

Techno-economic and life cycle analysis of biochar amended Anaerobic Digestion of animal manure for Renewable Natural Gas (RNG) production



Md Mosleh Uddin, Zhiyou Wen, Mark Mba-Wright
Iowa State University

Background

Anerobic Digestion is challenging because of:

- Higher capital investment costs
- Frequent digester failure, low biogas yield
- Lower prices of fossil-based energy sources
- Lack of policy support

Possible Solutions:

- Enhance the yield
- Produce higher value-added products
- Couple multiple biorefineries
- Reduce supply chain costs
- Multiple revenue streams



Impact of Biochar Addition on AD

- Increases biogas yield
- Adsorbs inhibitory products
- Increases digester buffering capacity
- Improves electron transfer among microbes
- Provides support for microbial colonization

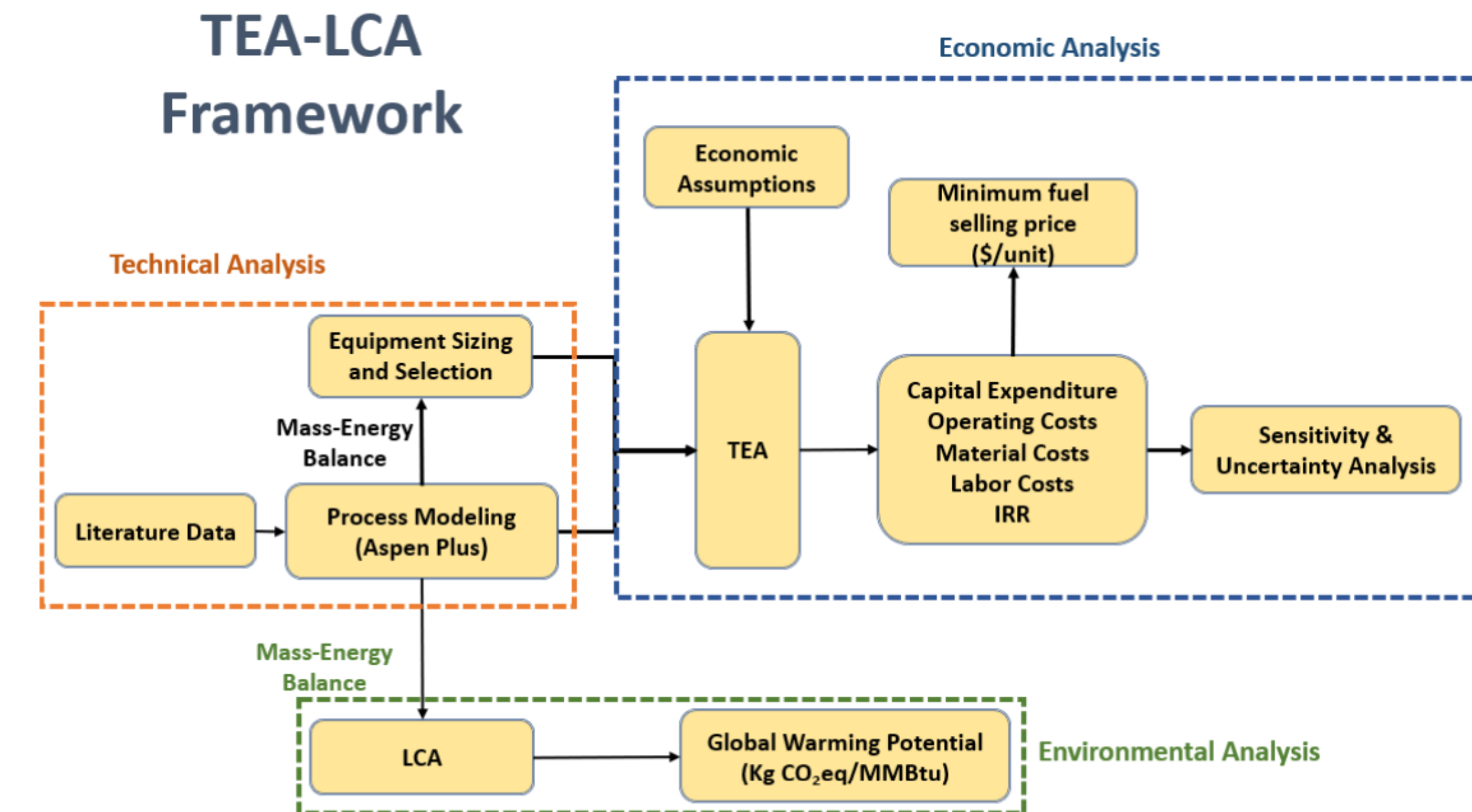


Research Questions?

- Is biochar addition economically viable?
- What is the net environmental impact of biochar addition?

Methods

TEA-LCA Framework



Results

Biochar addition to AD-RNG reduces minimum fuel selling price up to 22%

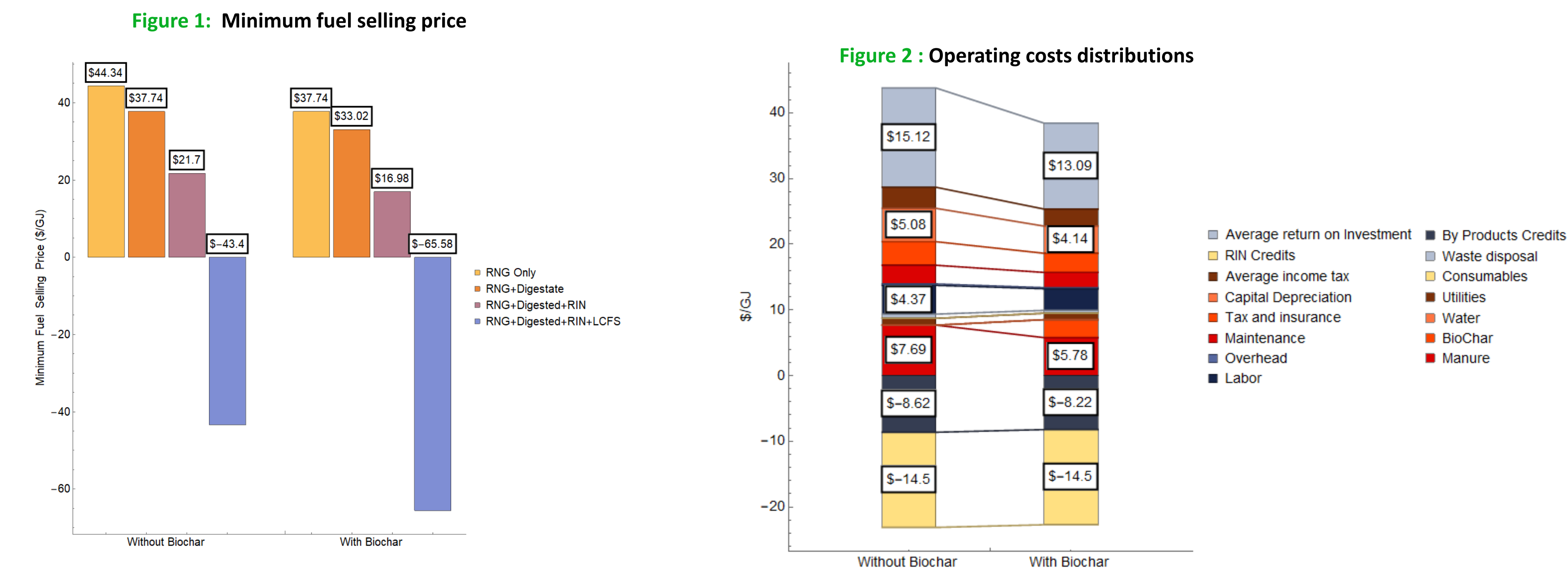


Figure 2: Operating costs distributions

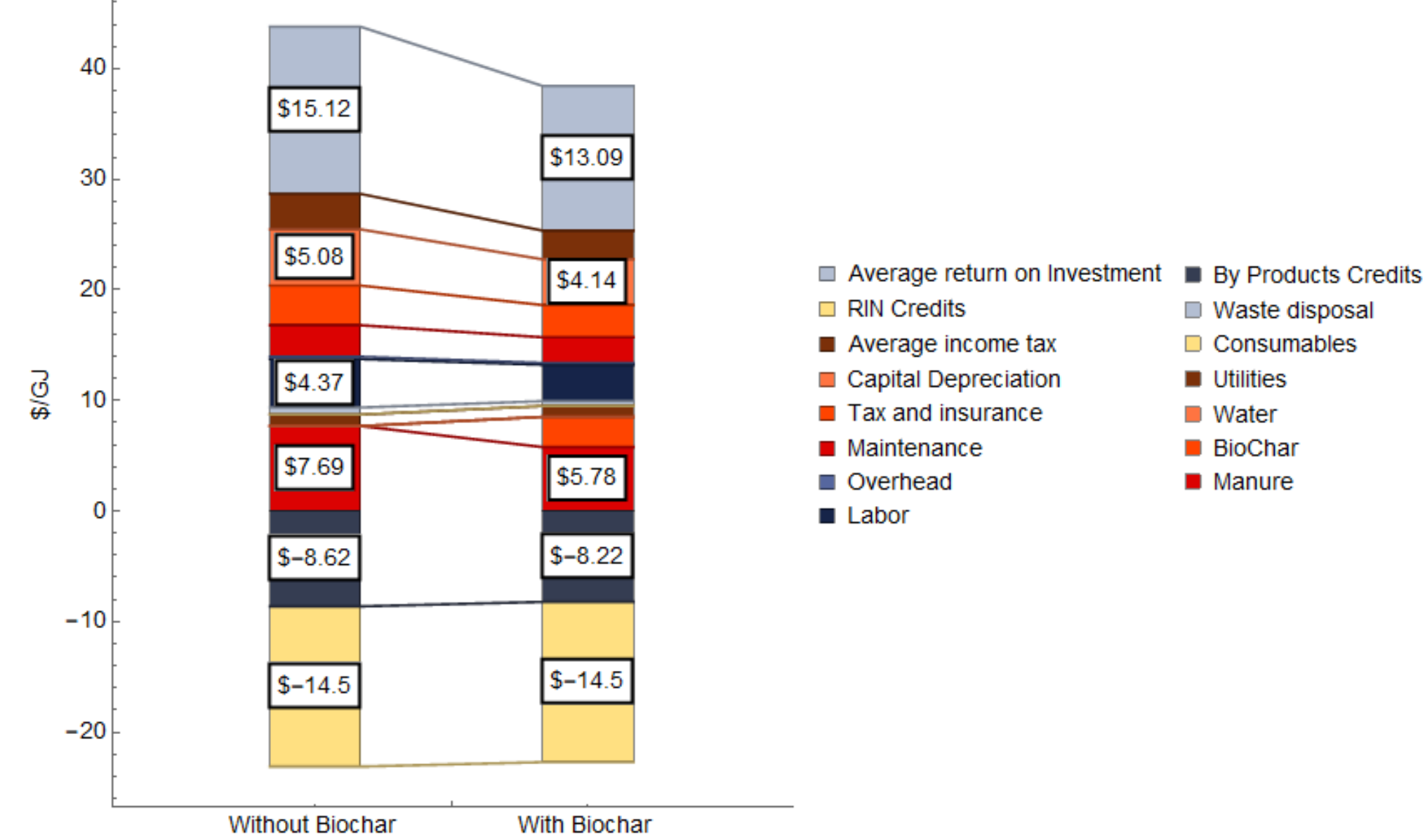


Figure 3: Capital costs distributions

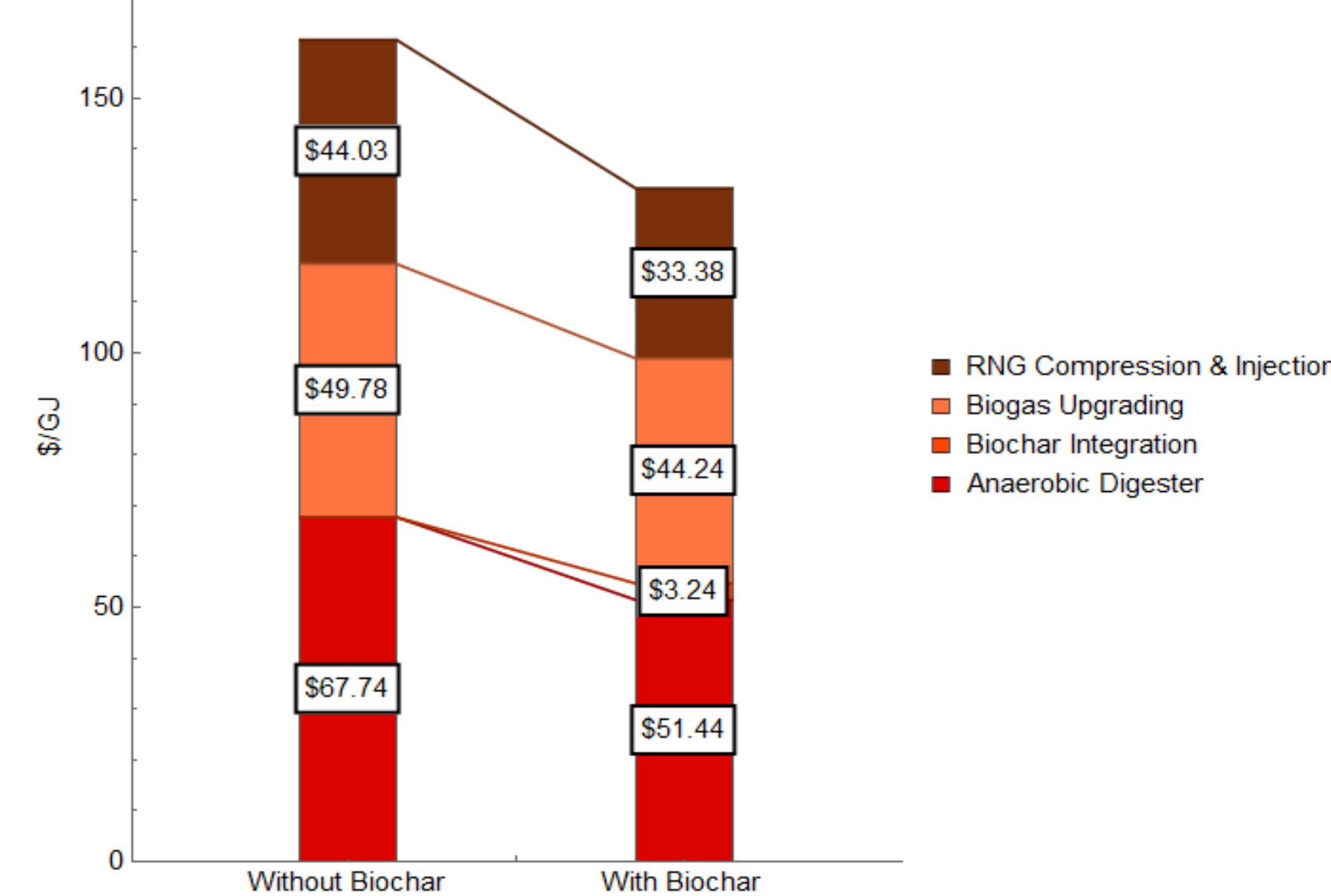
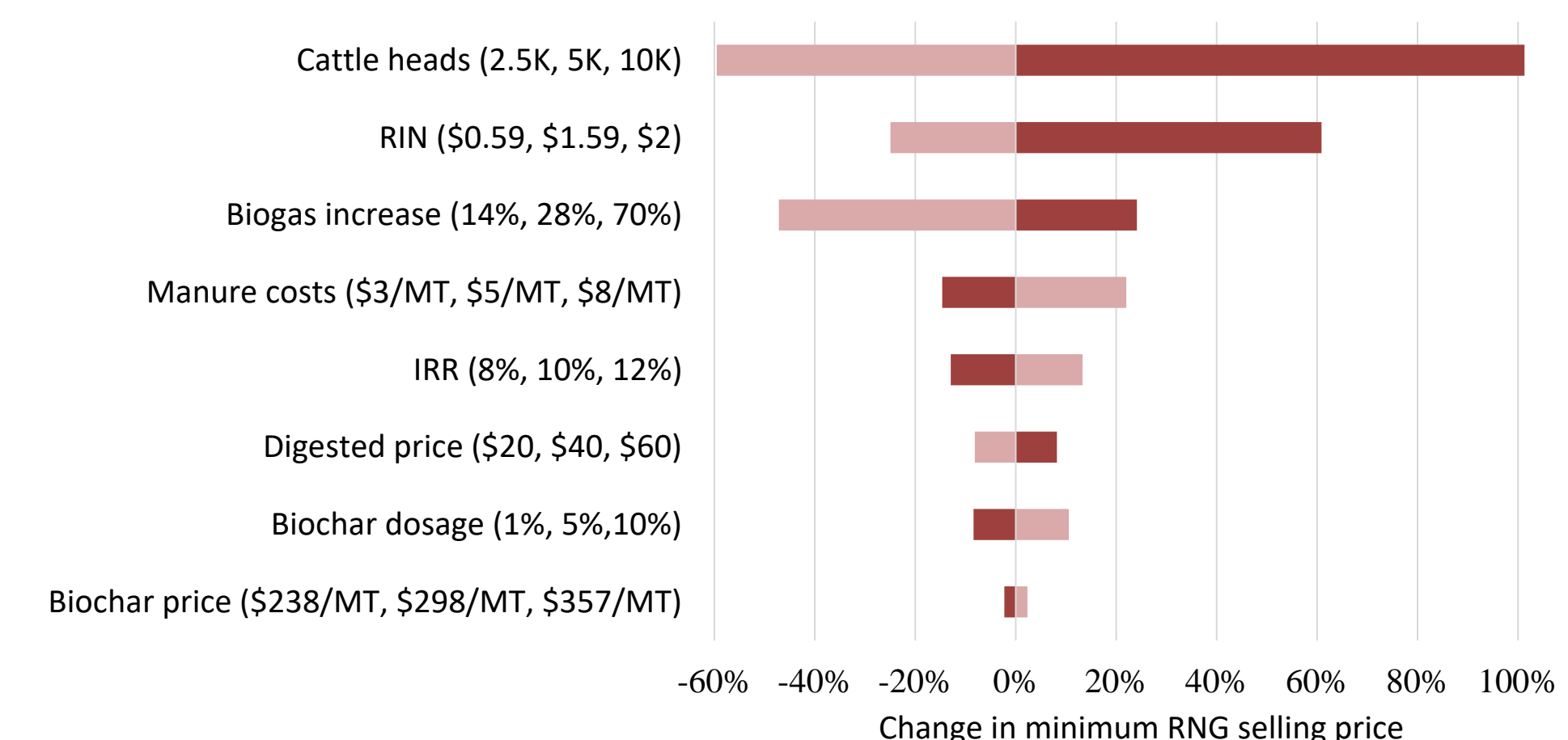
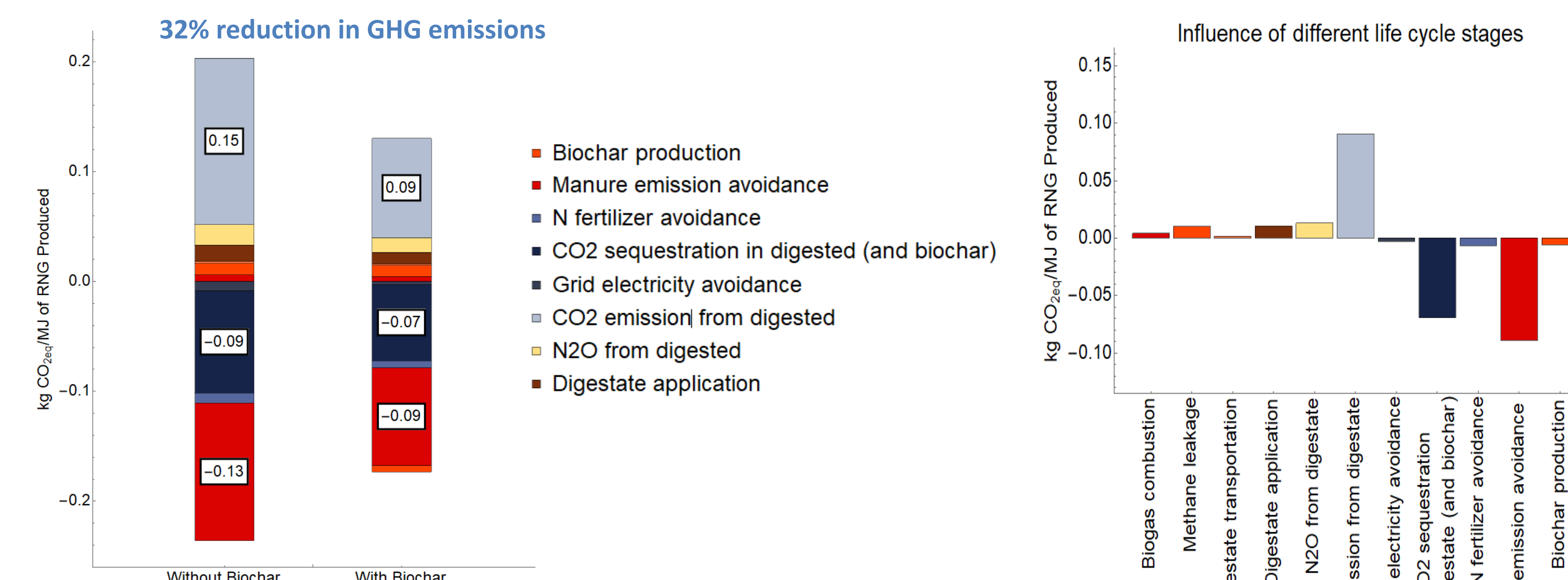


Figure 4: Sensitivity of the economic parameters

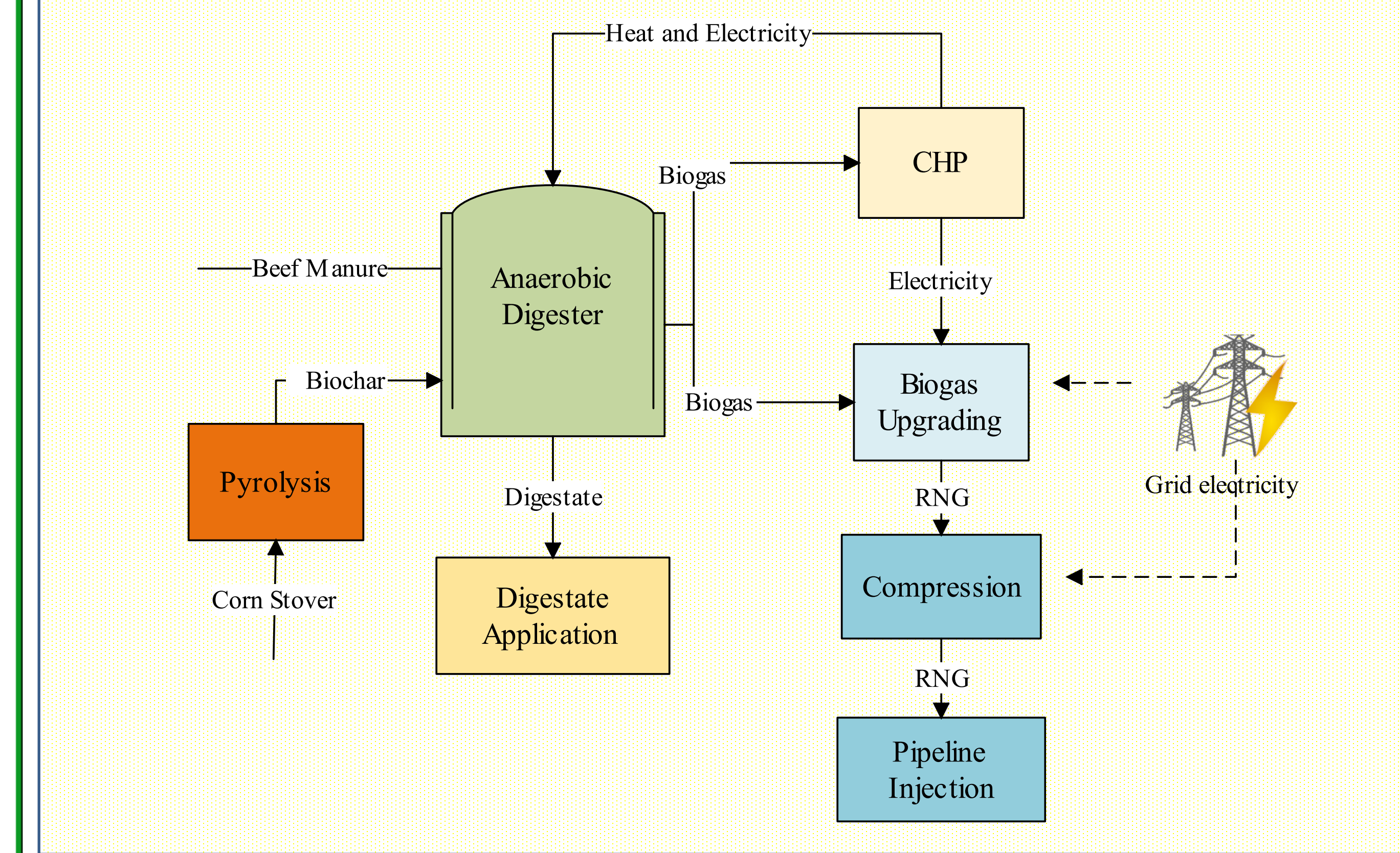


Biochar addition reduces GHG emissions by 32%

Figure 5: GHG emission reduction for biochar addition into AD



AD-RNG Pathway



Conclusion

- Biochar addition can reduce RNG selling price by 12 -22%
- Increased capital and operating costs for biochar addition are offset by the increased biogas yield
- Farm size is the most influencing factor followed by RIN credit
- Federal and state level incentives are the deciding factor for economic viability

Limitations

- Data gaps:
- Lack of generic kinetic model
 - No consensus on the real mechanism
 - Only lab-scale data are available
- Bottlenecks:
- High capital costs for RNG compression & distribution
 - Farm size
- Market barrier:
- No established market for biochar and byproducts
 - Valuation of biochar added digestate is not clear

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For additional information



Contact Information:

Md Mosleh Uddin muddin@iastate.edu | Zhiyou Wen wenz@iastate.edu | Mark Mba Wright markmw@iastate.edu