Electrolysis assisted biomass gasification for biofuels production - a technoeconomic perspective

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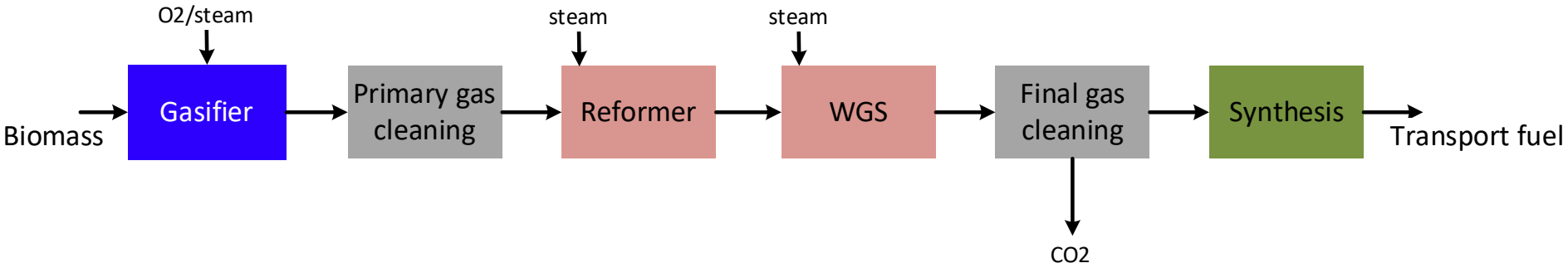
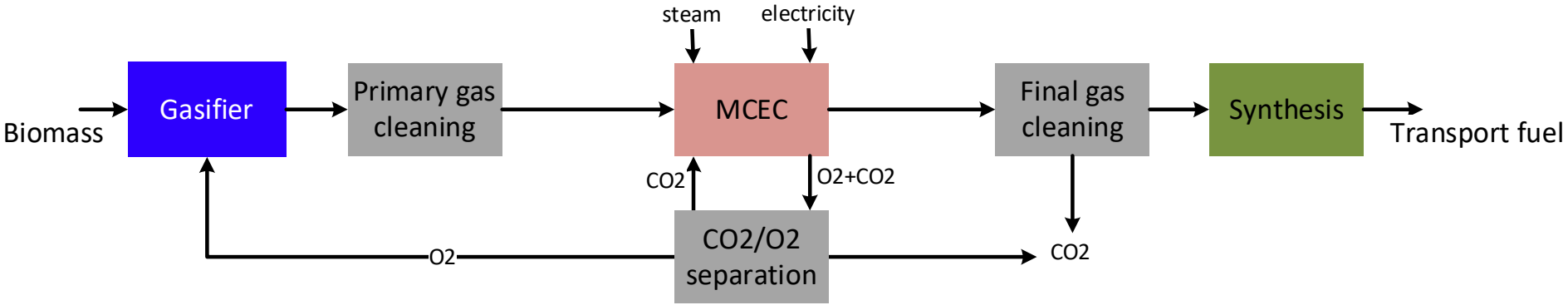
Background



Biomass gasification-based biofuels

- Scalability of gasifier
- Multiple process steps

Background



Electrolysis assisted biomass gasification

- reduce process steps?
- increase productivity for the same carbon source

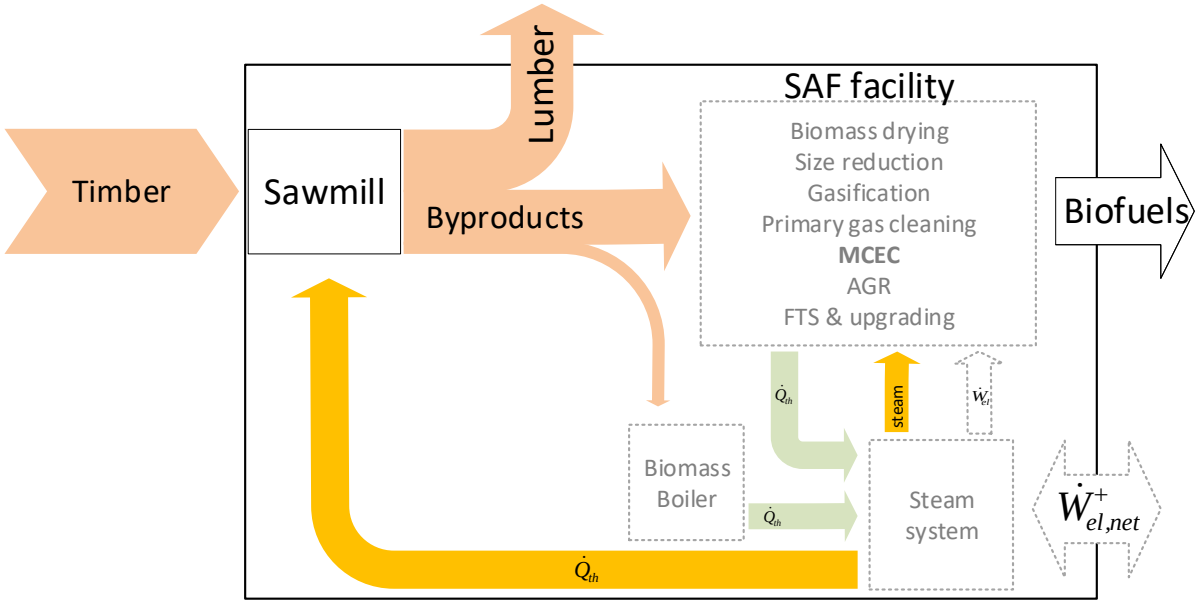
Objectives

investigate Molten Carbonate Electrolysis Cell (**MCEC**) for syngas conditioning

"To produce knowledge specific to the operating range, scale and feasibility of MCEC as an alternative pathway to a multiple-stage downstream conditioning of raw-syngas (from biomass gasification) prior to its synthesis to transport grade biofuel"

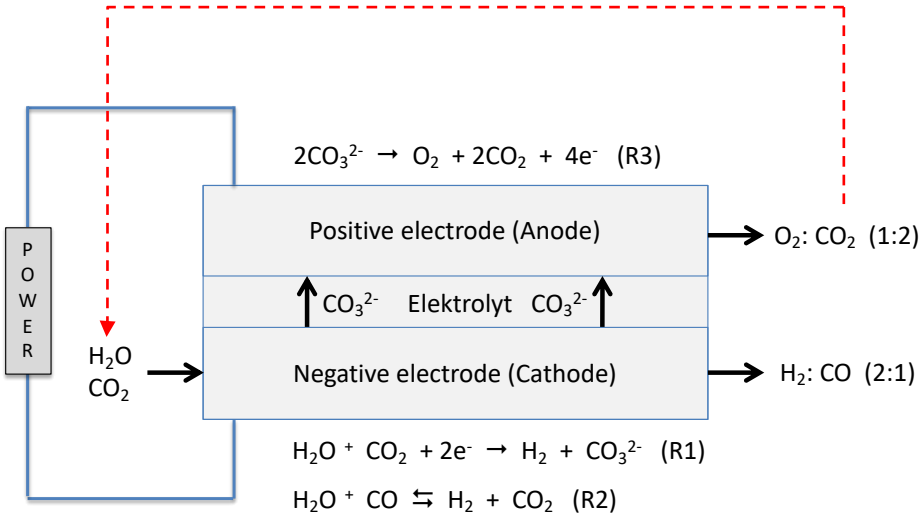
extent of linking electricity to liquid fuels

Technology track and scope of work



- Host facility – sawmill (generic)
- **M**olten **C**arbonate **E**lectrolysis **C**ell (**MCEC**)
- **S**ustainable **A**viation **F**uel (**SAF**)

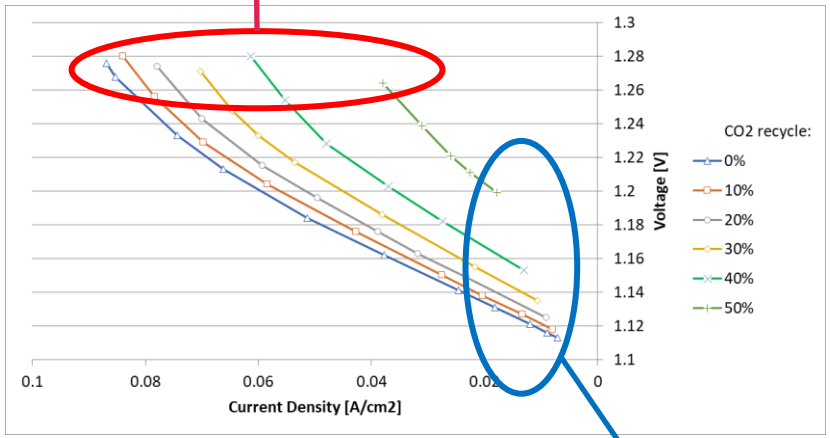
MCEC — operational parameters



- polarization curve
- stack temperature
- methane behavior
- CO_2 recycle (anode)

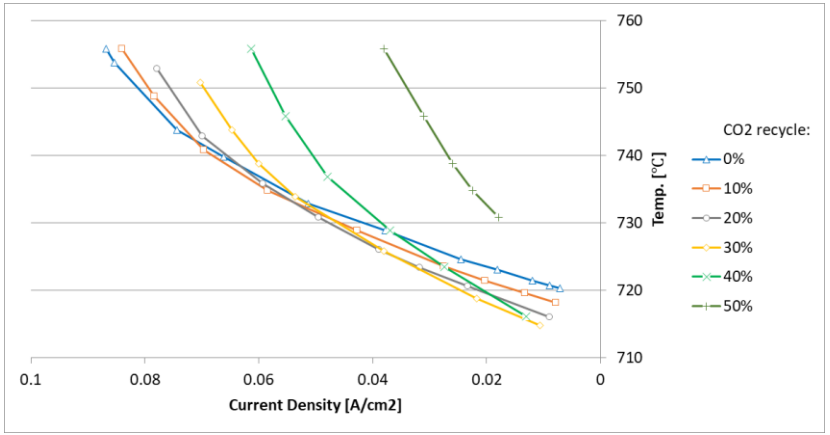
MCEC — operational parameters

stack size↓



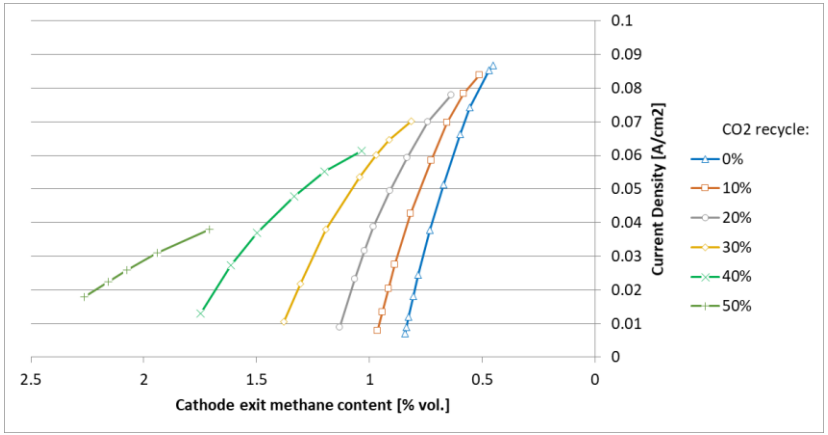
El. use ↓

polarization curves

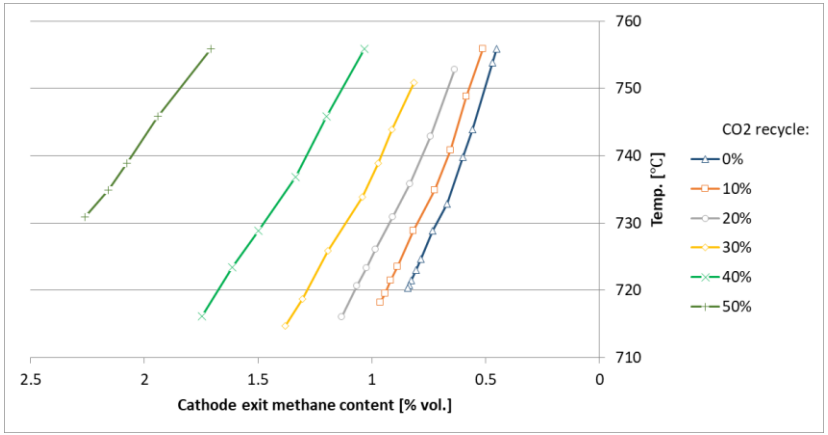


stack temperature

MCEC — operational parameters



methane vs current density

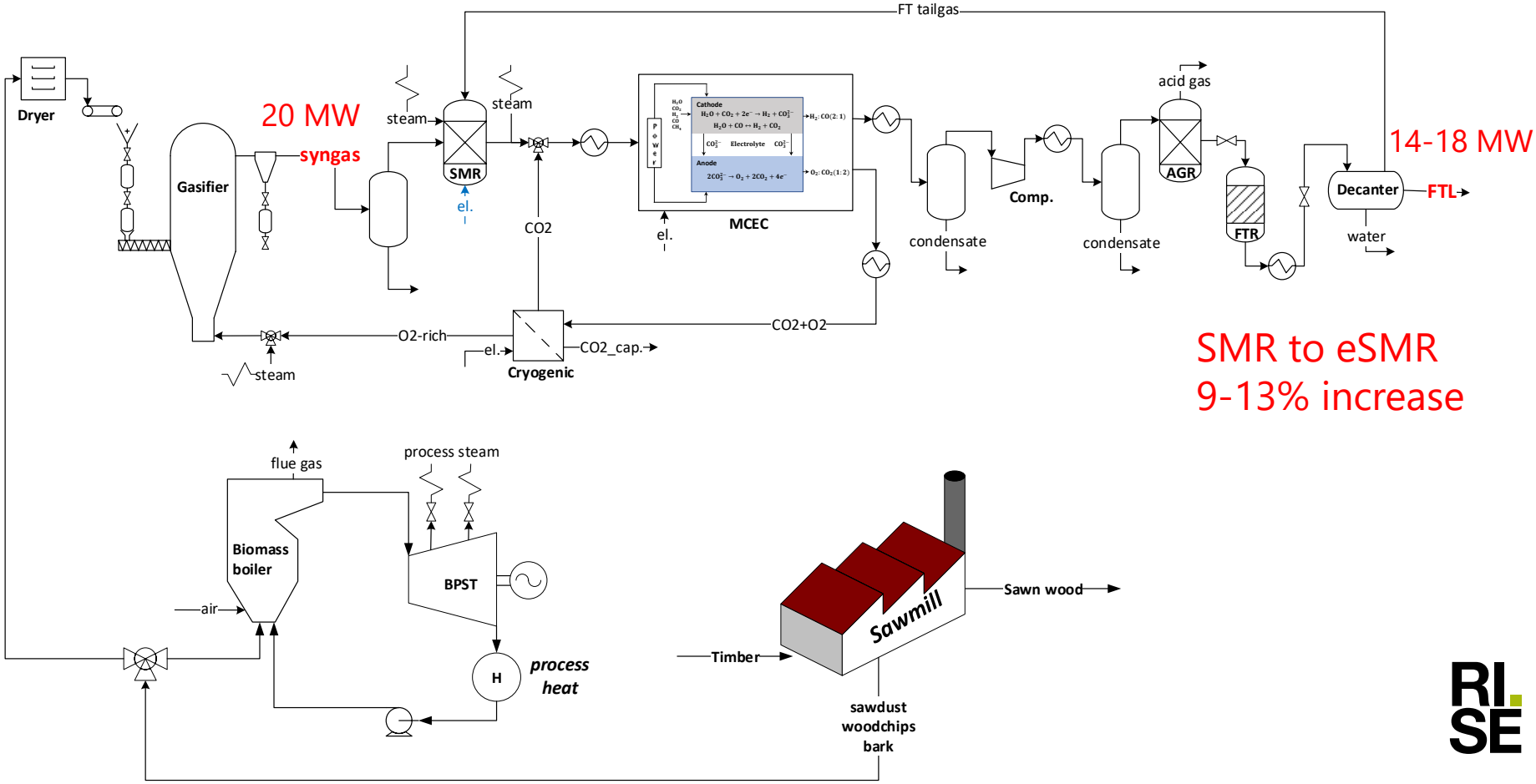


methane vs stack temperature

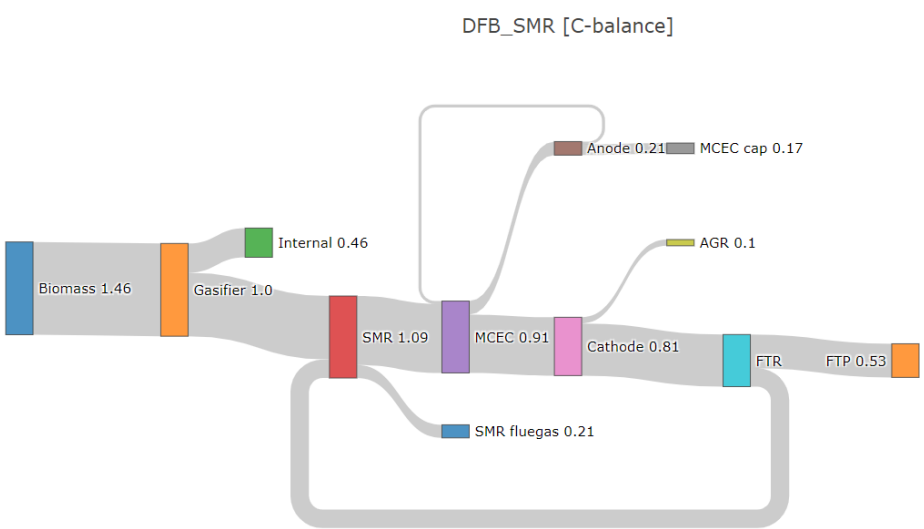
Cases evaluated

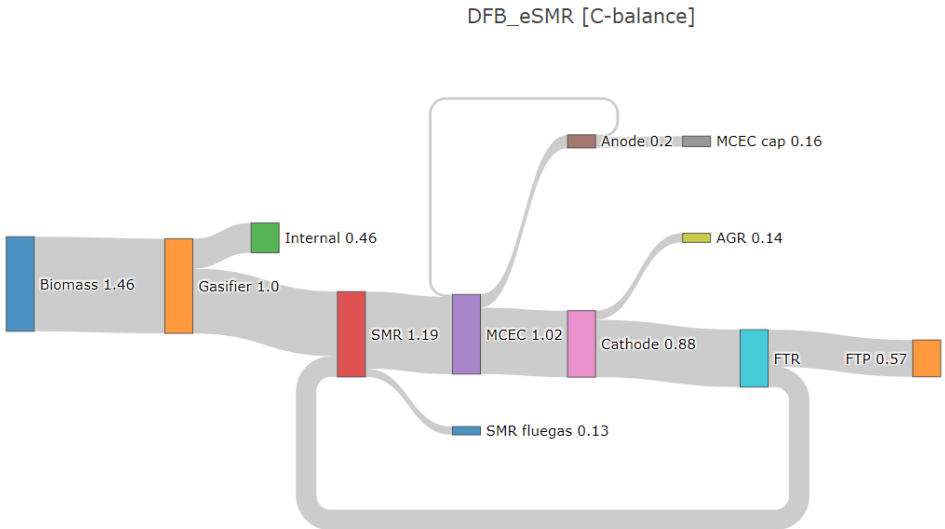
- MCEC integrated with 3 gasification technologies (20 MW LHV syngas)
  - WoodRoll (WR, Cortus Energy AB)
  - Dual Fluidized Bed (DFB, e.g. GoBiGas)
  - Bubbling Fluidized Bed direct heated (BFB, Andritz Carbona)
- 2 process configuration
  - side-fired steam reformer (SMR)
  - electric heated steam reformer (eSMR)
- Economic indicators: investment and *production cost estimates* for the studied cases

Process configuration (20 MW LHV syngas)



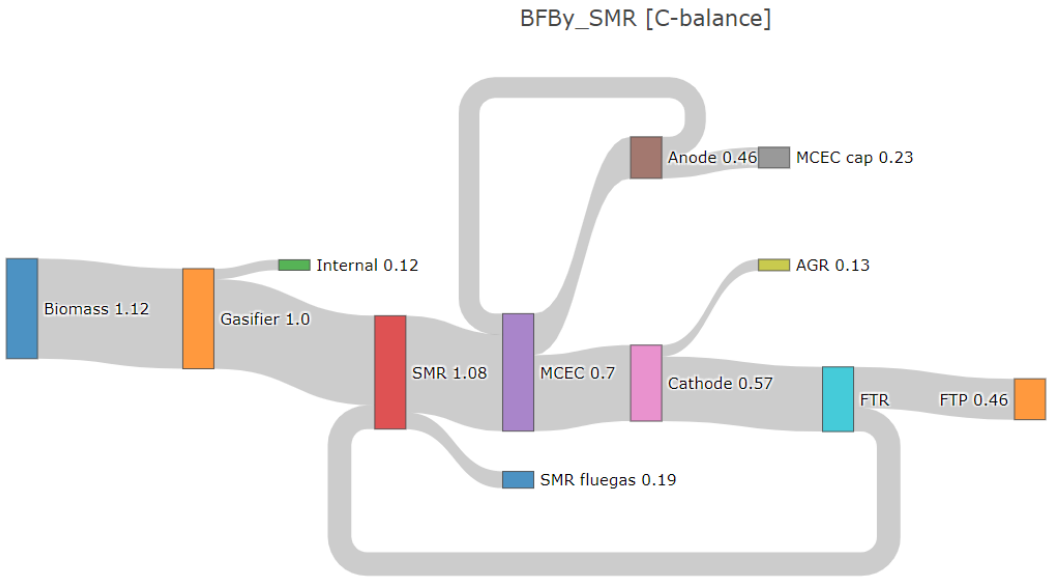
Carbon balance (Dual fluidized bed)





Normalized to carbon in syngas

Carbon balance (Bubbling fluidized bed)

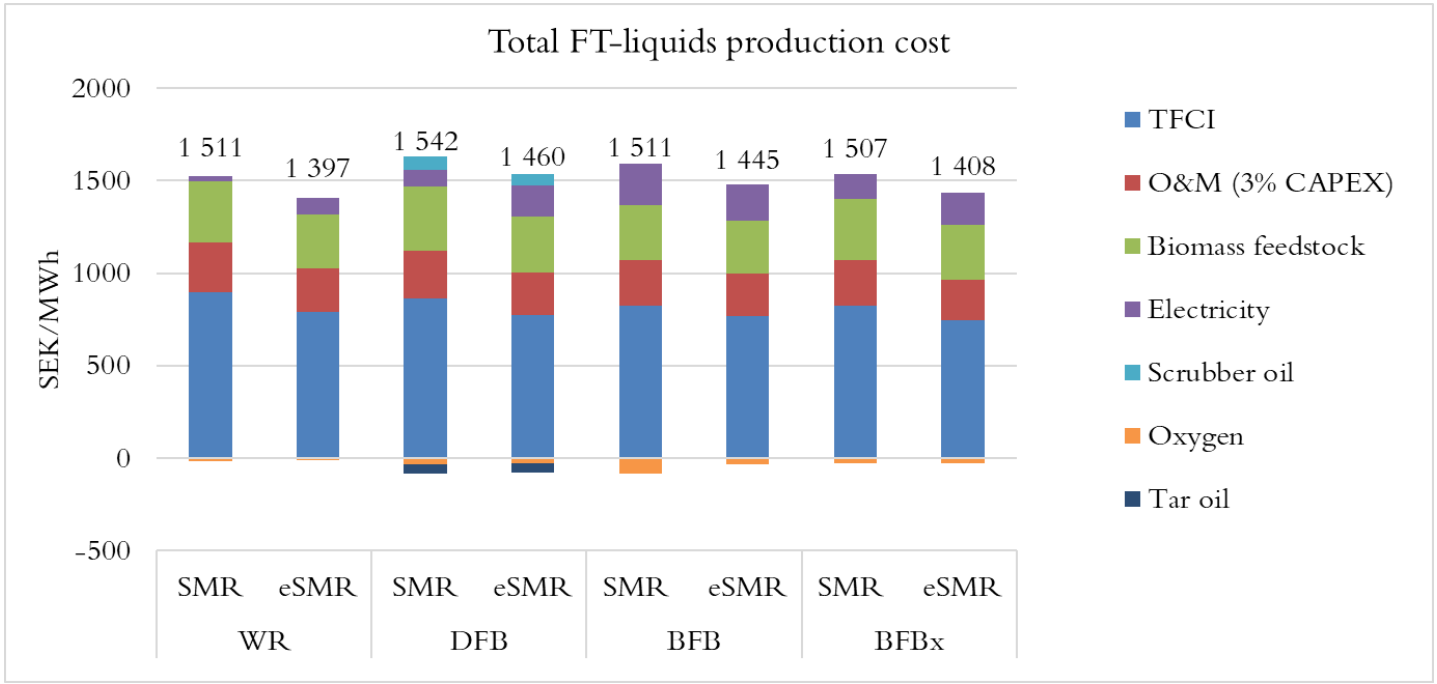


Normalized to carbon in syngas

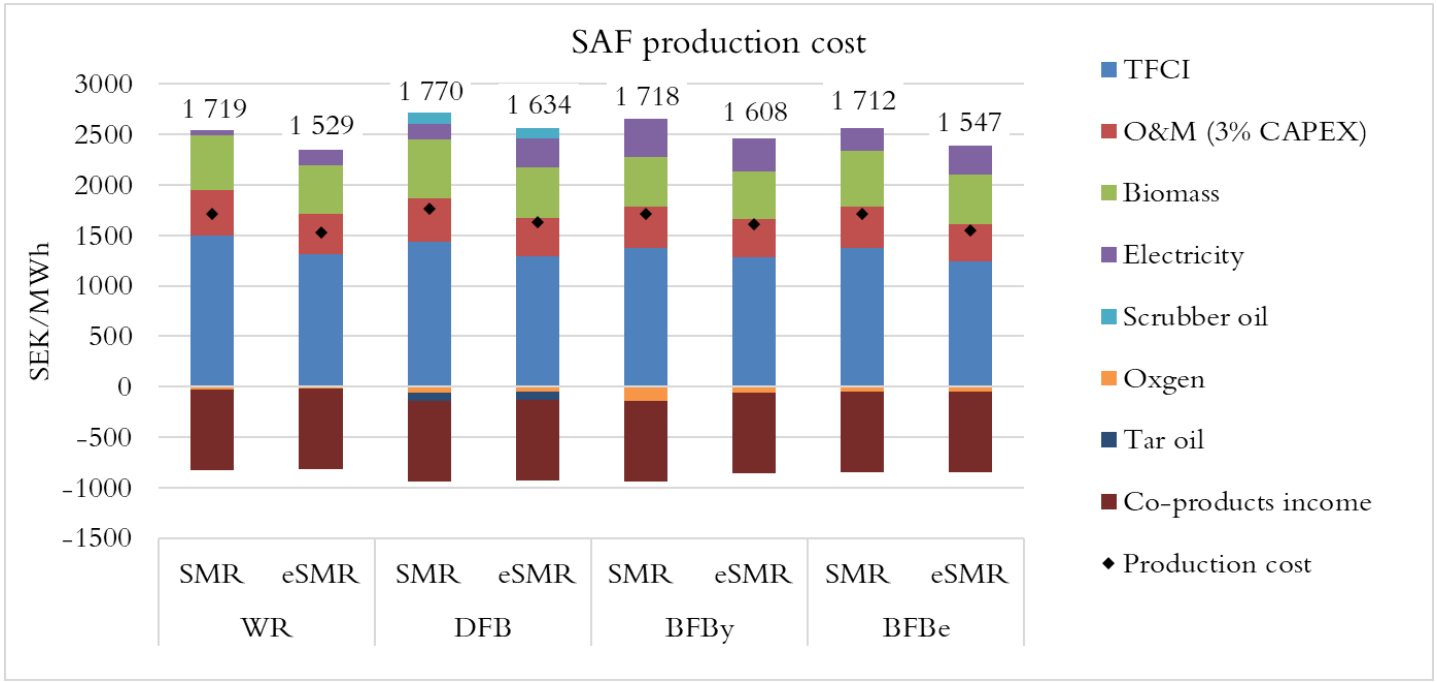
Economic performance

Parameter	Unit	Value	Remark
Biomass	SEK/MWh	172.5	mixed bark, sawdust, woodchips
Electricity	SEK/MWh	400	
Oxygen	SEK/ton	600	
Scrubber oil	SEK/MWh	1060	DFB configuration
Annuity	-	0.1	~20 years, 8% interest
O&M	%	3	of Total Fixed Capital Inv. (TFCI)

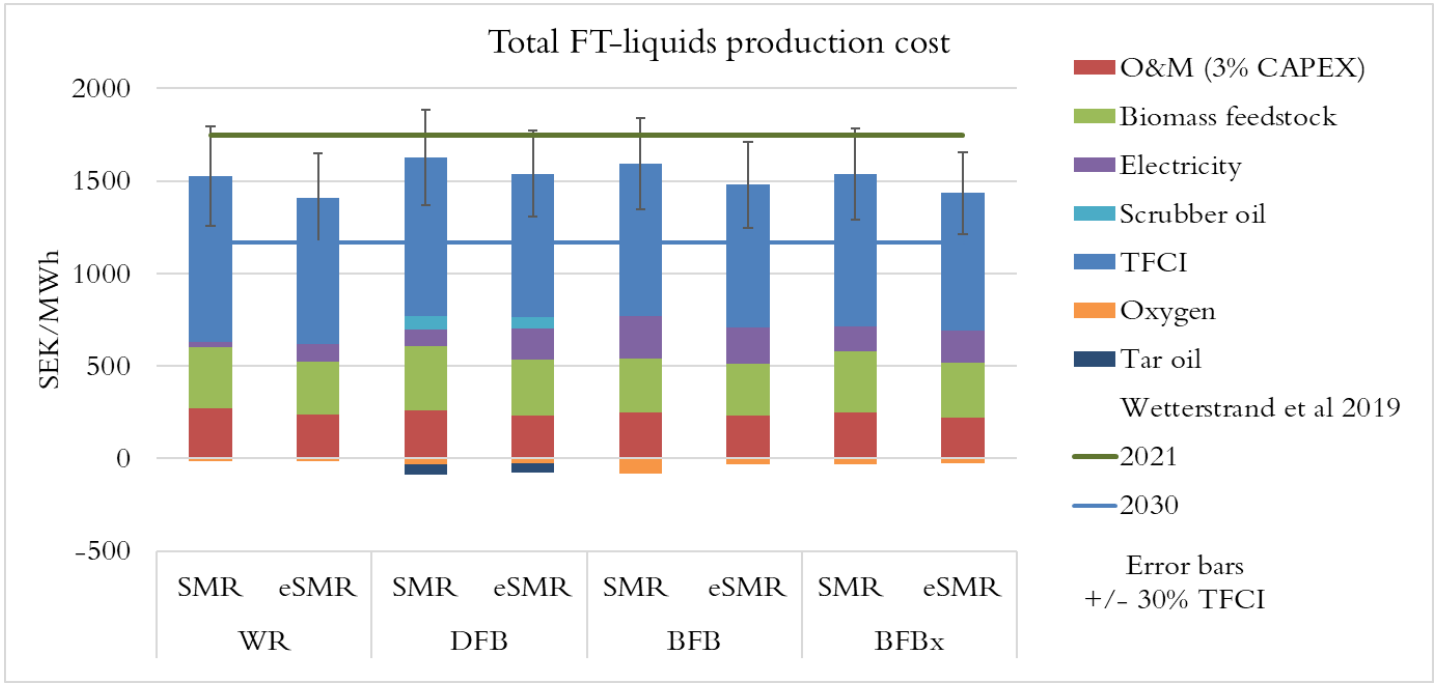
Production cost



Production cost



Production cost



Concluding remarks

- MCEC activity varies depending on syngas composition & requirements for downstream upgrading, WR<DFB<<BFB
- Syngas yield increase by 15-31% compared to WGS conditioning
- For a given MCEC size, lower current densities pronounce methane content of the syngas, e.g. suitable for SNG process
- Electrification of other process sections can boost carbon efficiency, worth checking electrical heating for the gasification process (DFB & WR)
- Process capital intensive (TFCI ~55% production cost), about 35% TFCI derives from gas conditioning section that include MCEC

Thank you for your attention!
Questions?

This project is carried out within the collaborative research program *Renewable transportation fuels and systems*, financed by the Swedish Energy Agency and f3 Swedish Knowledge Centre for Renewable Transportation Fuels.

www.f3centre.se/en/renewable-transportation-fuels-and-systems/

Swedish Energy Agency

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