Sustainable Mobility
An Automaker Perspective on Environmental & Energy Policy

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“The Search for Wise Energy Policy”
School of Public and Environmental Affairs – Indiana University
Washington D.C. – June 11, 2009
Contributions to CO₂ Emissions is Across Global Regions and Industry Sectors

- 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 significant source of GHGs but are often perceived to be the major source
Ford’s CO₂ Footprint is Predominantly Vehicle Emissions

CO₂ in million metric tonnes (MMT) – 2005 data

Total CO₂ Emissions
415 million metric tonnes
U.S. Fleet Fuel Consumption: Influenced by Vehicle Population & Mix

- 68 Million vehicles in the 1960s
- 241 Million vehicles in the 2000s
- 16% of vehicles were trucks in the 1960s
- 46% of vehicles were trucks in the 2000s
U.S. Fleet Fuel Consumption: Influenced by Vehicle Miles Traveled

- Gasoline Consumed (Bils. Gallons): 719 Billion
- Total Miles Traveled: 2.9 Trillion
- Percentage:
  - 13%
  - 38%
  - 66%
Auto Industry Progress to Date: Fuel Economy has Increased

- Fuel economy rates in cars increased more than 100 percent since 1974.
- Fuel economy rates in trucks (minivans, vans, SUVs, and pickups) increased 53 percent since 1975.
- Today’s average light truck gets better mileage than an average 1970s compact car.
- Today’s average SUV gets at least 33 percent better mileage than the average car in 1975.
Well-to-Wheels CO2 is Determined by Fuel, Propulsion System and Source of Power Generation

WTW Fossil CO2 g/km for 2010 compact-size vehicle
Addressing climate change and energy security issues will require the involvement of all stakeholders.
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Science – Stabilizing Atmospheric CO₂ Levels

Atmospheric Concentration (ppm)

Year

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

Accepted Range To Minimize Environmental Impact
Ford’s Sustainability Framework for CO₂ and Technology Migration Development

**Inputs:**
- Targeted CO₂ Atmospheric Glide path
- Auto Industry: Vehicle fleet CO₂ requirements
- Energy Industry: Low-fossil-carbon fuels glide path

**Outputs:**
- Vehicle / Technology Migration Plan
- Vehicle / Fuel Strategic Alignment
- Well-to-tank Plan: Reduce fossil CO₂ contribution from fuel sources

**Key Models and Strategies:**
- CO₂ Reduction Model
- Fuel Development Cost Minimization Strategy
- Technology Optimization Model
- Vehicle / Technology Migration Plan
- Vehicle / Fuel Strategic Alignment
- Well-to-tank Plan: Reduce fossil CO₂ contribution from fuel sources
CO₂ Model to Estimate 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
- Factors in things that impact year-over-year emissions output (old / new vehicle mix, bio fuel availability)

**Outputs**
- “New fleet” targets that are required to move the “overall fleet” glide path in line with the required emissions reduction trajectory

![Graph showing emissions reduction over time from 2000 to 2050](image)
Sustainability Strategy – Technology Migration

Near Term
Begin migration to advanced technology

- Significant number of vehicles with EcoBoost engines
- Electric power steering 70 – 80%
- Dual clutch and 6 speed transmissions replacing 4 and 5 speeds
- Four Hybrid applications
- Increased unibody applications
- Introduction of additional small vehicles
- Battery management systems 75%
- Aero improvement up to 5%

Mid Term
Full implementation of known technology

- EcoBoost engines available in nearly all vehicles
- Electric power steering 100%
- Six speed transmissions 100%
- Weight reduction of 250 – 750 lbs
- Engine displacement reduction aligned with weight save
- Additional Aero improvements up to 5%
- Increased use of Hybrids
- Introduction of PHEV and BEV
- Diesel use as market demands

Long Term
Continue leverage of Hybrid technologies and deployment of alternative energy sources

- Percentage of internal combustion dependent on renewable fuels
- Volume expansion of Hybrid technologies
- Continued leverage of PHEV, BEV
- Introduction of fuel cell vehicles
- Clean electric / hydrogen fuels
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Introduction of EcoBoost Technology

- Gasoline Direct Injection
- Turbocharging
- "Downsizing & Boosting"
EcoBoost Torque Comparison

EcoBoost V-6 vs. Comparable V-8

Engine Torque Comparison

Engine Speed (rpm)

Engine Torque (lbf·ft)

3.5L V-6 Gasoline Turbo-Charged Direct Injection

4.6L V-8
Affordability of New Technologies is Critical

Payback of Incremental Cost (w/o incentives) Through Fuel Savings

- EcoBoost: 2.7 years
- I-4 Diesel: 6.9 years
- I-4 Hybrid: 12.6 years
- I-4 CNG: 7.1 years
- I-4 PHEV: 14.5 years
- BEV: 29.2 years

Assumptions:
15,000 miles / year
Gas: $2.62 / gallon
Diesel: $2.50 / gallon
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Fuel Economy Leadership on The Road Today
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Mid Term
Full implementation of known technology

- Electrification Strategy
  - Additional Aero improvements up to 5%
  - Increased use of Hybrids
  - Introduction of PHEV and BEV
  - Diesel use as market demands aligned with weight save

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2007
2011
2020
2030
Electrification Strategy – Family of Electrified Vehicles

Electric Powered Vehicles by 2012 Include:

- Full Battery Electric Transit Connect Commercial Van in 2010
- Full Battery Electric Focus in 2011
- All New Hybrid Vehicles Including Plug-In Version in 2012
Leveraging Global Platforms

Plug & Play into High Volume Platforms with Global Reach
Ford / Southern California Edison
Plug-In HEV Partnership

- Unique partnership between automotive and utility sectors
- 20-40 miles daily use
- Off-peak charge provides low-cost opportunity
- Success depends on affordable model – value to customers, manufacturers and utilities
- Diversifies transportation energy supply
Ford, DOE, EPRI and Utility Partners
Sustainability Strategy – Technology Migration

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- Lightweight Materials
  - Aligned with weight save
  - Additional Aero improvements up to 5%
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Long Term
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2007
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Addressing climate change and energy security issues will require the involvement of all stakeholders.
Technology Migration for Fuels

**Near Term**
Begin migration to advanced technology

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

**Mid Term**
Full implementation of known technology

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

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

- 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
Sustainable Supply of Biofuels

1st Generation Biofuels

2nd Generation Biofuels
Energy Independence Drives Different Regional/Local Choices

Regional energy sources (present reserves) will shape policy/response to increased oil prices, climate change and energy security. While sources of petroleum are limited, sources for electricity exist in all regions.


* %'s are of total global reserves

* Note data on Africa not available
Addressing climate change and energy security issues will require the involvement of all stakeholders.
Passenger car sales made up more than 60% of the light-duty vehicle market in May 2008 – a 20% shift since August 2005.

Percentage Passenger Car Sales (May 2008) – 61.1%

Percentage Truck Sales (May 2008) – 38.9%

Shift to Car 20.4%

Percentage Passenger Car Sales (August 2005) – 40.7%
Fuel Prices Matter...When Prices Drop, So Do Sales of HEVs
Historically low fuel prices reinforced consumer behavior

- Consumers drive more when fuel prices are low
- Consumers drive less when fuel prices are high
Eco Driving Training:

- Documented Fuel Consumption Savings of 25%
- Addresses Entire Vehicle Population
- Not Just Tips – Include in Drivers Education Programs, Driver License Renewal and Training Events
- Safety Benefits as Well

Modest Eco Driving Program that Results in a 10% Improvement in Fuel Consumption

<table>
<thead>
<tr>
<th>Gasoline Savings</th>
<th>CO₂ Reduction</th>
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<tbody>
<tr>
<td>13.6 Billion Gallons</td>
<td>120.6 Million Metric Tons</td>
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Addressing climate change and energy security issues will require the involvement of all stakeholders.
“One National Standard”

Combined Car/Truck CAFE

Historical Federal Car/Truck CAFE

Federal CAFE Legislation
(30.2 mpg in 2015MY; 35 mpg in 2020-4%)

Potential “One National Standard”
(35.5 mpg in 2016)

Combined Car/Truck California AB1493

Model Year


Combined Car + Truck FE (mpg)
Climate Change / Energy Security
Policy Principles

- Should achieve the most economically efficient CO2 reductions possible – comprehensive economy-wide cap and trade policy framework.

- Transportation sector must be an integral component of a national program.

“We are committed to a pathway that will slow, stop and reverse the growth of U.S. emissions while expanding the U.S. economy.”
## The Role of Stakeholders: An Integrated Approach

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<tr>
<th>Stakeholders</th>
<th>Actions</th>
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| **Auto Industry**     | ✓ Accelerate advanced technology vehicle deployment  
                         ✓ Continue to improve the efficiency of our products  
                         ✓ Educate consumers/provide “eco-driving” training |
| **Fuel Industry**     | ✓ Invest in developing and marketing biofuels  
                         ✓ Increase R&D into advanced low carbon bio-fuels (including cellulosic ethanol) |
| **Government**        | ✓ Policies to align consumer action with vehicles and fuels  
                         ✓ Incentives for advanced technology vehicles & E85 fueling infrastructure development  
                         ✓ Investment in improved road traffic management infrastructure  
                         ✓ Public awareness and education |
| **Consumers**         | ✓ Drive vehicles in an energy-conscious fashion  
                         ✓ Vehicle choice and miles traveled ultimately determines how much fuel is consumed |
Why Ethanol Now?

Opportunity for Immediate Impact

- **Ford**: Over 2 million FFVs on America’s roads
- **U.S. Automakers**: More than 7 million E85 FFVs
- Over 4.2 billion gallons of gasoline could be displaced
  - Equal to gasoline consumption in New Jersey or North Carolina.
- Doubling our production by 2010 – half by 2012
Renewable Fuel Standard will Require Expansion of Cellulosic Biofuels

Non-advanced Renewable Fuel: Conventional Corn-starch Ethanol

Non-cellulosic Advanced: Sugar Ethanol Co-processed Renewable Diesel

Biomass-based Diesel: Biodiesel-ester Standalone Renewable Diesel

Advanced Cellulosic Biofuel

Billions of Gallons per Year

California’s 2012-14 Zero Emission Vehicle Requirements

12% Mandate

- **“Bronze”** 6% PZEV (30% volume)
- **“Silver”** 3% AT-PZEV HEV or CNG (4.6% volume)
- **“Gold”** 3% ZEV

- **“Silver +”** 0 – 2.21% Enhanced AT-PZEV Plug-in Hybrid or H2 ICE
  - 10,000 – 14,000 PHEVs / yr for all 12 ZEV states

- **“Gold”** 0.79% – 3% ZEV BEV or FCEV
  - ~ 600 BEVs / yr in any ZEV state

* Requirements increase in 2015MY and beyond. Rulemaking in 2010.*