# The $CO_2$ Electrofuel Project

RESEARCH | TECHNOLOGY | CATALYSTS


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# The $CO_2$ Electrofuel Project

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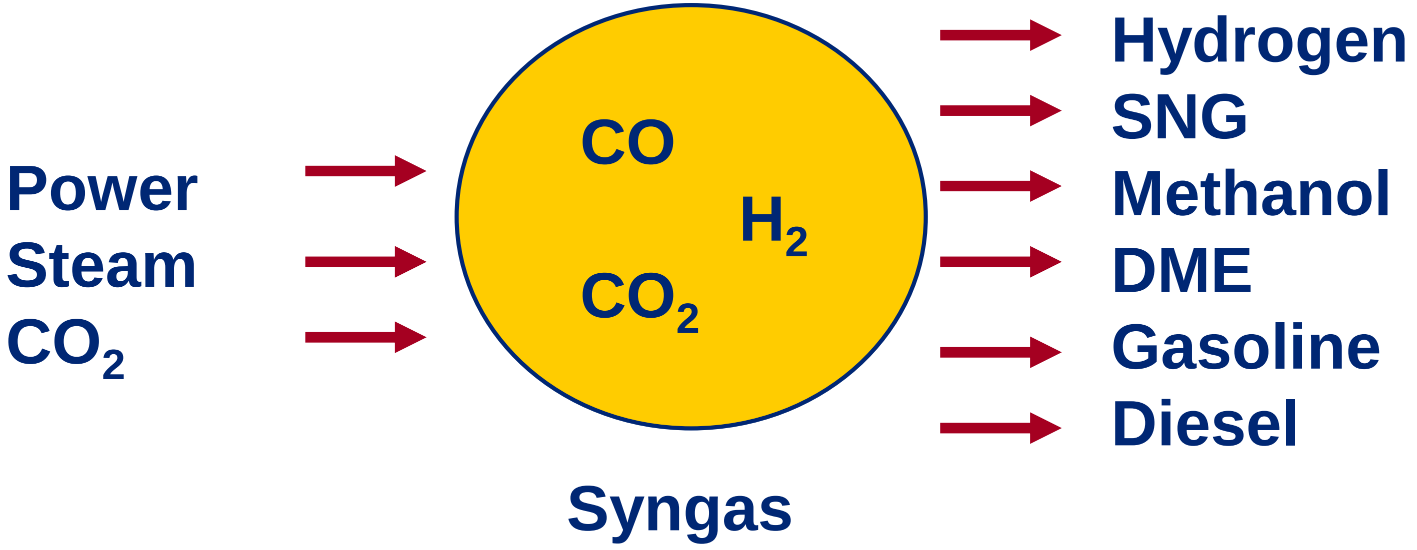
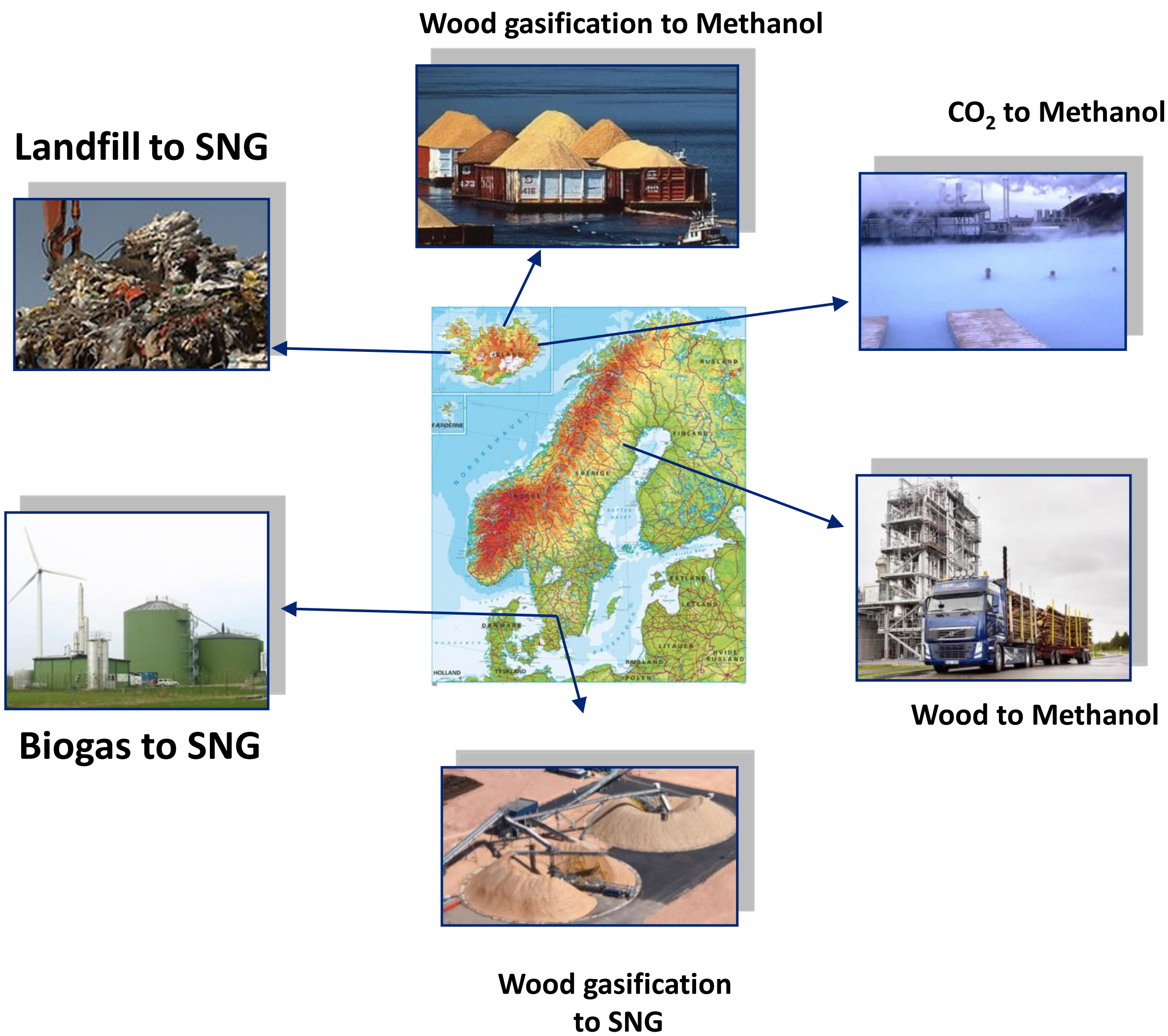
Ea Energy Analyses HALDOR TOPSØE DTU

Is $CO_2$ electrofuels a viable and competitive technology for the Nordic countries?

# Electrolysis



# $CO_2$ Electrofuel Project Sponsored by NER

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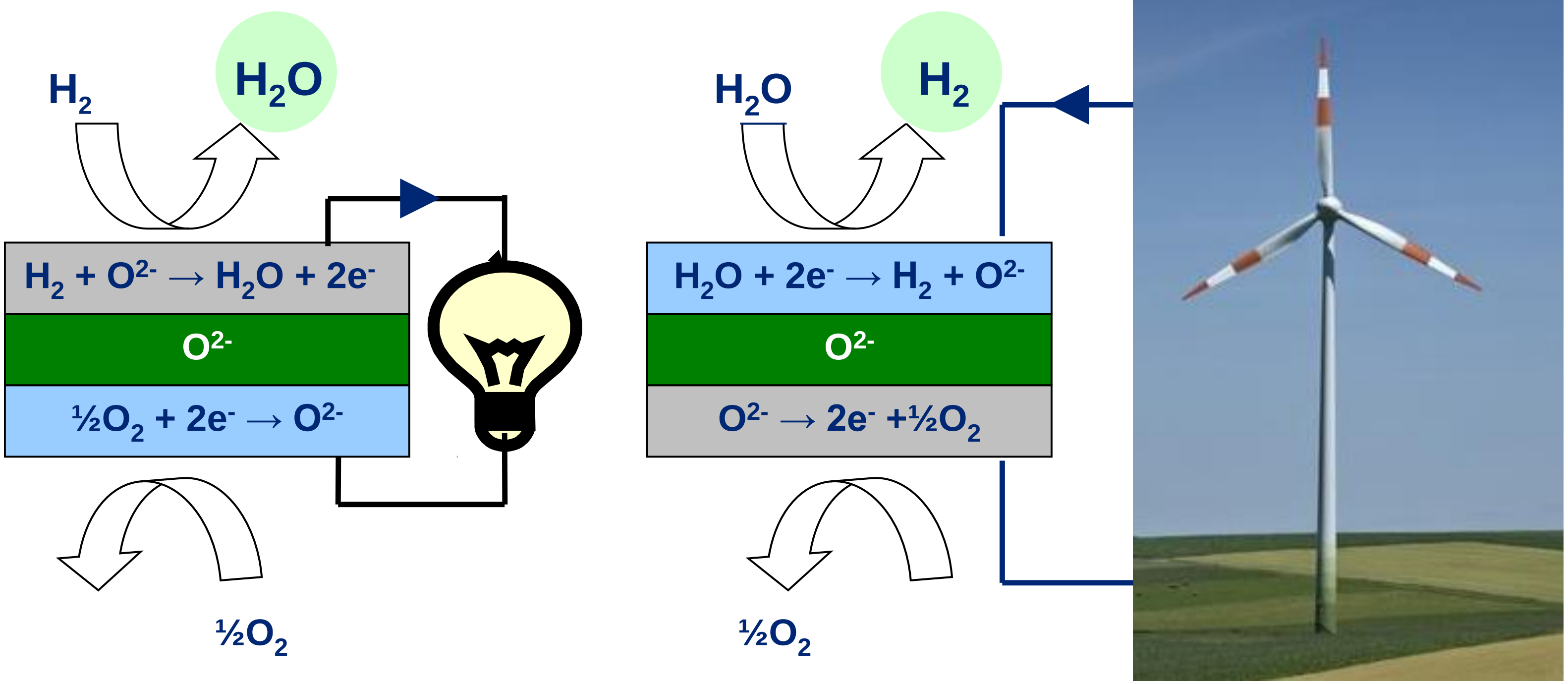
# Fuel Cell and Electrolyser

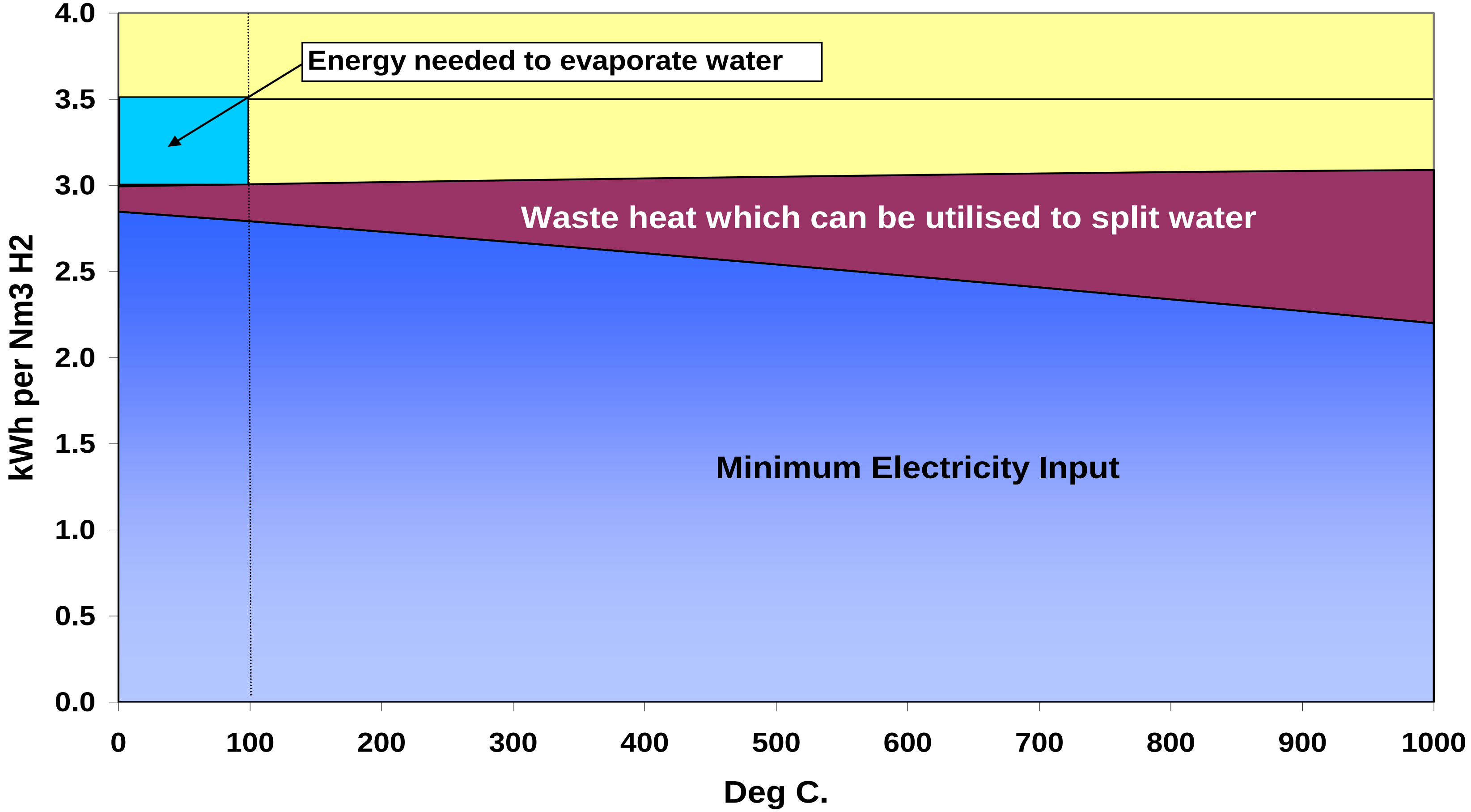
## SOFC

## SOEC




$H_2 + CO + O_2 \underset{SOEC}{\overset{SOFC}{\rightleftarrows}} H_2O + CO_2$ + electric energy ($\Delta G$) + heat ($T\Delta S$)

# SOEC more efficient than present Electrolysers Internal waste heat used to split water

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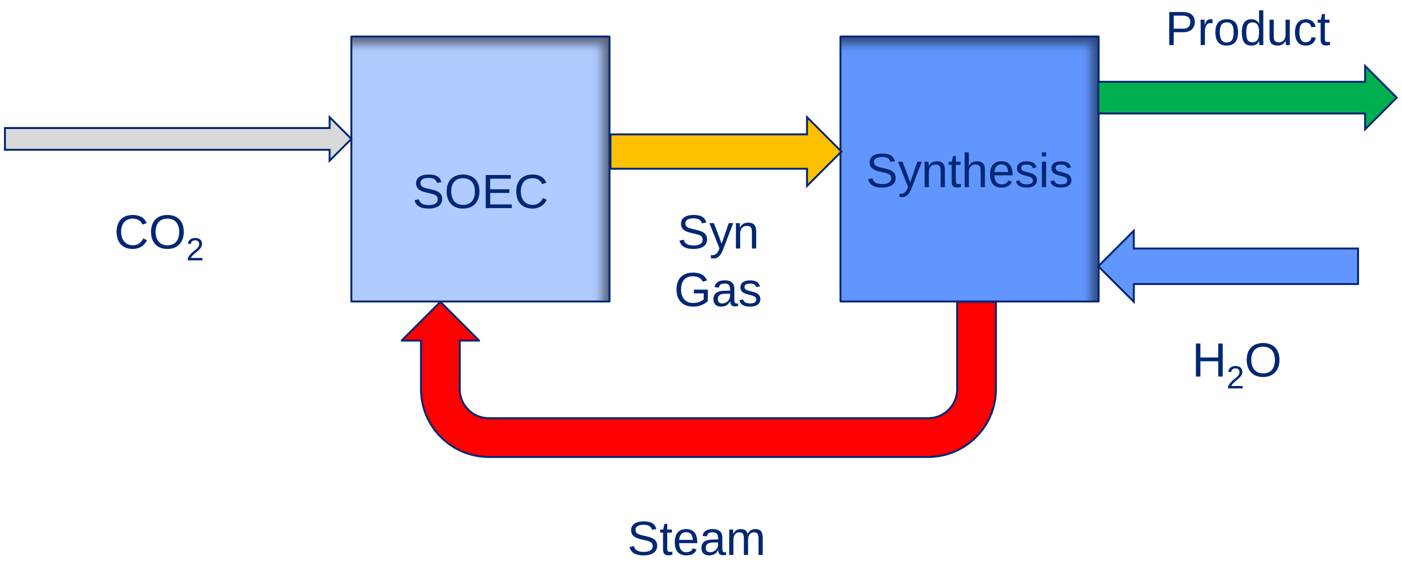
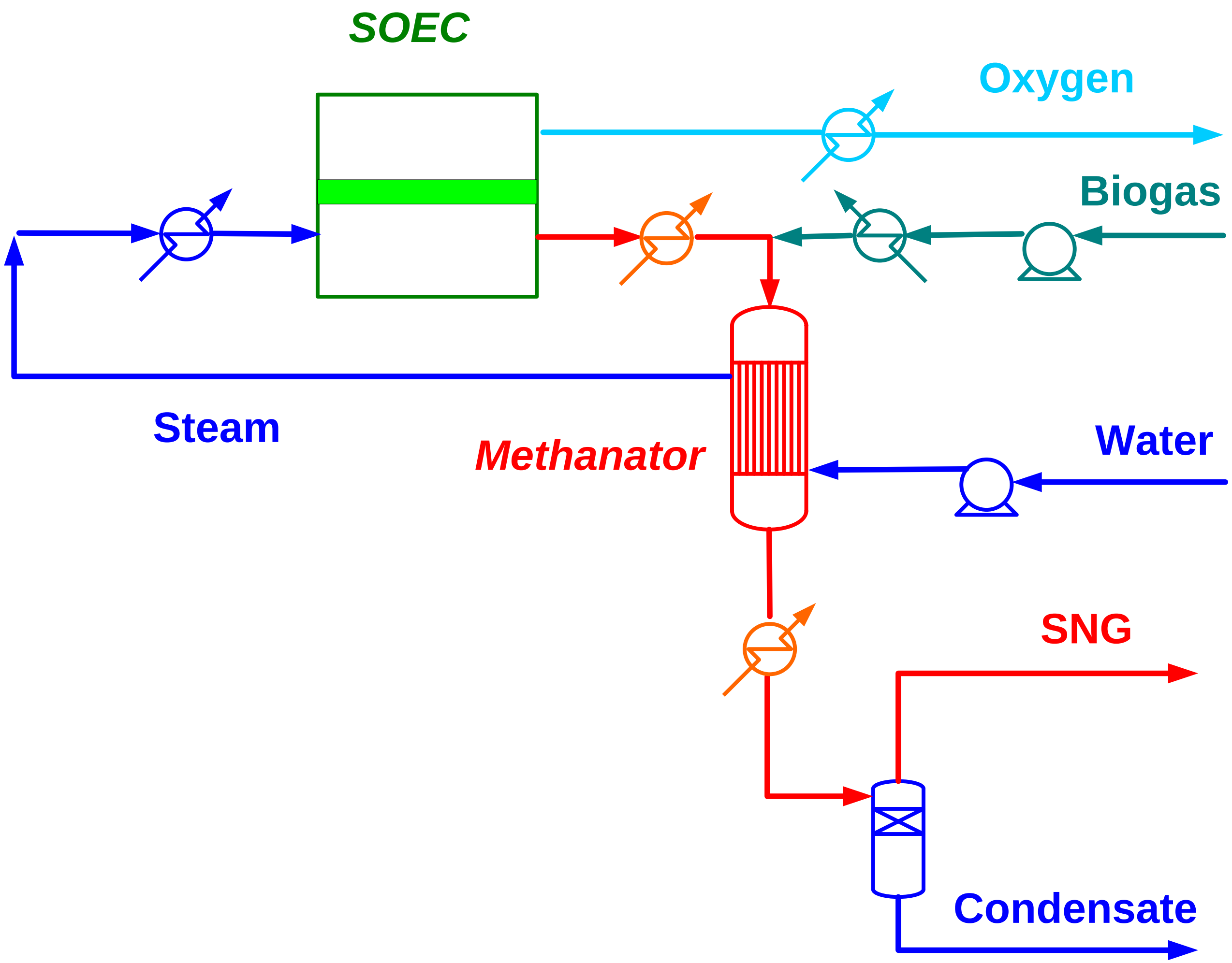
# Synergy between SOEC and fuel synthesis



# Biogas upgrade by means of SOEC

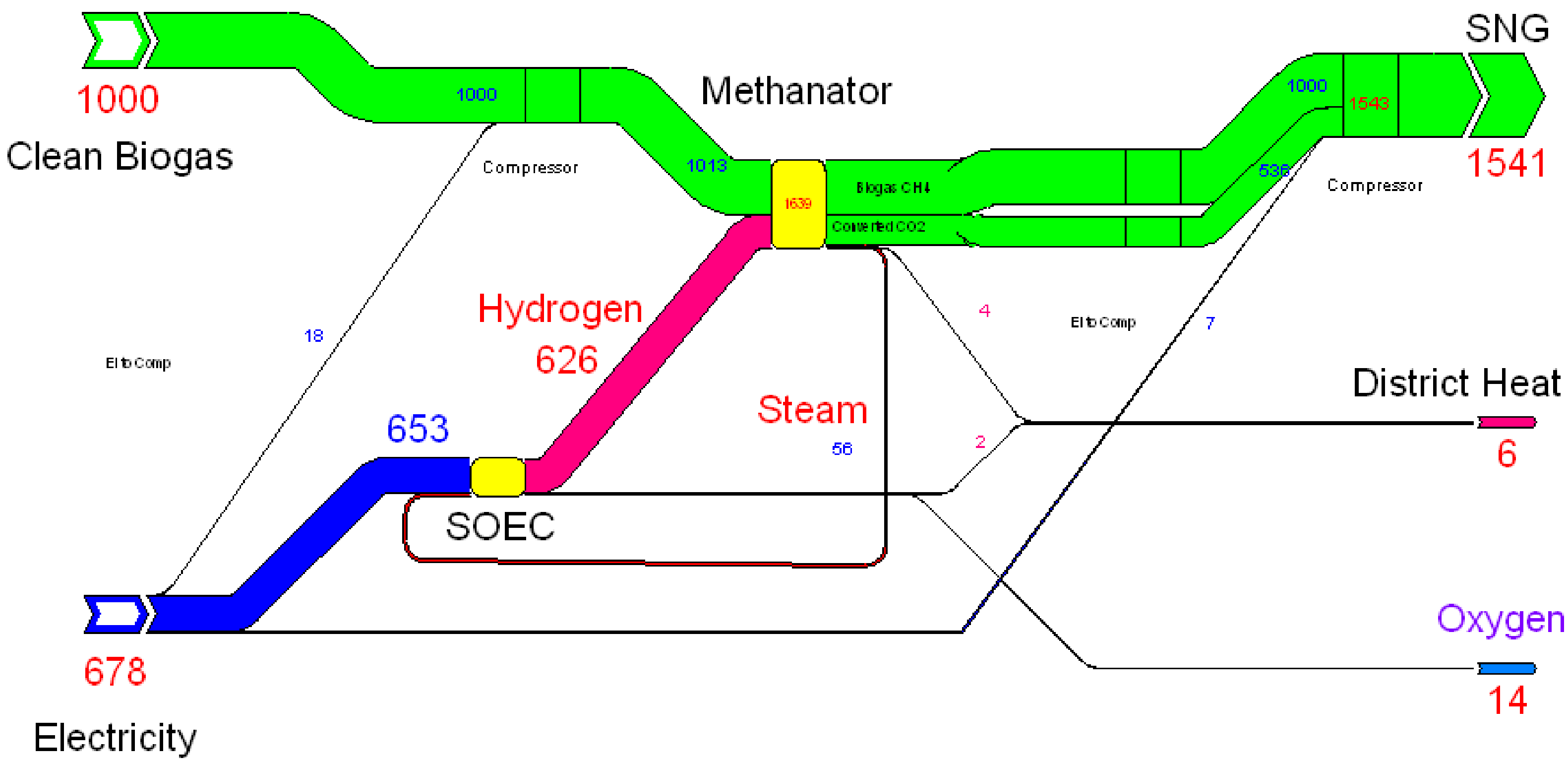
$$CH_4 + CO_2 \;\; + 3H_2O + El \rightarrow 2CH_4 + H_2O + 2O_2$$

# Biogas to SNG via SOEC and methanation of the $CO_2$ in the biogas:

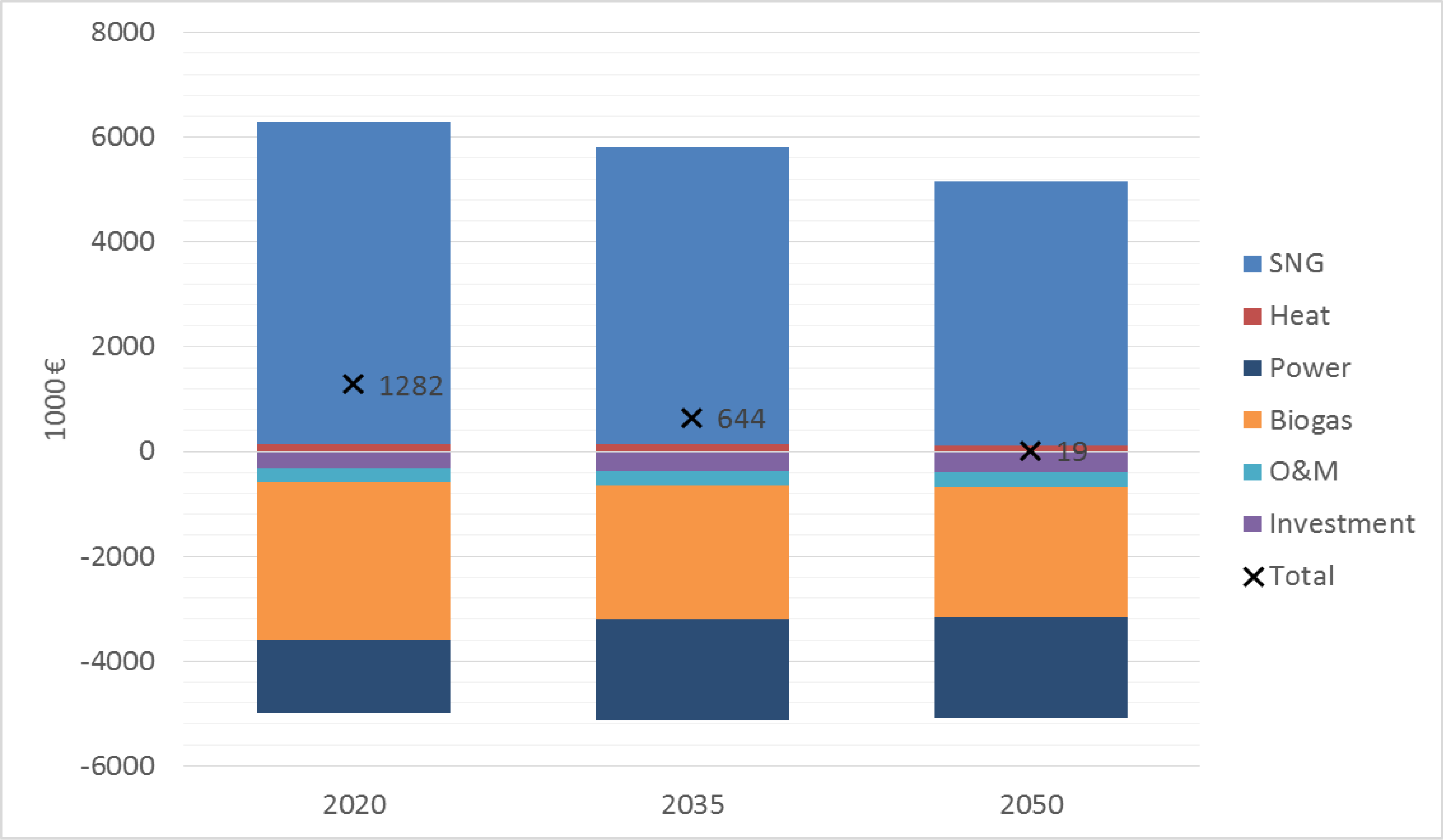


# Exergy Flows in $CO_2$ case

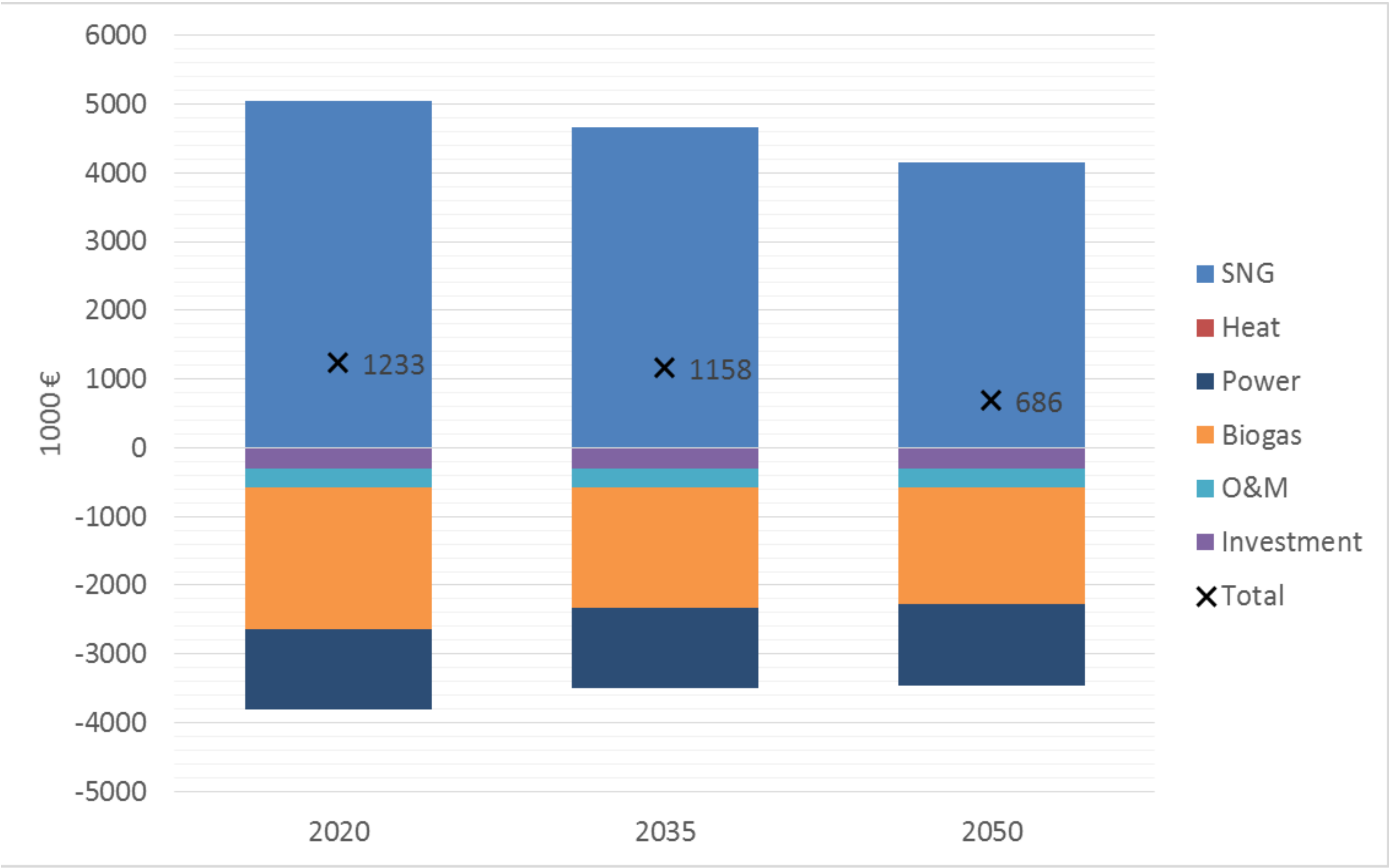
Power to Gas Exergy Efficency 79.8 %



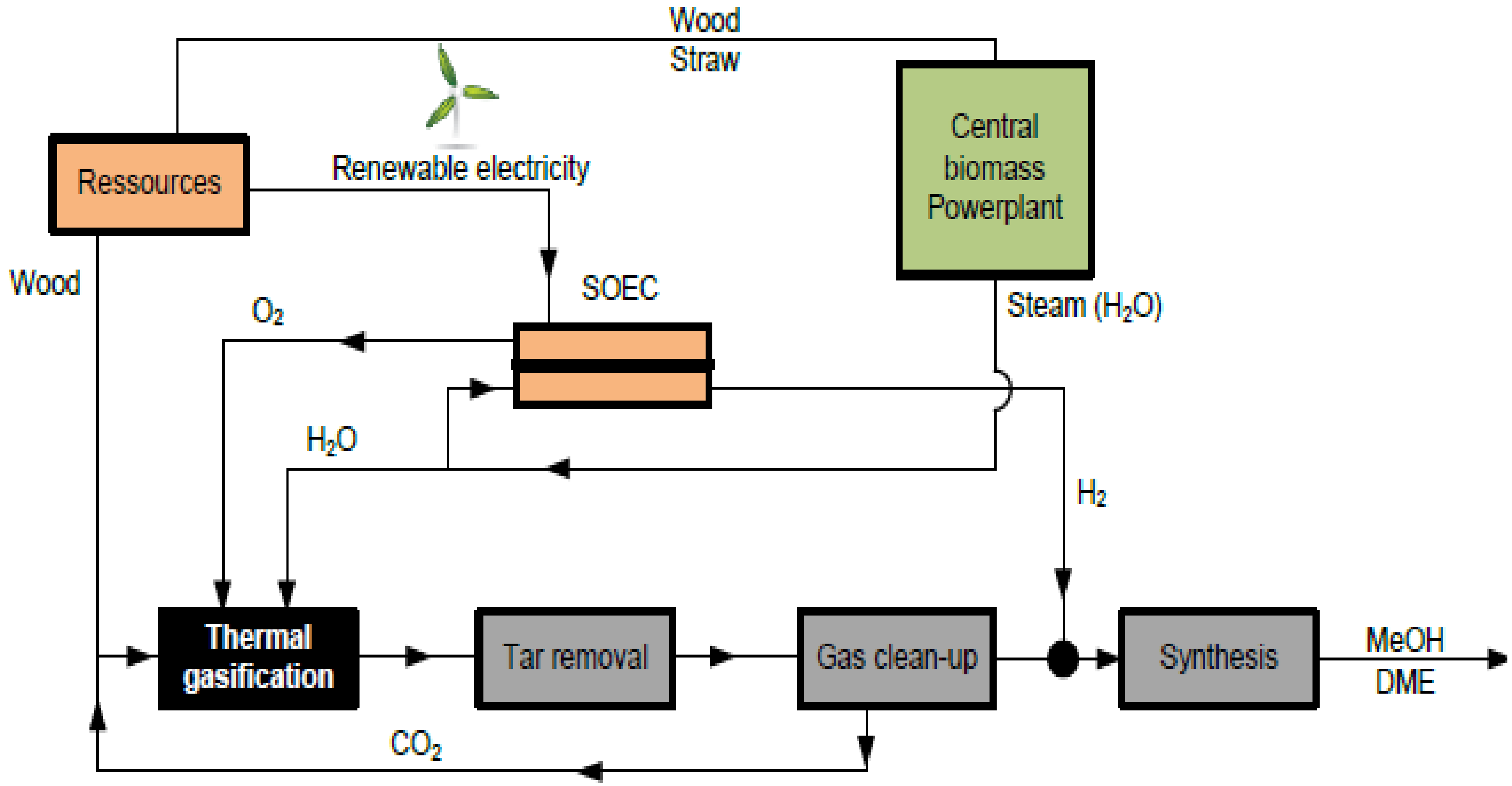
# Economics of Biogas upgrading, Southern Sweden



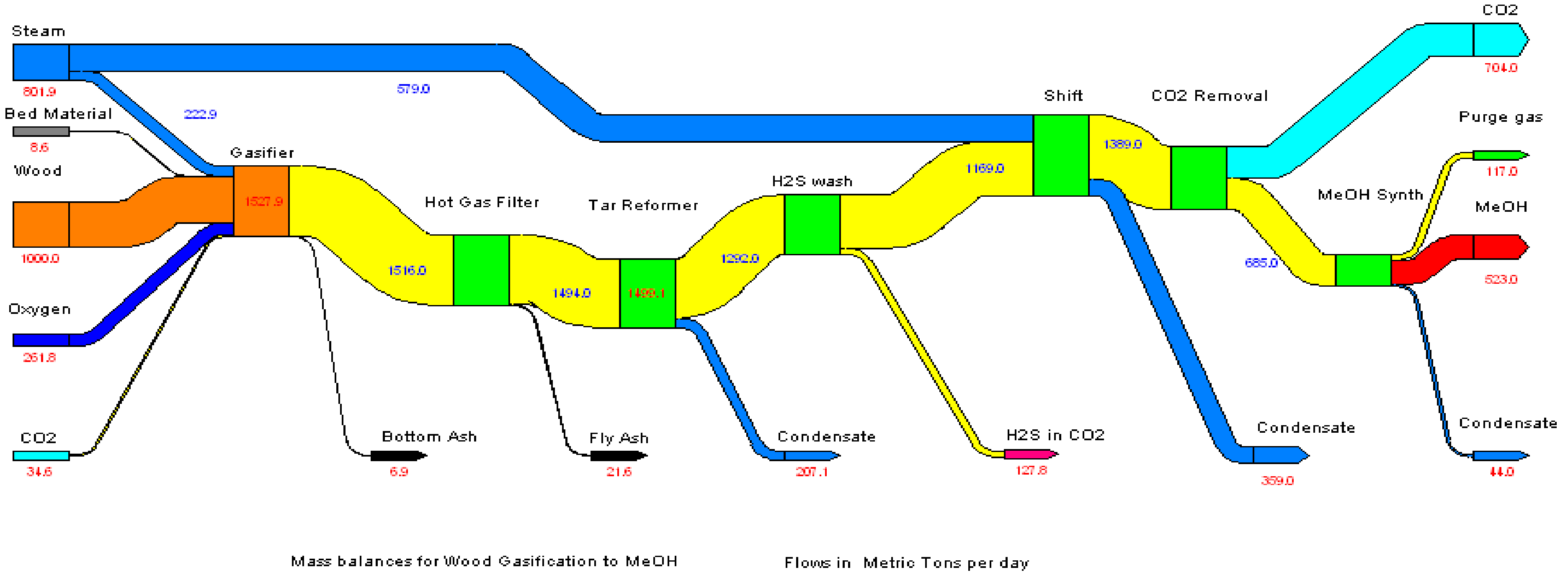
# Economics of Icelandic Landfill gas Upgrading



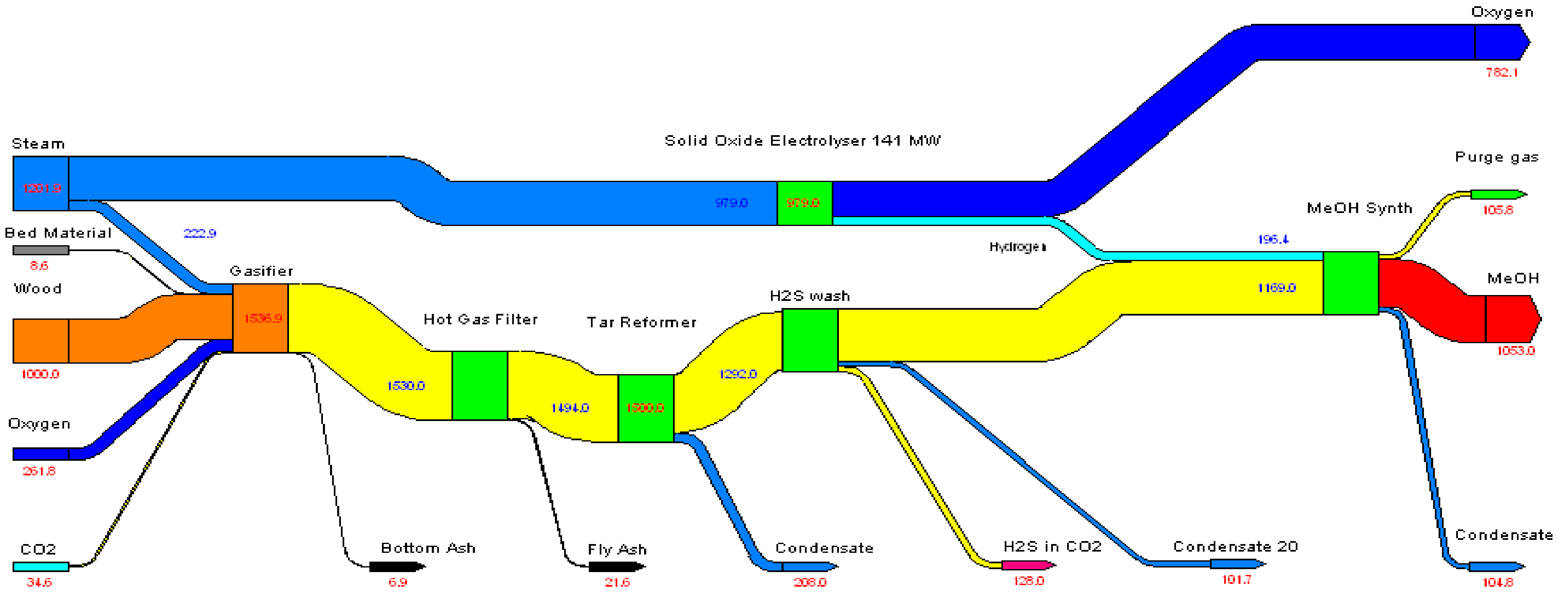
# GreenSynFuel Project



# Mass Flows in Wood to MeOH



# Mass Flows in Wood + SOEC to MeOH




Mass balances for combined Wood Gasification and SOEC to MeOH

Flows in Metric Tons per day

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# Key findings

- Electricity coupled with biomass conversion can be converted with high efficiency (> 70 to 80 %) into liquid or gaseous fuels suited for heavy duty transport
- The biomass resource base for fuel production can be doubled
- $CO_2$ electro fuels will be more expensive than fossil fuels, given the foreseen international $CO_2$ quota prices
- The $CO_2$ electro fuels will, however, be cheaper than biofuels
- There are sufficient resources available in the Nordic region to supply the internal needs for transport fuels using $CO_2$ electro fuels without resorting to import of biomass