Alternative fuels – Beyond biofuels. Options for heavy duty road vehicles

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E4tech provides strategic advice in clean energy & vehicles

- International consulting firm, offices in UK and Switzerland
- Focus on sustainable energy
- Established 1997, always independent
- Deep expertise in technology, business and strategy, market assessment, techno-economic modelling, policy support...
- A spectrum of clients from start-ups to global corporations
Energy transitions take time and have in the past been driven largely by economics

Share of US Energy Consumption 1780-2010

Source: O’Connor & Cleveland, Boston University
There are strong reasons to consider new road fuels, but change is largely in the hands of policymakers.

Efficiency and modal shift alone cannot deliver required GHG reductions.

Air quality is a health problem with potential for social unrest.

Source: EC (2015)

Source: Nanjing Air Quality Index - aqicn.org (23/2/16); Guardian (2014)
Alternatives to gasoline and diesel cannot be selected at will, a collaborative approach is needed.

Collaboration:
- Auto industry preference
- Fuel producers
- Fuel retailers
- Government
- Consumers
- NGOs

Roll out:
- Policy support

Planned transition:
- Planned transition
In future a one size fits all solution is unlikely. Heavy duty vehicles have fewer options

- Vehicle energy requirements and range narrow the suitable options
- Heavy duty vehicles to consume >40%* of total EU road fuel by 2030
- CO$_2$ emissions from HD vehicles forecast to be >>40% of road total due to lack of low carbon fuels in this sector

*Source: E4tech analysis – A harmonised Auto-Fuel biofuel roadmap for the EU to 2030 (2014)
Liquid fuels are inherently attractive, and biofuels have been considered the main low carbon route.
There are many low carbon fuels, which are classified by the level of renewability of their components.

Examples

 Diesel, gasoline, Natural Gas

 Fuels <50-60% GHG saving*
  - Ethanol, biogas, methanol
  - HVO, FAME
  - Enerkem (alcohols, diesel)
  - Chemrec (DME), BioMCN (methanol)
  - Lanzatech (Ethanol, jetfuel)
  - CRI (methanol), Audi e-gas

*50% from 2017. 60% for new build plants from 2018

Source: E4tech and Ecofys Novel Low Carbon Transport Fuels and the RTFO: sustainability implications, 2015
Sustainable liquid fuels could help lower GHG and pollutant emissions, but economics depend on taxation

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Comb. process</th>
<th>EU VI capable</th>
<th>Range per litre</th>
<th>Liquid</th>
<th>Energy costs (pre tax)</th>
<th>Sustainable</th>
<th>Powertrain Technology developers</th>
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</thead>
<tbody>
<tr>
<td>Diesel</td>
<td>CI</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>All</td>
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<tr>
<td>Biodiesel, HVO etc.</td>
<td>CI</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td></td>
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<tr>
<td>LNG</td>
<td>Dual Fuel</td>
<td>No(^1)</td>
<td>Cryo</td>
<td>Yes</td>
<td>Vayon</td>
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<td>No(^1)</td>
<td>Cryo</td>
<td>Yes</td>
<td></td>
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<tr>
<td>SI, (\lambda=1)</td>
<td>Yes</td>
<td>Cryo</td>
<td>Yes</td>
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<td>Methanol</td>
<td>Dual Fuel</td>
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<td>Yes</td>
<td>Wartsilla, MAN (shipping)</td>
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<td>CI(^2)</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Scania, VTT</td>
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<td>DME</td>
<td>CI</td>
<td>Yes</td>
<td>low pressure</td>
<td>Yes</td>
<td>Volvo, Denso, Ford</td>
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</tbody>
</table>

1) Due to methane slip
2) With ignition improver

- Several sustainable liquid fuels could be commercially attractive under the right taxation regimes
Roadmaps aid fuel transition planning

- Roadmaps are increasingly used to build consensus around transitions
- Other sectors also approaching fuels this way
Pilot trails, where major stakeholders collaborate, aid fuel introduction
Various liquid fuels can provide GHG solutions for Heavy Duty transport if this transition is carefully planned

• Heavy Duty road transport is a significant GHG emission contributor and set to grow in relative terms

• Low carbon fuel choice for this sector is limited compared with light duty vehicles

• A number of sustainable liquids can provide suitable alternatives to diesel under the right taxation conditions

• An integrated fuel infrastructure and technology plan is required to aid transition planning

• Pan EU pilot trials will aid actual transition
E4tech – strategic thinking in sustainable energy

Questions?

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