

ORGANICS TO ENERGY: ANAEROBIC DIGESTION



2014

Town of Greenfield
14 Court Square
Greenfield, Massachusetts, 01301

EXECUTIVE SUMMARY

I. Project Overview & Community Response

The intent of this feasibility study is to assess the potential for an anaerobic digestion (AD) system located at the Greenfield Transfer Station. The feasibility study is funded through the Massachusetts Clean Energy Center (MassCEC) Organics-to-Energy (OTE) Program. This program supports community education and technical assistance in evaluating organics to energy applications throughout Massachusetts.

Anaerobic digestion is a naturally occurring process that converts organic material, such as wastewater sludge and food waste, into biogas (methane) in the absence of oxygen. This process is replicated in air tight vessels that optimize the conditions to promote a healthy population of anaerobic bacteria, in turn enhancing methane production. The biogas (methane) is captured and used as a renewable energy generator as fuel for transportation or to generate electricity, both of which displace fossil fuel consumption. The process of analyzing a potential anaerobic digestion facility can be broken down into four basic stages. These stages include feedstock preparation, organic digestion and methane generation, gas recovery and energy generation, and digestate recovery and management.

Primary feasibility study drivers for the Town of Greenfield include:

- The reduction of disposal costs for the Greenfield Water Pollution Control Plant (WPCP), which costs the town approximately \$200,000 annually.
- To provide a long-term disposal solution for organic waste generated within the Franklin County community. The MassDEP newly promulgated organic waste ban, going into effect October 1, 2014, will limit disposal options for nearly 30 Greenfield organic waste generators. The addition of an AD facility will provide a local option for affected entities to manage adherence to regulations.
- Reducing municipal vehicle transportations costs and generating additional revenue through the sale of CNG for vehicle or fleet use.

Major economic impacts that can be accrued to Greenfield include lowering the disposal costs for the WPCP and the creation of CNG for vehicle use, which can offset current fleet costs. In addition to these economic benefits, environmental benefits of the proposed anaerobic digestion facility include reduced vehicle emissions due to local waste disposal (currently trucked long distances for disposal) and the generation of renewable bio-methane for vehicle use, which has a lower emissions profile than diesel or gasoline.

Community engagement with Greenfield residents and local environmental groups has been a priority from the launch of the feasibility study. BEAM Engineering, in partnership with the Town of Greenfield, hosted a public community forum regarding the potential of anaerobic digestion in Greenfield. This forum offered an opportunity for residents to learn, voice potential concerns, and ask questions about the technology, processes, and impacts. Support has been shown by the Greenfield community and local environmental groups, specifically through the drafting of the proposed biomass zoning ordinance. Clear language excludes 'anaerobic digestion' from the ordinance and construction restrictions of biomass facilities, as to not limit future opportunities for the development of an AD facility within the town.

II. Baseline Project and Market Conditions

The primary stakeholders associated with the project include the Greenfield Transfer Station (site of the proposed AD facility and municipal organics collection), the Greenfield Water Pollution Control Plant (source of sludge feedstock), and the regional generators of source separated organics (SSO's), including restaurants,

food processors, and supermarkets. Important findings related to baseline project and market conditions include:

- Three (3) acres of land are available at the Transfer Station for construction of the anaerobic digestion system (not including current operations and structures).
- The water pollution control plant (WPCP) has a high flood risk and therefore it is not a good location to site the anaerobic digestion system.
- Defined in the current Site Assignment, the Transfer Station is permitted to accept municipal solid waste, recycling, leaves, grass clippings, landscape refuse, and municipal food waste.
- Sludge disposal costs at the WPCP were \$187,158 in 2012 and forecasted to exceed \$200,000 in 2014.
- In evaluating potential feedstocks for the digester, the WPCP generates 7,796 tons of sludge waste annually and regional food waste generators will provide an estimated 7,108 tons annually. Traffic impacts will be minimal, with an additional one to two trucks delivering feedstock to the Transfer Station per day due to feedstock deliveries to the digester. Available data of proposed AD facilities in the region establishes that it is not likely Greenfield will have extensive competition for feedstock resources.
- Collection of municipal food waste has recently begun at the Transfer Station. This may provide additional organic feedstock to the digester, though the program is new and therefore the processing needed prior to integration into the digester will be determined in the final design stage.
- Vehicle costs for town related departments exceed \$324,385 annually; major municipal departments include the DPW-Solid Waste (\$63,175/year), School (\$58,082/year), and the Police Department (\$53,788/year).
- There are no CNG fueling stations that are currently located in the Greenfield region. Given the location at the juncture of Route 2 and I-91, there is strong stakeholder support to install a bioCNG fueling station in this area. The Massachusetts Clean Cities Coalition, an organization that promotes clean fuel vehicles, has been made aware of the project and has offered to provide support during the development process.

III. Anaerobic Digestion Equipment Research & Analysis

Commercially available anaerobic digestion technologies were explored to determine those best suited for the project. Major components of the system include feedstock processing equipment, digester types, biogas storage strategies, energy conversion systems, digestate processing, and remote system monitoring. Based upon the technical review in Section III, the following equipment strategies are recommended for Greenfield:

- Incorporate the ability for feedstock acceptance of both low-solid (pumpable) and high-solid substrates, with a trommel and chopper-pump for pre-processing.
- The anaerobic digester should be a complete mix mesophilic system with mechanical variable-angle mixers.
- Integrated PEX tubing should be used to provide heat to the hydrolysis and anaerobic digestion tanks.
- A tank mounted dual-membrane should be installed for biogas capture.
- A bioCNG fueling station should be installed for vehicle use.
- The necessary biogas cleaning and conditioning technologies will be included in the bioCNG system to ensure a high level of methane quality.
- The solid digestate is recommended to be composted on-site and used in either municipal applications, brownfield reclamation, or provided to a reseller. The liquid digestate will be returned to the WPCP through the existing sewer system.

CNG is recommended due to the interest Greenfield has in reducing municipal vehicle operational costs. CHP was explored but is not recommended due to the low electrical and thermal energy consumption at the Greenfield Transfer Station. Additionally, injecting bio-methane into the natural gas pipeline is not recommended due to the low cost of natural gas on the wholesale energy market.

IV. Design Scenario Analysis & Recommended Configuration

In order to effectively determine the optimal recommendation for Greenfield, diverse configurations were analyzed given the project's baseline conditions and the findings related to the anaerobic digestion equipment research. Findings and recommendations include:

- Six options were selected to represent a variety of configurations and were investigated in detail given the location, energy, feedstock, and operational conditions specific to this project.
- It is recommended that Greenfield pursue an anaerobic digestion system at the Transfer Station, where the bio-methane generated in the system can be used to establish a CNG fueling station for municipal, private, and public use. The system will co-digest organic waste (7,601 tons/year, 25% solids) and wastewater sludge from the WPCP (7,796 tons/year, 3-5% solids).
- The system will consist of two (2) receiving tanks, each at 25,000 gallons; there will be a 'high' strength and 'low' strength tank to facilitate optimal recipe management within the digester. Feedstock will flow from the receiving tanks to the hydrolyzer tank (52,000 gallons, 3-5 day retention time), and then to the digester tank (265,000 gallons, 30 day retention time).
- The digestion process is estimated to generate 1,097,664 m³ of methane annually.
- The CNG vehicle fueling station is estimated to generate 775 gallons equivalent of fuel daily.

V. Ownership Structures and Financial Analysis

The installation of an anaerobic digestion plant is a capital intensive project. Therefore, it is important to understand the conditions and risks associated with the investment, along with the sensitivities related to operational costs and future revenue streams. In discussions with Greenfield, the following items were established relating to ownership and contract structures:

- Greenfield has an interest in operating the anaerobic digestion side of the proposed system, though would like the CNG station to be operated by a specialty contractor under a turn-key contract.
- In order to reduce project risk during the financing period, it is recommended that the contract rates for feedstock, off-takers, and operational costs align with the period of financing where possible.
- Potential long term off-takers for the bioCNG have been determined and include vehicles owned by the Town of Greenfield, as well as a regional waste hauler who has expressed interest in converting their refuse disposal vehicle fleet to CNG.

Key revenue, savings, and costs for the recommended configuration include:

- Annual benefits are estimated to be \$1,066,175/year. This value is largely driven by the sale of CNG as vehicle fuel, renewable fuel standard credits, and a reduction in the disposal cost of sludge at the WPCP. Annual net benefit, after accounting for operating and maintenance costs are \$631,817.
- Capital costs for the system are estimated to be \$4,048,000. These costs are largely driven by the anaerobic digestion system and feedstock processing (\$2,120,000), the compressed natural gas fueling station (\$1,300,000), digestate dewatering (\$100,000), composting (\$100,000), and project contingencies (\$428,000).
- To support construction of the recommended system, grants through programs such as MassCEC Organics to Energy Program are estimated to provide \$400,000 towards construction costs.

- Annual operating and maintenance costs are estimated to be \$434,358. These costs are largely driven by operating costs of the anaerobic digestion system (\$202,400/year) and the bioCNG fueling station (\$231,958/year). The costs for the bioCNG fueling station are inclusive of bio-gas cleaning.

Key sensitivities relating to the projected financial analysis include:

- The value of high-energy organic waste as a feedstock is expected to increase as digesters are built in the region; for this reason, it was conservatively estimated that the tipping fees at the anaerobic digestion facility be zero revenue (compared to current average of \$78.50/ton in Massachusetts). 'Tipping fee' revenue for accepting regional food waste at the digester could generate additional revenue streams and should be pursued by the project development team.
- Determining a viable off-taker for the composted solid digestate is critical to the viability of the project; our financial model assumed a modest value of \$5.00/ton. The Town or development team should define a clear, long-term use for the solid digestate as well as a back-up plan for alternate uses or disposal.

VI. Regulatory, Permits, and Approvals

The process of permitting an anaerobic digester biogas to energy project may take anywhere from 4 to 12 months in Massachusetts, though could potentially take longer. Regulations are evolving and therefore all respective agencies should be consulted at time of project development.

- The *Town of Greenfield Guide to Development Permits* outlines a chronological step-by-step explanation of the permit process and is included in this report. Next steps include submitting a site plan design and convening a Staff Technical Review Group meeting to review the project with representatives from the following municipal entities: Planning & Development, Engineering from DPW, Fire Department, Licensing Commission, Health Department, and Building & Inspecting Department.
- Modifications to the existing WPCP Treatment Work Plan Approval (BRP WP 68) will be required to define that the anaerobic digestion system will serve as the primary sludge disposal method; the current primary disposal method should be included as a back-up.
- The proposed AD facility will accept solid food waste, pumpable food waste (FOG, food and beverage manufacturers/processors), as well as sludge from the WPCP. Given that the final permit for the Greenfield Sanitary Landfill states that as of 1996, sludge from the Greenfield WPCP would no longer be accepted at the landfill, modification to the existing site assignment will be necessary. Also, as a conversion and composting facility, the proposed operations are likely to trigger a Permit for Recycling, Composting or Conversion (16.05).
- The disposal of the separated liquid digestate will be returned to the WPCP through the existing sewer system line that runs directly from the Transfer Station to the WPCP. The additional wastewater due to the liquid digestate being returned to the WPCP has been discussed with the town and they do expect the additional flow to be acceptable given their current operations. The separated solid digestate will be composted on-site to meet state and federal requirements for land use. These disposal methods avoid the necessity of a NPDES for the digester system.
- Biosolids refer to sewage sludge that has been treated to meet federal and state standards. As sludge will serve as a primary feedstock in the digester, the digestate is therefore considered a biosolid. Both state and federal standards apply for pathogen and contaminant reduction and restrictions of use for biosolids. The EPA standards regulate the digestate to Class A and Class B, while the MassDEP classifies to Type I, II, III.
- Current Site Assignment language excludes sludge from the Transfer Station Site, so modification through traditional permitting is expected. MEPA review is a component of traditional permitting and is required when the project is seeking State Financial Assistance or requires a Permit from a State

Agency and exceeds a MEPA review threshold that is related to the subject matter of the State Permit. If it is determined that the project will not be accepting state financial assistance, it is likely that no MEPA review would be required, although if the proposed AD project accepts state financial assistance and triggers a threshold review condition, a MEPA review will likely be required.

- The BioCNG facility is a 'turnkey installation' where the responsibility to adhere to National Fire Protection Association regulations and the Massachusetts Board of Fire Prevention Regulations covering Compressed Natural Gas Containers and Systems should lie with the developer.

VII. Next Steps

The project has been determined to be feasible from a technical, economic, regulatory, and community perspective. If Greenfield would like to continue to pursue the project, the following key items should be defined as the project shifts to the pre-design and request for qualification (RFQ) or request for proposal (RFP) phase:

- Ownership and operational structure(s)
- Establish agreements for feedstock availability and type
- Digestate application or off-taker agreements
- CNG fleet vehicle agreements
- Establish grant and incentives through "offer letters" issued by the governing agency
- Civil site assessment for Transfer Station location
- Conceptual site plan submitted for a Greenfield Staff Technical Review Group meeting and to MassDEP for a permitting review meeting