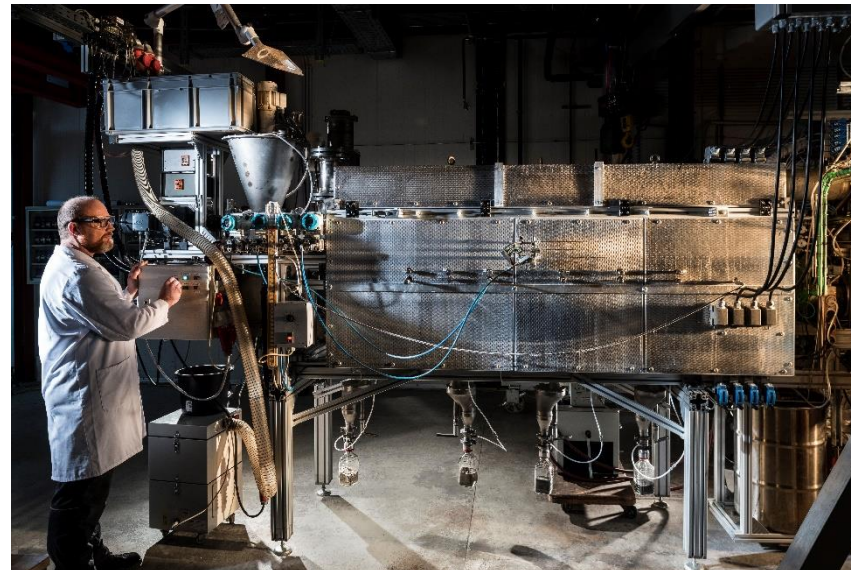


# Alternative pathways to incineration of mixed plastic waste

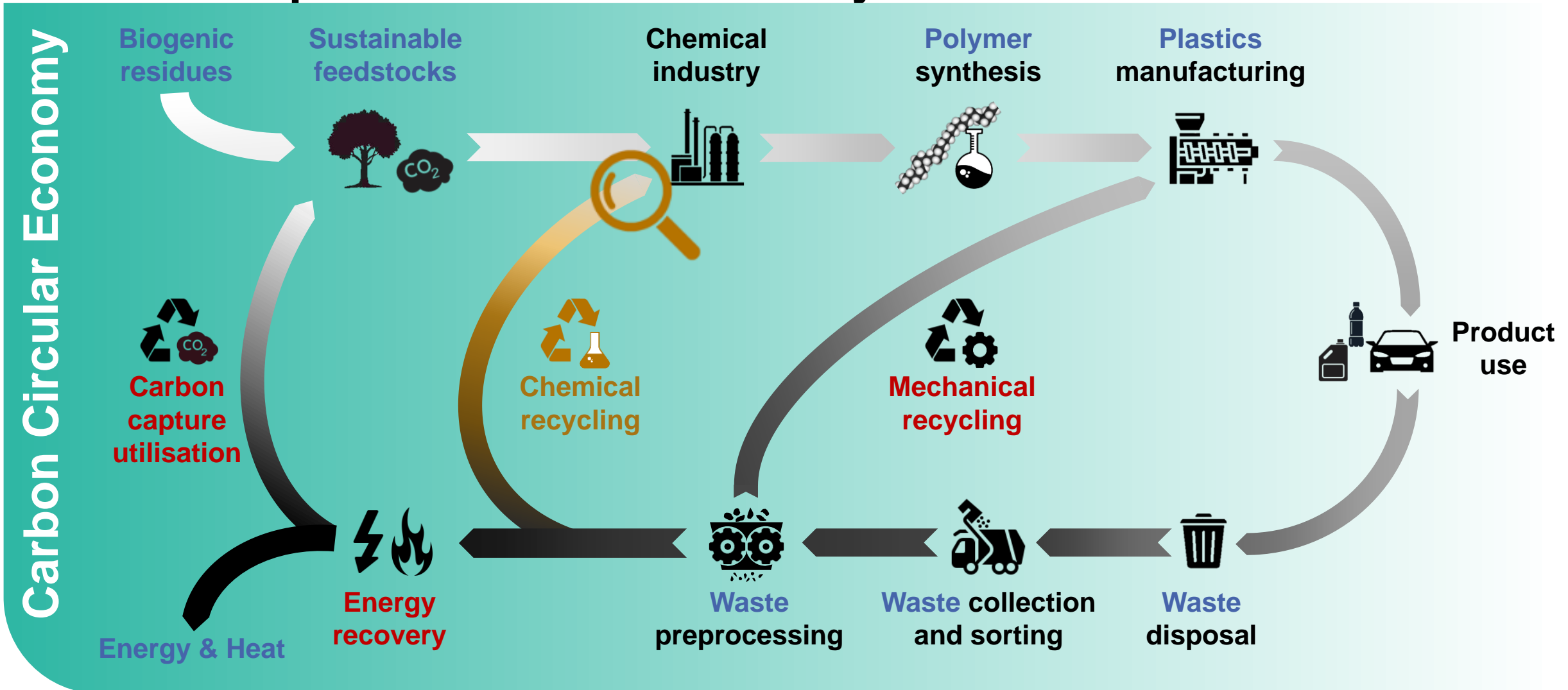
## Circular Plastics for Closing the Carbon Cycle

Institute for Technical Chemistry, Karlsruhe Institute of Technology, Karlsruhe, Germany

Salar Tavakkol, Malte Hennig, Dieter Stapf

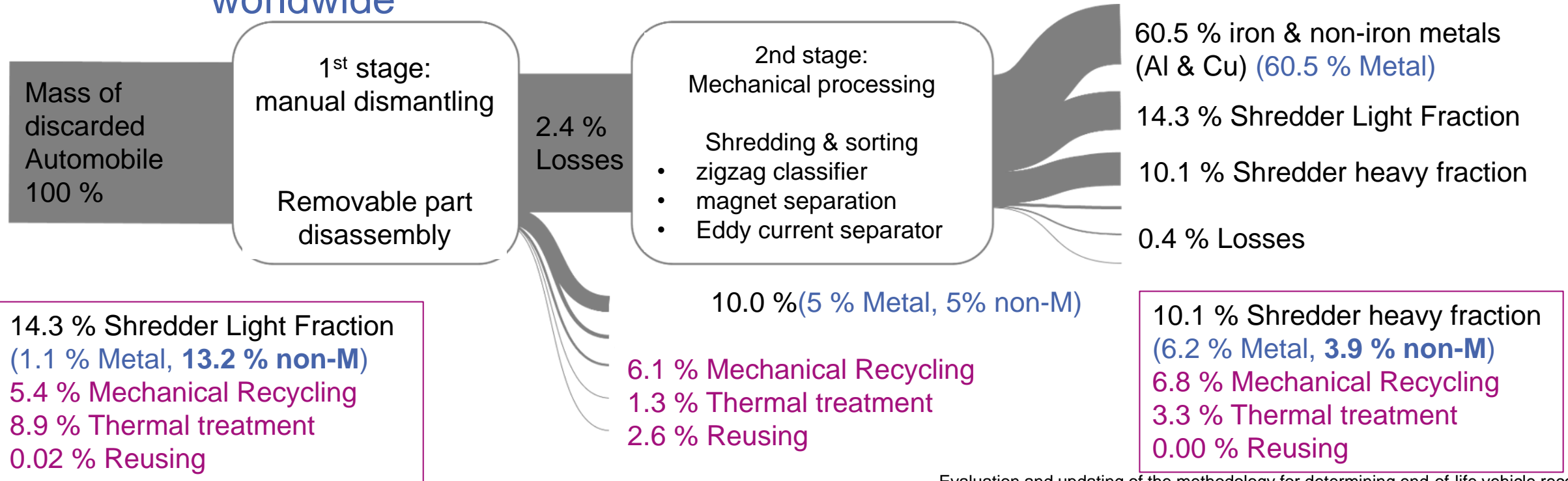


# Future Perspectives for Plastic Lifecycle



# Circularity of organic-rich fraction from mechanical recycling of Automobiles

27 millions of cars\* each year sends to shredding plants worldwide → The average weight of a car is around 2 tons\*\* → 9.2 M tons of mixed plastic fraction



\* Automobile Recycling Stats: What Percentage of Old Cars are Junked? <https://www.cashcarsbuyer.com/automobile-recycling-stats-what-percentage-of-old-cars-are-junked/>. Accessed June 1, 2021.

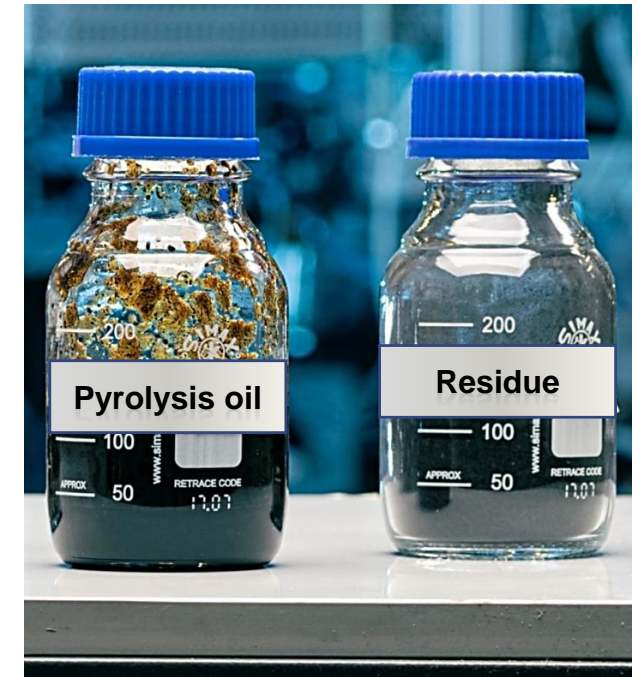
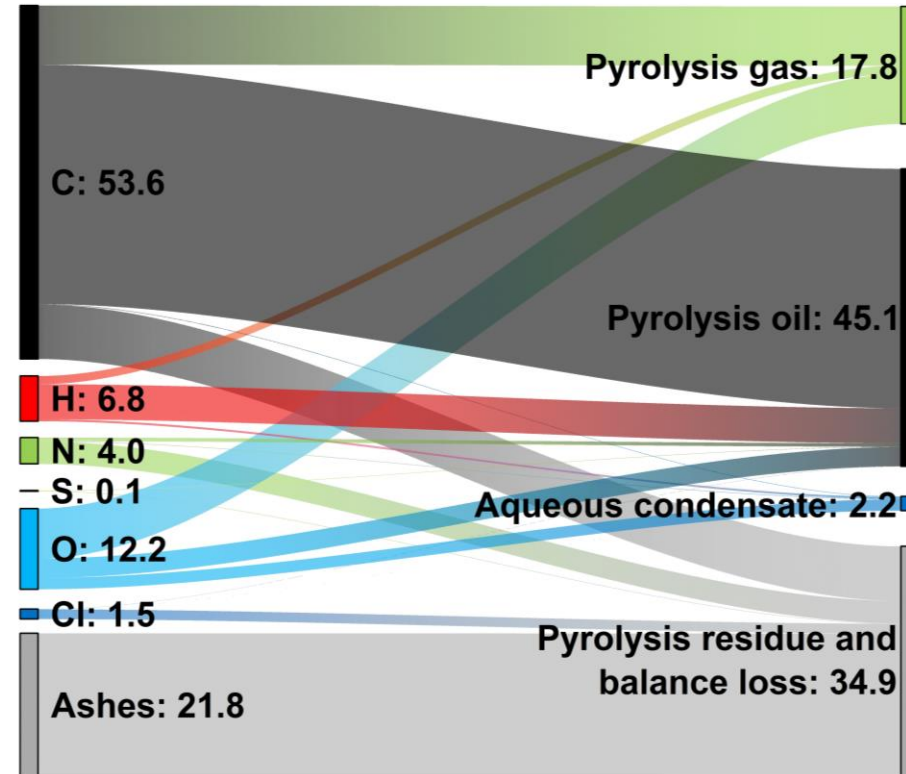
\*\* WORLDMETRICS.ORG REPORT 2024 Analysis: US Cars Weighing Averagely

Evaluation and updating of the methodology for determining end-of-life vehicle recovery rates through shredder tests under the EC End-of-Life Vehicles Directive 2000/53/EC, Environmental Research Plan of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety - ISSN 1862-4804, Germany, Januar 2020

# Pyrolysis of Shredder Light Fraction (SLF)



Case study feedstock

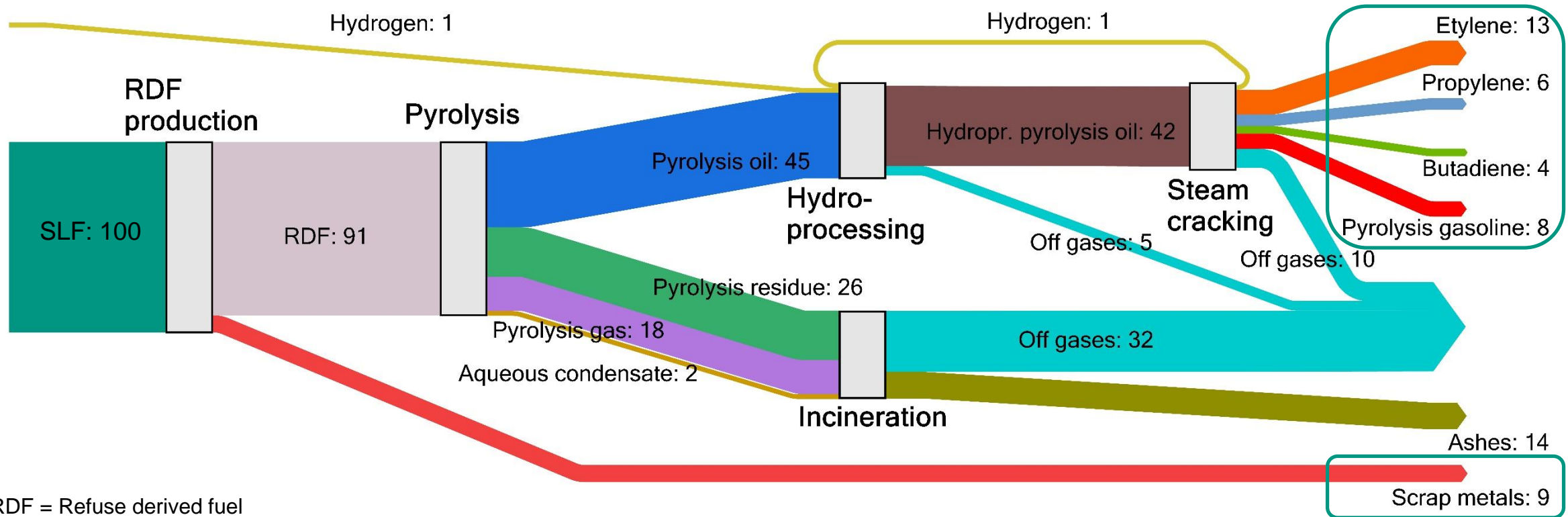


Pyrolysis products

Stallkamp, C., Hennig, M. et al. (2023). J. Ind. Ecol., DOI: 10.1111/jiec.13416

**What is the most beneficial process in terms of climate change impact?**

# Mass balance of SLF recycling via pyrolysis

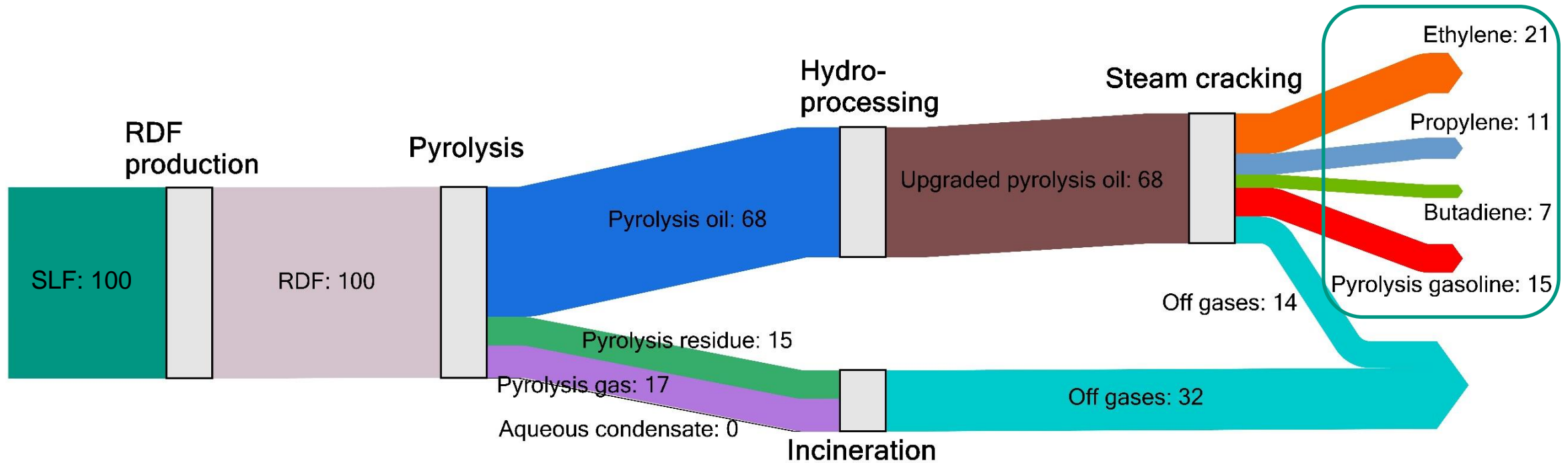


RDF = Refuse derived fuel  
Percentages refer to input mass flow of SLF

**31% of input material is recovered as High Value Chemical (HVC), 9% as scrap metals**

Stallkamp, C., Hennig, M. et al. (2023). J. Ind. Ecol., DOI: 10.1111/jiec.13416

# Carbon efficiency of SLF recycling



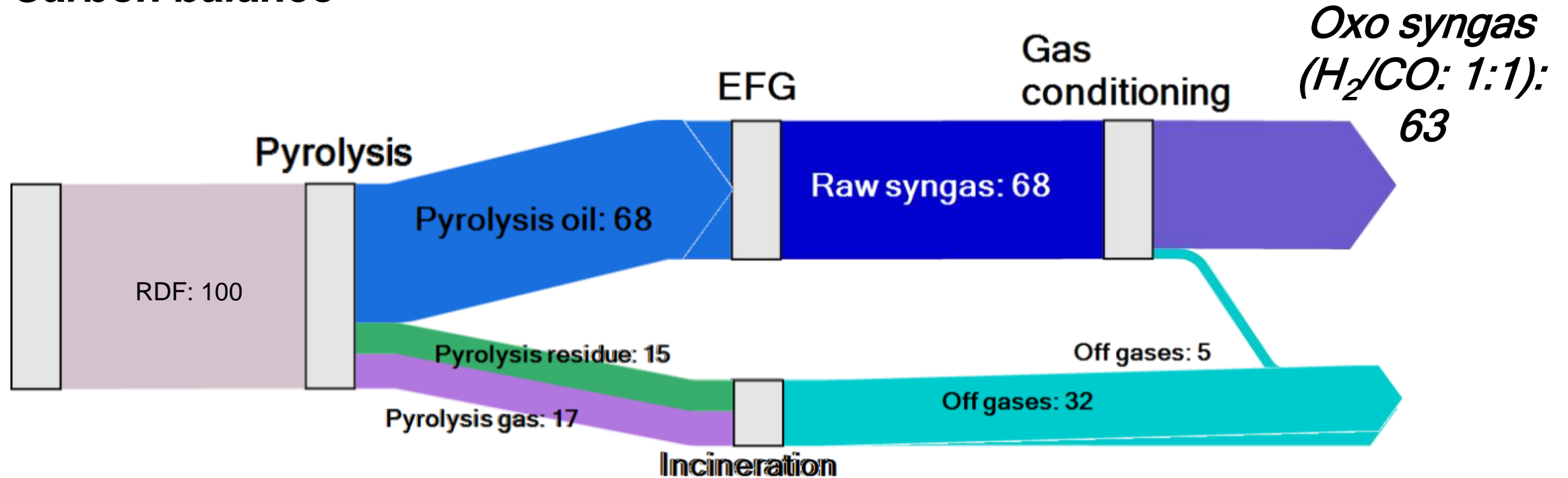
Percentages refer to input carbon mass flow of SLF

**Steam cracking of upgraded pyrolysis oil results in carbon recovery > 50 %**

Stallkamp, C., Hennig, M. et al. (2023). J. Ind. Ecol., DOI: 10.1111/jiec.13416

# Entrained flow gasification (EFG) for Oxo syngas production

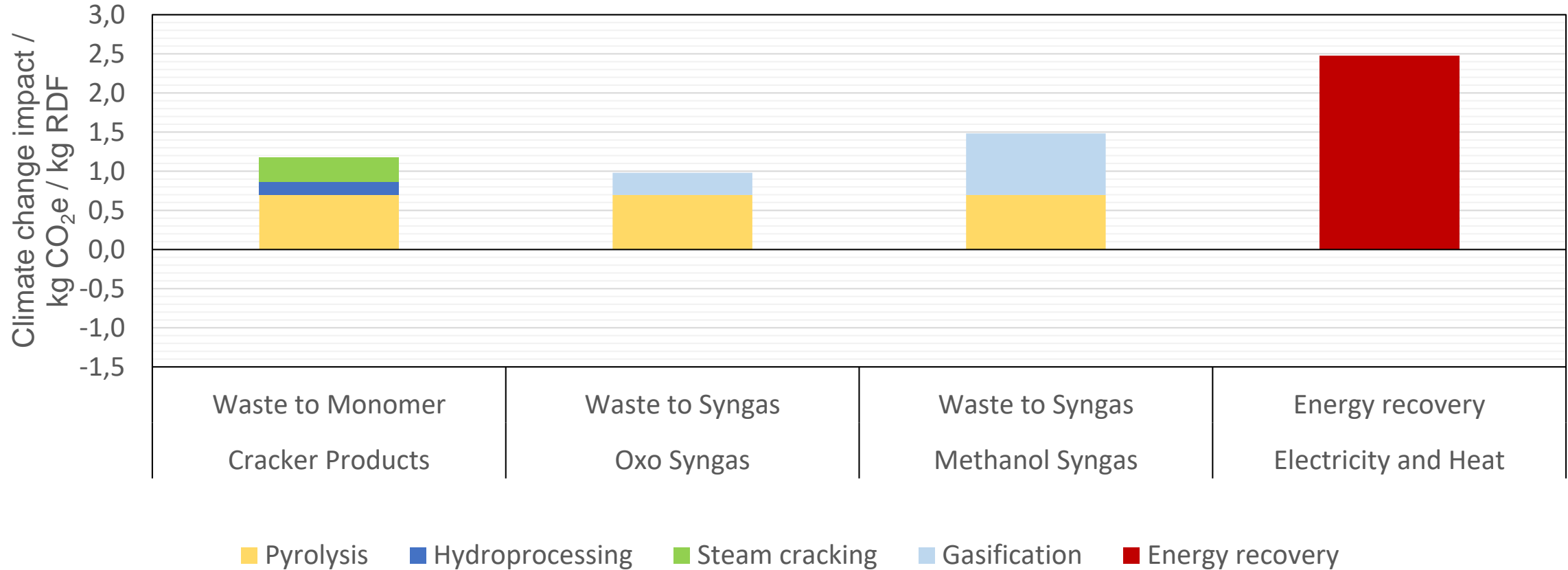
## Carbon balance



**Production of Oxo syngas via EFG preserves most carbon contained in pyrolysis oil**

Hennig, M., Tavakkol, S. Stapf, D. (2024). Conf. WasteEng 24, Sendai, Japan

# Comparison of climate change impact for SLF

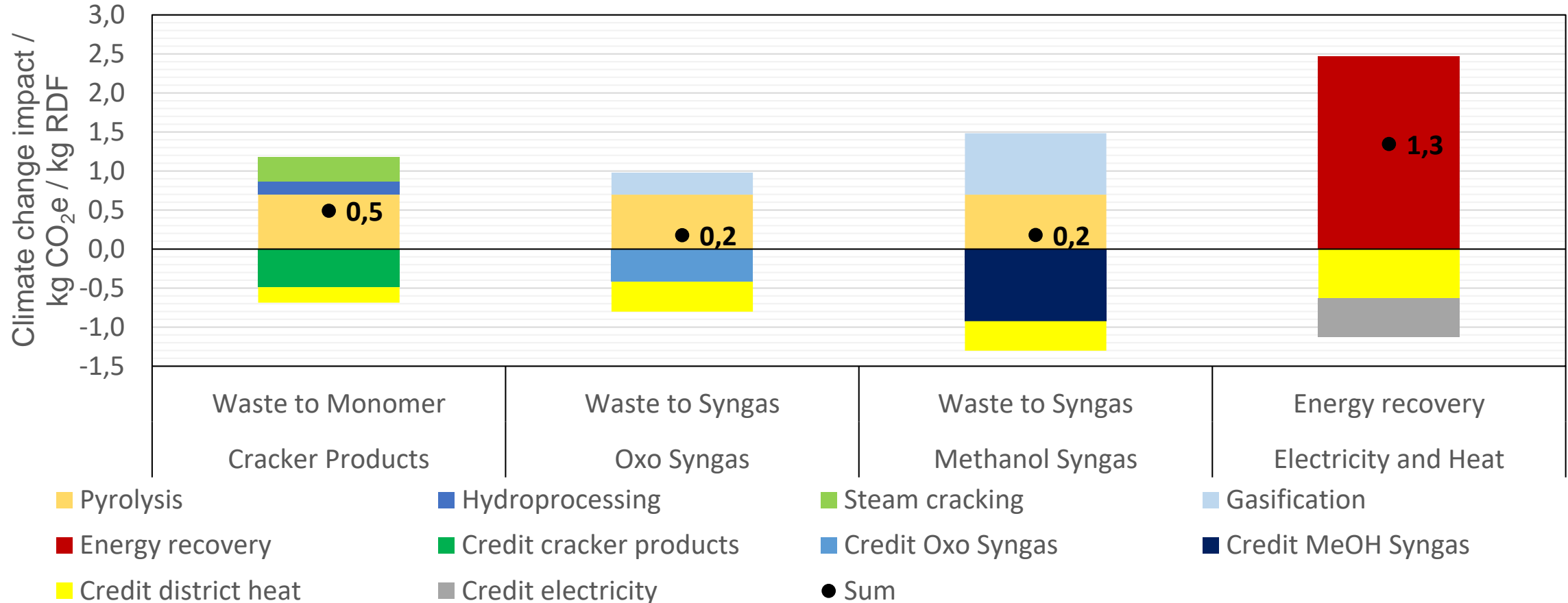


**All chemical recycling routes show potential to reduce gross impact of MPW treatment**

Hennig, M., Tavakkol, S., Stapf, D. (2024). Conf. WasteEng 24, Sendai, Japan



# Comparison of climate change impact for SLF



**Syngas production (Oxo and Methanol) shows lowest climate change impact by substituting syngas production from heavy fuel oil**

Hennig, M., Tavakkol, S., Stapf, D. (2024). Conf. WasteEng 24, Sendai, Japan

# Conclusion

- Chemical recycling → Complementary to the existing mechanical recycling
- Pyrolysis & Gasification → are Chemical recycling processes for plastic recycling
- Enormous amount of Plastic available to be recycled in all ways
- Hard to have numerous dedicated specific plastic sorts
- Feasible is to have several mixed plastics waste fractions with comparable polymer/contamination content
- Heteroatom contamination a challenge in chemical recycling