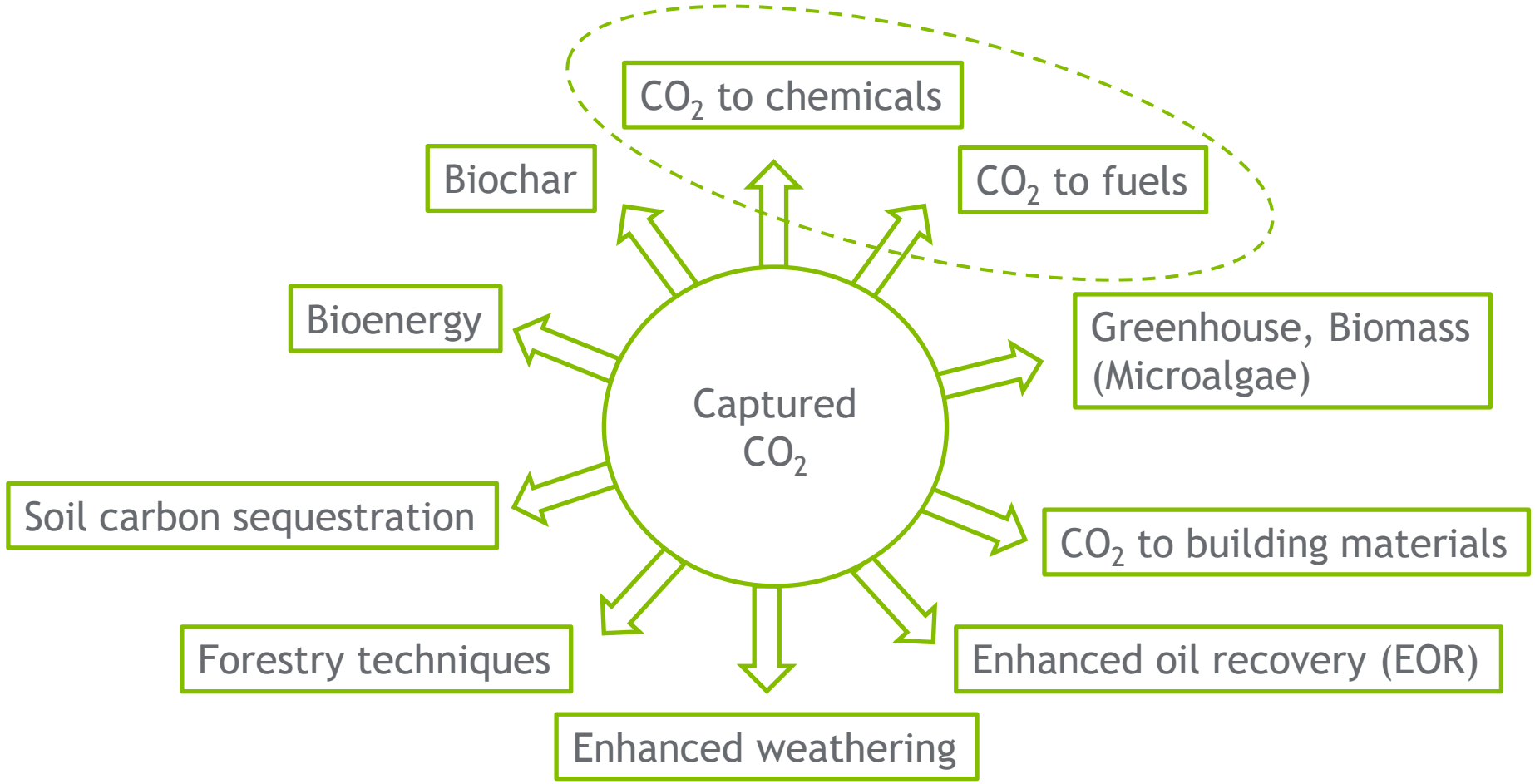
Carbon Recycling to Chemicals and Fuels

Ahmed O. Khowaiter

October 2021

CO_2 Utilization Pathways | CO_2 as a feedstock



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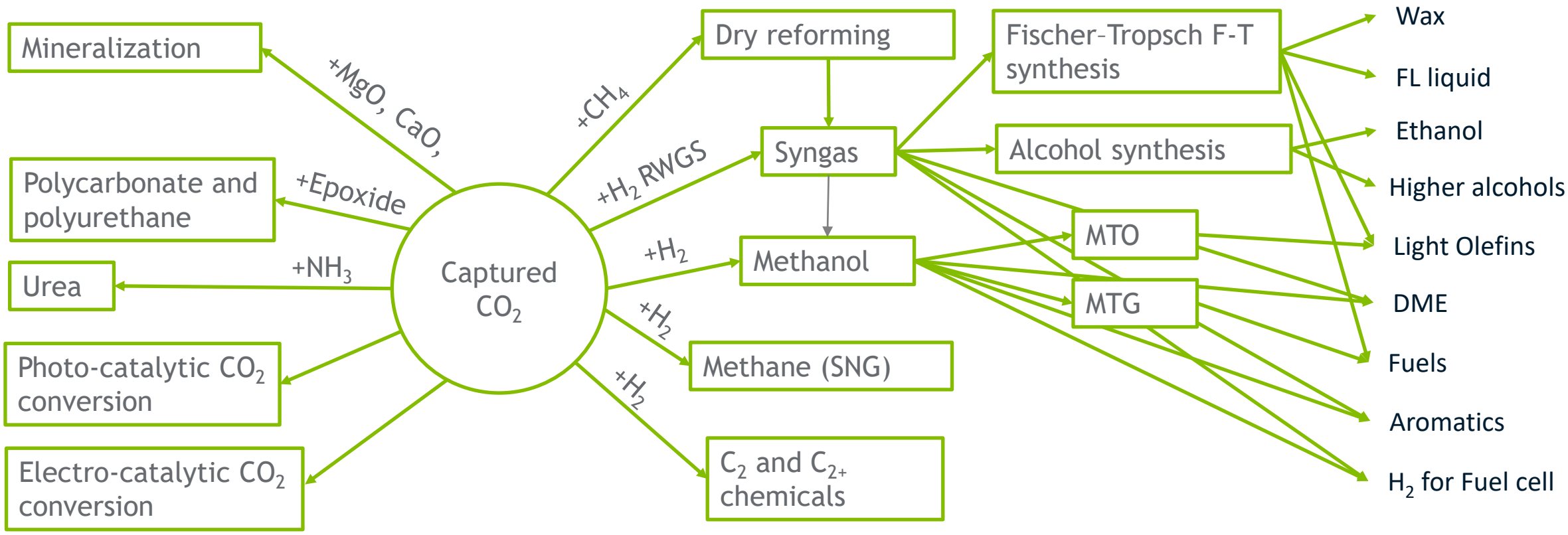
CO_2 to Chemicals | CO_2 as a feedstock

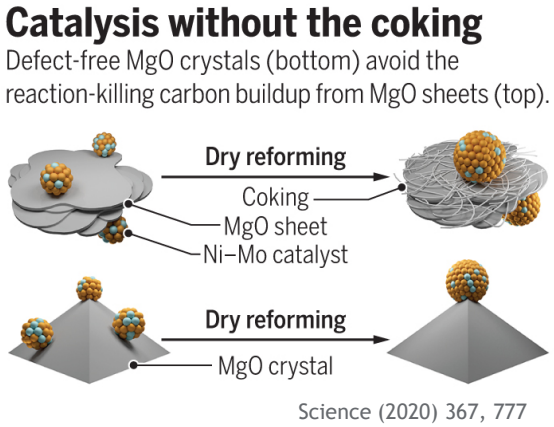


CO_2 to Chemicals | CO_2 conversion approaches

CH_4 Dry Reforming

- Technology demonstrated, commercial-ready
- Technology providers: Linde/BASF and Chiyoda
- Saudi Aramco/KAIST next-generation catalyst


Linde pilot plant



CO_2 Hydrogenation to Methanol

- Technology commercial
- Technology providers: CRI, BluChemicals, BASF, Haldor Topsoe


CRI Georg Olah plant
Iceland

CO_2 to Chemicals | CO_2 conversion approaches

CO_2 to Methane (SNG):

- Technology commercial
- Technology providers: TKI, BASF

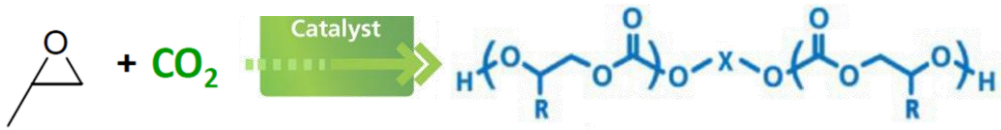
CO_2 to Urea

- Technology commercial
- Technology providers: Stamicarbon

CO_2 to Chemicals | CO_2 conversion approaches

CO_2 Polymerization

- Technology semi-commercial
- Converge® technology – Aramco Performance Materials

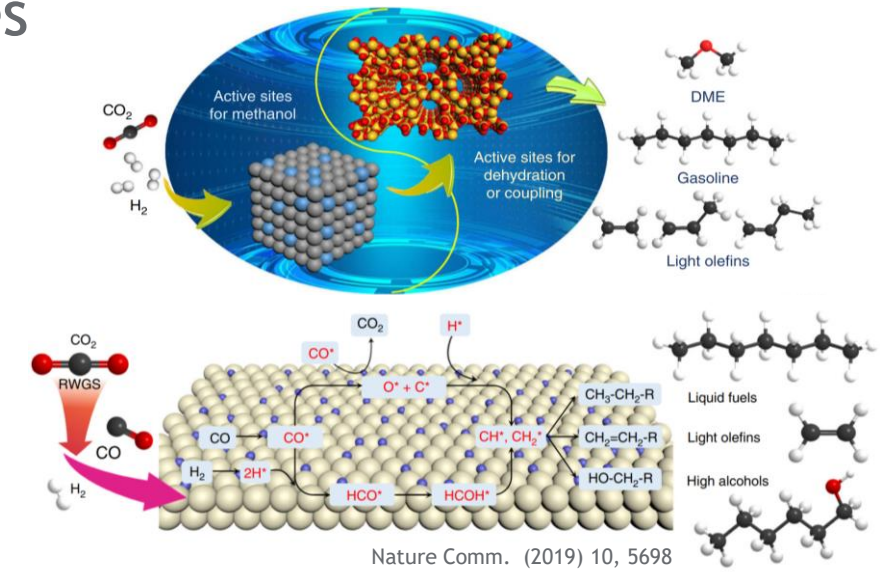


Polyols
(containing up to 40 wt% CO_2)

CO_2 to Chemicals | CO_2 conversion approaches

CO_2 Hydrogenation to C_{2+} Alcohols and HCs

- Early development stage
  - Methanol-mediated route
  - CO_2 modified Fischer–Tropsch route

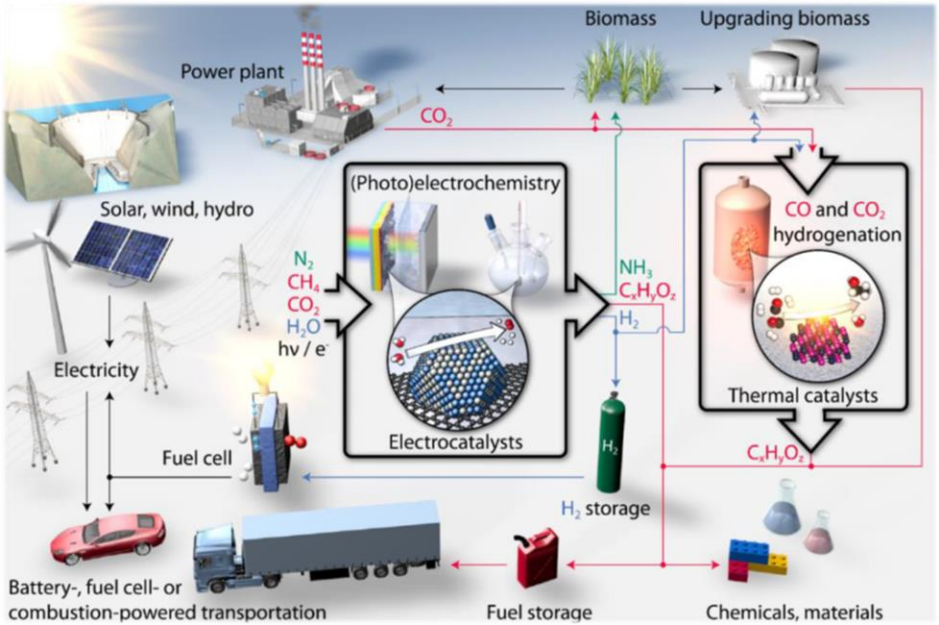


Nature Comm. (2019) 10, 5698

Electro/Photo-catalytic CO_2 Conversion

- Early development stage

$$xCO_2 + nH^+ + ne^- \rightarrow \text{product} + yH_2O$$

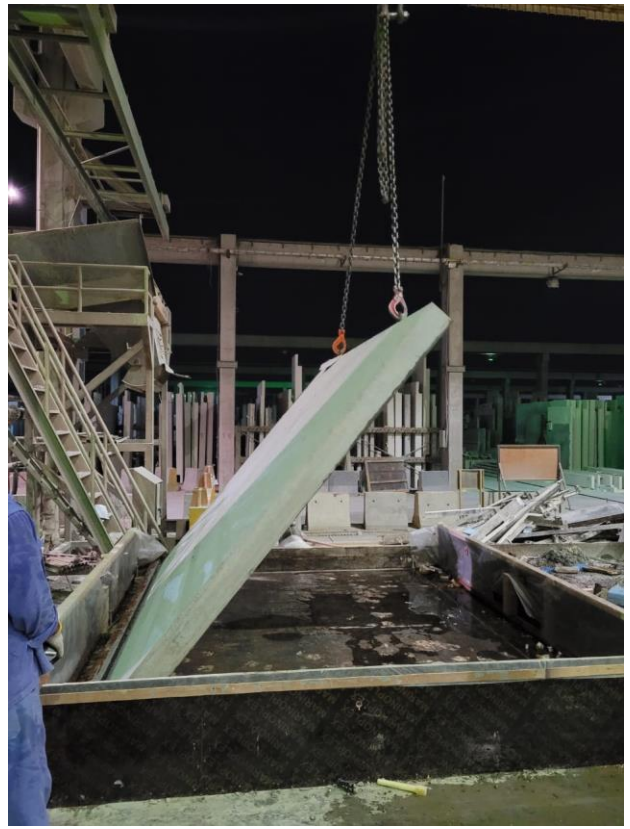


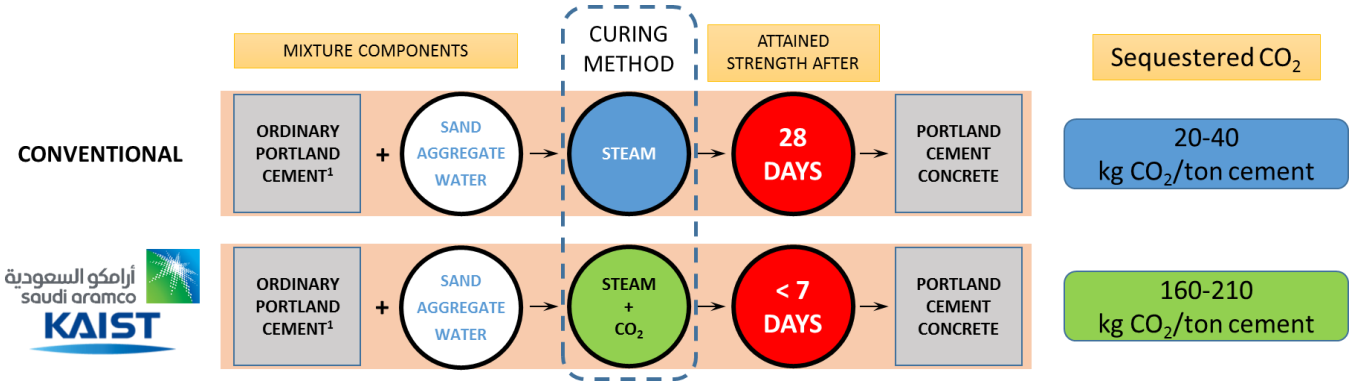
Science (2017) 355, 146

CO_2 in construction materials| CO_2 recycle and storage

CO_2 Polymerization

- Technology demonstrated
- Large sink for CO_2
- Superior products in mechanical strength and chemical resistance
- Reduce curing time and increase productivity





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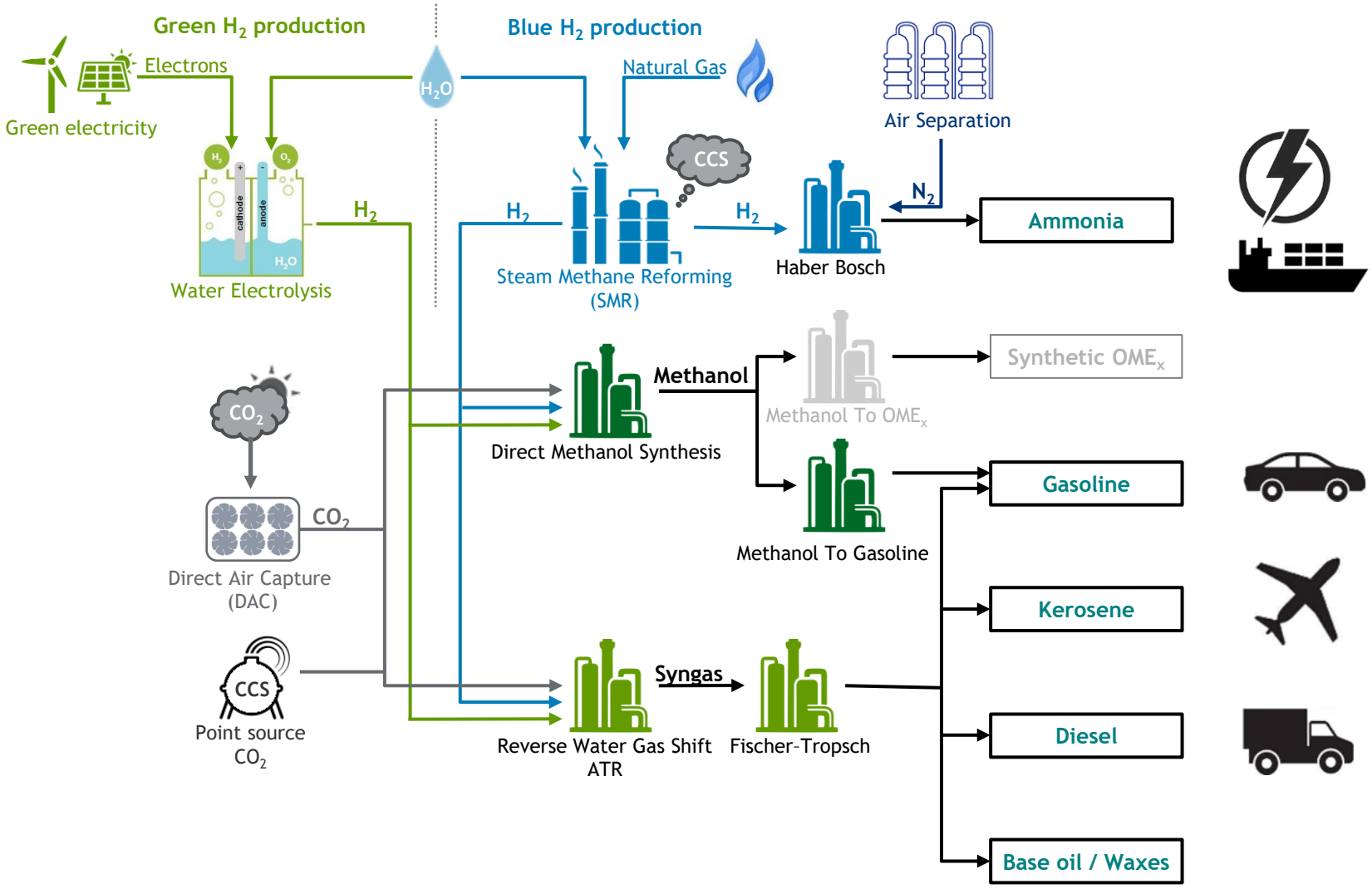
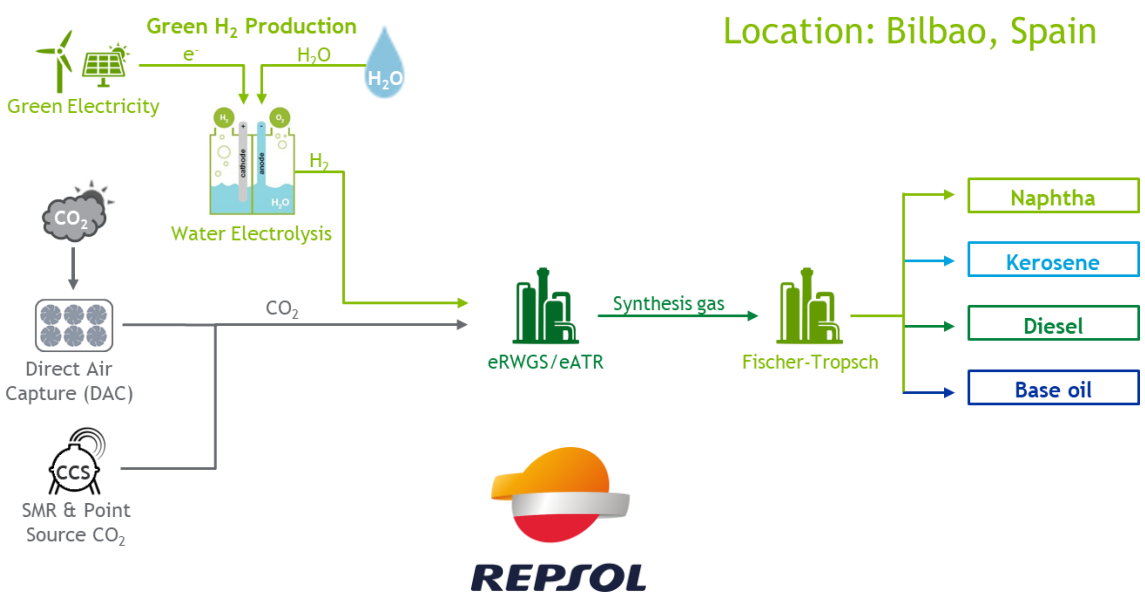
CO_2 to Fuels | Energy carriers derived from H_2



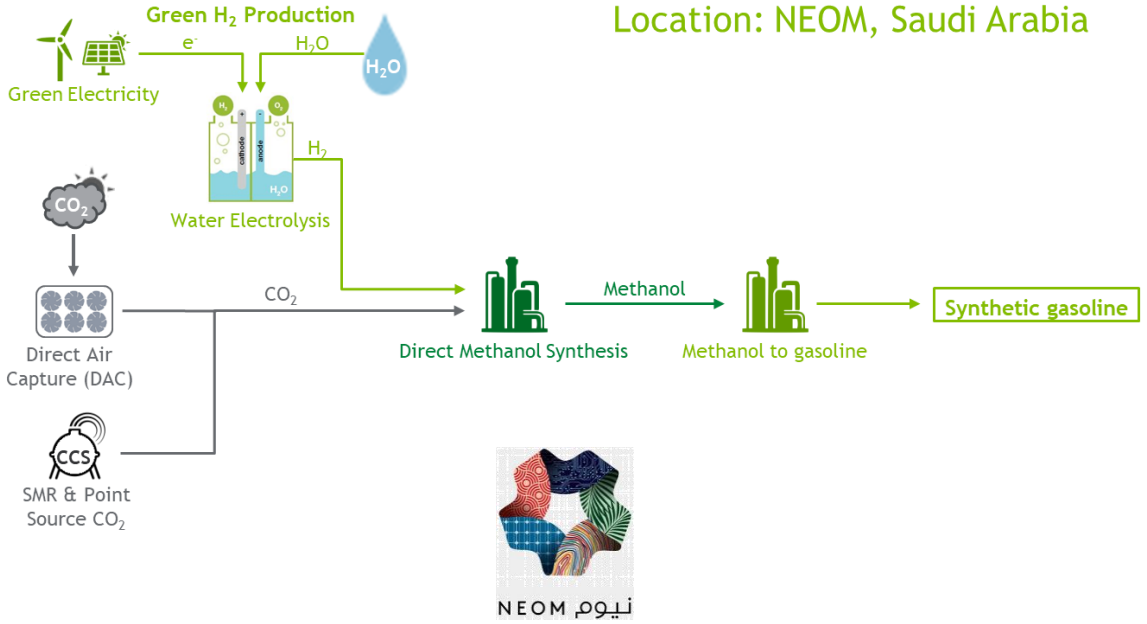
CO_2 to Fuels demo plants | Two 50 BPD fuel demo plants

Synthetic diesel and aviation fuels



Location: Bilbao, Spain

Synthetic gasoline



Location: NEOM, Saudi Arabia

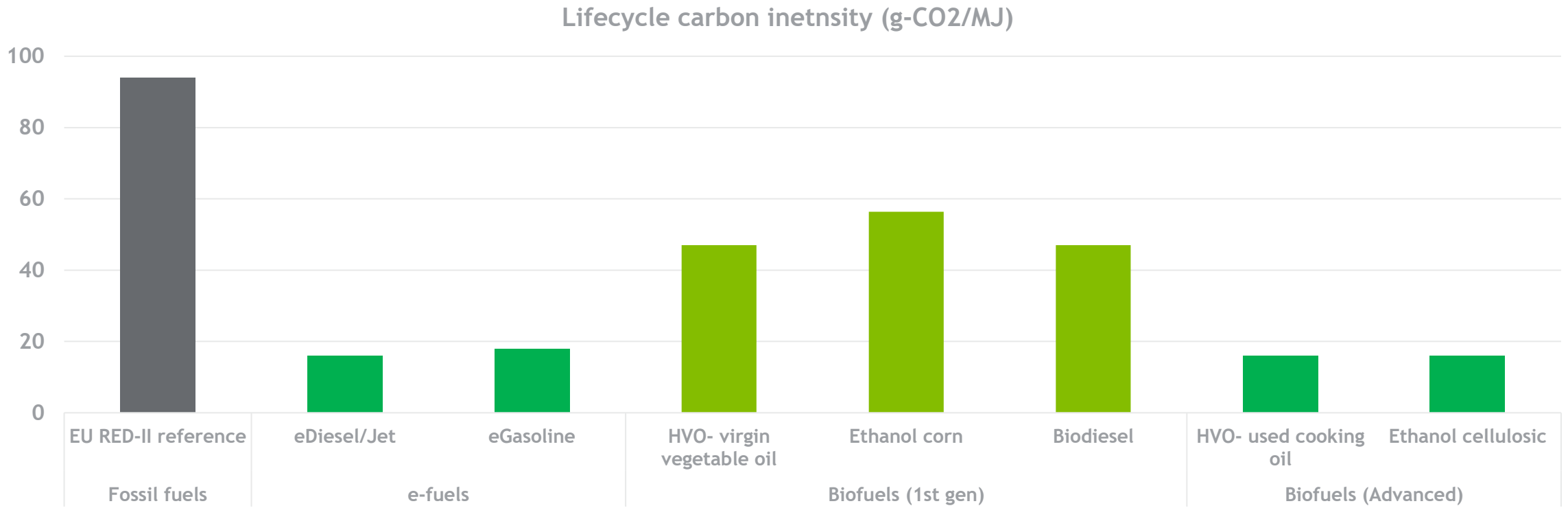
Forging partnerships and scope development (2019-2021)

FEED studies (Q2'22)

Detailed Engineering and EPC (Q3'22-Q4'24)

Plants operational 2024-2025

Synthetic fuels carbon intensity



- More than 80% CI reduction possible compared to fossil fuels
- Comparable CI to advanced (waste based) biofuels

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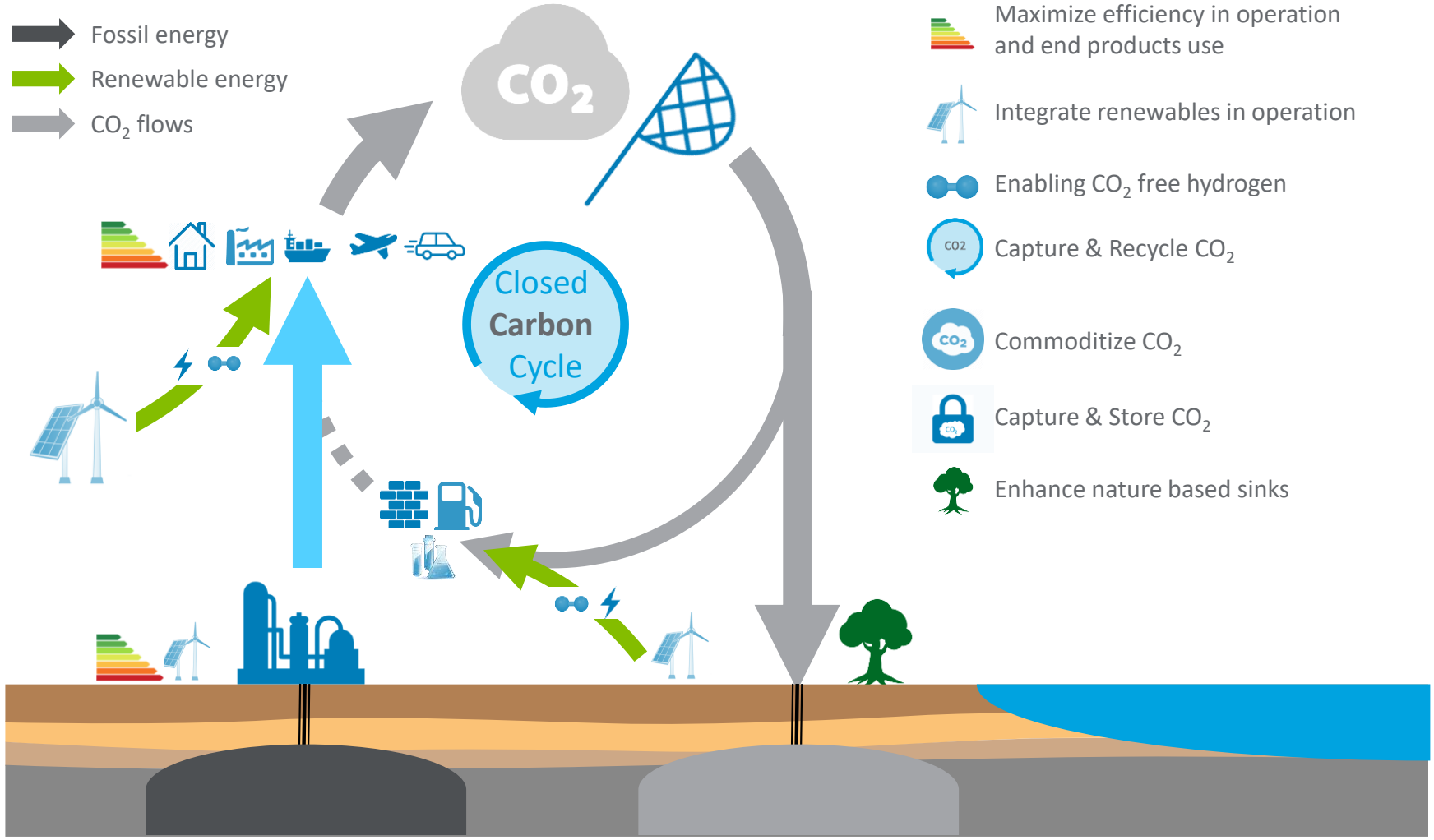
Enabling the 4 Rs| Technology-agnostic low-CO_2 products enabled through regulation



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