Apples to Energy: Achieving Pittsburgh, PA's Climate Action Goals Using Food Waste as a Feedstock for Anaerobic Digestion

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INTRODUCTION

- Anaerobic digesters (ADs) can turn biomass from farms, wastewater treatment plants (WWTP), & municipalities into energy through the creation of biogas (a mixture of CH_4 & CO_2 greenhouse gases (GHG))
- Although PA generates 1.1 million tons of food waste/yr, no ADs that use food waste as a feedstock exist in Pittsburgh (PGH) [2]
- Goals from PGH's Climate Action Plan include:
  - **Reducing 80% of 2003's GHG emission levels by 2050** [1]
  - **Installing 200 MW of renewable energy by 2030** [1]
- In this research, I determine if installing an AD that uses food waste as a feedstock could help PGH meet their climate goals by quantifying:
  - An estimate of the food waste PGH generates each year
  - How much GHG could be reduced by installing an AD
  - How much energy could be generated by installing an AD

YEAR	GHG % Reduction Goal	Target Amt. of GHG (US tons CO_2e /yr)
2003	0	6.60 million
2023	20	5.28 million
2030	50	3.30 million
2050	80	1.32 million

Figure 1. PGH's Climate Action Plan goals in terms of GHG reductions per year (2017). [1]

BACKGROUND

- Methane (CH_4) has 34x the global warming potential of CO_2, so it is beneficial to harness the biogas from AD & use it as energy (heat or electricity) to reduce GHG emissions to the atmosphere [3]
- In a best case scenario, CO_2 produced from AD can be sequestered in the ground (CCS) and CH_4 can be burned to produce electricity/heat

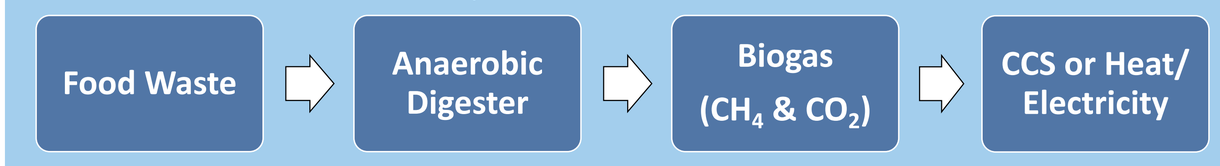


Figure 2. Simplified flow process of anaerobic digestion.

METHODOLOGY

1. Determined how much food waste is produced in PGH each year using US Census Data and specialized equations from the National Renewable Energy Laboratory [4,5,6]
2. Calculated the amount of biogas & energy that could be produced from AD using the amount of food waste in PGH as well as stoichiometry based on two collection scenarios (see **Figure 3**) & three "end-of-life" scenarios (see **Figure 5**): [6,7,8]
   - Landfill with flare
   - Landfill with electricity generation
   - AD with renewable natural gas (RNG) separation, carbon capture & storage (CCS), and electricity generation

Food Waste Producer	Medium Collection (% Obtained)	Low Collection (% Obtained)
Food Manufacturers	30	20
Grocery Stores	25	10
Restaruants	20	10
Hospitals	50	20
Nursing Homes	10	5
Universities	50	25

Figure 3. Low and medium scenarios regarding the amount of food waste that could realistically be collected in an urban area. [6]

RESULTS

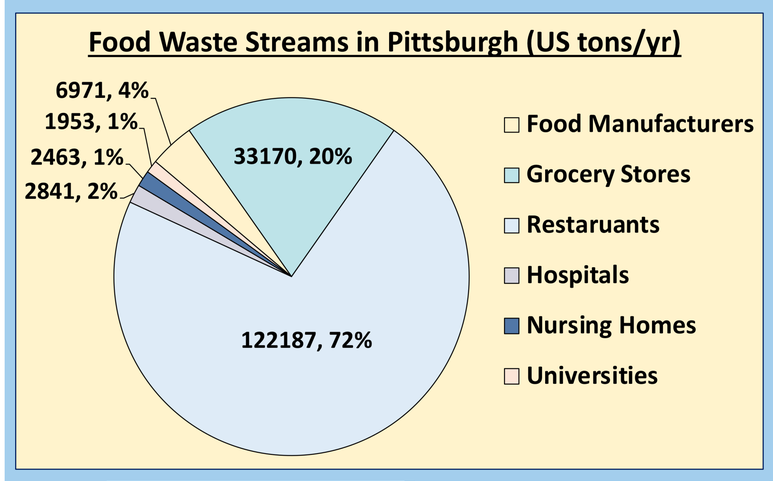
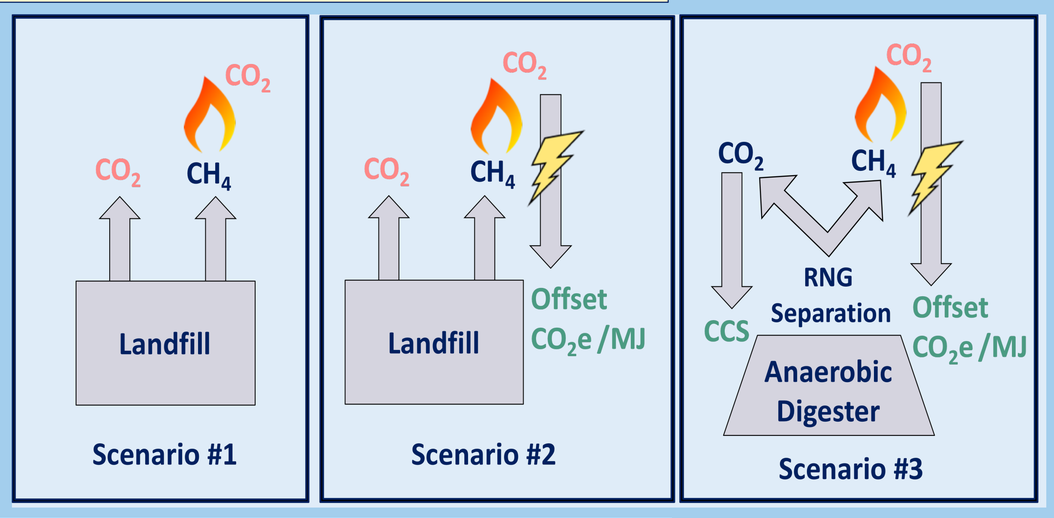


Figure 4. *Left.* Industrial food waste estimates for PGH in tons/yr. PGH produces ~169,584 tons of food waste/yr. [4,5,6]

Figure 5. *Below.* Three possible end-of-life scenarios for food waste in terms of GHG emittance.



% of 2050 GHG Goals Achieved			
	High Collection (Baseline)	Medium Collection	Low Collection
Scenario #1	-0.87	-0.19	-0.09
Scenario #2	1.50	0.33	0.16
Scenario #3	2.20	0.49	0.24
% of 2030 Energy Goals Achieved with AD			
Scenario #3	3.21	0.71	0.34

For every ton of food waste, 0.27 tons of CO_2e would be emitted in Scenario #1, 0.47 tons of CO_2e would be drawn down in Scenario #2, and 0.69 tons of CO_2e would be drawn down in Scenario #3 (a difference of almost 1 ton of CO_2e from Scenario #1 to #3)

Figure 6. *Above.* Percent of GHG reduction and energy goals from PGH's Climate Action Plan that could be achieved based on the 3 food waste scenarios. [1,7,9,10]

CONCLUSION

- PGH should consider AD technology to meet their climate goals
- Future research pathways to consider:
  - Financial feasibility of food waste collection
  - Other potential waste streams (stadiums, yard waste, etc.)
  - Determining if adding an AD to a WWTP could be a more feasible alternative to promote co-digestion / higher biogas yield
  - Looking at a high collection scenario

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REFERENCES*

[1] Pittsburgh Climate Initiative (2017). Climate Action Plan: Version 3.0. *Green Government Task Force of Pittsburgh.* 1-81. Retrieved from: https://apps.pittsburghpa.gov/redtail/images/606_PCAP_3_0_Draft-_9-26-17.pdf

[2] Pennsylvania Waste Industries Association: A Chapter of the National Waste & Recycling Association (2019). Waste Facts. *Pennsylvania Waste Industries Association.* Retrieved from: http://pawasteindustries.org/waste-industry/waste-facts/]

* Scan QR code for full list of references →