

Clarke Prize Design for Sustainability Challenge

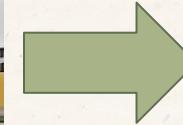
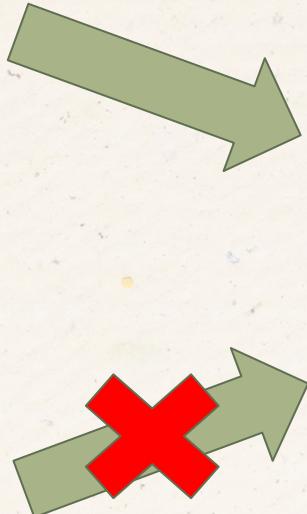
Brody Howard, Nathan Li, Matthew Pihowich, Jonah Shapiro, Andrew Teutenberg

Food Waste: An On-Campus Solution



5:23 PM 27/1/2024 EngSci Common Room

How does U of T Currently Handle Food Waste?



How Much is Being Wasted?

Figure 2: Daniels Building

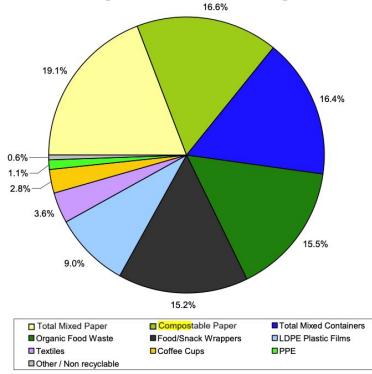
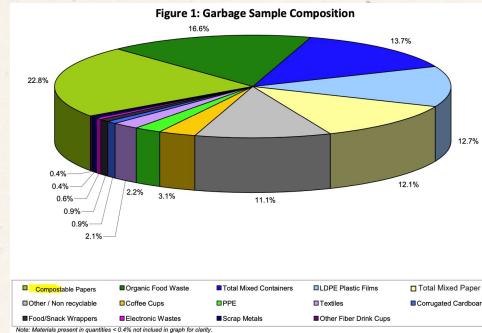


Figure 1: Garbage Sample Composition



U of T 2023 Waste Audit: 351 tonnes of food waste went to landfill.

This equates to 30.4 tonnes of methane gas (~759 tonnes of CO₂)

<https://www.epa.gov/land-research/quantifying-methane-emissions-landfilled-food-waste#:~:text=Due%20to%20its%20quick%20decay,are%20from%20landfilled%20food%20waste>

[https://mygug.eu/carbon-emissions/#:~:text=Greenhouse%20Gas%20Emissions%20Associated%20with%20Food%20Waste&text=The%20%25%20Volatile%20solids%20\(VS\).of%20food%20waste%20of%20127m3](https://mygug.eu/carbon-emissions/#:~:text=Greenhouse%20Gas%20Emissions%20Associated%20with%20Food%20Waste&text=The%20%25%20Volatile%20solids%20(VS).of%20food%20waste%20of%20127m3)

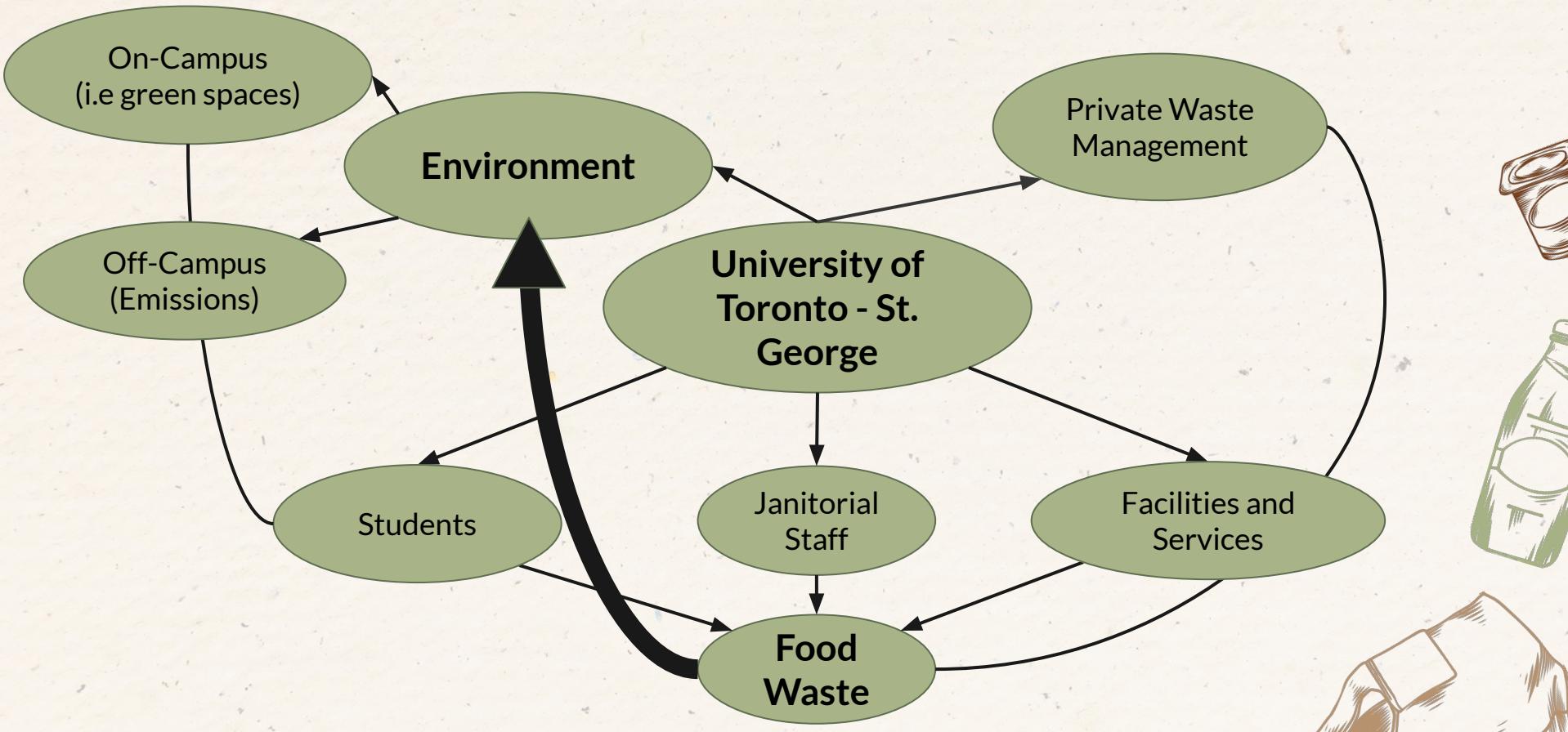
<https://www.fs.utoronto.ca/wp-content/uploads/2021/04/Waste-Audit-2020.pdf>

Opportunity Statement

To provide an **effective** method of food waste collection **on** the University of Toronto St. George Campus to allow for the production of **fertilizer** and biomass **energy** for campus use.



Stakeholder Network



Key Objectives

1

Reduce the amount of compost going to landfills from UofT St. George (kg)

2

Minimize/offset GHG emissions from the entire Compost System (Metric Tonnes of CO₂)

3

Increase amount of energy and fertilizer and energy produced on campus (Metric Tonnes of compost & kWh)

4

Minimize the total cost of a new Compost System (\$CAD)

5

Improve student lived experience



System Diagram

Additional Compost Bins



Revamped collection system



On-Campus Processing Plant



Fertilizer and Biogas for Steam Plant



Proposed Waste Setup

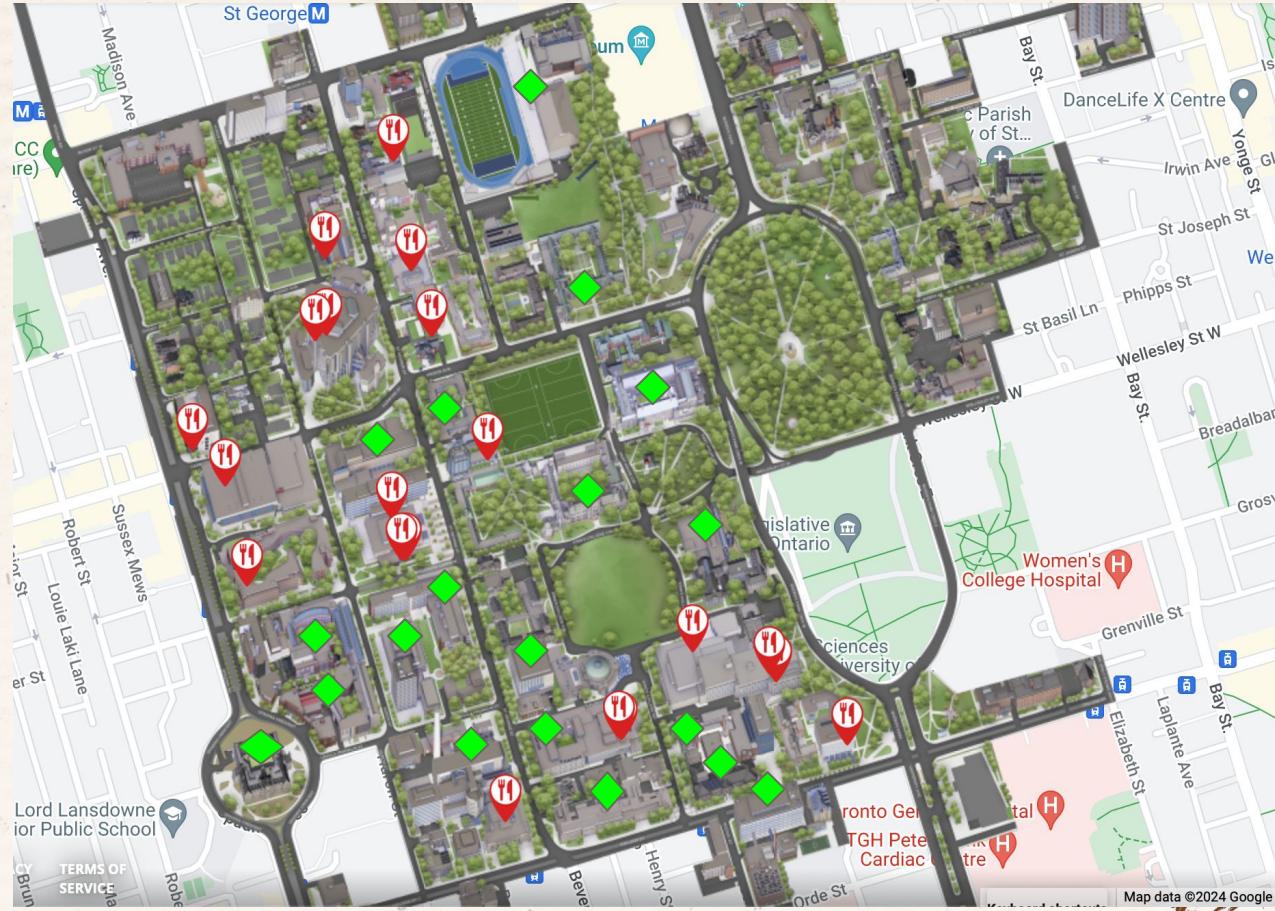


Current and Proposed Compost Bin Locations

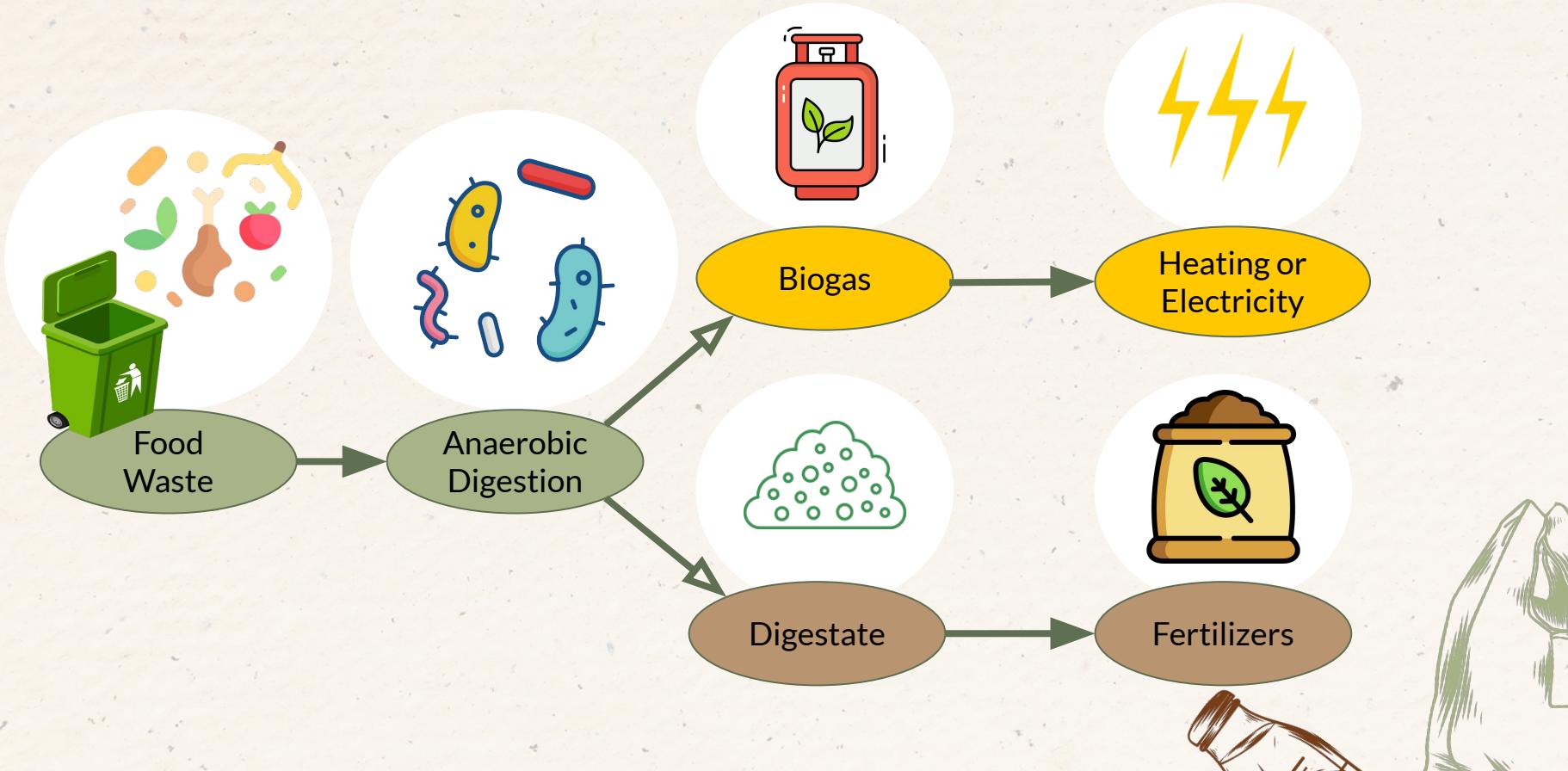
Current
Locations:



Suggested
Locations:



Processing Plant



Processing Plant Details

What is Required?

- Storage for 717 Tonnes of Food Waste per year (~2 Tonnes per day)

What we propose

- 3 Homebiogas Industrial Anaerobic Digesters (3 tonnes per day)
- **1600 square feet** (equivalent of six parking spaces)
- Produces **1728 KWh/day**
- Estimated **\$1,000,000** to build plant



<https://www.jstor.org/stable/26554637?seq=3>

<https://www.fs.utoronto.ca/wp-content/uploads/2023/12/U-of-T-waste-audit-2023.pdf>

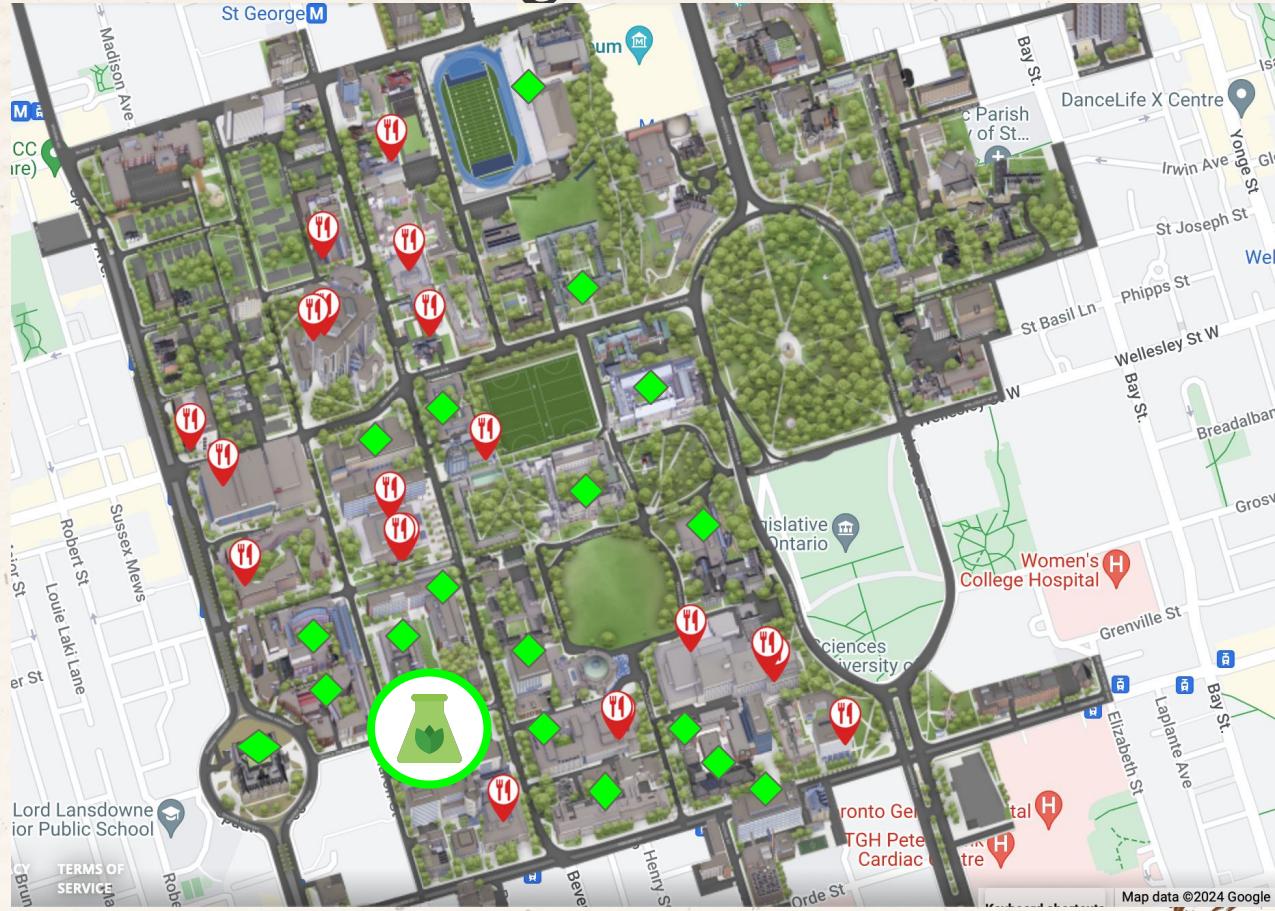
<https://www.homebiogas.com/industrial-system/>

Processing Plant Location

Current Locations:



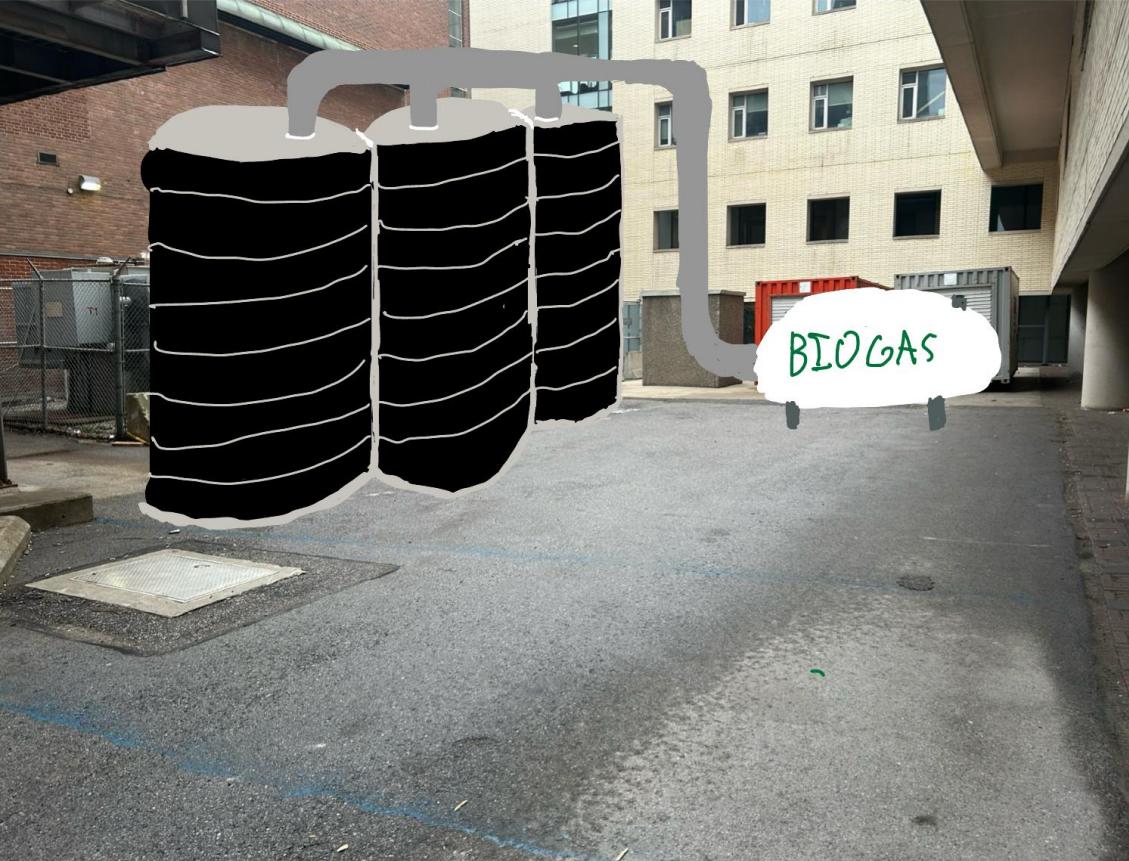
Suggested Locations:



TERMS OF
SERVICE

Map data ©2024 Google

Potential Processing Plant



Current schools using in-vessel: Fort Lewis College, Princeton, Western Michigan, Colorado State

Requirement	“Backyard Piles” ¹	Vermicomposting	In-Vessel ²	Aerated Static Pile (ASP)	Windrow	Requirement	“Backyard Piles” ²	Vermicomposting	In-Vessel ³	Aerated Static Pile (ASP)	Windrow
Planning											
Food Waste Needed (per week)	0-50 lbs.	<10 lbs.	350-10,000 lbs.	1,000-10,000 lbs.	>1,000 lbs.	Carbon Source (Recommended)	Garden debris	Shredded paper/paper towel	Wood shavings	Wood chips	Animal bedding, leaves
Time to Produce Finished Compost	3-8 mo.	3-8 mo.	1-3 wks. inside vessel; 3 mo. curing in windrow or pile	3 wks. in ASP; 15 wks. curing in windrow or pile	3 mo. in windrow; 3 mo. in curing pile	Ability to Handle Compostableware	(Unbleached) Napkins Only	(Unbleached) Napkins Only	Some BPI certified	Some – Most (with enough time)	Some – Most (with enough time)
Space Commitment	Small	Depends on bin size	1,000 sq. ft covered w/ add. space for piles or windrows	1,000-10,000 sq. ft or ¼ acre	> ¼ acre	Scalability	Low	Add bins	Low - would need to buy more units	Add bins as needed	Add windrows as needed
Time Commitment (labor hours/week)	1 hour (max)	1 hour (max)	10 - 30 hours	10 - 60 hours	20 - 60 hours	Equipment & Infrastructure Needs	Low	Low Bin and red wiggler worms	Low-Medium Access to electricity Lifter mechanism for large bins	High Access to electricity Payloader & other auxiliary equipment	High Tractor, turner, skid steer, water source
Capital Cost	Very little	<\$100	\$20-\$200k+ (system only)	\$20-\$250k	\$150-300k	Pest/Odor Management	Medium	Medium	Low	Medium-High	Medium-High
Dedicated manager	No	No	Yes	Yes	Yes	Stormwater & Leachate Management	Little to None	Little to None	Little to None	Medium-High	Medium-High
Operations											
Labor: # of persons (per week)	1	1	1 manager & 2 students	1 manager & 4 students	1 manager, 1 driver, 1 intern	Cold Weather Challenges	Lowered activity unless insulated (e.g. compost covers)	None (inside); Insulation (outside)	May need supplemental heating source to maintain a min. temp.	Lowered activity unless insulated (e.g. compost covers)	Lowered activity unless insulated (e.g. compost covers)
Food Waste Restrictions	No meat & dairy	No meat & dairy Limit acidic food	None	None	None	Hot or Dry Weather Challenges	Low	None (inside); <30°C or 86°F (outside)	Exhaust fans/ventilation for enclosed facilities	May need to add water or cover to prevent evaporation	May need to add water or cover to prevent evaporation
						Academic Aspect	Yes but small	Yes	Yes	Yes	Yes

Next Steps + Limitations

First: Pre-feasibility screening (Anaerobic Digestion Screening Tool developed by US EPA)

Separating compost (filtering out) to ensure efficiency



- Different kinds of compost bins
- Screens to filter out plastics

Upfront capital cost



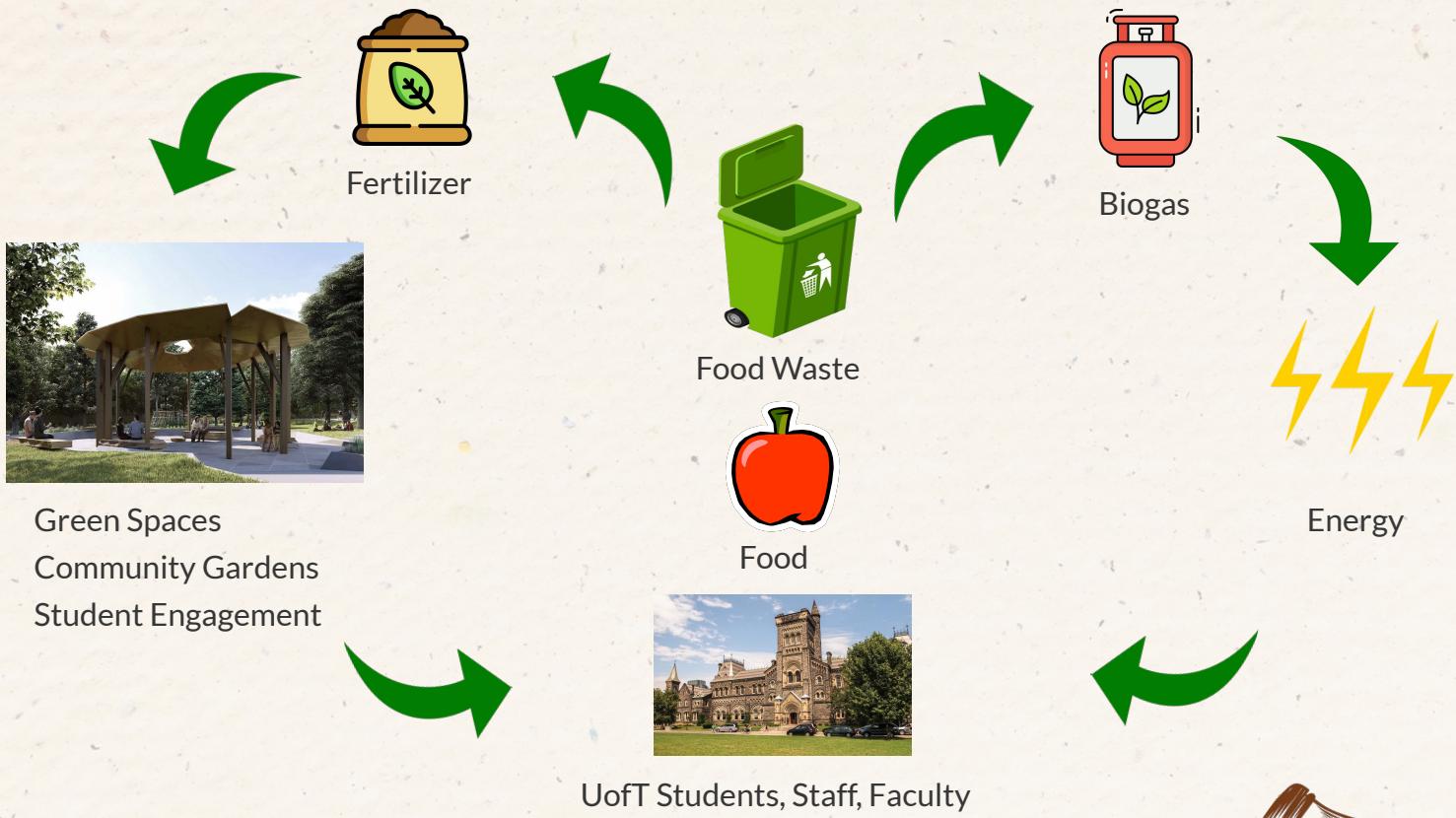
Some plants return on investment in 10 years on the bins.

https://www.edmonton.ca/programs_services/garbage_waste/edmonton-composting-facility

https://www.epa.gov/sites/default/files/2014-12/documents/funding_digestion.pdf

<https://www.ccacoalition.org/resources/anaerobic-digester-project-screening-tool>

A Reimagined Life Cycle



Conclusion

Our team sees an opportunity for University of Toronto to continue to lead the world in sustainability by creating the first **on-campus circular and regenerative compost system** in Canada.

