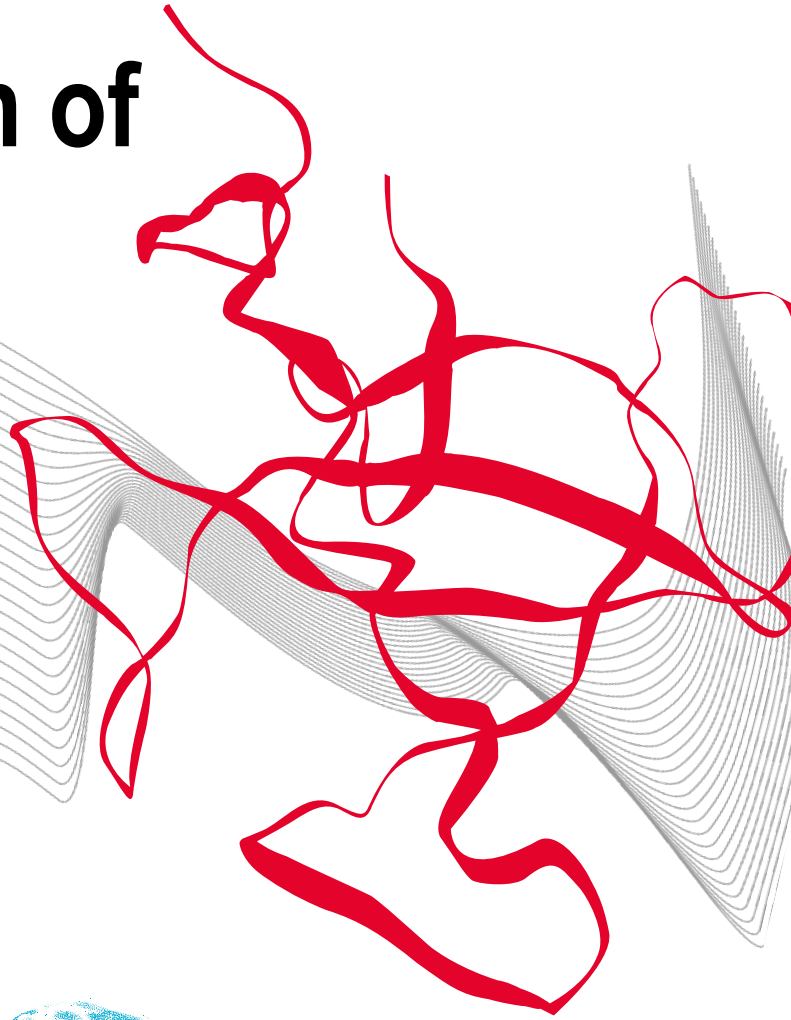
Integrated process for the production of glycols from lignocellulosic biomass



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Denver, 21 April 2022

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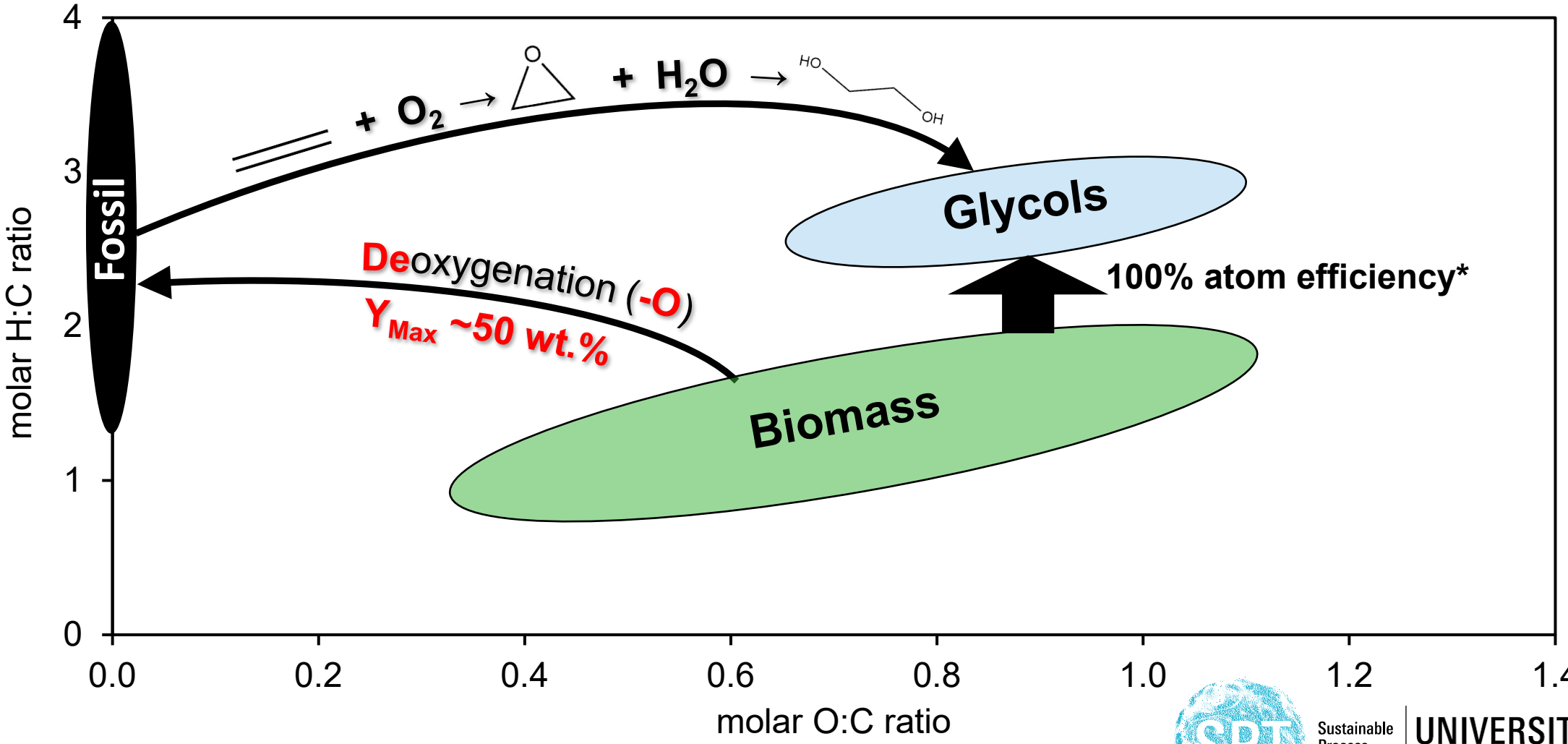
BIOMASS TO GLYCOLS

MOTIVATION

Ethylene glycol: 30 Mton/year

- Polyesters
- PET
- Coolant



*In terms of C and O

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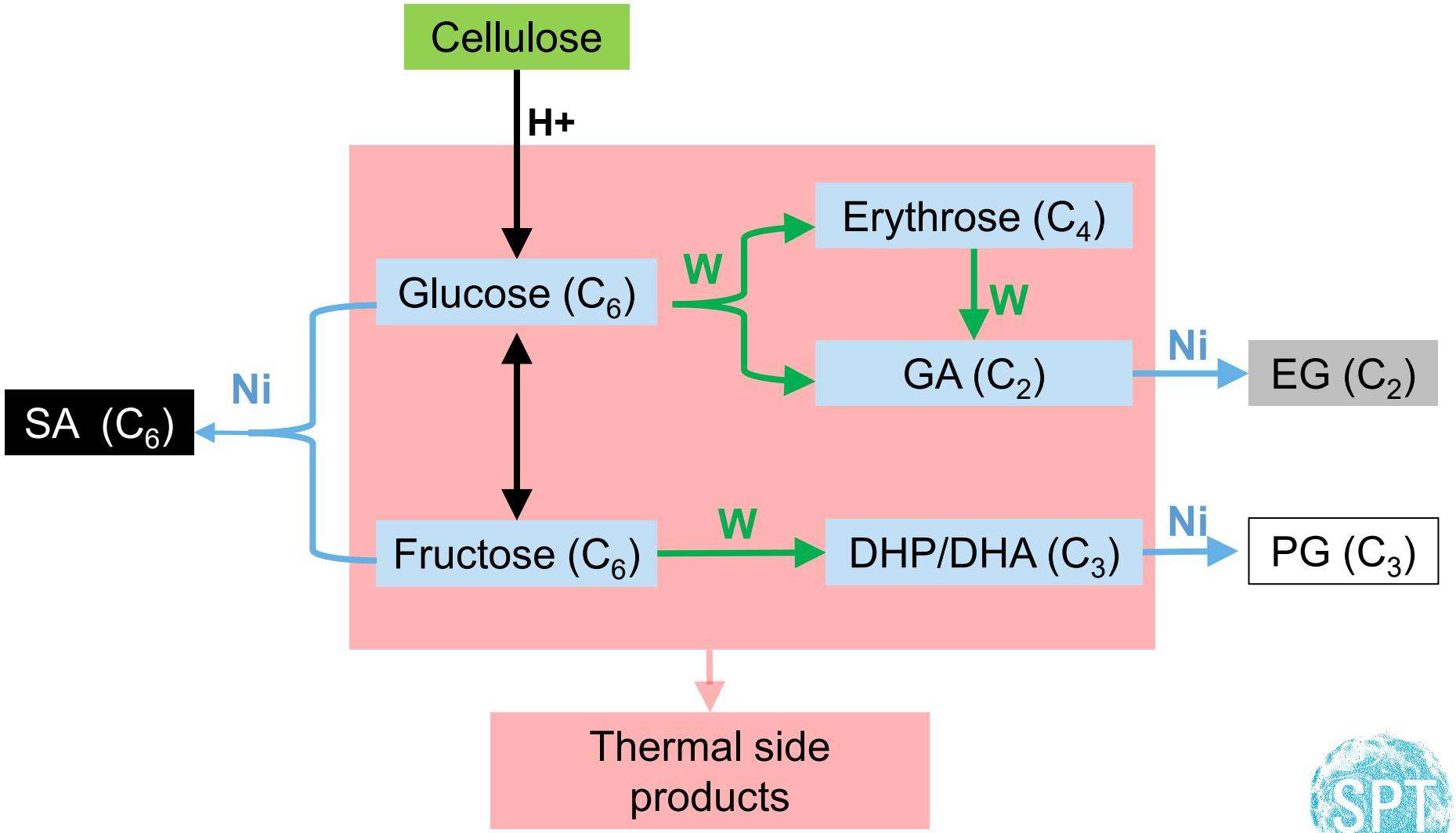
REACTION MECHANISM

HYDROGENOLYSIS



Hydrogenation

W-catalysed

Experimental conditions

- 45 ml Autoclave
- 245ºC
- pH ~3.3
- 60 bar H_2 at RT
- Solvent = water

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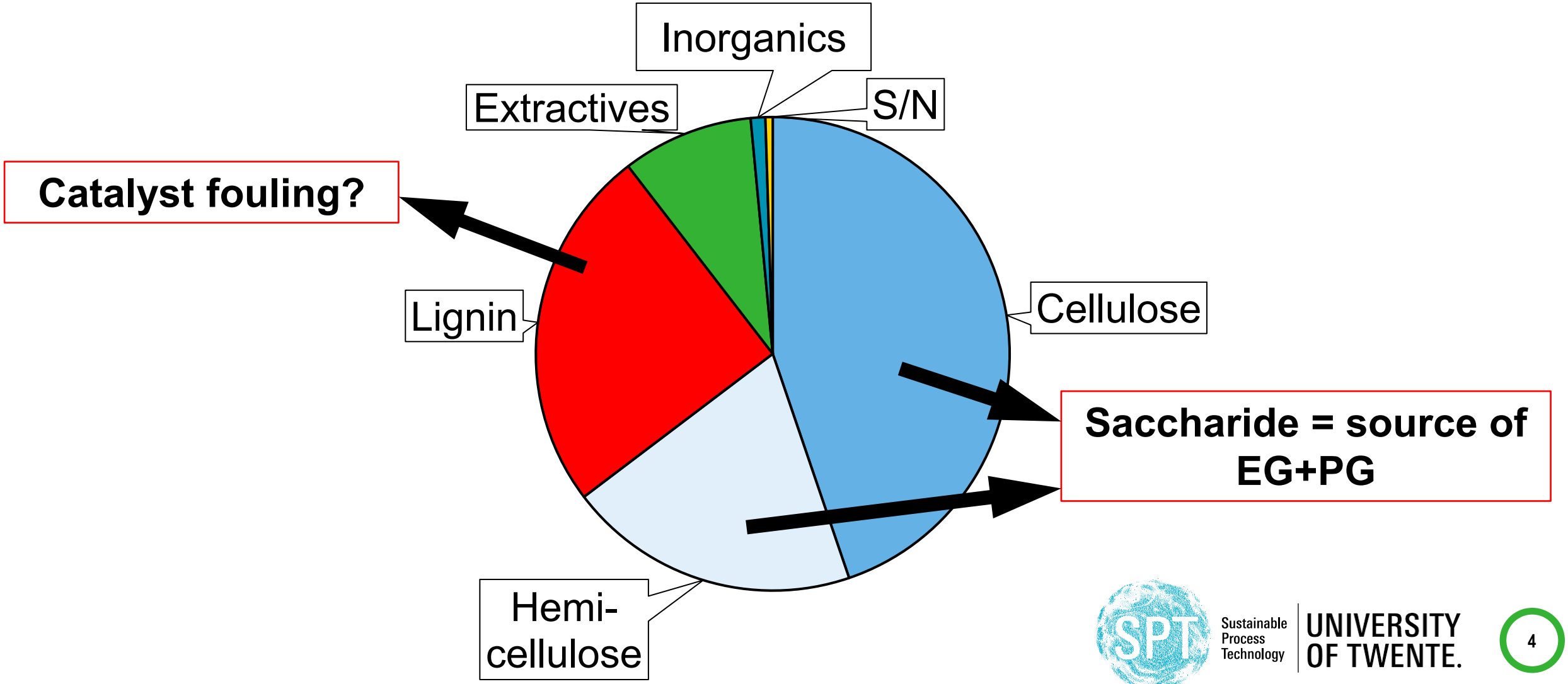
BIOMASS COMPOSITION

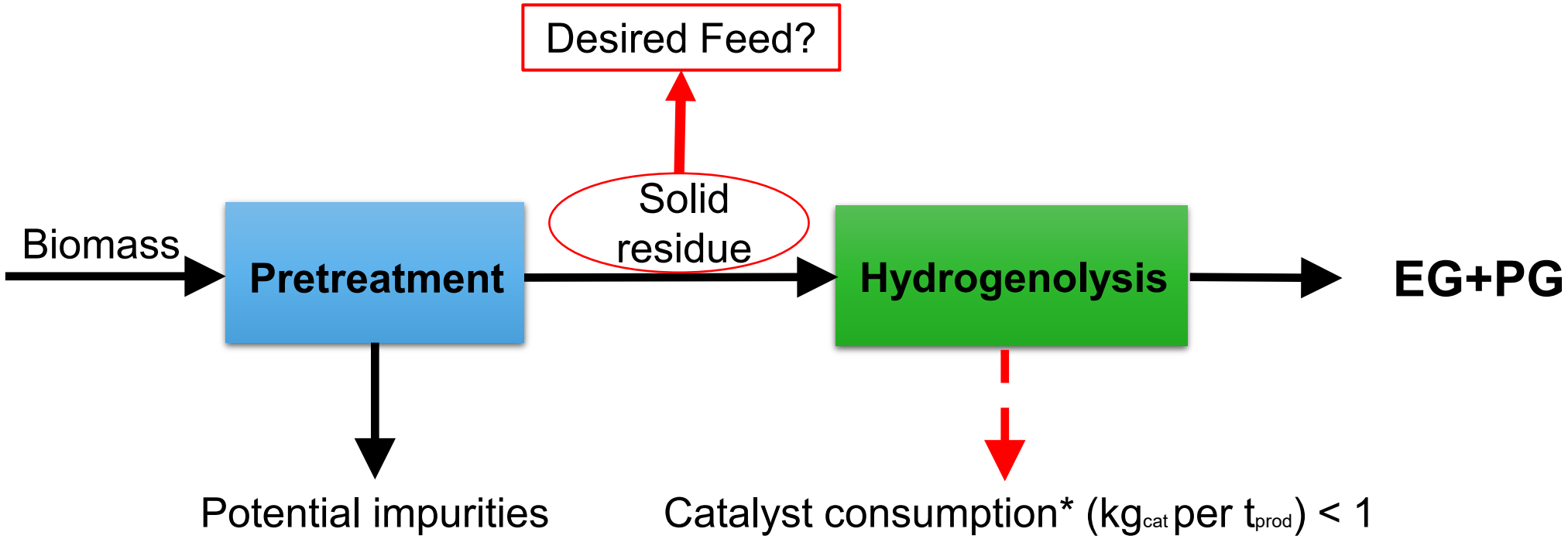
HYDROGENOLYSIS FEEDSTOCK



INTEGRATED PROCESS

HYDROGENOLYSIS FEEDSTOCK

1. **Suitable lignocellulosic feed?**
2. **Which pretreatment?**



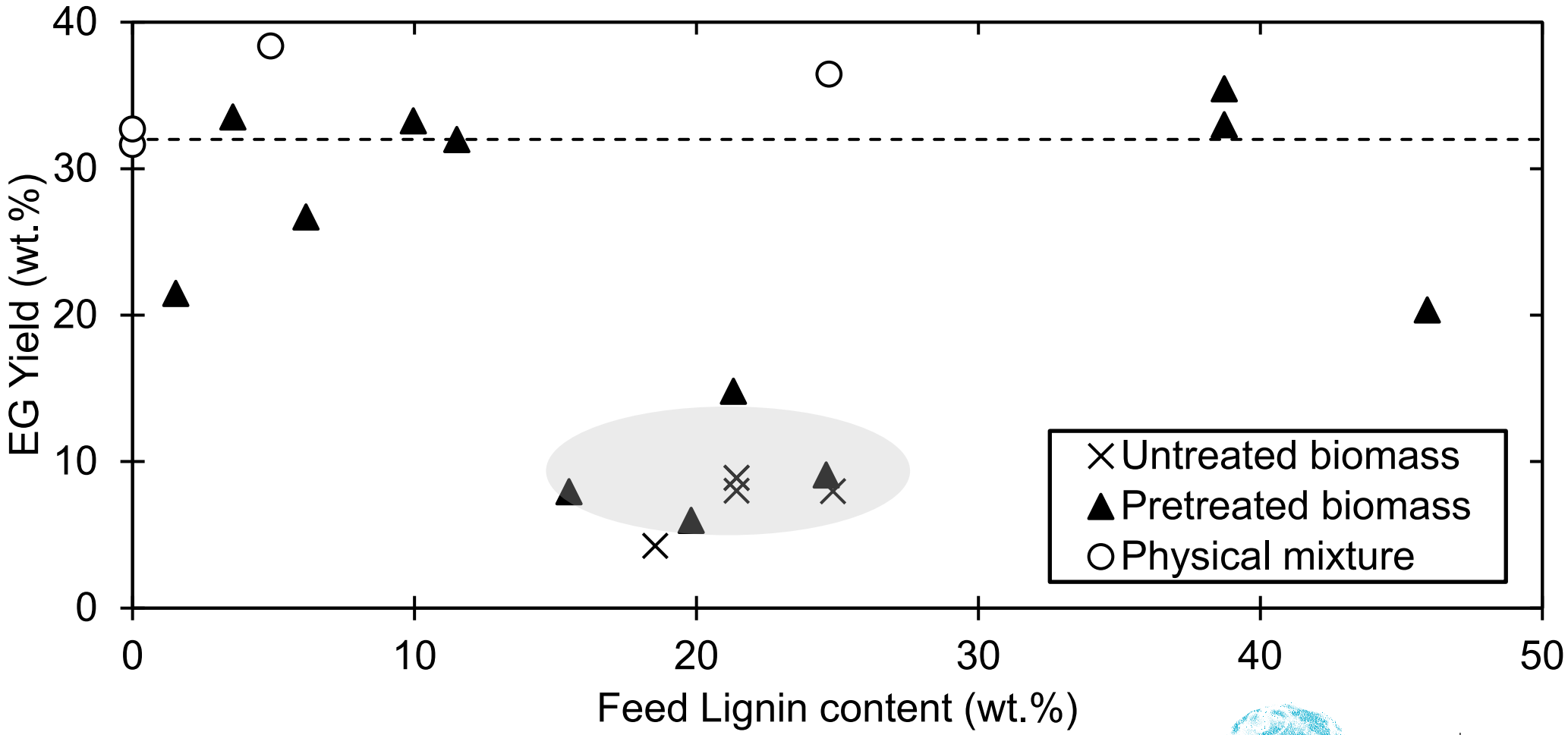
*J.P. Lange. **Performance metrics for sustainable catalysis in industry.** Nature Catalysis volume 4, pages 186–192 (2021)

EFFECT OF LIGNIN

HYDROGENOLYSIS (Ni + W)

Reaction conditions:

- 5wt.% biomass loading
- t = 60 min, T = 245°C, pH ~3.3,
- Solvent = Water (buffered)



- T.D.J. te Molder, S.R.A. Kersten, J. P. Lange, and M. P. Ruiz - **Ethylene Glycol from Lignocellulosic Biomass: Impact of Lignin on Catalytic Hydrogenolysis, I**nd. Eng. Chem. Res. 2021, 60, 19, 7043–7049

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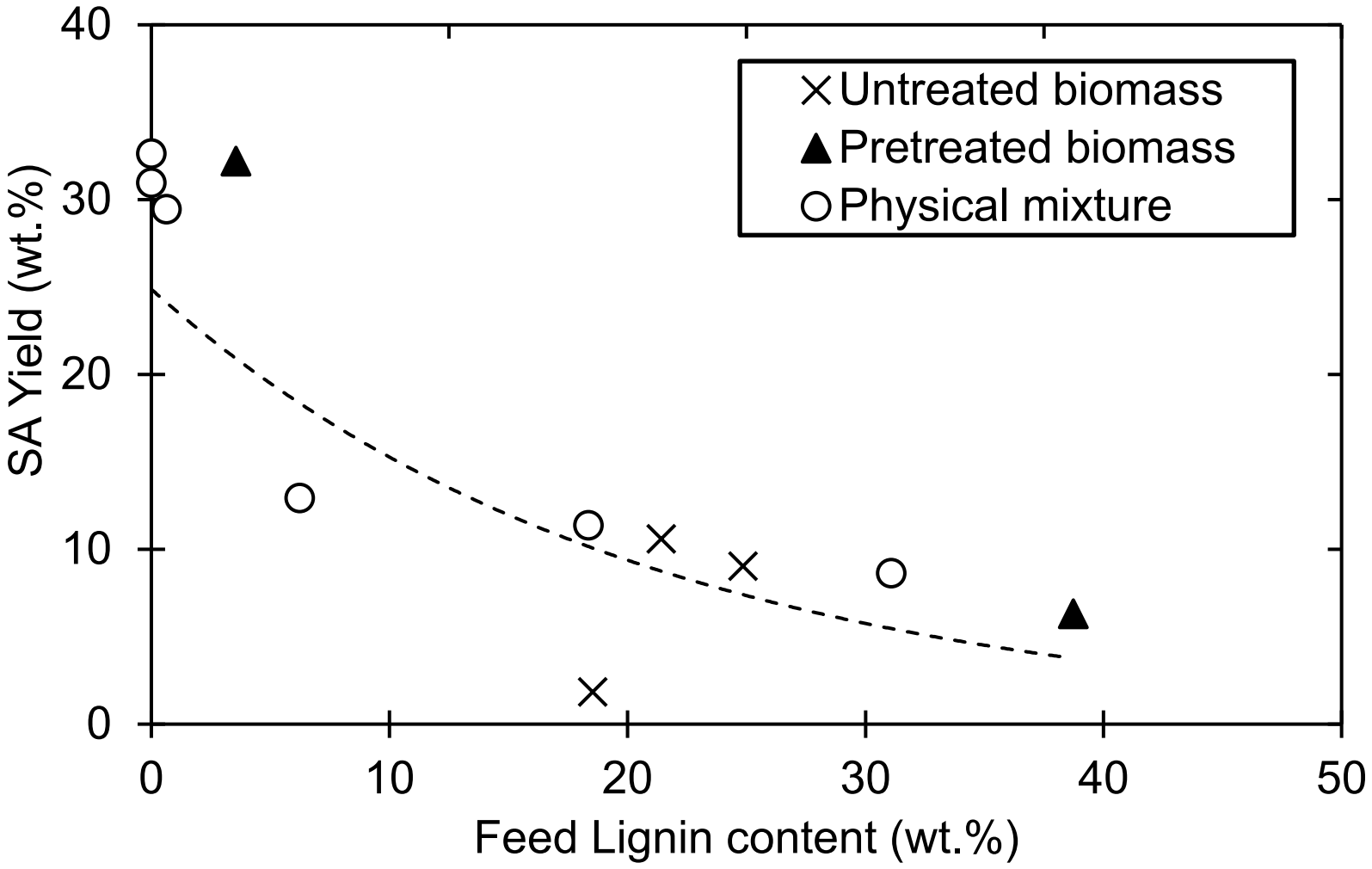
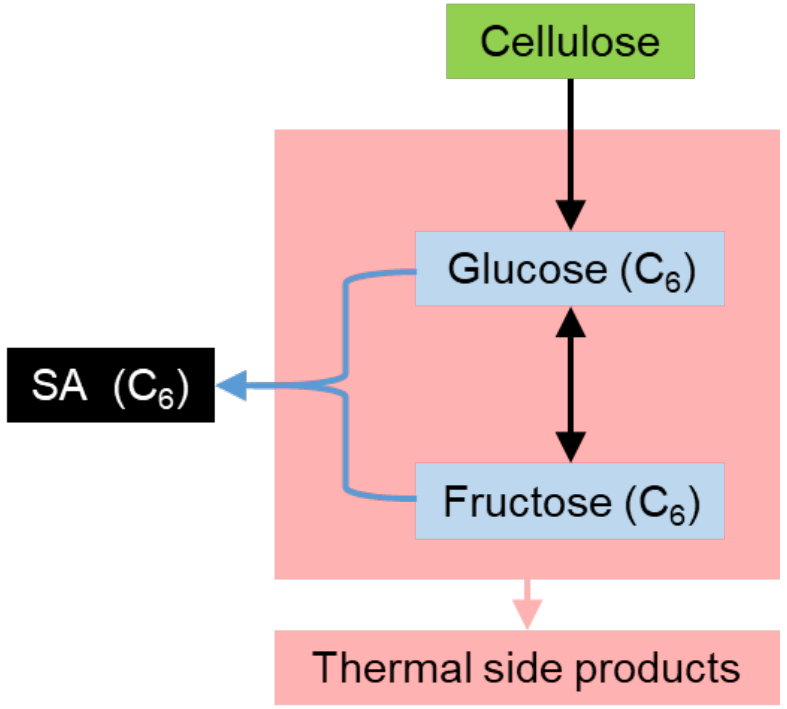
EFFECT OF LIGNIN

HYDROGENOLYSIS - ABSENCE OF W





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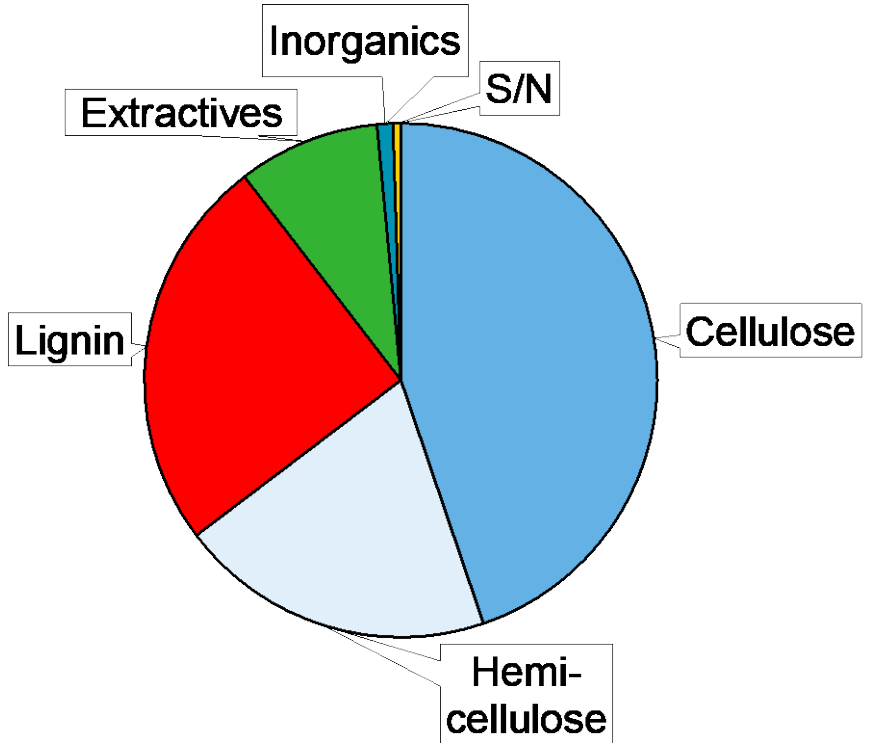
EFFECT OF LIGNIN

CONCLUSIONS

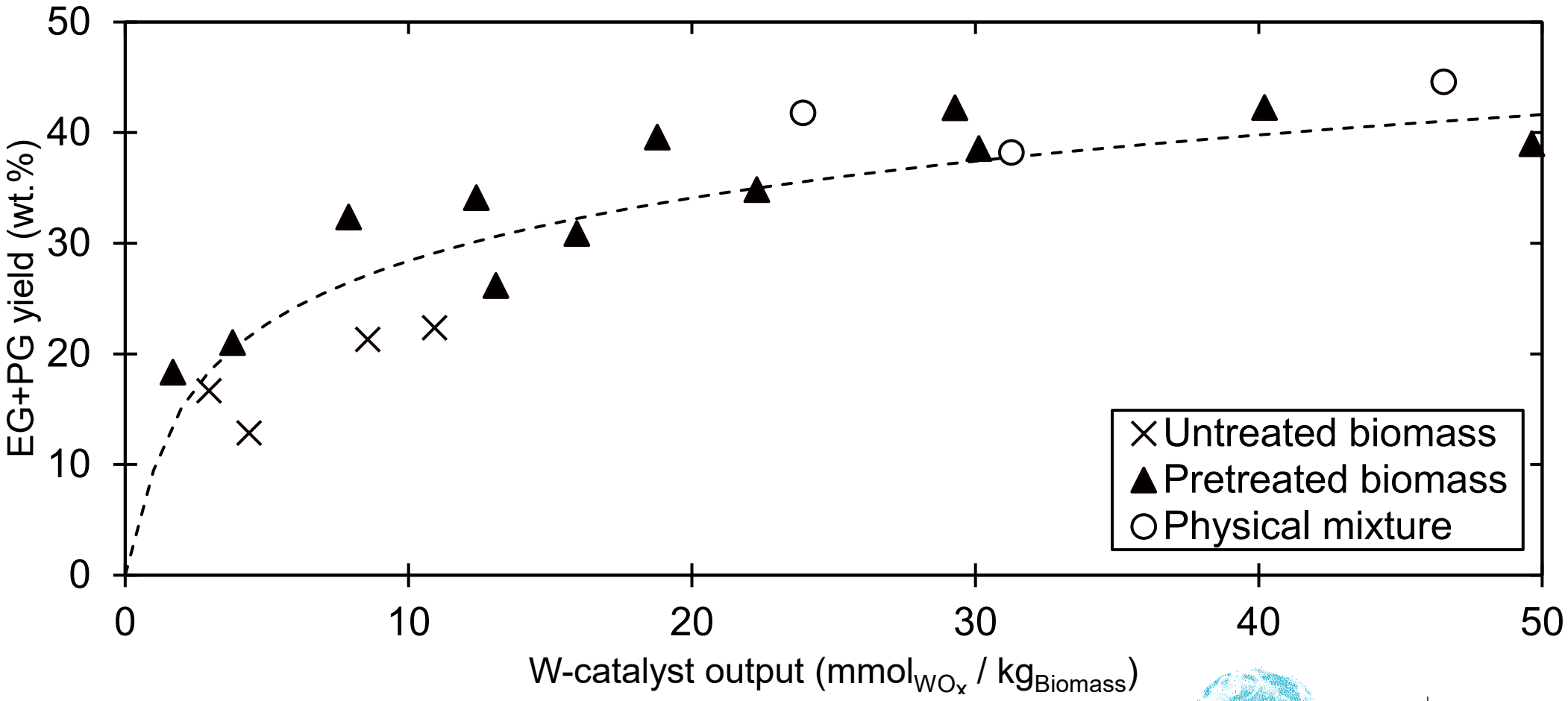
- ☑ Lignin deactivates the hydrogenation catalyst
- ☑ Lignin is still problematic for process development
- ☑ Lignin is not the root cause for EG deficient



Another fraction(s) in the biomass deactivates the catalyst(s)

HYDROGENOLYSIS

TUNGSTATE CATALYST



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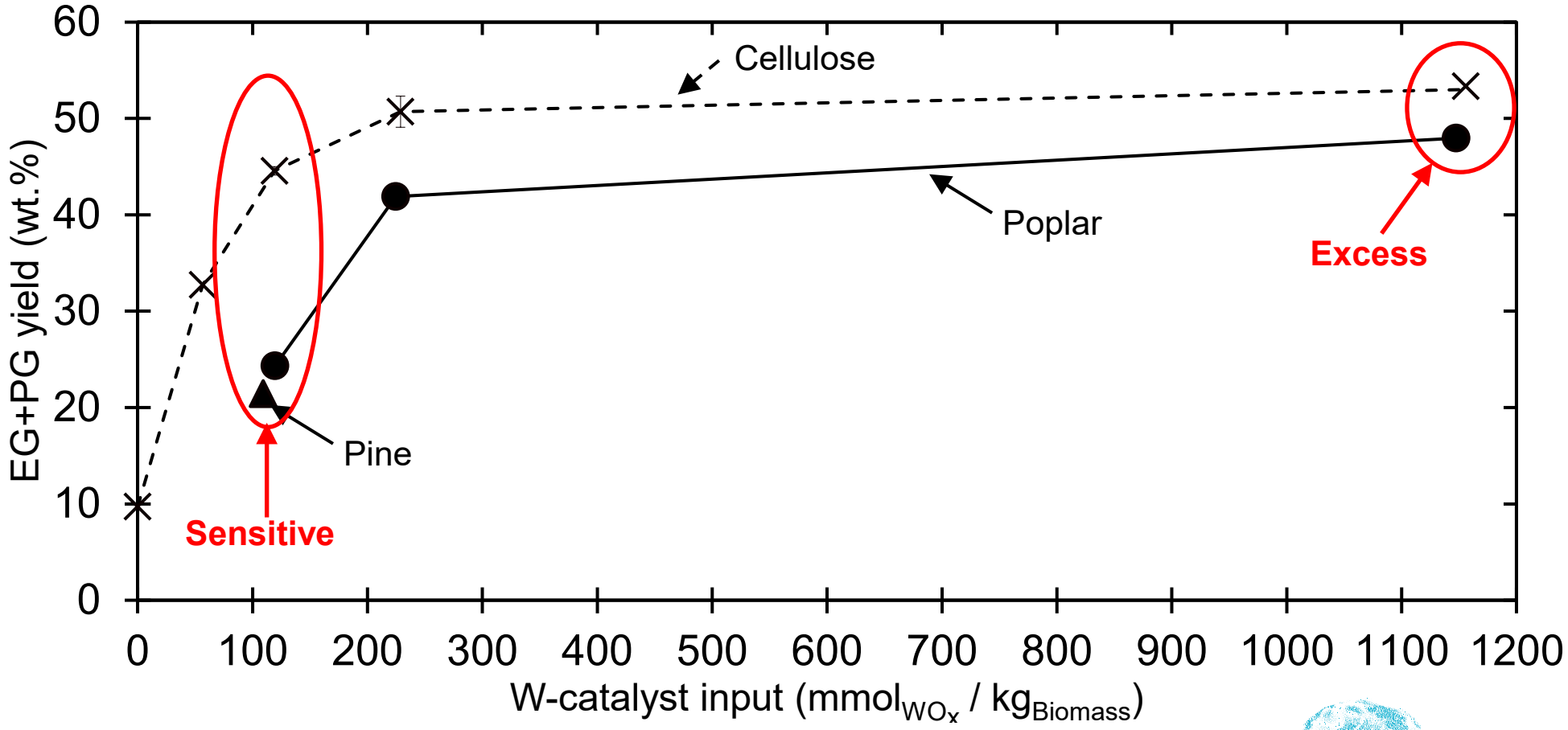
HYDROGENOLYSIS

INCREASING W-CATALYST INPUT



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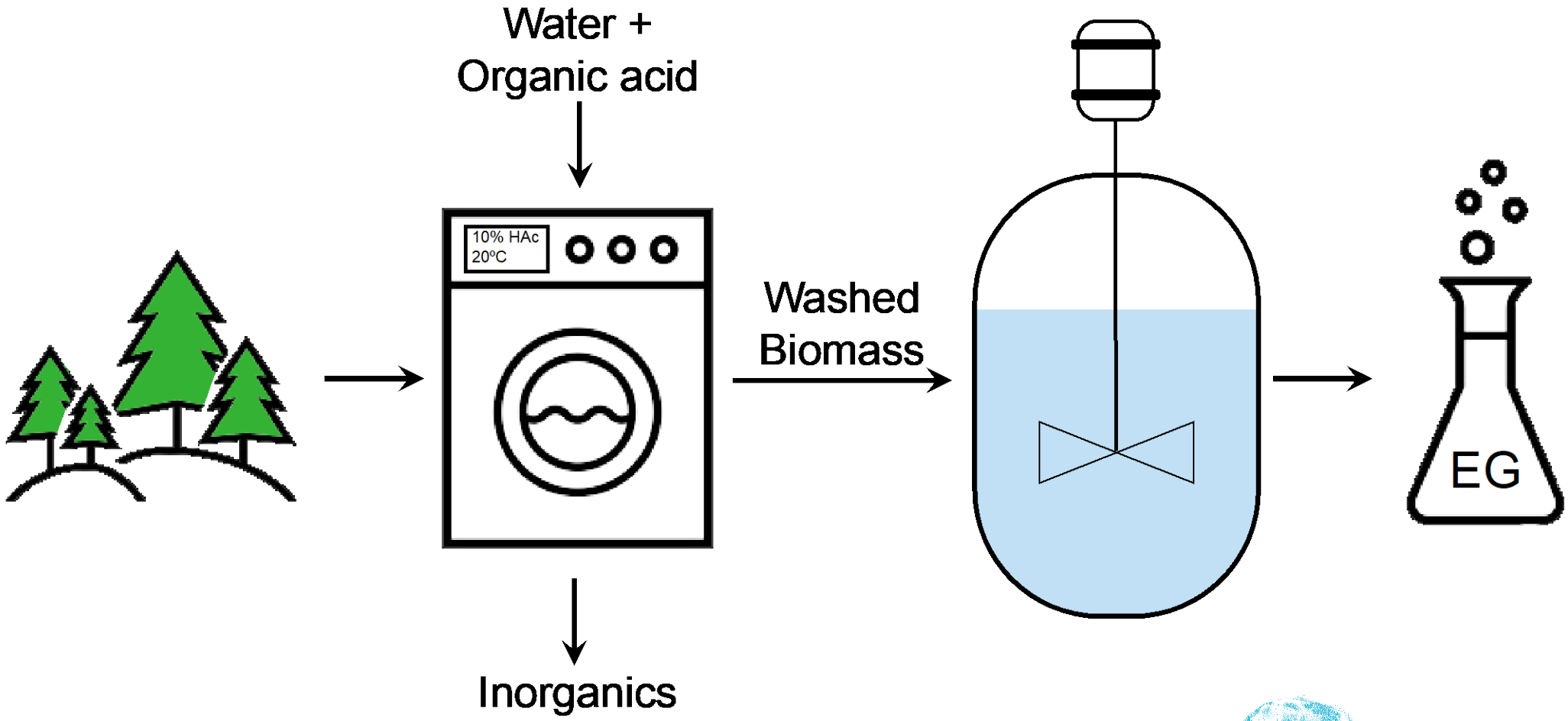
EFFECT OF ASH

ACID LEACHING



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EFFECT OF ASH

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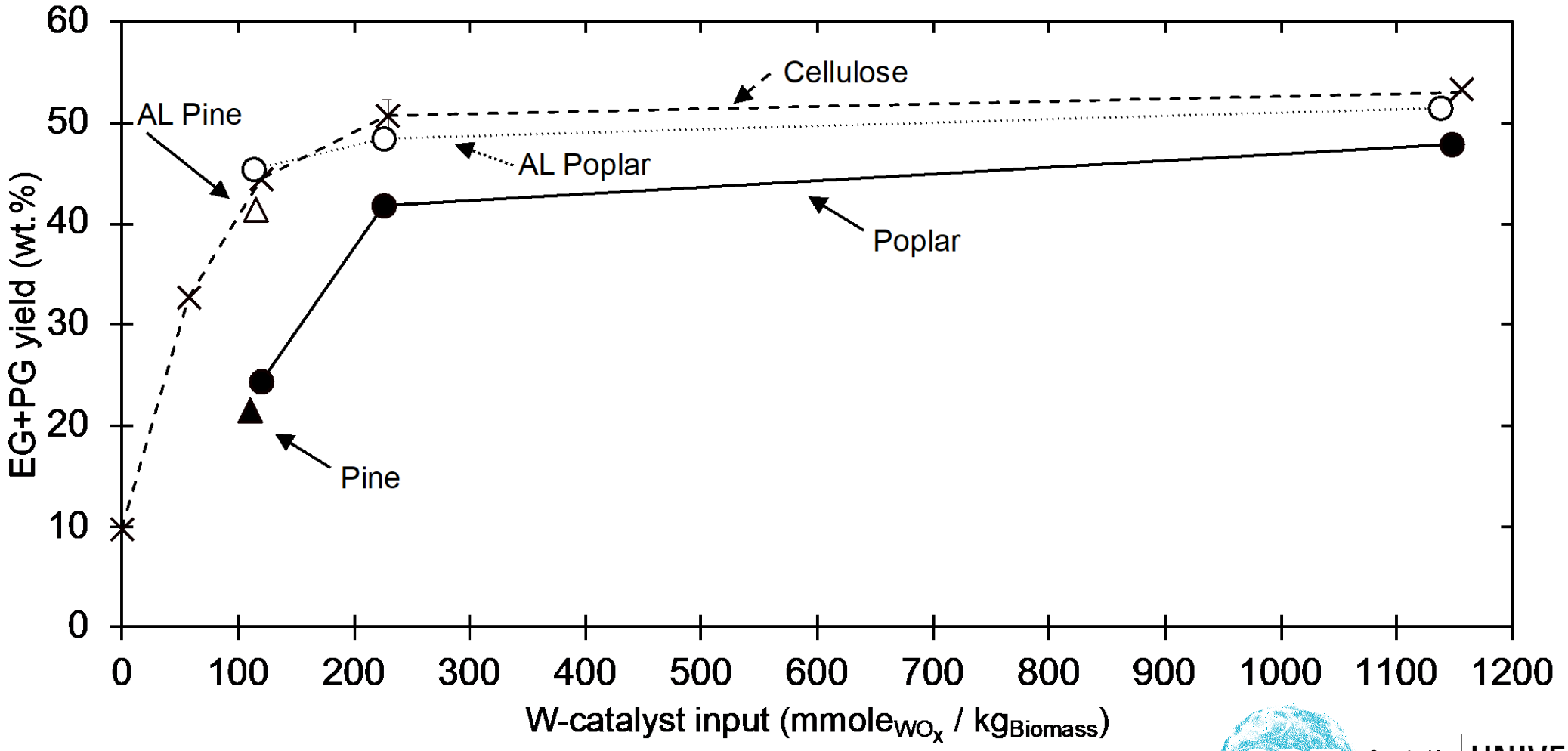

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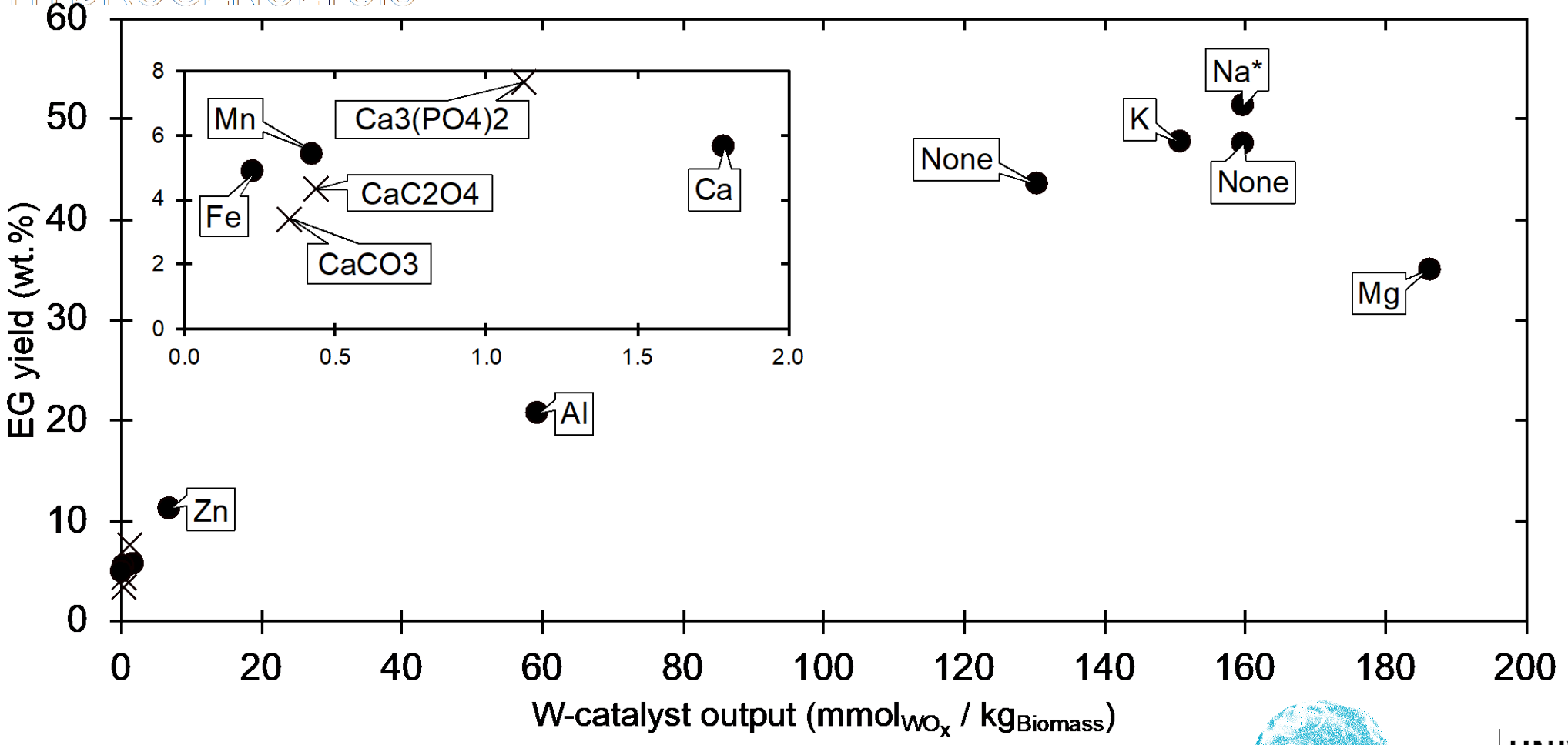
EFFECT OF ASH

ADDITION OF MODEL COMPOUNDS

HYDROGENOLYSIS



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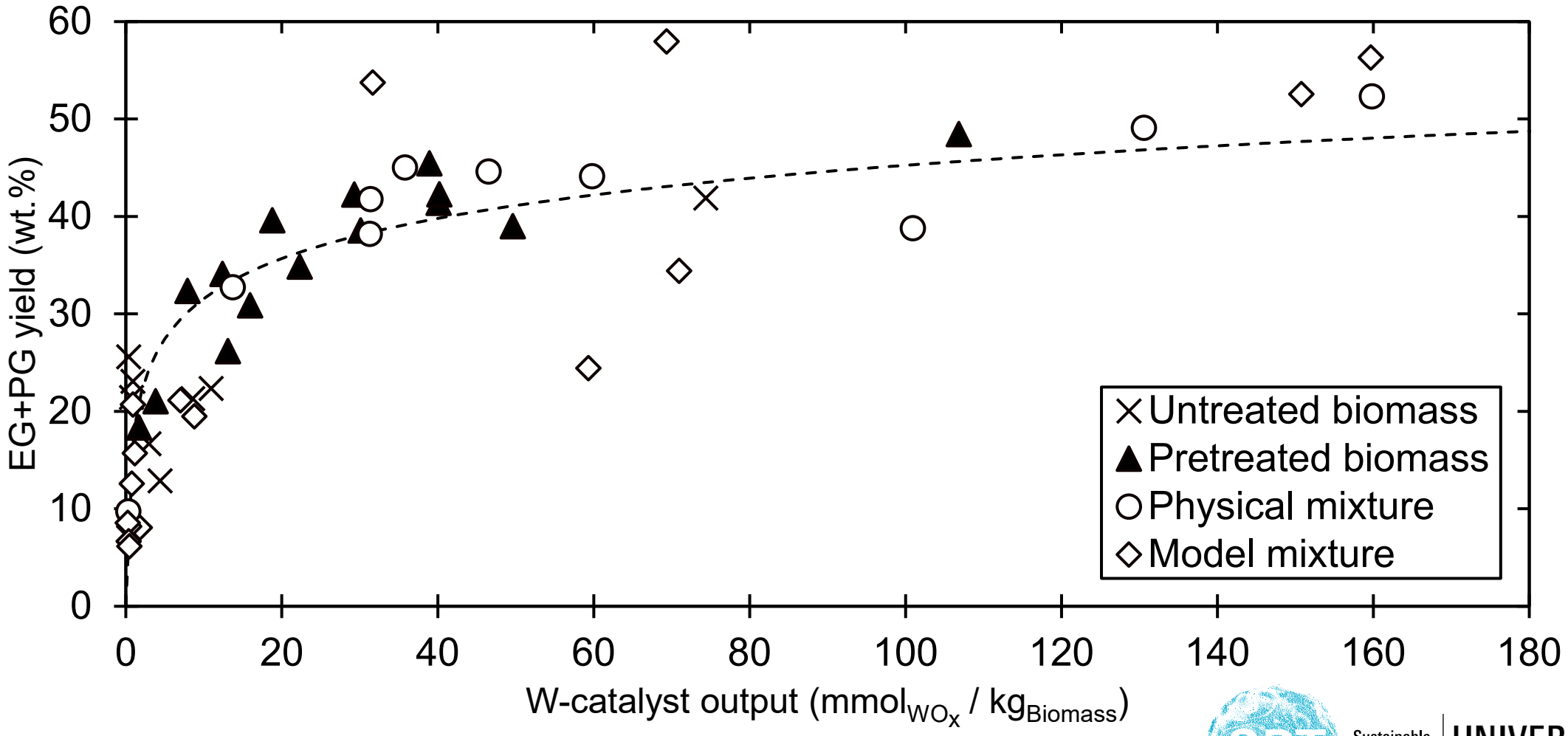
EFFECT OF ASH

HYDROGENOLYSIS - OVERVIEW



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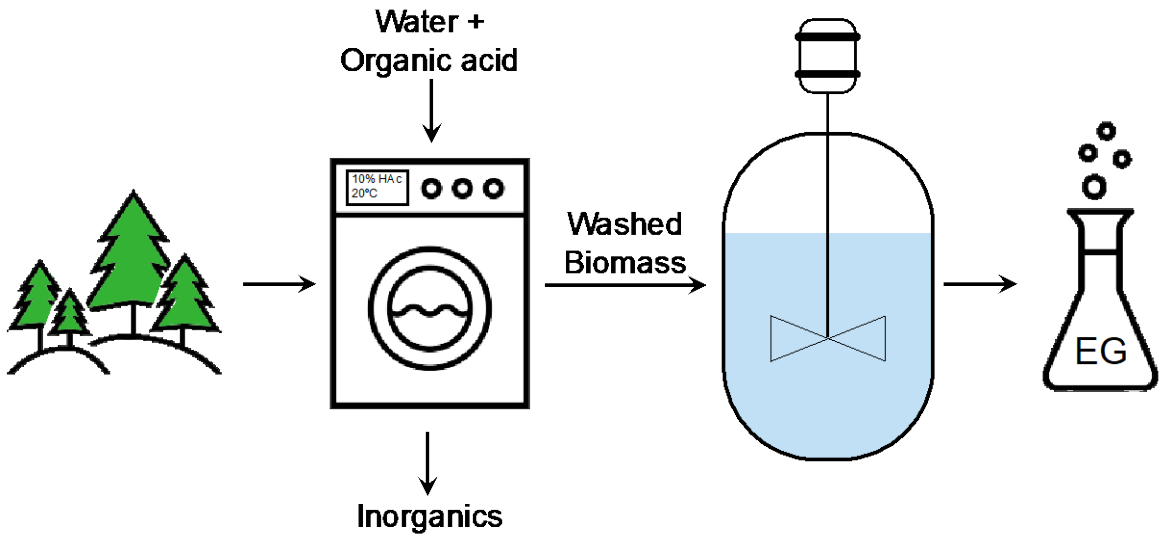
EFFECT OF ASH

CONCLUSIONS

- ☑ Inorganics, in particular X^{2+} ions, precipitate the homogenous tungstate catalyst
- ☑ Acid leaching effectively removes the inorganics from biomass
- ☑ Target: Feed < 4 mmol W-cat poisons per kg of biomass*



*To achieve: catalyst stability (mass product / mass catalyst) > 1000

ACKNOWLEDGEMENTS

SPT / SHELL

Thimo te Molder

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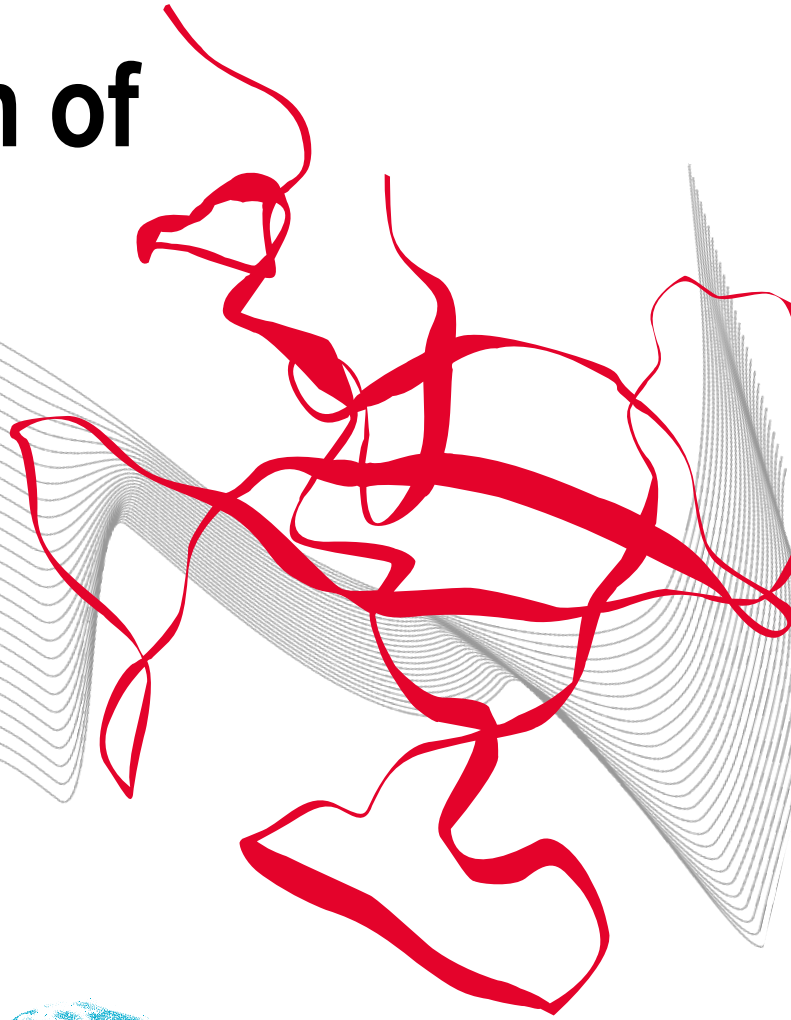

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