Energy Future of the West:
(1) Demand Response and Dynamic Pricing;
(2) Energy Use and Sustainable Growth

Utility Energy Forum

Granlibakken Conference Center

May 6, 2005

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Time-of-Use (TOU), Critical Peak Pricing(CPP), and Real-Time Pricing (RTP)

- Time-of-Use (TOU) rates consist of 2 or 3 price/time blocks published in advance: peak, off-peak, and in some cases, shoulder
- Critical Peak Pricing (CPP) rates include a higher price for 50-100 hours per year when prices are high or system conditions are critical
  - In exchange for facing these higher-priced hours, prices in other hours are proportionally reduced
  - Customer pays the critical peak price when invoked by the utility
    - day ahead CPP forecast offers additional time for response
- Real-Time Pricing (RTP) is an hourly price related to the marginal cost of a kWh
  - Reflects hot weather, scarcity, or equipment failure
    - day ahead RTP forecast offers additional time for response

Joint CPUC-CEC Demand Response Proceeding R.02-06-001

Working Group 1. Peevey, Rosenfeld, now joined by Grueneich. Joint CPUC-CEC staff

WG-2. Large Buildings, >200 kW interval meters installed

TOU tariff mandatory, CPP voluntary now, default in ’06.

Facilitators: Hungerford (CEC) + PUC staff

WG-3. AMI. Sponsored SPP (Statewide Pilot Pgm)

Facilitators: Messenger (CEC) + PUC Staff.

CEC has Load Management Power, and plans to require interval meters and communicating thermostats in new buildings under Title-24/Title-20, starting in 2008. We’re looking for new-building pilot programs NOW.

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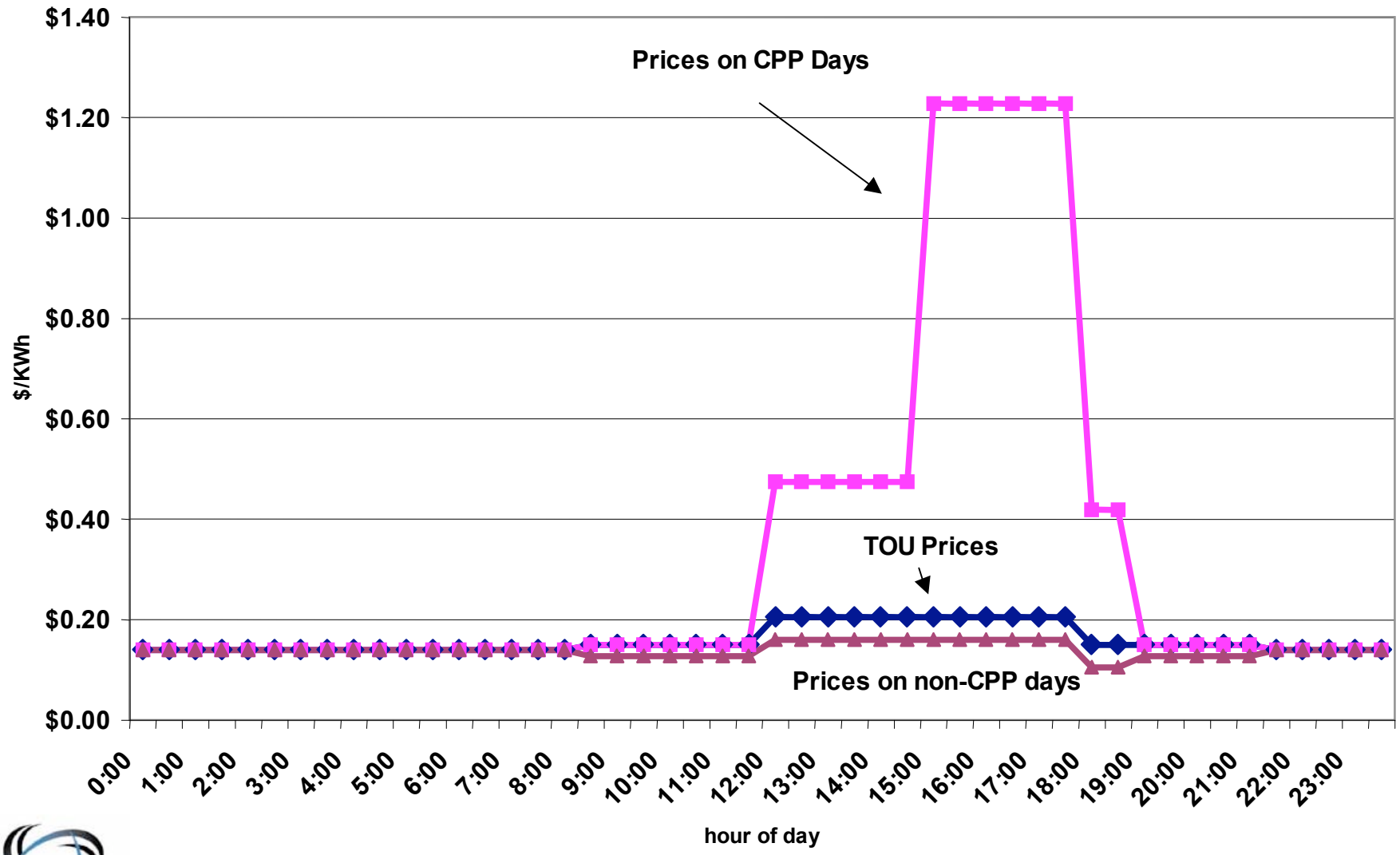
An Example of a CPP Tariff for Large Customers



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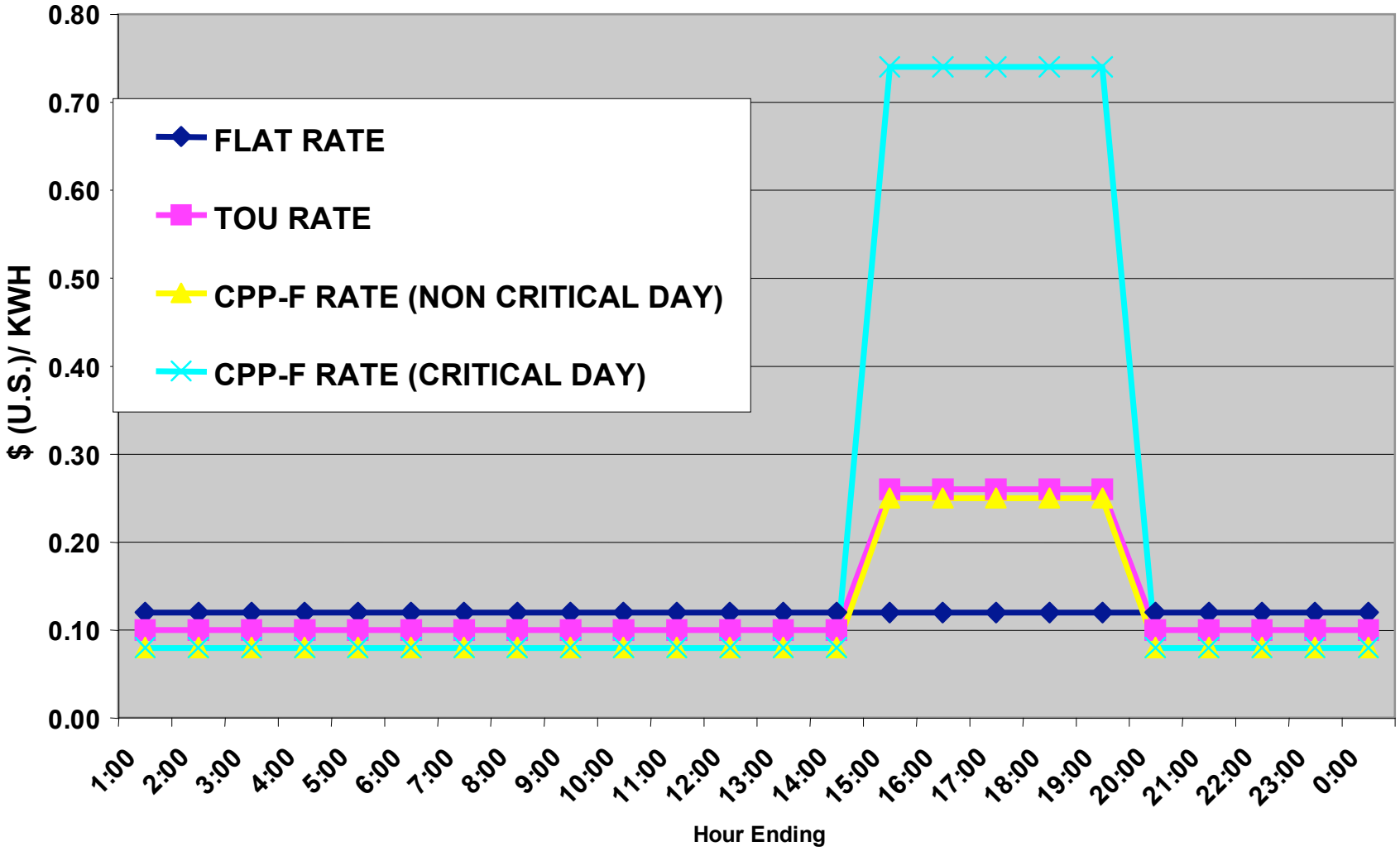
CEC/CPUC Vision: Dynamic Prices & Choice

- Always TOU or Better if digital meters available and if economic
- "CPP" is an extension of TOU
- Residential and Small Commercial
  - Default = CPP
  - Hedge = TOU
- Intermediate Size Customers (perhaps 200 kw to 1 MW)
  - Default = CPP
  - Hedge = TOU
  - Option = RTP (voluntary)
- Large (perhaps > 1 MW)
  - Default = RTP
  - Hedges to CPP or perhaps TOU
- Goal of an additional 1% of Load Response per year

Residential Tariffs Tested in California Statewide Pilot



Note: Tariffs have additional tiered surcharges based on monthly consumption

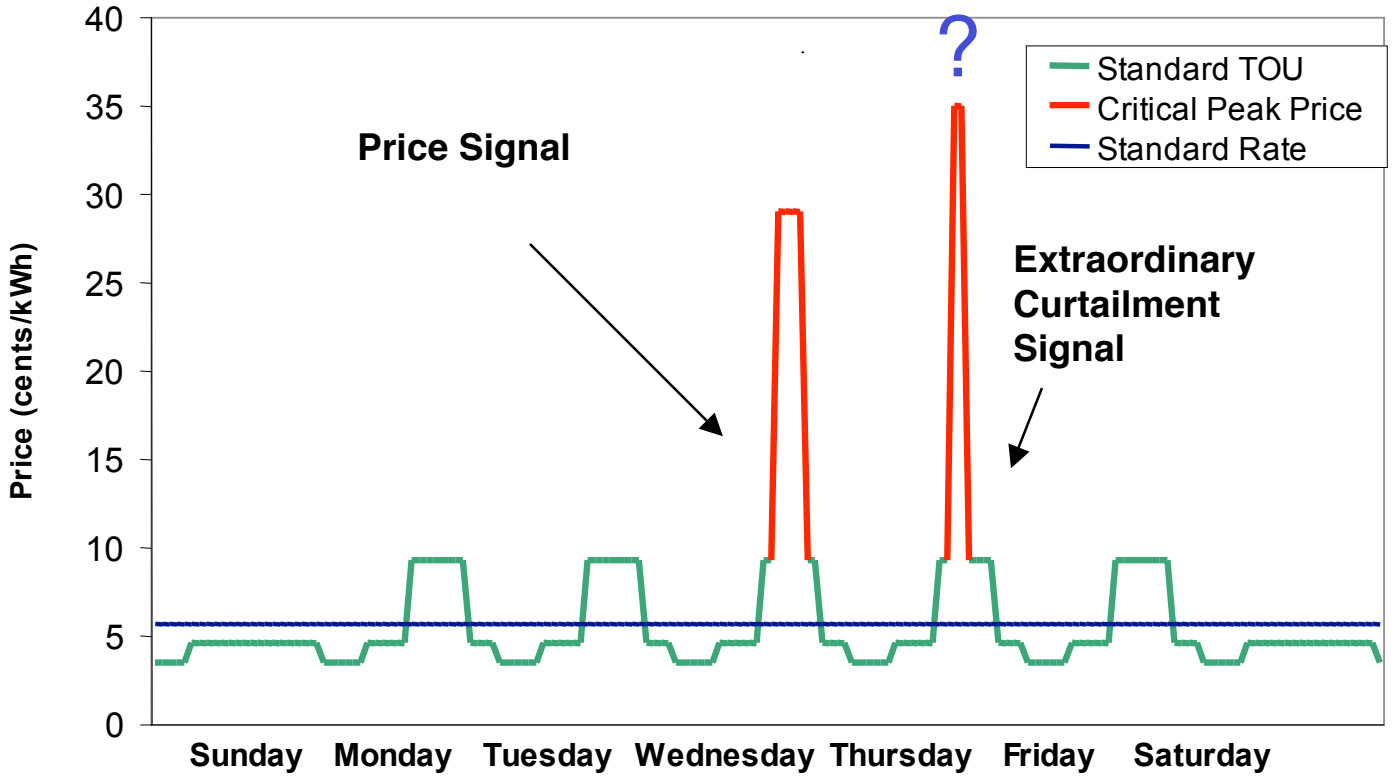
Small Customers Statewide Pricing Pilot "SPP"

- Results for the two-summer pilot
  - Average savings for CPP_F customers of 12% to 13% during the critical peak periods
    - CPP_F = 5 hour event; customers without smart thermostats
  - Average savings for CPP_V customers of 27% during the critical peak periods
    - CPP_V = event period varies 2 to 5 hours; customers have smart thermostats and receive signal from utility that sets-up thermostat
- Savings show little degradation from summer 2003 to summer 2004
- Savings remain nearly the same even over three-day heat events

Observations Regarding the Statewide Pricing Pilot

- Results indicate demand elasticity does exist in the residential electricity market
- Such price responsive demand will enhance the competitiveness of electricity markets
- However, other types of electrical system emergencies may require instantaneous load response
- California had a separate proceeding dealing with interruptible load programs
- We plan to merge price-sensitive demand response and interruptible programs
  - For example, one approach could involve a curtailment signal that a customer would not have the option to over ride.
  - The next graph illustrates how this might work

Critical Peak Pricing (CPP) with additional curtailment option



Demand Response and Interval Electricity Meters

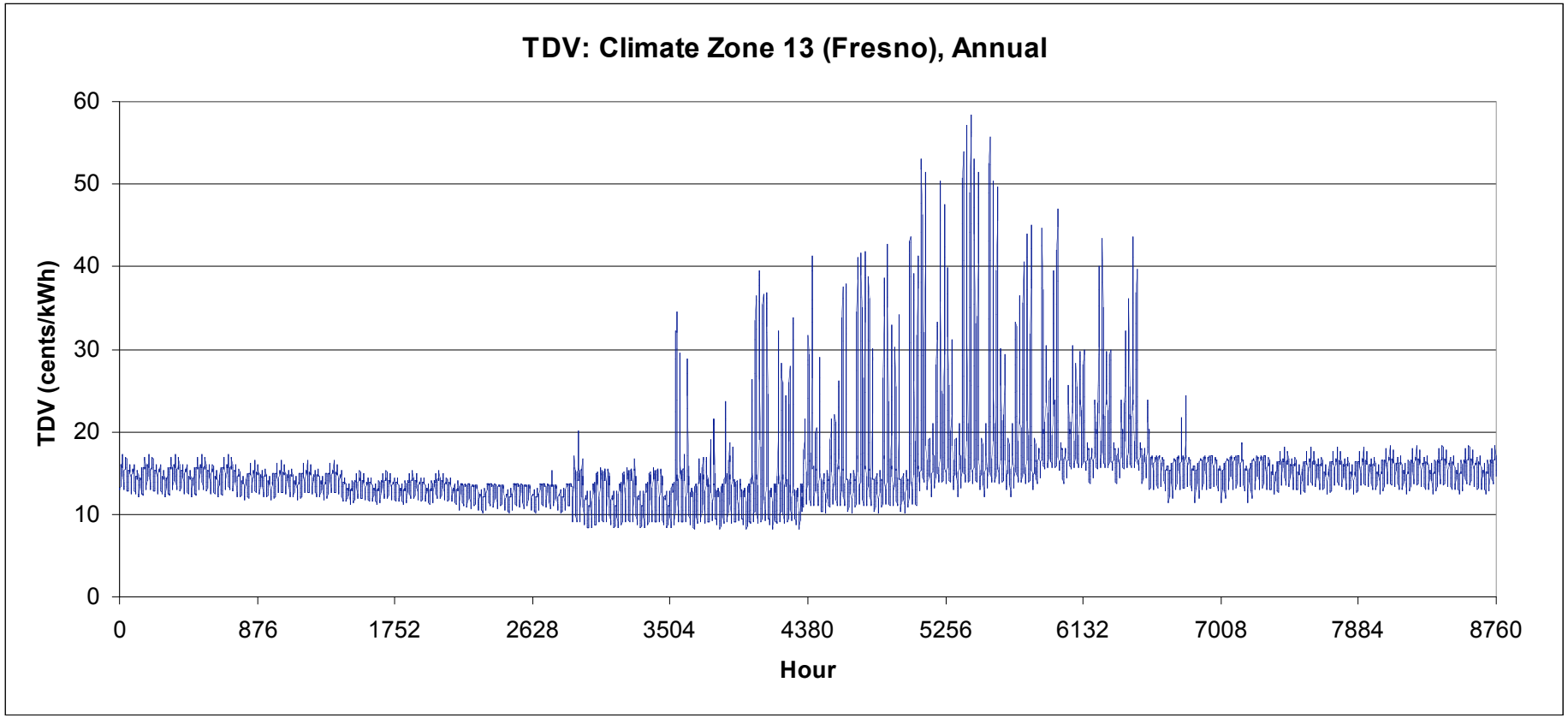
- Currently large customers have interval meters, mandatory time-of-use pricing, and limited participation in interruptible programs
- Starting Summer 2006, these customers expected to be put on default Critical Peak Pricing (CPP) tariffs in IOU areas
- Also in 2006, PG&E and SDG&E expect to begin installation of interval meters for electricity customers and will relay gas use and will offer CPP to customers will meters
- Installation to take several years during which time SCE plans to follow suit
- CEC will define communicating thermostats which can be programmed to respond to CPP and for grid protection
- The state has an ambitious goal of 5% demand response (2000 MW) from "price-sensitive" load by 2007

Dependable DR in IOUs, 2004

Category	PG&E	SCE	SDG&E	Total
Interruptible/Curtailable	342	595	2	939
Demand Bidding	40	56	1	97
Critical Peak Pricing	12	6	5	23
Power Authority Demand Response	200	31	5	236
Direct Load Control	-	256	2	258
Backup Generators	-	-	17	17
20/20; Voluntary Programs				
Total	593	944	32	1,569

Time dependent valuation (TDV) prices vary over the year

- Although TDV prices in some hours exceed 50 ¢/kWh, annual average TDV price equals ~15 ¢/kWh



Cost of Conserved Energy (CEE) can also be used to evaluate designs

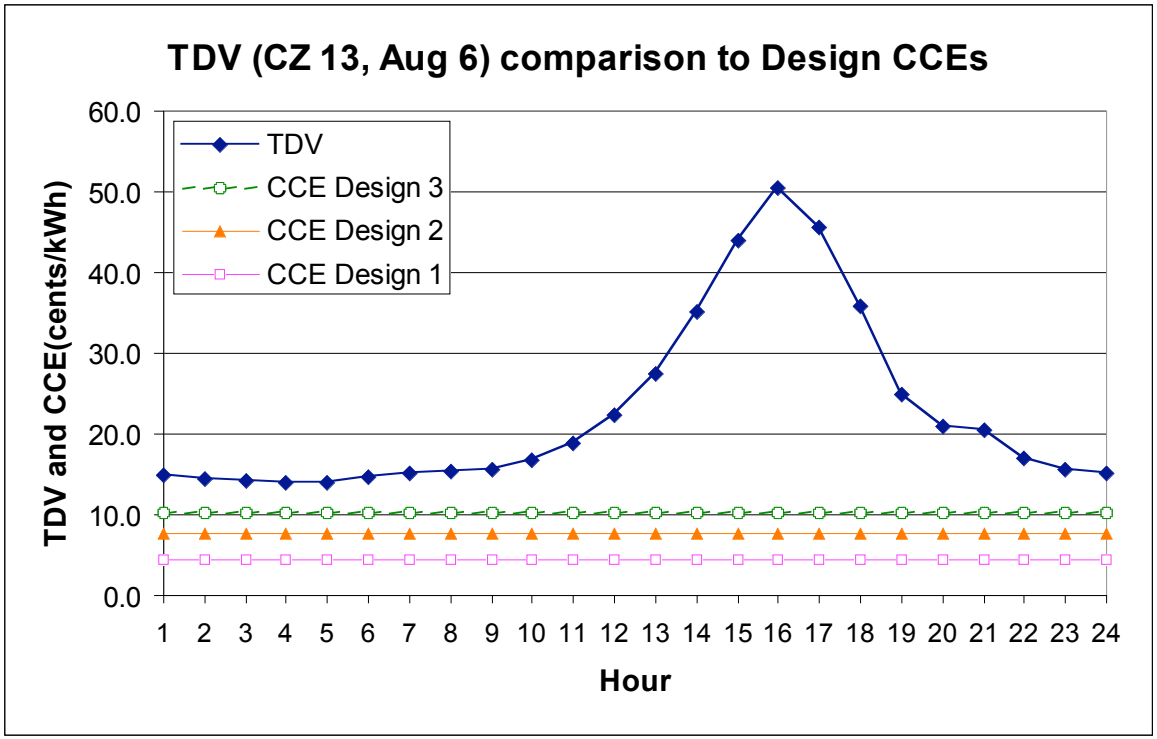
$$CCE = \frac{\Delta\$_{AC} \cdot CRR}{\Delta kWh_{\text{per year}}}$$

CEE = **Cost of Conserved Energy**

$\Delta\$_{AC}$ = **Consumer price increase due to hot/dry AC design**

CRR = **Capital recovery rate; set at 10% per year**

$\Delta kWh_{\text{per year}}$ = **Annual energy savings due to hot/dry AC design**



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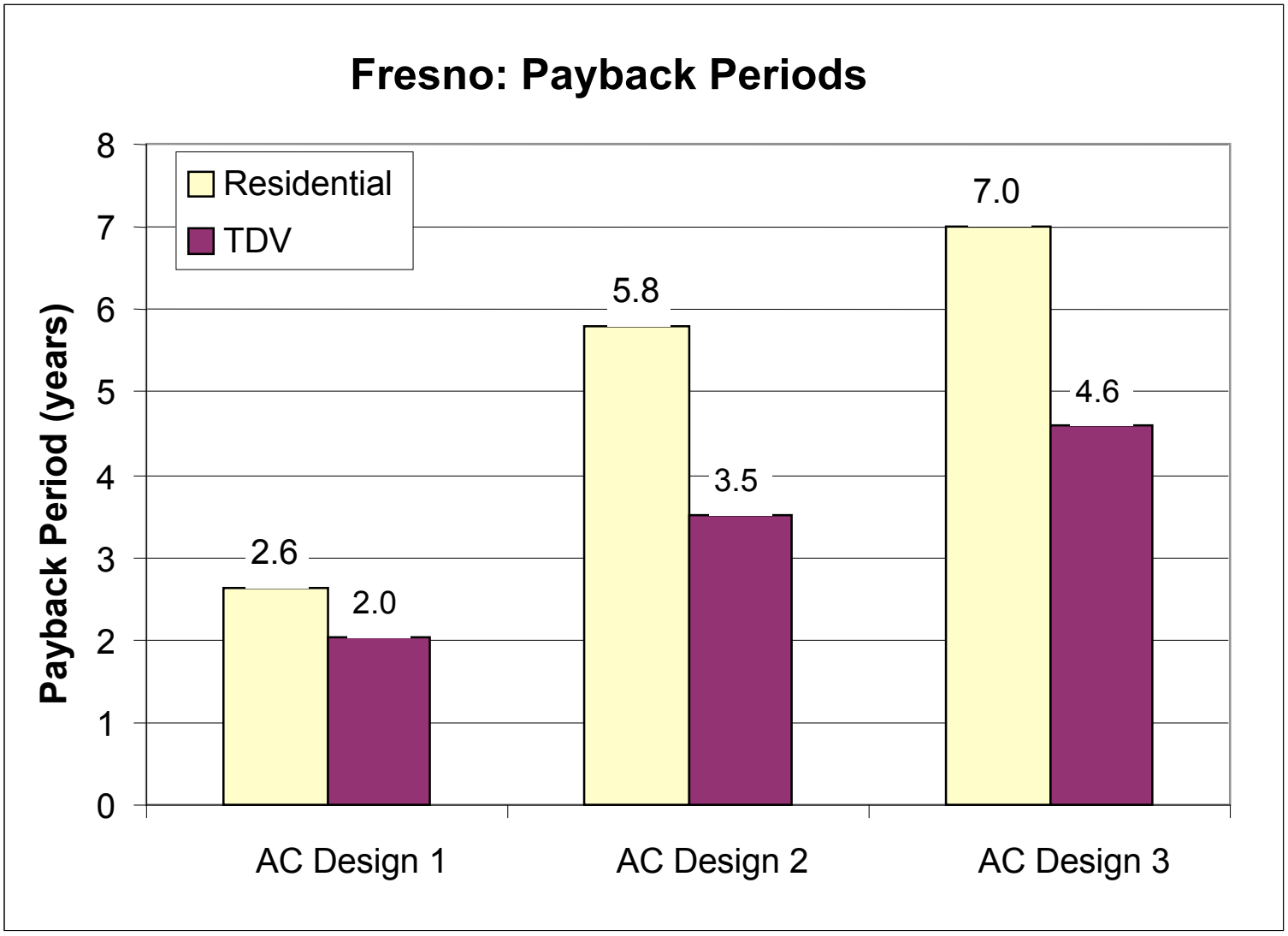
TDV impacts cost-effectiveness



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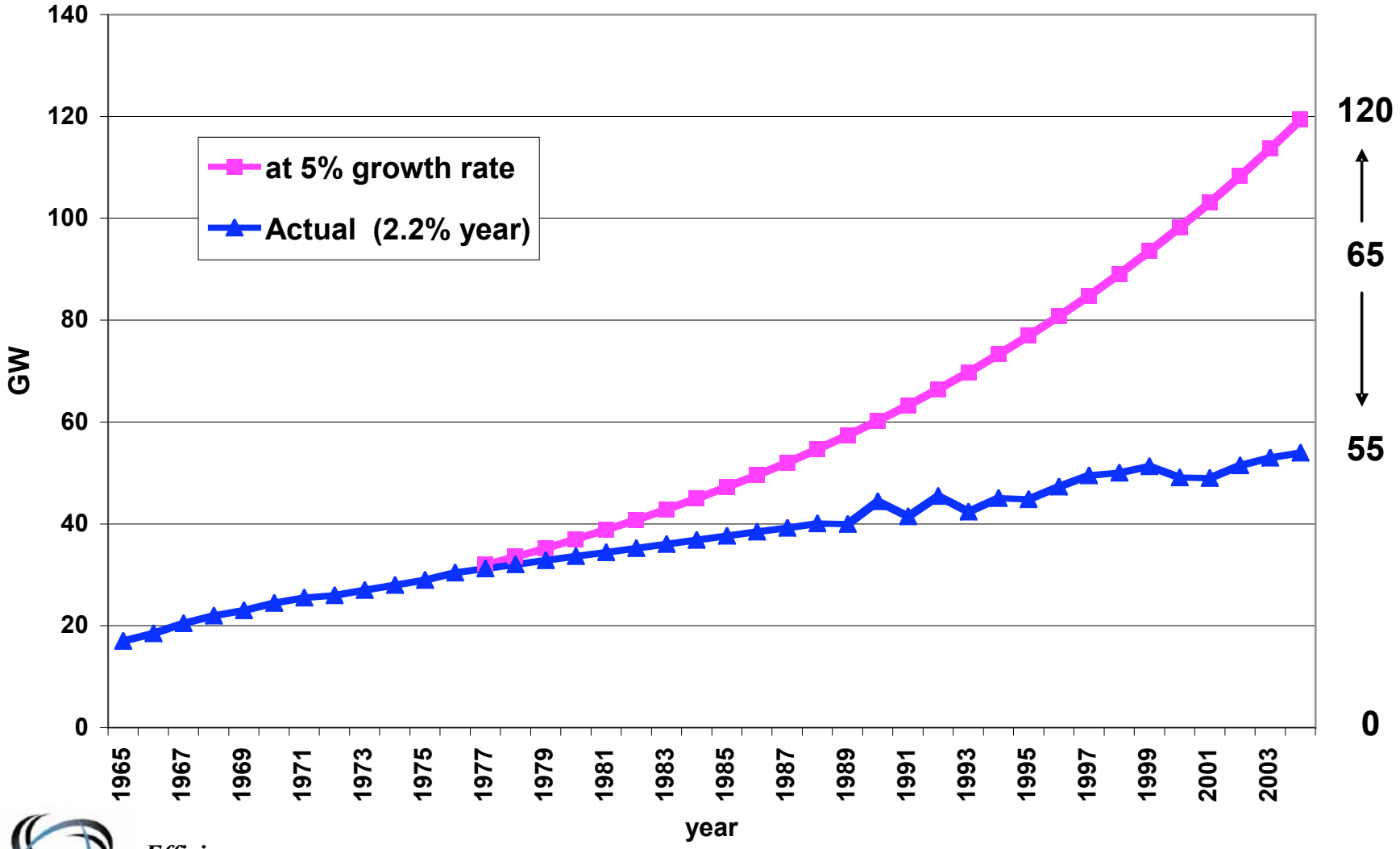
California Peak Demand 1965 - 2004



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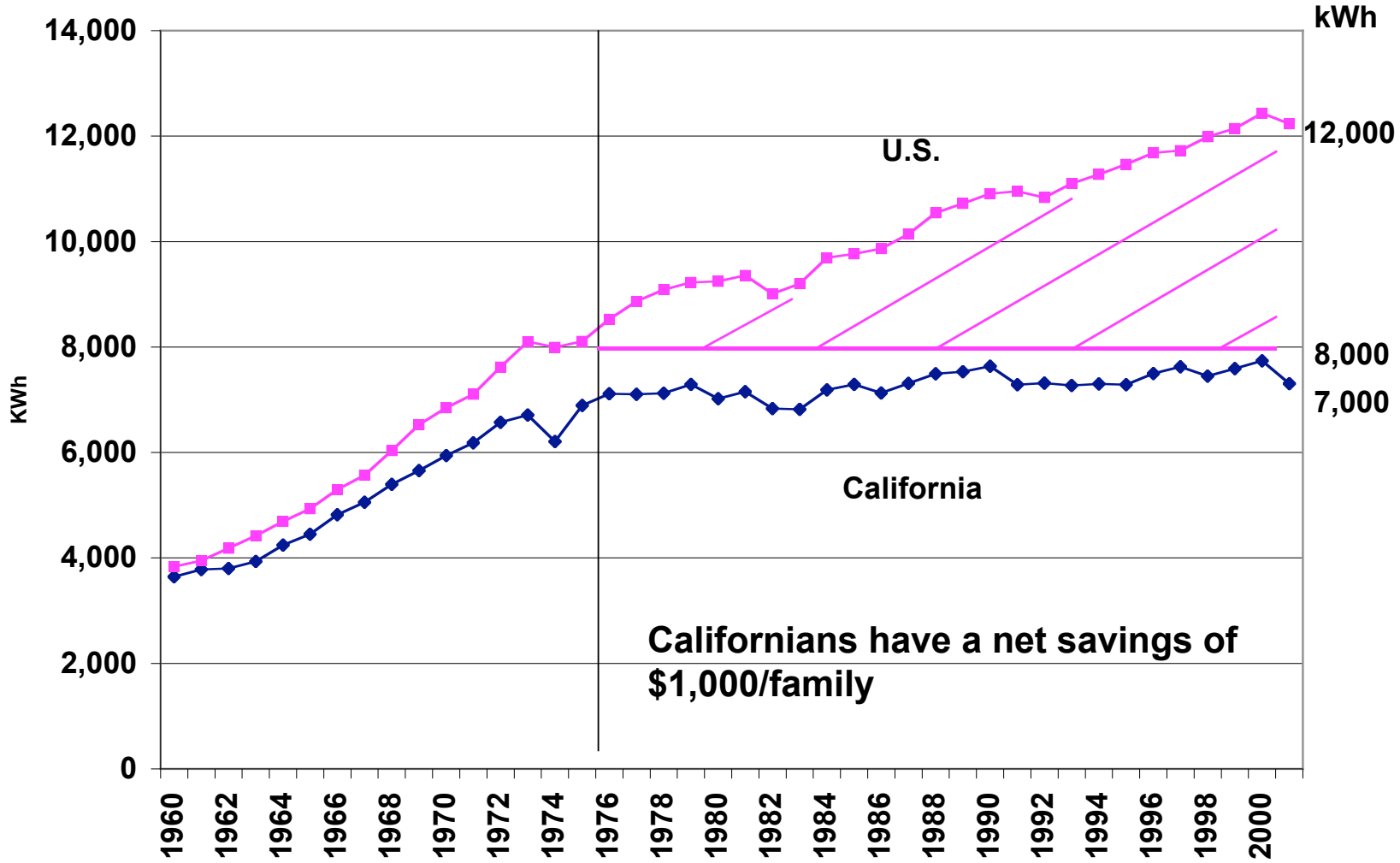
Total Electricity Use, per capita, 1960 - 2001



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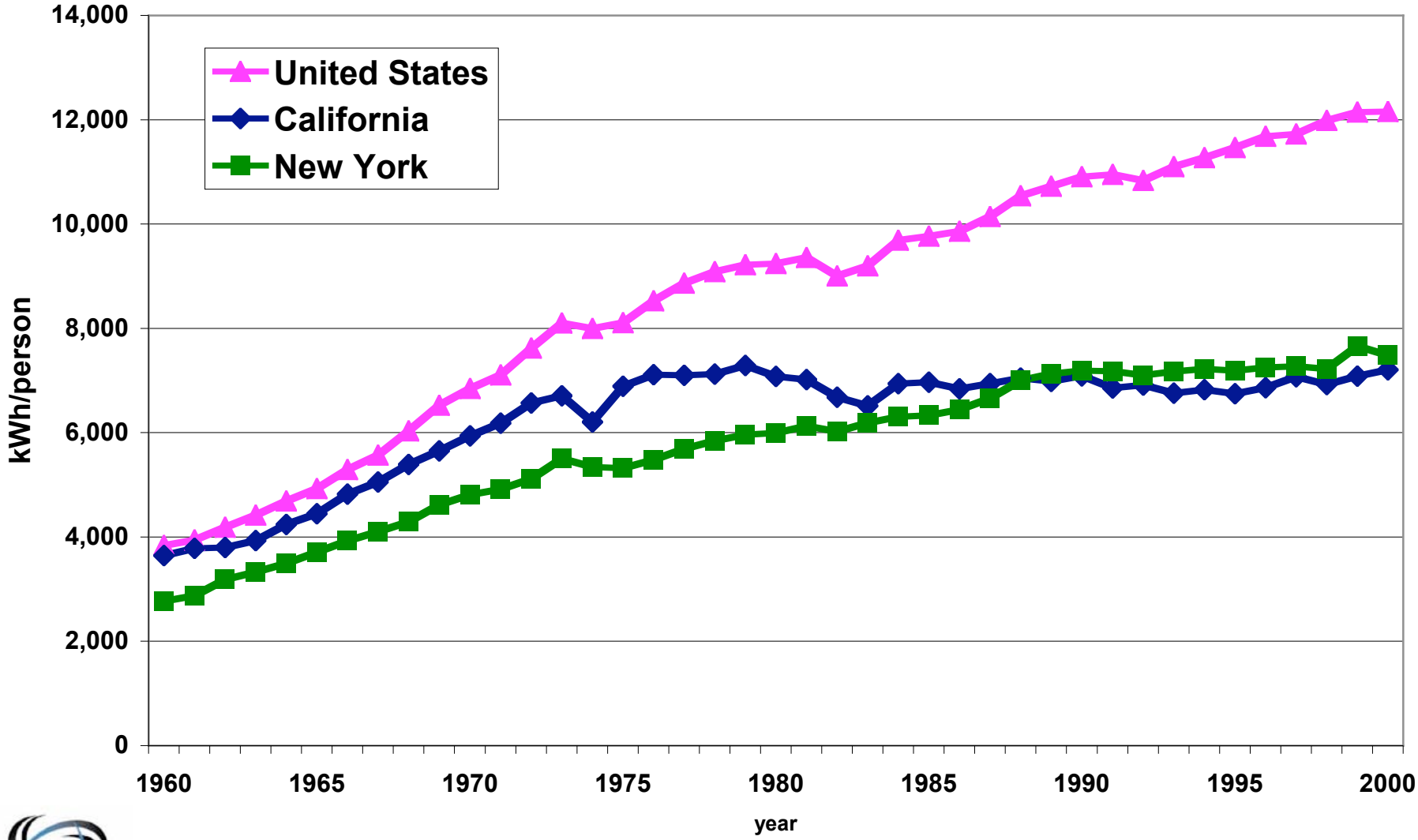
Costs and Pollution Saved by Avoiding a 50% expansion of California Electric System.

- Avoids 18 Million tons/year of Carbon
- Equivalent to getting 12 million cars off the road,
  - along with their NOx, CO, and particulate emissions.
- California has ~25 million motor vehicles,
  - **avoided 50% more equivalent pollution**.
- The Pavley bill, starting in model year '09, should start to reduce another 30%.

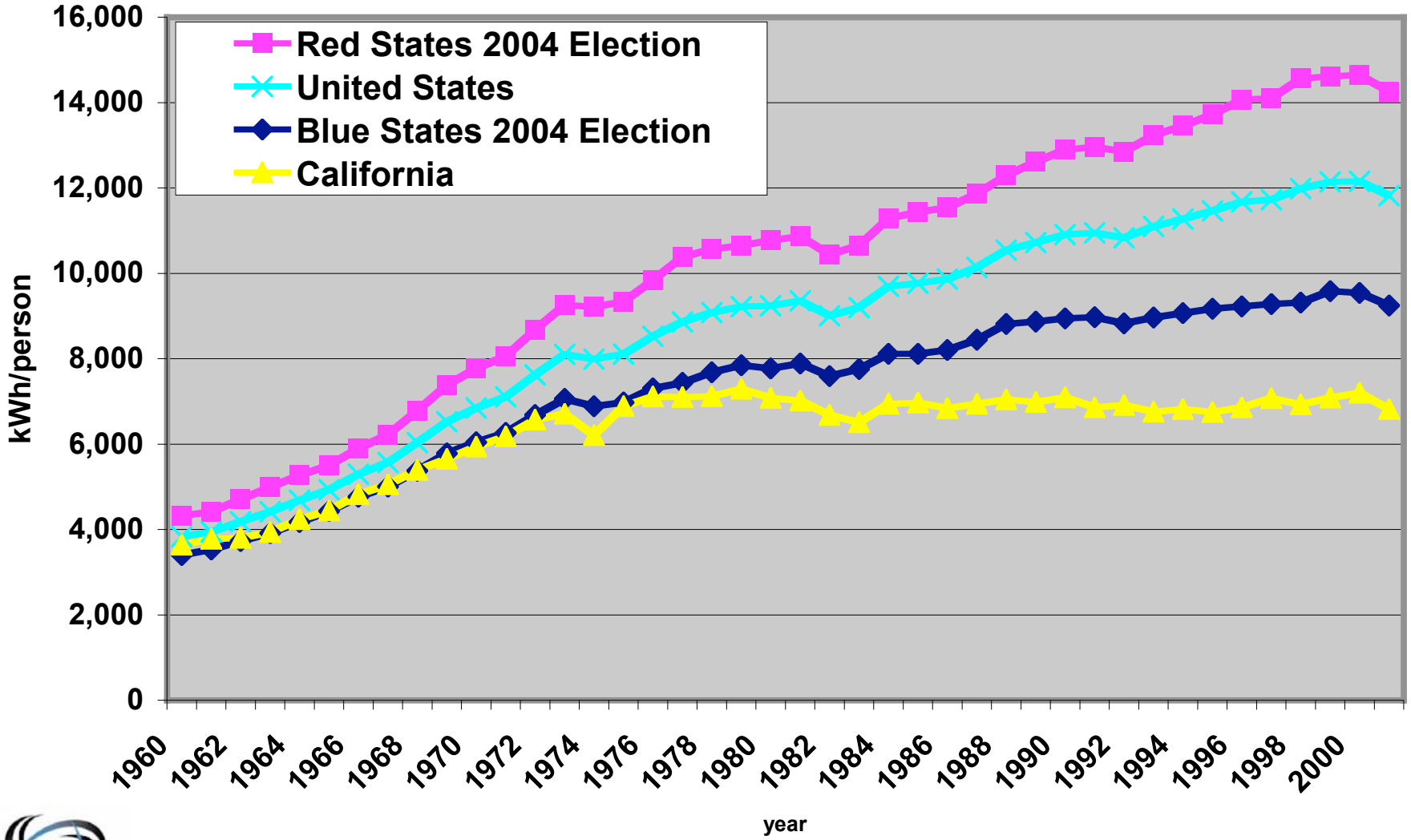
- California annual electric bill in 2004 ~ $30 Billion
- Avoided ~$16 Billion of bills, but net saving is only ~$12Billion/year, i.e**. $1000/family.**

Per Capita Electricity Consumption

Source: http://www.eia.doe.gov/emeu/states/sep_use/total/csv/use_csv

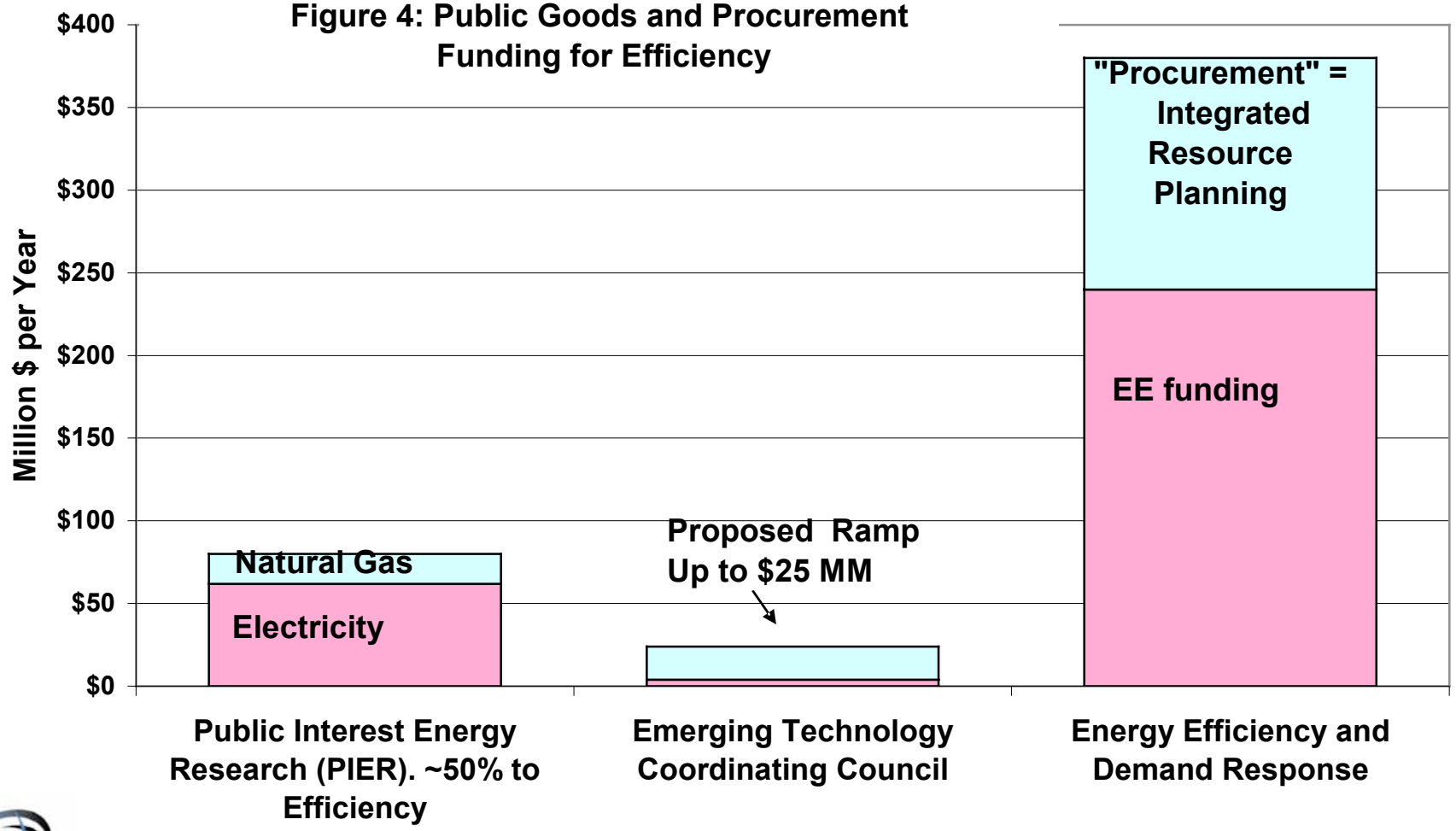


Per Capita Electricity Consumption

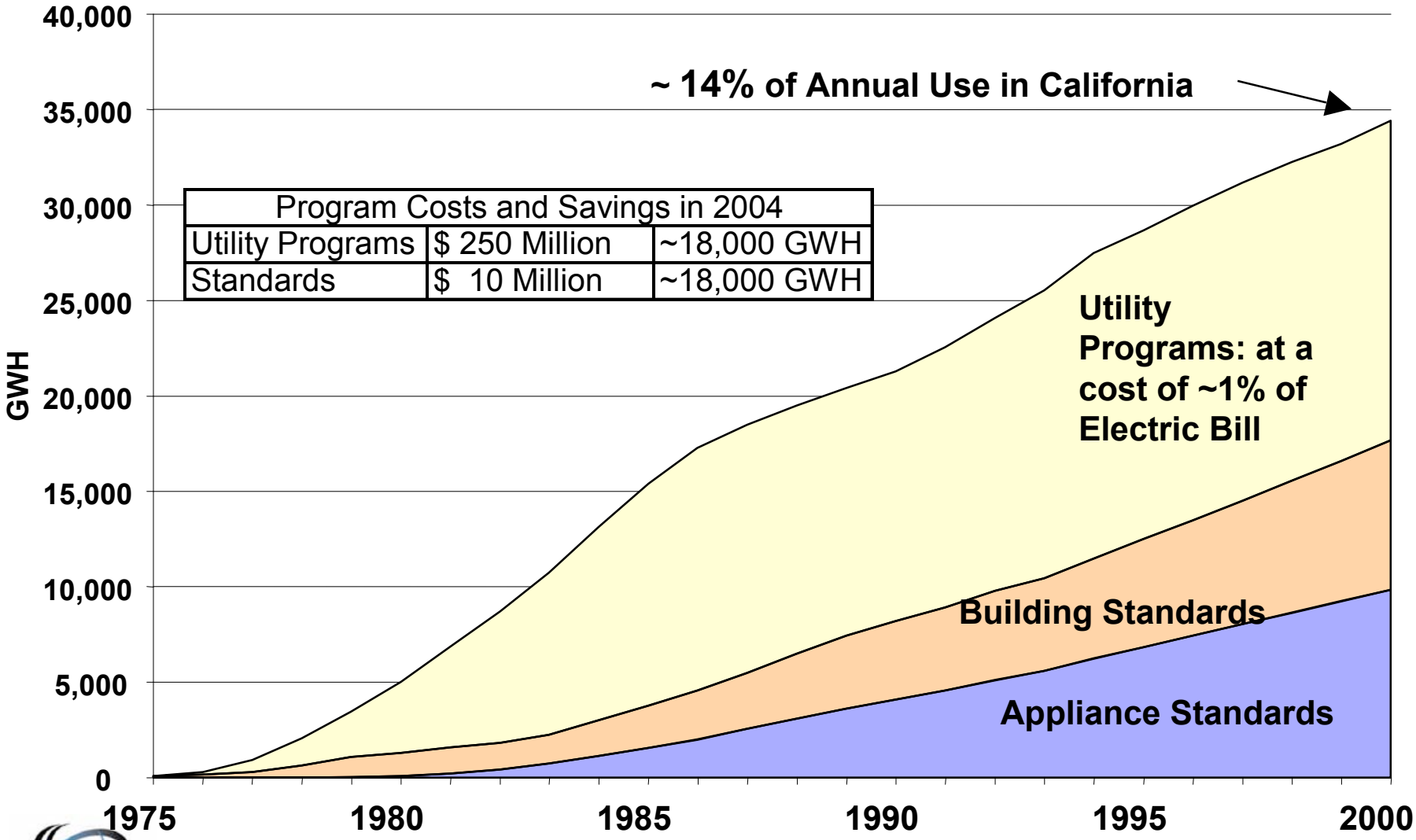


Arthur Rosenfeld, Commissioner, California Energy Commission
Nancy Jenkins, PIER Buildings Program Manager, California Energy Commission
Robert Shelton, Managing Director, Navigant Consulting

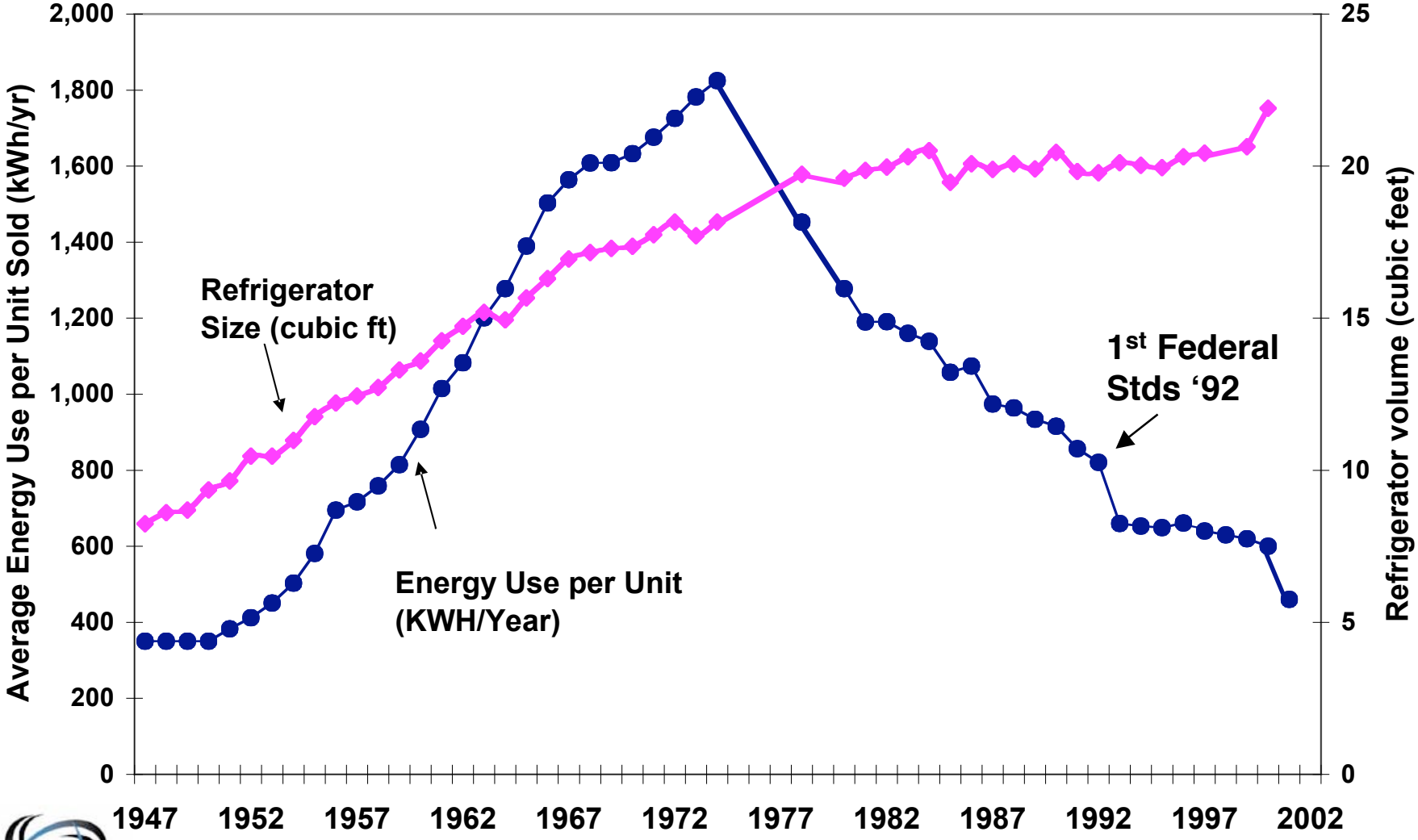
Figure 4: Public Goods and Procurement Funding for Efficiency



GWh Impacts from Programs Begun Prior to 2001



United States Refrigerator Use v. Time



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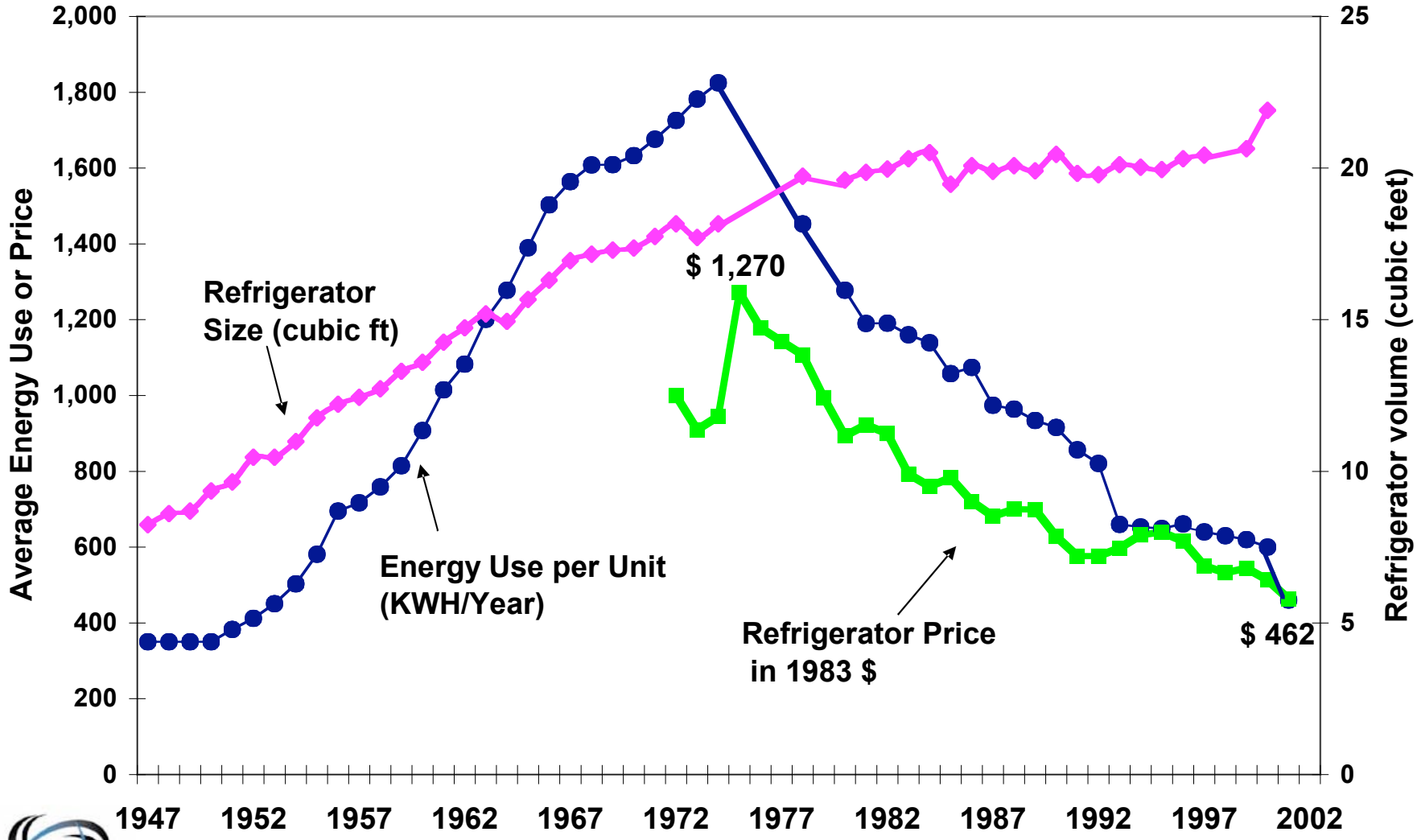
Source: David Goldstein

United States Refrigerator Use v. Time



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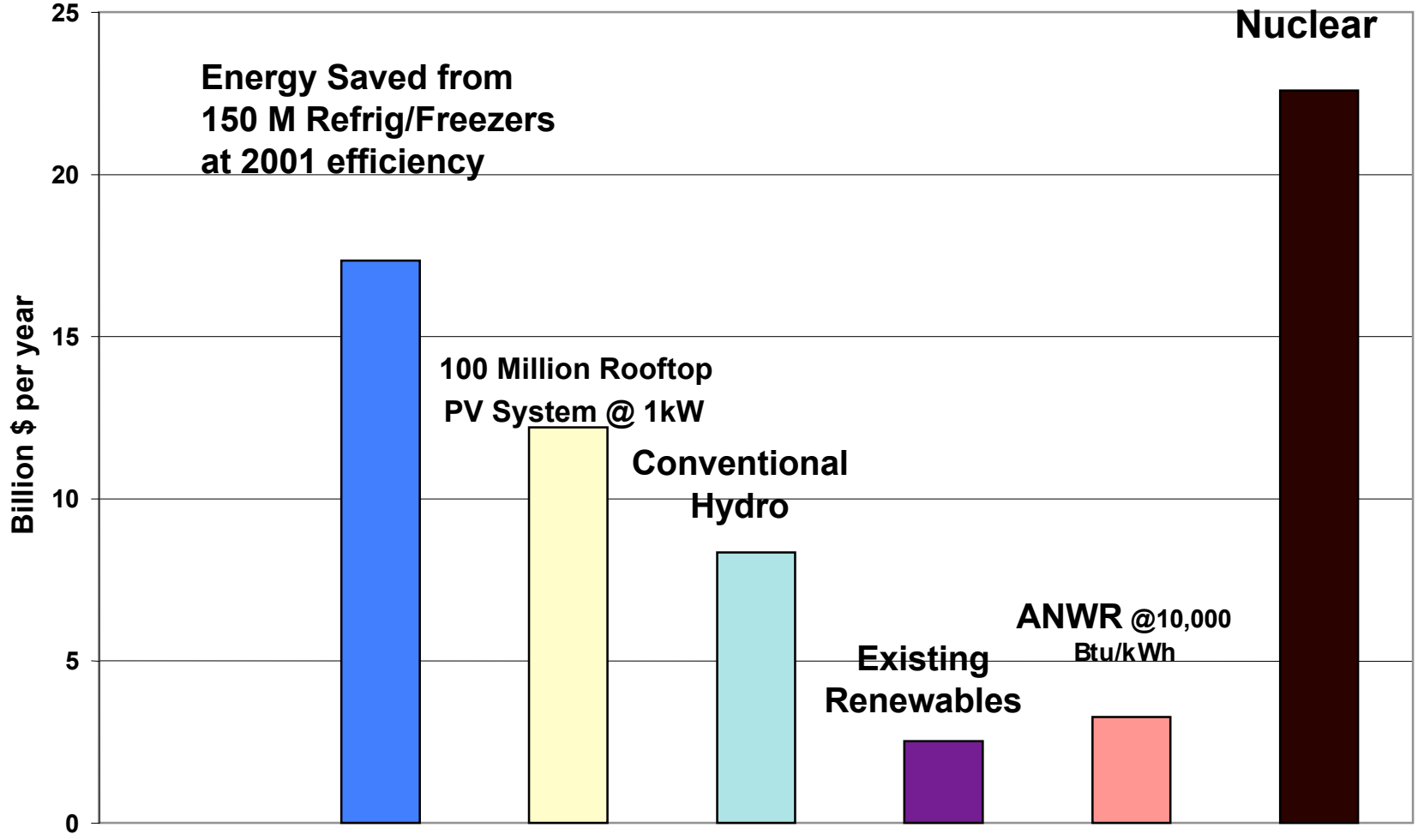
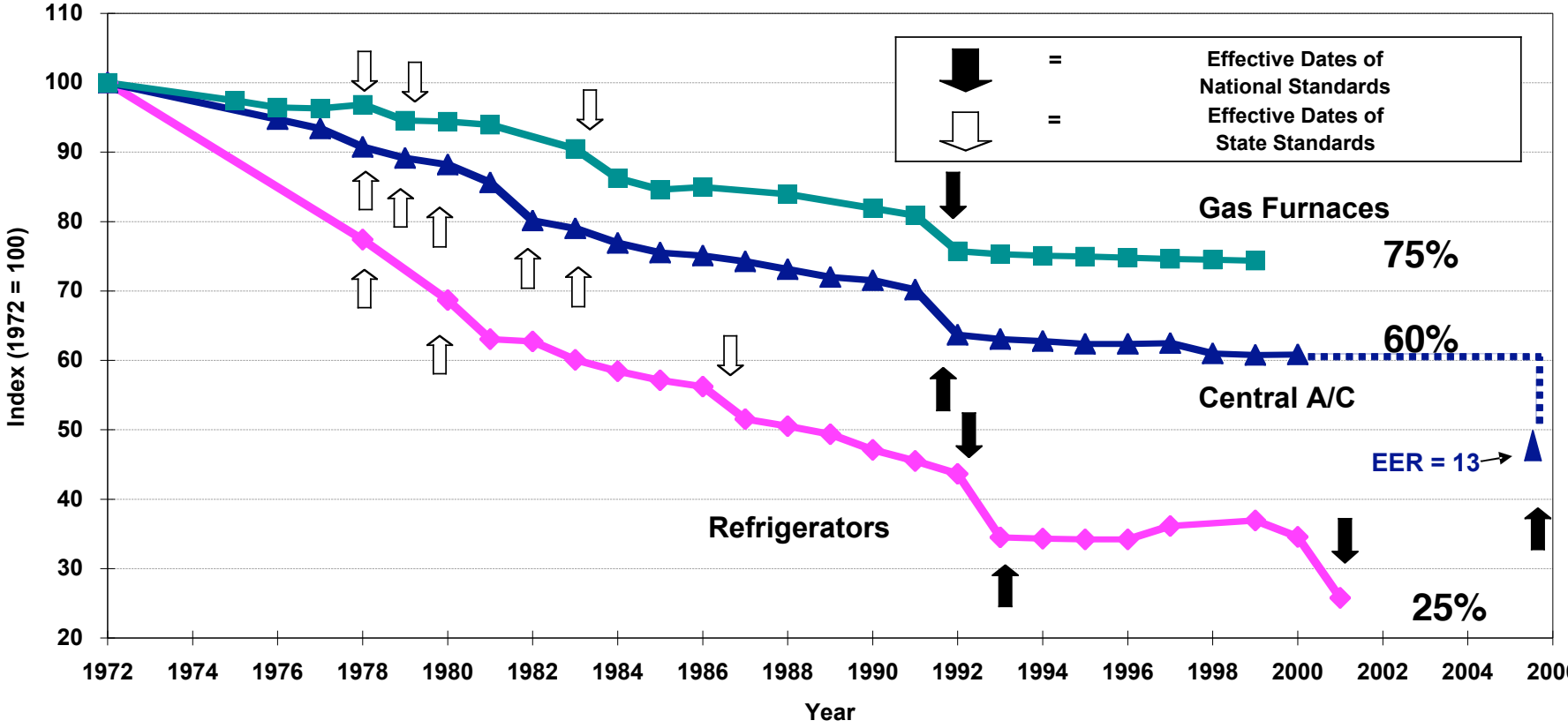
Source: David Goldstein

The Value of Energy Saved and Produced

(production @ .03 and savings @ .085 $/kWh)



Impact of Standards on Efficiency of 3 Appliances



Source: S. Nadel, ACEEE,

in ECEEE 2003 Summer Study, www.eceee.org

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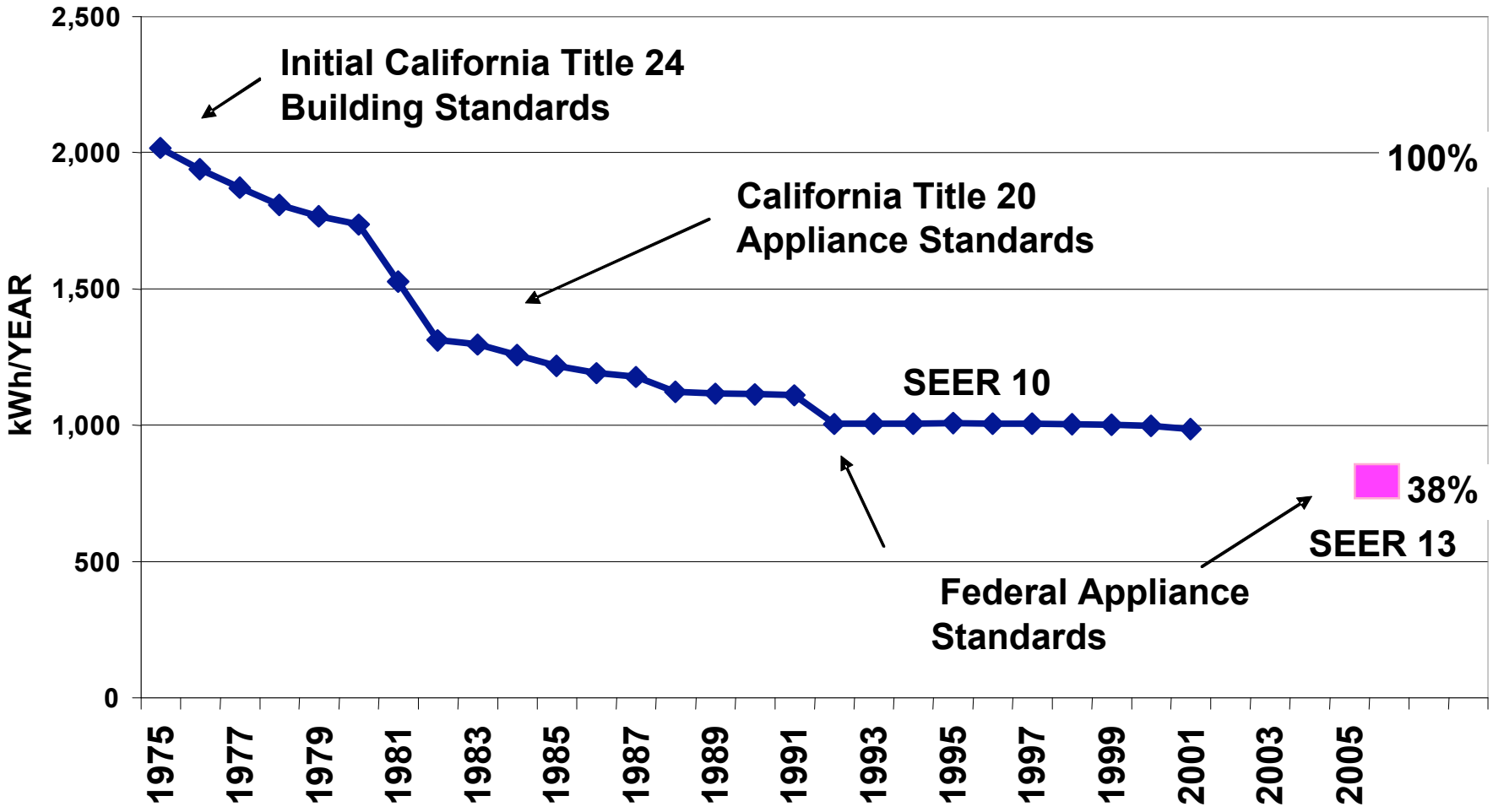
Annual Usage of Air Conditioning in New Homes in California
Average drop of 3% per year while House size grew 1.5% per year



Source: CEC Demand Analysis Office

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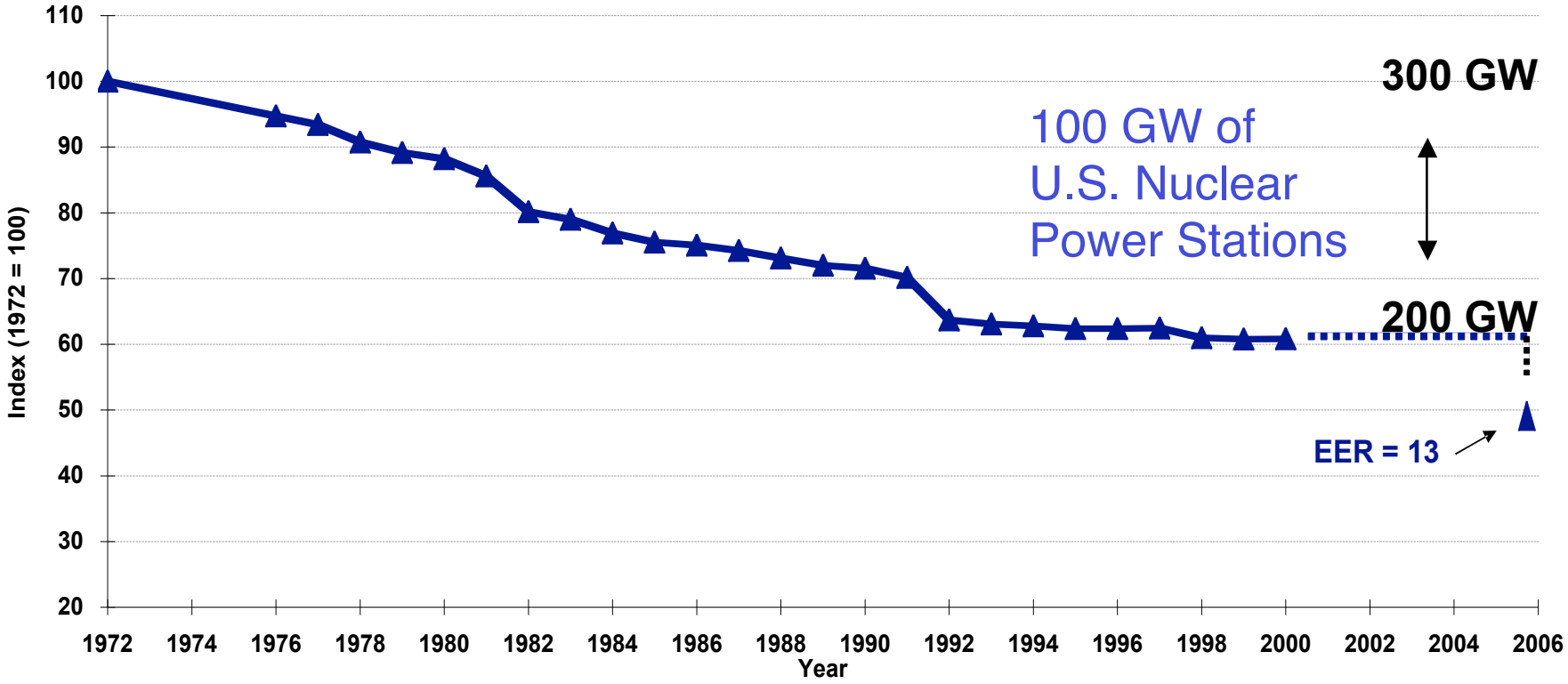
After Saturation (16 years)
Impact of Standards on Residential Central A/C and Roof Top A/C Units in the United States



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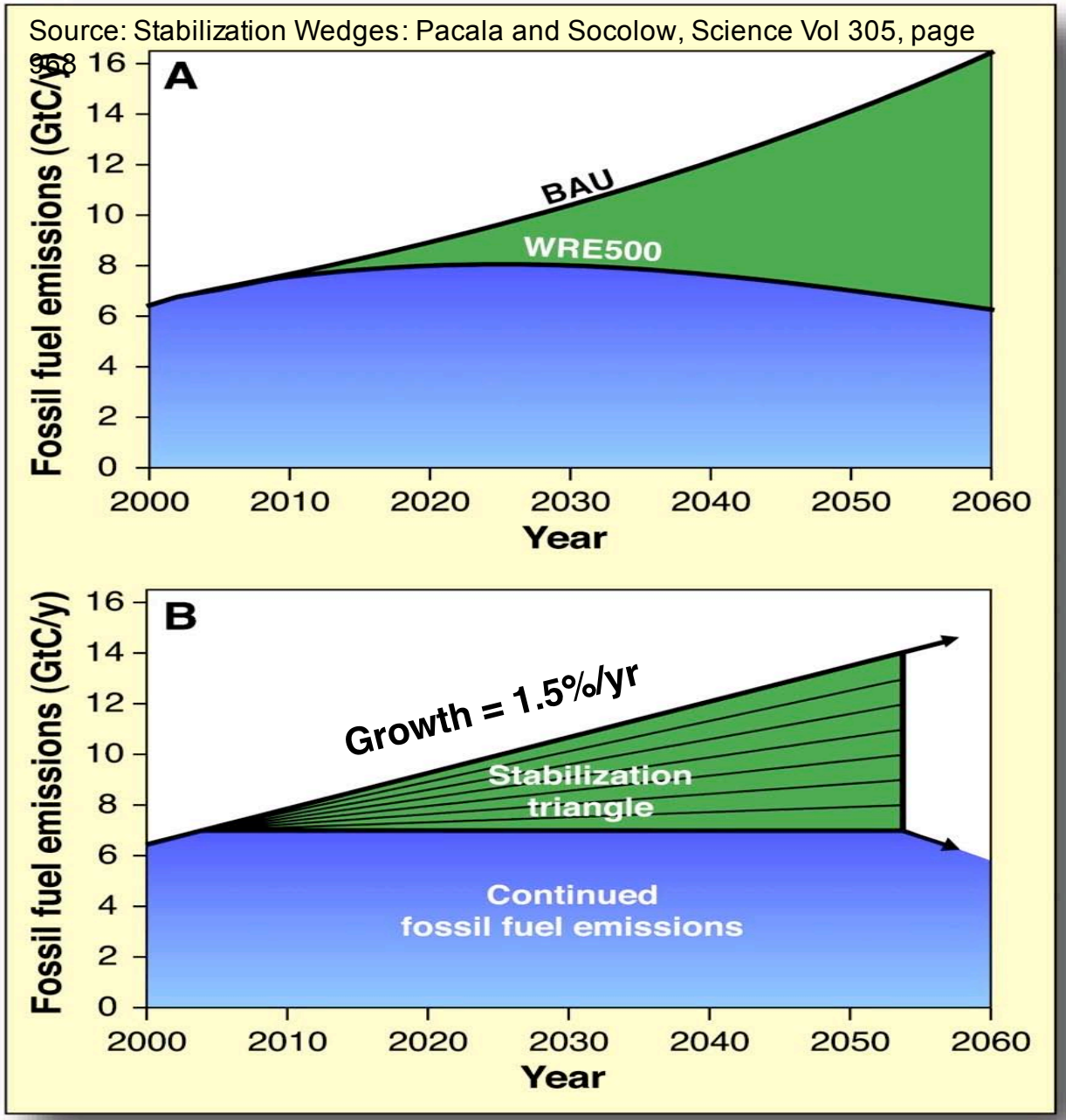
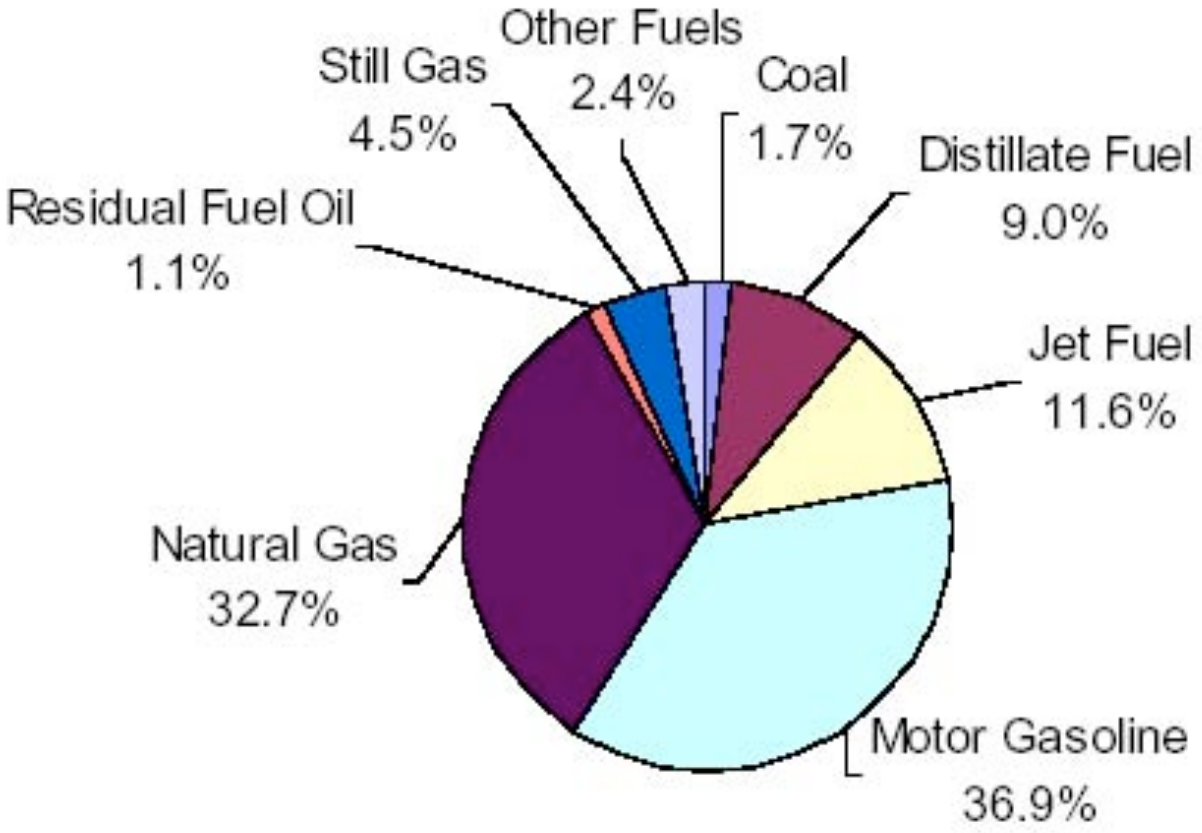
Source: Stabilization Wedges: Pacala and Socolow, Science Vol 305, page 968



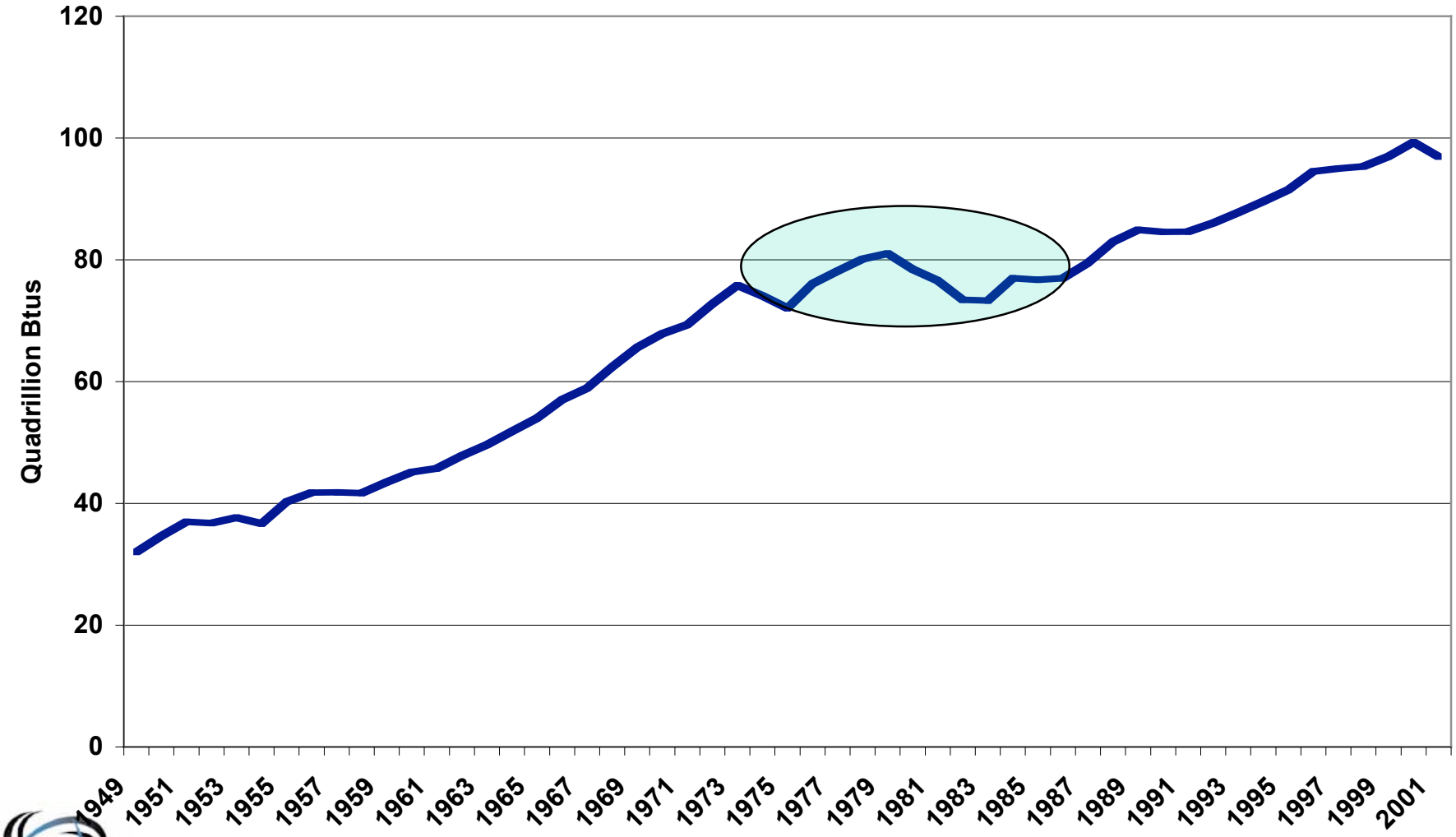
Carbon Dioxide Emissions from Fossil Fuel Combustion in California -- 1999



Source: Inventory of GHG Emissions, CEC, Nov. 2002

United States Energy Consumption 1949 to 2001

Source: Table 1.5 Annual Energy Review; data for 2001 is preliminary



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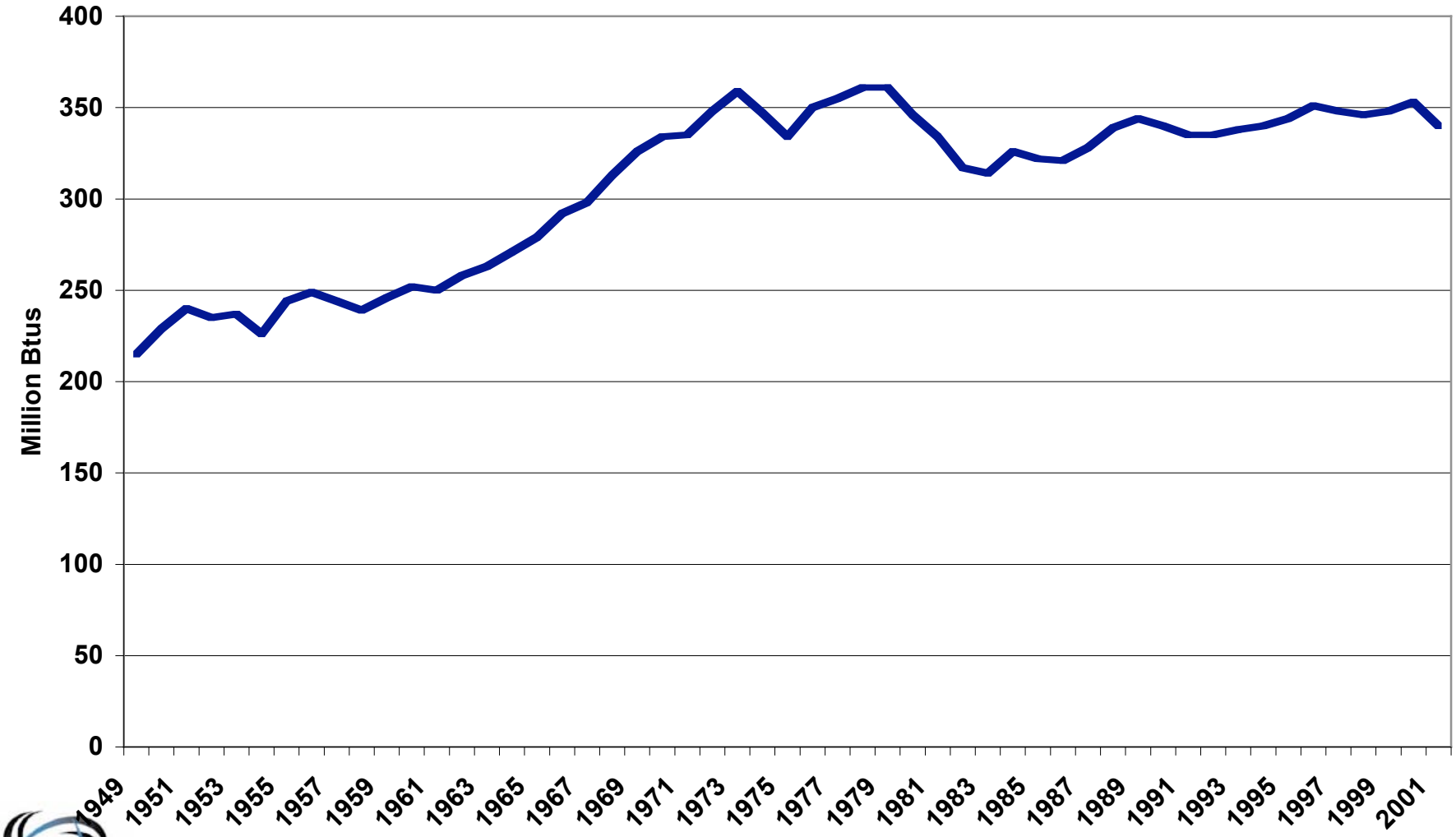
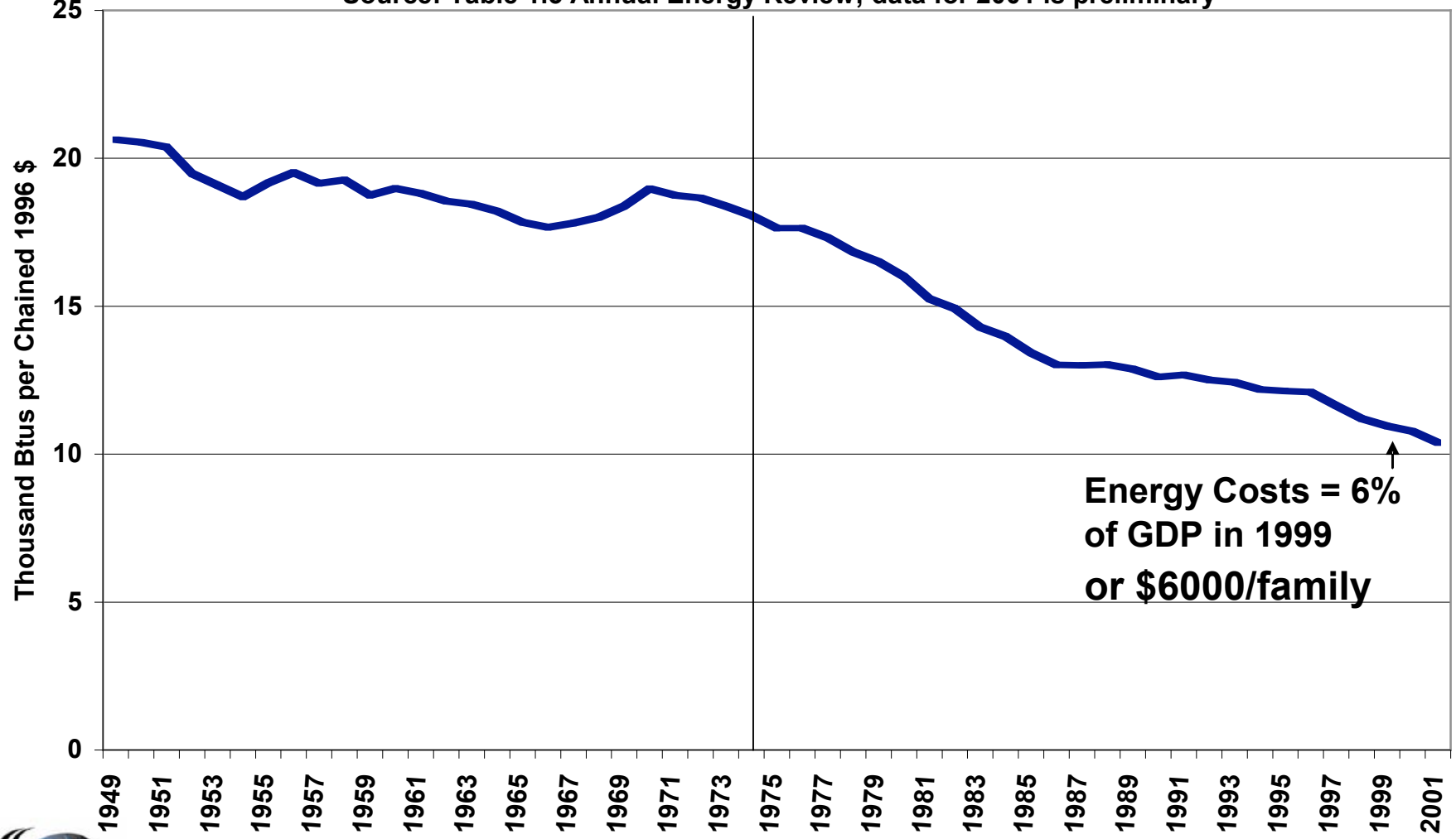
United States
Energy Consumption Per Person 1949 to 2001
Source: Table 1.5 Annual Energy Review; data for 2001 is preliminary



Energy Intensity in the United States
Energy Consumption Per $ of Gross Domestic Product 1949-2001

Source: Table 1.5 Annual Energy Review; data for 2001 is preliminary



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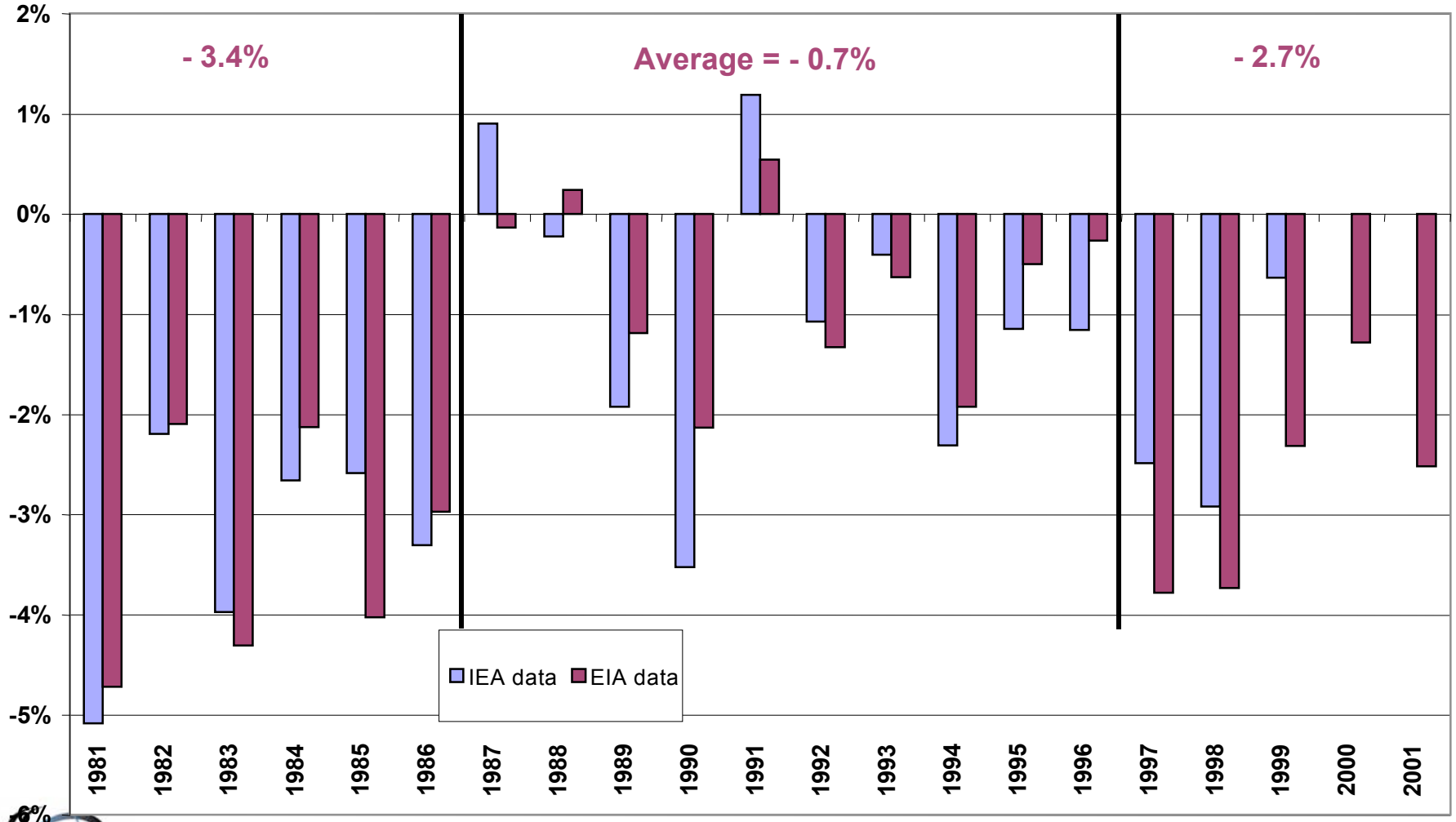
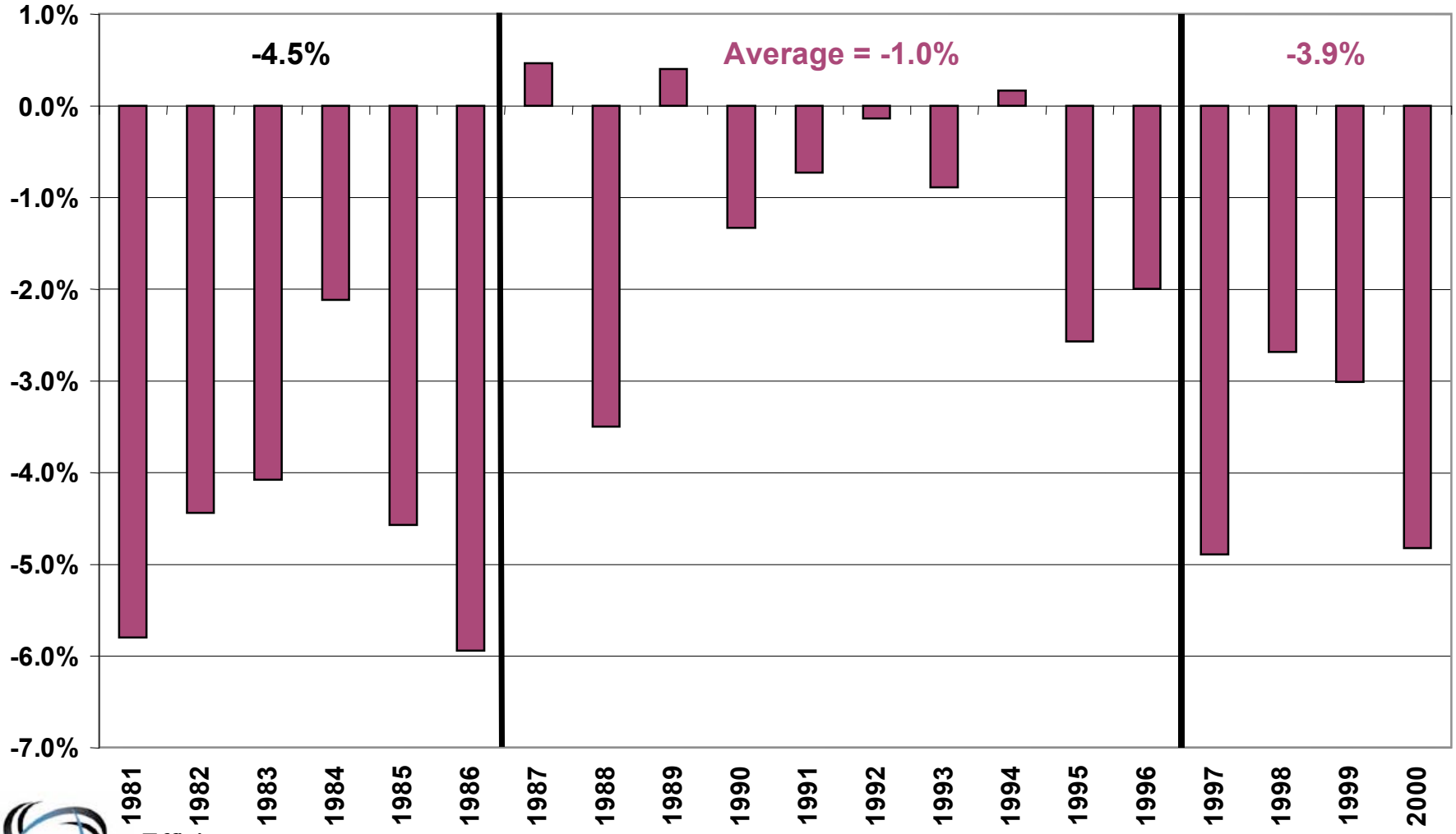
Annual Rate of Change in Energy/GDP for the United States

International Energy Agency (IEA) and EIA (Energy Information Agency)



Annual Rate of Change in Energy/Gross State Product for California

(Sources: EIA and California Department of Finance)



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World Primary Energy Consumption
1980 to 2001
Source: EIA