

Vehicles Today and Tomorrow:

*What they can offer and the fuels
they need.*

Nancy L Homeister
Ford Motor Company
28 July 2001

Issues of the Future

- The environmental concerns we see in the future are pretty much as they are today:
 - Urban air quality
 - Global environmental issues (sic: CO2 emission reductions)
 - Use of natural resources
 - Waste disposal

Manufacturers' Response

- In each case, manufacturers will
 - A. Strive to get the most out of conventional technologies
 - B. Develop all-new technologies
- "Bridge" technologies are necessary to get us from A to B.

"Conventional" Technologies: Cleaner Cars

Technologies to improve light-off times, A/F control during cold start and catalyst efficiency include:

- Catalyst Design: Ultra-thin wall, high density catalysts with advanced substrate materials
- Fast response oxygen sensors and advanced fuel & spark control strategies
- Dual wall exhaust manifolds and ultra close coupled catalysts to reduce light-off times
- Improved materials, seals and tolerances to improve emissions durability and robustness
- Gasoline and Diesel lean NO_x catalysts and/or traps
- PM filters - either continuously regenerating or catalyzed.

“Conventional” Technologies: More Efficient Cars

- Efforts on the following improvements have been on-going for quite some time:
 - Weight reductions
 - Reduced rolling resistance
 - Improved aerodynamics
 - Advanced powertrain technologies
 - 4-stroke direct injection

P2000 Diata Direct Injection

Features

- ➔ 1.2L DIATA 4-cylinder engine
- ➔ 63 miles per gallon
- ➔ weighs 2000 pounds -- 40% lighter than a 1997 Ford Taurus. It contains more lightweight aluminum, carbon fiber, magnesium, and titanium.



P2000 DIATA

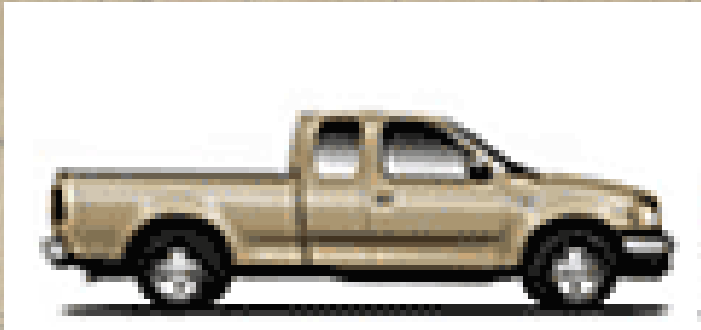
Cleaner Fuels are Needed

- The technologies discussed rely on high quality fuels - not only to reduce the emissions, but also to minimize emissions/fuel efficiency trade-offs
 - "Zero" sulphur (gasoline and diesel)
 - Higher cetane
 - Reduced aromatics (gasoline and diesel)
 - Careful use of additives
 - Detergents, "good"
 - Metallic octane enhancers, "bad"

“Bridge” Technologies

- These technologies provide benefits over “conventional” vehicles, but have trade-offs that indicate we can still do better yet.
 - Alternative fuel vehicles
 - Hybrid electric vehicles
 - Battery electric vehicles

Propane Vehicles



- F-150 Bi-Fuel
 - 5.4L
 - ULEV
- F-350, 450, 550
 - 6.8L
 - ULEV



Propane Vehicles

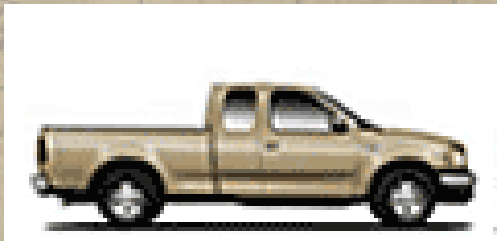
Advantages

- High octane
- Reduced average fuel cost
- Infrastructure somewhat available
- Domestic sources
- Certain emissions reduced

Disadvantages

- Highly variable fuel cost
- Limited public refueling sites
- Higher vehicle cost
- Potentially limited fuel supply

Natural Gas Vehicles



- Crown Victoria - ULEV
- E-250/350 - SULEV
- F-150 - SULEV
- E-450 Cutaway - ULEV
- F-150 Bi-Fuel - ULEV

Natural Gas Vehicles

Advantages

- High octane
- Reduced fuel cost
- Opportunity to fuel at home
- Domestic sources
- Readily available natural-gas pipeline system
- Certain emissions reduced

Disadvantages

- Limited refueling sites
- Refueling sites costly
- Higher vehicle cost
- Local tunnel/parking garage restrictions
- Reduced driving range or cargo area
- Increased fuel tank weight and volume
- Highly pressurized fuel tanks

E85 Flexible Fuel Vehicles



- Taurus -
 - 3.0L
 - LEV



- Explorer and Explorer Sport Track
 - 4.0L
 - LEV



E85 Flexible Fuel Vehicles

Advantages

- High octane
- Slightly increased performance
- Ability to use ethanol or gasoline
- Renewable, domestic sources
- Similar refueling system for customers
- Certain emissions reduced

Disadvantages

- Reduced driving range
- Much higher fuel cost
- Slightly higher vehicle cost
- Limited public refueling sites
- Increased aldehyde emissions

AFVs in Europe



- Transit LPG and CNG
- Focus LPG and CNG
- Mondeo LPG
- Transit, Mondeo and Focus - Bi-fuel LPG and CNG
- Th!nk Neighbor and City

AFVs in Asia



Dedicated and Bi-Fuel
LPG Falcon

- Available in Australia
- Used in Hong Kong for taxis



Mazda Titan

- Available in Japan
- CNG and LPG

Escape Hybrid Electric Vehicle



- Debuts 2003
- Targeting 40 miles per gallon
- SULEV emissions
- 500 mile driving range per refill
- I4 engine with performance of V6



HEV - Technology

The Benefits:

- Fuel Economy: 30-50% improvement vs. gasoline
- Improved emissions (SULEV possible)
- Infrastructure not a problem

The Challenges:

- Lowering cost of the dual powertrain system
- Improving reliability
- Securing appropriate government incentives

Ranger EV

Features

- Conductive on-board charging
- 4-wheel ABS and regenerative braking
- Customer Range:
 - NIMH: 65 - 80 miles
 - PbA: 50 miles
- Available in the US and Canada



TH!NK city Battery EV



For sale in Europe now

- 2 passenger
- 50 mile range
- 55 mph top speed
- Recyclable thermoplastic body

U.S. demonstration beginning this Fall
"Global" version debuts in 2002

Dimensions

Length: 9.8 feet
Width: 5.25 feet
Height: 5.1 feet
Luggage: 12.4 cu. Ft.



BEV's - Vision of the Future

☞ Specialized use:

- City cars
- Station cars
- "Gated" communities

☞ Provides technology bridge to fuel cell and hybrid electric vehicles

☞ Not a replacement for traditional vehicles due to customer compromises

Electric Vehicles

Advantages

- Readily available fueling
- Zero tailpipe emissions
- Quiet operation
- Reduced maintenance
- Reduced fuel cost
- Opportunity to fuel at home

Disadvantages

- Increased vehicle weight
- High initial vehicle cost
- High cost of battery replacement
- Reduced driving range
- Long battery recharge time
- Lack of public recharging facilities
- Increased utility emissions

Future Technologies

- Fuel Cell vehicles are largely touted as the technology of the future. While some prototypes are out there, we still have a ways to go before they become the “everyman’s” car.
- Other “breakthrough” technologies will always be considered.

Fuel Cell Electric Vehicles



P2000

No compromise, family size research vehicle; Direct hydrogen fueled ZEV
100 hp, 0-60 mph in under 14 seconds

Focus

Focus-based demonstration vehicle debuts at the CaFCP headquarters this fall. Pilot production announced for 2004.



Fuel Cells: Vision of the Future

- A major strategic focus because of the long term potential to be a no trade-off vehicle technology.
- We will continue to develop and optimize supporting technologies and work to overcome market barriers.
- We plan to be ready to produce FCEVs in 2004

Fuel Cell - Technology

The Benefits:

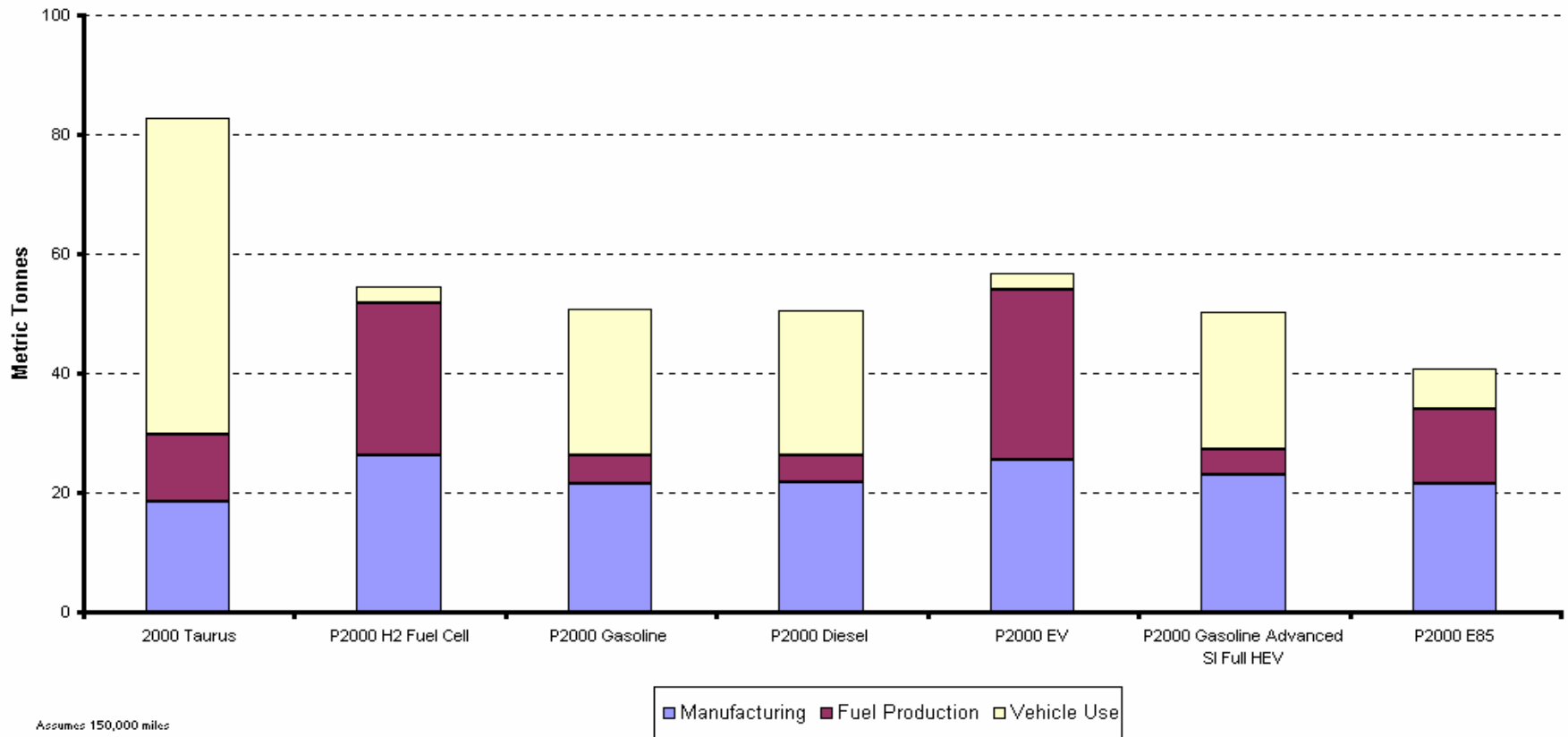
- Clean Air - Potentially a zero emission vehicle
- Customers - Technology capable of providing the same function as a gasoline vehicle
- Fuel Economy - More than 2 times the efficiency of today's vehicles

The Challenges:

- Complexity of technology
 - major technological stretch (significantly higher than BEV's)
- Enormous cost reduction challenge
 - Current vehicles cost in excess of \$2 million each
- Infrastructure
 - No hydrogen infrastructure
 - Methanol infrastructure has to be created

Life Cycle Emission

Life Cycle CO₂ Equivalent



Into the Future

- Ford's environmental actions will continue to demonstrate that we care about preserving the environment for future generations
- Work is progressing on every promising advanced technology
- Protecting the environment is everyone's job, and better yet, its good for the Company -- our environmental performance ultimately contributes to the well-being of the company and to shareholder value