An Investigation of the Process and Applications of Biomass Gasification

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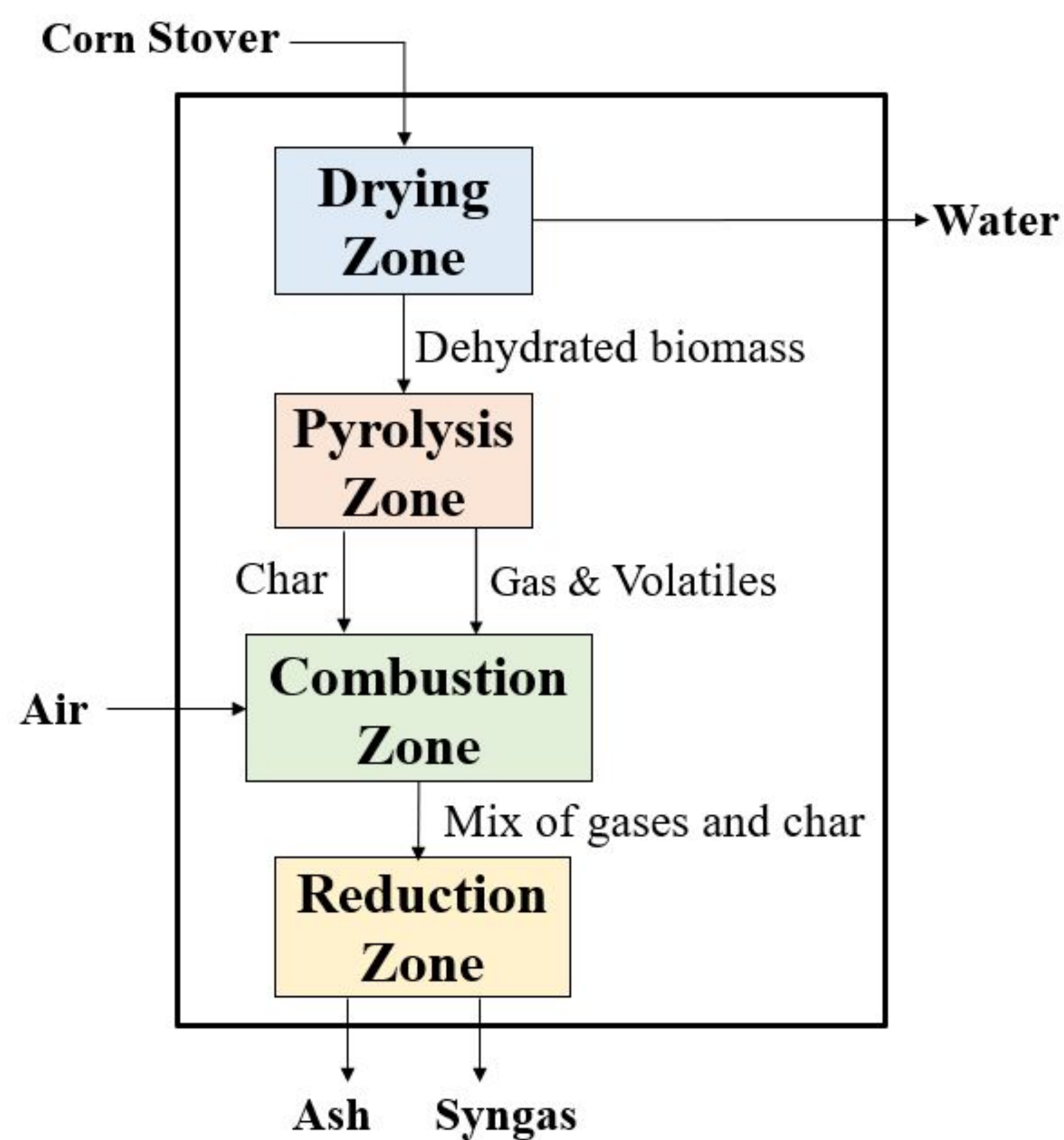**NC STATE UNIVERSITY**

1. Project Motivation and Goals

To investigate the feasibility of biomass gasification as part of a necessary shift towards renewable energy sources. From this motivation, the group worked to model a biomass gasification plant with the following goals:

- Select a feedstock and plant location
- Develop a functioning ASPEN simulation
- Perform an economic analysis
- Perform an environmental analysis

2. Process Background

Biomass is organic material, such as agricultural residues, animal manure, or wood residues.

Fixed bed Downdraft Gasification Process:

Corn Stover → **Drying Zone** → Water
Dehydrated biomass
Pyrolysis Zone
Char / Gas & Volatiles
Air → **Combustion Zone**
Mix of gases and char
Reduction Zone
Ash / Syngas

The product syngas can be used for heating, electricity generation, or making other fuels like ethanol.
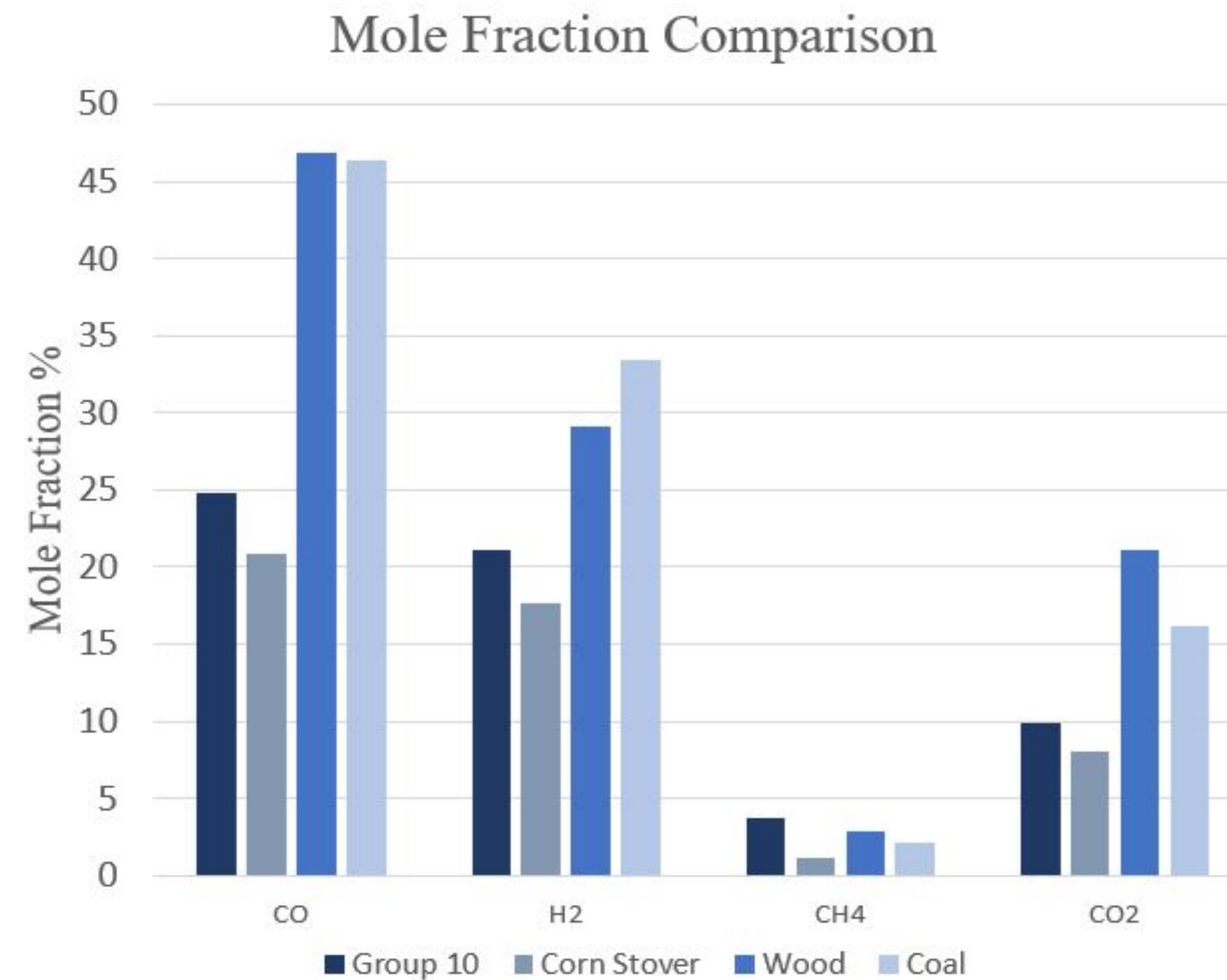
3. Feed and Location

The proposed plant is located in Litchfield, Minnesota.
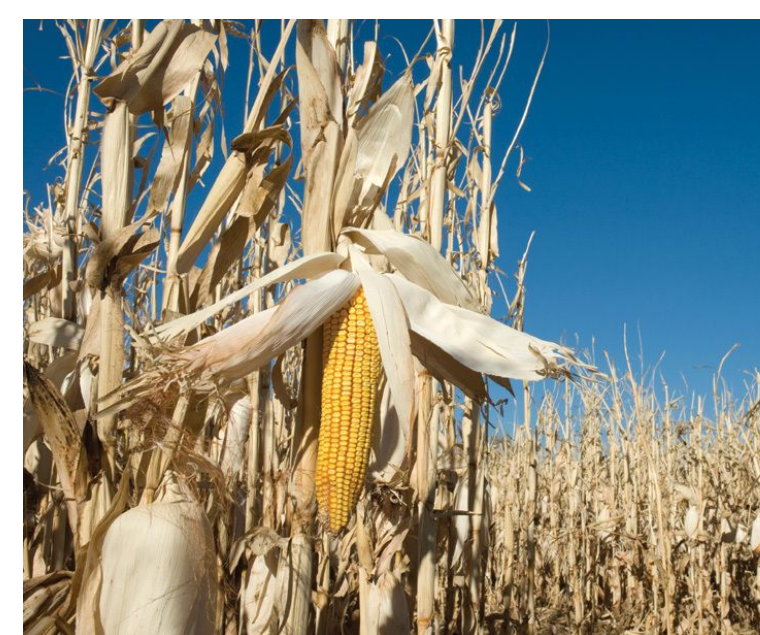
Corn stover was chosen as the feedstock due to its abundance and low moisture content.
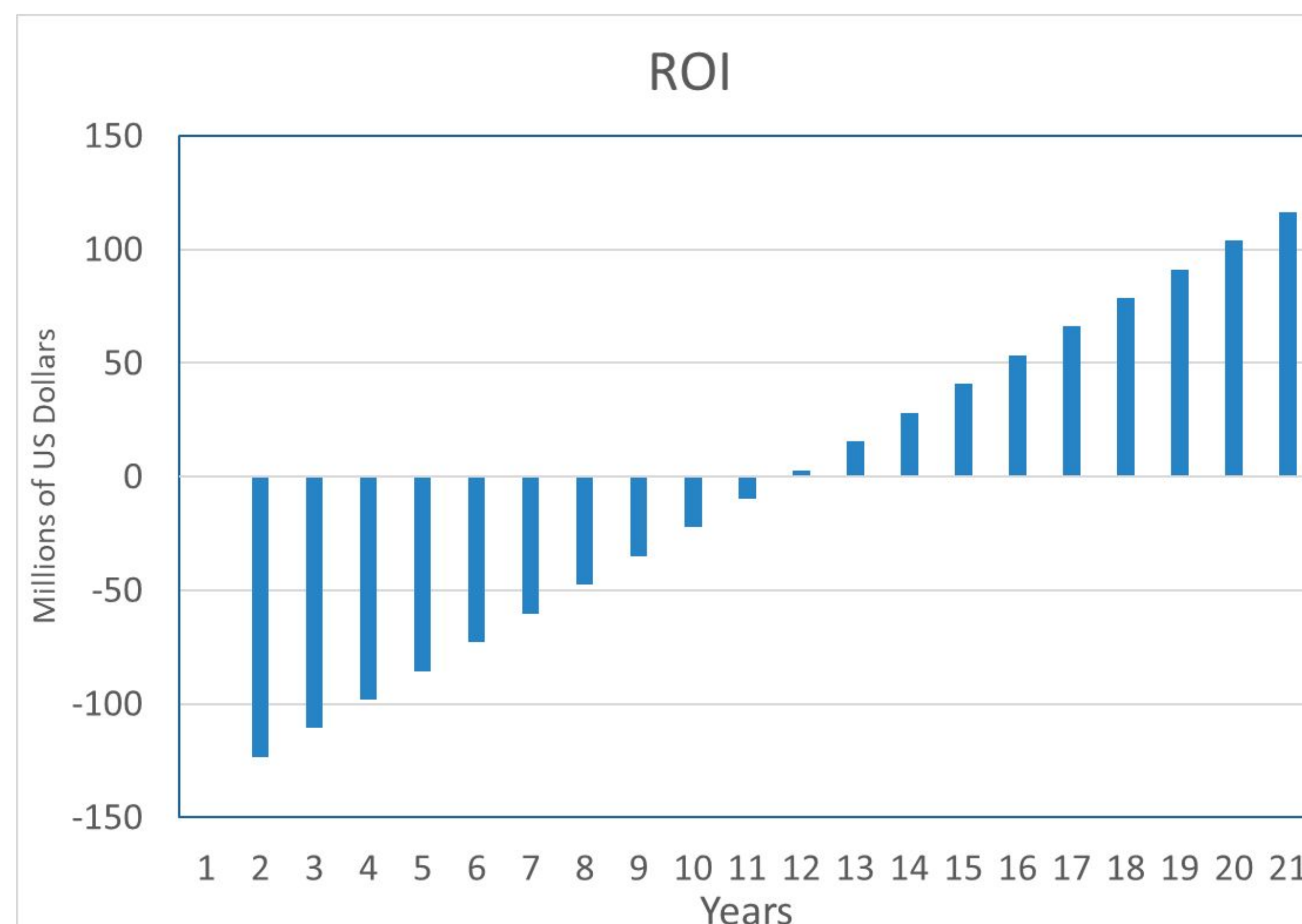

4. ASPEN Results vs. Industry

Mole Fraction Comparison — Mole Fraction % vs. CO, H2, CH4, CO2

Legend: ■ Group 10 ■ Corn Stover ■ Wood ■ Coal

5. Economic Analysis

ROI — Millions of US Dollars vs. Years (1–21)

	Operating Labor	Raw Materials	Utilities	Facility and Equipment
Cost	$320,000	$360,000	$310,000	$350,000

6. Plant Emissions

Pollutant	kg/yr
Lead	0.00 (less than 1 g)
Volatile organic carbon	4.65
CO	71.08
NO_x	84.62
Particulate matter	6.43
SO_x	0.51
CH_4	1.95
N_2O	1.86
CO_2	101546.74

An environmental analysis of the emissions produced in the process was conducted with a GREET simulation.

7. Conclusion

- ASPEN results are comparable to syngas compositions found in industry using corn stover.
- The plant is profitable and can expect 100% return on investment during the duration of year 20.
- The negative environmental impacts of the plant are outweighed by the benefits of creating renewable energy.
- In its current state, production of the plant would not be recommended. Further investigation is required to make a final conclusion.

8. Acknowledgements

9. Sources

All sources can be found by scanning the QR Code here: