# Market Characterization Report

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# Anaerobic Digester Gas-to-Electricity for the Food Manufacturing Sector in New York

Prepared for the
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# 1. Market Characterization

## 1.1. Description of New York's Food Manufacturing Sector

Food and beverage manufacturing facilities typically generate high strength waste streams as a by-product of their manufacturing operations. These waste streams are characterized by high Chemical Oxygen Demand (COD) and solids loading, making them well suited for treatment using anaerobic processes. Given the apparent market potential for anaerobic treatment and recovery of biogas for electricity generation within the sector, the New York State Energy Research and Development Authority (NYSERDA) retained Malcolm Pirnie to conduct an initial market characterization of the potential for electricity generation within this industrial sector in New York. A dataset of food processing factories and facilities across New York State, initially developed by Cornell University (Cornell) as part of a NYSERDA funded study titled, "A Web-Based Spatial Decision Support System for Utilizing Organic Wastes as Renewable Energy Resources in New York State", was used as the basis for the evaluation.

The original dataset included 149 food and beverage manufacturing facilities in New York. Malcolm Pirnie made up to three attempts to contact each of the facilities by telephone. Twenty one (21) industries had disconnected their telephone numbers since the database was developed, leaving 128 active food and beverage manufacturing facilities in the sector. Of the 128 active food and beverage manufacturing facilities, 75 facilities provided information on their wastewater with varying levels of detail. Table 1.1 shows a breakdown of the responses.

Efforts were also made to contact electric service providers to obtain records for food manufacturers that might have power generation systems. Central Hudson, Con Edison, NYSEG, National Grid, Orange & Rockland, and Rochester Gas & Electric were contacted, but no information could be obtained about interconnected ADG-to-electricity systems.

**Table 1-1.**
**Summary of Responses**

| Category | Number |
|---|---|
| Provided complete information | 27 |
| Provided partial information | 17 |
| Do not have treatment; do not know flow characteristics | 15 |
| Have very small flow or have no manufacturing at the facility | 16 |
| Unable to contact after 3 separate attempts | 46 |
| Refused to participate in call | 7 |
| Number had been disconnected | 21 |
| Total Facilities | **149** |

## 1.2. Biogas Production Potential

The COD loading data received from respondents were used to estimate the biogas production potential within the sector. For the industries that provided insufficient information on their waste discharge to develop an estimate of biogas production, results were extrapolated by grouping manufacturers by number of employees, which is an indication of facility size. Although not ideal, since facilities of the same size may manufacture different products, this was the most reasonable method to estimate overall biogas production potential in the sector from the information included in the dataset. Table 1.2 shows a breakdown of facilities by the number of employees.

**Table 1-2.**
**Summary of Facilities Size by Employees**

| Employees Size | Total Number | Number Responding to Survey with Complete Information | Percent of Same Size Facilities |
|---|---|---|---|
| More than 1,000 | 1 | 0 | 0% |
| 500-999 | 3 | 1 | 33% |
| 250-499 | 11 | 4 | 36% |
| 100-249 | 24 | 9 | 38% |
| 50-99 | 27 | 5 | 19% |
| 20-49 | 13 | 0 | 0% |
| 1-19 | 13 | 0 | 0% |
| Did not report size | 36 | 8 | 22% |
| Total Facilities | **128** | **27** | |

Extrapolating the data received from the survey respondents, and using the assumptions described below, it is estimated that the 128 active food and beverage manufacturing facilities included in the dataset have a biogas production potential of 3.8 billion cubic feet per year (cf/yr), with a corresponding theoretical heating value of 2,106 billion British thermal units (2,106,000 MMBtu). The assumptions used to develop the estimate were: 1) 70% of the influent COD is converted using anaerobic treatment, 2) based on stoichiometric relationships, the volume of methane produced per pound of COD converted is 6.4 cubic feet, 3) the methane content of the biogas is 60%, 4) the COD concentration in industrial food discharge is 1.5 times the biochemical oxygen demand (BOD), which is supported by the data from those respondents providing both BOD and COD data, and 5) the thermal value of biogas is 550 Btu/cf. Using a further assumption that an average electrical conversion efficiency of 25% will be achieved, the electrical production potential of the State's 128 food manufacturers is approximately 17.5 megawatts (MW).

Twenty-three of the 75 respondents reported that they discharge full strength waste to a municipal WWTP for treatment. These 23 facilities represent approximately 15% of the sector's estimated biogas potential, or approximately 0.6 billion cf/yr. Obviously, should on-site anaerobic treatment and electrical generation become a widespread practice in the food manufacturing facilities, the biogas potential at the WWTPs currently serving those industries would be reduced.

Four (4) of the 128 facilities surveyed have anaerobic digestion facilities in place. One facility uses the biogas to power blowers, which were installed with NYSERDA funding in 2005; one uses the biogas for digester and facility heating; and the remaining two facilities flare the biogas. None of these facilities use biogas to generate electricity. Using the same methodology described above, the biogas production potential of these four facilities is estimated at 133 million cf/yr, which represents 3% of the sector's potential.

**Table 1-3.**
**Biogas and Electrical Production Potential of NYS Food Manufacturers**

| Category (Number of Food Mfrs) | Biogas Production Potential (cf/year) | Theoretical Heating Value (MMBTU) | Electrical Production Potential [1] (kwh/yr) |
|---|---|---|---|
| Statewide (128) | 3,828,500,000 | 2,106,000 | 154,000,000 |
| Existing Anaerobic Digestion (AD) Facilities (4) | 133,400,000 | 73,000 | 5,369,000 |

[1] Based on an electrical conversion efficiency of 25%.

A breakdown of the estimated biogas production is shown in Table 1.4.

**Table 1-4.**
**Breakdown of Biogas Production**

| Employees Size | Biogas Production Potential (cf/year) | Theoretical Heating Value (MMBTU) | Electrical Production Potential [1] (kwh/yr) |
|---|---|---|---|
| 500-999 | 244,217,120 | 134,319 | 9,832,181 |
| 250-499 | 688,967,094 | 378,932 | 27,737,815 |
| 100-249 | 342,332,342 | 188,282 | 13,782,300 |
| 50-99 | 1,132,786,912 | 623,033 | 45,606,001 |
| Did not report size | 1,420,197,412 | 7881,109 | 57,177,148 |

[1] Based on an electrical conversion efficiency of 25%.

## 1.3. Market Assessment

Biogas recovery and use offers significant opportunities within the food and beverage manufacturing sector of New York. While a number of facilities employ on-site treatment or pretreatment of their wastes, only four of the respondents currently use anaerobic treatment processes, and none of the respondents generate electricity on-site using the biogas that is produced. The greatest initial opportu-

nity is through implementation of on-site electrical generation at the existing facilities. It is estimated that these facilities have a generating capacity of approximately 0.5 MW. In the mid- and long-term, implementation within the sector may prove economically justifiable for many facilities as waste disposal and treatment rates and electricity costs continue to escalate.

### 1.3.1. Market Opportunities

One of the greatest obstacles to widespread implementation of biogas-fired electrical generation in the sector is resistance on the part of manufacturers to move away from the core business of manufacturing and into waste treatment. In addition, because of the relatively large thermal demands of many food manufacturing processes, facilities that do implement anaerobic treatment may choose to use biogas as fuel for an on-site boiler, rather than for electrical generation. To maximize success in this sector, in addition to the direct benefits of electrical generation, the indirect benefits of waste heat recovery from distributed electrical generation equipment should be emphasized. A number of manufacturers currently employ some level of on-site treatment and, as evidenced by a number of successful applications throughout the State, collaboration between municipal WWTPs and food manufacturing facilities may offer an alternate means of capitalizing on the biogas potential within the food manufacturing sector without significantly affecting manufacturing operations. As a result, capitalizing on the biogas potential within the sector is feasible.

Options that are available to the food and beverage manufacturing sector include:

- Direct discharge to the headworks of a local WWTP for treatment. This alternative may offer the lowest capital cost, particularly if the WWTP has existing anaerobic digesters and adequate treatment capacity, and allows the biogas potential of the industrial waste to be recovered without requiring the manufacturer to undertake on-site treatment and electrical generation. A disadvantage of this alternative is a potential loss of control and manufacturing constraints that may be posed by treatment capacity.

- On-site treatment of the high strength wastewater at the food industry. This alternative may require greater capital investment, but offers the benefit of biogas use without the loss of control and potential capacity constraints of the previous alternative. Potential drawbacks include the requirement for the industry to operate a waste treatment and biogas recovery system, the administrative and permitting obligations associated with maintaining a discharge point, and potentially higher capital cost.

- Provide on-site anaerobic pretreatment of the high strength waste at the food industry with discharge of the pretreated wastewater to a WWTP. This alternative offers the benefits of biogas use at the industry without the potential capacity constraints at the WWTP. It also eliminates the need for a permitted discharge point and may result in lower capital costs when compared to construction of a treatment system to achieve effluent limits needed for direct discharge to a receiving water. Disadvantages of this alternative include the need for the industry to operate a waste treatment and biogas recovery system and the continued reliance on a WWTP for ultimate treatment of the waste.

- Discharge of high strength industrial waste directly to the anaerobic digesters at a WWTP either via a dedicated pipeline or by hauling the waste. If the existing digesters have sufficient treatment capacity, this alternative is likely to result in lower capital costs, is less constrained by the wet stream treatment capacity of the WWTP, and eliminates the need for the industry to operate a waste treatment and biogas recovery system. However, this option may make it more difficult for the industry to directly benefit from the biogas recovery and use. Additionally, should the existing digesters have insufficient capacity to treat the industrial waste, the capital costs for implementation will increase with the construction of additional anaerobic treatment processes at the WWTP for dedicated pre-treatment.

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