

# ***Can we increase quality of life by decreasing electricity consumption?***



*Prof. John Dernbach*

*The Role of Coal-Fired Electric Power  
Generation*

*February 9, 2012*



# *Problem*

- ✧ U.S. economy has grown partly because of abundant, low-cost energy, including coal.
- ✧ Other countries apply the same model (and greatest growth in energy consumption is occurring in developing world)
- ✧ Because of cost, resource, and environmental constraints, this model is not sustainable.



# *Challenge*

- ✧ U.S. has decoupled many forms of pollution from economic growth-- e.g., GDP increases while criteria air pollutants decrease

- ✧ Can we do that for energy consumption (including electricity consumption)?
- ✧ (If so, how much?)

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*"I'm afraid you've had a paradigm shift."*





## *Questions:*

- ✧ How much could the U.S. improve *electricity* efficiency if it really tried?
- ✧ What opportunities (economic, environmental, social, peace/security) could we create by doing so?
- ✧ Paradox: if efficiency is such a great idea, why aren't we doing more of it?

# *Overview*

- ✧ 1. Why Energy Efficiency and Conservation Matter
- ✧ 2. Legal and Policy Options
- ✧ 3. The Path Ahead





# *1. Why energy efficiency and conservation matter*

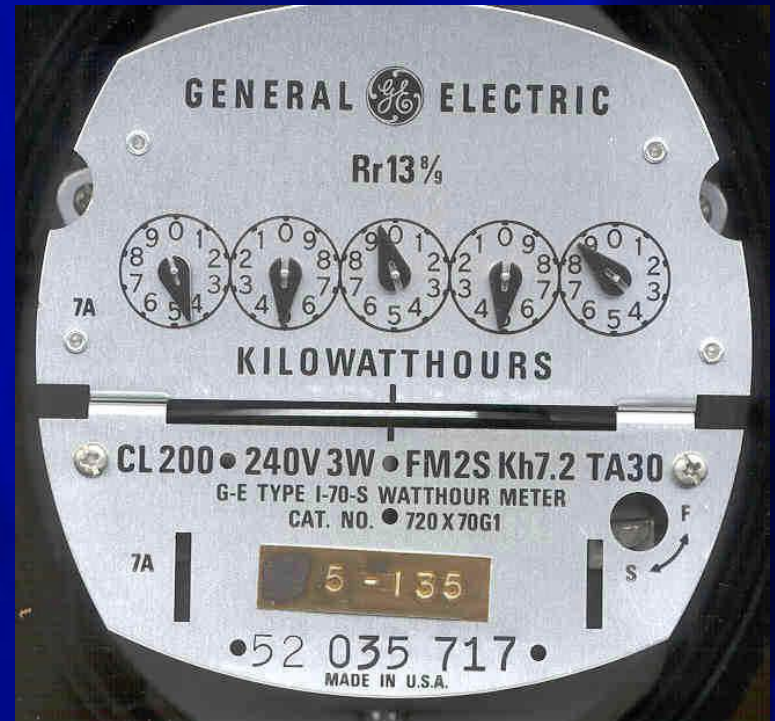
✧ **Energy efficiency**--  
doing the same  
amount of work, or  
producing the same  
amount of goods or  
services, with less  
energy.

✧ **Energy conservation**--  
using less energy  
regardless of  
whether energy  
efficiency has  
changed.



# *Consumption*

✧ The energy we don't use is the cleanest – and cheapest – energy of all





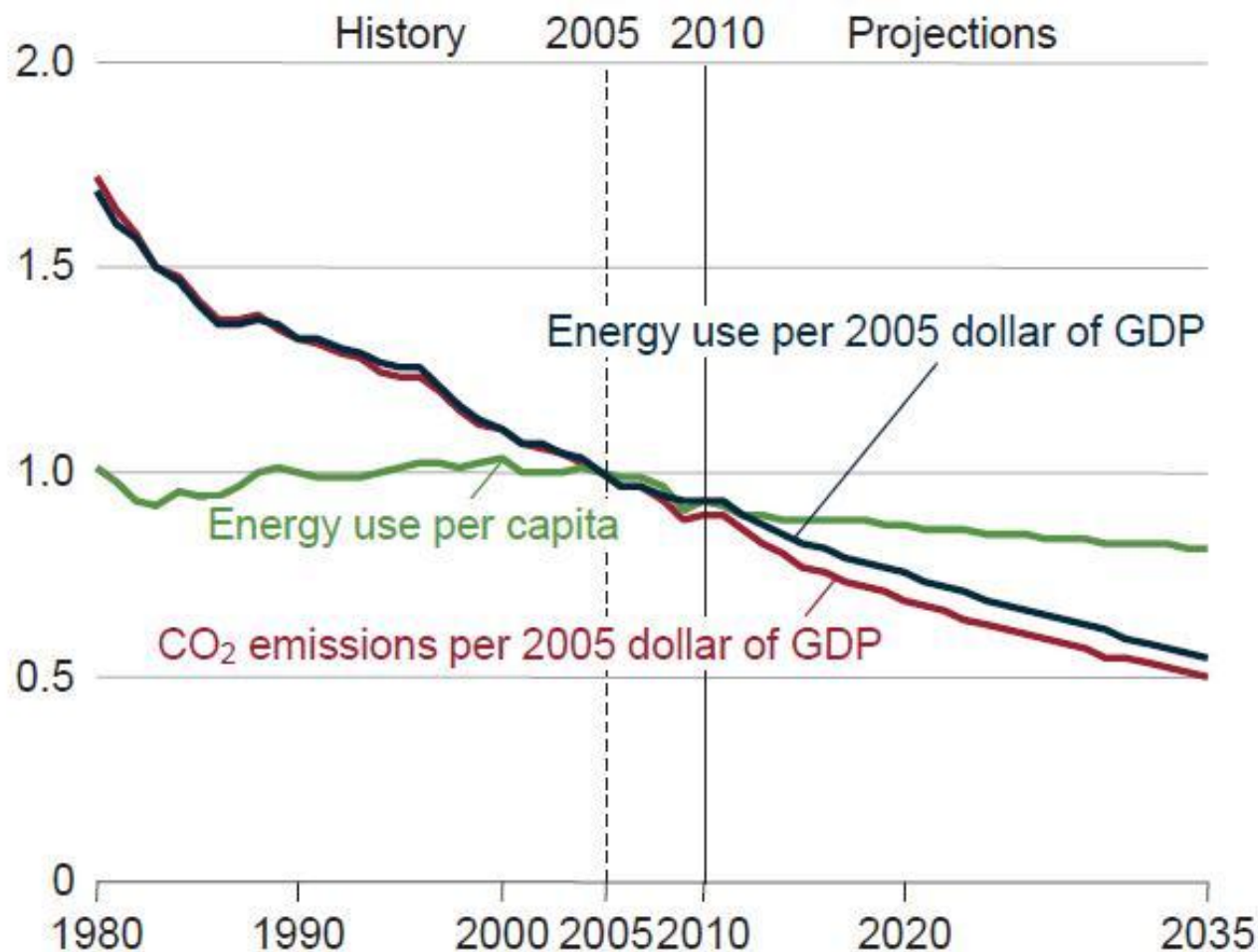


# *Opportunities/Needs for Efficiency are Greater*

## ✧ Effectiveness:

- ✧ 78% of rise in demand for energy services over past decade met by efficiency
- ✧ 22% met by increasing energy supply
- ✧ Climate science suggests need for deep cuts in energy use

## Energy use per capita and per dollar of gross domestic product and emissions per dollar of gross domestic product, 1980-2035 (index, 2005=1)





## *Many reasons*

- ✧ Reduce demand pressure on prices
- ✧ Strengthen the economy
- ✧ Create more opportunities technology and business development
- ✧ Protect the poor and those on fixed incomes
- ✧ Reduce vulnerabilities
- ✧ Mitigate climate change





# *Better than renewables?*

✧ In many ways, energy efficiency and conservation are better than renewable energy:

- ✧ delivering significant and reliable short-term results
- ✧ improving national security
- ✧ Improving economic competitiveness.

[Of course, greater use of renewables is also necessary.]

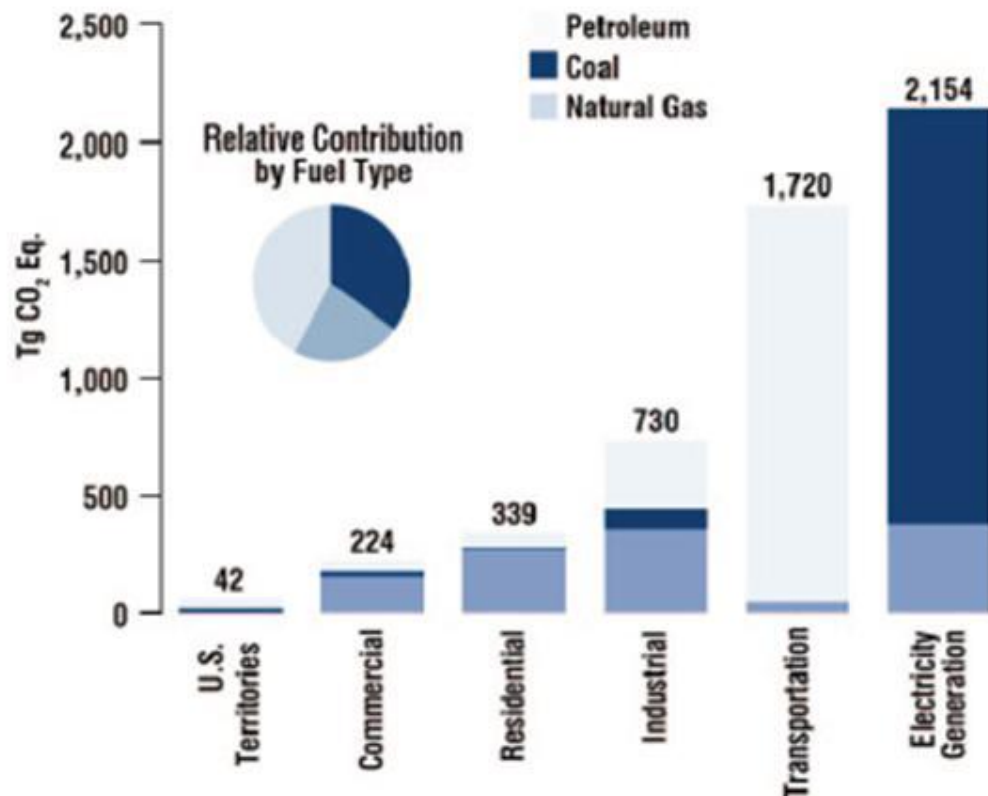


## *Energy Efficiency Creates More Jobs*

- ✧ How many jobs for \$1 million invested?
  - ✧ Construction and services (sectors where energy efficiency jobs are concentrated)--19–20 jobs on average
  - ✧ Traditional energy sector--10 jobs on average.

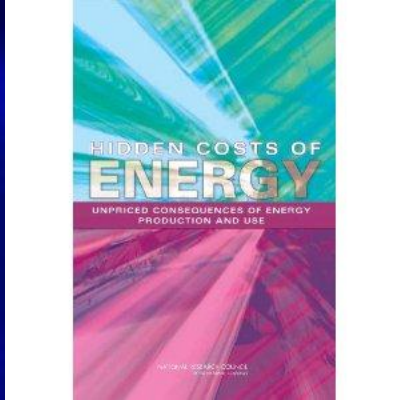
✧ ACEEE/MIG, Inc. (2010)

## 2009 CO<sub>2</sub> Emissions from Fossil Fuel Combustion by Sector and Fuel Type



Note: Electricity generation also includes emissions of less than 0.5 Tg CO<sub>2</sub> Eq. from geothermal-based electricity generation.

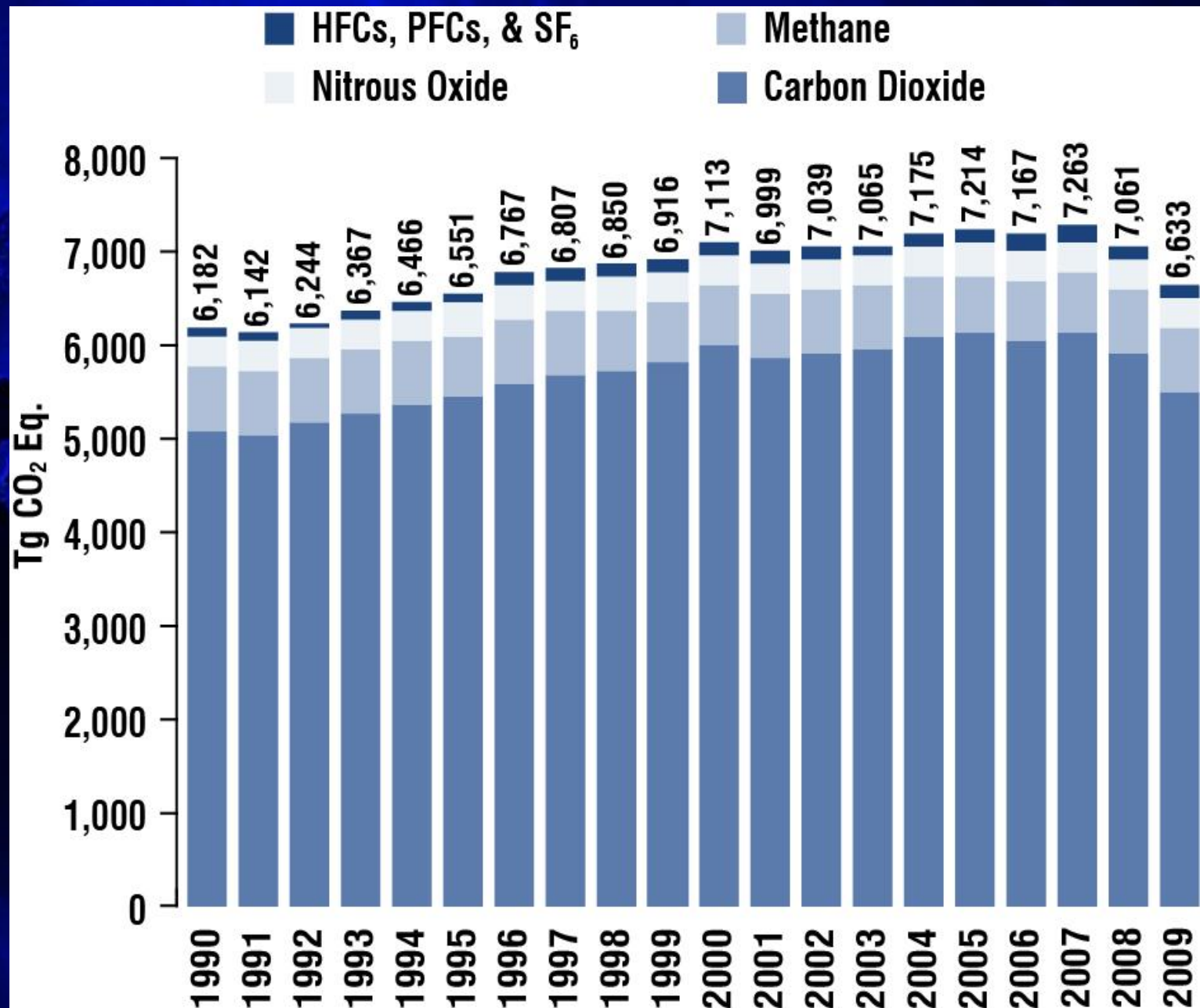


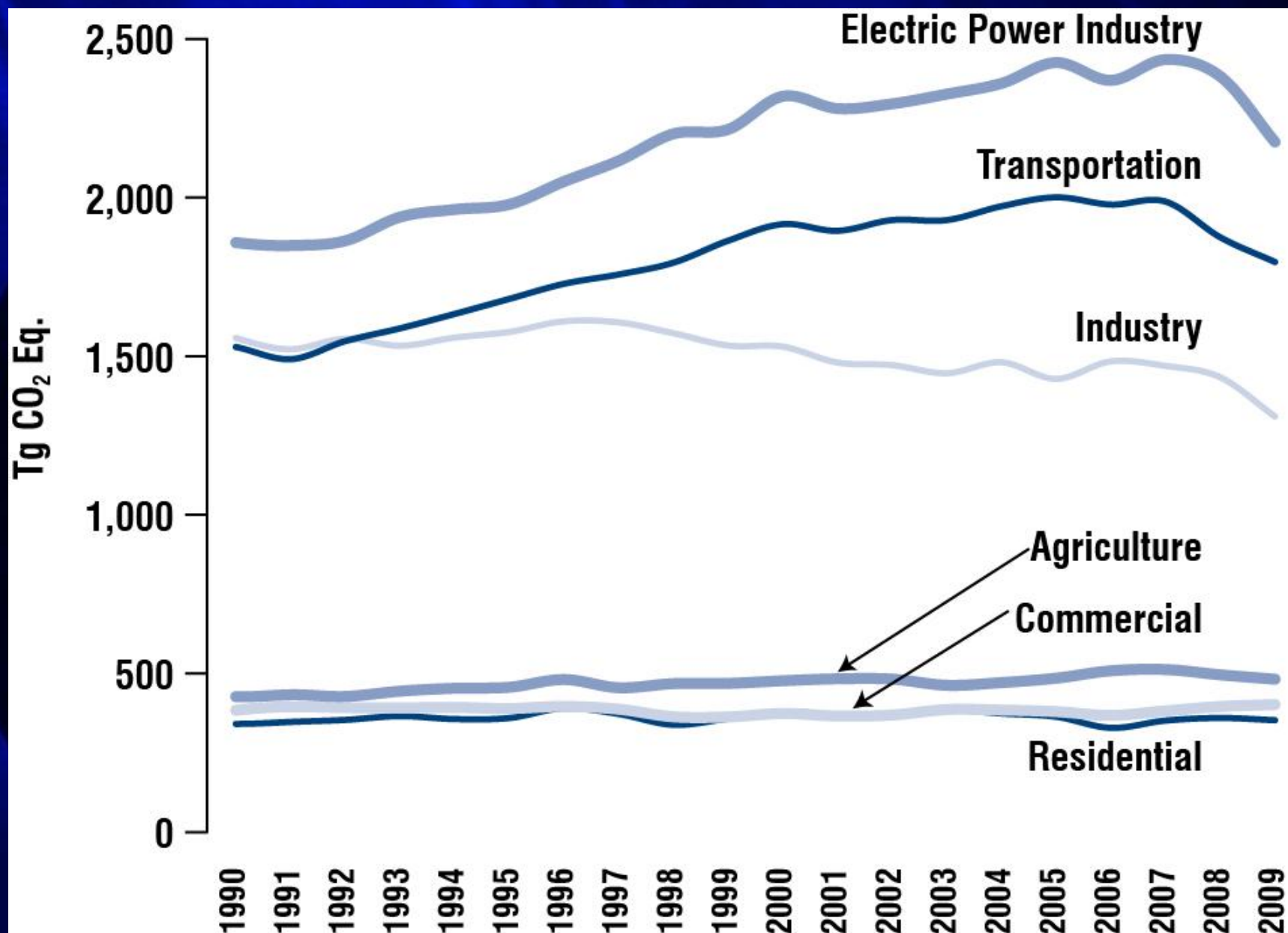


## *External costs of coal*

- ✧ Aggregate damages associated with emissions of SO<sub>2</sub>, NO<sub>x</sub>, PM<sub>2.5</sub>, and PM<sub>10</sub> from coal generation in 2005:
  - ✧ \$62 billion (2007 USD), or \$156 million per plant on average (406 plants included)
  - ✧ 3.2 cents per kilowatt hour (kWh)
- ✧ More than 90% monetized damages from premature human mortality
- ✧ About 85% of damages from SO<sub>2</sub> emissions
- ✧ Climate change impacts not counted.

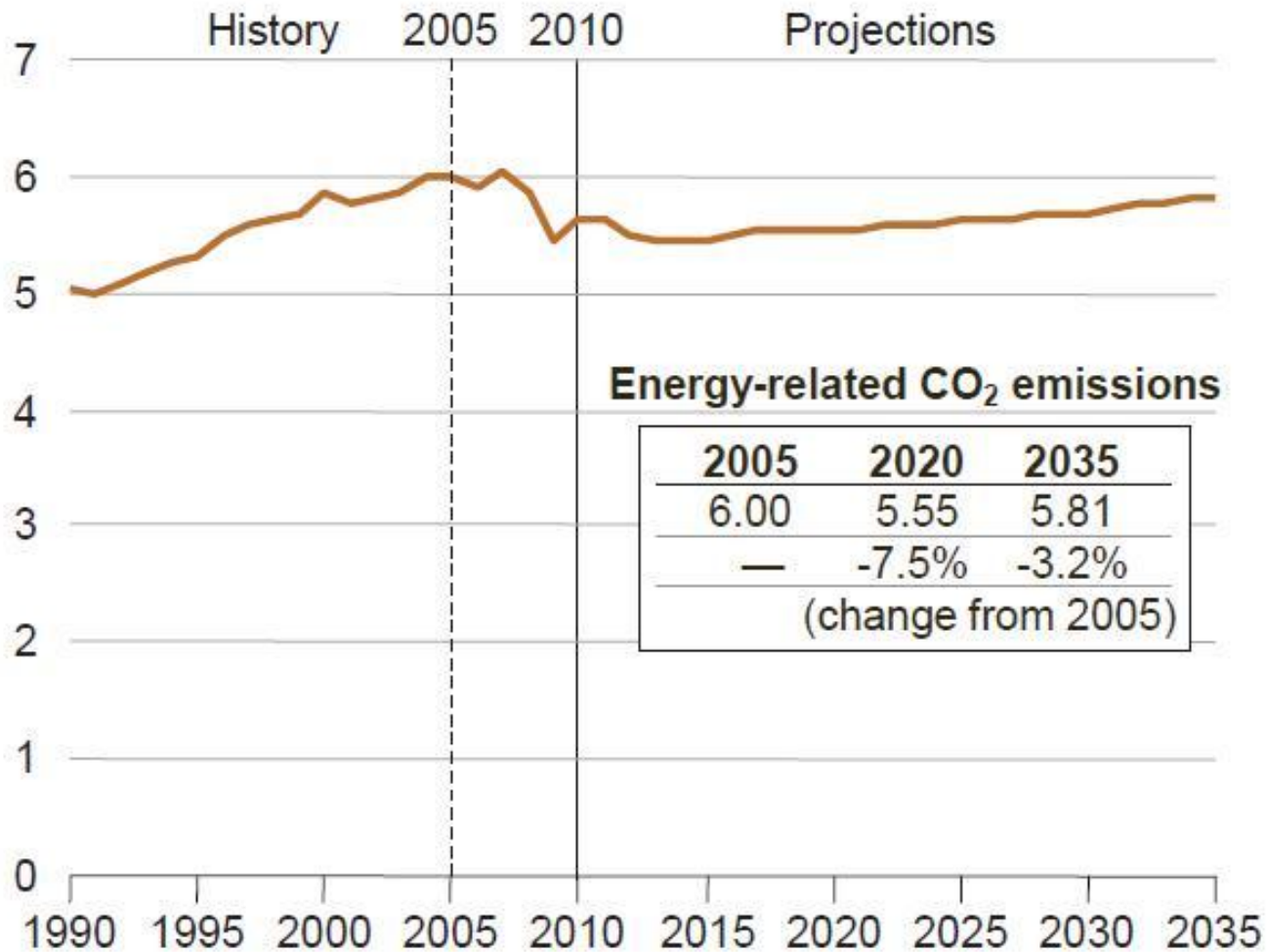
NRC (2010)

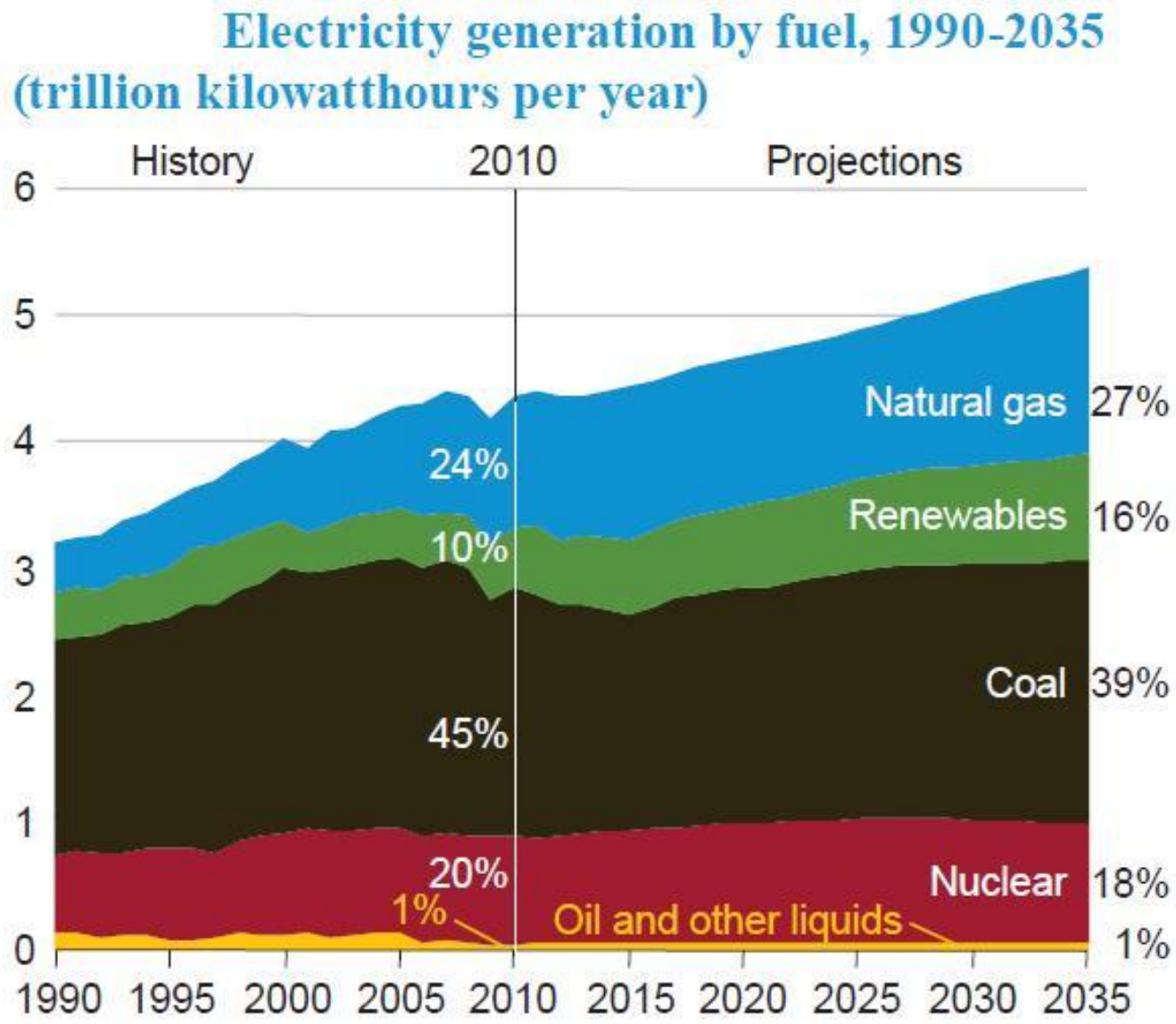






## U.S. energy-related carbon dioxide emissions, 1990-2035 (billion metric tons)



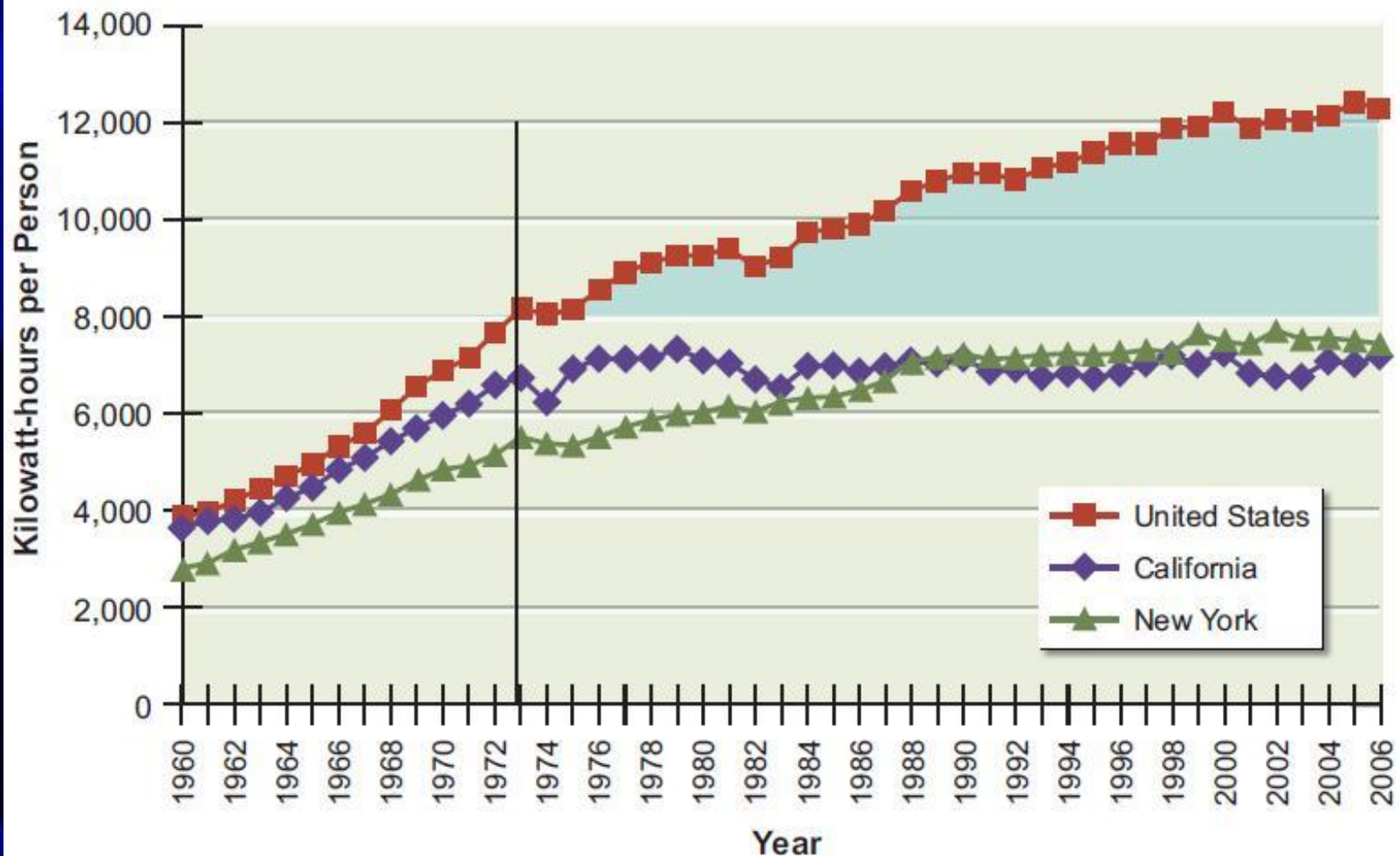


# Average exergy efficiency of primary work— electrical power distribution and generation (percent)

- “Exergy is ...the maximum amount of work that can theoretically be recovered from a system....”
- “The exergy embodied in a fuel can be equated approximately to the heat of combustion...of that fuel.”
- Ayres & Warr (2009)

1900	3
1910	4.4
1920	9.2
1930	17.3
1940	20.8
1950	24.3
1960	31.3
1970	32.5
1980	32.9
1990	33.3



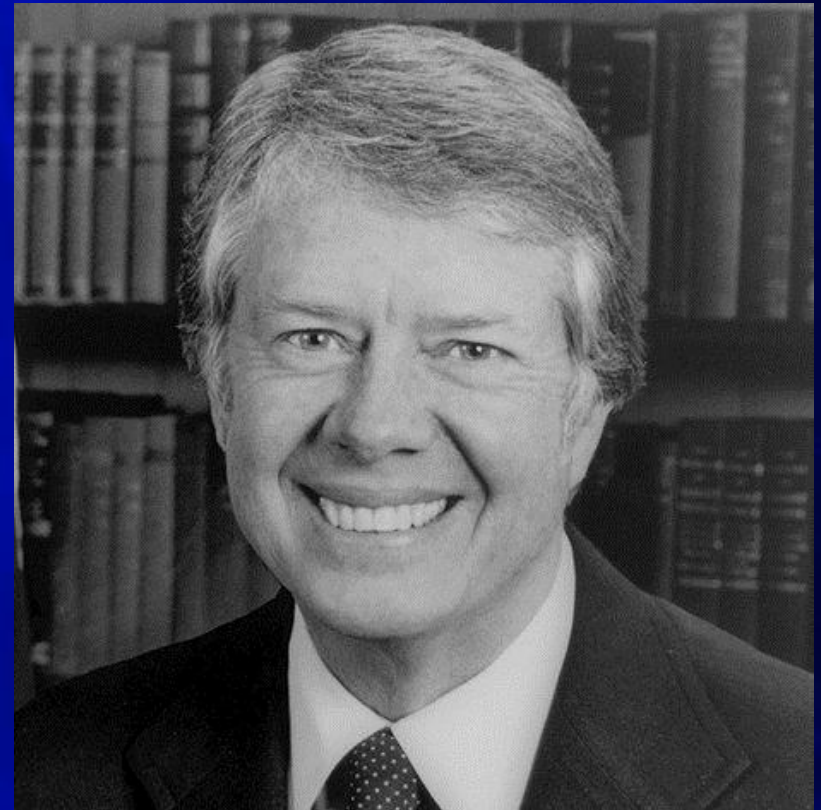


*Per capita electricity consumption (not including on-site generation) in California, New York, and the United States, 1960–2006.*

*Source: U.S. Department of Energy, Energy Information Administration. State Energy Data System, State Energy Consumption, Price, and Expenditure Estimates, available at [http://www.eia.doe.gov/emeu/states/\\_seds.html](http://www.eia.doe.gov/emeu/states/_seds.html).*

# *Challenges to Greater Efficiency*

- ✧ Efficiency (doing more with less) confused with doing less or doing without
- ✧ High consumption as a value
- ✧ Potential improvements scattered everywhere
- ✧ Cheap energy
- ✧ Habits/rules that foster inefficiency
- ✧ Up-front investment costs
- ✧ Lack of information





## *2. Legal and policy options*

National and state laws and  
policies





# *What is upper limit of what can be achieved?*

✧ “Energy-efficient technologies for residences and commercial buildings, transportation, and industry exist today, or are expected to be developed in the normal course of business, that could save 30 percent of the energy used in the U.S. economy while also saving money.”

✧ NRC, Real Prospects for Energy Efficiency in the United States (2010)




# U.S. could *reduce* overall energy consumption

	2008	2020	2030
Energy production (in quadrillion BTUs or quads)	99	111	118
Revised projection	99	89-92	82-88

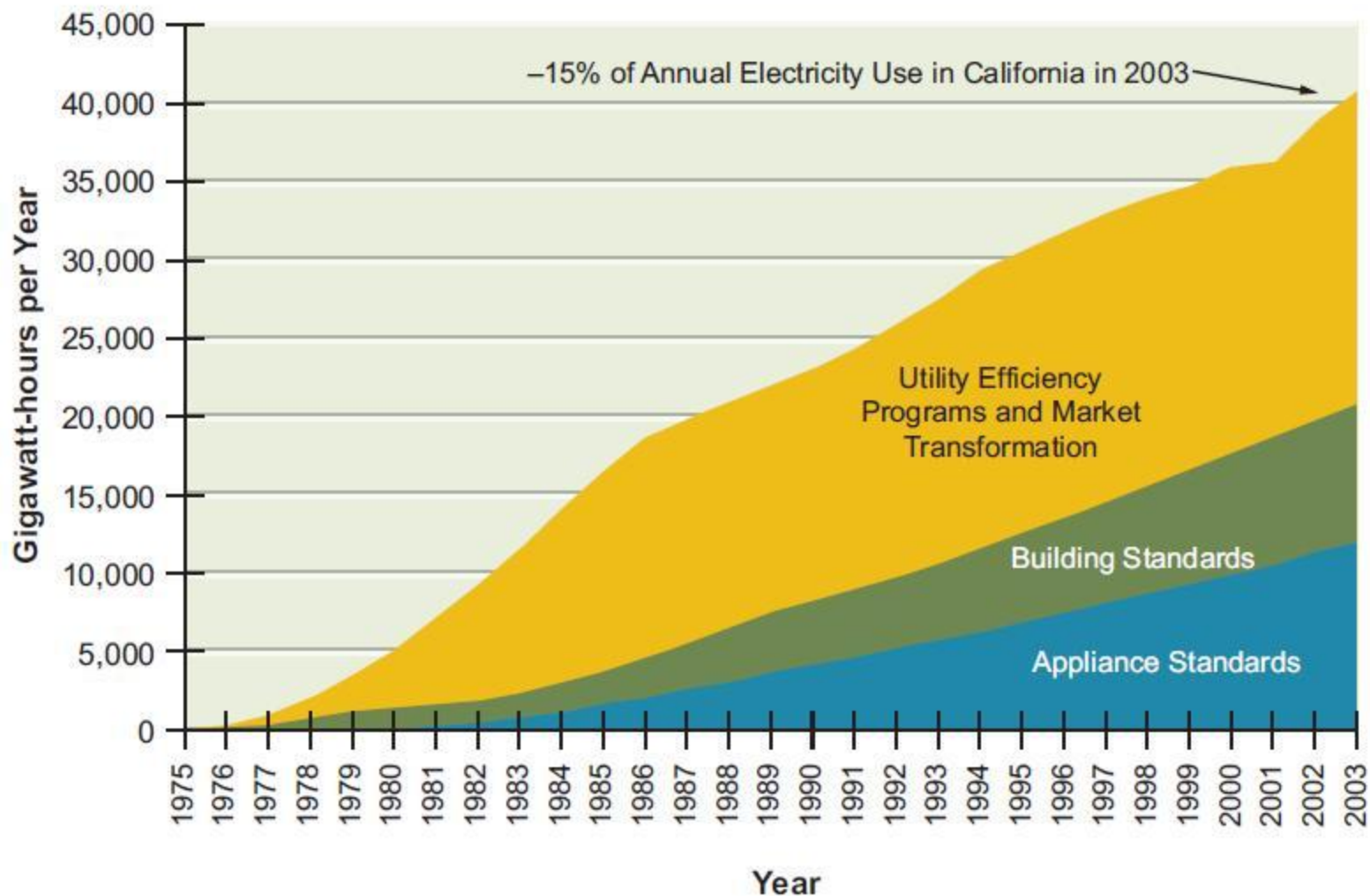
# Electricity reduction

	2020	2030
Buildings & industry (conservative assumptions, in quads)	14.3	19.3
Buildings & industry (optimistic assumptions, in quads)	17.1	22.1



✧ “The full deployment of cost-effective energy-efficient technologies in buildings alone could eliminate the need to add U.S. electrical generation capacity.”

✧ NRC (2010)



*Annual electricity savings from key energy efficiency policies and programs implemented in California, 1975–2003.*

*Source: CEC, 2007.*





## *What California did*

- ✧ 1982: decoupled utility profits from sales of electricity
- ✧ 1998: charge of 0.3 cents/kWh to fund energy efficiency and other public benefit activities
- ✧ 2001: included efficiency as part of Integrated Resource Planning
- ✧ 2004: established energy efficiency goals of about 1%/year through 2013
- ✧ 2007: established specific energy efficiency targets with bonus, in addition to cost recovery, if utilities achieve 85% of savings goals

# *States: Building Codes*

- ✧ Building sector is largest energy consumer in U.S.
- ✧ Buildings more than 25% more energy efficient since 1972
- ✧ Only half of states have latest/most efficient residential and commercial codes
- ✧ Codes focus on new buildings, not existing buildings

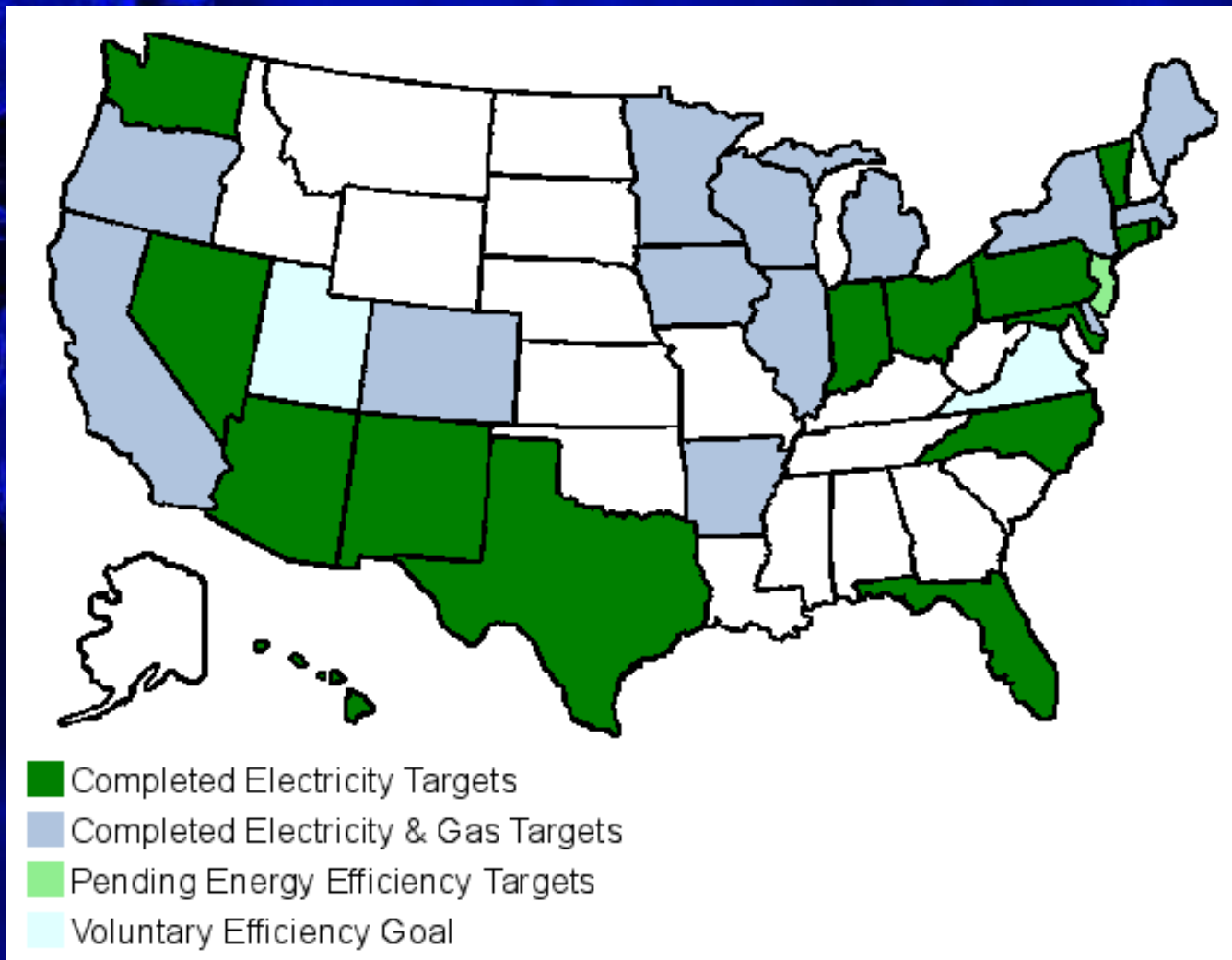




# *PACE programs*

- ✧ Property Assessed Clean Energy (PACE)
- ✧ Municipality loans money to homeowner or business to install solar power or other clean/renewable energy or energy efficiency/conservation
- ✧ Homeowner can take tax credits – federal and state if they have it
- ✧ Repayment is secured through a voluntary tax or utility assessment on property
  - ✧ Passed on to subsequent owners even if property is sold

# *State energy efficiency standards and targets*





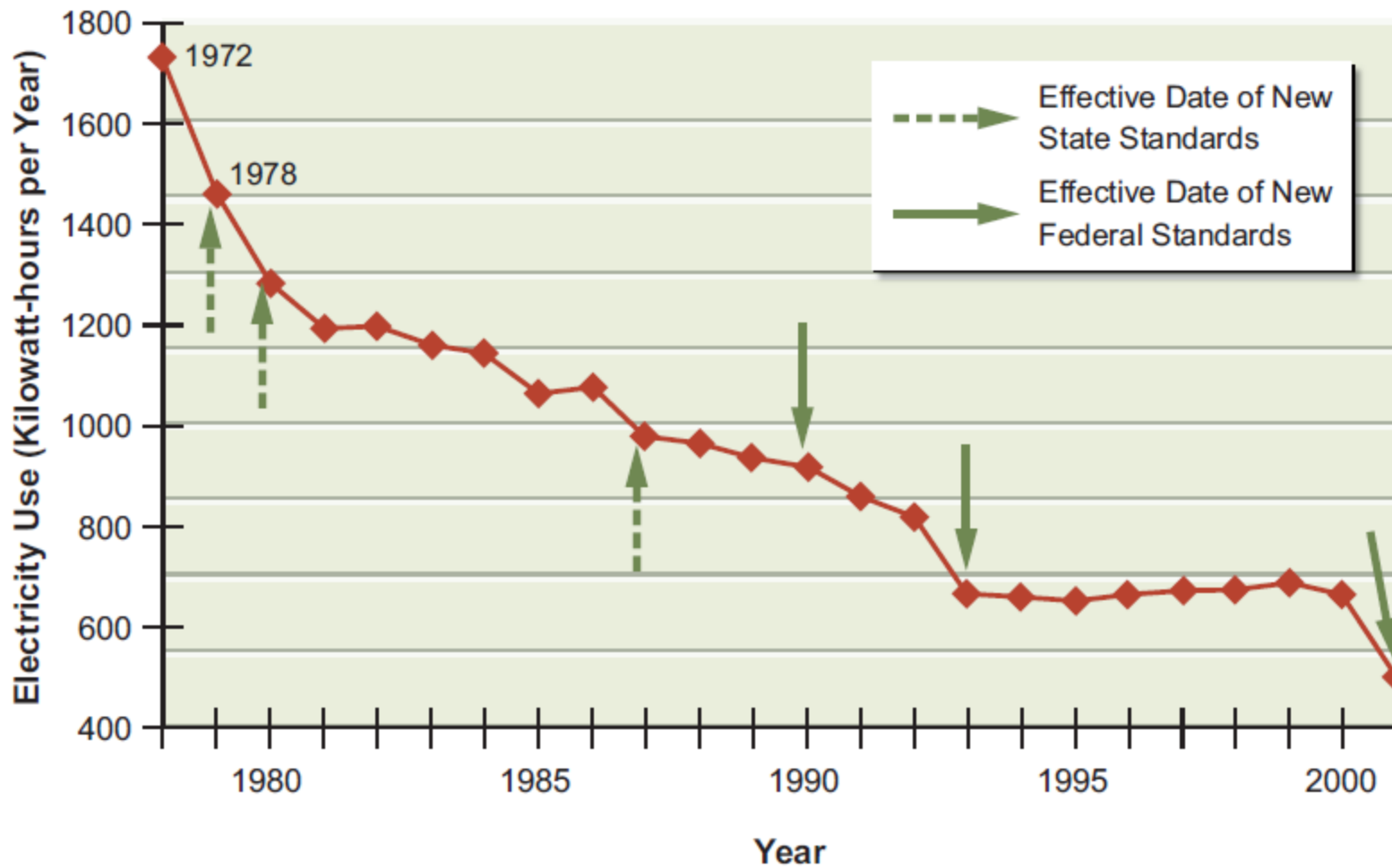
A blue-tinted image of the Earth from space, showing the Americas. The text is overlaid on the right side of the image.

*Applying state experience at  
national level*

# *National Laws: Appliances*



- ✧ National appliance rules started as state rules
- ✧ There are now standards for dozens of different kinds of household appliances and industrial equipment
- ✧ Energy Star builds on these standards



*Average annual electricity consumption of new refrigerators sold in the United States, 1972–2001.*

*Source: Geller, 2003.*



# *Well crafted combinations of tools are best*

- ✧ For appliances, for example:
  - ✧ Government-funded RD&D helps develop and commercialize new technologies
  - ✧ Product labeling educates consumers
  - ✧ Efficiency standards eliminate inefficient products from marketplace
  - ✧ Incentives by some utilities and states encourage purchase of more efficient appliances
    - ✧ NRC (2010)





## *EERS in federal climate change bills*

- ✧ Would require electricity distributors to achieve a savings of 1% in 2012 that rises steadily and reaches 15% in 2020.
- ✧ Would require natural gas distributors to achieve a 0.75% energy savings in 2012 that increases to 10% in 2020.



# *Projected benefits of federal EERS:*

- ✧ Savings to American consumers and businesses of almost \$170 billion
  - ✧ Creation of over 220,000 jobs
  - ✧ Elimination of need to build 390 power plants.
  - ✧ Reduce projected 2020 U.S. greenhouse gas emissions by four percent.
  - ✧ All in addition to impacts of existing state laws.
- ✧ Steven Nadel, ACEEE (2009)

# *Clean energy standard*

- ✧ The differences in this chamber may be too deep right now to pass a comprehensive plan to fight climate change, but there's no reason why Congress shouldn't at least set a clean energy standard that creates a market for innovation.
- ✧ State of the Union message, 1/24/12





# *An opportunity for energy efficiency?*

- ✧ Depends on definition of “clean energy”
- ✧ Proposed CES bills are often broader than renewable energy—e.g, gas, nuclear
- ✧ Could include energy efficiency



✧ Sen. Lisa Murkowski  
(R-Alaska)





- ✧ Of course, the easiest way to save money is to waste less energy. So here's a proposal: Help manufacturers eliminate energy waste in their factories and give businesses incentives to upgrade their buildings. Their energy bills will be \$100 billion lower over the next decade, and America will have less pollution, more manufacturing, more jobs for construction workers who need them.
- ✧ Send me a bill that creates these jobs.



## *Individual behavior*

- ✧ 1. Energy efficiency/conservation require engagement of individuals.
- ✧ 2. It is impossible to separate design issues from the role of the individual.
- ✧ 3. There is a moral obligation to reduce energy consumption, at least in developed countries, and that obligation needs to be part of the conversation.



### *3. The Path Ahead*

- ✧ If we cannot have federal climate legislation, we should at least be able to reduce energy consumption
- ✧ Energy efficiency and conservation have multiple benefits, only one of which is reduced greenhouse gas emissions



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