

Problem Statement

We have an anaerobic digester located on campus that has the potential to produce usable energy from food waste. However, there is not enough food waste entering the system for the digester to work at its full potential. An expansion of the collection of food waste on campus and transportation to the digester could remedy this problem. The digester on campus is designed for a maximum of 500 – 600 lbs of food waste each day. With this volume, the biogas produced could be used in an engine and generator to make heat and electricity. There is also a nutrient-rich liquid product produced that can be used as a fertilizer for our greenhouse, and for the grounds and athletic fields on campus. Before our project, less than 100 lbs of food waste was fed to the digester on an average day.[i] It is estimated that more than enough food waste is produced daily on campus to meet this requirement, from campus dining halls as well as dormitories and particularly on campus apartments. Unfortunately, most of this waste was not making its way into the digester.

Our team addressed the problem of collecting food waste from the on campus apartments, and feeding it to the digester. Previously, food waste was carried by truck to a landfill 90 miles away, so this truck transportation has a very significant environmental footprint [ii]. Also, the natural fertilizer produced from the digester reduces the need to purchase commercially made fertilizer, which also has an environmental footprint. The goal of this project was to encourage students and other members of our campus community to collect food waste to feed the anaerobic digester. Working with other groups, we want to help feed the digester at its full potential, 500-600 lbs per day. Based on this semester's work, we know that there is enthusiasm from students and potential to expand our project to approach the aforementioned goals.

Project Summary/ Background

With funding from the NYSP2I and our college, our team purchased collection bins to give to apartments that expressed interest in our project.



Image 1: Food Waste Collection Bin and Replacement Filters

When we collect food waste from on campus apartments, we reduce the amount of total waste that has to be transported to a landfill. While we may not collect a significant amount compared to a truckload, over time, our efforts may make a difference. By reducing the overall amount of landfill waste our college produces, we lower the number and/or weight of the trucks, which means less pollution and a reduction in the environmental footprint. According to waste management company Casella, their trucks travel about 90 miles (143 km) from the transfer station landfill. The average Casella garbage truck carries approximately 29.23 tons, or 58,460 lbs. (26,500 kg). Using this total, Casella estimates that their average truck's trip uses 46.25 gallons of gasoline (175.1 L). Casella's trucks pick up garbage twice a week from campus. This means that if the anaerobic digester is taking in its full capacity, about 2,100 lbs. (952.5 kg) less waste would make the trip to the landfill. Therefore, over 15 weeks (a semester), 1 truckload, or 46.25 gallons of gasoline, would be saved. [iii]

The same concept applies to the fertilizers. If more natural fertilizer is produced by the digester, the greenhouse and grass fields on campus will require less commercial fertilizer. Since

the production and possibly the use of store bought fertilizer has an environmental footprint, we are further reducing our campus environmental footprint by helping the production of natural fertilizer in the digester. Our project also serves as a pilot study to prove that we are able to collect significant amounts of food waste from apartment residents. Because the digester and the food waste collection projects are relatively new, our project is very important to this effort. Lastly, when we explain the impacts of our project to apartment residents, and when they actually empty their food waste from their normal trash to the bin we collect from, they become more sustainability and environmentally minded. Doing a simple task like recycling food waste may make residents think about other simple ways they can make a difference in reducing their own environmental footprint.

The most innovative aspects of this project have been managing unforeseen problems, particularly with cleaning the bins. Each apartment has a bin that stays with them, and when we empty them twice a week, we try to get all of the food waste from the bin. Excess waste that stays in the bottom of the bin can cause odor problems. To prevent these issues, we had to analyze the bin and the types of messy food waste. Our team got creative by purchasing a toilet brush cleaner and a car ice scraper to better remove the food from bins. Once a semester, we will collect all the bins and fully wash them out. We have also suggested that residents reuse plastic grocery bags as liners for the bin, to keep the bin clean. Repurposing grocery bags for use in the food waste bins is another simple sustainable solution to the odor problem caused by residual food waste.



Image 2: Apartment Food Waste Bin with Grocery Bag

In the future, we plan to be more innovative in the way we encourage apartments to participate in food waste collection, including giving away prizes for participating apartments, and promoting our project on a larger scale on campus. We also plan to get inventive and build a bike trailer to transport food waste, and further reduce our environmental footprint. Unfortunately, this was not practical this semester due to weather conditions.

One environmental tradeoff associated with our project is the use of a pickup truck to collect food waste. Because of the recent weather and distance, it is more practical, safe, and time efficient to use a truck to drive between the apartments and the digester. However, there is a separate group of apartments closer to the digester that we are able to minimize our environmental footprint by transporting food waste via walking, rather than using the truck.

Other possible approaches to getting more food in the digester include collecting from on campus dining halls and kitchens, off campus housing, or even restaurants off campus. We chose to collect from on campus apartments, because we felt that our project would have the biggest educational impact on other students. We hope that students will be mindful of their food waste at college, and will continue to recycle any food that is wasted and perhaps even

develop other sustainable, environmentally friendly habits when they leave college. Being on campus makes the collection and transportation easier, but it is a possibility for us to collect food waste from off campus locations in the future. Other students are collecting from dining halls and kitchens, and we continue to coordinate our efforts with them.

Relationship to Sustainability

This project promotes sustainability for the college, because we save the college money and reduce its overall waste produced. With more food waste collection bins being used by students, a larger amount of food waste can be brought to the anaerobic digester, steering it away from the regular garbage. This will save the college money in waste removal costs, because the college pays a waste management company by weight for its trash. Calculations have shown that if the digester operates at max capacity of 600 pounds of waste per day during the 210 day fall and spring semesters, 63 tons of food would be saved from being thrown away. Instead it would be used for a much better cause, which in this case the methane gas that is produced after the food is processed by the digester. Based on a savings of \$180/ton, the savings from using the digester would amount to \$11,340. The college could also save an additional \$8,577 on electricity during the 210 day period. This energy saving would come from the biogas running a co-generator. The co-generator would be programmed to first power the digester, then the greenhouse, and then the University or back to the grid. With these combined costs, the college would save an average of \$18,027 for each academic fall and spring semesters that the digester is running at maximum capacity [iv].

Getting the whole campus involved, or at least the on campus apartments, can end up saving the college money typically used for waste disposal. We must get the word out and make sure the student body and faculty/staff know how important it is to sort their food waste properly

in order to keep the digester functioning at an efficient level. As stated earlier, those who participate in collecting food waste become more sustainably minded, and will likely make more sustainable improvements in their daily lives. Residents who collect their food waste have told us that participating in our project reminds them to recycle other waste, and have other sustainable/environmentally friendly habits.

The environmental impacts of this project include a reduction in landfill waste and the production of usable fertilizer. In the future, there will be energy produced by a generator connected to the digester. The digester, itself, is part of a larger sustainable initiative which includes an energy cabin and greenhouse. With its cyclic nature, it will be a more environmentally friendly method of energy production compared to other methods.

Materials and Methods

Our work on this project started when we heard we would receive funding from NYSP2I and a sustainability project fund at our school for the project. We started spreading awareness about our project through our team and via emails. We ordered new bins and filters to accommodate the apartments. One of our professors graciously donated their empty cat litter bins to us for the collection of food waste. Because the project idea originated from a sustainability project club on campus, where students join and work on projects related to sustainability, we were able to get volunteers to help with our project. The first milestone we reached was when we had 20 participating apartments (our initial goal) and a regular schedule for us to collect food and feed the digester twice a week, coordinated with other food waste collection groups. Food waste is collected from the apartments into bins, which we bring to the digester, weigh and record the data, inspect for impurities, and start the digestion process as we have been trained. NYSP2I funds were used to purchase bins and replacement filters for the apartments. The four team

members and the volunteers all contributed equally to food waste collection. We dealt with minor problems such as odor and having to collect and clean the bins. After about a month of collection, we decided to try and get more apartments to participate in our project by hanging up fliers on their doors. Twelve more apartments expressed interest, and we ordered more bins and filters accordingly, and included them in the normal collection. Throughout the semester, we met with graduate students and a professor who work with the digester, and students who collect food waste from dining halls. Our project continues to expand as more apartments become interested in collecting their waste.

The roles of this team included collecting food waste, driving the truck, purchasing bins, filters, cleaning supplies, and other equipment for the project, managing our budget, communicating and meeting with the professors and students working with the digester, and promoting the project among students. Other people who have contributed include students from a sustainability club who helped with food waste collection, driving, and promoting the project; our advisors who helped us with advice and logistics; the graduate students who operate the digester for training our team and giving us information on the type of food to collect, and a professor for their donation of empty bins.

Results, Evaluation, and Demonstration

Before our project began, the digester was only being fed approximately 100 pounds per day. Since we started our involvement, we have increased that amount. Initially, we collected about 100 lbs of food waste each week, spread over 4 collection days. The average apartment puts an average of 5 lbs of food waste in their bins each week, and we had 21 apartments participating. After 5 weeks worth of collecting data to make sure the bins are making a significant increase, we added more compost bins to augment the participation in the project. After recently adding

12 more bins (to give a total of 33 bins), we have had an increase in food waste collected. More importantly, this expansion has proven to be manageable by our leadership team. We have several team members and volunteers who are knowledgeable about collecting the waste, and we were able to accommodate more apartments by adding an extra person to a collection shift where necessary. As of April 7th, we have collected over 725 lbs of food waste. Also, the waste put out by the apartment residents was almost entirely free from impurities. Residents responded well to our instructions for what can and cannot be collected as food waste.

Based on our results, we learned that students living in the apartments are indeed willing to voluntarily collect their food waste. The 33 apartments all emailed us expressing interest, even though they had no incentive besides helping our project, the environment, and sustainability. If we offer an incentive such as a prize, and directly speak to apartment residents, we are confident that even more apartments would be willing to participate. We have also learned that the residents follow our instructions and suggestions about what food to put in their bin and how to keep it clean. This respect that they have for our project is promising, because if there are non-food items in the bins, it is our job to remove them or they could damage the digester.

Along with the environmental assets that the group was hoping to see with this project, another goal was to change the way students thought about waste disposal. As the apartments received collection bins, some of the students were unsure as to what was considered acceptable food waste and what was garbage. It was important to teach the apartment residents exactly what belonged in the digester, as even a small amount of something that doesn't belong can disrupt the machine. The residents have learned over the course of the project not only what can be considered food waste, but also how much energy they are saving by taking part in the

project. Making more people environmentally minded through our project definitely has a great societal and environmental impact. As stated earlier, diverting food waste from the normal waste collection saves the university money in waste removal; money is also saved when the university uses the fertilizer from the digester. The environmental benefits can be seen in reducing the weight of the normal garbage trucks (which makes them more fuel efficient), and potentially the number of the trips they make.

The project we have done this semester, collecting from 33 apartments, can be scaled to include as many as all 176 on campus apartments. With added incentives, and from spreading awareness of our project, we know we can include more apartments next academic year. Also, we have successfully managed the collection and feeding aspect of the project, and the members of our team and the volunteer helpers have learned a lot about food waste collection. This will help with scaling up the project. If all 176 apartments participated in food waste collection, at 5 lbs per week, we would be collecting 880 lbs of food waste per week, and 12,320 lbs in a 14 week semester. This would account for almost $\frac{1}{4}$ of the food waste required to feed the digester for it to run at its full potential.

We will have a poster display, pictures, and a clean food waste collection at the exhibition event. This will help give detail to and explain our project and what we have done this semester with the NYSP2I funding.

Conclusions

Based on the work we have done this semester, we have learned that it is possible to successfully collect a good amount of food waste from on campus apartments. Treating this project as a pilot study, we have determined that we can expand the project to include more apartments, which means more food waste diverted from the landfill and fed to the digester. Between February 1st

and April 7th, we collected over 725 lbs of food waste. If this project is expanded, we will expect even more total waste, which will certainly be a substantial amount.

Our conclusions came from data we recorded every time we collected food waste, and are very accurate. Everyone collecting food waste had been trained to recognize acceptable and unacceptable waste material, and they reported that the apartments rarely put anything unacceptable in the bins. From talking to students living in apartments who did not collect waste, they expressed interest in participating, if they had an incentive. Future research includes surveys to all students, and specific ones for those who collect food waste. Therefore, we are confident in our conclusion that this semester's work has been successful, and that it has proved that we can expand the project in the future.

Please see the letter from the professor who oversees the digester operations. He has continuously given support for our project, and wants to see our project to expand in the future. He states in the letter: "I commend the student group for their dedication and organization to reliably maintain the collection system and to increase the organic substrate for the digester. As we improve our materials handling system and will be able to accept also post-consumer waste the anaerobic digestion system will be able to provide necessary energy and will allow [our university] to meet its sustainability goals." [v]

[i] Kelsey, Bradley. "Anaerobic Digester." Personal interview. 24 Sept. 2013.

[ii] "Solid Waste Management." *Clarkson University*. Sustainable Campus Operations, n.d. Web. 14 Oct. 2013.

[iii] Powers, Sue and Bisnett, Skip. "Casella Truck Trips." Personal interview. April 1 2014.

[iv] Waldron, Ashley, Shannon Gibson, Laura Pohl, and Kevin Labas. *Anaerobic Digestion of Clarkson Cafeteria* <https://www.clarkson.edu/green/docs/NYSP2I%20Digester-Final.pdf>

[v] Grimberg, Stefan. "Letter of Support for On Campus Food Collection." April 7 2014.