Alternative fuels for road transport

IEA EGRD mobility: technology priorities and strategic urban planning workshop
22 - 24 May 2013, Finland

Tobias Denys
VITO
Outline

» VITO
» European context
» Overview of alternative fuels
» FP7 LNG demonstration project
European context
European context

Let’s start in 2010...

→ EC communication “A European strategy on clean and energy efficient vehicles”
  » Promotion of clean and energy efficient mobility on the EU level
  » > 40 actions in the field of legislation, research, standardization, etc. for:
     » Conventional ICE (eg. CO₂-legislation, alternative fuels)
     » Ultra-low carbon EV & H₂ (eg. standardized recharging plug)
European context

  - Alternative fuel options for substituting oil as energy source for propulsion in transport are:
    - EV/H₂, and liquid biofuels as the main options
    - Synthetic fuels as a technology bridge
    - CH₄ (natural gas and biogas) as complementary fuels
    - LPG as supplementary fuel
  - For road transport, this means:
    - EV for short distances
    - H₂ and CH₄ up to medium distance
    - Biofuels/synthetic fuels, LNG and LPG up to long distance
European context

→ **White Paper on Transport (2011)**
  » Presents the Commission’s vision for the future of the EU transport system and defines a policy agenda for the next decade
  » By 2050, key goals will include (a.o.):
    » No more conventionally-fuelled cars in cities
    » A 60% cut in transport emissions
  » Alternative fuels as defined by EGFTF
European context

  - Establish EU-wide minimum coverage of refuelling infrastructure for the main alternative fuels
  - Implementation of harmonized standards for the main alternative fuels
  - Align policy and public/private funding and taxation in the field of alternative fuel infrastructure

  “Targets for MS with regard to alternative fuel infrastructure is considered a feasible path forward for ensuring the availability of alternative fuels”
European context

EC communication “Clean Power for Transport: a European alternative fuels strategy” (2013)

The Communication lays out a comprehensive alternative fuels strategy for the long-term substitution of oil as the primary energy source for transport.

- Alternative fuel infrastructure
- Common technical specifications
- Addressing consumer acceptance
- Addressing technological development

- Alternative fuels as defined by EGFTF (- LPG)
## European context

<table>
<thead>
<tr>
<th>Range</th>
<th>Urban</th>
<th>Short</th>
<th>Medium</th>
<th>Long</th>
<th>Short</th>
<th>Medium</th>
<th>Long</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>LNG</td>
</tr>
<tr>
<td>Electricity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biofuels</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
European context

→ Proposal for a “Directive on the deployment of alternative fuels infrastructure” (2013)

» Legislative proposal on infrastructure: each MS shall adopt a national policy framework for the market development of alternative fuels and their infrastructure
  » support the build-up of alternative fuels infrastructure
  » support research, technological development and demonstration

» Sets binding targets for the build-up of alternative fuels

» Ensure clarity on consumer information (labelling, compatibility, …)
European context

» Infrastructure build-up by 2020
  » A minimum number of recharging points for EVs are put in place, with at least 10% publicly accessible
  » A sufficient number of H\textsubscript{2} refuelling stations, with a maximum distances of 300 km
  » A sufficient number of CNG refuelling stations with maximum distances of 150 km
  » LNG refuelling points for road transport vehicles along the TEN-T Core Network, with a maximum distance of 400 km
  » Complying with common technical specifications
TEN-T EU Core Network...

» ... is a multi-modal transport network
» ... will remove bottlenecks, upgrade infrastructure and streamline cross border transport operations
» ... will improve connections between different modes of transport
» ... will contribute to the EU's climate change objectives
» ... is to be completed by 2030
European context

» Targets for each MS have been defined according to:
  » Current vehicle fleet
  » National targets
  » Share of population in urban areas

» Example: Belgium in 2020
  » Electricity: 210,000 recharging points (10% publicly accessible)
  » Hydrogen: 1 existing station, 3 stations to be built
  » CNG for vehicles: 9 existing stations, 10 stations to be built
  » LNG for trucks: 1 existing station, 2 stations to be built
European context

→ **Renewable Energy Directive**
  » 10% renewable energy in transport by 2020
  » Biofuels and green electricity

→ **Fuel Quality Directive**
  » to reduce the greenhouse gas intensity of transport fuels
  » sustainability criteria for biofuels

→ **Proposal for Energy Taxation Directive**
  » CO₂ emissions and energy content taken into account

→ ...
Overview of alternative fuels
Alternative fuels – LPG

» Proven technology
» By-product of hydrocarbon fuel chain
» Interesting WTW GHG emissions, low air quality impact
» Future: possibly from biomass?
» Currently most widely used alternative fuel in EU
  » 3% of the fuel for cars, 5 million cars
  » > 27.000 filling stations
Alternative fuels – electricity

» Short range road transport – passenger cars & delivery vans & city busses?
» Promising technology
» Can be considered as the cleanest fuel (E-production!!!), no local emissions
» Demonstration projects EU wide
» Large part of infrastructure already exists: electricity grid

Challenges
» Battery technology (E-density, temp sensitivity, ...)
» Cost of the vehicles/batteries
» New business models?
» Build-up of charging infrastructure (slow charge vs. fast charge)
» Smart grids to cope with increasing E-demand & renewable (and mostly intermittent) E-production
Alternative fuels – electricity
Alternative fuels – hydrogen or H₂

» Same propulsion technology as EV
» E-storage in H₂ instead of battery
» Electricity production in fuel cell
» Longer range and faster recharging then EV
» H₂-production determines environmental benefit, no local emissions

Challenges:
» New infrastructure needed for H₂ production, distribution and storage
» Cost-competitive fuel cells
» On-board H₂ storage
» Refuelling infrastructure
Alternative fuels – biofuels

» 1st generation: biodiesel & bio-ethanol
   » Controversial: competition with food & sustainability uncertain
   » Mainly blends with fossil fuel, minor engine modification for high blends
   » GHG benefits uncertain
   » Economically viable only within MS incentive schemes
   » Will be limited in the future...

» Future generation: synthetic fuels (eg. FT diesel), ethanol, HVO, ...
   » Waste streams (residues, animal fat, ...), ligno-cellulosic biomass, non food feedstock (such as algae, jatropha)
   » Evolution slower than expected
   » Economical viability & environmental benefits uncertain
   » Large scale demo needed → financing?
Alternative fuels – methane or CH$_4$

» CNG for short & medium distance
  » Passenger cars, vans, city busses, distribution trucks
  » Proven technology
  » Air quality benefits greater than GHG benefits
  » Biogas/biomethane also great GHG benefits
  » Economically viable (low excise duties...)

» LNG for long distance road transport
  » 3 times energy density CNG → long distance trucks
  » <100 trucks & <40 stations in the EU
  » Refuelling stations independent of gas grid
  » Dual fuel & dedicated engines
Alternative fuels – Well to Wheel

Well to tank

Tank to wheel
Passenger car

CAR WTW Global Warming Potential

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>WTT</th>
<th>TTW</th>
</tr>
</thead>
<tbody>
<tr>
<td>petrol</td>
<td>180</td>
<td>160</td>
</tr>
<tr>
<td>diesel</td>
<td>180</td>
<td>160</td>
</tr>
<tr>
<td>electricity (EU mix)</td>
<td>140</td>
<td>120</td>
</tr>
<tr>
<td>electricity (Be mix)</td>
<td>90</td>
<td>70</td>
</tr>
<tr>
<td>electricity (sun, wind, hydro)</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>CNG</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>CBG</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>
Passenger car

CAR WTW external costs pollutants

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>€/km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrol</td>
<td>0.016</td>
</tr>
<tr>
<td>Diesel</td>
<td>0.012</td>
</tr>
<tr>
<td>Electricity (EU mix)</td>
<td>0.018</td>
</tr>
<tr>
<td>Electricity (Be mix)</td>
<td>0.016</td>
</tr>
<tr>
<td>Electricity (sun, wind, hydro)</td>
<td>0.008</td>
</tr>
<tr>
<td>CNG</td>
<td>0.006</td>
</tr>
<tr>
<td>CBG</td>
<td>0.004</td>
</tr>
</tbody>
</table>
FP7 LNG demonstration project
LNG Blue Corridors

» European Expert Group on Future Transport Fuels (2011)
  » “European Blue Corridors should be investigated for the build-up of
    Liquefied Natural Gas (LNG) infrastructure to support the use of
    liquefied methane gas in medium and long distance freight transport.”

» EU FP7 DG MOVE call 2012
  » “to perform a large-scale demonstration in order to facilitate a broad
    market development for heavy duty trucks running with liquefied
    methane”
### EU FP7 call 2012: “Demonstration of HDV running with liquefied methane”

<table>
<thead>
<tr>
<th>Project:</th>
<th>8</th>
<th>4</th>
<th>05/13</th>
</tr>
</thead>
<tbody>
<tr>
<td>scope</td>
<td>M€</td>
<td>years</td>
<td>start</td>
</tr>
<tr>
<td>EU</td>
<td>4</td>
<td>27</td>
<td>12</td>
</tr>
<tr>
<td>corridors</td>
<td></td>
<td>partners</td>
<td>countries</td>
</tr>
<tr>
<td>partners</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>countries</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LNG Blue Corridors Goals

» Oil substitution

» Reduction of GHG emissions

» Increase of E efficiency

» Euro VI

» Facilitate market development
Long distance truck

Truck WTW Global Warming Potential

- Diesel:
  - WTT: 1000 g CO2 eq/km
  - TTW: 900 g CO2 eq/km

- LNG:
  - WTT: 800 g CO2 eq/km
  - TTW: 700 g CO2 eq/km
Long distance truck

Truck WTW external costs pollutants

€/km

- diesel
- LNG

WTT
TTW
Long distance truck

Vehicle speed [km/h]

- Euro V Diesel
- Euro V Diesel EEV
- Euro V LNG

NOₓ/CO₂ [g/kg]
LNG Blue Corridors WP’s

» Work Package on LNG Vehicles
  » Euro VI dual fuel & dedicated engines
  » Identification of other LNG vehicle & engine technologies

» Work Package on LNG Fuel Logistics
  » Guideline and Best practices of LNG refuelling stations
  » Identification of EU LNG network and supporting infrastructure
  » Technology and processes to secure full compatibility between fuel, refuelling stations and vehicles

» Work Package on Harmonization and Standardization
  » State of the art & identify limitations and missing aspects
  » Further improvement and development of common EU standards and regulations
LNG Blue Corridors WP’s

» Work Package on analysis & evaluation
  » Quantitative & qualitative evaluation of the demonstration activities
  » Provide recommendations for a broad market development

» Work Package on Roadmap to LNG Blue Corridors
  » Define new corridors & optimize existing
  » Further market development
LNG Blue Corridors

» Core of the project: demonstration activities
  » 4,8 M€ (of the 8 M€)
  » Direct subsidy for 100 heavy duty vehicles
  » 14 LNG filling stations (in addition to existing)

» 4 corridors:
  » WEBblue: West-East corridor
  » SONOR: South-North corridor
  » ATBlue: Atlantic corridor
  » MEDBlue: Mediterranean corridor
LNG Blue Corridors
Thank you for your attention!

tobias.denys@vito.be