P2X - Carbon neutral fuels
P2X - Carbon neutral fuels

Drivers

• Climate and air quality
  • Transition to electricity as primary energy source is taking place
  • Transition to full electric mobility in 20 years, however, is not possible (ships, airplanes, heavy
duty, and cars)
  • Biofuels are insufficient in global scope
  • Recycling of CO2 reduces the use oil and coal
• Cheap, unlimited electricity (solar and wind)
  • Cheap hydrogen
  • Renewable electricity requires system balancing, peak power & seasonal variation.
    Balancing of power can be done by engines and turbines running carbon neutral fuels
• CO2 Emission trading costs on fossil fuels
• Production of synthetic, carbon neutral fuels (P2X) is profitable is certain “sweetspots” (cheap
  hydrogen, cheap electricity)
P2X Fuels

Emerging demand
Shell aims to become world’s largest electricity company (Financial Times 13.3.2019)

Maersk will cut carbon emissions to zero by 2050

British Airways to offset carbon emissions from 2020, IAG invests in sustainable aviation fuels

Lufthansa pilots synthetic kerosine production

Shell, Neste, Wärtsilä, Finnair, St1, Kemira, Finnsementti and LUT university work together in project Industrial Pilot P2X Fuels at Joutseno

Carbon Recycling International (CRI) signed an agreement for CRI's first CO2-To-Methanol Plant in China to produce 180,000 tons of methanol and LNG annually.

LUT
- Wärtsilä, LUT University and Nebraska Public Power District to develop business case for alternative fuels. Final report delivered.
- LUT Feasibility study on investment of recycling CO2 at Joutseno P2 Fuels with leading Nordic firms
- LUT preliminary study on recycling CO2 at St1 Göterborg refinery (delivered and continues on Feasibility Study)

P2X Fuels
Timing and profitability
P2X Fuels - Timing of the demand

- Pricing
  - Methanol
    - Fossil approximately 400 EUR/tn
    - Renewable approximately 700 EUR/tn
  - Methanol to (total yield around 45%) of which
    - Diesel 50%
    - Kerosene 20%
    - Gasoline 20%
  - Aviation Kerosene
    - Fossil approximately 700 EUR/tn
    - Renewable approximately 2100 – 2800 EUR/tn

- Conclusion
  - Production of green drop-in fuels is very profitable
  - Demand is unlimited for the years to come

1) Andreas Teir, Renewable products -business area, development director
P2X Fuels

Production process – Industrial Pilot
P2X Joutseno Industrial Pilot

- **CO₂** capture
- **Electrolysis**
- **Water electrolysis**
- **LUT, Wärtsilä** Technology providers
- **Synthesis**
- **Storage**
- **Heat**
- **O₂** Balancing
- **Grid and Balancing**
- **Existing chemical industries**
- **Transport** (airplanes, ships, cars, lorries)
- **Small and medium size engineering companies**

**Finnsementti**
Lappeenranta

**Kemira**
Joutseno

**St1, Neste**
Finnair

**Finnair**
Shell

**27 000 tn/a**
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