

Next Generation Automotive Technology

Evolution Before Revolution

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US Dependence on Imported Oil Has Significant Financial Implications

- In 2007, US consumed 20.7mb/d; 23.9% of the total world consumption
- In the same year, US oil production was 6.8mb/d; 8.0% of total world consumption
- The US spent \$546 billion on foreign oil in 2007
- We estimate the cumulative deficit (through 2040) created by the purchase of foreign oil to support transportation will exceed \$9.6 trillion

Greenhouse Gases Must Be Reduced to Avoid Permanent Climate Change

- Transportation accounts for 30% of GHG in US
- Transportation accounted for 47% of increase in total US GHG since 1990
- For most consumers, personal economic considerations preclude socially responsible actions
- The US Government has stated its intention to influence the adoption of technologies that address this problem

Scenario 1 - Slow Penetration of Hybrids & Plug-In Electrics to 2040

- Slow acceptance – less than 3% of new vehicles today to 10% by 2040

ADVs are 6% of the US fleet by 2040

- Annual \$ outflows for foreign oil *INCREASE* from \$328b to \$340b by 2040
- Relatively small improvement in GHG
- Major contributor to oil savings and GHG from improvement of existing technologies

Scenario 2 - Moderate Penetration of Hybrid Vehicles to 2040

- Moderate penetration – 100% of new vehicles sold in 2040 are ADV
- Fleet Composition of US fleet by 2040:
 - Gas/electric hybrids = 54%
 - PHEV = 9%
 - ICE = 37%
- Light-vehicle oil consumption reduced 50% to 4.7 mb/d in 2040.
- Annual \$ outflows for foreign oil drop to \$300b by 2040. Cumulative outflow is \$10 trillion

Scenario 3 - Aggressive Penetration of Plug-In Hybrid Vehicles to 2040

- Aggressive acceptance – 80% of new vehicles sold in 2040 are PHEV & EVs
- Fleet Composition of US fleet by 2040:
 - PHEV = 47%
 - Gas/electric hybrids = 13%
 - ICE = 40%
- US vehicle fleet would consist of 60% ADV (150 million units) by 2040 and reduce oil consumption by 68.5% to 3mb/d
- Annual \$ outflows for oil cut to \$254b
2009-2040 cumulative oil spend = \$9.6 trillion

An Industry with Investment Merit

- Unless the consumer is motivated to make meaningful change, the most significant contributor to the oil and gas solution over the next 30 years will be incremental advances in existing technologies
- Nameplates (even entire companies) come & go and design changes. Key components will remain and increase in importance
- Freedom of mobility will not be sacrificed to solve oil dependence/GHG issues

Conclusions

- Even the most intense adoption of electric technology fails to solve the US dependence on foreign oil, or reduce GHG
- Detroit 3 also-rans in electric vehicle development
- Meaningful competitive advantage will come from an early commitment to the technology that offers the most complete solution

Hydrogen-powered Vehicles

- The only complete long-term solution to eliminating dependence on foreign oil and the emissions-related effects of GHG
- Dealership footprint addresses initial infrastructure needs; serve as technology, service, and fueling centers.
- Gov't infrastructure stimulus expanded to include additional hydrogen capabilities

Hydrogen Transportation Future

Demand Analysis

Consumer vs. Corporation

- Personal economics is key factor for the consumer, but economic viability is key factor for the company.
- Consumers – cost/benefit analysis of every input is unique to every transaction
- Corporation – profitability is the only acceptable outcome

Consumer Behavior – HEVs as a Guide

- MPG advantage varies with gas prices, but is meaningful (average gain of 24% in 2008)
 - Avg premium in 2007 = \$4700
 - Since 1999 (10 years)
 - 165 million light vehicles sold in US
 - 1.3 million HEVs sold (0.78%)
- In 2008, HEV sales -11.3% versus 18% drop in overall US market

Corporate Behavior

EVs, SUVs as a Guide

- GM kills EV1 in 1999, buys Hummer in same year.
- EV1 lease based on \$34K to \$44K; estimated cost \$80K; Hummer \$10K+ profit per unit
- Ford Taurus best-selling car in US 1992-1996
- High fixed cost structure and low margin fleet sales force Ford to deemphasize Taurus and invest in SUVs & pickup trucks
- Toyota builds \$1.23b, 200K unit Tundra plant in San Antonio; shuts it completely for 3 months in 2008

Historical Adoption Rates

- HEV is the most intense technology advance in the modern auto industry
- EPA – “...this indicates that, in the past, it has taken a decade for a technology to prove itself and attain a sales fraction of 40 to 50 percent and as long as another five or ten years to reach maximum market penetration.”
- With less than 3% penetration after 10 years and impending EV launches, HEVs failed to alter the buying habits of the US consumer

Reasons for HEV Failure

- HEV technology acceptable but cost premium not justified to consumer
- Overlap with ICE vehicles
 - unfavorable direct comparison when gas price low
- Differentiation with ICE vehicles
 - benefit of HEV drivetrain most effective in small cars
 - eliminates utility needs of many consumers.
- Domestic automakers' cost structure forced design and marketing focus on light-trucks

Creating Hydrogen Demand

- Demand exists for domestic vehicles
 - OEs need to be “made whole” on costs
 - Opportunity for Detroit 3 to move to the top of the technology curve
- Consumers get all-in cost benefit of long-term ownership relative to other technology
 - Tax incentives; low financing rates; service/warranty plans
 - Incentivize accelerated trade-in (ACEEE plan +)
- Overlap with ICE vehicles
 - Platforms across all segments increase potential customer base
- Differentiation with ICE vehicles
 - Design, technology and features exclusive to hydrogen vehicles (at least initially) to negate potential premium