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Life Cycle assessment of the Production of Hydrogen and Transportation Fuels from Corn Stover via Fast Pyrolysis

Abstract

The goal of this project is to perform a life cycle assessment (LCA) and quantify the environmental impacts of the production of hydrogen and transportation fuels from the fast pyrolysis of corn stover and upgrading of the resulting bio-oil.

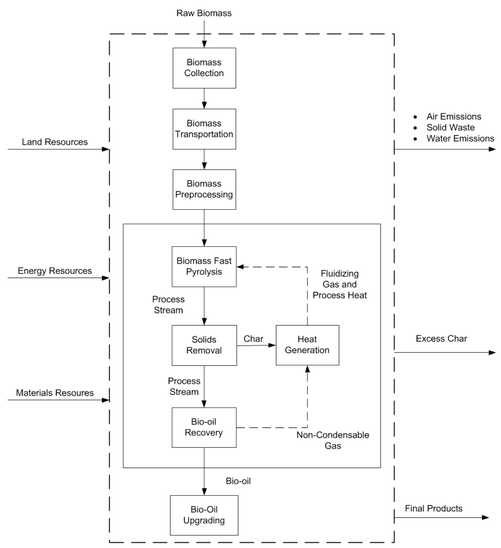
Input data for this analysis come from Aspen Plus modeling, a GREET model database and a U.S Life Cycle Inventory Database. SimaPro 7.3 software with Eco-invent 2.2 data base is employed to estimate the environmental impacts.

This study finds that Global Warming potential for this scenario is **88%** and **94%** lower than for petroleum-based gasoline and diesel fuel (2005 basis), respectively.

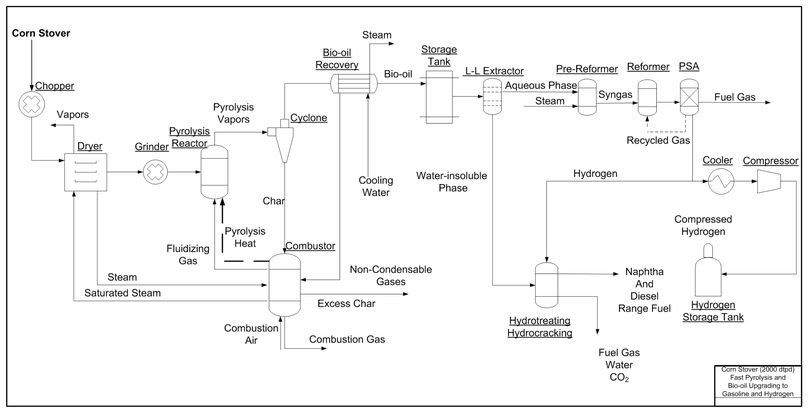
Methodology

Goal and scope → Inventory → Impact assessment → Interpretation

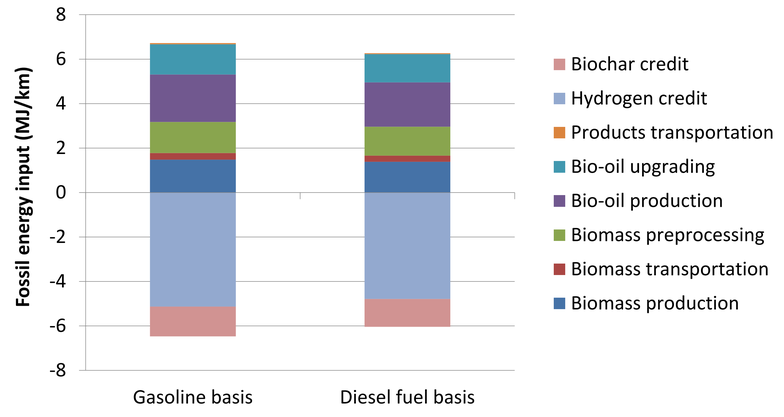
- Indirect land use change is not included
- Electricity from fuel mix in the Midwest region of the U.S
- Corns stover is with 25% moisture and dried to 7% via pretreatment
- Hydrogen is set as the avoided produce with credits
- IPCC 2007 GWP 100a, TRACI 2 method
- Cumulative Energy Demand (CED)

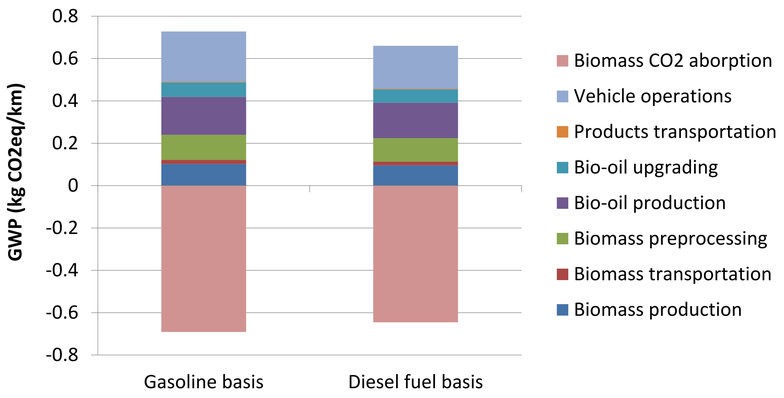


Process



Results

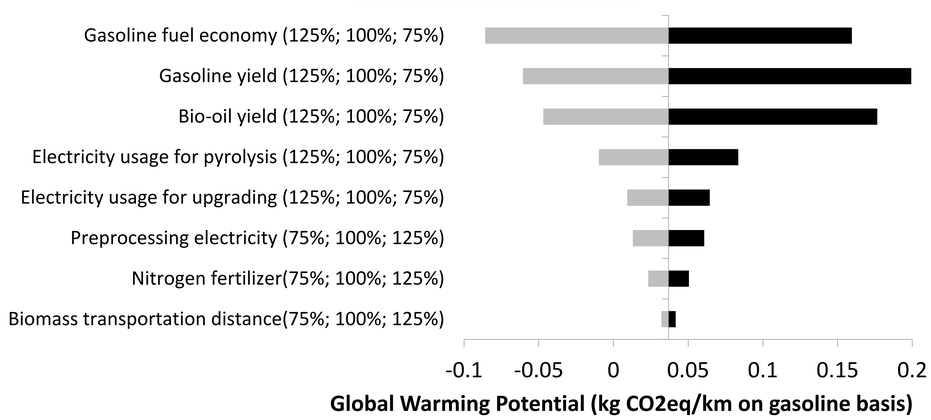




Comparison

Scenario	GHG emissions (kg CO_2eq/km)	Fossil energy (MJ/km)
Pyrolysis-based gasoline for the current study (co-production of hydrogen and gasoline)	0.037	0.25
Case A: Pyrolysis-based gasoline from forest residue (external hydrogen)	0.117	1.7
Case B1: Pyrolysis-based gasoline from corn stover (hydrogen from bio-oil reforming)	0.0422	0.4
Case B2: Pyrolysis-based gasoline from corn stover (hydrogen from natural gas steam reforming)	0.0975	1.22
Case B3: Pyrolysis-based gasoline from forest residue (hydrogen from natural gas steam reforming)	0.115	1.5
Case C: Ethanol via gasification	0.15	1.2
Case D: 2005 petroleum-based gasoline	0.3	4.5

Sensitivity Analysis



Conclusions

- Net fossil energy input is 0.25 MJ and 0.23 MJ per km traveled for a light duty vehicle fueled by gasoline and diesel fuel, respectively.
- In the overall system, bio-oil production has the largest fossil energy input.
- The Global Warming Potential (GWP) is 0.037 kg CO2eq and 0.015 kg CO2eq per km traveled for a vehicle fueled by gasoline and diesel fuel, respectively.
- Vehicle operations contribute up to 33% of the total positive GWP.
- The GWPs in this study are **88%** and **94%** lower than for petroleum based gasoline and diesel fuel (2005), respectively.

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https://www.cset.iastate.edu/tcbiomass2013