Views from Industry: Oil Refineries towards 2050

Workshop on Hydrogen Production with CCS

6th November 2019

Damien Valdenaire, Science Executive, Refining Technologies

1 Concawe Association

Concawe - Science for European Refining

Concawe Membership

Concawe represents 40 Member Companies ≈ 100% of EU Refining

Open to companies owning refining capacity in the EU

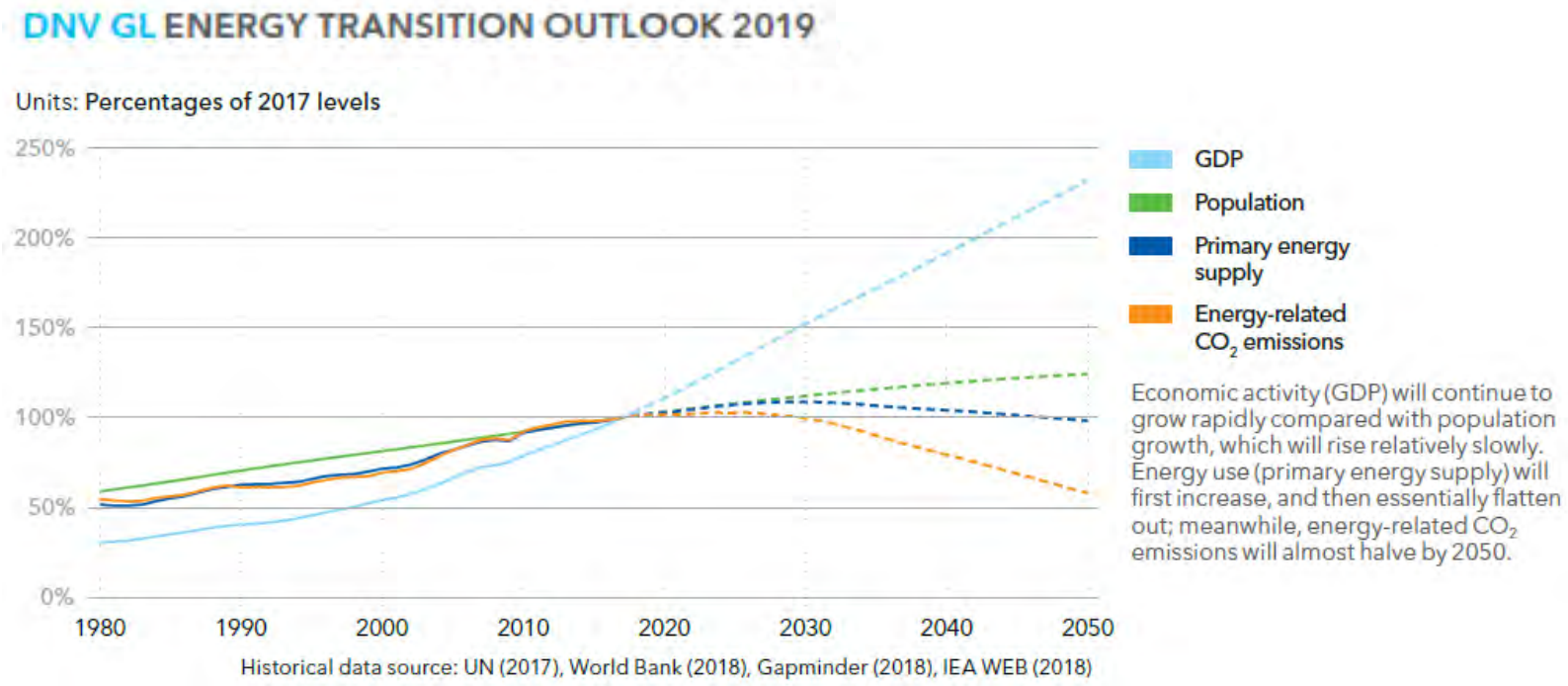
Concawe mission

To conduct research to provide impartial scientific information regarding:

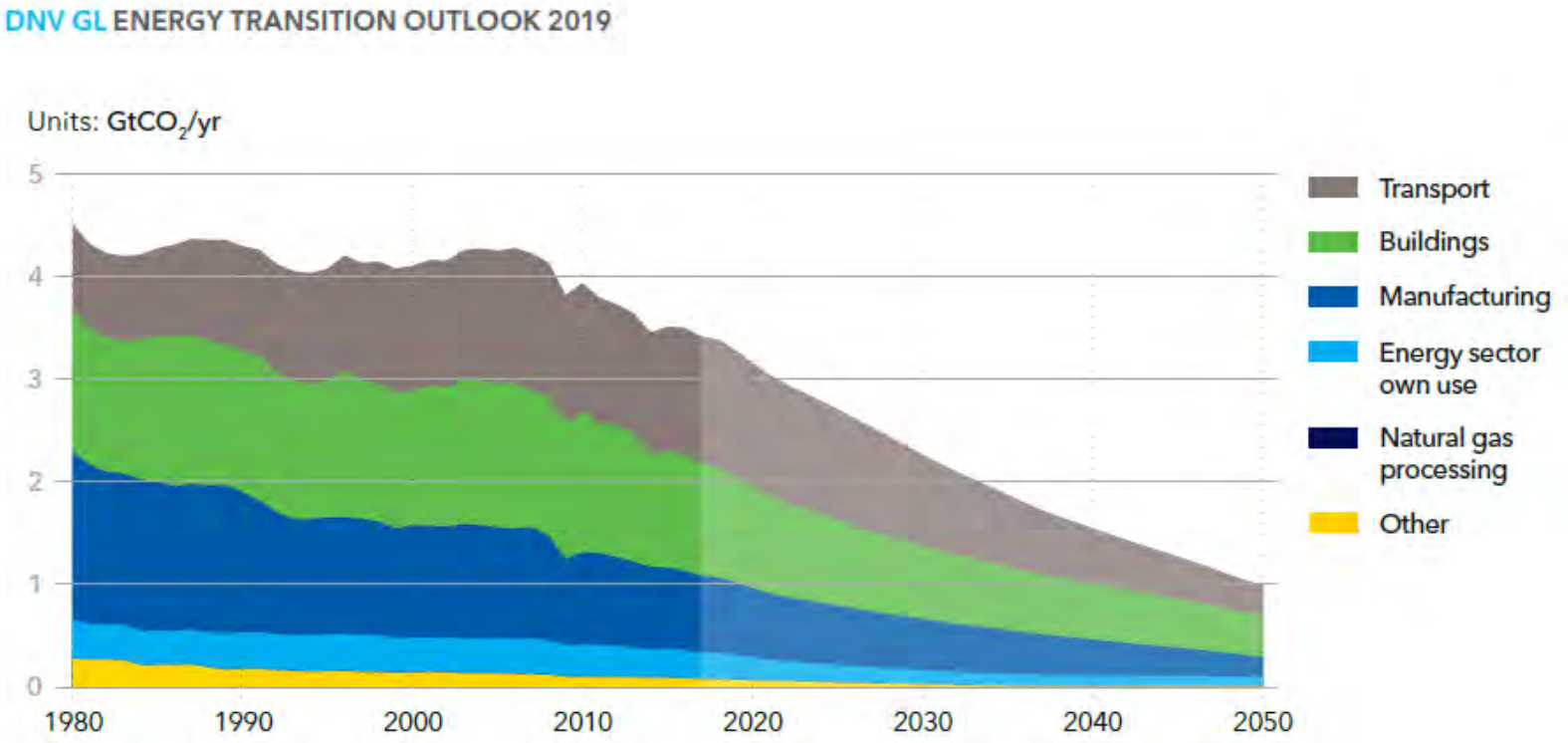
- scientific understanding
- feasible and cost effective policies and legislation
- legislative compliance

2 Energy demand & refinery 2050

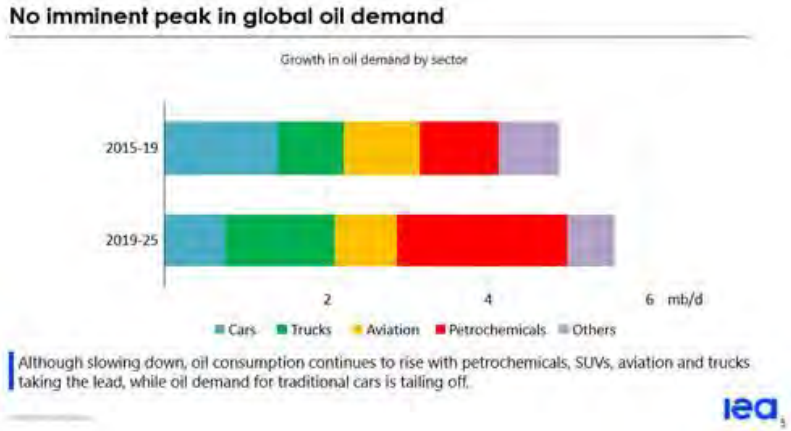
Decoupling economic growth from other key parameters

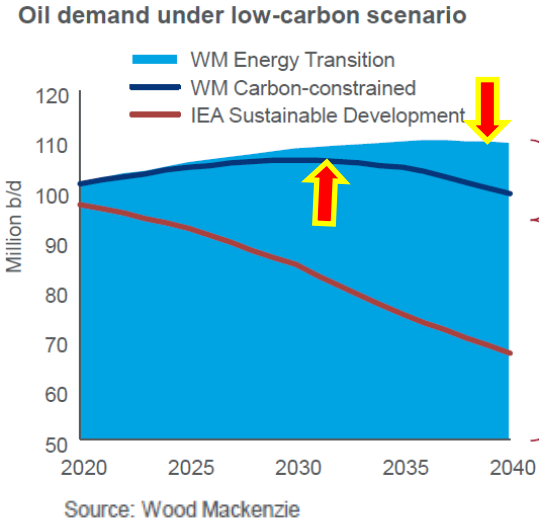


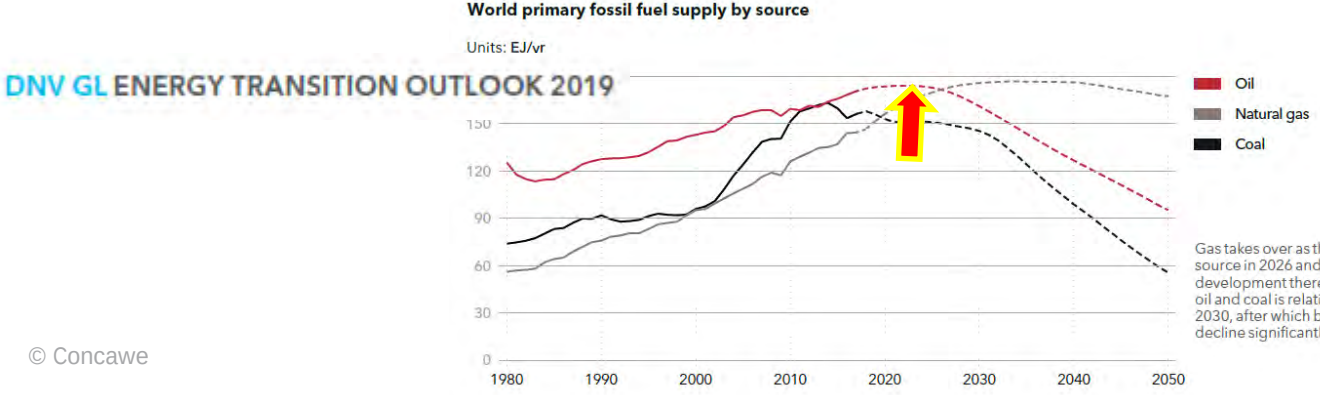
EU related CO2 energy by sector



Peak oil demand: range from ~2022 to ~2040 …







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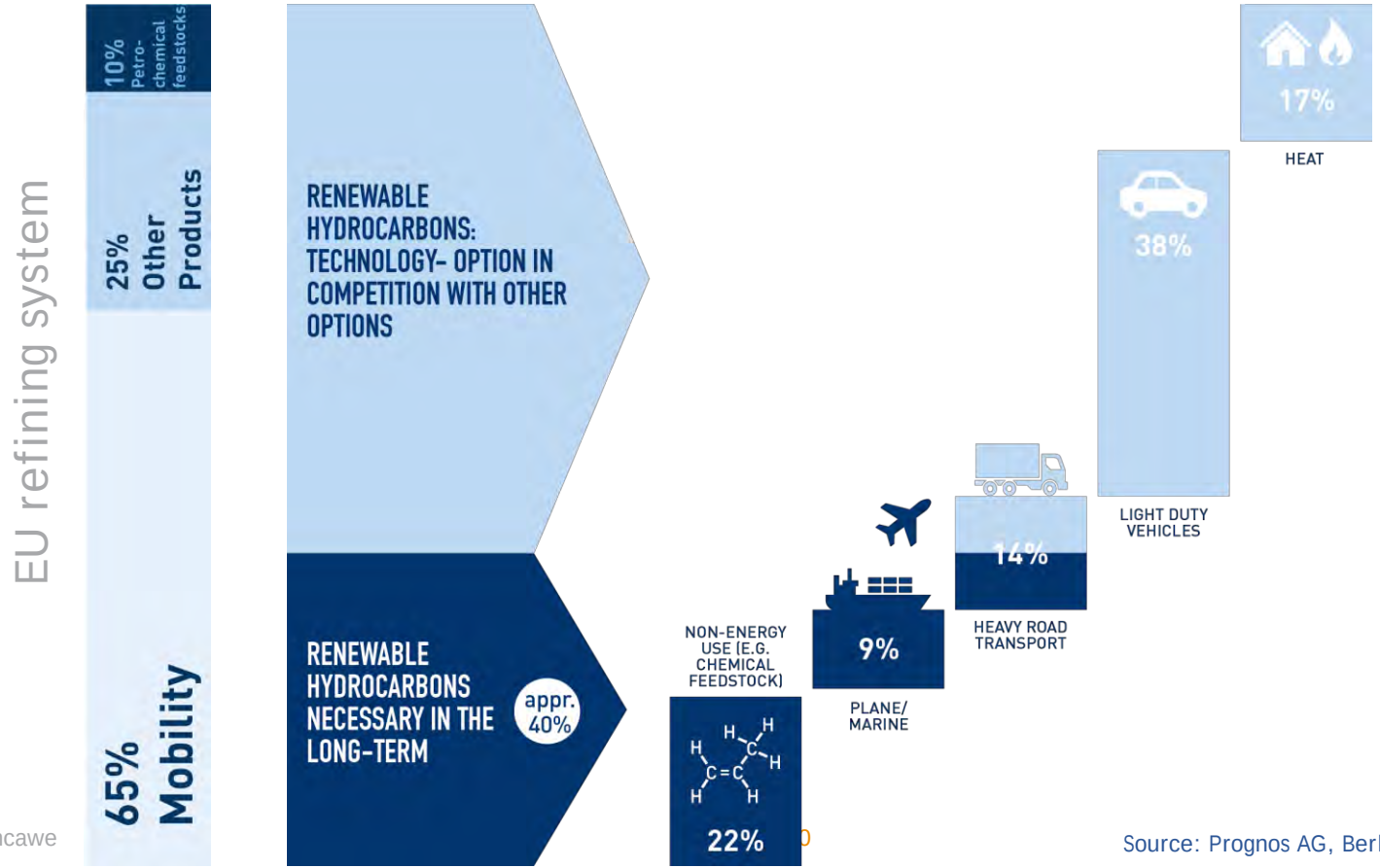
Low-carbon liquid fuels and products



Source: Prognos AG, Berlin

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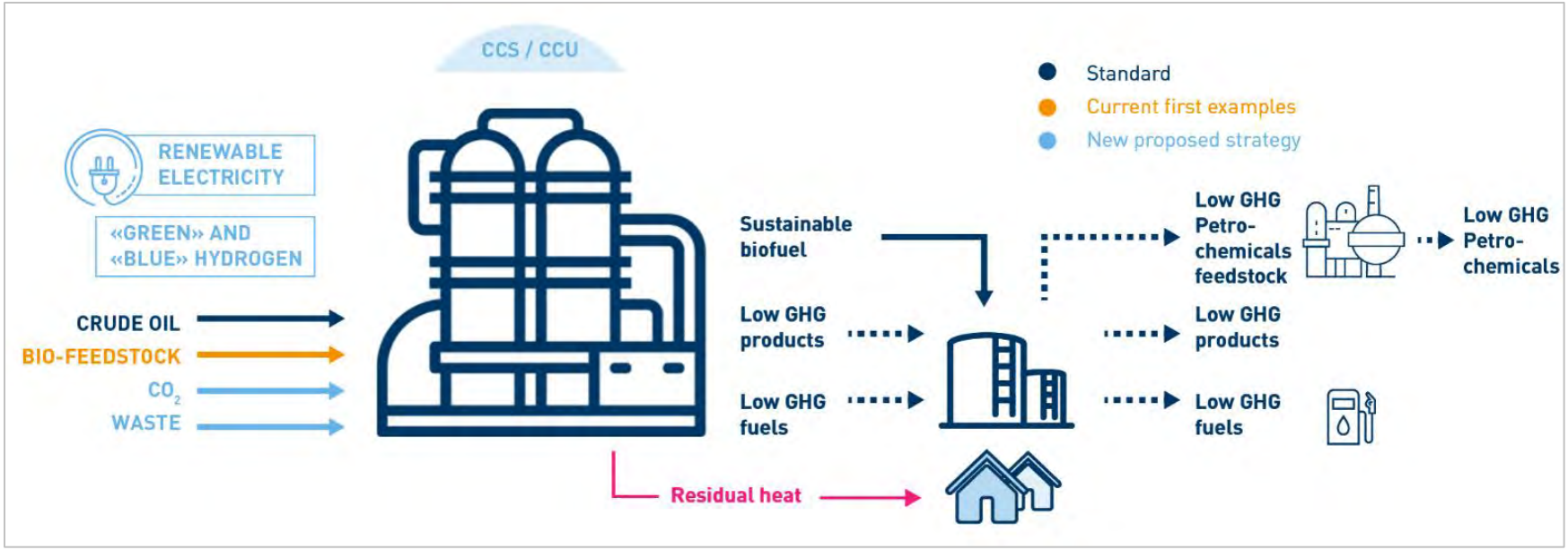
Vision 2050: The refinery as an ENERGY **HUB…**

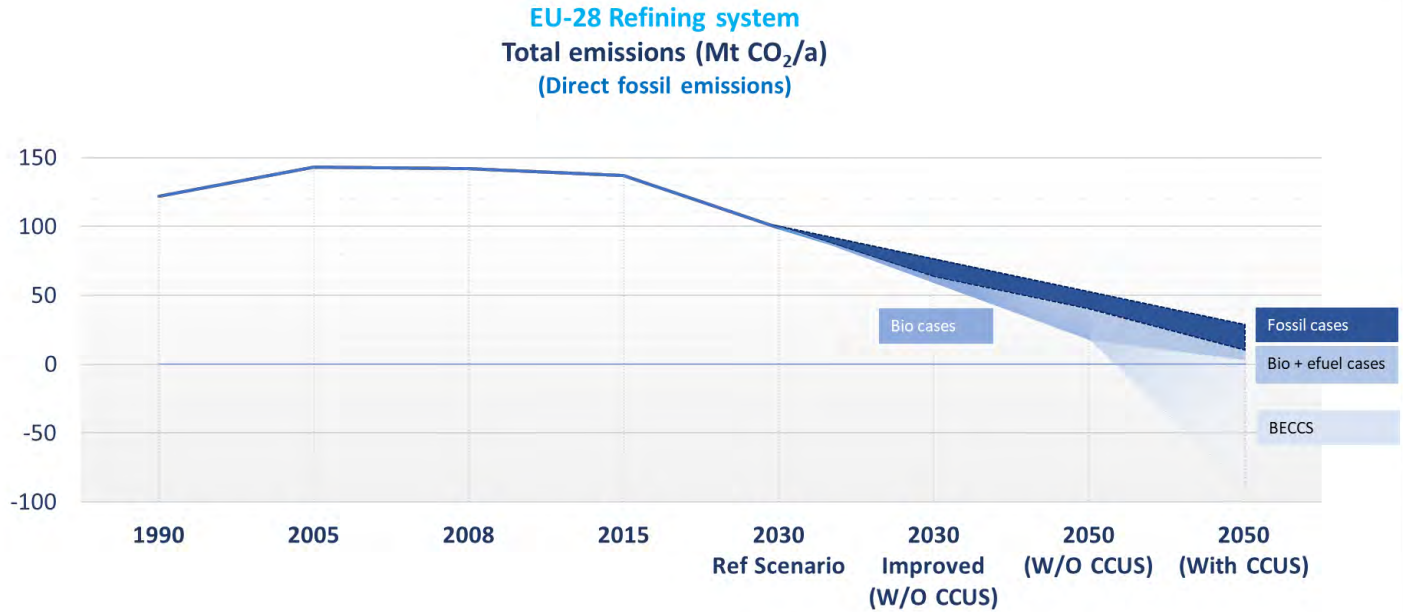
… within an INDUSTRIAL CLUSTER,



Reducing emissions within the site + the final use of our products

Refinery 2050

EU-wide scale



- Potential CO_2 savings range from 50 to 90% vs 1990 and 85% vs 2030 improved scenario (~70% Optimized oil-based cases)
  Pathways enabling negative emissions through Biomass + CCS!
- Total electricity consumption from 150 to 550 TWh/y in 2050
  Multiplied by 5-18 times vs 2030 improved scenario
- Total Hydrogen consumption (from 7 to 15 Mtoe/y) multiplied by 2-5 times vs 2030 improved scenario
- Estimated CAPEX could range between 1 - 10 G€ for the limited penetration cases, and between 6 - 15 G€ for the extreme cases.

https://www.concawe.eu/publication/refinery-2050-conceptual-assessment-exploring-opportunities-and-challenges-for-the-eu-refining-industry-to-transition-towards-a-low-co2-intensive-economy/

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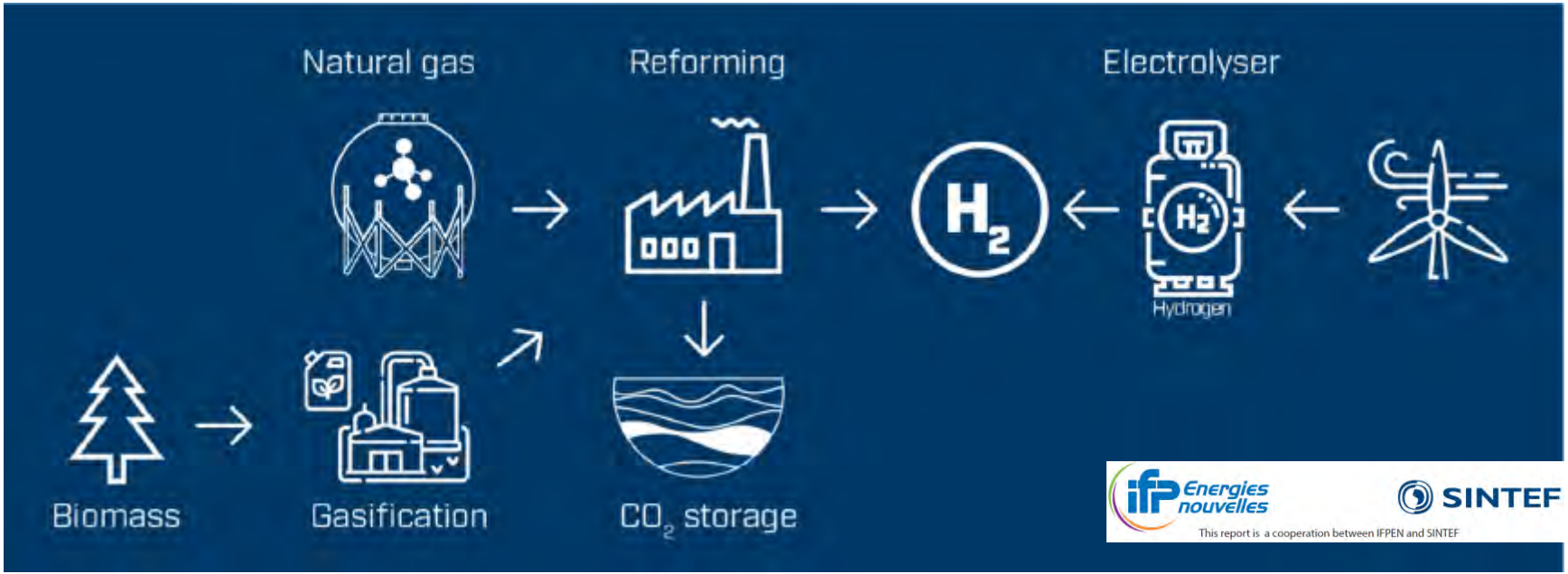
Project: “Hydrogen for Europe”

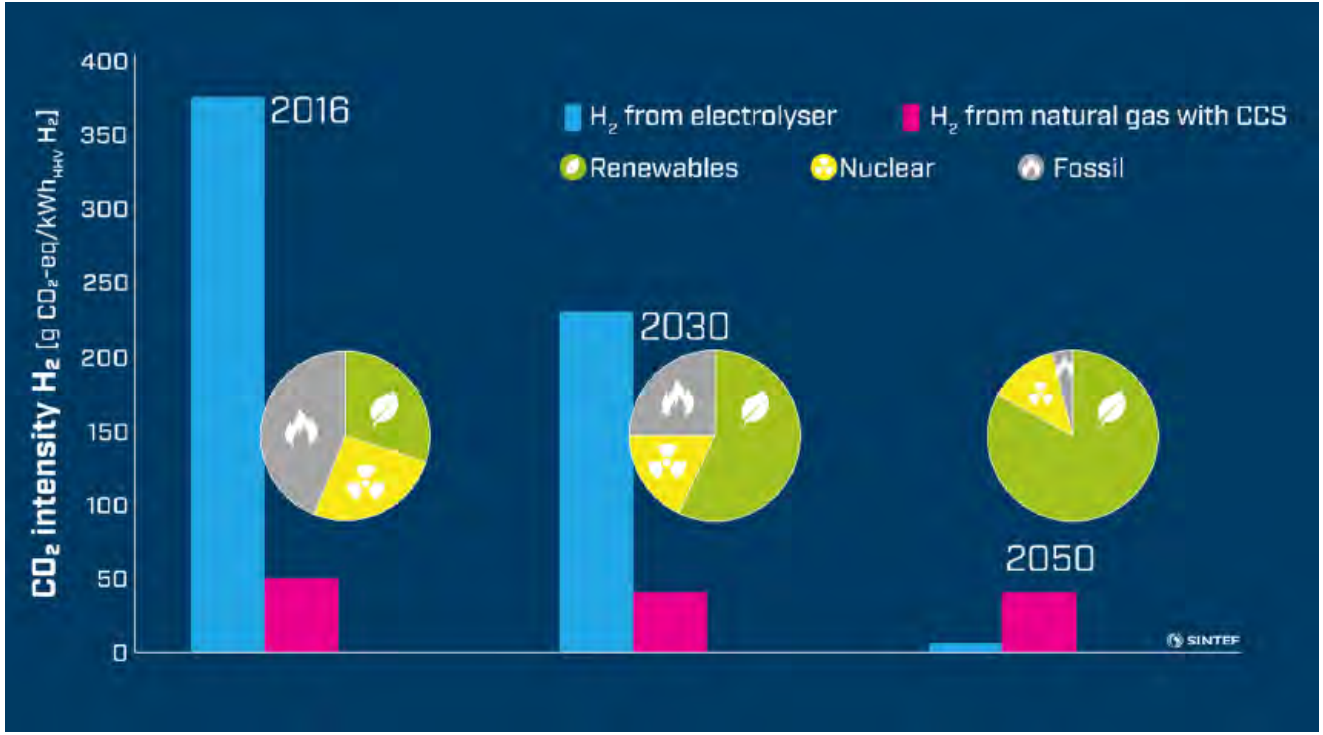
Pre-study results

Hydrogen production pathways from renewable sources and natural gas



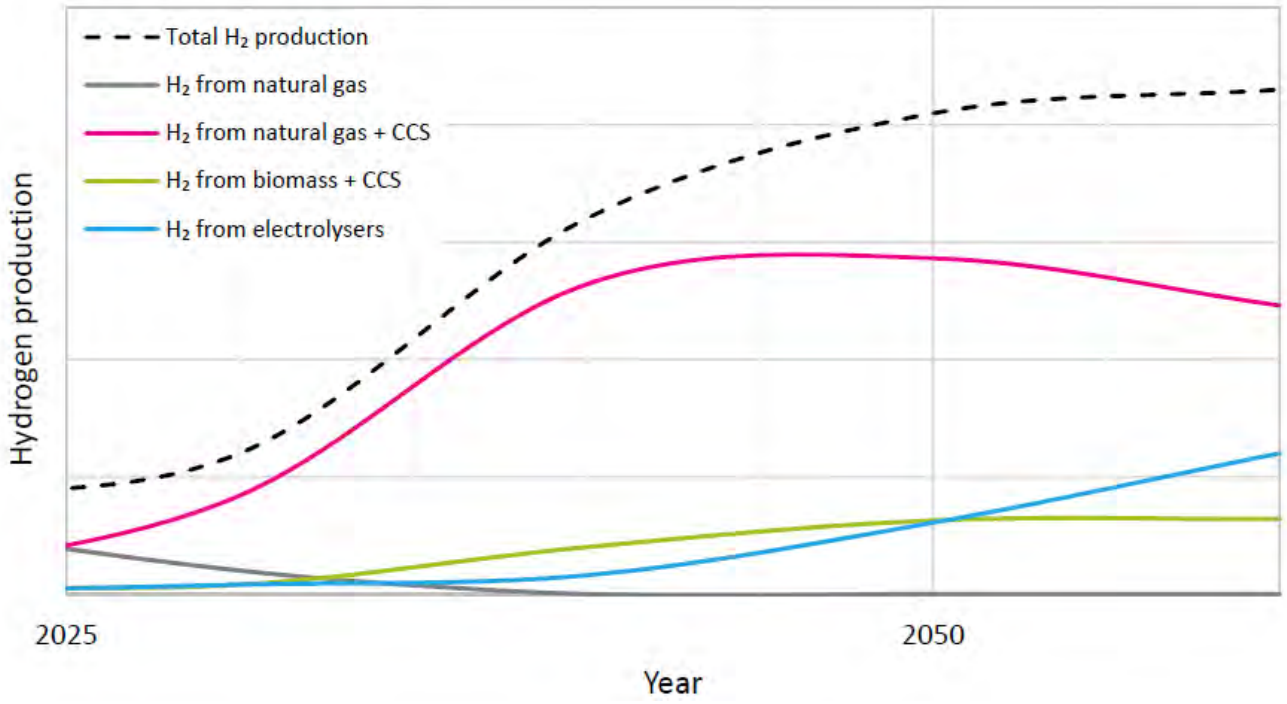
The full pre-study report can be accessed here: https://www.sintef.no/Hydrogen4Europe

Comparison of the CO2 intensities of hydrogen production



Comparison of the CO2 intensities of hydrogen production using electrolysers and grid electricity (blue bars) and natural gas with carbon capture (pink bars). The pie charts illustrate the desired electricity mix according to the REmap case for 2030 and the decarbonised scenarios from "A Clean Planet for all" for 2050.

A scenario for future production of hydrogen from natural gas, electricity from renewables and biomass



4 Takeaways

The conceptual assessments …

Next step = « blue H2 study »

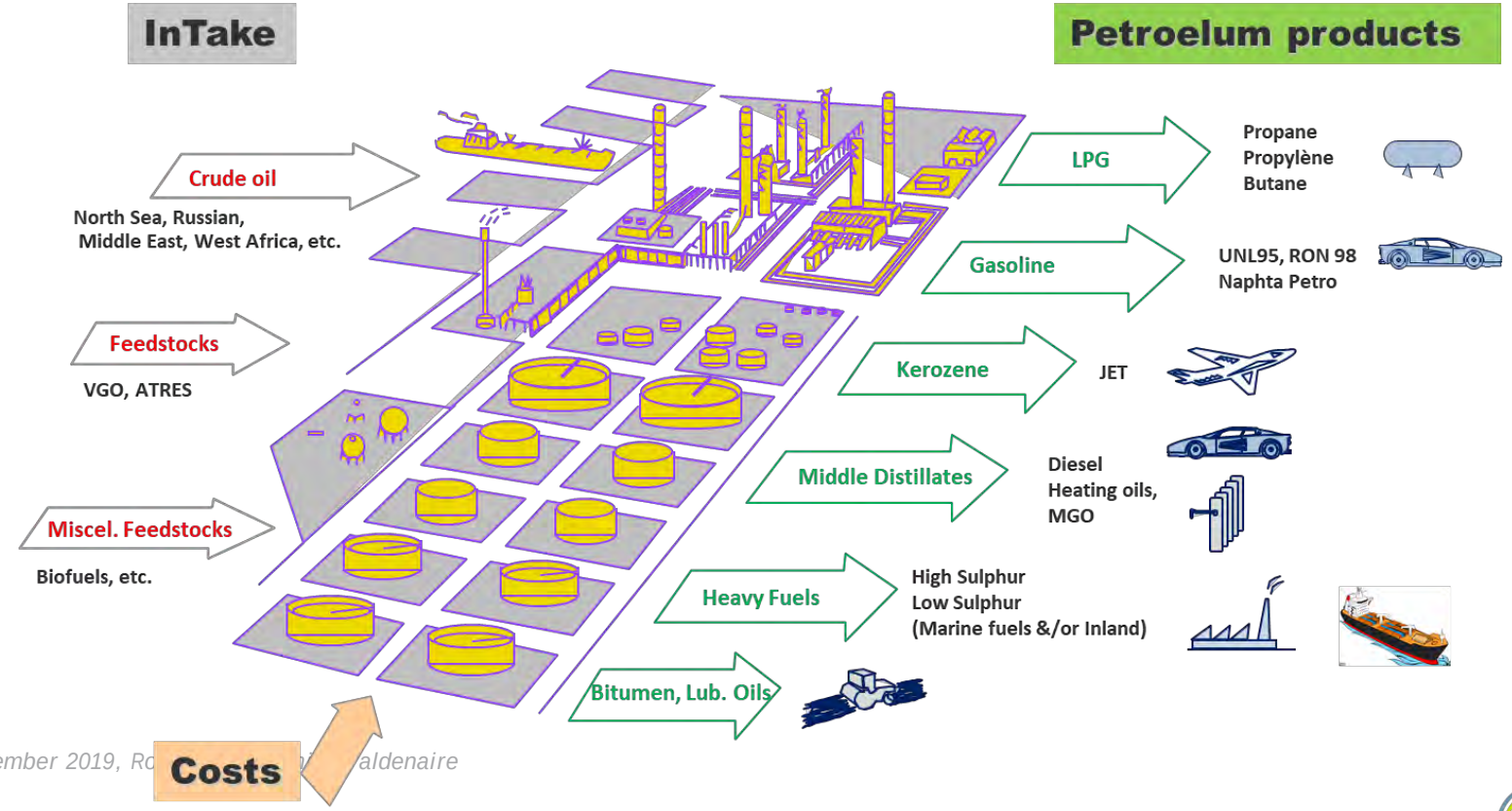
- Refinery 2050:
  - low-GHG intensive hydrocarbons
  - New opportunities for new business models

- Capture costs for dedicated streams (ex SMR for example) expected to drop well below 100$/tCO2 avoided

- As for other Energy Intensive Industries, the paths towards 2050 require carbon Capture
  - *As shown in EU Commission report "A clean planet for All", every scenario includes CO2 captured*


Liquid fuels deliver
happiness everyday...
...and they can
be low-carbon
#Vision2050
#Going4LowCarbonLiquidFuels
FuelsEurope

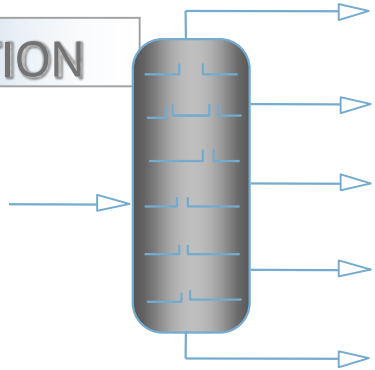
Oil refining: operating principle



Crude oil refining

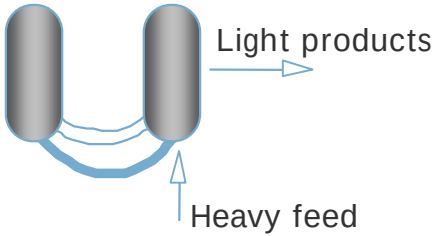
1 DISTILLATION

- Crude Oil (LS & HS)
- Condensate



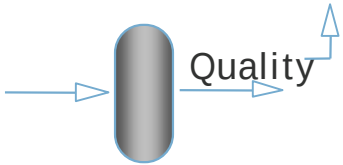
2 CONVERSION

- FCC
- Hydrocraking
- Coking
- Visbreacking

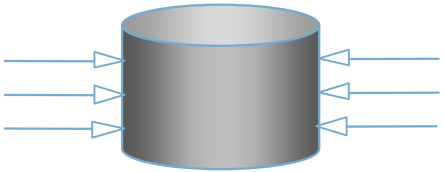


3 IMPROVEMENT

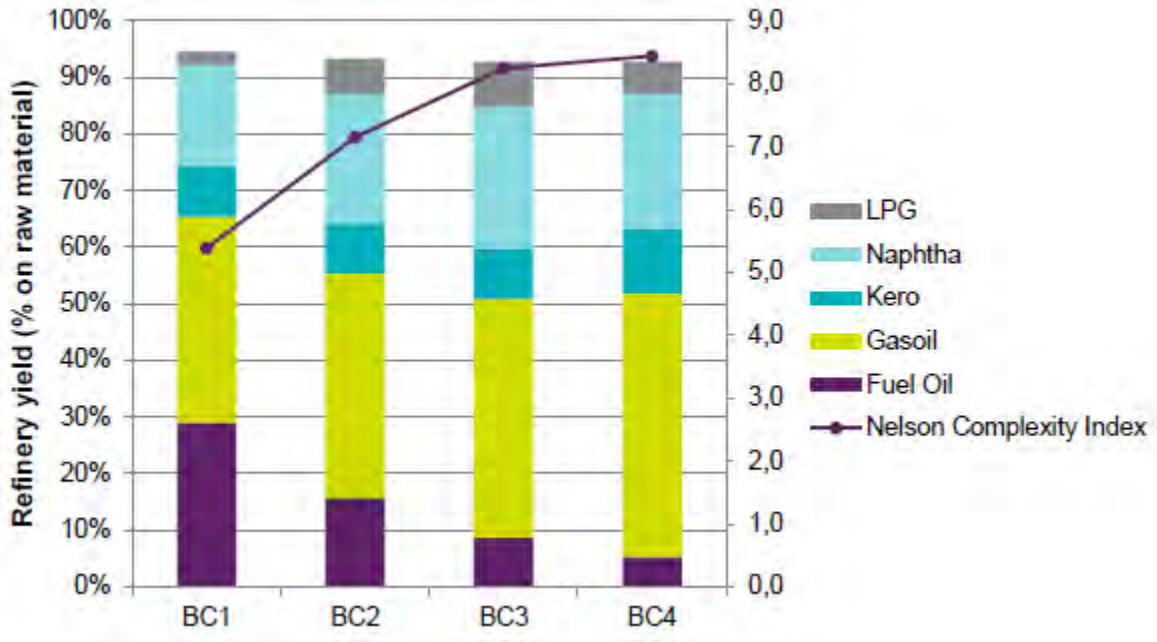
- Reforming
- Hydrotreating
- Alkylation
- Isomerisation



4 BLENDING



Refinery yields in different European Base Case configuration



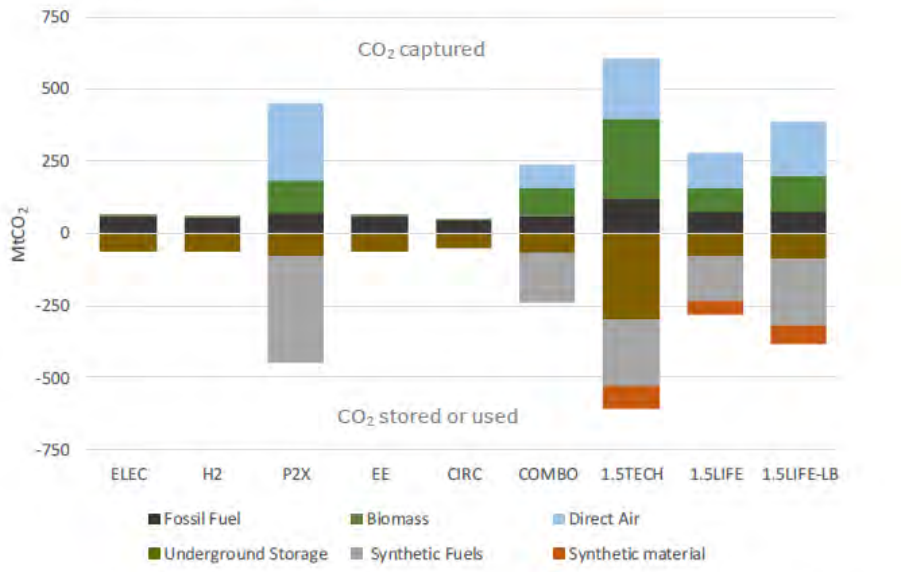
BC1 = Hydroskimming (simple)
BC2 = Medium complexity
BC3 = Highly Complex (220kbbl/d)
BC4 = Highly Complex (350kbbl/d)

AMEC FOSTERWHEELER: ReCAP Project, Evaluating the Cost of Retrofitting CO2 Capture in an Integrated Oil Refinery, September 2017

« A clean Planet for All »

CO2 captured is present in every scenario

Figure 89: CO_2 capture and storage or reuse (2050)



Source: PRIMES.

https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf