

Environmental impact of SAF Value Chains

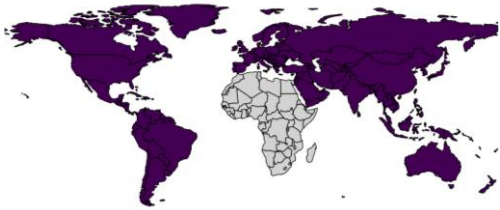
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Part I: Global screening of key sustainability indicators



Are SAFs globally sustainable?

Regions

Europe, Americas, Asia and Oceania

Routes

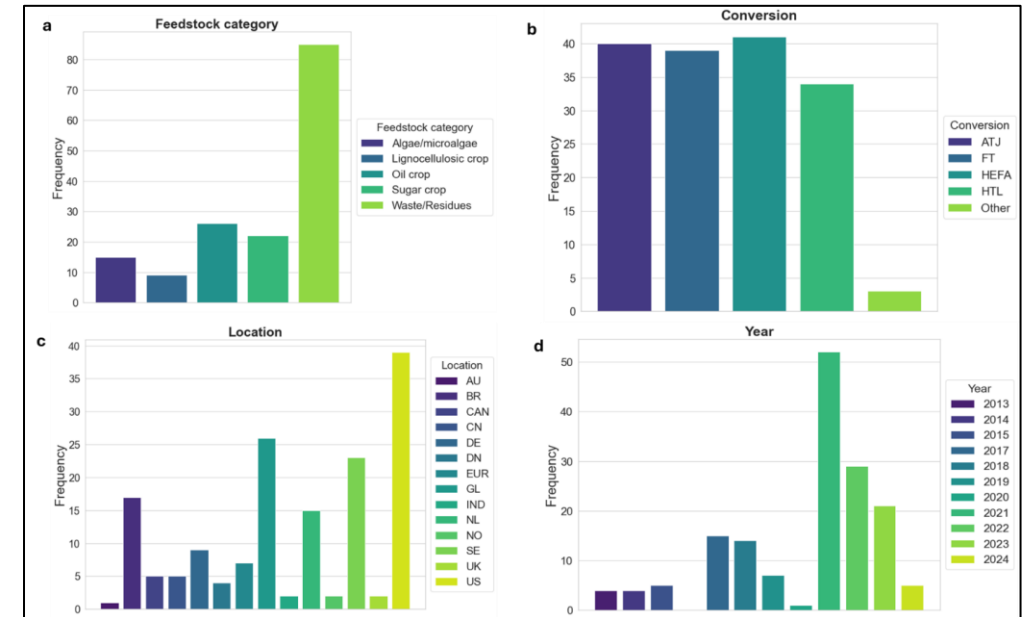
Biocrude-, Alcohol-, and Syngas-to-SAF, HEFA

Feedstock

Waste, residues, lignocellulosic crops, others

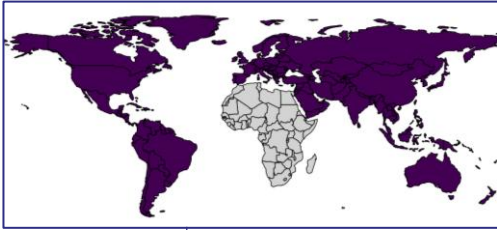
Impacts

Carbon footprints, SDG-related indicators



Source: ICARUS – D.3.3. LCA and SDG analysis of SAFs: screening of sustainability indicators

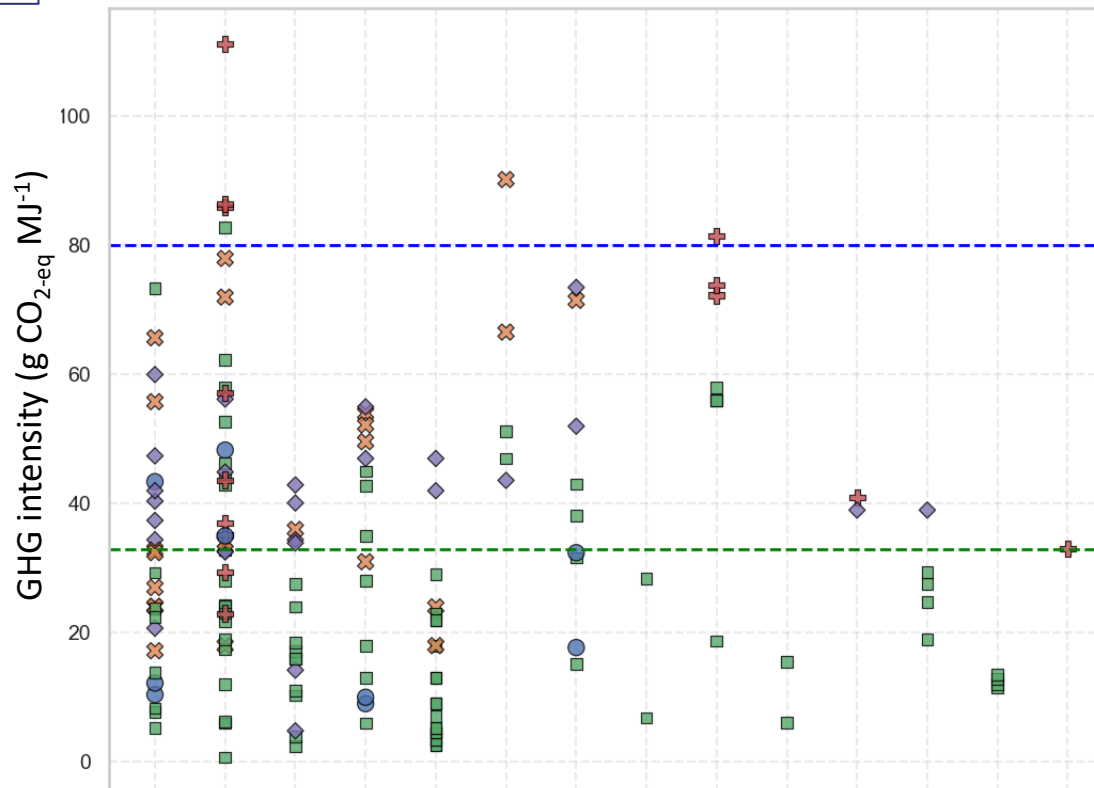
Part I: Global screening of key sustainability indicators



Do SAFs promote enough decarbonization?

Impacts

157
Carbon footprints
(g CO_{2-eq} MJ⁻¹)



CORSIA

Target: -10% (Fossil: 89g CO_{2-eq} MJ⁻¹)

96% of cases
≤ 80g CO_{2-eq} MJ⁻¹

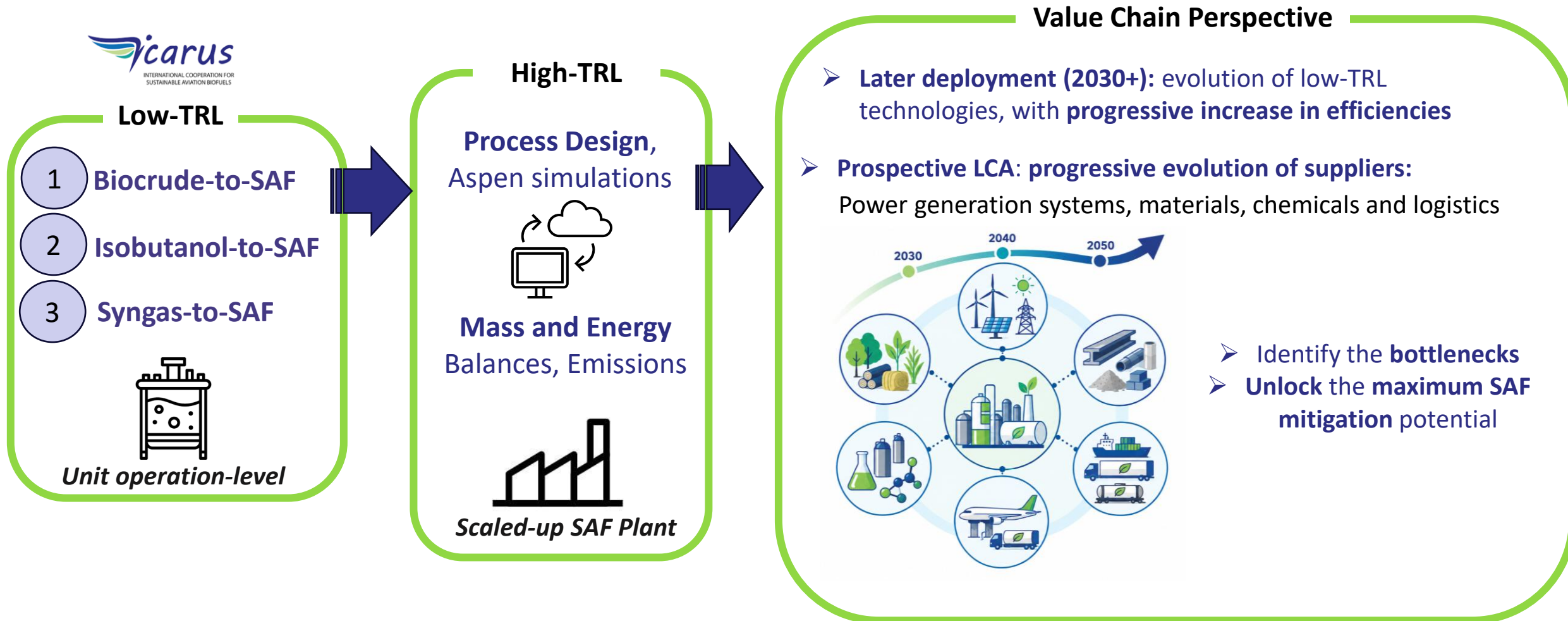


RED: -65% (Fossil: 94g CO_{2-eq} MJ⁻¹)

57% of cases
≤ 33g CO_{2-eq} MJ⁻¹

Part II: Sustainability assessment of 3 Value Chains

ICARUS low-TRL technologies



Part II: Sustainability assessment of 3 Value Chains



Environmentally-oriented Sustainable Development Goals

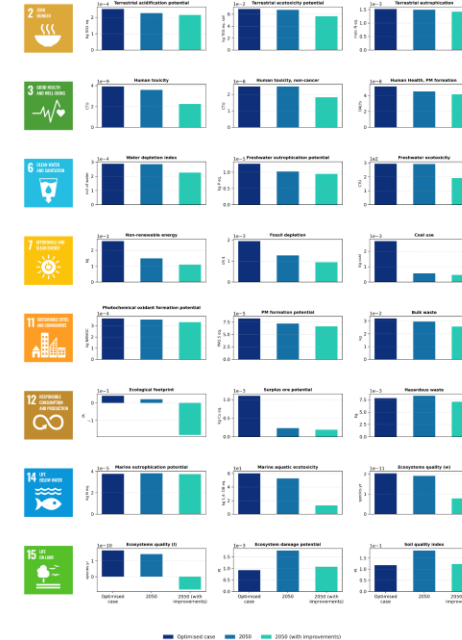


Methodology based on Cavalett & Cherubini, 2018

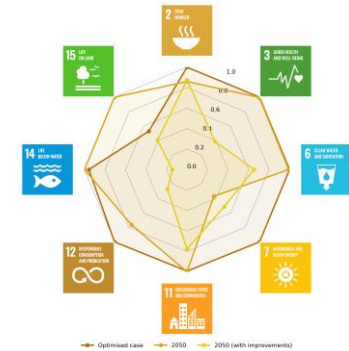
LCA-Impact categories

2 ZERO HUNGER	Terrestrial acidification potential Terrestrial ecotoxicity potential Terrestrial eutrophication
3 GOOD HEALTH AND WELL-BEING	Human toxicity Human toxicity, non-cancer Human health, PM formation
6 CLEAN WATER AND SANITATION	Water depletion index Freshwater eutrophication potential Freshwater ecotoxicity
7 AFFORDABLE AND CLEAN ENERGY	Non-renewable energy Fossil depletion, as surplus costs Coal use
11 SUSTAINABLE CITIES AND COMMUNITIES	Photochemical oxidant formation potential PM formation potential Bulk waste
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	Ecological footprint Surplus ore potential, kg Cu eq. Hazardous waste
14 LIFE BELOW WATER	Marine eutrophication potential Marine aquatic ecotoxicity Ecosystem quality
15 LIFE ON LAND	Ecosystems quality Ecosystem damage potential Soil quality index

Impact scores



Normalized aggregated scores



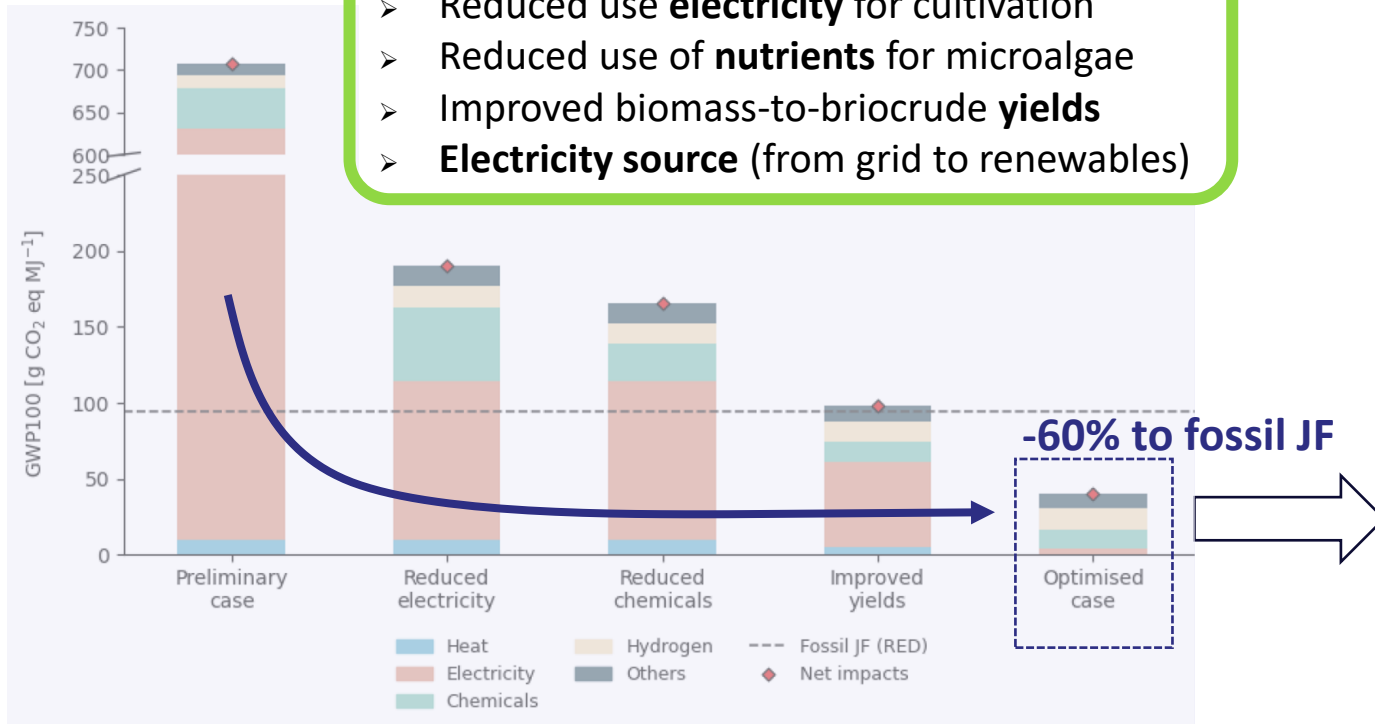
Part II: Sustainability assessment of 3 Value Chains

1 Biocrude-to-SAF

VC1: Wastewater Microalgae + HTL

Measures for **maximizing climate mitigation**:

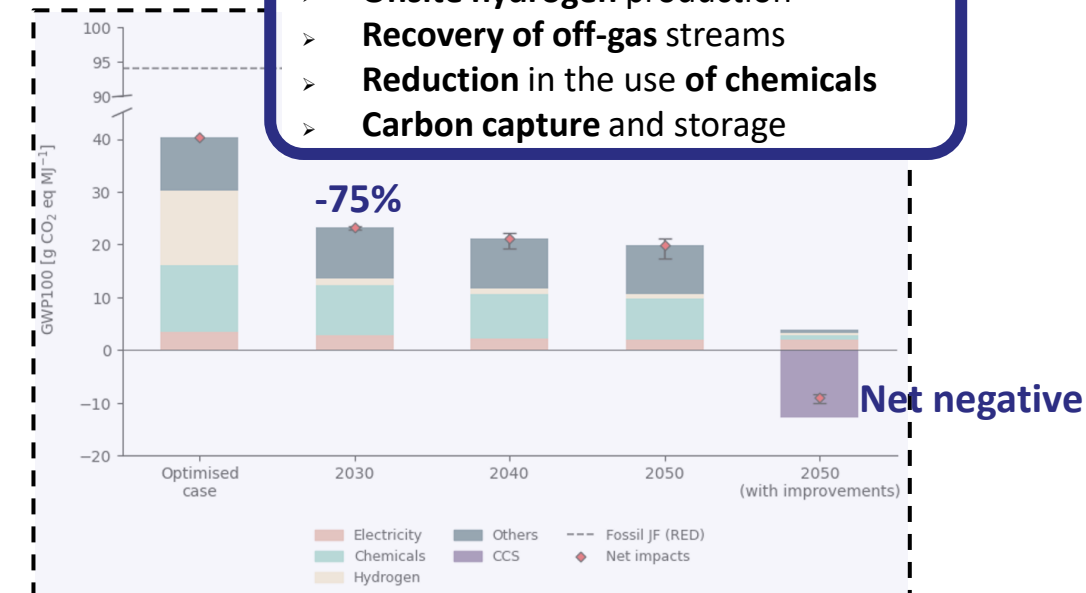
- Reduced use **electricity** for cultivation
- Reduced use of **nutrients** for microalgae
- Improved biomass-to-biocrude **yields**
- **Electricity source** (from grid to renewables)



Reduction in all SDG-related environmental impacts

Additional push towards 2030+

- Onsite hydrogen production
- Recovery of off-gas streams
- Reduction in the use of chemicals
- Carbon capture and storage



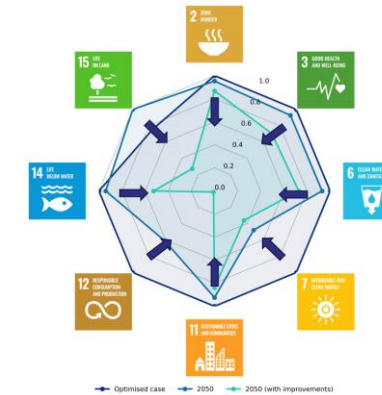
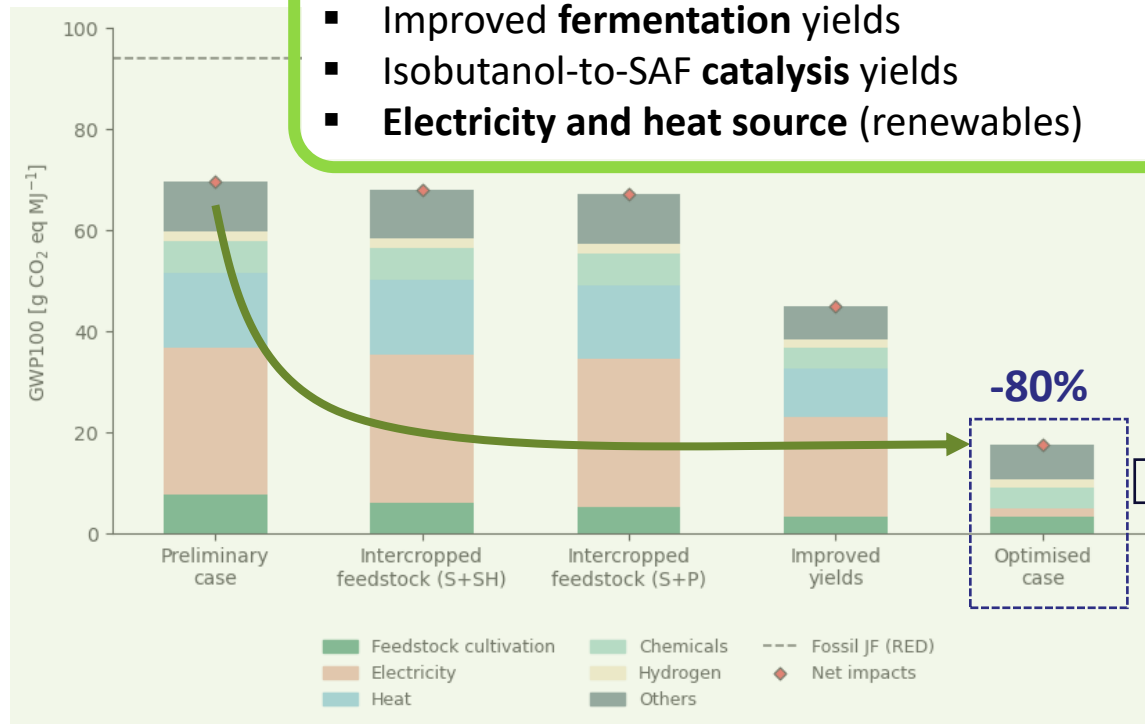
Part II: Sustainability assessment of 3 Value Chains

2 Isobutanol-to-SAF

VC2: Biomass sorghum + ATJ

Measures for **maximizing climate mitigation**:

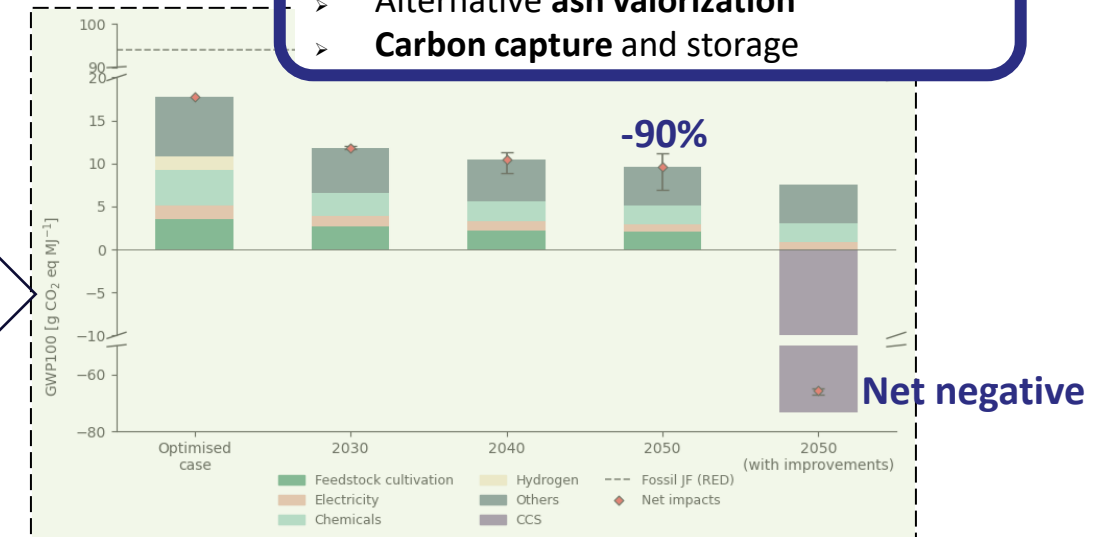
- **Intercropped** system (*Sunn hemp*, *Pigeon pea*)
- Improved **fermentation** yields
- Isobutanol-to-SAF **catalysis** yields
- **Electricity and heat source** (renewables)



Reduction in all SDG-related environmental impacts

Additional push towards 2030+

- **Reduced use of external grey hydrogen**
- **Use of biomass residues**
- **Alternative ash valorization**
- **Carbon capture and storage**



Part II: Sustainability assessment of 3 Value Chains

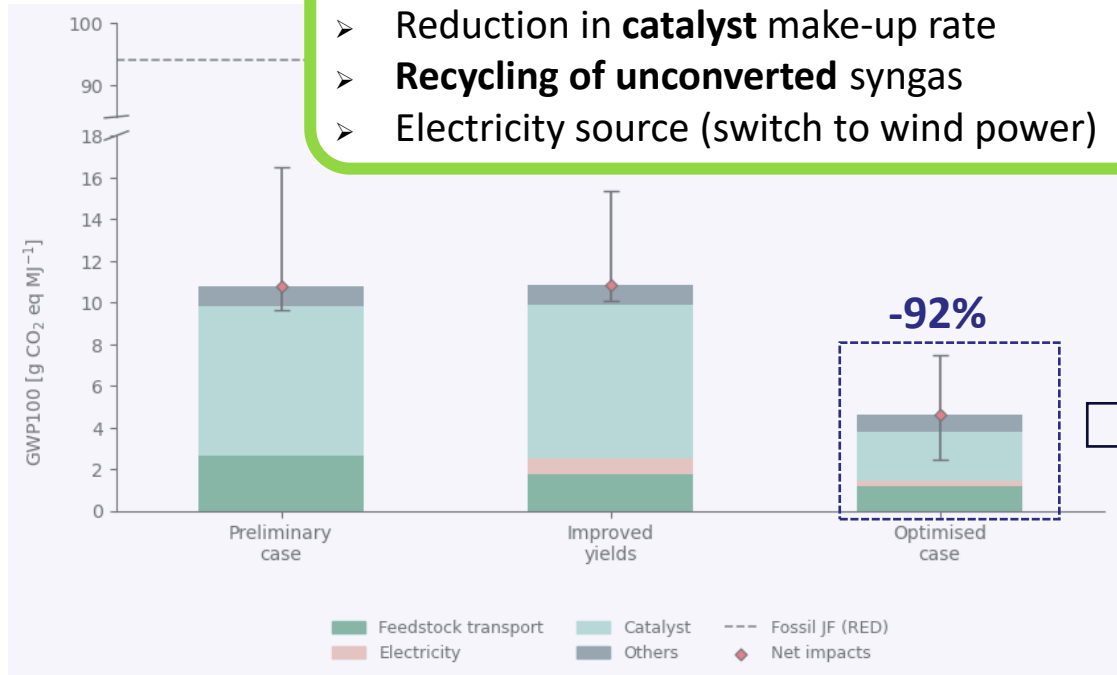
3

Syngas-to-SAF

VC3: Agroforestry residues + olefin-to-SAF

Measures for **maximizing climate mitigation**:

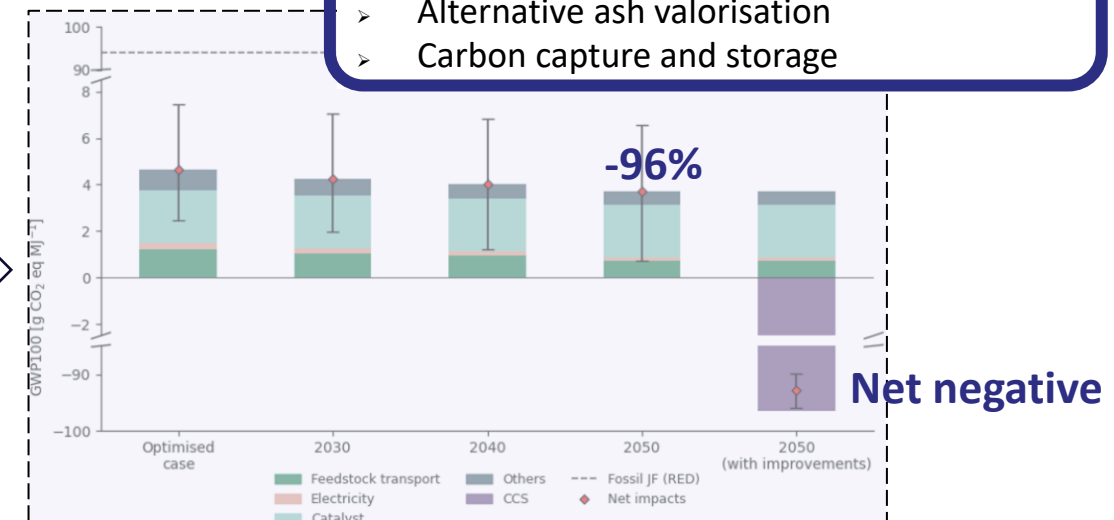
- Increase in **CO-to-olefins conversion**
- Reduction in **catalyst** make-up rate
- **Recycling of unconverted syngas**
- Electricity source (switch to wind power)



Reduction in all SDG-related environmental impacts

Additional push towards 2030+

- Decarbonization of **transport and fuel mix**
- **Decarbonization of metals** (catalysts)
- Alternative ash valorisation
- Carbon capture and storage



Final remarks

- **Identifying bottlenecks at early stages** of development is essential to improving the environmental performance of SAFs.
- **Biocrude- and Iso-butanol-to-SAF** are dependent on decarbonization of upstream sectors such as chemicals and electricity. **Syngas-to-SAF** is more dependent on improvements in the biofuel plant,
- **Strong climate mitigation** potential across all value chains, **provided key bottlenecks are addressed**
- Achieving these mitigation targets **will depend on the pace of future research, R&D, and investment** in technology development



Thank you!

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