Energy Efficiency and Energy Policy

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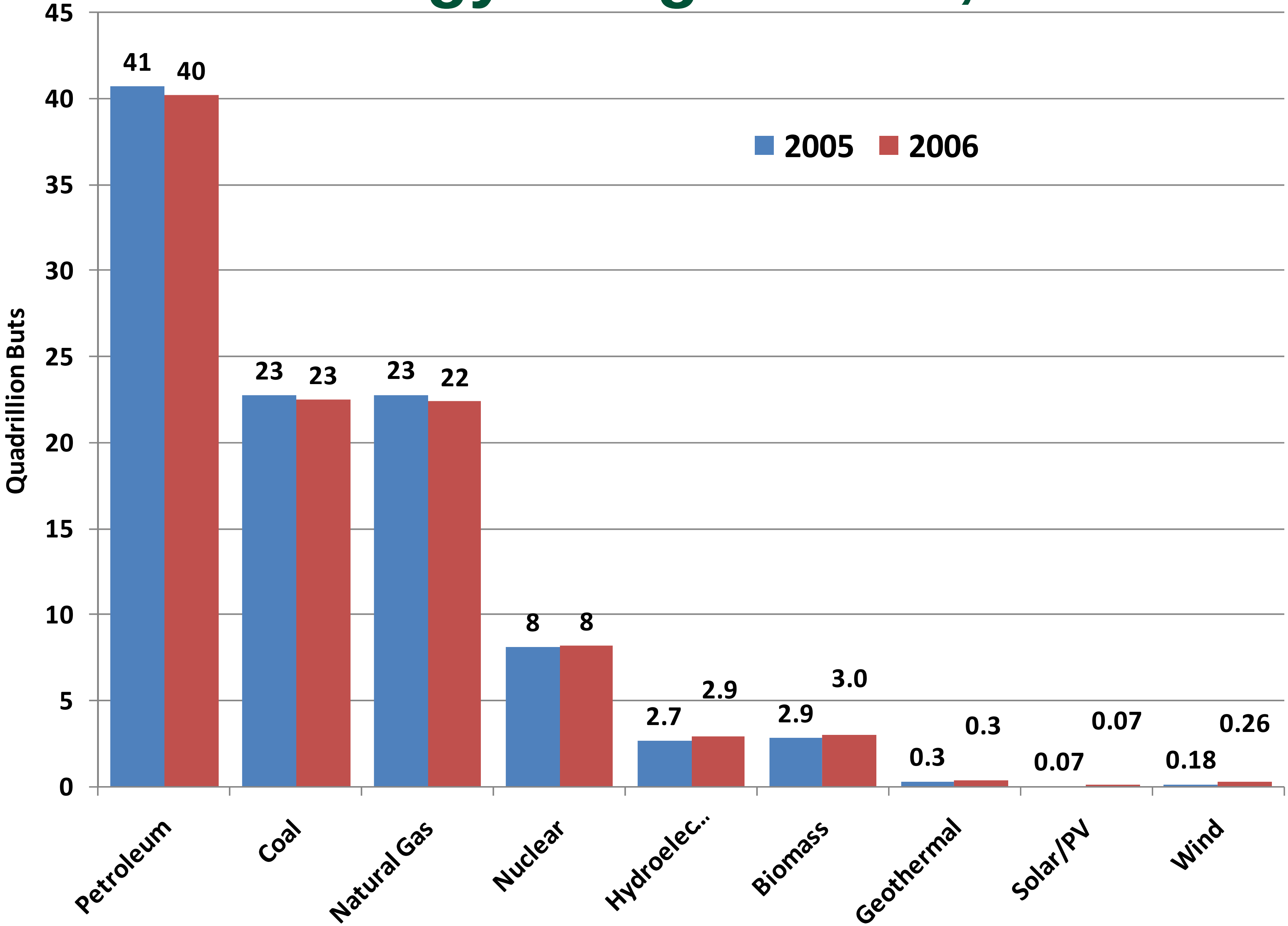
Policy Drivers

- 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, 2006



Source: EIA, Annual Energy Review

Energy Efficiency Compared to CO_2-Free Energy Supply

- A 10% reduction in all energy intensity implies that 8.5 quads of fossil fuels are not used, reducing CO_2 emissions by 8.5%
- A 25-fold increase in wind plus solar can displace about 8.5 quads of fossil fuels.
- A doubling of nuclear power can displace 8 quads of fossil fuels.

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Environmental

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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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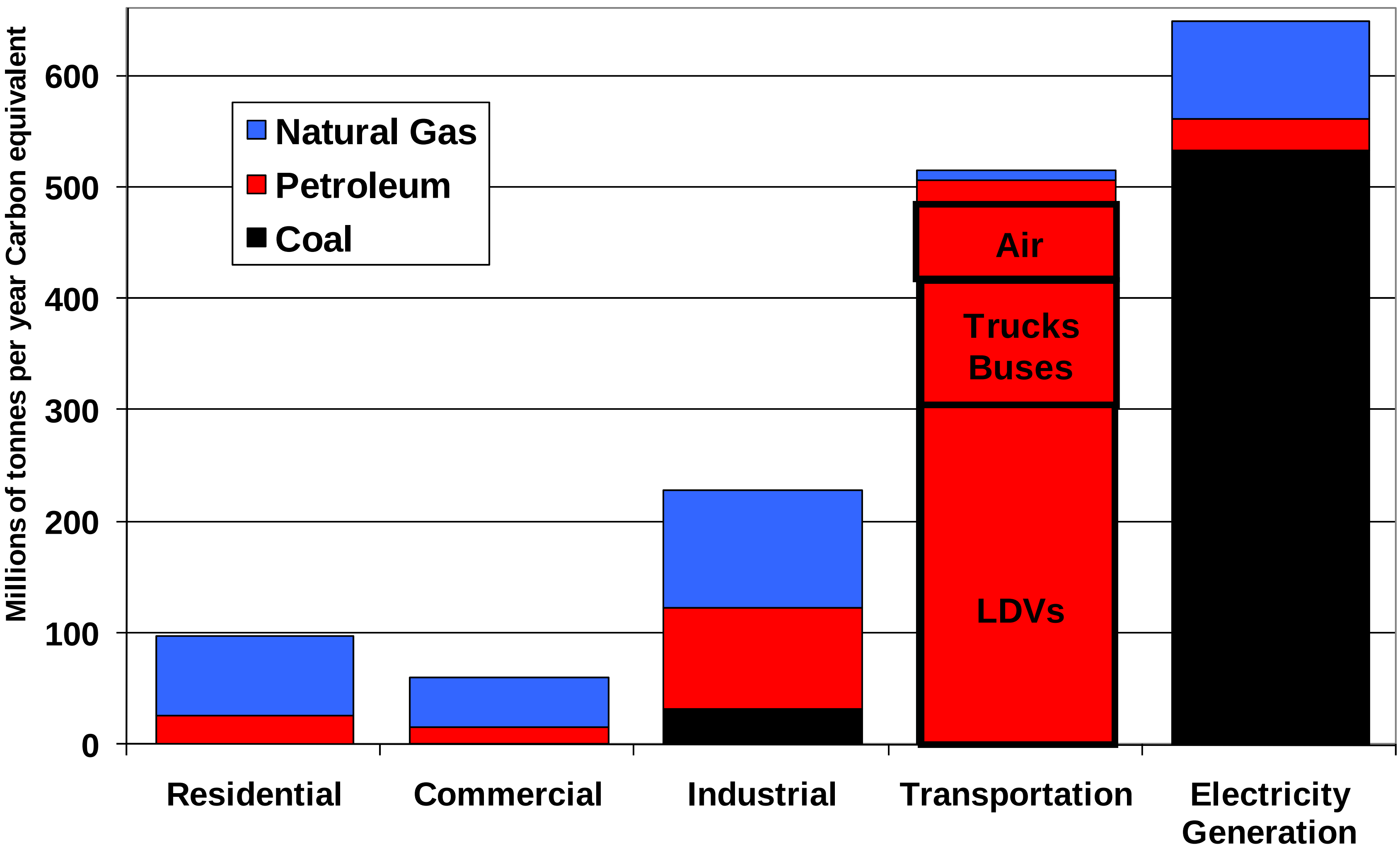
U.S. CO_2 Emissions by Sector and Fuels 2005: 1,568 Tonnes Carbon (5,751 Tonnes CO_2)



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

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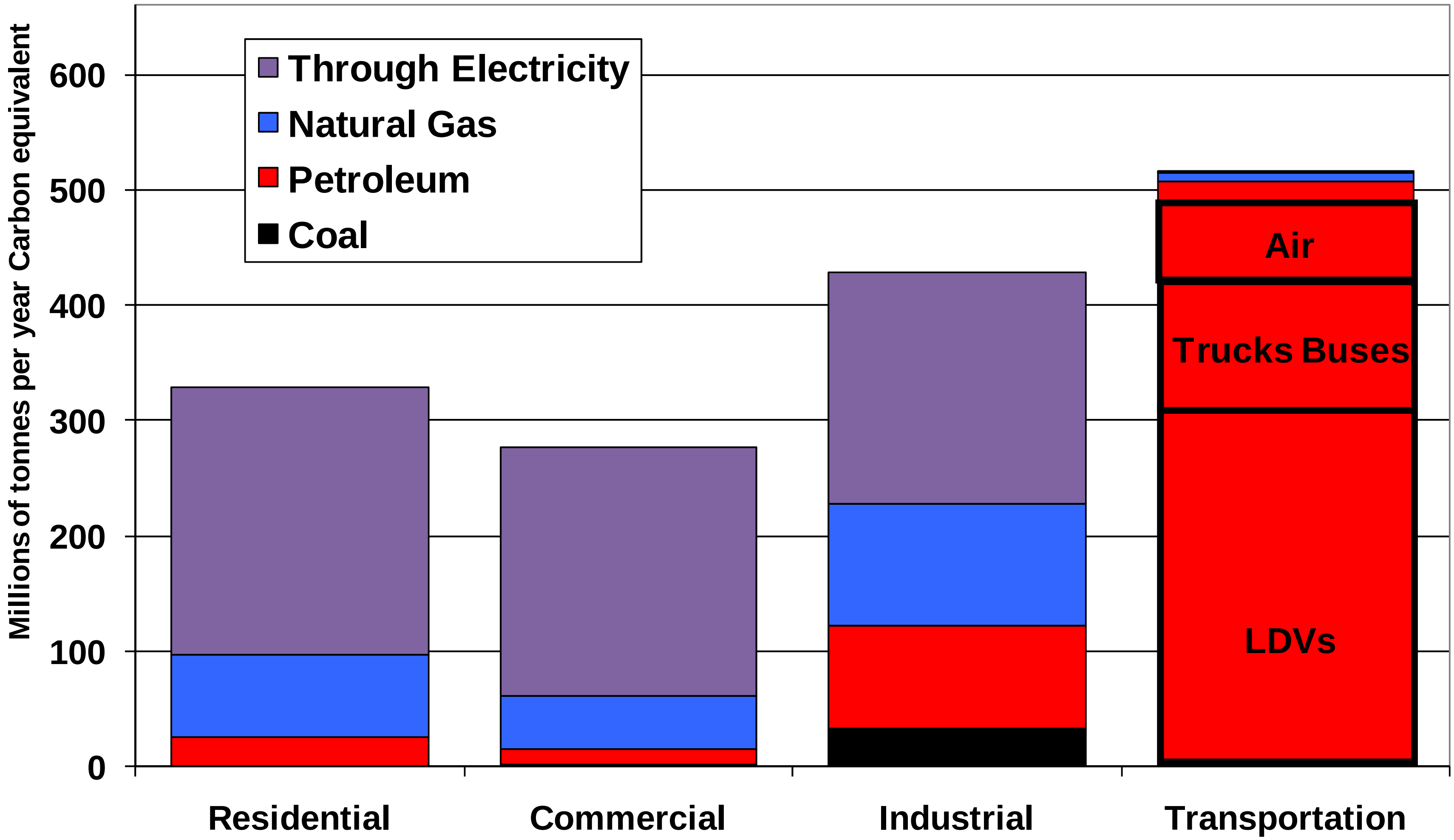
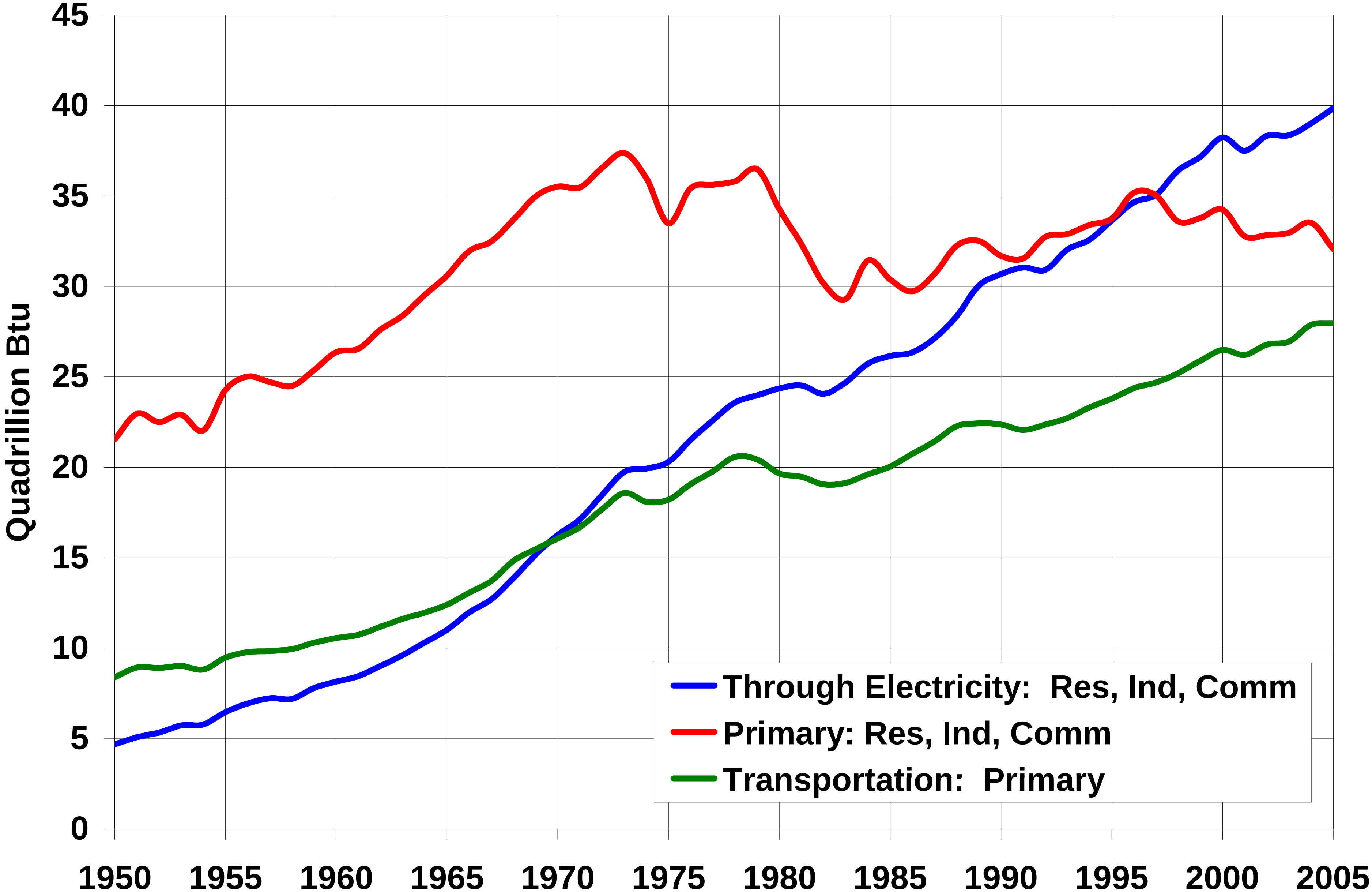


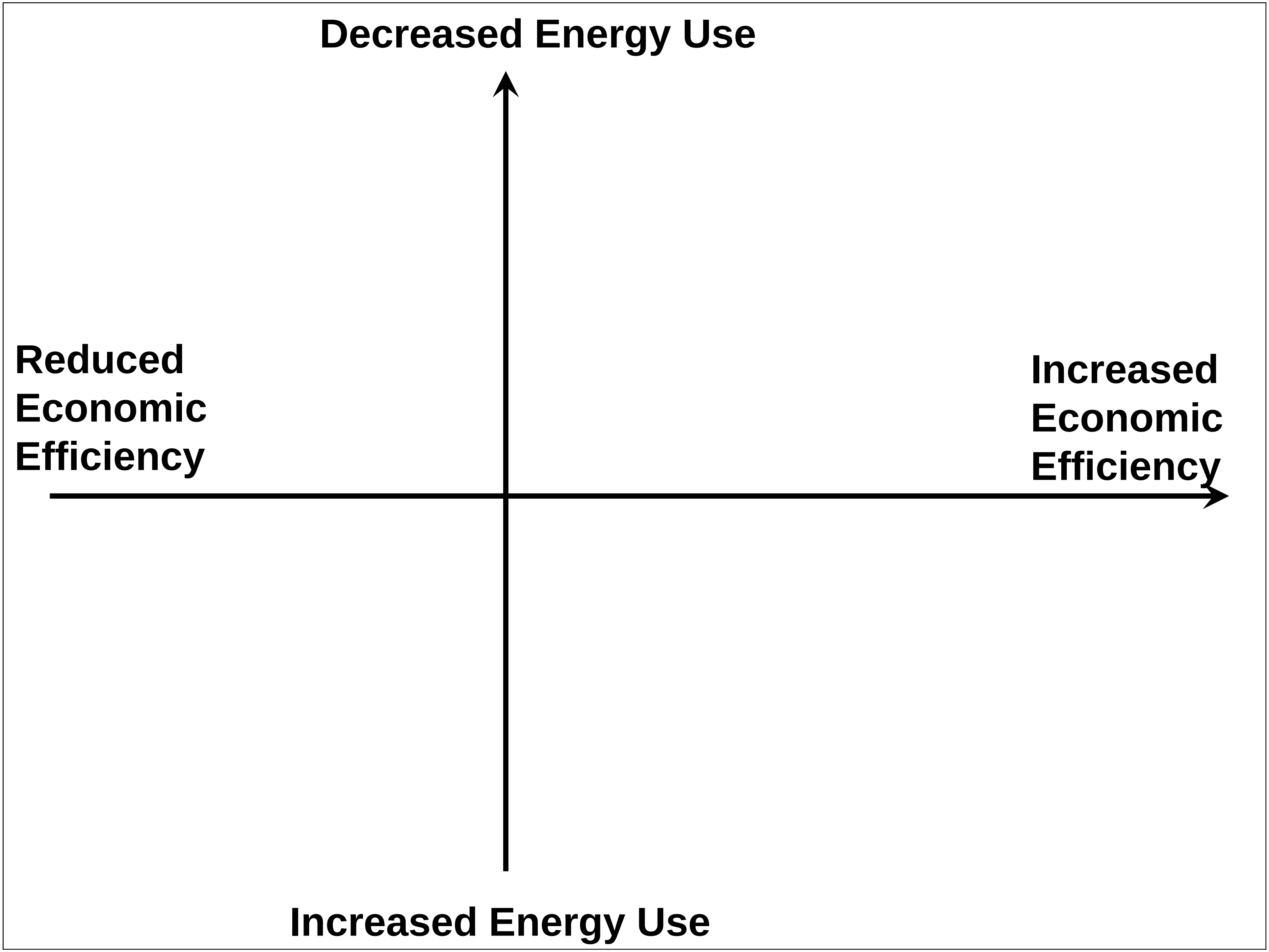
Source: U.S. EPA Inventory of Greenhouse Gas Emissions, April 2007

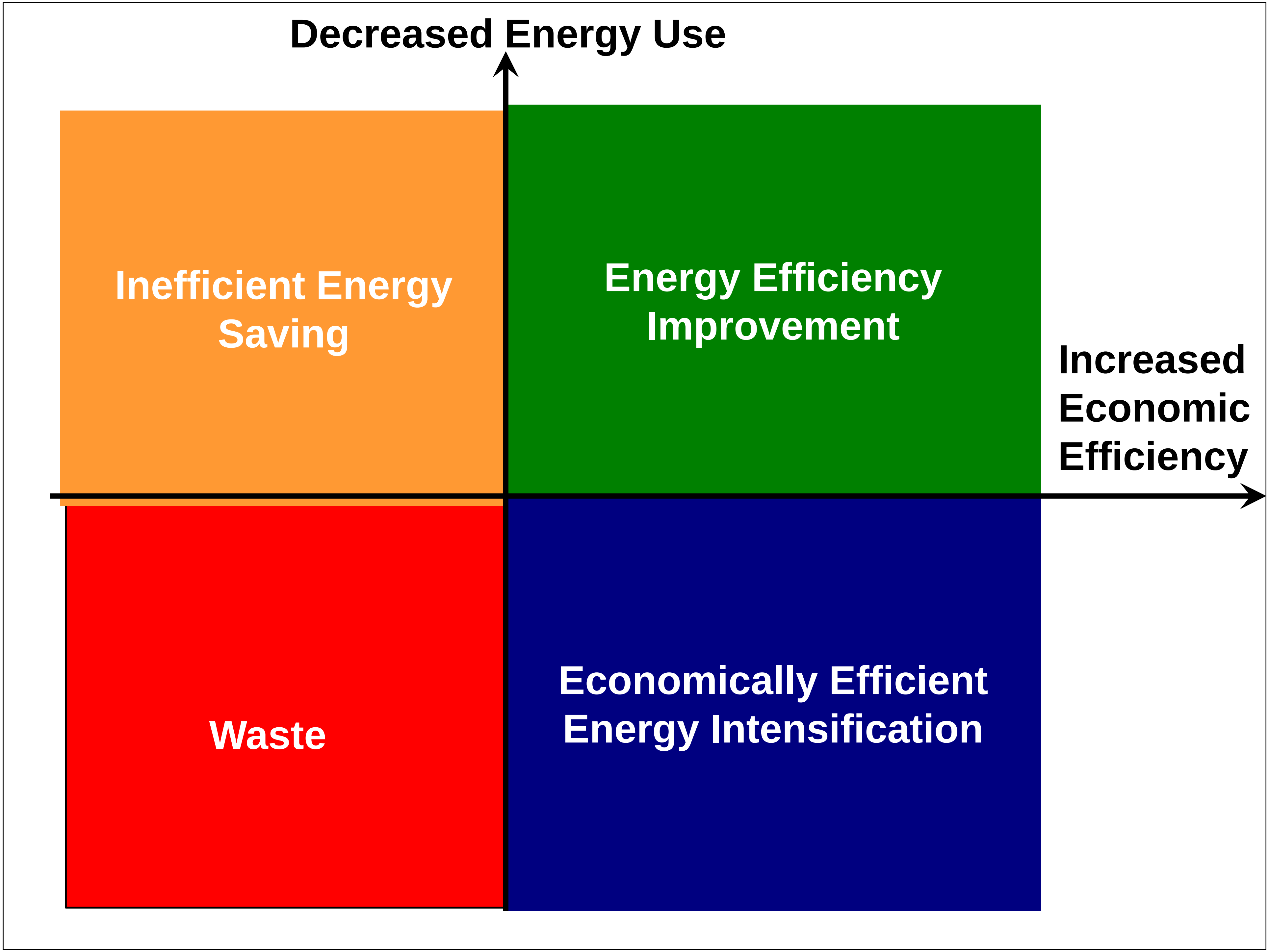
US Primary Energy and Electricity Use by Sectors



Energy Efficiency:

Economically Efficient Reductions in Energy Use Intensity


Decreased Energy Use
Reduced Economic Efficiency
Increased Economic Efficiency
Increased Energy Use


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

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")
  - 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
  - Under-investment
  - Sub-optimal technology directions, due to externalities
- Non-Convexities
  - Learning By Doing Technology Spillovers
  - "Chicken and Egg" Problems

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Minimizing Economic Cost of Reducing CO_2

- Multiple market failures imply multiple instruments are needed
- Best instruments depend on nature of failures
  - Carbon dioxide externality
    - Carbon tax or carbon cap and trade
  - Information externalities
    - Labeling, standards, regulations, disclosures
  - Behavioral issues
    - Education, marketing, cultural shift
  - Risk shifting externalities
    - Regulations, incentives
  - R&D under-investment
    - Incentives, government R&D, IP protection

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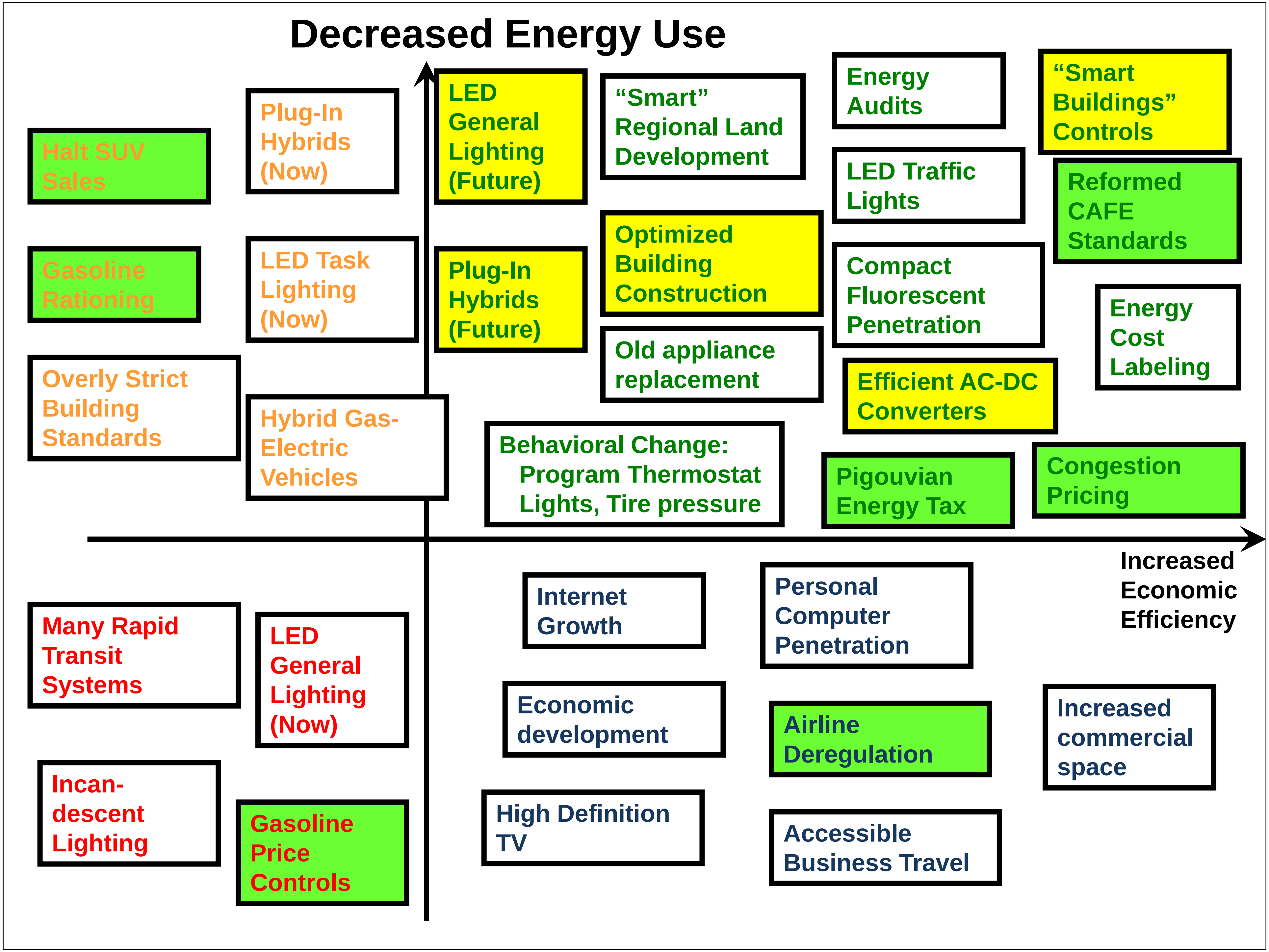


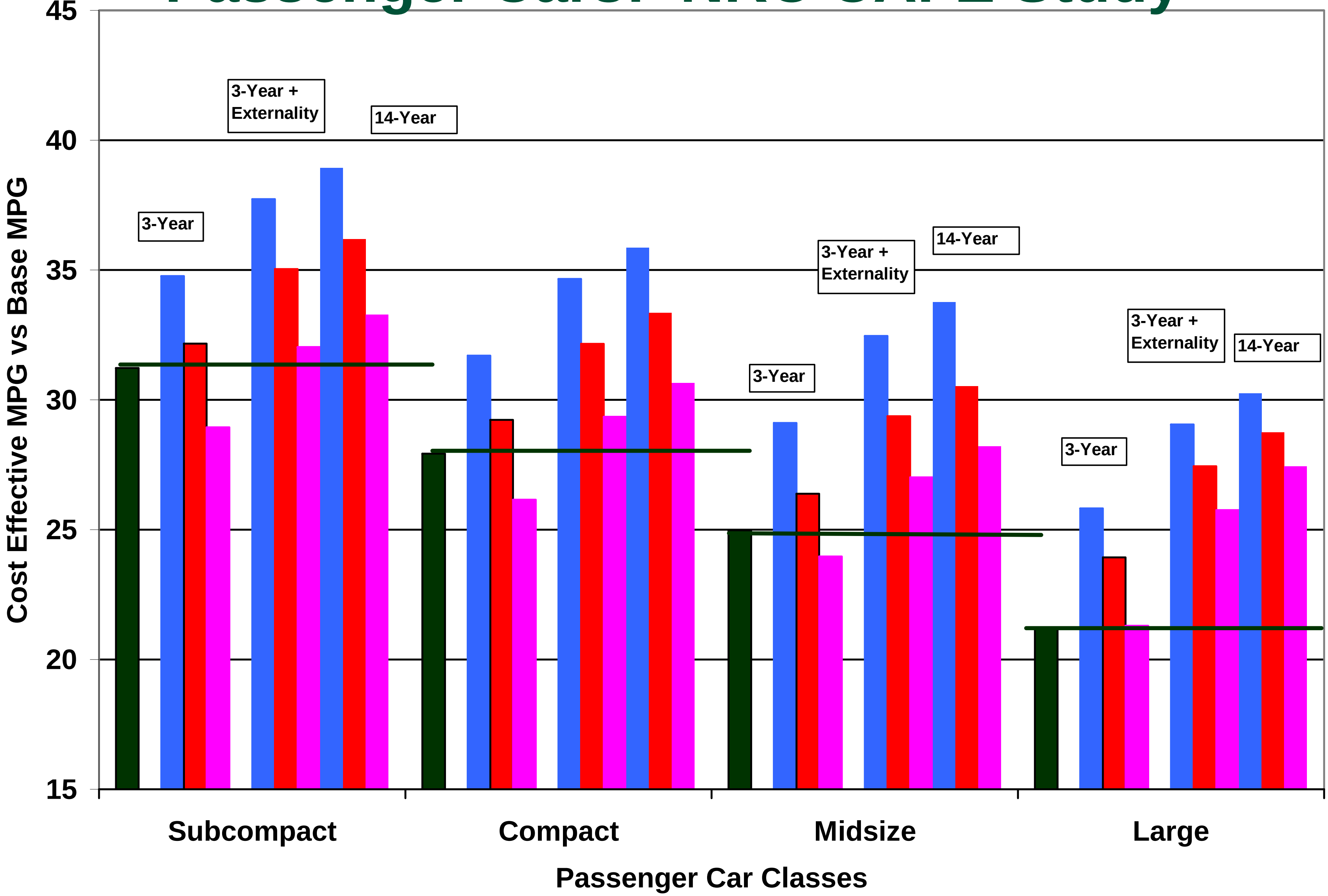
Decreased Energy Use
Increased Economic Efficiency
Halt SUV Sales
Gasoline Rationing
Overly Strict Building Standards
Plug-In Hybrids (Now)
LED Task Lighting (Now)
Hybrid Gas-Electric Vehicles
LED General Lighting (Future)
Plug-In Hybrids (Future)
"Smart" Regional Land Development
Optimized Building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

CAFE Standards

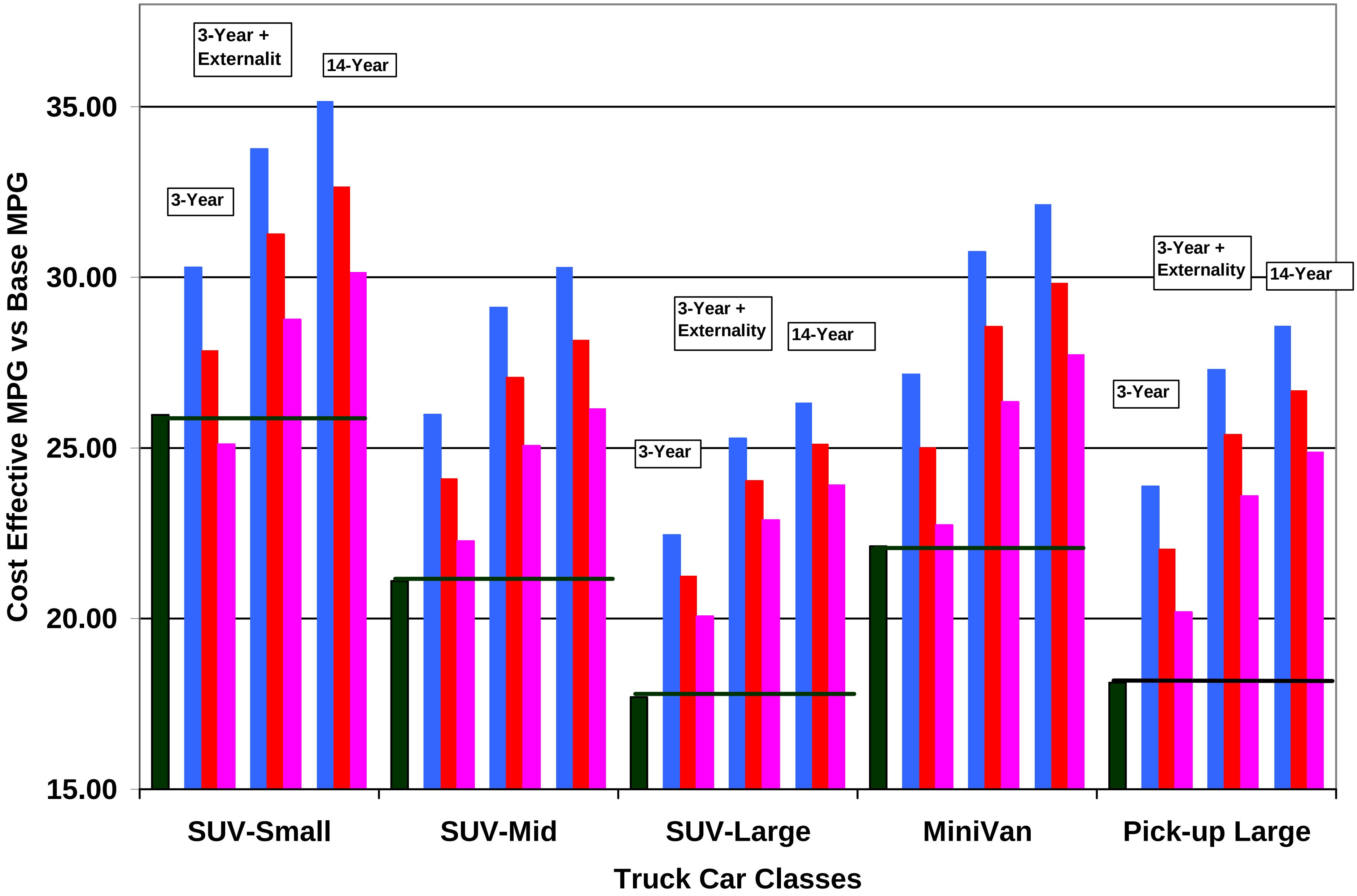
Actual (2001) vs DPV Cost Minimizing Fuel Economy – Without Hybrids – NRC CAFE Study

	MPG		Gallons Per 100 Miles		
Type	2001	DPV Cost Minimizing	2001	DPV Cost Minimizing	Optimal % Reduction
Subcompact	31.00	36.00	3.23	2.78	14%
Compact	28.00	33.00	3.57	3.03	15%
Mid Size	25.00	30.10	4.00	3.32	17%
Large	21.00	29.00	4.76	3.45	28%
SUV Small	25.10	32.50	3.98	3.08	23%
SUV Mid	21.00	28.00	4.76	3.57	25%
SUV Large	17.50	25.00	5.71	4.00	30%
Minivan	22.00	30.00	4.55	3.33	27%
Large Pickup	18.00	27.00	5.56	3.70	33%

Estimated Cost-Minimizing MPG vs. Current Passenger Cars: NRC CAFE Study



Estimated Cost-Minimizing MPG vs. Current: "Trucks"



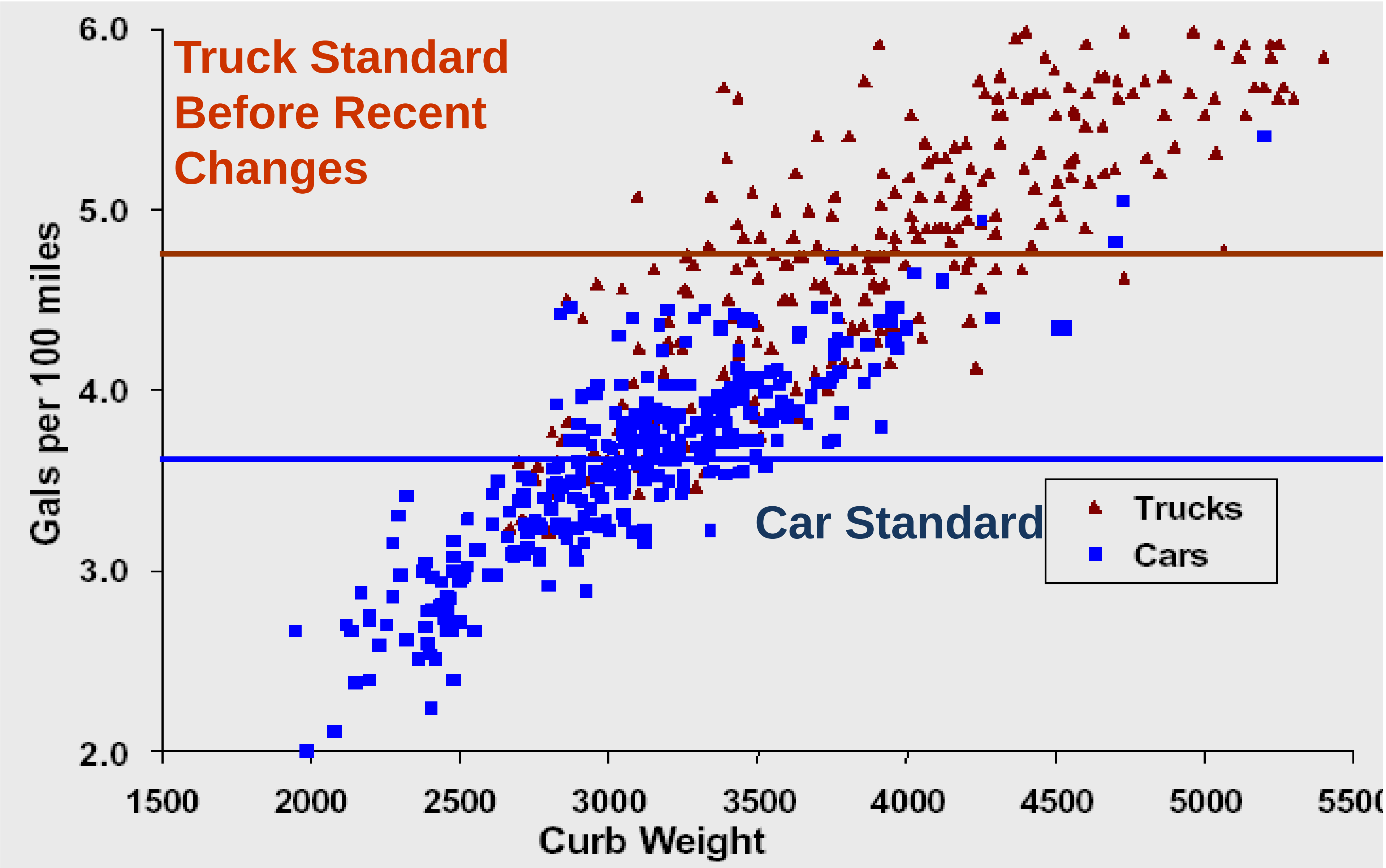


Figure 2: Car and Truck Fuel Consumption per Mile Driven vs Curb Weight 1999 Model Year. Source: Charles Lave.

Restructuring of CAFE

- Tradable Fuel Economic Credits
- Attribute-Based Targets

Tradable Fuel Economy Credits

- Government sets target fuel economy
  - Should vary with weight or footprint of vehicles
- Manufacturers must meet average target fuel economy or acquire enough credits
- Credits can be purchased from other manufacturers or from government
- Excess credits can be sold if manufacturer exceeds average fuel economy targets.
- Government sales of credits at a legislated price would set a cap on price of credits.

Advantages: Tradable Fuel Economy Credits

- Incentives for <u>all</u> manufacturers, including those beating targets, to increase fuel economy
- Incentives available for new entrants to the industry
- Flexibility to meet consumer preferences
- Limit costs if standards turn out to be more difficult to meet than expected
- Will reveal information about costs of fuel economy improvements
- Keep aggressive fuel economy goals from creating irreparable harm

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Attribute Based Targets

- Current Attribute Based Standards:
  Vehicle is a Car or a Truck
  Heavy Vehicles Not Regulated

- Large Incentive to Design Vehicle to be a Truck
  E.g.: PT Cruiser

- Better Approach: Make Targets Continuous with Meaningful Variables
  E.g.: Gross Vehicle Weight or Footprint

- Target Rule May or May Not Provide Incentives To Change Meaningful Variables

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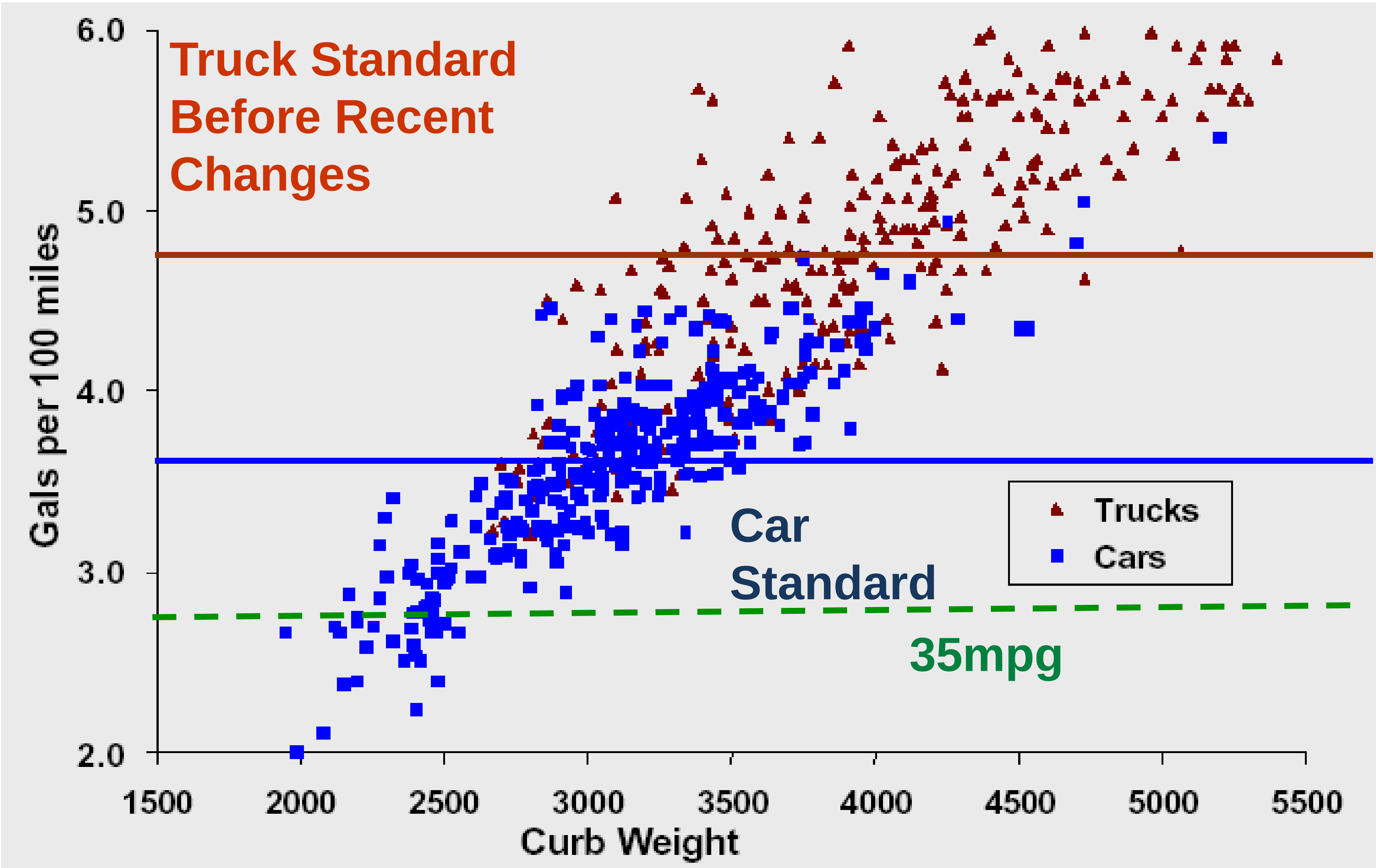

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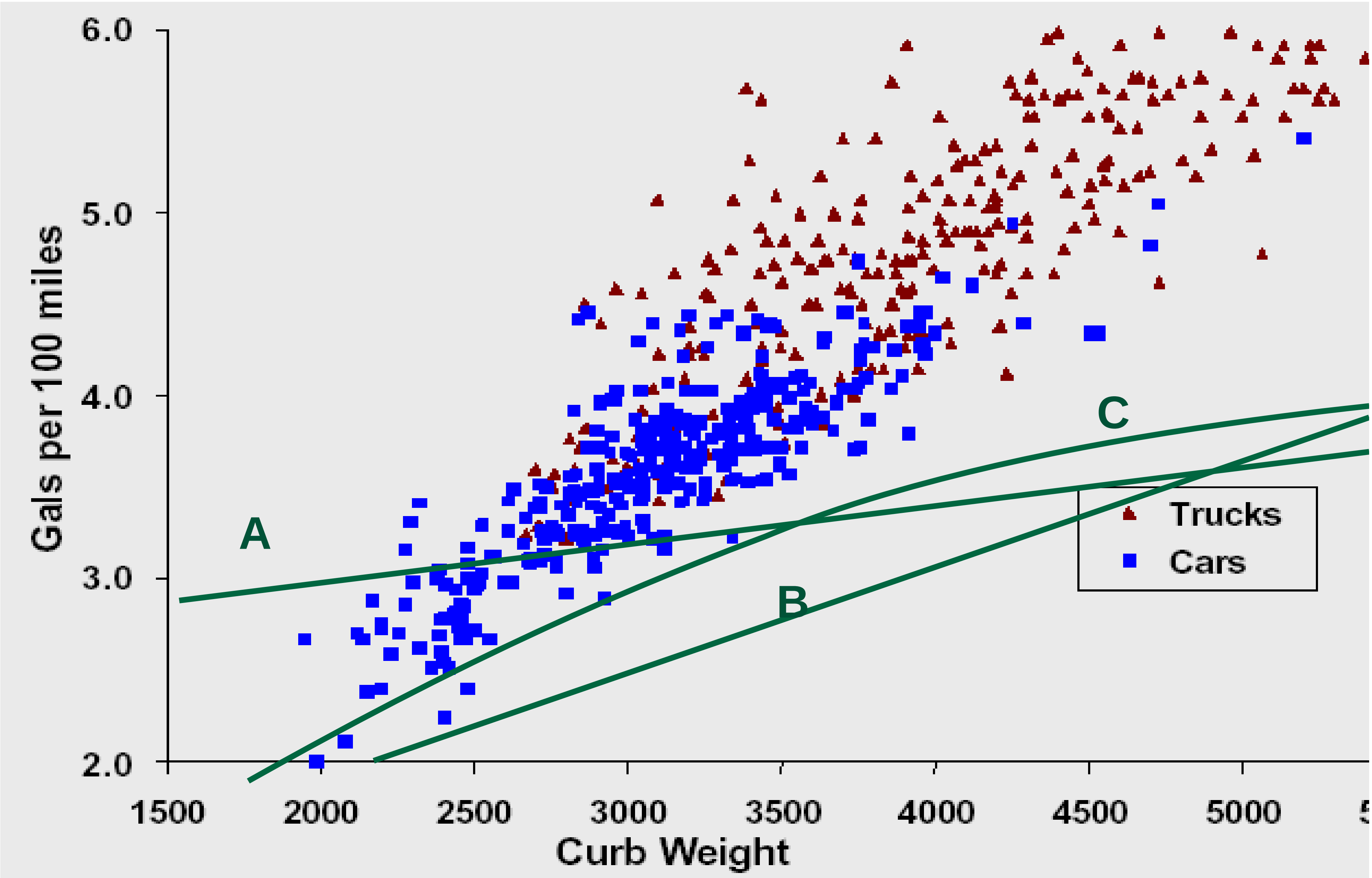
Possible Integrated Targets



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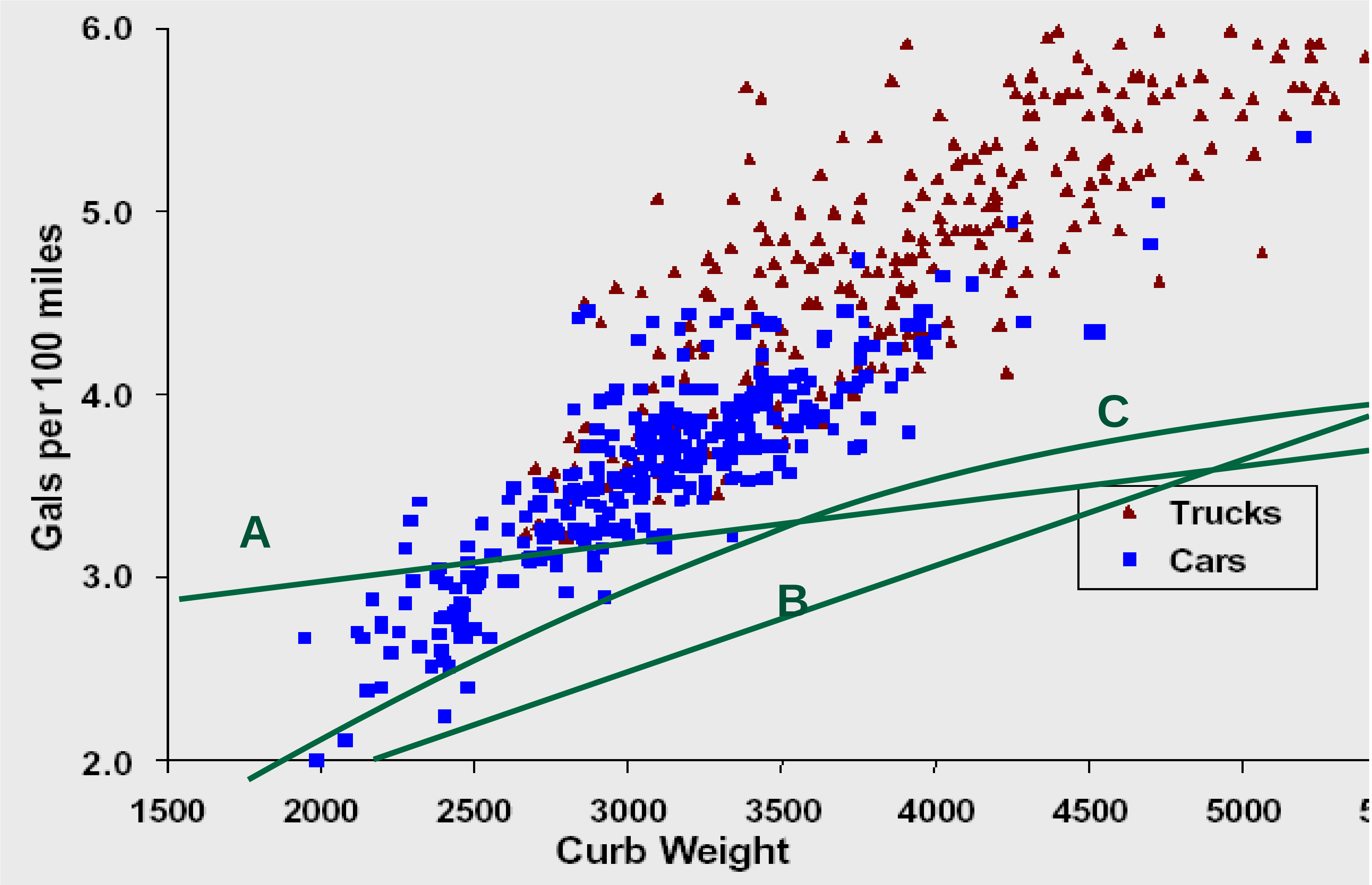
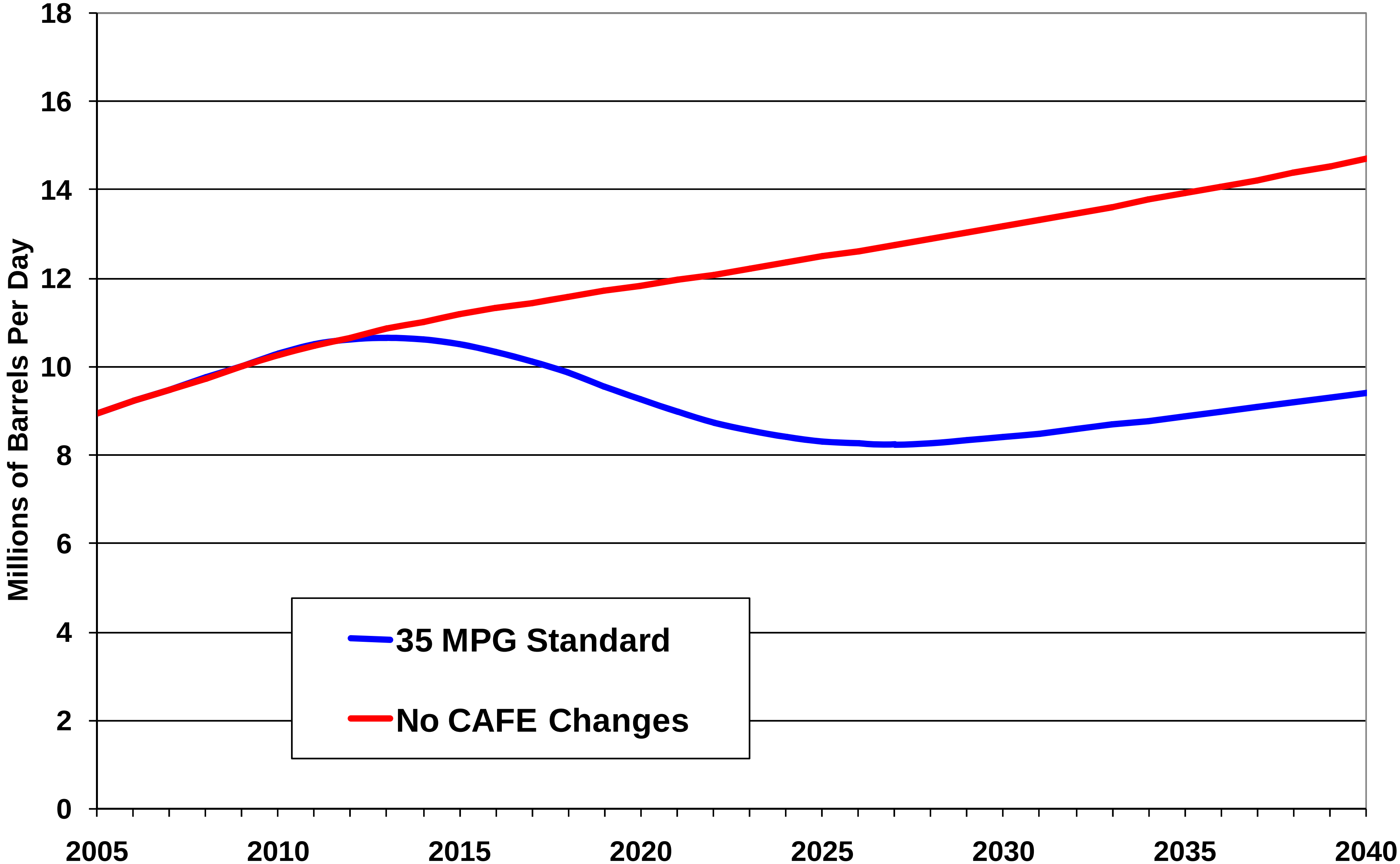


Gasoline (Or Equivalent) Use: Light Duty Vehicles



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Example: Lighting

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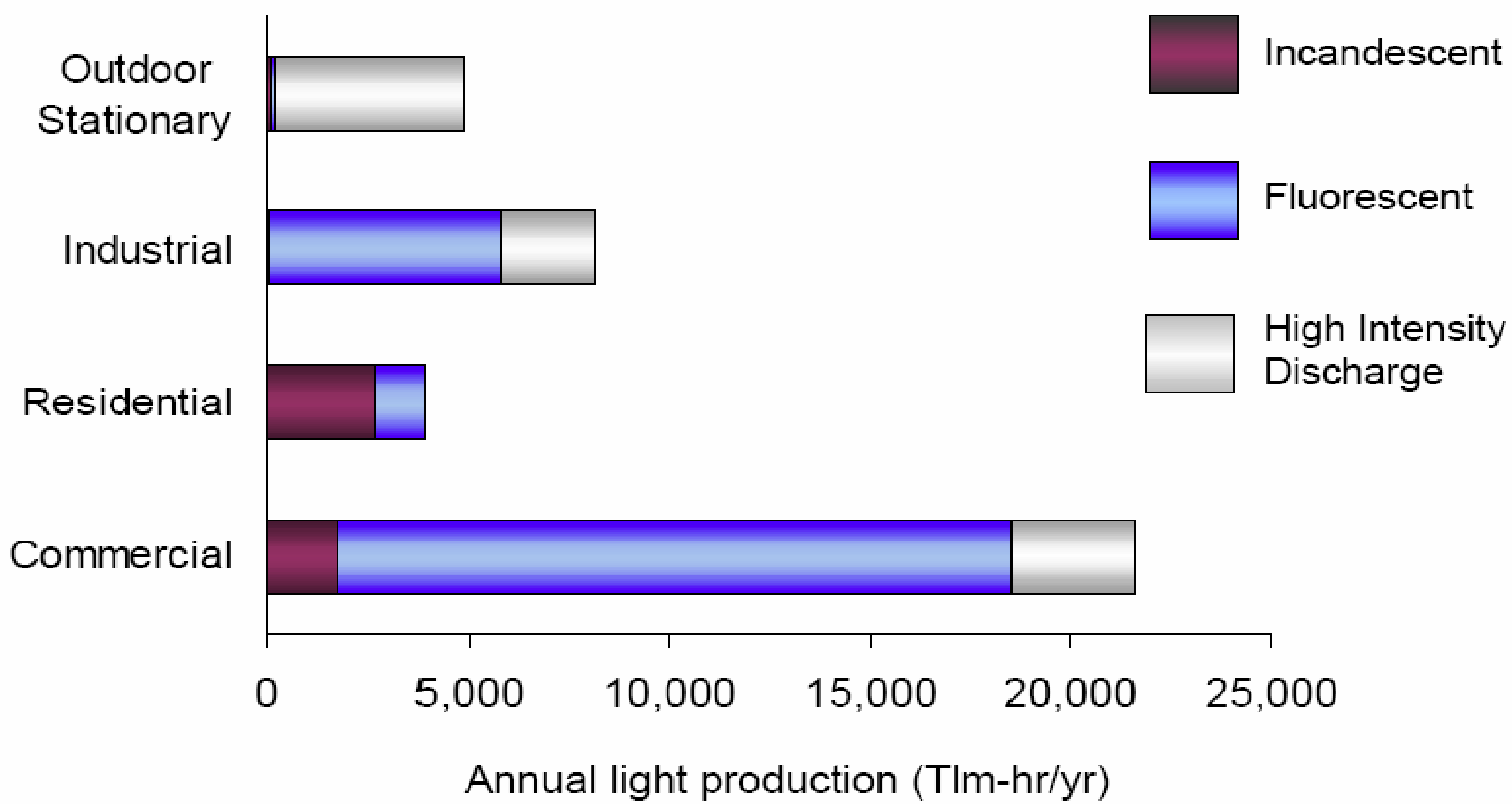

Figure 8-4. Source Light Production by Sector & Source

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

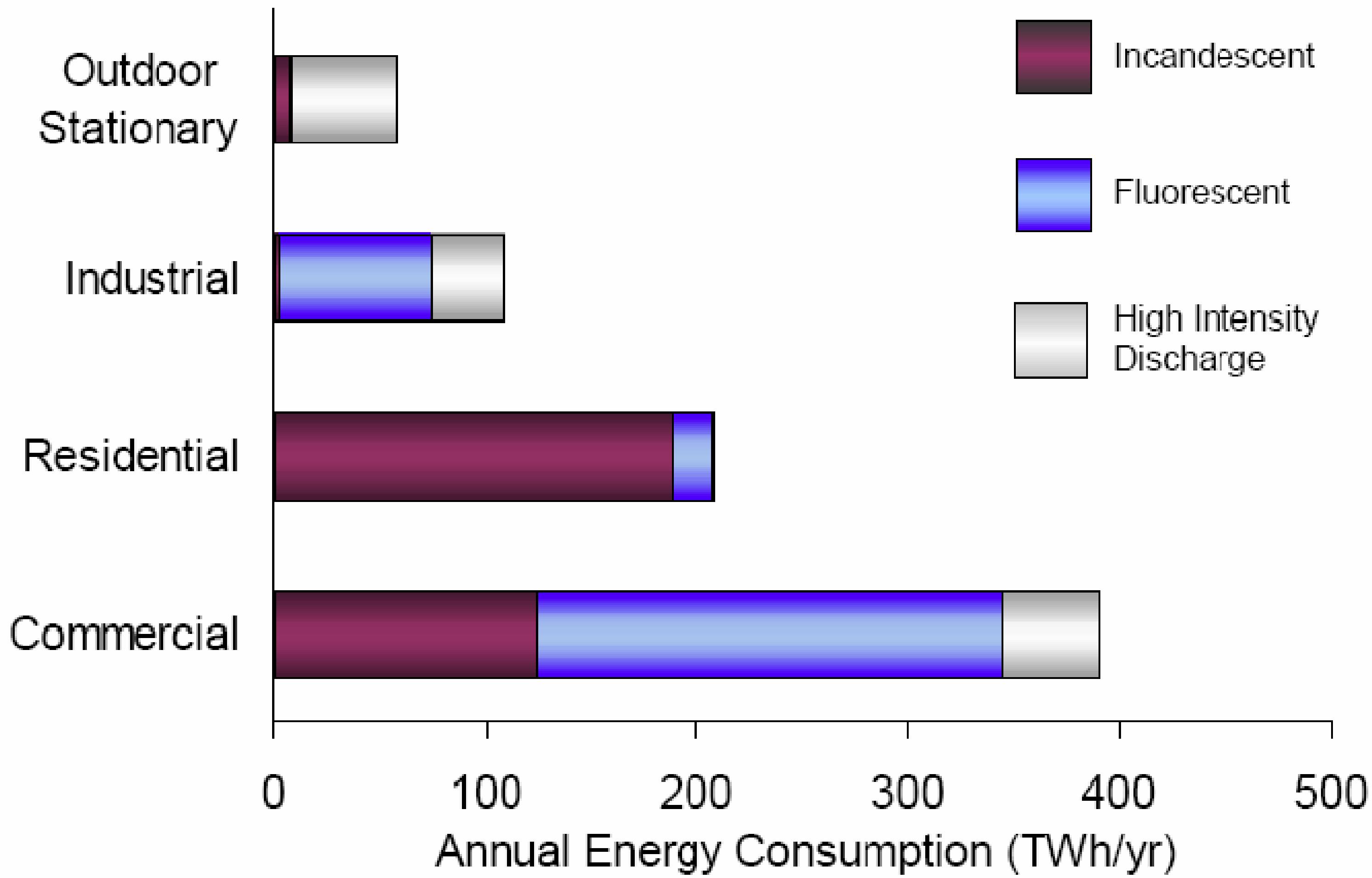

Figure ES-1 Shares of Sectoral Energy Use by Lighting Technology

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

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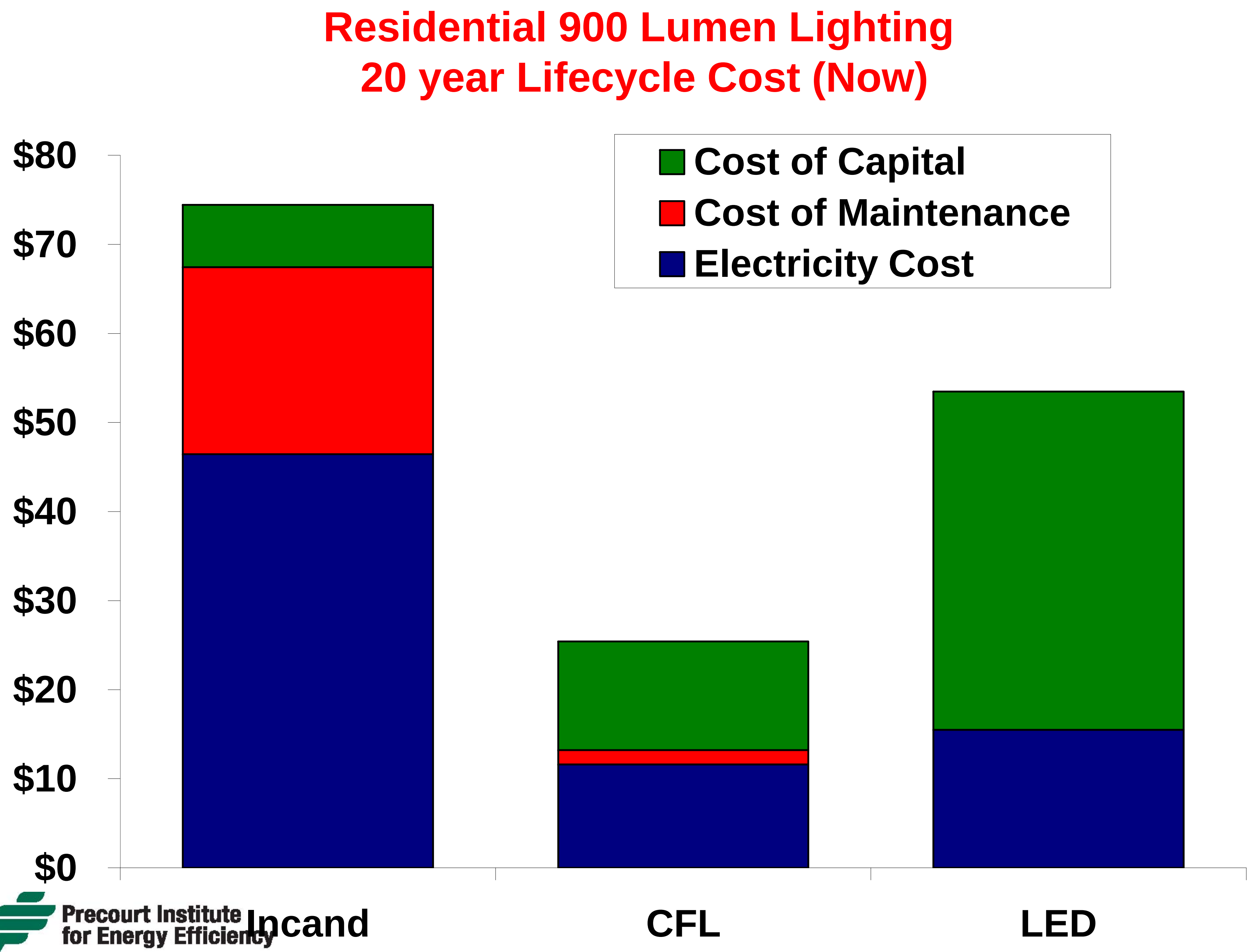

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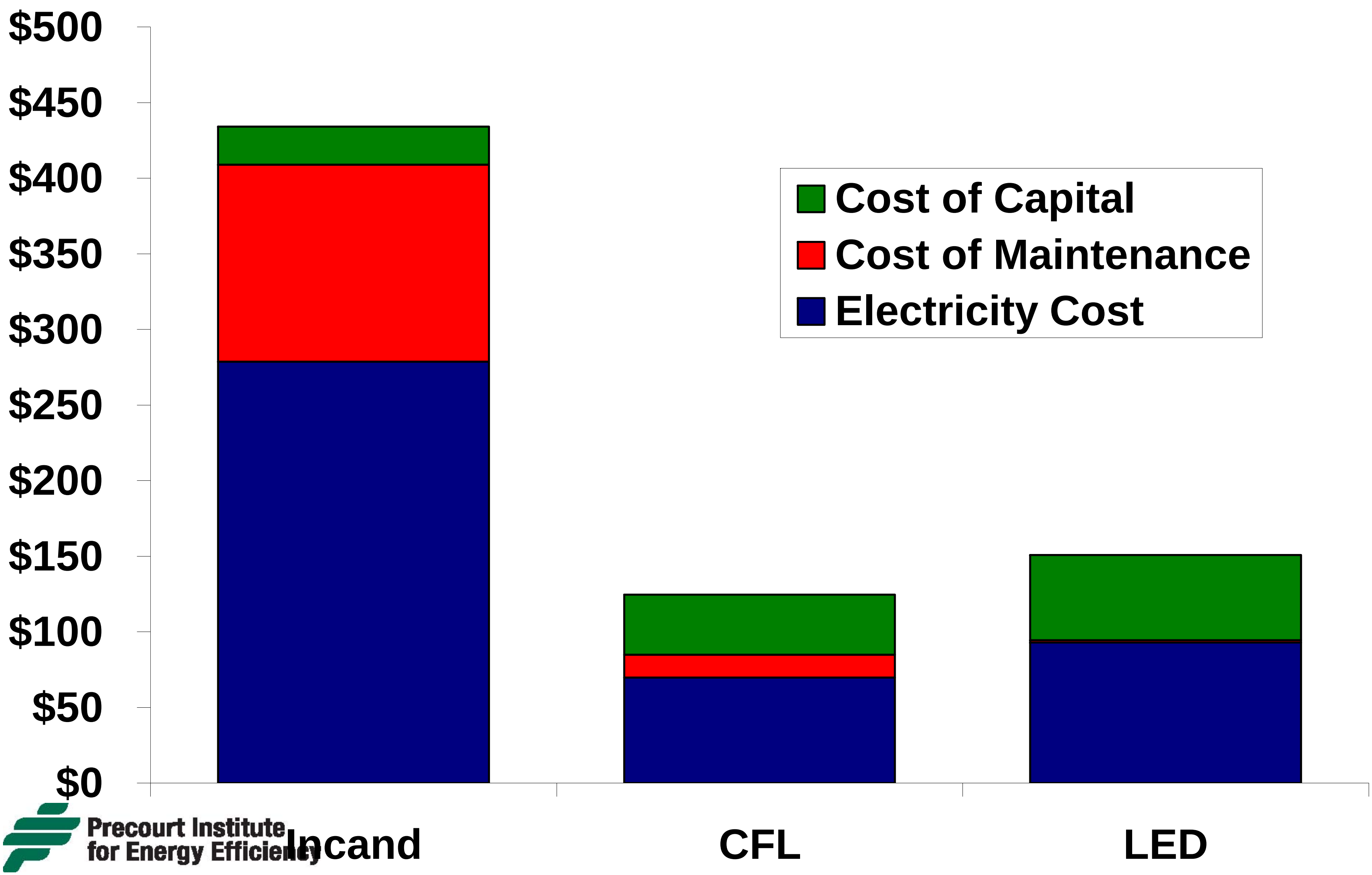
Commercial 900 Lumen Lighting
20 year Lifecycle Cost (Now)



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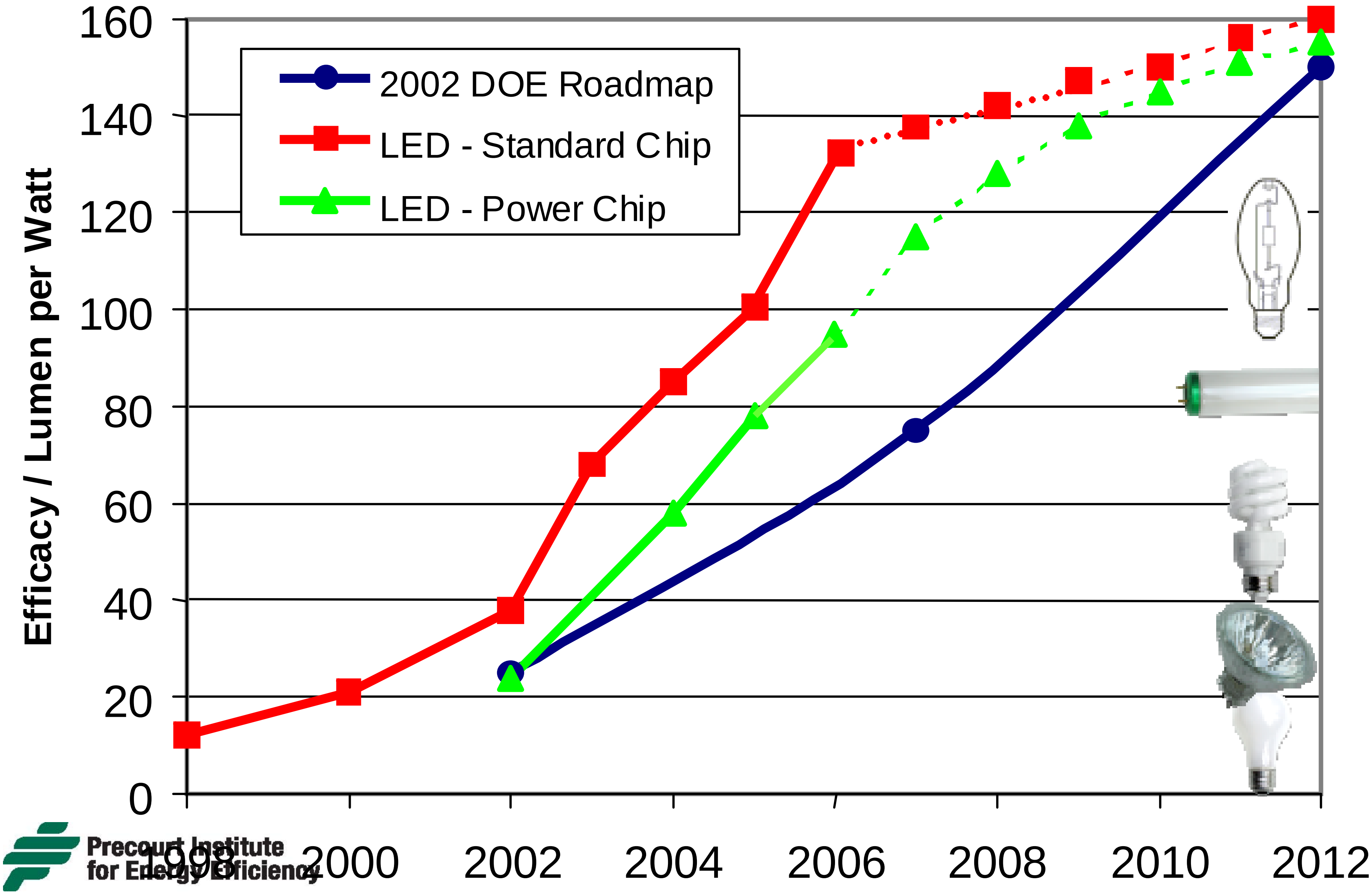
LEDs Efficacy Increases by 30% Per Year



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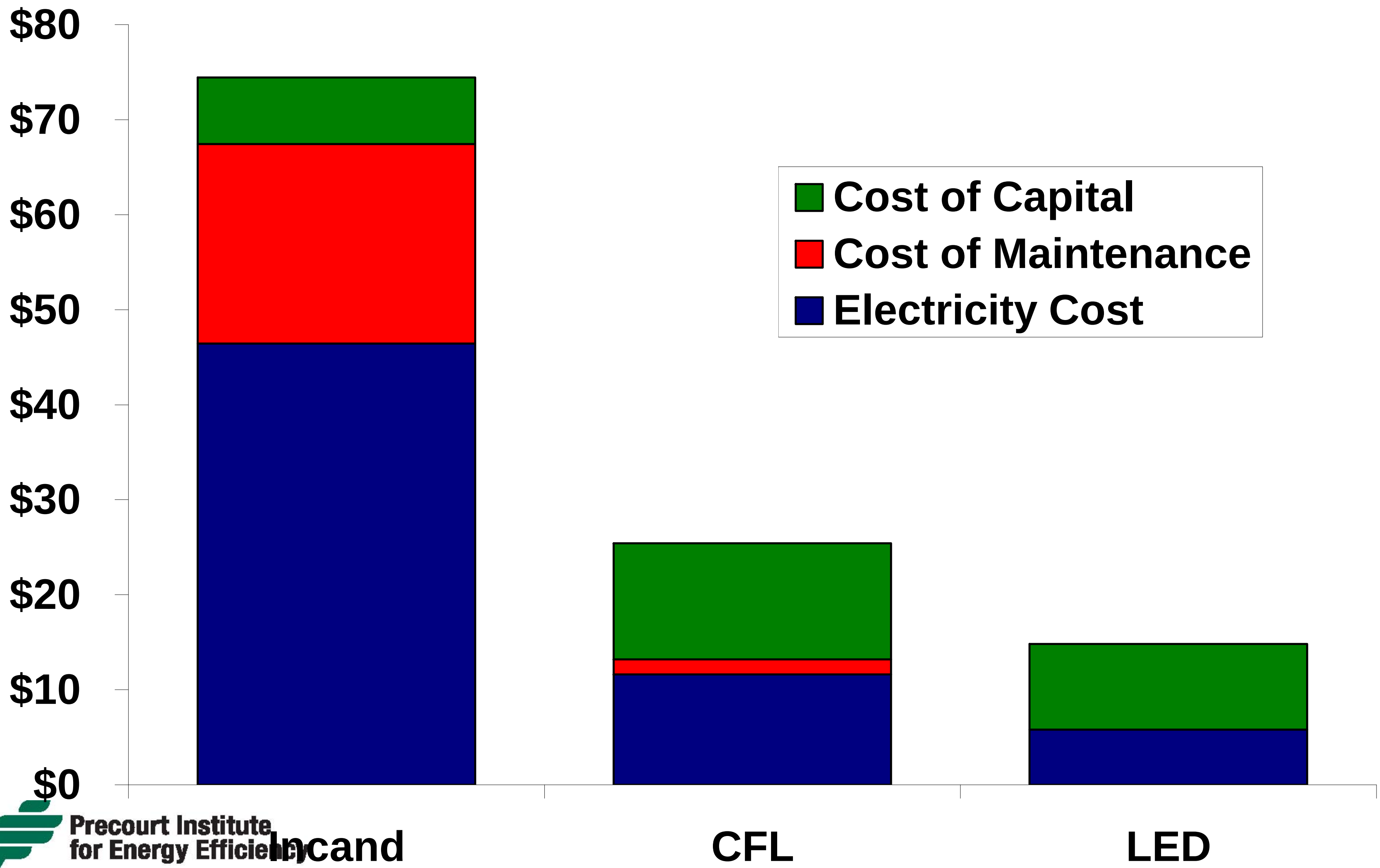
Residential 900 Lumen Lighting
20 year Lifecycle Cost (In 5 – 10 Years)



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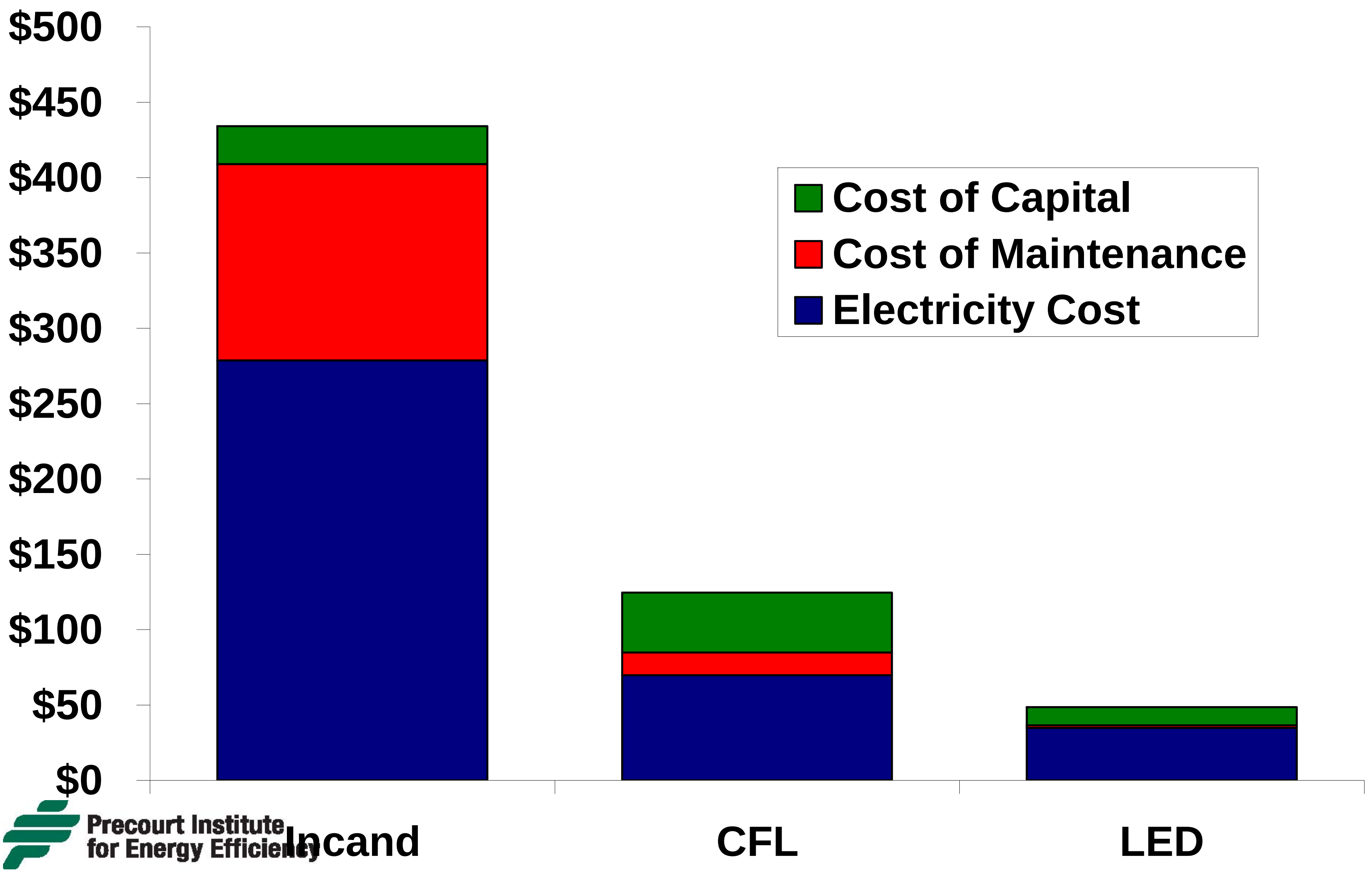
20 year Lifecycle Cost (In 5 – 10 Years)



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