Potential Integration between Residual Biogenic Process Resources and Greener Hydrogen Production from Steam Reformers

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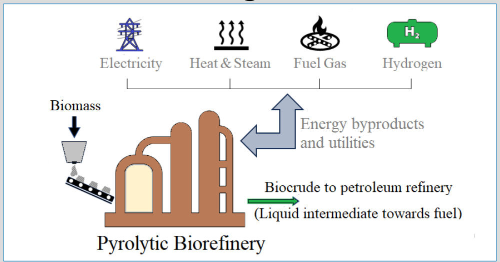
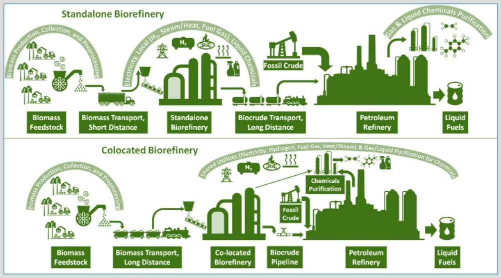
Background



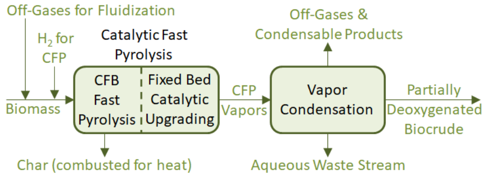
Biomass conversion processes have varying efficiencies towards specific products like liquid fuels; process inefficiencies result in byproducts such as off-gases, heat, and solid residues such as char. The efficient use of these byproducts is key towards getting the maximum sustainability benefits from valuable biomass resources. *Colocation with other industrial facilities that can allow sharing of utilities is important to realize the maximum utilization potential.* For example, there are various utility product options that can make use of heat and off-gases from biomass pyrolysis processes; they include *process heat and steam, hydrogen, fuel gas, and electricity*. Further, there is potential for the use of the off-gases to supplement natural gas feed into steam reformers for hydrogen production. This presentation highlights results from previous analyses on tradeoffs based on utility byproduct choices [1]; maximizing hydrogen production from off-gases is one potential winning strategy. This leads to the question regarding the utilization of these off-gases in existing steam reformers and the process impacts from feeding off-gases. Process modeling of a steam reformer system [2] quantifies those impacts and shows how much off-gas substitution is possible within the limits of an existing design with such an integration strategy.

Standalone / Colocated Biorefineries



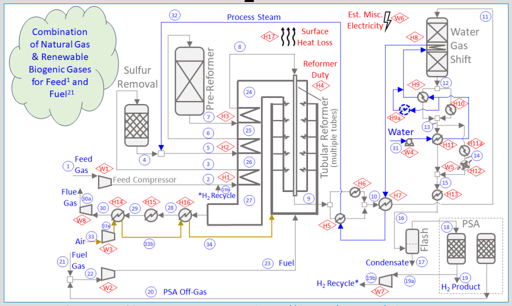
Example Conceptual Process

Catalytic Fast Pyrolysis (CFP) Configuration



Major Inputs	Major Outputs	Utility Integration Options
Woody biomass	CFP Biocrude	Hydrogen
Hydrogen	Heat and steam	Electricity
Electricity	Off-gases	Steam
Other utilities	Chemical coproducts	Fuel Gas

Process Impacts of Off-Gas use as Feed/Fuel for H_2 from Reformers



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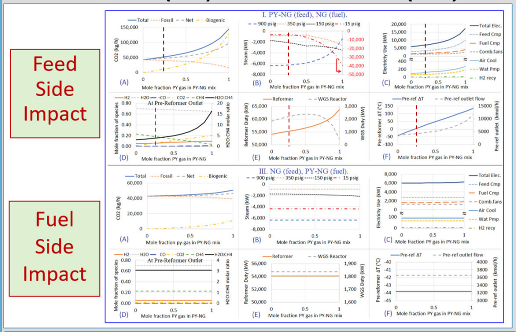
Additional results and details included in this publication

Feed & Fuel Side Process Impacts with Increasing Fractions (0 to 1) of Pyrolysis Off-Gas (PY) in Natural Gas (NG)

Feed Side Impact

Fuel Side Impact

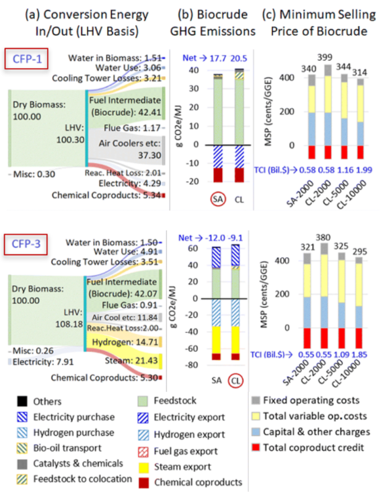


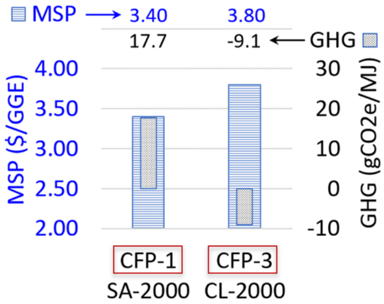
Substitution of fuel side natural gas has minimal process impacts and may be a first step. Up to 25% replacement possible on the feed side within design tolerances [2].

Potential Cost and GHG Benefits of Expanding Options for the use of Excess Heat and Off-Gases

Case: CFP-1
Standalone with only electricity export feasible

Case: CFP-3
Colocated with complete flexibility for utilization of resources



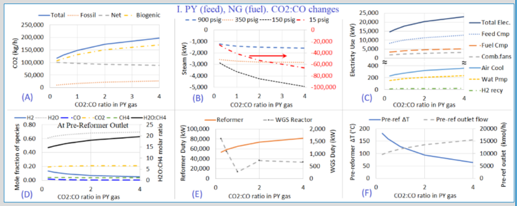


Displacement method used for assessing GHG impacts of energy resources
Abbreviations: SA = Standalone, CL = Colocated, MSP = Minimum Selling Price
SA-2000 = SA 2000 tonnes/day, CL-2000 = CL 2000 tonnes/day

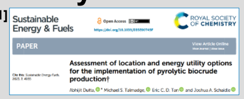
Note the MSP of $2.95/GGE for CL-10000 (colocated 10,000 tonnes/day plant), which is possible via better economies of a larger scale if feedstock is aggregated at a colocated facility from a larger biomass collection radius.

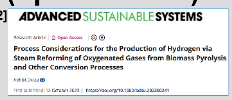
Impacts of making other additional choices are presented in:
Sustainable Energy Fuels, 2023,7, 4955-4966. https://doi.org/10.1039/D3SE00745F

Impact of Poorer Off-Gas Quality (increased CO_2)



Key References (open access)

[1] 

[2] 

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