Synthetic Transport Fuels

Power-2-Fuels: Opportunities for the production of synthetic fuels from renewable energy

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VoltaChem in 1 slide

- Public-Private *Shared Innovation Program* of 6M/year initiated in 2015 by TNO, ECN and Topsector Chemistry.

- Accelerate innovation and implementation of *electrification for achieving decarbonization* in chemicals.

- Initiate and facilitate *collaborative development* of technology and associated business models.

- Addresses both the *indirect and direct use of electricity* within the chemical industry, involving stakeholders from *chemicals, energy & equipment supply*. 
Agenda

- Introduction fuels for transport
- Synopsis Power to Fuels workshop (Sept. 2018)
- Discussion in two groups
- Wrap up
Introduction

Why synthetic fuels for transport?

• Global warming:
  – Max 2° → 60% CO₂ reduction in 2050
  – Max 1.5° → 95% CO₂ reduction in 2050

• Shortage of biomass / biofuels

• Battery electric only suitable for cars, city busses & distr. trucks

→ Synthetic fuels needed for Long haul trucks, Maritime and Aviation
EU policy

Renewable Energy Directive II

- conventional biofuels
- advanced biofuels
- biofuels from waste (capped)
- electricity & P-t-X

2020 2025 2030
Power-to-Fuel options for transport

- Wind
- Solar
- Other sustainable
- Nuclear

Electricity → Electrolysis → Synthesis

- Hydrogen
- Methane
- Methanol
- FT diesel
- Formic acid
- Ammonia
- ... (other liquid fuels)
- Circular H₂ carrier

- O₂
- H₂O
- CO₂
- N₂
Power-to-Fuel options for transport

Criteria for synthetic fuel choice:

– energy density and packaging
– Fuel price
– Energy efficiency
– Mass / bulk production & long term availability
– Safety (regulations)
Volumetric energy density

![Graph showing volumetric energy density comparison between different fuels including Diesel or FT diesel, Methanol, bio-LNG, liquid H2, NH3, H2 - 700 bar, and LOHC.]
Volumetric energy density

Space requirement for bunkers shorth sea ship

- H2 - 700 bar
- LOHC
- liquid H2
- NH3
- bio-LNG
- Methanol
- Diesel or FT diesel

max volume available

m3

Autonomie days

0 5 10 15 20 25 30 35

0 1000 2000 3000 4000 5000 6000 7000
**Timing?**

- **Biofuels**
- **Battery Electric**
- **H₂ (fuel cell)**
- **Power to Fuel, carbon based**
- **Power to Fuel, non-carbon based**
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New fuels should be main stream fuels agreed upon on a world-wide level. New fuels require a new distribution infrastructure.

Climate policies should be enforced through international regulations (IMO, EC, IATA).

Alternative fuels always take up more space on board of the vehicles ranging from a factor 2 to about 20.

Maritime and road vehicles can handle a range of fuels. For aircrafts this is a much larger challenge.
• (Power to) Methanol and (liquid) Methane look like good options, especially for maritime. Other options are Formic acid, NH3 and alternative H2 storage in liquids or salts.

• For maritime and aviation, it can take several decades to introduce a new fuel due to the long life time. For road vehicles this can be rather fast (5-10 years).

• Several end-users and manufacturers see the need for a reduction of transport activities and/or an increase in transport price.
Power-2-Fuels might be a good option to handle the flexibility needs for the electricity market in 2030.

Synthetic fuel production routes include among others the utilization of hydrogen and CO₂.

Gaseous synthetic fuels (like hydrogen) are moving through deployment towards maturity. Liquid synthetic fuels are still earlier in the development phase.

Indicative costs of production provide insight in the possibilities of certain synthetic fuels.
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• Wrap up
Discussion in two groups

What does the competition for renewable products between industry and transport mean for the choice of synthetic fuel for transport?

- Carbon or non-carbon based
- Timing or roadmap
- Recommendations for energy carrier
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Next steps

• VoltaChem will summarize all event learnings per breakout and overall.

• Depending on the outputs of the workshop specific follow-up will be done by the team.

• Some examples of possible follow-up:
  – Study on the electrification scenario’s for Europe.
  – Start of a community of practice on green hydrogen.
  – Initiation of a shared R&D program on CO$_2$ electrolysis.
  – Start of a cofunded project on paired electrosynthesis.
Power-2-Fuels Innovation Outlook

Central question: Which Power-2-X fuels for transport are promising how can they be developed faster in the light of the climate objectives?

- Requirements for the use of future P2X fuels
- State of the art technology and how do they relate to alternatives
- Development of value chains and new value cases
- Requirements for large-scale application

Proposed fuels: hydrogen, methane, methanol, FT-diesel, ammonia, formic acid

Planning: 2019
Soundboard Group

- Interviews (2x)
- Workshop (3x)
- Letter of support

Partner Group (light)

- Activities of the soundboard group plus:
  - Active role during organisation of the workshops (facilities etc)
  - Review white paper
  - Hours count towards project contribution

Partner Group (full)

- Activities of the partner group (light) plus:
  - Active in project execution
  - 12,5k cash contribution
Let’s energize innovation together!

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