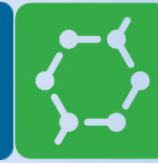




ICEEM 12

12<sup>th</sup> International Conference on Environmental Engineering and Management  
Circular Economy and Sustainability  
13 - 16 September 2023, Iasi - Romania



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# Challenges in Modelling and Sustainability Assessment of Biorefineries: CO<sub>2</sub> Refinery

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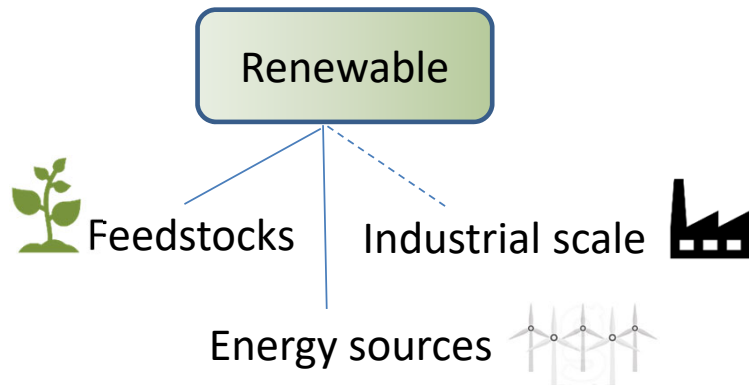
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# Introduction

Climate change has caused adverse impacts, losses and damages:

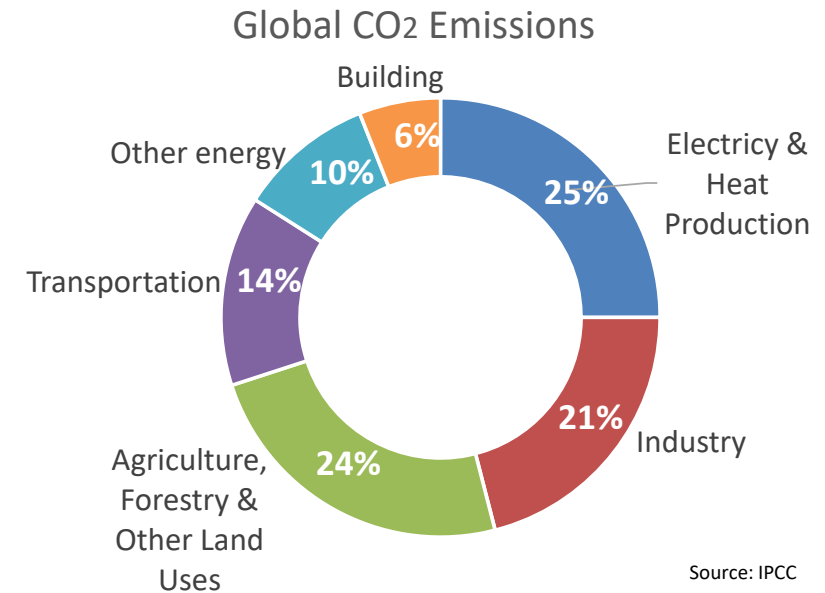
- Affecting food and water security
- Hindering the efforts to reach net zero emissions by 2050

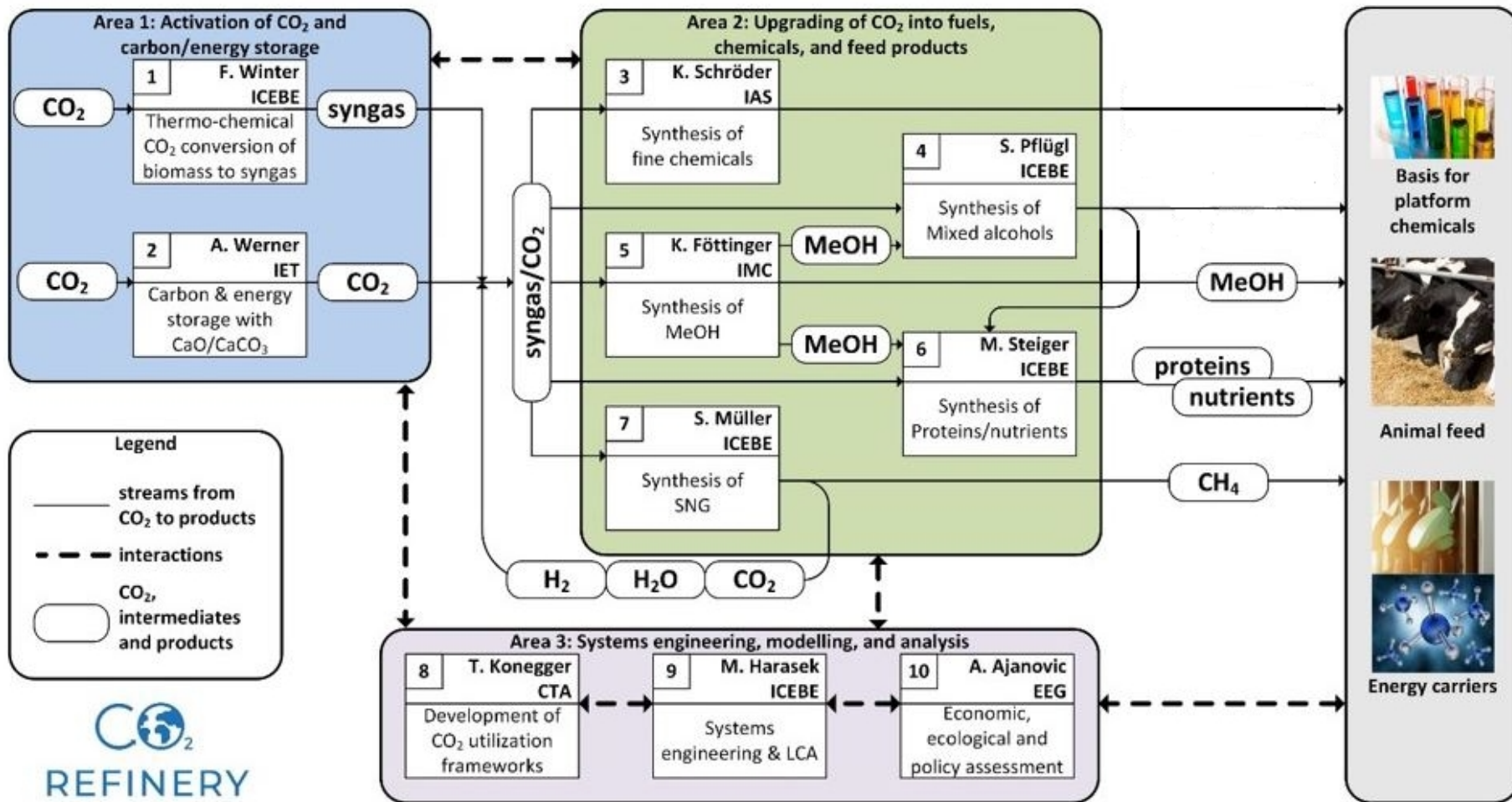
Chemical industry is the third main contributor to emissions, after cement and steel production



Emission mitigation  
Fossil resource dependency  
Resource depletion

Carbon neutrality  
Value added products





# Challenge

Emerging technologies with low technology readiness level (TRL): 1-4

Process Simulation (PS) & Life Cycle Assessment (LCA) tool for process development and optimisation

## Aim of the work



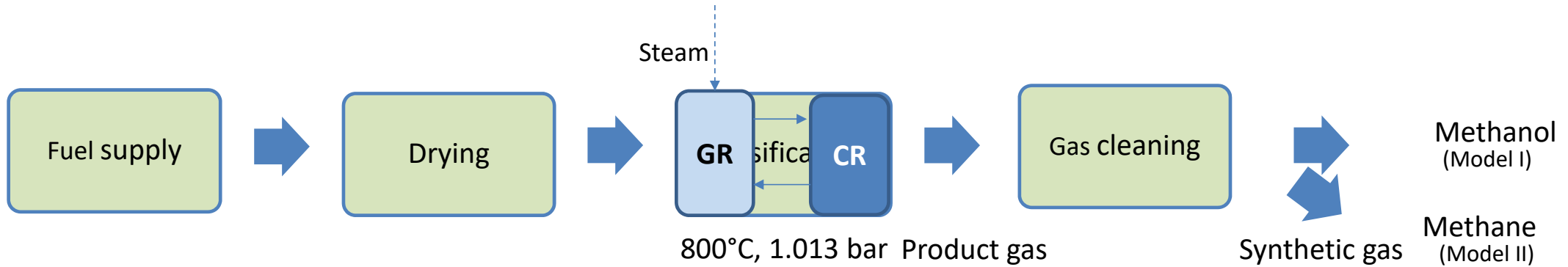
Balance biomass gasification process  
Find environmental hotspots  
Improve process development

## Methodology

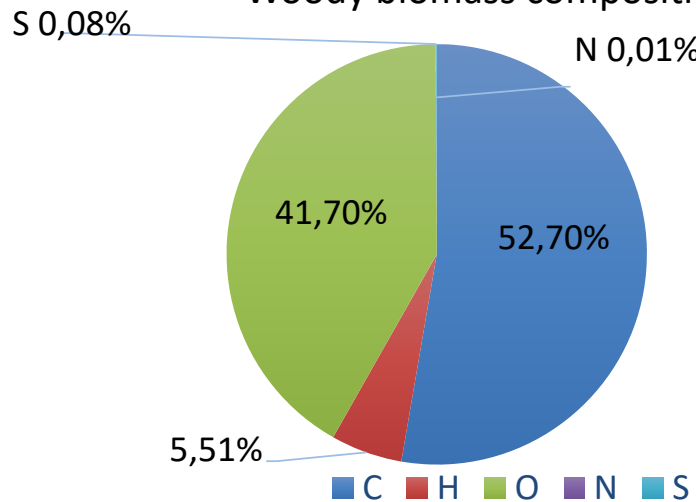


Model developed in Aspen plus v.10  
- Validated with experimental results  
LCA in Simapro v. 9.5, using Ecoinvent v. 3.9.1  
- 1 m<sup>3</sup> of synthetic gas  
- Hotspot analysis

# Process scheme



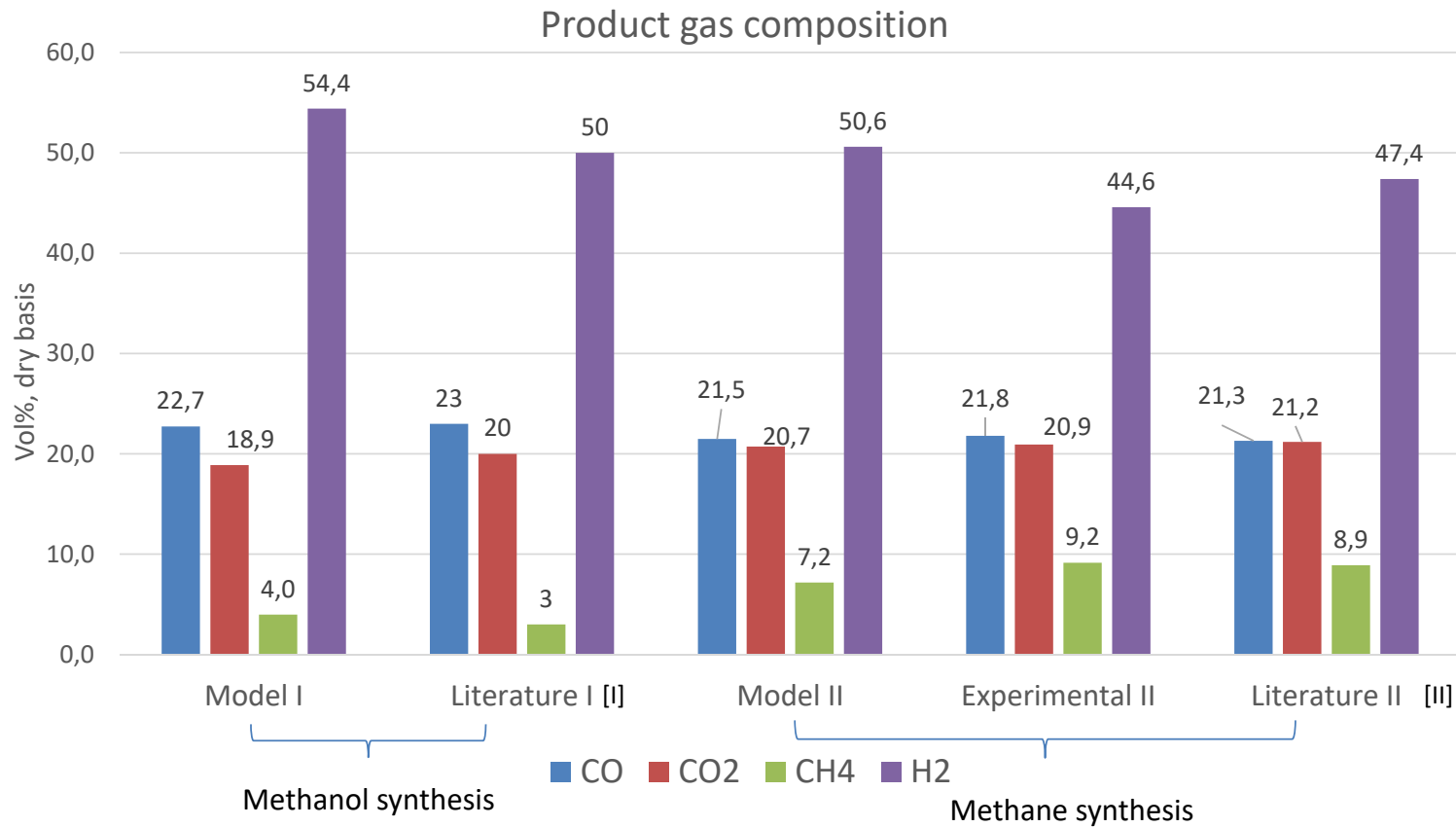
Woody biomass composition



## Assumptions model:

- Steady-state
- Ideal gases
- Isothermal processes
- Inert ash
- Equilibrium Gibbs minimization
- Impurities: NH<sub>3</sub> and H<sub>2</sub>S

# Results



[I] Puig-Gamero, M. et. al, (2018). Three integrated process simulation using aspen plus®: Pine gasification, syngas cleaning and methanol synthesis. *Energy Conversion and Management*, 177, 416–427. <https://doi.org/10.1016/J.ENCONMAN.2018.09.088>  
 [II] Schmid, J. C., et. al (2021). *Syngas for biorefineries from thermochemical gasification of lignocellulosic fuels and residues—5 years' experience with an advanced dual fluidized bed gasifier design*. <https://doi.org/10.1007/s13399-019-00486-2/Published>

# Results - LCA

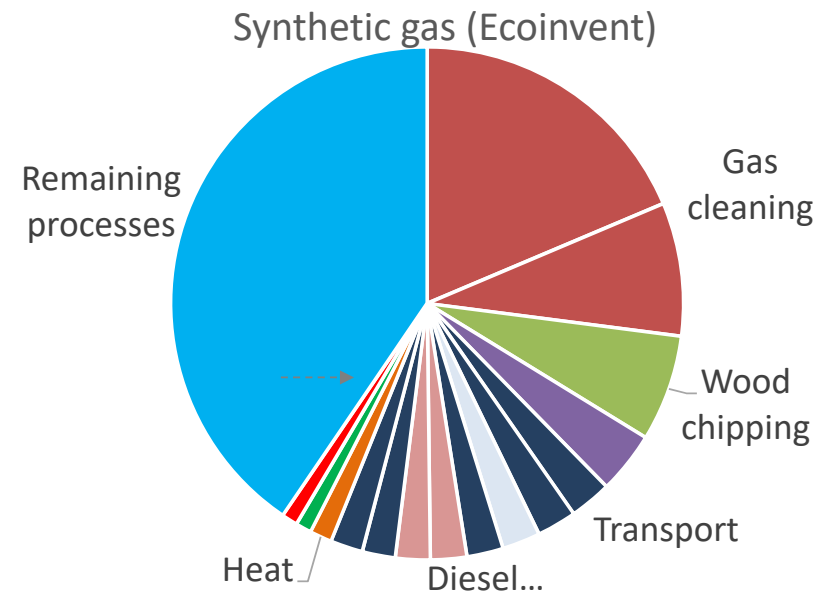
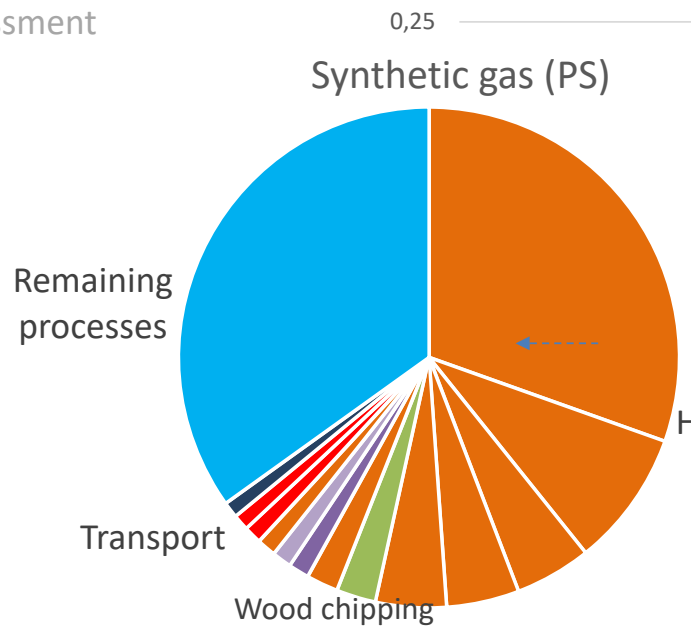
Synthetic gas production via wood chips mix gasification

Gate-to-gate assessment

1% Cut-off

➤ Investigate the PS model via

Climate change



# Conclusion & Outlook

## Key takeaways

- The model agrees with the literature and experimental data
- Versatile applications: based on parameters and model set-up
- Gas cleaning technologies are chosen according to the aimed synthesis gas composition

## Challenges

- Biomass definition and conversion (PS)
- Lack of data in databases (LCA)
- Assumptions

## Outlook

- Extend the model to methanol and methane synthesis
- Set up the inventory for the LCA





Thank you for your attention



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