‘e-Fuels in Industry’

The route to industrial value chains based on affordable renewable hydrogen

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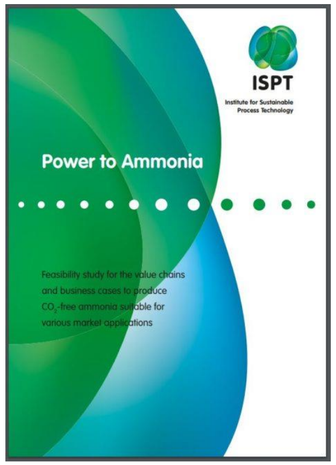
ISPT & ‘e-fuels’ (Power-2-X)

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

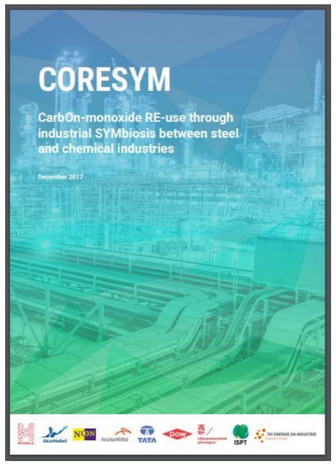
- ‘e-fuels’ track record

2015

2016



2017

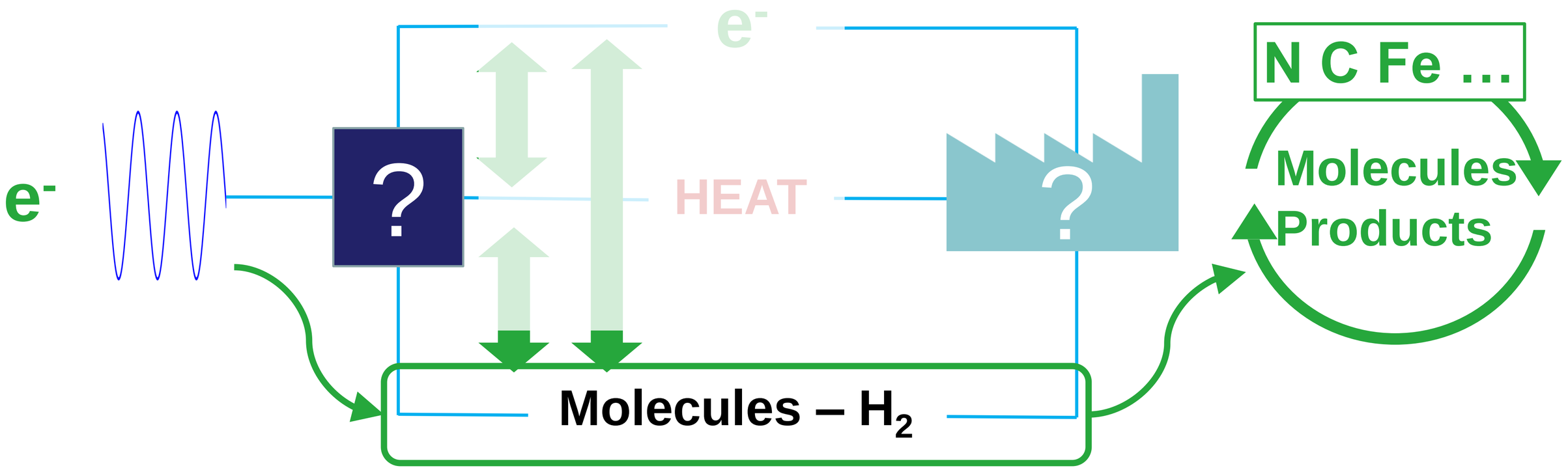


- ***Over 100 partner organisations***
- ***Some of our most active partners in this field***

Key Points from the Background Note – Industrial Perspective

- Feedstock or Fuel?
- Where does the Carbon come from?
- Transition timelines?

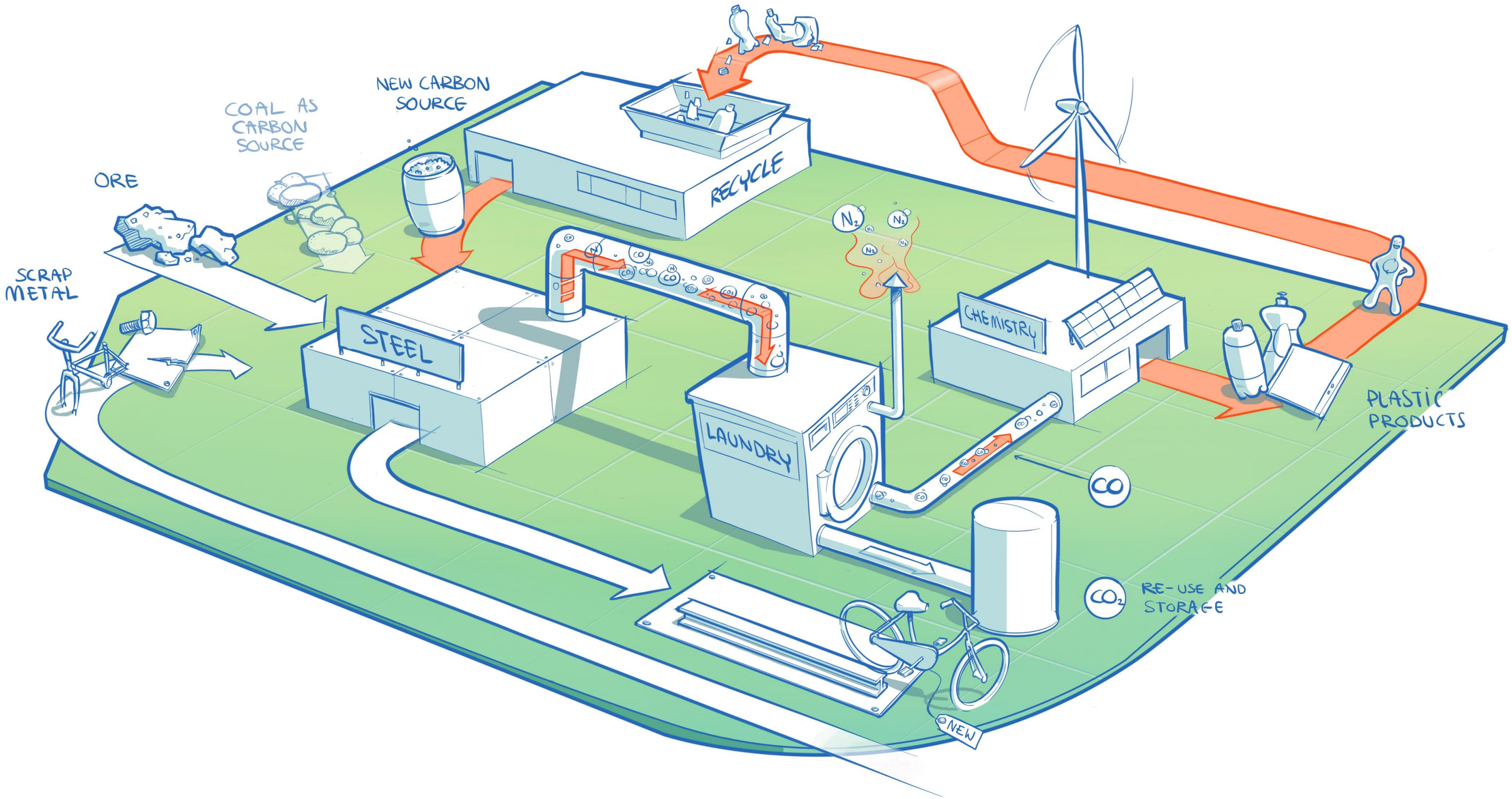
Renewable electrons to industry
Three green energy modes – many industrial challenges



Renewable feedstock is the key for industry

CIRCULAR CARBON

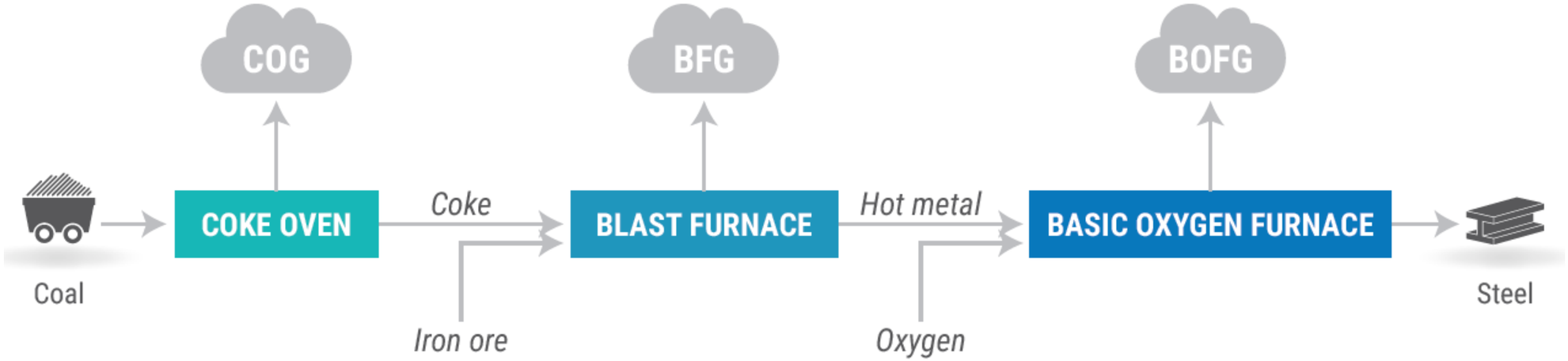
ISPT
Institute for Sustainable Process Technology



The challenge in steel making – opportunity for chemistry?

H_2 + CO + CO_2 + N_2 + …

2 kg gas per kg steel



Other societal C-sources?

$CO + H_2 \longrightarrow$ **Methanol**

<u>Waste-to-Chemicals project</u>

Enerkem

AkzoNobel

Van Ganzewinkel

AVR

Air Liquide

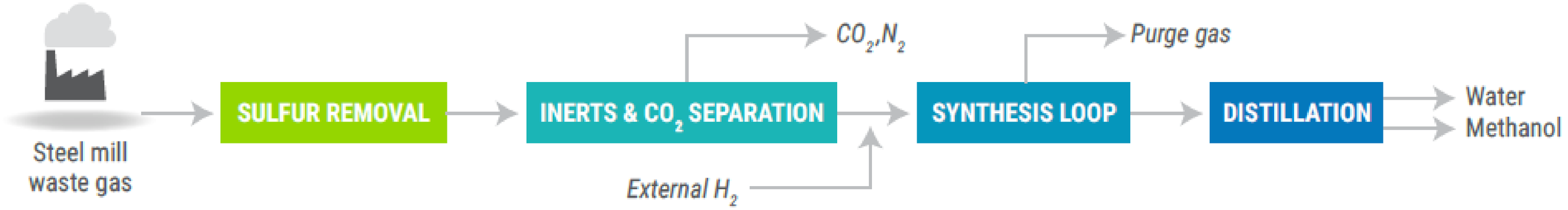
Port of Rotterdam

By Alex Marshall 2004, Clarke Energy Ltd - Originally uploaded to Wikipedia by Vortexrealm, here., CC BY-SA 2.5, https://commons.wikimedia.org/w/index.php?curid=2965770

Plastic waste picture – original location SMU website – http://blog.smu.edu.sg/academic/schools/smulkcsb/nudging-consumers-to-reduce-plastic-waste/

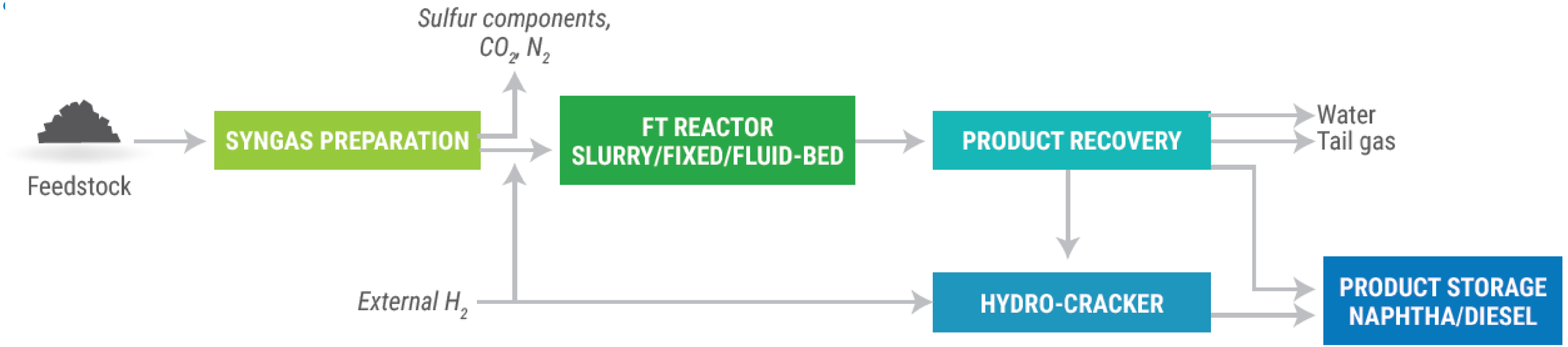
Methanol from Syngas from Steel waste gases

- EU Market for Methanol – 7,5 mta – of which EU production 2,5 mta
- $CO + 2\ H_2 \rightarrow H_3COH$
- H_2 from external (green) source
- 7 mta steel mill → 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 (H_2 @ 3400 €/ton) to 46 €/ton (H_2 @ 1700 €/ton)
- Key technical challenge to separate CO – N2

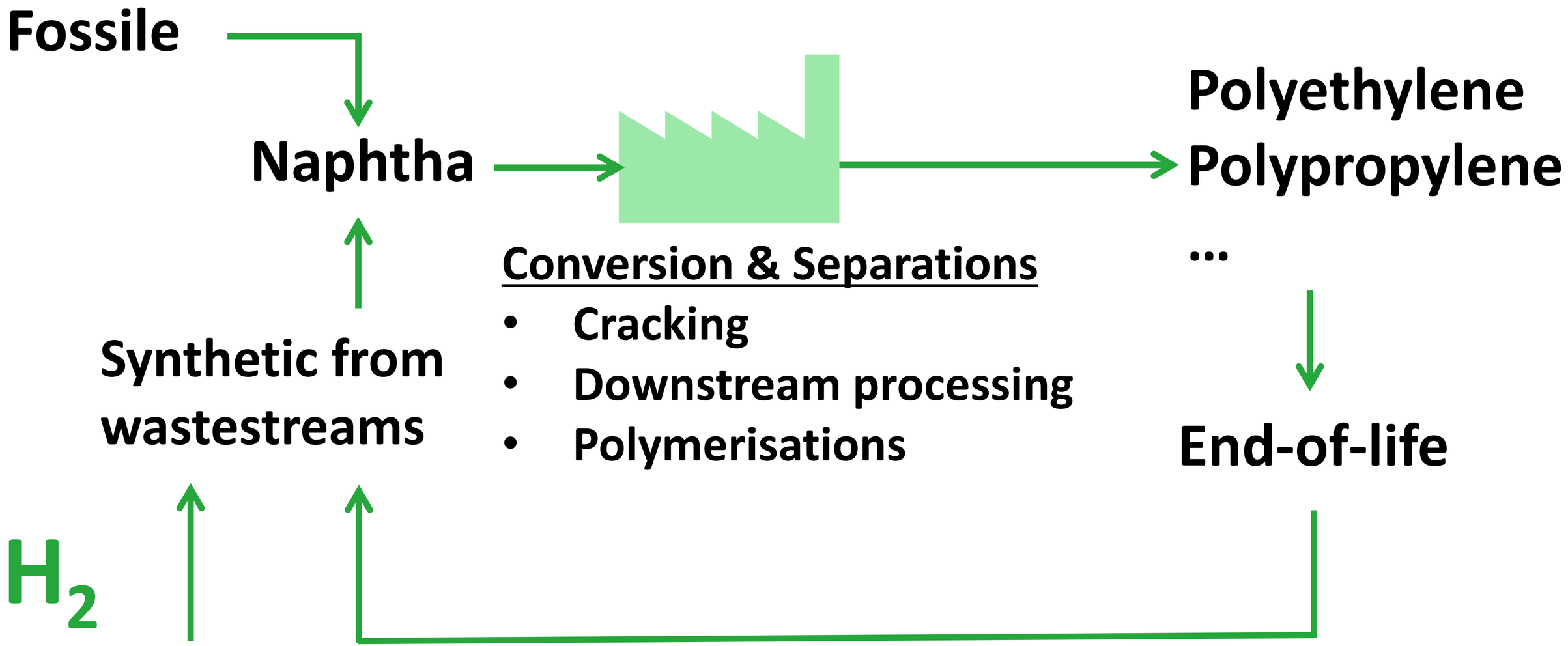


Fischer-Tropsch Naphtha from Syngas from Steel waste gases

- EU Market for Naphtha – 450 mta of mixed products
- $CO + 2H_2 \rightarrow -CH_2- + H_2O$
- 7 mta steel mill → 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



Coherent program towards affordable green hydrogen

Technology development

Strategic oportunity scouting

MW scale electrolyser testing

H2 supply chains

GW scale concept

Source: ITM POWER www.itm-power.com

Exploring limitations and possibilites of water electrolysis

Understanding scale-up Potential – economies of scale & economieso fnumbers

Matching supply and Demand for industrial use

ITM electrolyzer stack (2.2 MW)

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 H_2 may come available sooner – however – it *should not* hamper investment in acceleration of Green H_2 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) investement cycles until 2050 → timing of large-scale adoption is crucial

Thank you

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