Routes for production of transportation fuels via deoxygenated bio oil

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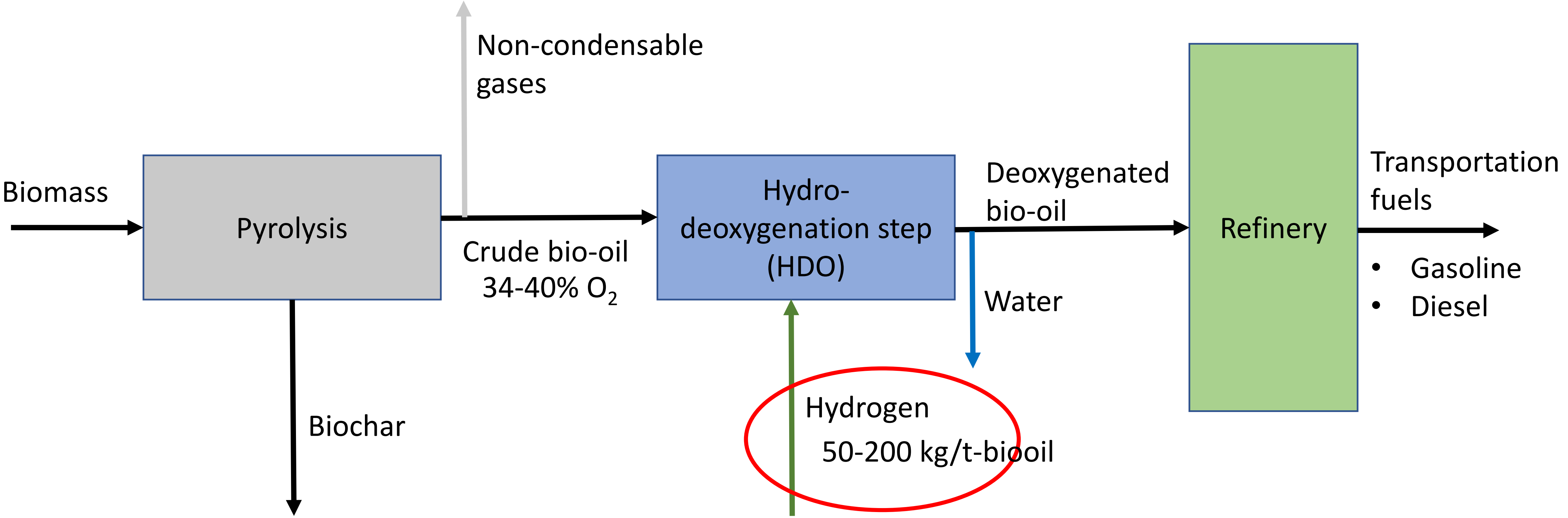
Outline

- Biofuels in transportation
- Hydrogen in producing drop-in fuels via deoxygenated biooils
- Process performance for different hydrogen generation methods
- Economic and greenhouse gas assessment
- Summary and Conclusions

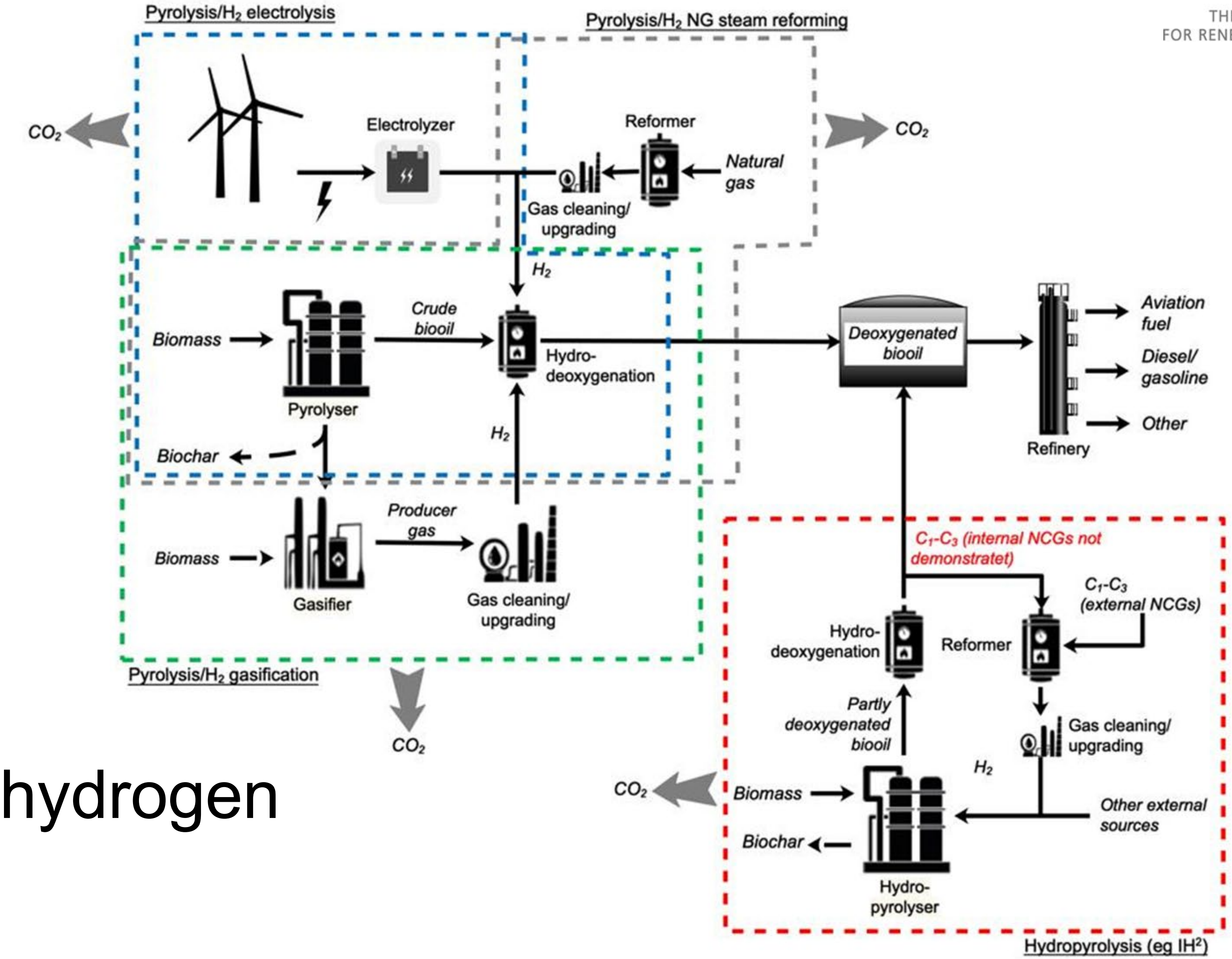
Biofuels in future transport system

- Sweden has the long-term goal to achieve zero net greenhouse gas emissions by 2050
- Sweden aims to reduce GHG emissions from domestic transport (excluding aviation) by 70% by 2030 with respect to the levels in 2010
- Aim to have 27% blending of jet fuels with bio-jet fuel
- Biofuels currently account for 19.5%, or 16 TWh/year, but to achieve the 2045 targets, this is predicted to increase to 38 TWh/year
- Production of hydrocarbon-based drop-in fuels such as petrol and diesel from residual biomass provides
    - possibility of utilizing the existing industrial processes
    - utilizing distribution networks
    - compatibility with the existing vehicle fleet

Drop-in fuels via deoxygenated biooil

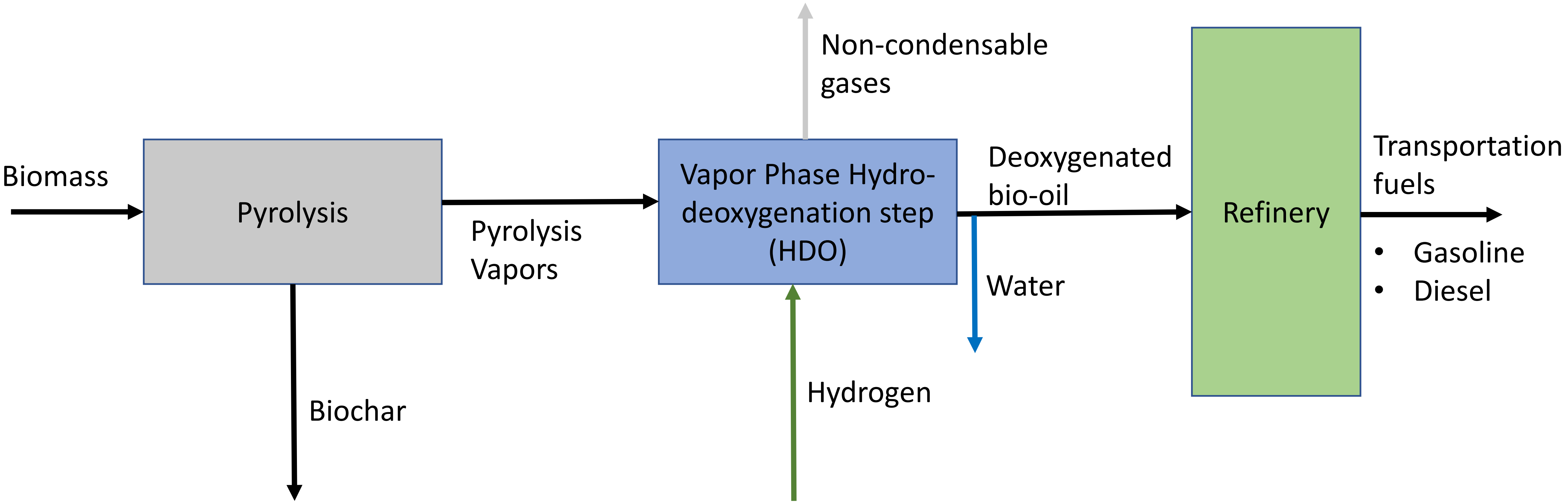


0.17-0.42 million tonnes H_2 per year in HDO to achieve 2045 climate targets



Integrating hydrogen production

Vapor phase HDO step



Different process scenarios

Case	Definition
Reference case scenarios	
NG	HDO step uses hydrogen generated from natural gas reforming process
EL	HDO step uses hydrogen generated from electrolysis
BG	HDO step uses hydrogen generated from biomass gasification
I-BG	HDO step uses hydrogen generated from gasification of biochar from the process and additional biomass
CCS case scenarios – These scenarios have a post-combustion MEA absorption-based CCS process integrated with the bio-oil production process	
CCS – NG	CO_2 is captured from the NG reforming process that generates hydrogen for the HDO step. The remaining process is similar to case Ref1
BECCS	CO_2 is captured from the combustion exhaust gases from both pyrolysis and gasification step in the I-BG case.
IH2	Bio-oil is produced in the IH2 process

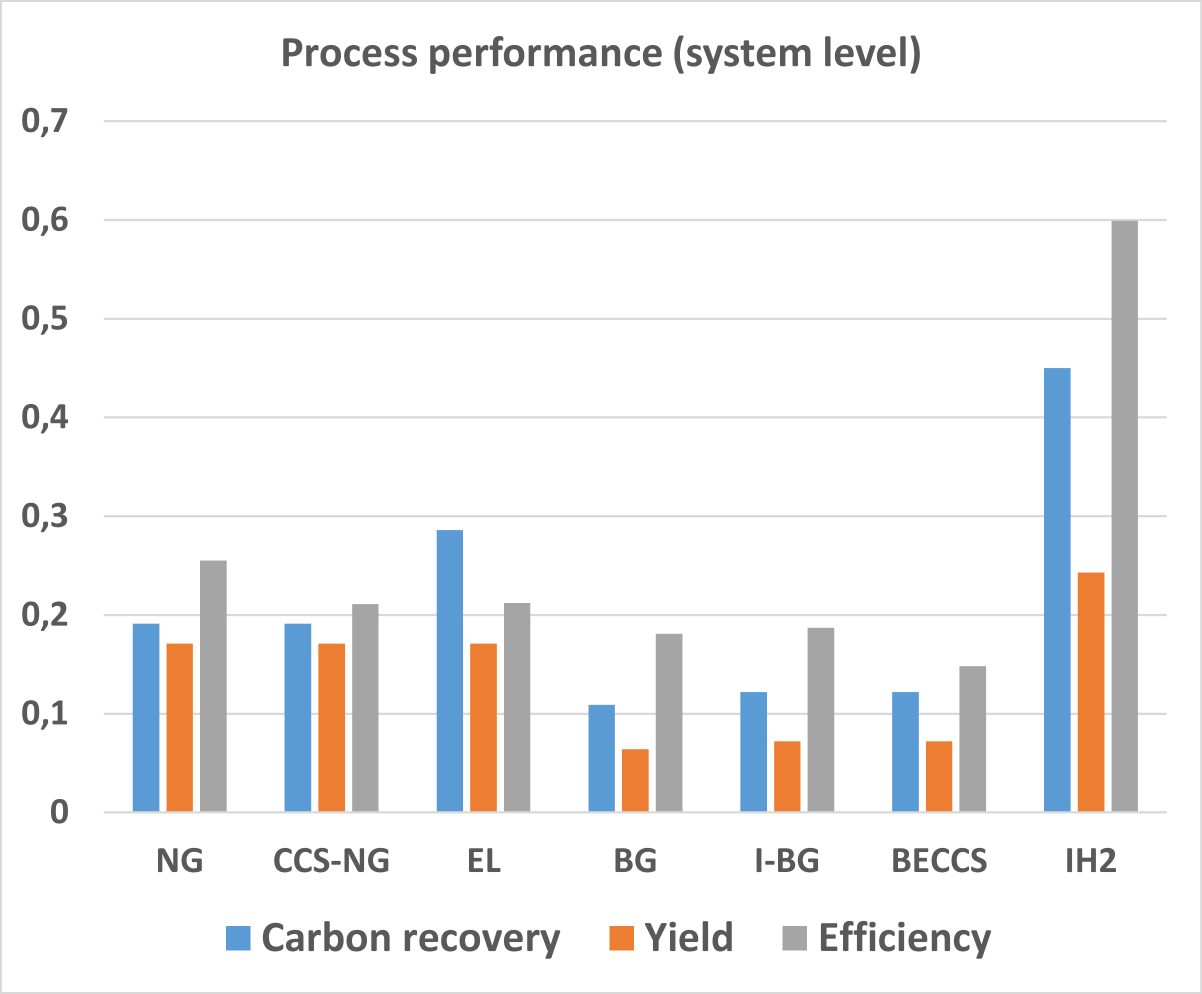
Key performance indicators for process performance

$$System\ level\ carbon\ recovery = \frac{Mass\ of\ Carbon\ in\ biooil}{Mass\ of\ Carbon\ input\ to\ the\ entire\ system}$$

$$System\ level\ yield_{biooil} = \frac{Mass\ of\ biooil}{Mass\ of\ dry\ biomass\ feed\ to\ the\ system}$$

$$System\ level\ conversion\ efficiency\,(\eta_{system}) = \frac{Output\ Energy}{Input\ Energy}$$

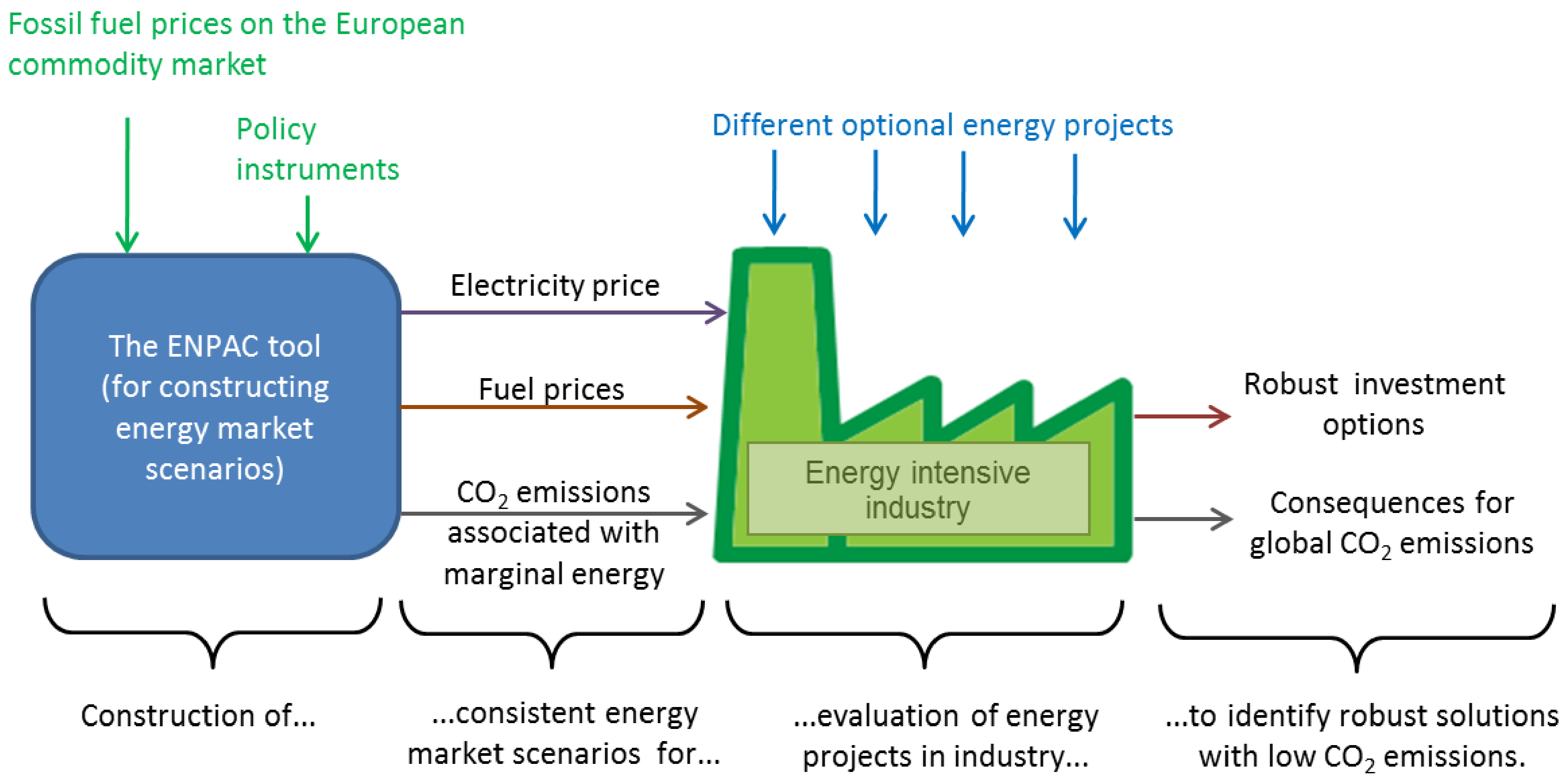
Process performance



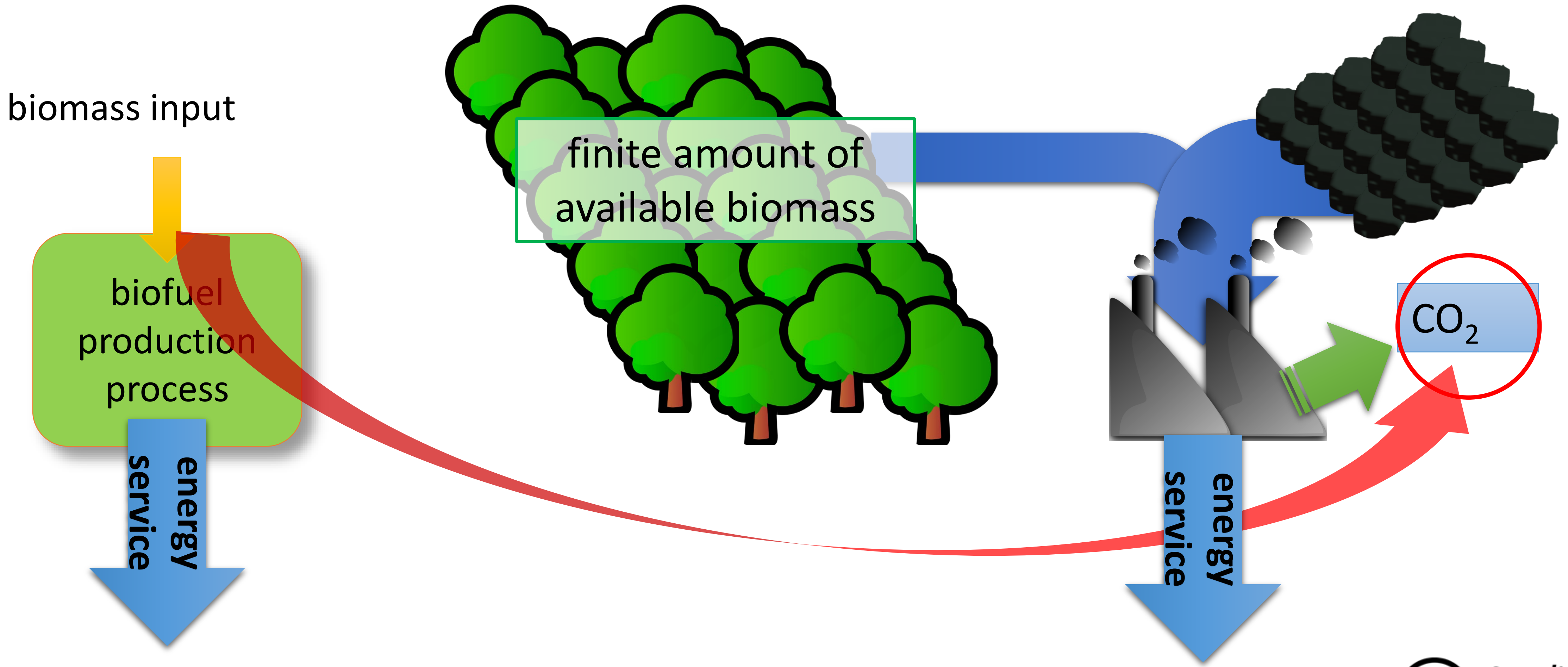
Economic and GHG assessment

- Material and energy flows from process modelling
- Economics: OPEX estimate to determine investment opportunity (no detailed CAPEX estimate)
- GHG: Well-to-gate + combustion
- Energy prices and GHG-emission factors for 2030 based on two ENPAC-scenarios

ENPAC Scenario tool



ENPAC - Biomass use and CO_2 consequences



ENPAC - Output

Two scenarios:

- New policies 2030 – lower biomass prices, lower CO_2 charge, biomass *unlimited resource*
- Sustainable development 2030 – higher biomass prices, higher CO_2 charge, biomass *limited resource*

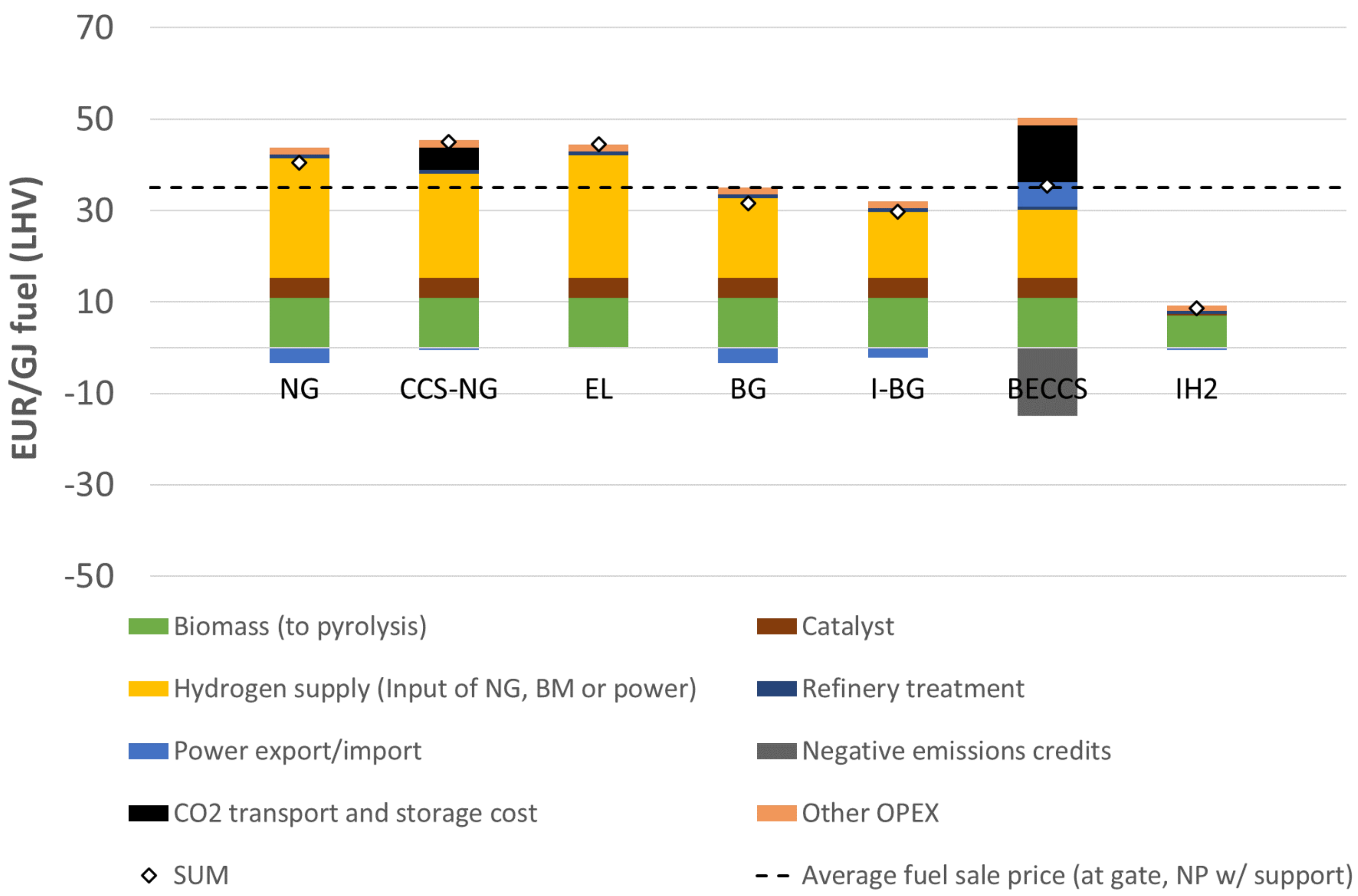
Prices and emission factors for

- Fossil petrol, diesel
- Natural gas
- Biomass
- Electricity
- CO_2-charge

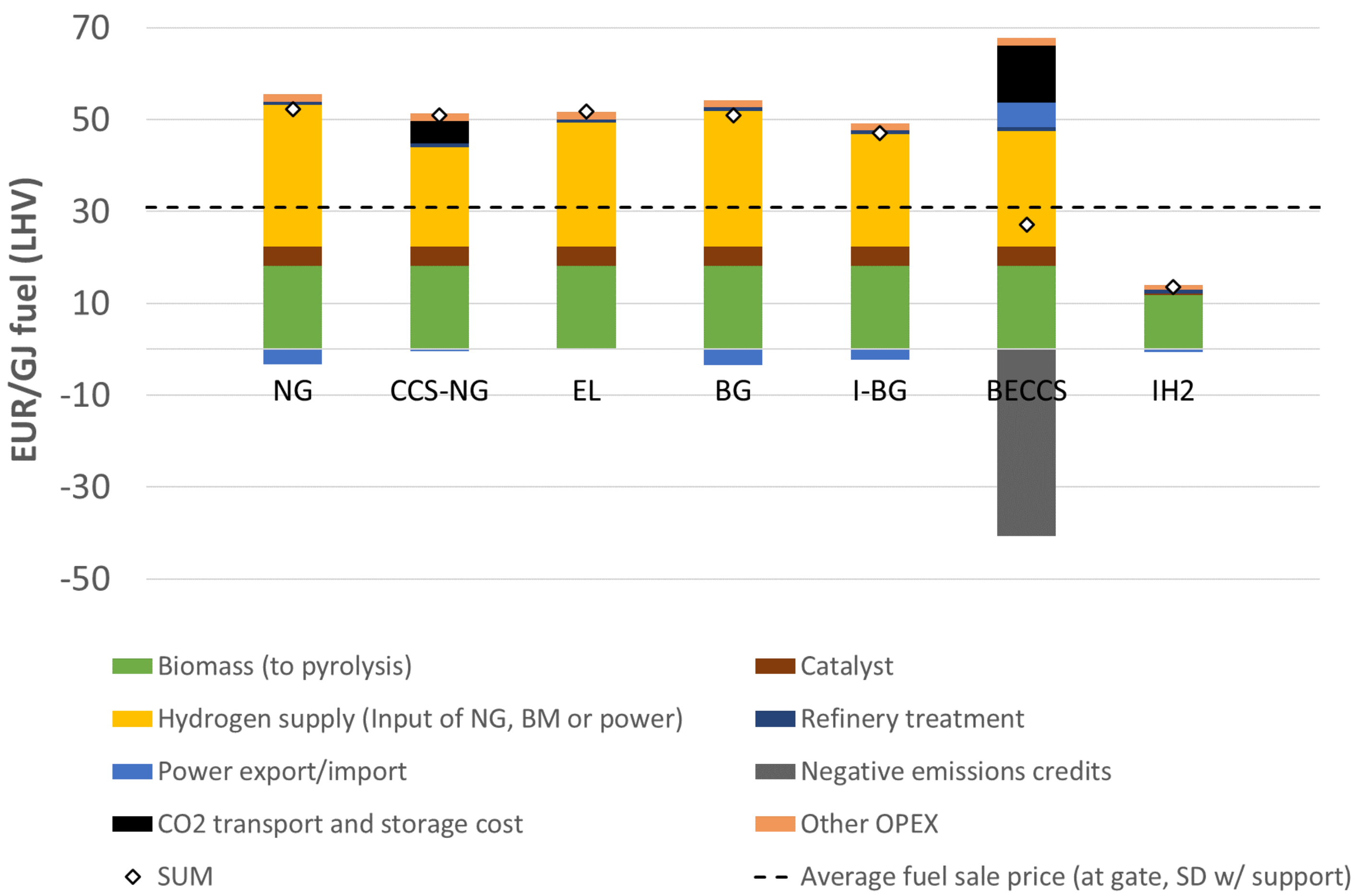
Economic assessment

- Biomass, power, fuel and CO2 prices based on ENPAC-scenarios
- Focus on plant OPEX and revenue, no detailed CAPEX estimate
- Difference between annual biofuel revenue and production plant OPEX = Investment opportunity

OPEX – New policies scenario (2030)



OPEX – Sustainable dev. scenario (2030)



GHG assessment

- Feedstock, power and fossil fuel emission factors based on ENPAC-scenarios
- Well-to-gate and combustion emissions
- Combustion emissions for biomass/biofuel = 0 gCO_{2eq}.

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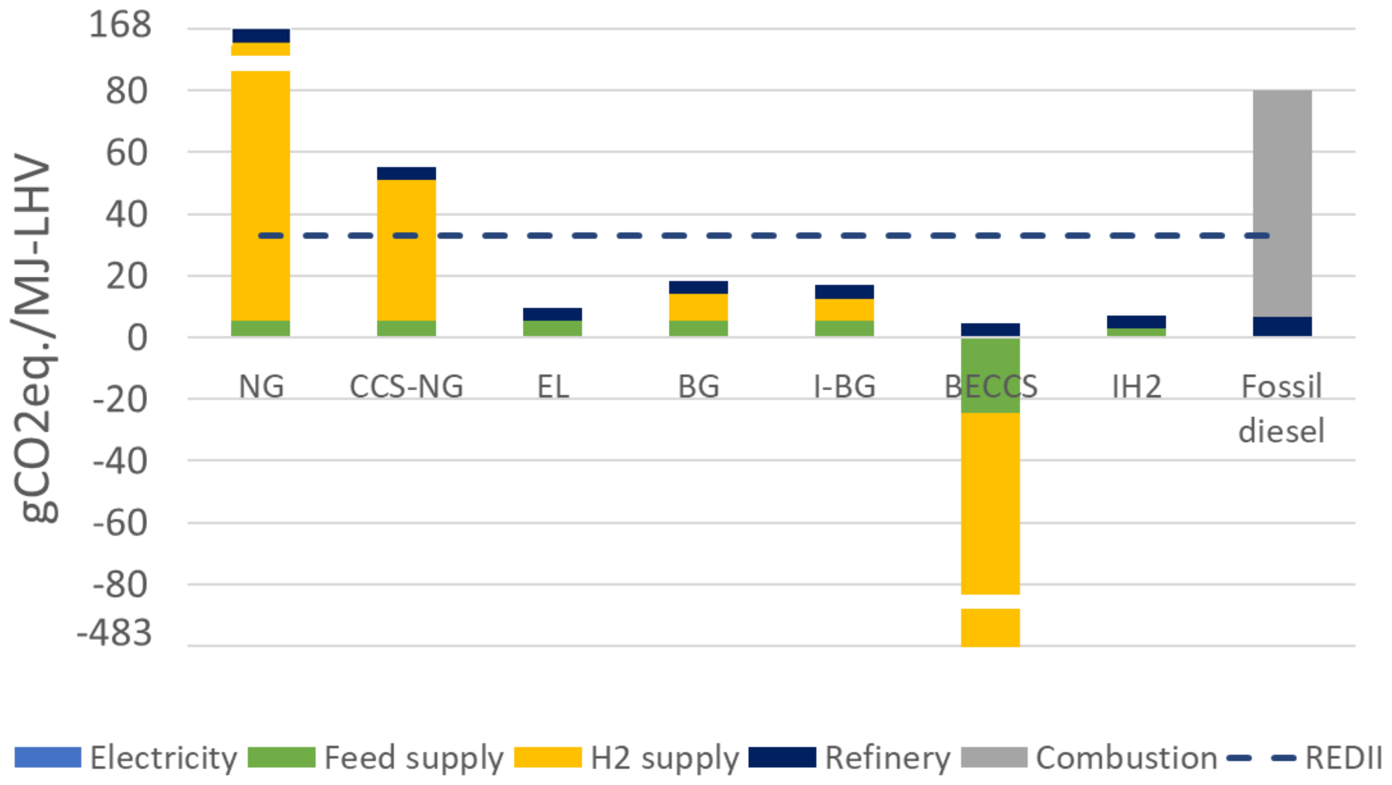
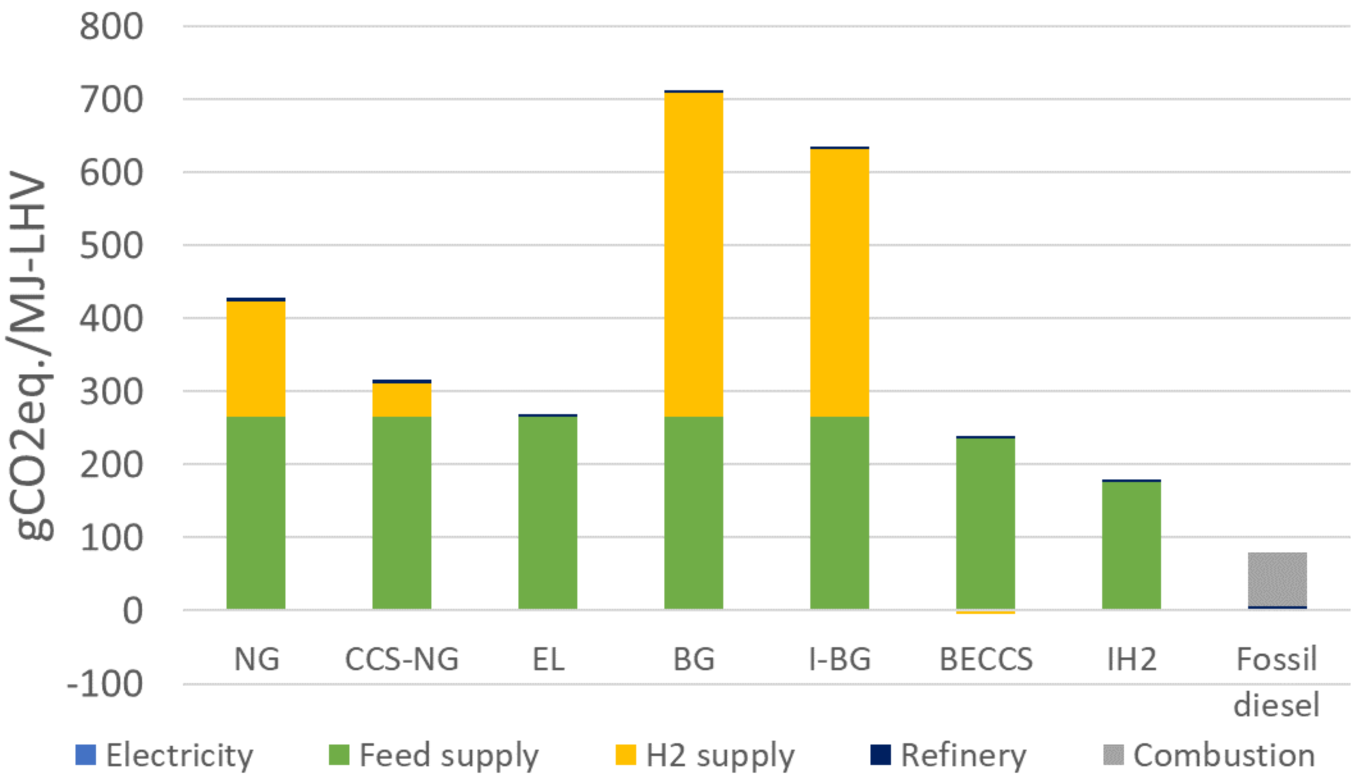
GHG – New policies scenario (2030)



GHG – Sustainable dev. scenario (2030)



Summary

- Studied the techno-economic-environmental performance of transportation fuels productions via deoxygenated biooil and different hydrogen generation processes
- The IH2 process outperforms the other process routes techno-economically
- Hydrogen generation process and its efficiency has a significant impact on the system level carbon recovery, system level yield and system efficiency
- Electrolysis is better route to generate hydrogen for HDO step with respect to system level carbon recovery
- Integrating CCS reduces the system level efficiency of the processes by 4-5%-points
- In the scenario with incentives for negative emissions, integrating BECCS makes the biomass gasification route for hydrogen production very attractive
- CO_2 utilization can enable improvements in carbon recovery in biofuels production
- Further research is required in hydro-deoxygenation processes

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Thank you