Ford Highlights 2007

John Ginder
Manager, Systems Analytics and Environmental Sciences Department
Research and Advanced Engineering

February 21, 2008
Toward a turnaround

- Continued progress toward profitability (lost $2.7B vs. $12.7B in 2006)
- South America, Europe, Asia Pacific/Africa and Mazda all profitable for full year and significant improvement over 2006
- US market share stabilized around 14%
- Reached agreement with UAW on new 4-year contract

- Launched the Ford Focus and Escape in US
- 3 months-in-service quality in statistical dead heat with Toyota, trending toward Honda
- Fusion 999 set land speed record for fuel-cell-powered vehicle
- Hired Jim Farley from Toyota as Group VP of Marketing and Communications
Next Up

Ford Vehicles

Ford Flex

Ford Fiesta

Ford Fusion Hybrid
Alan Mulally: "...we are at an inflection point in the world's history as it relates to climate change and energy security. The time for debating whether climate change is real has past. We now are working hard to find solutions."

Bill Ford: “No single technology on the horizon will enable our industry to play its full part in stabilizing levels of industry to play its full part in stabilizing levels of atmospheric CO2”
Stabilizing Atmospheric CO2 Levels

- Business As Usual
  - 650 ppm: 2.3 - 3.7 °C
  - 550 ppm: 2.0 - 3.4 °C
  - 450 ppm: 1.7 - 2.8 °C

- Reduced Risk of Environmental Impact

Target Range To Reduce Environmental Impact
Need to Reduce CO2 Emissions

• Simply “not getting worse” is not good enough
• CO2 reduction is required on a global basis going forward
• This is a long-term commitment for a sustainable future
On-road cars (32%) and light-duty trucks (29%), as a portion of the transportation sector (33%), contribute about 20% of US and ~11% of global CO2 emissions.

Vehicles are a significant source of GHGs, but are often perceived to be the major source.
Ford’s Sustainability Framework

• Enabling Technology Development and Migration for Fossil CO2 Reduction
CO2 Reduction Modeling

• Estimating the Emissions Reduction Requirement of the Light-Duty Vehicle Fleet

**Inputs**

- Sales volume
- Vehicle miles driven
- Vehicle fuel consumption
- Vehicle retirements
- Fuel CO2 information
- Emission reduction per stabilization trajectory

**CO2 Reduction Model**

- Proportionally applies emissions reduction to all sectors and regions
- Includes factors that impact year-over-year emissions output (old / new vehicle mix, biofuel availability)

**Outputs**

- “New fleet” targets that are required to move the “overall fleet” glide path in line with the required emissions reduction trajectory
Example: NA Light-Duty Fleet “New Vehicle” CO2 Emissions Range To Stabilization
Ford’s Model for Technology Migration

**Inputs**
- Vehicle segmentation
- Performance targets
- Fuel economy targets
- Technologies migration for:
  - Powertrain architecture and technology attributes
  - Vehicle system technologies
  - Weight reduction actions
  - Cost models

**Technology Migration Optimization Model**
- A vehicle systems approach to maximizing fuel economy and minimizing cost
  - Primary Weight Reduction
  - Secondary Weight Reduction
  - Aero
  - Electrical Loads
  - P/T and Driveline Efficiency

**Outputs**
- Projections for:
  - Fuel economy
  - Performance
  - Costs
- Vehicle and technology glide paths
- Weight reduction actions
- Scenario futuring
Schematic Technology Migration Path

**Near Term**
Begin migration to advanced technology

- Significant number of vehicles with GTDI
- Dual clutch and 6 speed transmissions replacing 4 and 5 speeds
- Increased hybrid applications
- Increased unibody applications
- Introduction of smaller showroom entries
- Electric power steering 80% - 90%
- Battery management systems 75%
- Aero improvement up to 5%

**Mid Term**
Full implementation of known technology

- Weight reduction of 250 - 750 lbs
- Engine displacement reduction aligned with weight save
- GTDI available in nearly all vehicles
- Increased use of hybrids as a percentage of gas engines
- Diesel use as market demands up to 10%
- Additional Aero improvements up to 5%
- EPAS approaching 100% on light-duty

**Long Term**
Volume roll-out of Hybrid technologies and alternative energy sources

- Percentage of internal combustion dependent on renewable fuels
- Volume introduction of HEV, PHEV
- Introduction of BEV and fuel cell vehicles
- Clean electric / hydrogen fuels
Typical Near Term FE Improvements

Mid-Size Utility Vehicle

% Fuel Economy

150 LBS | EPAS, Fast Engine Warm-up, etc. | Downsized PT with GTDI Technology | 5 to 6 speed +ASC | Aero and Parasitic Improvements | Final

0% | 5% | 10% | 15% | 20% | 25%

Ford Research & Advanced Engineering
Schematic Alt Fuels Migration Path

Near Term
- Begin migration to advanced technology

Mid Term
- Full implementation of known technology

Long Term
- Volume roll-out of stretch technologies and alternative energy sources

2007
- 1st gen biofuels ramp-up to capacity
- Growth of fossil fuel peaks as advanced vehicle tech migrates into the in-use fleet

2012
- 2nd gen biofuels become viable
- Total renewable fuel capacity is expanded
- Fleet programs confirm readiness of plug-in HEV and hydrogen vehicles

2020
- Renewable fuels are the primary content as fossil fuels ramp down
- Clean alternative fuels (electricity and hydrogen) enable volume applications of plug-in HEVs, H2ICEs, and eventually FCVs

2030
Integrated Approach With Shared Responsibility

Key Roles Of:
- Vehicle Technology
- Renewable Fuels
- Policy
- Consumers
Emerging Technologies for Sustainability
EcoBoost GTDI Engine

Benefits

• High volume
• Scalable from small cars to large trucks
• Benefits relative to large-displacement engines:
  • Up to 20 percent better fuel economy
  • 15 percent fewer CO2 emissions
  • Superior driving performance
• Will be available in half a million Ford, Lincoln and Mercury vehicles annually in North America during the next five years
  • Lincoln MKS sedan
  • Ford Flex

• Affordable
EcoBoost GTDI Engine

Payback of Incremental Purchase Price Through Fuel Savings

- **EcoBoost I-4**
- **I-4 Diesel**
- **I-4 Hybrid**

Assumptions:
- 15,000 miles/year
- Gas: $2.87/gallon
- Diesel: $2.90/gallon

Lower Is Better
Ford R&A Activities

Biofuels are an important approach to reduce petroleum consumption and GHG emissions.

Auto industry needs biofuels expertise:
- Significant opportunities exist for the innovation and development of biofuels, currently directed from supply-side.
- Fundamental understanding supports vehicle testing and enables investigation of current biofuels issues.
- Life-cycle benefits and risks of various alternatives need to be evaluated.

Ford projects include optimized combustion, measurement and optimization of physical properties.
Ford-SCE Collaboration on Plug-In Hybrids

Initiated in July 2007

Vision:
Two industries, connected through a common fuel, changing the transportation & energy paradigm

Collaboration Goals:
• Accelerate introduction of PHEVs
• Develop data/knowledge leading to new business models
• Bring key stakeholders together utilities/suppliers/government
• Develop customer-driven solutions
Ford Plug-In Hybrid Programs

PHEV Escape Prototype

Specifications
• Engine: 2.3L Atkinson cycle
• Li-Ion Battery: 10 kW-hr
• Fuel Capacity: 15 gal
• Seating: 5-passenger
• Weight: 3900 lbs
• Max Speed: 102 mph
• 0-60 mph acceleration: 10.3 s

Attributes
• Superior fuel economy – up to 120 mpg
• Overnight recharging from standard 110 V home outlet
• All-electric mode during low speed driving
• Regenerative braking

Key challenges:
Technical
• Battery
• Vehicle system interface
• V2G, V2H enablers

Business case
• Customer/company affordability
• Developing new value streams