ALTERNATIVE FUELS FOR SUSTAINABLE MOBILITY

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### European targets of GHG emissions reduction against global warming

**Energy & climate package**
- 20% of GHG in 2020 (vs. 1990)
- 40% of GHG in 2030 (vs. 1990)

**Energy & climate package**
- 30% of GHG in 2030 (vs. 2005) for non-ETS sectors, including transport

**White Paper on transport** (non binding)
- 60% of GHG in 2050 (vs. 1990)

**Regulation 443/2009**
- 95 g CO\(_2\)/km max for new Passenger Cars in 2021, and higher objectives after

**Regulation 510/2011**
- 147 g CO\(_2\)/km max for new Light Duty Vehicle in 2020, and higher objectives after

**Still under discussion** (VECTO)

### Multiplication of restricted traffic areas to improve air quality

- Vehicle classification by level of "exhaust cleanliness"
- City tolls
- Advantages for clean vehicles

*Source: BIPE, 2015*
From light vehicles to trucks, there are three types of solutions:

**Increase energy efficiency of vehicles**
Aerodynamics, weight decrease, energy recovery, engine optimization, hybridization, driving assistance, premium fuels
→ Still significant gains to harvest in the medium/long term

**Incorporation of fuel products of renewable origin**
Biofuels, biomethane, electricity from renewable sources…
→ The incorporation of renewable products can decrease GHG emissions

**Technology diversification**
Natural gas, compressed (CNG) or liquefied (LNG), electro mobility, hydrogen and fuel cells…
→ A direct effect on local pollutant emissions for certain technologies
PERFORMANCE FUELS
TOTAL EXCELLIUM
Vehicles whatever the generation are sensitive to fouling
Fuels may incorporate more and more biofuels
Customer expectations for high quality fuels increase

Total R&D develops and improves its high quality fuels to a constantly moving environment

TOTAL EXCELLIUM: high quality fuels that bring exceptional cleanliness to the engines for:
- Longer lasting engines*
- Less consumption*
- Less pollutant and CO₂ emission*

* In comparison to a non additized fuel
DEPLOYMENT IN 37 COUNTRIES WORLDWIDE (June 17)

Americas
Dominican Republic, Puerto Rico, Virgin Islands

Europe
Andorra, Belgium, France, Germany, Italy, Luxemburg, The Netherlands, Poland, Turkey

Africa
Botswana, Burkina Faso, Cameroon, Chad, Ghana, Ivory Coast, Kenya, Lesotho, Mali, Mauritius, Morocco, Namibia, Niger, Senegal, Sierra Leone, South Africa, Swaziland, Togo, Uganda

Asia Pacific
Cambodia, China (Beijing, Wuhan), Fiji, Macau, New Caledonia, Philippines

MS/SMR/PROD 2017
**WHAT’S NEW FOR BIOFUELS?**

**Evolving European regulations**

- Introduction of 2 new fuels standards:
  - EN 15940 for paraffinic diesel as HVO
  - EN 16374 for B10

- Member states have to translate these standards through their NSB and are then free to allow the distribution of these fuels.

**Increasing production of HVO and bionaphta**

- New European framework for biofuels:
  - First draft of RED II
  - Final regulation end of 2018 or 2019

- Difficult to now know what would be the future regulation.

Unlike FAME, HVO and bionaphta are pure paraffin → Drop-in molecules (HVO is only limited in EN590 by density) → very good properties as fuels.
NATURAL GAS FOR VEHICLES
NATURAL GAS FOR VEHICLES - NGV

Natural Gas for Vehicles:

Alternative fuel to petrol and diesel for all land-going applications (light vehicles, heavy duty vehicles, off-road vehicles)

Composition (depending on source):

Methane (over 80%), then above all ethane, propane

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Compressed at 200 bar

CNG

(1L Diesel ↔ 5L CNG)

- CNG logistics: Gas pipeline network
- CNG vehicle storage: Pressurised cylinders
- CNG vehicles: (P_max < 400 hp*)
- CNG range: 300-570 km

*IVECO Stralis NP

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Liquefied at -160°C

LNG

(1L Diesel ↔ 1.8L LNG)

- LNG logistics: Transport by truck
- LNG vehicle storage: Cryogenic tank
- LNG vehicles: (P_max < 400 hp*)
- LNG range: 700-1500 km
- LNG Special feature: Boil-off

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An alternative fuel driven by 5 main boosters

Among the first reasons, a limited environmental impact

- Compliance with the strictest standards. Same performance, even better, than a diesel with AdBlue® and DPF regarding NOx and particulate emissions
- Noise reduction by 50%
- The more biomethane is incorporated, the less CO₂ is globally emitted

Natural gas is the short term credible alternative to diesel, especially for road transportation
CNG AND LNG FOR LAND TRANSPORT
The Total Group’s vision

**LV / LDV Markets**
**NGV – Urban and Regional**

- **Simplicity and safety of operations** in the refuelling station
- **Sites easily accessible** to respond to usage requirements
- **Financial benefit (TCO)**
- **Compliance with environmental and health constraints and decision-makers’ requirements**

**NGV - Long Distance**

- **In pursuit of range improvements**
- **Financial benefit (TCO) under intensive usage**

**VISION**

- **Need for an intensive refuelling station network, synergies with our existing sites**
- **Complementarity with our conventional fuel offers and our refuelling services in stations**
- **Mature station technology and supply**
- **Lower HSE exposure** for CNG vs LNG refuelling operations

- **Network on major traffic routes**
- **Favoured by countries which have developed or planned infrastructures**
- **HSE issues** relating to more stringent refuelling operations than for CNG
Excluding Germany, NGV growth perspectives are driven by increasing HD demand. Progression for CNG LD for markets in Belgium, Netherlands and positive perspectives for Germany.
E-MOBILITY
The BEV market is an emerging market with a very fast growth (2011-2016: +64% / year), concentrated in 6 countries. China is the region where the EV growth was the most significant in 2016 (+75% vs. 2015). In Europe, the EV growth was still positive in 2016 but slowed down in comparison to the previous years.
CUSTOMER USES OF ELECTRIC CHARGING POINTS

**Private charging points**
> 85% of charges

**Public charging points**
- Slow charge → 10% of charges
- Fast charge → <5% of charges

**MAIN CHARGING POINT**
- Home
- Condos
- Workplace

**CONVENIENCE CHARGING**
- Shopping centers
- Street / Car park

**EXTENSION OF RANGE**
- Service stations

The customer’s main charging point is at home or at the workplace. Fast charging points will mainly be installed along major highways for top-off or emergency charges on longer distances.

* Sources: RENAULT, PORSCHE, TESLA, Valeo, IEA, Orange, Idaho National Laboratory, Observatoires Mobilité BIPE, Roland Berger, NPE
E-MOBILITY: THE CUSTOMERS AND THEIR NEW NEEDS

1. I am going to use electric cars as part of my company fleet – How can I manage my electric cars alongside my conventional vehicles?
2. I need to take a long-distance trip – Where will I find recharging points along the way?
3. I charge my car at many different points – How can I keep track of and pay the various electricity bills for my car?
4. There is a growing demand for public charging points – How can I meet this need and turn it into a business opportunity?

1. Providing access to Europe’s largest network of public charging points with GR and Eurotrafic cards
2. Equipping our stations along the major highways
3. Providing an offer of electricity for mobility, enhanced by additional services such as intelligent invoicing
4. Seizing potential opportunities in slow public charging

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FAST CHARGING TECHNOLOGIES

FAST CHARGING

- 50 kW (Equivalent capacity: urban 10 Flats)
- 120-150 kW (Equivalent capacity: highway 30 Flats)
- <350 kW

SUPER FAST

- Tesla supercharger
- 100 km: 30 – 35 min
- 30 min: 70 – 100 km
- 240 – 330 km

ULTRA FAST

- Announced by OEMs (from 2018 onwards?)
- 100 km: 4 – 8 min
- >300 km

Evolution of charging capacities to insure an optimal client experience.
For superfast 150 kW charging, the electric power requirement equals the needs for a 30-unit residential building.
H2-MOBILITY
THE HYDROGEN POWERED VEHICLE, ANOTHER TYPE OF ELECTRIC VEHICLE

The hydrogen vehicle is powered by a fuel cell (Fuel Cell Electric Vehicle - FCEV)

The advantages of the hydrogen vehicle over the battery electric vehicle

BEV – 2020
(eg. Renault ZOE)

H2
(eg. Toyota Mirai)

Classed as a Zero Emission Vehicle, the hydrogen vehicle can complement the automakers’ vehicle portfolio. The usage of a hydrogen vehicle is very close to that of a combustion engine vehicle, and it requires a service station network similar to the conventional service station network.
THE H2 CHALLENGES: COSTS AND GREENHOUSE GAS EMISSIONS

Vehicle, Infrastructure and Fuel Costs

A main challenge for hydrogen lies with the reduction of costs associated to its production, the required retail infrastructure and hydrogen vehicles.

Even if the fuel cell price was divided by 2, the vehicle price would still be high compared to other technologies.

Well-to-Wheel Greenhouse Gas Emissions

In order to reduce WTW GHG emissions as compared to conventional fuels, hydrogen needs to be produced using renewable sources (« green » electricity or biogas) or natural gas linked to Carbon Capture and Storage (CCS).

This promising alternative fuel needs to be integrated to the European political R&D agenda in order to achieve more rapidly the technological and economical maturity of decarbonized hydrogen production.
WORLD HYDROGEN VEHICLE MARKET & TOTAL ACTIVITIES

CURRENT SITUATION  (MID 2016)

USA
• 50+ H2 stations
• 500 FCEV

South Korea
• 10+ H2 stations
• 40 FCEV

Japan
• 85+ H2 stations
• 600 FCEV

Germany
• 30+ H2 stations
• 100+ FCEV

Hydrogen Refuelling Stations Worldwide
(public and private H2 stations)

H2 VEHICLES AVAILABLE AND PROJECTS

100% H2 propelled vehicles available

Range-Extender 3 Vehicles available

Projects

JV  H2 MOBILITY GERMANY

- H2M Germany foundation in 2015 along with 6 shareholders
- 12 H2 stations within Total German network
- Target 100 H2 stations by Q1-2019 with ~25% in Total network
- Final target  H2M: 400 H2 stations and 250 000 FCEV

PRODUCTION FORECASTS FOR TOYOTA

2015: 1,000 Miraï
2016: 2,000 Miraï
2017: 3,000 Miraï
2020: aiming at 30,000 units/yr

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MULTI-ENERGY STATION IN BERLIN