Sustainable Mobility

An Automaker Perspective on Transportation Climate Policy

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Asilomar Transportation and Climate Policy
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Overview

- Sustainable Mobility: Maintaining a Critical Balance
- Climate/Energy Principles: Integrated Approach & Shared Responsibility
- Key Challenges Moving Forward
- Ford's Perspective on CAFE
- Pathway for the Future: Advanced Technology Vehicles and Fuels
- Challenges of the Business Environment
- The Role of Stakeholders: An Integrated Approach

Sustainable Mobility

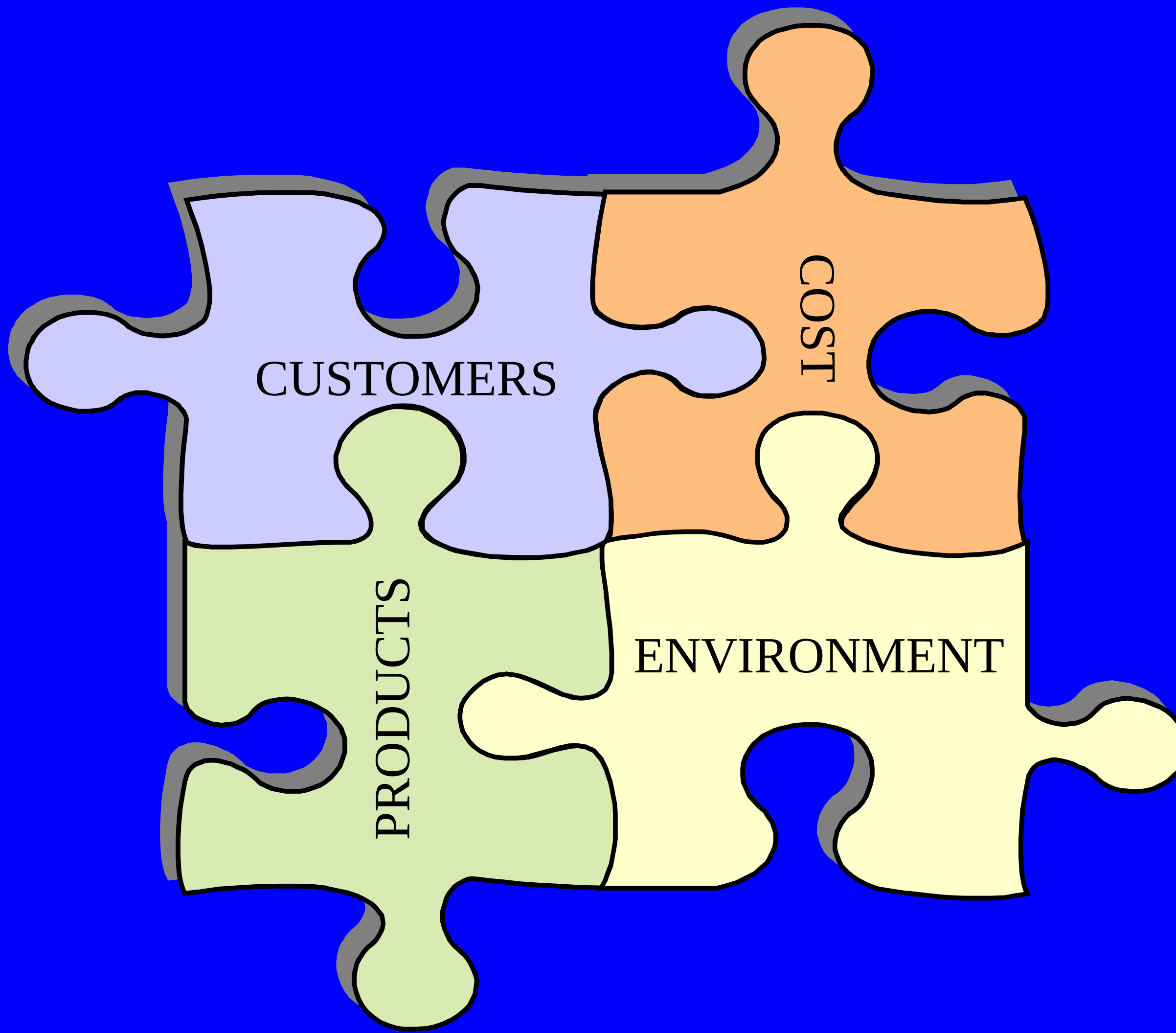
"Improved sustainable performance is not just a requirement, but a tremendous business opportunity."

- Bill Ford

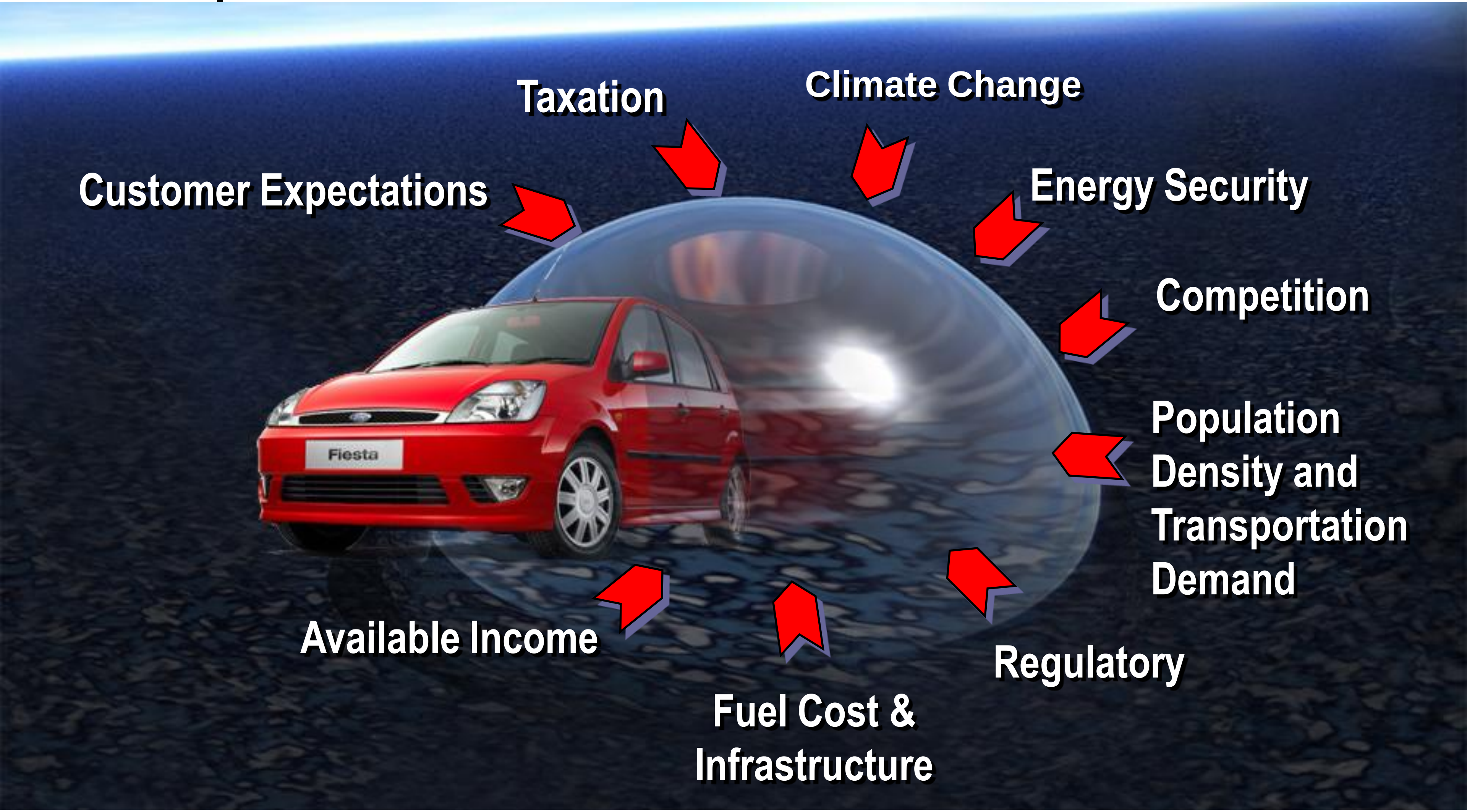
Our vision for the 21st century is to provide SUSTAINABLE transportation that is affordable in every sense of the word:

Socially, *Environmentally*, & *Economically*

Maintaining a Critical Balance



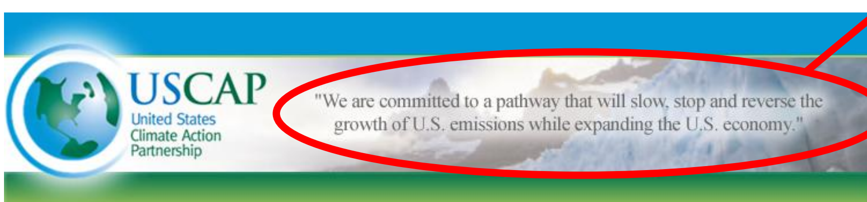
Global Market Drivers



Different needs drive different solutions. No Single Solution Fits All.

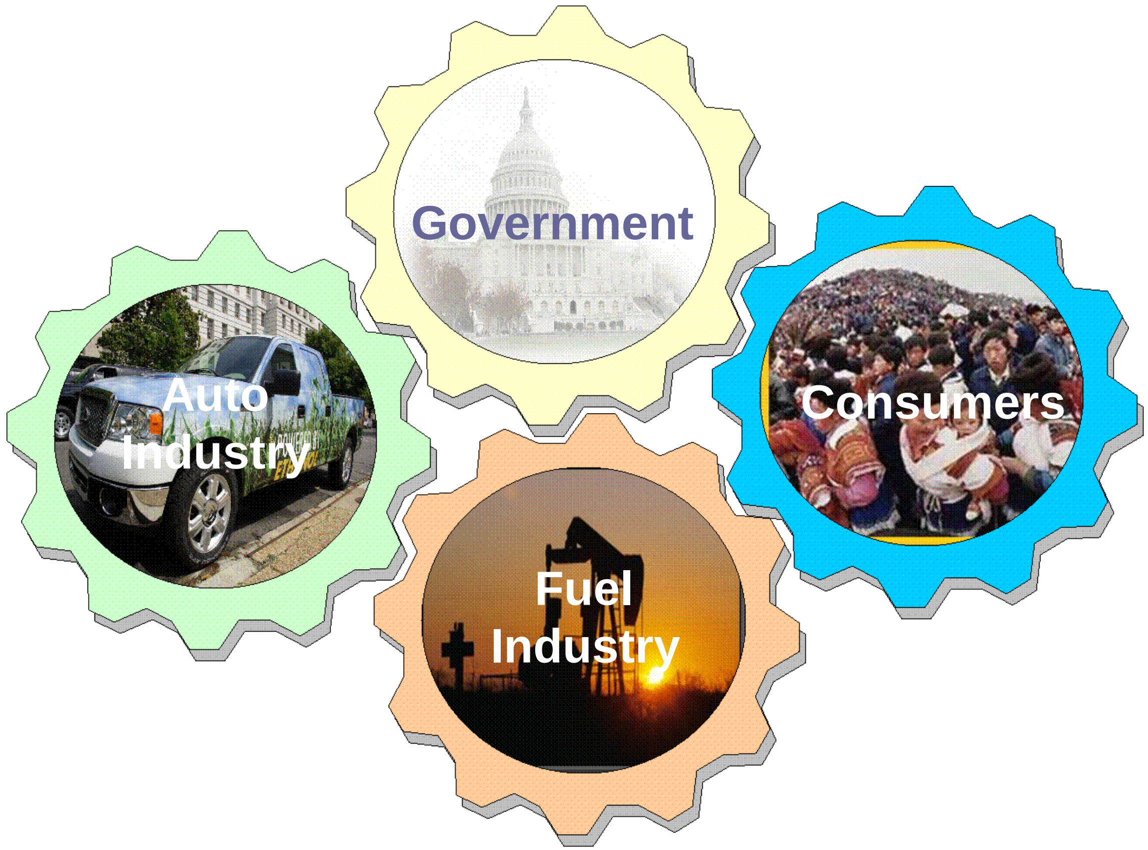
Key Climate Change / Energy Security Policy Principles

- Ford is committed to securing our energy future and addressing climate change.
- Should achieve the most economically efficient CO2 reductions possible.
- There is "no silver bullet" solution – Ford is involved in numerous development paths, sometimes with unique partners.
- Transportation sector must be an integral component of a national program.



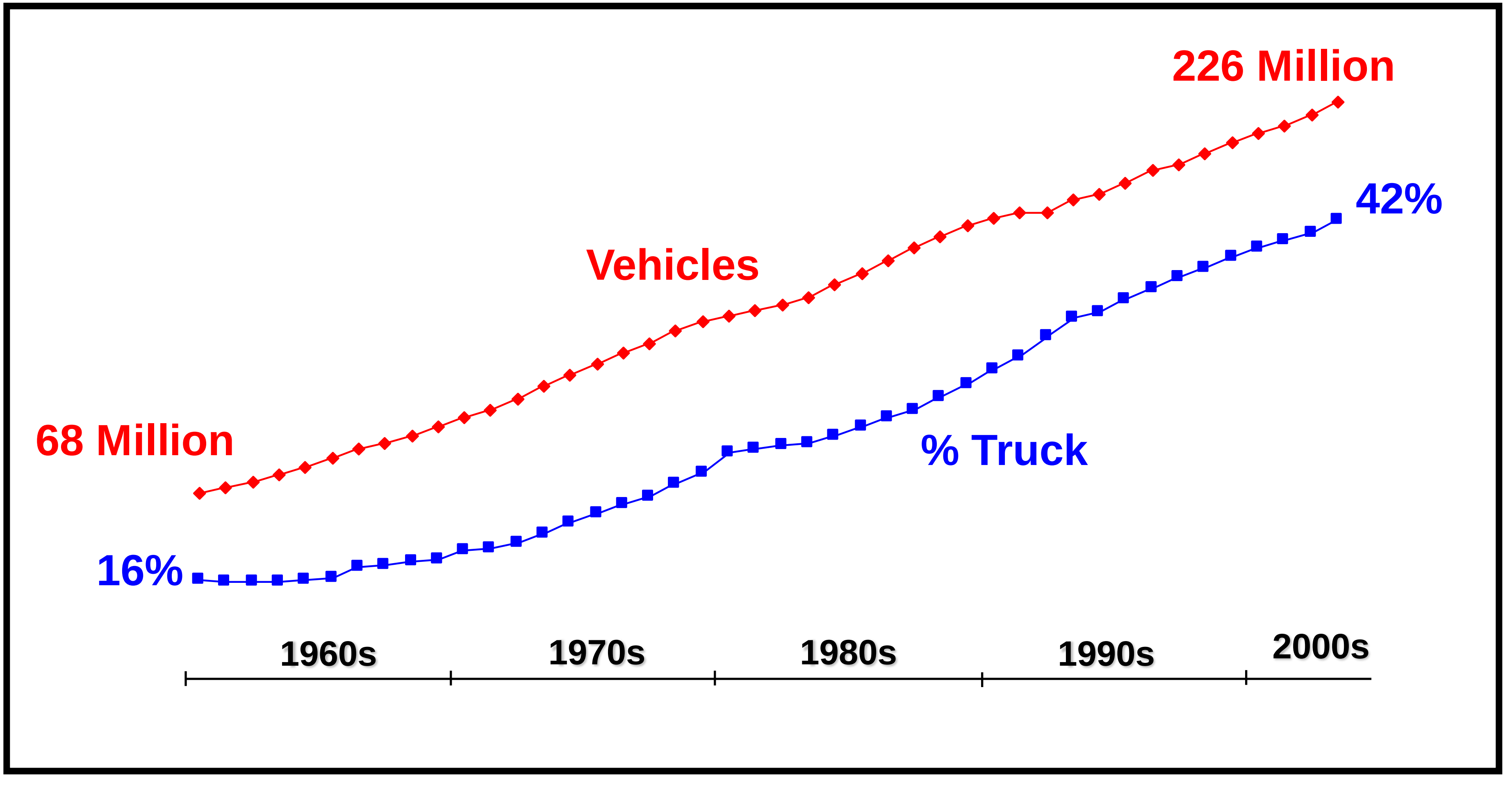
"We are committed to a pathway that will slow, stop and reverse the growth of U.S. emissions while expanding the U.S. economy."

Integrated Approach With Shared Responsibility

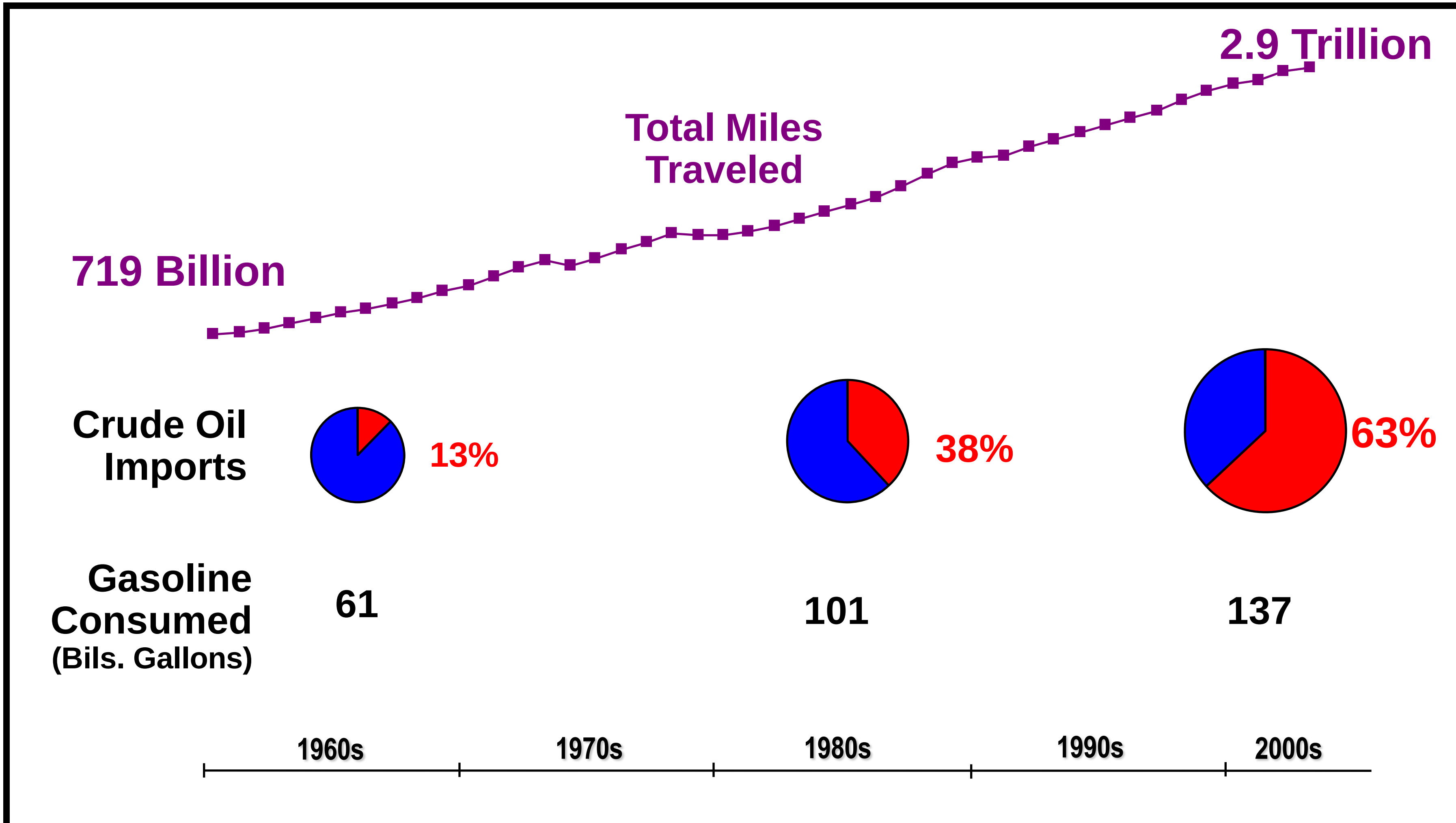


Our initial modeling efforts show that the most cost effective solutions to lowering CO2 emissions is a combination of bio-fuels and vehicle technology advancements.

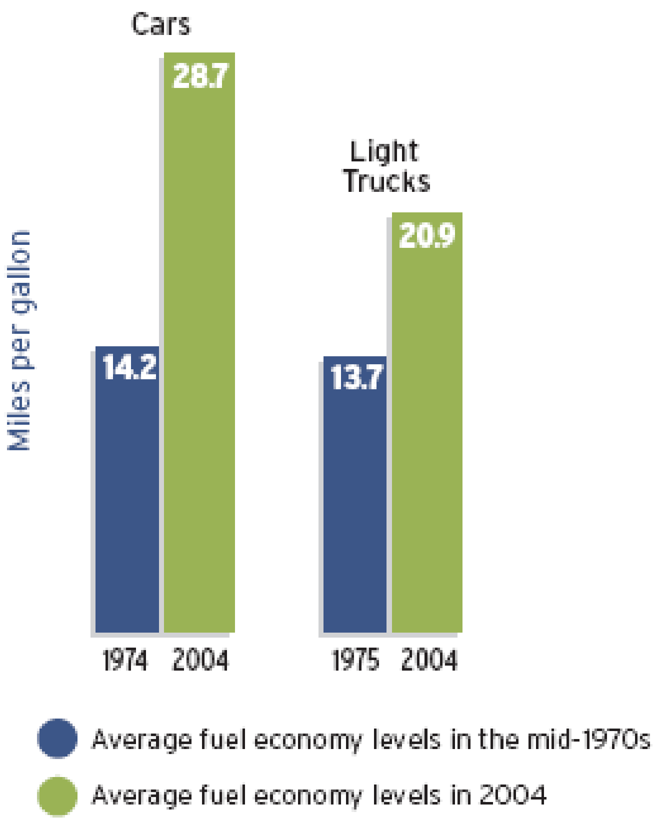
U.S. Fleet Fuel Consumption: Influenced by Vehicle Population & Mix



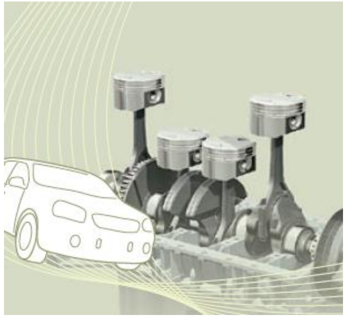
U.S. Fleet Fuel Consumption: Influenced by Vehicle Miles Traveled



Auto Industry Progress to Date: Fuel Economy has Increased



- Fuel economy rates in cars increased more than 100 percent since 1974.
- Fuel economy rates in trucks (minivans, vans, SUVs, and pickups) increased 53 percent since 1975.
- Today's average light truck gets better mileage than an average 1970s compact car.
- The average 2004 SUV gets 33 percent better mileage than the average car in 1975.



Source: Alliance of Automobile Manufacturers, www.autoalliance.org

Consumers Have Demanded Fuel Economy Gains without Sacrificing Performance

Attribute	**1985 Ford Crown Victoria** 	**2008 Ford Taurus (FWD)** 
Comparative Fuel Economy*	16 city / 23 highway	20 city / 31 highway
Engine	5.0L V8	3.5L 4V V6
Horsepower	140 hp	263 hp
Size (length x width)	113 ft^2	104 ft^2
Luggage Volume	21 ft^3	21 ft^3
Passenger Volume	111 ft^3	108 ft^3
Weight	3740 lbs.	3740 lbs.

**Actual 2008 Ford Taurus (FWD) fuel economy ratings 18 city/28 highway based on new 2008 EPA calculation methodology*

Corporate Average Fuel Economy: Determining A Manufacturer's CAFE

- CAFE is the sales weighted harmonic average fuel economy of a manufacturer's fleet of passenger cars or light trucks.
- There are three separate fleets an automaker must manage – domestic passenger car, import passenger car and a truck fleet (combined).
- CAFE constrains the mix of products that Ford can sell. Recently reformed light truck rules attempt to set standards independent of mix, but this has not yet been applied to passenger cars.

Corporate Average Fuel Economy: Determining A Manufacturer's CAFE

Calculation Methodology – Example Calculation

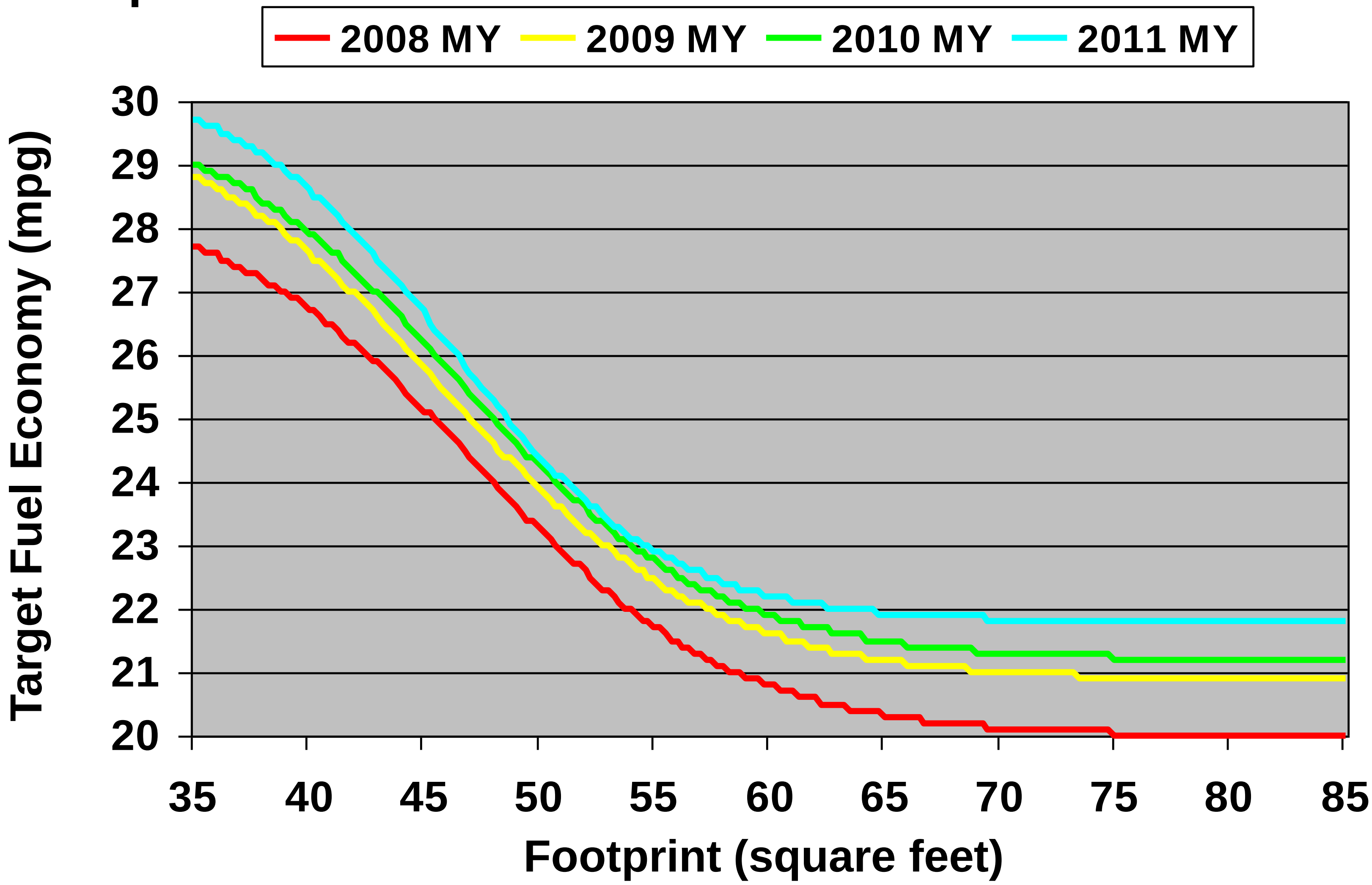
- Car and truck fleet CAFE values are calculated via a "harmonic" average versus a simple "arithmetic" average.
- A manufacturer produces 1,000 units of Vehicle A and 1,000 units of Vehicle B for a total production volume of 2,000 units
- If Vehicle A achieves 40 mpg and Vehicle B achieves 20 mpg, using simple arithmetic averaging we would expect a 30 mpg CAFE. However, with harmonic average:

$$\text{Harmonic} = \frac{2000}{[\,(1{,}000 / 40) + (1{,}000 / 20)\,]} = 26.67 \text{ mpg}$$

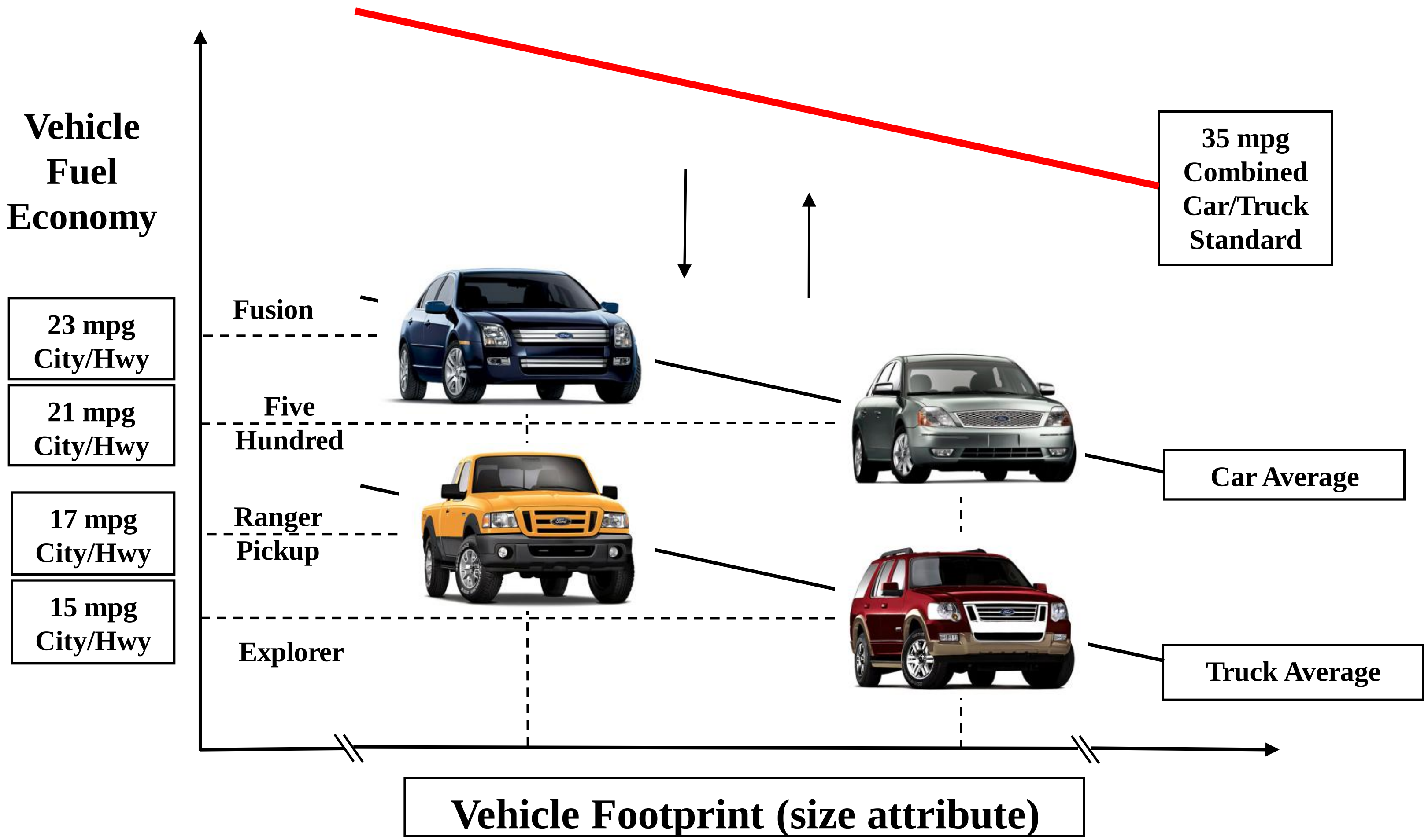
$$\text{Arithmetic} = \frac{[\,(1{,}000 \times 40) + (1{,}000 \times 20)\,]}{2000} = 30.00 \text{ mpg}$$

FOR A COMPANY TO MAINTAIN A 30 MPG CAFE LEVEL WITH THESE TWO MODELS, IT WOULD HAVE TO PRODUCE TWO 40 MPG VEHICLES FOR EVERY 20 MPG VEHICLES IT SOLD

U.S. Truck CAFE Regulatory Changes – Reformed CAFE



Adverse Competitive Impact of Combined Car/Truck Standards on Full Line Automakers

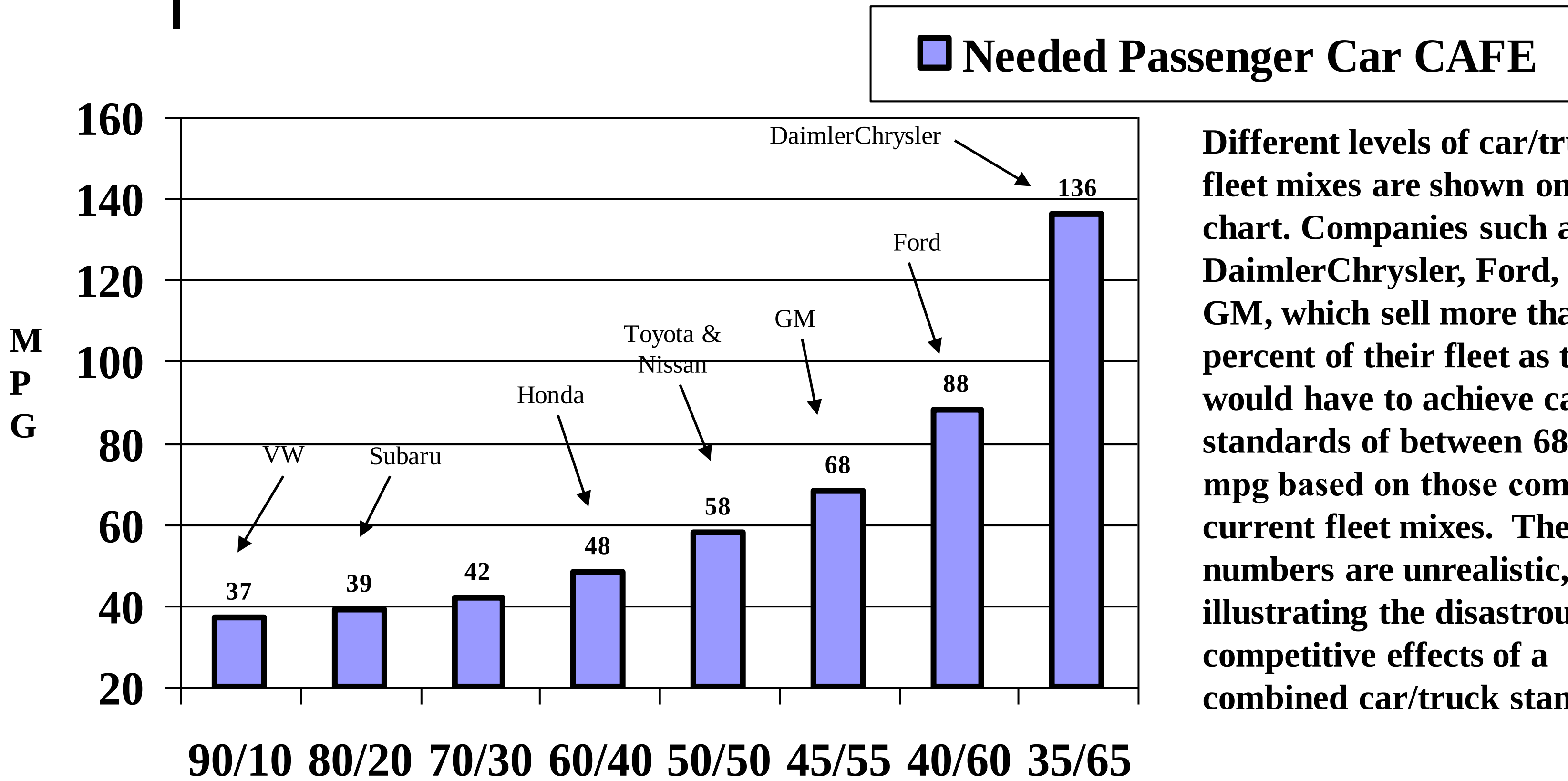


Current Footprint Attribute System Does Not Recognize Car/Truck Differences

2007 4.0L Ford Ranger 4WD		**2007 2.3 Fusion FWD**
		
Seats 5	Seating	Seats 5
Tows up to 5,650 lbs.	Towing	N/A
63.1 cu ft	Passenger Volume	100.1 cu ft
37.4 cu ft	Cargo Volume	15.8 cu ft
Off-road capable	Terrain Capability	On-road operation only
15 / 19 mpg	Fuel Economy	23 / 31 mpg
44.9 sq ft	Footprint	45.8 sq ft

A single footprint system would assign both of these essentially the same standard, even though the truck differs in intended use from the sedan

Adverse Competitive Effects of a Combined Car/Truck Standard of 35 MPG



Different levels of car/truck fleet mixes are shown on the chart. Companies such as DaimlerChrysler, Ford, and GM, which sell more than 50 percent of their fleet as trucks, would have to achieve car standards of between 68-136 mpg based on those companies' current fleet mixes. These numbers are unrealistic, illustrating the disastrous competitive effects of a combined car/truck standard.

This chart shows what various companies' passenger car CAFE would have to be, *under a hypothetical assumption that each company's light truck fleet could achieve 25 mpg*, in order for the combined car/truck fleet to average 35 mpg. The larger the percentage of a manufacturer's fleet that is made up of light trucks, the higher the passenger car fleet CAFE would have to be.

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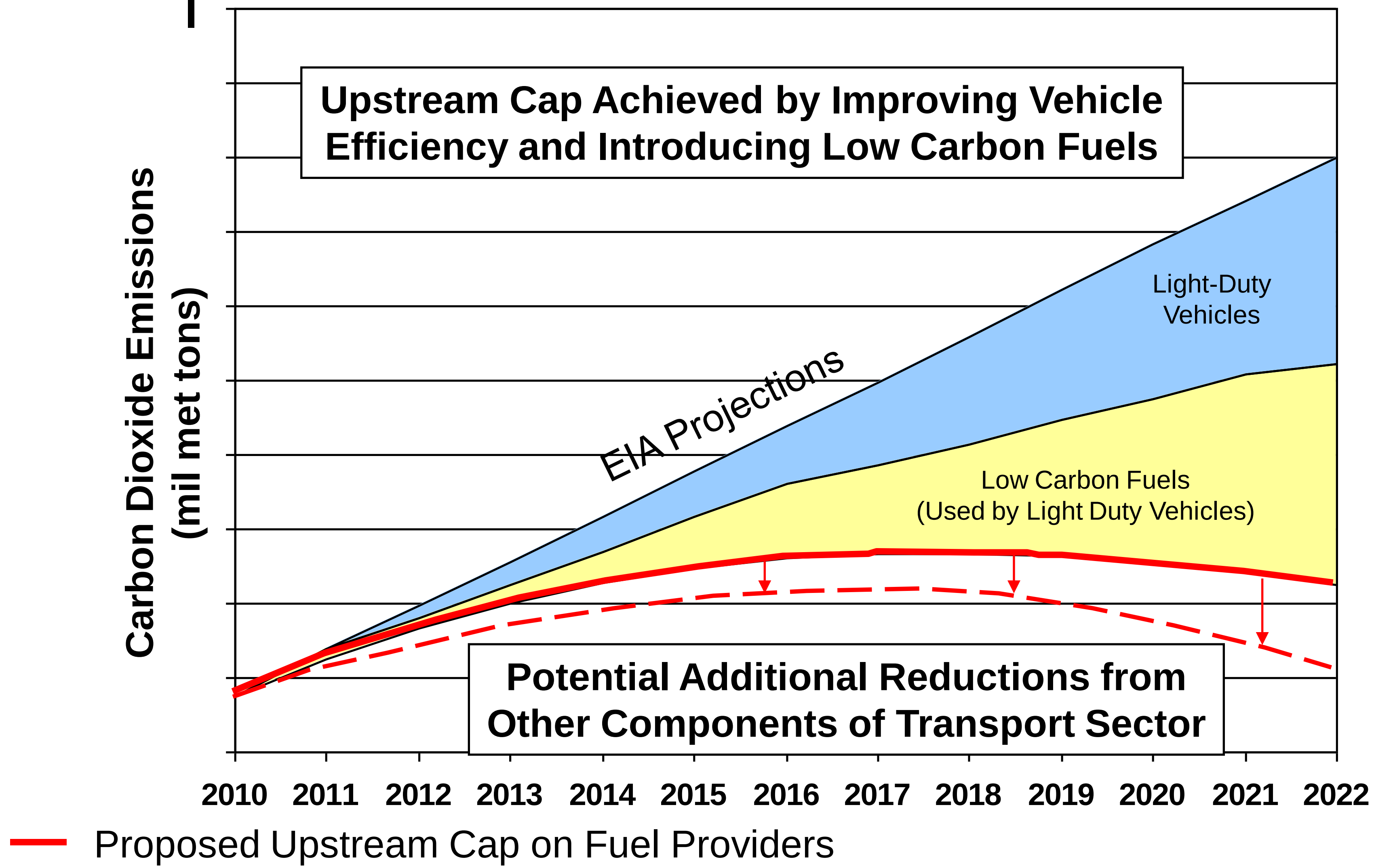
Transport Sector – Shared Responsibility for CO2 Reductions



Pathway to the Future: Advanced Technology

Fuel Cells

Hydrogen Powered Internal Combustion Engines

Hybrid Powertrains (Including Plug-Ins)

Modern Clean Diesels (Including Biodiesel

Advanced Gasoline Internal Combustion Engines (ICE) (Including Biofuels)

Near Term

Mid Term

Long Term

Fuel Cell: Impact in 20-30 yrs
- Endgame for the hydrogen economy
- Environmentally neutral powertrain

Hydrogen Internal Combustion Engines: Bridging technology
- Bridging action / enabler for H_2 Economy
- H_2 emissions benefits realized in near term

Hybrid Powertrain: 10-15% Market
- Market driven niche solution
- Benefits realized in urban driving conditions

Modern Clean Diesel: Core for next 40+ yrs
- Challenges – fuel quality, Tailpipe Emissions standards

Gasoline Engine Efficiency: Core for 30+ yrs
- Low cost, reliable, familiar
- Existing capital & refueling infrastructure

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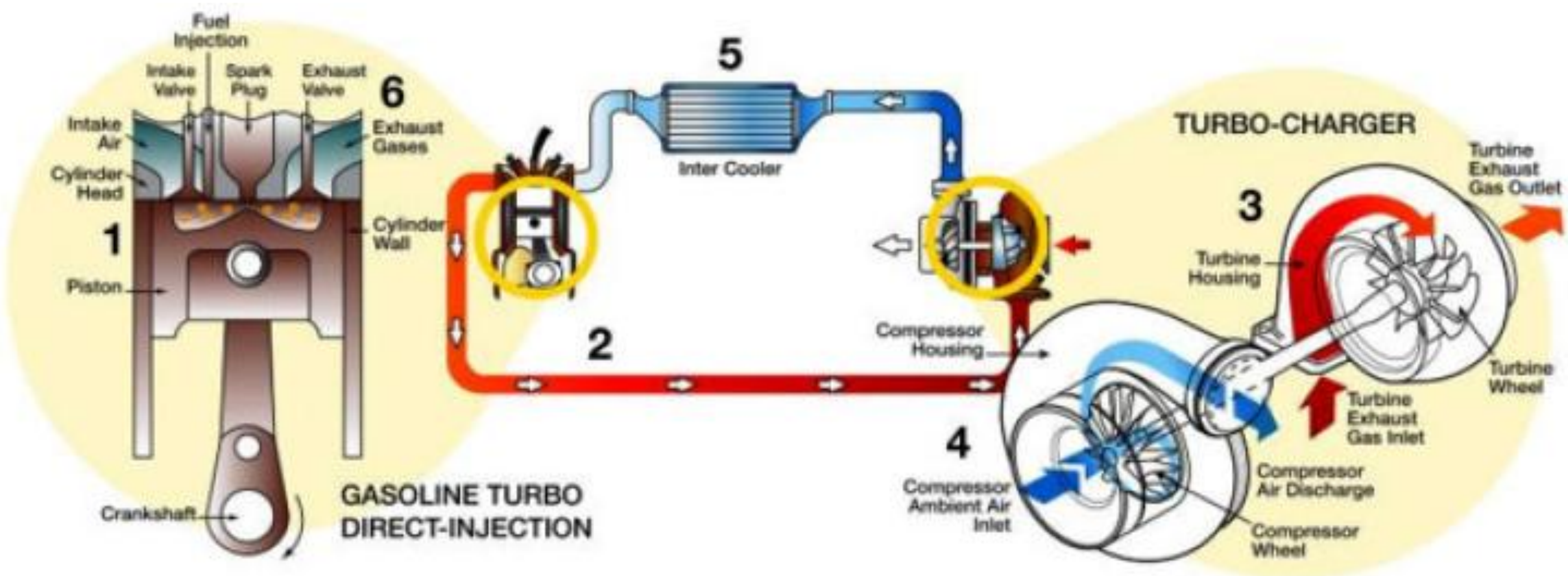
Advanced Gasoline Internal Combustion Engines (ICEs)



Below is how Ford's gasoline, turbocharged, direct-injection system operates:

1: A precisely controlled amount of gasoline is directly injected into the engine's cylinders at high pressure.
2: Exhaust gas from the engine is routed to a turbocharger.
3: The exhaust air drives the turbine, which drives the compressor.
4: The compressor the compresses the intake air.
5: The compressed intake air is then routed through the inter cooler and to the engine. Cooling the intake air before it reaches the engine improves combustion.
6: The air is then forced at high pressure into the engine cylinder mixing with high pressure gasoline.

A Pathway for Today: Ethanol (E85)

- Ethanol has been a transportation alternative fuel choice for more than 10 years
- About 4.9 billion gallons of ethanol were produced for transportation purposes in 2006
- Most U.S. ethanol is currently derived from corn
- Ethanol produced from cellulosic feedstocks planned for the future

Why Ethanol Now?

Opportunity for Immediate Impact

- Ford has placed over <u>2 million</u> E85 FFVs on America's roads
- As a whole, U.S. automakers have produced more than <u>6 million</u> E85 flexible fuel vehicles
- If all of these vehicles were operated on E85, over <u>3.6 billion</u> gallons of gasoline a year could be displaced.
  - ✓ That's like saving a full year of gasoline consumption in a state like Missouri or Tennessee.
- Ford, GM and DaimlerChrysler voluntarily committed to doubling our production of FFVs by 2010.
  - ✓ We expanded that commitment to include half our vehicles each year by 2012, provided sufficient infrastructure is in place

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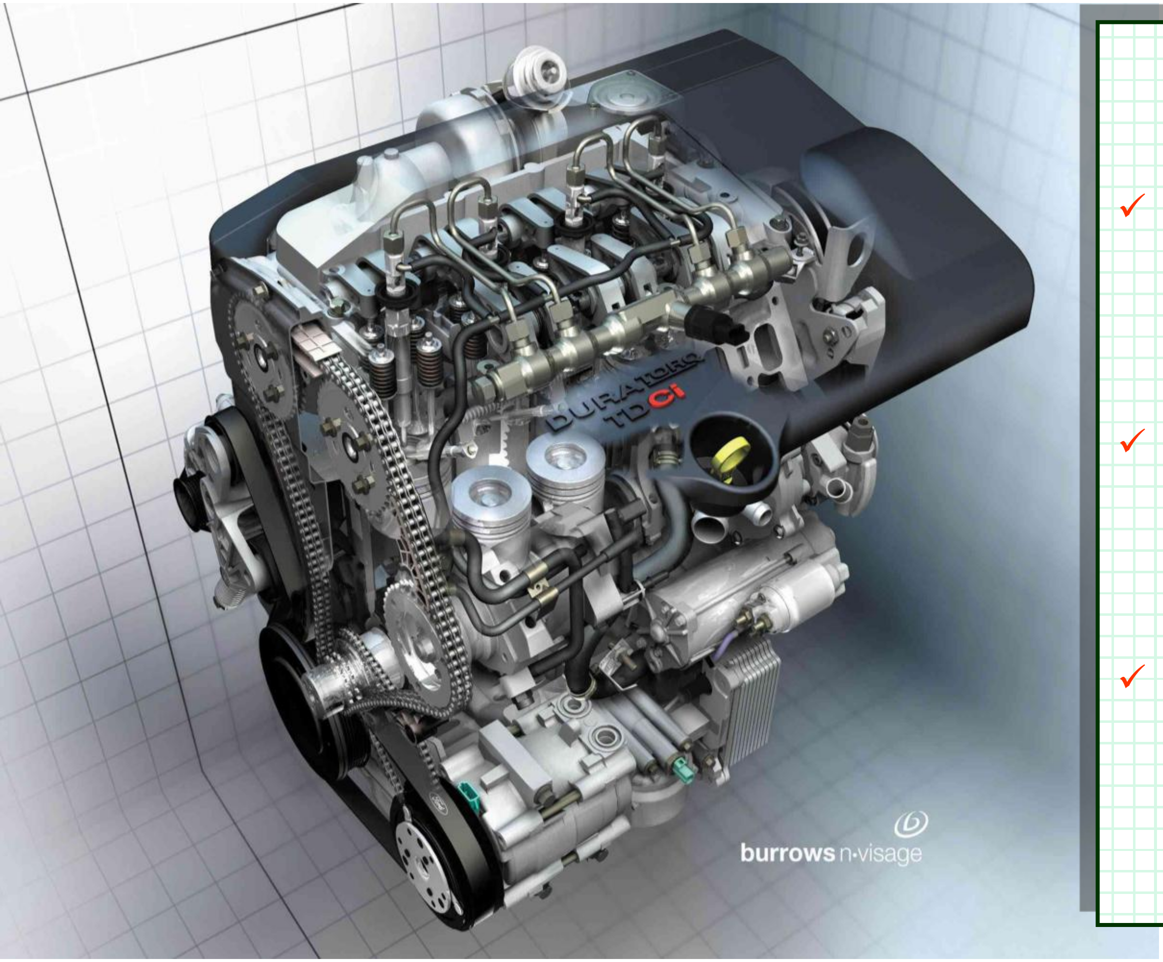
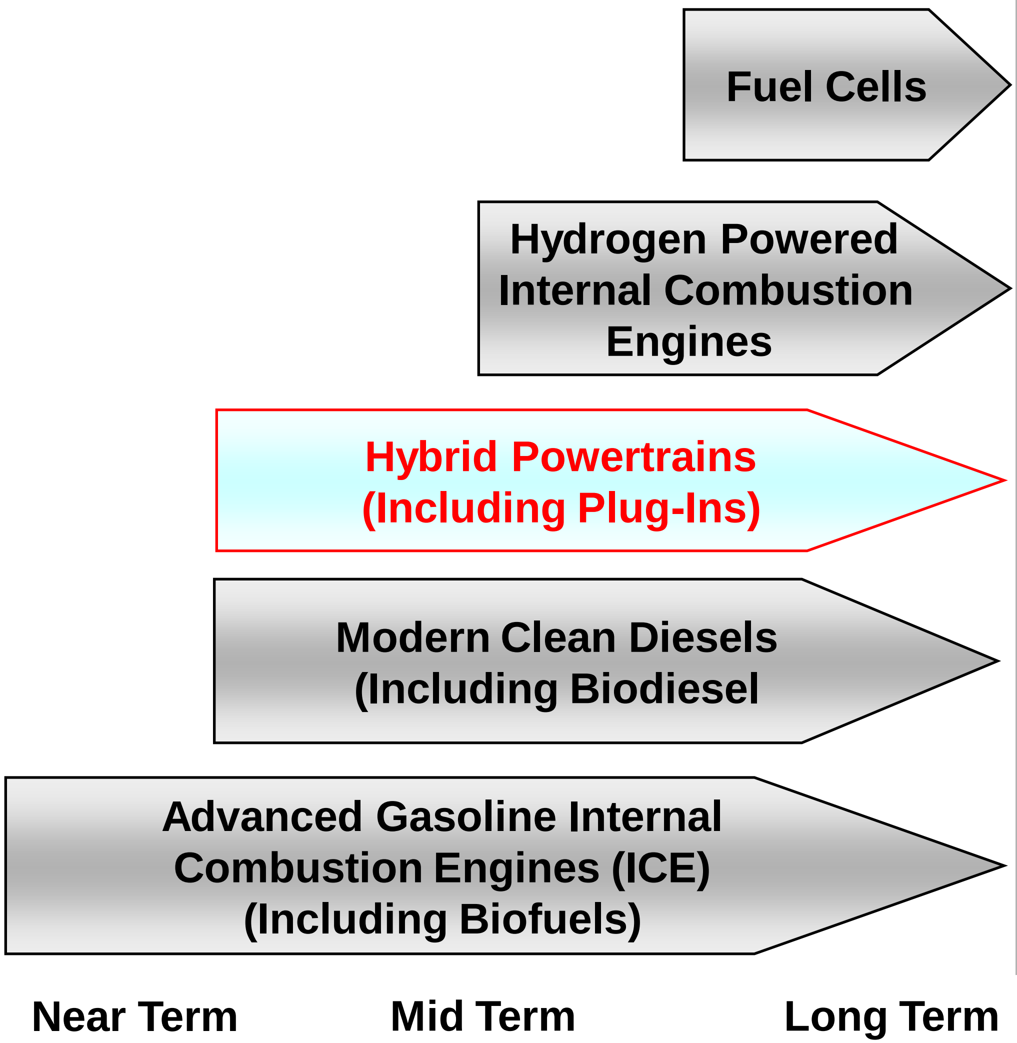
Modern Clean Diesels



- ✓ Significant increase in fuel economy (20-30%)
- ✓ Higher performance, less noise, less odor
- ✓ Improved emissions performance

Pathway to the Future: Advanced Technology



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Hybrid Electric Vehicles

- "No Compromise" Escape Hybrid delivers improved fuel economy and emissions while providing SUV functionality and utility
- Over 75% fuel economy improvement in City driving
- Over 400 mile range
- Efficiency benefits with engine downsize, regenerative braking, and electric launch and drive
- Acceleration performance similar to a V-6
- Meets strict SULEV and AT-PZEV (Advanced Technology PZEV) emissions standards
- More HEVs on the way – 5 models by 2008

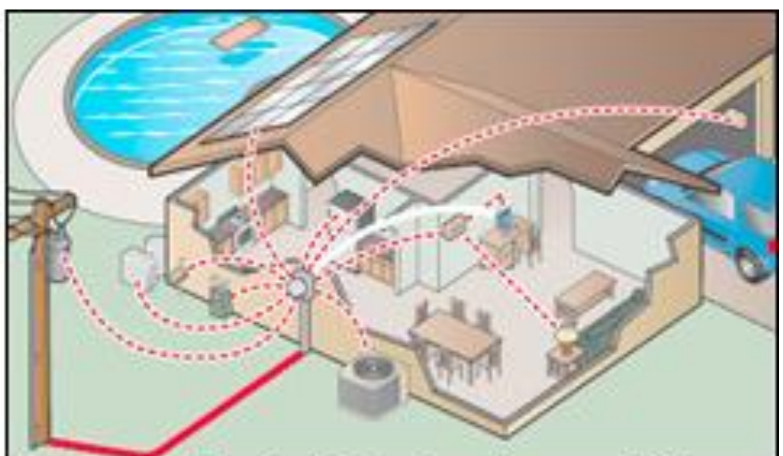
Escape Hybrid E85 Demonstration Fleet

- Demonstration program marrying two petroleum-saving technologies – hybrid electric power and flex-fuel capability
- 20 vehicles are being delivered this summer
- Helps reduce dependence on imported oil
- Produces about 25% less carbon dioxide than a gasoline-fueled Escape Hybrid

HySeries Drive™ Technology with Plug-In Capability

- First drivable fuel cell HEV with plug-in capability
- Operates using a fuel cell, small gasoline or diesel engine connected to an electric generator
- Powered by a 336-volt lithium-ion battery pack (refreshed by an on-board charger from a standard home outlet)
- Drives first 25 miles on stored electricity, after which the fuel cell kicks in to keep battery charged (provides additional 200 miles range)
- Significant technical hurdles to overcome before commercialization – including fuel cell and lithium-ion battery costs

Ford / Southern California Edison Plug-In HEV Partnership



Ford and Edison's vision for a home vehicle charging system

- ✓ Unique partnership between automotive and utility sectors to accelerate the affordability and availability of plug-in hybrids.
- ✓ Breakthrough fuel economy improvements for customers with 20-40 miles daily use.
- ✓ Off-peak electric charge provides low-cost power opportunity and increases grid productivity by leveraging existing excess capacity.
- ✓ Success of plug-ins will depend on finding a model that provides value to customers, vehicle manufacturers and utilities.
- ✓ Diversifies transportation energy supply.

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Hydrogen Powered Internal Combustion Engines (H_2ICEs)

- Key “Bridge” Technology
- H2ICE Shuttle Bus Demonstration w/6.8L Supercharged H2 Triton V10
- Holds up to 12 passengers plus luggage
- Worked with State of Florida, Dallas-Ft.Worth airport, Canadian government and others to launch a 2006 demo fleet
- Working to place 2 in California with the Air Resources Board

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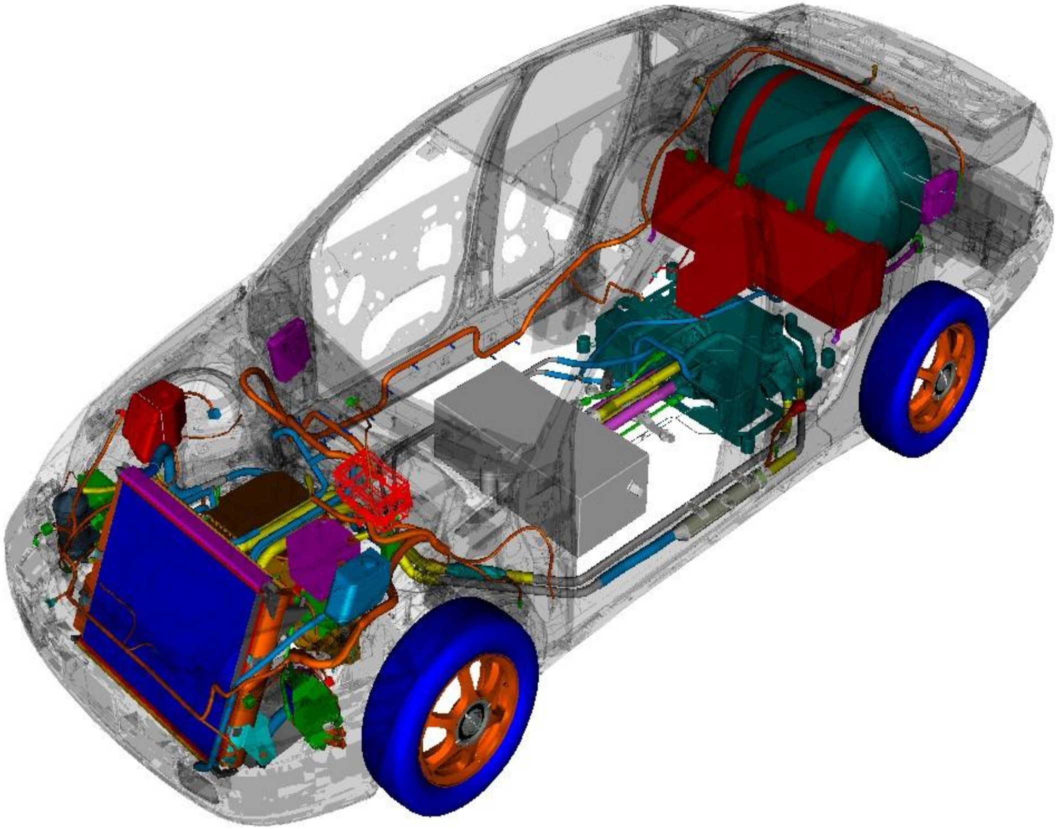
Fuel Cell Powertrains



- ✓ Hydrogen fuel cells are the highest-efficiency technology
- ✓ Currently, Ford has 30 Focus Fuel Cell Vehicles (FCVs) on the road, helping to prove out, develop and demonstrate the technology
- ✓ To be competitive, fuel cell systems must have costs several orders of magnitude lower than today

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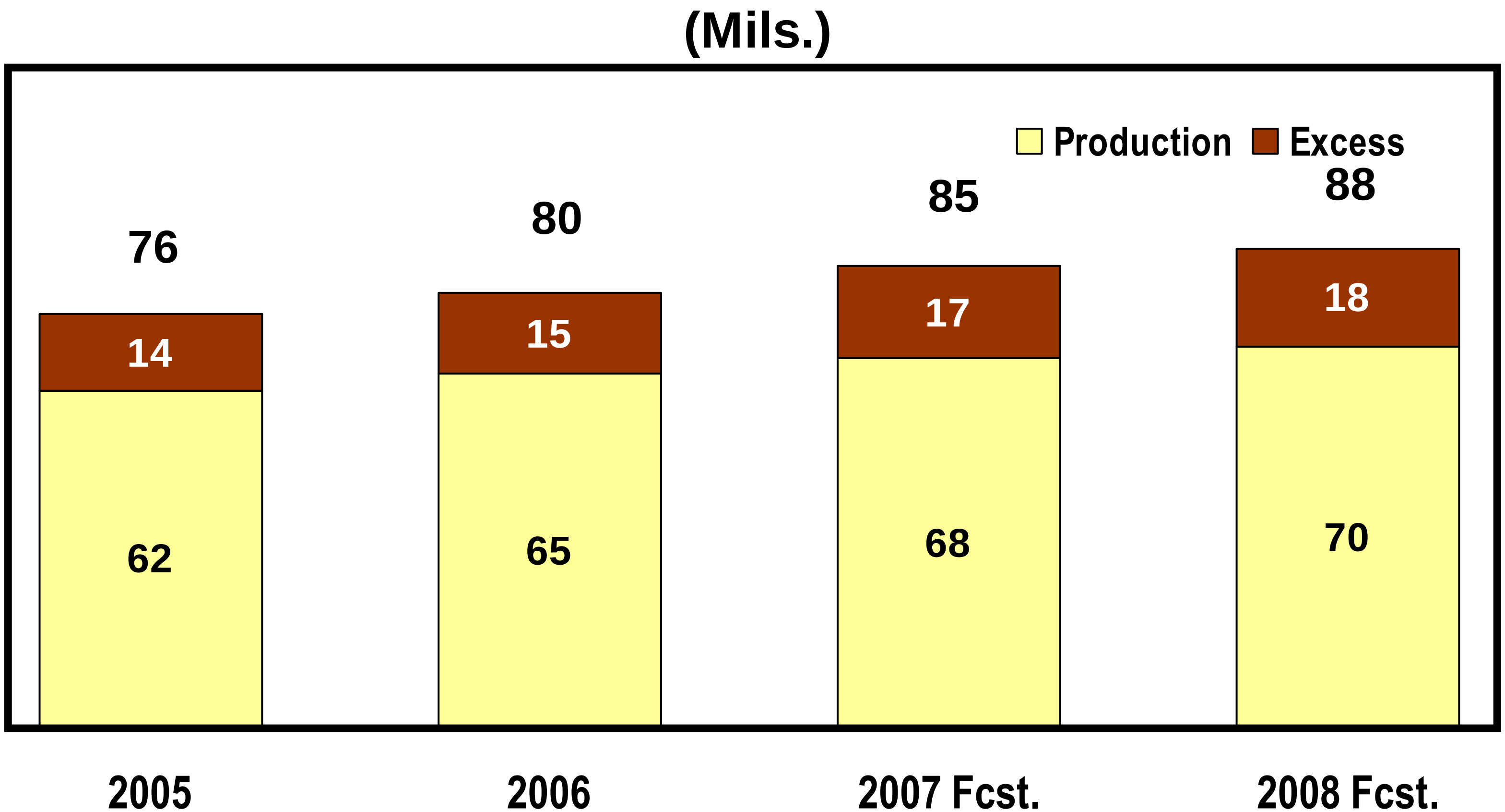
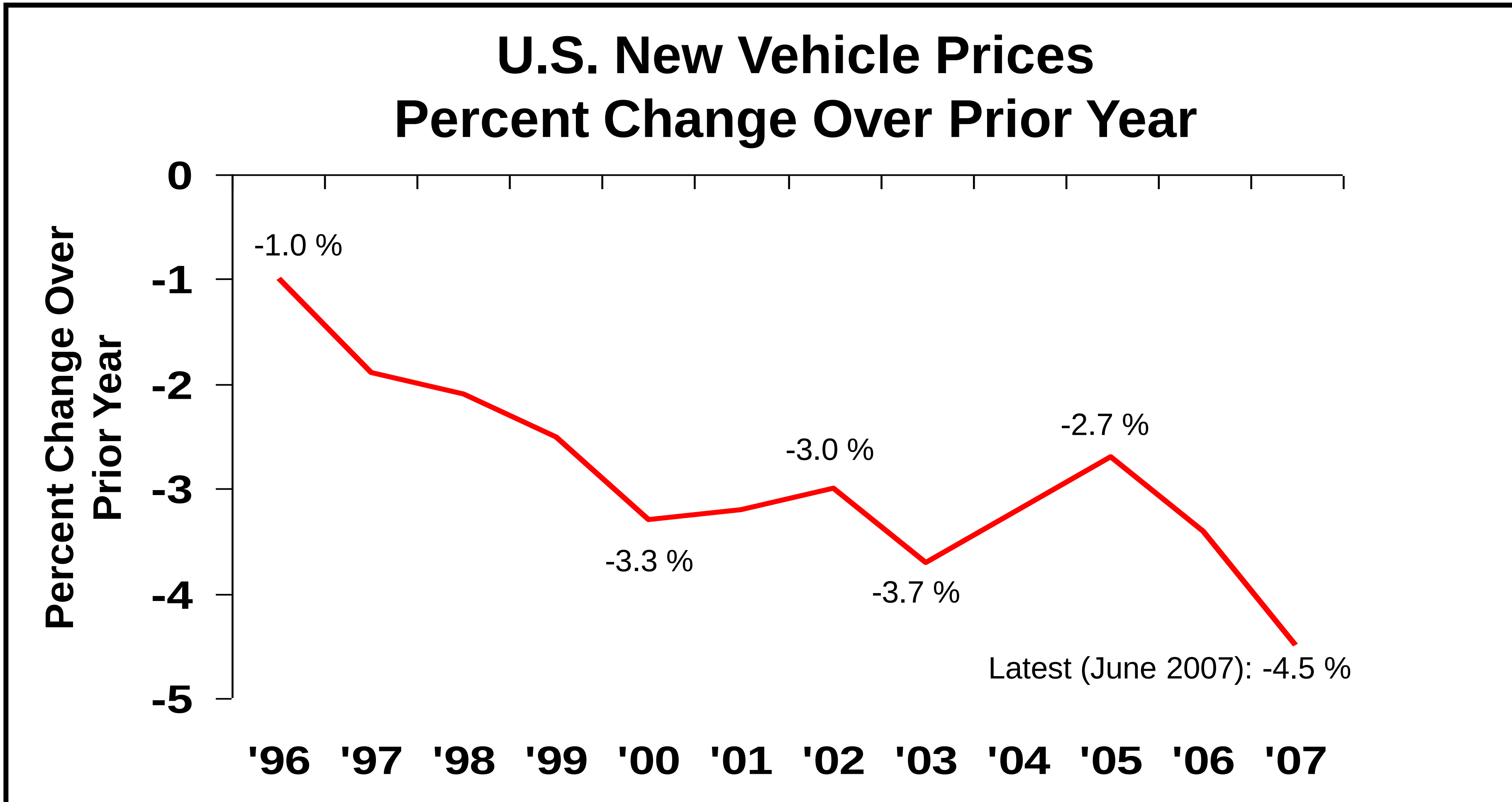
Growing global excess capacity worldwide focused on U.S. market



Memo (Excess as Pct. of Production): 23% 23% 25% 25%

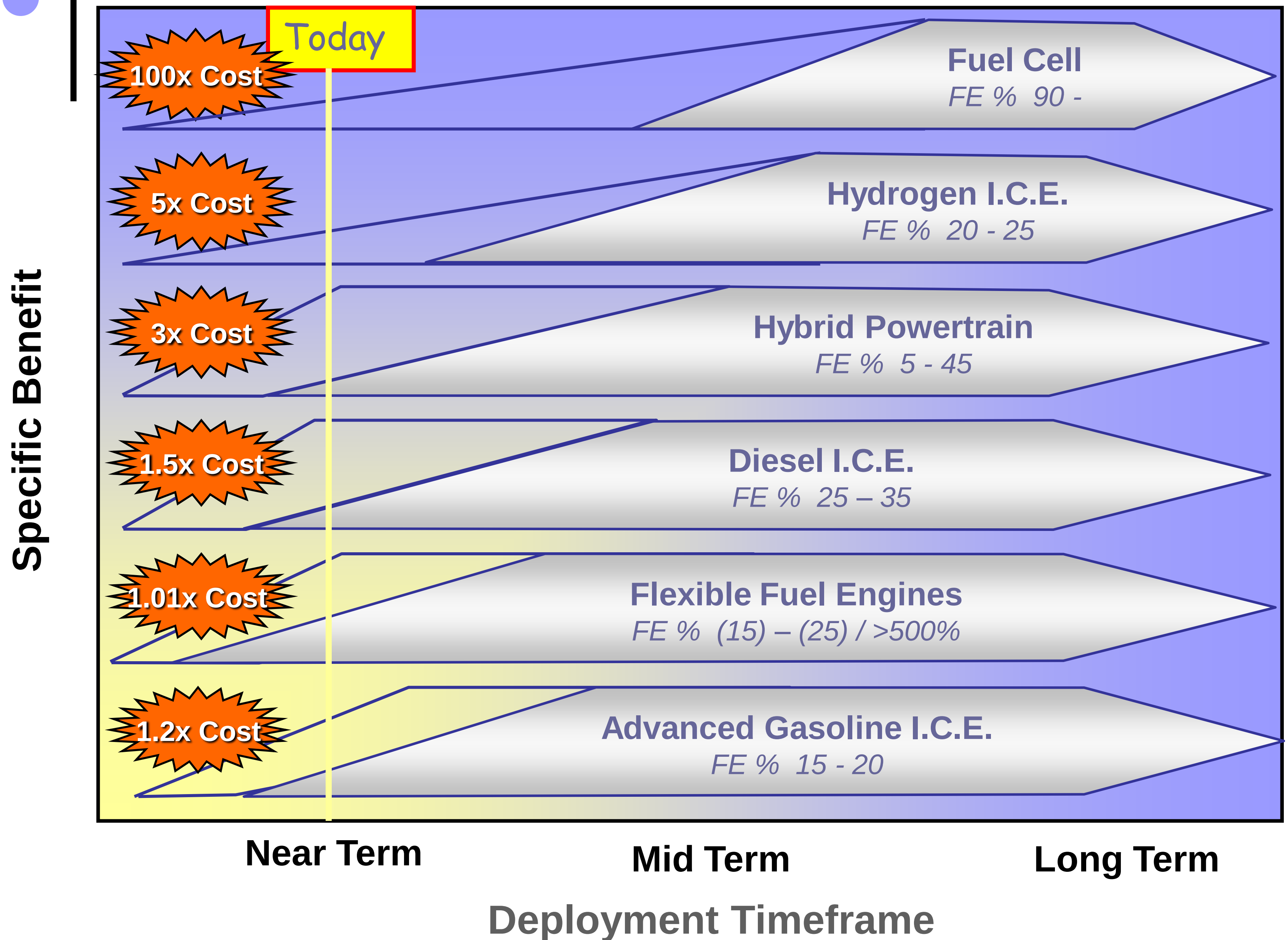
Source: CSM Worldwide 3Q 2007 Forecast

U.S. New Vehicle Prices are Down 30% Since 1996

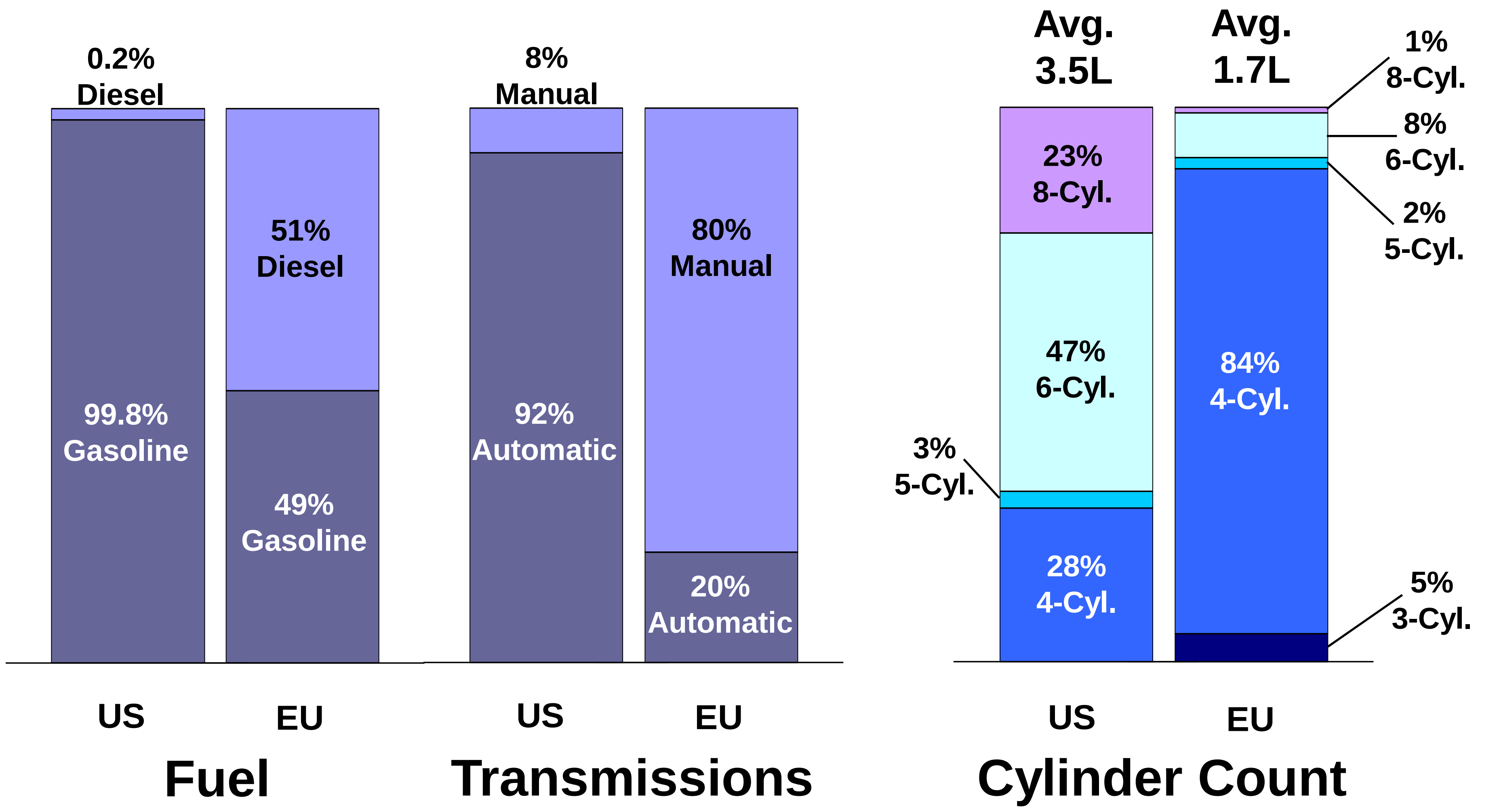


* Adjusted for Inflation

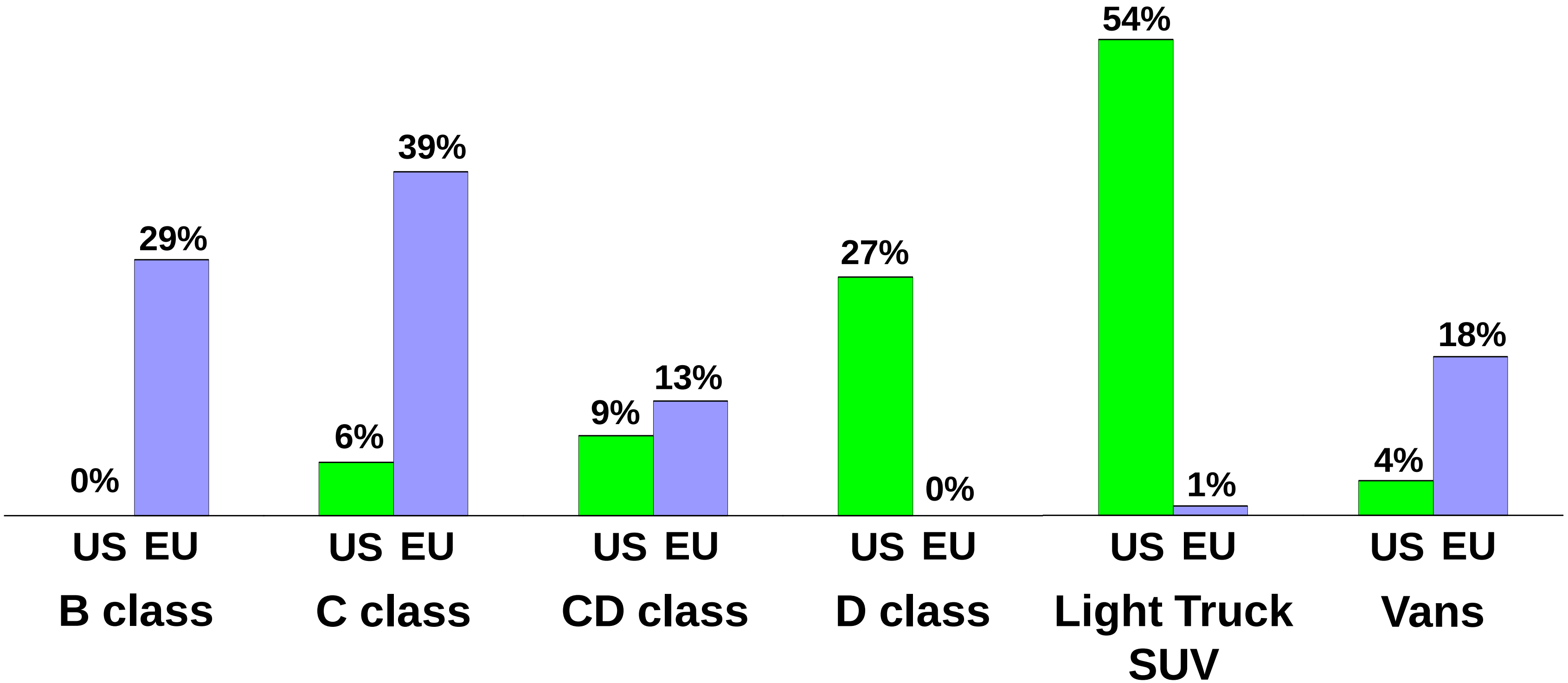
Powertrain Technologies – Timeline



Autos in Europe vs. United States



Vehicle Segmentation: Ford U.S. vs. Ford Europe

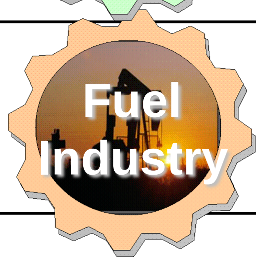


Worldwide Fuel Prices

Country	Gasoline Price	Diesel Price
U.S.	$ 2.39	$ 2.61
U.K.	$ 6.17	$ 6.55
Germany	$ 5.87	$ 5.22
France	$ 5.60	$ 5.04
Japan	$ 4.13	$ 3.41
Australia	$ 3.52	$ 3.56
Brazil	$ 4.77	$ 3.18

November 2006

The Role of Stakeholders: An Integrated Approach

 Auto Industry	✓ Accelerate advanced technology vehicle deployment ✓ Continue to improve the efficiency of our products ✓ Educate consumers/provide “eco-driving” training
 Fuel Industry	✓ Invest in developing and marketing E85 ✓ Increase R&D into advanced low carbon bio-fuels (including cellulosic ethanol)
 Government	✓ Policies to align consumer action with vehicles and fuels ✓ Incentives for advanced technology vehicles & E85 fueling infrastructure development ✓ Investment in improved road traffic management infrastructure ✓ Public awareness and education
 Consumers	✓ Drive vehicles in an energy-conscious fashion ✓ Vehicle choice and miles traveled ultimately determines how much fuel is consumed

Ford