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CAFE and the U.S. Auto Industry

A Growing Auto Investor Issue, 2012-2020

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- **What's New?** — In partnership with Ceres and the Investor Network on Climate Risk, we, along with industry experts at the Planning Edge, University of Michigan Transportation Research Institute, and NRDC, evaluated potential changes to the U.S. Corporate Average Fuel Economy (CAFE) program.

- **CAFE on the Rise** — We expect Congress to enact changes to the U.S. CAFE program before 2012 that will raise standards by 40% to a market-wide 35 mpg by 2020. We expect the National Highway Traffic Safety Administration (NHSTA) to "reform" the program for cars to allow automakers to have different standards based on the average size of their new car sales (already in place for light trucks), which should mitigate the impact on sales mix.

- **Limited OEM Earnings Impact Through 2012** — Changes in internal combustion engine (ICE) technology are the most cost-efficient way to meet stricter fuel economy standards. We anticipate that 2012 standards can be met with modest additions of existing technologies. Margins on incremental technologies are likely lower than existing margins. We expect some modest fuel economy-imposed mix shifts in 2012, and automakers with products in growing segments will be best positioned. We estimate that the 2012 profit and loss changes attributable to CAFE will be most beneficial to General Motors and least beneficial to Chrysler.

- **Analyzing the Outer Years** — Higher standards can be met with higher efficiency ICEs and turbocharging, supplemented by increased sales of advanced drivetrain hybrid and diesel vehicles in the outer years. Automakers that focus on higher performance and have lower fuel economy for their size class including BMW and Mercedes may be somewhat challenged, with diesels as their likely solution.

- **Suppliers of Fuel Economy Technologies Will Benefit** — We estimate that the auto industry must grow the fuel savings technology market by an incremental $4.3 billion to meet CAFE standards in 2012, and more so in 2013-20. Key beneficiaries of this growth include BorgWarner, Johnson Controls, and Tenneco. BorgWarner appears best positioned to benefit from stricter fuel economy standards as the company derives most of its sales from fuel savings technologies.

- **Alternative Propulsion Technology** — Longer term, investors will need to ponder the likelihood of evolutionary advancements in alternative propulsion technology.

See Appendix A-1 for Analyst Certification and important disclosures.

Contents

US Auto Industry: Tightening CAFE Standards

Figure 1. Automaker Fleet MPG Averages, 2005

Automaker	Average MPG, 2005
GM	22.1
Ford	22.1
Chrysler	22.0
Honda	28.2
Toyota	26.5
Nissan	24.0

Source: The Planning Edge, UMTRI and Citi Investment Research

Update on Fuel Economy and Climate Change Regulations

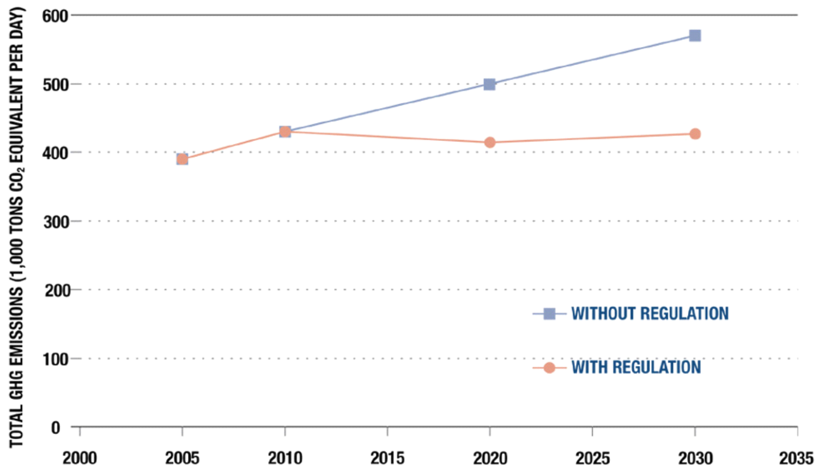
Regulators around the world are moving to reduce greenhouse gas emissions from automobiles, and lessen dependence on volatile nations for petroleum. We have issued this report as a follow-up to Citigroup's January 2007 Industry-Brief titled "CO2 – A New Auto Investor Issue for 2007" in which we examined the mix threat to European automakers from the pending CO2 standards in the European Union of 130 g/km.

In the United States, Congressional proposals to raise corporate average fuel economy (CAFE) standards would "reform" the current system to allow attribute-based standards based on size (wheelbase times track width) which will greatly mitigate impact on the sales mix. As we described in Europe, automakers in the U.S. will likely need to rapidly adapt to changing reforms.

- In June 2007, the United States Senate passed an energy bill that included a provision mandating the first major increase in CAFE standards in over 30 years, raising standards for passenger vehicles to 35 mpg by 2020, about 40% or 10 mpg above today's levels. Under the proposed law, NHTSA would be required to "reform" the program for cars to allow manufacturers to have different standards based on the average size of their new car sales (light trucks are already treated in this manner). The House energy bill did not contain a CAFE provision, and as of the date of this writing, Congress has not acted on reconciling the two energy bills.
- In 2004, California adopted a new regulation that requires a 30% reduction in passenger fleet-wide carbon emissions from new vehicles sold in the state by 2016 (approximately 32.9 mpg), with the standards phasing in starting in 2009. Eleven other states[1] have adopted California's standards and several more are considering adopting it. While automakers are challenging the case in court, recent rulings by the Supreme Court (Mass. vs. EPA) and in Vermont have increased the likelihood the programs will be implemented. The U.S. Environmental Protection Agency (EPA) is currently considering whether to grant California a waiver that is required for it and other states to enforce the standard. A decision could occur as early as December 2007.

[1] MD, ME, MA, NY, VT, CN, NJ, RI, OR, WA, PN

Figure 2. California Motor Vehicle Greenhouse Gas Projections



California Motor Vehicle Greenhouse Gas Emission Projections (CARB 2004)

From: International Council on Clean Transportation, *Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update,* July 2007.

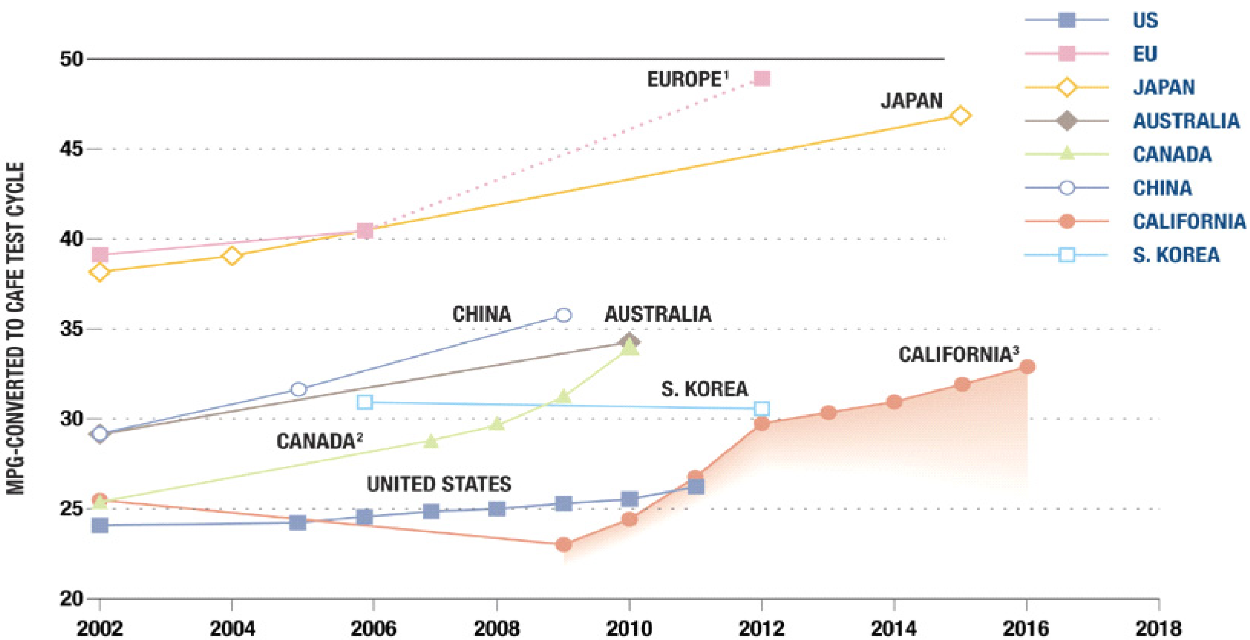
- In April 2007, the Supreme Court ruled in a 5-4 decision that greenhouse gases are considered air pollutants under the Clean Air Act, allowing EPA to regulate greenhouse gas emissions from vehicles. In May 2007, President Bush issued an Executive Order directing EPA to use its greenhouse gas emission authority to increase fuel economy by as much as 4% per year over the next 10 years, equivalent to a fleet-wide average of about 34 mpg by 2017. A proposed rule from EPA is expected as early as December 2007.

- Internationally, governments the world over are increasing regulation of vehicle fuel economy and greenhouse gas emissions. In 2006, Japan revised its fuel economy targets, with projected increases of 24% by 2015 (over 2004) to roughly 46.9 mpg.[2] In June 2007, the European Union resolved to set mandatory standards for automakers to achieve 130g/km, roughly 48.9 mpg. Chinese fuel economy standards reached 31.6 mpg in 2005 and will increase to 35.8 mpg by 2009. Chinese consumers only pay 3% tax for small engine vehicles (1-1.5 liters), while paying 20% tax for large engine vehicles (over 4 liters). Australia's fuel economy standards will increase to 34.4 mpg by 2010.

[2] All fuel economy levels are given in terms of US CAFE test cycle equivalent and are from estimates by the International Council on Clean Transportation. See: ICCT, Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update, July 2007.

Figure 3.

Actual and Projected Fuel Economy Standards for New Passenger Vehicles by Country 2002-2018



Actual and Projected Fuel Economy for New Passenger Vehicles by Country, 2002-2018.

[1] The relative stringency of Europe's CO_2-based standards is enhanced under a fuel economy standard because diesel vehicles achieve a boost in fuel economy ratings due to the higher energy content of diesel fuel.

[2] For Canada, the program includes in-use vehicles. The resulting uncertainty of this impact on new vehicle emissions was not quantified.

[3] Shaded area under the California trend line represents the uncertain amount of non-fuel economy related GHG reductions (N_2O, CH_4, HFCs, and upstream emissions related to fuel production) that manufacturers will generate from measures such as low-leak, high efficiency air conditioners, alternative fuel vehicles, and plug-in hybrid electric vehicles.

From: International Council on Clean Transportation, *Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update*, July 2007.

The regulatory movements now occurring in the U.S. and around the world underscore the increasing importance of this issue. With regard to fuel economy standards and the automotive industry, the pace of change is indeed ramping up, and—as financial markets can often move rapidly and ahead of regulatory enactment—understanding the competitive and profitability impacts of an attribute-based CAFE system is critical to our valuation of automakers.

Overview of Findings

We expect Congress to enact changes to CAFE that would come into effect before 2012. First, Congress is very likely to mandate an attributes-based system (similar to that already in place for light trucks) for setting passenger car CAFE standards. The second change we expect is an increase in the market-wide CAFE target (covering both cars and light trucks) to 35 miles per gallon by 2020. The 35 miles per gallon market-wide target is a 40% increase over the 25 miles per gallon that light vehicles meet today. Automakers have expressed concern about their ability to meet such a high goal. One industry lobbyist (Dave McCurdy of the Alliance of Automobile Manufacturers) recently told Congress:

The proposed increases in fuel economy requirements would present major technology challenges for automakers, requiring tremendous investments over a sustained period of time…As a result, overly aggressive fuel economy standards could undermine the economic health and stability of automakers. [Statement of the Alliance of Automobile Manufacturers before the U.S. House of Representatives Committee on Energy and Commerce, Subcommittee on Energy and Air Quality, June 7, 2007]

In this analysis, we sought to understand the profitability and competitiveness impacts, given the automakers' stated concerns. Our analysis reveals that the 2020 target is tough but attainable, requiring aggregate improvements of 2.5% per year, and—surprisingly—generating some growth in variable profits for most automakers. Further, replacing the way that CAFE standards are set for passenger automobiles to an attribute-based system has the potential to mitigate automaker concerns about economic impacts of higher regulation. A well-crafted attribute-based system could eliminate some dysfunctional features of CAFE that have been factored into product mix decisions and the competitive positions of the various automakers.

A size-based CAFE standard has a number of advantages over the un-reformed system it is replacing. All automakers are required to improve the fuel economy of their vehicle fleets in contrast to legacy CAFE that required improvements only from some automakers. The size-based system is less biased than legacy CAFE, which penalized full-line manufacturers and rewarded niche manufacturers. Under the size-based system, "gaming" CAFE by shifting mix or making vehicles bigger is reduced because changing mix and vehicle size will result in a change in the CAFE standard in the same model year.

We expect the market response to include two elements: a consumer demand shift toward more fuel-efficient vehicles and an increase in the application of fuel-saving technologies by automakers to meet the higher CAFE standards. These two elements of the market response are expected to have very different (partial) impacts, so to understand our analysis it is useful to separate the impacts' mix shift and technology application in the discussion. However, the two elements occur simultaneously, so the separation done for clarity should not be taken literally.

It may seem counterintuitive to argue that consumer demand can reinforce a tightening in regulatory requirements. But looking at the introduction and growth in the usage of air bags is instructive in understanding the interplay between regulations and consumer preferences. Safety has always been a concern for consumers, and automakers have understood that marketing safety is a winning strategy. Initially, air bags were mandated only for the driver and automakers scrambled to meet these regulations with a technology that was "not quite ready for prime time." As the technology was perfected and costs were reduced, consumers embraced the technology and supported a wider use of air bags throughout the vehicle.

Luxury vehicles led the way in offering additional air bags, but consumer interest ran ahead of regulations that mandated additional air bags in the vehicle. As a result, the usage of air bags spread quickly (thereby reducing the costs for manufacturers and consumers alike) throughout the vehicle lineup, well before the additional mandates actually came into place. Multiple air bags in a vehicle went from a "nice to have" to a "need to have" feature and automakers responded to consumer demand before regulations compelled their inclusion. Based on current and future trends, it is reasonable to believe that improvements in fuel economy will feed upon themselves in a similar manner. There are of course cost and technological limitations to this process, which have been included in the results of this analysis.

Fuel Economy

Figure 4.

FUEL ECONOMY IMPACTS OF MIX SHIFT AND TECHNOLOGY APPLICATION
(Miles per Gallon)

			Total Change		Mix Shift		Technology	
	2012 Base	Scenario	Change in MPG	% of Base	Change in MPG	% of Base	Change in MPG	% of Base
Car	29.7	30.3	0.55	1.9%	0.06	0.2%	0.50	1.7%
Truck	22.0	25.2	3.21	14.6%	0.07	0.3%	3.14	14.3%
Vehicle Total	25.1	27.4	2.29	9.1%	0.10	0.4%	2.19	8.7%

Source: The Planning Edge, UMTRI and Citi Investment Research

Note: The baseline does not include the latest light truck CAFE rulemaking which will raise the baseline average to 24.0 mpg by 2011 according to the National Highway Safety Transportation Administration. Thus the impact we analyze here is for both the new NHSTA light truck rule and the proposed Senate Energy Bill increase.

Congress' goal in raising CAFE standards is to improve the fuel economy of the U.S. light duty vehicle fleet. The Senate Energy Bill would increase fuel economy standards to an industry-wide fleet average of 35 mpg by 2020. We assume that this standard will be met while maintaining the current separate standards for cars and light trucks. The table above contains our estimates of the improvement in the fuel economy of new vehicles required by 2012 due to both the most recent administrative increase in light truck CAFE and the future increase required by the Senate Energy Bill. The table splits the total change into impacts of mix shift and technology application. Mix shift barely registers on fuel economy, contributing 0.10 of a mile per gallon of the total improvement of 2.29 miles per gallon. Fuel economy of both cars and trucks get less than 0.10 of a mile per gallon improvement from mix shift, and the shift from trucks to cars lifts the overall vehicle impact.

Technology, in contrast to mix shift, contributes most of the fuel economy improvement we expect. To meet higher overall CAFE standards, automakers cannot rely on shifting sales mix to more fuel-efficient models—they must make significant investments in fuel-saving technologies and apply them to their vehicles. And the vehicles that need to be improved the most are trucks. Automakers are expected to increase the fuel economy of their new trucks by 14.6%, with almost all of the improvement coming from technology. This dwarfs the 1.9% change in car fuel economy, but even in cars, most of the improvement comes from technology—1.7 points.

Figure 5. Impact of Mix Shift on Segment Shares

Segment	2012 Base	Scenario	% Change
Luxury Car	9.0%	9.0%	(0.02)
Midsize Car	21.0%	20.9%	(0.13)
Small Car	18.3%	18.9%	0.65
Car Total	**48.3%**	**48.8%**	**0.51**
Luxury CUV	2.4%	2.4%	(0.01)
Midsize CUV	9.2%	9.4%	0.17
Small CUV	7.9%	8.1%	0.17
CUV Total	**19.5%**	**19.8%**	**0.33**
Large Pickup	11.9%	11.7%	(0.27)
Midsize Pickup	0.5%	0.5%	(0.02)
Small Pickup	2.4%	2.4%	0.02
Pickup Total	**14.8%**	**14.5%**	(0.27)
Large SUV	3.0%	2.9%	(0.17)
Luxury SUV	2.2%	2.1%	(0.05)
Midsize SUV	5.3%	5.0%	(0.32)
Small SUV	0.7%	0.7%	0.00
SUV Total	**11.2%**	**10.6%**	**(0.55)**
Minivan	3.7%	3.7%	0.00
Large Van	1.7%	1.7%	(0.01)
Luxury Van	0.8%	0.8%	(0.00)
Van Total	**6.2%**	**6.2%**	**(0.01)**
Car Total	**48.3%**	**48.8%**	**0.51**
Truck Total	**51.7%**	**51.2%**	**(0.51)**
Vehicle Total	**100.0%**	**100.0%**	**0.00**

Source: Planning Edge, UMTRI, and CIR

Mix Shift

Figure 5 presents our assessment of the impacts on light vehicle segment shares of the shift in vehicle mix that we expect. Overall, cars gain 0.51 of a share point from trucks. We also anticipate some inner segment shifts to smaller platforms.

Within trucks, CUVs gain 0.33 of a share point, equally split between midsize and small CUVs. CUVs gain because they offer size and amenities comparable to some SUVs and pickups, but with better fuel economy.

Large pickups lose share, but remain the truck segment share leader. In many situations in which large pickups are used, there simply are no good substitutes. To meet higher CAFE, improving the fuel economy of large pickups is essential for any automaker competing in this segment. The unique functionality of large pickups makes these improvements worth doing and limits their loss of share.

The SUV segments collectively lose 0.55 of a share point; about twice what pickup segments collectively lose. SUVs have been hurt by higher fuel prices to a greater extent than have pickups, as more fuel-efficient CUVs have become better substitutes for SUVs than for pickups. The SUV is not dead by 2012, by our assessment, but buyers are dwindling as the cost of truck functionality (towing and off-roading) in terms of high and volatile operating expenses makes more SUV owners switch to CUVs. Improving the fuel economy of SUVs is essential for automakers to meet CAFE, and the necessary increases in retail prices that result are likely to give SUV owners more reason to switch to other segments.

Technology

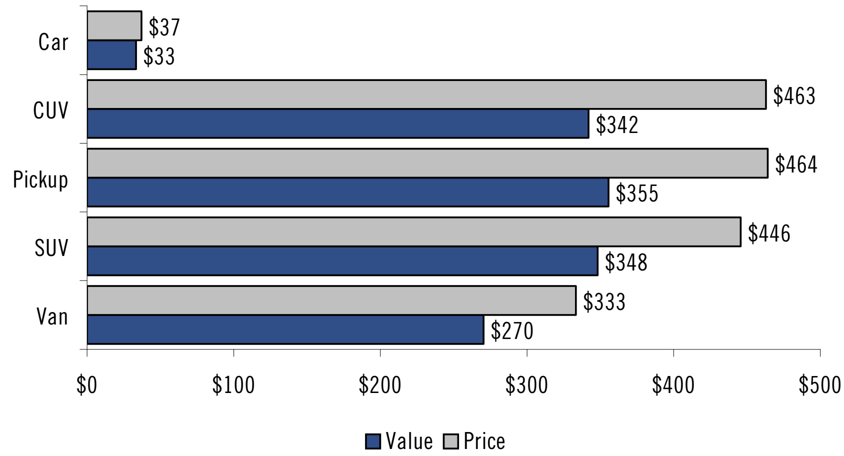
In our analysis of the impacts of CAFE reform and increases in standards, we relied on the estimates of the costs and benefits (in higher fuel economy) of technologies developed by the National Academy of Sciences (NAS) in 2002.[3] These estimates were mandated by Congress and have been relied upon by NHTSA in setting light truck CAFE standards. The NAS is currently revising these estimates, with results expected in 2008.

The NAS report contains lists of specific technologies along with the range of percentage increases in fuel economy and the range of costs (the retail price impact) of each technology. For our vehicle market and automaker analysis we followed what has become the common practice of summarizing the NAS estimates in “cost curves” that show the increase in retail price that would be required for a desired increase in fuel economy. This approach assumes that automakers improve a vehicle’s fuel economy to the required level at the lowest possible increase in retail price. This is consistent with maximizing profit.[4]

[3] National Research Council, Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards, National Academy of Sciences, 2002.

[4] See David L. Greene, Philip D. Patterson, Margaret Singh, and Jia Li, “Feebates, rebates and gas-guzzler taxes: a study of incentives for increased fuel economy,” Energy Policy 33 (2005) 757–775 for an explanation of this approach. In our analysis we used the functions in this paper for average costs, average fuel economy improvements.

Figure 6. Technology: Retail Price versus Consumer Value



Source: The Planning Edge, UMTRI and Citi Investment Research

Figure 6 shows the average change in vehicle retail price resulting from our analysis of the technologies (the lighter bars). It also shows our estimate of the added value to consumers (the buyers of the new vehicles). We find that the value added to consumers is less than the increase in retail price in every segment. (This is also true for every vehicle that has technologies applied to improve fuel economy.) The disparity between price and value influences our results in two ways. We assume that the retail price increases according to the technology costs, but in our market simulations the price that we assume influences consumers is net of the added consumer value. Since this value increase measures the value of the increased fuel economy, we measure the market response holding fuel economy at its base. The other way the disparity influences our results is in computing the profit margin on the fuel-saving technologies. We assume that automakers earn their ordinary variable profit margins (the base margins) only on the added consumer value, not on the total price increase. The impact of this is clear in the table below.

Figure 7.

PROFIT MARGINS:
BASE AND ADDED TECHNOLOGIES

	Base Variable Profit Margin	Margin on Fuel-Saving Technologies
Luxury Car	30%	26%
Midsize Car	24%	22%
Small Car	22%	18%
Car Total	**25%**	**21%**
Luxury CUV	29%	23%
Midsize CUV	25%	18%
Small CUV	23%	17%
CUV Total	**25%**	**18%**
Large Pickup	26%	20%
Midsize Pickup	23%	16%
Small Pickup	24%	17%
Pickup Total	**26%**	**20%**
Large SUV	28%	21%
Luxury SUV	32%	25%
Midsize SUV	25%	20%
Small SUV	24%	19%
SUV Total	**28%**	**21%**
MINIVAN	25%	20%
Large Van	24%	18%
Luxury Van	24%	20%
Van Total	**24%**	**19%**
Car Total	**25%**	**21%**
Truck Total	**26%**	**19%**
Vehicle Total	**26%**	**19%**

Source: The Planning Edge, UMTRI and Citi Investment Research

Figure 8 shows our estimates of the impact of the NAS technologies of retail price. By 2012 we expect that many of the NAS technologies (identified in 2002) will have been applied. Thus we show an impact on our base prices for 2012, the cumulative impact on base prices for the scenario, and show the change in dollars and percent of base.

Figure 8. Impact of Technologies on Retail Prices ($ Per Vehicle)

	2012 Base	Scenario	$ Change	% Change
Luxury Car	$1,812	$1,841	$29	2%
Midsize Car	$1,598	$1,645	$47	3%
Small Car	$1,321	$1,348	$28	2%
Car Total	**$1,533**	**$1,569**	**$36**	**2%**
Luxury CUV	$744	$1,109	$366	49%
Midsize CUV	$434	$973	$538	124%
Small CUV	$464	$865	$401	86%
CUV Total	**$485**	**$946**	**$461**	**95%**
Large Pickup	$268	$729	$461	172%
Midsize Pickup	$287	$1,014	$727	254%
Small Pickup	$281	$703	$423	151%
Pickup Total	**$271**	**$735**	**$464**	**171%**
Large SUV	$694	$1,230	$537	77%
Luxury SUV	$528	$902	$374	71%
Midsize SUV	$336	$764	$428	128%
Small SUV	$113	$488	$374	330%
SUV Total	**$458**	**$902**	**$444**	**97%**
MINIVAN	$189	$453	$264	139%
Large Van	$310	$776	$466	151%
Luxury Van	$22	$390	$367	1635%
Van Total	**$201**	**$534**	**$333**	**166%**
Car Total	**$1,533**	**$1,569**	**$36**	**2%**
Truck Total	**$384**	**$826**	**$443**	**115%**
Vehicle Total	**$938**	**$1,185**	**$247**	**26%**

Source: The Planning Edge, UMTRI and Citi Investment Research

Our base assumes that the technologies will have four times the absolute impact on car that they do on truck prices—$1,533 per car versus $384 per truck. In the scenario, while the total changes are relatively small, we expect a dramatic reversal. The scenario-added technologies will have 12 times the impact on truck prices that they have on car prices.

Figure 9. Summary of Domestic Impact by Manufacturer

	Sales		MPG		Revenue (in millions)		Variable Profit (in millions)	
	Base	Scenario	Base	Scenario	Base	Scenario	Base	Scenario
Chrysler	2,083,368	2,057,300	23.7	26.3	49,596.8	49,388.5	12,209.8	12,117.3
Ford	3,030,300	3,013,600	23.3	26.2	78,637.4	79,135.7	19,997.5	20,037.9
GM	3,706,900	3,732,100	22.8	26.4	98,173.7	99,697.4	25,333.4	25,553.7
Honda	1,699,800	1,713,900	29.1	29.6	40,021.6	40,358.5	9,860.2	9,939.1
Nissan	1,223,400	1,229,700	26.4	28.7	28,902.2	29,219.1	7,245.5	7,298.9
Toyota	2,851,700	2,843,700	27.8	28.7	70,124.7	69,917.6	17,695.6	17,623.6
Other	2,766,800	2,774,300	26.9	28.1	82,335.9	82,506.3	22,885.2	22,879.0
Total	**17,362,268**	**17,364,600**	**25.1**	**27.4**	**447,792.3**	**450,223.1**	**115,227.3**	**115,449.4**

Source: The Planning Edge, UMTRI and Citi Investment Research

This section examines the impact of the carbon reduction scenario on the **domestic performance** of the various manufacturers. Their overall performance is based on their global result, which dependent on the automaker, will have a varying impact on their overall results.

In addition, while the U.S. CAFE attribute-based system is designed not to penalize those that are truck-heavy or larger vehicle-heavy, automakers that tend towards those vehicles may face pressure as consumers move toward higher mileage vehicles (demand may grow as more higher mileage alternatives are presented to them).

General Motors

Figure 10. CAFE Impacts: General Motors

	Sales		MPG		Revenue (in millions)		Variable Profit (in millions)	
	Base	Scenario	Base	Scenario	Base	Scenario	Base	Scenario
GM								
Cars	1,539,500	1,590,100	27.1	29.0	34,955.8	35,970.6	8,633.3	8,848.6
Trucks	2,167,400	2,142,000	20.5	24.9	63,217.9	63,726.7	16,700.1	16,705.1
Total	**3,706,900**	**3,732,100**	**22.8**	**26.4**	**98,173.7**	**99,697.4**	**25,333.4**	**25,553.7**

Source: The Planning Edge, UMTRI and Citi Investment Research

GM is in the midst of a major change in its global footprint and will continue to utilize its own international sources for vehicles and powertrains, enabling it to increase its volume of small cars and diesel engines, among other products. GM is ahead of Ford in this regard which is also seeking to leverage its global resources. GM also has the highest car share of its Detroit Three competitors, which gives it some advantages as it seeks to increase its fuel economy.

As a result of this, GM is able to gain share and volume in cars and has a modest decline in trucks. This latter fact is due in part because GM's truck products are modestly ahead of its Detroit rival with respect to fuel economy. Ironically, GM's stronger position in large, low mileage sport utilities may also provide an advantage for the company. Increased CAFE regulations will require significant improvement in these product categories and assuming that GM meets these regulations, its products will be more attractive to consumers.

Of course, we believe the company will be challenged by the cost of this improvement, but the end result may be quite positive for the company.

Although the results in 2012 look relatively positive for GM, the challenge is much greater in future years as the requirements become more challenging.

Although GM is working hard to improve its public perception via the launch of the Chevrolet Volt (a flexible platform that may be the base for a variety of fuel saving technologies), significant hurdles remain and the impact by 2012 is likely to be modest. Solving the technological hurdles could result in significant gains for GM.

Ford

Figure 11. CAFE Impacts: Ford

	Sales		MPG		Revenue (in millions)		Variable Profit (in millions)	
	Base	Scenario	Base	Scenario	Base	Scenario	Base	Scenario
Ford								
Cars	1,134,400	1,133,300	28.9	29.0	25,849.7	25,772.5	6,305.8	6,284.1
Trucks	1,895,900	1,880,300	20.9	24.8	52,787.7	53,363.2	13,691.6	13,753.8
Total	**3,030,300**	**3,013,600**	**23.3**	**26.2**	**78,637.4**	**79,135.7**	**19,997.5**	**20,037.9**

Source: The Planning Edge, UMTRI and Citi Investment Research

We estimate Ford will hold its market position in 2012 (unchanged in cars and down very modestly in trucks) as the required increases in fuel economy moderate what would otherwise be a greater loss due to the fact that almost two-thirds of their product line is in trucks. While Ford is seeking to broaden its product line (and increase its presence in segments with greater fuel economy) by utilizing its global resources, we believe it will have made modest progress in this regard by 2012. As the fuel economy requirements become more significant, increased globalization of its product line (including gains in small cars and smaller crossover vehicles) will likely have occurred.

The company is currently benefiting from new entries and will likely continue to do so in the near term from new vehicles that are not merely updates of predecessor products, but are filling in holes in their vehicle lineup, thus making them more competitive. This trend has been overshadowed by significant losses in core segments such as sport utility vehicles and large pickups. While the decline in these segments is likely to continue, we believe the rate of decline will slow in the period under review in this report.

Chrysler

Figure 12. CAFE Impacts: Chrysler

	Sales		MPG		Revenue (in millions)		Variable Profit (in millions)	
	Base	Scenario	Base	Scenario	Base	Scenario	Base	Scenario
Chrysler								
Cars	587,100	596,800	27.1	28.8	14,521.6	14,750.2	3,632.6	3,680.3
Trucks	1,496,268	1,460,500	22.6	25.3	35,075.2	34,638.4	8,577.1	8,437.1
Total	**2,083,368**	**2,057,300**	**23.7**	**26.3**	**49,596.8**	**49,388.5**	**12,209.8**	**12,117.3**

Source: The Planning Edge, UMTRI and Citi Investment Research

Chrysler has the highest share of truck-based product of the Detroit Three and is behind its competitors in the crossover market. In 2012, its SUV and pickup products will be towards the end of their product cycle and therefore will likely be less competitive (including with respect to fuel economy), resulting in some share loss in this portion of the market. It is expected that new products will appear after 2012, based on a revised product plan established by the new ownership of the company.

By 2012, we estimate the company will be well positioned with respect to its powertrains based on the modern I4 GEMA engine and the forthcoming Phoenix (V6) program, which will be fully available by that time. However, its V8 engines are not and will likely not be competitive with respect to fuel economy, resulting in some losses in volume as its competitors make stronger gains.

The company will be a leader in diesels, in our view, applying this technology in multiple segments (including personal use pickups, cars and SUVs) based on supply agreements with Volkswagen, Daimler, and Cummins. Chrysler is somewhat behind the curve on hybrids, but has set up a new internal unit to attempt to improve.

The biggest issue for Chrysler is capital availability, with vehicle and powertrain investment competing with a number of initiatives, all within the context of Cerberus' goal of near- and medium-term cash flow improvement.

Honda

Figure 13. CAFE Impacts: Honda

	Sales		MPG		Revenue (in millions)		Variable Profit (in millions)	
	Base	Scenario	Base	Scenario	Base	Scenario	Base	Scenario
Honda								
Cars	978,600	984,200	33.1	33.2	20,360.8	20,427.9	4,812.2	4,824.8
Trucks	721,200	729,700	25.1	25.8	19,660.8	19,930.5	5,048.0	5,114.3
Total	**1,699,800**	**1,713,900**	**29.1**	**29.6**	**40,021.6**	**40,358.5**	**9,860.2**	**9,939.1**

Source: The Planning Edge, UMTRI and Citi Investment Research

Honda is unusual among the major auto manufacturers in that it has a very limited product lineup, almost all of which are based on its core products, the Civic and the Accord. It has long enjoyed an above average level of fuel economy, owing in large part to its technology leadership in engine technology, which has served as the foundation of the company. While it has foregone some profit in the past because of its limited product line, its strong position in fuel economy has served and should continue to serve it well with its customers.

Honda makes gains in both car and truck volume, given its competitive position in the face of the fuel economy requirements. Between now and 2012, it will continue to refine its powertrain technology, resulting in incremental improvement in its fuel economy performance. It should also expand its hybrid portfolio with a dedicated product and introduce diesels to a variety of its car and truck products in the American market. The strength of the company in this technology will continue to serve it well, but ironically its advantage over its competitors will likely be eroded as CAFE forces its competitors to improve their fuel economy.

Honda continues to explore expanding its product line, with the biggest issues whether it will add a rear wheel drive platform and a V8 engine. Given its relatively limited cash position, it must carefully use its financial resources for maximum effect. Investment in increased fuel economy may limit its ability to broaden its product line and move into more profitable vehicle segments.

Nissan

Figure 14. CAFE Impacts: Nissan

	Sales		MPG		Revenue (in millions)		Variable Profit (in millions)	
	Base	Scenario	Base	Scenario	Base	Scenario	Base	Scenario
Nissan								
Cars	809,700	817,500	30.7	30.8	16,955.8	17,048.7	4,117.9	4,135.2
Trucks	413,700	412,200	20.7	25.4	11,946.4	12,170.3	3,127.6	3,163.7
Total	**1,223,400**	**1,229,700**	**26.4**	**28.7**	**28,902.2**	**29,219.0**	**7,245.5**	**7,298.9**

Source: The Planning Edge, UMTRI and Citi Investment Research

In 2012, much of Nissan's product line will be towards the end of its life cycle. The company has won praise for its design, but relying on design is a difficult position, since today's breakthrough design is often eclipsed by competitors soon thereafter. The 2012 fuel economy requirements will likely have a limited impact, as Nissan is relatively well-positioned for the early years of the cycle given its somewhat limited product line and acceptable fuel economy performance.

From a powertrain perspective, Nissan enjoys acclaim among enthusiasts for efficient and responsive engines, but is generally not viewed by its broader customer base as a leader. Nissan has relied upon its transmission supplier, JATCO, in which it holds a large stake for CVT technology which delivers some advantages in fuel economy.

While Nissan has made a strong recovery from the "bad old days" of several years ago, we believe its current financial position (and that of its partner, Renault) will limit its ability to invest in fuel saving technologies and new products that will appear in the 2012-2015 period. Furthermore, it has been rather conservative in the use of diesel and hybrid technologies in the U.S.

market. In fact, Carlos Ghosn has been quite skeptical about the value of these technologies.

Toyota

Figure 15. CAFE Impacts: Toyota

	Sales		MPG		Revenue (in millions)		Variable Profit (in millions)	
	Base	Scenario	Base	Scenario	Base	Scenario	Base	Scenario
Toyota								
Cars	1,520,900	1,525,700	32.3	32.3	34,233.5	34,249.9	8,449.8	8,447.7
Trucks	1,330,800	1,318,000	24.0	25.4	35,891.2	35,667.7	9,245.9	9,175.9
Total	**2,851,700**	**2,843,700**	**27.8**	**28.7**	**70,124.7**	**69,917.6**	**17,695.7**	**17,623.6**

Source: The Planning Edge, UMTRI and Citi Investment Research

Toyota will soon be the highest volume automaker in the world, and its U.S. product line reflects this leadership position, with a broad array of offerings across almost all vehicle segments. The company has been very successful in establishing its market position on the basis of delivering superior fuel economy, while at the same time offering a variety of low-mileage vehicles that until recently have flown “under the radar.”

The requirement of the industry to meet higher CAFE requirements poses a threat to Toyota’s market position, in our view, both in terms of its public view and in reality, since its competitors will be closing the gap with Toyota, again in both perception and reality. As a result, Toyota will likely lose a modest amount of truck volume as its competitors improve their fuel economy performance significantly. Toyota will of course, not sit still, and over the next several years, the company should fare well as it continues to improve its fuel economy. Just as the Detroit Three will be challenged by strong requirements among its truck products, an attribute-based system will require strong improvement from Toyota among its less fuel-efficient truck products in full-size pickups and its SUVs.

Hybrids are and remain a key component of Toyota’s plans, with the company stating that all high-volume products will offer hybrid variants, with those products fully in the marketplace by 2012. Application of these products are designed to allow company to offer a full range of products, continue its leadership in fuel economy, and continue to grow its market share as it expands capacity aimed at the North American market.

Toyota’s key advantage is its strong financial position and cash flow, giving it an unparalleled ability to invest in multiple technologies and products and bring the “winners” to market. While many companies have to make careful choices among a variety of potential products and technologies (including fuel saving approaches), Toyota’s unique position allows it to invest in a variety of approaches and then capitalize on those with the most potential.

Financial Implications of CAFE in 2012

We anticipate implementation of the U.S. CAFE attribute-based system in 2012 will have a limited affect on the leading six U.S. automakers by sales, as described previously. We estimate that the incremental technology content and mix shifts in the market attributed to CAFE implementation will be most beneficial to General Motors and least beneficial to Chrysler from a profit and loss perspective. Our forecasts indicate that GM could gain as much as $0.25 per share in earnings from CAFE standards – $0.05 from profit on new technology and $0.20 from a net shift in volumes. Compared to F2009 Street earnings expectations, incremental earnings attributed to CAFE changes represent a 7.5% improvement in GM's earnings. Please see Figures 16-17. We estimate that Chrysler will experience the most profit pressure, with an incremental decline in revenue of $208 million and operating profit of $92 million.

Surprising, our analysis suggests that for the remaining four leading automakers CAFE implementation will have little-to-no earnings affect as 2012 will only be the first step in achieving 2020 CAFE standards. We would expect that the profit and loss affect for CAFE implementation would become more magnified beyond 2012.

Figure 16. 2012E EPS Chg: Scenarios vs Base

	Tech Change, Price	Mix Change, Volume	Total
Chrysler	NA	NA	NA
Ford	$0.04	($0.03)	$0.01
GM	0.05	0.20	0.25
Honda	0.00	0.03	0.03
Nissan	0.00	0.01	0.01
Toyota	0.00	(0.01)	(0.01)

Source: Planning Edge, UMTRI, and CIR

Figure 17. 2012E EPS Chg: as % of 2009E EPS

	Tech Change, Price	Mix Change, Volume	Total
Chrysler	NA	NA	NA
Ford	7.8%	(5.7%)	2.1%
GM	1.6%	5.9%	7.5%
Honda	0.0%	0.9%	0.9%
Nissan	0.2%	0.5%	0.8%
Toyota	(0.1%)	(0.2%)	(0.3%)

Source: Planning Edge, UMTRI, and CIR

Figure 18. 2012E Revenue Change: Scenarios versus Base Case (in $Millions)

	Incremental Tech, Price	Incremental Mix, Volume	Total
Chrysler	$412.3	($620.6)	($208.2)
Ford	931.7	(433.4)	498.3
GM	856.2	667.4	1,523.6
Honda	4.9	332.0	336.9
Nissan	168.1	148.8	316.9
Toyota	(10.3)	(196.7)	(207.1)

Source: Company Reports, The Planning Edge, UMTRI and CIR estimates

Figure 19. 2012E Operating Profit Change: Scenarios versus Base Case (in $Millions)

	Incremental Tech, Price	Incremental Mix, Volume	Total
Chrysler	$60.3	($152.8)	($92.4)
Ford	150.6	(110.2)	40.4
GM	48.1	172.2	220.3
Honda	(3.0)	81.8	78.8
Nissan	16.1	37.3	53.4
Toyota	(22.4)	(49.6)	(72.0)

Source: Company Reports, The Planning Edge, UMTRI and CIR estimates

Figure 20. 2012E Incremental Operating Margin: Scenarios versus Base Case

	Incremental Tech, Price	Incremental Mix, Volume	Total
Chrysler	14.6%	24.6%	44.4%
Ford	16.2%	25.4%	8.1%
GM	5.6%	25.8%	14.5%
Honda	-60.0%	24.6%	23.4%
Nissan	9.6%	25.1%	16.8%
Toyota	216.1%	25.2%	34.8%

Source: Company Reports, The Planning Edge, UMTRI and CIR estimates

Capital expenditure requirements for new CAFE standards also appear meager. We anticipate that the market for fuel efficiency technology related to CAFE requirements will increase by 26%, or by $4.3 billion, to $20.6 billion. We estimate the capital investment that the industry must make to achieve this technology at roughly $5 billion, driven by a ten year payback estimate and our sales and margins expectations. For the leading six U.S. automakers by sales, this means that the investment necessitated by CAFE should average over $700 million, or roughly 8% on average of Citi's 2009 capital expenditure estimates for these companies. We note that these investments will occur over a period of years and are incremental to current automaker efforts to improve fuel economy.

Figure 21. Incremental Capital Expenditures: Scenarios versus Base Case (in $Millions)

	Value	% 2009E Capex
Chrysler	$625.1	NA
Ford	915.7	9.8%
GM	1,134.0	12.1%
Honda	520.8	5.6%
Nissan	373.6	4.0%
Toyota	864.1	9.3%

Source: Company Reports, The Planning Edge, UMTRI and CIR estimates

Today's Technologies That Help Meet CAFE Standards

In this section, we examine the key technologies that would be employed by manufacturers to meet the longer term fleet-wide average of 35 mpg by 2020. To obtain the 35 mpg fleetwide average, we estimate the fuel economy levels for the car fleet to be 40.3 mpg and light trucks to be 31.0 mpg.

To predict what types of technologies will be required to meet the standards, we based our assessment on recent studies by the California Air Resources Board[5] and the National Academy of Sciences.[6] These studies demonstrate that through the application of existing and emerging technologies, fuel economy of conventional gasoline vehicles can be greatly improved.

[5] California Air Resources Board, Initial Statement of Reasons for Proposed Rulemaking, Public Hearing to Consider Adoption of Regulations to Control Greenhouse Gas Emissions from Motor Vehicles, August 6, 2004.

[6] National Research Council, Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards, National Academy of Sciences, 2002.

The CARB study models packages of technologies and relies heavily upon packages that include gasoline direct injection engines, turbochargers, integrated starter generators, camless valve actuators and improved transmissions (both automated manual transmissions and continuously variable transmissions).[7] According to ICCT 2007, the 2016 California standards where these packages are fully applied results in a fleetwide average of about 33 mpg. Using this estimate, to meet 35 mpg by 2020, modest penetrations of hybrids and advanced diesels would likely be deployed. The NAS study examined many of the same technologies and estimated that the application of its "Path 3" (commercially ready in 10 to 15 years) would yield a somewhat higher fleetwide average, about 37 mpg. We conclude to meet the 35 mpg size-based standards, automakers will primarily rely on improved conventional gasoline vehicle technology, and not have to rely heavily on more expensive advanced drivetrains.

Based on CARB 2004 and NAS 2002. the key technologies for gasoline cars to meet a 40 mpg average level are:

- Gasoline direct injection engines
- Turbochargers
- Automated manual transmissions
- Continuously variable transmissions
- Integrated starter generators
- Camless valve actuators

Hybrids and diesels are also forecast to increase penetration. Therefore in addition to the above list of technologies, we believe that key advanced drivetrain components are:

- Diesel engines
- Common rail injectors
- Diesel aftertreatment systems (especially particulate filters and lean NOx catalysts)
- Hybrid batteries
- Hybrid transmissions
- Hybrid motors
- Hybrid power electronics

Investing in Tightening Fuel Economy Trends

Our analysis suggests that automakers and suppliers must grow the fuel savings technology market by an incremental $4.3 billion to meet CAFE standards in 2012 alone. We would expect considerably more growth to achieve CAFE in 2020, as 2012 would be the first step to reaching tightening

[7] Other refinements will likely occur, including reduced friction losses in the engine, modest weight reduction through the greater use of lightweight materials, better aerodynamics and lower rolling resistance tires.

fuel economy standards. Key beneficiaries of this growth in our supplier universe include BorgWarner, Johnson Controls, and Tenneco. We note that CAFE implementation also disadvantages some suppliers who rely on larger vehicle platforms for profits, like American Axle who derives most of its revenues from large General Motors and Chrysler pickups and sport utility vehicles. Although our forecast assumes minimal segment shifts, it does anticipate inner-segment shifts to smaller platforms.

BorgWarner (BWA-1M)

Most of BorgWarner's products support improved fuel economy. We believe the company is best positioned in our coverage universe to benefit from stricter fuel economy standards. We anticipate that smaller gasoline and diesel turbocharged engines will replace larger gasoline motors to improve fuel economy. BorgWarner and Honeywell should benefit from this trend, as they are the leading turbocharger producers globally. Turbochargers made up 18% of BorgWarner's $4.6 billion in sales in 2006 and represent 40% of the companies new business backlog through 2009. BorgWarner also produces a DualTronic transmission (DCT), which is an automated manual transmission that improves fuel economy. Automakers continue to adopt DCTs internationally. In the U.S., Chrysler is taking the lead among Detroit Three producers in this area and expects to have DCTs in vehicles in the next few years. Additional fuel savings products in BorgWarner's arsenal include variable cam timing and other chain systems, as well as diesel and gasoline ignition products and emissions control systems.

Johnson Controls (JCI-2M)

We anticipate that some limited hybridization of the U.S. fleet will be necessary to meet tightening fuel economy standards. Johnson Controls should grow with this trend, as it has increasing leverage to the hybrid battery market. The company expects to be a one of the leading hybrid battery suppliers over the coming years, as it holds a strong position in lithium-ion hybrid batteries. Currently, production hybrids use nickel-metal hydride batteries due to previous overheating complications with early lithium batteries. Automakers and suppliers expect to shift to lithium-ion technology over the next five years due to size and power advantages.

Tenneco (TEN-3H)

Tenneco should benefit from any increase in diesel engine penetration in the U.S. The company is a leading producer of diesel particulate filters and selective catalytic reduction technologies. These products are necessary for diesel engines in the U.S. to meet clean diesel engine requirements. We note that although Tenneco produces these products, most of the higher margin content goes to second tier suppliers, which limits the extent of Tenneco's profit growth.

Appendices

Appendix A

How We Assessed Vulnerability in the United States

Predicting the impact of the Senate-passed change in corporate average fuel economy (CAFE) on overall fuel economy levels is straightforward, but (because the Senate is calling for structural reform of CAFE) predicting the impacts on future requirements facing specific automakers is difficult. However, by making plausible assumptions about the future structure of CAFE and simulating the impact of these assumptions with robust supply- and demand-side computer models, we have developed estimates of the impacts on market shares, segment shifts, technology costs, and profits.

Figure 22. Expected CAFE Standard Updates

		2012
Cars	Chrysler	28.7
	Ford	28.8
	GM	28.8
	Honda	29.2
	Nissan	29.1
	Toyota	29.1
	Other	28.9
	Cars	**29.0**
Trucks	Chrysler	25.2
	Ford	24.7
	GM	24.6
	Honda	25.8
	Nissan	25.3
	Toyota	25.5
	Other	25.6
	Trucks	**25.0**
	All Vehicles	**26.8**

Source: Planning Edge, UMTRI, and CIR

A Brief Overview on Corporate Average Fuel Economy (CAFE)

U.S. CAFE standards are defined in terms of the harmonic average fuel economy of vehicles sold by a manufacturer in a given model year, and manufacturers are required to meet the standards for light trucks and standards for cars (with domestic and imported fleets measured separately), or else they are assessed penalties. Since CAFE's inception in the 1970s, no American manufacturer has ever changed position in terms of whether they meet the standards—either they have always exceeded the standards, always barely met them, or always had to pay fines. Fines are assessed at a rate of $5.50 per tenth of a mpg that the manufacturer's attained CAFE level is below the CAFE standard, multiplied by the number of vehicles in the affected fleet in a given year. Asian and domestic manufacturers have typically met or exceeded CAFE standards and thus not paid such fines; European manufacturers have typically been more susceptible to exceeding the standards, owing to their production of high-performance, luxury vehicles.

While the CAFE program has some recognized weaknesses—among them the lack of automatic review and adjustment, the CAFE credit given to producers of "dual-fuel" vehicles whether or not those vehicles actually use the alternative fuel in question, and the fact that there are other more cost-effective methods to reduce oil consumption—it has nonetheless proven to be a viable option for reducing oil consumption in the United States, a topic of increasing priority for a country reliant on oil imports from several politically volatile countries. According to the National Academies of Science, CAFE contributed to saving 2.8 million barrels of fuel a day, the equivalent of 14 % of consumption in that year, and noted that increases to CAFE standards would contribute to future oil savings—and that the improvements to fuel efficiency necessary could be achieved without large increases in vehicle costs.

Forecasting CAFE Updates

The agency with authority to regulate light truck CAFE, the National Highway Traffic Safety Administration (NHTSA), recently completed an overhaul of the system. As reformed by NHTSA, light truck CAFE sets a target fuel economy level for each vehicle based on a measure of size (footprint or wheelbase multiplied by track width) and sets a CAFE standard for each automaker based on the weighted (harmonic) average fuel economy targets of its trucks. We expect (and the Senate's CAFE proposal requires) a similar reform of passenger car CAFE.

For this analysis, we developed market-wide vehicle, car, and truck CAFE targets for 2012 through 2020, assuming that the overall vehicle target in 2020 would be the Senate's 35 miles per gallon. We then developed size-based CAFE targets for cars following a methodology similar to NHTSA's in its truck targets. These size-based car and truck targets were then applied to automakers to establish their expected CAFE standards, shown in the table.

A size-based CAFE standard has a number of advantages over the un-reformed system it is replacing. All automakers are required to improve the fuel economy of their vehicle fleets in contrast to legacy CAFE that required improvements only from some automakers. The size-based system is less biased than legacy CAFE, which penalized full-line manufacturers and rewarded niche manufacturers. Under the size-based system, "gaming" CAFE by shifting mix or making vehicles bigger (just to game CAFE) is reduced because changing mix and vehicle size will result in a change in the CAFE standard in the same model year. (It is the function that the automaker faces, not a single number.)

In predicting automakers' response to CAFE changes, we assumed their goal is to maximize profits, subject to CAFE and other constraints. Some automakers pay fines rather than meet CAFE today, but the magnitude of the increases we expect by 2020 and the greater scrutiny all automakers are coming under led us to assume they all meet their car and truck CAFE standards in the future.

Consumer demand links prices and unit sales so that automakers can choose one or the other but not both independently. Automakers are thus assumed to choose the unit sales and fuel economies of the vehicles it sells in each CAFE fleet (cars and trucks) so as to minimize the cost of meeting CAFE. Compliance with CAFE is measured for the automaker's car and truck fleets, at the end of the model year. The overall fuel economy the automaker achieves in each fleet must be equal to or greater than the fleet CAFE standard established for that automaker.

An automaker can choose to meet its CAFE standard in a given fleet (cars or trucks) through two avenues:

1. Shift its mix to more fuel-efficient vehicles for the same size, or
2. Apply technologies to improve the fuel economy of specific vehicles

This is not an either/or choice. In our analysis we assumed that automakers would use a combination of these two means to meet their CAFE standards.

The results assume that consumer preferences complement the impact of governmental requirements for increased fuel economy. Consumer preferences have and are likely to continue to move the automakers in the same direction as regulatory requirements and these preferences are likely to be affected by changes in the CAFE regulations, just as the automaker's behavior will be affected by these regulations. It is a complex process, with consumers presenting certain (modified) demands, with the automakers modifying their supply, both because of the regulation and the (regulation-induced) changes in consumer demand.

There are two major adjustments that have been made to the base volumes for 2012 to generate the results shown in our forecast:

1. At the segment level, factors are applied to all vehicles in the segment to adjust volumes based on trends in segmentation in response to

changes in fuel economy and price. As an example, luxury segments are not changed at the segment level as the increased cost and demand for these vehicles is not sensitive (relatively speaking vs. other segments) to additional costs incurred due to fuel economy improvement. As an example of these changes, there is movement from SUV to CUV (similar footprint, but greater fuel economy in CUVs therefore meeting requirements) and a movement from some medium sized car segments to small car segments (newer designs of small cars are internationally sourced), thereby reducing costs, and have more content and performance, therefore are more attractive to consumers. These trends will be spurred by changes in CAFE as the automakers will be more aggressive in increasing volume in this growing segment.

Another set of moves will be from pickups to SUVs and crossovers as some personal use buyers move out of the pickup market. Again, the CAFE requirements are likely to hasten these changes, both in terms of consumer demand and altering what the automakers will offer. Increased vehicle prices (occurring as a result of mileage requirements) will cause consumers to reduce their outlays for vehicles, either by putting off purchases or moving to alternative vehicles. The segment shifts reflect this by moving more volume to lower cost products; the underlying assumption is that the size of the market will not change.

It is also assumed that the automakers are not able to dramatically change their product plans (that is, introduce new platforms) by 2012, both due to cost issues and the fact that these plans require a long lead time. However, there will be a modest change in product mix (increasing over time).

Product introductions will be affected by CAFE, as certain vehicles will be inconsistent with the tighter regulations, particularly in later years. Other vehicles will be brought forward in order to help the automakers meet their requirements.

2. The second level of adjustment is done at the vehicle/powertrain level and is based upon the improvement in fuel economy of the particular vehicle/engine combination relative to the segment in which it is placed. For example, if the improvement in fuel economy for a particular model exceeds the average of the segment, then additional volume will flow to that model (either increasing the gain for segments where the adjustment factor is positive or reducing the decline for segments where the adjustment factor is negative). The reverse is true if the fuel economy for the model trails the segment average. This approach "rewards" automakers who achieve greater fuel economy than average, just as consumers will "reward" these automakers with their purchases (since increased fuel economy relates directly to the cost of ownership of the vehicle).

The Costs of Meeting CAFE Standards:

The cost of improving fuel economy will require different levels of effort and cost dependent on the engine technology of the vehicles involved. For example, SUVs with older technology are less amenable to MPG improvement than CUVs that generally use more modern powertrains. (In some cases, mileage improvement can be gained by adjustments in software.) Because of this, the CAFE requirements will require significant investment to upgrade fuel economy in some of the older products (for example, SUVs) that will not be a productive use of limited investment funds. This will result in a shift of volume from SUVs to CUVs, as an example.

One approach that the automakers are planning to take to improve fuel economy and reduce the decline in SUV volumes is to convert some of its SUV products to unibody design (which is much lighter than a full framed vehicle), but this will mostly occur after 2012. Some companies, particularly the Detroit Three, cannot complete all tasks including improving fuel economy across the board, provide new products in segments where they are lagging, and leapfrog the competition in new technologies.

Another approach that will be taken is to deemphasize flagging products (particularly if they contribute negatively to fuel economy requirements) to focus on products that are growing and offer better fuel economy. This impact is directly related to greater mileage requirements.

Appendix B

Energy Security, Climate Change and Autos

Energy security and climate change have become important political topics, with Congress highly motivated to address these issues prior to next year's presidential elections. Passenger vehicles are the largest single source of oil consumption, accounting for approximately 40% of U.S. oil consumption. Emissions of greenhouse gases such as carbon dioxide (CO2) are the principal driver of climate change—which, according to the Intergovernmental Panel on Climate Change, a group of more than 2700 international scientists, is "very likely" to have been induced by human actions—and the single largest source of emissions in the United States is the transportation sector. One-third of U.S. emissions from fossil fuel combustion in the U.S. come from transportation, and 62% of that 33% comes from cars and light trucks.

Figure 23. Relationship of CAFE to CO_2 Emissions

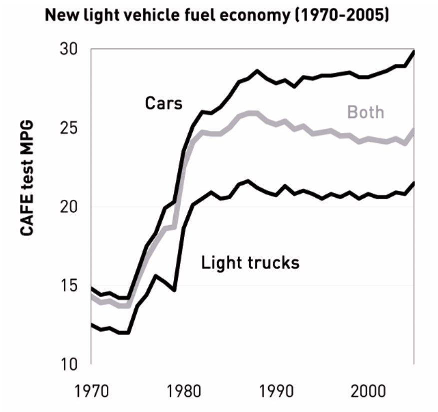
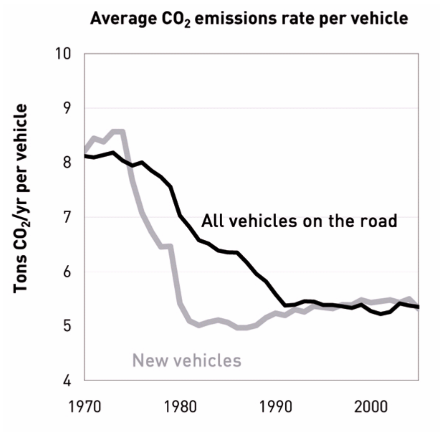


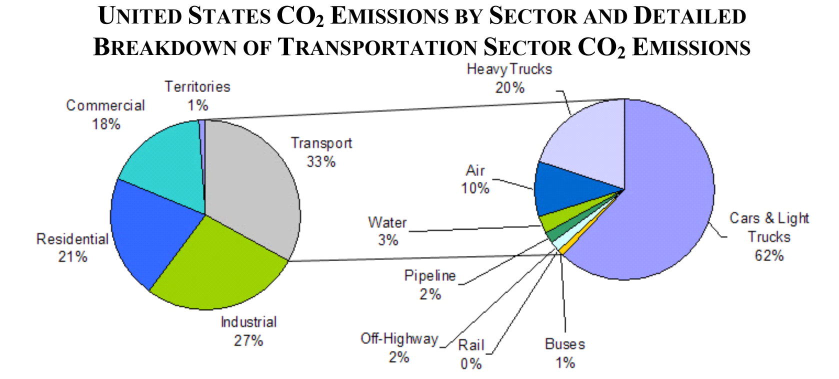
Figure 24. Relationship of CAFE to CO_2 Emissions



Legislators in the U.S. are increasingly looking to lessen our dependence on foreign oil supplies, while focusing on regulating carbon emissions in an attempt to mitigate the effects of climate change. Given the prominent role autos play in both oil consumption and CO2 emissions, automakers are very likely to feel the impact of at least one if not more than one of those legislative efforts.

These legislators—acting both at the state and the federal levels—have multiple policy options available to them. They can either mandate that something be done (or not done), or they can rely upon market-based incentives, which provide incentives or disincentives to consumers or manufacturers (usually monetary) to achieve the aim they desire. If they choose to specifically target the emissions from the auto sector through policies designed to achieve greater fuel efficiency or reduced carbon emissions, these tools provide them with various options: CAFE standards are a mandate directed at automakers, while the low-carbon fuel standard is a mandate directed at refiners; feebates, gas guzzler taxes, and technology tax credits are market-based incentives directed at consumers.

Figure 25. U.S. CO_2 Emissions by Sector



Source: EPA Inventory of U.S. GHG Emissions 1990-2005, 2007

However, in addition to these options, legislators can also target carbon emissions more broadly; economy-wide proposals such as carbon cap-and-trade or carbon tax scenarios, while not directed specifically at automakers, will nonetheless impact the industry. And while it is impossible to exactly judge the consequences of such policy options until their structure and timing is clearer, it is nevertheless possible to assess their possible implications for the profitability and competitiveness of automakers, given that we have a rough sense of both the policymakers' aims and the automakers' current technology and product mixes.

Appendix C

The Next Evolution: Emerging Alternative Fuel Technologies

Stars aligned for significant propulsion advancements: We believe the combination of long-term economic realities setting in over the past few years coupled with recent technological advancements have set a new sense of urgency and optimism behind the development of alternative propulsion systems.

While fuel economy is anything but a new concept, the steady rise in gasoline prices, unsettling tension in the Middle East and increasing consumer attentiveness to global warming have forced many to refocus on automotive fuel economy and advanced propulsion. Global demand for automobiles is expected to rise to 94 million vehicles by 2016 from 70 million in 2007, led by international markets like Asia, South America and Eastern Europe. And according to the US Department of Energy, the US will consume 28% more oil in 2030 than 2005.

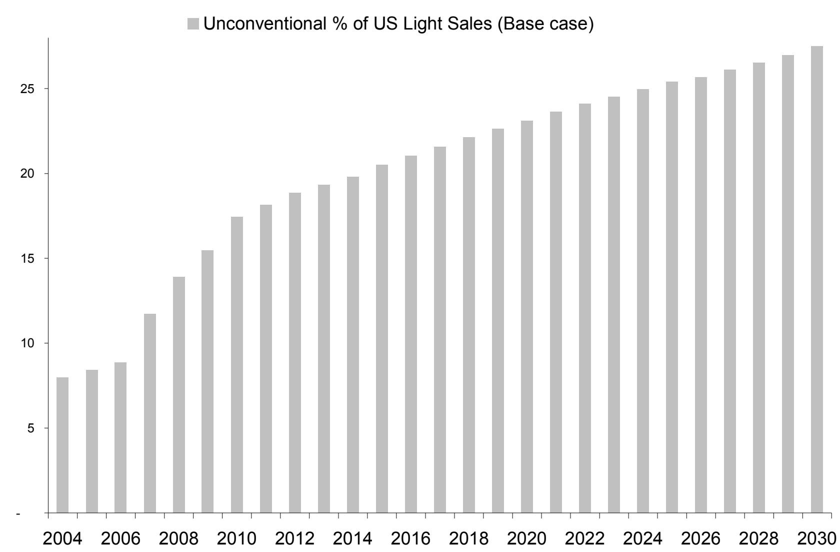
In response, governments have become increasingly focused on setting tougher emissions standards, with the US government contemplating stringent increases to Corporate Average Fuel Economy (CAFE) standards. An increasing amount of US states, led by California, also seek to impose their own emissions standards, including zero emission vehicle (ZEV) regulations.

The good news: Technological advances in areas ranging from advanced internal combustion systems (diesel turbochargers) to battery and fuel cell applications have turned advanced propulsion development into a more viable long-term option. In the past, domestic automakers came under criticism for failing to aggressively pursue alternative propulsion technologies. Automakers typically cited a lack of consumer demand for such products, technological shortfalls (cold starts, range, etc.) and unfavorable economics. The so-called delay in advancing these technologies was also driven by easing regulatory pressure in the earlier part of the decade--most notably the 2003 amendments to California Air Resource Board (CARB) ZEV regulations

Today, many of the same issues that slowed the advancement of these technologies have come a long way to becoming resolved, though hurdles do remain. Automakers' concerns over consumer acceptance have eased thanks to the popularity of hybrid vehicles and the steady demand shift from large SUVs to crossover vehicles and smaller cars. Technological breakthroughs have been reported in battery technology (lithium ion), diesel systems and hydrogen storage. These, coupled with increasing regulatory pressures (i.e. other states besides California adopting ZEV regulations), have encouraged substantial incremental investments by automakers. The appeal of achieving first mover advantage has also become more valuable ever since the industry witnessed consumers' praise over Toyota's Prius hybrid. In contrast, domestic automakers till today have arguably failed to receive similar recognition despite offering their own an array of hybrids.

The US Department of Energy estimates that 27% of 2030 US light vehicle sales, or 5.5 million units, will comprise some form of unconventional propulsion, which includes flex-fuel, electric-hybrid, advanced diesel, gaseous technology and fuel cell/electric. However, this is likely a conservative estimate as it assumes no new legislation or regulation. In a high oil price environment, the DOE estimates that 40% of new 2030 light vehicle sales will be deemed unconventional. Technological advances and increasingly optimistic assessments from automakers, particularly on electric and fuel cell technologies, could make even this estimate prove conservative.

Figure 26. Unconventional Vehicles as % of US Light Vehicle Sales (no new legislation)



Source: US Department of Energy

An independent panel hired by the California Air Resources Board (CARB) estimates that fuel cell electric vehicles will achieve mass commercialization (100,000's units of production a year) by 2020, with plug-in-hybrid vehicles doing so by 2015. Fuel cell developers probed by the panel provided conflicting estimates of mass commercialization—one estimated volumes of 100,000 units by 2020, another estimated commercial viability by 2010 if production rates of 500,000 can be achieved. One trend is clear. Technological advancements over the years have consistently raised optimism that eventual mass commercialization is more of a reality than a fantasy. Just this past August, GM reported achieving many of the goals necessary to further its battery and fuel cell technology, though hurdles do remain, as discussed further below.

Next few years will provide many key investment data points: We believe that over the next few years, investors will need to increasingly ponder the likelihood of real evolutionary advancements in the way automobiles are assembled. Though many uncertainties exist, technological efforts over the next few years will likely determine whether battery electric and fuel cell vehicles can eventually replace the internal combustion engine. In the meantime, we would expect continued growth in diesel technologies as well as a steady emergence of bio-fuel additives over the next several years.

Our investment approach to these trends is two-tiered. We favor auto suppliers that are well-positioned in growing fuel economy technologies for internal combustion engines. Yet, at the same time we believe it is prudent to begin distinguishing between those auto suppliers who would benefit from the emergence of non-combustion propulsion systems (battery and fuel cell), since we do believe that the next few years will reveal whether such transformation is truly feasible on a globally commercialized scale.

In our valuation of automotive suppliers, we begin to address this emerging long-term trend by distinguishing discounted cash flow terminal value assumptions between those suppliers who may be negatively impacted and those who we believe would see a limited, or perhaps even positive, impact. Pending further developments, we view this approach as a reasonable way to begin to value a potential long-term shift in vehicle assembly. Currently, we assume negative terminal value growth for automotive suppliers American Axle, BorgWarner, Magna, and Tenneco – all suppliers whose product platforms would be vulnerable to a shift from gasoline internal combustion to lighter (i.e. possibly no frame) battery and fuel cell (i.e. potentially no traditional driveline or exhaust systems) alternatives.

As far as the OEMs, we believe that General Motors has demonstrated a leading edge in its efforts to at least achieve a first mover advantage on plug-in hybrid and fuel cell development, most notably with its E-flex architecture and plans to pursue development of the Chevrolet Volt, an extended-range battery vehicle. Though other OEMs are also making notable progress, we believe those that begin to brand their product early in the process will garner the most consumer support, much as Toyota has with hybrid vehicles.

Overview of Alternative Fuel Technologies

Several technologies provide a viable medium-term option: Several propulsion technologies have already begun to gain significant momentum, from advances in internal combustion engines (turbochargers), hybrids and diesel engines, to alternative bio-fuels like E85 (85% ethanol blend), cellulosic ethanol, bio-butanol and B20 (bio-diesel blend). Over time, we expect a steady migration from conventional gas and diesel propulsion to a greater mix of bio-fuels (B20, E85), and eventually, a greater mix of electric based vehicles (plug-in or extend range hybrids) and hydrogen fuel cell propulsions.

Diesels poised for continued growth over the next few years: As a result of technological advances in noise, vibration and cold starting, diesels are poised to increase in popularity in the US. Diesel engines offer a 30-35% fuel efficiency advantage over gasoline engines, with newer “clean” diesels like ultra-low sulfur diesel fuel (ULSD) containing 97% less sulfur than conventional diesels.

US diesel sales could double to 1.5 million units by 2012 from an estimated 750,000 units in 2007, with US market share approaching 15% by 2015, far outpacing hybrid sales in that time. CSM and BorgWarner anticipate global diesel penetration to increase to 25% by 2011 from 23% in 2006. Compared with hybrids, diesel engines can provide superior performance, better fuel economy, and in time comparable emissions levels, for a cheaper price. In our view, today’s hybrids serve an important role in preparing consumers for more advanced plug-in versions, and eventually, hydrogen fuel cell vehicles.

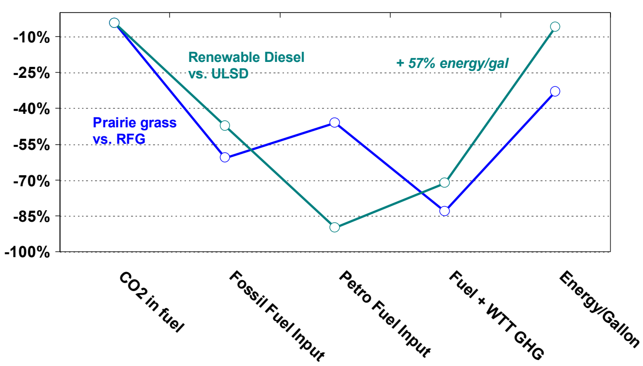
Ethanol advances also promising, though slightly edged by bio-diesel: Ethanol is an alcohol derived from corn, sugar and plant fiber (trees, grasses). Key advantages include domestic production, minimal vehicle modification requirements and lower carbon dioxide emissions. There are currently over 5 million (less than 3%) vehicles today that are referred to as flexible fuel vehicles (FFV), which can operate on a blend of 85% ethanol and 15% gasoline, or E85. At year-end 2006, 45 states offered E85 through over 1,000 stations.

A key disadvantage of E85 is its lower fuel economy, as 1.5 gallons of ethanol contain the same amount of energy as 1.0 gallon of gasoline. As such, E85 has not proven to be a solution for consumer seeking to reduce their monthly gas costs. Other challenges include a costly ramp up of production and distribution as well as the impact on food prices. E85 does not appear as a viable long-term solution, though demand is expected to grow.

Cellulosic ethanol more promising, but plagued by hurdles: A more promising, yet relatively young technology, is cellulosic ethanol, which is derived from plant fiber and other biomass residues. The key advantage of cellulosic ethanol is that it is derived from a non food source, increasing the amount of fuel ethanol that can be produced, thereby addressing one of the key long-term drawbacks of conventional ethanol. Cellulosic ethanol offers a significantly greater reduction in greenhouse gas emissions than E85. However, celloulosic ethanol production faces a number of challenges, including higher capital and operating costs and an enzymatic process that is yet to be commercialized. Additionally, recent data suggests bio-diesel has a slight advantage to cellulosic ethanol with respect to energy density-per-gallon.

Figure 27. Fuel Comparisons

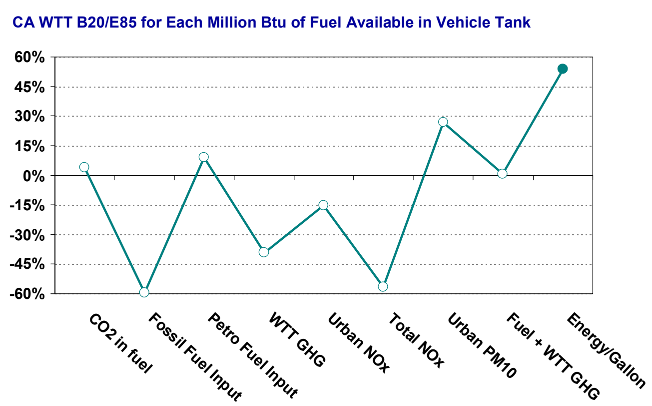
RD and cellulosic ethanol yield similar GHG and energy input benefits, but RD is significantly advantaged on energy density/gallon.



Source: California Energy Commission and MARTEC

Figure 28. Fuel Comparisons

CA B20 is significantly advantaged vs. CA E85 on a WTT emissions and energy efficiency.



Source: California Energy Commission and MARTEC

Bio-butanol possibly next generation biofuel: Bio-butanol is produced from biomass and is another emerging biofuel that contains 30% higher energy content than ethanol and lower heat vaporization, which eases cold start. Bio-butanol would require few changes to auto engine designs. Although a relatively new bio-fuel, it is one that is showing encouraging signs.

A University of Toronto study concluded that ethanol has the potential to comprise 39% of US light duty fuels by 2020, with cellulosic ethanol comprising 35% of this.

No dominant "winner" over the next several years... Government policies, consumer acceptance and technological breakthroughs make it difficult to conclude that a single alternative propulsion technology is likely to dominate over the next 10-15 years. We believe this is best highlighted by examining GM's E-flex architecture, which combines three propulsion systems into one underbody for future global compact vehicle production. The Chevrolet Volt, GM's concept plug-in electric vehicle with an engine generator (extend-range electric vehicle), is projected to become the first production vehicle on the E-flex architecture, likely on the next generation Delta platform. The Volt's projected battery pack is expected to support 40 miles of full-range electric driving, with a back-up 1.0 liter engine that recharges the battery upon depletion. The engine would run on gasoline, E85, E100, diesel or bio-diesel, evidencing GM's view that no particular alternative fuel source is likely to dominate the market

…but zero-emission technology a likely eventual end-game: Over the long-term, regulatory pressures are likely to encourage automakers to aggressively develop zero emission technologies, including battery electric with zero or little emissions and fuel cell vehicles.

Electric Vehicles: old concept, new realities: For over a century, the automotive industry has flirted with the concept of an electric vehicle. Throughout this period, the principle shortcoming of the technology remained consistent---limited range necessitating frequent and long battery recharges. Increasingly stringent regulations in the 1990s caused automakers to revisit electrical vehicles, led by GM's attempt to distribute the EV1 vehicle through Saturn dealers in 1996, a program that was eventually cancelled in 2003. Last year, GM revived the focus on electric vehicles by introducing the Chevrolet Volt concept based on its E-Flex architecture, which serves as the underbody for GM's future range-extender electric and fuel cell vehicles.

The revival of the electric vehicle concept was spurred by a number of factors: (1) advances in battery technology; (2) a continued rise in gasoline costs that improved the economics of electric motors; (3) increasingly stringent fuel economy regulation; (4) an urgent national interest to reduce domestic dependency on foreign oil; and (5) increased customer awareness of electric motors stemming from the popularity of conventional hybrid vehicles. Electric vehicles offer the benefit of zero tailpipe emissions, a smoother ride with superior acceleration and lower maintenance than internal combustion engines, since electric motors lack components like oil, filters and mufflers.

Most of today's challenges revolve around firming up the battery's capabilities to fit into a vehicle at a reasonable weight, assessing low temperature performance, degradation, battery life and crash testing. GM has reportedly established an aggressive goal for the Chevrolet Volt, aiming to produce 60,000 in the first year (late 2010), a level that took Toyota's Prius five years to achieve. GM's aggressive volume target is likely aimed at achieving a lower cost per vehicle. In fact, GM Vice Chairman, Bob Lutz, reportedly estimated that the Volt would cost roughly the same as a "mid-market car". We believe that GM's aggressive volume target speaks to the company's seriousness behind advancing the technology.

Hydrogen Vehicles: A long-term and increasingly viable solution. Similar to electric vehicles, fuel cell vehicles are powered by an electric motor. However, full cell vehicles create electricity internally through a chemical process involving hydrogen fuel and oxygen, which occur inside one of many fuel stacks positioned near the motor. Hydrogen is an energy carrier that can be produced in vast quantities from renewable resources. Inside the fuel stack, hydrogen is mixed with oxygen from the air are fed where chemical reactions produce enough electricity to power the vehicle. The hydrogen is stored in a tank towards the back of the vehicle. Storage technology remains a hurdle in fuel cell development, though GM recently indicated that it believes the technology is already viable. Compared to battery-powered electric vehicles, fuel cells provide a longer operating life and arguably offer an environmental advantage over batteries (disposal). The benefits of fuel cell technology are plentiful: no greenhouse gases or harmful pollutants, additional efficiency, reduce reliance on foreign oil, quieter ride and smooth acceleration.

Principle challenges of the technology include: (1) managing the infrastructure transition towards hydrogen stations; (2) meeting competitive cost targets, and (3) reassuring consumers about the safety and durability of hydrogen vehicles. However, at its recent investor meeting, GM reported making significant progress towards overcoming these challenges. Since 2000, GM has improved on eleven fuel cell development benchmarks anywhere between by 2x and 30x, effectively meeting all but two criteria: durability and propulsion system cost---quantified as $50/kW, 150,000 mile life and 300 mile range. If the last seven years of progress is indicative, the last remaining challenges should be surmountable. As far as infrastructure, various study groups have estimated the cost of expanding hydrogen stations, often with differing views. GM estimates that a $10-15 billion investment would establish a network for 12,000 stations, covering 70% of the US population.

Companies mentioned:

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(GM.N - US$38.01; 1H)
(DAIGn.DE - €71.79; 1M)
(F.N - US$8.44; 2S)
(7267.T - ¥3,750; 1M)
(7201.T - ¥1,095; 2M)
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