FUTURE TRANSPORTATION FUELS
ROLE OF MOTORSPORT

Richard Karlstetter
Global Technology Manager Race Fuels
Shell Global Solutions (Germany)

Road Atlanta, 30th September 2010
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ABOUT SHELL

- Recognised for technical innovation and operational excellence
- Network of around 44,000 service stations
- Active in alternative energies – biofuels, hydrogen, wind
- Employs 101,000 people in more than 90 countries
- Committed to social and environmental sustainability
- Partners in innovation with Ferrari F1 team
- Selling transport fuel to some 10 million customers a day
- One of the world’s best known brands
### ORGANISATIONAL STRUCTURE

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Combining the operating experience of 10000 staff with proven implementation skills and advanced technologies

- Diverse cultures and nationalities
- Over 50 years of implementing business and engineering solutions
- Continued investment in innovation
- Close industry cooperation

Motorsport Activities

Part of Shell’s R&D

- Automotive Fuels Technology Group
- Lubricants Technology Group
FUNDAMENTAL FUELS EXPERTISE THROUGH CLOSE PARTNERSHIP WITH WORLD'S LEADING AUTOMOTIVE INDUSTRY COMPANIES
First branded petrol: Shell “Spirit”
In 1907 Peking to Paris rally

Shell “Super Aviation Spirit” used to cross Atlantic 1919

Shell Racing Spirit 1921

Shell first to introduce iso-octane 1930’s

Thornton Research Centre established 1940

ICA - first engine deposit control additive 1953

ASD - advanced inlet system deposit control additive 1970

Lead replacement gasolines first introduced in Europe 1993

100th Formula One Grand Prix winner fuelled by Shell

Optimised fuel offerings meeting key consumer needs
SHELL FUELS DEVELOPMENT “A DECADE OF FIRSTS”

1999

1st Shell V-Power win with Ferrari

2000

1st Shell Optimax launch
1st Shell V-Power Diesel launch
1st Shell V-Power100 Gasoline launch
1st use of synthetic GTL technology in Shell V-Power Diesel
1st oil company to win the Porsche prize for innovation for work on GTL
1st diesel car to win Le Mans powered by Shell V-Power Diesel
1st New Shell Diesel with fuel economy formula launch
1st commercial aircraft flight on GTL Jet Fuel
1st Shell FuelSave gasoline launch
1. Step-change in energy demand
2. Supply will struggle to keep pace
3. Environmental stresses are increasing

**World population**

- 1950
- 1975
- 2000
- 2025
- 2050

1 billion people  OECD  Non OECD

**Climbing the energy ladder**

GJ per capita (primary energy)

- USA
- Russia
- Europe EU 15
- Japan
- South Korea
- China
- Brazil
- India

GDP per capita (PPP, ‘000 200 USD)

Source: UN Population Division

Source: Energy Balances of OECD and Non-OECD Countries © OECD / IEA 2006
Transport energy demand will increase rapidly

- Energy-related CO₂ emissions account for 62% of the global total
- Transport accounts for about 23% of energy-related CO₂ emissions. Road transport accounts for 17%
- Global population is growing and demand for mobility is increasing
- The number of vehicles on the road is expected to double to more than two billion by 2050

**Energy Related CO₂ Emissions**

- Industry & Manufacturing: 76.5%
  - Power Generation
  - Buildings & Commerce
- Road Transport: 17%
  - Commercial Heavy Duty and Passenger Light Duty Vehicles
- Other Transport: 6.5%
  - Rail, Aviation, Marine

**Estimate of worldwide vehicle demand**

<table>
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<tr>
<th>Year</th>
<th>Billion vehicles</th>
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<tr>
<td>2007</td>
<td>1.0</td>
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<tr>
<td>2027</td>
<td>1.5</td>
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<tr>
<td>2050</td>
<td>2.5</td>
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Source: International Energy Agency
* 62% of global CO₂ emissions

TIMING OF CO2 REDUCTION IS IMPORTANT AS END-POINT

Global emissions (GtCO2)

Temperature rise driven by cumulative emissions – area under curve

Based on Meinshausen et al Nature Vol 458, April 2009

Better we start now
Global production of primary energy sources.

Terajoules/year


*Coal and natural gas used in power generation with carbon capture and storage

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WHAT IS DRIVING A GLOBAL FUEL?

Reduced NOx Emissions

Energy Security

European road transport emissions

Societal Priorities Result in Different Local Regulations

Source: WBCSD / Shell

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OPTIONS FOR TRANSPORT FUELS

Energy sources

- Oil
- Gas
- Coal
- Biomass
- Solar
- Wind
- Hydro
- Nuclear
- Fusion?

Energy carrier

- Conventional & advanced biofuels
- Synthetic fuels
- Partial Oxidation
- Syngas CO, H₂
- CCGT
- Shift Reaction
- CO₂ CCS
- Electrolysis
- Electricity
- Hydrogen

Drive-train options

- Conventional ICE
- Hybrid diesel
- Plug-In hybrid
- Electric Vehicle
- FCV/H2-ICE

**CCS: carbon capture & sequestration**

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<th>Premium Fuels</th>
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<th>Hydrogen</th>
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<td><strong>V-Power</strong></td>
<td><strong>Pioneer in the development of Gas to Liquid technology</strong></td>
<td><strong>Leading in current and future biofuels</strong></td>
<td><strong>World's largest public transport joint venture (NL)</strong></td>
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<td>V-Power fuels: Best performance in Latest engine technology</td>
<td>Premium diesel containing GTL Fuel launched in: Austria, Germany, Greece, Hungary, Italy, Luxembourg, Netherlands, Slovakia, Switzerland, Thailand, UK, Poland</td>
<td>Conventional biofuels • 5 billion litres (2007) • COSAN joint venture</td>
<td>Demonstration projects in USA, Europe and China</td>
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<td>• in 60 markets since 1998</td>
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<td>Advanced biofuels pathways • Iogen • Codexis • Cellana • Virent</td>
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<td>• VP-Diesel with unique GTL component</td>
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<td>• V-Power racing with 100 Octane and FMT-Technology</td>
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<tr>
<td>• V-Power 95 for better performance fit all Engines</td>
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Biofuels are a low ‘well-to-wheel’* CO₂ sustainable alternative to gasoline and diesel available today

But CO₂ emission reductions depend on whole journey to combustion – feedstock production, process used, distribution and use in vehicles

Biofuels diversify transport fuel pool and offer prospect of improved energy security

Biofuels can be used in existing liquid transport fuel infrastructure

For some countries biofuels can offer economic and rural development opportunities

*Well-to-Wheel CO₂ analysis calculates the CO₂ emissions relating to a particular fuel pathway. The calculation divides the pathway into two parts: (i) ‘Well-to-Tank’ (WtT) CO₂ emissions – from the production and distribution of the fuel feedstocka and the actual fuel (ii) ‘Tank-to-Wheel’ CO₂ emissions – from the use of the fuel in the vehicle


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Proposed $12 billion joint venture, binding agreement signed August 25th, 2010*

Brazilian sugar cane – lowest CO$_2$, most sustainable and cost competitive of today’s biofuels

2 billion litres of ethanol production capacity per year – with room to grow

Robust sustainability principles, standards and operating procedures

* Regulatory approval required
Advanced biofuels, using feedstocks such as crop wastes or inedible crops and new conversion processes

Offer the potential for improved CO₂ reductions and improved fuel characteristics.

Accelerating research, development and demonstration of advanced biofuels

Research agreements with experts in leading academic institutions across the world

Technical partnership with leading biotechnology companies

Our aim: to narrow down technology options to a feasible set of commercial solutions
Iogen  
(Cellulosic Ethanol)

Codexis  
(Optimized Enzymes)

Cellana  
(Marine Algae)

Virent  
(Catalysts)
Shell is successfully progressing new technologies from lab-based process to demonstration phase and towards commercial scale-up.

Shell aims to narrow down advanced biofuels technology options to a feasible set of commercial solutions.

In the long term all biofuels will need to be cost competitive with all road transport fuels.

In the short term, government policies, incentives and financial support accelerate development from lab to commercial deployment.
The leading candidate changes over time

- **late 1990s**: Hydrogen
- **early 2000s**: Biofuel
- **late 2000s**: E-Mobility
- **2010s?**: Natural Gas?

The real answer?

- **Emission concerns**: 2010
- **Energy security concerns**: 2025 “Simple Mosaic”
- **Cost concerns**: 2050 “Full Mosaic”
BIOFUELS ARE THE ONLY NEAR-TERM MATERIAL LOW CO₂ FUEL OPTION

Road Transport Fuels (2010 to 2050)
Displaced mileage expressed as Million boe per day

Displacement of Oil (2010 to 2050)
Percentage of displaced boe

Source: Shell Energy Scenarios 2008
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The **global demand** for energy and mobility will continue to grow until 2050. All fuel options will be needed.

Development of **new energy technology** takes time; however climate change requires short term actions.

Shell is providing **short term options to improve efficiency** in transport already today. These options work in the current infrastructure.

Today’s **biofuels** are the most realistic **commercial solution** to take CO2 out of the transport fuels sector and diversify supply over the next twenty years.

Shell is building **capacity in biofuels** that provide best combinations of performance and low ‘well-to-wheel’ CO2 performance from more sustainable feedstocks.

**Electric and hydrogen** will play an important role if technical and infrastructure challenges can be overcome.
Technology transfer between the track and the road and vice versa
- an integrated part of our product development

The desire to gain performance / efficiency advantages for the track over competitor
- through new and innovative technologies

- Multi-year Motorsport technical co-operations are in place with
  - Ferrari in Formula 1 (Fuels & Lubricants)
  - Audi Sport in Le Mans/Endurance Racing (Fuels & Lubricants) until 2009
  - Ducati in MotoGP (Fuels & Lubricants)
  - Richard Childress Racing in NASCAR (Lubricants)
• Motorsport product development drivers and targets for these programmes are identical to our road fuels and lubricants

  • Power output
  • Fuel efficiency
  • Reliability / Durability
  • Clean emissions
  • ‘Affordability’

  (acceptance on market)

• Motorsport can be a show case and an early proving ground supporting the technology message.

• Racing fuel and lubricant specifications are sometimes ahead of road car specifications.
• Conventional fuels from crude oil will further dominate over the next 20 years.

• CO2 reduction, emissions, sustainability and energy efficiency, are the core drivers for future fuels, also for racing fuels.

• Diesel racing will further grow, as providing a significant contribution to energy efficient ("low CO²") racing.

• Shell is supporting the Global Race Engine Development

  • Motorsport Diesel Fuels will contain synthetic (as GTL) - acting as a bridge to advanced bio components.

  • Motorsport Gasoline Fuels: Higher Ethanol blends – RON/MON spec. to be watched to understand knock issue. Increased use of cellulosic Ethanol.

• Shell is investing in technologies and partnerships and is a Leader in future fuel technology, backed up by our technical cooperation in Motorsport.

• What we learn on the track is used to improve and create new fuels for the road to the benefit of the 20 mln+ drivers every day who fill up at Shell.