‘e-Fuels in Industry’

The route to industrial value chains based on affordable renewable hydrogen

Dr. Andreas ten Cate
Program Director System Integration
Director for International Business Development
Andreas.tenCate@ISPT.EU

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ISPT & ‘e-fuels’ (Power-2-X)

- Industry-centered open-innovation network
- Operating in the triple-helix of industry – research – policy

- ‘e-fuels’ track record

2015

2016

2017

• Over 100 partner organisations
• Some of our most active partners in this field
Key Points from the Background Note – Industrial Perspective

• Feedstock or Fuel?

• Where does the Carbon come from?

• Transition timelines?
Renewable electrons to industry
Three green energy modes – many industrial challenges

Renewable feedstock is the key for industry
CIRCULAR CARBON

Institute for Sustainable Process Technology

COAL AS CARBON SOURCE
ORE
SCRAP METAL
NEW CARBON SOURCE
STEEL
LAUNDRY
CHEMISTRY
PLASTIC PRODUCTS
CO2 RE-USE AND STORAGE
CO2
The challenge in steel making – opportunity for chemistry?

\[ \text{H}_2 + \text{CO} + \text{CO}_2 + \text{N}_2 + \ldots \]

2 kg gas per kg steel
Other societal C-sources?

\[
\text{CO} + \text{H}_2 \rightarrow \text{Methanol}
\]

- Waste-to-Chemicals project
- Enerkem
- AkzoNobel
- Van Ganzewinkel
- AVR
- Air Liquide
- Port of Rotterdam
Methanol from Syngas from Steel waste gases

- EU Market for Methanol – 7,5 mta – of which EU production 2,5 mta
- \( \text{CO} + 2 \text{H}_2 \rightarrow \text{H}_3\text{COH} \)
- \( \text{H}_2 \) from external (green) source
- 7 mta steel mill \( \rightarrow \) 2,36 mta MeOH; 4,9 mta CO\(_2\) avoided; total CO\(_2\) capture ready 4,7 mta
- 1,5 billion € investment Capex, negative revenues
- CO\(_2\) avoidance cost – 136 (\( \text{H}_2 \) @ 3400 €/ton) to 46 €/ton (\( \text{H}_2 \) @ 1700 €/ton)
- Key technical challenge to separate CO – N2

**Diagram:**
- Steel mill waste gas
  - Sulfur removal
  - Inerts & CO\(_2\) separation
  - Synthesis loop
  - Distillation
- External \( \text{H}_2 \)
- Purge gas
- Water Methanol
Fischer-Tropsch Naphtha from Syngas from Steel waste gases

- EU Market for Naphtha – 450 mta of mixed products
- \( CO + 2H_2 \rightarrow -CH_2- + H_2O \)
- 7 mta steel mill \( \rightarrow \) 0,95 mta FT product; 3,5 mta \( CO_2 \) avoided; total \( CO_2 \) capture ready 4,7 mta
- 1,4 billion € investment Capex, negative revenues
- \( CO_2 \) avoidance cost – 280 (\( H_2 \) @ 3400 €/ton) to 160 €/ton (\( H_2 \) @ 1700 €/ton)
Route to products and back – bulk plastics

Fossile \[\text{Naphtha} \rightarrow \text{Conversion \\& Separations} \rightarrow \text{Polyethylene} \rightarrow \text{Polypropylene} \rightarrow \text{End-of-life}

\text{Synthetic from wastestreams} \rightarrow \text{Cracking} \rightarrow \text{Downstream processing} \rightarrow \text{Polymerisations}

H_2
Coherent program towards affordable green hydrogen

Technology development

Exploring limitations and possibilities of water electrolysis
Understanding scale-up economies of scale & numbers

MW scale electrolyser testing

GW scale concept

H2 supply chains

Matching supply and Demand for industrial use

Strategic opportunity scouting

ITM electrolyzer stack (2.2 MW)

Source: ITM POWER www.itm-power.com
Considerations on time path for transition (1)

- Economies-of-scale for Solar and Wind → growing investments in RE sector
- Scale-up and innovation for large-scale electrolysis is essential for Capex/Opex – follow in slip-stream of RE scale-out
- Truely large-scale (~GW) green H2 not before 2030 on-stream
- Blue H₂ may come available sooner – however – it should not hamper investment in acceleration of Green H₂ scale-up and numbering-up path – careful with setting right policy incentives
Considerations on time path for transition (2)

Focus on **circular carbon** – will need substantial support from

- Innovation on technology and operations/practices
- Right policy incentives
- Secure public support

For hard-to-transform industries:

- Re-use of waste-cases is impactful transition option when alternatives are not (yet) ready (in particular Steel-to-Chemicals vs. Direct Reduction)
- Industry – Capex intensive - 1 (or maybe 2) investment cycles until 2050 → timing of large-scale adoption is crucial
Thank you

www.ispt.eu

Andreas.tencate@ispt.eu