Waste Side Story: A Sustainability Rivalry
Dehydrator vs. Biodigester

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Overview

The goal of this project was to analyze the benefits of a biodigester versus a dehydrator to manage food waste in the redevelopment of the North Campus dining facility. Housing and Food Services (HFS) is looking to integrate food waste management equipment into the remodeling of McCarty Hall where the new North Campus dining hall will be located. Reviewed here is a determination of which food waste operation is preferable, the cost-benefit analysis of a dehydrator versus biodigester, and analysis of additional methods. Composting via food waste collection by Cedar Grove is the current operation for the University of Washington. Under further examination, we hope to replace it with a more sustainable method of dealing with food waste. Our client is Kara Carlson, known as the Business and Sustainability Manager for Housing and Food Services at UW. Based on the initial analysis our hypothesis is that the dehydrator will be the best option for the North campus dining facilities on the University of Washington campus.

Methods and Findings

In order to determine the cost of the current operation of food management at HFS, we looked at the datasheet provided by our client, which contained the logistic numbers for transportation costs to Cedar Grove. We calculated the amount of food waste transported, the monetary cost of transportation, and the amount of pollutants emitted due to waste transportation.

According to the EPA Emission Facts document by the Office of Transportation and Air Quality, the amount of pollutants emitted by garbage trucks alone is 16.3 tons per year.[1] The monetary cost of transportation is dependent on the weight of the waste being transported. Our team estimated approximately 445 tons of food waste, 11,841 pickups, and $61,568 spent per year. Based on these findings we determined that HFS was searching for a more cost-effective and energy efficient waste management method to integrate into the remodeling of McCarty Hall.

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[1] EPA. “Average In-use Emissions from Heavy Duty Trucks” (2008). *Office of Transportation and Air Quality.* 1-6. Oct. 2008. Web. 20 Feb. 2016. < https://www3.epa.gov/otaq/consumer/420f08027.pdf>.

Biodigesters convert solid food waste into liquid effluent and chemical byproducts that are disposed through a drain into the city's wastewater management. Biodigesters are unable to process non-food waste such as compostable to-go containers and cups. Given that students already have difficulty sorting waste, to invest in a biodigester would require additional staff to sort waste and since the biodigester is unable to deal with non-food waste, pickups to Cedar Grove would still be a requirement. While biodigesters convert food waste into liquid effluent and chemical byproduct, dehydrators can handle non-food waste, remove all the water from the compostable food waste which reduces it by 85 to 95 percent in weight. Although Cedar Grove would still need to pick-up the byproducts, the weight would be significantly reduced resulting in fewer pick-ups.

While researching these two products we also came across an additional product called an in-vessel composter. An in-vessel composter only has the capacity to process food waste, not compostable to-go containers and cups. However what makes this product unique is that it has the ability to turn the food waste into a compost soil amendment, which can be used for landscaping on campus or on the UW farm. Any extra compost can be donated to the local community.

Biodigester

The biodigester we chose was Enviropure brand, which had the appropriate capacity and in particular the wet system. A wet system is an anaerobic process that uses biological enzymes to breakdown the food producing methane and carbon dioxide inside of the biodigester. There were two different models: the GT series that works under a batch system, and the i Series that works under a continuous feed system. Continuous feed models do not require a set amount of waste before disposal like a batch system, and it allows the user to remove any non-food waste in the unit before it gets processed. However, one of the cons of the i Series is that the dispenser entry is only 7 inches wide diameter. Given the large amount of waste UW produces, it would require much more time to insert it into the machine and may require additional labor. Although the batch system does have a entry large enough to throw away food waste directly from a 32 gallon garbage can, the waste must be properly sorted before

dumping unlike the continuous feed system. Based on the characteristics of UW waste in Housing and Food Services, it was decided that a continuous feed system would be the better choice.

A unique characteristic of a biodigester is that it breaks down food into liquid effluent. This is done using a proprietary *Biomix*, an amendment that aids bacteria in decomposition, turning food waste into liquid effluent and CO_2[2]. Daily CO_2 emissions are displayed and reported with the iSeries. According to the vendor, CO_2 emitted can range from 300-1000 ppm, depending on whether the machine will be installed outdoors or indoors. Effluent discharged from the machine contains BODs (biochemical oxygen demand), FOGs (fat, oil, and grease) which would require a yearly permit of $17,000 if the disposed effluent is greater than the annual municipality limits. The size of the machine is 8 feet by 9 feet, it requires 4-7 gallons per minute while loading, and electricity costs are estimated to be $967 per year[3]. The Enviropure model EPW-2000i costs $40,000, according to our best estimates. Installation and transportation are $6,400, the *Biomix* that is required every six months would total $117 per year. Assuming the amount of labor is part time, the cost would be $19,500 per year. All things considered, the starting year would cost $83,979. Figure 1 illustrates a more detailed cost-benefit analysis for Enviropure Biodigester as described.The return on investment is expected to be within three years.

Dehydator

A dehydrator is a machine that pulps food waste and extracts water. Less transportation to Cedar Grove is required because of weight reduction. Dehydrators work in batch systems and each load would require 8-11 hours to complete its cycle[4]. The brand and model we selected, Gaia Recycle G-1200H from Ecco Technologies, was one of the few on the market that has the appropriate capacity for our study,

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[2] "EnviroPure Systems - How It Works." *EnviroPure Systems - How It Works*. N.p., n.d. Web. 14 Mar. 2016. <http://www.enviropuresystems.com/biomix.php>.

[3] Customer Service. (n.d.). Retrieved March 13, 2016, from http://www.seattle.gov/light/conserve/resident/appliances/cv5_appK.htm

[4] "Welcome to Ecco Technologies - 100% Waste Management in California."*Welcome to Ecco Technologies - 100% Waste Management in California*. Gaia Recycle, LLC, 2011. Web. 14 Mar. 2016. <http://www.ecco-technologies.com/giai.html>.

however the representative at Ecco Technologies advised against it for our purposes. We have included information for comparison and feasibility.

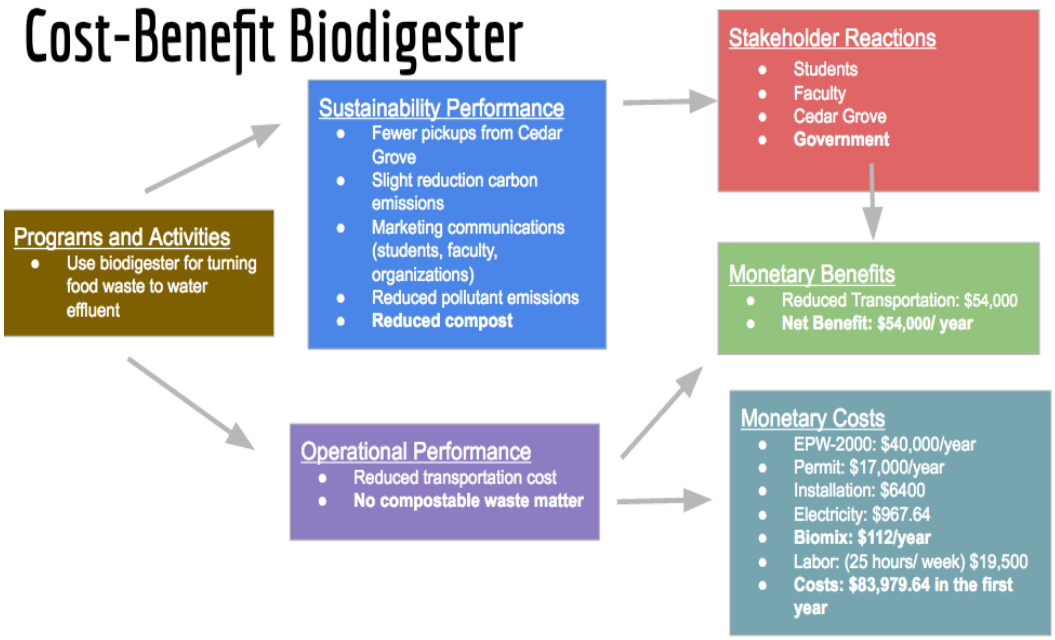

Figure 1: Cost-Benefit Analysis for Enviropure Biodigester. Image created by: Cristina Arias, Jenna Duncan, Susanne Gov, and Kevin Hua.

Gaia Recycle G-1200H can process up to 2.6 tons of of food waste per day and reduces the total weight to ⅛ of the original input[5]. It does not require any additional water or additives as it simply removes the water from the compost. A major benefit to using a dehydrator is that they can accept compostable containers and silverware. The cost for the Gaia Recycle G-1200H costs is approximately $200,000 and requires electricity, which equates to $11,664 annually. Labor costs would be $19,500, assuming part-time, and installation would be $3,500. Total initial cost for the first year would be

[5] Griffith-Onnen, Isaac, Zak Patten, and Jennifer Wong. "On-Site Food Systems for Food Waste." (2013): 1-55. MassDEP Food Waste Final Report. Northeastern University, 26 Apr. 2013. Web. 20 Jan. 2016. <http://www.mass.gov/eea/agencies/massdep/recycle/reduce/massdep-food-waste-final-report.pdf>.

$251,664. Figure 2 includes a cost-benefit analysis for the Gaia-Recycle Dehydrator. The return on investment would take 5 years.

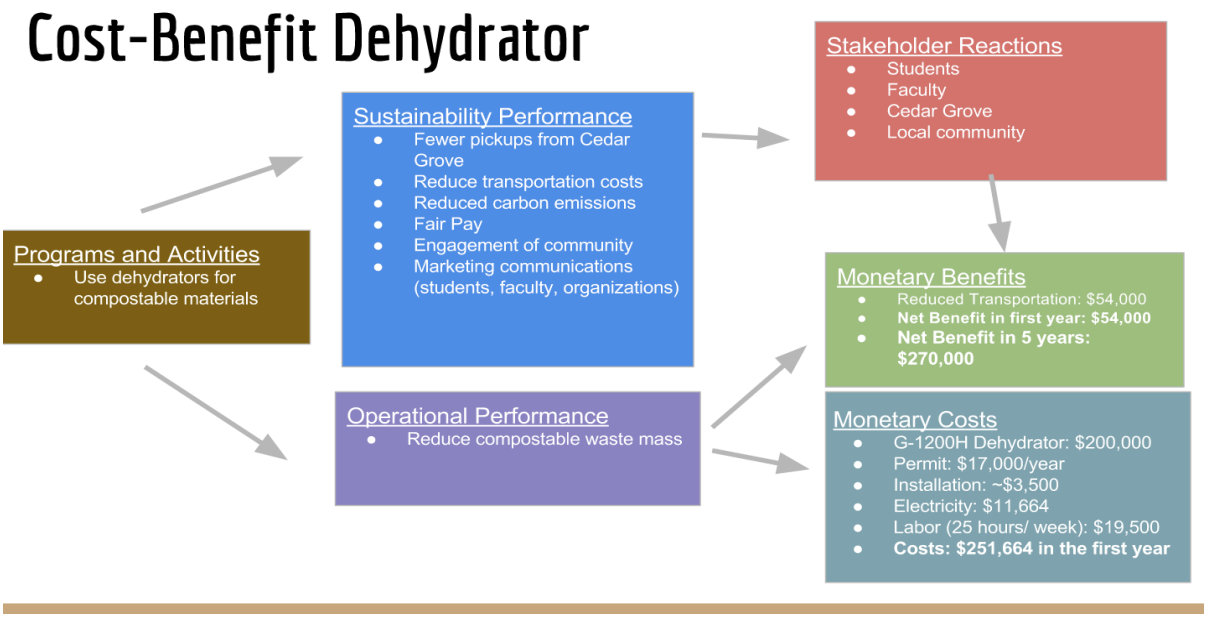

Figure 2: Cost-Benefit Analysis for Gaia-Recycle Dehydrator. Image created by: Cristina Arias, Jenna Duncan, Susanne Gov, and Kevin Hua.

In-Vessel Composter

An In-Vessel Composter was not part of the initial study, but was found along the way during the research. The representative with Ecco Technologies recommended that we consider an in-vessel composter as part of the cost-benefit analysis for the North Campus dining halls. This equipment pulps food waste and converts it into compost over the course of 6-10 weeks through aeration and natural decomposition[6]. Food waste is emptied daily into the machine and finished compost automatically unloaded into a collection bin where the compost is ready to use, or can be placed in maturation bays[7]. It is also vital to note that the In-Vessel Composter is the only food waste system

[6] "Big Hanna - How It Works." *Big Hanna - How It Works*. Susteco AB, n.d. Web. 14 Mar. 2016. <http://www.bighanna.com/how.html>.
[7] Ibid.

that can produce a compost soil amendment researched in this study. The in-vessel composter we have chosen is the largest capacity Big Hanna T480 from Susteco AB.

The Big Hanna T480 has the capacity for 2.6 tons of food waste per week. The Big Hanna cannot accept compostable containers or silverware and the cost for this particular in-vessel composter is $154,000. Washington State Department of Ecology requires a permit[8], which is $800 annually. Annual electricity costs would be $3,032. Labor costs would calculate to about $19,500 per year at a rate of 25 hours per week at the Seattle minimum wage. There would also be a National Pollution Discharge Elimination System (NPDES) permit [9] that would fall under the Standard Industrial Classification (SIC) code of Organic Chemical Fertilizers and cost about $17,000 a year.[10] The cost for the first year is estimated at $194,332. The return on investment is expected to be in 4 years when the net benefits from the reduction in transportation costs are approximately $54,000 per year. Figure 3 describes the details of the cost-benefit analysis. There is also a positive aspect of the In-Vessel Composter since it is likely that there will be a large amount of compost produced that will be available to be used for landscaping on campus, used on the UW farm and even donated to the community for personal gardening purposes.

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[8] "Permitting Process | Solid Waste Facilities | Waste 2 Resources Program | Washington State Department of Ecology." Permitting Process | Solid Waste Facilities | Waste 2 Resources Program. Washington State Department of Ecology, n.d. Web. 14 Mar. 2016. <http://www.ecy.wa.gov/programs/swfa/facilities/process.html>.

[9] "NPDES Wastewater & Stormwater Permits." Water. Web. 14 Mar. 2016. <http://www3.epa.gov/region09/water/npdes/>.

[10] "WAC 173-224-040: Permit Fee Schedule." WAC 173-224-040: Permit Fee Schedule. Web. 14 Mar. 2016. <http://apps.leg.wa.gov/WAC/default.aspx?cite=173-224-040>.

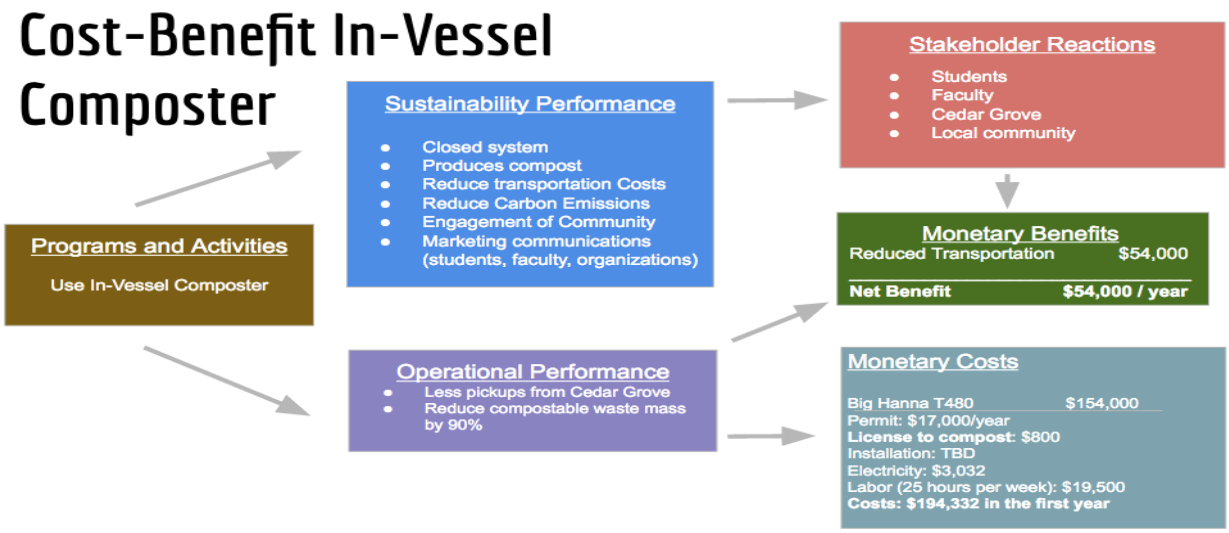

Figure 3: Cost-Benefit Analysis for the Big Hanna In-Vessel Composter. Image created by: Cristina Arias, Jenna Duncan, Susanne Gov, and Kevin Hua.

Recommendations

Considering the costs, energy requirements, and transportation we would recommend the in-vessel composting system. This was the only product that is a closed system, in which everything that goes into vessel comes out and it can continue to be used. Additionally if the UW transitioned to reusable to-go containers then sorting food and non-food waste could be eliminated. During our research we found schools like McGill University are successfully using the Big Hanna,[11] and have the same population size as the UW. Furthermore, using the in-vessel composter would be beneficial for the UW farm where they currently purchase most of their compost from Cedar Grove, which would reduce transportation costs for the farm as well. Any additional compost can be donated to the local community and P-Patch gardens in neighborhoods like the University District. Figure 4 breaks down the pros and cons for each of the options we have described.

[11] https://www.mcgill.ca/sustainability/campus-big-hanna-composter-sp0018

Technology	Cost	Benefits	Drawbacks	Net Benefit	Time for ROI
Dehydrator	$251,664	--Non-food waste -- Large input	-- Expensive -- Batch system --Company unavailable	-- Less trips to Cedar Grove $54,000/year	5 years
Biodigester	$83,579	-- Less Expensive -- Continuous Feed	-- No non-food waste -- Emits CO_2 -- Small input size	-- Less trips to Cedar Grove $54,000/year	3 years
In-Vessel Composter	$194,332	-- Large input --Produces compost	-- Expensive -- Batch system	--Less trips to Cedar Grove -- Compost as end product $54,000/year	4 years

Figure 4: Comparisons analysis for each option. Image created by: Cristina Arias, Jenna Duncan, Susanne Gov, and Kevin Hua.

Next Steps

We definitely recommend that our client looks further into these options as the UW campus increases in population. Any of these options would be beneficial as the university continues to grow and strive to become more sustainable. Ultimately as stated above the in-vessel composter would be more cost-effective as it requires the least amount of trips to Cedar Grove and would build a stronger, more sustainable community.

Conclusion

Compiling the amount of information needed for this project was one of the most challenging tasks given the amount of time and resources. However, we were able to create a cost-benefit analysis for each of the options featured in this paper because of

the in-class readings and research. As the UW continues to expand we hope this research will help provide a tool that can be utilized for a more sustainable campus.