Drivers For Future Technology Deployment

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

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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

- 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

Graph showing:
- 4-cylinder Penetration
- 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: CO₂ Drivers – Where Are We Going?

GHG Emissions for New Passenger Vehicles By Country

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**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


North America Trends
Direction of North American Industry – 35.5mpg

<table>
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<tr>
<th>Year</th>
<th>Make</th>
<th>Model</th>
<th>Engine</th>
<th>Miles/yr</th>
<th>Tons of CO₂</th>
<th>Offset Cost</th>
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<td>2008</td>
<td>Honda</td>
<td>Fit</td>
<td>1.5L 4-cyl.</td>
<td>20,000</td>
<td>5.75</td>
<td>$57.23</td>
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25-35 mpg – 4.39 tons CO₂ per year

**Mid-size: $43.90**

15-25 mpg – 7.32 tons CO₂ per year

**Biggie: $73.20**

35+ mpg – 3.14 tons CO₂ per year

**Mini: $31.40**

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

- 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?

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

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

- 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
Future Technology Portfolio: GMNA

- 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

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<tr>
<th>Vehicle</th>
<th>Cost</th>
<th>Payback years at Fuel Price of:</th>
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<td></td>
<td></td>
<td>$2</td>
<td>$3</td>
<td>$4</td>
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<td>Toyota Camry Hybrid</td>
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<td>Chevrolet Silverado Hybrid</td>
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<td>10</td>
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<td>5</td>
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<tr>
<td>Chevrolet Volt</td>
<td>$40,000</td>
<td>29</td>
<td>19</td>
<td>15</td>
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<tr>
<td>VW Jetta Sportwagen Diesel</td>
<td>$23,870</td>
<td>30+</td>
<td>17</td>
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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.
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