EDISON ELECTRIC INSTITUTE

Codes, Standards, Efficiency, and DR – One Big Happy Family, or Sibling Rivals?

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Overview

- Thesis
- Federal Efficiency Trends
- Residential Sector
- Commercial Sector
- Lessons from PEPCO
- Other Issues
- Q&A

Thesis Statements

- Building Codes and Appliance Energy Efficiency Standards are designed to make residential and commercial facilities and equipment as **efficient** as possible, while maintaining necessary/proper conditions for space function, comfort, and productivity.
- Not demand responsive, **efficient**.
- The more efficient a facility is, the less demand response is available (except DG).
- Efficiency Upgrades ==> Less DR

Federal / National Trends

- Residential / Commercial Equipment Energy Efficiency Standards
- Recent rules and effective dates:
  - Room Air Conditioners, October 2000
  - Refrigerators and Freezers, July 2001
  - Commercial Gas & Electric heating and cooling equipment, lighting power densities, envelope, water heating, etc. (ASHRAE 90.1-1999), October 2001
  - DOE certification of ASHRAE 90.1-1999 July 2002
    - States have 2 years to upgrade building codes (EPACT)

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Federal / National Trends

- More rules and effective dates:
  - Residential electric, gas, and oil-fired water heaters January 2004
  - Residential Clothes Washers, Tier 1, January 2004
  - Commercial Fluorescent Lamp Ballasts, April 2005
  - Residential split and packaged central heat pumps and air conditioners, January 2006
  - Residential Clothes Washers, Tier 2, January 2007
- States create their own appliance efficiency standards (CA, MD, NJ, CT, CO)

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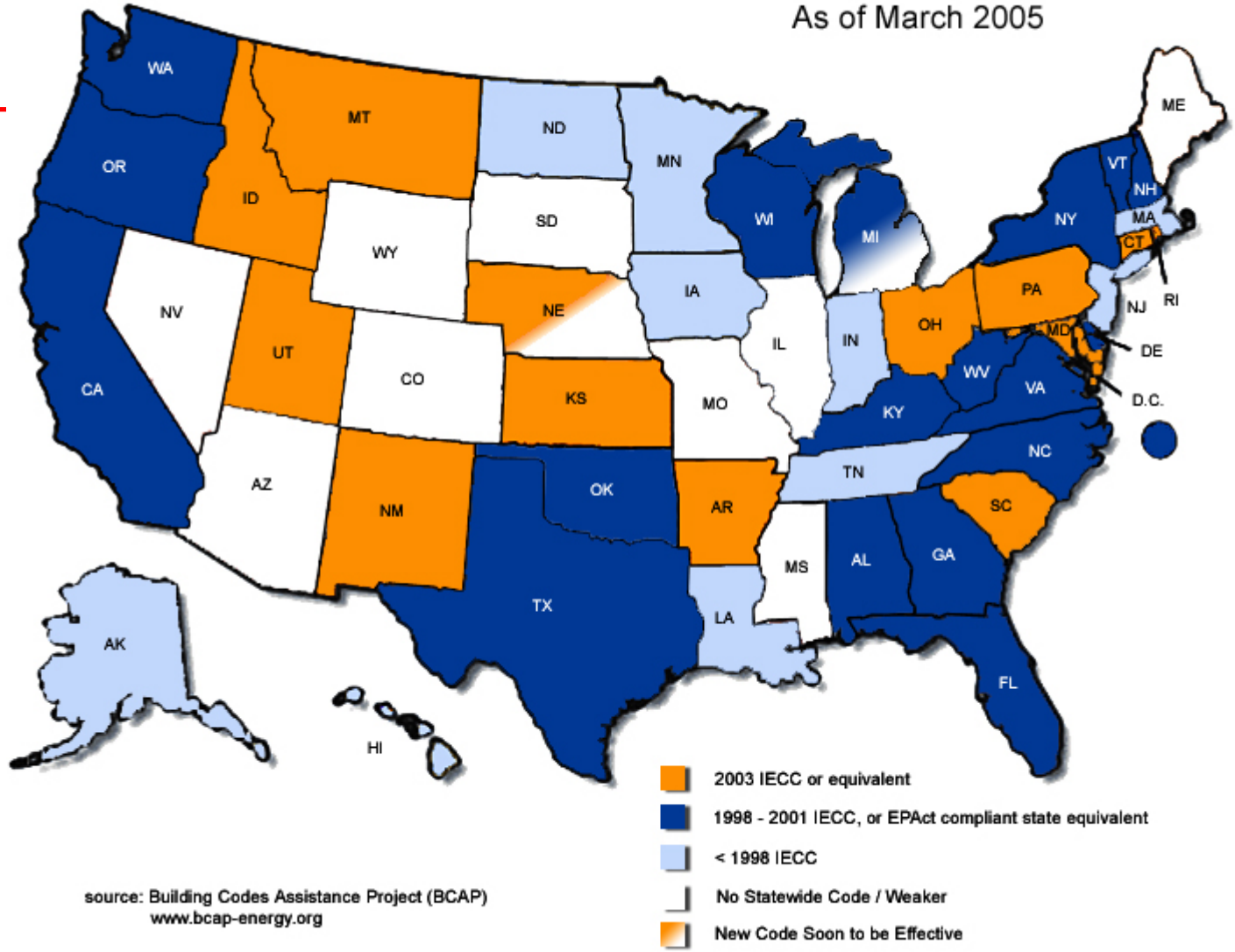
Residential State Energy Code Status

As of March 2005



source: Building Codes Assistance Project (BCAP)
www.bcap-energy.org

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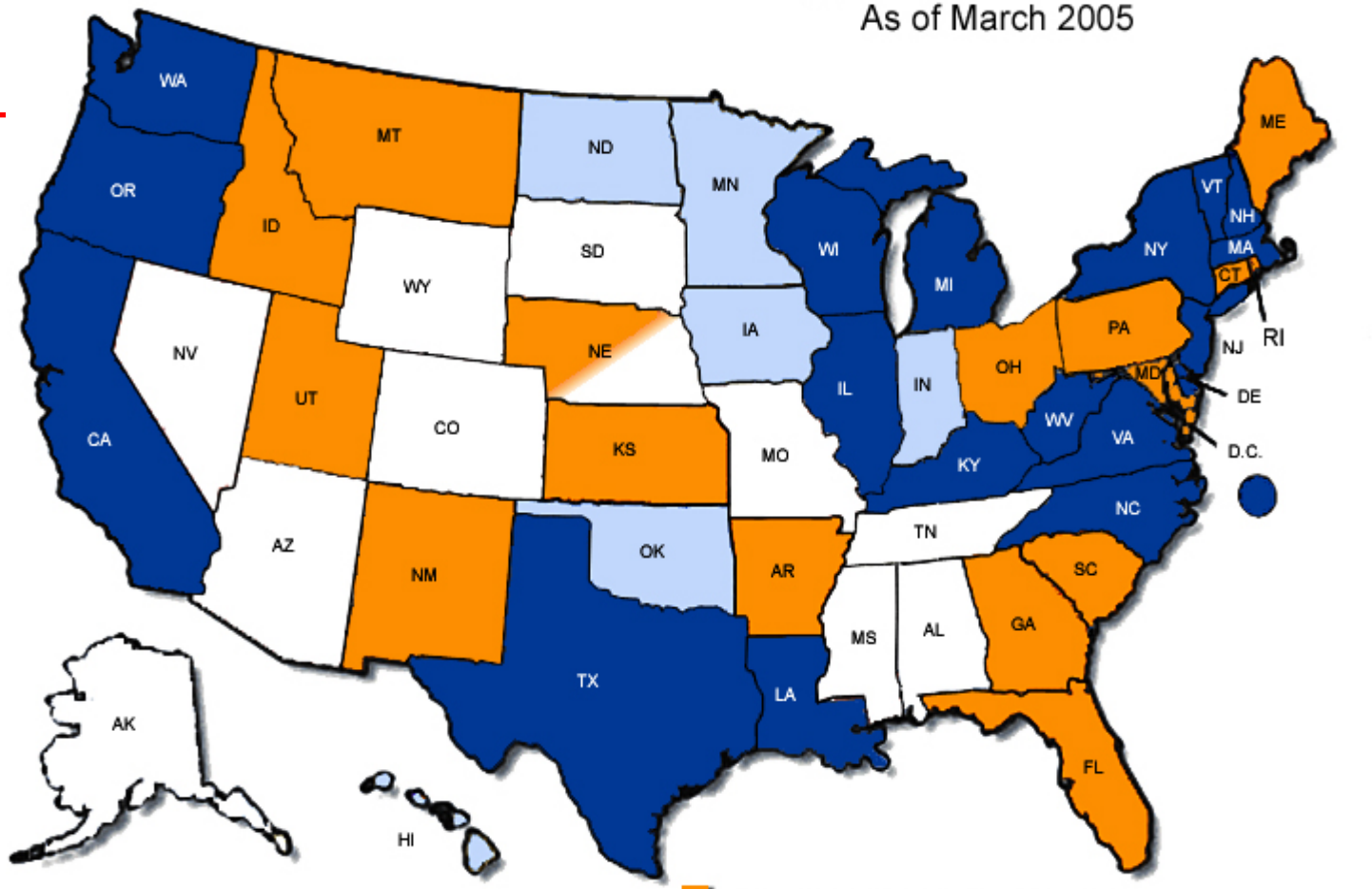
Commercial State Energy Code Status

As of March 2005



2003 IECC / ASHRAE 90.1-2001, or equivalent

2000 - 1 IECC / ASHRAE 90.1-1999, or EPAct compliant state equivalent

< ASHRAE 90.1-1999

No Statewide Code / Weaker

New Code Soon to be Effective

source: Building Codes Assistance Project (BCAP)
www.bcap-energy.org

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Residential Sector

- Many technologies have been improving:
  - Lighting
  - Refrigerators and Freezers
  - Dishwashers
  - Clothes Washers
  - Cooking
  - Heating and Air Conditioning

- Meaning less DR potential…….

Residential Sector DR – Lighting

- Incandescent to Compact Fluorescent
  - 50-75% savings compared to incandescents, depending on the application.
  - Dimming CFL's in torchieres
- Assumption: 20 sockets/fixtures and 2 torchieres in a "typical" house
- Old Connected load: (20 * 75 W) + (2 * 300) = 2,100 W
- Old Typical load: 10% of Connected = 210 W

- New Connected load: (20 * 20 W) + (2 * 67) = 534 W
- New Typical load: 10% of Connected = 53.4 W
- Result: Lighting DR potential reduced by 74.6%

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Residential Sector - Refrigeration

- AHAM Refrigerator/Freezer data on size and annual energy usage (shipment weighted averages):
  - 1972: 18.16 Cubic Feet, 1,726 kWh (197.0 W/hr ave)
  - 1983: 20.31 Cubic Feet, 1,160 kWh (132.4 W/hr ave)
  - 2003: 22.28 Cubic Feet, 514 kWh (58.7 W/hr ave)
    - 55.7% - 70.2% reduction in energy use, and DR potential
    - 31% of units sold in 2003 were Energy Star units
- AHAM Freezer data
  - 1983: 25.32 Cubic Feet, 813 kWh (92.8 W/hr ave)
  - 2001: 20.93 Cubic Feet, 438 kWh (50.0 W/hr ave)
    - 46.2% reduction in energy use, and DR potential

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Residential Sector – Clothes Washers

- AHAM data:
  - 1988: 2.61 ft^3 tub volume, 2.74 kWh / cycle
  - 2002: 2.96 ft^3 tub volume, 2.13 kWh / cycle
    - 22.3% reduction in energy use and DR potential
- Impacts of New Innovations:
  - Horizontal Axis / Front loading Units (8.5% of the US market in 2001, 16.5% in 2004):
    - 35-45% less water
    - 45-55% less energy for washer and hot water
  - "Cold Water" Detergent
    - Use cold water for all loads, all the time
    - New water heater Clothes Washer demand: 0 kW

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Residential Sector – Dishwashers

- AHAM data:
  - 1988: 2.71 kWh / cycle (2.71 kW if cycle = 1 hour)
  - 2002: 1.84 kWh / cycle (1.84 kW if cycle = 1 hour)
    - 32.1% reduction in energy use and DR potential

- DOE test procedure data for efficiency standards:
  - Late 1970's: 416 cycles per year
  - 1984: 322 cycles per year
  - 1990's: 264 cycles per year
  - 2003: 215 cycles per year
    - % chance of use for DR: from 114.0% to 58.9%

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Residential Sector – Air Conditioning

- AHAM data for room air conditioners (750 hrs/year):
  - 1982: 10,801 Btu/hr, 1,135 kWh/yr, 7.14 EER
  - 1992: 10,100 Btu/hr, 853 kWh/yr, 8.88 EER
  - 2002: 9,800 Btu/hr, 754 kWh/yr, 9.75 EER
    - 33.6% reduction in annual energy use
- Peak demand at EER conditions (95º F outdoors):
  - 1982: 1.51 kW
  - 1992: 1.14 kW
  - 2002: 1.01 kW
    - 33.1% reduction in peak demand DR potential

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Residential Sector – Air Conditioning (continued)

- ARI/DOE data for central air conditioners:
  - 1978: 7.34 SEER (~ 6 EER) average efficiency
  - 1992 NAECA Std: 10 SEER (~ 8.5 EER)
  - 1997: 10.66 SEER AC, 11.0 SEER for heat pumps
  - 2003: 11.20 SEER AC, 11.5 SEER for heat pumps
  - 2006 Std: 13 SEER (~ 10.5 EER)
- For a 2.5-ton unit (30,000 Btu/hr), the peak demand at EER conditions (95º F outdoors):
  - 1978: 5.00 kW
  - 1992: 3.53 kW
  - 2006+: 2.86 kW
    - 42.8% reduction in peak demand DR potential

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Residential Sector – Air Conditioning (continued)

- Impacts of Innovations:
  - New (proposed) Energy Star ratings: 14 SEER, 12 EER
    - 2.5 ton unit at EER conditions: 2.5 kW
  - Lennox Air Source XC21 Unit: 20.5 SEER, 14.75 EER, sized from 2-5 tons
    - 2.5 ton unit at EER conditions: 2.04 kW
- GeoExchange (ground source heat pumps) systems. Energy Star is 14.1 (closed loop) to 16.2 EER (open loop). ClimateMaster has new unit rated at 27 EER.
  - 2.5 ton unit, 17 EER at GS EER conditions: 1.76 kW
  - 2.5 ton unit, 22 EER at GS EER conditions: 1.29 kW
  - 2.5 ton unit, 27 EER at GS EER conditions: 1.11 kW
- More efficiency and less DR…..

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Commercial Sector

- Lessons from consulting and facilities engineers:
- "No one ever got sued for over-designing a heating or cooling systems (or ventilation or lighting….)"
- "Your building is only as cool/warm as your warmest/ coolest tenant"
  - Or your "most important tenant" (e.g, CEO, CFO, etc)
- Result: Over-design = DR opportunities

Commercial Sector - Lighting

- 1960's / Early 1970's: 3 Watts / square foot
- 100,000 sf office building: 300 kW (connected), 270 pk
- ASHRAE 90.1 – 1975, 1989, 1999, 2001 and 2004
- T8 Lamps, CFL's, Electronic Ballasts, etc

- Late 1990's: 1.0 Watts / square foot
- 100,000 sf office building: 100 kW (connected)
- Mandates for motion sensors means lights already off where no one is using them (~ 70-85 kW peak load)
- Result: > 70% reduction in peak demand and DR

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Commercial Sector - Cooling

- 100,000 sf building using a 300 ton centrifugal chiller:
- 1976: 0.90 kW / ton at peak load = 270 kW
- 1980: 0.75 kW / ton at peak load = 225 kW
- 1989 ASHRAE 90.1 Std: 0.68 kW / ton
- 1993: 0.61 kW / ton at peak load = 183 kW
- 1999 ASHRAE Std: 0.58 kW / ton, 0.55 kW/ton IPLV
- IPLV: Chiller "sweet spot of efficiency" at 70-80% of full load

- 2002: 0.55 kW / ton at peak load = 165 kW
- 2002: 0.50 kW / ton at IPLV load = 150 kW

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Commercial Sector – Cooling (cont'd)

- 100,000 sf building using a 300 ton centrifugal chiller:
- More innovations:
- 2004 best chiller: 0.48 kW / ton at peak load, 144 kW
- 2004 best chiller: 0.45 kW / ton at IPLV load, 135 kW

- Variable Frequency/Speed Drives on Chillers (and cooling tower fans)
- At IPLV, 0.38 kW / ton = 114 kW

- DR result: From 270 to 114 kW, a 57.8% reduction in peak available DR load

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Commercial Sector – Ventilation

- 100,000 sf building:

- Motor efficiency standards in increased in 1997.
- NEMA “premium efficiency” motors are 40%+ of the market

- ASHRAE Std 90.1-2004: all motors ≥ 15.0 horsepower must have a variable frequency/speed drive
- Demand Control Ventilation: only move as much air as needed for the occupants
- ➔Less opportunity for DR

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Commercial Sector – Office Equipment

- Fax Machines
- Copiers
- Printers
- Computers and Monitors
- Scanners
- Multi-function Devices

- According to EPA (and LBNL) studies, Energy Star rated devices had market shares of 70% (scanners) to over 90% (all others) in 2003.

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Lessons From PEPCO

- PEPCO is the electric distribution company serving Washington DC and the majority of two surrounding counties (Montgomery and Prince Georges) in Maryland.
- 1985 Peak Demand: ~ 4600 MW
- Commercial DR started in 1985 (50 MW by 1987)
- Residential DR started in 1988-1989 (100 MW by 1990)
- 1990 Peak Demand: 5442 MW
- 1991 Peak Demand: 5769 MW (with use of DR)
- 2004 Peak Demand = ???

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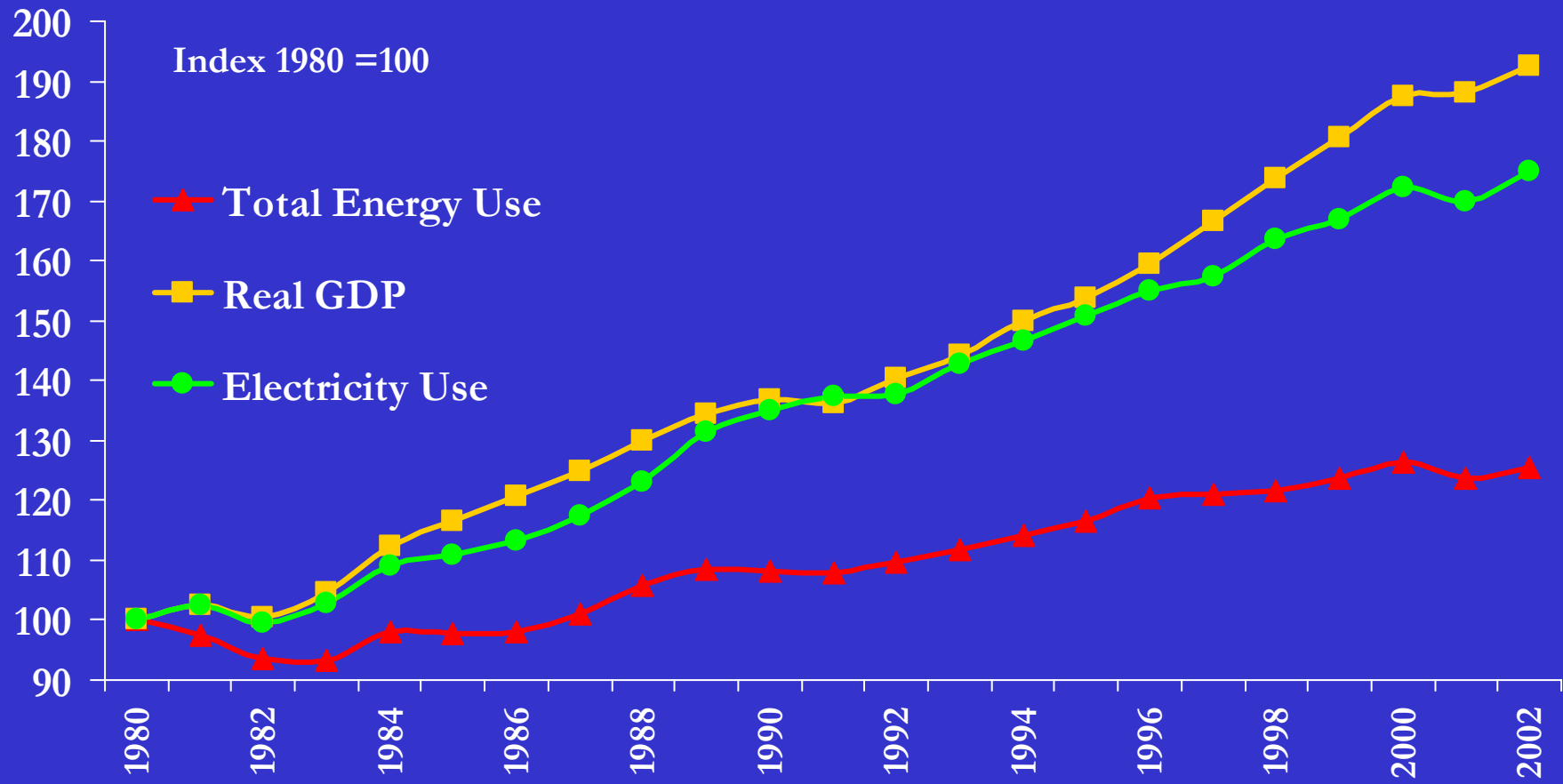
PEPCO Lessons

- 1991-1998: Era of PEPCO Rebate**$$$$ - $180 Million** spent on efficiency programs in DC and MD
- 1992: NAECA standards go into effect for appliances, ASHRAE 90.1-1989 is published for commercial buildings
- 1997: EPACT standards go into effect
- 1999: Restructuring in MD and DC
- 2001: ASHRAE 90.1-1999 is published, adopted by MD and DC in 2002 and 2003
- DR programs used on peak days (changes in 2001)

U.S. Economic, Total Energy, and Electricity Growth 1980 - 2002



Sources: Energy Information Administration (EIA) & Bureau of Economic Analysis (BEA)

PEPCO Area Economy

- Montgomery County Population: 19.7% increase from 1990 to 2003
  - 48,927 homes built between 1990 and March 2000
- Prince Georges County Population: 15.5% increase from 1990 to 2003
  - 46,986 homes built between 1990 and March 2000
- Washington DC Population: 7.2% Decline 1990-2003
  - 7,246 homes built between 1990 and March 2000
- US GDP rose 46% between 1990 and 2003
- DC metro area GDP rose at a faster rate

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PEPCO Lessons

- PEPCO peak demand in 2004?
- 1985: ~ 4600 MW
- 1990: 5,442 MW
- 1991: 5,769 MW

PEPCO Lessons

- PEPCO peak demand in 2004?
- 6,086 MW (and no DR), compared to
- 1990: 5,442 MW (11.8% higher)
- 1991: 5,769 MW (5.5% higher)

- Comparing 1991 to 2002 (blister to blister….)
- 2002: 6,364 MW (15 days > 94 F in Aug, 11 days > 94 F in July, ASHRAE 0.4% design day is 95 F)
- 10.3% increase over 12 years….

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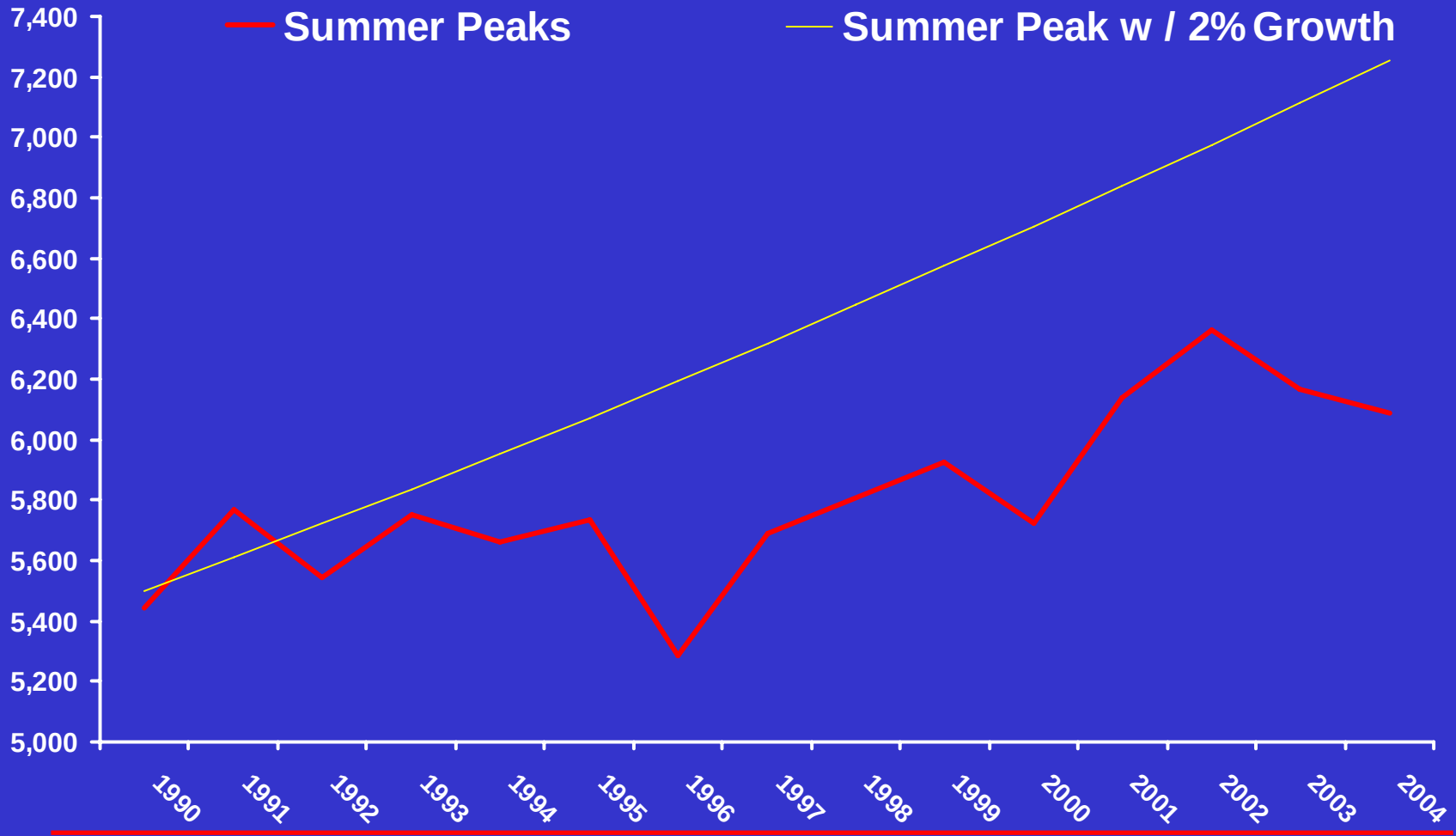
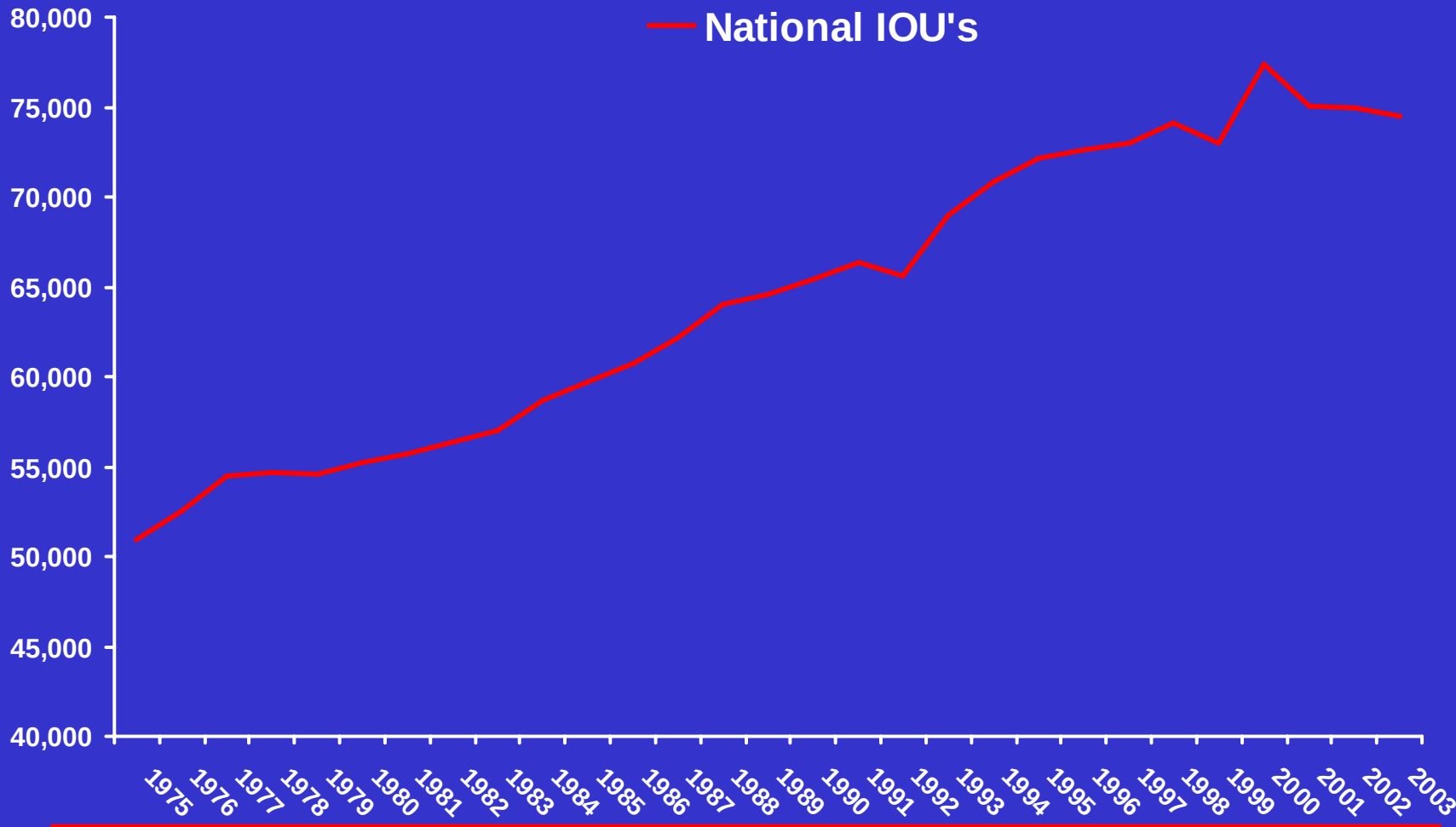
PEPCO Annual Peak Demands, 1990-2004 (MW)



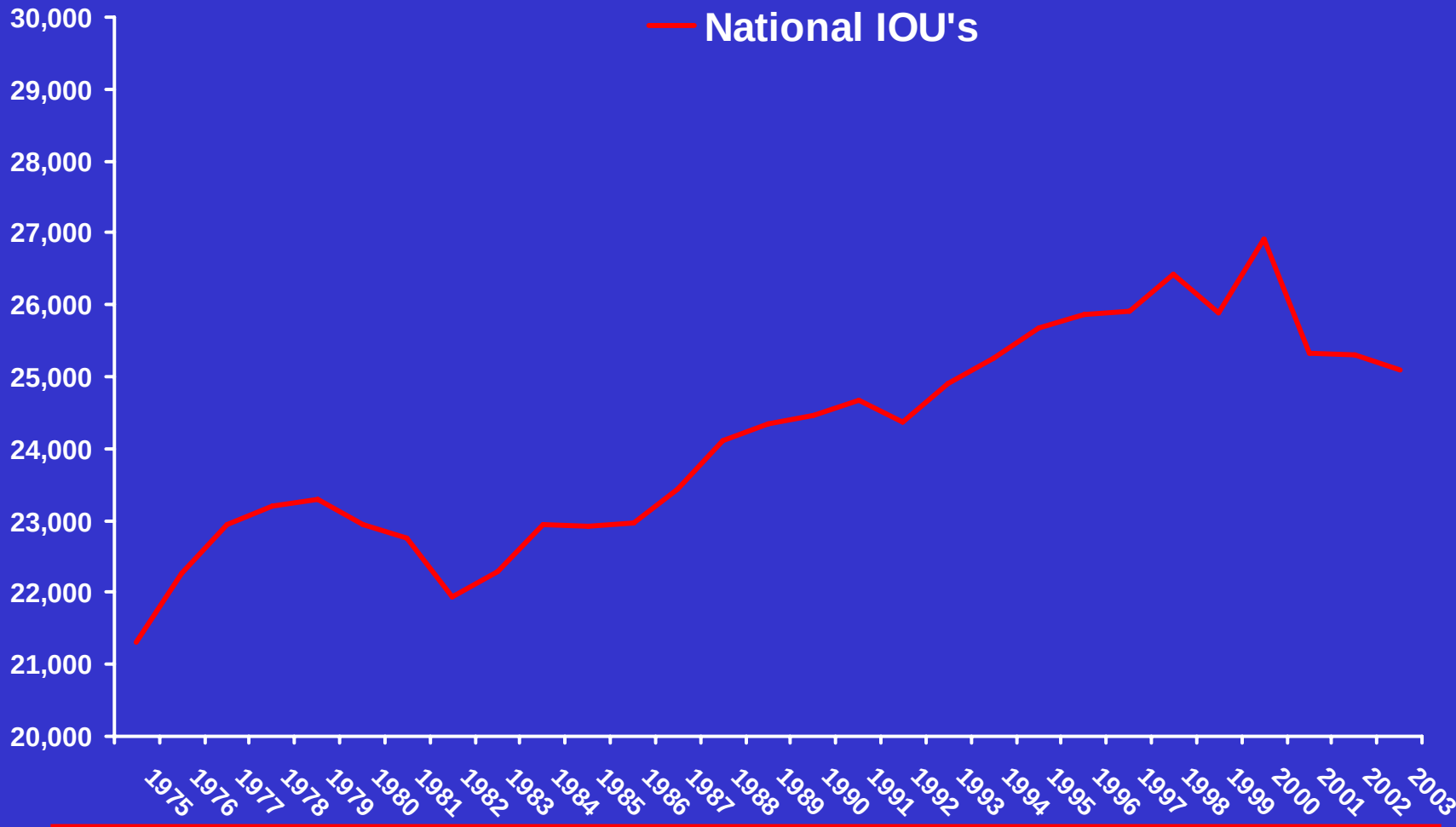
Source: PEPCO Statistics March 2005

Average Annual Commercial Electric Use per Customer, 1975-2003 (kWh / yr)



Sources: EEI Statistical Yearbooks 1980-2004,
Historical Statistics of the Electric Utility Industry through 1992

Average Annual Electric Use per Total Ultimate Customer, 1975-2003 (kWh / yr)



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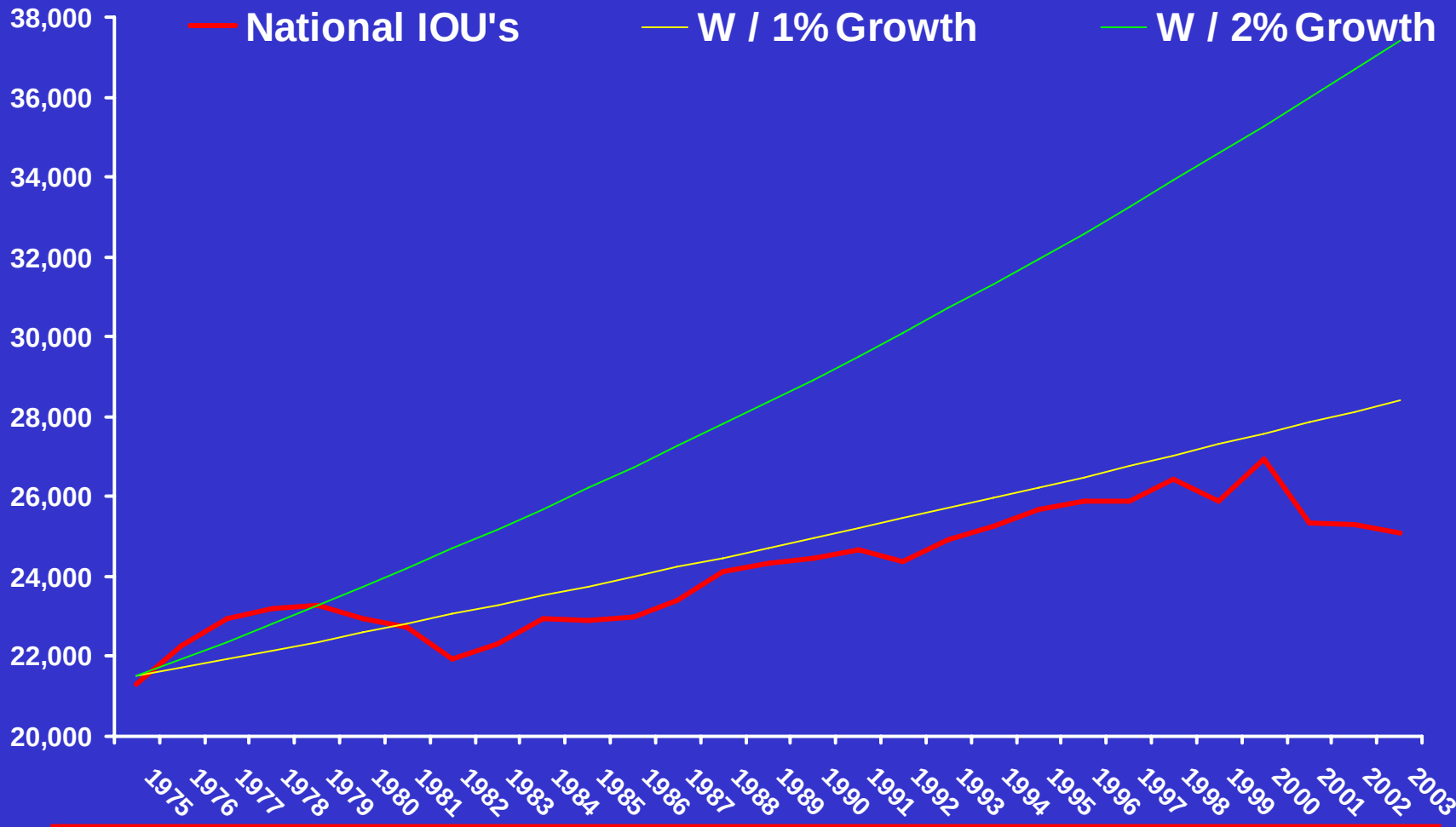
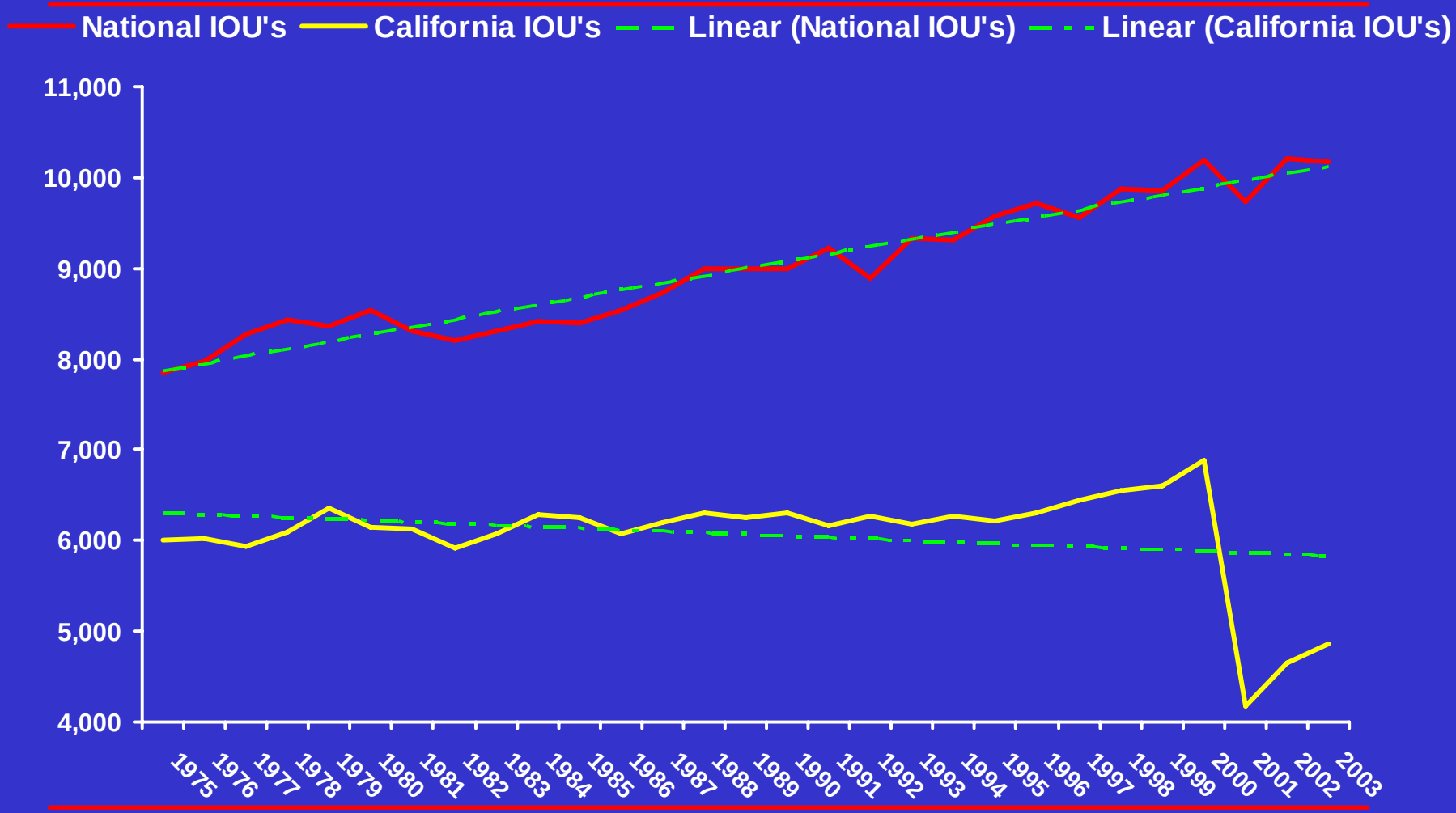


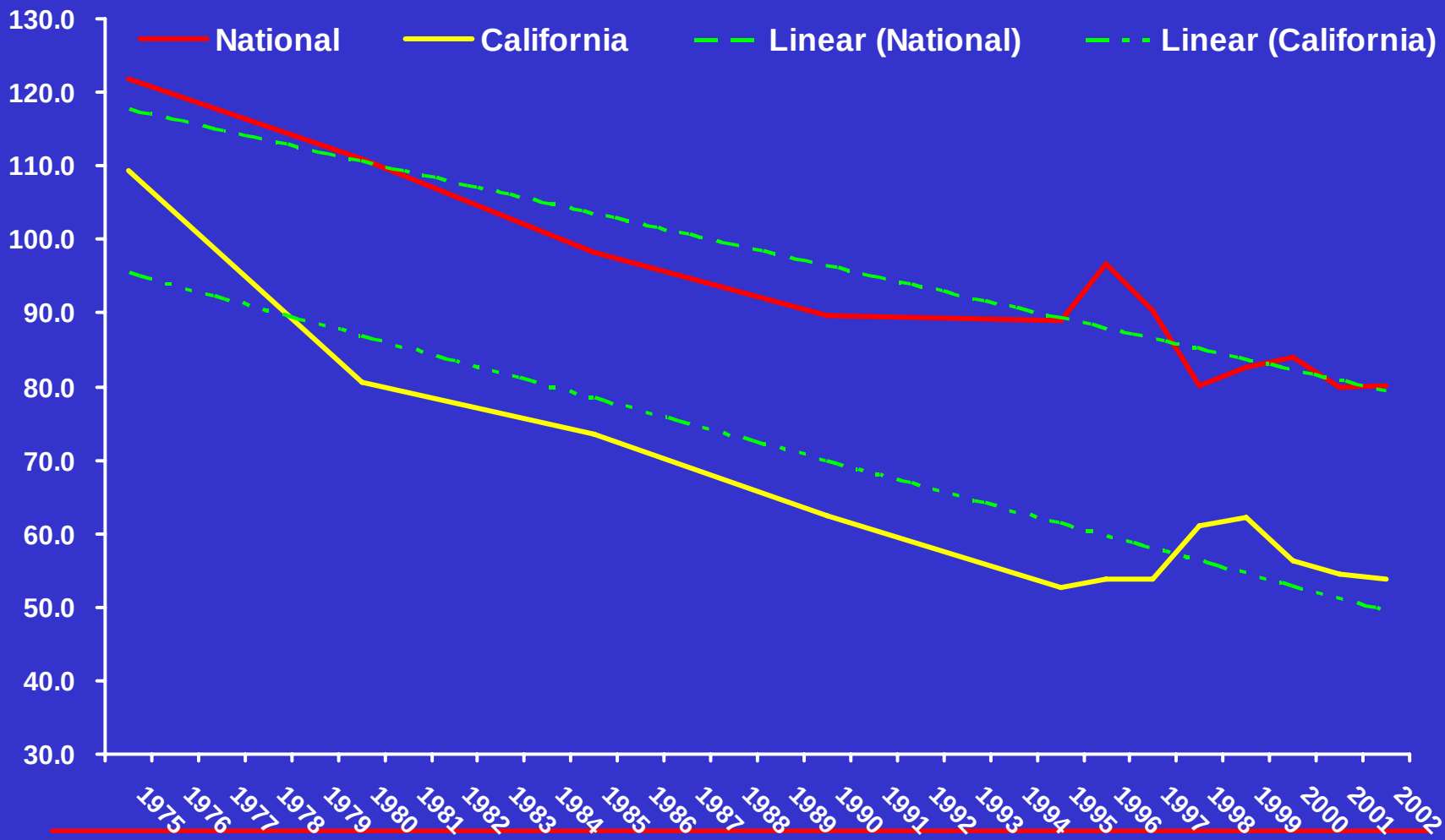
Sources: EEI Statistical Yearbooks 1980-2004,
Historical Statistics of the Electric Utility Industry through 1992

Average Annual Residential Electric Use per Customer, 1975-2003 (kWh / yr)



Sources: EEI Statistical Yearbooks 1980-2004,
Historical Statistics of the Electric Utility Industry through 1992

Average Annual Residential Gas Consumption per Customer, 1975-2002 (Million Btus/yr)



Sources: American Gas Assocation *Gas Facts 2000* and *Gas Facts 2003*

Q & A

- The floor is open!