Techno-Economic Analysis on Biogas Utilization in Refuse Power Plants (DE-FE0032194)

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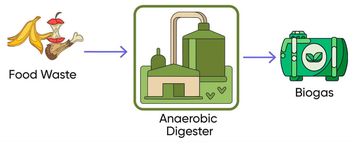
Opportunity

- Use retrofitted power plant to generate greener energy
- Co-firing (waste coal/biogas) integrated with CO_2 capture can achieve net negative carbon emissions
- Inflation Reduction Act Section 45Q offers $85/tonne-$CO_2$ sequestered with sufficient GHG Abatement [1]

Present Situation

- Determine if 80MW-net powerplant combusting waste coal could benefit from co-firing biogas with a CO_2 capture system
- Retrofit process implements turbine to co-fire biogas, generating power, reducing waste coal usage



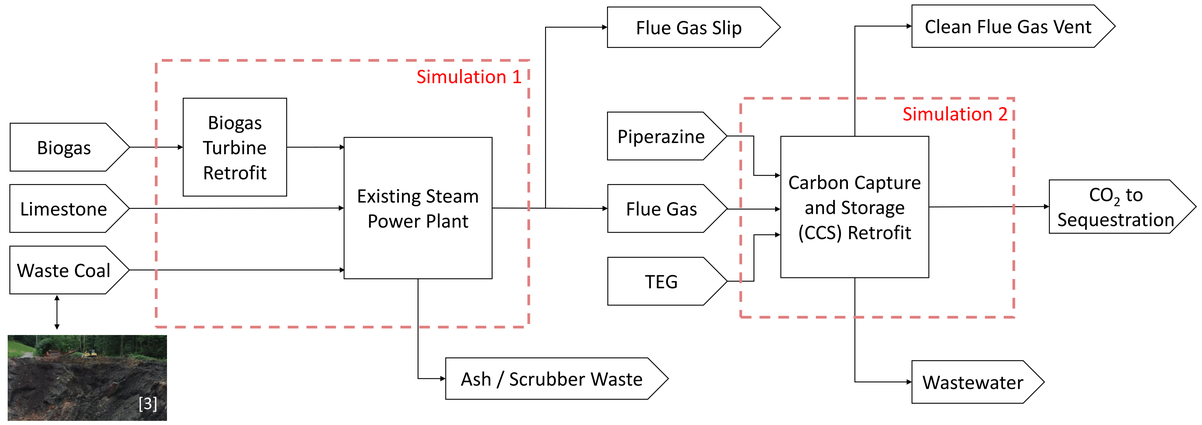
[2]

Process Description

Investigate configuration of fuel ratios and varying sizes of CCS system to assess economic viability

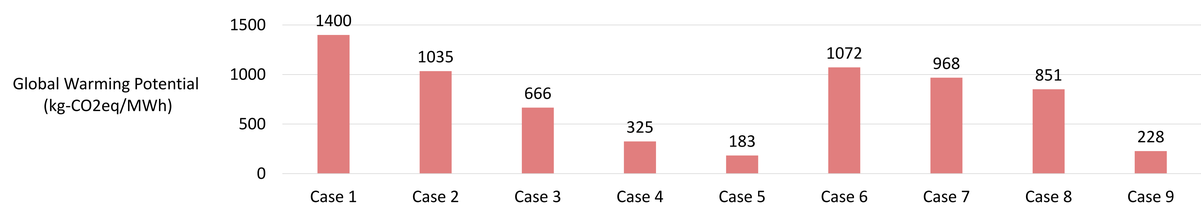
- Case 1 - no retrofit is implemented (baseline)
- Cases 2-4 - use biogas generated power to implement a larger CCS system
- Cases 6-8 - constant CCS size with excess biogas power sold in place of steam-generated power
- Case 9 - assumes plant's willingness to derate its power output to capture 90% CO_2 (68 MW-net)

Retrofit Process Overview



Case Identification

	Units	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9*
Biogas	kg/hr	-	5,300	10,600	15,900	21,200	5,000	10,000	15,000	15,000
Waste Coal	kg/hr	56,800	55,400	54,000	52,600	51,200	55,500	50,400	44,400	44,400
Capture %		0%	32%	61%	84%	91%	29%	29%	29%	90%
Sequestered CO_2	tonne/hr	-	33	67	98	111	30	30	30	92



Methodology

Modeling Based Approach

- ASPEN Plus V14 Simulations developed to determine optimal operating conditions
- Piperazine → lower degradation and energy consumption vs industry standards for CO_2 removal
- TEA utilized NETL-based Cost Estimation Methodology with -15/+30% uncertainty [4]

Compare

- Levelized Cost of Electricity (LCOE) - needed revenue per MWh-net to meet retrofit's capital & operating cost
- Breakeven CO_2 Value - minimum CO_2 value per tonne-CO_2 stored to justify retrofit costs
- Breakeven CO_2 Emissions Penalty - minimum CO_2 value per tonne-CO_2 emitted to ensure positive expenditure

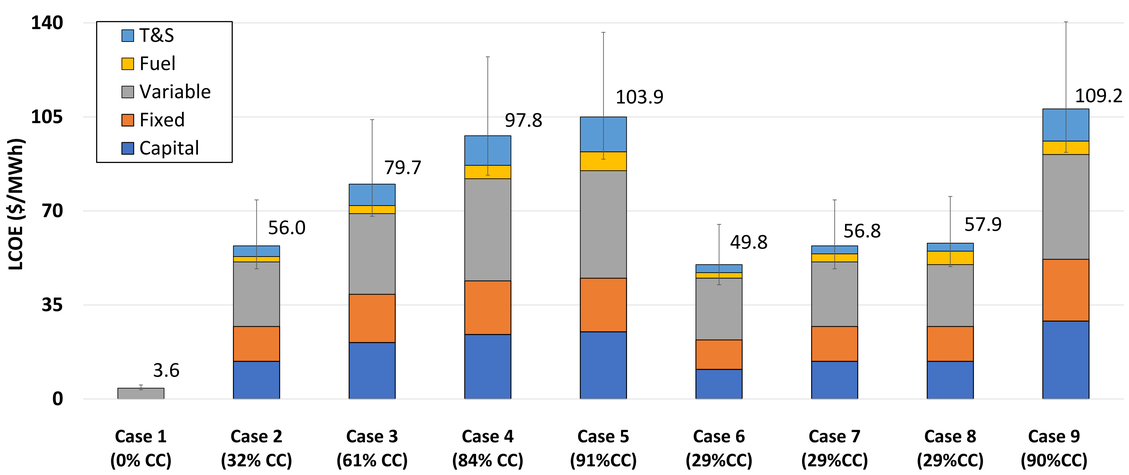
Conclusions

- Increased biogas utilization resulted in lower GWP with same net power output
- Lower GWP correspond to Higher LCOE values
- Efficient implementation dependent on current and future accessibility to biogas
- Higher amounts of biogas necessitate lower GHG abatement incentive to justify feasibility

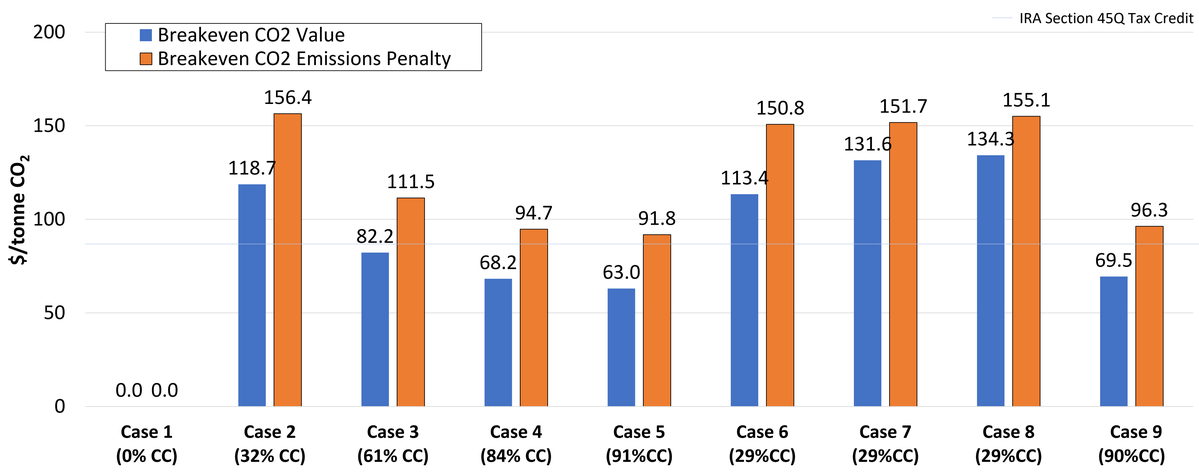
This tool informs powerplants of the potential benefits of implementing biogas utilization and carbon capture as it aligns with their priorities.

Future Work: determine economic viability of a newly constructed powerplant utilizing both resources

Levelized Cost of Electricity Breakdown



Carbon Dioxide Incentives



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Acknowledgement: Lawrence Anyim, Ahmed Essam

[1] Congressional Research Service (CRS), "The Section 45Q Tax Credit for Carbon Sequestration," CRS, 2023.

[2] Heidari-Maleni, A., Taheri-Garavand, A., Rezaei, M., & Jahanbakhshi, A. (2023). Biogas production and electrical power potential, challenges and barriers from municipal solid waste (MSW) for developing countries: A review study in Iran. Journal of Agriculture and Food Research, 13, 100668. https://doi.org/10.1016/j.jafr.2023.100668

[3] Wade, S. (2021, November 8). What to do with gob?. Cardinal News. https://cardinalnews.org/2021/11/09/what-to-do-with-gob/

[4] National Energy Technology Laboratory, "Quality Guidelines for Energy System Studies: Cost Estimation Methodology for NETL Assessments of Power Plant Performance," U.S. DOE, Pittsburgh, PA, 2021.

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