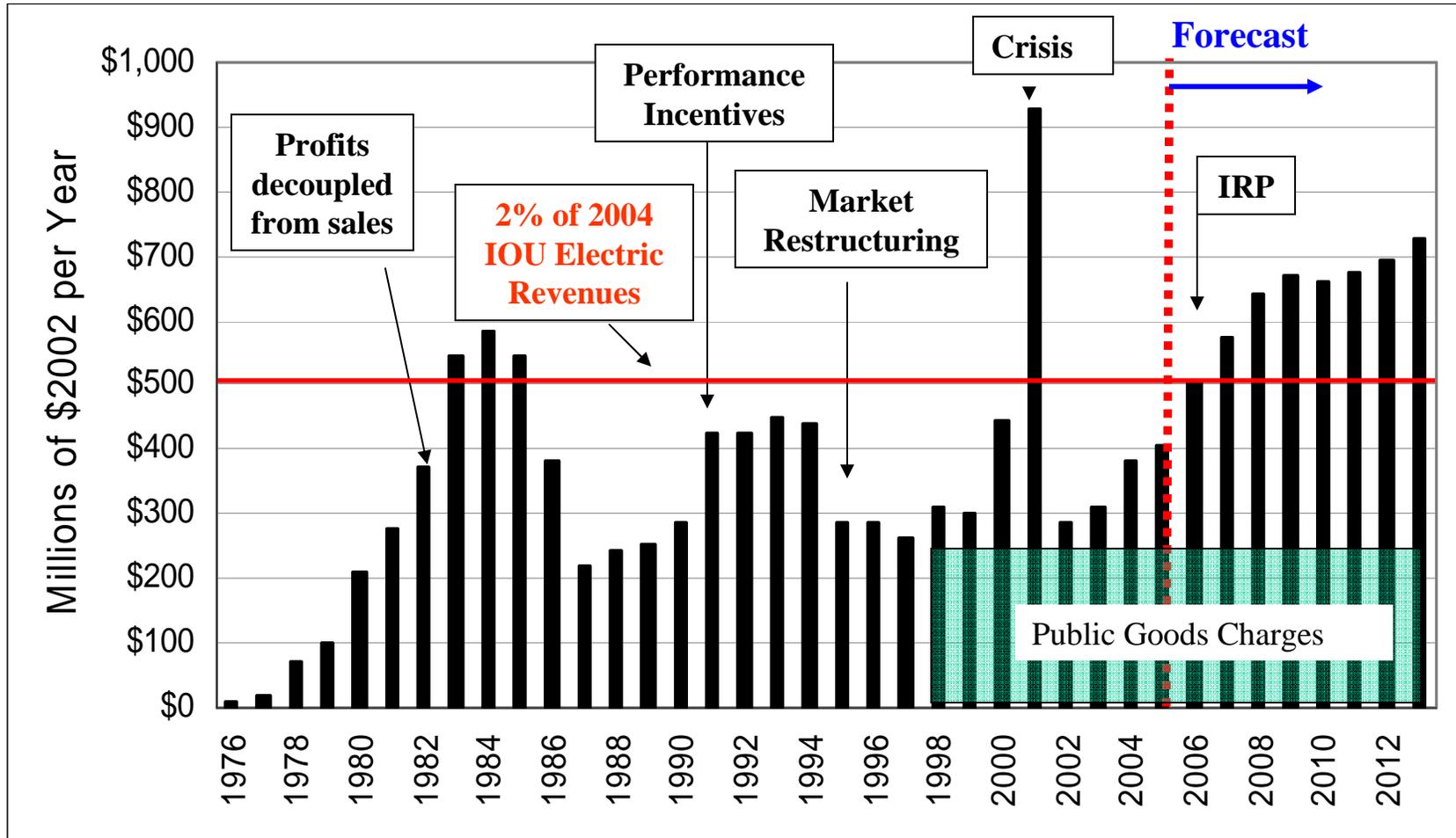
California spends ~\$1B/year on EE and Renewables to reduce electricity use by ~1%/year,

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



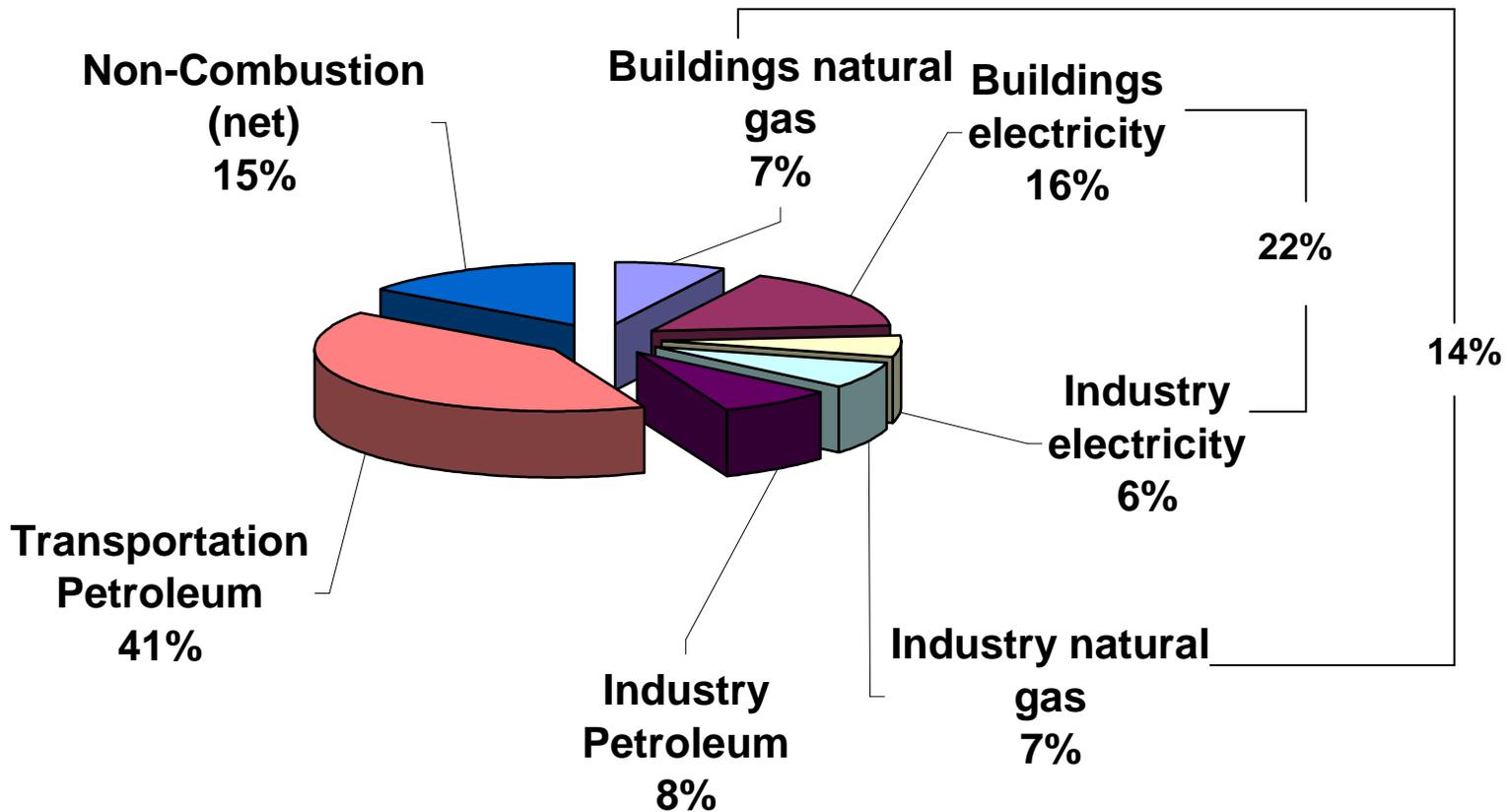
What about Public Utilities – the Other 25% ?

- ◆ 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

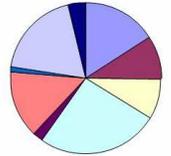
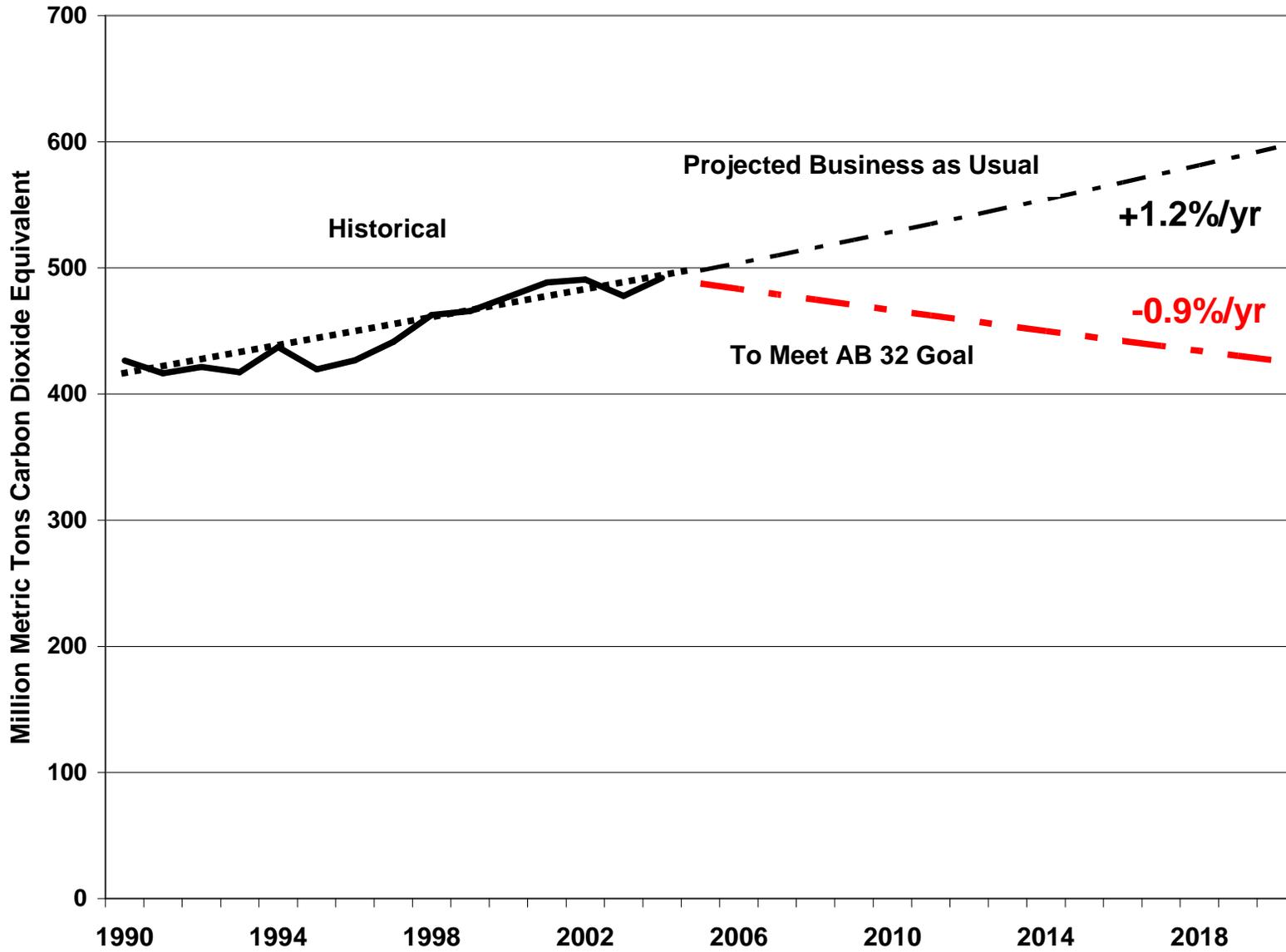
Total Emissions = 490 Million metric tons CO2 equivalent



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>

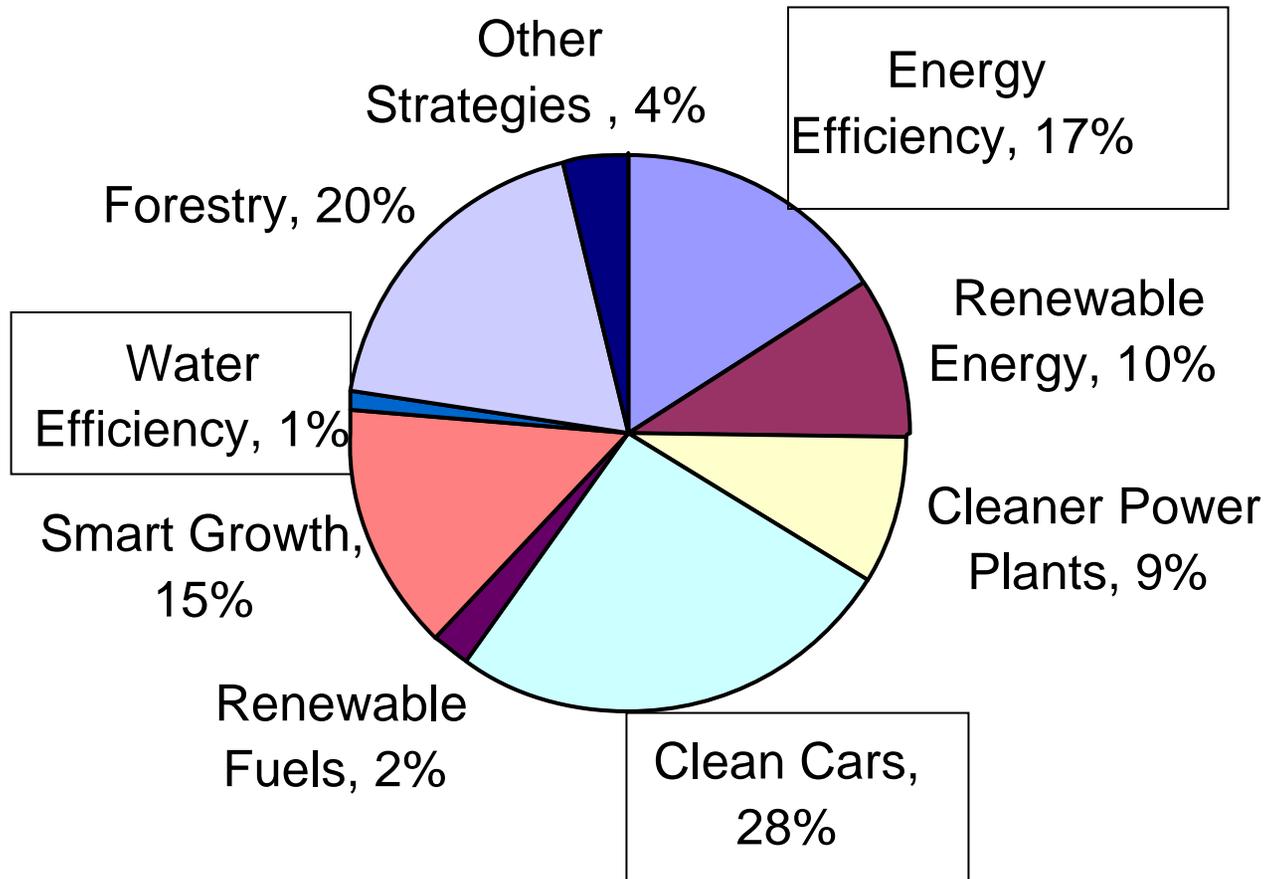
CO2 Emissions in California: Historical and Projected



Strategies for Meeting California's CO2 Goals in 2020

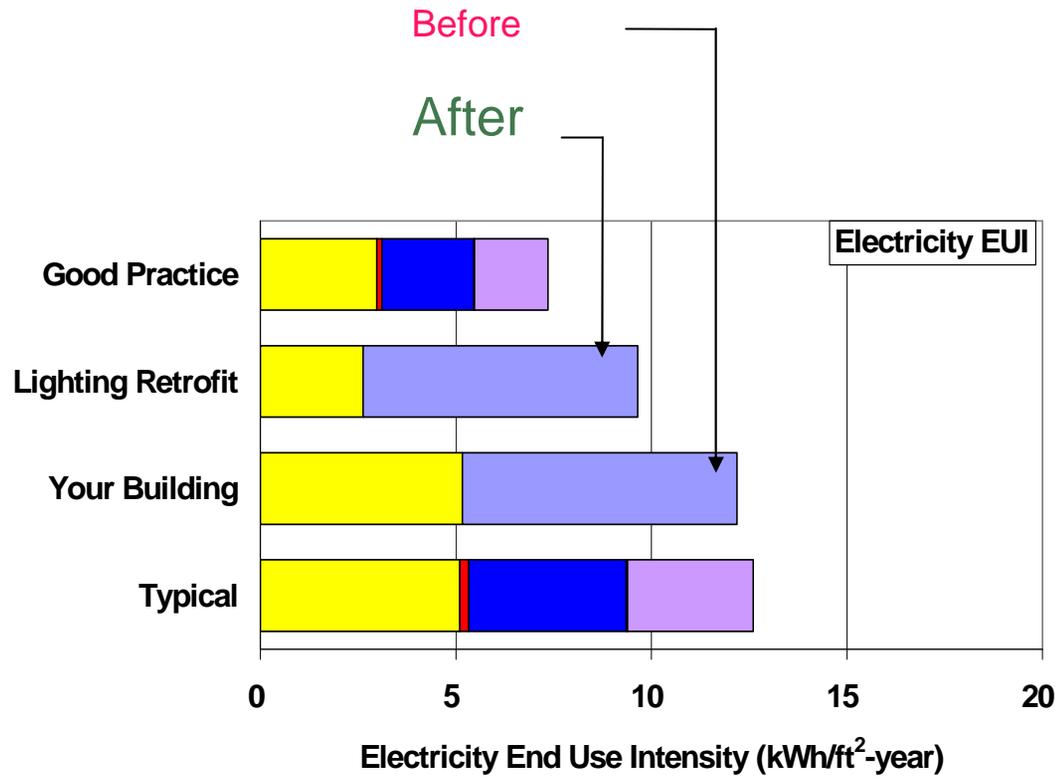
Total Reductions = 174 Million metric Tons CO2 equivalent

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 MtCO₂ 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

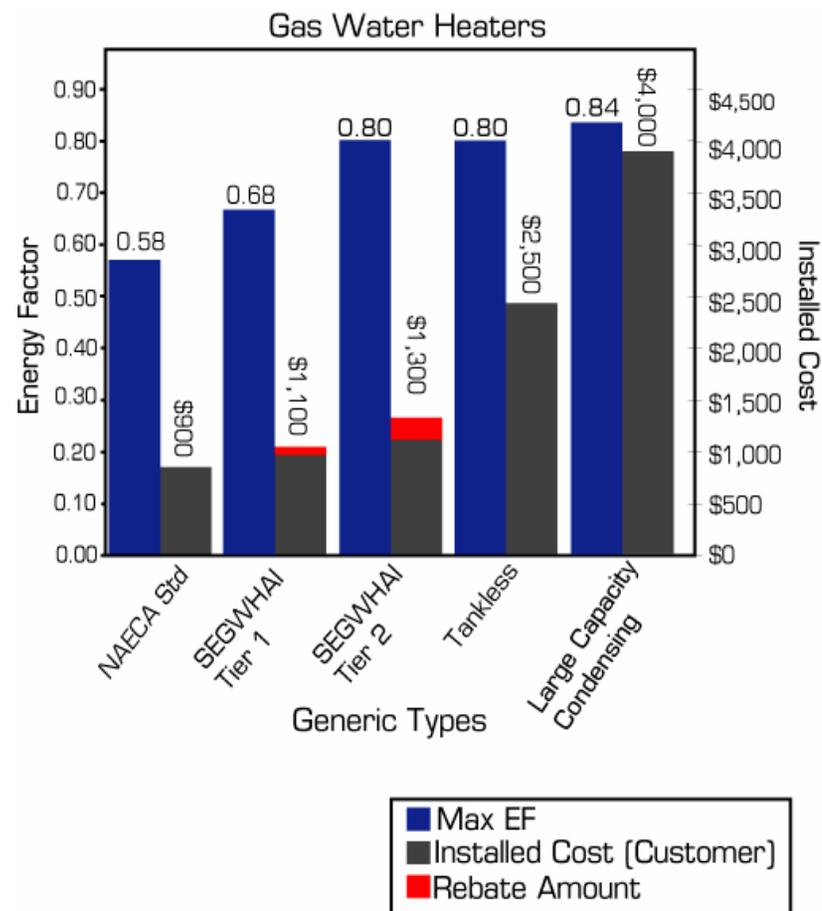


- ◆ Toyota experiment (surface temperature 10C = 18F cooler)
- ◆ Ford and Fiat are also working on the technology

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_x
 - Cost effective market price, pay back less than 5 years
 - Equivalent to standard water heaters for the customer and installing plumber



SEGWHAI

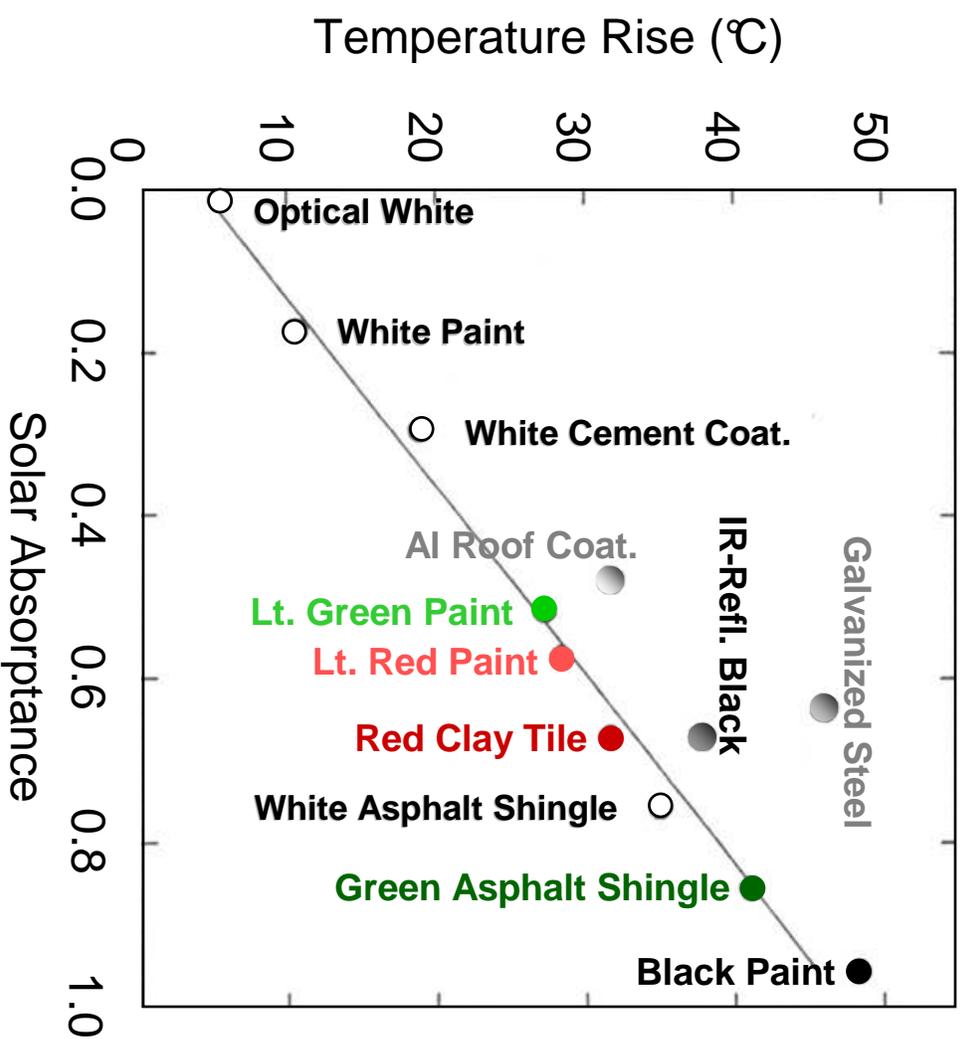
Super Efficient Gas Water Heating Appliance Initiative

Benefits to California

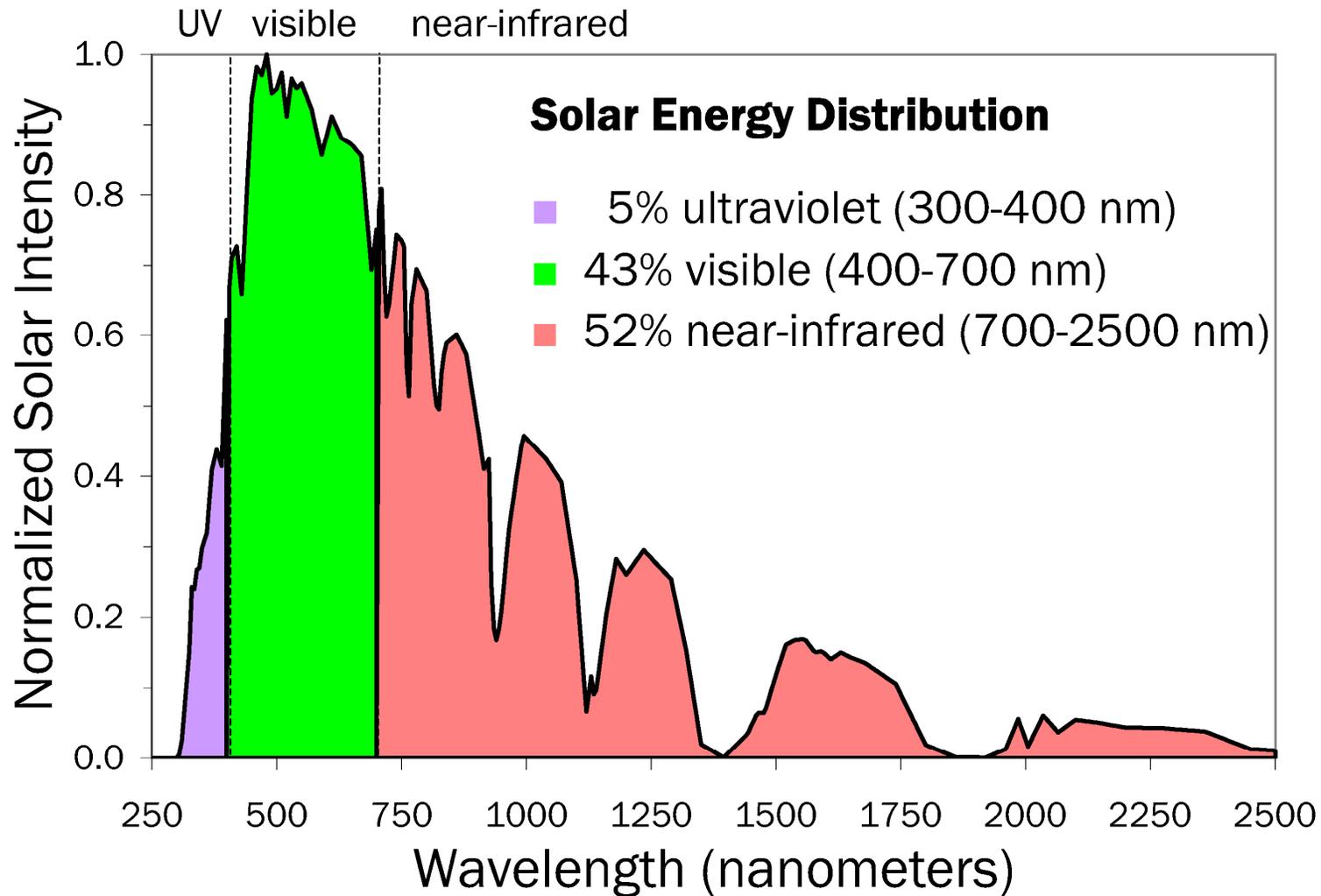
- ◆ Savings per water heater (over the equipment lifetime):
 - 400 - 700 therms
 - 2.4 – 4.1 metric tons CO₂
 - 13 pounds of NO_x
- ◆ If 50% of existing water heaters in CA are replaced w/ SEGWHAI Tier 1 units:
 - \$154 M in natural gas costs saved each year
 - **900,000 metric tons of CO₂** avoided each year
 - 5 M pounds of NO_x avoided each year
- ◆ These emission reductions are valued at more than \$30M per year

Temperature Rise of Various Materials in Sunlight

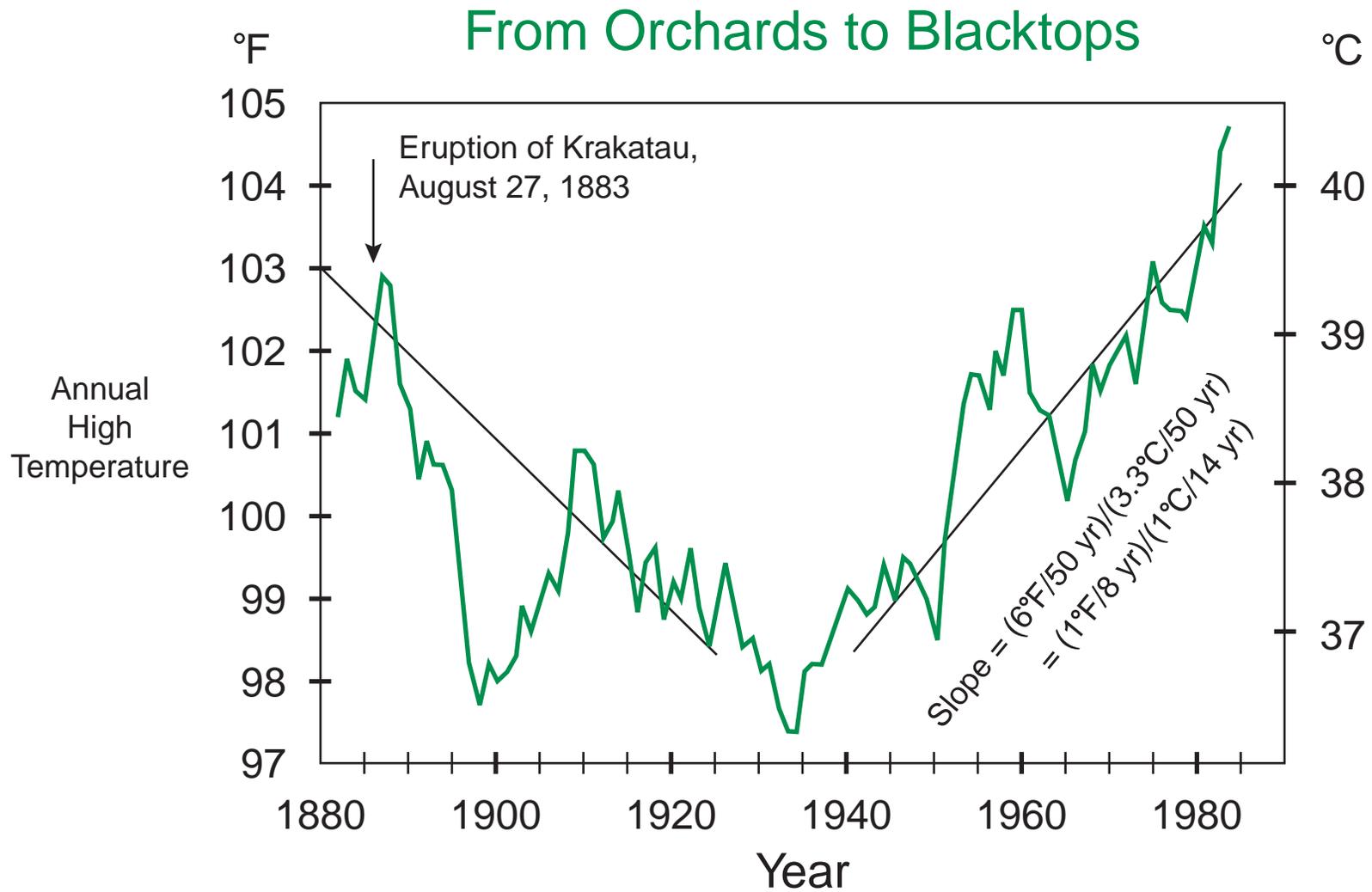
Dr. Hashem Akbari, LBNL Heat Island Group



Cool Colors Reflect Invisible Near-Infrared Sunlight



Temperature Trends in Downtown Los Angeles

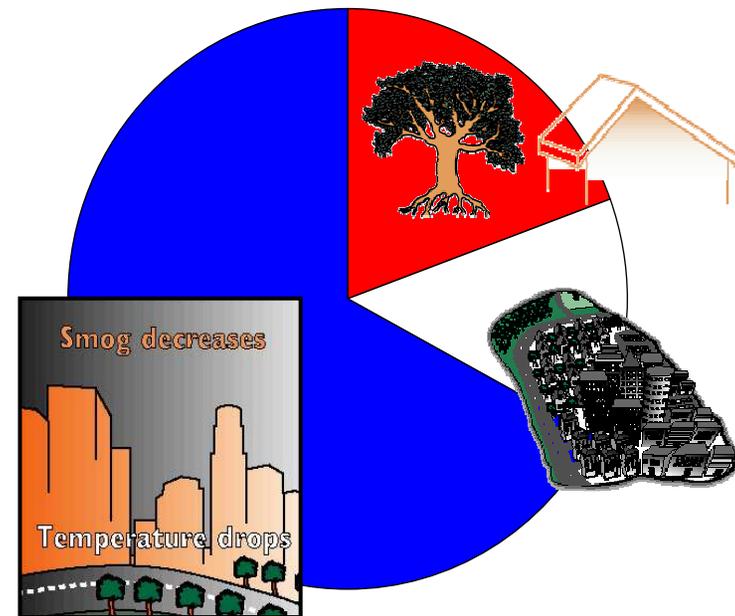


Potential Savings in LA

◆ Savings for Los Angeles

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

- Smog, \$360M/year
- CO₂, ~2 MtCO₂/year



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- ◆ This talk available on my web page

- ◆ Just Google

“Art Rosenfeld”