TECHNISCHE UNIVERSITÄT WIEN

Energy Economics Group

Economic assessment of CO_2 utilization for waste biomass conversion into transport fuels

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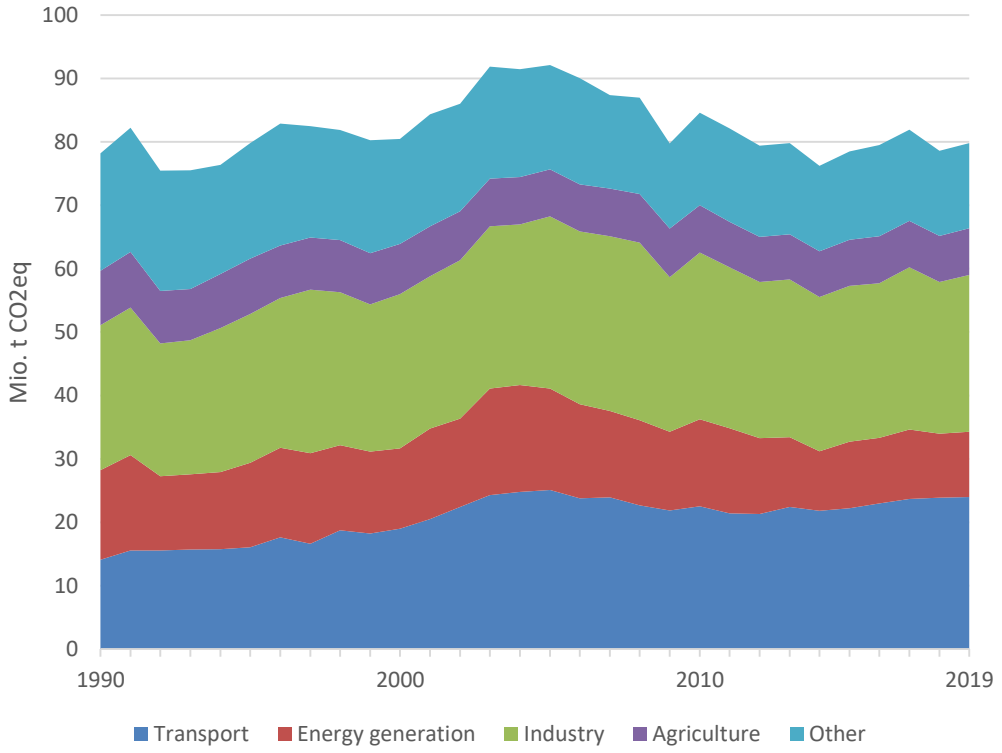
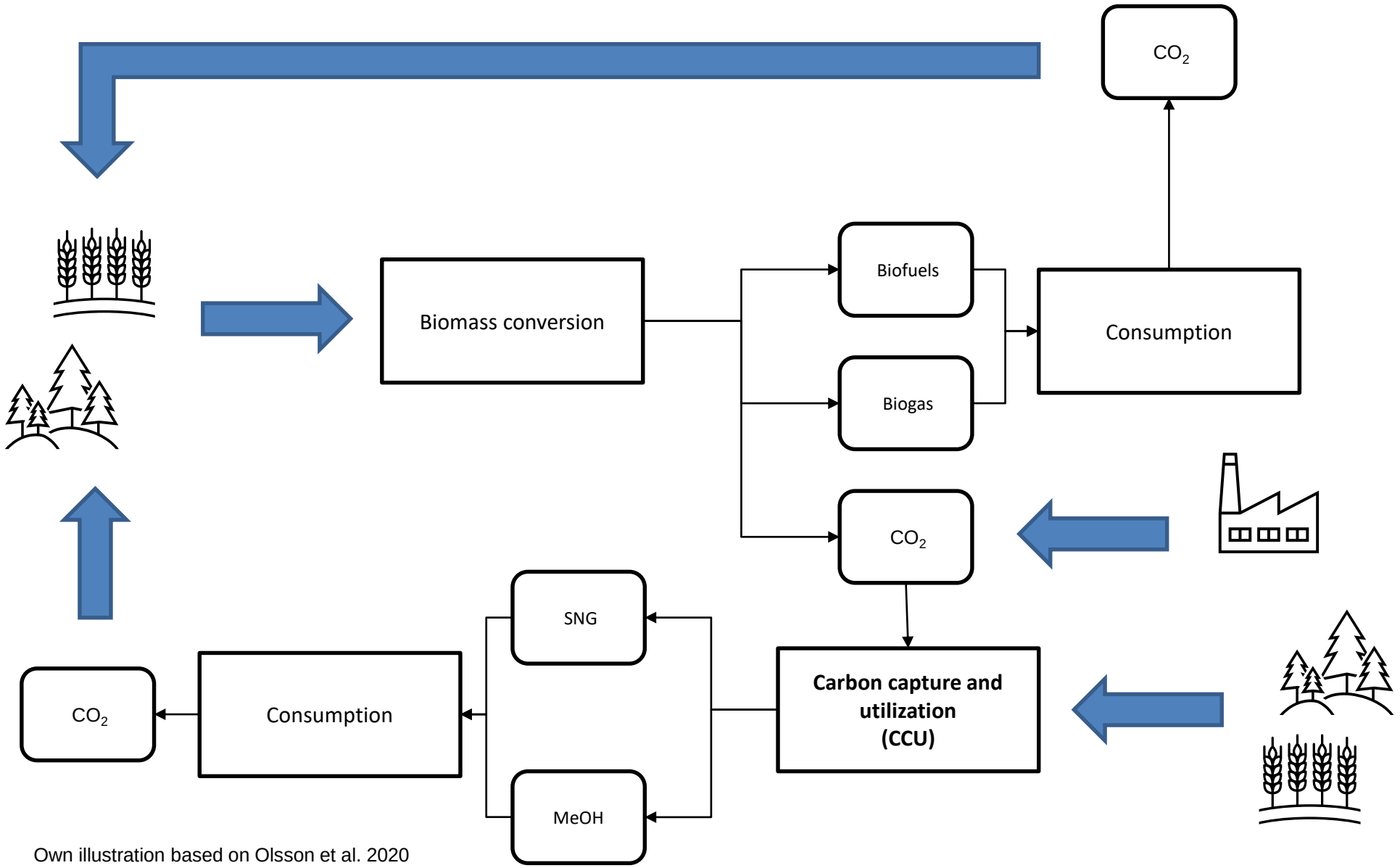
Background

- Paris agreement
- Emissions in transport sector increased by 25% in EU, 75% in AT from 1990-2019
- Decarbonization of the transport sector



Source: Umweltbundesamt 2021

Bioenergy with carbon capture and utilization (BECCU)

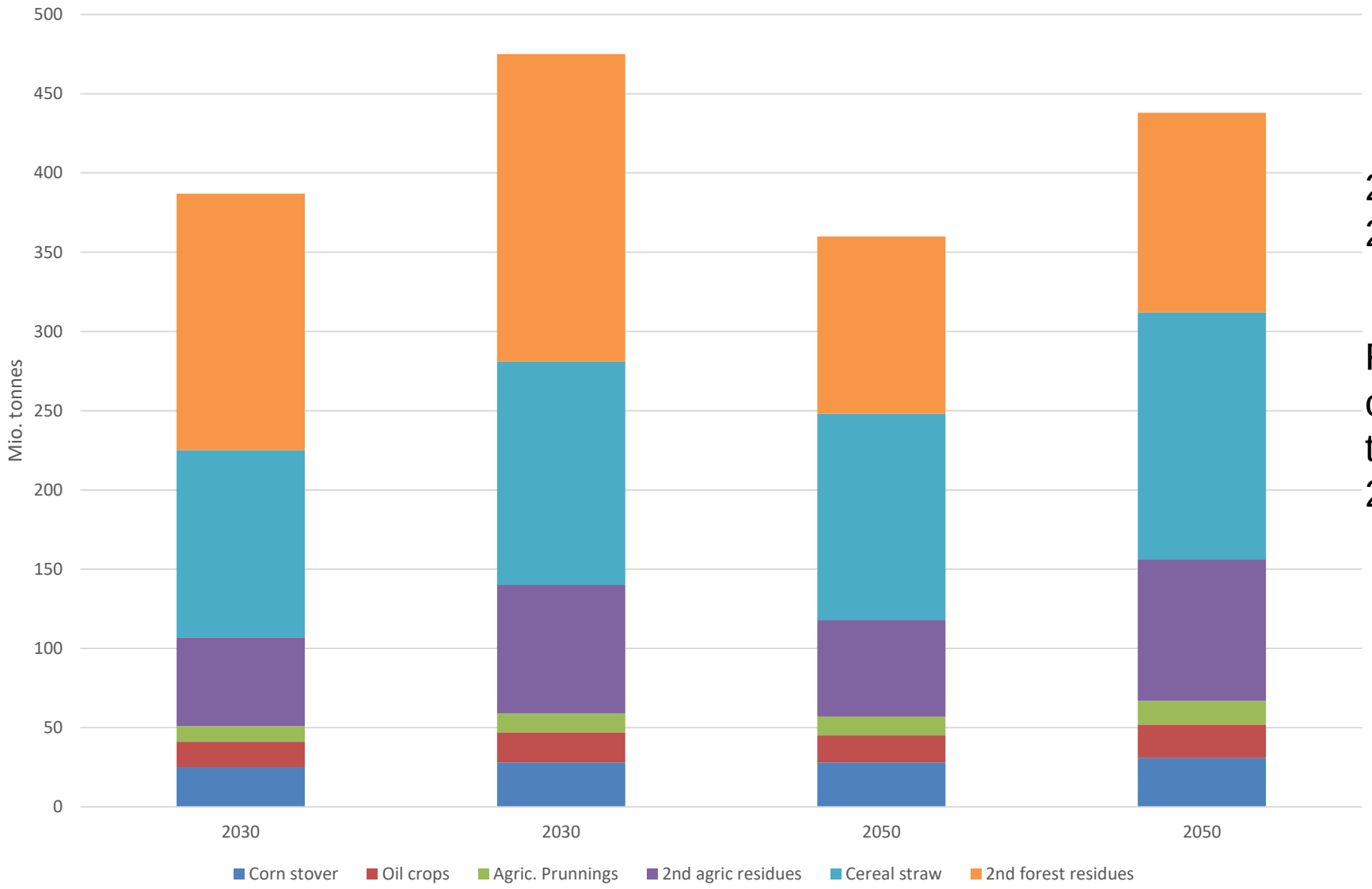


Own illustration based on Olsson et al. 2020

SNG and MeOH in the transport sector

- Contribution to the decarbonization
- SNG production has lower emissions than biogas production with upgrading, gas grid
- 1.4 million natural gas vehicles in Europe, 3665 CNG and 214 LNG fuelling stations (2019)
- MeOH is a widely used chemical, easier to store than CH_4 and has a high octane rating, already used in racing
  - Low heating value

Feedstock potentials 2030/2050



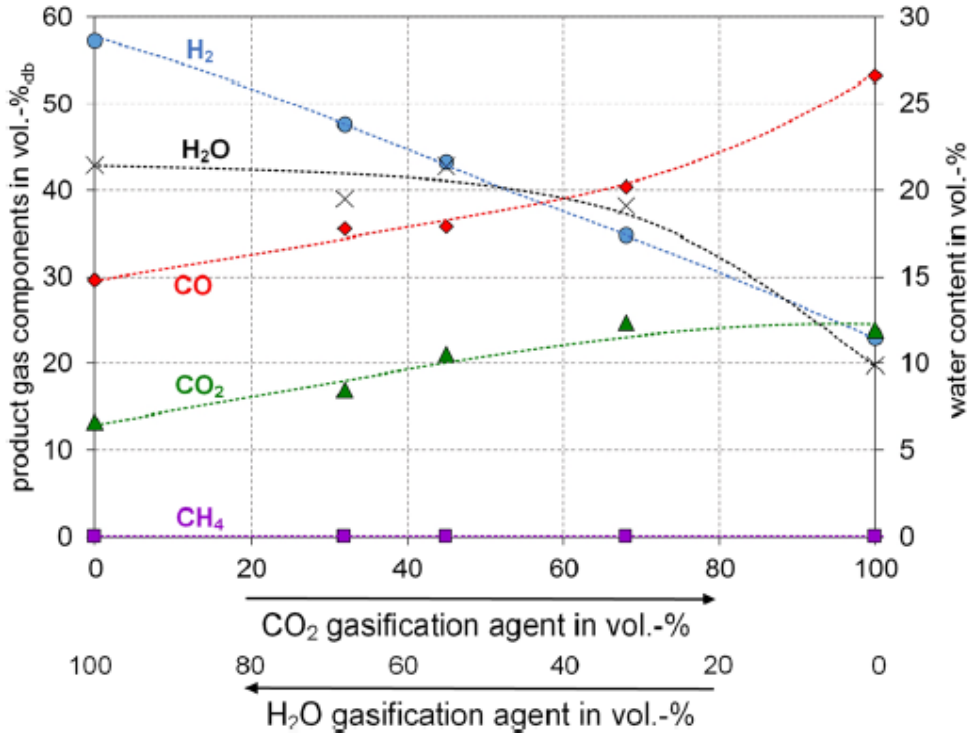
2030: 46-97 Mtoe
2050: 71-176 Mtoe

Final energy consumption of transport sector 2019: ~ 290 Mtoe

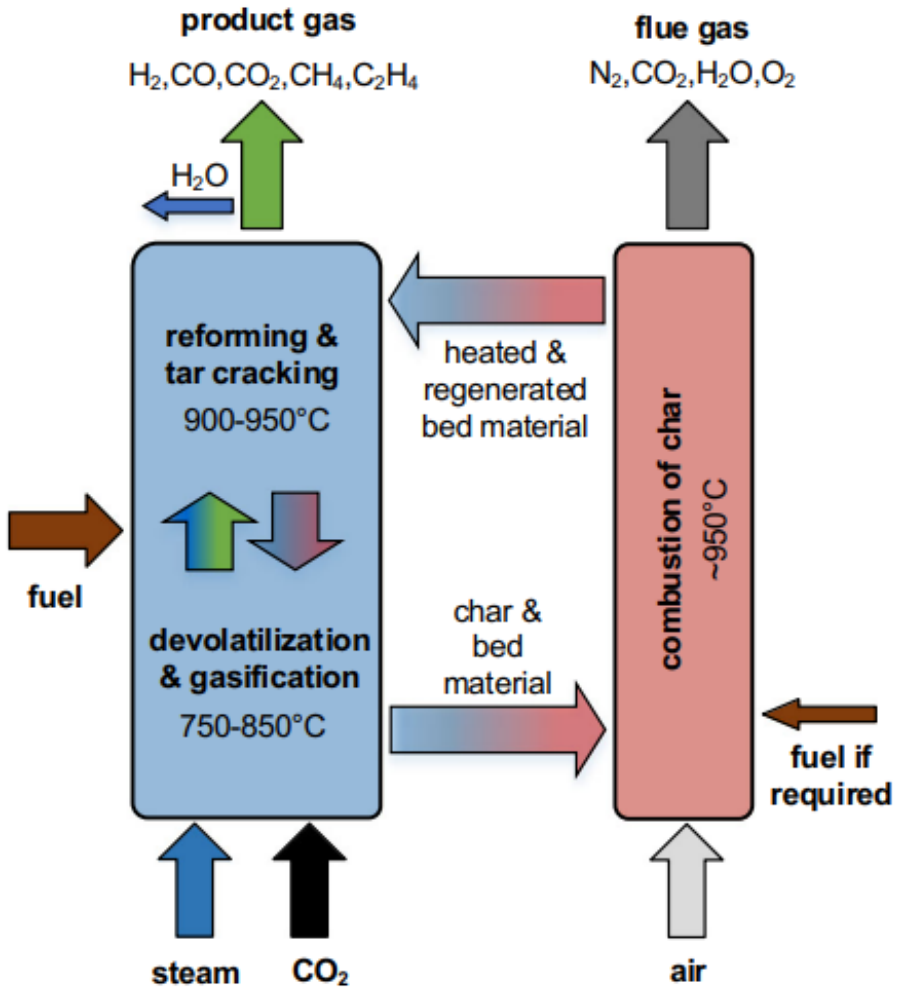
Feedstock potentials in the former EU-28 with focus on biomass waste and residues. Source: Imperial College London 2021

CO_2 gasification

- Allothermic process
- Combustion reactor: fluidized with air
- Gasification reactor: fluidized with CO_2/ steam
  - Boudouard-reaction $CO_2 + C \leftrightarrow 2\ CO$



Mauerhofer et al. 2021



Mauerhofer et al. 2021

Economic assessment

- Capital recovery factor
  - $CRF = \frac{(1+r)^n r}{(1+r)^n - 1}$
- Levelized cost method
  - $C_{fuel} = I_C * \frac{CRF}{FLH} + p_{Biomass} * \frac{z}{LHV} + c_{var}$

$p_{Biomass}$= biomass price [€/ t FS], z = conversion factor [t FS/ t fuel], c_{var}= variable cost including: operating and maintenance (O&M), heat & electricity, labor [€/ MWh], FLH = full load hours, LHV = lower heating value [MWh/t], FS=Feedstock

Investment cost from GoBiGas project/ Innovation Outlook: Renewable Methanol

Lifetime: 20 years

Interest rate: 7.5%

Economic assessment

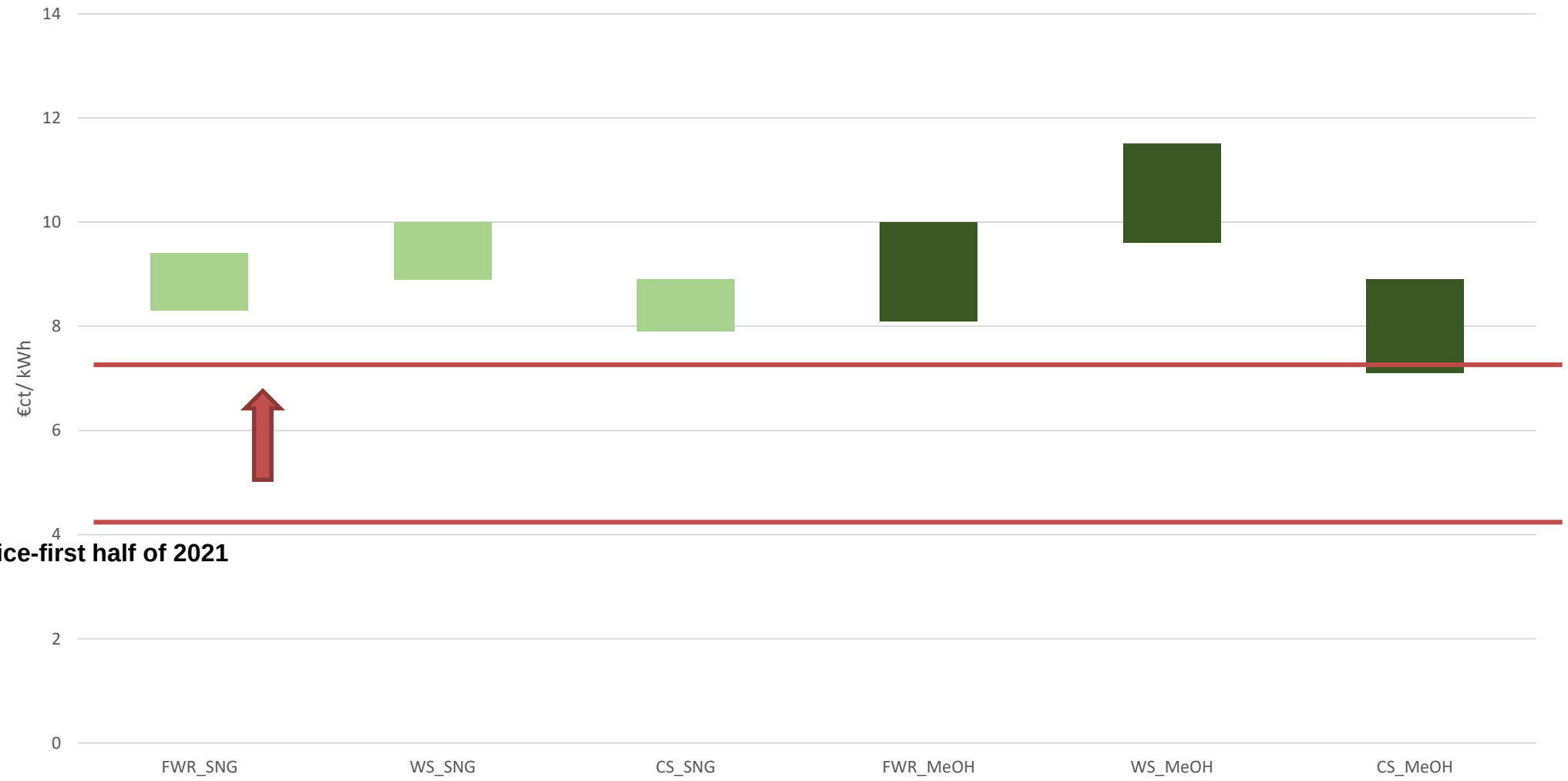
Feedstock prices: forest wood residues (FWR)[1] : 50€/t, wheat straw (WS) [2] : 81 €/t, corn stover (CS) [3] : 22 €/ t

SNG investment cost: 3246 €/t (200 MW), 3654.54 €/t (100 MW)

Bio-MeOH investment cost: 1318 €/t (low), 1876 €/t (high)

[1] Holzmarktbericht 01/2022, [2] Statistik Austria 2020, [3] Câmara-Salim et al. 2021

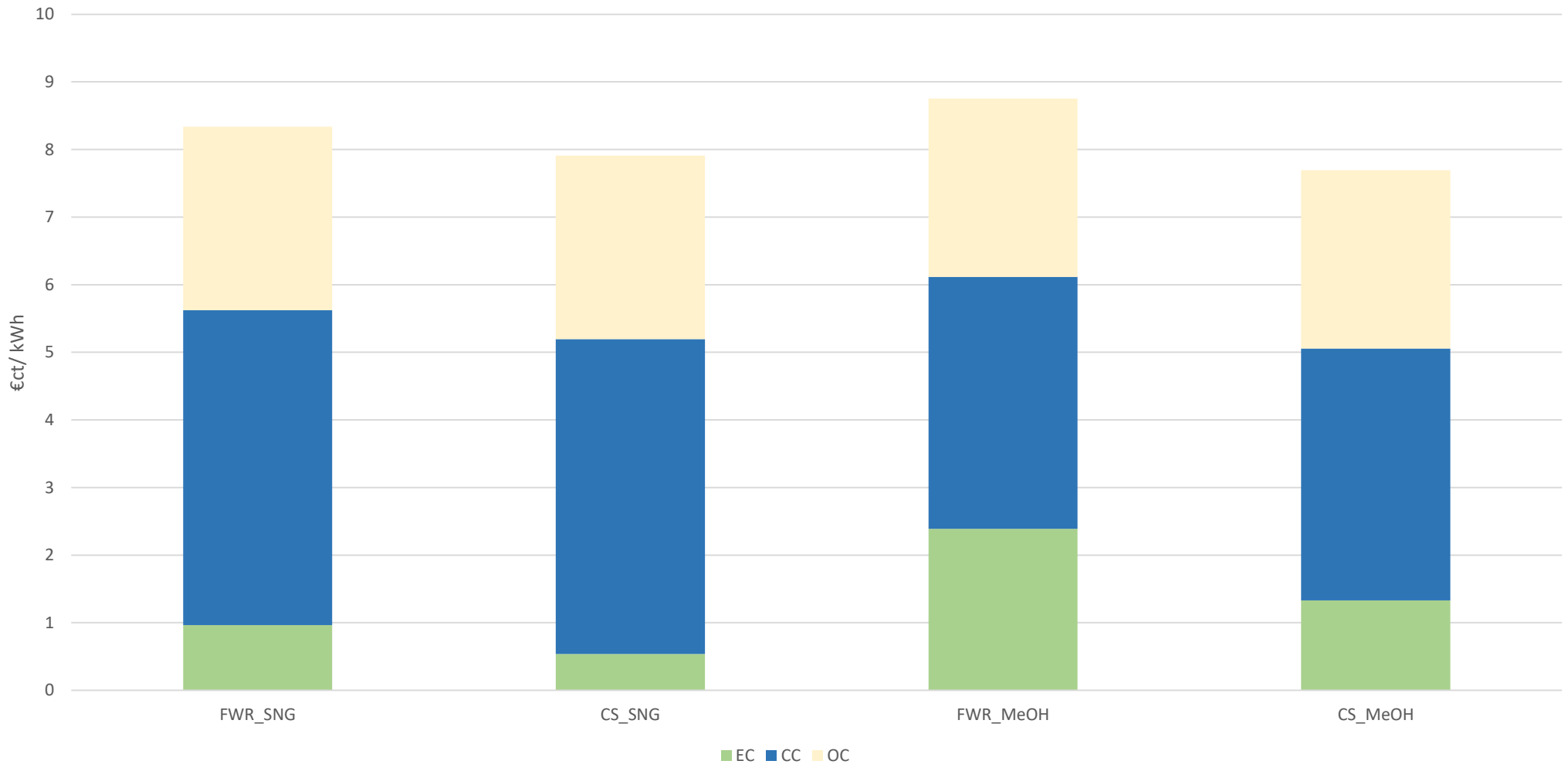
Production costs



NG price-first half of 2021

Production costs for SNG and MeOH for three different feedstocks. FWR=forest wood residues, WS=wheat straw, CS=corn stover, SNG=synthetic natural gas, MeOH=methanol

Production costs



Differentiated production costs [€ct/ kWh] for SNG= synthetic natural gas and MeOH=methanol for FWR=forest wood residues and CS=corn stover

Conclusions

- Large quantities of biomass waste available
- Economic competitiveness is an issue
- Assumptions based on steam gasification
- Further research: effect of parameters from CO_2 gasification on the production costs
  - Carbon credit and sensitivity analysis

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Thank you for your attention!

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