Energy Problems; Energy Policy; Energy Efficiency

Classes without Quizzes

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Three Public Policy Drivers for Energy Policy

- **Environmental Protection**
  - **Global Climate Change**

- **Security**
  - **Oil/International vulnerability**
  - **Vulnerability of infrastructure to terrorism, natural disaster, or human error**

- **Economics (Public policy and private sector issues)**
  - **Prices of electricity, gasoline, natural gas**
  - **Price volatility: oil, natural gas, wholesale electricity**
  - **Management for energy efficiency can be very profitable**

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Environmental

Fossil fuels account for

- **98% of the US carbon dioxide net releases into the atmosphere**
- **82% of the releases of greenhouse gases, measured on a carbon equivalent basis.**

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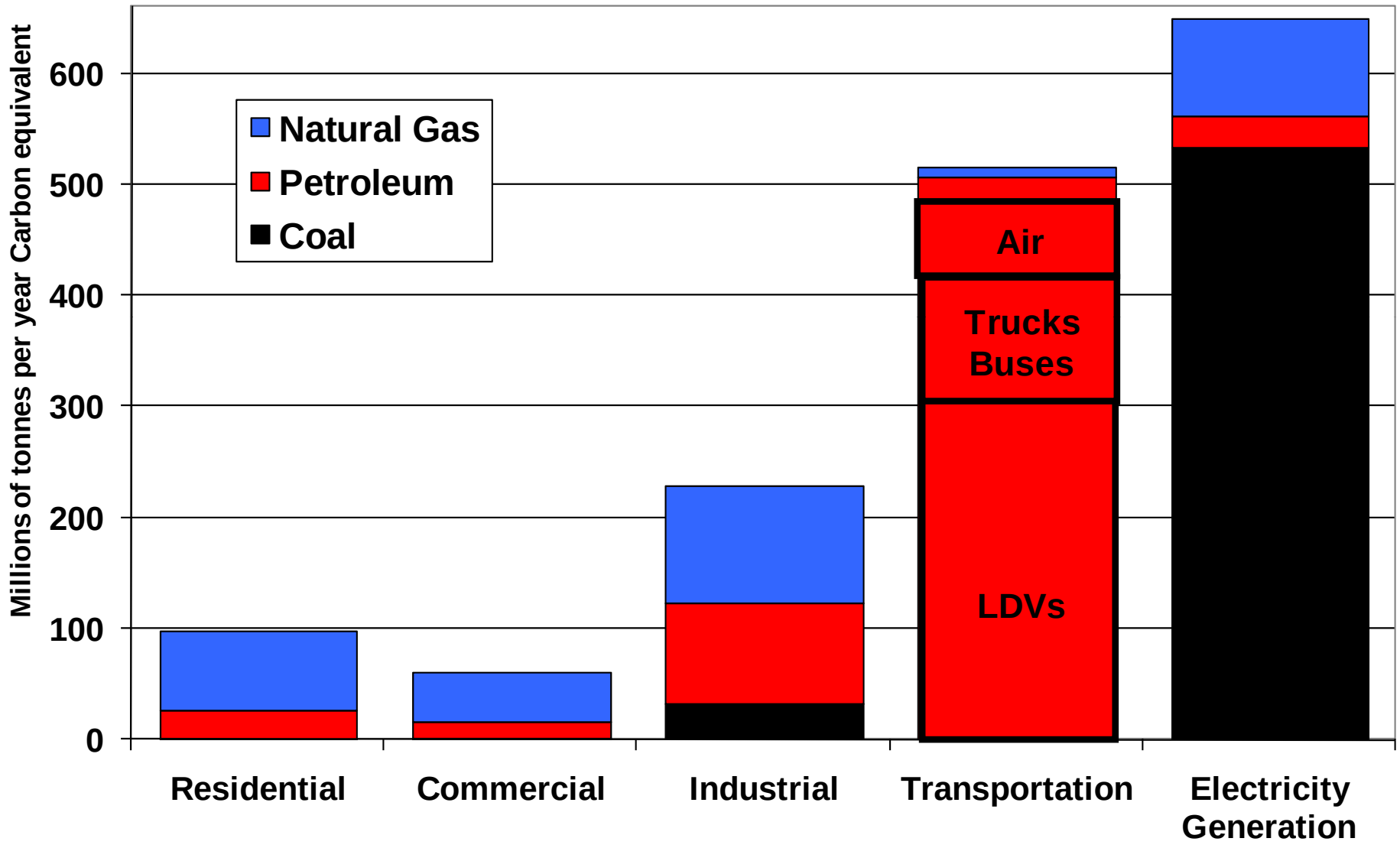
U.S. CO_2 Emissions 2005



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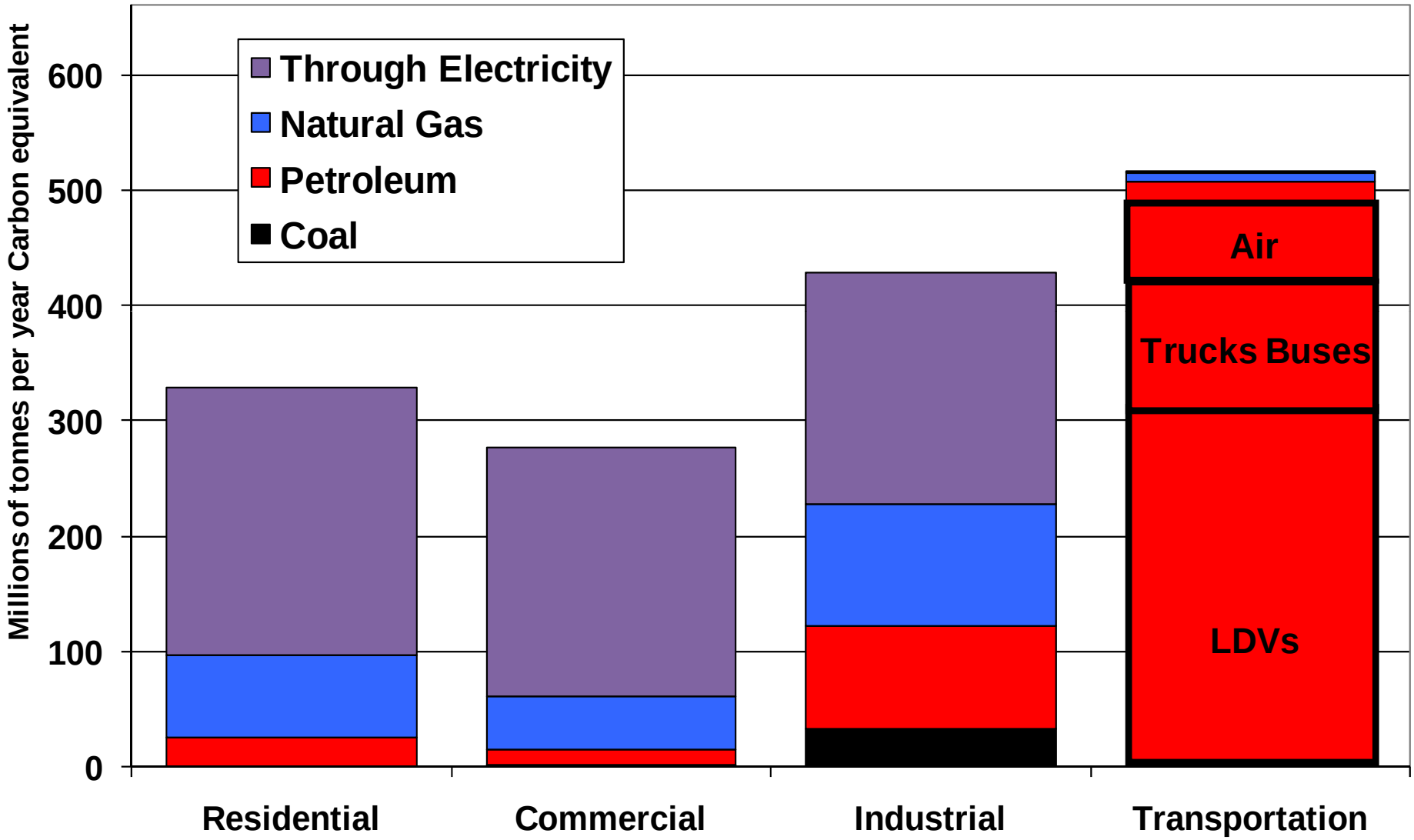
Source: U.S. EPA Inventory of Greenhouse Gas Emissions, April 2007

U.S. CO_2 Emissions 2005



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Source: U.S. EPA Inventory of Greenhouse Gas Emissions, April 2007

Energy Security Issues

- Production of oil concentrated into unstable areas of the world
- Sudden supply reductions can sharply increase oil price
  - Short run demand elasticity about

    - 0.1 to - 0.2
  - Percentage price increase will be 5 to 10 times the percentage supply reduction
- Sudden oil price increases can lead to worldwide recession
- Petroleum revenues fund terrorist activities

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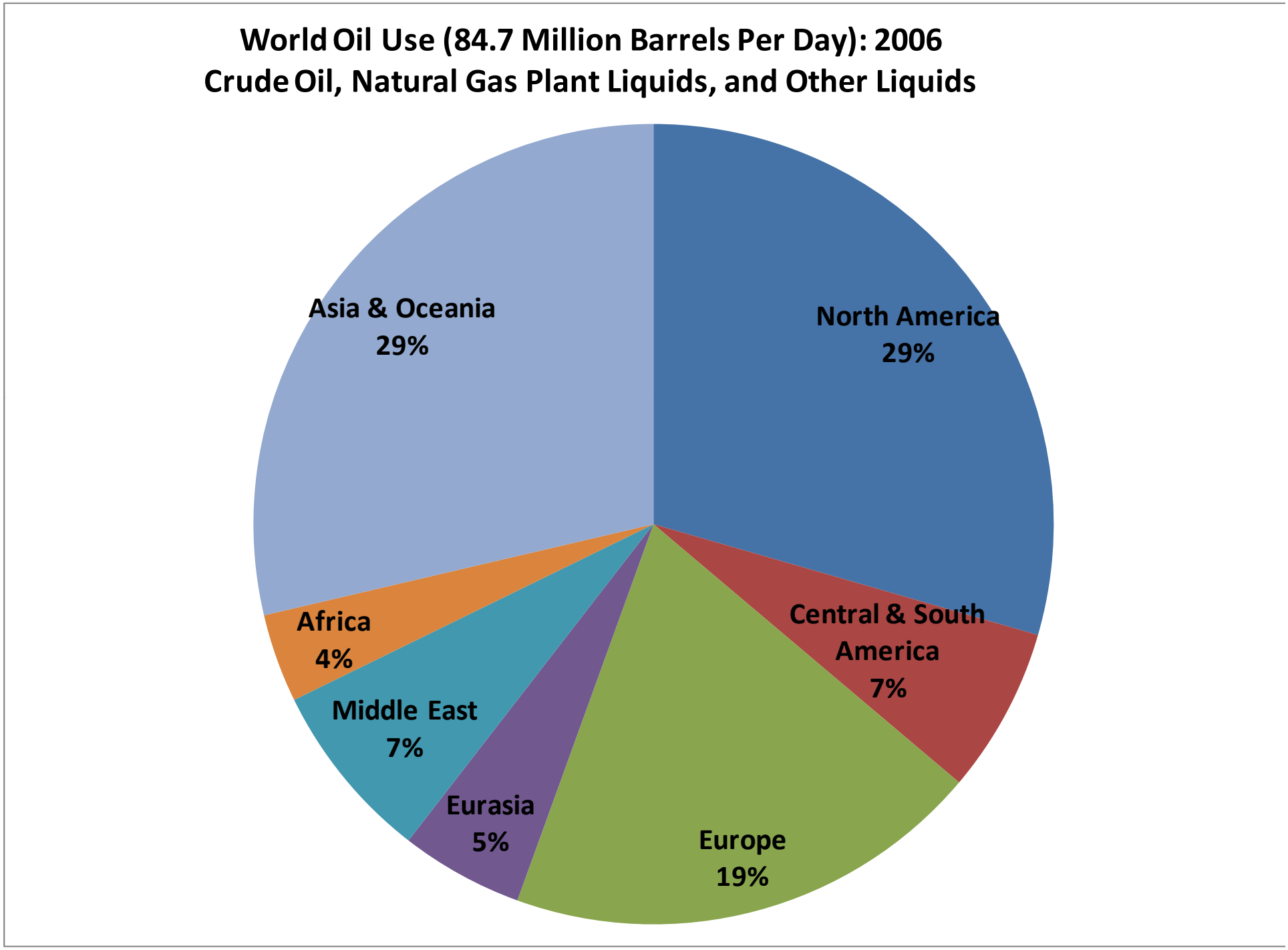
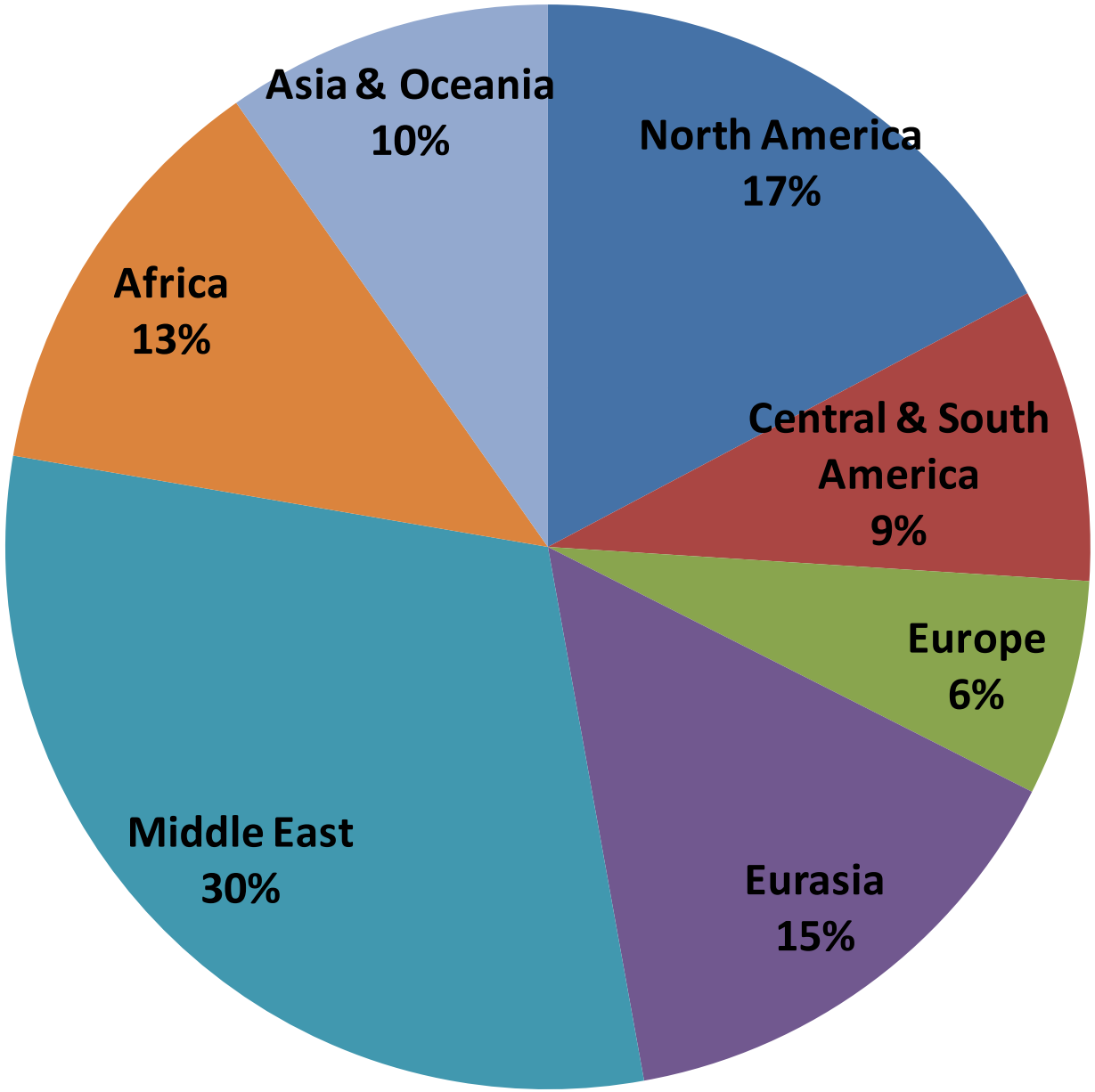

World Oil Use (84.7 Million Barrels Per Day): 2006
Crude Oil, Natural Gas Plant Liquids, and Other Liquids
Asia & Oceania
29%
North America
29%
Central & South
America
7%
Europe
19%
Eurasia
5%
Middle East
7%
Africa
4%

World Oil Production (84.5 Million Barrels Per Day): 2007
Crude Oil, Natural Gas Plant Liquids, and Other Liquids



Oil and Gas Reserves, Billion Barrels Oil Equivalent

Saudi Aramco (Saudi Arabia)	302	ExxonMobil	23
National Iranian Oil Co	302	Pertamina (Indonesia)	22
Gazprom (Russia)	198	Lukoil (Russia)	21
Iraqi National Oil Co	136	BP	19
Qatar Petroleum	133	Pemex (Mexico)	19
Kuwait Petroleum Co	109	PetroChina	19
Petroleos de Venezuela	105	Shell	16
Adnoc (Abu Dhabi)	80	Yukos (Russia)	13
Nigerian Natnl Petroleum Co	41	Chevron	12
Sonatrach (Algeria)	38	Petrobras (Brazil)	12
Libya NOC	31	Total (France)	11
Rosneft (Russia)	28	Surgutneftgas (Russia)	9
Petronas (Malaysia)	26		

State Owned/Controlling Interest. **Private Sector Owned**

Energy - Economic Issues

Crude Oil prices

- Crude Oil prices are currently high
- Prices on futures markets suggest that crude oil prices are most likely to further increase
- World demand continues to grow
  - Development of China and increase in the number of passenger cars
  - India is likely to follow
- Expectation that conventional oil supply may peak soon
- Incentives for dominant suppliers to limit investment in new production capacity so as to keep prices
- Incentives for dominant suppliers to keep future prices uncertain so as to limit competitive investments

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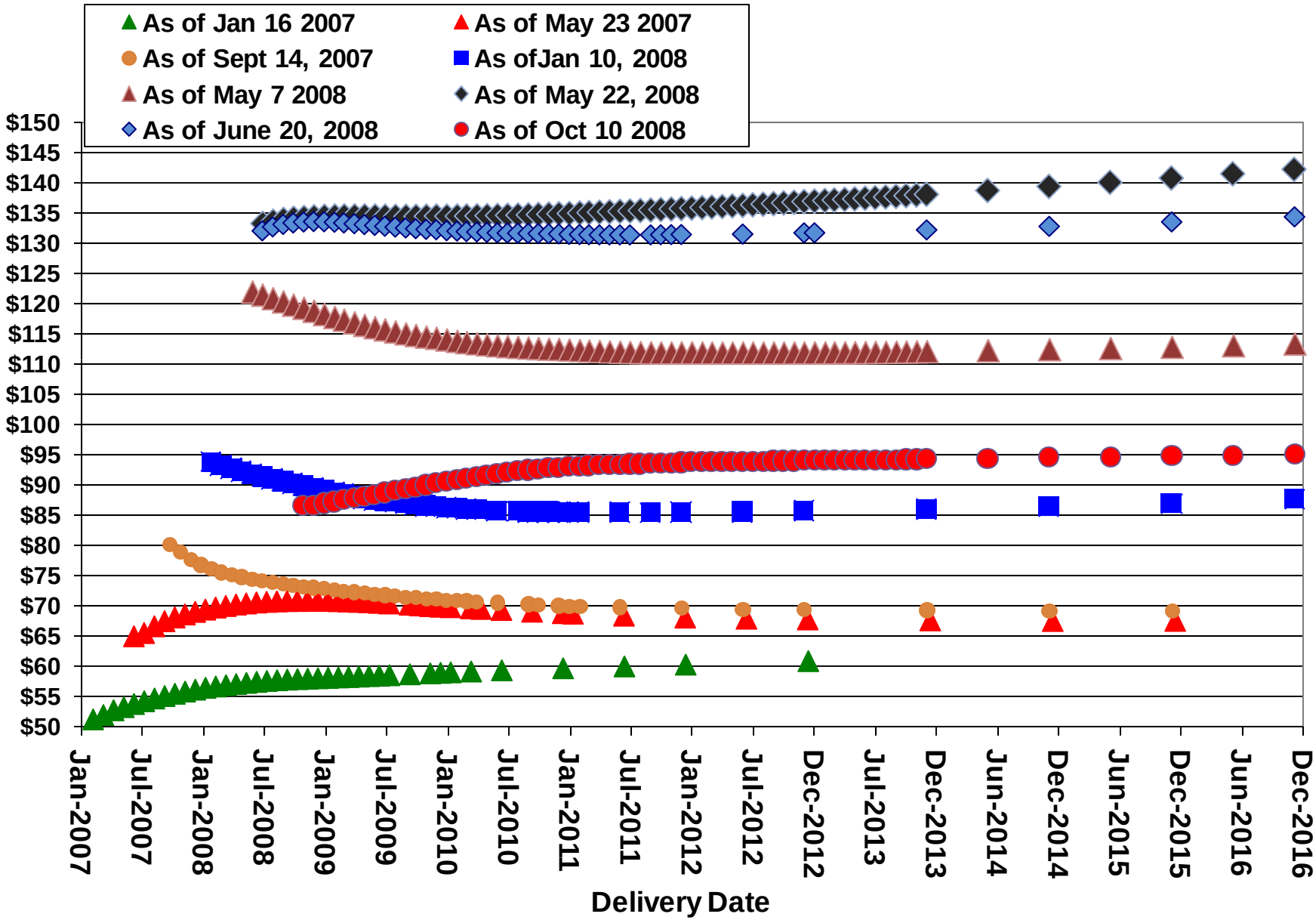
Crude Oil Futures Prices: As of Eight Dates



Energy Efficiency:

Economically Efficient Reductions in Energy Use Intensity

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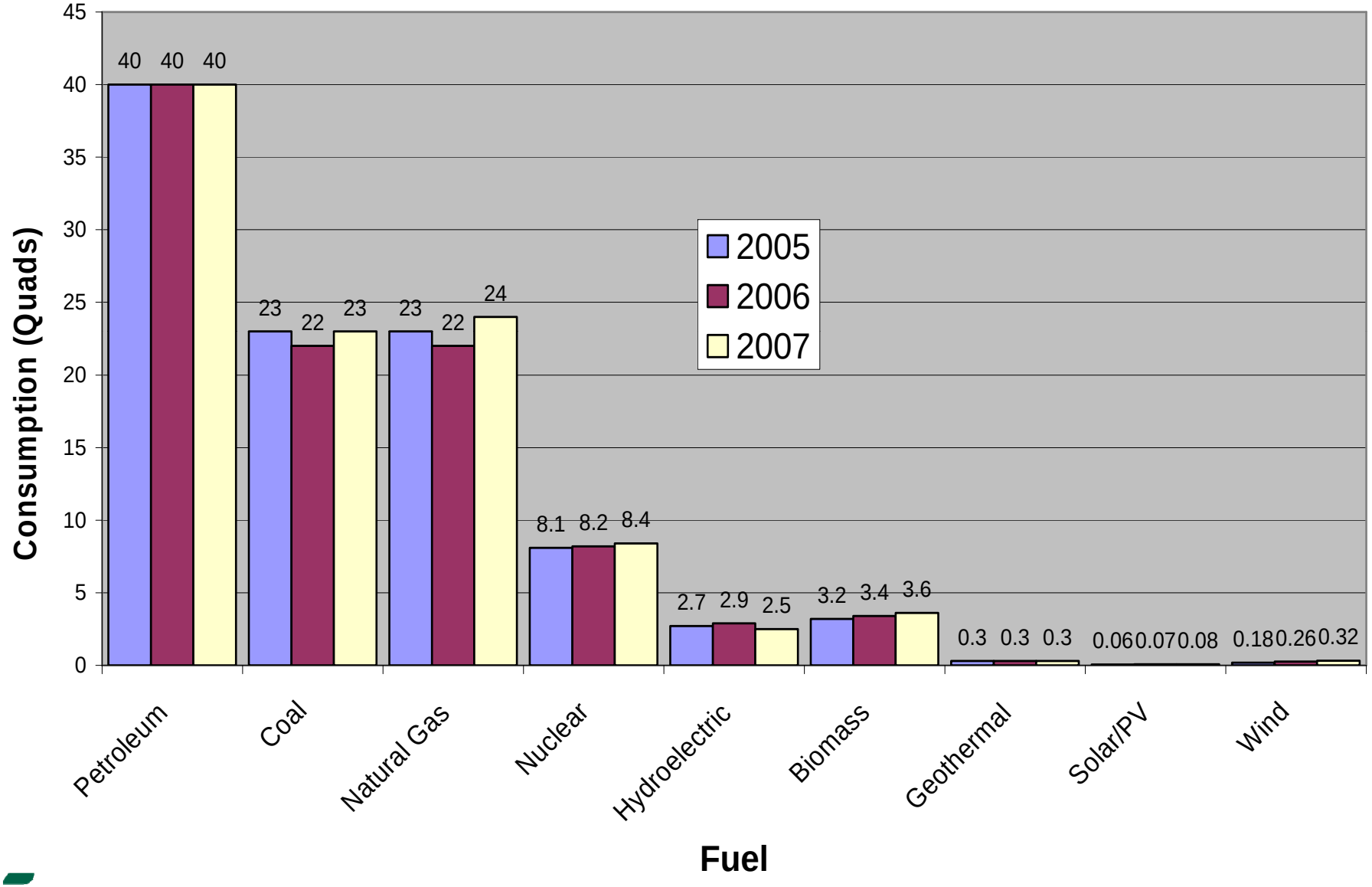
US Energy Consumption By Fuel



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Source: EIA, Annual Energy Review

Energy Efficiency Compared to CO_2-Free Energy Supply

- A 30% reduction in all energy intensity implies that 25.5 quads of fossil fuels are not used, reducing CO_2 emissions by 25.5%
- A 60-fold increase in wind plus solar can displace about 25 quads of fossil fuels.
- A factor of five increase in nuclear power can displace 30 quads of fossil fuels.
- 1 billion tons per year of celluosic conversion of biomass can displace 5 quads of gasoline.

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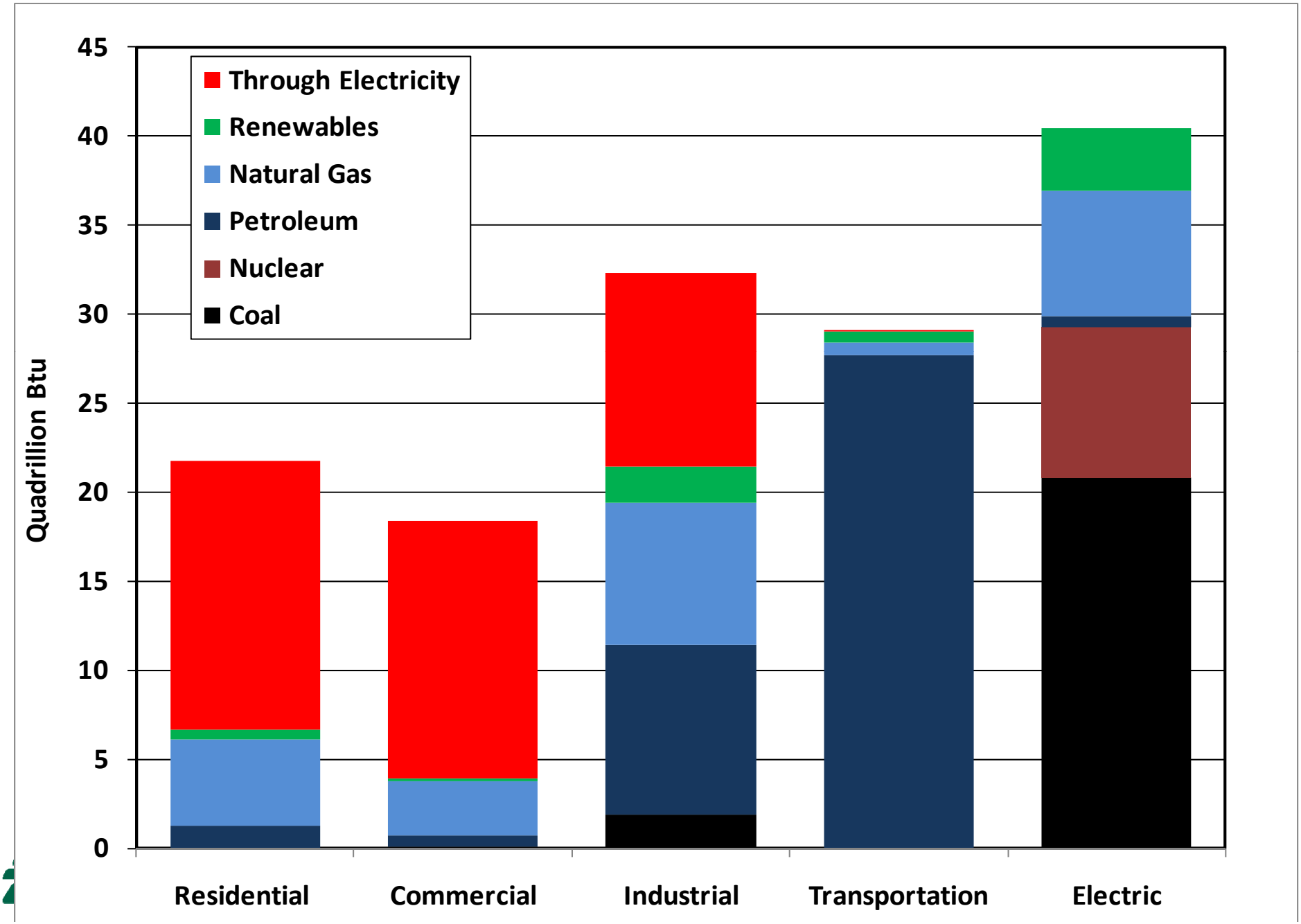
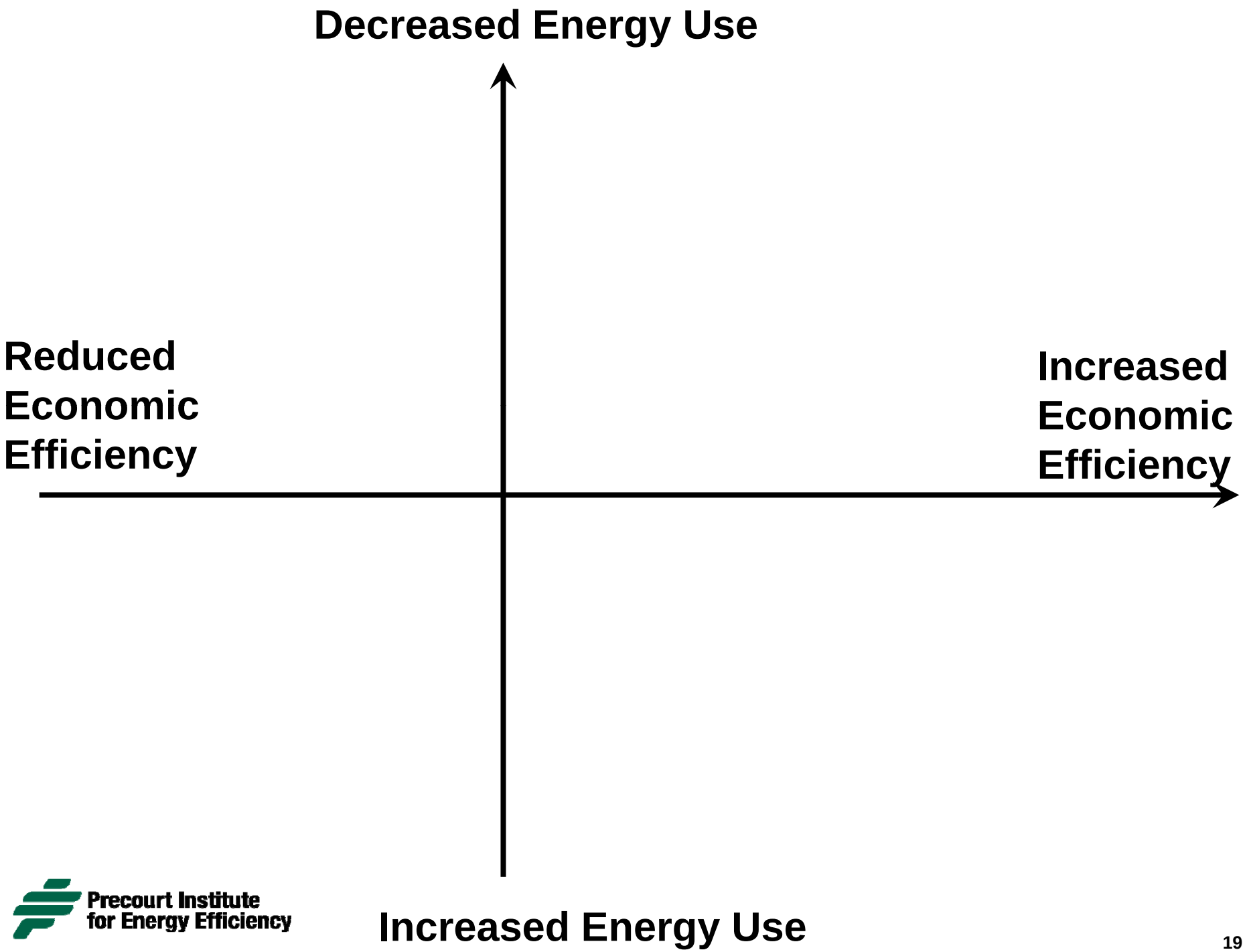
U.S. Energy Use by Sectors: 2007





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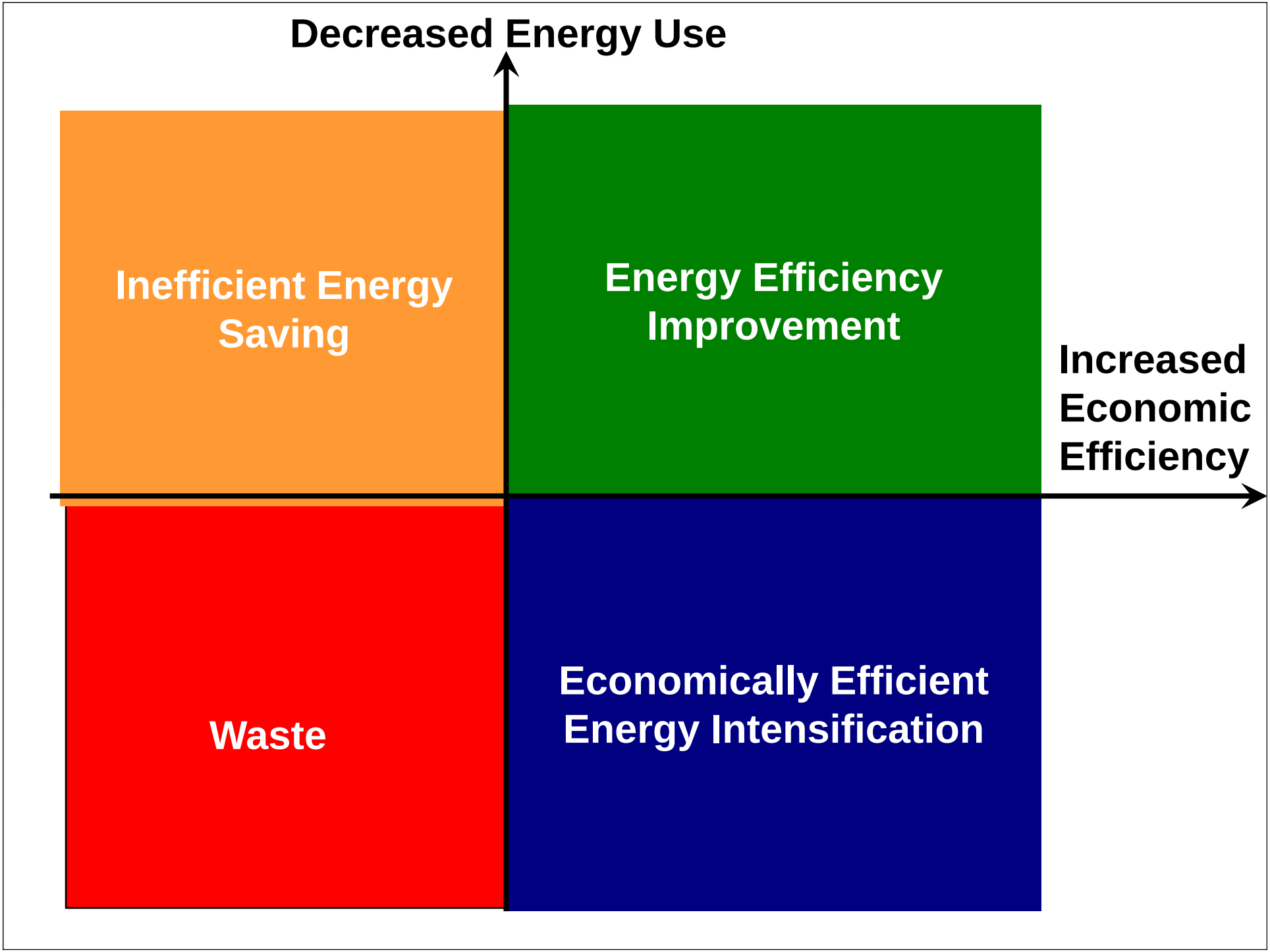
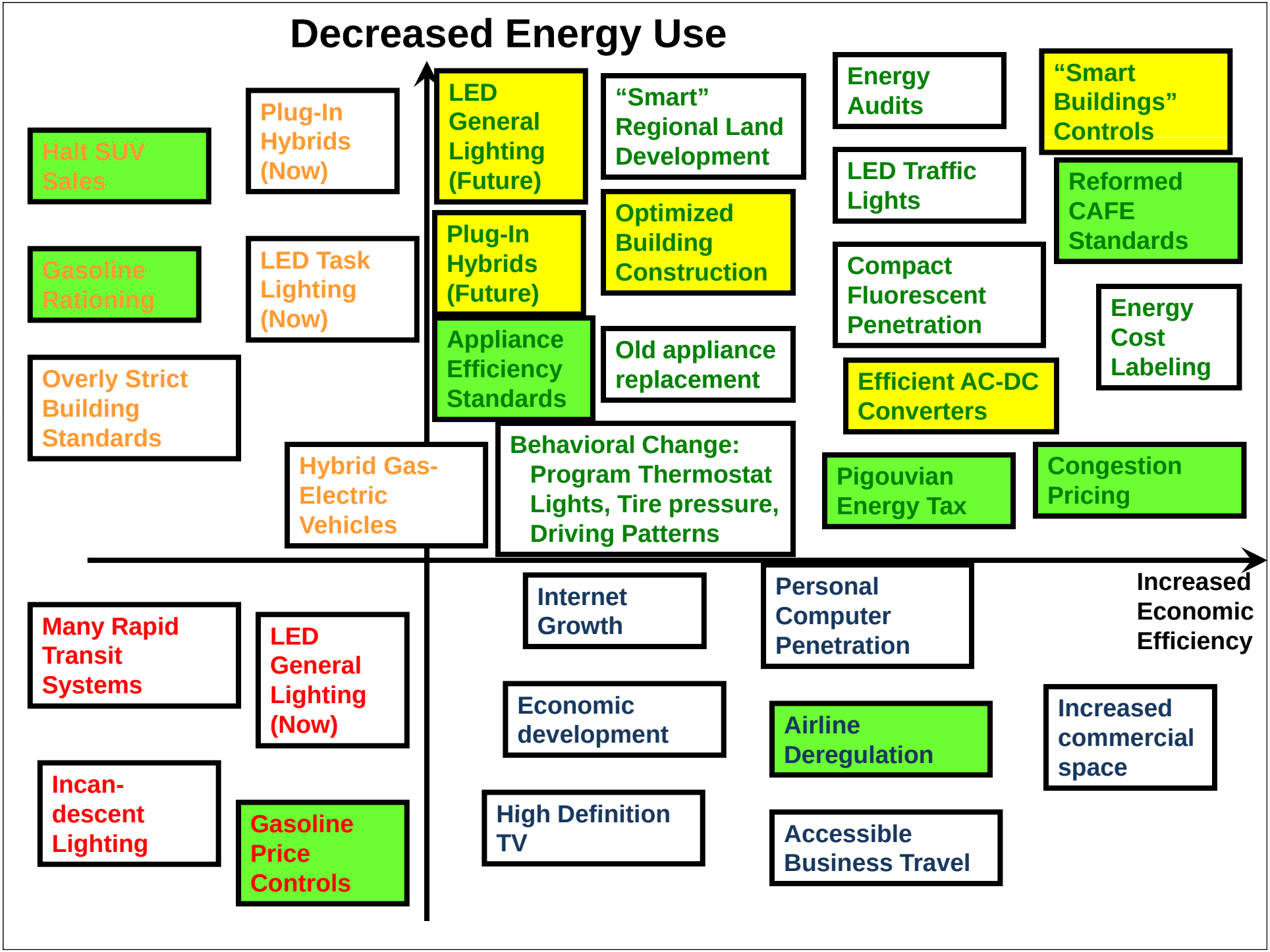
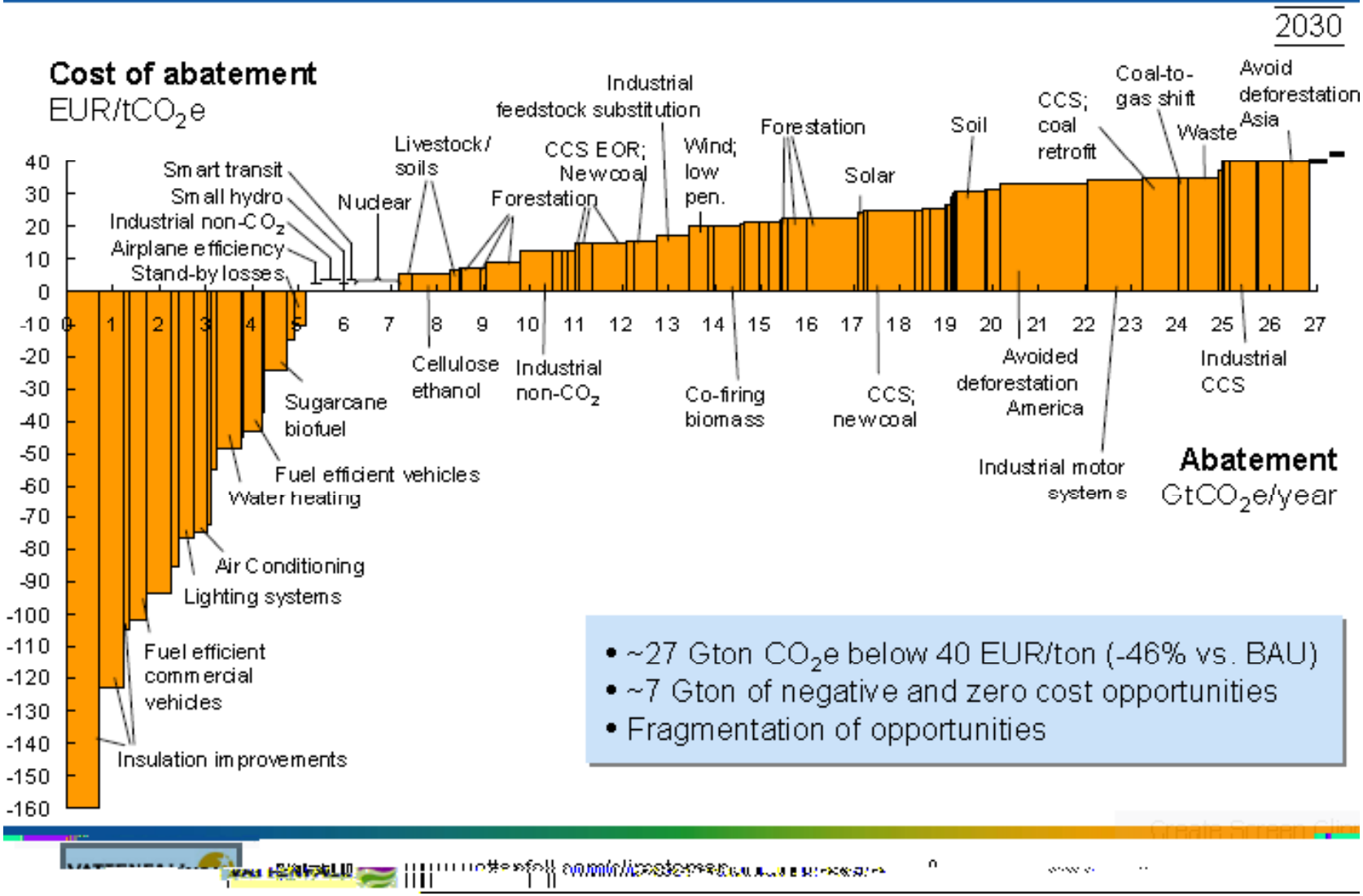

Decreased Energy Use
Inefficient Energy Saving
Energy Efficiency Improvement
Increased Economic Efficiency
Waste
Economically Efficient Energy Intensification


Decreased Energy Use
Halt SUV Sales
Plug-In Hybrids (Now)
LED General Lighting (Future)
"Smart" Regional Land Development
Energy Audits
"Smart Buildings" Controls
LED Traffic Lights
Reformed CAFE Standards
Gasoline Rationing
LED Task Lighting (Now)
Plug-In Hybrids (Future)
Optimized Building Construction
Compact Fluorescent Penetration
Energy Cost Labeling
Overly Strict Building Standards
Appliance Efficiency Standards
Old appliance replacement
Efficient AC-DC Converters
Hybrid Gas-Electric Vehicles
Behavioral Change: Program Thermostat Lights, Tire pressure, Driving Patterns
Pigouvian Energy Tax
Congestion Pricing
Increased Economic Efficiency
Many Rapid Transit Systems
LED General Lighting (Now)
Internet Growth
Personal Computer Penetration
Economic development
Airline Deregulation
Increased commercial space
Incan-descent Lighting
Gasoline Price Controls
High Definition TV
Accessible Business Travel

Global cost curve of GHG abatement opportunities beyond business as usual



- ~27 Gton CO_2e below 40 EUR/ton (-46% vs. BAU)
- ~7 Gton of negative and zero cost opportunities
- Fragmentation of opportunities

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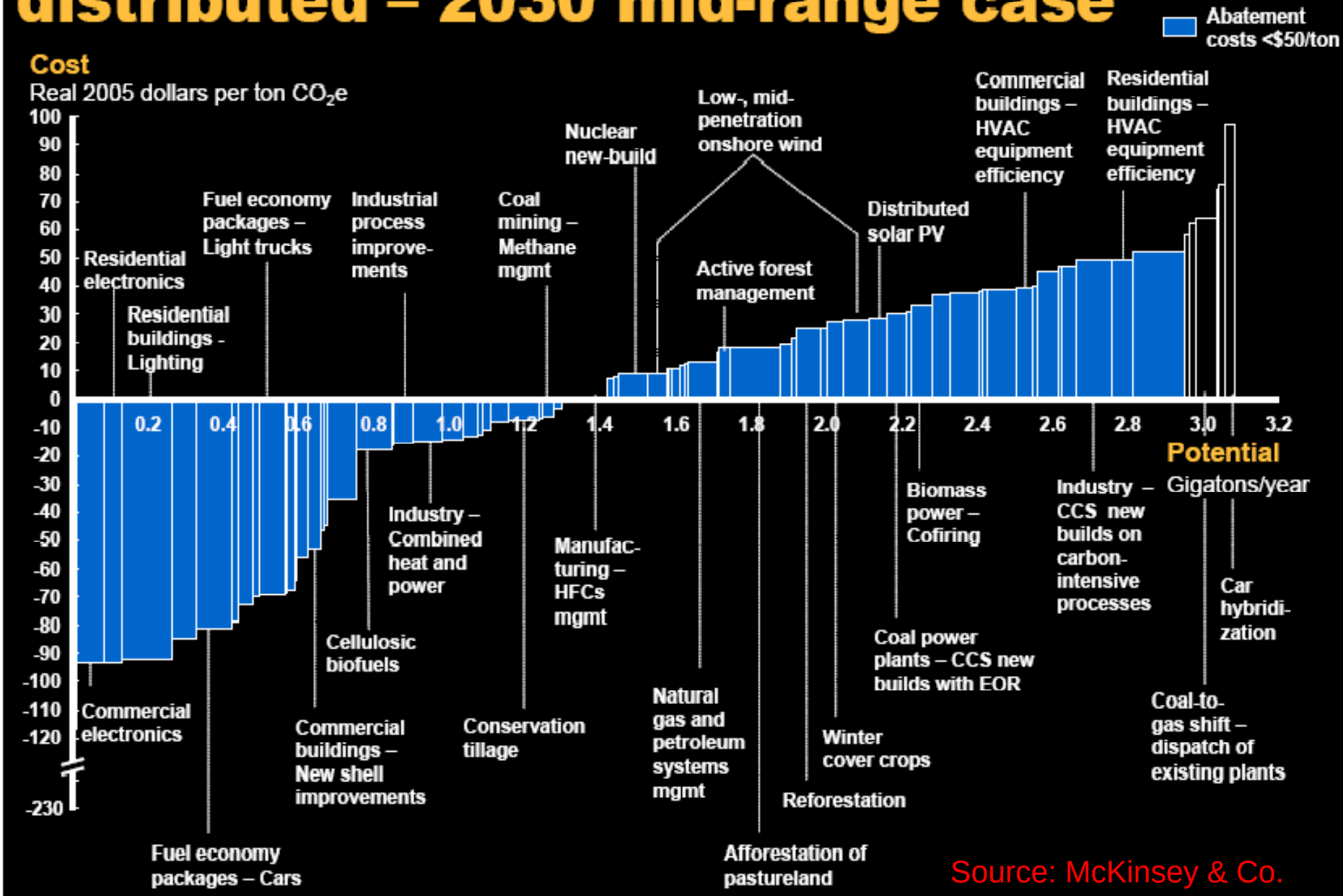
GHG reduction opportunities widely distributed – 2030 mid-range case



Source: McKinsey & Co.

Why Do Negative Cost Options Continue ?

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Market Failures and Market Barriers

Market failures	Market barriers
Unpriced costs and benefits	Low priority of energy issues
Distortionary regulatory and fiscal policies	Incomplete markets for energy efficiency
Misplaced incentives	Capital market barriers
Insufficient and inaccurate information	(Cognitive Skills)

Source: Brown, Marilyn. 2001. "Market failures and barriers as a basis for clean energy policies." *Energy Policy*

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Market Failures

- **Externalities of Energy Use (“Unpriced costs and benefits”)**
  - **Global Climate Change**
  - **Risks of Energy Price Shocks**
  - **Limitations on our Foreign Policy Options**
  - **Terms of Trade Impacts (Pecuniary “Externalities”)**
  - **Automobile risk shifting by purchase of heavy vehicles**
- **Pricing Below Marginal Cost**
  - **Non-time-differentiated Electricity Pricing**
- **Information Asymmetry/ Agency Problems**
  - **Consumer Product Marketing**
  - **New Building Construction**
- **Suboptimal Technology Options**
  - **Incomplete capture of intellectual property**
  - **Sub-optimal technology directions, due to externalities**
- **Non-Convexities**
  - **Learning By Doing Technology Spillovers**
  - **“Chicken and Egg” Problems**

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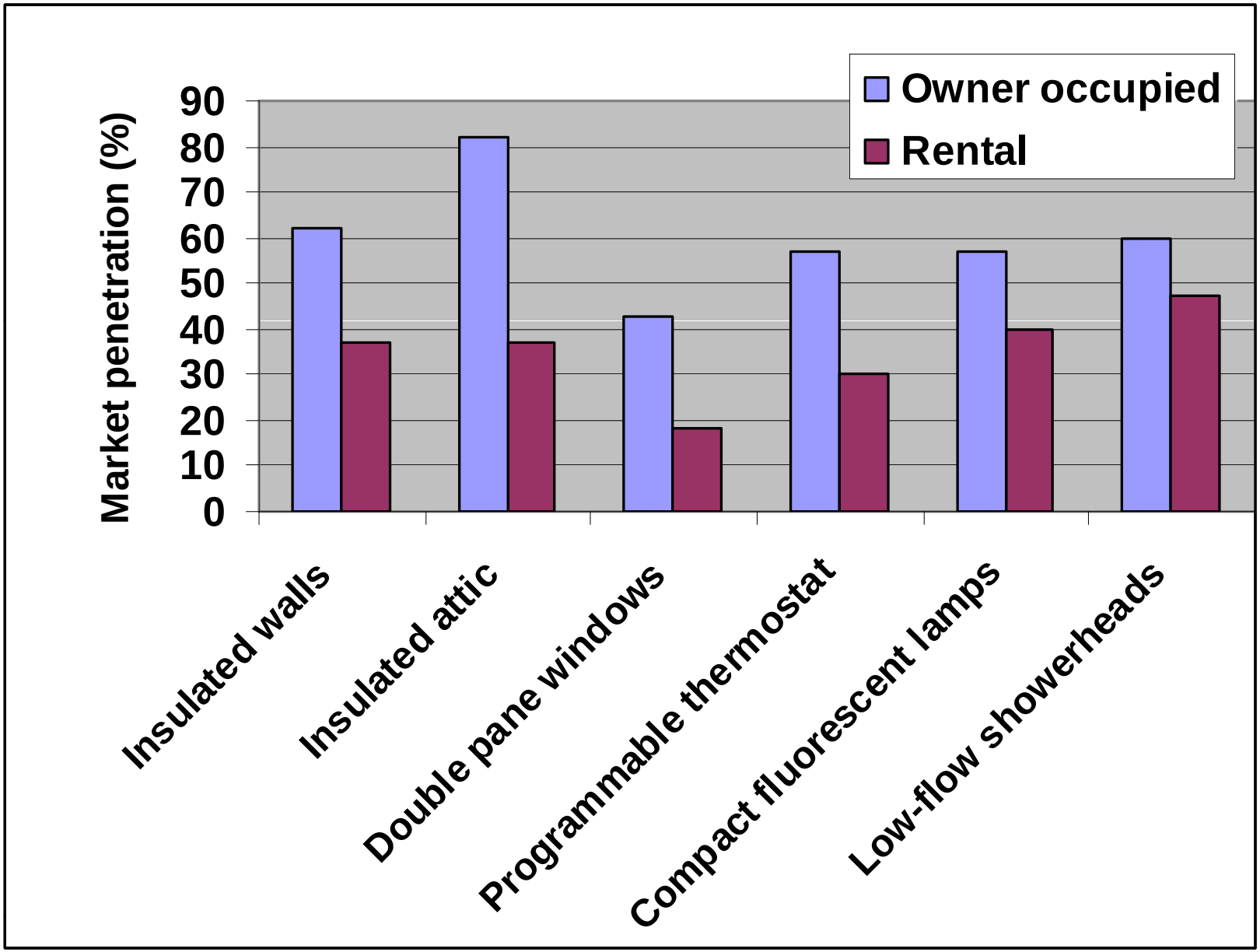
Split Incentives: Market Penetration of Energy Efficiency Measures in Owner-Occupied and Rental Housing in California (CEC 2004)



Market Barriers

- Low Priority of Energy Issues
  - Generally means that energy costs are so small that it is not worth the effort to try to optimize
- Incomplete markets for energy efficiency
  - Discrete nature of commodities offered for sale
  - Information problems when offering energy efficiency services
- Capital market barriers
  - Simply a recognition of opportunity cost of capital investments
- Cognitive issues
  - Probably very important for residential, small commercial, and individual transportation decisions

Market Barriers Example

- **Cognitive issues: automobile purchase**
  - **Automobile purchase decisions**
    - **First cost bias**
  - **Automobile design decisions**
    - **Understand first cost bias**
    - **Don’t design optimally efficient cars**
  - **Consumers don’t have option to choose optimally efficient cars because they are not offered for sale**
  - **Market stays in equilibrium**

- **Cognitive issues: programmable thermostats**
  - **2004 study. Only 20% of Americans own programmable thermostats. Of those, 70% don’t use programmable features because they're too complicated.**

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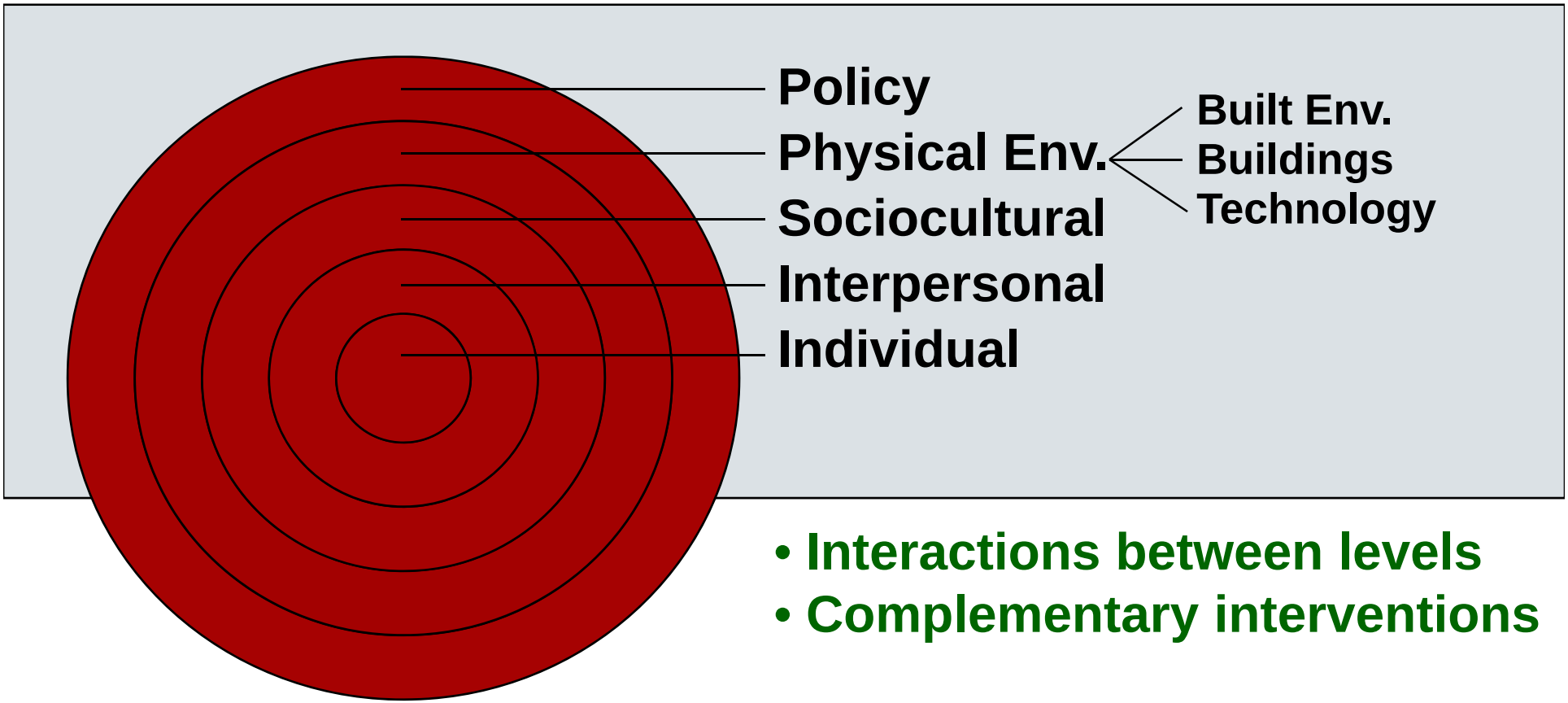
Levels of Interventions



- **Interactions between levels**
- **Complementary interventions**

Based on the socio-ecological model of health behavior

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Thanks to Carrie Armel

- **Policy interventions:**
  - **formal rules, instituted by government, utility companies**
- **Physical environment characteristics:**
  - **Built environment: e.g., is a city is walkable**
  - **Technology: e.g., are programmable thermostats are intuitive so people use them.**
- **Sociocultural level: include media communications**
  - **serial dramas and public service announcements**
- **Interpersonal or face-to-face contact**
  - **Programs at schools, faith-based organizations, Girl Scout troops, YMCAs**
- **Individual level:**
  - **people figure out changes themselves**

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Thanks to Carrie Armel

Example:
Lighting for Residential and Commercial Use

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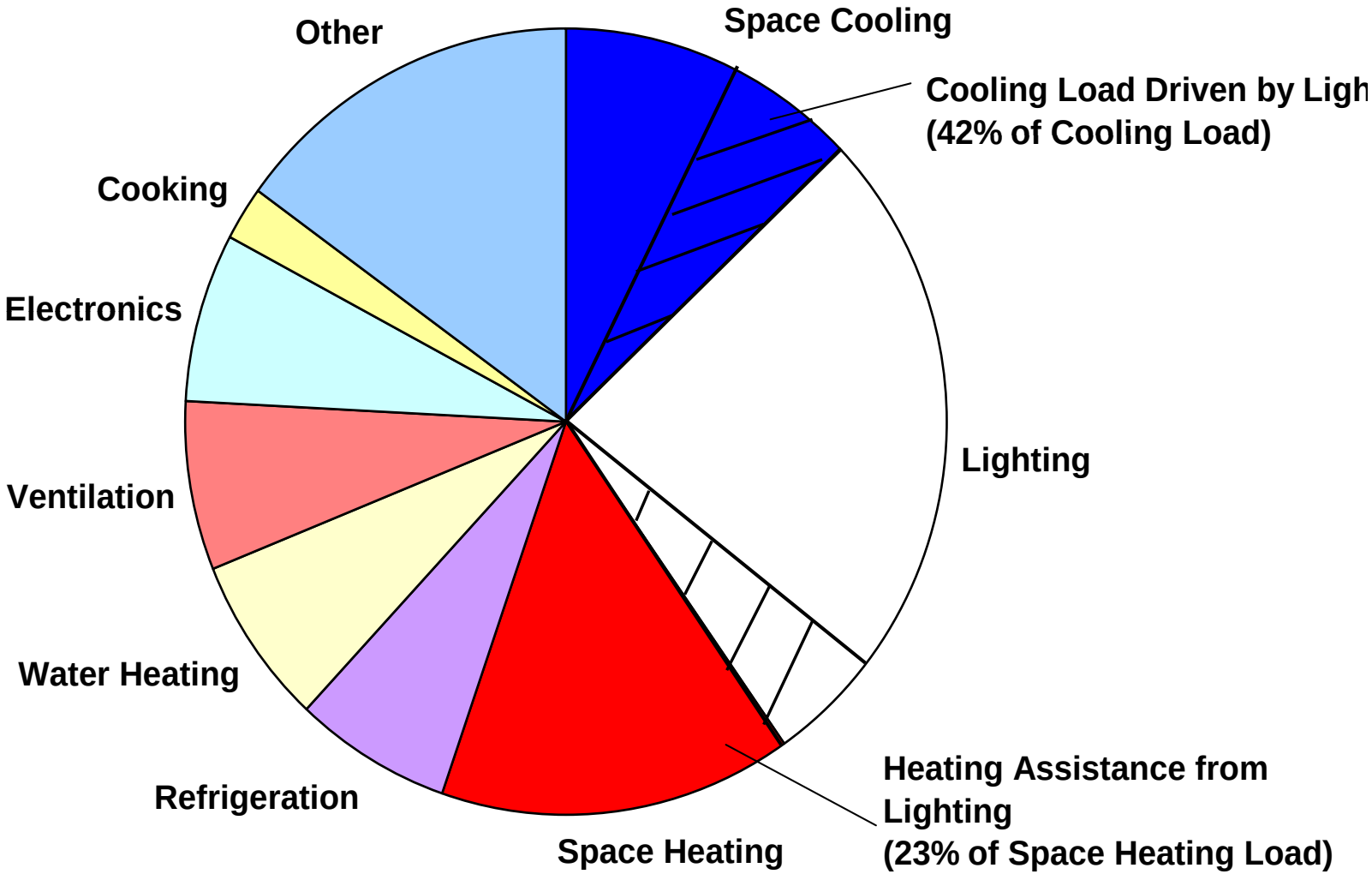
Commercial Building Energy Uses



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Source: 2006 Buildings Energy Data Book

Lighting as Share of U.S. Electricity

- **Lighting use**
  - **About 800 Terawatt hours (10^{12}) per year**
- **Electricity Generation**
  - **3815 Terawatt hours per year**
- **Lighting is 21% of all electricity use**

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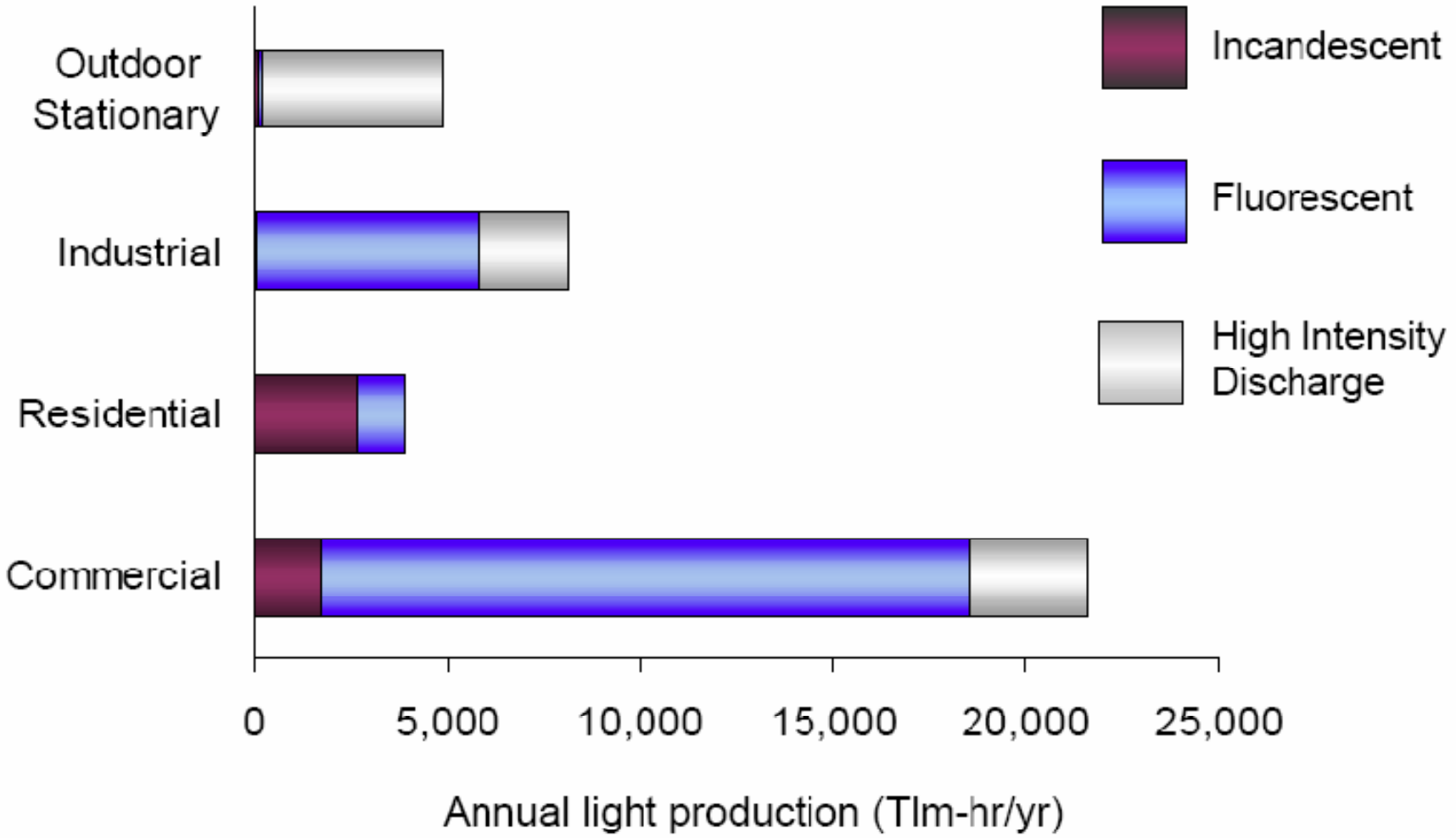

Figure 8-4. Source Light Production by Sector & Source

From "U.S. Lighting Market Characterization" prepared for DOE EERE by Navigant Consulting, 2002

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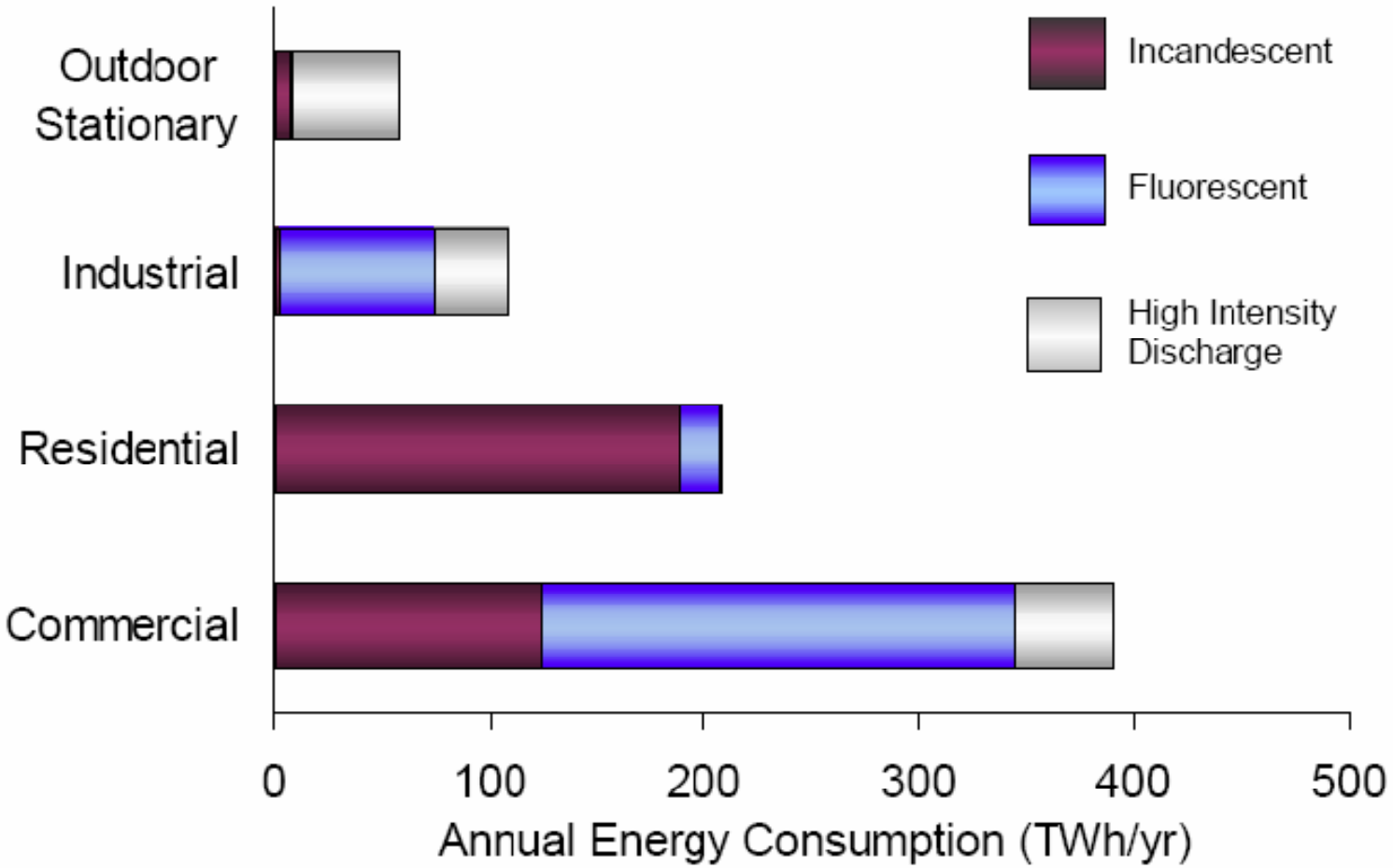

Figure ES-1 Shares of Sectoral Energy Use by Lighting Technology

From "U.S. Lighting Market Characterization", prepared for DOE EERE by Navigant Consulting, 2002

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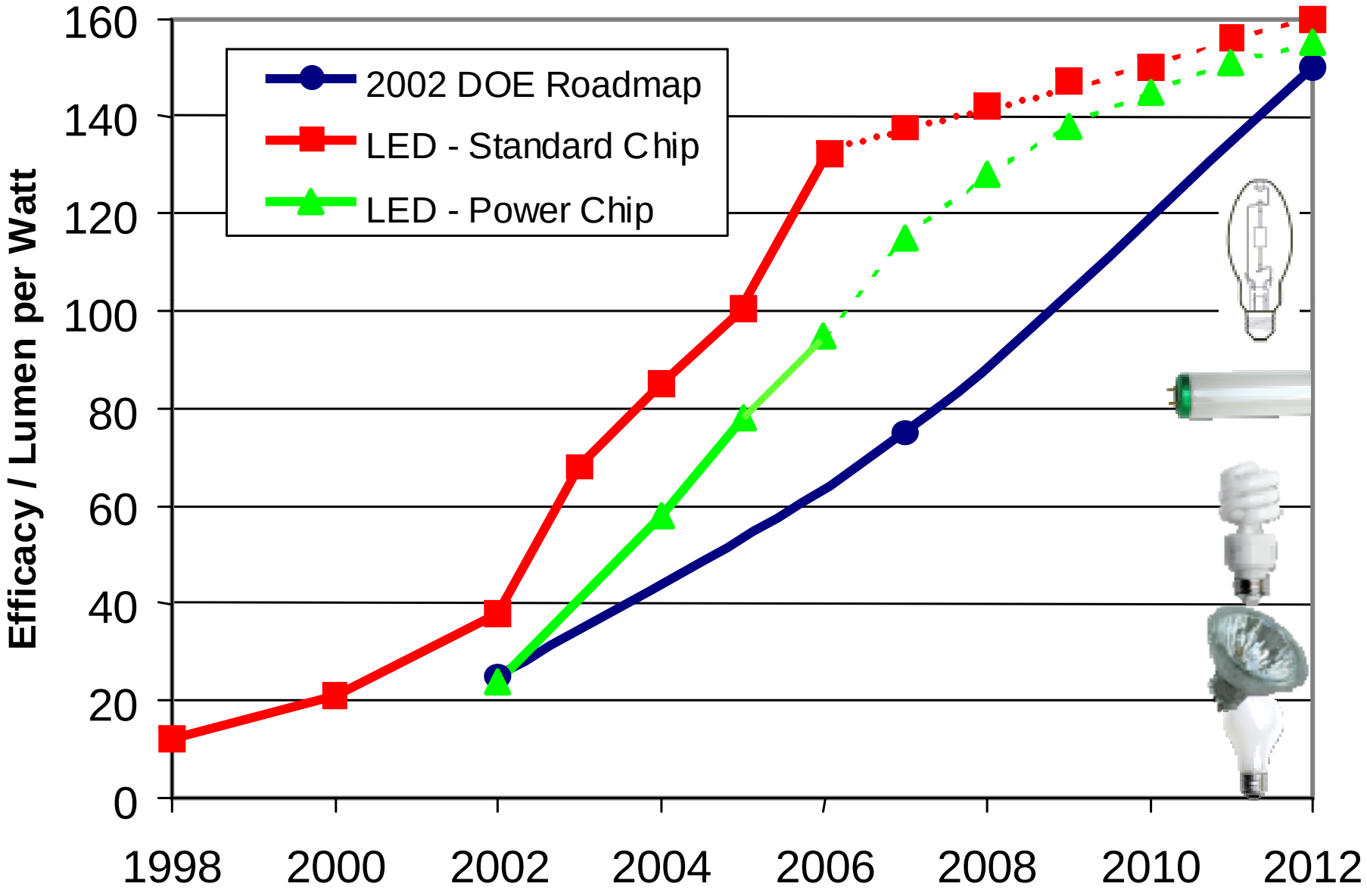
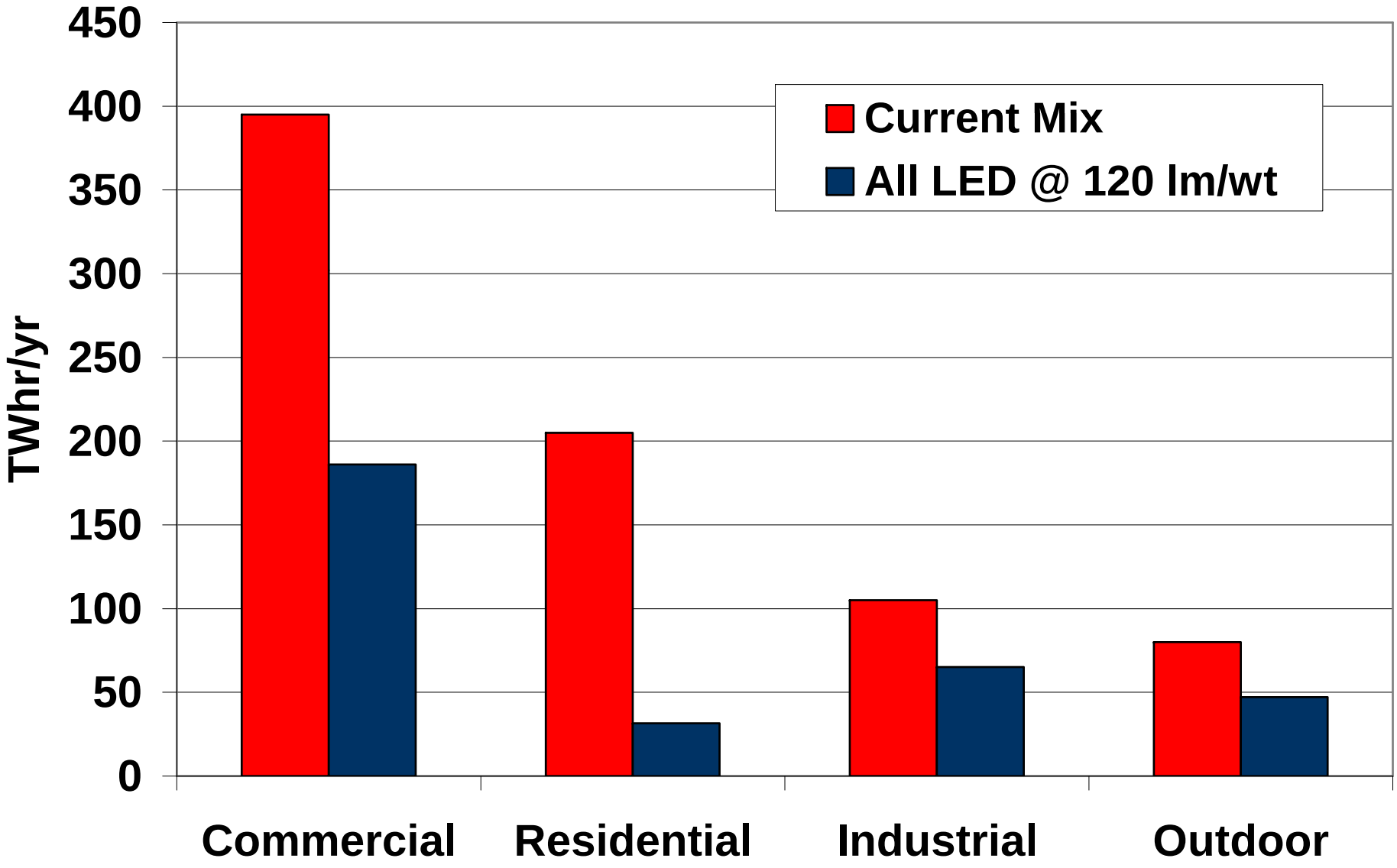
LEDs Efficacy Increases by 30% Per Year



Energy Implications of 100% LEDs @ 120 Lm/wt System Efficacy



The Precourt Institute for Energy Efficiency

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Precourt Institute

- A research and analysis institute at Stanford
- Established in October 2006
- Initial funding by Jay Precourt
- Mission
  - To improve opportunities for and implementation of energy efficient technologies, systems, and practices, with an emphasis on economically attractive deployment
  - Focus on the wise use of energy
  - Energy efficiency: economically efficient reductions in energy use (or energy intensity)

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Key Distinguishing Features of the Precourt Institute

- **Focus on significant short term (no more than a decade**

PIEE Research Matrix

	Sectors				
Methods	**Buildings**	**Transpor-tation**	**Electricity**	**Industry**	**Appliances**
Engineering					
Modeling					
Systems					
Behavior					
Policy					

Current Emphasis

Anticipated Additions

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Workshops/Conferences

Completed

- 2007 Energy Summit, June 2007. Jointly with Silicon Valley Leadership Group
- Behavior, Energy, and Climate Change. Jointly with ACEEE, California Institute for Energy and Environment , November 2007
- Energy Crossroads. (Stanford Student-Organized Event, partial support). Spring 2007; Spring 2008
- Energy Efficiency Workshop, with Snowmass Workshop on Integrated Assessment of Global Climate Change, July 2007
- 2008 Energy Summit, July 11, 2008. Jointly with Silicon Valley Leadership Group.
- Electricity Measurement and Feedback Workshop. Sept. 4th-5th, 2008

Future

- Behavior, Energy, and Climate Change. Jointly with ACEEE, California Institute for Energy and Environment, November 16-19, 2008
- 2009 Energy Summit, June 29, 2009. Jointly with Silicon Valley Leadership Group.

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