Wellspring Waste to Energy Feasibility Study

Andrew Clinton, Emily Hajjar, and Frank Nakashian

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Center for Public Policy and Administration

Gordon Hall

418 North Pleasant Street

Amherst, MA 01002

(413) 545-3940

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I. Executive Summary:

This study was conducted by University of Massachusetts Amherst public policy masters students for Springfield based Wellspring Cooperative, a non-profit focused on cooperative job creation and training. The project assesses three potential scale options for Wellspring in order to use organic material to heat and/or generate electricity to power its hydroponic greenhouse. Though the greenhouse is not constructed as of yet, its source of energy is an important element for Wellspring. Motivations for utilizing organic waste to power the greenhouse are due in part to the influx of food waste sources being diverted due to the new Massachusetts Food Waste Ban. Indeed, new Massachusetts Department of Environmental Protection (DEP) restrictions on commercial food waste entering into landfills (CMR 310 19.017(3)) has created a conducive environment for composting and associated organic waste processing technology growth. Moreover, the commercial organic waste ban was a catalyst for Wellspring to contact the Center for Public Policy and Administration to determine what types of waste to energy technology could be incorporated to power their greenhouse and subsequent associated job growth.

In assessing potential energy generation sources, we researched the technological aspects for a compost-to-heat system, a small-scale anaerobic digester, and a large scale anaerobic digester. We then evaluated the relevant financial and implementation factors involved. We determined Wellspring's goals of waste to energy generation should be framed through the context of a short term and long term lens. The recommended short term strategy is to utilize composting systems to heat the greenhouse and connect the greenhouse to the electrical grid. The recommended long term strategy includes partnering with the City of Springfield to develop an organic waste processing facility that would generate electricity from food, animal, and human waste and/or contract with the city as a food waste hauler. With these recommendations we believe that Wellspring will achieve its goals and lead the way in sustainable energy generation practices.

II. Introduction:

Background of Wellspring:

Wellspring is a university-community collaborative that works to create jobs in inner city Springfield based on the purchasing power of the colleges, hospitals and universities that are the region's largest employers. These institutions purchase over $1.5 billion in goods and services a year, yet less than 10% of these purchases come from Springfield. Wellspring has built a partnership with these institutions to develop a network of worker-owned companies that will provide job training, stable employment, and an ownership stake among unemployed and underemployed residents of Springfield.

In December 2013, Wellspring Upholstery opened as Wellspring's first cooperative business. The cooperative's upholstery work includes dorm furniture, auditorium seating for colleges and universities, seating for area hospitals, and chairs for area restaurants and banquet facilities. The organization recently completed a business plan for a hydroponic greenhouse slated to open in 2015 as the second Wellspring Company. The Greenhouse will grow produce for surrounding businesses as well as serve as an educational tool. Wellspring has also recently developed a plan for a landscaping cooperative company.

Wellspring's mission is to create jobs for low income and unemployed residents of Springfield by establishing a network of worker-owned companies that meet the purchasing needs of the region's large medical and educational institutions that anchor the region's economy. Wellspring is looking to grow and develop new projects in the Springfield area after the success of Wellspring Upholstery. Wellspring has reached out to the University of Massachusetts as a partner to research new possibilities for their organization. The following section outlines the charge for this project and the research questions the CPPA students used to proceed with this project.

Wellspring Project Vision:

As a sustainable economic engine for the Greater Springfield area, Wellspring is involved in a myriad of projects to spur sustainable growth. One such project includes the development of a 20,000 sq. ft. hydroponic greenhouse that aims to "bring healthy, locally produced produce to area hospitals, schools, businesses, and residents."[1] In order to sustainably power this greenhouse, Wellspring is commissioning this feasibility study to explore sustainable energy production options that utilize anaerobic digestion and composting technologies. Long term Wellspring goals include the development of a sustainable energy company that utilizes these green energy production technologies.

In order to provide Wellspring with critical information regarding this project's feasibility, our study addresses the financial, technical, and implementation factors that will impact any action Wellspring takes. Additionally, in order to address all possible options for the project's scope, this study will address these three variables across three different scale options. These include small scale composting for heat production, medium scale anaerobic digestion energy production, and large-scale anaerobic digestion energy production.

At the same time, Wellspring seeks to understand:

A. How new regulations promulgated by the Commonwealth of Massachusetts may impact the market demand for organic waste processing centers;

B. How implementing each type of sustainable energy source could create jobs in the Greater Springfield area;

C. How the development of an anaerobic digestion or composting energy source could provide direct economic benefits to the Greenhouse Co-op by realizing energy savings for heating and/or supplying the Greenhouse with electricity;

D. How Wellspring can potentially leverage this technology in order to develop a sustainable energy company in the long term. Wellspring is also generally interested in identifying best practices for anaerobic digestion or composting implementation in urban settings, possible revenue variables associated with these types of projects, and costs and risk factors.

The following sections will explore the new legislation that has prompted the exploration of these green energy technologies, the various research strategies employed in this report's production, the key findings of this study, as well as the recommendations developed from this research for Wellspring.

<u>Background of New Legislation</u>:

As previously mentioned, recent regulations by the Commonwealth of Massachusetts have created an increased demand for organic waste processors in the short to medium term.[2] In 2014 the Massachusetts Department of Environmental Protection (DEP) implemented new rules regarding the disposal of organic waste by large organic waste generators.[3] As of October 1, 2014 any single location, facility, entity, or campus disposing of one or more tons of organic waste material per week is required to donate or repurpose the useable organic waste.[4] Specifically, the regulations promulgated by the DEP prohibit the disposal of organic waste materials in landfills or incineration facilities. These efforts are part of a broader strategy to reduce the amount of food waste going into landfills by 450,000 tons per year.[5] Additional policy goals include a decrease in greenhouse gas emissions generated as a result of burning or disposing large quantities of organic matter in incinerators or landfills and to reduce the overall organic waste stream by 30% by 2020.[6] Indeed, the amended waste ban has created a significant need for organic waste disposal and treatment centers in the immediate short and near term. Furthermore, the regulations incentivize the investment of sustainable waste management systems and renewable energy production technologies.

In the greater Springfield area, there are over 52 producers of commercial organic waste materials that will be impacted by the one ton/week waste regulations. According to guidance published by the Recycling Works program charged with overseeing this new rule, "delivering food waste to an off-site composting or anaerobic generation facility through a hauler is a common strategy"[7] for waste disposal. These anaerobic digestion facilities utilize the power of bacteria, mixing, and heat to break down organic solids in low oxygen environments. The output products of anaerobic digestion include methane, carbon dioxide, and other traces gases. These gases, referred to as biogas, can then be refined and used to produce heat and electricity. This clean fuel source can then be used to offset fuel costs and generate revenues through the exportation of excess electricity back to the electrical grid through a process known as net metering. Since exporting excess energy to the electrical grid requires significant involvement by public utilities, all distributed generation systems (i.e. anaerobic digestion systems) must be approved by the jurisdictional public utility through the interconnection authorization process.[8] Indeed, since Wellspring's identified potential site locations are within Western Massachusetts Electric's (Eversource) jurisdiction it will need to have its anaerobic digestion facilities approved by this utility. Furthermore, in order to be eligible to receive net metering credits as a result of producing excess electricity and exporting it to the grid, Wellspring would have to ensure its anaerobic digester's compliance with a myriad of technical regulations promulgated by the Departments of Energy Resources and Environmental Protection. For specific information related to receiving net metering credits see a link to Western Mass. Electric's net metering compliance guide located in Appendix E.

Business and organizations impacted by the commercial waste ban must divert their waste products to composting, food donation, and assorted biogas creating avenues. This will create an increased demand and development for organic waste processing services via anaerobic digestion or composting. This aligns with Wellspring's short-term goals of developing regular sources of organic waste materials for sustainable energy production to heat and/or provide electricity to its greenhouse. Due to the ultimate shrinkage of organic waste products as the regulation's ultimate goal, it is less clear if Wellspring's long term goal of developing a sustainable energy business based on the digestion of organic waste materials is viable.

The Two Potential Site Locations for a Wellspring Greenhouse:

Wellspring is currently assessing whether or not to purchase two parcels of land within Springfield for a potential anaerobic digester or composting development project. The two properties are described below:

The 1 acre site at 743 Worthington Street: (Appendix B):

This property is expected to be the future location of Wellspring's ½ acre greenhouse. This property is zoned industrial and is made up of 7 small parcels, of which Wellspring would purchase. Since the greenhouse would take up a half acre of the already small site, there would be limited space for an anaerobic digester as small scale designs still usually take up at least an acre of land. However, a composting system could be located at this site.

The 6 acre site at the intersection of Tapley & Bay Streets: (Appendix C):

This site is currently being assessed by Wellspring for potential purchase. The 6 acre site is currently owned by the city of Springfield and can be made available for sale. The city acquired the land due to tax neglect by the previous owners. The plot lies on industrial zoned land and could potentially be the site for a small to large anaerobic digester. Though the site does not lie near an agricultural area, it is in close proximity to Route 291 which would make transporting waste inputs and outputs more manageable. Before any plans can be made for this site, Wellspring or another buyer would need to pay for an environmental assessment and potential remediation measures. Due to its size, this site could hold a small to large anaerobic digester and a composting facility. *Figure 1* projects the electrical needs and costs for the potential 20,000 sq. ft. greenhouse.

Wellspring Greenhouse electrical need:	Average Cost of electricity per kWh in MA	Total potential energy costs for Wellspring per year
450 kWh/day	\$0.09-\$0.13[9]	450*.13*365 = \$21,352.50/year in electricity costs

Figure 1: Rate Calculations for a Small Scale Anaerobic Digester

Sector Growth & Incentives:

While the application of anaerobic digesters for the generation of sustainable green energy and the reduction of waste streams are quite common across Europe, the technology is a relatively new phenomenon in the United States. Traditionally, anaerobic digesters have been utilized in combination with waste-water treatment facilities as the process can reduce waste solids and provide power to operate plants or offset energy costs. Recently, as anaerobic digestion technology has become more ubiquitous in the US, other facilities such as dairy farms and large organic/food processing plants have opted to install anaerobic digesters to offset their own operational costs. Additionally, state and federal authorities have begun to realize the potential for anaerobic digestion in reducing greenhouse gas emissions and creating sustainable forms of energy by converting organic matter such as human refuse, manure, and other organic waste products through the chemical digestion process. In Massachusetts, the Department of Energy Resources (DOER) and the Department of Environmental Protection (DEP) have established sizeable grant and loan programs for municipalities, agricultural organizations, and private entities seeking to implement organic waste recycling systems for the production of sustainable energy. Some of these include:

The Recycling Loan Fund, which provides low interest loans of $50,000 to $500,000 to businesses that are reusing, processing, composting, or converting recyclable materials into marketable products. Because of the new regulations established by the DEP, this program offers priority assistance for food waste projects with specifics outlined below:

- Preferred terms for composting, anaerobic digestion, or other facilities that divert food waste from disposal.

-Interest rates as low as 2% (depending on credit and risk factors).

- Businesses such as food processors that are not recycling or composting entities but generate food waste, may be eligible to develop on-site composting or digestion operations for food waste diversion.[10]

The Department of Energy Resources grants funding for anaerobic digestion creation for public entities. By providing $1 million to DEP's Sustainable Materials Recovery Grant Program, DOER seeks to directly offset costs for municipal anaerobic digester projects.[11] If Wellspring is indeed able to bring the City of Springfield on board with its long-term goals this may be a viable financing option.

The Federal Government also offers grants for agricultural renewable projects. It is currently unclear whether Wellspring's operations would qualify because of its urban location. Further investigation into these financing opportunities will be needed once the technical outlines of Wellspring's project are finalized. One possible federal grant program is the USDA Rural Energy for America Program Renewable Energy Systems & Energy Efficiency Improvement Loans & Grants program. This provides guaranteed loan financing and grant funding for agricultural producers and rural small businesses to purchase or install renewable energy systems or make energy efficiency improvements. This grant program is applicable to agricultural producers with at least 50% of gross income coming from agricultural operations with grants for up to 25% of total eligible project costs and loan up to 75% of total project costs.[12] The Barstow Farm Anaerobic Digester for example was financed partially by similar federal grant programs. It will be incumbent on Wellspring to determine its project's eligibility status as this could substantially change the analysis of an anaerobic digester's viability.

The following sections of the report will detail how this initial feasibility study was conducted as well as its findings based upon the available information related to the commercial organics waste ban and the financial, technical, and implementation variables for composting and anaerobic digestion.

III. Methods:

In order to fully explore the options for sustainable energy production from anaerobic digestion or composting, we have decided to orient our feasibility study around the financial, technical, and implementation variables across our three identified scale options. Additionally, we have outlined the facets of a feasibility study, the various resources we contacted in order to derive information for this report, and the information we gathered from a site visit to a medium sized anaerobic digester in Hadley, MA.

Feasibility study:

After discussion with the client, it was determined that a feasibility study would be the best analysis for this particular project. By meeting with Wellspring and discussing the project, we identified questions of costs, scale, and job creation. To analyze these in the correct manner we determined a feasibility study would be the best option to answer all relevant questions.

Feasibility studies often look at areas including: market issues, organization/technical issues, and financial matters[13]. This type of analysis takes into account the associated variables with the ultimate goal of determining whether a project or an idea can be plausibly incorporated. In depth analyses of these variables allows for a comprehensive look at the possible outcomes of each scale option and the implications for Wellspring and Springfield as a whole.

This analysis also looks at the market for food waste among other organic waste inputs. The market for food waste changed dramatically under the Massachusetts Waste Ban, which will be taken into account in this analysis. Each project option has its own technological and financial issues. After the analysis was complete, a set of recommendations were composed[14] to help Wellspring make feasible steps in the right direction.

Food Waste Sources:

This data found in Appendix A was obtained through the Massachusetts Department of Environmental Protection to identify sites that generate at least 1 ton of food waste per week and fall under the Commercial Food Waste Ban. Moreover, this data was the starting point in researching potential firms Wellspring could use as food waste suppliers. Wellspring can reach out to these companies and firms to potentially establish a waste collection partnership, processing and collecting a firm's waste via a Wellspring owned composter or anaerobic digester.

In compiling Appendix A, we selected firms within towns and cities including Springfield, Chicopee, Ludlow, Agawam, and East Longmeadow. All of these municipalities share a border with Springfield and can be easily accessible for transportation to either potential Wellspring site located at (Appendix B and C). Once the municipalities were selected, the data was searched by zip codes. The data was further sorted to include amount of food waste generated per year. If the firm produced 52 tons of food waste a year it was kept in the data set.

Once the final list of potential food waste suppliers was compiled, each site was contacted and in some cases we spoke with facility and/or waste managers. From the calls, we obtained information in regards to how the firms disposed of their food waste (i.e. current waste disposal contracts) as well as specific names and contact information. The team first introduced themselves as students, and asked a set of three questions. The questions were as follows:

1) Do you fall under the MA new state food waste law?
2) What do you currently do with your food waste?
3) Would you be interested in working with Wellspring in the future for an alternative to your current hauling?

Our contacts indicated that most sites already had contracts for hauling away their waste. Some sites did not want to disclose how much they paid in tipping fees to have their waste hauled or the names of their current partners. Regardless, Appendix A lists the potential waste input sites that Wellspring could potentially contact in the future

Going forward, analyzing the availability of local organic food waste material that can be used in anaerobic digestion or composting is a critical factor in determining any project's feasibility. Factors that must be considered and addressed are: total tonnage of organic food waste available in the Greater Springfield area, the amount of viable waste inputs for anaerobic digestion or composting, potential competing facilities, and cost of securing the material.

Farm Visit:

As part of our feasibility report, we toured the Barstow Farm's digester in Hadley, MA as a case study and reference guide. This information significantly informed this report's understanding of small-scale anaerobic digestion systems discussed further below.

We chose to visit the Barstow Farm anaerobic digester due to its similar size and composition to the acre sized 734 Worthington Street site (see Appendix C) and its proximity to Wellspring's Springfield location.

The Barstow digester is a small-scale dairy farm based anaerobic digester that receives manure and food waste inputs. Each day approximately 6,000 gallons of cow manure and 4,000 – 9,000 gallons of separated sourced organics are delivered and pumped into the digester's 600,000 gallon holding tank. The manure is produced on site via dairy farm operations, and the food waste products are brought in by Rutland VT based Cassella Waste Systems (hereinafter named "Casella"). Once the waste inputs are digested in the low oxygen environment, the material breaks down and produces biogas. This biogas is then scrubbed for toxic chemicals and is combusted in a 300-kilowatt engine. Using a combined heat and power (CHP) capture system, also known as a "cogeneration system," the combustive activities are used to generate both electricity, which powers the system, and heat, which heats the digester tank to 100 degrees Fahrenheit. In addition, the output of heat and power is enough to operate the system and heat onsite buildings and export enough electricity to the grid to power 250 homes continuously.[14]

Picture 1: Barstow Digester Manure Tank

Picture 2: Separated Source Organic Waste Tank

In regards to financing and maintaining the digester, the Barstow Farm co-owns the digester with Cassella. Cassella works as a contractor for the Barstow Farm and is responsible for operations including maintenance, oversight, and associated technological and operational support. Additionally, Cassella is the supplier for the food waste inputs (ex. commercial organic materials, other associated materials). Cassella also removes and transports the byproduct digestate. In contracting supply and maintenance duties, Barstow is able to save money by not hiring or training farm staff on technical maintenance roles. However, the Barstow Farm loses a sense of autonomy by co-owning the digester with Cassella. In addition, the Barstow Farm is still responsible for "tipping fees" to Cassella for both the delivery of waste inputs and byproduct digestate removal.

Impact of Case Study for Wellspring:

One of Wellspring's core agency goals is to work to hire locally and foster on-the-job training skills for its workers. In this vein, establishing a contracting relationship similar to that of the Barstow and Cassella would on one hand enable Wellspring to establish a partnership providing on-site technical support and oversight. Moreover, Wellspring would not have to spend time and resources training staff member(s) on the maintenance and technical knowledge needed to autonomously take care of their potential digester. However, Wellspring stresses fostering job skills for local workers, so losing some autonomy may pose issues related to its core mission.

We would recommend Wellspring contract out technical support aspects associated with their projected digester. Anaerobic digesters are ultimately investments and specified care for digester components requires associated engineering expertise. Anaerobic digesters are also expensive, with capital costs ranging from 1.5 million to upwards of 10 million dollars. It would be in the best interests of Wellspring to invest in hiring maintenance contractors responsible for the construction, maintenance, and oversight of the facility. However, Wellspring employees should still be responsible for less technical operations such as cleaning and filling the digester. Assuming Wellspring can establish partnerships with commercial organic food waste suppliers, we recommend that Wellspring should have direct control of transporting the COM materials to the site of the digester. This would allow Wellspring to be free of tipping fees for COM waste delivery/digestate disposal and would also be in conjunction with Wellspring's mission goal of local employment and training.

One other takeaway from the case study site visit was the gained insight regarding the varying composition of potential waste inputs. By and far, the industry standard of anaerobic waste digesters use at least some percentage of manure or wastewater as a waste input. Using manure/wastewater is very efficient at providing energy and when situated on agricultural land, can be a "free" source of waste inputs. Additionally, manure is also widely used by digesters located on or near farms. Indeed, one of the reasons why the development of anaerobic digesters are so appealing on dairy farms is due to the fact that the digesters simultaneously dispose of manure while generating electricity.

The fact that a hypothetical Wellspring anaerobic digester would not be located on a farm is problematic in regards to waste inputs. Strictly logistically speaking, it would be easier for Wellspring to solely use commercial organic food waste material for its waste inputs. Since Wellspring is not located on a farm, it does not readily have access to manure waste. Getting this waste would require contacts with a nearby farm and constant delivery. Thus, it would be easier to rely on commercial organic food waste for the waste inputs.

IV. Findings:

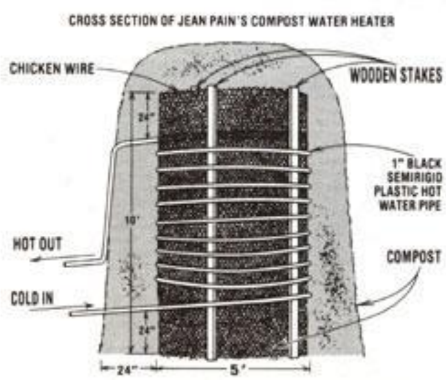
In this section we outlines the results of our investigation of the three scale options that Wellspring can possibly employ. Our goal was to develop and compile knowledge and best practices on the implementation of each scale option as it relates to our key orienting variables. Specifically, we focus on the financial, technical, and implementation variables across our identified scale options in order to address a wide range of project scopes. Through exploring each scale option and the various resources, technologies, and implementation capacities needed to implement them we are providing Wellspring with an important first step in achieving its short term energy goals and long term economic goals. The table below provides a summary of the key findings for each scale option researched. The sections to follow expand on these findings.

Figure 2: Scale Based Schematic

	Financial	Technical	Implementation
Scale Option 1: Compost to Heat Greenhouse	-Cost of equipment $6,300 for 1 mound, for 11 mounds $69,300 -At current propane rates[15], project pay back in 9 - 10 month, Saving $7,475 a month.	- 1 mound generates 680,544 BTU per day[16] 248,398,560 BTU per year -for 20,000 sq. ft. greenhouse approx. 11 mounds needed	-Waste needed: food waste, woody biomass, manure -Zoning for large compost pile - Must comply with regulations for composting under 310 CMR 16.00 promulgated by DEP
Scale Option 2: Small Scale AD on the magnitude of the Barstow Farm AD (e.g. 600,000 gallon digester tank, 285 kW engine, 20k-25k gallons per day of organic input)	- Capital Costs: >/= to $2 million dollars	- 1,000,000 BTU per hour - 285 kilowatts of power continuously (sufficient to power 250 average sized homes)	- Waste Inputs: separated source organic food waste, manure or human refuse sludge -Must comply with 310 CMR 16.00 and 19.00 promulgated by DEP, including site assignment and permitting regulations (See Appendix E)
Scale Option 3: Large Scale AD	- Capital costs are variable and range from around 5 to 10 million[17]	-At 100tpd, of waste inputs:7.9MWh/year, at 200tpd waste inputs: 15.8MWh/year[18] --Joint biogas anaerobic digesters have a digester capacity ranging from a few hundred meters3 to several thousand meters3[19] - Over 100 tons of organic matter needed at a minimum	-For a large scale digester, Wellspring would have to establish considerable partnerships with either municipal waste-water sources, large-scale agricultural waste sources. - Would need to complete a MA DEP RCC permit

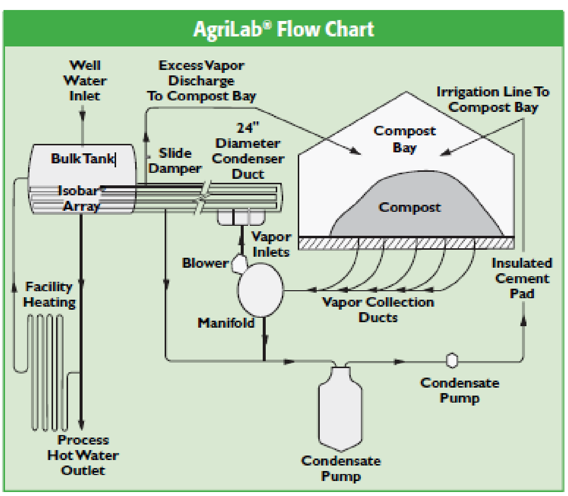
Scale Option 1: Compost to heat greenhouse:

Figure 3: The Jean Pain Mound



A commonly used technology design in compost-to-heat systems for greenhouses is the Jean Pain mound[20]. Developed in the 1970s, the Jean Pain mound generates heat from the compost mound and transfers it to the green house structure. This heat combustion and a seedbed heating system can be installed in the green house to evenly distribute the heat generated. Moreover, no turning is required for these mounds. For a 2,000 foot greenhouse, seedbeds the size of the compost mound would need to be 13-20 feet in diameter and between 8-10 feet tall[21]. It would require 30 to 50 cubic yards of material, which could include food waste, mulch, and manure. The heat exchange occurs in plastic tubing that is placed under the pile of wood chips and compost material where the temperature is the highest[22]. Additional materials can be added to the mound but with care so not to damage the system. The major advantage of this style of heat exchange are the low costs and strong ability to generarte heat. The diagram in *Figure 3* shows the composition of a Jean Pain mound. (Source: Compost Power[23])Another design for a similar composting implantation design can be built by AgriLab IsoBars. This technology uses heat transfers at fixed temperatures "while absorbing heat energy to change from a liquid to a gas[24]". The estimated cost for this system is $89,500 and would also need to be connected to a compost structure like a rotary drum composter. However, this can potentially be financed by USDA Rural Development grants and loans. In a feasibility study completed for the Franklin Park Zoo, the estimated capital costs for this system plus other equipment needed to use the compost for heat was $682,020[25]. See *Figure 4* for a diagram of this system.

Figure 4: AgriLab Flow Chart



(Source: AgriLab[26])

After researching different compost – to – heat systems and their initial capital costs and energy outputs, the Jean Pain Mound will be the recommended technology for Wellspring to use. The following estimates are based off of the project completed at the University of Vermont which has recently won several awards. The style used by UVM is a Jean Pain mound. The energy estimates will be based on a 40 yard mound. The project at UVM has been the basis for many case studies and will be used in this study to explain costs and inputs for a similar sized greenhouse. This project is a comparable size to what Wellspring should consider for their own project.

Energy generation from this project are estimated to be 680,544 BTU per day and 20,416,320 BTU per month for a 40 yard mound. If using a propane generator and buying propane at a price of $2.99[27] it would cost $245.75 per day to use a propane generator for heat. This would equal to $7,475 a month. If the total cost to build the project was $69,300, it would take just over 9 -10 months to break even on the project from the cost savings of not buying propane. This is determined by calculating the alternative cost of using a propane generator per month and comparing it to building costs of the compost system.

Upfront capital costs are based off the funding proposal which students from UVM used when proposing their compost for their heat project. The estimated costs include $3450 for equipment including: compost bay structure, piping, wood stakes, chicken wire, fans, wiring, and other composting materials. $2850 for monitoring and data collection equipment including; HOBO 4 channel data logger, HOBO 50' air/water/soil temperature probes, and a USB connector for data download. This also uses water to transfer heat and the initial water costs should be included.

Associated organic matter needed for this project include: food waste, woody biomass, and manure. This project has a lower demand of organic waste needed to supply heat for the green house. Since this project needs less material, the source of organic matter can come from the greenhouse itself and additional waste could come from other sources. Mulch is a significant part of this process and can be sourced from a farm or landscape supply company. The possibility of gathering food waste and organic matter from sites in Springfield is also possible for the construction of this project.

Possibly employment for this option could include one to two individuals to manage the system by regulating the heat in the green houses and maintaining the mounds. Additionally, managing the compost material gathered from the green house would also be required. In order to sell compost made from the green house, crops permits must be filed to make sure the material is safe and viable. Wellspring would need to contact MA DEP to fill out a General Permit Certification Form for New or Newly Acquired Recycling, Composting, Aerobic or Anaerobic Digestion Operations Pursuant to 310 CMR 16.04[28]. By selling compost made on site, the green house could produce a revenue stream and employ individuals to manage and sell the compost. In partnership with Wellspring's landscaping cooperative, a viable compost could be made to sell to the Springfield community. Possible grants could come from Northeast Share[29]. This organization has grants for professional development, sustainable community projects, as well as a partnership grant.

Scale Option 2: Small Scale Digester:

Since the 1940's, anaerobic digestion has been most commonly utilized around the Commonwealth of Massachusetts at wastewater treatment facilities. As the technology has developed and become more accessible, it has become increasingly used in the generation of heat and electrical energy.[30]

Through the use of conversion technology, it is now possible to harness the power of biogases produced by anaerobic digestion processes to heat facilities and generate electricity. A small scale anaerobic digester like the Barstow Farm digester would be completely sufficient for

Wellspring's short and potentially long term goals. This type of system would require the input of approximately 20,000 to 25,000 gallons of organic matter a day (including manure and food waste products). This system has the capability of powering a 285 kWh engine continuously and would certainly allow for the generation of sufficient amounts of energy to power Wellspring's ½ acre greenhouse in addition to many hundreds of other buildings. As a result there will be a significant amount of energy that can be "sold" back to the grid through the net metering process, meaning there will be potential opportunities for the realization of profits with this type of digester. This is especially true given Wellspring's identified energy needs for its ½ acre greenhouse. The potential energy value produced by a small scale digester with a similar capacity to Barstow's digester is approximately $324,558 dollars. The actual energy savings/ revenues will depend on the outcome of the net metering process. This will need further investigation once the project's scope is more specifically defined and the appropriate utility is engaged.

Picture 3: Barstow Farm Digester "cogeneration" Engine produces enough electricity to power 250 homes continuously

Additional revenue possibilities stem from the nutrient rich digestate that is created as a result of the digestion process. The Barstow Farm digester produces 30,000 gallons of liquid digestate a year that is directly applied to its crops. Wellspring could remove the water from this digestion output and potentially market it as fertilizer if pathogens were removed adequately.

However, there are some barriers that may make this type of digester less feasible than a smaller composting option especially: space considerations, the costs and logistical challenges of importing sufficient amounts of organic materials, and the financial costs for actually building such a facility and disposing of the unusable digestate. The development and construction of a digester of this size would require a capital investment of approximately $2 million dollars. Additional costs include the disposal of the unusable organic waste that is created as a result of the digestion process and the maintenance and operation of the facility itself.

According to other comparable feasibility studies exploring this issue, the single largest logistical barrier in developing any anaerobic digestion system is the procurement of an adequate supply of organic waste if the location is not located at a dairy farm or wastewater treatment facility.[31] For more feasibility studies addressing this topic see Appendix E. Given this, it will be necessary to secure contracts with organic waste producers in and around the City of Springfield so as to ensure an adequate supply of organic waste to fuel the digester. Even if Wellspring is able to secure these critical contracts it may need to add additional pre-digestion processing capacity to its system so that it can turn solid organic food wastes into a medium that can be pumped into and out of the digester. This again would mean greater upfront capital costs. In *Figure* 5 the logistical processes and technical needs to supply a digester with organic waste are outlined.

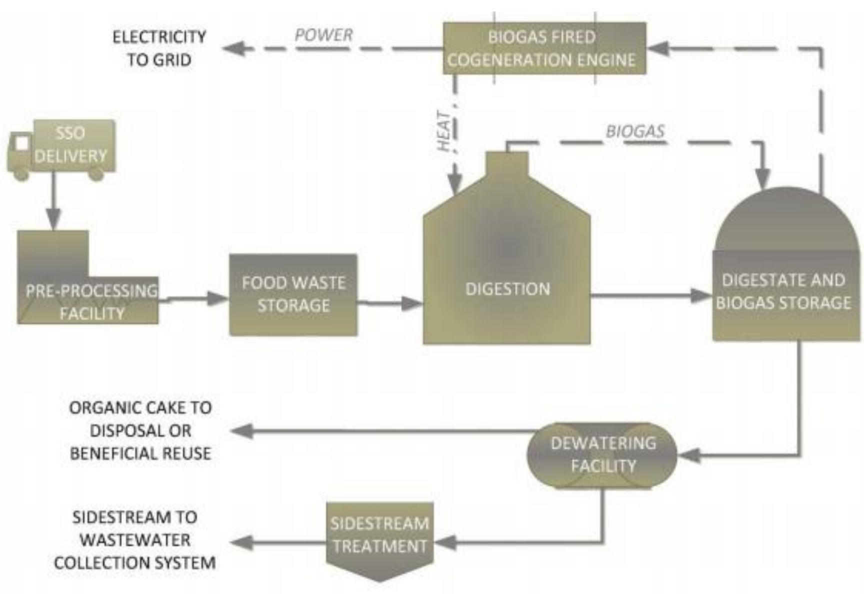


Figure 5: Logistical Steps Required for Supplying Small Scale Digester

(Source: Millbury Organics to Energy Feasibility Study[32]) Important to note is that Barstow's small scale digester does not require the pre-processing facility because it secures its organic waste through contracts with Cassella. If Wellspring is able to develop its own shipping systems to import the needed organic wastes then this activity could theoretically offer opportunities for employment. The costs of developing such an operation will need to be further investigated, however it is very likely that if Wellspring were able to develop this logistical system it could recoup tipping fees for removing and processing the organic waste for large scale producers. The operators of the Barstow Farm digester have recently secured contracts with large organic waste producers including Coca-Cola and HP Hood. A key difference in this context however is that Barstow Farm contracts the procurement of food waste materials to Cassella, which ultimately charges them for delivering that waste.

A final consideration is that food waste alone is often not an adequate enough source of organic waste to produce efficiently combustible biogas. From discussing the operation of the Barstow Farm digester with the Cassella technician it was clear that manure or some other organic refuse material was essential to biogas composition and that the technical difficulty of producing an adequate supply of biogas solely from organic food wastes may not be viable.

<u>Scale Option 3: Large Scale Anaerobic Digestion:</u>

Large scale anaerobic digesters process organic waste and produce biogas at the level to provide sufficient electricity generation for towns and small cities. It should be stressed that there are no definitive classifications or cutoff criteria differentiating large from smaller scale digesters[33]. Indeed, the power generation capacity and waste input levels are general delineators of whether a plant is large or not. Plants situated on farmland that produce electricity primarily for a farm's energy needs with a lesser degree of power sold back to the grid are usually considered small scale. In contrast, a plant which provides power needs for a town or city would be considered a large scale generator.

Conceptually, anaerobic digesters requiring an RCC permit by MA Department of Environmental Protection require over 100 tons of waste materials per day to be processed[34].

Digesters meeting this waste input threshold would be considered large scale. The majority of input sources for large scale generators come from industrial, agricultural, and municipal waste slurries such as wastewater and manure. Certain large scale digesters such as waste water treatment plants for instance can be located in an industrial zone use area as opposed to an agricultural zone.

One type, joint co-digestion biogas facilities are mostly large scale digesters, and have digester capacities varying from a few hundred to several thousand meters[35]. These facilities are designed to process manure and other waste sources from several farms in a centralized location. In this vein, joint co-digesters are primarily agriculturally based plants located on or in close proximity to farms. Another commonly seen large scale digester type are waste water treatment plants. Though the primary function of these plants is for sewage treatment, certain waste water treatment plants use anaerobic processes to treat water and provide electricity[36]. In Europe, around 30-70% of sewage is treated by anaerobic digestion in waste water treatment plants[37]. These plants can offset operation costs by biogas generation produced[38]. Additionally, a small amount of water treatment plants also have the capacity to treat post-consumer food waste for energy production such as the East Bay Municipal District plant, which averages 200 tons/week[39]. Two other types of digesters that can be constructed at the large level are batch reactors and plug flow continuously stirred reactors.

From a construction standpoint, large scale anaerobic generators require expert manufacturing capacity and communication from engineers, associated public sector regulators, and repair technicians. Larger digesters require more technical support and staffing. Larger digesters are also more complex than smaller designs. In comparison to their smaller counterparts, large scale digesters require more resources to operate, transport, and maintain[40]. In addition, large scale anaerobic digesters require very expensive capital costs and construction fees[41].

The fact that large scale digesters are able to function simultaneously as waste treatment and electrical functions make them appealing source of renewable energy production for urban areas[42]. Large scale generators use a mixture of wastewater slurry, manure from farm sources, and commercial organic materials.

How large scale digesters apply to Wellspring

Wellspring prides itself on promoting local employment opportunities and job training programs as part of its core mission. In this vein, the main employment opportunity presented by the creation of a large scale digester would be the transportation operations needed to deliver the supply of waste inputs and digestate transfer. In order to effectively carry out this task, Wellspring will need to operate at least a handful of trucks to pick up the waste inputs to the digester, and transfer out the digestate. In addition, Wellspring could employ auto mechanics to run both periodic and ad hoc vehicle maintenance. These transportation related jobs would be relatively easy to operate solely through Wellspring employees since the jobs would not require extensive training and technical expertise. The alternate option would be for Wellspring to contract out its waste transport duties to a separate entity. Though, saving these roles for Wellspring staff would be feasible and support agency goals.

In regards to the construction and technical operations of the digester, Wellspring would need to contract out duties and responsibilities due to the highly technical aspect of the work involved. The process of designing, building, and maintaining a digester requires structural, civil, environmental engineers, and other people with technical knowledge in a very niche market. Furthermore, the creation of anaerobic digesters requires the involvement of private firms that specialize in the creation and implementation of digesters. Since establishing an anaerobic digester requires large capital costs, it would not be wise to cut corners and have anyone but experts be a part of the design and maintenance process. Similarly, for long term operations, the continued maintenance and technical oversight should be overseen by independent contractors.

Additionally, large scale anaerobic digesters are often owned through a public or public/private partnership. Under solely public ownership, the state run plant has direct oversight on biogas production, though it would likely still contract out technical support position. Under a private/public partnership, the town/city would receive electricity for energy funding.

Even assuming that Wellspring will be able to pay for an environmental assessment and cleanup of the 6 acre Tabley & Bay Street parcel, a Wellspring owned large scale anaerobic digester would not be feasible to develop. From a logistic framework, the transportation costs of bringing in waste in large bulk (around 100 tons a day) would be very large. Similarly to a smaller scale design, the fact that the location is not on a farm site makes a potential joint co-digester very difficult to implement. From a financial perspective, the capital costs involved in a large scale construction would be extremely burdensome for Wellspring. Capital costs for a large scale design can range from 5 to 8 million dollars[43]. Waste water treatment plants are estimated even higher at over 9 million dollars for a 100,000 gpd facility[44]. Wellspring would have to establish a partnership to provide the city of Springfield with a sizeable amount of its energy for a large scale generator from being developed. Ultimately, Wellspring doesn't have nearly the amount of resources to undertake such a large investment.

V. Implementation Factors/ Other Research:

Food Waste Sources:

Currently within Springfield and surrounding municipalities there are 52 sites that are mandated under the MA Food Waste Ban to divert their food-waste out of the waste stream. These sites range in food generation from 1 to almost 9 tons per week. On average the available food waste from sites in this area is 144.65 tons per week and 7,522.14 tons per year[45].

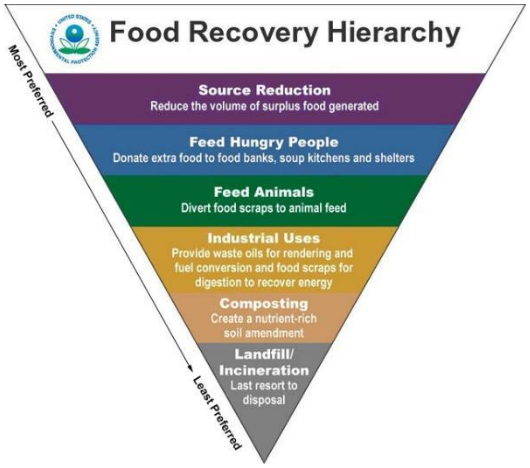
When companies were contacted to discuss their existing arrangements for diverting food-waste out of the waste stream all sites had existing contracts. Some were not willing to share what their contracts entailed or how much they were paying for hauling from private companies but most were happy with the services they were being provided. The sites that were the most receptive to communication were:

- Springfield Technical Community College
- Springfield College
- American International College

- Western New England College
- Baystate Medical Center
- Mercy Medical Center

These sites will be listed for Wellspring to contact and discuss the potential of establishing a waste contract. Wellspring will have to provide a competitive price for hauling as well as start negotiations before the sites sign new contract with private companies.

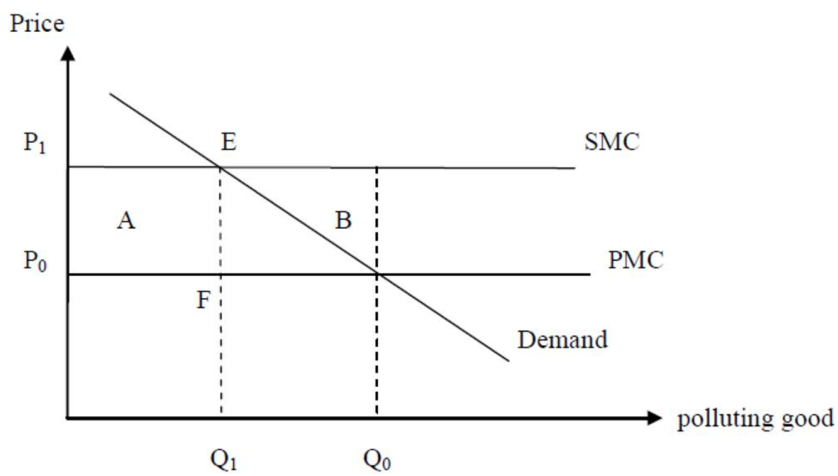
Figure 6: Food Recovery Hierarchy



The primary objective of the food waste ban in MA is to accomplish an overall reduction in food waste entering landfills and incinerators. The Massachusetts Department of Environmental Protection uses models created by the U.S. EPA for waste policy and education. *Figure 6* is a diagram of the U.S. EPA's standard for food recovery and waste. (Figure 6 Source: U.S. EPA[46])
Its objective is to stop waste at the beginning of the waste stream at consumption.

Indeed, limiting access to traditional waste streams for organic food waste is another main motivation of the ban. This follows various economic models for pollution. By implementing a cost on polluting, the amount of pollution will decrease. (Figure 7 Source: Zhou & Segerson[47])

Figure 7: Price and Pollution Abatement



This indicates that over time, the MA food waste ban will lower the amount of material flowing into traditional waste streams (landfills) as well as new waste streams (composting, energy generation). It will be important to track food waste at the generation stage over time to determine how long the market for food waste hauling and organic waste processing will be viable. In addition, there are reports that MA Department of Environmental Protection under the new Baker administration is providing waivers to sites regulated under the ban and is delaying enforcement of the ban[48]. Specifically, the new Republican administration in MA has provided waivers to sites that need extensions on implementation or cannot pay the necessary costs to haul the organic material. This unexpected infringement of the commercial food waste ban could negatively affect the market that has been developed for organic waste. The expansion of this waste ban could make it more viable. If it expanded to all commercial sites or public sites the organic waste stream could be a more stable market. Furthermore, individual municipalities could impose food waste bans on their residential waste. The city of Seattle passed Ordinance #124582 effective January 1st 2015 that bans food waste from being disposed of in the trash streams[49]. Municipalities in MA such as Springfield could propose similar ordinances to increase sustainable waste practices as well as promote job creation.

Yard Waste Sources:

Wellspring is currently planning on developing Viva Verde: an additional cooperative specializing in lawn care/maintenance slated to be established in the later portion of 2015. The operations conducted by Viva Verde would offer an additional waste input source for a potential anaerobic digester or compost facility. Assorted lawn waste collected from Viva Verde's operations can be a free input source of organic solid organic waste. Moreover, Wellspring would be able to avoid tipping fees with the inclusion of this waste source. Further follow up regarding Viva Verde's specific yard waste weekly/monthly generation estimates would need to be assessed when more information becomes available.

State Level Permitting:

According to MA CMR 310 16.05 anaerobic digesters receiving an average of over 100 tons daily of organic material input sources must complete a Recycling, Composting and Conversion (RCC) permit issued by the DEP[50]. RCC permits are issued when a proposed project meets defined criteria including environmental compliance, public hearings, and a site visit among others[51].

Anaerobic digesters in MA which receive less than 100 tons of organic material input sources daily based on a rolling basis must complete a less comprehensive general permit from the DEP as stated in CMR 310 16.04. General permits are less stringent than RCC permits[52]. Critical elements include the establishments of an odor control plan, environmental compliance, and the maintenance of general compliance standards among other items. See Appendix E for more information on permitting requirements for both anaerobic digestion and organic composting.

Additionally, according to MA CMR 301 11.3(9), plants that process, treat, and store 150 tons per day or more of solid waste must complete a mandatory environmental impact report (EIR)[53]. This regulation is relevant to waste water treatment plants and very large farm based digesters.

Springfield City Permits and Zoning:

Within Springfield, the anaerobic digester would be located in a zoned industrial area under a City Council Special Permit Review. Under the Springfield zoning guidelines, there are no specific guidelines on anaerobic digesters[54]. Moreover, the only inclusion of something close to a digester facility is a "residential renewable energy facility"[55]. However, this section refers to wind and solar energy facilities, not anaerobic digesters or composting operations.

Springfield city permitting ordinances that may be applicable to Wellspring's plans include:

- Removal of topsoil/loam requires a permit from the Springfield Building Commissioner per (4.7.62).[56]
- Building structures and misc. excavation must adhere to environmental variables addressed in Section 4.7.70.[57]
- Tanker truck use must receive clearance from the Fire Department.
- Registration of underground tanks must receive clearance from the Fire Department
- Gas storage/fuel oil storage receive clearance from the City Council
- Excavation/Earth removal receives clearance from the City Council
- Disposal works receives clearance from the Department of Health and Human Services
- Cross Connection Permit, Device Installation & Plan Review Water Commission

Noise:

The exhaust stream and electrical generator which produce electricity from the biogas created serve as the main noise creating aspects of anaerobic digesters[58]. Assuming constant operation, the associated noise generated could be a nuisance for nearby businesses and homes. Zoning restrictions aside, the associated noise generation (among other considerations) make the case for a digester to be located in an industrial/mixed use non-residential area.

Strategies can be implemented to abate exhaust and generator noise. Noise abating methods may also be necessary via zoning use and nuisance prevention. Potential strategies include implementing noise cancelling/abating noise fencing, sound attenuating brick, indoor enclosed area for the generator, and other acoustic insulation methods[59].

Smell:

The process of digesting liquid manure slurry results in lesser odor problems compared to the standard practice of storing manure in pits. However, as in most waste treatment applications, odor concerns pertaining to anaerobic digesters do occur and can be persistent problems[60]. The source of odor issues do not just come from manure inputs, but of food waste and other associated commercial organic matter as well[61].

One source of odor is generated when settling occurs in the digester during retention time. Settling is where heavier materials settle at the bottom and lighter matter converges at the top of the digester forming a crusty scum[62]. These effects reduce the space in the digester and result in incomplete digestion, while keeping excess gas near the top of the digester. More importantly, settling can lead to odor issues generated. Implementing a slurry pump or mechanical stirrer can control and reduce instances of settling and subsequent odor problems[62]. Mechanical design flaws can also result in odor problems. Damage to pre-treatment plants and feedstock storage can increase foul odor emissions. Periodic maintenance and proper insulation should reduce odor problems from pre-treatment storage tanks.

Additionally, non-ideal bacterial conditions can also result in increased foul smelling odor instances. Just as there are ideal pH, temperature, and matter components, the bacterial composition also plays an important role in the digestion process. Notably, the presence of acid forming bacteria (in contrast to methane forming bacteria) result in excess of odor producing acids which may not be fully converted to the resulting biogas[62]. Taking the proper precautions to ensure the contents in the digester are processed with the right temperature and mixing balance can be very valuable and effective at odor reduction.

VI. Discussion of findings & Recommendations:

Given the data explored as a result of this study, it is clear that Wellspring should pursue the development of composting technologies in order to provide heat for its greenhouse. This step, while the smallest scale explored, will provide Wellspring with the ability to build its organic recycling capacity while developing relationships with commercial organic food waste producers in the greater Springfield Area. This is a sensible first step for Wellspring, especially in light of the changing regulatory and economic landscapes for organic waste material producers and recyclers.

Three critical factors contribute to this recommendation. First, this option will enable Wellspring to attain its short-term goal of producing enough heat for its greenhouse through utilizing sustainable energy practices. This aligns with Wellspring's goals of supporting its for-profit economic activities in sustainable ways that benefit the surrounding Springfield Community. Not only will this strategy achieve energy savings for the facility itself, it will also contribute to a cleaner urban environment. Additionally, this composting strategy will also produce a potentially viable revenue-generating product that can be marketed along with the greenhouse's produce.

A second critical factor is the changing regulatory and economic landscape for organic waste producers and recyclers. Since the Commonwealth has instituted the commercial waste ban in October of 2014, there has been significant change and uncertainty in the economic and regulatory spheres governing these activities. Part of this has arisen out of the changing values of organic waste materials and the nascent organics waste material processing and recycling industry that is developing across the state. Despite these changes the costs of importing fully processed organic waste necessary for anaerobic generation are still high compared to costs across various parts of the country where anaerobic digestion is more ubiquitous. Further complicating the situation is the fact that the Department of Environmental Protection has begun granting waivers exempting waste producers for participating in the waste ban in certain circumstance which has contributed to the slow implementation of necessary organic waste processing capacity around the state. This has also created uncertainty regarding the future of the ban. For Wellspring's purposes this indicates that it is not clear how much the material may cost to import to a digestion facility, or if there will be enough material to sustain these processes in an economically viable way.

Finally, the third factor contributing to this recommendation is due to the fact that the capital and maintenance costs are significantly greater for a small scale or large-scale anaerobic digester as compared to implementing a composting system. While further exploration will be necessary, the smallest dollar cost for an anaerobic digester we identified was $1.8 million dollars and this specific system happened to be located on a dairy farm which boasted a continuous supply of organic waste materials to power the digester. Given the limited availability of pre-processed organic food waste materials in the Greater Springfield Area it is likely that any anaerobic digestion system would necessarily need a pre-digestion waste processing capacity, which could potentially add to the cost of construction. Furthermore, given the uncertain regulatory environment regarding the commercial organic waste ban and fluctuating economic realities, we find that it makes more sense for Wellspring to explore these more technical and costly digestion technologies after implementing a lower stakes demonstration project. While the economic benefits of a small-scale digester might pay off eventually it is too early in the implementation phase of the commercial organics waste ban to determine if this type of project would be viable for Wellspring.

Notwithstanding this conclusion we also recommend that Wellspring conduct future feasibility studies and a more site specific analysis in order to determine if there were variables excluded from this analysis that may in fact increase the economic viability of developing an anaerobic digestion project. In the future it may also be possible to work with the City of Springfield to capture a larger share of organic waste materials that are produced in and around the City.

VII. Conclusion:

The Massachusetts ban on commercial organic waste products entering landfills and incinerators has created an incentivized environment for composting and anaerobic waste digester operations. Indeed, the new divestment of large commercial organic waste inputs from traditional waste disposal methods coupled with state/federal loan and grant funding is projected to increase the amount of municipal and privately owned anaerobic digester/composting plants in the coming future. In this vein, Wellspring is wise to seek opportunities for anaerobic digester construction. Ideally, a digester would enable them to provide a renewable source of heat and electricity for their greenhouse, as well as a source of income in electricity sold back to the electrical grid. However, utilizing an on-site composting generator would be a more practical first step due to the multitude of cost and implementation variables.

Though Wellspring can very well establish a partnership with a food waste producing entity and import their waste as digester inputs, the most problematic feature of this scenario is that the anaerobic digestion process produces the most efficient biogas composition when manure or human refuse is included. In order to justify the requisite capital costs sizeable even for a small scale anaerobic digester, Wellspring would have to use manure waste inputs in addition to food waste. This would require Wellspring to have to ship the manure from a farm or other agricultural entity, likely at a cost, as agricultural entities usually sell their waste for fertilizer or compost activities. It would, however, be plausible for Wellspring to partner with the City of Springfield and haul in food waste to the city’s existing waste water treatment plant on Bondi’s Island. This would capture the city’s commercial food waste, use existing structures, and create jobs with Wellspring.

The other barrier to anaerobic digester development include the high associated capital costs. Small scale digesters cost approximately $2 million dollars at the smallest scale, which makes financing without grants cost prohibitive. In order for Wellspring to make the digester financially feasible, it would need to acquire grant and other financing sources for the project. If Wellspring takes on the costs alone, it could result in internal budget cuts, narrowing of services, and other associated losses in program activities.

Establishing a composting generator represents the best current avenue for organic waste to energy production for Wellspring. This option incurs the least amount of capital costs, and is the easiest option to implement. The decision to create a composting generator would also withstand a potential changing regulatory environment impacting food waste input streams. The first step to organic waste based renewable energy generation would be by compost energy utilization.

VIII. Appendix:

Appendix A. List of potential food waste supplies

Name	Address	City/Town	Zip Code	Generation (tons/year)	email	Phone Number Location
Geisslers Supermarket, Incorporated	830 Suffield St.	Agawam	1001	120		413-821-8904
Friendly's	19 Springfield St.	Agawam	1001	58.5		
Country Estates if Agawam	1200 Suffield St.	Agawam	1001	57.816		413-789-2200
Heritage Hall West	61 Cooper St.	Agawam	1001	53.874		413-786-8000
Elms College*	291 Springfield St.	Chicopee	1013	75.55275	marketing@elms.edu	413-265-2231
Fruit Fair Inc	398 Front St.	Chicopee	1013	52.5	fruitf398@yahoo.com	413-592-1097
Stop & Shop	672 Memorial Dr.	Chicopee	1020	450		413-593-1111
Big Y	650 Memorial Dr. # 3	Chicopee	1020	253.5		413-593-0204
Friendly's	529 Memorial Dr.	Chicopee	1020	93		
Lucky Strike Restaurant	703 Grattan St.	Chicopee	1020	82.5		413-536-7912
Debra Kopec	467 Memorial Dr.	Chicopee	1020	64.5		
Bridge Cafe	840 Memorial Dr.	Chicopee	1020	63		413-593-5553
Bernie's Dining Depot	749 James St.	Chicopee	1020	61.5		413-539-9268
Fifties Diner	363 Burnett Rd.	Chicopee	1020	52.5		413-594-5436
Big Y	2189 Westover Rd.	Chicopee	1022	249		413-504-4000
Stop & Shop	470 North Main St.	East Longmeadow	1028	304.3875		413-525-5747
99 Restaurant & Pub	390 N Main St.	East Longmeadow	1028	90		413-525-9900

Redstone Rehabilitation & Nursing	135 Benton Dr.	East Longmeadow	1028	83.439		413-224-3100
Friendly's	562 N Main St.	East Longmeadow	1028	55.5		
Big Y	425 Center St.	Ludlow	1056	300		413-589-0161
Mercy Medical Center Campus*	271 Carew St.	Springfield	1102	156.66165		413-748-9315
Student Prince & Fort Rest	8 Fort St.	Springfield	1103	120	info@studentprince.com	413-734-7475
Red Rose Pizzeria	1060 Main St.	Springfield	1103	57		413-739-8510
The Fat Cat Bar & Grill	232 Worthington St.	Springfield	1103	52.5		413-734-0554
Big Y	2145 Roosevelt Ave.	Springfield	1104	450		413-504-4000
Stop & Shop	1277 Liberty St.	Springfield	1104	255		413-732-6150
Big Y	1090 Saint James Ave.	Springfield	1104	253.5		413-732-5177
Consolidated Restaurant Operations	60 Congress St.	Springfield	1104	112.5		
99 Restaurant & Pub	1371 Liberty St.	Springfield	1104	85.5		413-731-9999
Panorama Restaurant	711 Dwight St. FL 12	Springfield	1104	75		413-781-0900
Chapin Center	200 Kendall St.	Springfield	1104	52.56		413-737-4756
Springfield Technical Community College*	One Armory Square	Springfield	1105	130.1832		413-755-6306
Lido Restaurant	555 Worthington St.	Springfield	1105	60		413-736-0887
Food Mart	355 Belmont Ave.	Springfield	1108	225		413-731-5600
Friendly's	65 Sumner Ave.	Springfield	1108	52.5		
Springfield College*	263 Alden St.	Springfield	1109	356.146875		413-748-3205
American International College*	1000 State St.	Springfield	1109	128.638125	frank.matera@aic.edu	413-205-3451

Kindred Hospital Park View	1400 State St.	Springfield	1109	79.26705		413-787-6160
Park View Rehabilitation & Nursing	1400 State St.	Springfield	1109	56.502		
Western New England College*	1215 Wilbraham Rd.	Springfield	1119	264.292875	peter.varley @wne.edu	413-782-1634
Big Y	800 Boston Rd.	Springfield	1119	253.5		413-543-0931 ex store manager
Price Rite	665 Boston Rd.	Springfield	1119	150		413-796-2934
Olive Garden	1380 Boston Rd.	Springfield	1119	90		413-783-9003
Ruby Tuesday	1411 Boston Rd.	Springfield	1119	90		413-782-4001
Applebee's	1349 Boston Rd.	Springfield	1119	75		413-796-8183
Texas Roadhouse	Cooley St.	Springfield	1128	150		413-782-8100
Big Y	300 Cooley St. # 1	Springfield	1128	112.5		413-783-0105
Friendly's	430 Cooley St.	Springfield	1128	55.5		
Stop & Shop	1530 Boston Rd.	Springfield	1129	300		413-543-1041 ex 0
Pizzeria Uno	1722 Boston Rd.	Springfield	1129	105		413-543-6600
99 Restaurant & Pub	1655 Boston Rd.	Springfield	1129	85.5		413-273-8999
Baystate Medical Center*	759 Chestnut St.	Springfield	1199	411.31485		413-794-0000

Source:
Mass DEP. http://www.mass.gov/eea/docs/dep/recycle/priorities/foodgen.xls

Appendix B: The 6 acre site at Tapley & Bay Streets

Courtesy Google Maps: 2015

Appendix Figure C: The 1 acre greenhouse site at 743 Worthington Street

Courtesy Google Maps, 2015

Appendix D: Useful Contact Information

Organization Name	Contact Name	Contact Info
MA Department of Environmental Protection – Recycling and Compost	Sumner Martinson	(617) 292-5969 sumner.martinson@state.ma.us
Casella Organics	Josh Haley	Joshua.haley@casella.com
MA Department of Agriculture	Steven Herbert	
Springfield Office of Planning & Economic Development		(413) 787-6020
Springfield Department of Public Works		(413) 736-3111
MA Department of Environmental Protection – Regional Coordinator	Jim Barry	Jim.barry@state.ma.us
Cooperative Energy, Recycling & Organics – Boston, MA		(617) 291-5855

Appendix E: Additional Resources

Net Metering:

1. Mass Electric's Net Metering Compliance Guide: *http://nuwnotes1.nu.com/apps/wmeco/webcontent.nsf/AR/Net_Metering_Tariff/$File/Net_Metering_Tariff.pdf*
2. The Energy and Environmental Affairs Net Metering Resources Page: http://www.mass.gov/eea/grants-and-tech-assistance/guidance-technical-assistance/agencies-and-divisions/dpu/net-metering-faqs.html#3
3. The Department of Energy Resources Distributed Generation and Interconnection Page: https://sites.google.com/site/massdgic/home/frequently-asked-questions#question12

Compiled List of Feasibility Studies of similar projects and similar technologies:

1. Massachusetts Clean Energy Center List of completed feasibility studies on composting and anaerobic digestion projects in the Commonwealth: http://www.masscec.com/content/completed-organics-energy-studies
2. Massachusetts Clean Energy Center Technology Vendor List: http://www.masscec.com/content/small-scale-organics-energy-vendor-directory
3. CDM Smith. 2012. Fatal Flaw Analysis for Development of an Anaerobic Digester Facility at Hamilton Landfill Site. Final Report. Web Accessed 2 April, 2015 from http://www.hamiltonma.gov/Pages/HamiltonMA_PublicWorks/04-2012%20-%20Hamilton%20-%20Fatal%20Flaw%20Analysis.pdf

Relevant Permitting Regulations:

1. Mass DEP regulations (310 CMR 16.00) regarding the permitting of composting and anaerobic digestion facilities: http://www.mass.gov/eea/agencies/massdep/recycle/regulations/310-cmr-16-000.html#1
2. Mass DEP solid waste facility regulations (310 CMR 19.00): http://www.mass.gov/eea/agencies/massdep/recycle/regulations/310-cmr-19-00.html
3. Mass Department of Food and Agriculture regulations (330 CMR 25.00) regarding the permitting of agricultural composting (in case Wellspring's project is regulated under these rules): http://www.mass.gov/eea/docs/agr/legal/regs/330-cmr-25-00.pdf
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