Introduction

Biomass feedstocks can efficiently be converted to Bio-Synthetic Natural Gas (bio-SNG) using catalytic supercritical water gasification. Major advantages:

- Fuel can be used in the existing infrastructure
- Use of waste biomass (wet, containing lignocellulosic material)
- Recovery of inorganic material: use as a mineral fertilizer
- No drying or distillation steps

Process modeling and energy integration is used to simulate optimized Swiss industrial scale scenarios for manure and wood chips: life cycle assessment is used to assess the associated environmental impacts.

Results

Experimental

Wood before and after processing (complete gasification). Gas composition: 49 vol% CH₄, 43 vol% CO₂, and 8 vol% H₂.

Process modeling

Scenarios investigated: large-scale manure (rail transport, 16 Mtons of manure/year), small-scale manure (no long-range transport, 0.54 Mtons/year), wood (truck transport, 0.14 Mtons/year).

Methodology

Resources - land use

Supply to network

Energy integration + cost based choices among technology alternatives

Ecoinvent data is used for modeling

Life cycle assessment

Primary fossil energy source | Imbedded fossil energy [%]
-----------------------------|-----------------------------
Crude oil                    | 0.2                        | 5.5
Natural gas                  | 1.0                        | 1.6
Coal                        | 3.4                        | 4.1
Total                       | 6.8                        | 7.5

Life cycle assessment

Process efficiency (LHV basis) for different production scenarios and for the different heat generation scenarios (turbine or burner)

Conclusions

Process modeling - Meeting internal heat requirements is done most efficiently using a burner + Rankine steam cycle. Thermal efficiencies of 60% are obtained for manure and of 75% for wood.

LCA - About 10% imbedded fossil energy for the supercritical water gasification processes; in comparison, the US corn grain to ethanol process has over 40% of imbedded fossil energy just in the form of natural gas².

Avoiding emissions from spread manure ⇒ very beneficial for manure. Carbon footprint is of -0.6 Kg CO₂eq/MJ B2NG.

Treating a waste and reducing the emissions associated to its use ⇒ a strong environmental performance for the manure conversion processes .