(Energy Use Leading To)

Air Pollution as Climate Forcing

East-West Center

Honolulu

April 5, 2005

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For my Autobiography, visit

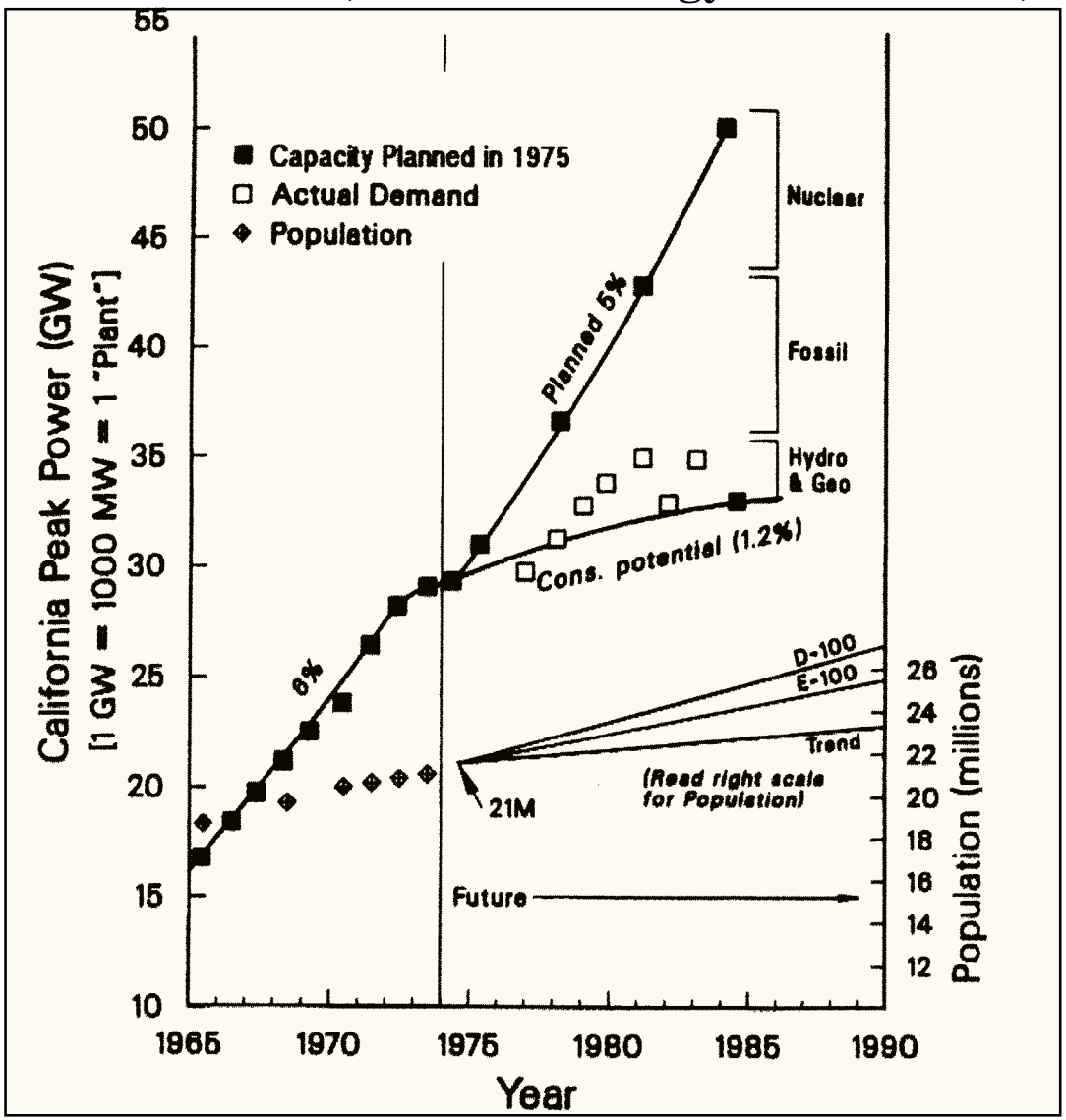
http://www.energy.ca.gov/commission/commissioners/rosenfeld.html

Efficiency

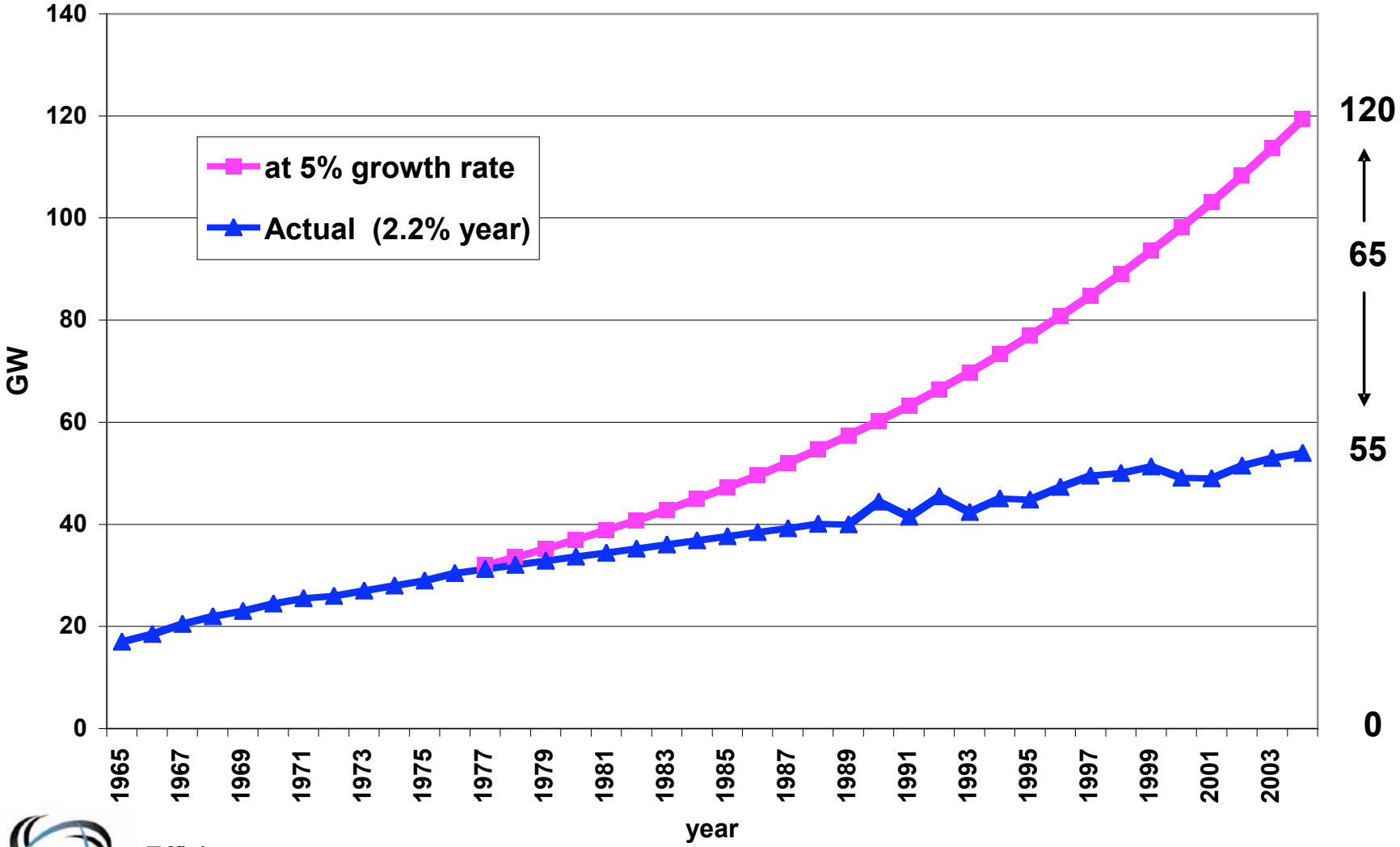
Energy for the Future

California Peak Power Demand:Planned in 1974, and Actual to 1984

Goldstein and Rosenfeld, at Calif. Energy Commission, Dec. 1975

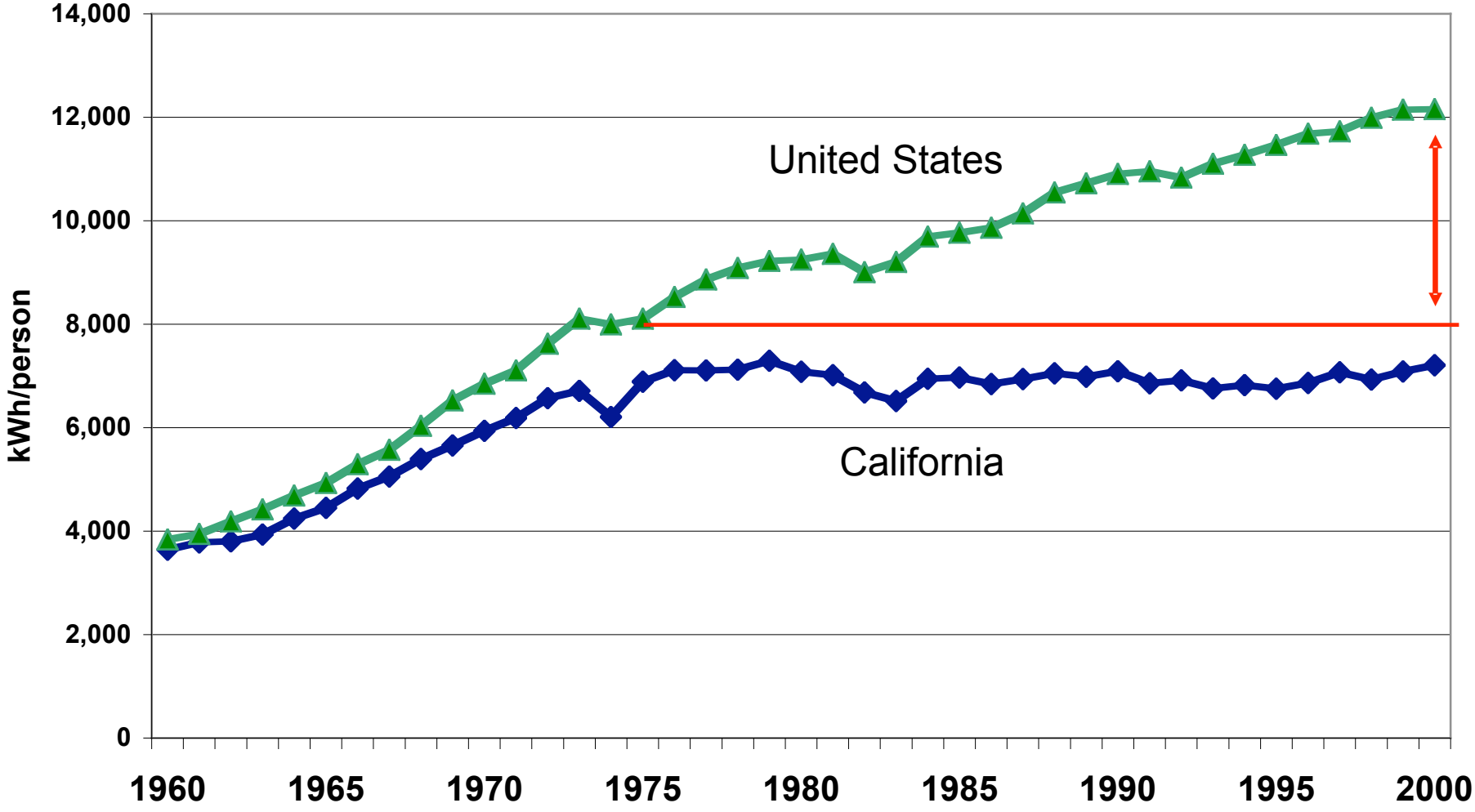


California Peak Demand 1965 - 2004

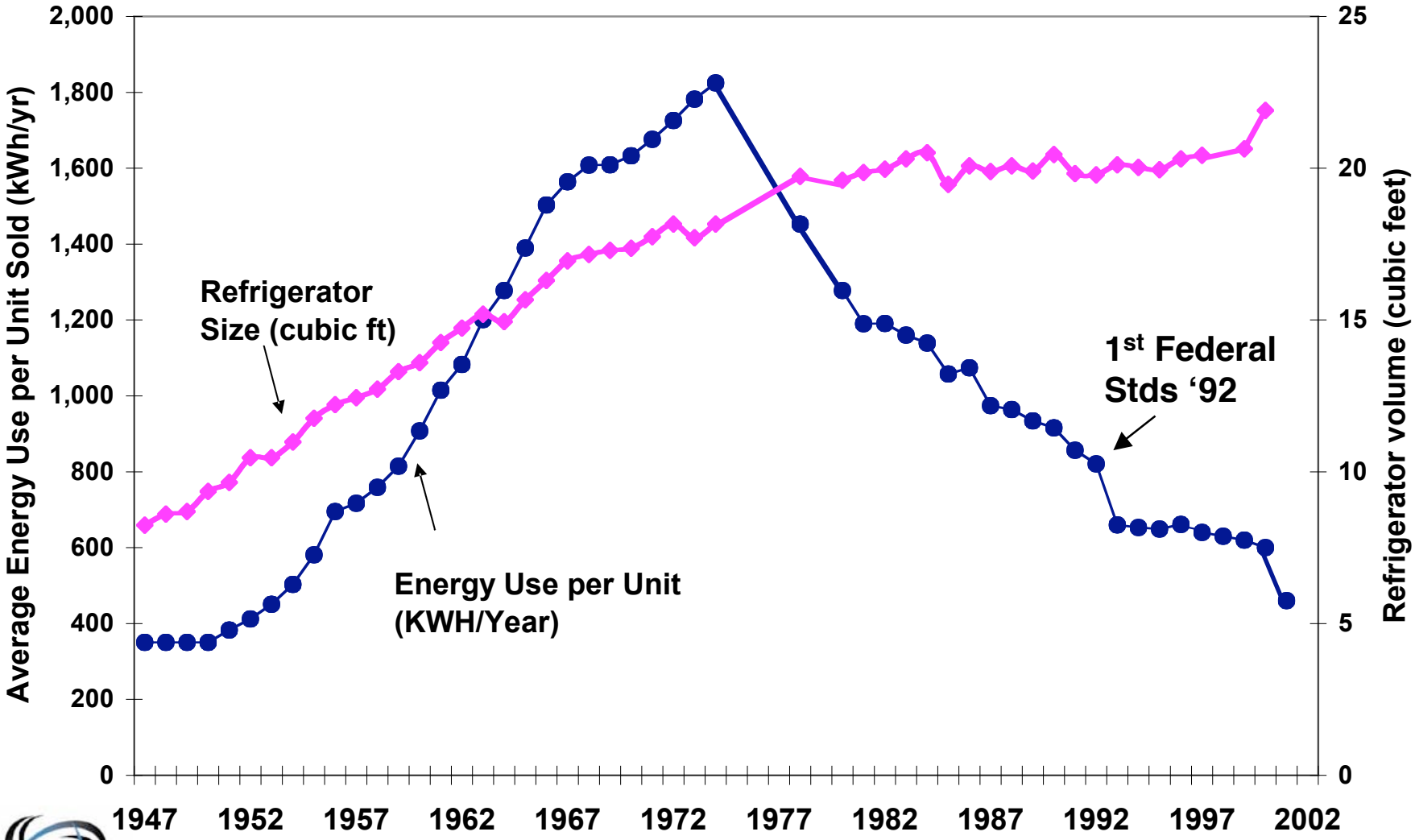


Per Capita Electricity Consumption

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

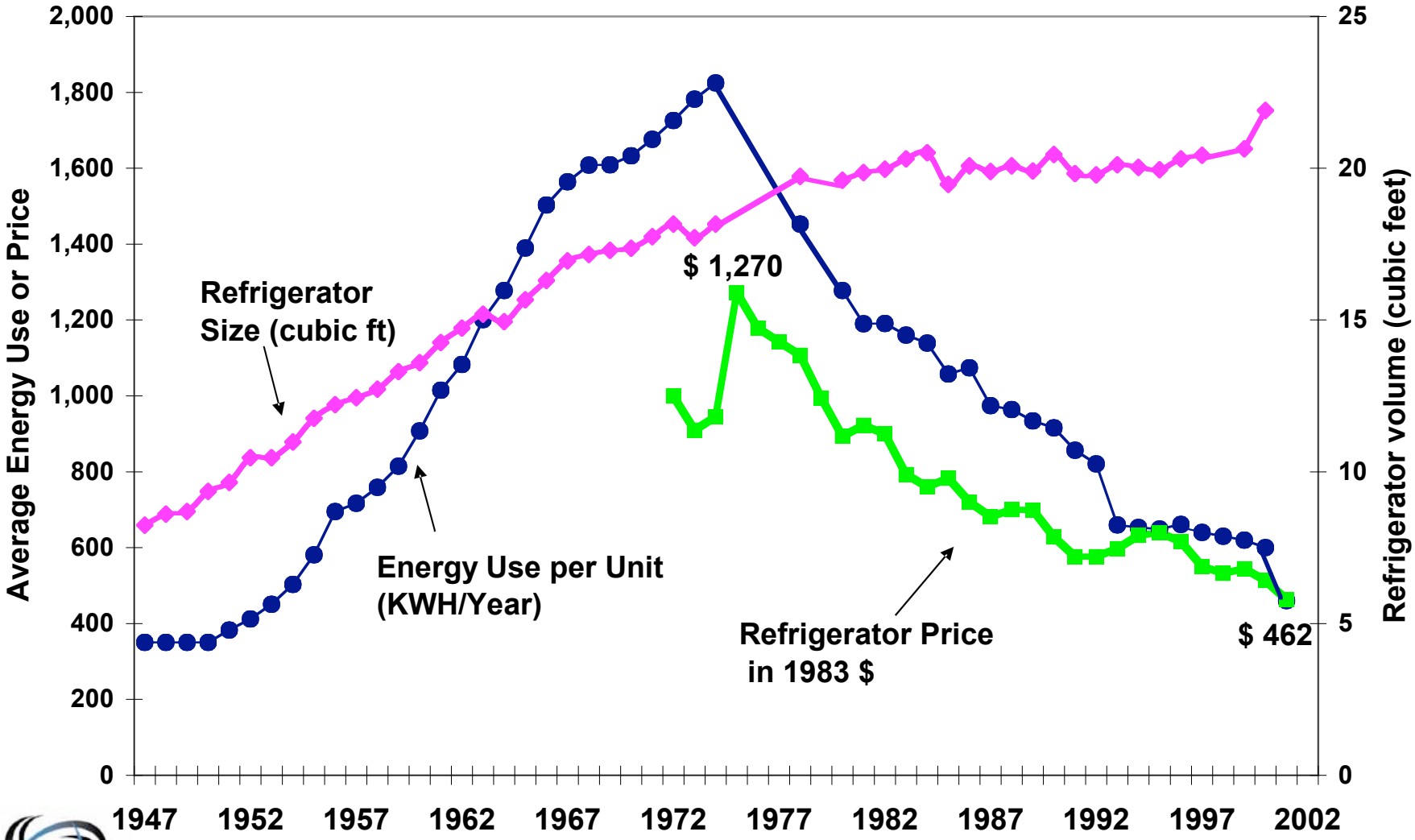


United States Refrigerator Use v. Time



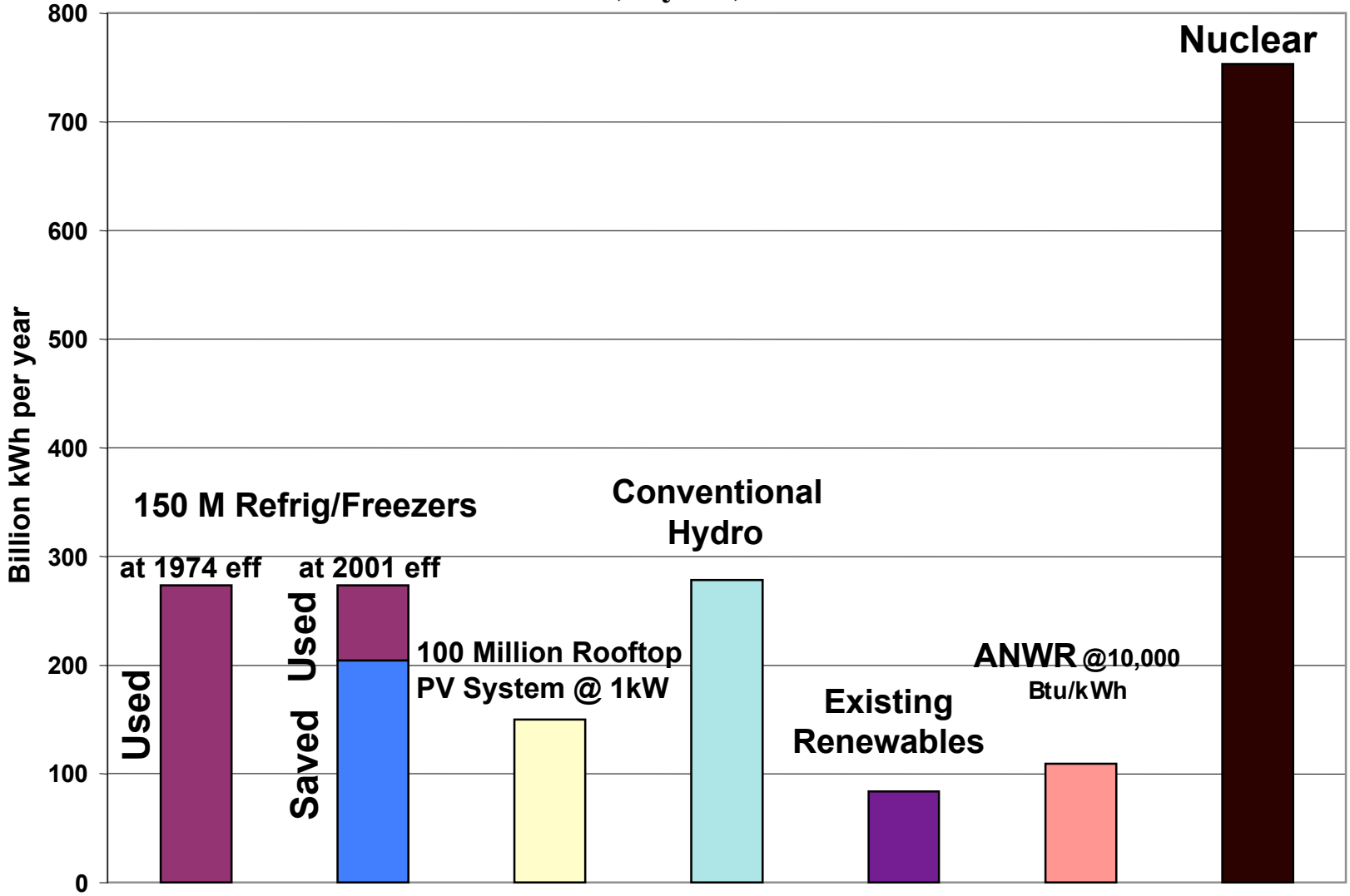
Source: David Goldstein

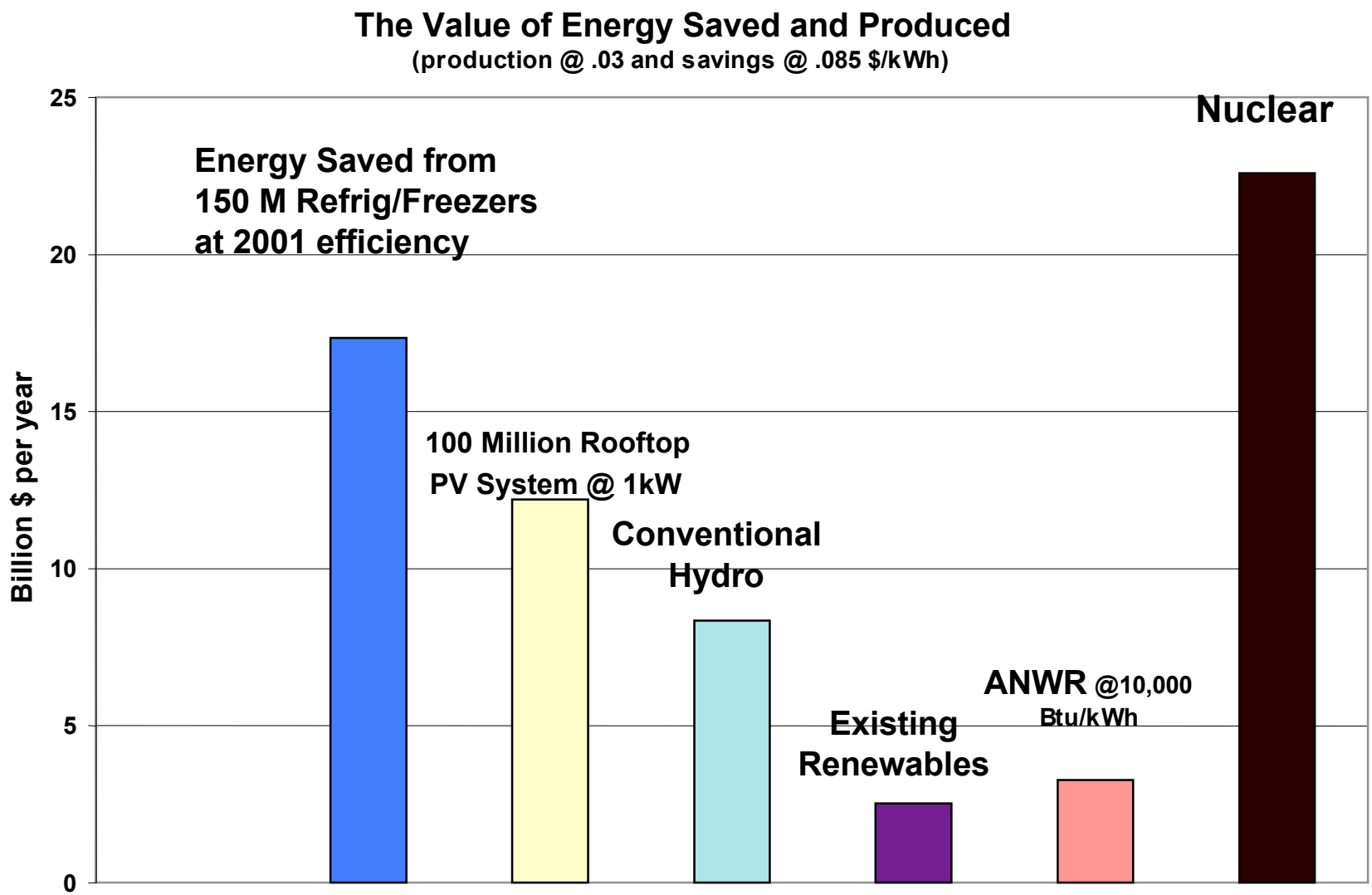
United States Refrigerator Use v. Time



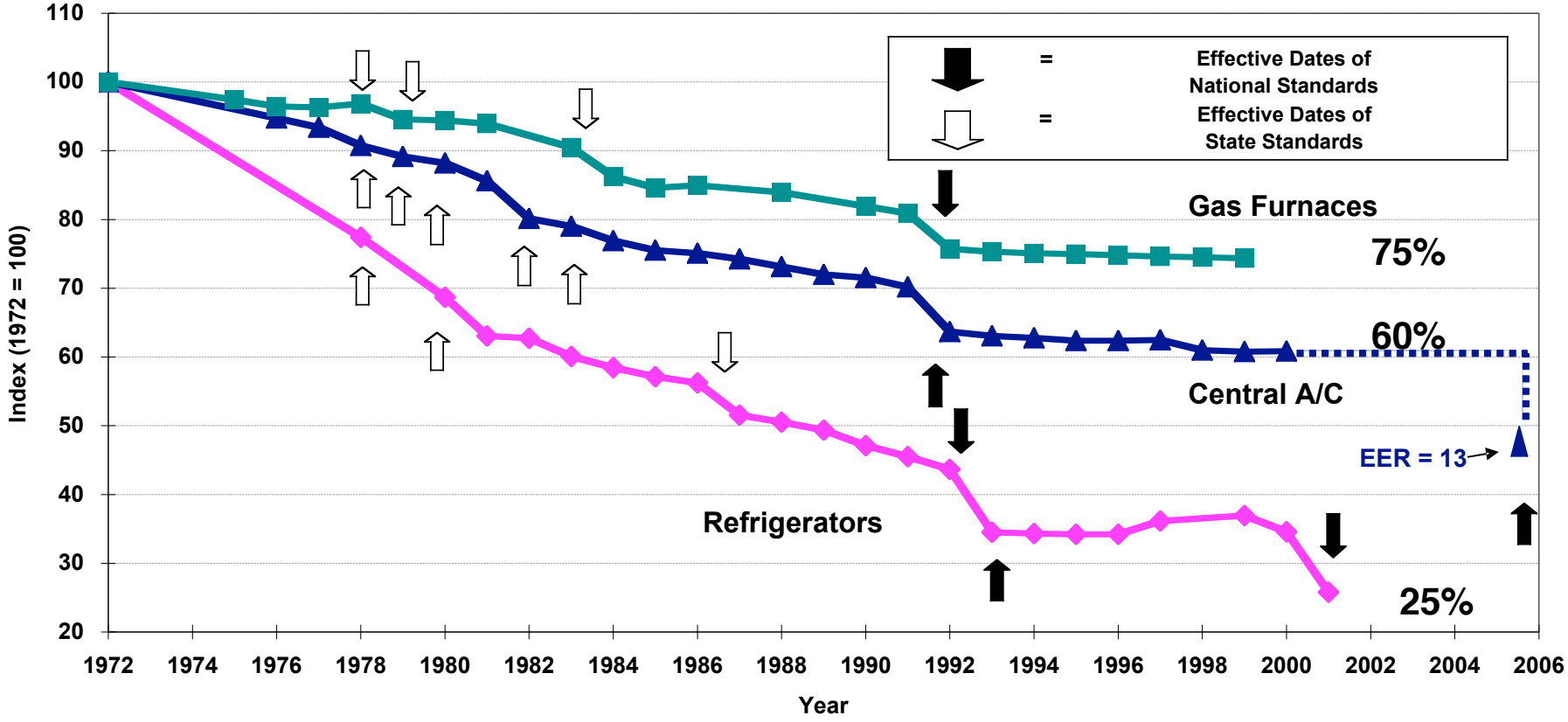
Source: David Goldstein

Electricity Use of Refrigerators and Freezers in the US compared to Generation from Nuclear, Hydro, Renewables and ANWR



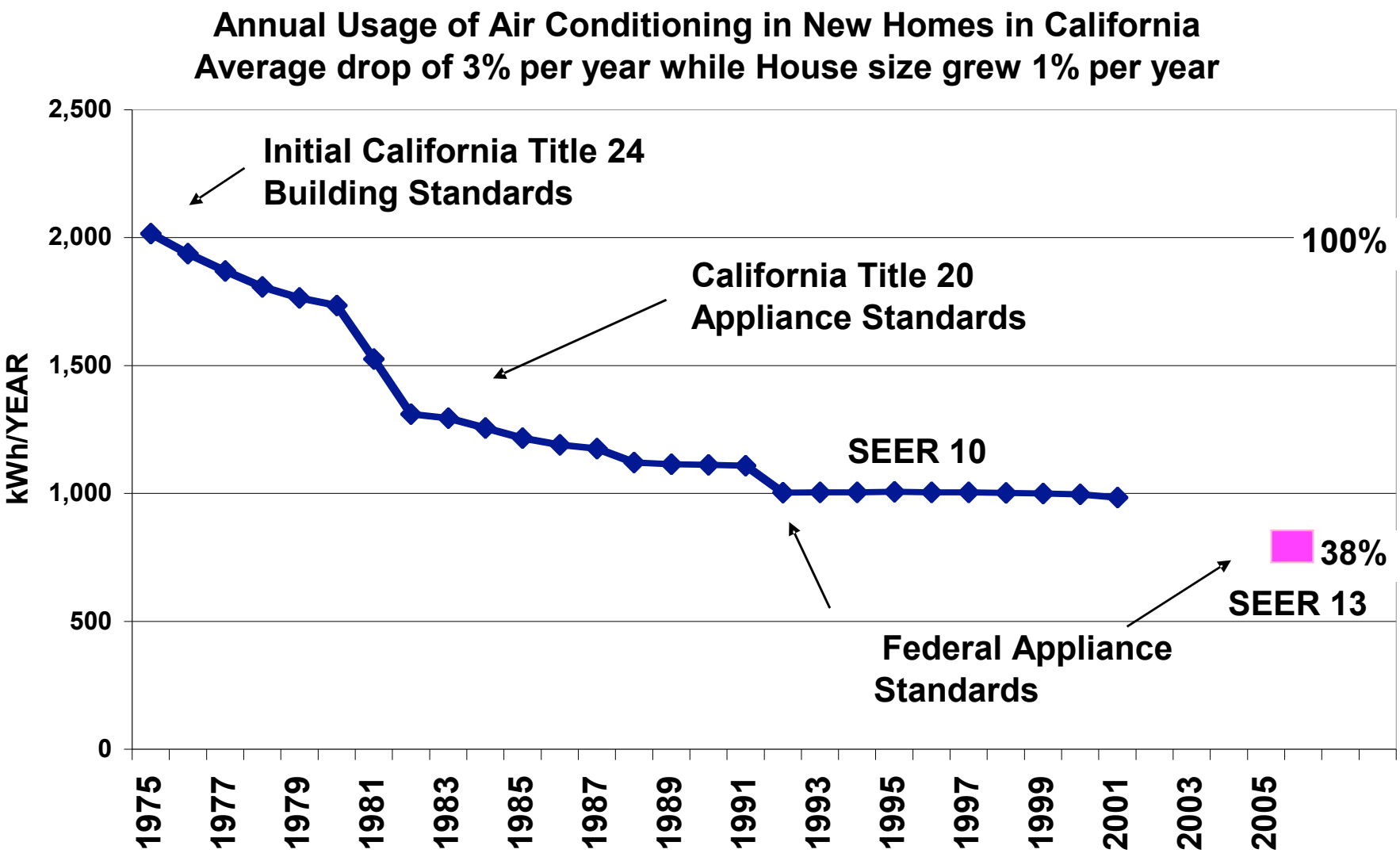

The Value of Energy Saved and Produced
(production @ .03 and savings @ .085 $/kWh)
Billion $ per year
25
20
15
10
5
0
Energy Saved from
150 M Refrig/Freezers
at 2001 efficiency
100 Million Rooftop
PV System @ 1kW
Conventional
Hydro
Existing
Renewables
ANWR @10,000
Btu/kWh
Nuclear

Impact of Standards on Efficiency of 3 Appliances



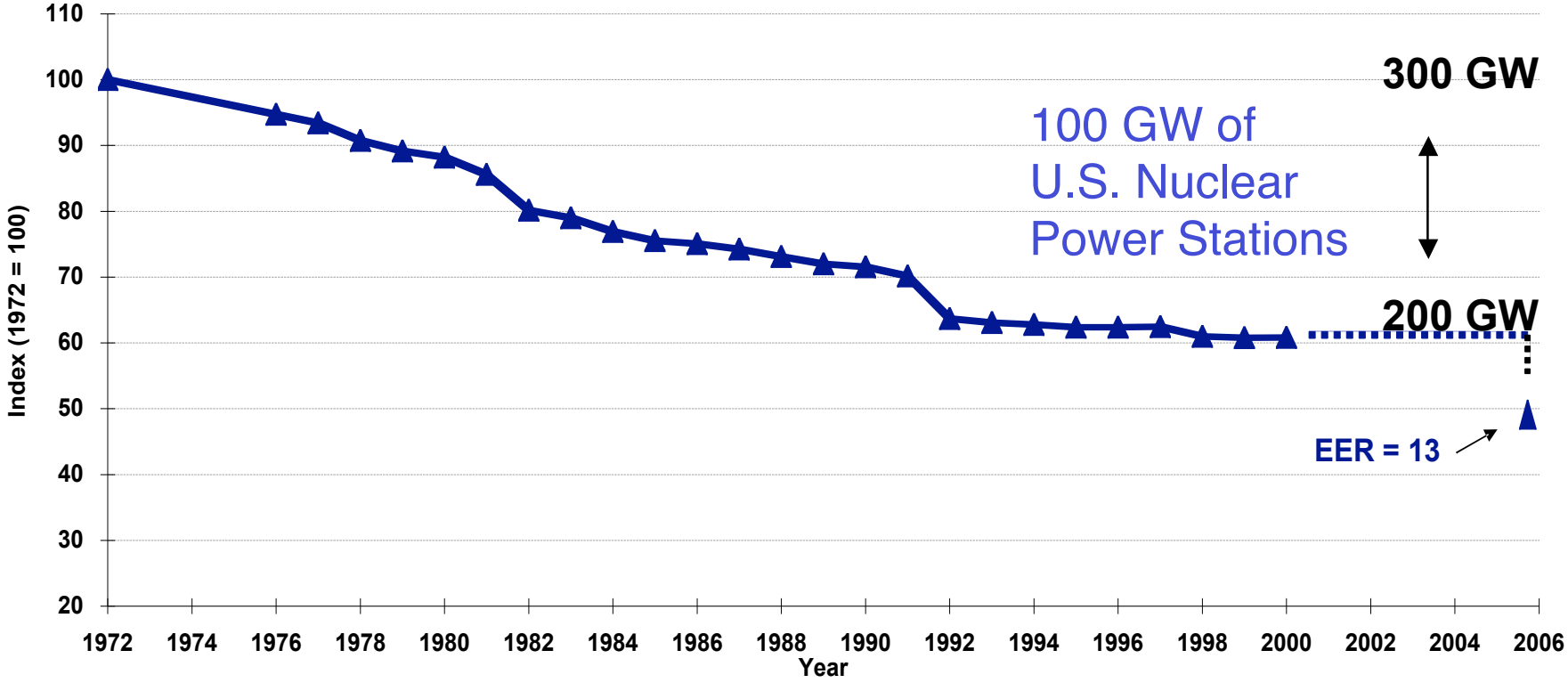
Source: S. Nadel, ACEEE,

in ECEEE 2003 Summer Study, www.eceee.org



Source: CEC Demand Analysis Office

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

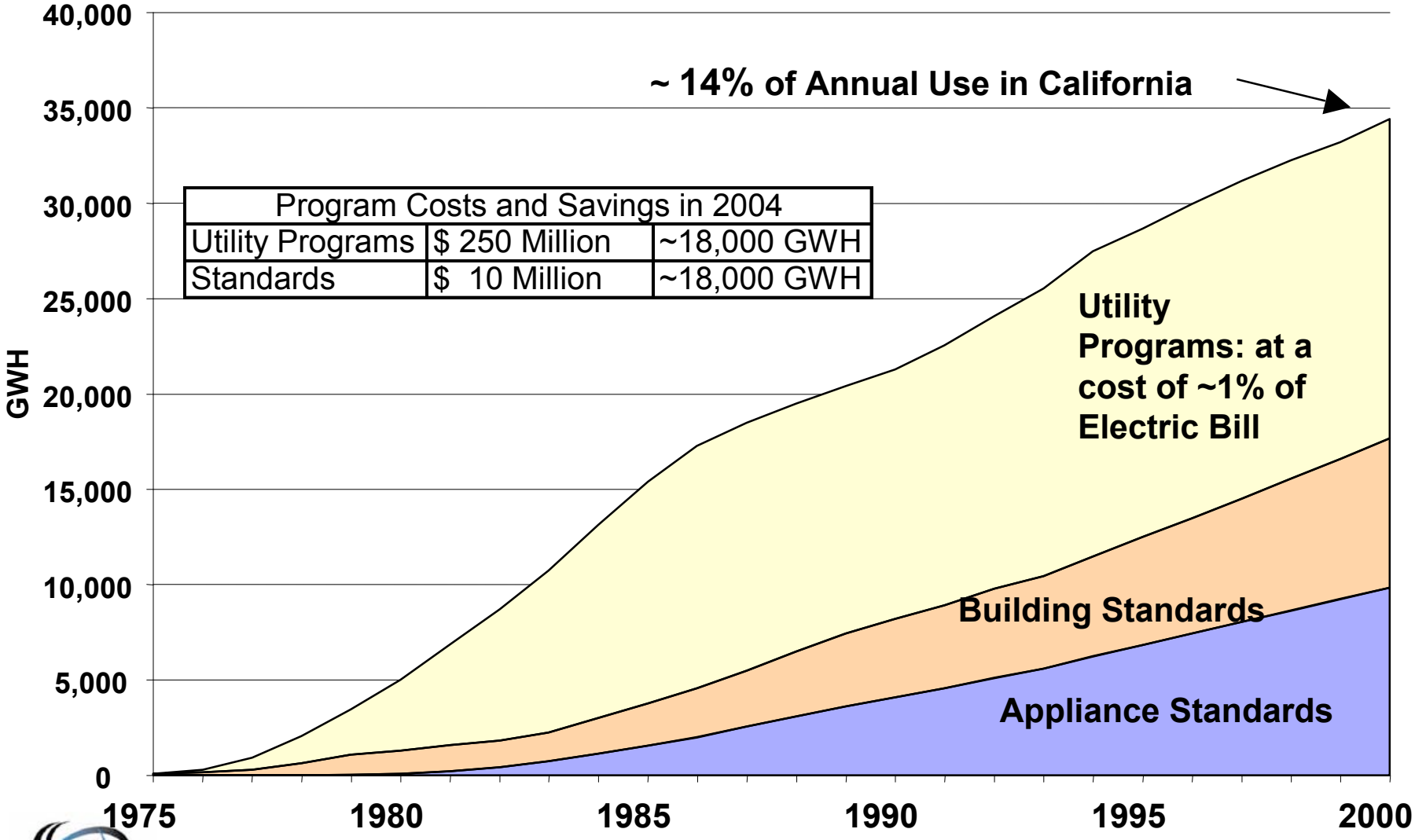


Costs and Pollution Saved by Avoiding a 50% expansion of California Electric System.

- 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.**

GWh Impacts from Programs Begun Prior to 2001



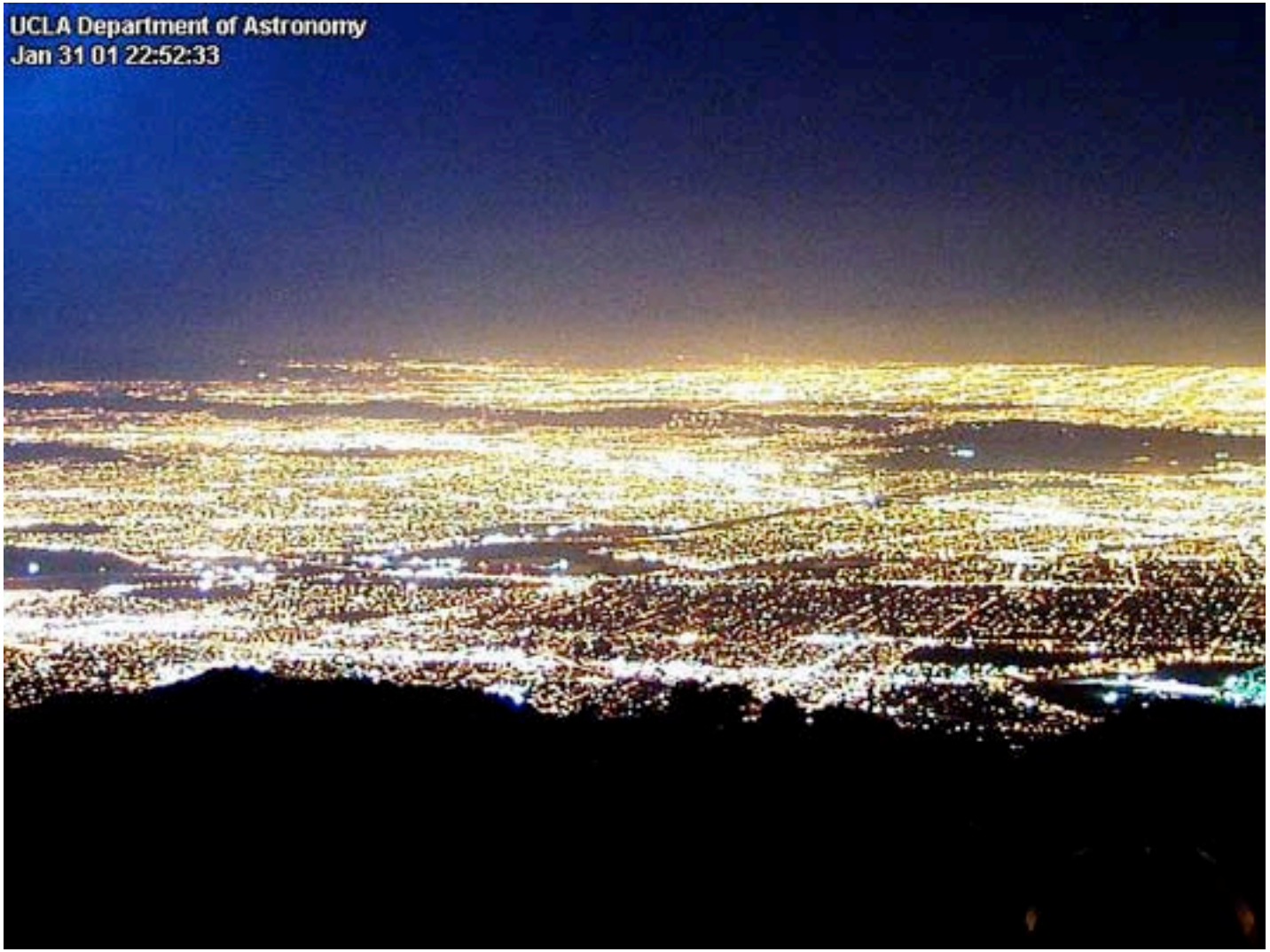
Program Costs and Savings in 2004		
Utility Programs	$ 250 Million	~18,000 GWH
Standards	$ 10 Million	~18,000 GWH

Extending Efficiency to Developing Countries:--- Standards are 25 times cheaper than Energy Efficiency Programs

- The entire California Energy Efficiency Strategy costs 1% of annual electric bills and less than 0.75% of total electric and natural gas bills
- But Standards Development, Training and Inspection yield 50% of the savings for only $ 10 million per year
  - That's 4% of the total costs
  - So, this is 25 x more cost effective that utility programs
- $10 M / $30 B electric bill, is 1/3000 of our bill, or 1/3 cent per $100.

How does this apply to Developing Countries?

- At a minimum, Standards should be extended to Developing Countries with funding matched by developed countries (0.1% of electric bills)
- Better yet, 1% of electric bills in developing countries should be set aside for utility programs and standard development
  - With matching funds provided by developed countries


UCLA Department of Astronomy
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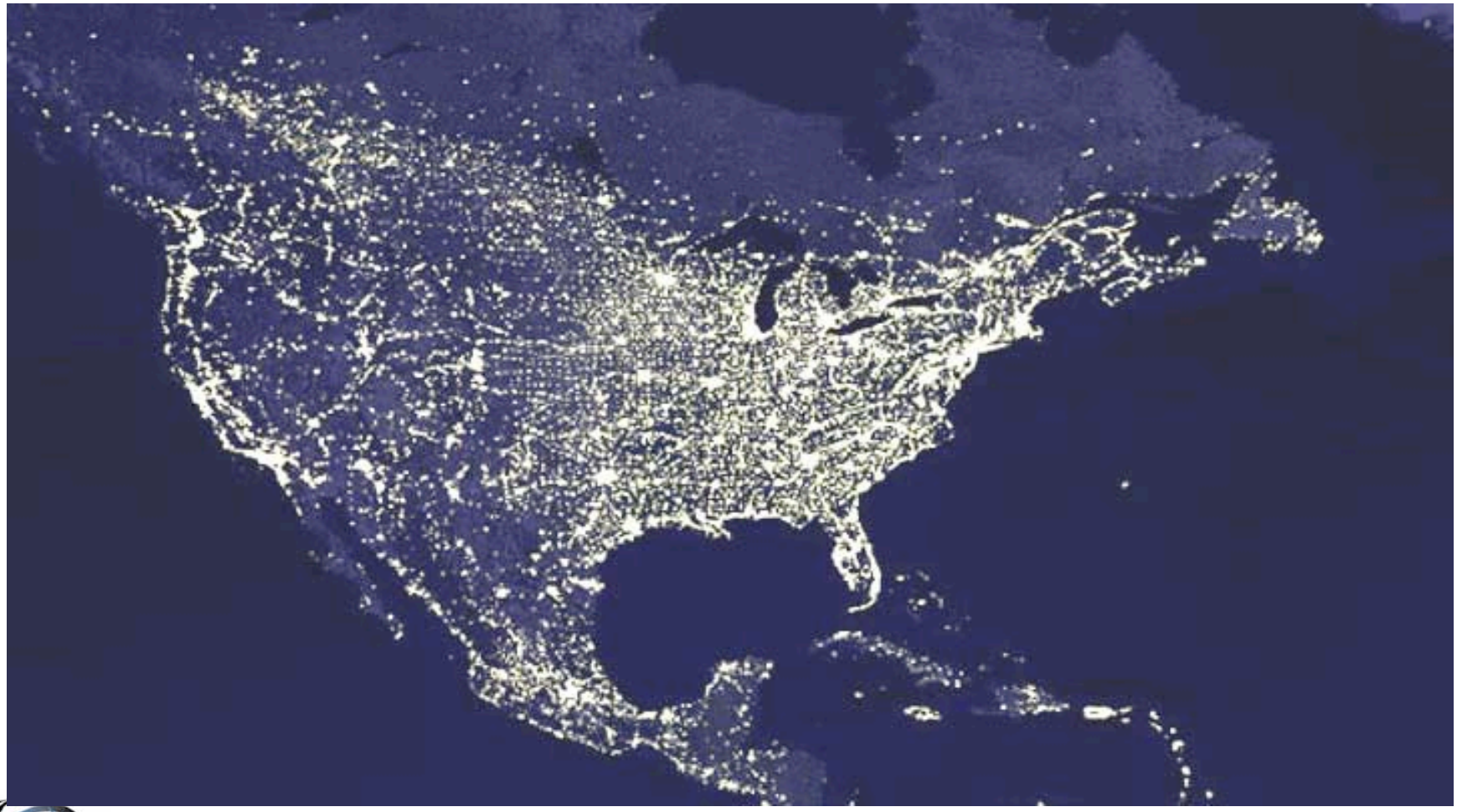
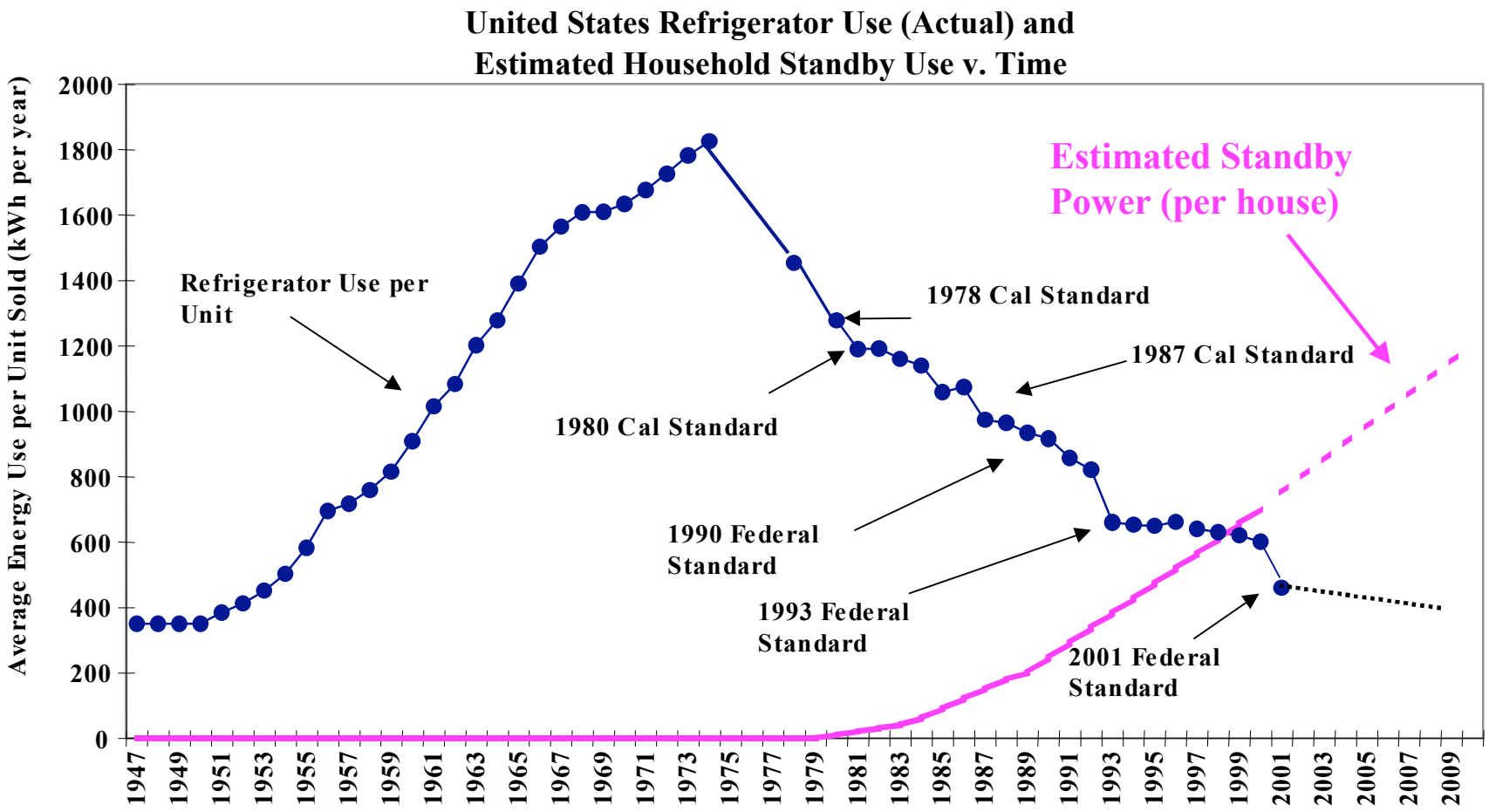
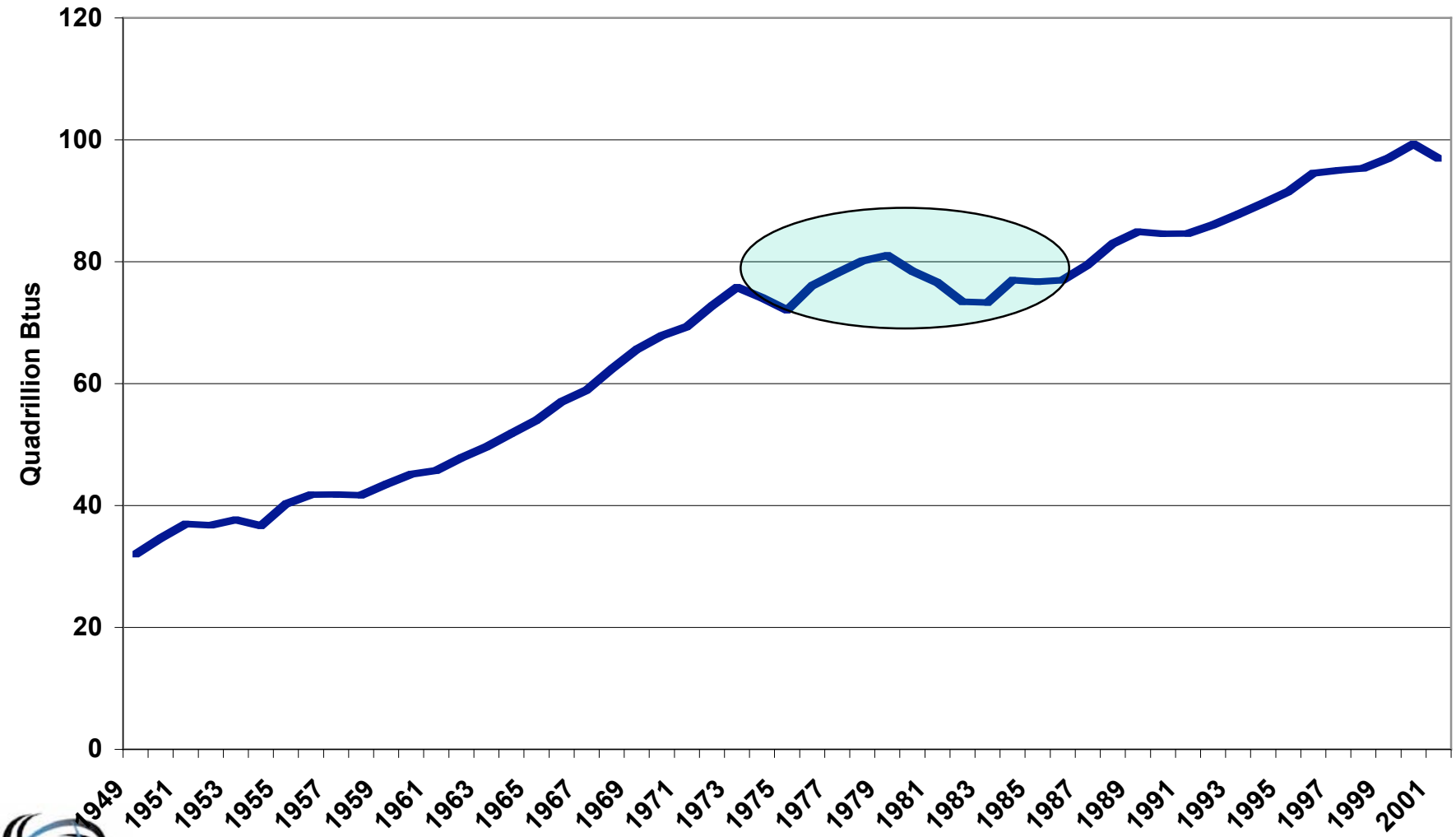
Illuminating Space vs. the Street



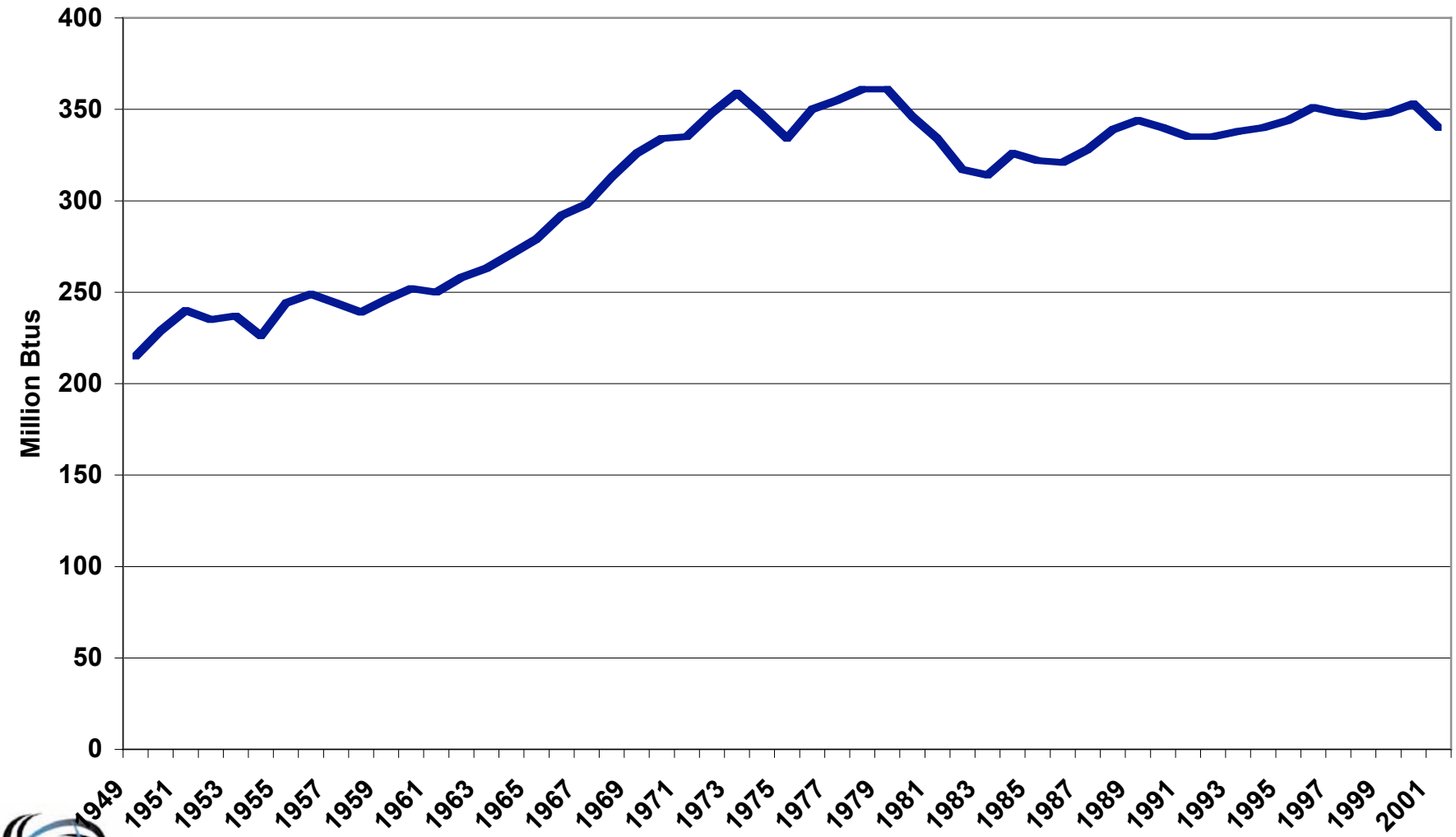

United States Refrigerator Use (Actual) and
Estimated Household Standby Use v. Time
Average Energy Use per Unit Sold (kWh per year)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1947
1949
1951
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
Refrigerator Use per Unit
1980 Cal Standard
1978 Cal Standard
1987 Cal Standard
1990 Federal Standard
1993 Federal Standard
2001 Federal Standard
Estimated Standby Power (per house)

United States Energy Consumption 1949 to 2001

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

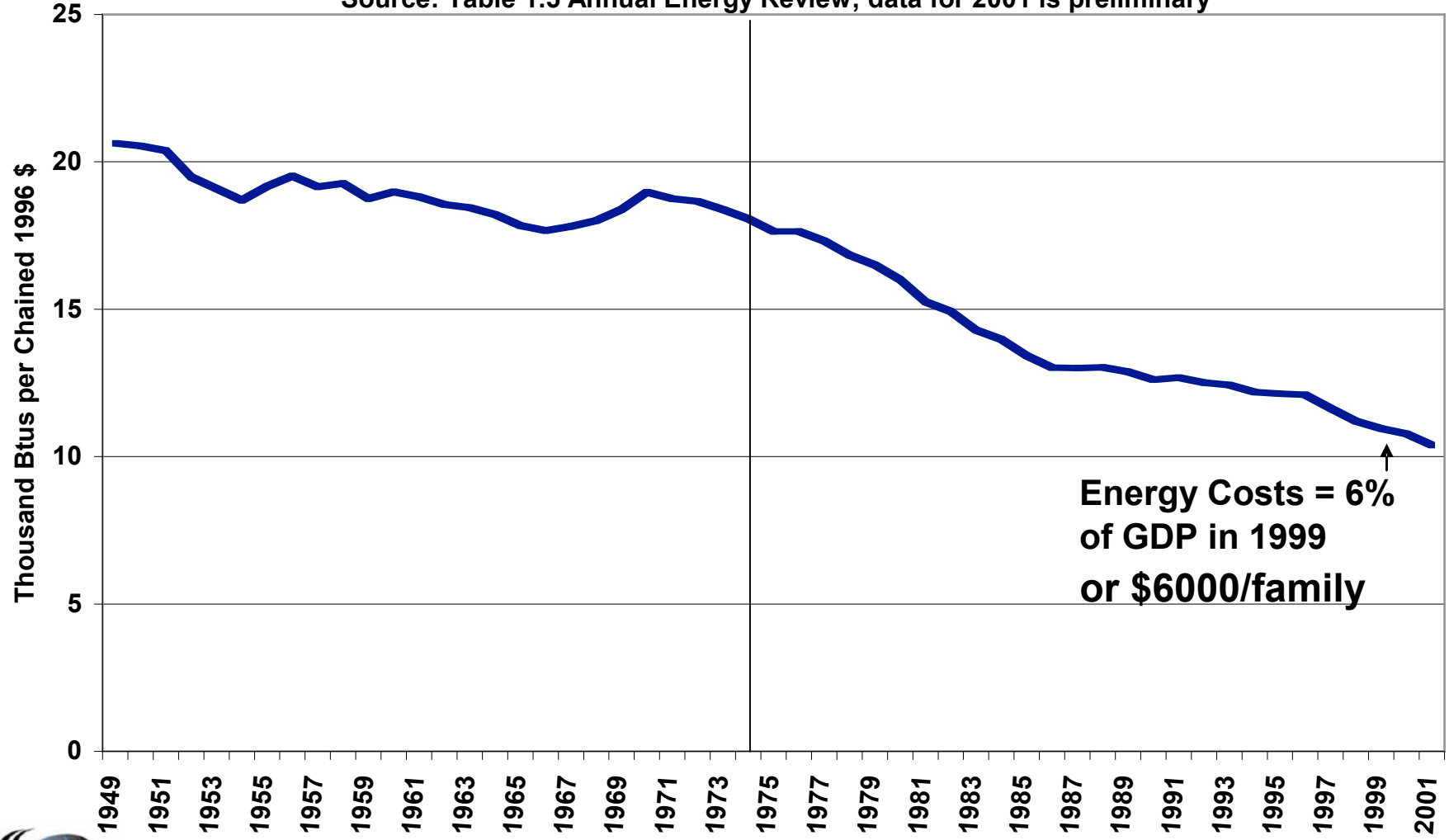


United States
Energy Consumption Per Person 1949 to 2001
Source: Table 1.5 Annual Energy Review; data for 2001 is preliminary

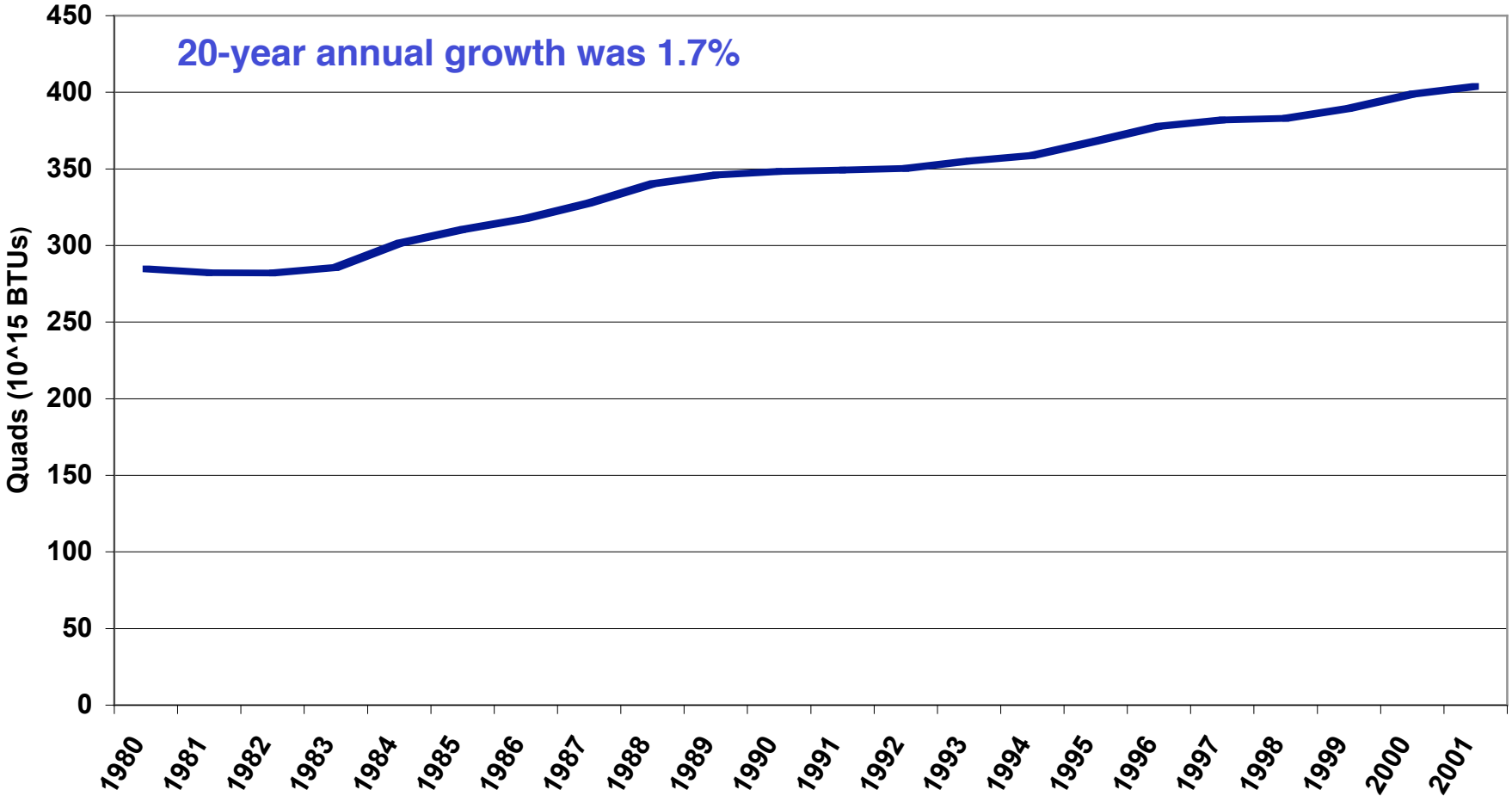


Energy Intensity in the United States
Energy Consumption Per $ of Gross Domestic Product 1949-2001

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

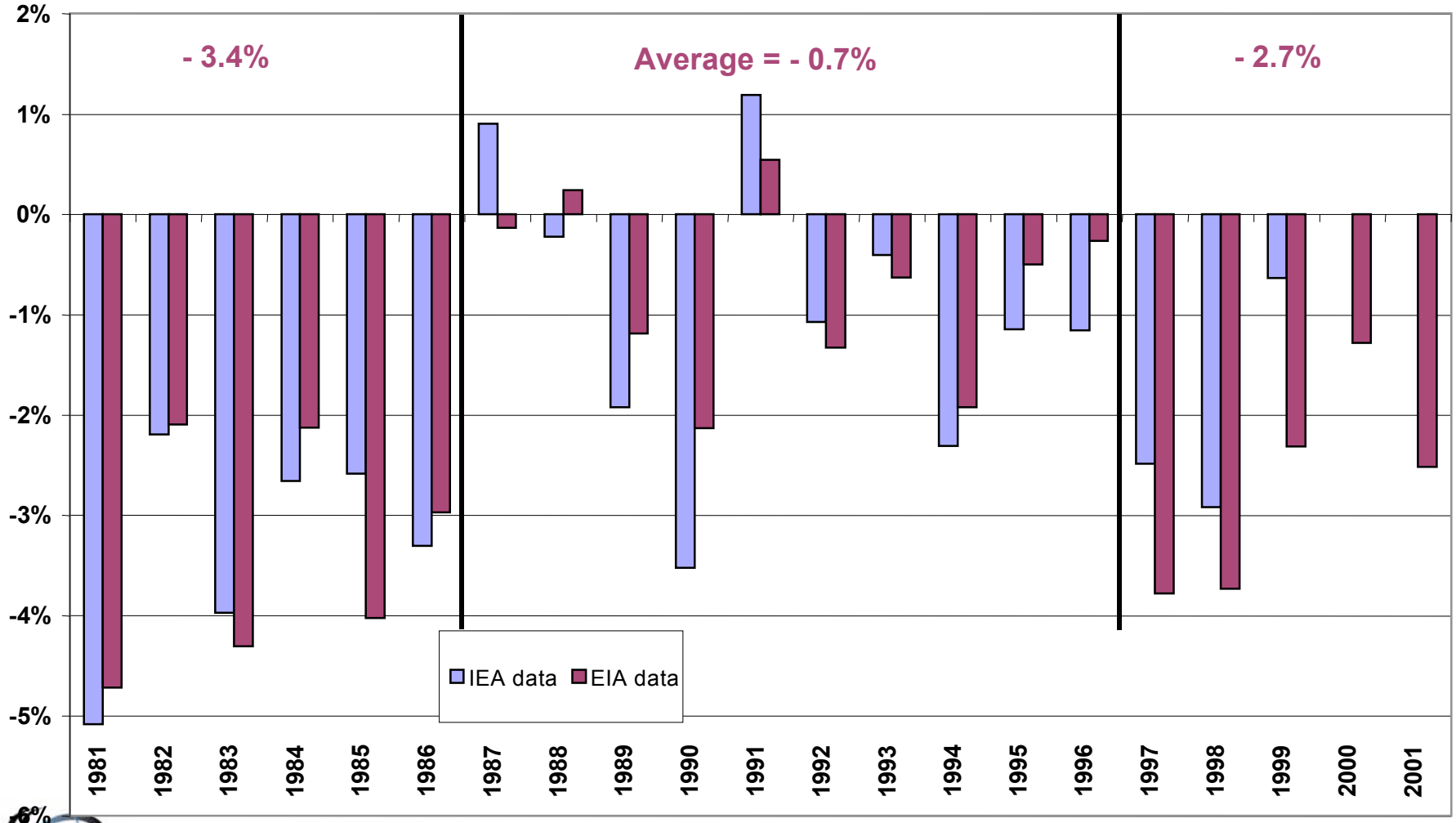


World Primary Energy Consumption
1980 to 2001
Source: EIA



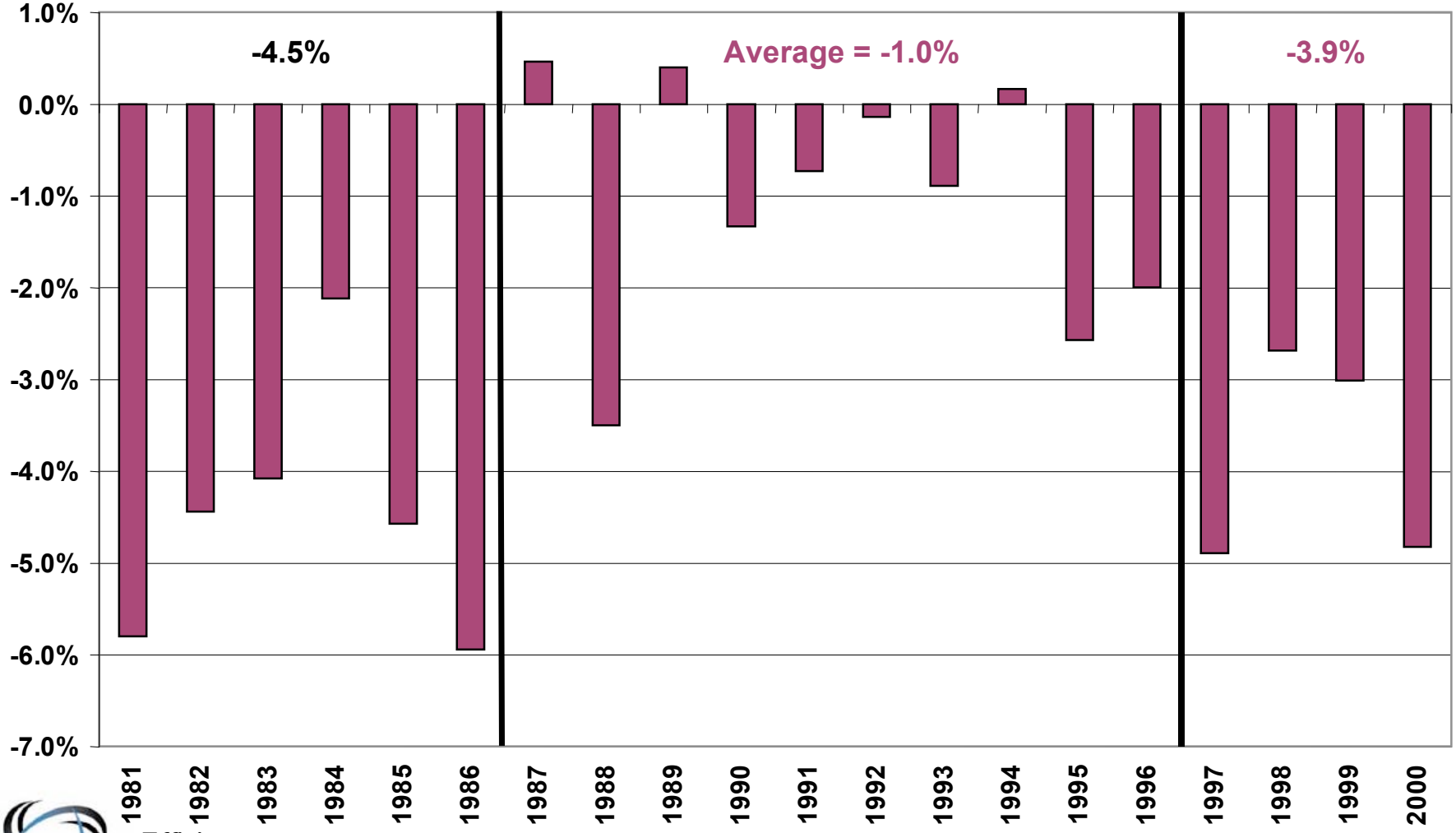
Annual Rate of Change in Energy/GDP for the United States

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



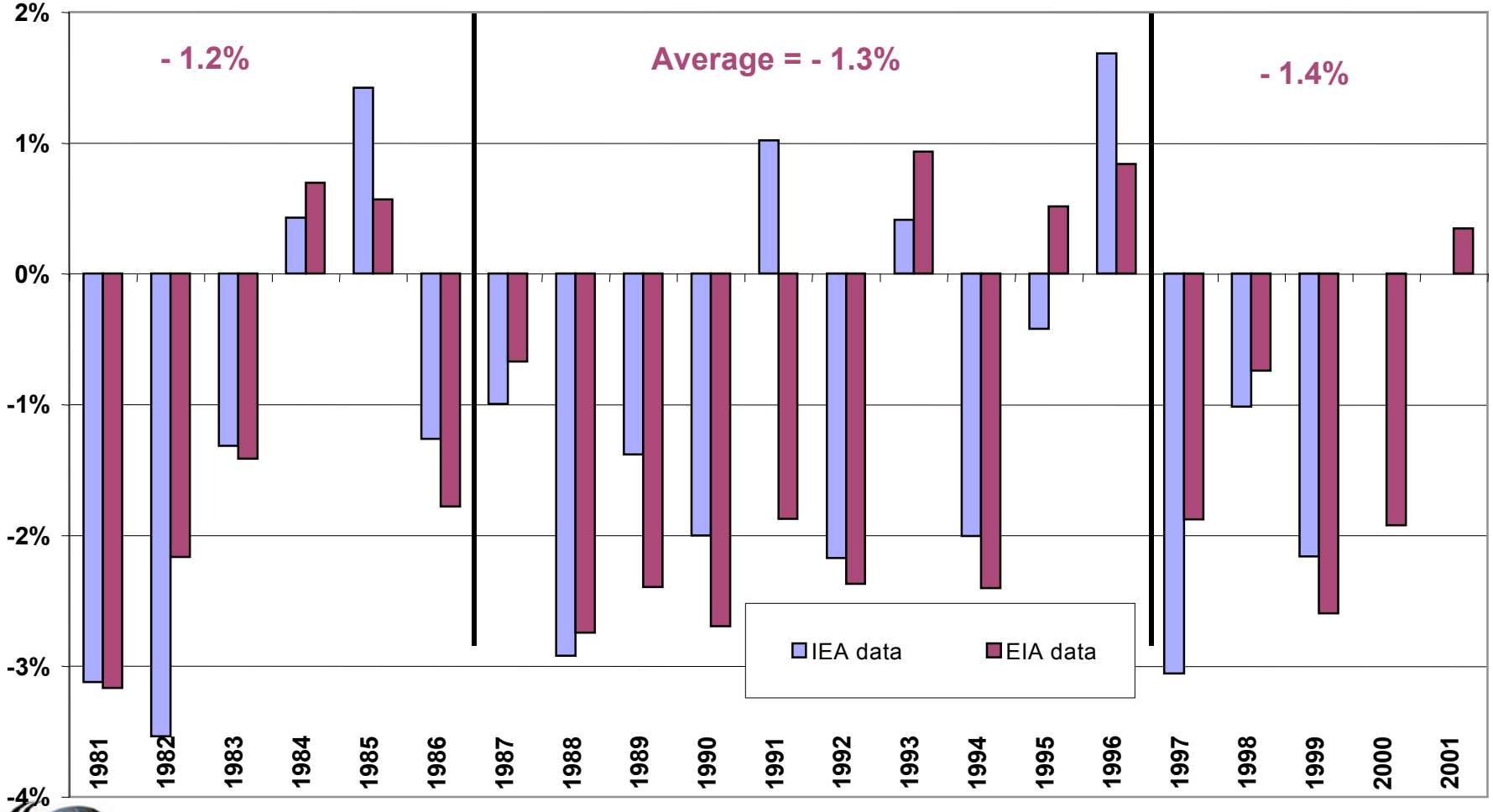
Annual Rate of Change in Energy/Gross State Product for California

(Sources: EIA and California Department of Finance)



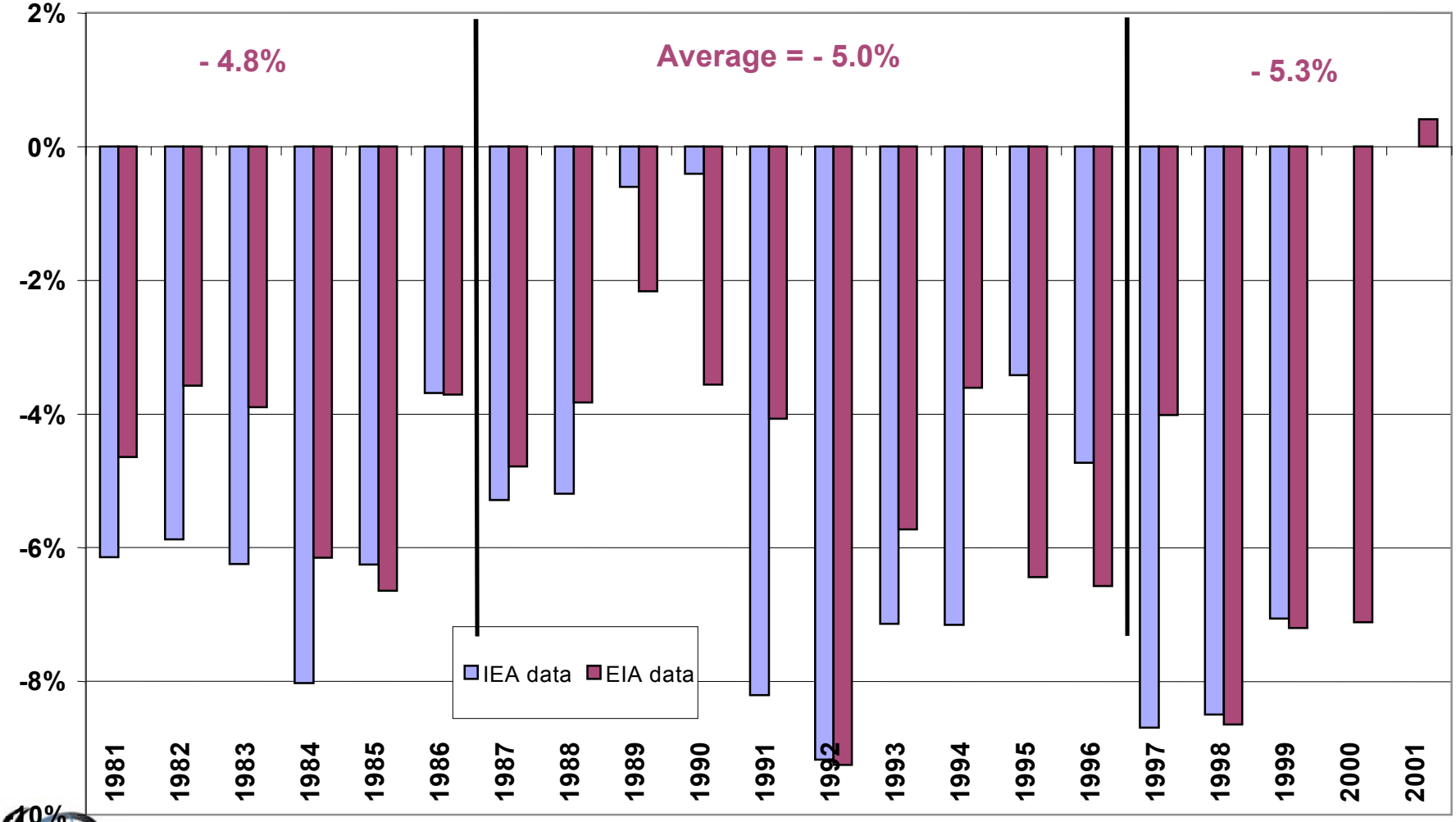
Annual Rate of Change in Energy/GDP for Europe

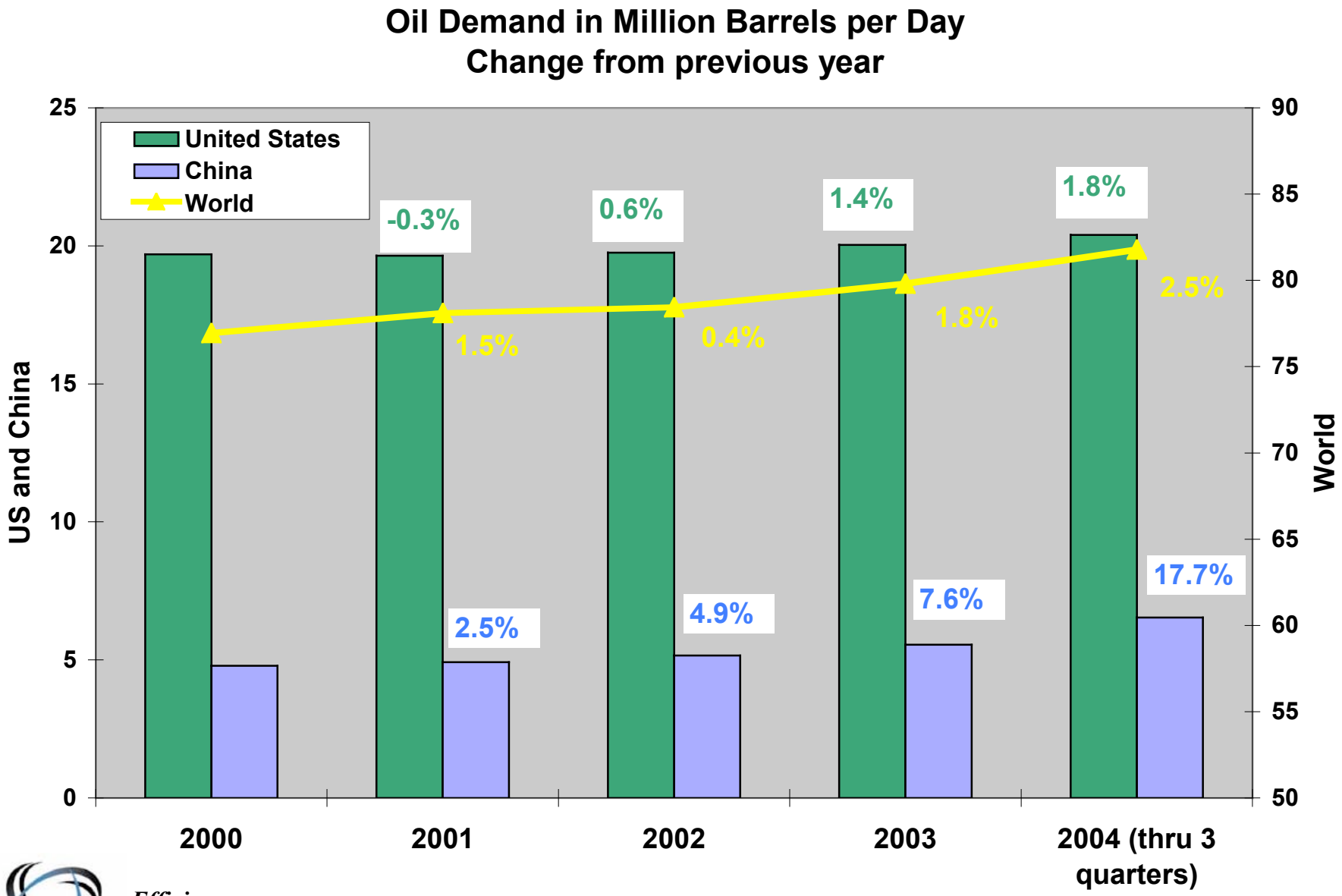
IEA (Energy/Purchasing Power Parity) for European Union and Western Europe EIA (Energy/Market Exchange Rate)



Annual Rate of Change in Energy/GDP for China

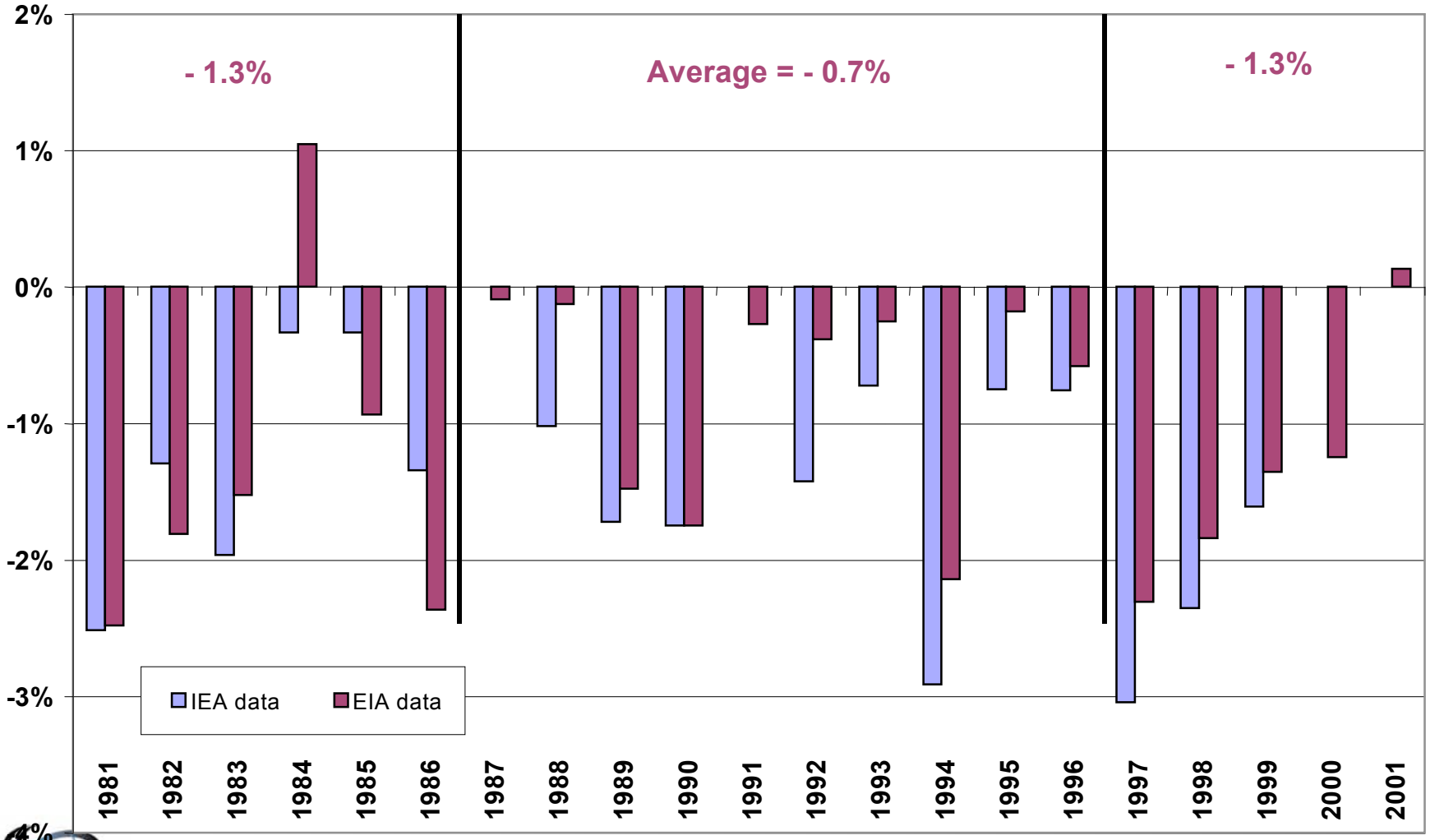
IEA (Energy/Purchasing Power Parity) and EIA (Energy/Market Exchange Rate)




Oil Demand in Million Barrels per Day
Change from previous year
United States
China
World
US and China
World
25
20
15
10
5
0
90
85
80
75
70
65
60
55
50
-0.3%
0.6%
1.4%
1.8%
1.5%
0.4%
1.8%
2.5%
2.5%
4.9%
7.6%
17.7%
2000
2001
2002
2003
2004 (thru 3 quarters)

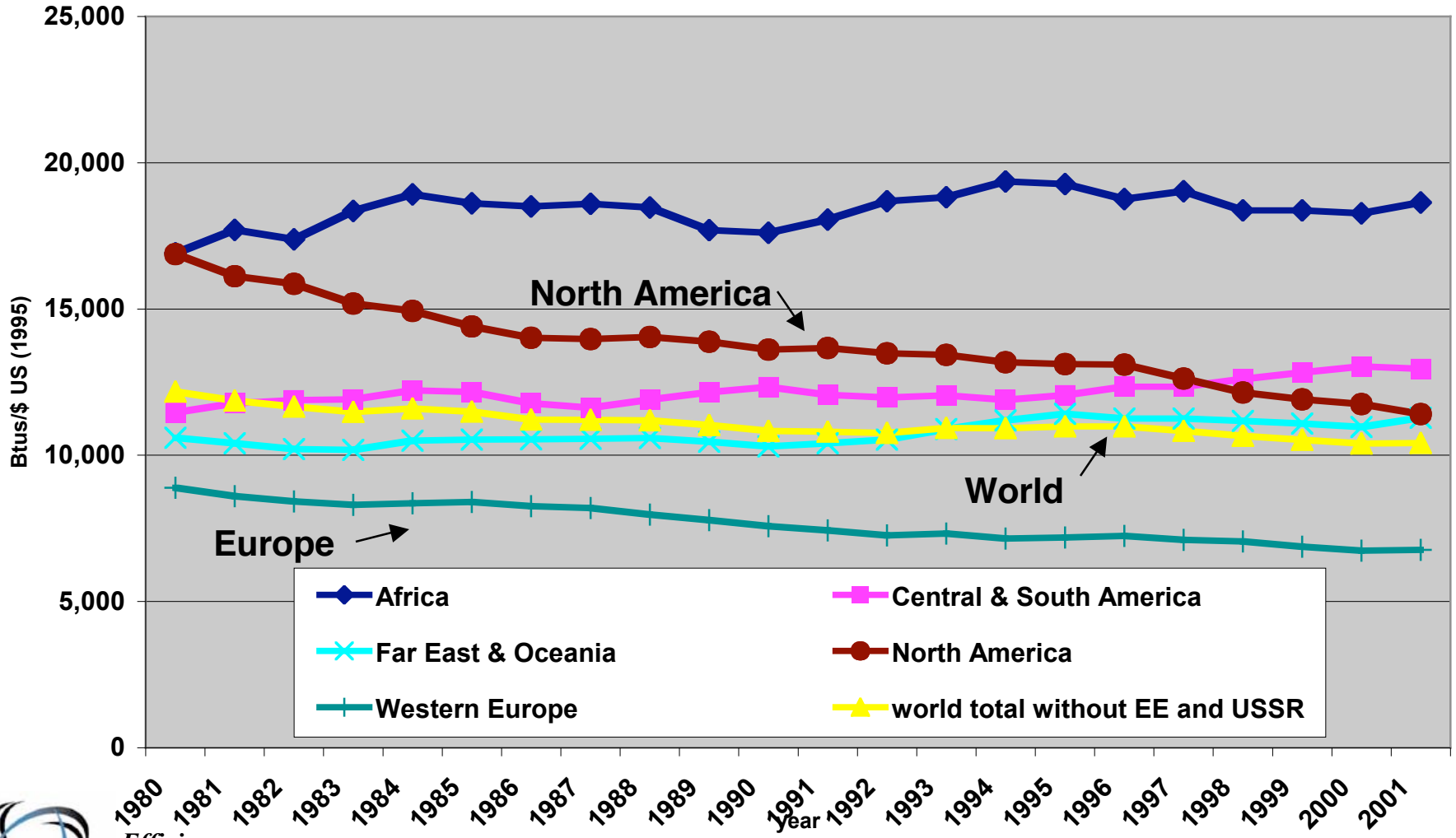
Annual Rate of Change in Energy/GDP for the World

IEA (Energy/Purchasing Power Parity) and EIA (Energy/Market Exchange Rate)

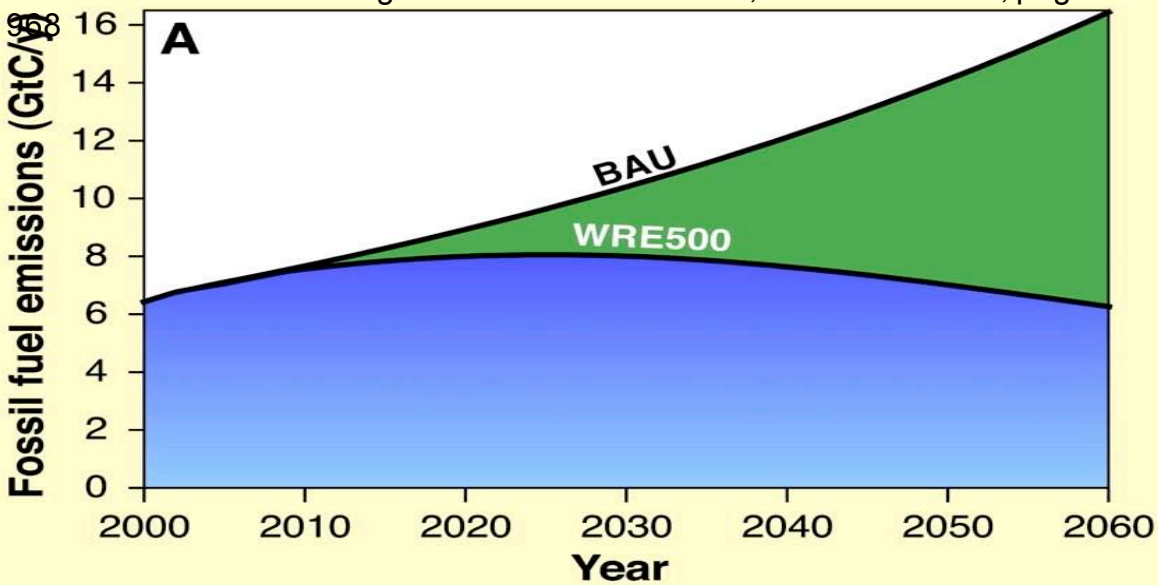


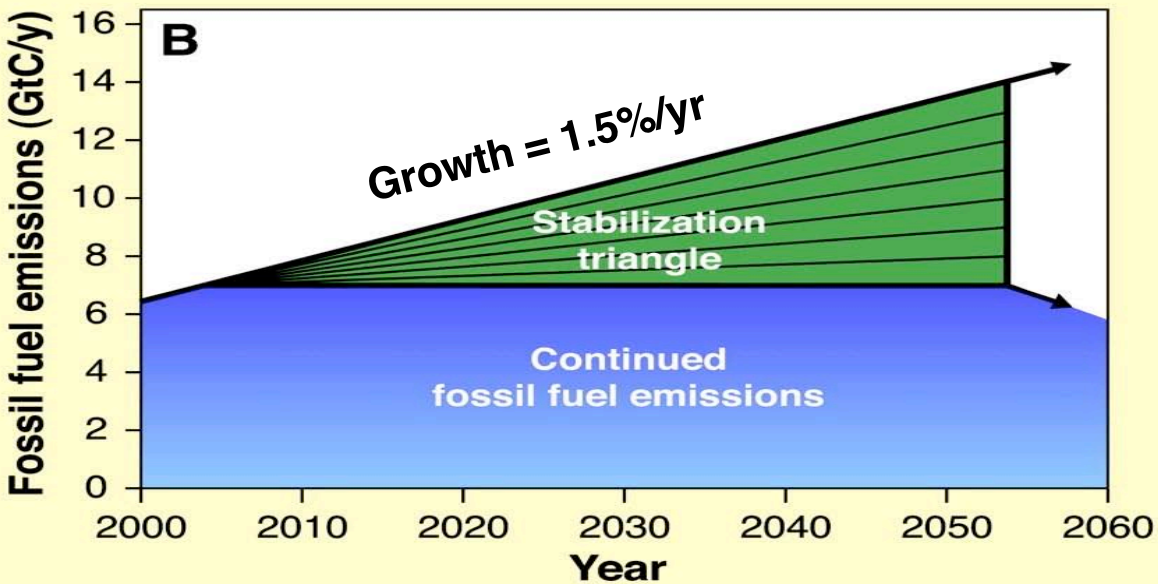
note: Russia not included until 1992 in IEA data and 1993 in EIA data

Energy Intensity By Geographic Region 1980 to 2001
(Btus/$US 1995) from EIA data



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

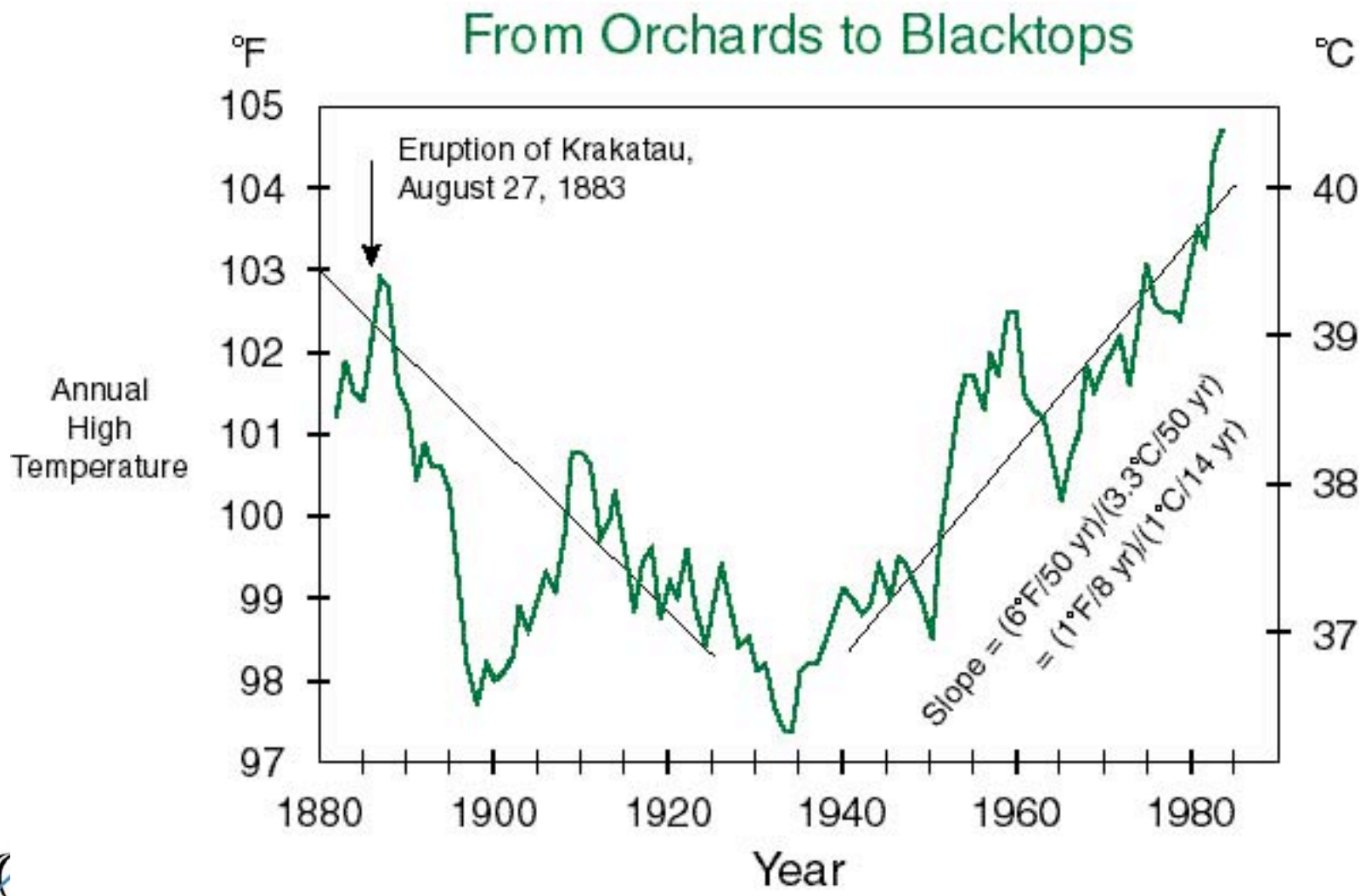




Stabilization Wedges: Pacala and Socolow
Science Vol 305, page 968

- **Efficiency and Conservation**
  - Efficient Vehicles
  - Reduced Use of Vehicles
  - Efficient Buildings
  - Efficient Coal Power Plants
- **Fuel Shifting**
  - Natural Gas for Coal
  - Nuclear Power for Coal
- **CO_2 Capture and Storage (CCS)**
  - At Power Plants
  - At Hydrogen Plants
  - At Coal to Synfuel Plants
- **Renewable Electricity and Fuels**
  - Wind Power for Coal
  - Photovoltaics for Coal
  - Wind Power for H_2
  - Biomass for fossil fuel
- **Forests and Agriculture**
  - Reduce Deforestation and Reforest
  - Conservation tillage

Temperature Trends in Downtown Los Angeles



Cool Communities

- The most lucrative way to:
  - Save air conditioning
  - Cool cities
  - Reduce Urban Ozone
- Involves 3 strategies:
  - White roofs (5,000 yr old idea) and cool **colored** roofs (a new idea)
  - Cooler pavements (concrete colored to avoid glare)
  - Shade trees (shade buildings and cool by evapo-transpiration)
- CEC spent $10 Million for white "re-roofs" and offers credits for cool roofs in meeting new building standards
- Benefits can be substantial:
  - In LA Basin, 3 strategies can save 1,500 MW and $ 200 million per year in A/C; Cool LA by 3-4 degrees Celsius; and reduce ozone by 4 – 8 %, worth another $ 250 million per year in reduced sickness and sick leave