

# Mitigating Greenhouse Gas Emissions from Transportation

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**Using a mix of practical policy measures, U.S. transportation should be able to cut GHG emissions by 20-25% by 2018 and 45-50% by 2033, compared to “Business as Usual.”**

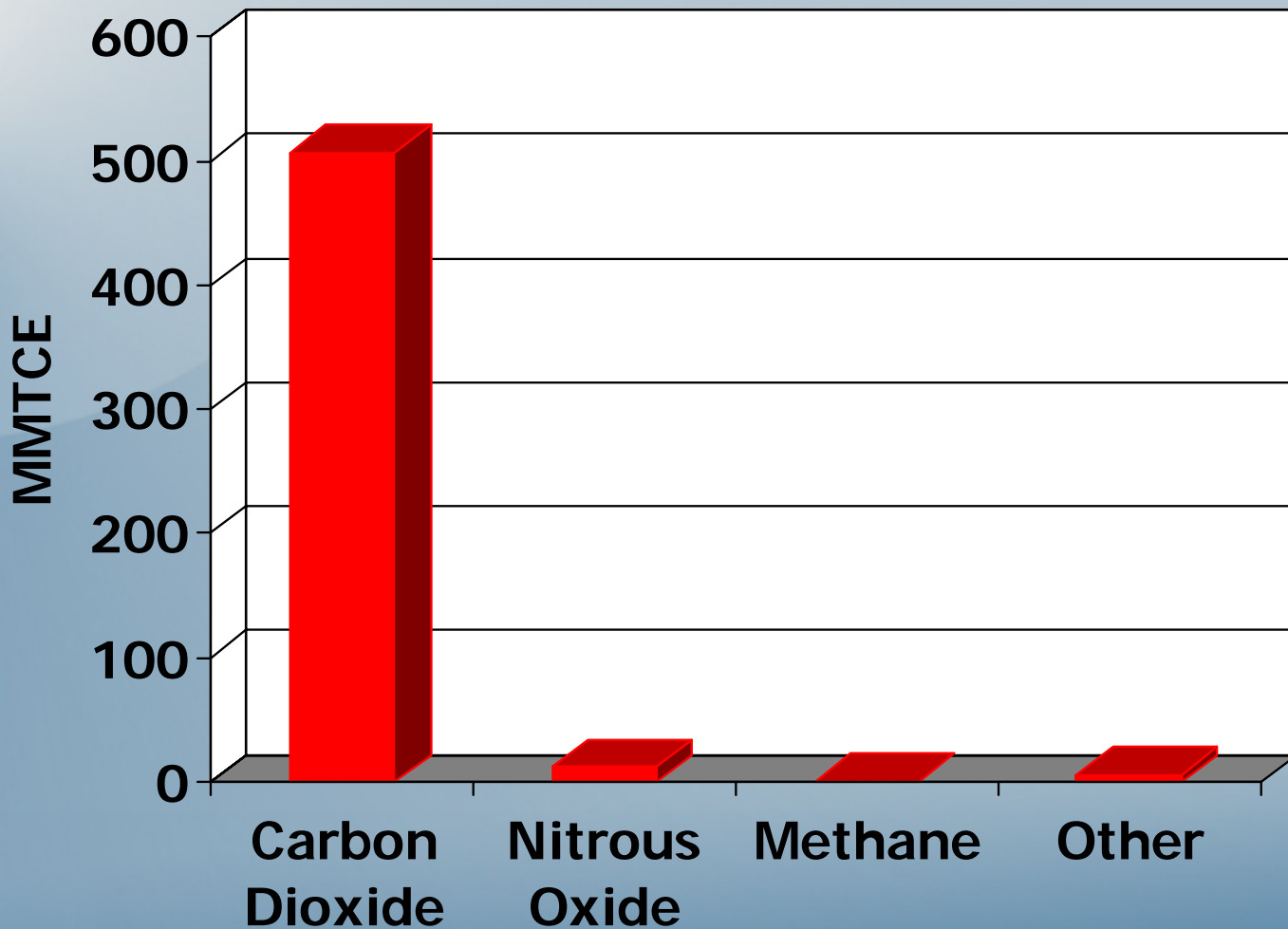
# **There is no panacea (not even a carbon tax) for transportation's GHG emissions.**

- Major government role in providing and regulating transportation infrastructure.
- Apparent market failures in the market for automotive fuel economy.
- Current absence of competitive, low-carbon alternatives to petroleum capable of supplying a major fraction of transportation energy use.
- Critical importance of advancing environmentally benign technologies.
- Strong interdependence of land use and transportation demand.
- State and national policy impacts will differ.

# The U.S. transportation system is the world's largest.

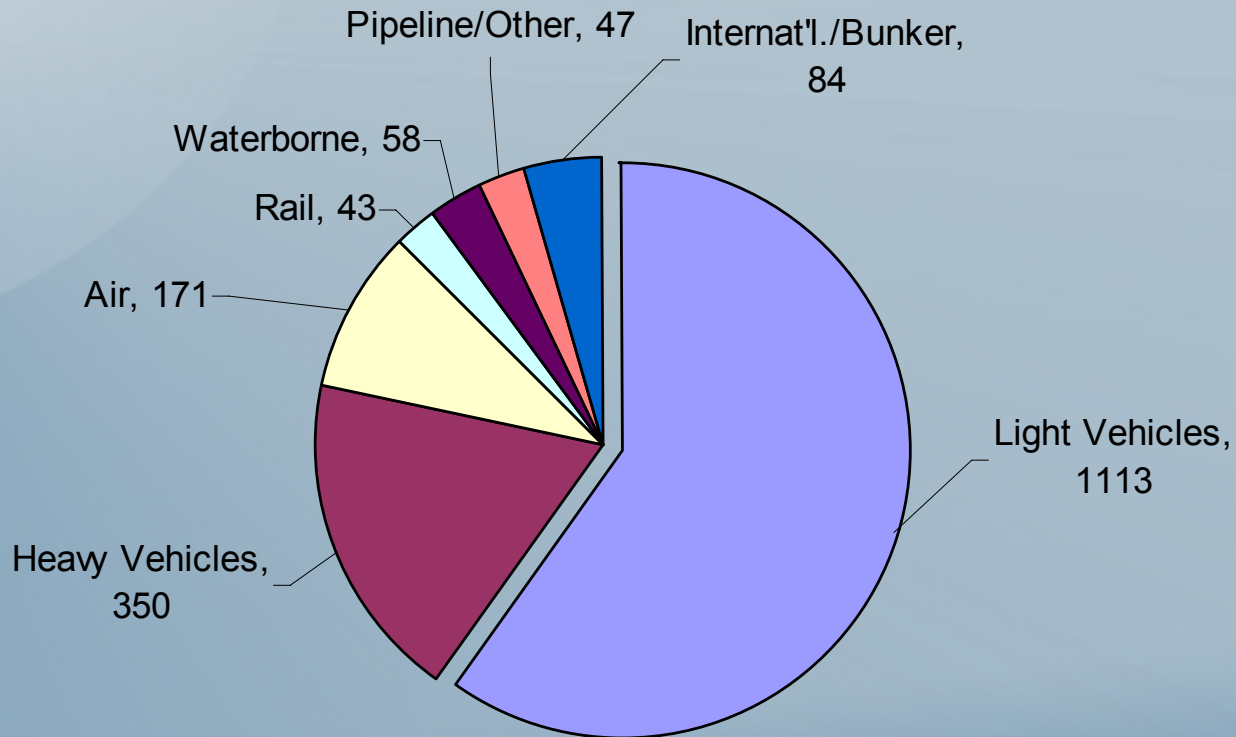
- 5.4 trillion passenger-miles 3.8 trillion ton-miles of freight per year
- 6,300 gallons/second
- Second to industry in U.S. GHG emissions, but growing faster
- Largest source of CO<sub>2</sub>
- More than any nation's total CO<sub>2</sub> emissions, except China
- 72% from highway vehicles, over half from cars and light trucks

**Carbon dioxide is by far the most important greenhouse gas emitted by transportation.**



# Highway vehicles, especially passenger cars and light trucks, account for most transportation GHG emissions.

U. S. Transportation Carbon Emissions by Mode, 2003  
(Million metric tons CO<sub>2</sub>)



# Increasing fuel economy can make the largest single contribution.

- Meaningful increases achievable at low to moderate costs
- No infrastructure changes required
- Main barriers:
  - goals sought are public not private benefits (GHGs, oil dependence)
  - consumers may undervalue fuel economy
  - Powerful interests oppose meaningful policies
- No shortage of effective policies: feebates, standards, carbon cap and trade, etc.
- Technology alone is not enough:

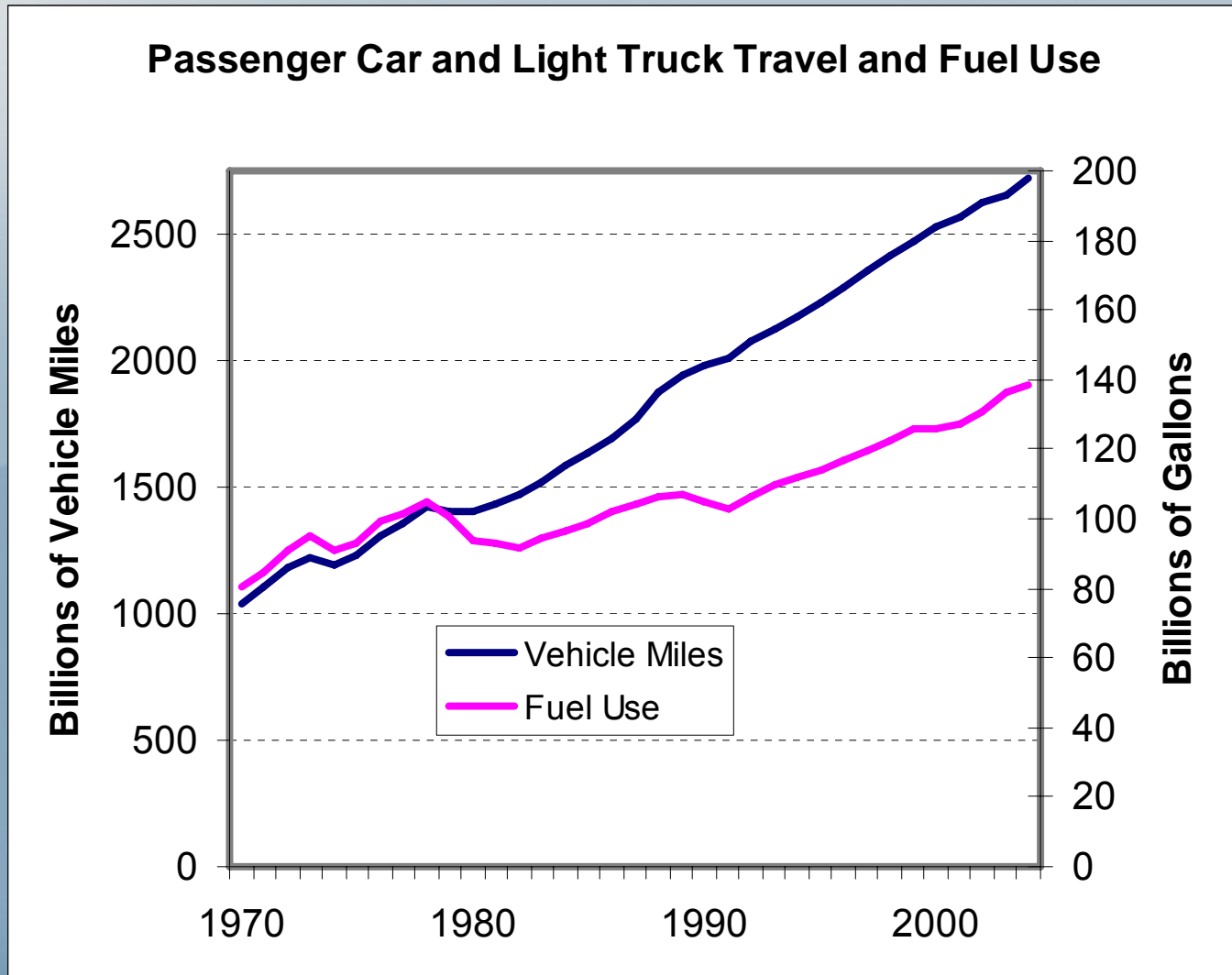
“EPA estimates that had the new 2005 light-duty vehicle fleet had the same distribution of performance and the same distribution of weight as in 1987, it could have achieved about 24 percent higher fuel economy.” (Heavenrich, 2005) (Hp/lb. up +42%)

# 1%

(Prof. John Heywood, MIT)

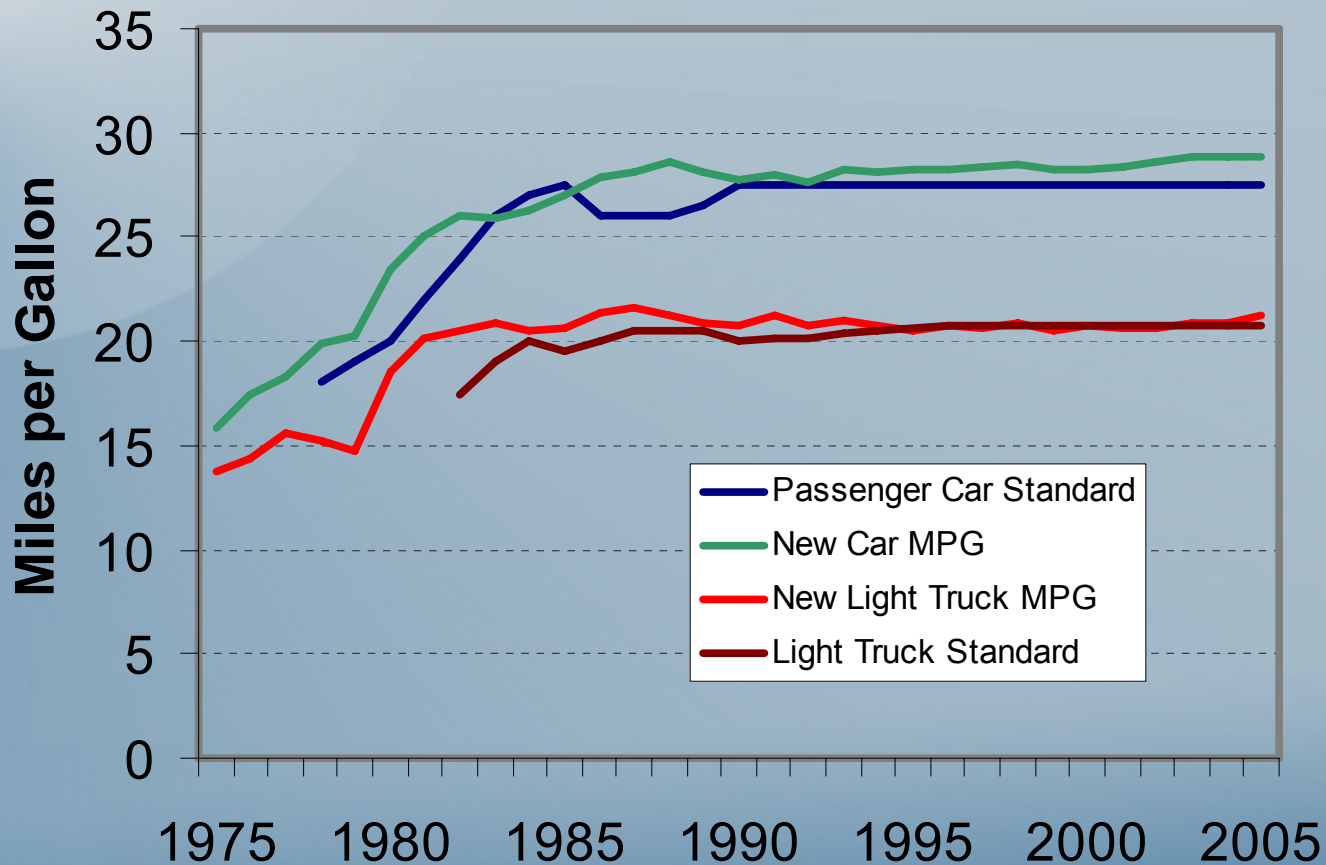
- A modern gasoline internal combustion engine vehicle converts about 16% of the chemical energy in gasoline to useful work.
- The average light-duty vehicle weighs 4,100 lbs.
- The average occupancy of a light-duty vehicle is 1.6 persons.
- If the average occupant weighs 160 lbs,
- $0.16 \times ((1.6 \times 160) / 4100) = 0.01$

**Fuel economy increases since 1978 are saving more than 60 billion gallons of gasoline every year.**



**Public policy, rather than market forces, has been primarily responsible for increased fuel economy.**

### U.S. Passenger Car and Light Truck Fuel Economy Standards

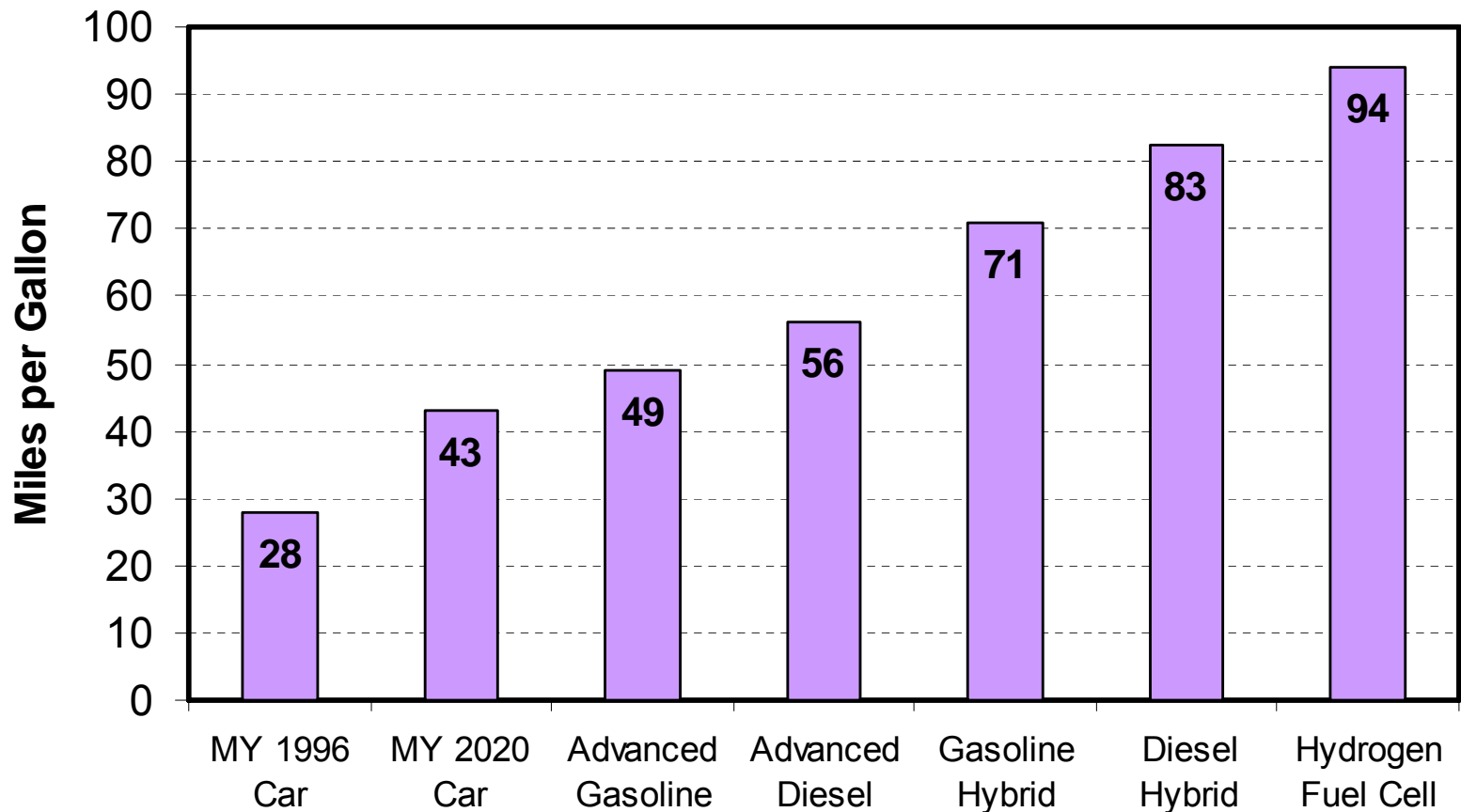


## The near-term (circa 2015) potential for GHG reduction from NEW vehicles via fuel economy improvements has been estimated by the NRC (2002) and others.

- “Technologies exist that, if applied to passenger cars and light trucks, would significantly reduce fuel consumption within 15 years.”
- Passenger cars 12% (subcompacts) to 27% (large cars).
- Light trucks 25% (small SUV) to 42% (large SUV)
- Present value of fuel savings > vehicle price increase
- No change in size, weight or **performance**
- Does not include hybrids or clean diesels, each offering 30-40% increases.
- Further market penetration of hybrids and clean diesels through 2012 and beyond could boost fleet average fuel economy by an additional 10% or more. (Greene, Duleep and McManus, 2004)

**In the future, if we focus on fuel economy instead of horsepower and size, much more will be possible.**

**MIT's "On the Road in 2020"**

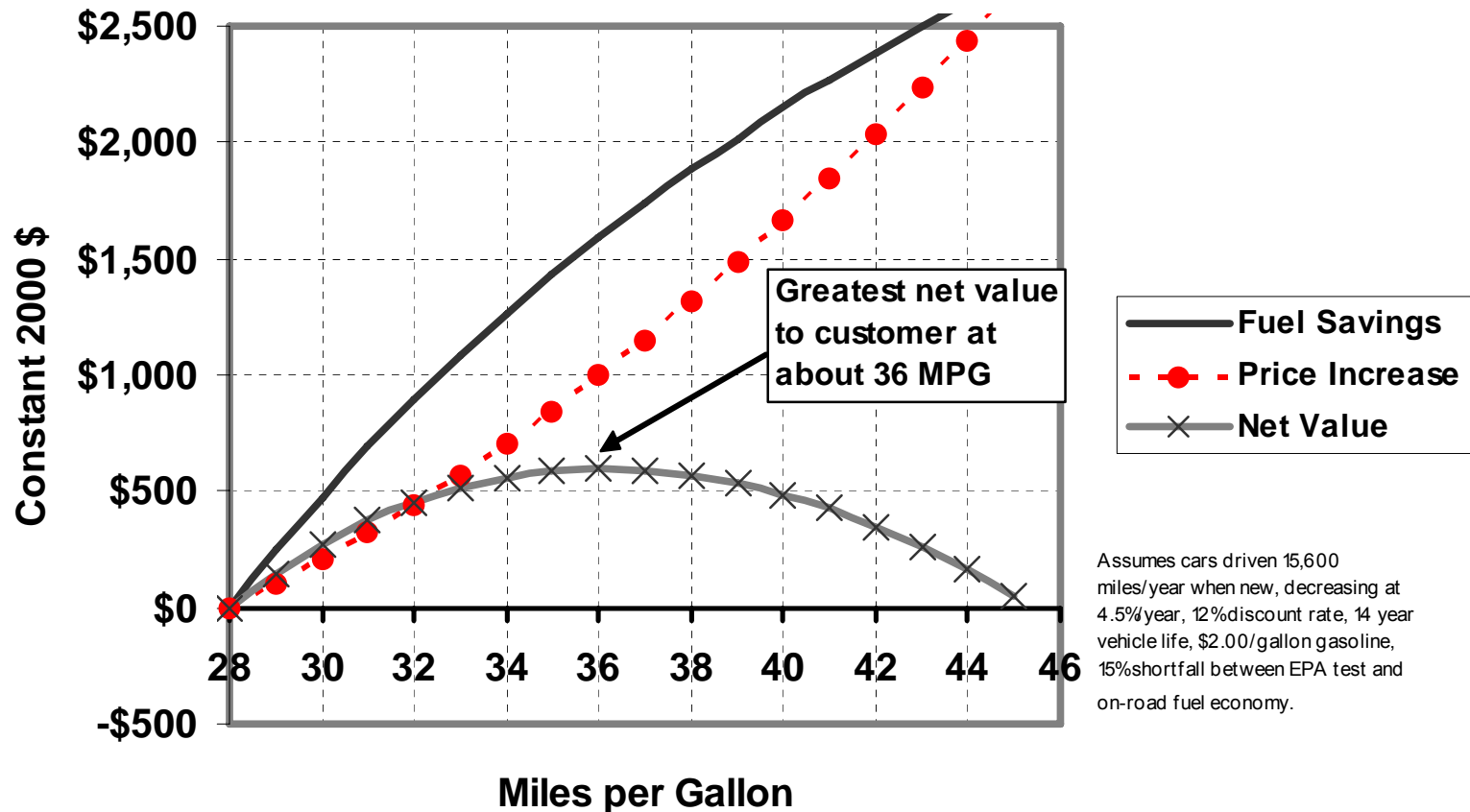


## There is substantial potential to improve consumers' decision-making about fuel economy.

- In-depth interviews of 60 California households' vehicle acquisition histories found ***no evidence*** of economically rational decision-making about fuel economy. (Turrentine & Kurani, 2004)
- Out of 60 households (125 vehicle transactions) 9 stated that they compared the fuel economy of vehicles when choosing a vehicle.
- 4 households knew their annual fuel costs.
- **None** had made any kind of quantitative assessment of the value of fuel savings.

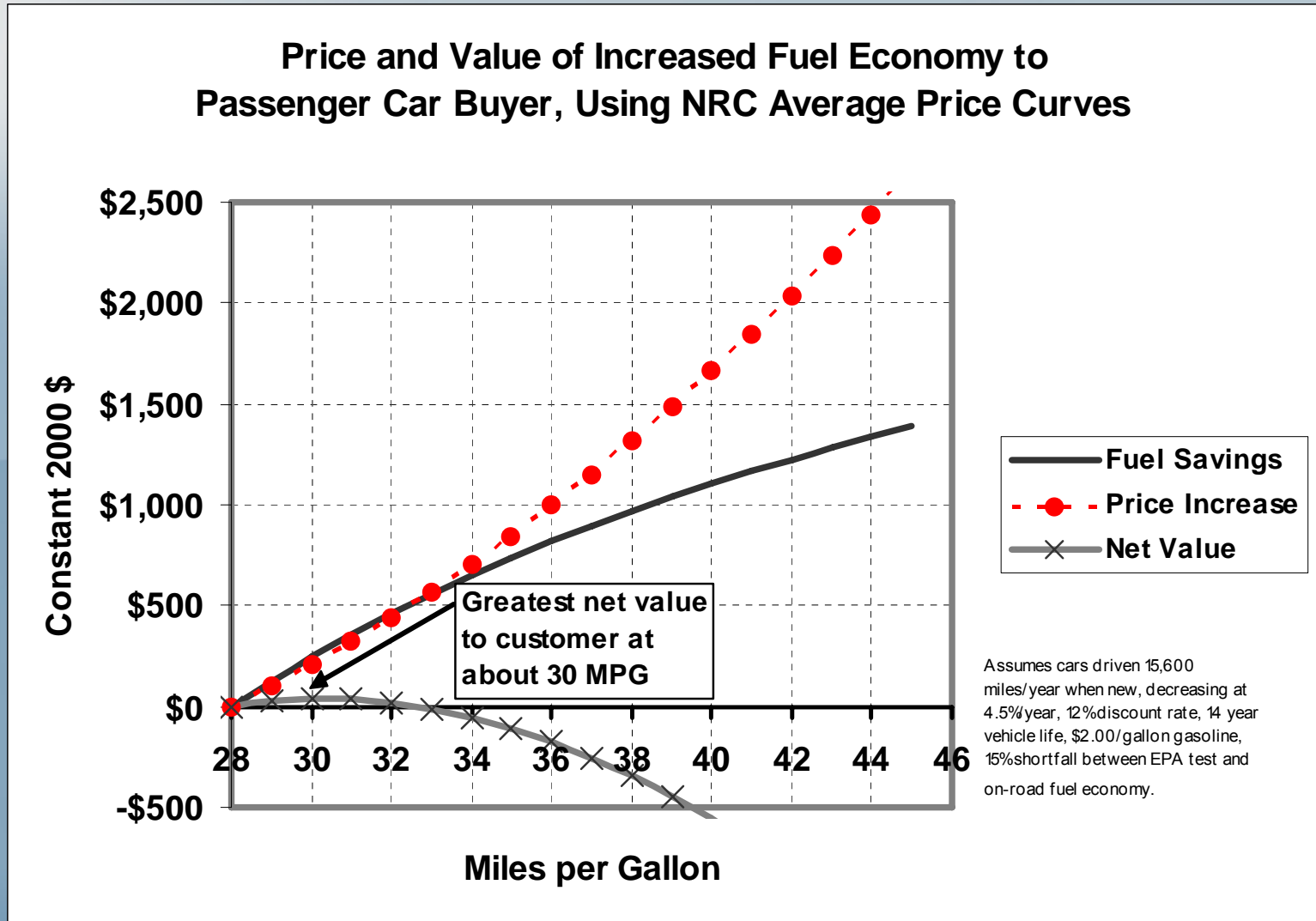
# Fuel economy can be traded off against cost, performance or weight. What matters to the consumer is the **net** value.

Price and Value of Increased Fuel Economy to Passenger Car Buyer, Using NRC Average Price Curves



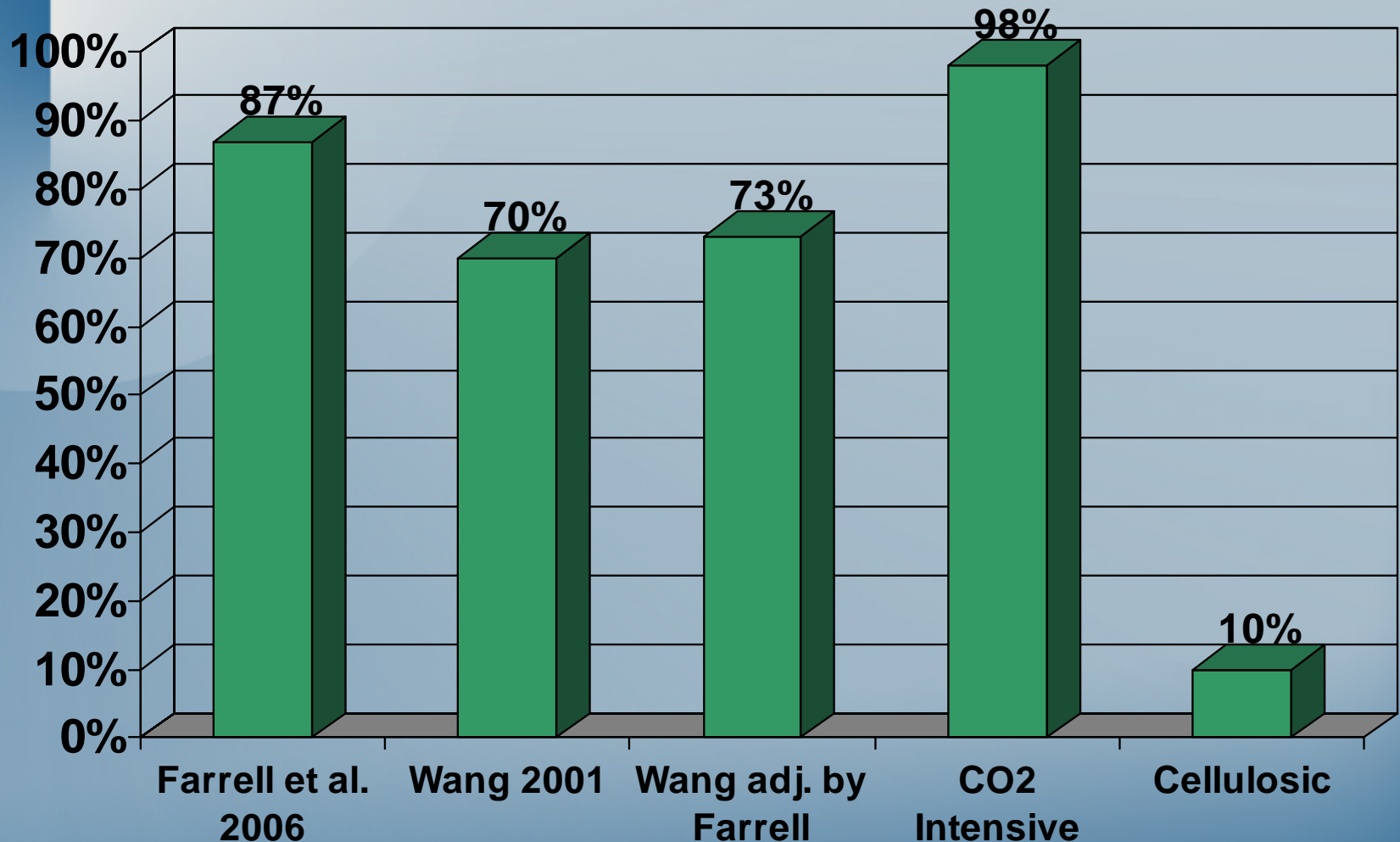
Source: Calculated from data in NAS, 2002.

But manufacturers assert that consumers are willing to pay for 3-years worth of fuel savings: still little difference over a range of 10 MPG, or so.



Source: Calculated from data in NAS, 2002.

Farrell et al. (*Science*, 2006) updating published estimates of ethanol's WTW CO2 reduction potential and putting them on a consistent basis found a range of reduction from 2% to 30%.



# The U.S. Departments of Energy and Agriculture have estimated that biofuels could replace up to 30% of U.S. petroleum use.

- 1.3 billion dry tons of sustainably produced biomass
- 370 million dry tons from forest lands, including 120 million of logging and other residues
- 1 billion tons from agricultural lands
  - 446 million tons of crop residues
  - 377 million tons of perennial crops
  - 87 million tons of animal manures and other residues
- Perlack et al., “Biomass as a Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Supply”, 2005.
- Cost-effective?

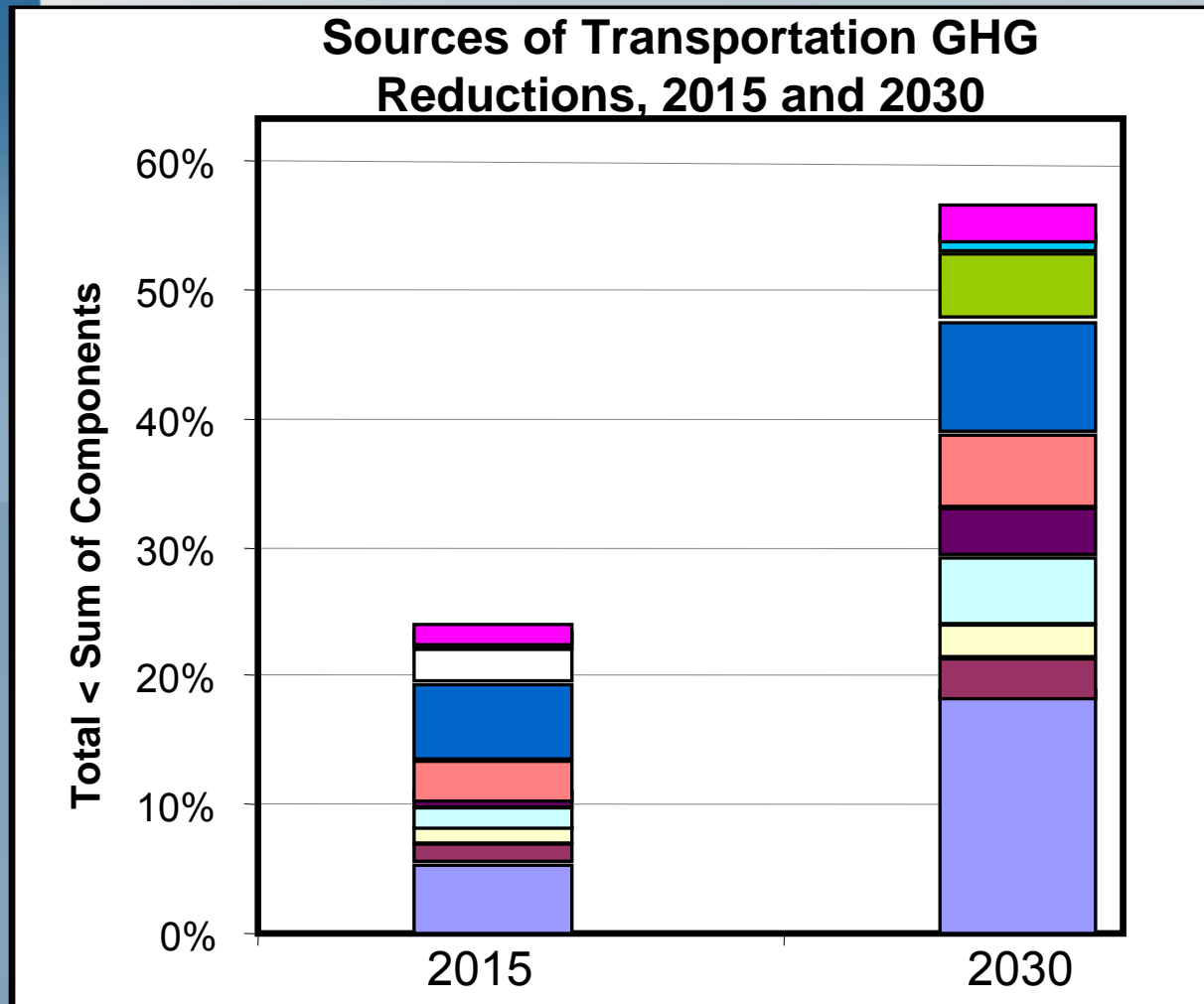
## **A comprehensive GHG strategy for transportation should address system efficiency, infrastructure, and land use.**

- Some external costs of motor vehicle travel could be “internalized” via policies that do not increase total costs (8-12% reduction), e.g. “pay-at-the-pump” insurance.
- Opportunities for transit and intermodal investments to increase system efficiency may exist.
- Operational efficiency improvements, e.g. reducing diesel truck idling, can make significant contributions.
- Improved consumer information could raise consumer awareness and improve market efficiency.
- Comprehensive “smart growth” policies could reduce vehicle travel by 25%, CO<sub>2</sub> emissions by 15% (Sacramento Area CoG, Garry, 2005).

**As the Pew Center's (2003) study demonstrated, there is substantial, practical potential to reduce transportation GHG emissions.**

- For 2015 assumed:
  - Proven energy efficiency technologies & fuels
  - Value of fuel saved  $\geq$  vehicle price increase
  - No change in vehicle size or performance
  - Carbon cap and trade to internalize external GHG costs
- For 2030 added:
  - Likely technological progress
  - Continuation or moderate extension of 2015 policies
- Greater reductions are possible with more effort, cost or technological success

# Major reductions in transportation GHG emissions call for a comprehensive approach.



- Information and Education.
- Systems
- Infrastructure
- Pricing
- Carbon Cap
- Hydrogen
- Low-Carbon Fuels
- Air Efficiency
- Heavy Duty Truck Effic.
- LDV Efficiency

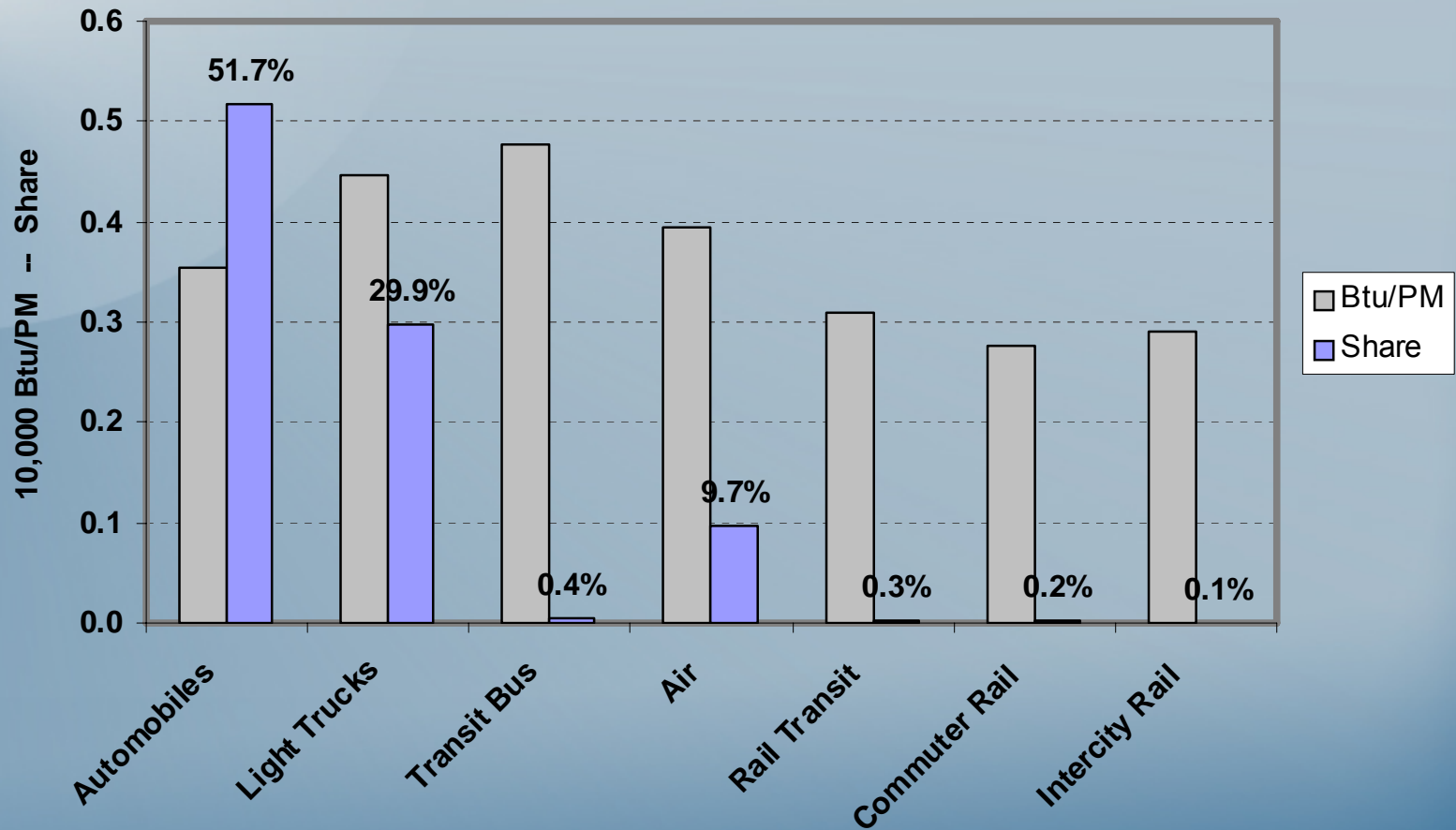
## **Clearly, state policies will have different impacts from federal policies.**

- Impacts of GHG emission standards will depend on leverage and control of leakage.
- States play a key role in educating motorists.
- States play an important role in promoting biomass fuels.
- States and local governments have the greater influence over system efficiency, land use, transportation planning and regional development.
- States and local governments may be better positioned to implement certain fiscal policies (e.g., pay-as-you-drive insurance).
- A comprehensive approach is essential for significant reductions in transportation GHG emissions.

**THANK YOU.**

# Significant modal shifts are difficult and may not produce significant reductions in the energy or GHG intensity of transportation.

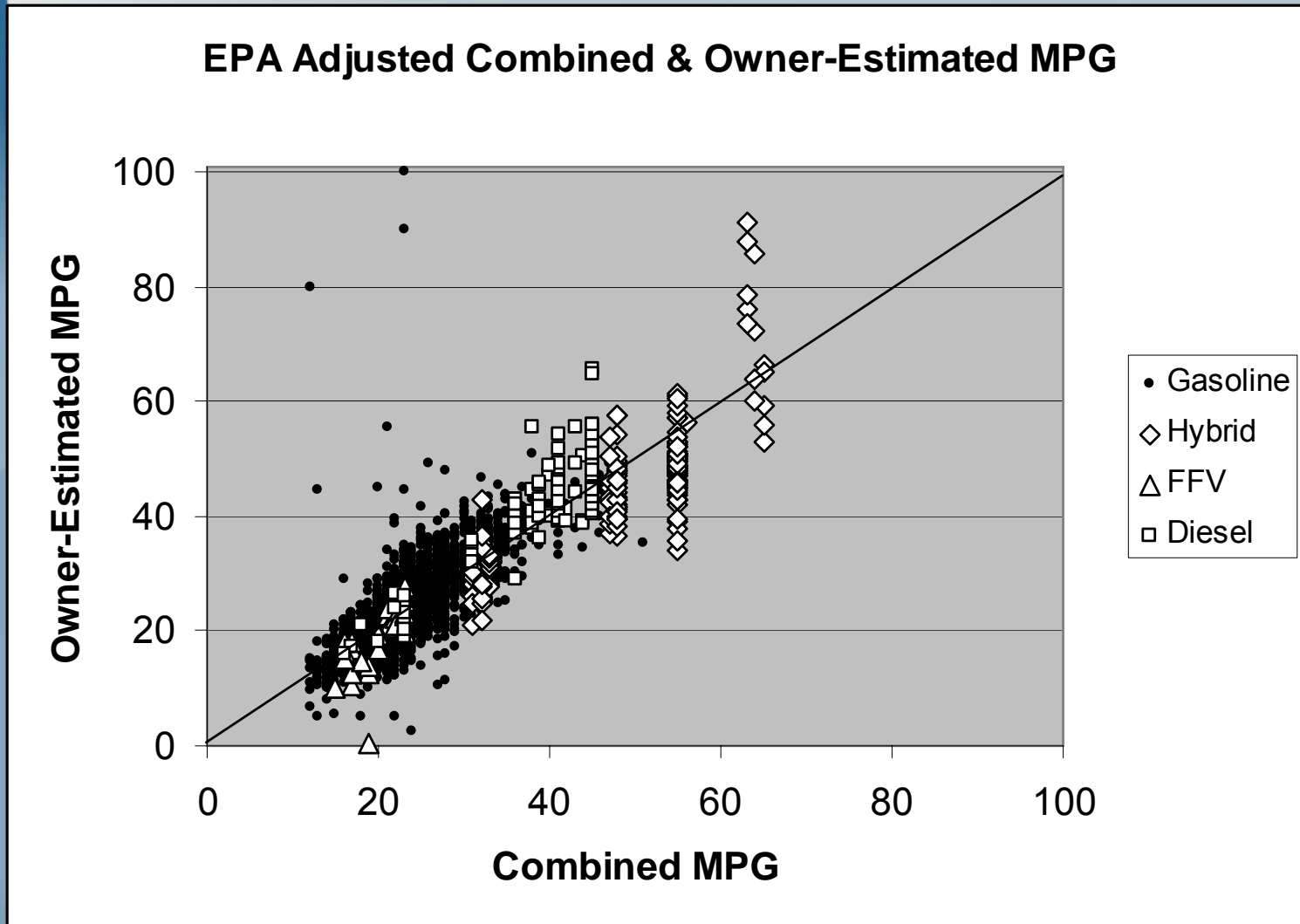
Average Energy Intensities and Modal Shares of Passenger Travel in the United States, 2000



# A comprehensive strategy could yield dramatic results.

Emissions Source	Example Policies	2000 Carbon Emissions (mmtC)	Potential reduction in 2015 (%)	Potential reduction in 2030 (%)	Emissions Weighted % GHG Reduction 2015	Emissions Weighted % GHG Reduction 2030
<b>Research, Development &amp; Demonstration</b>						
Passenger Car Efficiency	PNGV, FreedomCar	1061	11%	38%	7%	23%
Heavy Truck Efficiency	21 <sup>st</sup> Century Truck	294	11%	24%	2%	4%
Aircraft Energy Efficiency	NASA EEE. Aerospace Tech.	196	11%	27%	1%	3%
Low-carbon fuels	Biofuels	100	50%	100%	3%	6%
<b>New Vehicle Efficiency or GHG Emission Policies</b>						
Passenger Car and Lt Truck	CAFE, Voluntary, Feebates	1061	11%	36%	6%	21%
Heavy Truck	Voluntary Standards	294	11%	22%	2%	4%
Commercial Aircraft	Voluntary SMPG Standards	196	11%	26%	1%	3%
<b>Replacement &amp; Alternative Fuels</b>						
Low-Carbon Replacement Fuels	Ethanol tax credits	100	30%	100%	2%	6%
Hydrogen Fuel	Hydrogen-Fuel Cell Partnerships	1061	1%	6%	1%	4%
<b>Fiscal Policies</b>						
Low-carbon fuel subsidy	Federal Tax exemption for bio-ethanol	100	30%	100%	2%	6%
Carbon Tax		1792	3%	6%	3%	6%
Variabilization		1355	8%	12%	6%	9%
<b>Behavioral</b>						
Land Use & Infrastructure	Urban Design, Planning	903	5%	10%	3%	5%
Systems Efficiency	Rideshare, transit promotion	265	2%	5%	0%	1%
Climate Change Education		1792	1%	2%	1%	2%
Fuel Economy Information	Driver training, www.fueleconomy.gov	1061	1%	2%	1%	1%
<b>TOTAL</b>		<b>1792</b>			<b>23%</b>	<b>50%</b>

# Official fuel economy estimates appear to be unbiased but inaccurate, adding uncertainty. Can we do better?



Source: Greene, Goeltz, Hopson & Tworek, 2005 TRB.

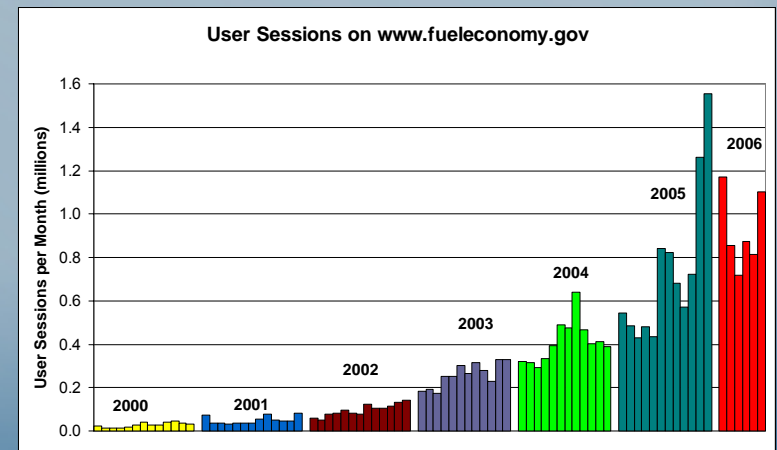
# There is substantial consumer interest in improving in-use fuel economy.

- Speeding and aggressive driving: up to 30% in highway driving.
- Proper tire inflation (3%), tune-up (4%), correct grade of oil (1-2%).
- Remove excess weight: 1-2%/100 lbs.
- Trip planning, avoiding idling, and more.
- [www.fueleconomy.gov](http://www.fueleconomy.gov)  
High level of media and consumer interest.

The screenshot shows the homepage of [www.fueleconomy.gov](http://www.fueleconomy.gov). At the top, there are navigation links for "Links | FAQ | Site Map | Search | Contacts". Below this is a banner image featuring several cars. The main content area is organized into several sections:

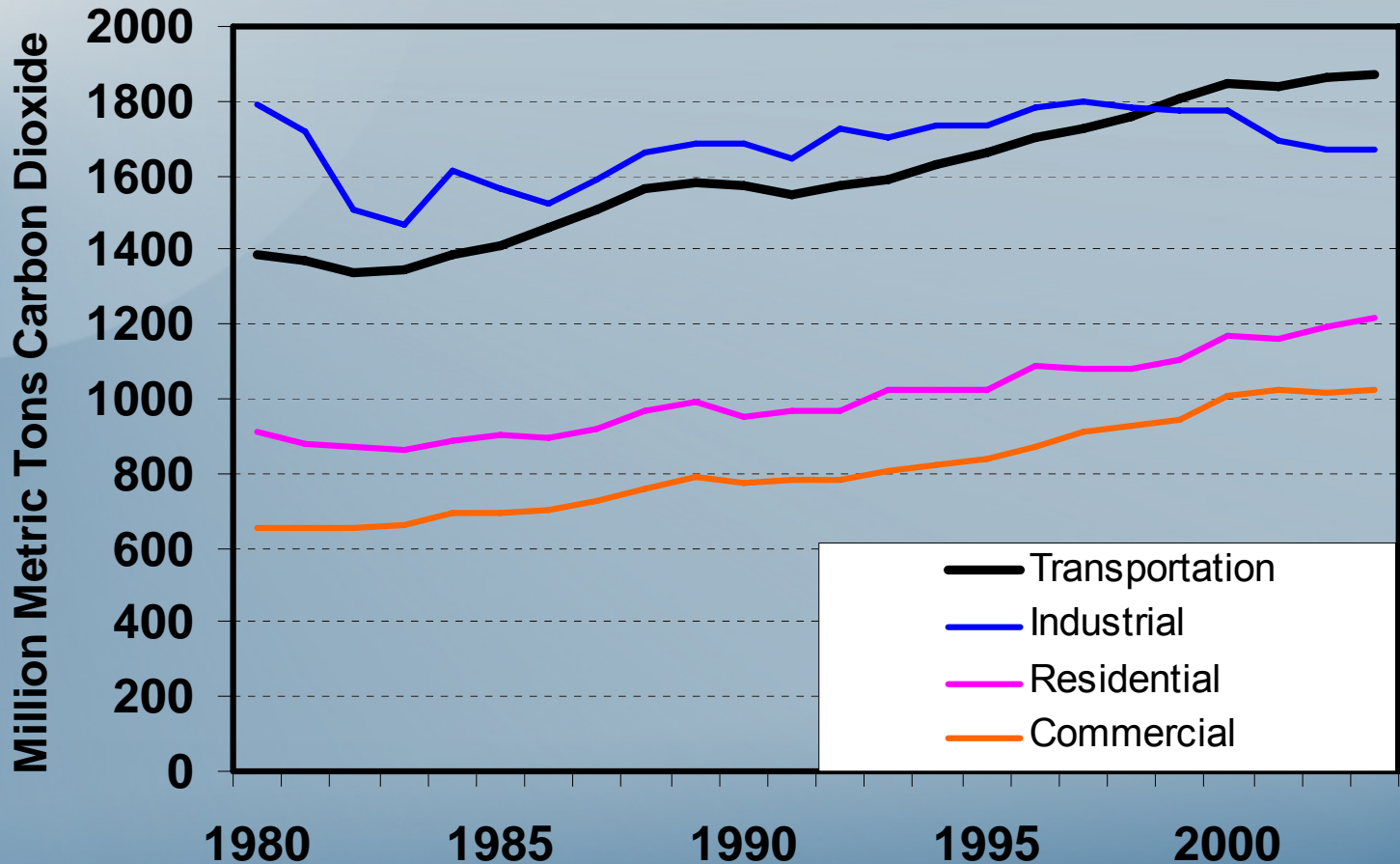
- FIND AND COMPARE CARS...**: Includes a photo of a woman at a computer and text about gas mileage (MPG), greenhouse gas emissions, air pollution ratings, and safety information. It offers "Compare Side-by-Side" and "Search by Class" options.
- MPG Estimates from Users...**: Features a photo of a red sports car and text about calculating and sharing MPG, and viewing estimates from other drivers.
- Gasoline Prices**: Links to "Find the Lowest Prices" and "Frequently Asked Questions".
- Gas Mileage Tips**: Links to "Driving More Efficiently" and "Maintaining Your Car".
- Hybrid Vehicles**: Links to "How Hybrids Work" and "Possible Tax Incentives".
- Alternative Fuel Vehicles**: Links to "Ethanol Vehicles" and "How Fuel Cells Work".
- Why Your MPG Will Vary**: Links to "How Vehicles are Tested" and "Fuel Economy Ratings".
- Energy Efficiency**: Links to "Diesel Vehicles and Fuels" and "Energy Efficient Technologies".
- Why is fuel economy important?**: Links to "Fuel Cost Calculator" and "Strengthen National Security".
- What's New?**: A section with a circular logo and text stating "EPA proposes to revise the methods used to determine the MPG estimates".
- In the News...**: A section with text about "Automakers Estimate Diesel Sales Will Grow - The Washington Post", "Automakers Introduce Several New Hybrids - ABC News", and "General Motors Looks for Green with Two New Hybrid SUVs - Automobile.com". It also includes a link for "EPA Proposes Update to Gas-Mileage Measures - NPR (audio)" and a "Disclaimer" link.
- Answers to Your Questions...**: A section with text asking "Why is my fuel economy different from the EPA rating?" and "Why don't you have ratings for large pickup trucks and SUVs?".
- Print the Fuel Economy Guide**: A button with a printer icon.

At the bottom of the page, there is a footer with links: "Download EPA's MPG Ratings | Find and Compare Cars | FirstGov.gov | Info for Auto Dealers | Privacy/Security | Feedback".



# Among the energy end use sectors, transportation is the largest emitter of CO<sub>2</sub>

## Carbon Dioxide Emissions From Energy Consumption by End Use Sector, 1980-2003



# The greatest near-term potential for low-carbon alternative fuels is as replacement fuels.

- Replacement fuels (e.g., ethanol) are compatible with vehicles and refueling infrastructure.
- Cellulosic ethanol needed for near zero fuel cycle GHG emissions & lower cost
- Tax subsidies effective
- CO<sub>2</sub> reduction per unit of energy:
  - $\cong$  1-3% by 2015 (ethanol from corn)
  - $\cong$  10% by 2030 (ethanol from cellulose)

**4 out of 10 U.S. car buyers did not consult any source of fuel economy information.**

**Sources of Fuel Economy Information  
Consulted by U.S. Car Buyers: 2005**

