Transportation Fuels for the Future

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Lotus Engineering, UK
The Flex-Fuel Lotus Exige 265E Project

Autocar, 13 September, 2006
Presentation Structure

Why we need to consider alternatives
The challenge for the automotive industry
Is Hydrogen the answer?
Alcohols as the alternative
A vision for the future ~ a viable transport fuel economy
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Motivating Factors – Climate Change

• Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations, CO₂ being the most important (IPCC Feb. 07).

‘Business as usual’ scenario will produce 1000 ppm by 2100

The primary source of recent CO₂ increase is fossil fuel use (IPCC Feb. 07).
Motivating Factors - Depletion of Resources

- Fossil fuels are a finite resource – they are not renewable on a human timescale!
- Population and energy consumption per capita are rising.

Energy demand by sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>22%</td>
</tr>
<tr>
<td>Industry</td>
<td>3%</td>
</tr>
<tr>
<td>Buildings</td>
<td>34%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>22%</td>
</tr>
</tbody>
</table>

IPCC 2001

Trillions (10^12) of Passenger-Kilometers/Year

Motivating Factors - Depletion of Resources (2)

ASPO projects a major shortfall of future discovery against projected demand.

Most oil discovered 1965

Last time more oil discovered than used

Giant Saudi and Kuwaiti fields discovered.
Motivating Factors - Energy Security

- Recent political events have made the issue of energy security more pressing.
- Current oil reserves heavily reliant on Middle-East.
- EU currently has 80% dependence on external oil.
- At €50 / barrel net transfer of wealth is €60 billion/year.
Motivating Factors

- Climate change
  - Reduce consumption of fossil fuels
- Finite resources
  - Find alternative fuels
- Energy security
  - Challenge for the automotive industry is to reduce engine fuel consumption

Air → Fuel → Engine

Nitrogen → CO₂ → H₂O → CO, HC, NOx
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CO₂ Challenge – Status of ACEA Commitment

The main challenge is to meet steadily reducing vehicle CO₂ emissions targets.

- 186 g/km
- 2004: 161 g CO₂/km
- 13,5%

Voluntary

EU Proposal for 2012: 130 g CO₂/km

Mandatory?

ACEA-Target: 140 g CO₂/km

- 52 mpg Gasoline

Official EU Commission figure for 2003: 163 g CO₂/km for 2004: 161 g CO₂/km

from: Ivan Hodac, Secretary General,
European Automobile Manufacturers Association
EU Conference Energy in Motion, Amsterdam, 20.10.2004
State of the Art - Europe

Manufacturers with > 150k sales in 2005

140 g/km target for 2008

Source: www.transportenvironment.org
State of the Art (2)

Percentage achievement of target

Source: www.transportenvironment.org
State of the Art (3)

Insufficient ‘over-achievement’ exists for Carbon Trading!
### Petrol Vehicles with 120g/Km CO₂ or less

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Make</th>
<th>Model</th>
<th>Engine Capacity cc</th>
<th>Transmission</th>
<th>CO₂ (g/km)</th>
<th>Fuel Consumption (mpg)</th>
<th>Fuel cost of driving 12000 miles</th>
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Source: www.VCAcarfueldata.gov.uk Feb 2007
## Diesel Vehicles with 120g/km CO₂ or less

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<tr>
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Source: www.VCAcarfueldata.gov.uk Feb 2007
Will the ACEA CO₂ Target be Met?

<table>
<thead>
<tr>
<th>Car Model</th>
<th>CO₂ (g/km)</th>
<th>mpg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamborghini Murcielago 6.0 l V12 (640 bhp)</td>
<td>495</td>
<td>+254%</td>
</tr>
<tr>
<td>Range Rover 4.197 l S/C V8 (390 bhp)</td>
<td>376</td>
<td>+169%</td>
</tr>
<tr>
<td>Lotus Exige S 1.8 l S/C (218 bhp)</td>
<td>215</td>
<td>+54%</td>
</tr>
<tr>
<td>Ford Mondeo 2.0 l Duratec (145 bhp)</td>
<td>187</td>
<td>+34%</td>
</tr>
<tr>
<td>VW Golf 2.0 l TDI diesel (140 bhp)</td>
<td>154</td>
<td>+10%</td>
</tr>
<tr>
<td>Ford Fiesta 1.25 l Duratec (75 bhp)</td>
<td>142</td>
<td>+1.4%</td>
</tr>
<tr>
<td>Ford Fiesta 1.6 l DuraTorq (90 bhp)</td>
<td>116</td>
<td>-17%</td>
</tr>
<tr>
<td>Toyota Prius 1.5 l gasoline / electric hybrid (76 bhp)</td>
<td>104</td>
<td>-26%</td>
</tr>
</tbody>
</table>

The 140 g/km of CO₂ target will not be met. 120 / 130 g/km will be very difficult to meet.

Burning 1 litre of gasoline produces about 2.3kg CO₂
10 tankfuls = the approximate mass of the car
What are the Options?

Any alternative basis for a future energy economy **must** address the CO₂ issue.

• Reduce energy (fuel) consumption
  – *Engine / transmission technology.*
  – *Vehicle technology (low mass, low rolling resistance/drag).*
  – *Changes in vehicle usage patterns, including adaptive driving.*

Improvements in efficiency will not off-set growth in demand.

• Change the fuel
  – *This is complementary to changes in engine / transmission technology.*
Changing the Fuel

The ideal energy carrier should:

1. be easy to manufacture from abundant resources;
2. provide high energy density;
3. be capable of being handled, stored, and distributed cheaply and safely;
4. be compatible with a wide variety of applications.

Gasoline and diesel are excellent examples because of their physical properties.

But we have already seen that we need alternatives....
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