

# Environmental assessment of a biorefinery concept for production of bulk and fine chemicals

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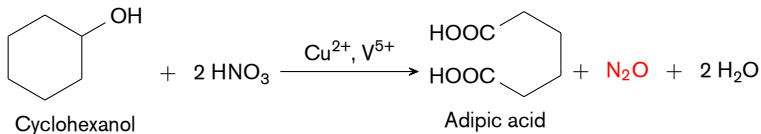
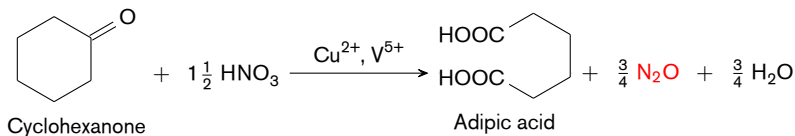


# Outline

- 1** The case for bio-based adipic acid production
- 2** Set-up of the systems analysis
- 3** Environmental impacts of the biorefinery concept
- 4** Lessons learned from the analysis

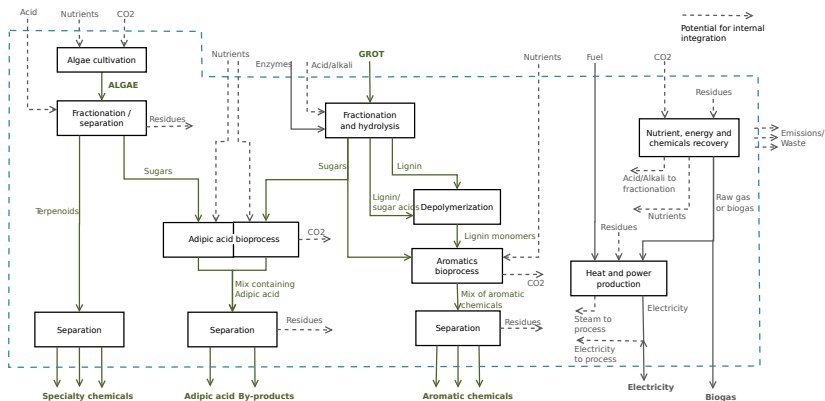
# Fossil-based production of adipic acid

- Traditional production from fossil resources → KA oil<sup>1</sup>

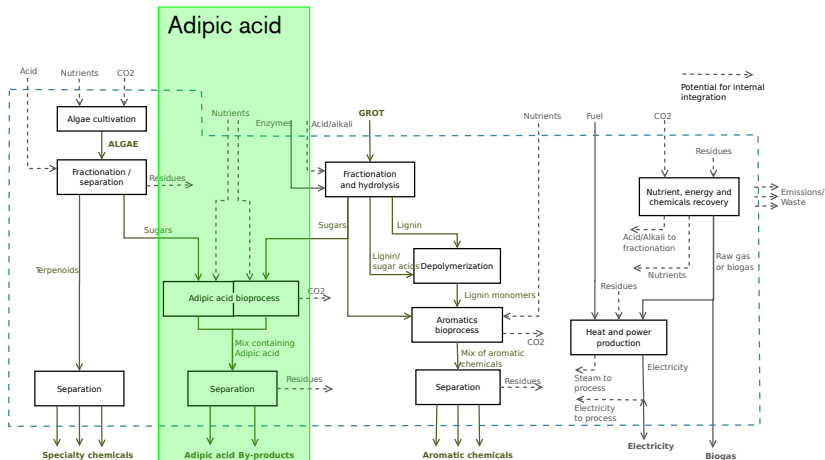


<sup>1</sup> A. Shimizu, K. Tanaka, and M. Fujimori. *Chemosphere Global Change Sci* 2.3-4 (2000), pp. 425–434.

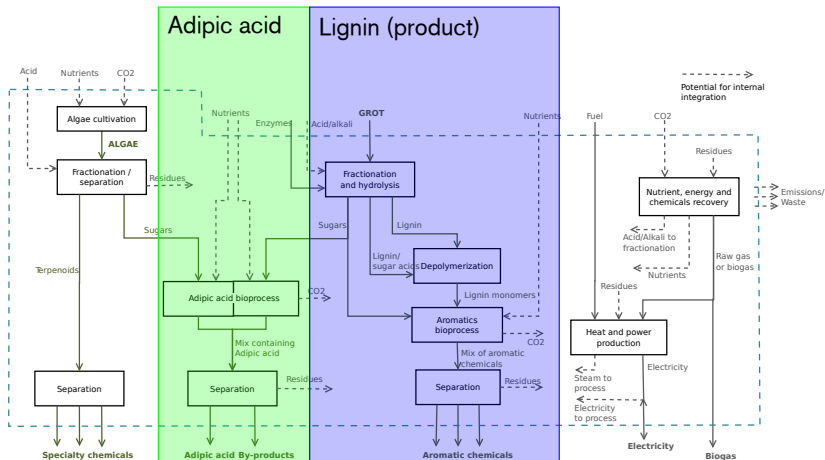
# Adipic acid production in a novel biorefinery concept



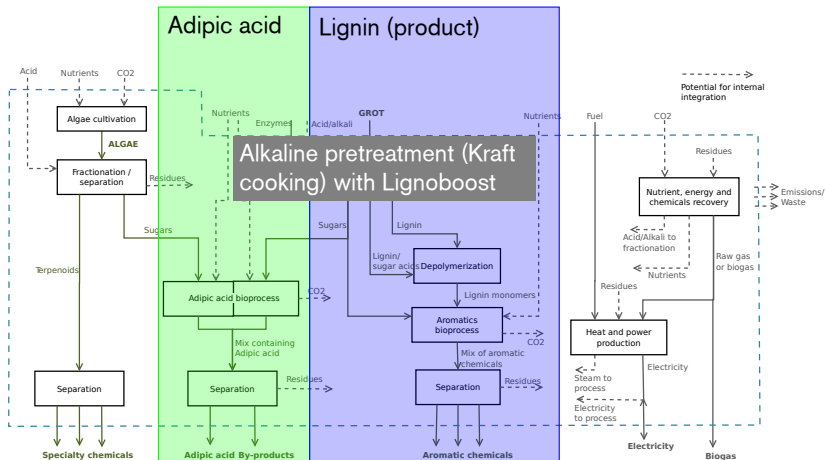
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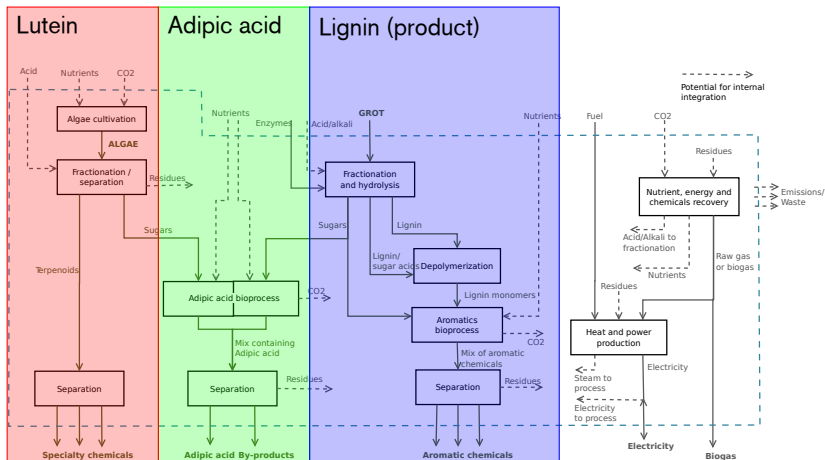
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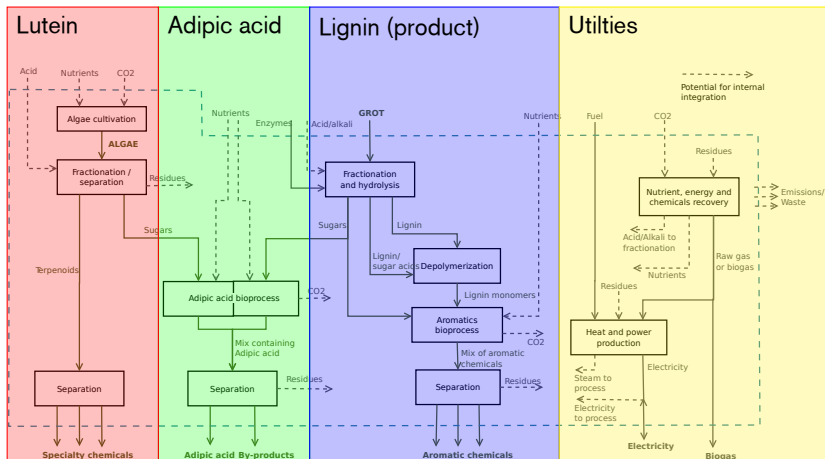


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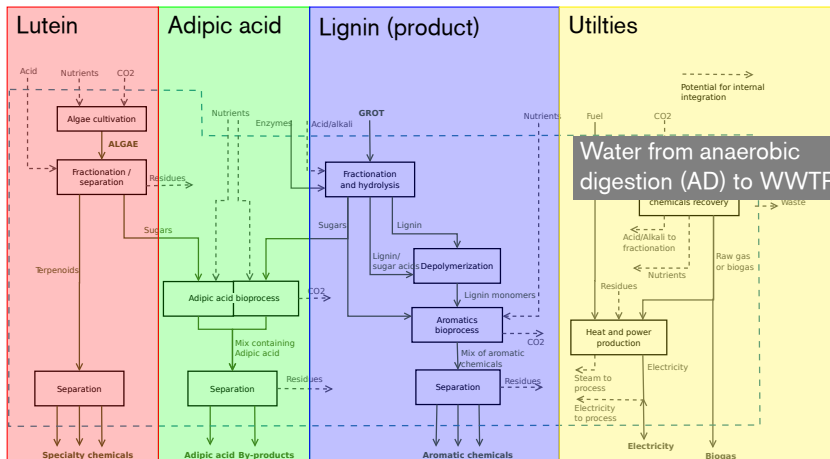




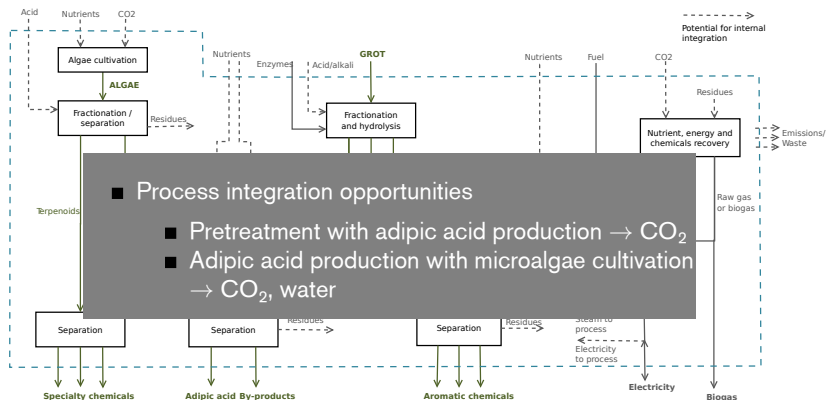
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# Applying prospective life cycle assessment

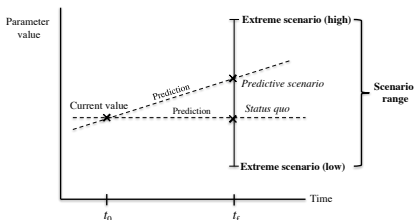
- Appropriate methodological choices need to be made<sup>2</sup>
  - Technology alternatives
  - Foreground system
  - Background system

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<sup>2</sup>R. Arvidsson et al. *J Ind Ecol* 22 (2018), pp. 1286–1294.

# Applying prospective life cycle assessment

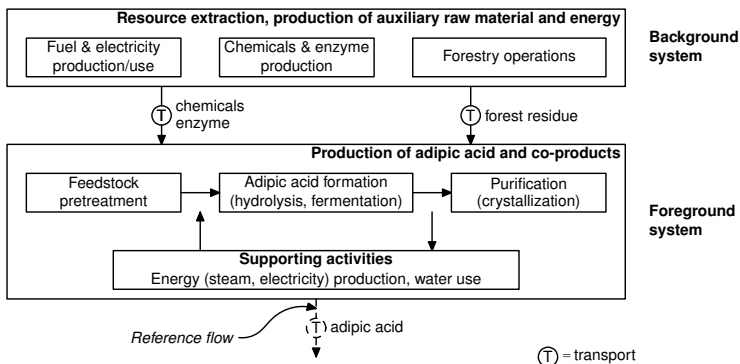
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- Predictive scenarios → Based on forecasts or trends
- Scenario ranges → Illustrate potential environmental impact

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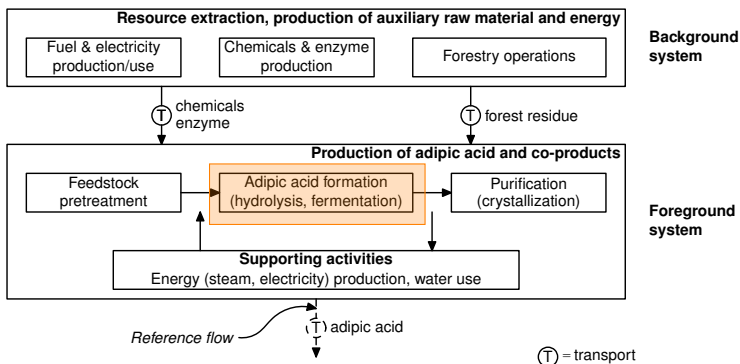
# Life cycle assessment



## ■ Goals

- Guiding technology development
- Future environmental performance of the concept
- Functional unit → 10 000 t of adipic acid produced

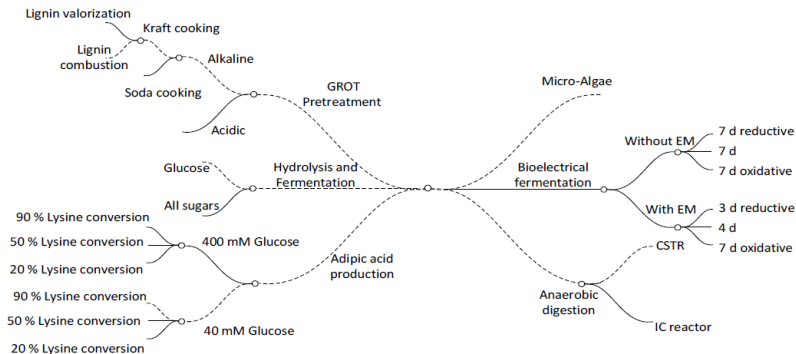
# Life cycle assessment



## ■ Goals

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# Construction of process alternatives

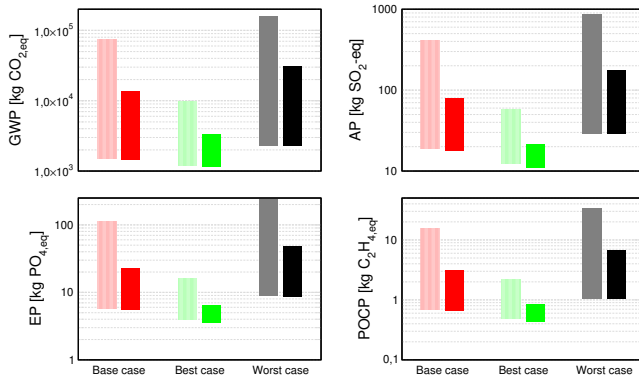


## ■ 24 alternatives were constructed for the assessment

- Lysine conversion → 20 %, 50 % and 90 %
- Sugar concentration → 40 mM and 400 mM
- Sugar conversion → Only glucose, all sugars
- Anaerobic digestion → conventional AD, IC reactor



# Ranges of environmental impacts

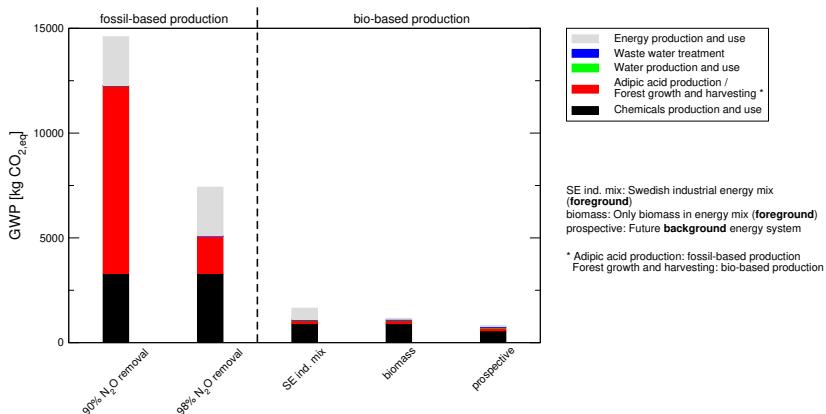


Semi-transparent bars:  
Conventional AD  
Solid bars:  
Internal circulation AD

- Variation due to
  - Heating and cooling demand of the alternative
  - Foreground energy system
  - Design of the AD

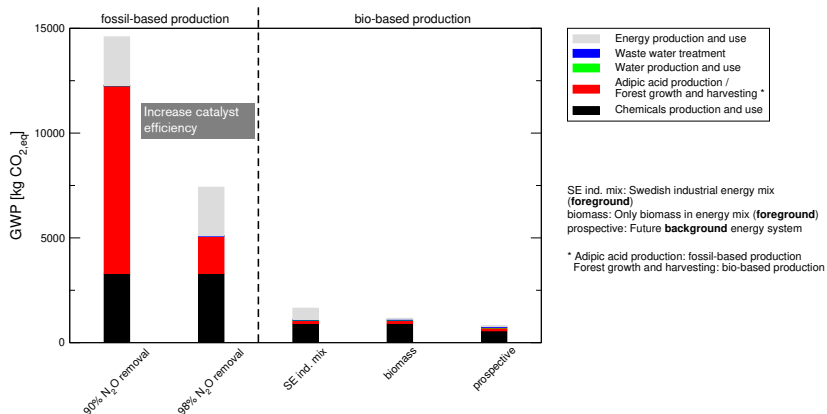
# Improvements in climate impact

From fossil-based to bio-based production (best case, minimum heat demand, IC AD)



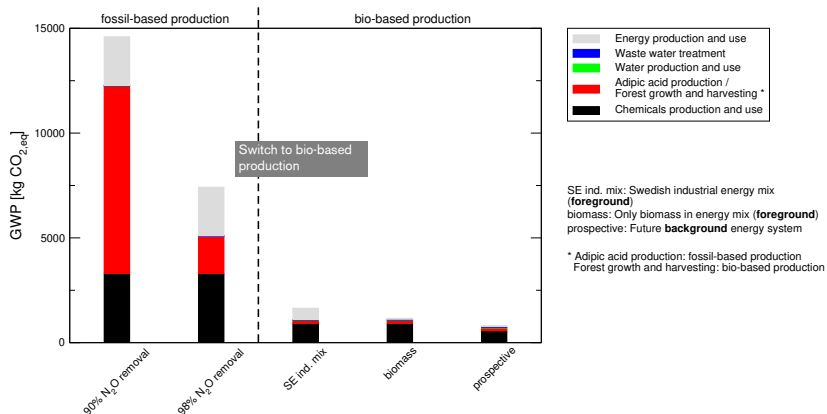
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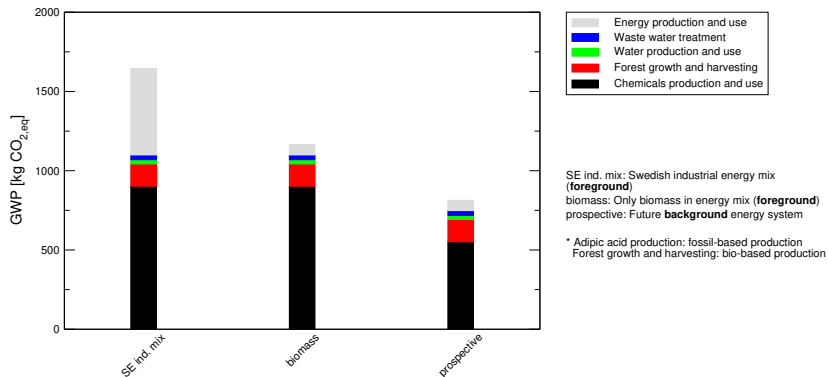
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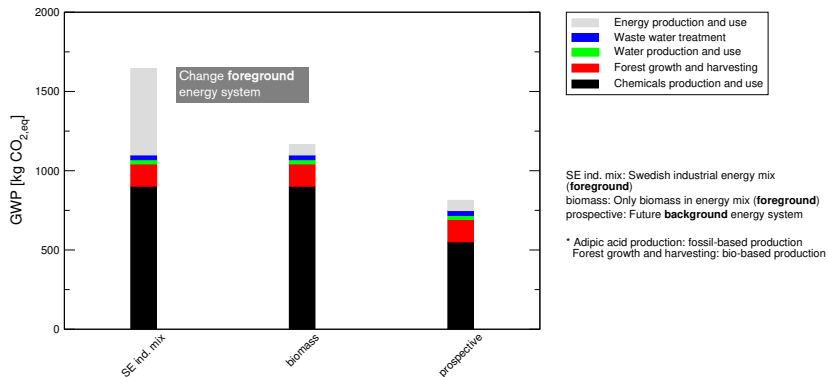
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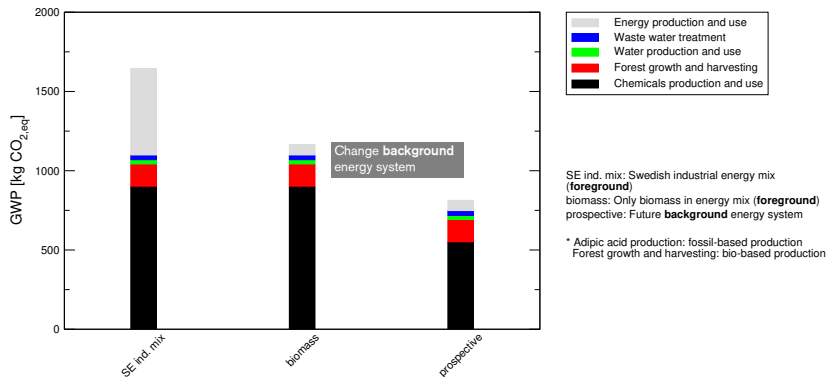
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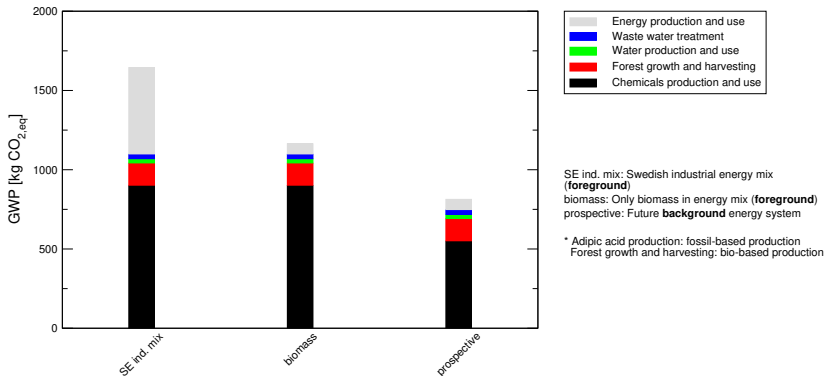
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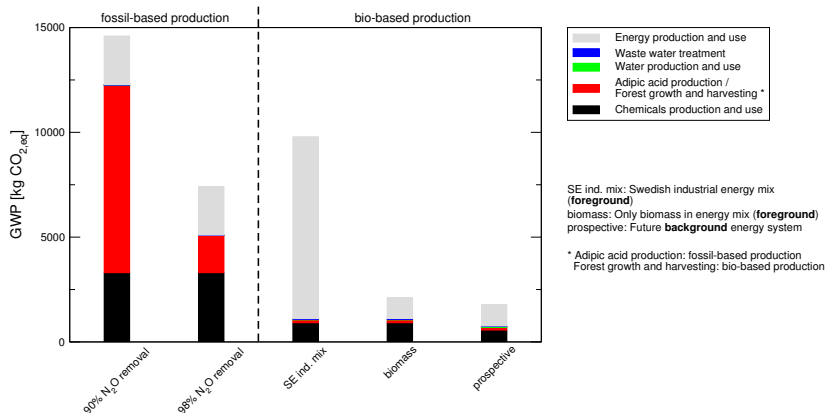


- Further improvements are possible
- Change in background energy system mainly affects chemicals production



# Improvements in climate impact

From fossil-based to bio-based production (best case, maximum heat demand, conventional AD)



- Fossil-based production might be the better option
- Clean foreground energy system is crucial

# Conclusion

- Technology
  - Switch to bio-based production of adipic acid can lower environmental impacts significantly
  - Clean foreground energy system and choice of technology is important
  - Future changes in the background energy system may improve chemicals production and use

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- Technology
  - Switch to bio-based production of adipic acid can lower environmental impacts significantly
  - Clean foreground energy system and choice of technology is important
  - Future changes in the background energy system may improve chemicals production and use
- Methodology
  - Inventory data generated with detailed process simulation
  - Construction of process alternatives helps identify process and environmental risks
  - Changes in background energy system need to be facilitated

# THANK YOU

## Any questions?