Processing biogenically produced intermediates to jet fuel – Technical comparison

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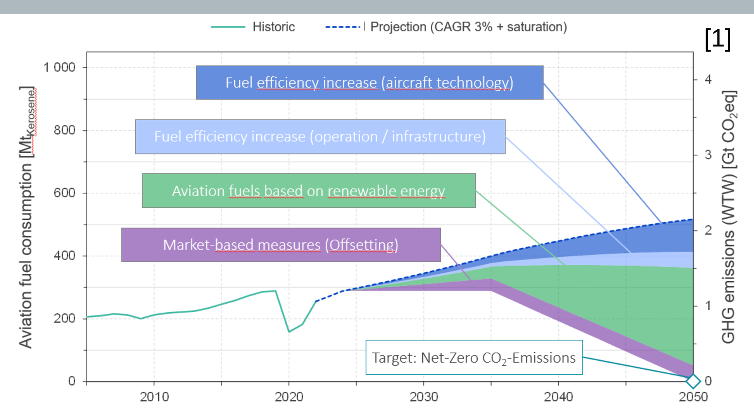
Motivation



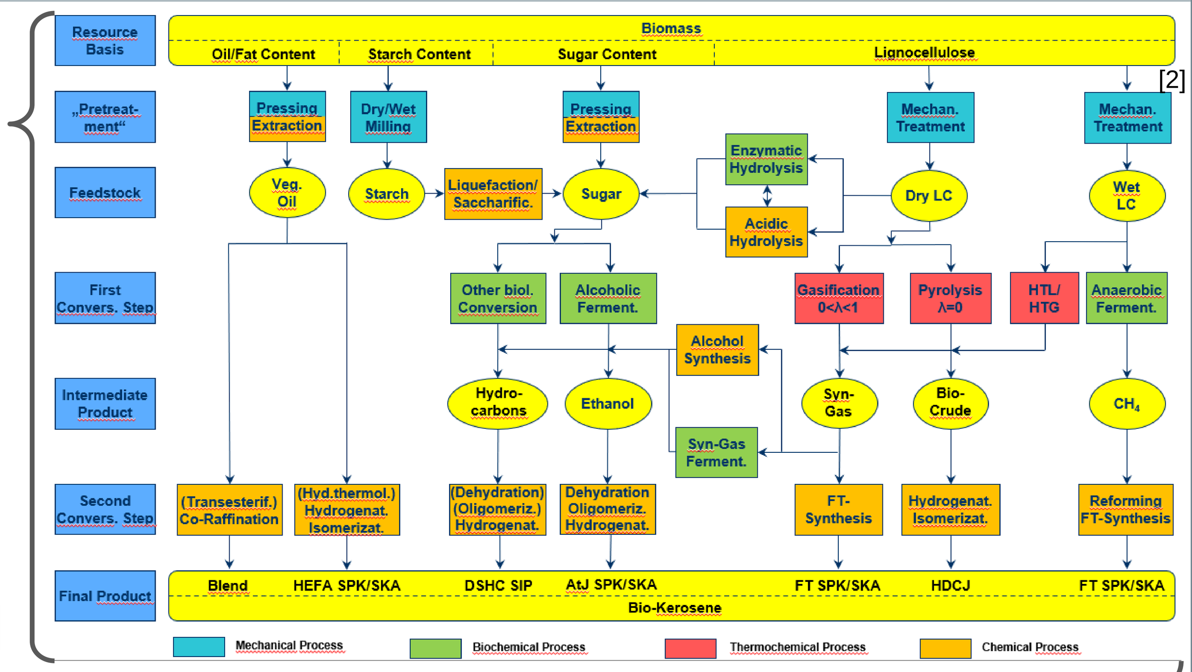
SAF will be needed in the aviation industry in the long term to defossilize

- Power-based SAF, have great potential, but currently limited renewable power generation
- Biogenic intermediates can act as feedstock today, reducing both CO_2 and non-CO_2 effects
- Carbon efficiency is of high importance due to limited non-fossil carbon availability

→ Currently available biogenic intermediates can play a decisive role in SAF ramp-up

Fundamentals and Feedstock

Today approved biogenic SAF production routes
↓
AtJ routes feasible on ethanol
↓
More alcohols to be allowed as feed



→ Biogenic products from cultivated biomass, in GER [3,4,5]

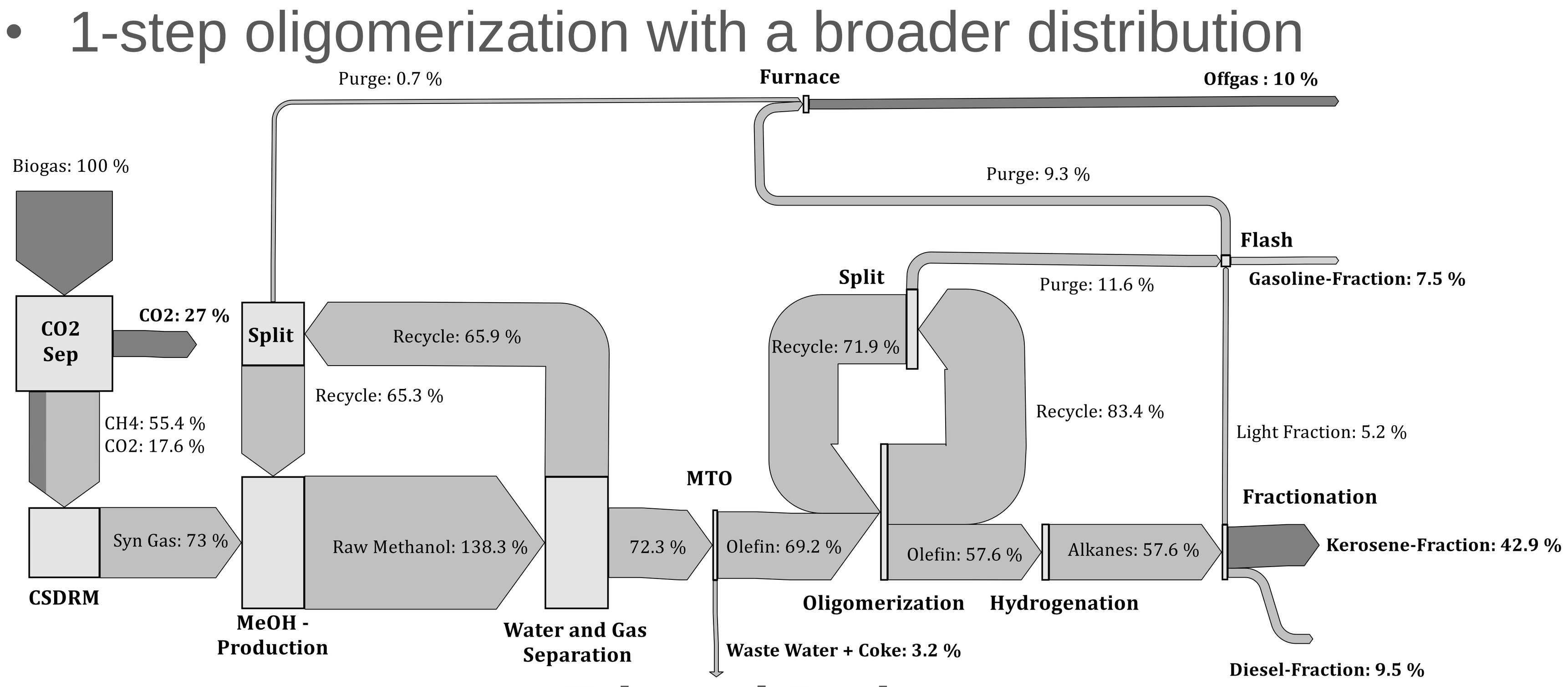
	Biomethane	Bioethanol	Biodiesel
Production	~ 700 000 t a^{-1}	~ 700 000 t a^{-1}	~ 3 000 000 t a^{-1}

→ Alcohol and biomethane production from lignocellulosic biomass possible
→ Further biogenic intermediates in research (2,3-BDO)

Results

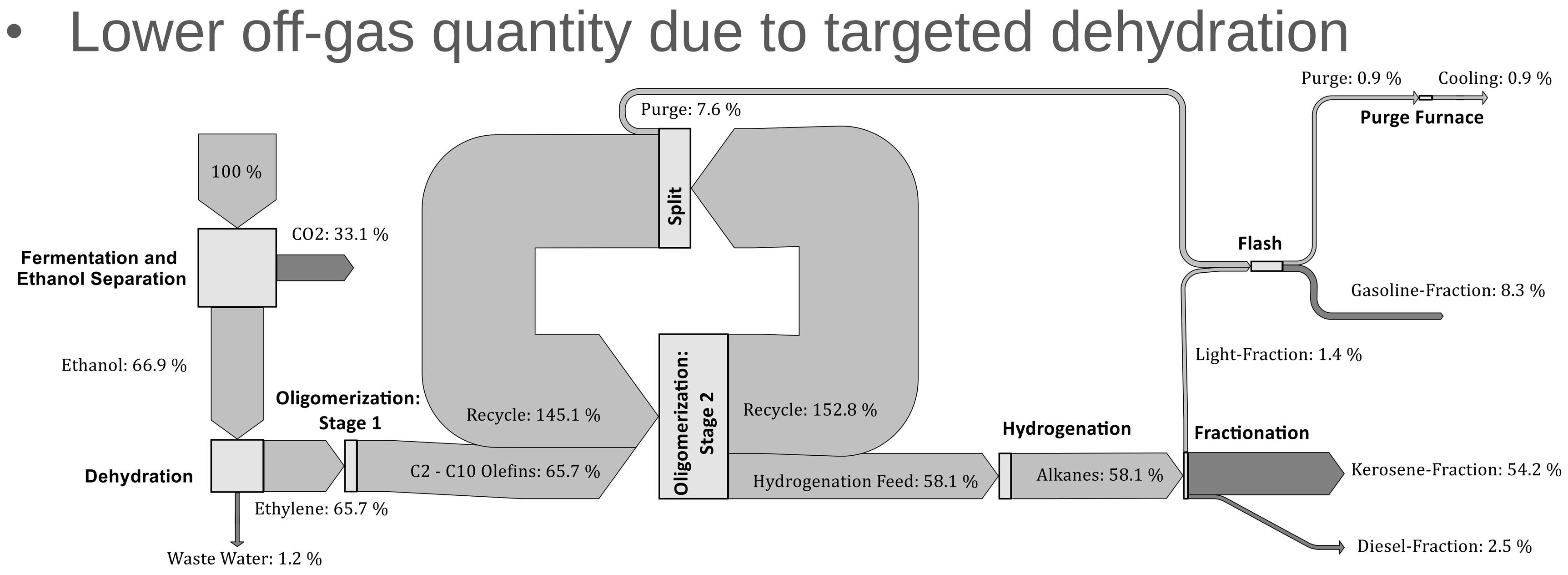
Biogas Pathway

- $\eta_{C,MeOH} = 72.3\ \%$ $\eta_{C,SAF} = 42.9\ \%$
- 1-step oligomerization with a broader distribution



Ethanol Pathway

- $\eta_{C,EtOH} = 66.9\ \%$ $\eta_{C,SAF} = 54.2\ \%$
- Lower off-gas quantity due to targeted dehydration



→ Both processes with similar alkane yields, but more selective oligomerization in the ethanol pathway
→ CO_2 also *valuable* by-product

Assessment Criteria

Technical assessment of carbon efficiency

$$\eta_{C,Prod} = \frac{\dot{n}_{C,Prod}}{\dot{n}_{C,Feed}}$$

$\eta_{C,Prod}$: Carbon efficiency [%]
$\dot{n}_C$: Molar flow [mol s^{-1}]

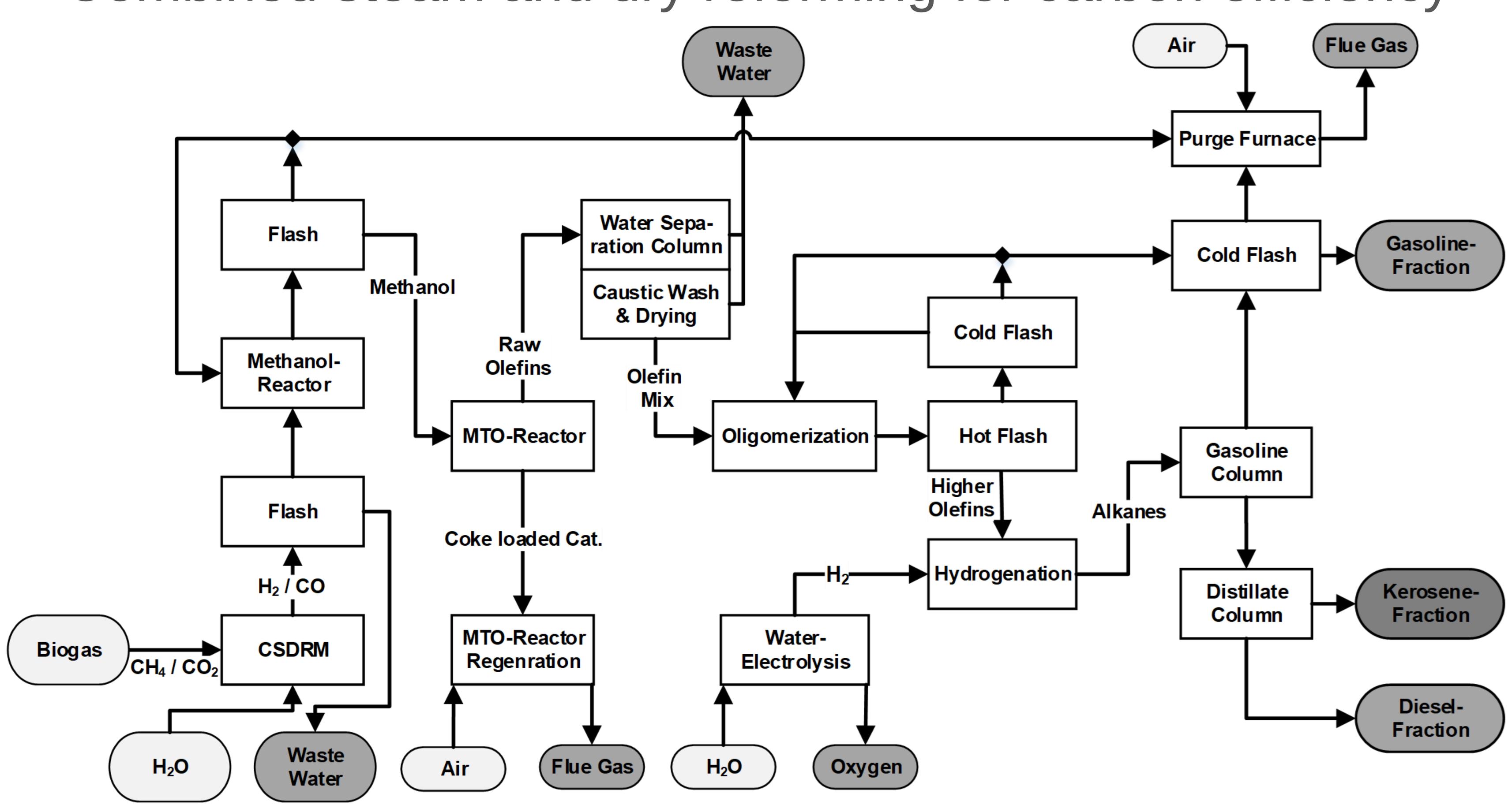
Process Design

Design criteria

- High carbon efficiency and TRL
- Feedstocks and intermediates on the market available

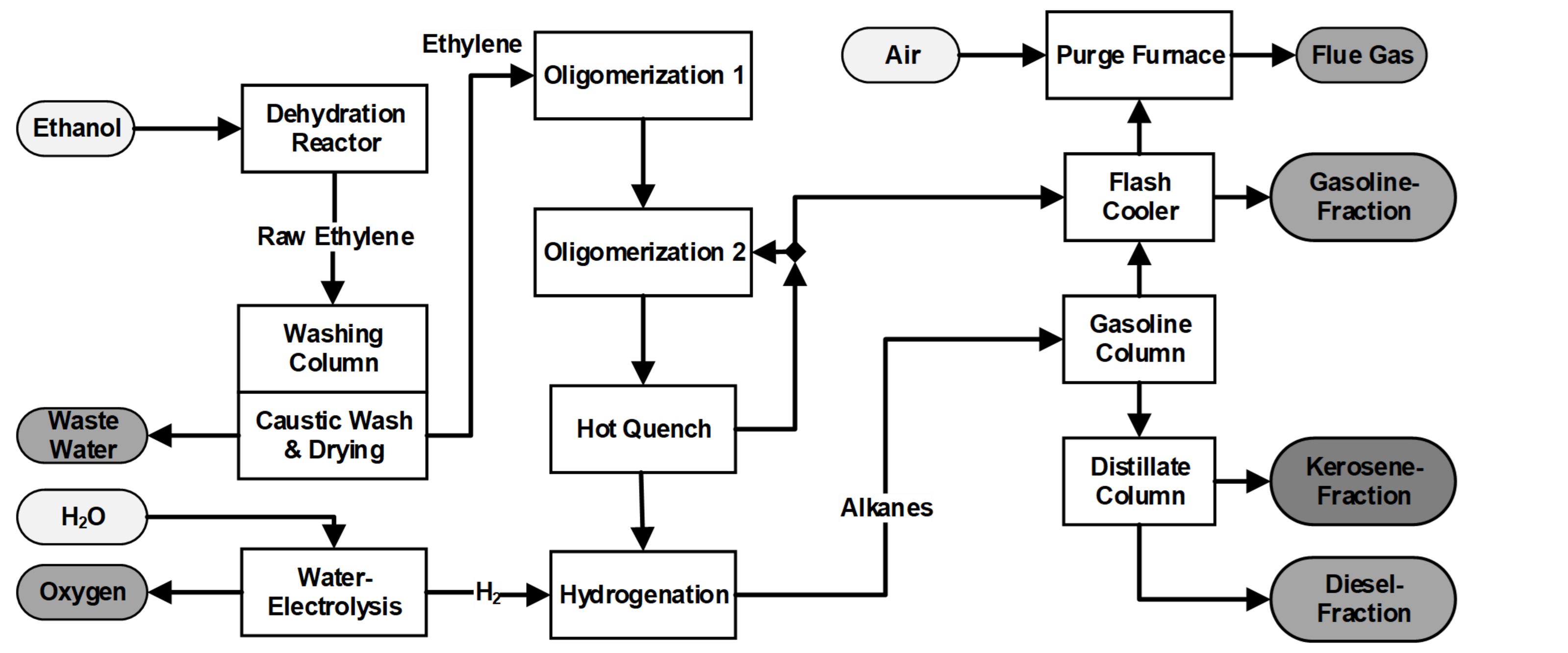
Biogas Pathway

- Combined steam and dry reforming for carbon efficiency



Ethanol Pathway

- 2-stage oligomerisation with potential increased selectivity



Outlook and Further Research

- Assessment of energy efficiency
- Inclusion of further biogenic intermediates (2,3-BDO)
- Consideration of biogenic intermediate production
- Evaluation of the use in other sectors (e.g. Chemicals)

Abbreviations: 2,3-BDO: 2,3-Butanediol | AtJ: Alcohol to Jet | CSDRM: Combined Steam and Dry Reforming of Methane | EtOH: Ethanol | MeOH: Methanol | R&D: Desearch and Development | SAF: Sustainable Aviation Fuels | TRL: Technology Readiness Level

References: [1]: IATA, 2021 | [2]: Neuling, U., Kaltschmitt, M.: Conversion routes for production of biokerosene—status and assessment. Biomass Conv. Bioref. (2015). https://doi.org/10.1007/s13399-014-0154-2 | [3] Bundesnetzagentur (2022): Monitoringbericht 2022, Monitoringbericht gemäß § 63 Abs. 3 i. V. m. § 35 EnWG und § 48 Abs. 3 i. V. m. § 53 Abs. 3 GWB | [4] Bundesverband der deutschen Bioethanolwirtschaft e.V. (2022): Marktdaten Deutschland | [5]: Naumann, Schröder et al. 2019 – Monitoring Biokraftstoffsektor

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