Energy Efficiency Overview

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Professor, Management Science and Engineering

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Agenda: Thursday

- Overview
  - James L. Sweeney
- Autos/Transport
  - David Greene
  - Terry Penney
  - Ian Parry
- Buildings/Appliances
  - Richard Newell
  - Alan Sanstad
- Implementation Through Utility-Based Programs
  - Steve Kline
  - Audrey Chang
- Group Discussion

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Agenda: Friday

- International Perspectives
  - Richard Moss
  - Scott Nyquist
- Behavioral Issues
  - Carrie Armel
- Electric Technology
  - Marek Samotyj
- Energy Efficiency: How Much, How Cheap
  - Amory Lovins, Rocky Mountain Institute
- Modeling Energy Use (Panel)
  - Leone Clarke
  - Tatsuya Hanaoka
  - Eric Smith
- Energy Efficiency Discussion (Panel)

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for Energy Efficiency

Precourt Institute

- A research and analysis institute at Stanford
- Established in October 2006
- Initial funding: $30 million pledge 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 demand side of energy markets
  - Energy efficiency: economically efficient reductions in energy use (or energy intensity)

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Advisory Council

- George Shultz, Council Chair, Thomas W. and Susan B. Ford Distinguished Fellow: Hoover Institution
- Jay Precourt, Council Vice Chair, Chair and CEO, Hermes Consolidated
- John Boesel, President and CEO: WestStart-CALSTART
- Joseph Desmond, Former Chair, California Energy Commission
- TJ Glauthier, TJG Energy Associates, LLC
- Agatha Precourt, Consumer Marketing/Brand Management Consultant
- Debra Reed, President and Chief Executive Officer, San Diego Gas & Electric and Southern California Gas Co.
- Burton Richter, Director Emeritus, Stanford Linear Accelerator Center; Nobel Laureate, Physics
- Ben Schwegler, Vice President / Chief Scientist: Walt Disney Imagineering
- Byron Sher, Former California State Senator
- Erik Straser, Partner: Mohr, Davidow Ventures
- Bill Valentine, Chairman of the Board: HOK
- Ward Woods, Retired President and CEO of Bessemer Securities
- Jane Woodward, CEO: Mineral Acquisition Partners

Priorities: Issues

- Pricing
  - Electricity
  - Carbon
  - Transportation fuels
- Information Issues
  - Building design
  - Labeling of consumer products
  - “Smart Building” controls
- Behavior
  - Consumer decisionmaking
- Energy Modeling
  - Demand response
  - Large scale planning models
- Technology
- Policy Development

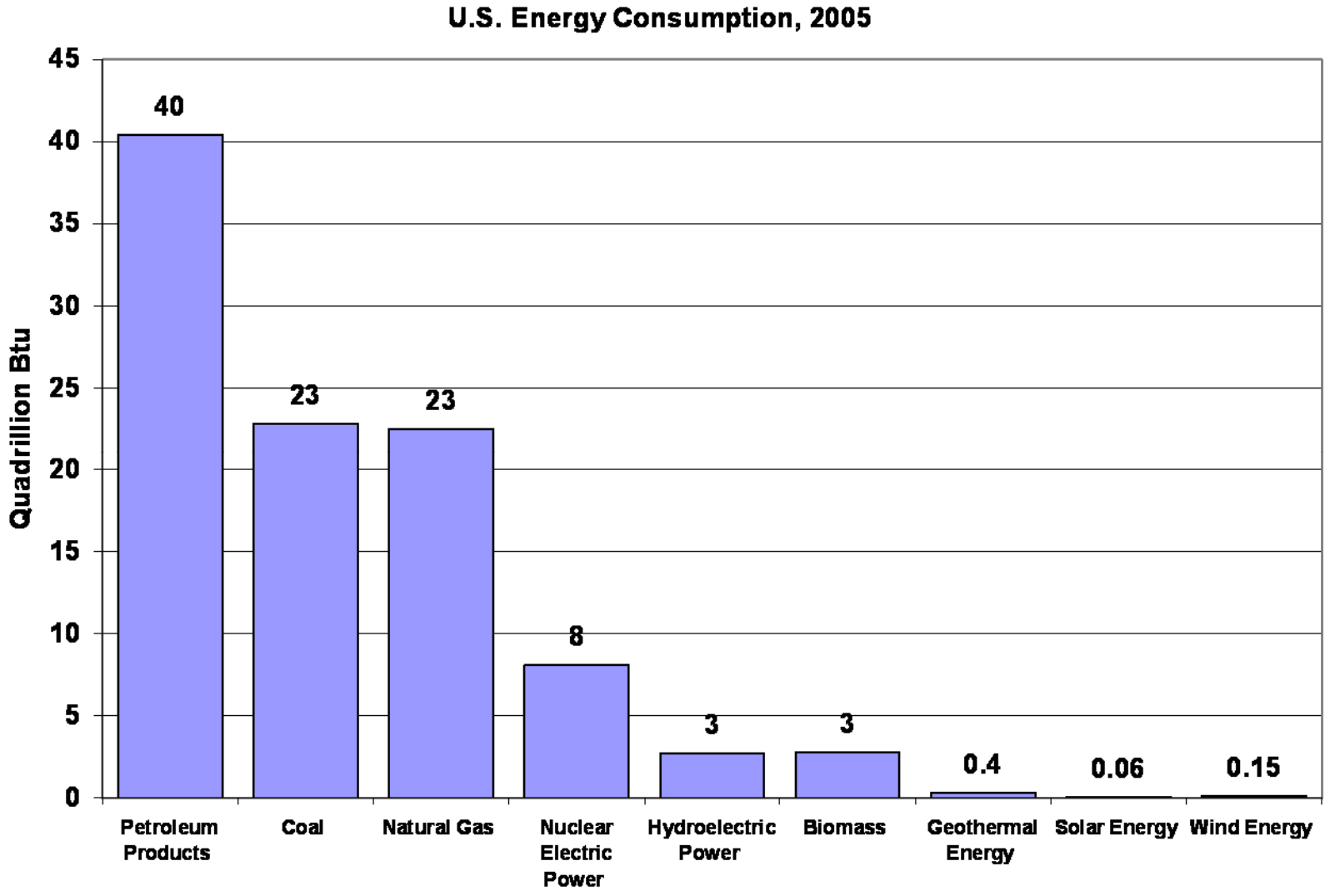
Priorities: Sectors

- Residential and Commercial
  - Buildings
  - Lighting
- Vehicles
  - Conventional Fuel Efficiency
  - Electrification
- At this point, not Industrial Sector
  - Fewer barriers exist
  - Innovative companies taking the lead, others are following
  - We have relatively little expertise

Policy Drivers

- Environmental Protection
  - Global Climate Change
- Security
  - Oil/International vulnerability
  - Vulnerability of infrastructure to terrorism, natural disaster, or human error
- Economics
  - Prices of electricity, gasoline, natural gas
  - Price volatility: oil, natural gas, wholesale electricity

U.S. Energy Usage: 2005



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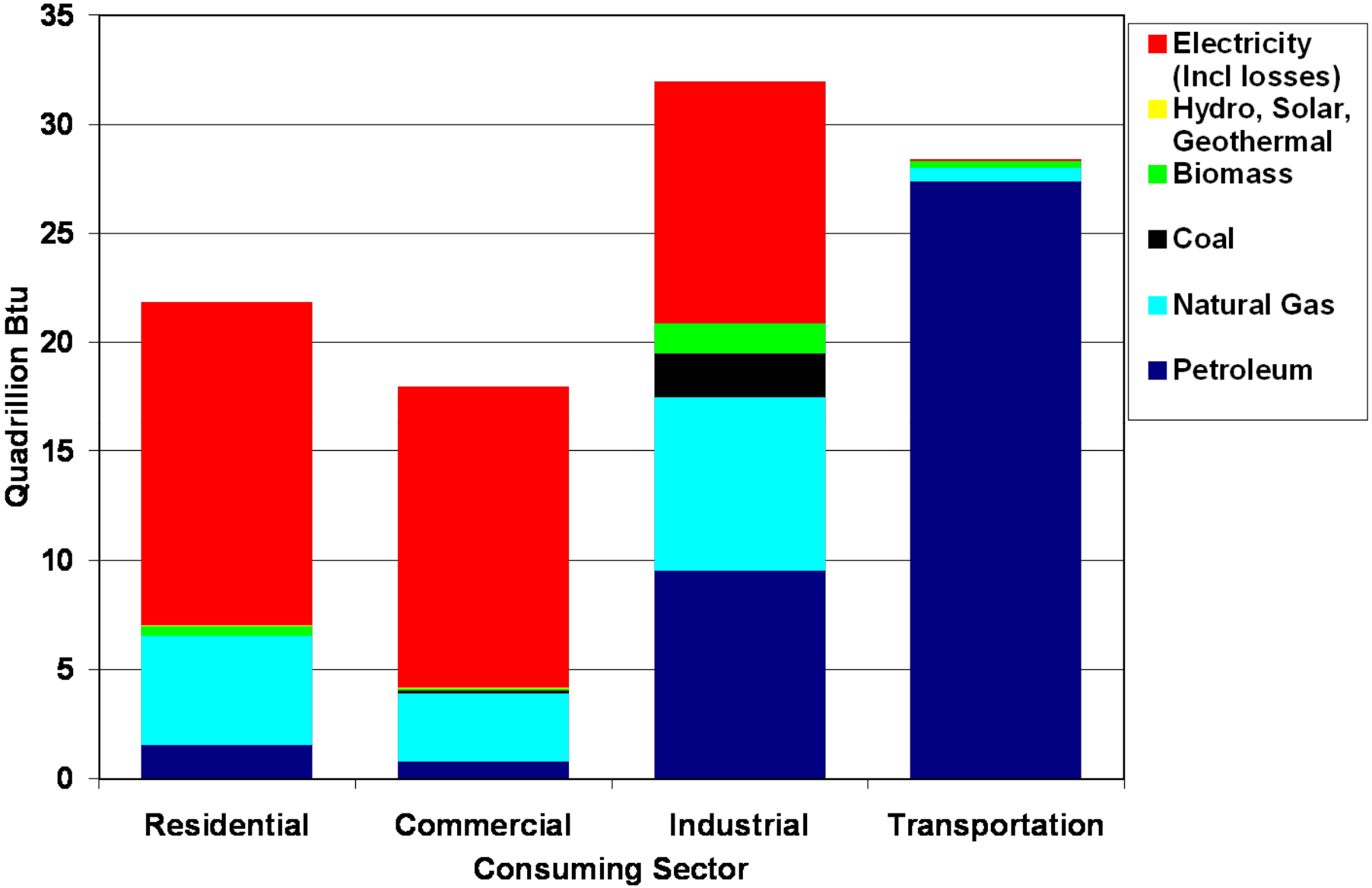
Source: EIA, Annual Energy Review

U.S. Sectoral Energy Use: 2005



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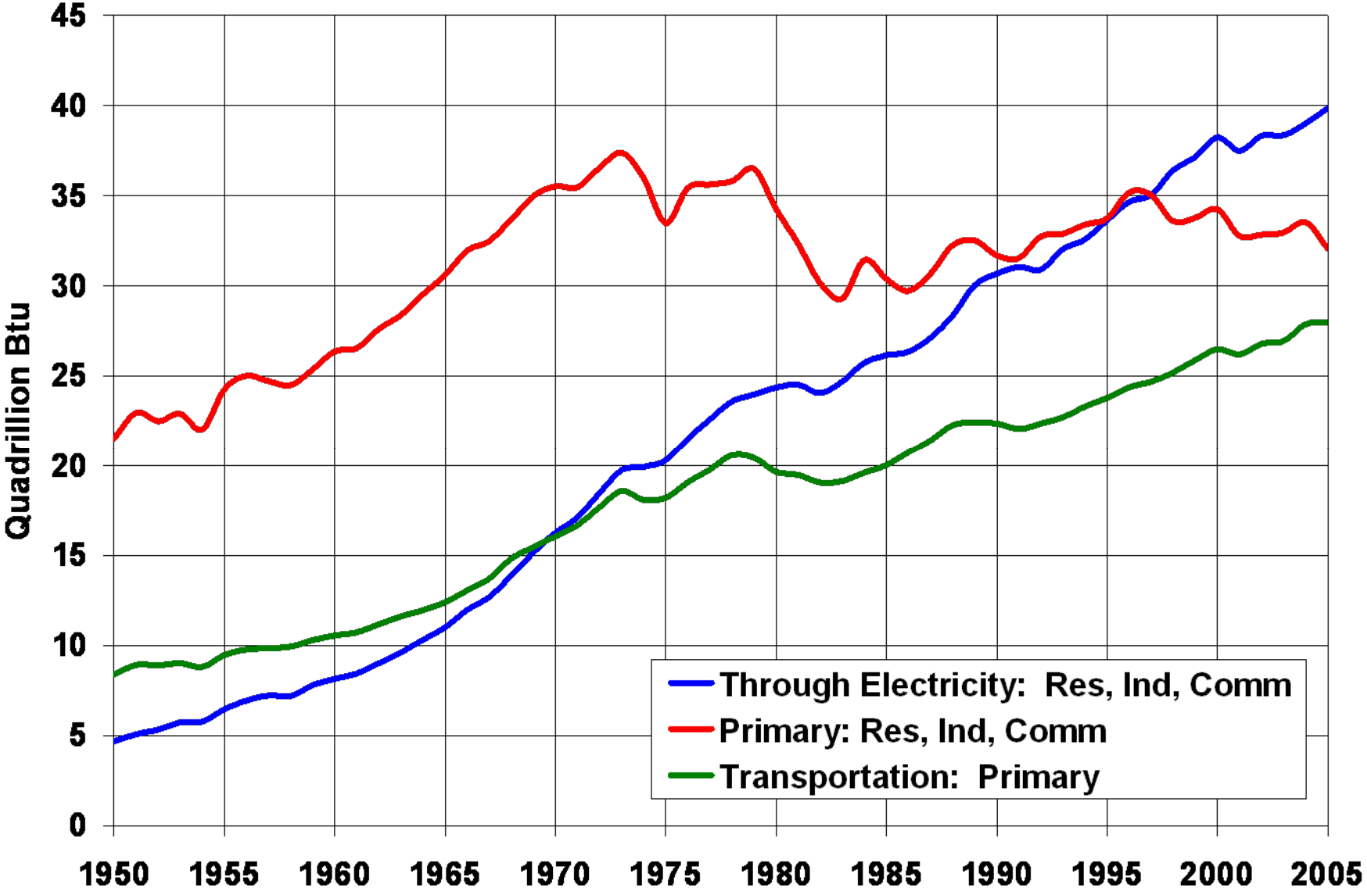
US Primary Energy and Electricity Use by Sectors



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Environmental

Energy Related Activities account for

- 85% of the releases of greenhouse gases, measured on a carbon equivalent basis.
- 98% of the US carbon dioxide net releases into the atmosphere
- 38% of methane
- 11% of nitrous oxide

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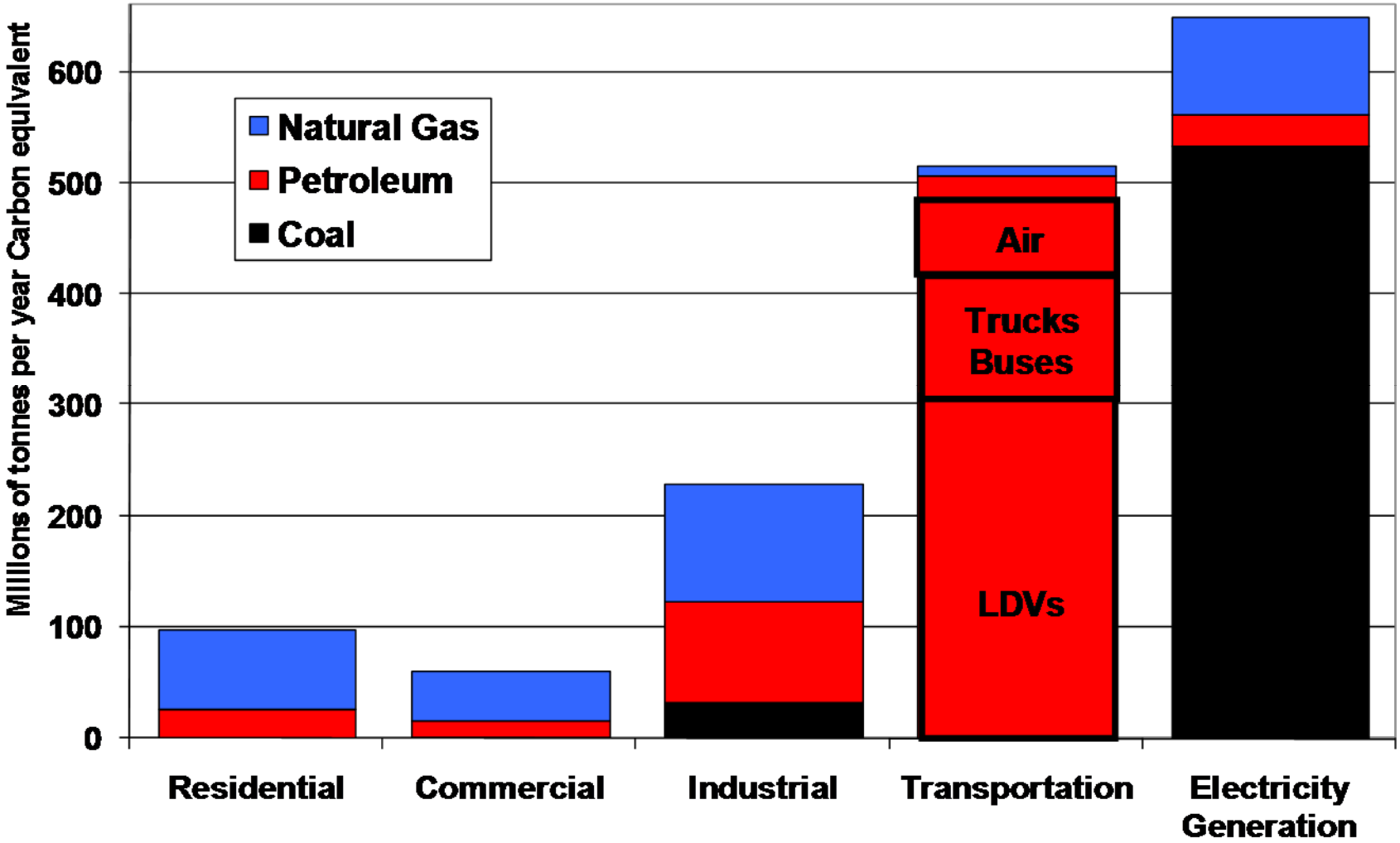
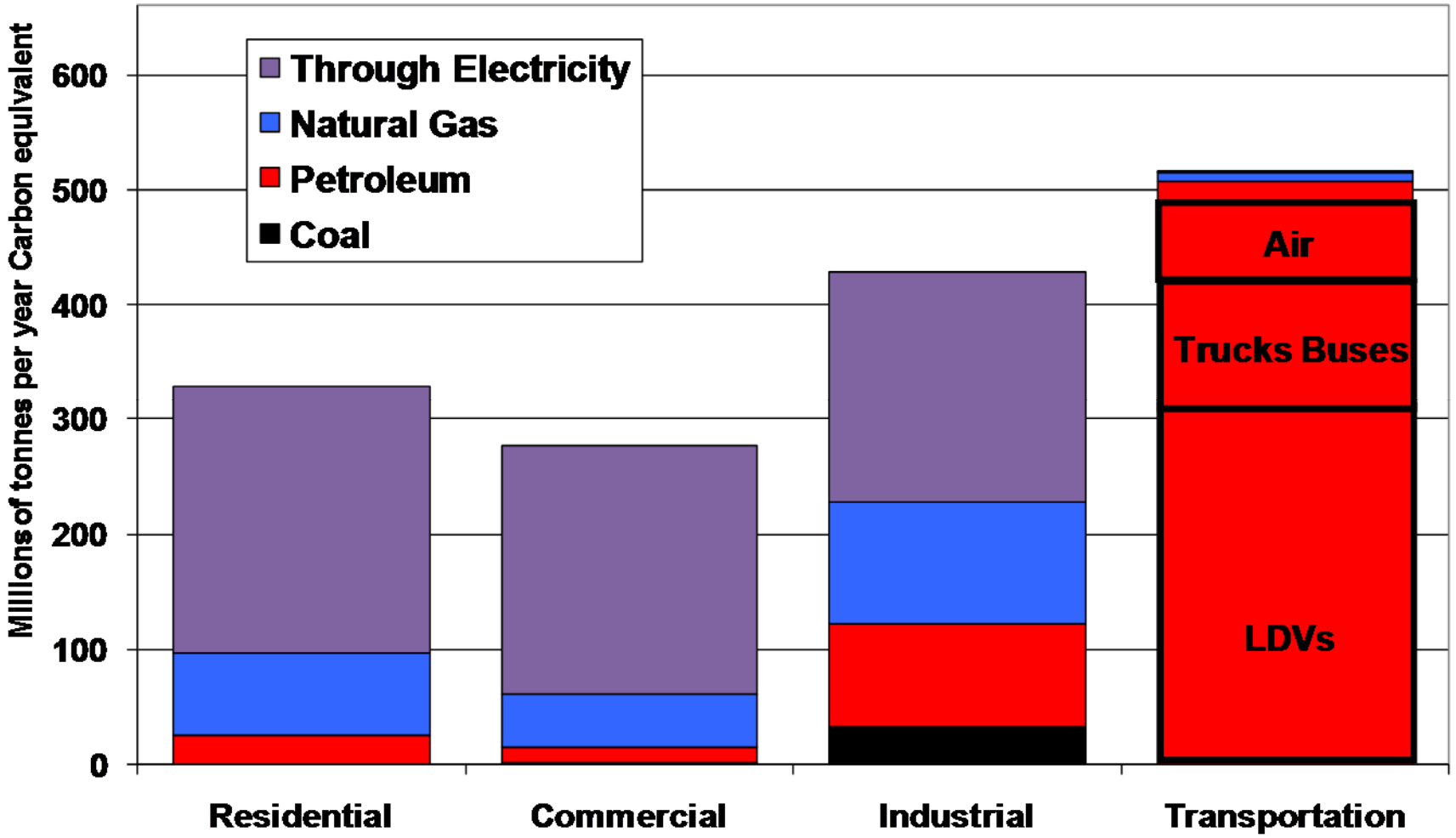
U.S. CO_2 Emissions by Sector and Fuels 2005



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

U.S. CO_2 Emissions by Sector and Fuels 2005



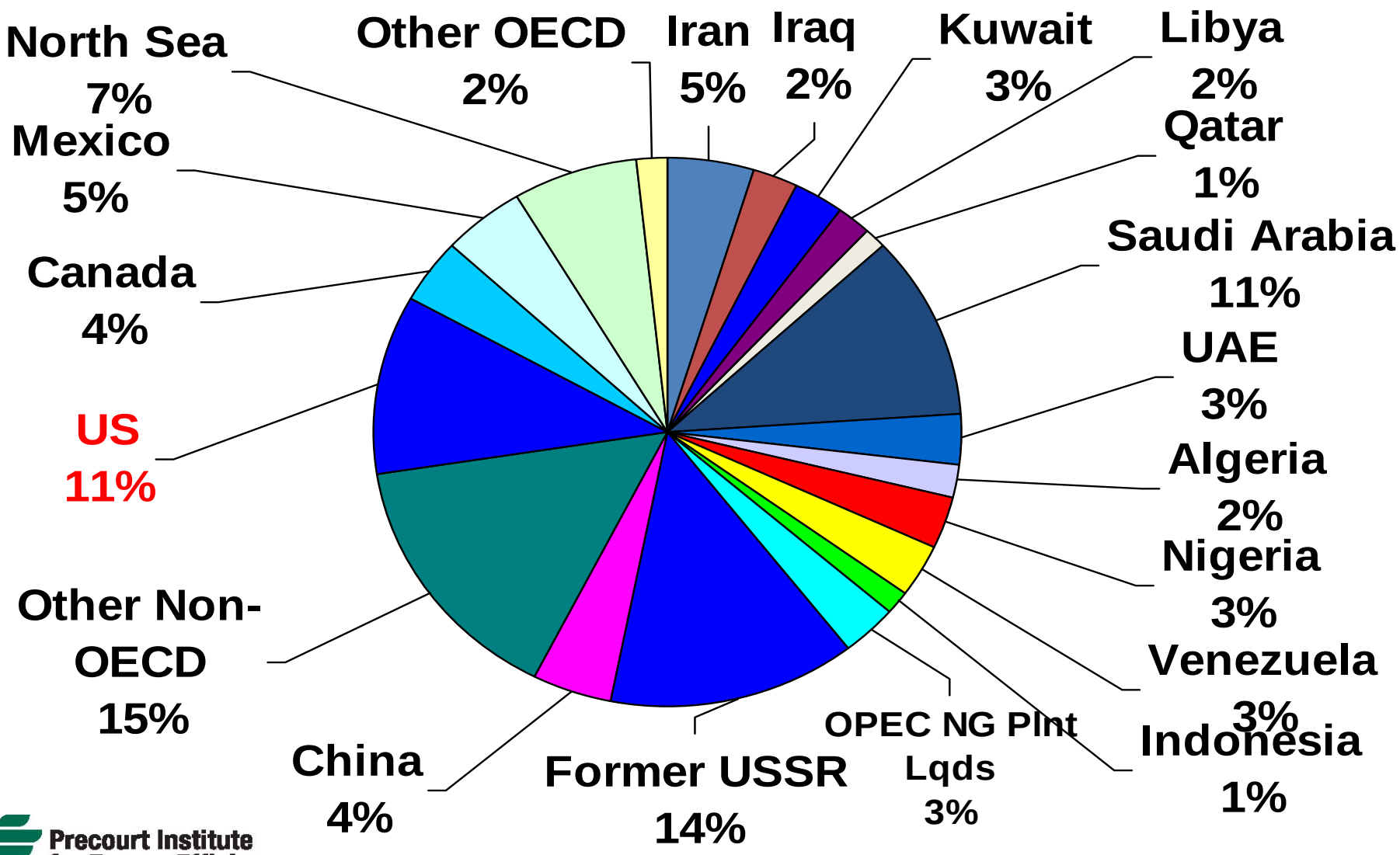
Source: U.S. EPA Inventory of Greenhouse Gas Emissions, April 2007

Security Issues

Oil Security

- 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

World Oil Supply, 2004, Total: 83 mmb/d



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Ownership of oil industry

- The largest 13 firms – as measured by oil and gas reserves – are all owned by nations or are controlled by other nations
- Oil supply may be manipulated for political purposes by those nations controlling the reserves

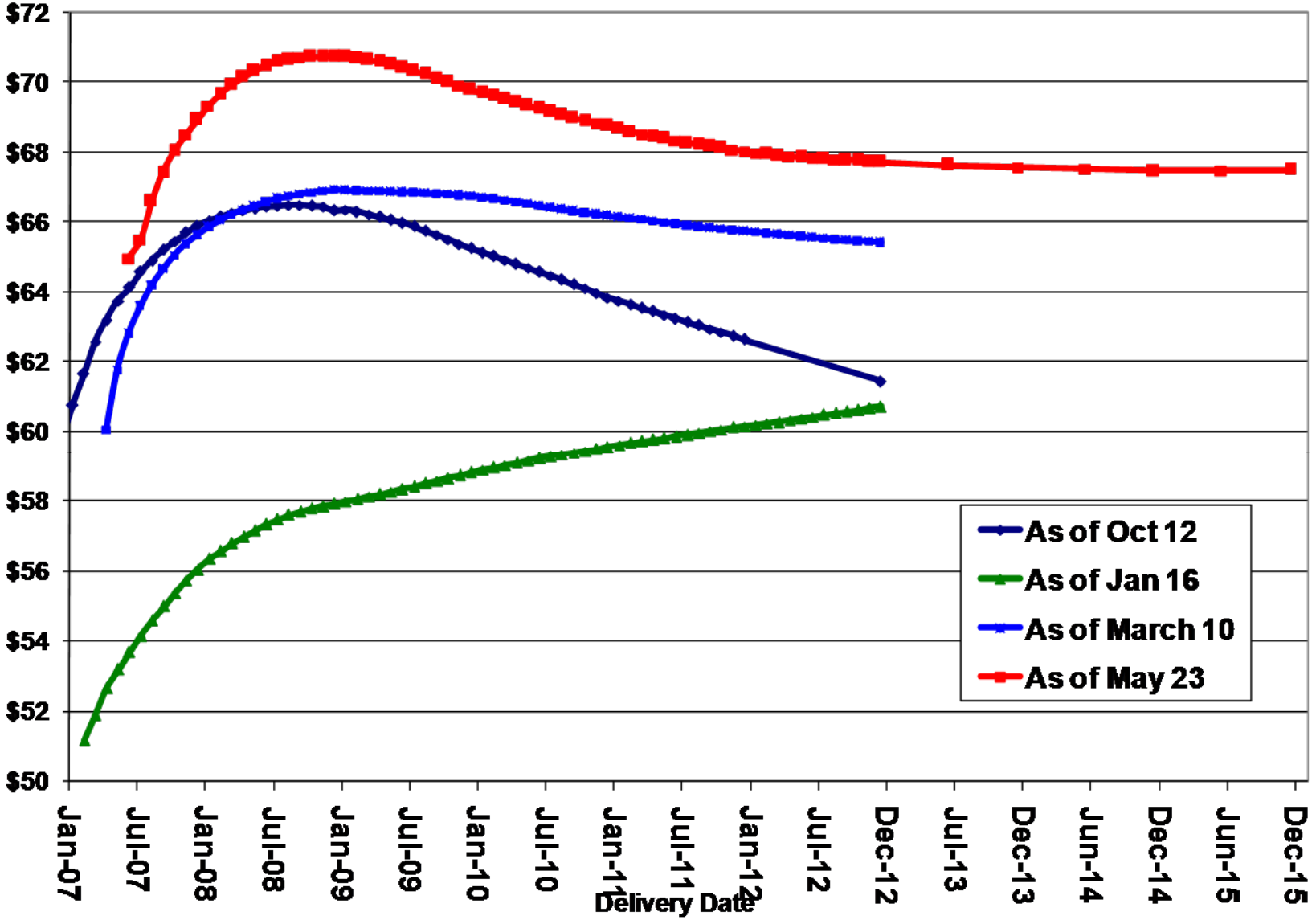
Oil and Gas Reserves, Billion Barrels Oil Equivalent

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**

Economic Issues

Crude Oil Futures Prices: As of Four Dates



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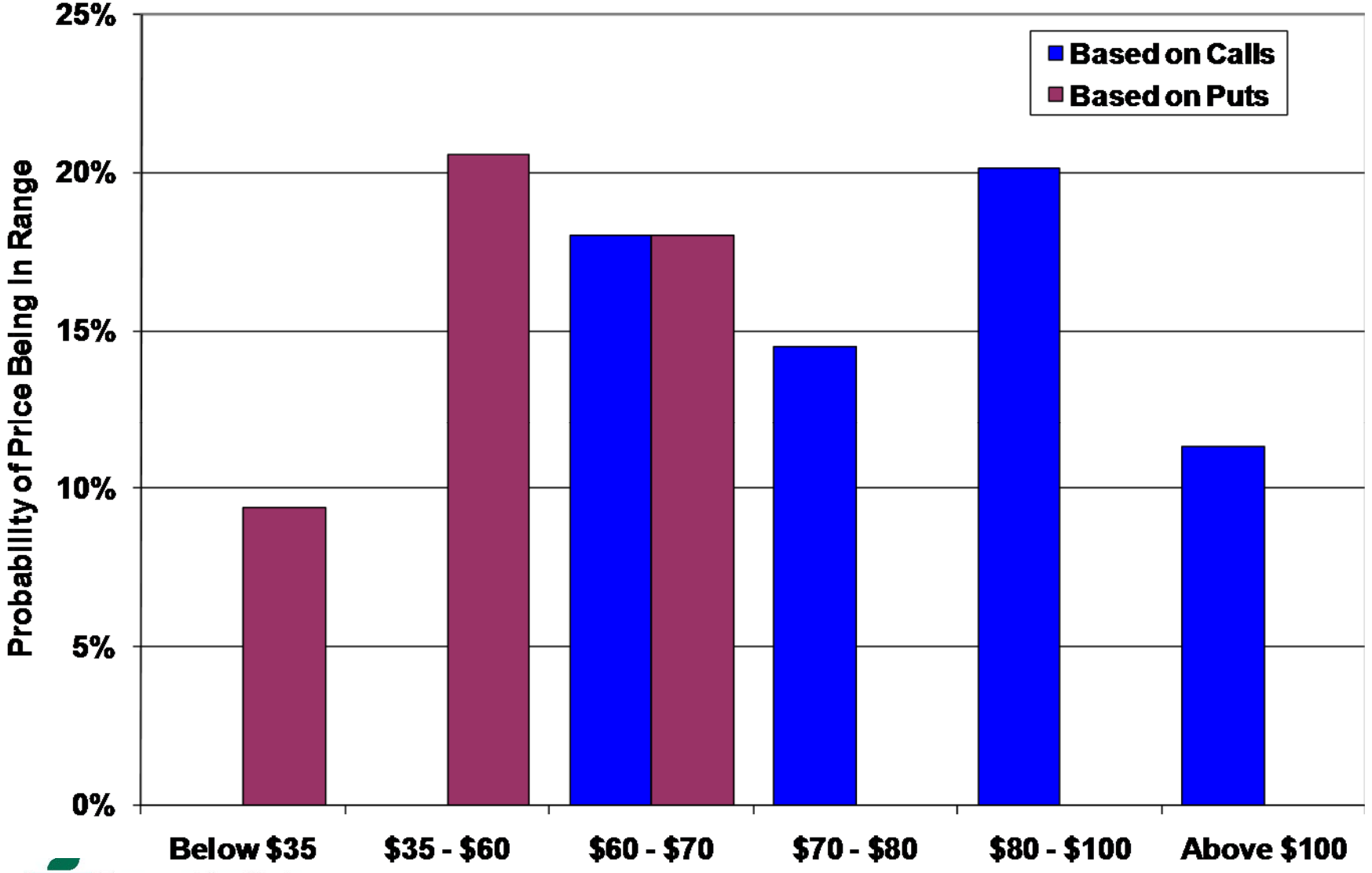
Oil Price Uncertainty December 2009 Delivery (data May 23, 2007)



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Energy Efficiency:

Economically Efficient Reductions in Energy Use Intensity

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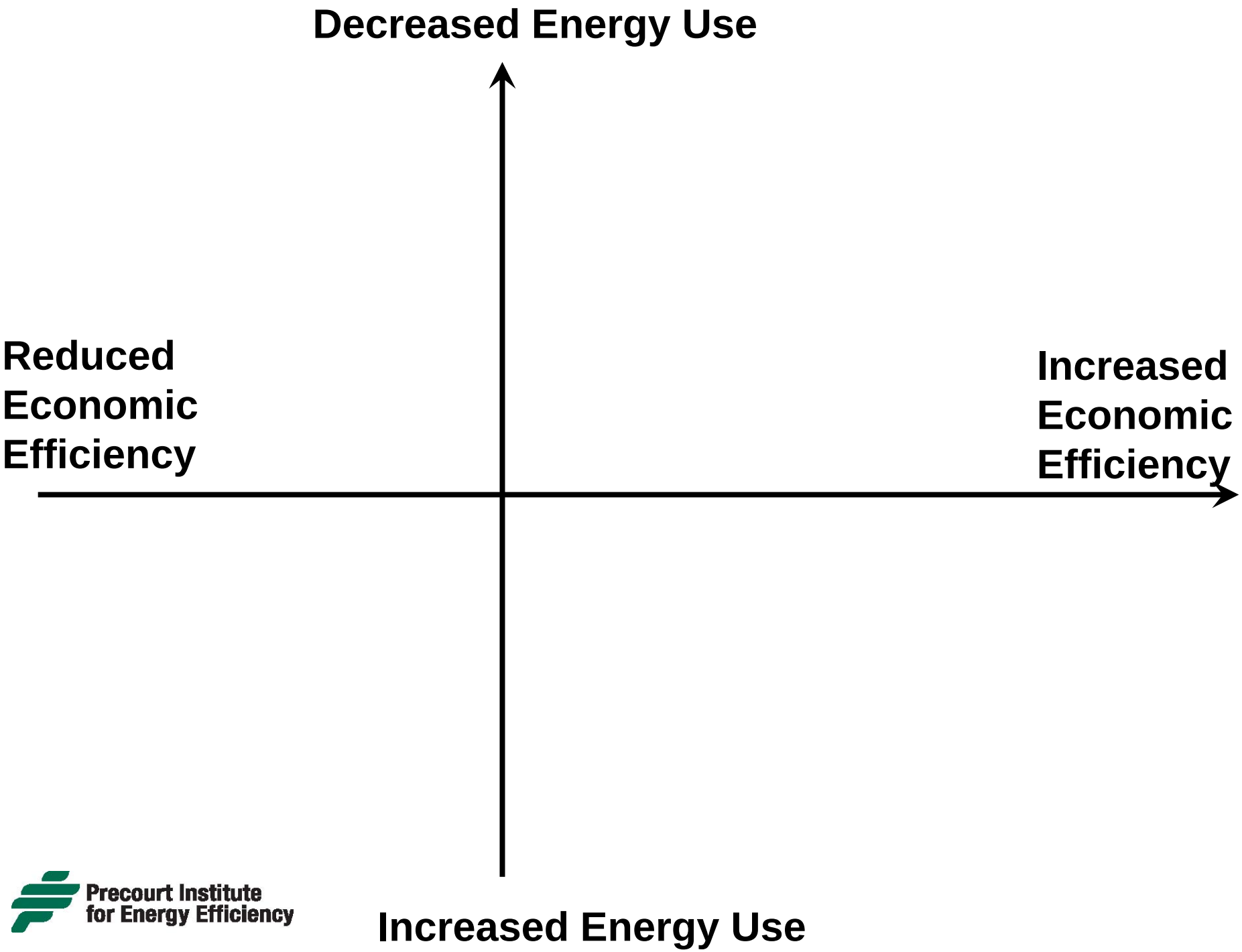

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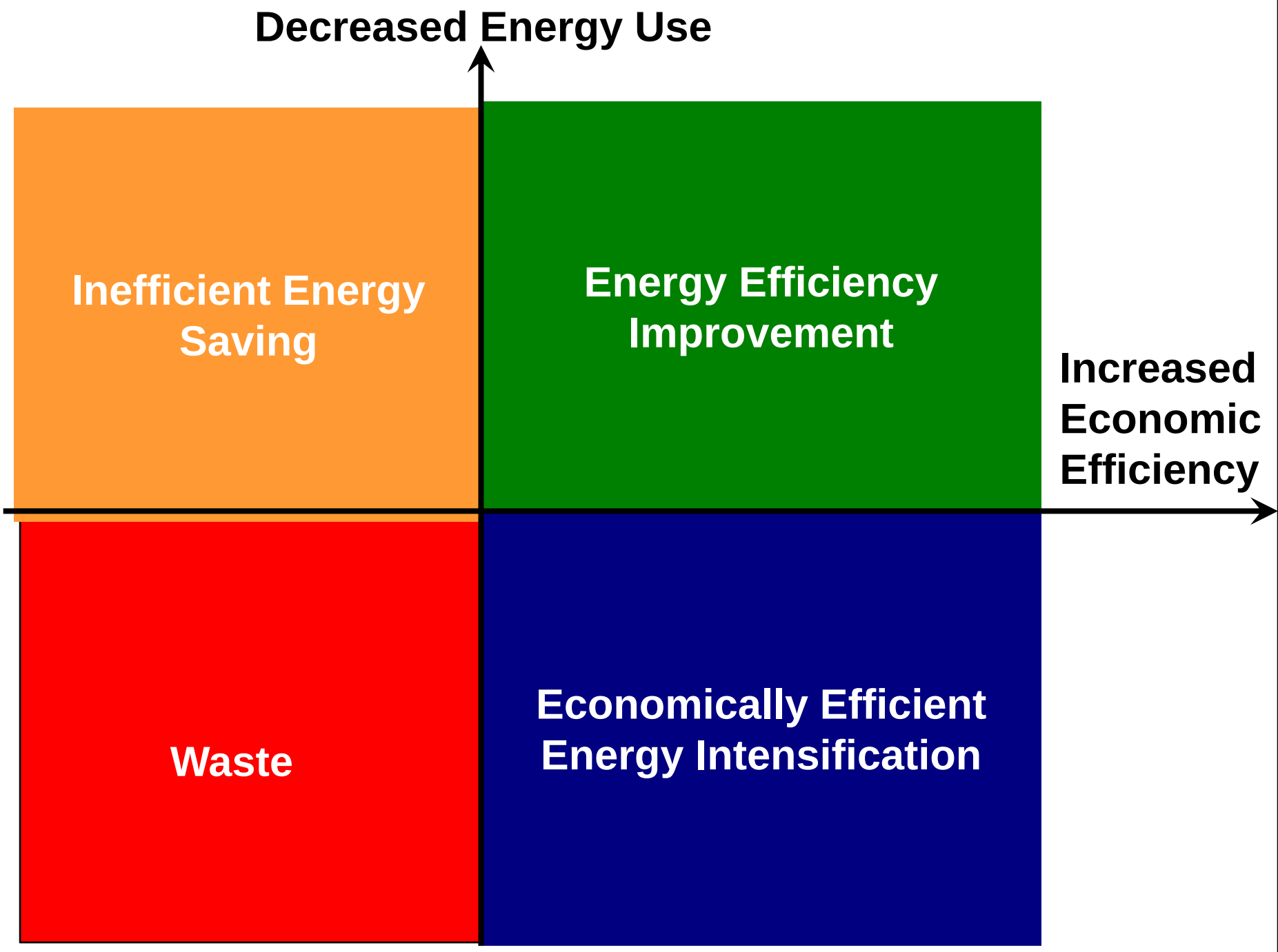
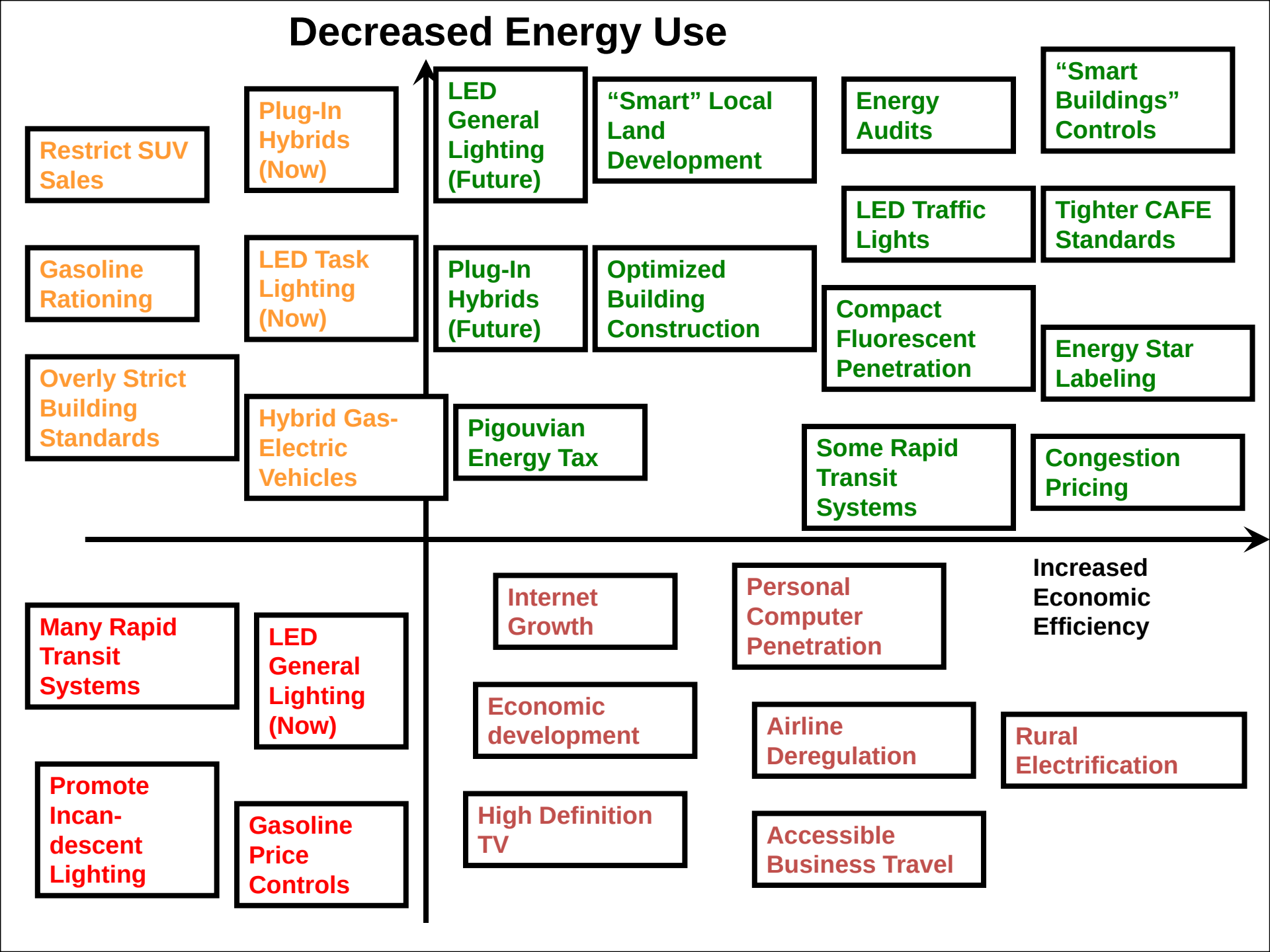

Decreased Energy Use
Inefficient Energy Saving
Energy Efficiency Improvement
Increased Economic Efficiency
Waste
Economically Efficient Energy Intensification


Decreased Energy Use
Restrict SUV Sales
Plug-In Hybrids (Now)
LED General Lighting (Future)
“Smart” Local Land Development
Energy Audits
“Smart Buildings” Controls
LED Traffic Lights
Tighter CAFE Standards
Gasoline Rationing
LED Task Lighting (Now)
Plug-In Hybrids (Future)
Optimized Building Construction
Compact Fluorescent Penetration
Energy Star Labeling
Overly Strict Building Standards
Hybrid Gas-Electric Vehicles
Pigouvian Energy Tax
Some Rapid Transit Systems
Congestion Pricing
Increased Economic Efficiency
Many Rapid Transit Systems
LED General Lighting (Now)
Internet Growth
Personal Computer Penetration
Economic development
Airline Deregulation
Rural Electrification
Promote Incan-descent Lighting
Gasoline Price Controls
High Definition TV
Accessible Business Travel

Some Sources of Efficiency Failures

- Externalities of Energy Use
  - Global Climate Change
  - Risks of Energy Price Shocks
  - Limitations on our Foreign Policy Options
  - Terms of Trade Impacts (Pecuniary “Externalities”)
  - Safety externality in autos
- Pricing Below Marginal Cost
  - Non-time-differentiated Electricity Pricing
- Information Asymmetry
  - Consumer Product Marketing
  - New Building Construction
- Incomplete Technology Options
  - Under-investment
  - Sub-optimal technology directions, due to externalities
- Non-Convexities
  - Learning By Doing Technology Spillovers
  - “Chicken and Egg” Problems

Example: Lighting

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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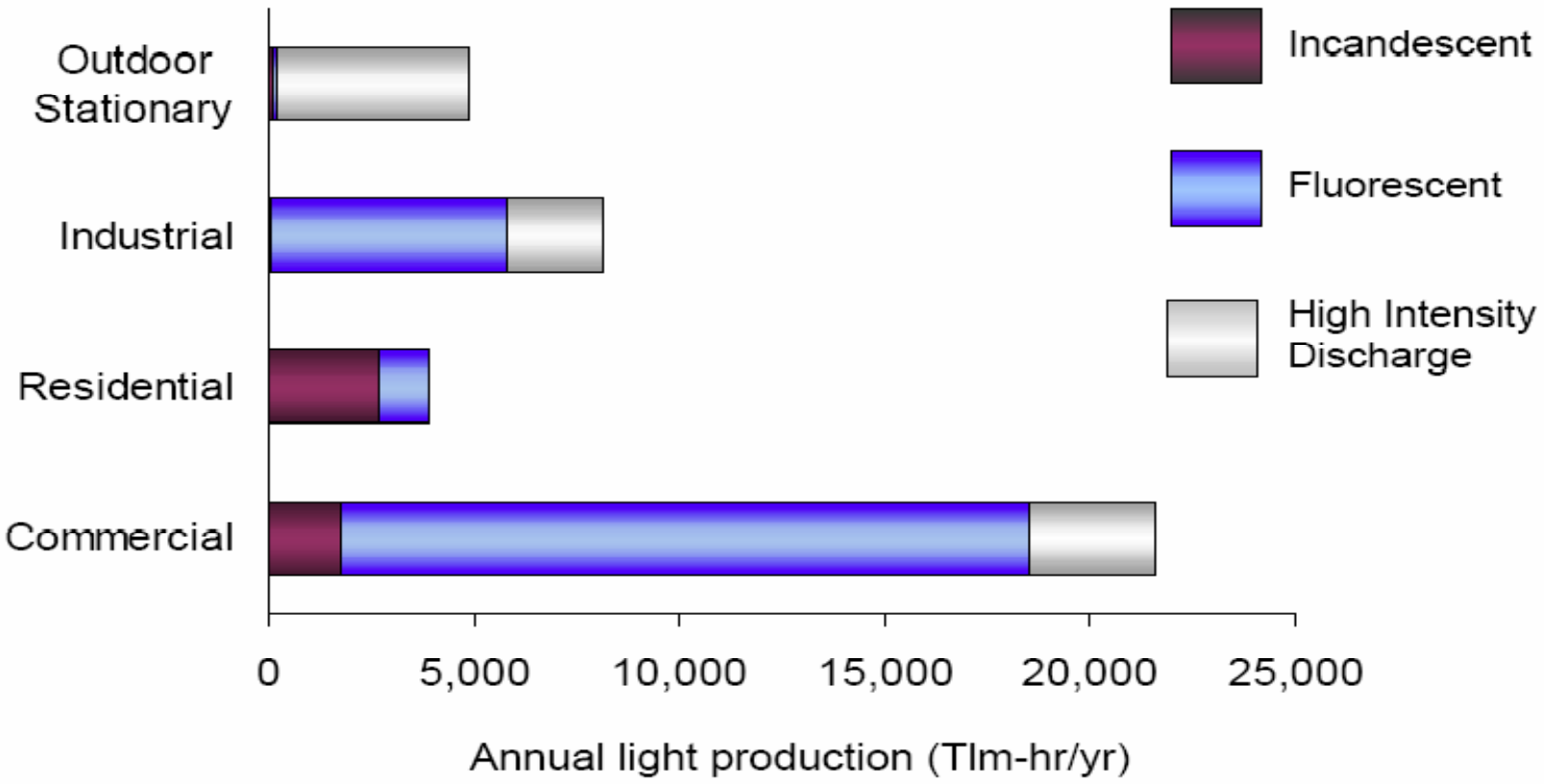


Figure 8-4. Source Light Production by Sector & Source

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

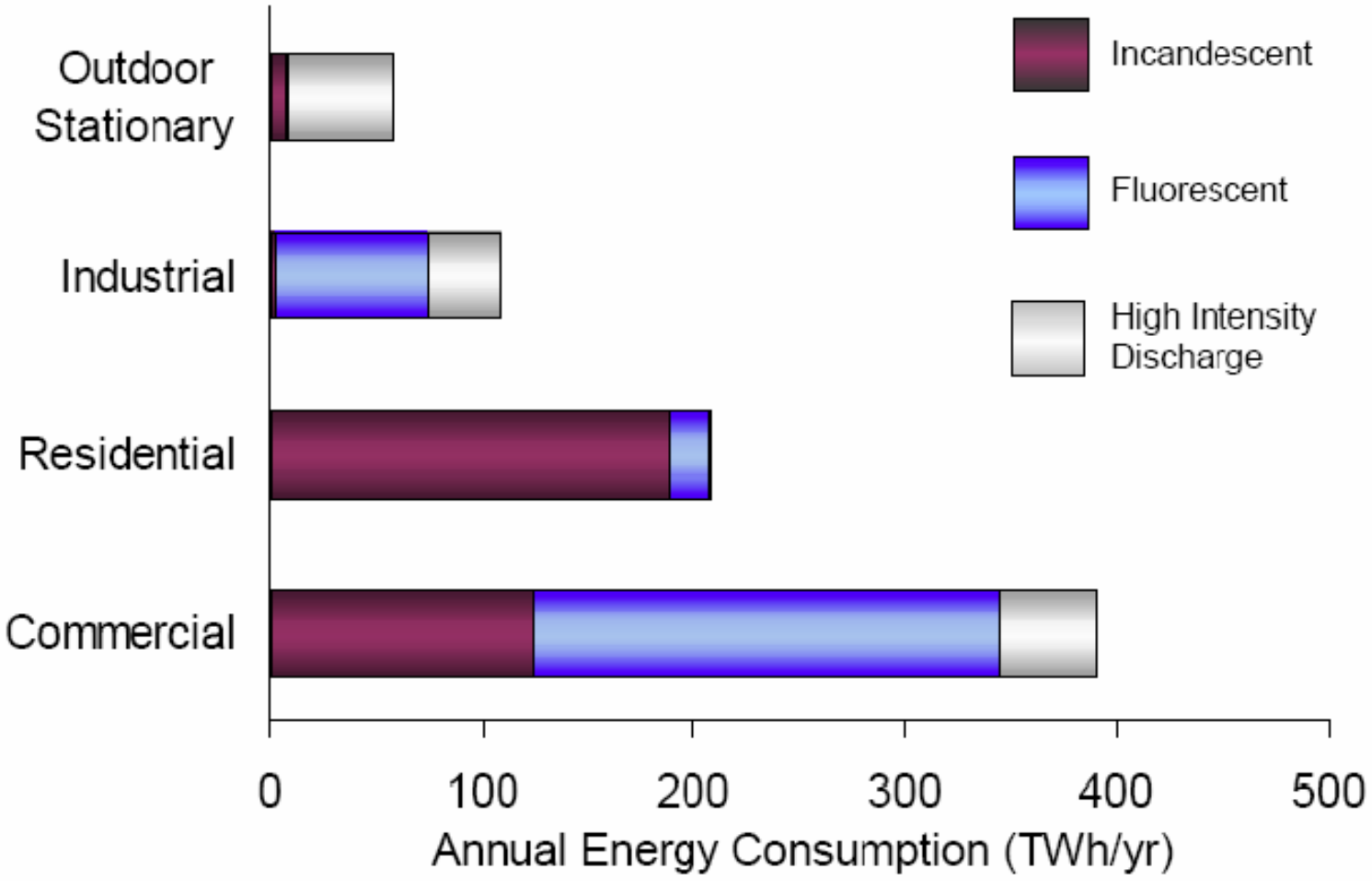
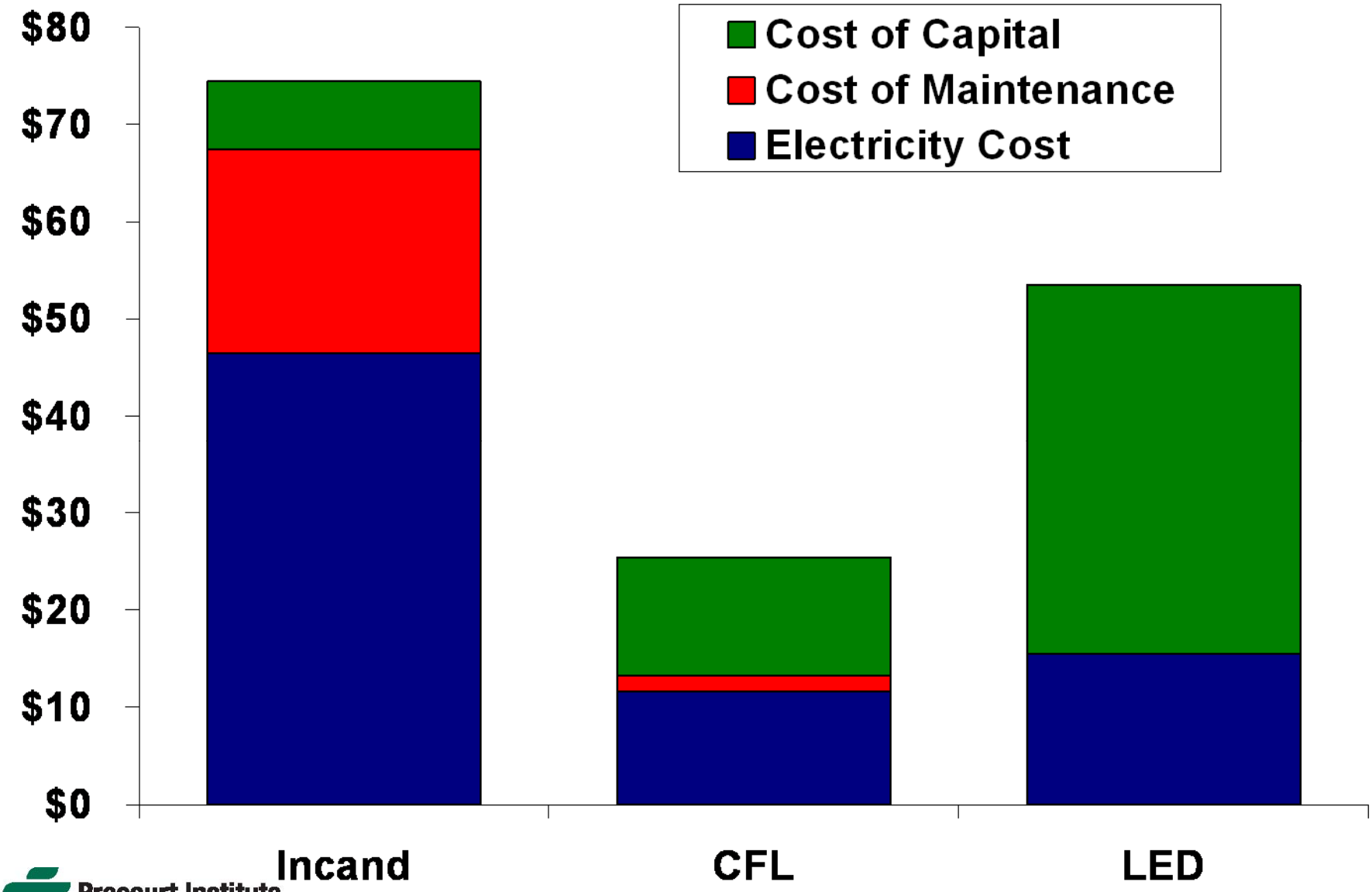


Figure ES-1 Shares of Sectoral Energy Use by Lighting Technology

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

Residential 900 Lumen Lighting
20 year Lifecycle Cost (Now)



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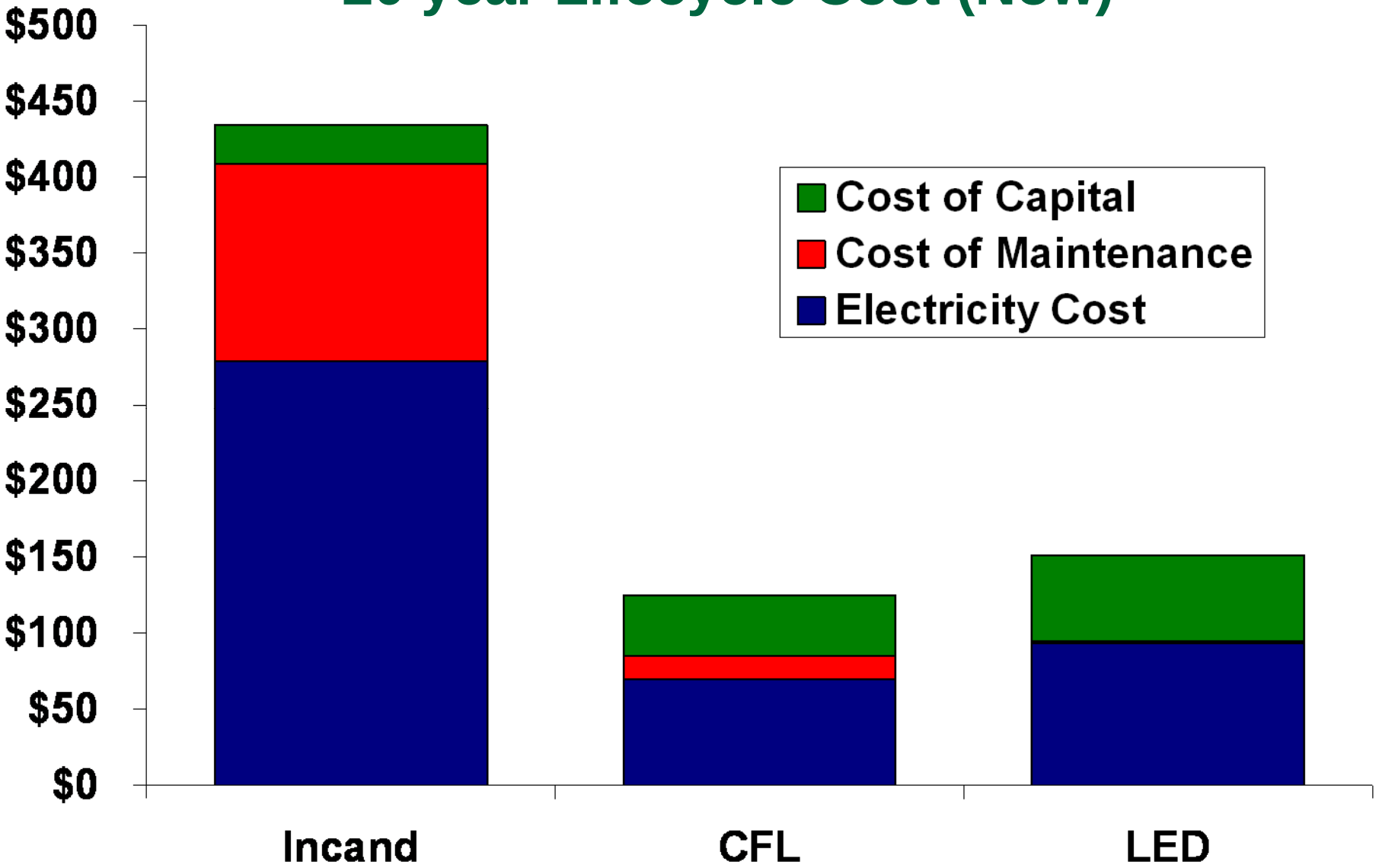
Commercial 900 Lumen Lighting
20 year Lifecycle Cost (Now)



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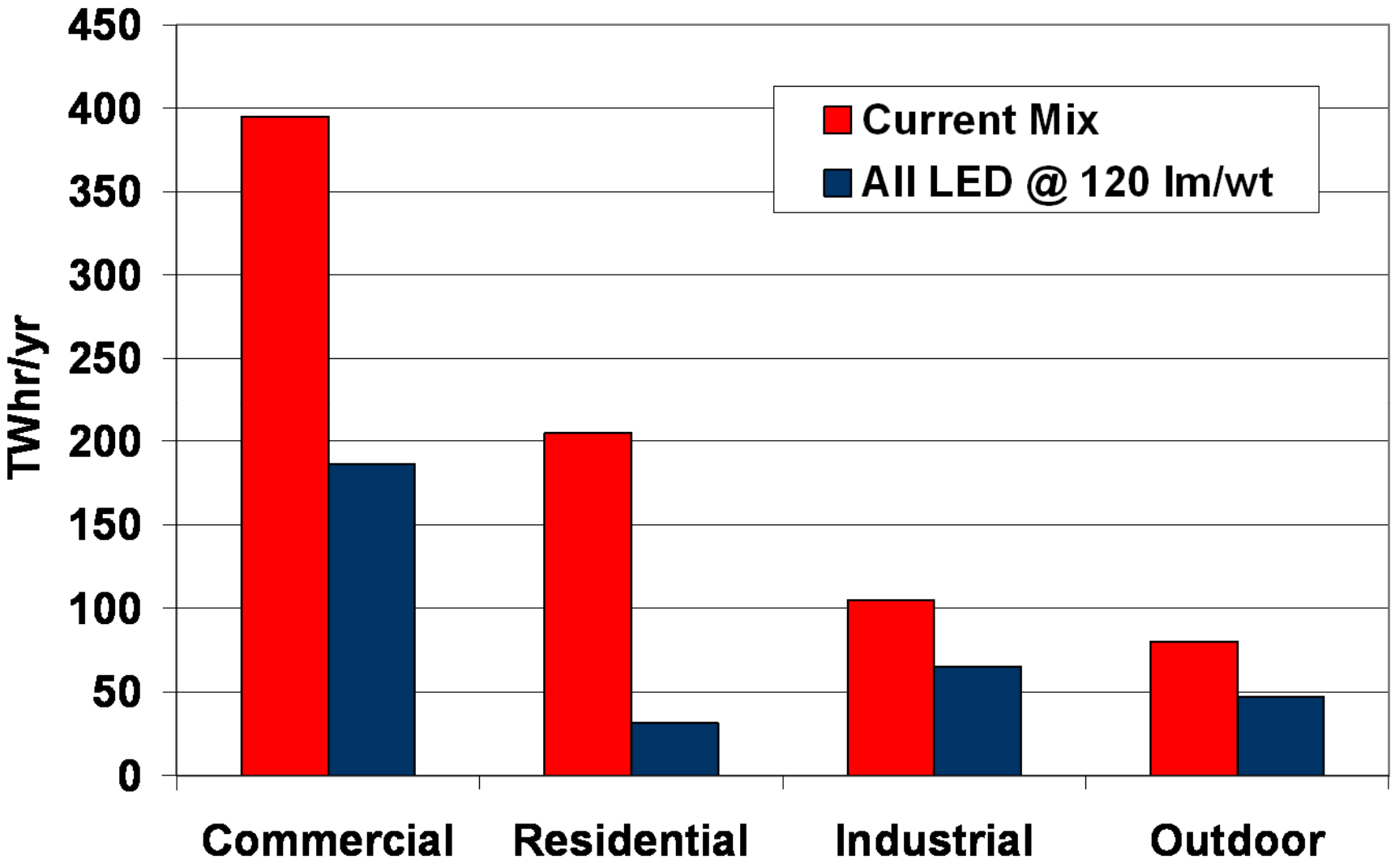
Energy Implications of 100% LEDs @ 120 Lm/wt System Efficacy



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Economy-Wide Impacts of All LED

- Lighting use: 21% of all electricity use
  - All LED saves about 60% of this electricity in long run:
    - 13% of all electricity use – after all adjustments
  - Adjustment time:
    - How long until LED system efficacy reaches 120 lm/wt? 5 years?
    - 50% adoption: 15 years afterwards?
  - 50% adoption will save 6.5% of all electricity use
- Electricity impact: Perhaps 6.5% reduction in 20 years
- Electricity cost impact
  - Total cost of U.S. electricity
    - Retail: $300 Billion per year
    - Variable Costs: say $200 Billion per year
  - 6.5% of $300 Billion dollars = $20 Billion per year
  - 6.5% of $200 Billion dollars = $13 Billion per year