Roadmap sustainable biofuels for shipping

Which strategy to follow?

Loes Knotter

22 January, 2019
Fuels of the Future, Berlin
Key-take away message:

Biofuels are already a cost-competitive low carbon fuel option for shipping containing no (or only limited) sulphur. However, a ‘dedicated’ marine low carbon fuel has not yet been developed.

Design criteria:

• Fuel on basis of extensive feedstock base
• Price competitive conversion
• Compatibility with existing engines
• New engines / new vessels have other options
• Biorefinery: multiple markets
• Development to e-Refinery and electrochemical fuels
Netherlands Platform Sustainable Biofuels

- Independent knowledge and innovation platform on all biofuels and renewable fuels
- Initiated partly financed by the NL Ministry of Infrastructure and Water Management
- An association of sector players,
- Founded October 2016

- Mission: stimulating demand and deployment of renewable fuels and their production
NL International bunkering outnumbers the transport fuels on Dutch territory

Source: CBS Statistic Netherlands
Energy in the EU international shipping sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>Netherlands</th>
<th>EU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Int. shipping</td>
<td>Road &amp; Rail</td>
</tr>
<tr>
<td>Energy use (PJ)</td>
<td>512 PJ</td>
<td>415 PJ</td>
</tr>
<tr>
<td>CO2 emissions (mln tCO2-eq)</td>
<td>40.5</td>
<td>29.4</td>
</tr>
</tbody>
</table>

Source: Eurostat: (data for 2016)
Two recent Platform publications

www.platformduurzamebiobrandstoffen.nl/infotheek
Shipping CO$_2$ emission reduction potential from individual measures

A recent review of around 150 studies by Bouman et al (2017) pointed to biofuels as having the highest CO$_2$ emissions reduction potential, compared to other energy efficiency and alternative fuel options.
E4tech evaluation of biofuel options for shipping

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Readiness of fuel production</th>
<th>Compatibility with current engine and vessel (typical to sector type)</th>
<th>GHG reduction potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Established and used widely,</td>
<td>Established and used widely, readily available and fully developed.</td>
<td>No modification to engine or infrastructure - Drop in fuel or high blends</td>
<td>&gt;90% GHG savings</td>
</tr>
<tr>
<td>readily available and fully</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>developed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercially available but</td>
<td>Commercially available but not in wide use, could be further developed.</td>
<td>Considerable changes to engine, fueling system and/or storage/infrastructure, or low blends</td>
<td>60-90% GHG savings</td>
</tr>
<tr>
<td>not in wide use, could be</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>further developed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working demonstration plant</td>
<td>Working demonstration plant</td>
<td>New vessel required</td>
<td>&lt;60% GHG savings</td>
</tr>
</tbody>
</table>
Biofuels based on waste oils and fats

- All the advantages of drop-in
- Main barrier: limitations on feedstocks
- HVO - compatible with engines, commercial production
- SVO - compatibility with deep sea engines, modifications necessary for use in short-sea and inland shipping vessels
- FAME/biodiesel - commercially available and widely used and more suitable for use in diesel engines than SVO
  - ISO 8217 - versus statement Wärtsila

GoodFuels brings bio-MGO/bio-HFO to the market
Alcohols: ethanol/methanol (DME)

- Global availability (ethanol / methanol)
- Potential extensive feedstock base, including e-methanol
- Substantial barrier: incompatibility with existing engines/infrastructure
- For new vessels: methanol/ DME-vessel is a lower cost option than LNG-vessel

With the Methanol Institute we work on operational aspects of methanol infrastructure in ports.
bio-LNG/bio-CNG

- For LNG-vessels bio-LNG is an interesting biofuel option.
- The same applies for bio-CNG, however more proof of concept is necessary according to E4tech. It sees the CNG-option more suitable in short sea and inland shipping.
New options FT Diesel / Upgraded Pyrolysis Oil

- Drop-in capabilities and extensive feedstock base
- Further technology developments required
- In theory, it is possible to produce any intermediary between crude and fully upgraded pyrolysis oil to produce a suitable (cost-competitive) fuel for particular engines, but this would require detailed testing with an engine manufacturer.
Biofuel options for inland shipping

- UPO
- FT
- DME
- EtOH 2G
- Bio-MeOH**
- Bio-LNG/CNG **
- HVO*
- FAME*
- EtOH 1G

GHG emission reduction potential: Very high, High, Medium

* Can achieve high GHG emission saving when using waste oils
** Readiness of fuel production depends on the production route
Biofuel options for deep-sea shipping

- **UPO**
- **SVO**
- **HVO**
- **Bio-MeOH**
- **DME**
- **EtOH 2G**
- **bio LNG**
- **EtOH 1G**
- **FAME**

**GHG emission reduction potential:**
- Very high
- High
- Medium
- Added/moved for deep-sea

**Ready of fuel production:**
- *Can achieve high GHG emission saving when using waste oils*
- **Readiness of fuel production depends on the production route***

**Compatibility:**
- Low
- High

**Deep-sea shipping**
Comparing GHG-reduction potential

Figure 4-2: GHG emission factors for marine fuels and selected biofuels\textsuperscript{220,221,222,223}
Comparing prices

Figure 4-3: Prices and production costs of marine fuels and selected biofuels. Prices are in light purple and production cost estimates in dark purple\textsuperscript{225,226}. 
How to get bio and renewable fuels to the international shipping market?

• Nothing so practical as (international) legislation
• IMO GHG Reduction target -50% by 2050. Demand from the shipping sector incentivates availability. (start already uptake of low carbon fuels in the short-term and mid-term measures)
• Missed opportunity for not connecting GHG reduction ambition with Sulphur regulation
• Dutch inland shipping sector is proposing a 30% GHG-reduction target by 2030 in national implementation of Red 2
• RED 2: 1,2 multiplier for shipping
Competition for biofuels between transport sectors, EU

EU Biofuel deployment under RED II (baseline)

- Advanced Aviation (IX-A)
- Used F&O Aviation (IX-B)
- Advanced Marine (IX-A)
- Used F&O Marine (IX-B)
- Conventional Marine
- Advanced Road (IX-A)
- Used F&O Road (IX-B)
- Conventional Road

Source: Grijpma, 2018
Competition for biofuels between transport sectors, the Netherlands

NL biofuel deployment under RED II (baseline)

Source: Grijpma, 2018
## Market segmentation

**GoodFuels Marine**

GoodFuels Marine is pioneer and global market leader for marine biofuels.

<table>
<thead>
<tr>
<th>Segment</th>
<th>Purchase drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dredging &amp; offshore wind</td>
<td>Green public procurement</td>
</tr>
<tr>
<td>Government</td>
<td>National GHG targets and energy security</td>
</tr>
<tr>
<td>Port authorities &amp; harbor services</td>
<td>Exemplary role model, air quality, regulation, inherent drivers</td>
</tr>
<tr>
<td>Pax transport</td>
<td>Green public procurement (ferries), passenger demands &amp; port access (cruise)</td>
</tr>
<tr>
<td>Inland waterways</td>
<td>Air quality regulation, CO₂ ambitions of cargo owners</td>
</tr>
<tr>
<td>Ocean freight</td>
<td>CO₂ ambitions of cargo owners</td>
</tr>
<tr>
<td>Boating &amp; yachting</td>
<td>Port's green reputation, air quality regulation &amp; intrinsic motivation of boat owners</td>
</tr>
</tbody>
</table>
Port of Rotterdam (PoR) energy transition programme

- Advocacy for alternative fuels
  - Dutch National policy: input green deal maritime sector / implementation RED2
  - EU (RED2)
  - IMO (MEPC - short term GHG measures)
  - World Ports Carbon Action Programma (international collaboration also on alternative fuels)

- PoR funding for demonstration Low Carbon Fuels in sea-going vessels. (€5 million 2019 - 2022) Launch Jan 2019

- Low Carbon Trade Lanes
  - Developing alternative fuel supply in partnerships on important seagoing trade lanes.
The transition for the NL petrochemical complex

Refinery 2050 Refining the clean molecule
Bio-refinery to maximise added value: co-producing bio-chemicals/materials and energy

SUSTAINABLE BIOFUELS TECHNOLOGY LAB

From gasification-based and biorefinery-based biofuel concepts to large-scale implementation of biofuels in all transport segments

- Create two strong biofuels development platforms by expanding existing gasification and bio-refinery infrastructure with the key options to produce biofuels
- Create sustainable alternatives for the Dutch fuel and chemical industry
- Ensure close cooperation with industry, universities, TO2’s (e.g. engine labs) and with national initiatives such as the expertise center for biomass gasification InVesta and Biorizon

Activities

- Gasification and (Organosolv) fractionation-based biorefining
- Bio-LNG production
- Fischer-Tropsch (FT) biofuel production
- Methanol biofuel production
- Bio-ethanol/Bio-butanol fuel production
- Novel furanics based fuel components
- Bio-heavy fuel oil production
- Cost reduction through co-production

From: A vision on Sustainable fuels for transport (SER vision program), 2014
What’s on the Roadmap Agenda:

• Address technical, economic and operational barriers to the use of biofuels in shipping

• Develop dedicated marine low-carbon biofuels taking into account:
  • Access to resources
  • Dedicated technology development for cost-competitive marine engine-fuel conversion
  • Development of bio-refinery / e-refinery business cases

• Dutch government intends 200 million EUR support for refineries for renewable fuel production (to be deployed in NL)
More information?

www.platformduurzamebiobrandstoffen.nl

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