CARBON RECYCLING INTERNATIONAL

Commercial scale CO2-to-methanol plant in Norway

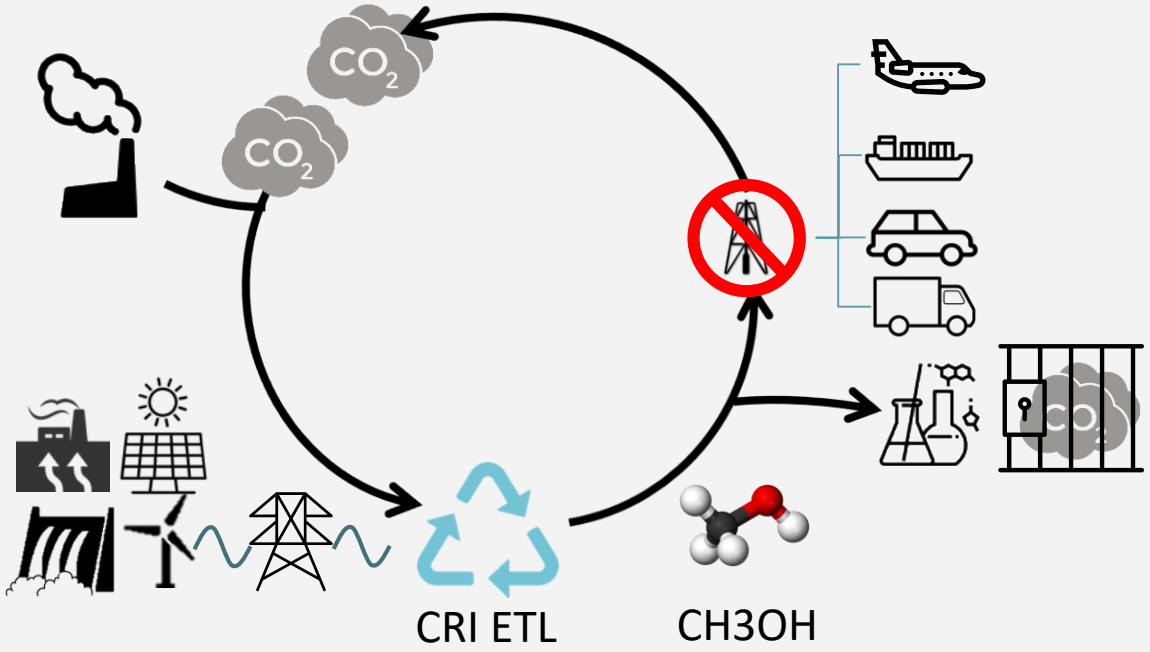
Presentation for CO2 Value EU workshop on Innovation Fund Brussels 2019-09-19

CirclEnergy

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No 848757

CRI's Emissions-to-liquids: Direct hydrogenation of CO_2 into methanol

Carbon recycling from renewable energy

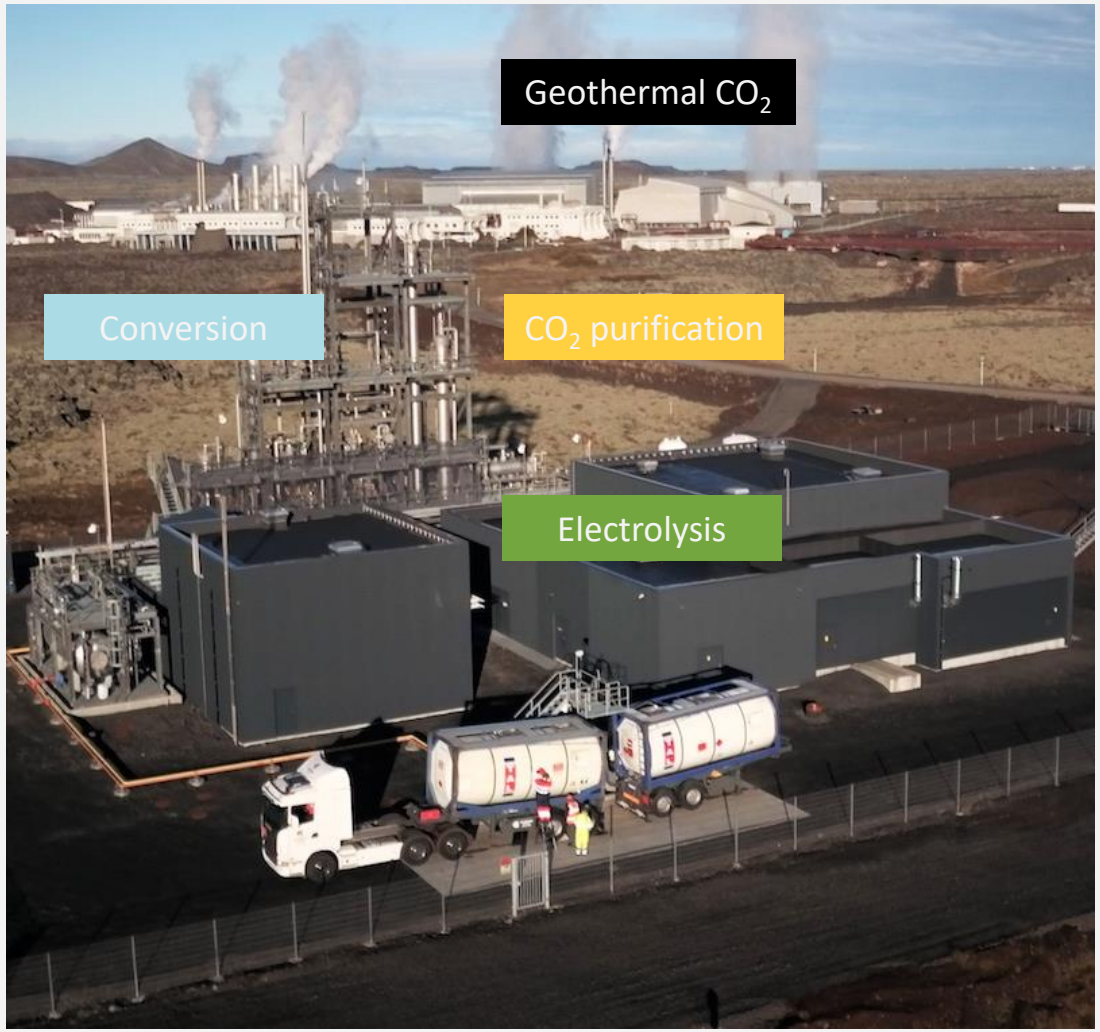


Some process advantages

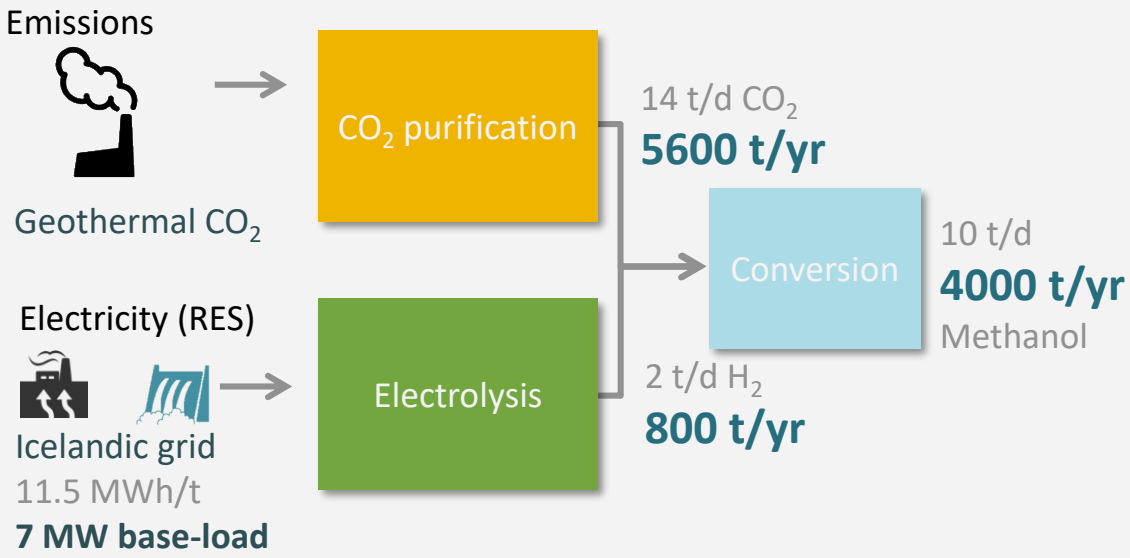
- **Direct and selective:** no reforming or byproduct
- **Low turndown:** flexibility for grid balancing
- **Validated catalyst:** thousands of hrs variable load
- **Low** temp/pressure and **waste heat** integration
- **Safety** for workers and environment

EU Horizon 2020 Research and Innovation Programme under grant agreement No 848757
CirclEnergy

CRI's industrial scale demonstration plant, Svartsengi, Iceland



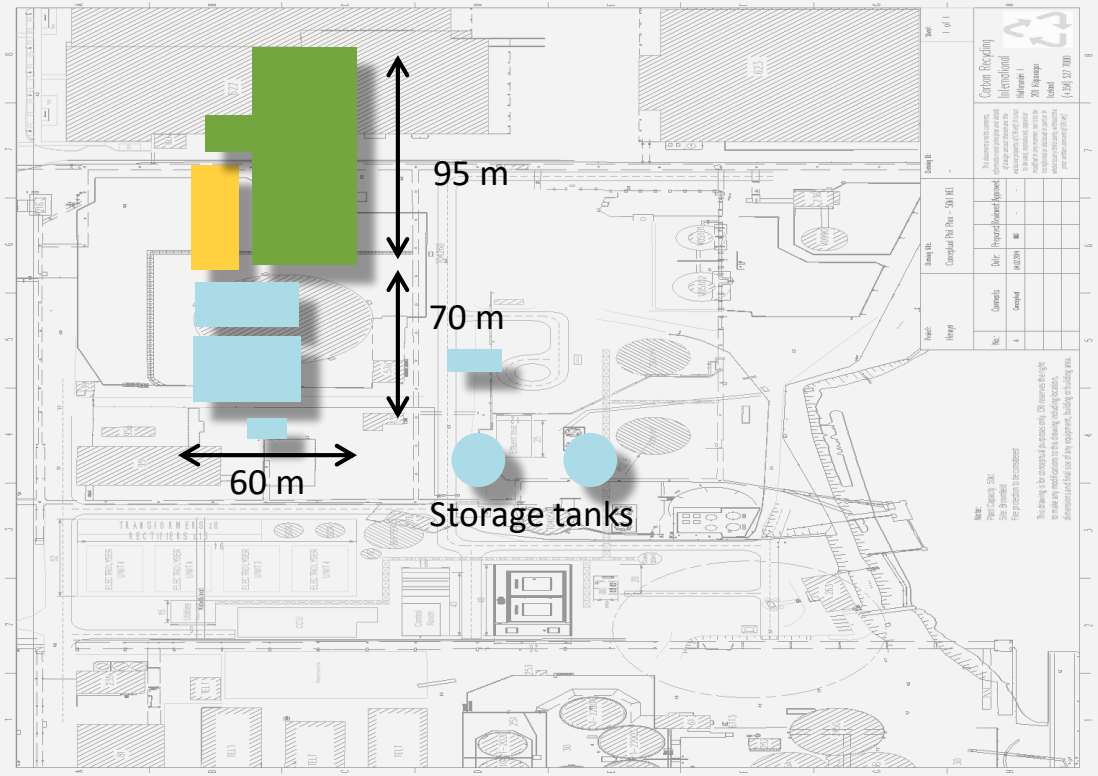
CRI's innovation: Direct hydrogenation of CO_2 at kt scale



First plant to recycle kilotons of flue-gas to produce liquid e-fuel according to RED/FQD for EU market

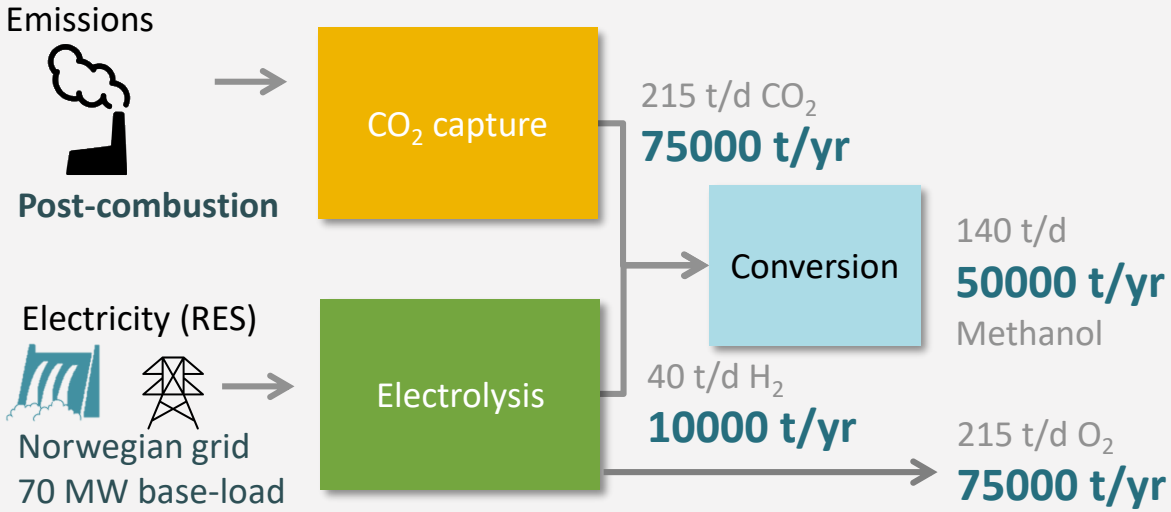
First producer of e-fuel with ISCC Plus certification and verification of sustainability (CO_2 abatement)

Proposed project in Norway



Commercial scale CO2-to-methanol plant using 100% RES

Brown field, 1-2 of several available flue gas sources for CO_2



Entering FEED (Q4)

Timeline: 24-30 mo.*

* After FID

CAPEX: €100 millio

Area: 1 ha.

25 permanent FTE

9/26/2019 *EU Horizon 2020 Research and Innovation Programme under grant agreement No 848757*

CirclEnergy

90%-100% reduction of life-cycle CO2 emissions compared to fossil fuel

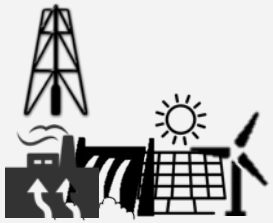
tCO2/toe -3 -2 -1 0 +1 +2 +3 +4 Energy source

NO 5 g/kWh
IS 9 g/kWh

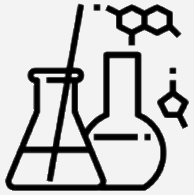
WTT

TTW

CRI ETL methanol from **renewable electricity**



CO_2 reduction/toe



NG methanol**

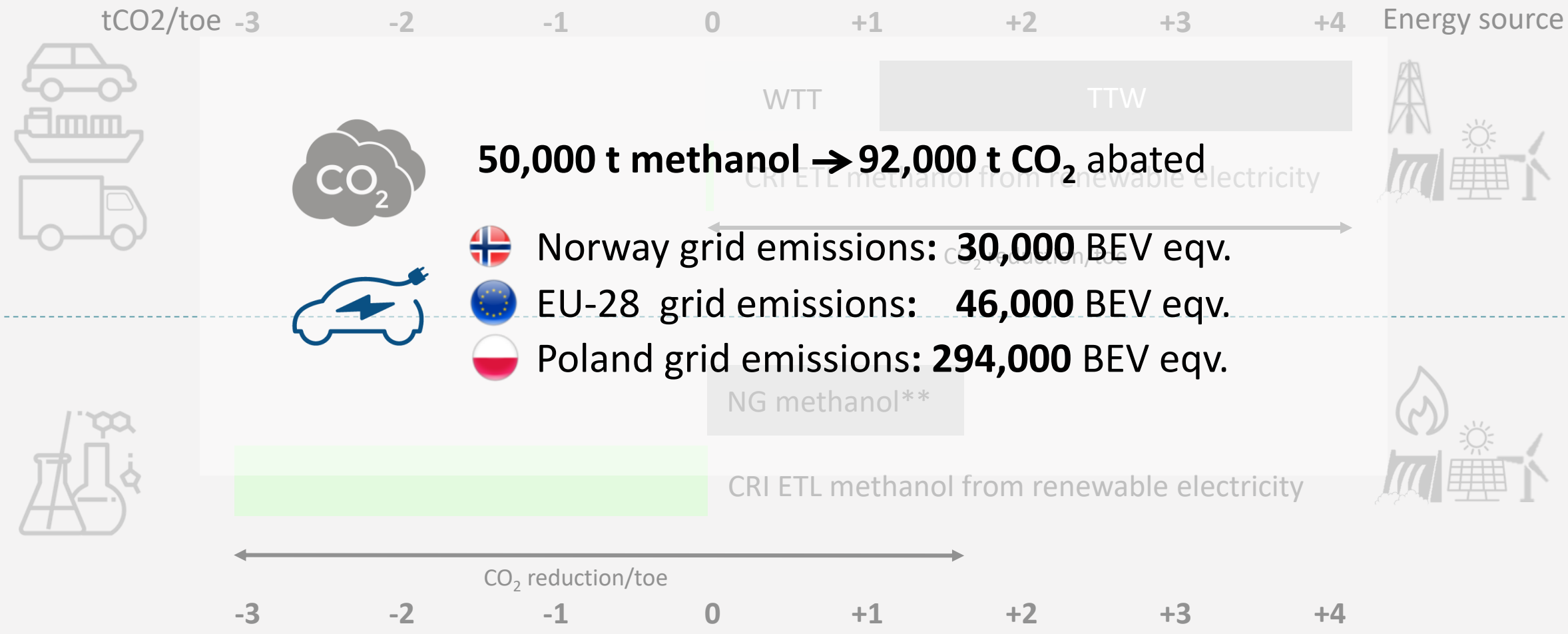
CRI ETL methanol from **renewable electricity**

CO_2 reduction/toe

-3 -2 -1 0 +1 +2 +3 +4

*RED II directive 94 gCO2e/MJ gasoline or diesel; **State-of-the art SME methanol Johnson Matthey Technol. Rev., 2017, 61, (4), 297–307

90%-100% reduction of life-cycle CO2 emissions compared to fossil fuel



50,000 t methanol → 92,000 t CO_2 abated

Norway grid emissions: **30,000** BEV eqv.

EU-28 grid emissions: **46,000** BEV eqv.

Poland grid emissions: **294,000** BEV eqv.

Source: US EPA, Koffi B. et. al. Covenant of Mayors for Climate and Energy (2017) Default emission factors for local emission inventories

EU Horizon 2020 Research and Innovation Programme under grant agreement No 848757

CirclEnergy

What are near-term offtake markets?

Cars

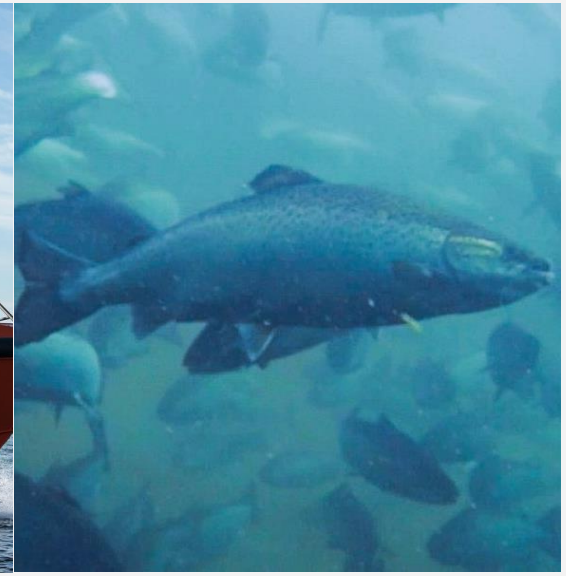
3% blend in standard gasoline (EN228), New gasoline blends (A20%), MTBE, FAME, M100%

Heavy Goods Vehicles

M100%, FAME, UCOME

Ships and barges

M100%, FAME, UCOME

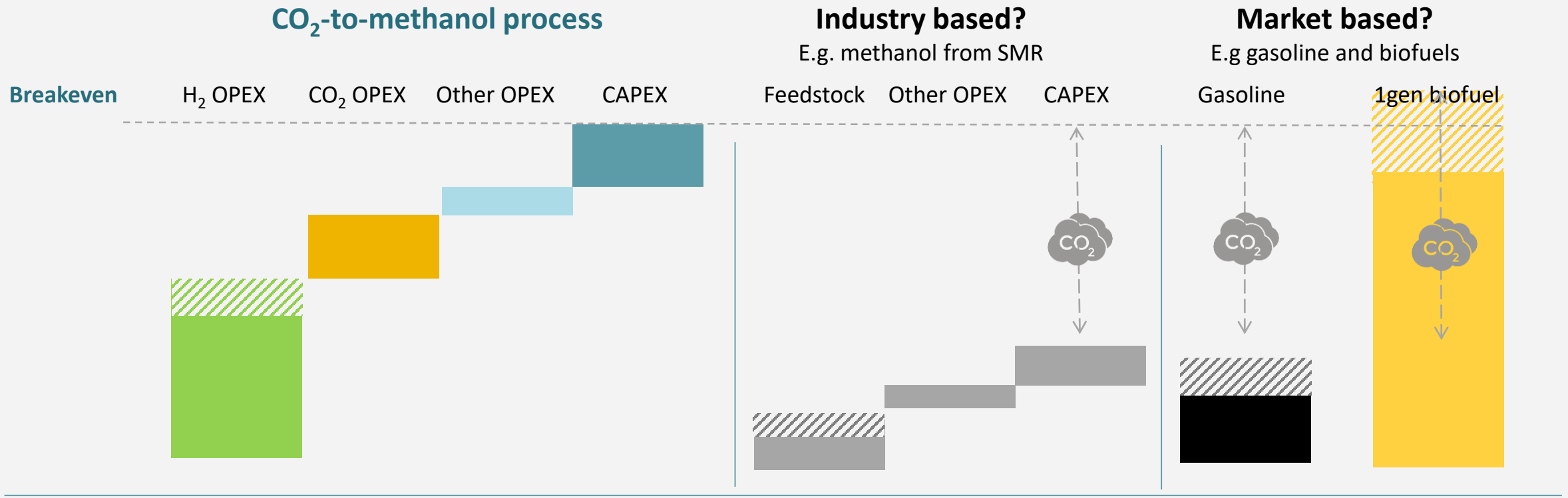


Other

Water denitrification, aquaculture (O_2 byproduct), traditional chemical applications

EU Horizon 2020 Research and Innovation Programme under grant agreement No 848757

Economics: what is the true abatement cost and value?



Drivers	Cost of **electricity**	Flue gas **source**	Cost of **labor**	Cost of **electrolyzers**	**Local NG** market	**Scale economy** of ≥ 1 MM t/yr	**Global oil** supply/demand	**Lipids/ sugar** supply/demand
Issues	Value of grid stabilization	In who's scope?		No mass production	Cost not transparent	Sustainable tech at lower scale	Volatilty & long run demand	Volatility and ag subsidies

EU Horizon 2020 Research and Innovation Programme under grant agreement No 848757

Thank you

benedikts [at] cri.is

www.cri.is

@CarbonRecyclePR