

## “Lighting the Way: Toward a Sustainable Energy Future”

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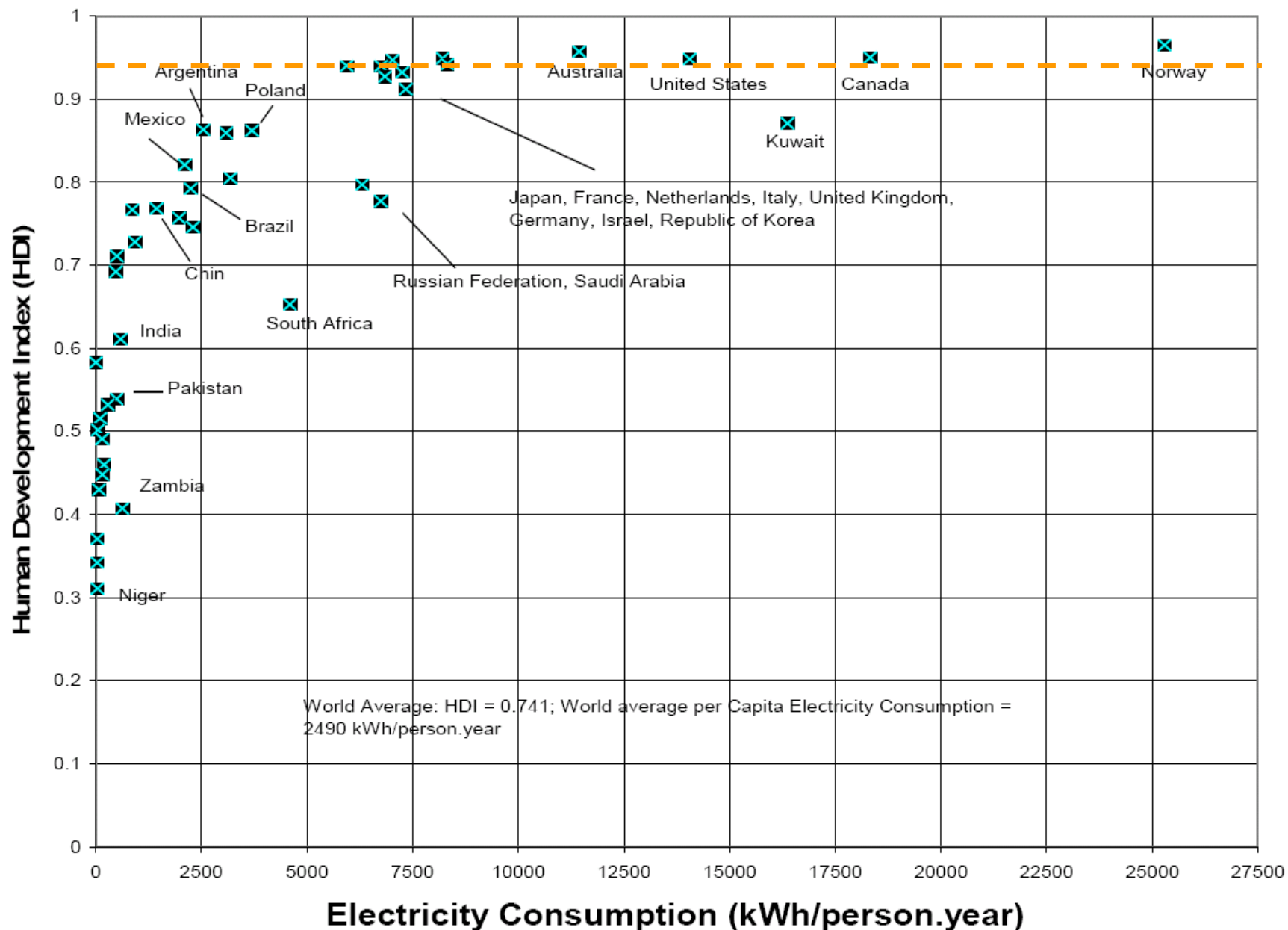
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# Energy Sustainability:

- (1) Environmental concerns: Local pollution, Climate Change, water use.
- (2) 2-3 billion people worldwide currently lack access to modern forms of energy.  
2.6 billion people use coal, charcoal, firewood, agricultural residues, or dung as their primary cooking fuel, while some 1.6 billion people worldwide live without electricity.
- (3) Reduce the security risks and potential for geopolitical conflict due to escalating competition for energy resources.

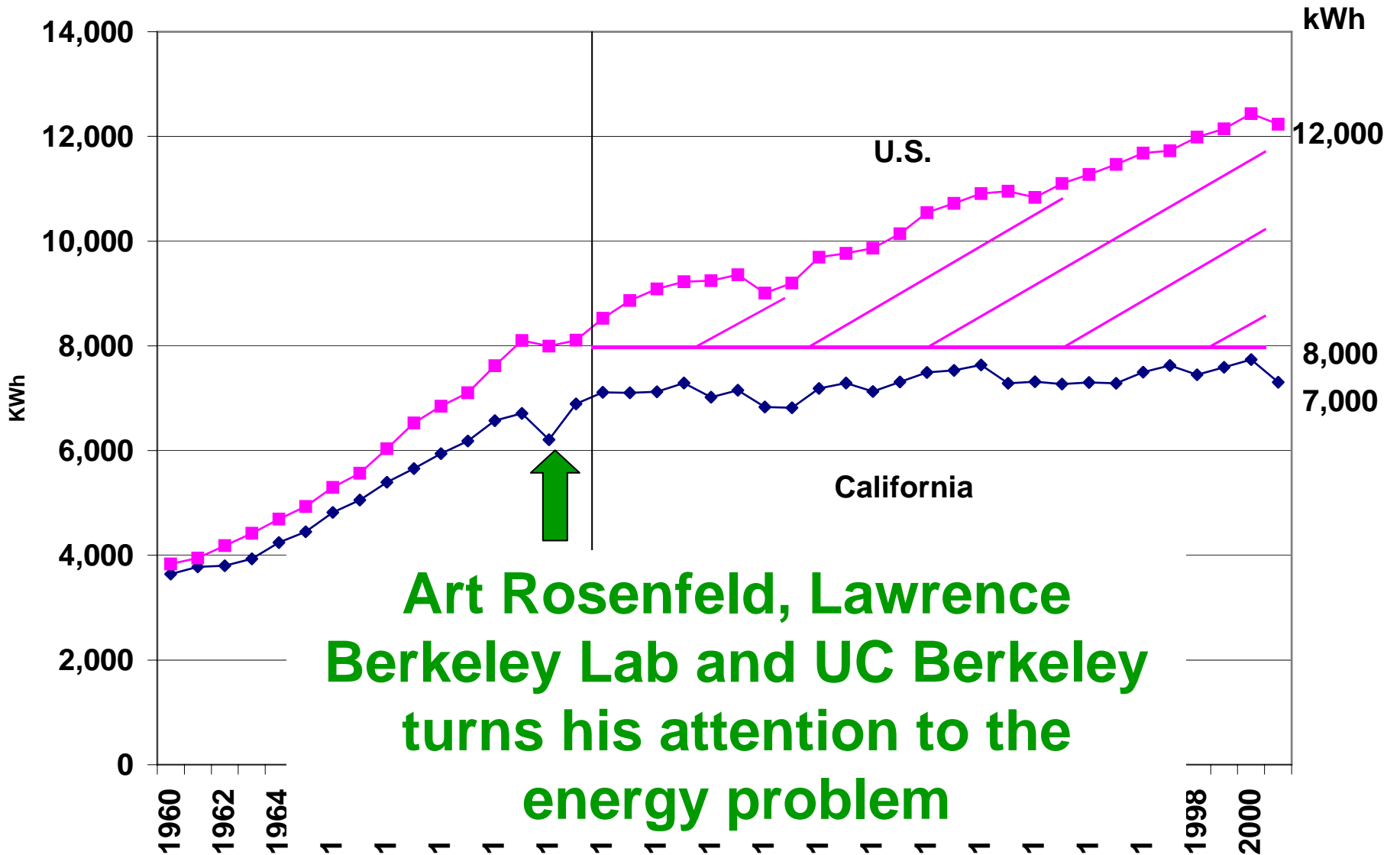
# Human Development Index vs. Energy consumption



# Energy demand vs. GDP per capita



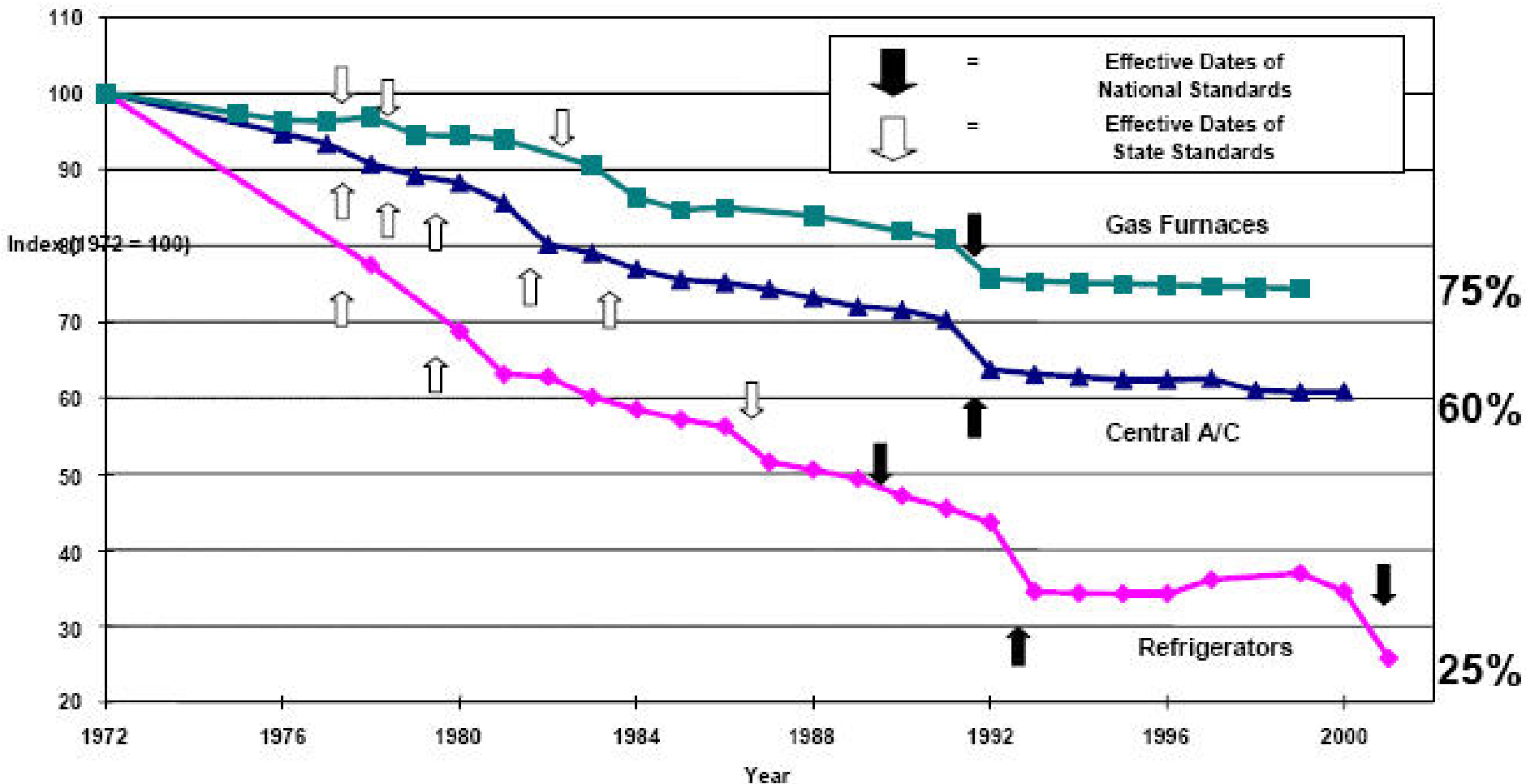
# Electricity Consumption/person in the US and California



**Art Rosenfeld, Lawrence  
Berkeley Lab and UC Berkeley  
turns his attention to the  
energy problem**

Figure 4

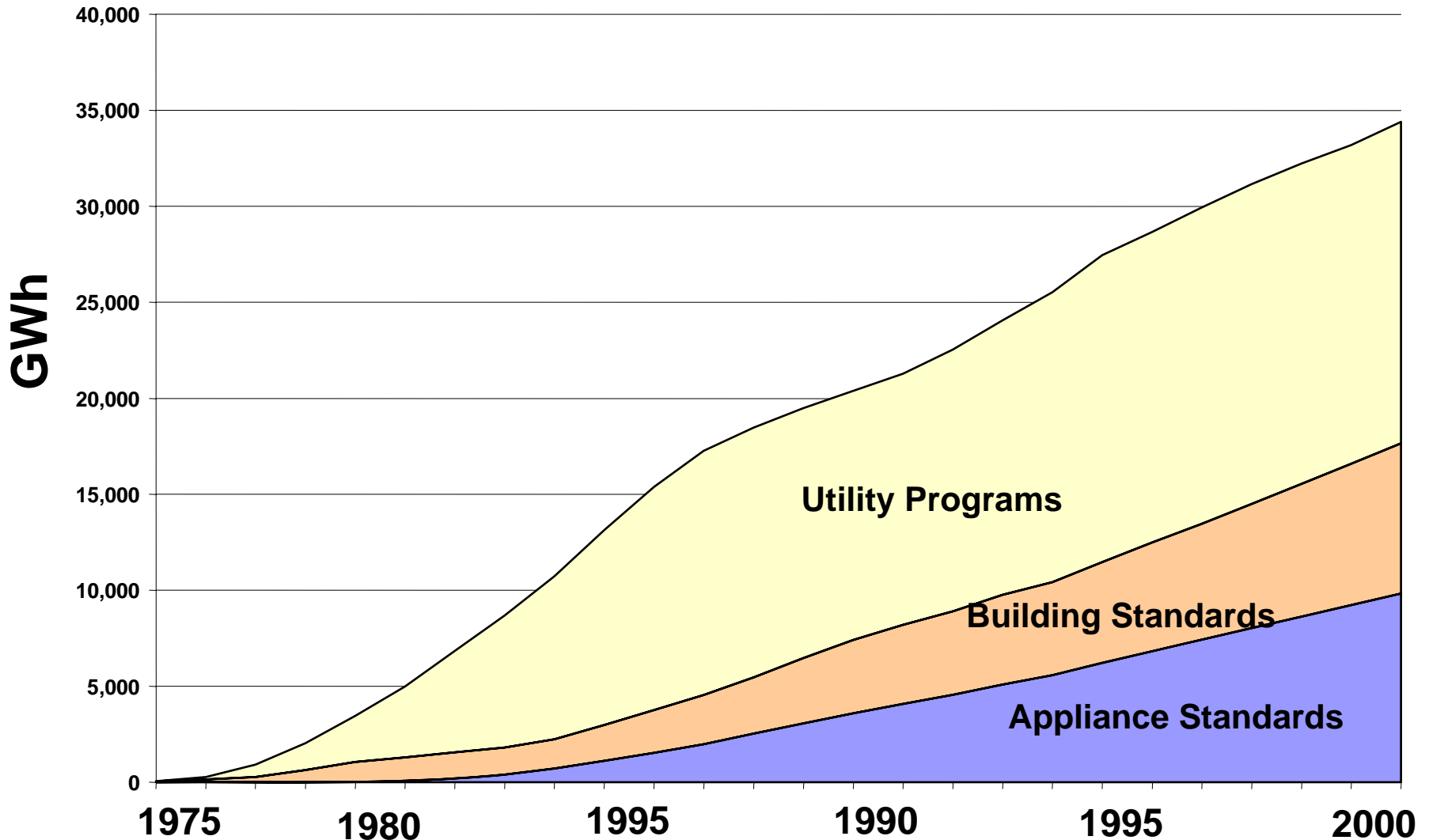
# Impact of Standards on Efficiency of 3 Appliances



Source: S. Nadel, ACEEE, in ECEEE 2003  
Summer Study, [www.eceee.org](http://www.eceee.org)

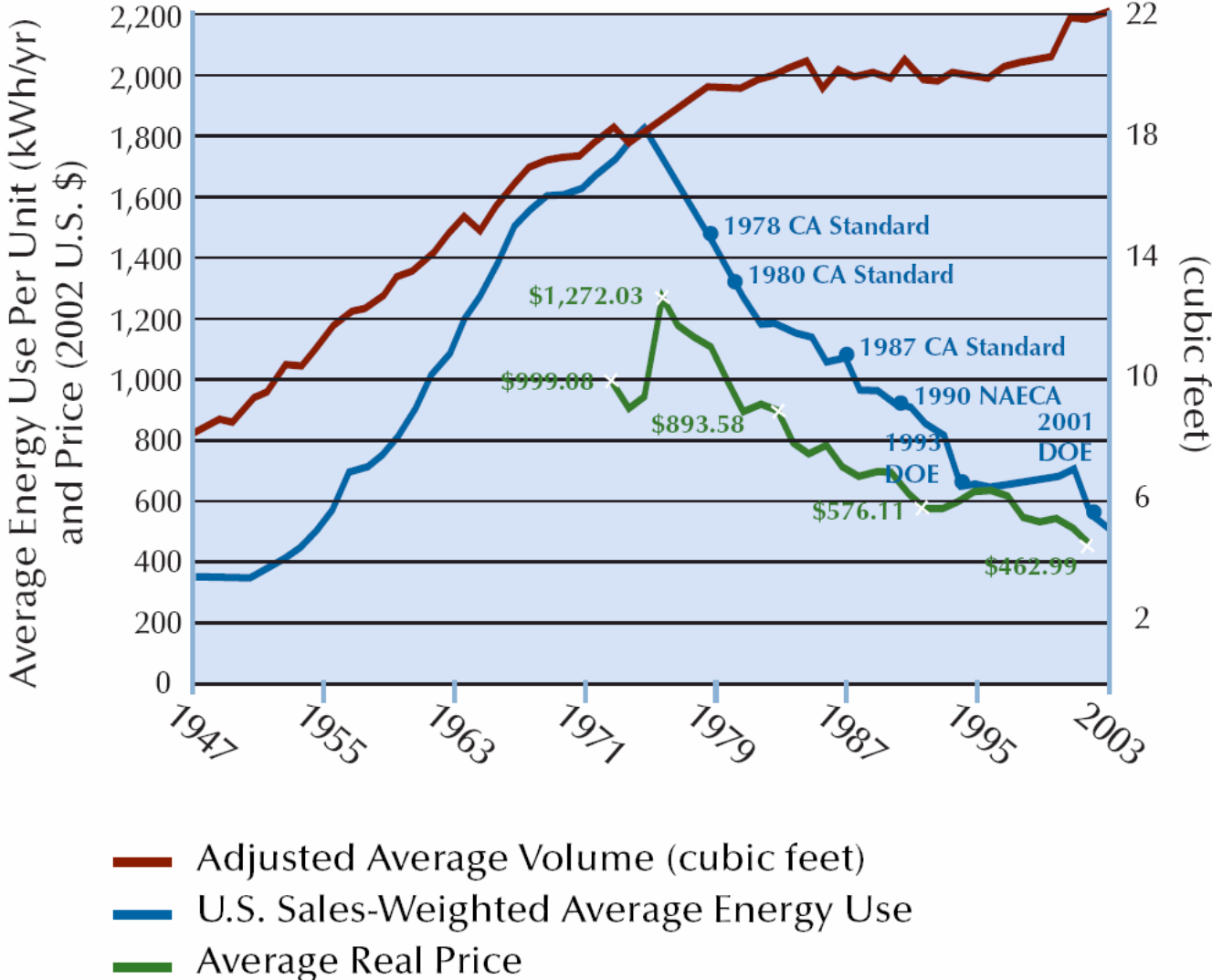


# Half of the energy savings in California were made by separating utility profits from selling more energy

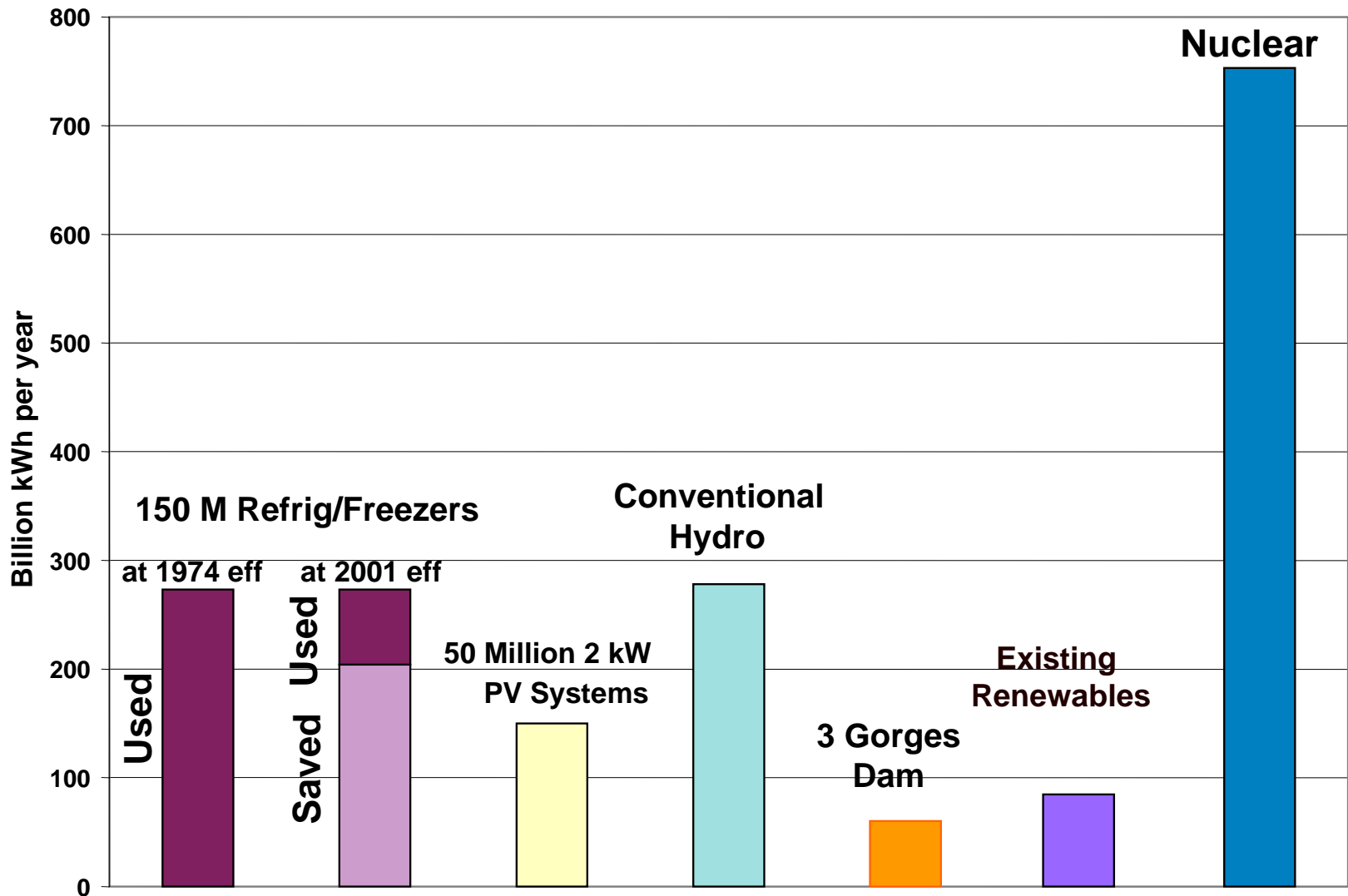


Source: Mike Messenger, Calif. Energy Commission Staff, April 2003

# Regulation stimulates technology: Refrigerator efficiency standards and performance. The *expectation* of efficiency standards also stimulated industry innovation



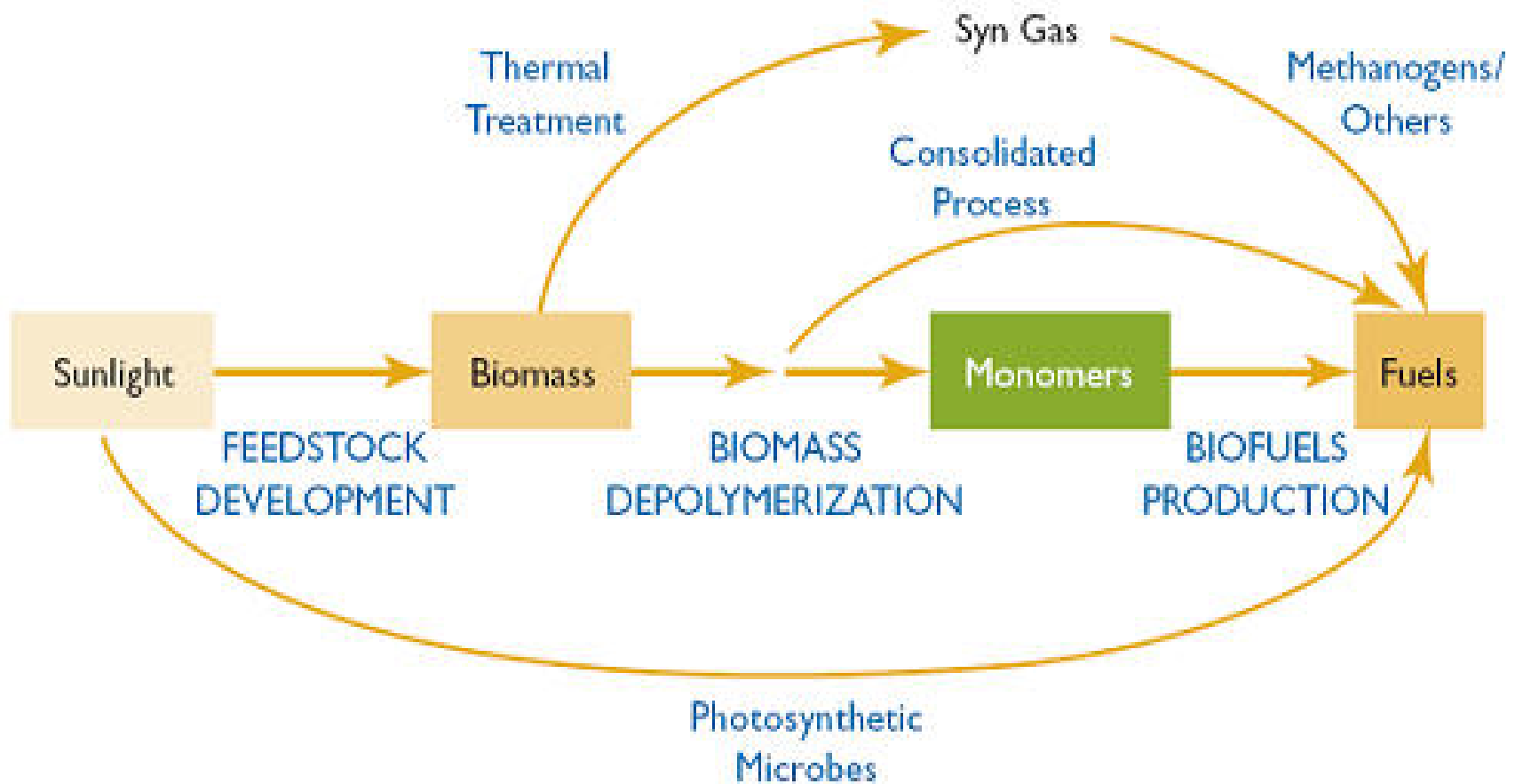
# US Electricity Use of Refrigerators and Freezers compared to sources of electricity



# Recommendations

1. Meeting the basic energy needs of the poorest people on this planet is a moral and social imperative that must be pursued in concert with sustainability objectives.
2. Concerted efforts must be made to improve energy efficiency and reduce the carbon intensity of the world economy.
3. Technologies for capturing and sequestering carbon from fossil fuels can play a central role in the cost-effective management of global carbon dioxide emissions.
4. To reduce future geopolitical conflict and economic vulnerability associated with competition for oil and natural gas supplies, conservation and alternative sources must be developed.

5. Nuclear power (currently ~16% of world electricity generation) can play a significant role. Major concerns are COST, safety, and weapons proliferation.
6. Renewable energy offers immense opportunities. Acceleration will occur if:
  - Price on carbon (\$100 - 150/avoided ton of carbon, \$27–\$41 per ton of carbon dioxide equivalent.)
  - Initial subsidies (wind, biofuels in Brazil, ..) Subsidies should be targeted to promising but not-yet-commercial technologies and decline gradually over time.
  - Renewable portfolio standards (which set specific goals for renewable energy deployment) and “reverse auctions” (in which renewable energy developers bid for a share of limited public funds on the basis of the minimum subsidy they require on a per-kWh basis).



- Invest in research and development on more transformational technologies, such as new classes of solar cells that can be made with thin-film, continuous, wet chemistry processes, new methods to convert cellulose to fuels (ethanol, butanol and beyond), new look at algae production of fuels, ...
- Assess and mitigate any negative environmental impacts associated with the large-scale deployment of renewable energy technologies. Although these technologies offer many environmental benefits, they may also pose new environmental risks as a result of their low power density and the consequently large scales at which they must be deployed.

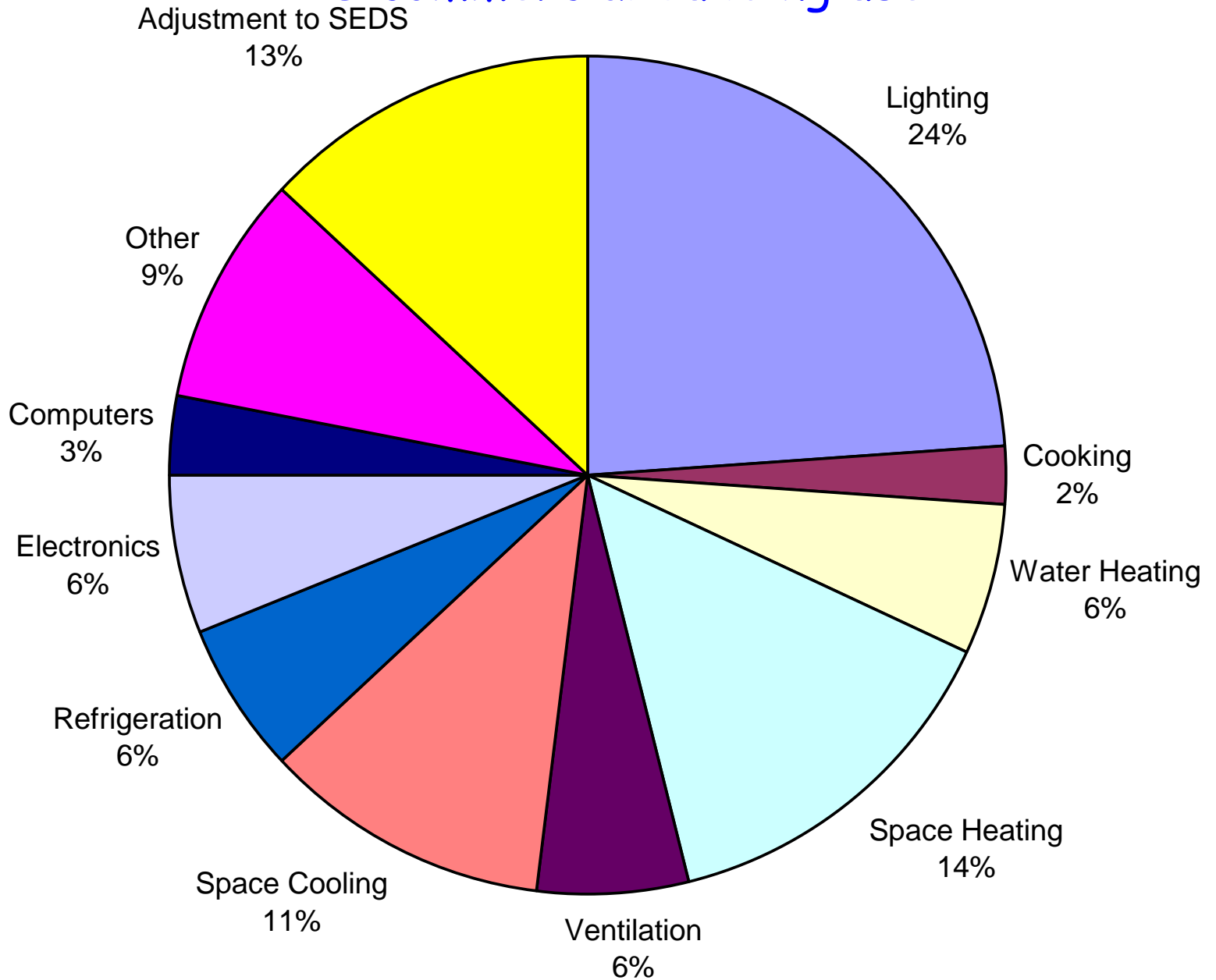
6. Develop better energy storage technologies, new energy carriers, and improved transmission infrastructure (DC).

(DC computer centers, buildings, factories ...)

7. The science and technology community—together with the general public— must be effectively engaged.



# US commercial building use



## Japan's Top Runner Program (1999)

Appliances, machinery, and equipment used in building and transportation

Identify best in product category efficiency. The energy performance of this “top runner” model is used to set a target for **all** manufacturers to achieve within the next four to eight years. (Weighted average efficiency of all the models). More flexibility than minimum efficiency standards for all products: manufacturers can still sell less efficient models, provided they more than compensate with higher efficiency in other models.

Manufacturers are only obliged to “make efforts”, but the Top Runner program has achieved good results in Japan. Company image important.

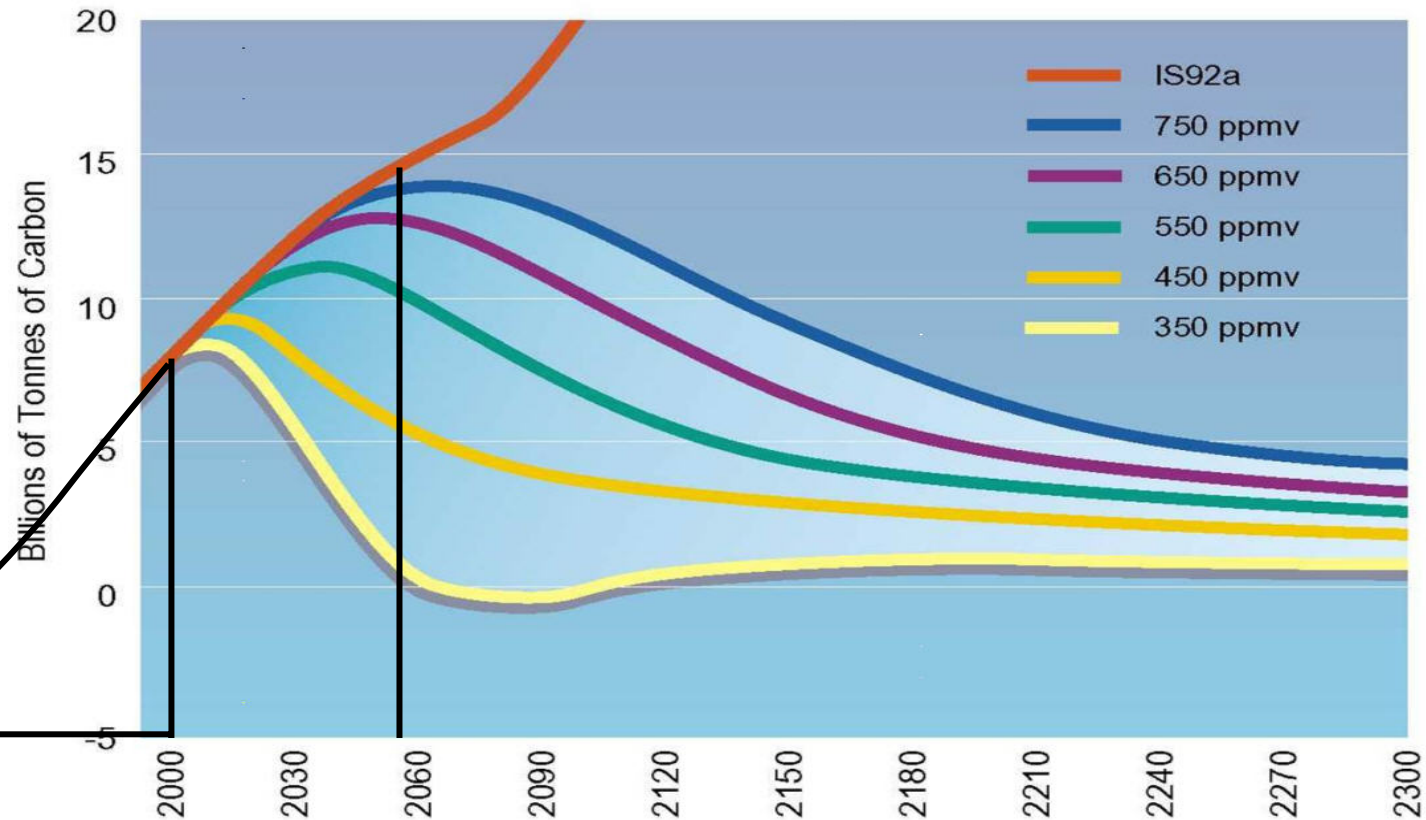
Top Runner program includes a consumer labeling information. Individual product models that do not meet the target can remain on the market, but receive an orange label. Models that do meet the target receive a green label.

## Efficiency in the industrial sector

- Iron and steel
- Cement
- Aluminum
- Chemicals
- Petroleum refining
- Pulp and paper

Energy-intensive industries account for more than half of the sector's energy consumption in most countries.

# Emissions Trajectories for various atmospheric CO<sub>2</sub> concentration ceilings



**Source: Fourth Assessment of the Intergovernmental Panel on Climate Change; Summary for Policy Makers, February 2007.**

## Potential effects of climate change could lead to:

- Increased damage from storms, floods, wildfires
- Property losses and population displacement from sea-level rise
- Productivity of farms, forests, & fisheries
- Increased species extinction
- Spread of disease (malaria, cholera, dengue fever, ...)
- **Water Shortages**

# Emissions pathways, climate change, and impacts on California

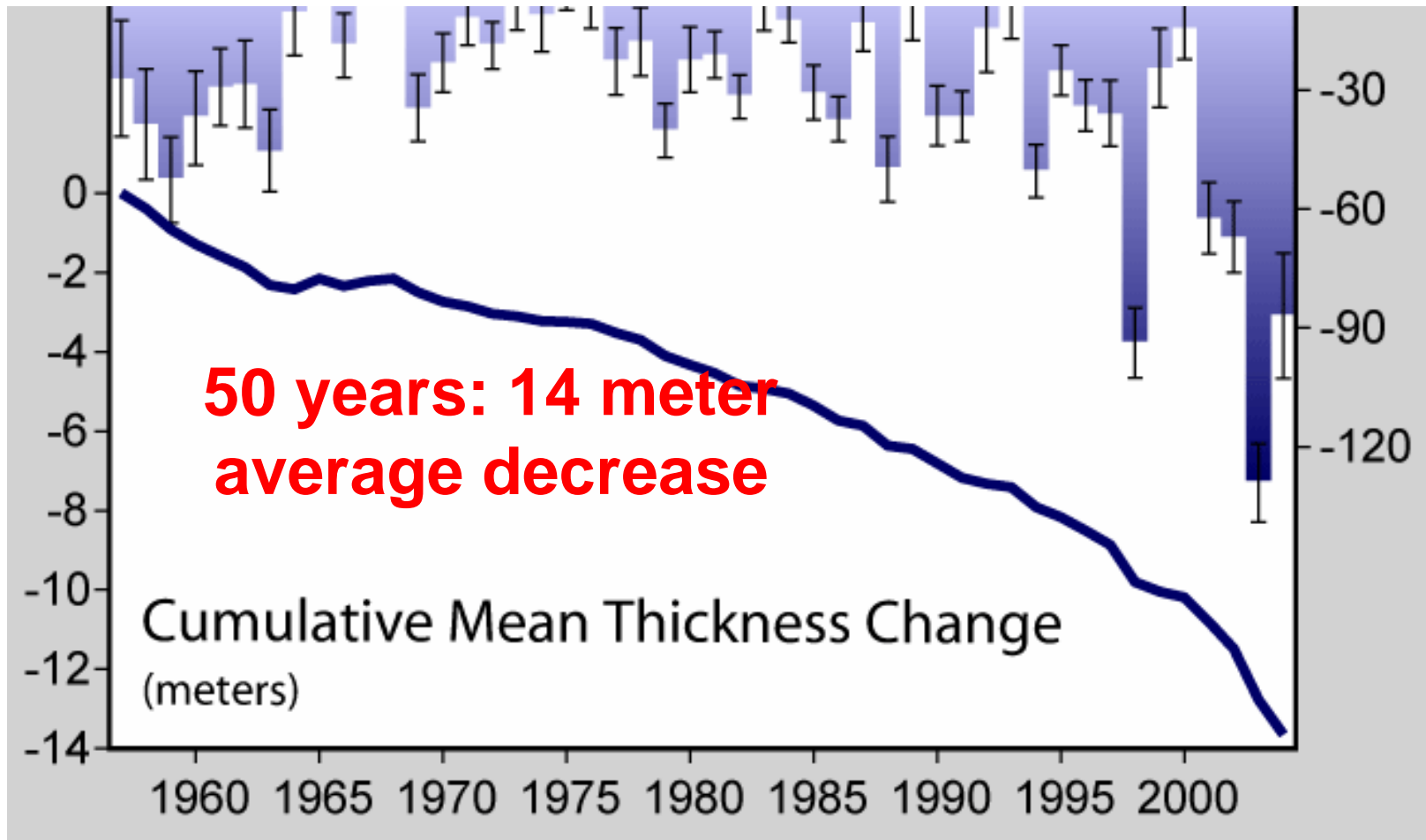
Proceedings of National Academy of Sciences (2004)

Using two climate models that bracket most of carbon emissions scenarios:

	<u>B1</u>	<u>A1 fi</u>
Heat wave mortality:	2-3x	5-7x
Alpine/subalpine forests	50–75%	75–90%
Sierra snowpack	30–70%	73–90%

“...[this] could fundamentally disrupt California’s water rights system.”

**Tibetan snow and glacial melt helps feed help feed ten of Asia's largest rivers, which bring freshwater to half of Earth's population.**



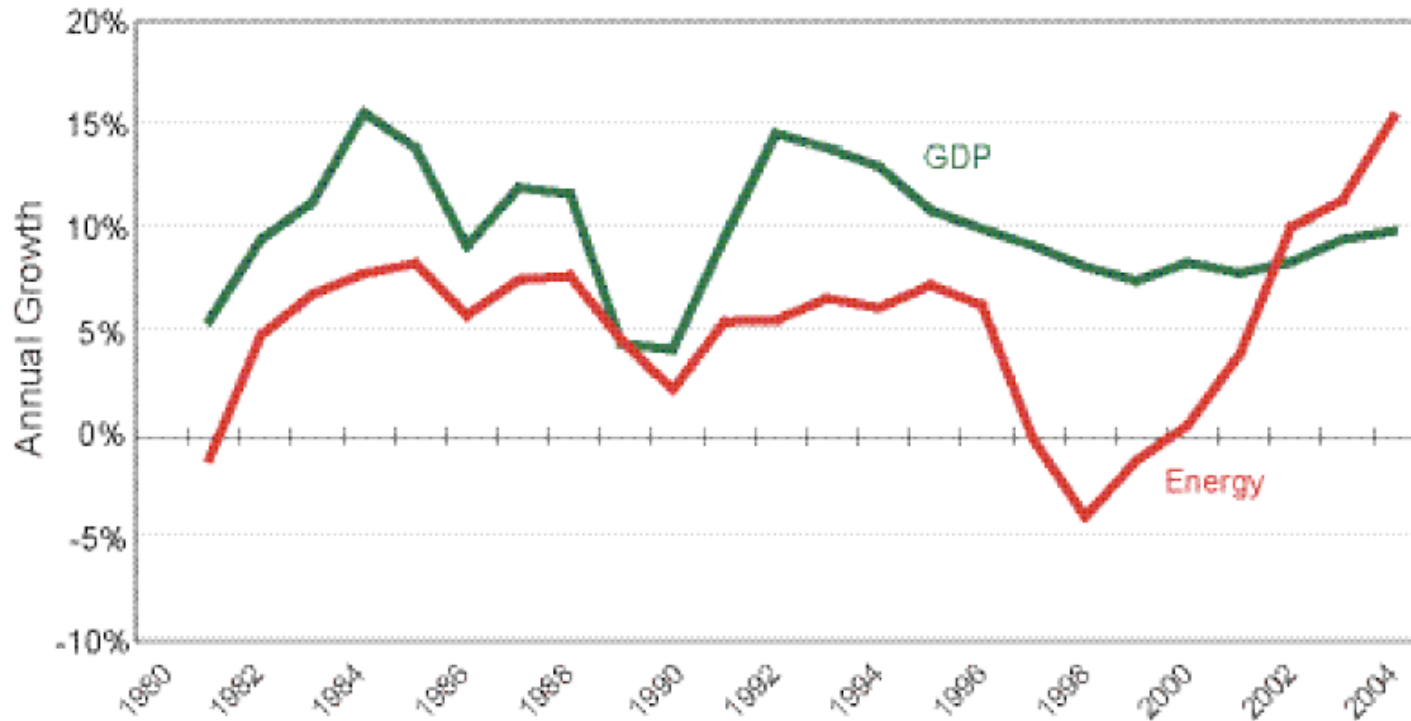
50 years: 14 meter avg. decrease world wide.

Tibetan glacier is shrinking by ~1.2m / yr





# Energy use in China is growing faster than GDP



Source: National Bureau of Statistics (various years) China Statistical Yearbook (Beijing: China Statistics Press); NBS (2005) China Statistical Communique of the People's Republic of China on the 2004 National Economic and Social Development ([www.stats.gov.cn](http://www.stats.gov.cn)); LBNL estimates.