csm | worldwide

automotive
market
foresight

Drivers For Future Technology Deployment

The role of the consumer, government, and industry to achieve the optimal fuel economy model

Eric A. Fedewa
V.P., Global Powertrain Forecasts

4 June 2009

Table of Contents

Drivers For Technology Deployment

Competing Priorities

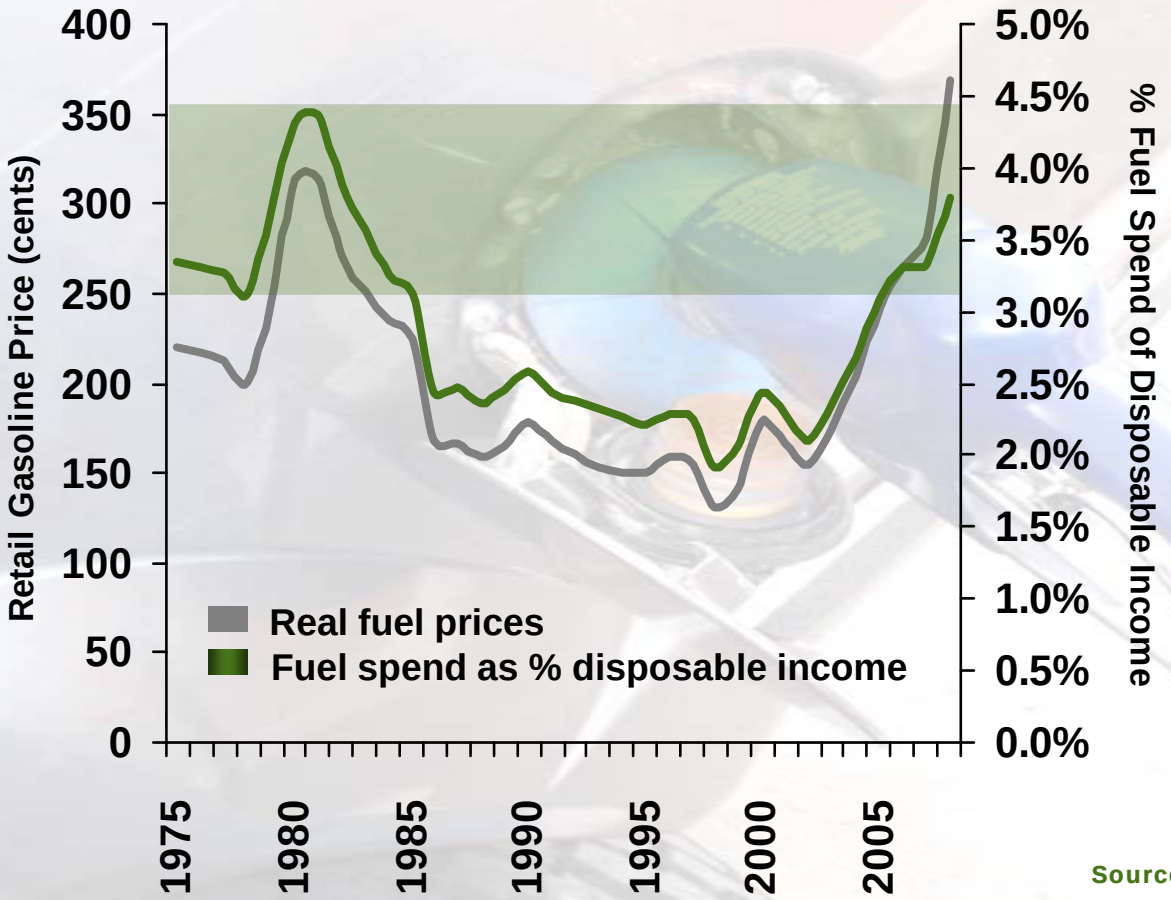
Needs of the Consumer

Government Legislation

Industry Capability & Profits

How Much Do We Spend on Fuel?

Real Fuel Prices vs. Fuel Spend as % of Disposable Income



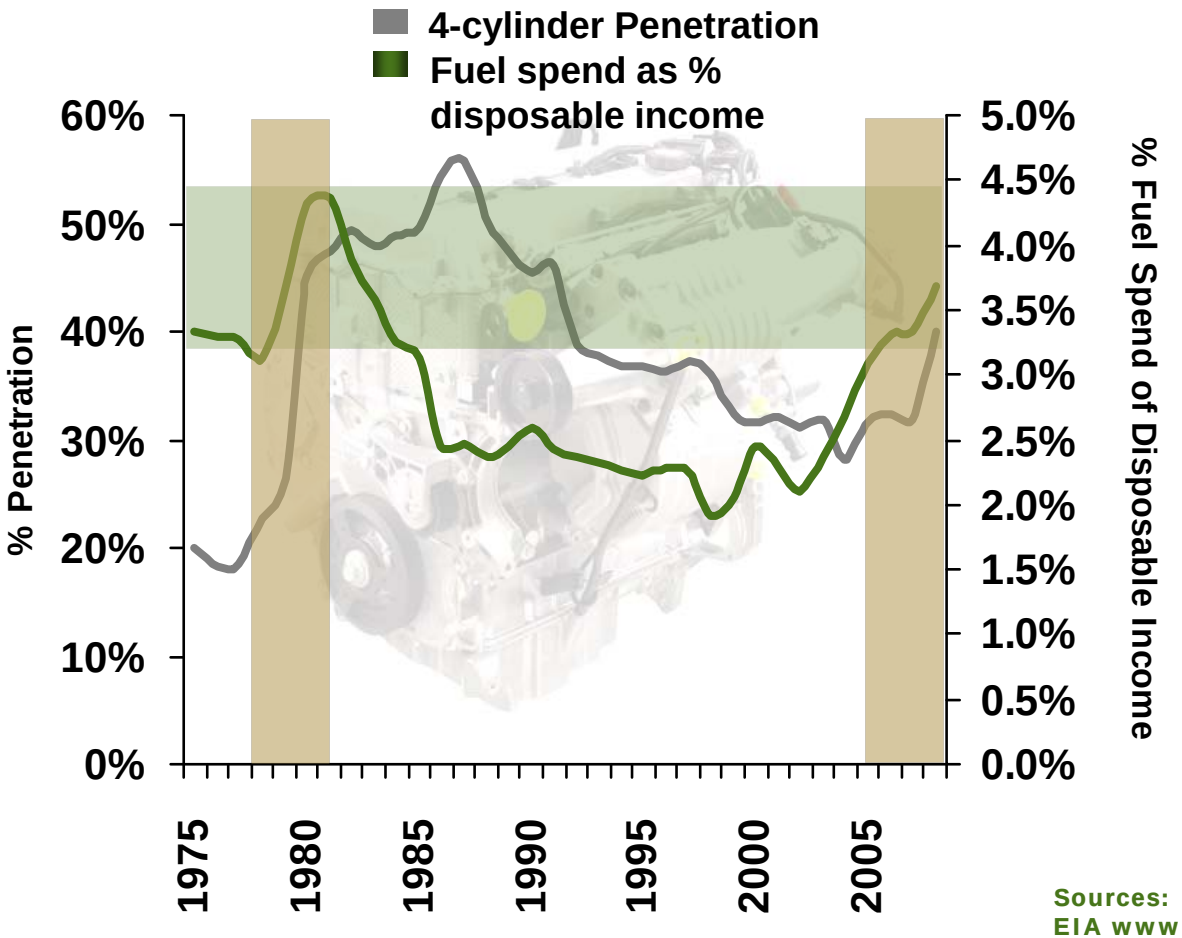
Highlights

- In 2008, families spent close to 4.0% of their disposable income on gasoline
- This was the highest level since late-70s/early-80s
- Average annual fuel cost to consumers in January 2002 was $1,210
- Average annual fuel cost to consumers in July 2008 was $4,302

Sources: Bureau of Economic Analysis www.bea.gov; EIA www.eia.doe.gov

What Engines Do We Prefer in Times Like This?

Cylinder vs. Fuel Spend as % of Disposable Income



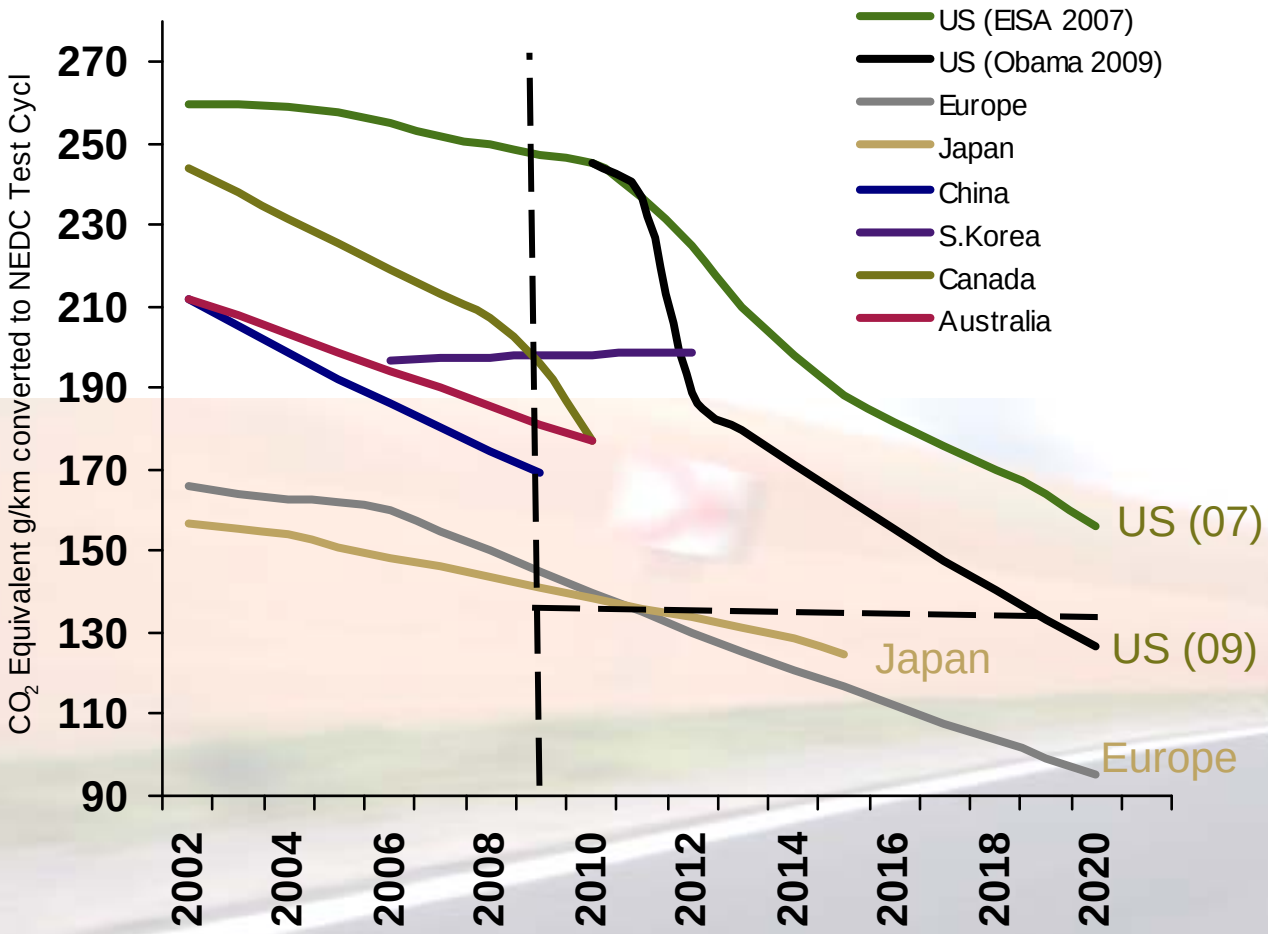
Highlights

- Late-70s trend very similar to today's environment - consumers moving away from engines with large displacements to engines with smaller displacements
- Vehicles like Chevy Malibu pushing close to 80% 4-cylinder penetration when fuel spend reached 3.5%

Sources: Bureau of Economic Analysis www.bea.gov; EIA www.eia.doe.gov; www.ethanol.org

Legislation: CO_2 Drivers – Where Are We Going?

GHG Emissions for New Passenger Vehicles By Country



Highlights

- 2020 US fuel economy mirrors European and Japanese fleets of today
- OEMs that sell to US: How to meet 155g/km (35.5mpg) by 2016?
- Fleet downsizing
  - Engine downsizing
  - Technology increase; turbocharging, diesel, hybrids, direct injection, advanced transmissions
  - Increased credits for bio-fuel vehicles
  - More technology sooner

Source: The International Council on Clean Transportation, Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update

Direction of North American Industry – 35.5mpg

35+ mpg – 3.14 tons CO_2 per year

Mini: $31.40

25-35 mpg – 4.39 tons CO_2 per year

Mid-size: $43.90

15-25 mpg – 7.32 tons CO_2 per year

Biggie: $73.20

Year	2008
Make	Honda
Model	Fit
Engine	1.5L 4-cyl.
Miles/yr	20,000
Tons of CO_2	5.75
Offset Cost	$57.23

Year	2008
Make	Ford
Model	F150 4WD
Engine	5.4L 8-cyl.
Miles/yr	20,000
Tons of CO_2	12.67
Offset Cost	$126.71

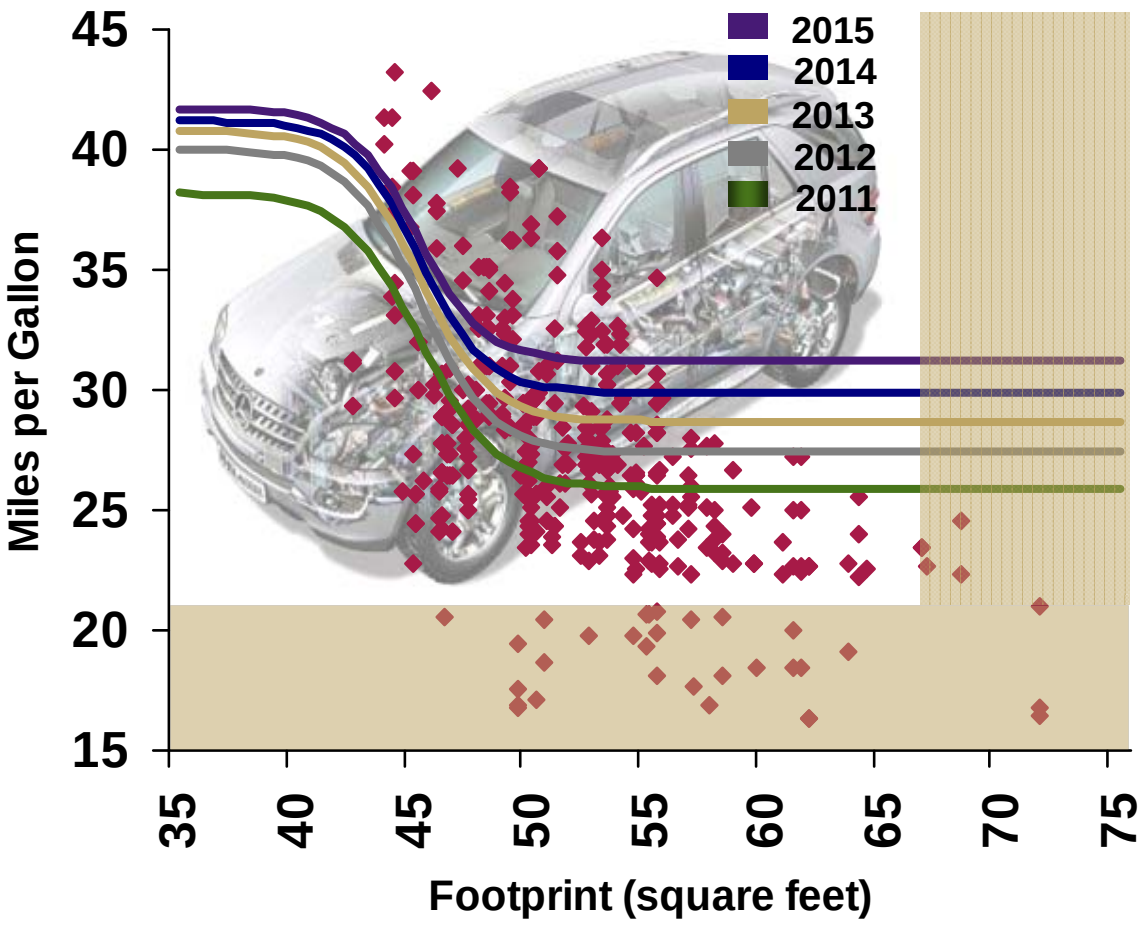
96.5 inches; curb weight = 2,432 lbs.

126.6 inches; curb weight = 4,709 lbs.

Source: http://www.carbonfund.org/vw

U.S. Passenger Car CAFE

MPG vs. Footprint

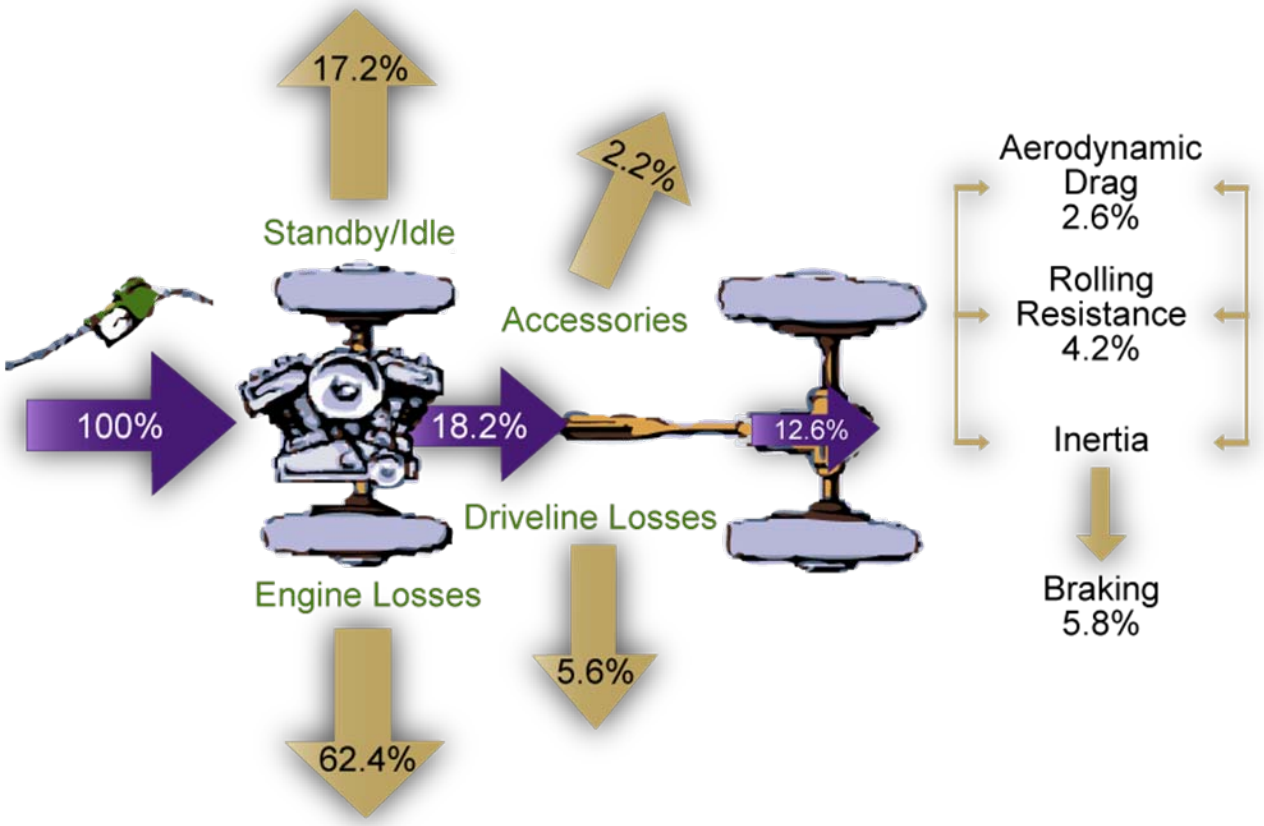


Highlights

- Small passenger cars generally in good position to meet future CAFE
- Outliers in shaded region correspond to performance vehicles or large legacy vehicles
- Goal will be to generate credits on this curve to help offset light truck CAFE curve

Improving Fuel Efficiency

Where Does the Energy Go?



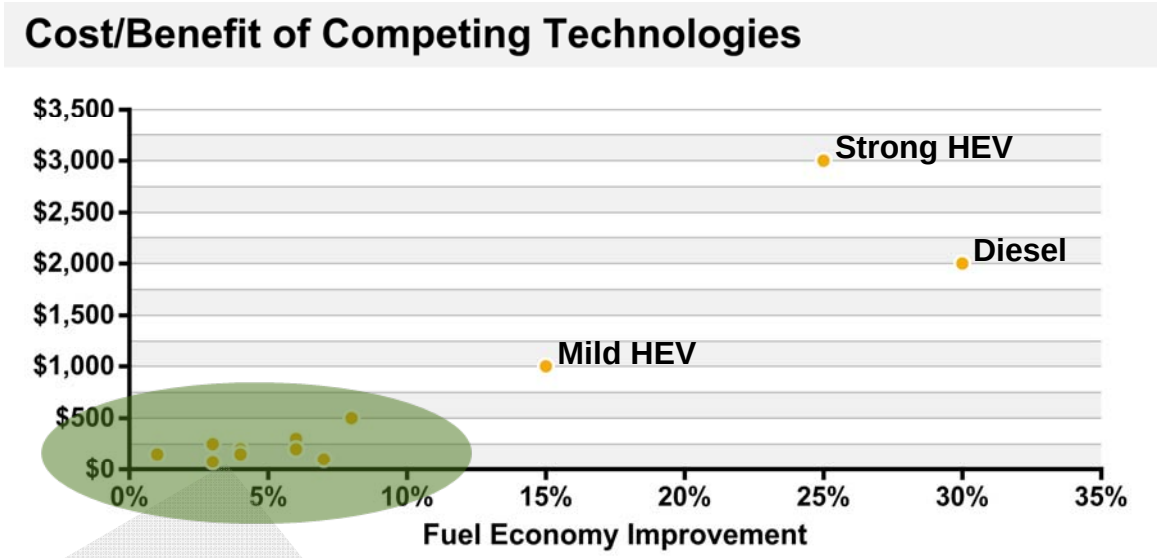
http://www.fueleconomy.gov/feg/atv.shtml

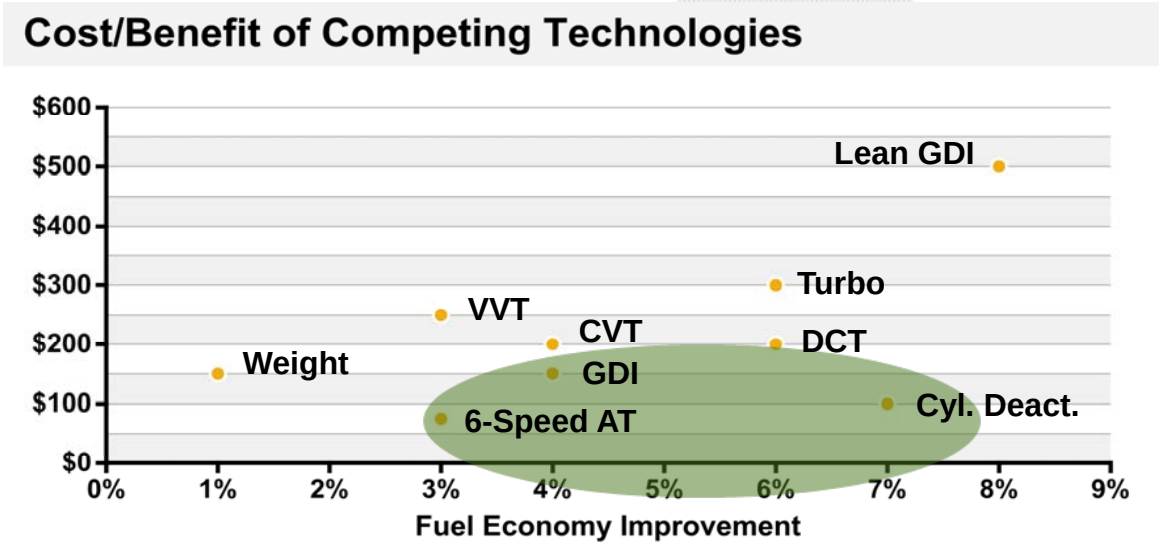
Highlights

- 87.4% of energy from fuel put into tanks is lost due to driveline losses
- The remaining 12.6% of energy is lost from over-coming inertia, rolling resistance, Aerodynamic drag and for braking.
- There is enormous potential to improve fuel efficiency with advanced technologies

Industry Capabilities/Profits – OEM Technology Portfolio

Improvements to ICE engines and multi-speed transmissions appear to be near-term, low-cost solutions for OEMs.

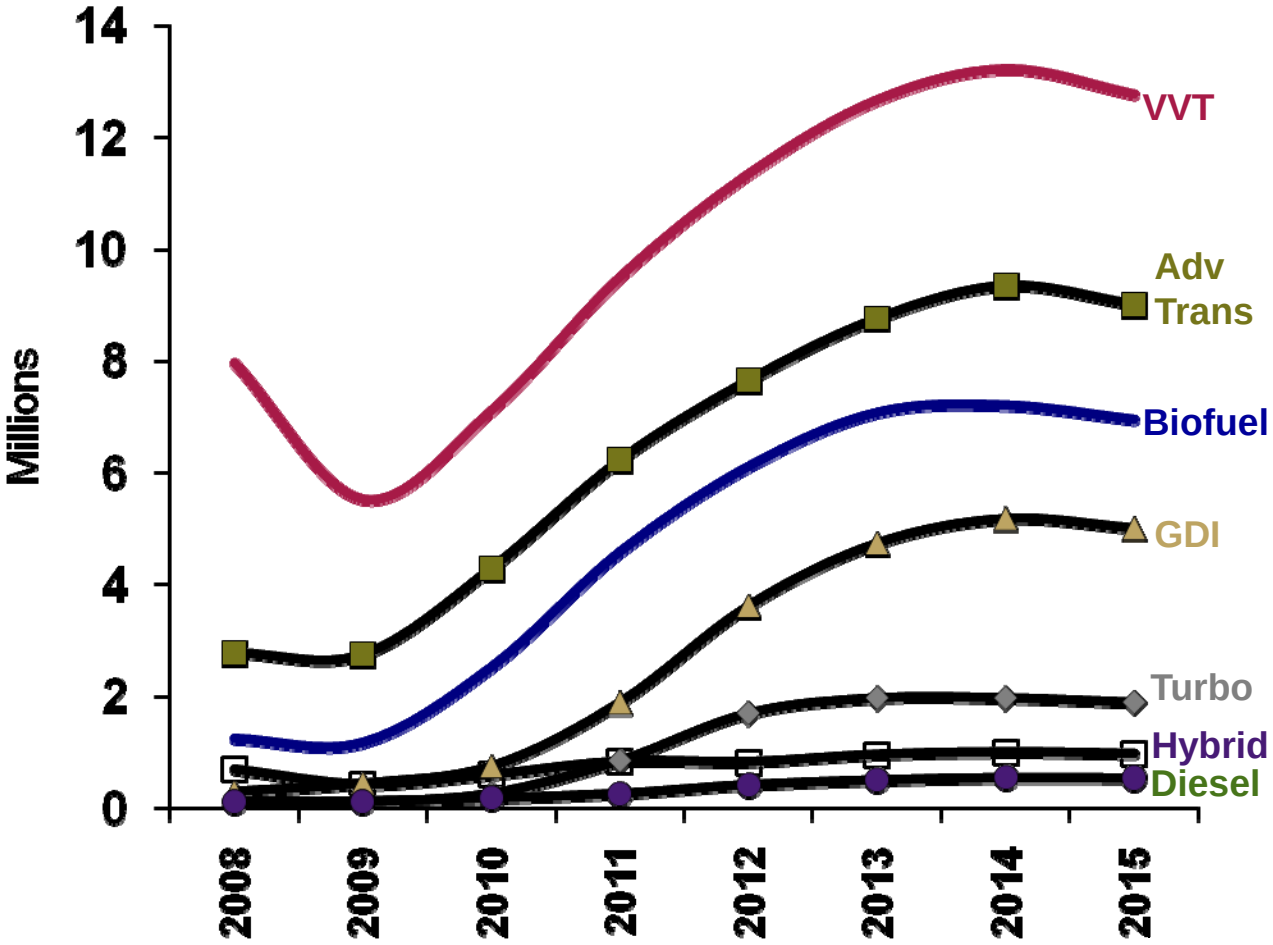




OEMs are looking for the lowest cost per fuel economy improvement.

North America Technology Roll Out

North American Technology Installation

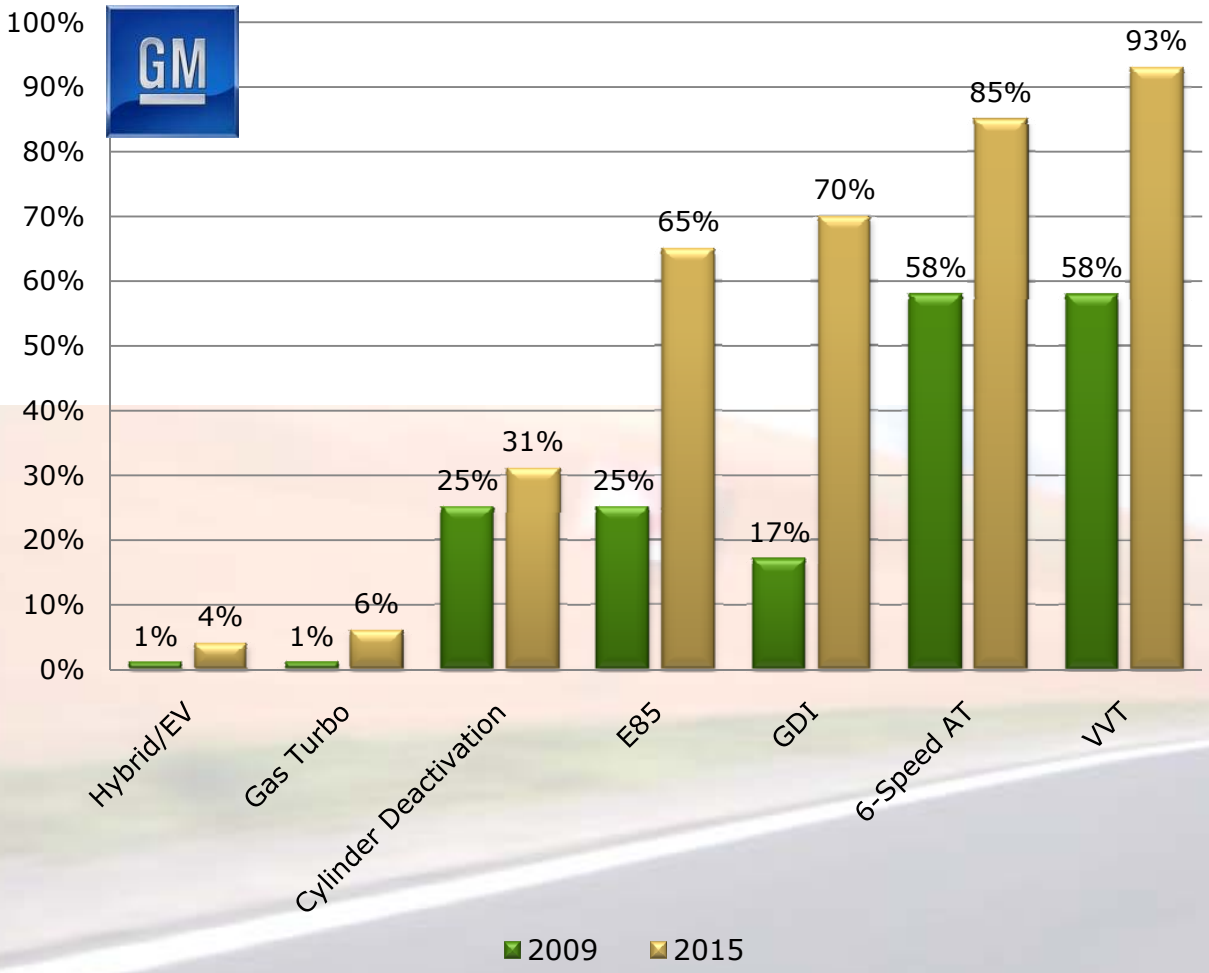


Highlights

- Certain technologies exist on an island
  - Diesel versus gas
  - DCT versus CVT versus AT
- Other technologies work in all regions
  - GDI
  - VVT
- Major OEMs have or have plans to develop 6AT+, DCT or CVT
- Next on OEMs' radar: turbocharging, Bio-Fuels, and GDI

Industry Capability And Profits

Future Technology Portfolio: GMNA



Notes

- Hybridization and Electric Vehicles limited in scope as fuel economy targets are met with more conventional technology
- 6-Speed automatic transmissions replace most all other automatics.
- Long-term focus on Gas-Turbo and Variable Valve Timing (VVT) in addition to robust Gasoline Direct Injection (GDI) roll-out
- E85 Flex Fuel a focus point as GM strives for maximum CAFE calculation multiplier.

Green Technology Payback
@ 15,000 miles per year

Vehicle	Cost	Payback years at Fuel Price of: $2	$3	$4
Toyota Camry Hybrid	$25,575	13	9	7
Chevrolet Silverado Hybrid	$39,000	10	7	5
Chevrolet Volt	$40,000	29	19	15
		$2.80	$3.80	$4.80 (Diesel)
VW Jetta Sportwagen Diesel	$23,870	30+	17	8

Payback: Cost of powertrain option above standard equipment gasoline engine, and compared to annual fuel cost savings to reach breakeven point of investment

Conclusion

- Consumer preference and energy price are key drivers for technology choice. Sustained higher energy price would better support the industry's achievement of the 35.5mpg CAFE goal.

- Legislation is sufficient to drive long term technology adoption. In the absence of higher energy price, more aggressive fuel economy legislation will provide needed stability to the OEM business model.

- Industry is already investing heavily in technological solutions to target powertrain inefficiencies. Adoption of further electrification will occur as technology price and payback period decreases.

csm worldwide

automotive
market
foresight

Eric A. Fedewa
V.P., Global Powertrain Forecasts

+248 380 9000
ericfedewa@csmauto.com

4 June 2009