



EDISON ELECTRIC
INSTITUTE

Demand Response - Best Practices (what to do, and not to do!)

Institute for Regulatory Policy
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Overview

- Flexibility
- Rate mandates
- DR mandates
- Impact of Efficiency
- Impact of Demographics
- Q&A

Flexibility and DR

- Best policies are flexible for:
- Electric / Natural Gas Suppliers
- Electric / Gas Distribution Companies
- And most of all, CUSTOMERS!
- Experience shows that mandates and competitive markets don't get along so well.

Rate Mandates and DR

- Some have called for mandatory TOU, critical peak pricing, and other types of rates for residential customers. However....
- What if customers don't want these rates?
- What if there is a backlash?
- Maryland utilities in the early 1990's (mandatory TOU for new or larger residential customers).

DR Mandates = Bad Idea

- Who is responsible for DR? ISO's? Distribution companies? Customers?
- The following ISO's have active DR programs and do **not** have any mandates as to how much DR they are required to have:
 - PJM ISO
 - NY ISO
 - ISO New England
 - CA ISO
- However, CA has mandates for electric distribution companies....

State Actions – CA (not flexible)

- From CPUC Decision 03-06-032, dated June 5, 2003:
 - 2003 150 MW * (for SCE only)
 - 2004 400 MW * (for SCE only)
 - 2005 3% of Annual System Demand* (all IOU's)
 - 2006 4% of Annual System Demand*
 - 2007 5% of Annual System Demand* = 900 MW
- * *Note: Excludes Demand Response from existing Programs (762 MW in 2003)*
- SCE ordered to include targets in procurement plans
- (Source: SCE presentation at PLMA conference Sept. 2003)

Lessons from Southern California

- In early 2000, SCE had about 1,500 MW of actual peak response in all of their DR programs. Number of curtailment events:
 - 1999 – 1 event
 - 2000 – 21 events
 - 2001 – 38 events
 - 2002 – 3 events
 - Result ?
 - By 2003, SCE had 762 MW from their programs.
 - A DR reduction of 738 MW, or 49.2%
 - (Source: SCE presentation at PLMA conference Sept. 2003)
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State Actions – PA (flexible)

- PA “Alternative Energy Portfolio Standard” was signed into law in November 2004.
- Their version of a renewable portfolio standard.
- Tier 1 includes “traditional” renewables such as solar, wind, geothermal, biomass, etc
- Tier 2 includes items such as Demand Response and energy efficiency
- PA utilities must meet the AEPS mandate of 18% of sales by 2020:
 - 8% from Tier 1 resources
 - 10% from Tier 2 resources

Impacts of Efficiency

- 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 home or business is, the less demand response is available (except DG).
- Efficiency Upgrades ==> Less DR (but permanent, lower peak demands, which can be beneficial)

Efficiency Impacts of Building Codes

■ Residential:

- Homes built to meet 2003 IECC will use 21% less energy for heating and cooling than homes built to 1989 codes. (Energy Star homes: 30% above code)

■ Commercial

- Buildings built to meet ASHRAE 90.1-2004 code will use 25% less energy for all purposed than buildings built to meet ASHRAE 90.1-1980.

- (Source: Oak Ridge National Laboratory, "An Evaluation of State Energy Program Accomplishments: 2002 Program Year" June 2005)

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 had 2 years to upgrade building codes (EPACT)

Federal / National Trends (cont'd)

- More rules / effective dates (pre-EPACT 2005):
 - 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 appl efficiency standards (CA, MD, NJ, CT, AZ, WA, OR, RI, VT, NY, MA)
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Federal / National Trends (cont'd)

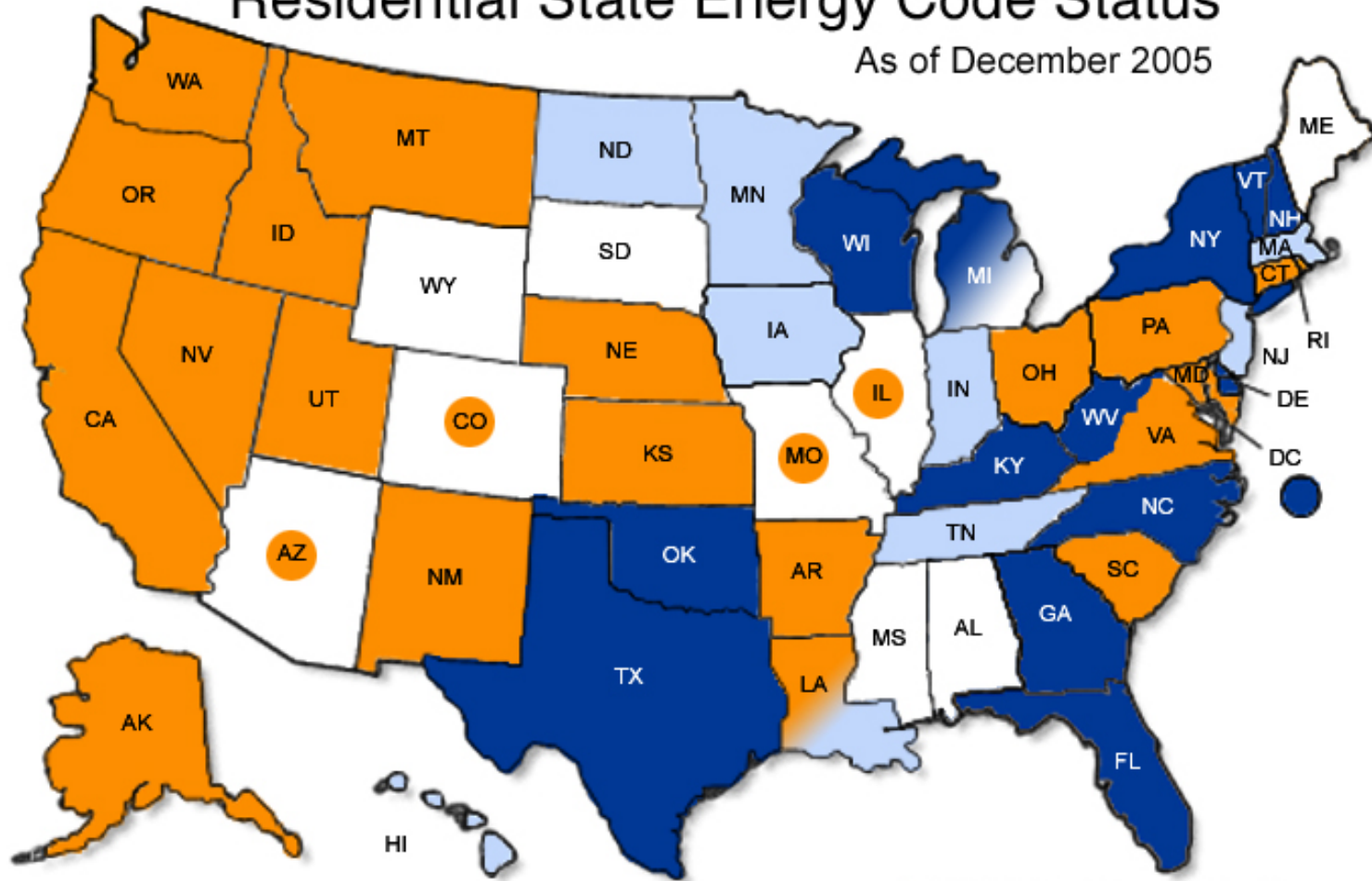
- The Energy Policy Act of 2005 mandated national efficiency standards (or rulemaking deadlines) for the following commercial equipment:
 - **Lighting** (exit signs, traffic signals, fluorescent & mercury vapor ballasts)
 - Commercial Refrigerators and Freezers
 - Rooftop **Packaged Air Conditioners and Heat Pumps**
 - Dry-Type Transformers
 - Commercial Ice Makers
 - Refrigerated Beverage Vending Machines
 - Unit Heaters (gas-fired)
 - Commercial Clothes Washers
-

Federal / National Trends (cont'd)

- The Energy Policy Act of 2005 also mandated national efficiency standards (or rulemaking deadlines) for the following (mostly residential) equipment:
 - Commercial Pre-Rinse Spray Valves (for dishwashers)
 - Compact Fluorescent **Lamps**
 - Torchiere **lighting fixtures**
 - Ceiling **Fans**
 - Ceiling Fan Light Kits
 - Dehumidifiers
 - Battery Chargers
 - External Power Supplies (“wall packs”)

Residential State Energy Code Status

As of December 2005

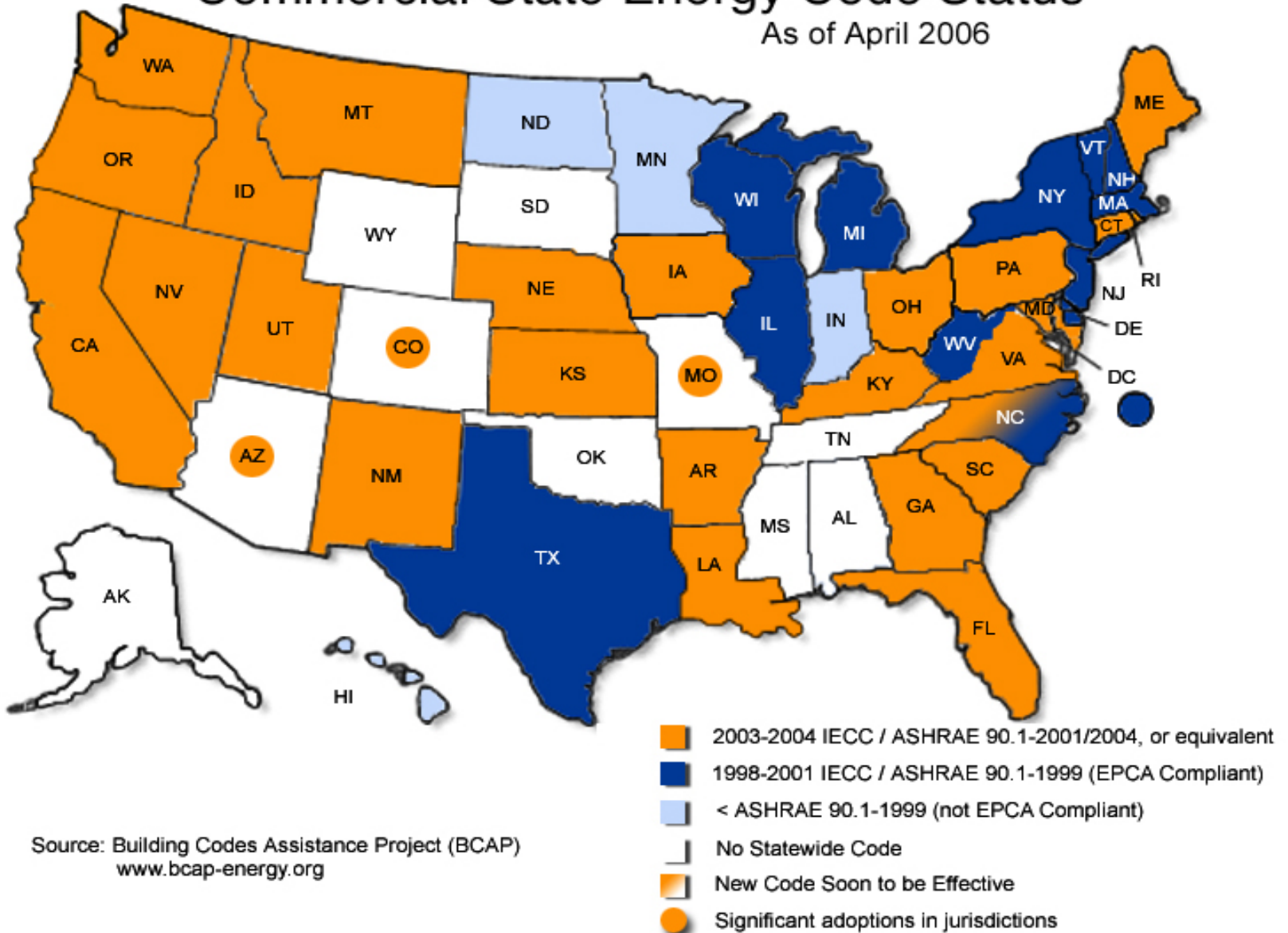


Source: Building Codes Assistance Project (BCAP)
www.bcap-energy.org

- 2003-2004 IECC or equivalent
- 1998-2001 IECC (EPCA Compliant)
- < 1998 IECC (not EPCA Compliant)
- No Statewide Code
- New Code Soon to be Effective
- Significant adoptions in jurisdictions

Commercial State Energy Code Status

As of April 2006



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



Residential Sector

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

- Meaning less DR potential.....

Residential 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: $(20 * 75 \text{ W}) + (2 * 300) = 2,100 \text{ W}$
 - Old Typical load: 10% of Connected = 210 W

 - New Connected load: $(20 * 20 \text{ W}) + (2 * 67) = 534 \text{ W}$
 - New Typical load: 10% of Connected = 53.4 W
 - **Result: Lighting DR potential reduced by 74.6%**
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Residential DR - Refrigeration

- AHAM Refrigerator/Freezer data on size and annual energy usage (shipment weighted averages):
 - 1972: 18.16 Cubic Feet, 1,726 kWh (197.0 Watts / hr ave)
 - 1983: 20.31 Cubic Feet, 1,160 kWh (132.4 W / hr ave)
 - 2004: 21.52 Cubic Feet, **500** kWh (57.1 W / hr average)
 - 55.7% - 71.0% reduction in energy use, and DR potential
 - 31% of units sold in 2004 were Energy Star units
- AHAM Freezer data
 - 1983: 25.32 Cubic Feet, 813 kWh (92.8 W / hr average)
 - 2004: 21.43 Cubic Feet, **448** kWh (51.1 W / hr average)
 - 44.9% reduction in energy use, and DR potential

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
 - 2004: 9,735 Btu/hr, 752 kWh/yr, 9.71 EER
 - 33.7% reduction in annual energy use

 - Peak demand at EER conditions (95° F outdoors):
 - 1982: 1.51 kW
 - 1992: 1.14 kW
 - 2004: 1.00 kW
 - 33.8% reduction in peak demand DR potential
-

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 Federal Std: 13 SEER (~ 10.5 EER)
 - For a 2.5-ton unit (30,000 Btu/hr), the peak demand at EER conditions (95° F outdoors):
 - 1978: 5.00 kW
 - 1992: 3.53 kW
 - 2006+: 2.86 kW
 - 42.8% reduction in peak demand DR potential
-

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, 1980, 1989, 1999, 2001, 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
-

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

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 = ???

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 (until 1999)

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 – 2003 (3% ave/yr)
- DC metro area GDP rose at a faster rate

PEPCO Lessons

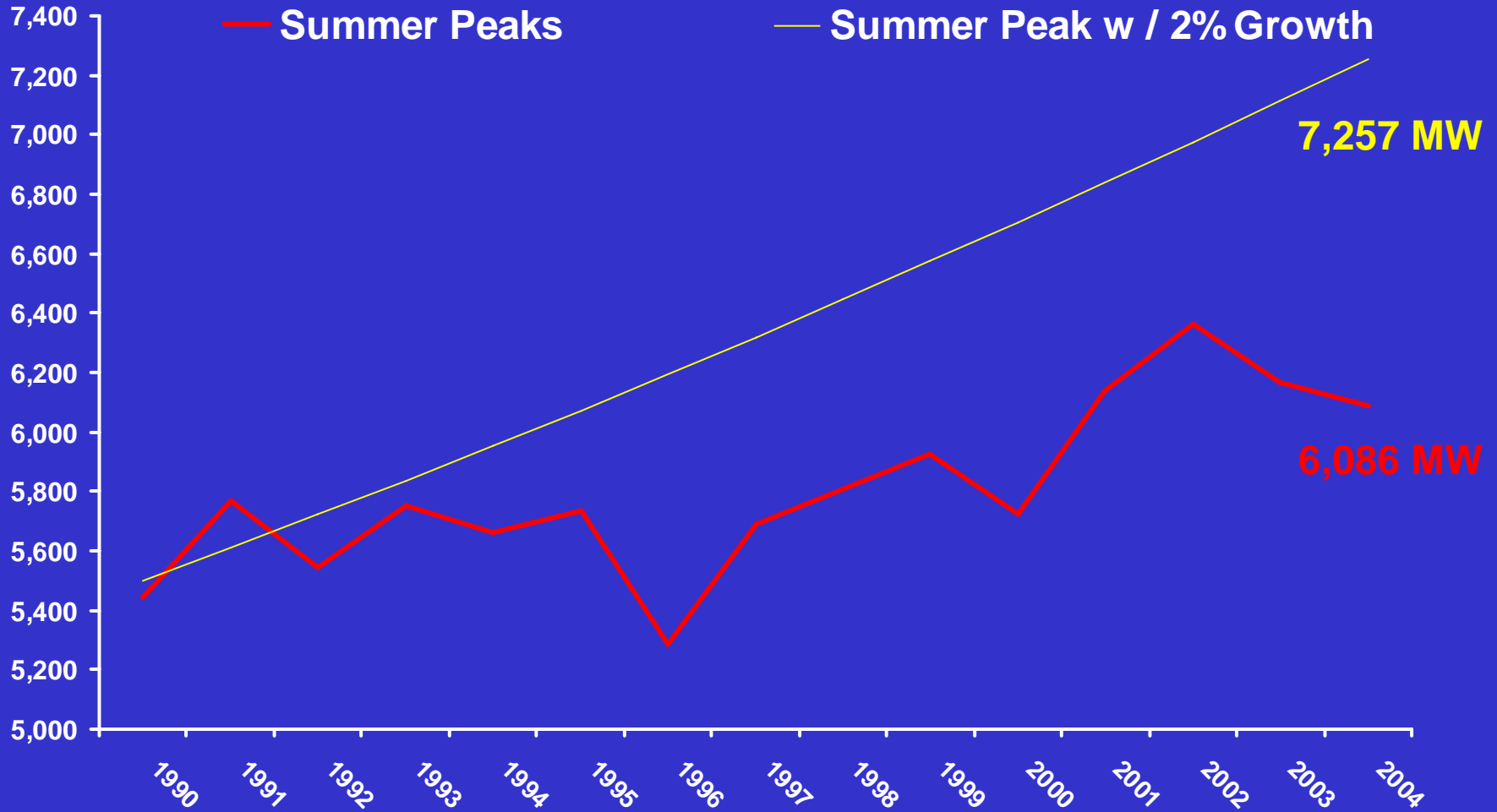
- PEPCO peak demand in 2004?
- 1985: ~ 4700 MW
- 1990: 5,442 MW
- 1991: 5,769 MW (over 1,000 MW in 6 years)

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)

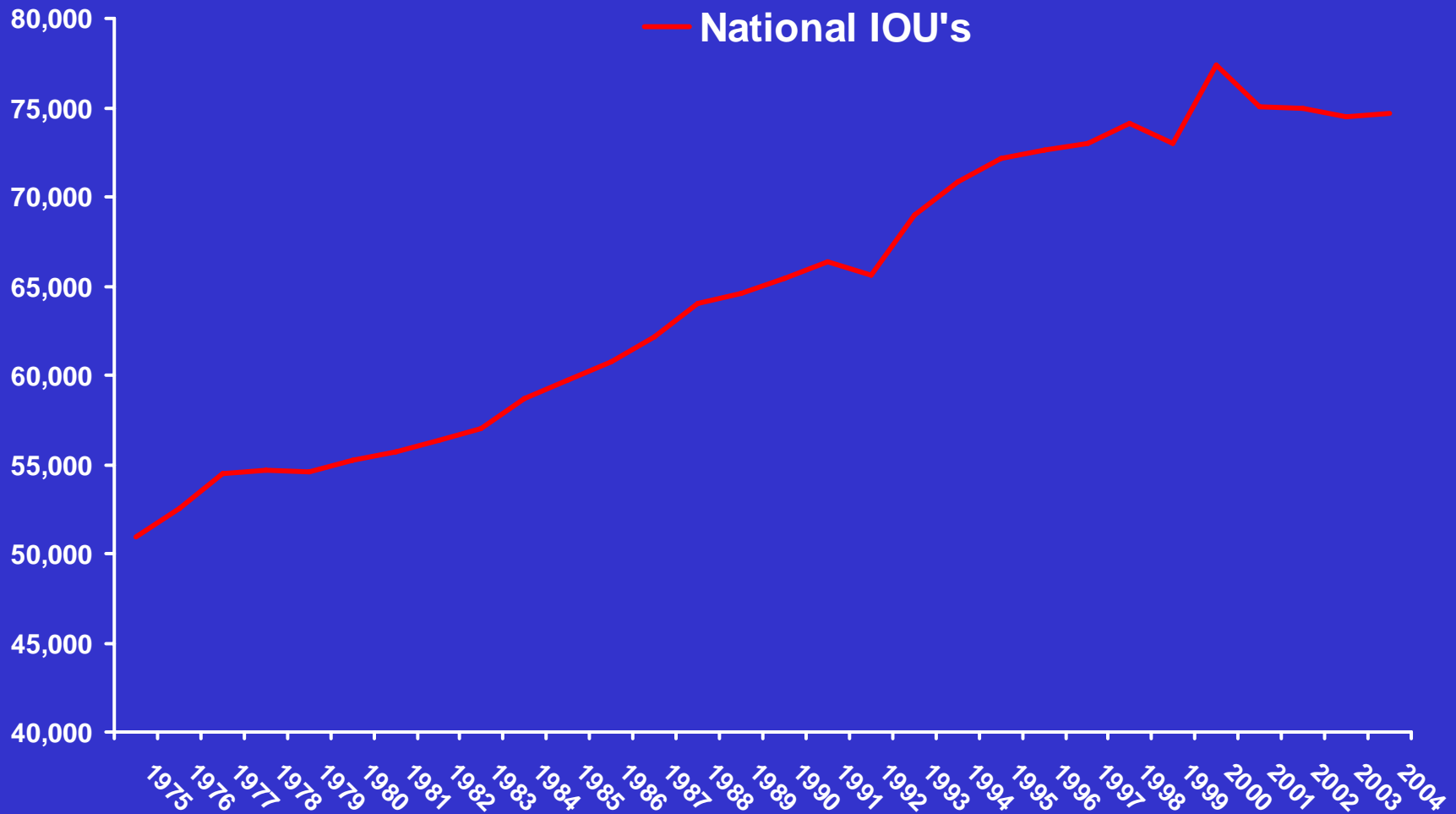
- Comparing 1991 to 2002 (blister to blister....)
 - 2002: 6,364 MW (15 days > 94 F in Aug, 11 days > 94 F in July, DC ASHRAE 0.4% design day is 95 F dry bulb)
- 10.3% increase over 12 years....

PEPCO Annual Peak Demands, 1990-2004 (MW)



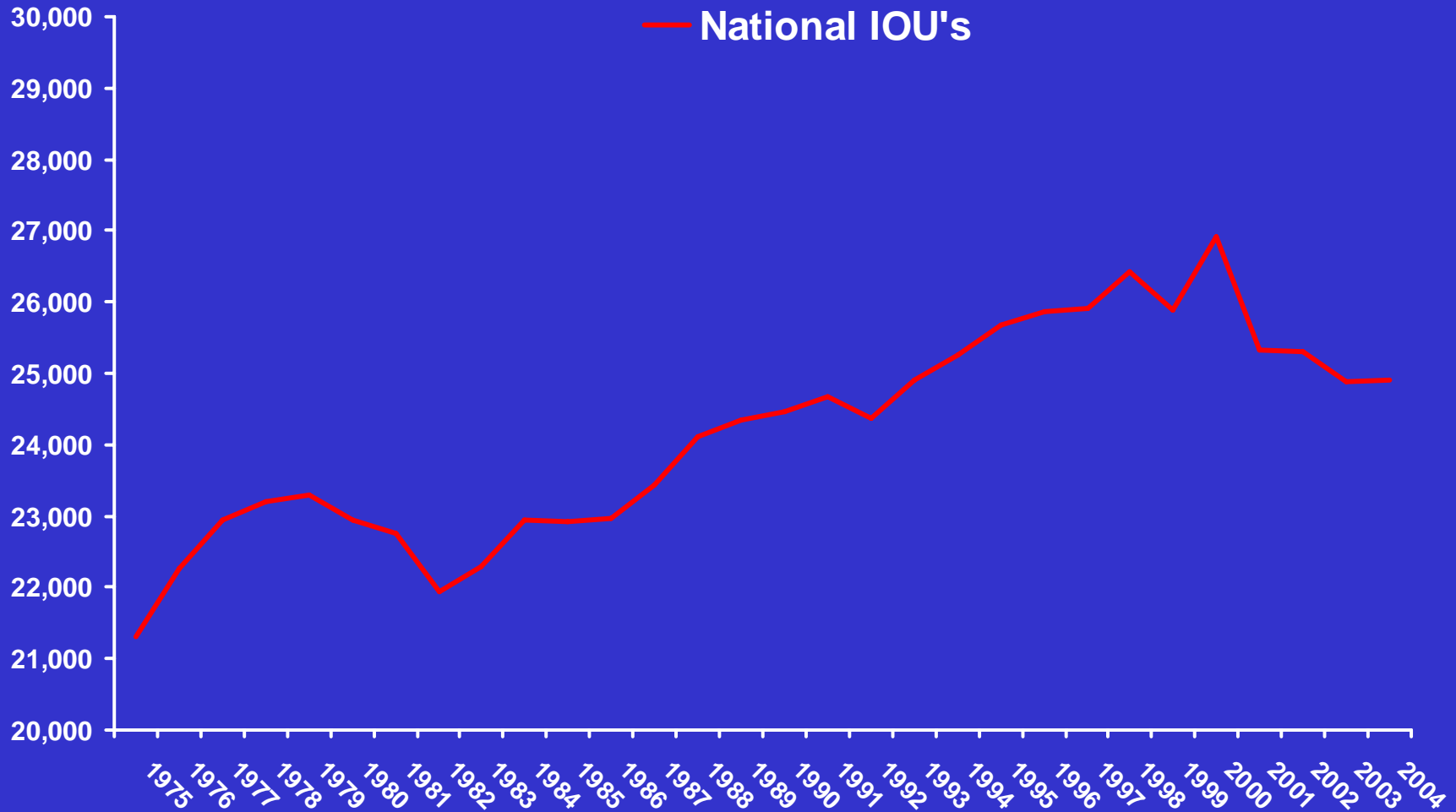
Source: PEPCO Statistics March 2005

Average Annual Electric Use per Commercial Customer, 1975-2004 (kWh / yr)



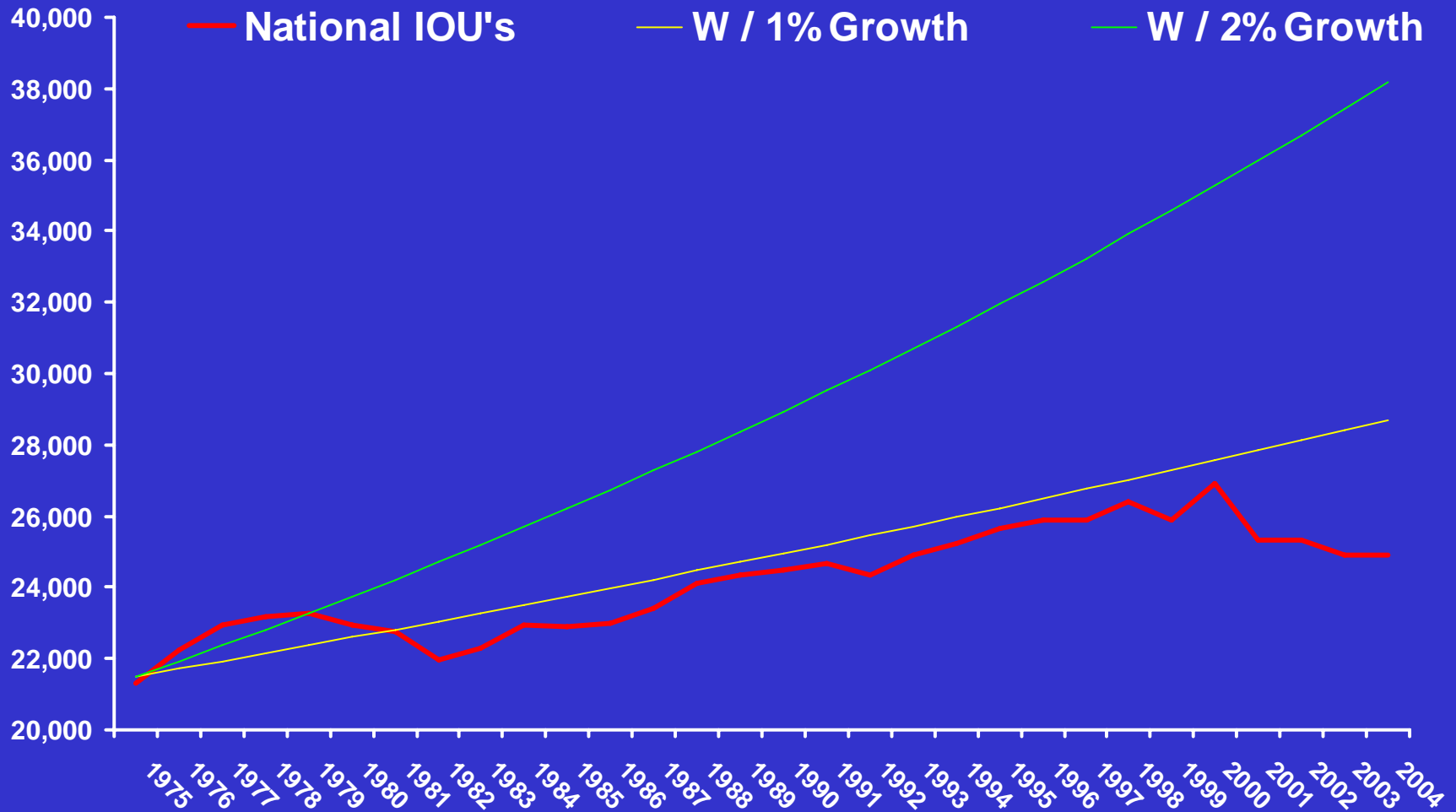
Sources: EEI Statistical Yearbooks 1980-2005,
Historical Statistics of the Electric Utility Industry through 1992

Average Annual Electric Use per Total Ultimate Customer, 1975-2004 (kWh / yr)



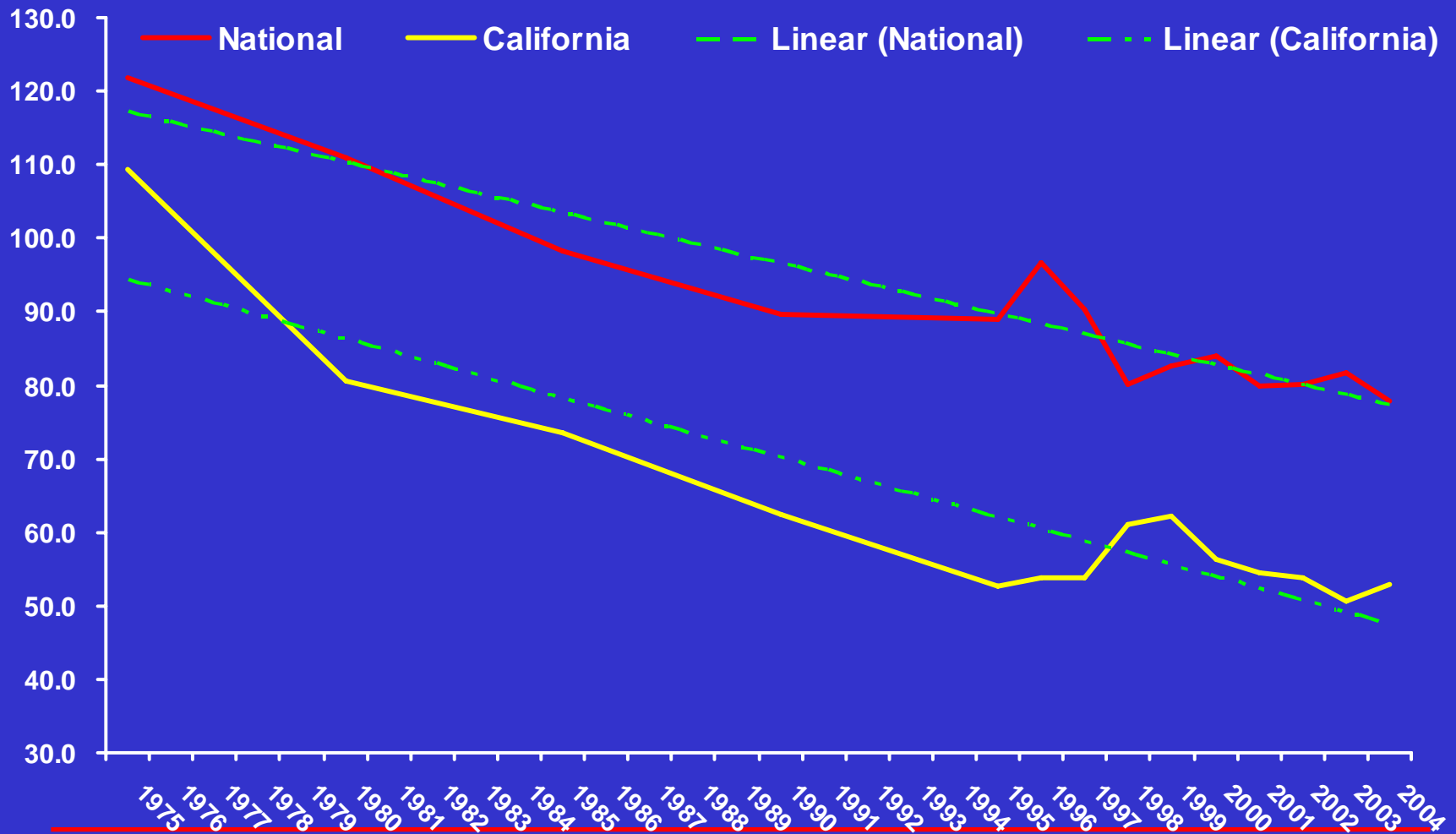
Sources: EEI Statistical Yearbooks 1980-2005,
Historical Statistics of the Electric Utility Industry through 1992

Average Annual Electric Use per Total Ultimate Customer, 1975-2004 (kWh / yr)



Sources: EEI Statistical Yearbooks 1980-2005,
Historical Statistics of the Electric Utility Industry through 1992

Average Annual Residential Gas Consumption per Customer, 1975-2004 (Million Btus/yr)



Sources: American Gas Association Gas Facts 2000,
Gas Facts 2003, and Gas Facts 2005

Impacts of Demographics

- Are industrial customers “over represented” in DR programs?
- Typically get the largest DR at lowest costs from industrial customers.
- Some suggest mandates for residential and small commercial programs.
- This is not a flexible policy, when you consider the following customer attributes:

Impacts of Demographics - Residential

- According to the US Census Bureau, in 2003-2004, 14% of the population moved. In some states, the rate is as high as 19%.
- In 1990-1991, 17% of the US population moved.
- In Illinois, in 2003, 14.1% of the population moved.
- In terms of residential DR programs:
 - A potential of 14% “churn” in DR customer base every year
 - A potential “churn” or “turnover” (or loss) of nearly 100% in DR resources every 7 years
- (Source: U.S. Census Bureau, *Statistical Abstract of the United States: 2006*, Tables 30-33)

Impacts of Demographics – Commercial

- According to the US Census Bureau, in 2002, there were 5,697,800 employer firms in the US. Of these, 89.3% had fewer than 20 employees.
 - In 2003, there were 553,500 employer firm “births”
 - Also in 2003, there were 572,300 employer firm “deaths” (elimination of all employees)
 - Illinois values: 253,700 firms, 86.1% with less than 20 employees; in 2003, there were 28,933 “births” and 41,112 “deaths” (in 2004, 33,472 “deaths”)
 - Churn rate of 13.2% - 16.2%???
 - (Source: U.S. Census Bureau, *Statistical Abstract of the United States: 2006*, Tables 744-745)
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Commercial Demographics – (cont'd)

- According to a Ohio State University study that tracked new restaurants in Columbus Ohio from 1996-1999:
 - In the first year, 26% closed.
 - In the second year, 19% closed.
 - In year 3, another 14% closed. (59% in 3 years)
 - Also, according to another study, typical small business survival rates are:
 - Year 1: 85%
 - Year 2: 70%
 - Year 3: 62%
 - Year 4: 55%
 - Year 5: 50%
 - (Source: *USA Today*, "Focus on success, not failure," Rhonda Abrams, May 6, 2004)
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Q & A

- The floor is open!