Moore+Bruggink
Consulting Engineers

MEMORANDUM

TO: Ann Arbor Environmental Commission

FROM: Brian Hannon, P.E. & Kelley Place, P.E. – Moore & Bruggink
Mark Lang, P.E. & Heather Cheslek, P.E. – Black & Veatch
Chad Antle, P.E. – BioWorks Energy

DATE: July 17, 2024

SUBJECT: June 27, 2024, Environmental Commission Meeting – Questions Regarding the Biodigester Feasibility Study Presentation

The following questions were submitted after the June 27, 2024, Environmental Commission meeting, where the members reviewed the Biodigester Feasibility Study presentation. The responses to these questions are provided in this memorandum.

1. Question: What is the capacity of the current wastewater treatment plant compared to the current population of Ann Arbor? Will there be a need in the future to increase the capacity of the wastewater treatment plant? If an expansion is possible, will the space required for the anaerobic digester impact the ability to expand?

   Response: The design flow rate provided in the Ann Arbor WRRF's NPDES Permit is 29.5 MGD. The plant is currently operating at an average daily flow of about 15.1 MGD, which equates to roughly 51 percent of the design capacity. There are no immediate plans to increase the capacity of the wastewater treatment plant. However, when the plant flow reaches 80 percent of the permitted capacity, the City will begin the planning for a future expansion.

   Care was taken to avoid areas reserved for future plant development. The recommended digester location utilizes the footprint of a gravity thickener that is no longer in service. We do not believe that the addition of a digester will impact any future expansion.

2. Question: Does OSI agree that the anaerobic digester is aligned with meeting the A^2Zero goals? It would be helpful to hear OSI and Public Works' thoughts on this.

   Response: See the response to Question 4 in the June 25, 2024, memorandum (attached).

3. Question: The presenter stated that anaerobic digesters are a known technology. PFAS/PFOS are also known to be in the land and water around. The anaerobic digester solid waste could still go to landfill as does the current sludge. Could the biogas from the digester contain PFAS/PFOS? Could the wastewater from the digester contain PFAS/PFOS?

   Response: The financial analysis anticipated that the dewatered solids would continue to be disposed of in a landfill, as is the current practice. See the response *to Question 3 in the June 25, 2024, memorandum (attached) regarding PFAS/ PFOS in biogas and wastewater.*

4. Question: Is there only one digester? What is the maintenance plan? If there is a catastrophic failure of the digester, what is the backup plan?

   Response: One 2-million-gallon digester is proposed in the Feasibility Study. See the response to Question 7 in the June 25, 2024, memorandum (attached), which addresses the questions regarding maintenance and other matters associated with a single digester.

5. Question: Is the digester sized to match the capacity of the WRRF? Would the digester accept waste from other WRRFs?

   Response: The anaerobic digester is sized to meet the 20-year projected needs of the WRRF. See the response to Question 2 in the June 25, 2024, memorandum (attached) for further explanation. The ability to accept solids generated at other WRRFs was not considered when sizing the anaerobic digester. However, accepting waste from other WRRFs would likely require a larger digester that may not fit due to the space constraints.

6. Question: Between the CHP and the RNG options, what is the fundamental difference from an environmental perspective?

   Response: Please refer to Question 6 in the June 25, 2024, memorandum (attached).

7. Question: How much volume is left over (the digestate/residual) after "digesting"? And will this still go to the landfill?

   Response: The anaerobic digestion process significantly reduces the mass of the solids entering the system. The mass of the of the digested biosolids is typically expected to be between 50 and 60 percent of the volume of undigested biosolids generated by the plant. This would provide a biosolids mass reduction of 40 percent to 50 percent. At this point in time, the WRRF still anticipates sending all of its biosolids to landfill. Digestion would reduce the amount of solids transported to the landfill.

8. Question: They mentioned a survey on the food waste and FOG input. Who was surveyed? (Individuals? Businesses?)

   Response: Discussion of the food waste and FOG evaluation is provided in Sections 10.1 and 10.2 of the "Ann Arbor Biodigester Feasibility Study." Please reference the report for a full discussion.

   The food waste evaluation estimated the volume of excess food generated by (1) educational institutions, (2) food banks, (3) food sales, wholesale, and retail, and (4) restaurants and food services, which are located within a 10-mile radius of the Ann Arbor WRRF. This evaluation is based on publicly available organics material information from the EPA's Excess Food Opportunities website to determine the volume of available food waste substrate. FOG haulers in the Ann Arbor area were surveyed to determine the volume of grease trap waste in Ann Arbor as well as in the surrounding communities.

9. Question: How would using food waste in the digester impact composting in Ann Arbor? Much household food waste in Ann Arbor is composted today. Would that need to change?

   Response: The anaerobic digester can operate using only the biosolids generated at the WRRF, if desired. Food waste and FOG can be added to the digester for added biogas generation, given that it does not exceed the maximum monthly organic loading rate (0.16 dry lbs. VS/cu ft digester volume-day), which equates to approximately 9,875 gallons of food waste per day. The biogas generation calculations used for the financial analysis used conservative assumptions, including addition of a lesser volume of food waste and FOG, which would provide less biogas and expected revenue.

   The sources of food waste evaluated in the feasibility study are provided in the answer to Question 8 above, and a full discussion of the food waste and FOG evaluation is provided in Sections 10.1 and 10.2 of the report. We believe that a balance can be met between the volume of food waste used for composting and that used for digestion to obtain good results for each.

10. Question: How far offsite would the food waste and FOG come? Is it only from Ann Arbor?

   Response: The food waste evaluation focused on readily available food waste from within a 10-mile radius of the Ann Arbor WRRF. The FOG survey assumed that FOG would be collected from the city of Ann Arbor as well as from the surrounding communities. See Sections 10.1 and 10.2 of the "Ann Arbor Biodigester Feasibility Study" for the full discussion.

11. Question: Who buys the RNG (RINs) in the RNG scenario?

   Response: The sale of RNG to two markets – the Renewable Fuel Standard (RFS) and the Voluntary Carbon Offset Market – was analyzed in the financial model. The RFS is a federal incentive program that assigns a value to RNG from wastewater solids-generated biogas. This program is managed by the U.S. EPA.

   The Voluntary Carbon Offset Market is designed to allow consumers and companies to offset their carbon emissions by paying a per-ton fee for carbon mitigation. This market will pay the market rate for the energy attribute for each BTU of RNG, which is the current Henry Hub prices for natural gas. In addition, voluntary markets will pay for the environmental attribute in each BTU of RNG, which is negotiated between the seller and the buyer.

12. Question: I struggled with all of the acronyms in the financial part of the presentation. It would be helpful to see some of the financial tables in a document with the acronyms spelled out and defined all in one place. I know they did that on the first slide, but I couldn't remember all of them later in the presentation.

   Response: See the attached pdf of the PowerPoint presentation with acronym definitions added to selected slides.

13. Question: Regarding the slide on GHG analysis:

a. Does the AnD/Landfill column, Anaerobic Digestion row, account for the CO_2 emissions from burning the methane?

Response: As discussed in Section 17.2.1 of the Ann Arbor Biodigester Feasibility Study, the BEAM Model anticipates that the biogas from the anaerobic digester is captured and used at the WRRF to create electricity and heat. That use is accounted for in the model. The biogas would not be "burned" using a flare under normal operation.

b. In the AnD/Landfill column, Transportation row, does this account for food waste and FOG being transported to the digester?

Response: The transportation row accounts for transporting dewatered cake from the WRRF to the landfill. It does **not** *account for the transportation of processed food waste or FOG to the WRRF.*

One additional note: Digesting the City's wastewater solids prior to transporting it for landfill disposal will reduce the greenhouse gas production associated with the WRRF's solids management by approximately 20,630 MT CO_2 Equivalent annually under design year conditions, which is equal to 22.3 dry tons of solids per day. Eliminating these greenhouse gases would represent a reduction of the City's GHG production of just under one percent (0.94 percent).

Moore+Bruggink
Consulting Engineers

MEMORANDUM

TO: Ann Arbor Energy Commission

FROM: Brian Hannon, P.E. & Kelley Place, P.E. – Moore & Bruggink
Mark Lang, P.E. & Heather Cheslek, P.E. – Black & Veatch
Chad Antle, P.E. – BioWorks Energy

DATE: June 25, 2024

SUBJECT: June 11, 2024, Energy Commission Meeting

The following questions were asked at the June 11, 2024, Energy Commission meeting, and the responses to these questions are provided in this memorandum.

1. The City of Ann Arbor previously looked at anaerobic digestion, and it was determined that it was not feasible to locate a digester at the WRRF. What has changed?

   At the time of the 2017 Feasibility Study, facility renovation was ongoing, and the old plant was being totally removed from the site. Thoughts of unforeseen issues made the WRRF hesitant to place a biodigester on site.

   The 2017 Feasibility Study therefore evaluated the economics of constructing a biodigester on the Wheeler Center property, which is located approximately 5.5 miles from the Ann Arbor WRRF. The study evaluated the expected volume of solids from the WRRF along with the expected volume of food waste, including FOG, generated from restaurants, schools, groceries, hospitals, hotels, and food banks in the city, as well as Washtenaw County. The study showed that the trucking costs were cost prohibitive for construction and operation of a biodigester at that location.

   Since that time, the residuals-handling process was changed, and the gravity thickener tank was no longer needed for normal operations. This created a prime location on the WRRF site for a biodigester.

2. The city is expecting a lot of growth in approved housing developments. Provide confirmation of the space needs and growth projections.

   Digester sizing is based on many factors, including the volume and characteristics of biosolids generated at the WRRF along with any food waste streams transported to the facility. Although the size of the digester is not directly calculated based on population, population growth was used to estimate the projected increase in biosolids in future years. The projected growth rate was determined by evaluating the growth rates of the city of Ann Arbor and the townships served by the Ann Arbor WRRF, and calculating a weighted average based on population.

Conservative values and assumptions were used when evaluating the biosolids data and calculating the size of the anaerobic digester:

a. *Maximum month volumes of primary solids and thickened waste-activated sludge (TWAS) based on evaluation of plant data.*

b. *Conservative TWAS concentration typical of current plant operations was used to determine volume. Achieving a higher concentration of thickened solids will decrease the volume of biosolids entering the digester, thereby allowing additional capacity.*

c. *Adjusted the volume of biosolids to include projected growth.*

d. *Assumed the full volume of food waste projected in the feasibility study would be added to the digester.*

3. What happens to PFAS/PFOS when they are "burned"? Will they spread to the environment? Are they destroyed in the digester?

Anaerobic digestion, in research trials, has shown a reduction in PFAS compounds. More research is being conducted to better understand the potential removal rates.

Thermal processes for wastewater solids and biosolids, such as incineration, pyrolysis, and gasification, have been shown to reduce the levels of PFAS in the resulting solid product, including ash and biochar. The processes can remove most of the PFAS compounds from the solid phase, often to below current detection limits. However, there are still unknowns relative to the overall fate and mass balance of these compounds through these processes.

Research conducted to-date indicates that these thermal processes may not destroy PFAS, but rather that they volatilize PFAS from the solids and break carbon-carbon bonds before breaking the carbon-fluorine bonds, which results in the formation of smaller-chain PFAS compounds. These transformed compounds, that are still classified as PFAS, can reside in the sidestreams, including process gasses. Further research will provide more definitive results. In general, these thermal processes can be categorized as "PFAS removal processes" because they remove PFAS from solids and biosolids, but not as "PFAS destruction processes" because they do not completely destroy all carbon-fluorine bonds that make up PFAS.

The WRRF is a receiver of PFAS compounds that are used daily in products including cookware, packaging, cosmetics, clothing, carpets, electronics, and firefighting foam. The best way to remove PFAS compounds from wastewater solids is to remove it from the influent wastewater. Part of the Michigan Department of Environment, Great Lakes, and Environment's (EGLE) approach to minimizing PFAS in wastewater solids and biosolids is to identify the sources of PFAS and control or eliminate those through wastewater pretreatment. This approach is being replicated in several other states, including Wisconsin, Colorado, and New York. EGLE is also supporting the US EPA's ongoing risk-based assessment of PFAS compounds in biosolids.

4. What are OSI and Public Works' thoughts on a biodigester?

   Keith Sanders reached out to the Ann Arbor Office of Sustainability and Innovations (OSI) and to the Ann Arbor Public Works Department after the meeting to follow up on this question. Missy Stults, PhD, Sustainability and Innovations Director, confirmed that OSI is supportive of the project and is very interested in helping find the funding to make it happen. Paul Matthews, Public Works Manager, also confirmed support for this effort.

5. The Grand Rapids digester project went way over budget (estimated cost of $40M and final project cost of $85M). What type of contingency is built into these estimates?

   A 30 percent contingency was built into the Ann Arbor project estimates. This is consistent with widely accepted engineering practices and AACE cost estimating guidelines.

   Although we were not involved in the Grand Rapids digester project, we are aware of a number of factors unique to that particular project that likely contributed to the cost escalation. The project included a delivery method whereby only 30 percent project design had been achieved at the time project costs were estimated. COVID-associated price adjustments then impacted project pricing, and unknown site conditions found during construction led to additional costs for contaminated soil removal and site dewatering.

6. What makes RINs more attractive than CHP? Just revenue? Which is environmentally friendlier?

   RINs produced from renewable natural gas have monetary value due to the federal Renewable Fuel Standard (RFS). The EPA, which administers the RFS, does not currently allow for electricity used as vehicle fuel to be eligible for RINs. In general, the electrical power generation requires less equipment and parasitic electrical loads when compared to RNG production.

   Both scenarios are alternative fuel sources and are environmentally friendly. An environmental impact analysis was not performed to compare these options.

7. Only one digester was proposed. Why wasn't this designed as a two-digester system so that one digester can remain operational when the other is taken down for cleaning or maintenance?

   Ideally, two digesters would be constructed to provide redundancy. However, there is very limited space available on the current WRRF site. As a result, only one digester can be constructed at the site.

   Only the digestion tank itself would be without redundancy. The other components of the process (pumps, heating, mixing, and biogas management) will have redundancy included in their design. When the digester system needs to be offline for a short period of time, the solids can be held within the treatment process. For longer term shutdowns such as tank cleaning or longer biogas management system repairs, the raw solids would be dewatered and landfilled as is the current practice.

8. Can the material collected in the residential organic carts be brought to the digester?

   The material collected from the residential organic carts can be processed by the digester. Additional equipment would be needed to accept, screen, and process the organic waste prior to feeding the material to the digester. The minimal equipment required at the plant to accept food waste and FOG was planned for in this study. The organic material will still require processing into a food waste slurry before coming to the facility.

Ann Arbor WRRF Biodigester Feasibility Study

Energy Commission Meeting

June 11, 2024

Moore+Bruggink Consulting Engineers

BLACK & VEATCH

BioWorks Energy
Advanced organics processing

BIOSOLIDS BASICS

- Biosolids are generated through the wastewater treatment process.
- Common biosolids management practices:
  - Land Application
    - Requires "Class B" treatment of biosolids, at minimum
    - Impacted by:
      - Agricultural Schedule
      - Distance to Application Site
      - Regulatory Changes
  - Landfill
    - More competition for landfill space
    - Disposal costs are increasing
  - Incineration
    - Not common in Michigan

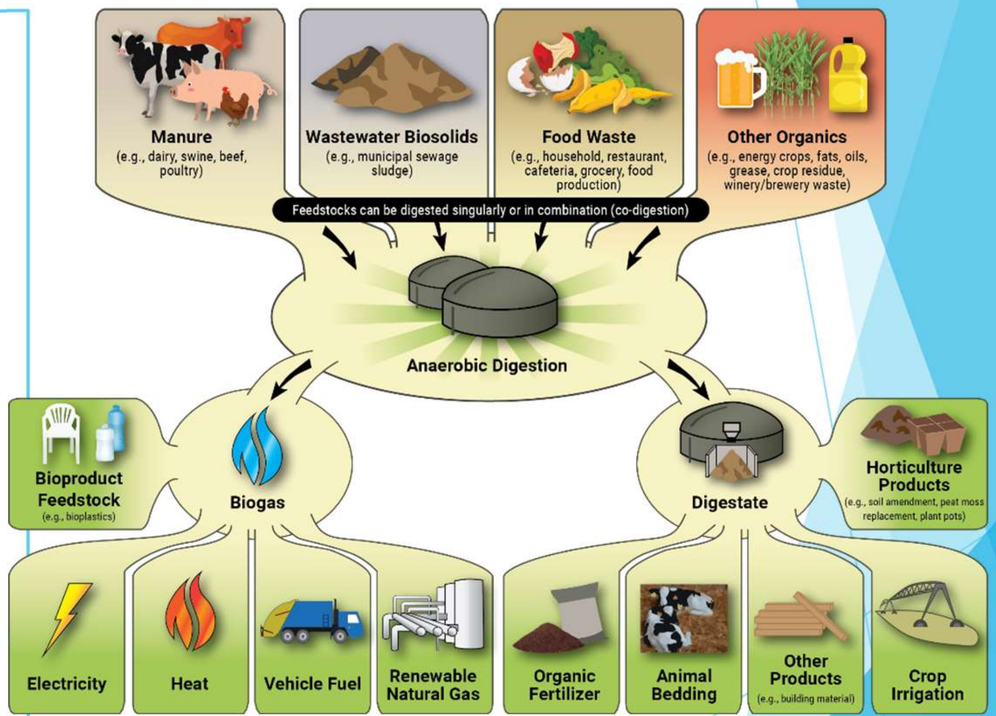
Current Practices at the Ann Arbor WRRF:

- No digestion
- Landfill disposal of dewatered biosolids
  - Currently 100% of biosolids are taken to landfill
  - Chemicals are added for odor control
- Able to lime stabilize and dispose of via land application, if desired

ANAEROBIC DIGESTION FUNDAMENTALS

- Anaerobic Digestion
  - Biological process in which microorganisms break down organic matter in the absence of oxygen.

- Benefits of Anaerobic Digestion
  - Reduce the volume of biosolids/divert materials from landfill
  - Produce biogas
  - Allows beneficial use of biosolids products
  - Reduced odors



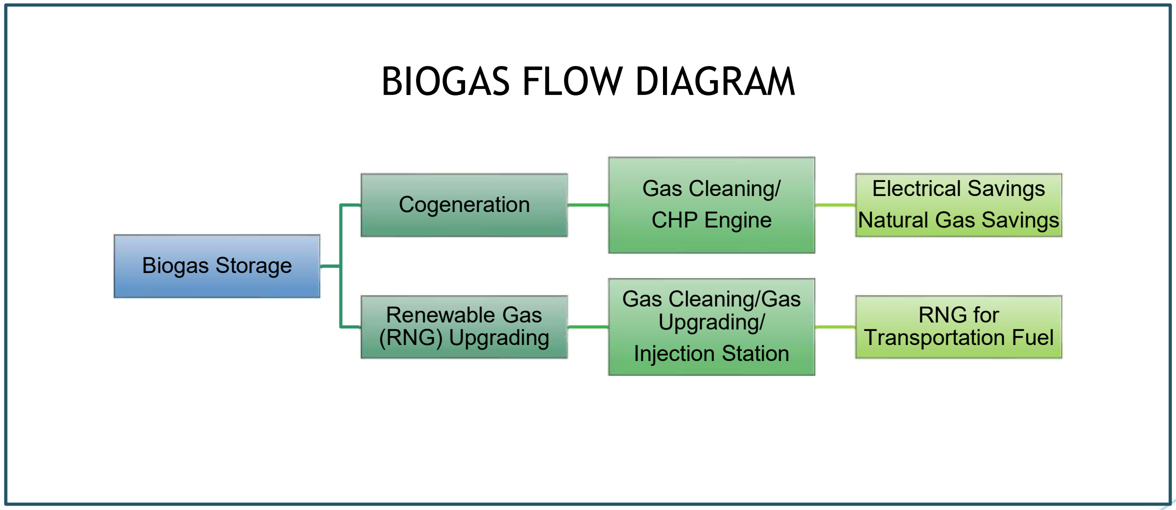
Anaerobic Digestion Feedstocks and Products
Source: EPA

ANAEROBIC DIGESTER SIZING & DESIGN

- Size considerations:
  - Solids Generation
  - Population Growth
  - Food Waste and Fats, Oils & Grease (FOG) Survey
- Evaluation based on:
  - 2 million-gallon Anaerobic Digester
  - Projected 2043 Solids Generation
  - Limited Food Waste and FOG
- Considered three locations on the WRRF site

BIOGAS HANDLING

- Biogas is a by-product of anaerobic digestion
- Biogas must be stored and cleaned/conditioned for beneficial use
- Considered two methods for biogas use:
  - Cogeneration / Combined Heat and Power (CHP)
  - Renewable Natural Gas (RNG)



SITE LAYOUT

GAS UPGRADING EQUIPMENT (FOR RNG OPTION ONLY)
GAS CLEANING SKID
FLARE
TO INJECTION STATION (LOCATION TBD)
2 MG BIODIGESTER (65' DIAMETER 105' HEIGHT INC. CONE)
HYDROLYSIS TANK (FUTURE)
BOILER BUILDING
RECEIVING STATION
ACCESS DRIVE
COGENERATION UNITS (FOR COGEN OPTION ONLY)
CONCEPT #1:
2 MG CYLINDRICAL BIODIGESTER WITH CONE-SHAPED BOTTOM (COGENERATION & RNG OPTIONS SHOWN)

FINANCIAL MODEL ACRONYMS

- CHP – Combined Heat & Power
- ITC – Investment Tax Credit
- MIRR – Modified Internal Rate of Return
- NPV – Net Present Value
- RFS – Renewable Fuel Standard
- RIN – Renewable Identification Number
- RNG – Renewable Natural Gas

FINANCIAL MODEL

CHP: Combined Heat & Power
FOG: Fats, Oils, & Greases
RNG: Renewable Natural Gas

MODEL INPUTS	DESCRIPTION
Capital Assets	Anaerobic Digester; CHP and RNG options
Discount Rate	3%
Depreciation	Straight-line, 30 years
Debt Service	4.5% with a 30-year term
INCOME SOURCES	
Food Waste/FOG	(1) Tipping fee (2) Increased biomethane potential
Renewable Natural Gas (RNG Option)	Sold to either the Renewable Fuel Standard (RFS) or to the voluntary offset market.
COST SAVINGS	
Electrical Generation (CHP Option)	For use by the WRRF
Odor control media; odor control additive	Less media changeout and chemical required
Landfill Fees	Reduced transportation and disposal
Food Waste/FOG	Diverts organic wastes from landfills

CHP: Combined Heat & Power
FOG: Fats, Oils, & Greases
O&M: Operation & Maintenance
RFS: Renewable Fuel Standard
RIN: Renewable Identification Number
RNG: Renewable Natural Gas

FINANCIAL MODEL COSTS & REVENUES

COST / REVENUE	CHP SCENARIO	RNG SCENARIO
CAPITAL COST	($40.3M)	($47.6M)
ANNUAL COSTS & REVENUES: ($/year)		
O&M Costs (Variable + Fixed)	($882,000)	
Cost Avoidances • Landfill Fees (transportation, disposal, labor reduction) • Odor Control Media (GAC) Replacement • Odor Control Additive • Natural Gas Usage for Heating • Reduced Dewatering Power Demand	$717,000	
CHP Electrical Generation Value	$456,000	--
Renewable Fuel Standard (RFS) Program RINs Estimated Revenue	--	$2,270,000
Renewable Natural Gas (RNG) Value	--	$323,000
FOG & Food Waste Tipping Fees	$364,000	

CHP: Combined Heat & Power
ITC: Investment Tax Credit
MIRR: Modified Internal Rate of Return
NPV: Net Present Value
RFS: Renewable Fuel Standard
RIN: Renewable Identification Number
RNG: Renewable Natural Gas

SUMMARY OF FINANCIAL PERFORMANCE

METRIC	CHP SCENARIO (No ITC)	RNG SCENARIO (No ITC)	CHP SCENARIO (with ITC)	RNG SCENARIO (with ITC)
NPV	-$22.661M	+$21.073M	-$11.589M	+$32.418M
MIRR	-0.09%	4.31%	1.82%	4.85%
Payback (years)	n/a	20.0	n/a	15.2
Estimated Cost	$40.329M	$47.596M	$40.329M	$47.596M
ITC Direct Pay $	n/a	n/a	$12.098M	$12.396M
Final Cost	$40.329M	$47.596M	$28.231M	$35.200M

CHP SCENARIO KEY TAKEAWAYS:

- Electrical generation ~600 kW of renewable energy to WRRF
- Surplus heat supplements natural gas normally required
- Electricity generated by a CHP currently qualifies for environmental incentives which are de minimis in value.

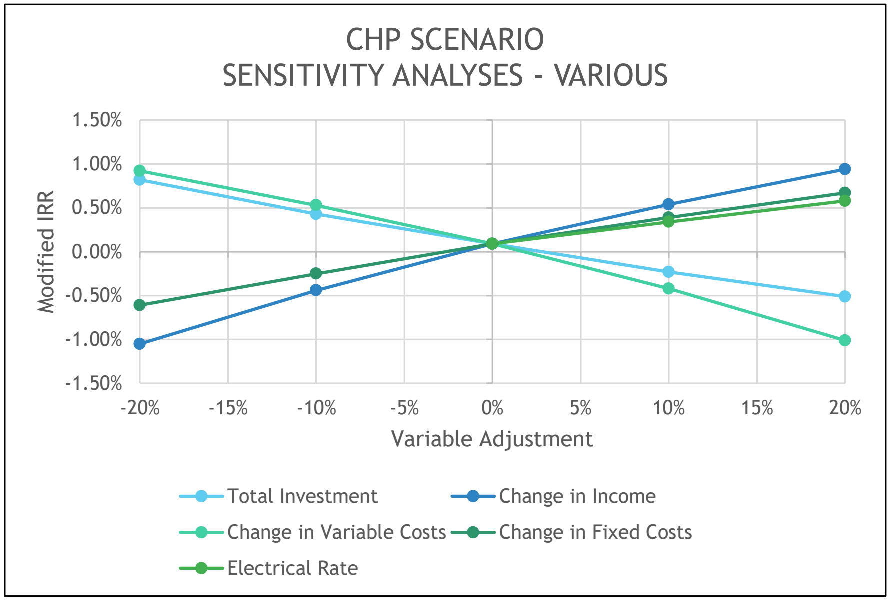
RNG SCENARIO KEY TAKEAWAYS:

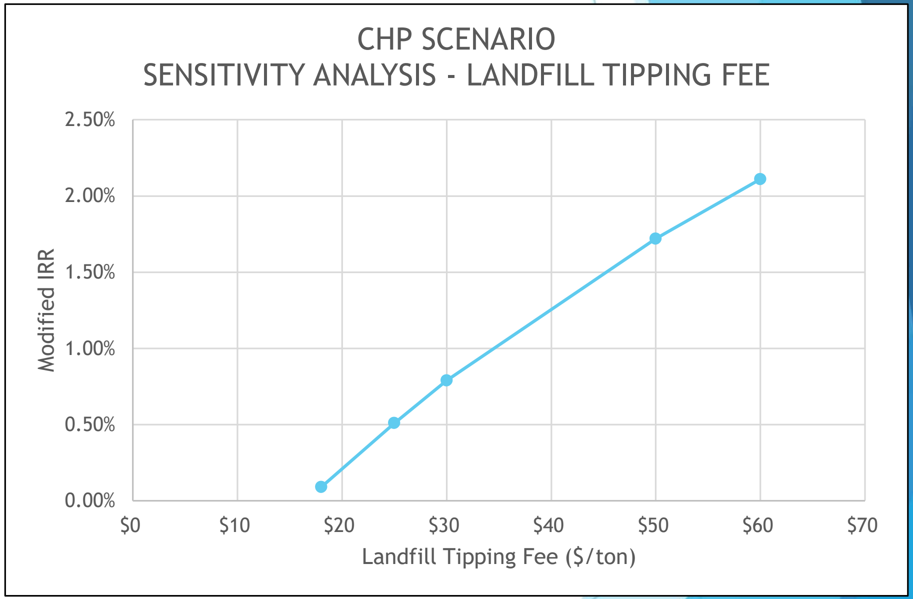
- Renewable Natural Gas can earn environmental credits (RINs).
- RINs earned from the RFS program allow the facility to earn in excess of $2 million per year.

SENSITIVITY ANALYSES – CHP SCENARIO*

* ANTICIPATING NO ITC

CHP: Combined Heat & Power
ITC: Investment Tax Credit
IRR: Internal Rate of Return

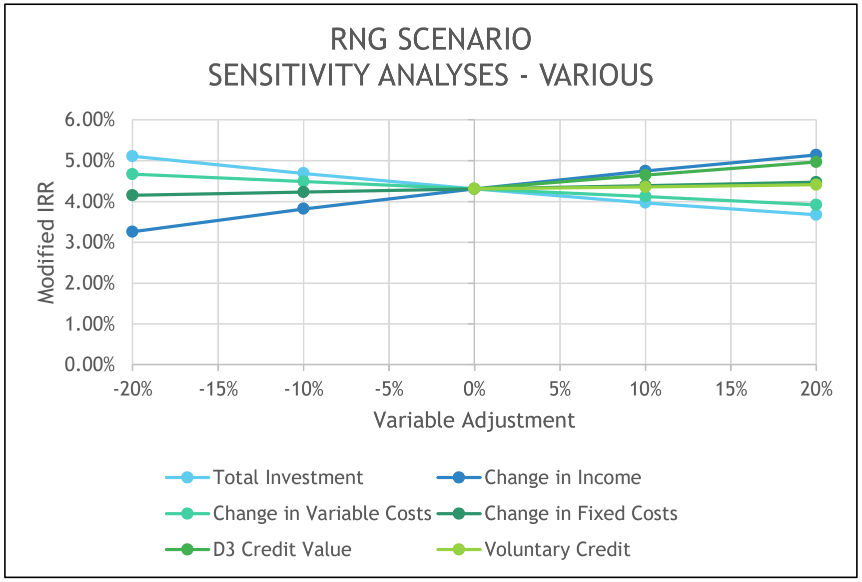


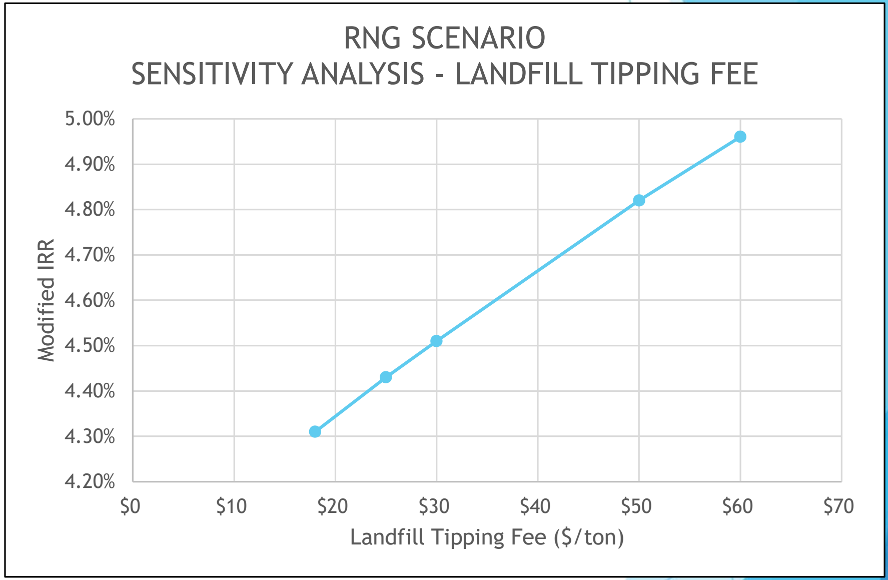


SENSITIVITY ANALYSES – RNG SCENARIO*

* ANTICIPATING NO ITC

ITC: Investment Tax Credit
IRR: Internal Rate of Return
RNG: Renewable Natural Gas





CHP: Combined Heat & Power
IRR: Internal Rate of Return
ITC: Investment Tax Credit
NPV: Net Present Value
RECs: Renewable Energy Credits
RIN: Renewable Identification Number
RNG: Renewable Natural Gas

CLEAN ENERGY INCENTIVES

INCENTIVE	DETAILS
Investment Tax Credit (ITC)	Available under the Inflation Reduction Act. Allows entities without federal tax liability to claim the "direct pay" provision for an ITC.
Renewable Energy Credits (RECs)	Utilities and Retail Suppliers of Electrical Power in Michigan are required to utilize cleaner sources of energy via Public Act 235 of 2023. • 50% renewables by 2030 • 60% renewables by 2035 • 80% clean energy by 2035 • 100% clean energy by 2040
eRINs (electronic-RIN)	Not yet authorized by the federal EPA. If authorized, the program would increase CHP projected revenues and result in both a positive NPV and IRR.
State of Michigan Clean Fuel Standard	This legislation is under consideration in the Michigan legislature. Seeks to reduce carbon emissions from the transportation sector by replacing diesel and gasoline with alternative fuels with lower Carbon Intensity numbers. In addition, biogas generated electricity would qualify as an alternative fuel to provide power for EV charging stations.
More Mature Voluntary Carbon Offset Markets	As demand for RNG increases, the voluntary RNG market is expected to expand.

FUNDING OPPORTUNITIES

FUNDING SOURCE	DESCRIPTION	FUNDING DETAILS
WIFIA Loan	• Low-interest loan pegged to US Treasury • Single, fixed rate • Flexible repayment structure • Can be combined with other funding sources • Biodigesters are regularly funded	• Current rate: ~4.5% • Loan for up to 49% of total project costs • Minimum project cost = $20M • Very long term (35 years post-Substantial Completion)
MI Clean Water State Revolving Fund (SRF) Loan	• Very low interest loan • Principal forgiveness option • Annual funding • No biodigester/biosolids projects were selected for funding in last round	• Current rate for 30-yr loan: 2.75% • 20 or 30 year loans • Median loan: $5.5M • Maximum loan: $120M
Grants	Examples: • EPA-Supporting Anaerobic Digestion in Communities Grant • EPA-Climate Pollution Reduction Grant Program	• Opportunities come and go • Timing and monitoring are critical
Tax Credits	Examples: • Investment Tax Credit for Energy Property • Qualifying Advanced Energy Project Tax Credit • Clean Electricity Investment Tax Credit or Production Tax Credit • Clean Fuel Production Tax Credit	• Eligibility and amount are determined by construction start, project characteristics, ultimate energy use, etc. • Can be as high as 50%, but realistically closer to 30%-40%

A^2ZERO INITIATIVE

MOVE THE CITY TOWARDS CARBON NEUTRALITY BY 2030

FOUR SECTORS OF CARBON NEUTRAL STRATEGIES PER A^2ZERO PLAN	
ENERGY	**MOBILITY**
Production of renewable sourced energy from digester biogas Production of renewable biogas in place of fossil fuels	Production of renewable fuel from digester biogas that can be utilized in vehicles or to produce electricity for electric vehicles
ADAPTATION & RESILIENCE	**RESOURCE REDUCTION**
Digestion fits into the enhanced use of green infrastructure	Food waste can be diverted from landfill to the digester
Digestion creates a more resilient wastewater treatment system and local economy	Composting can support beneficial reuse of stabilized biosolids

ENVIRONMENTAL BENEFITS OF A BIODIGESTER

- Greenhouse Gas (GHG) Reduction
- Diversion of Organics from Landfill
- Heat & Power or Natural Gas Generation from a Renewable Fuel Source
- Fuel & Chemical Savings
- Odor Reduction

THESE BENEFITS COMPLEMENT THE A^2ZERO PLAN GOALS AND INITIATIVES

GREENHOUSE GAS (GHG) ANALYSIS

BIOSOLIDS EMISSIONS ASSESSMENT MODEL (BEAM) RESULTS

Results are shown as *Mg/yr CO_2 Equivalent/dry ton solids/day processed*

Parameters	Baseline Scenario	Ann Arbor Scenario	
	Lime/Landfill	Lime/Landfill	AnD/Landfill
Thickening (Mg/yr)	3.72	3.72	3.72
Anaerobic Digestion (Mg/yr)	0	0	(109.82)
Dewatering (Mg/yr)	4.93	4.93	2.96
Lime Stabilization (Mg/yr)	69.31	69.31	0
Transportation (Mg/yr)	3.11	3.11	2.03
*Landfill (Mg/yr)	793.73	510.90	50.71
Total (Mg/yr)	**874.80**	**591.97**	**-50.41**

*Landfill emission went down from 510Mg/yr to 50Mg/yr because biodegradable organic was significantly reduced after digestion, so most of the CH4 emissions were avoided.
1 Megagram (Mg) = 1 Dry Metric Ton (Mt)

CITY OF ANN ARBOR CARBON NEUTRALITY PRIORITIZATION FRAMEWORK

(Preliminary Evaluation Performed by the Project Team)

PRIORITIZATION FRAMEWORK									
	-2	-1	0	1	2	3	4	5	6
GHG MITIGATION CRITERIA									
High Long-Term GHG Reduction Potential					2				
High Short-Term GHG Reduction Potential					2				
COST CRITERIA									
City Cost Effectiveness					2				
City Relative Cost (Capital)					2				
City Relative Cost (Operation)					2				
Residential and Business Cost Effectiveness					2				
Resident and Businesses Relative Cost (Capital)				1					
Resident Relative Cost (Operation)					2				
FEASIBILITY CRITERIA									
Technological Feasibility					2				
Current Policies or Ordinances					2				
Jurisdictional Control / Ease of Implementation					2				
Implementation Timeframe				1					
Public Acceptability				1					
CO-BENEFITS									
Affordability on Low-Income Residents				1					
Equity				1					
Historical Injustice			0						
Pollution Prevention				1					
Health and Well Being				1					
Reliability				1					
Resilience				1					
Job Development				1					
Resource Preservation				1					
Safety				1					
Social Capital, Culture, and Community			0						
Dollars Stay in Local Economy				1					
Scalable				1					
TOTAL SCORE AND PERCENTAGE OF MAXIMUM POSSIBLE POINTS:								34	72%

Thank you!

Moore+Bruggink
Consulting Engineers

BLACK & VEATCH

BioWorks Energy
Advanced organics processing