CO-DIGESTION ECONOMIC ANALYSIS TOOL (COEAT)

Model Objective:

The Co-Digestion Economic Analysis Tool (CoEAT) assesses the ***initial*** economic feasibility assessment of food waste co-digestion at wastewater treatment plants for the purpose of biogas production.

Note: This model is **not** intended to be a final evaluation of a food waste co-digestion project. Tool users should perform community and situation specific analyses of project viability prior to implementation.

Intended Audience:

Decision makers with significant technical and/or finance background; for example:

- Municipal Managers
- Engineers
- Finance Managers
- Wastewater Treatment Plant Managers and Operators

Background:

Organic materials—comprised of yard trimmings, food scraps, wood, and paper and paperboard products—make up more than 55% of the waste reaching landfills in the U.S.[1] In addition to taking up landfill space, organic materials produce methane, a potent greenhouse gas, as they degrade in landfills. The food waste component of organic materials alone comprises 18% of waste disposal in the U.S. and has a diversion rate of less than 3%. When properly processed, food scraps can generate renewable energy, enhance the soil as a fertilizer, and feed animals. Through anaerobic digestion, food waste can be transformed into a source of renewable energy as bacteria break down the food waste and release biogas as a byproduct.[2]

Food waste can be digested anaerobically to create renewable energy using a variety of methods, including:

- Co-digestion at a wastewater treatment plant[3]
- Co-digestion in a manure digester
- Digestion in a stand-alone digester

The East Bay Municipal Utility District (EBMUD) has successfully implemented a project that co-digests post-consumer food waste with biosolids at their main wastewater treatment plant.[4] From their project, the following key benefits of digesting food waste were identified:

- Food waste has 3 to 3.5 times the methane production potential per volume than biosolids. The methane production potential of biosolids was 120 m3 gas/ton and food waste around 367 m3 gas/ton.

[1] **U.S. Solid Waste Characterization 2008.** http://www.epa.gov/wastes/nonhaz/municipal/pubs/msw2008data.pdf

[2] **Organics: Anaerobic Digestion.** http://www.epa.gov/Region9/organics/ad/index.html

[3] **The Benefits of Anaerobic Digestion at Wastewater Treatment Facilities.** http://www.epa.gov/Region9/organics/ad/Why-Anaerobic-Digestion.pdf

[4] **EBMUD Report: Anaerobic Digestion of Food Waste.** http://www.epa.gov/Region9/organics/ad/EBMUDFinalReport.pdf

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- Food waste is more readily biodegradable and requires less residence time and digester volume than municipal biosolids.

Municipalities are increasingly interested in evaluating the viability of implementing food waste co-digestion in their service area as a way to reduce the amount of waste reaching landfills, generate renewable energy, and mitigate climate change. Currently, there are few examples in the U.S. of food waste co-digestion, and fewer still with data that capture the complexities of such a program including collecting food waste feedstock, pre-processing, and biogas production. ***This Co-Digestion Economic Analysis Tool was developed to provide municipalities and other organizations with an initial evaluation of the economic feasibility of food waste co-digestion.***

Model Overview:

The Co-Digestion Economic Analysis Tool (CoEAT) provides an ***initial*** economic feasibility assessment of food waste co-digestion at wastewater treatment plants for the purpose of biogas production.

The *Co-Digestion Economic Analysis Tool (CoEAT*) utilizes the current publicly-available data on the emerging practice of food waste co-digestion at wastewater treatment plants (WWTP). CoEAT does not require pre-existing WWTP digesters, and will calculate results with no pre-existing digester in place, however the model was intended to help WWTP operators assess the viability of implementing food waste co-digestion with existing anaerobic digesters. Because empirical data are not available for a wide variety of food waste co-digestion projects in the U.S., the model uses the best current data and should be considered a screening tool for initial evaluation.

CoEAT **does not** provide a rigorous feasibility study, but does identify the various logistical, operational, and equipment considerations within an "economic cost model" resulting in the calculation of the Net Present Value (NPV) of the project. The model is flexible and users can adjust assumptions and costs to fit their circumstances. Wherever available, source data is provided for further research and evaluation. For the best results, users should input community-specific information instead of using model assumptions.

Model Components (see below for more detailed explanation):

1. User Inputs: Community Data and Food Waste Sources
2. Feedstock Parameters
3. Food Waste Feedstock Data
4. Transportation and Processing
5. Pre-Processing and Ancillary Equipment
6. Digester Sizing
7. Financial Model Output

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The following schematic graphically depicts which components are considered as part of the tool and which are not. This tool models wet digestion and should not be used as a proxy for determining the feasibility of dry digestion. Key components which are not included as part of the tool are:

- Off-Site Pre-Processing
- Off-Site Use of Biogas
- Biogas Cleaning and Air Emissions Reductions
- Greenhouse Gas Emissions Reductions from Renewable Energy Generation
- Avoided Transportation to Landfill
- Operation and Maintenance of Collection Vehicles

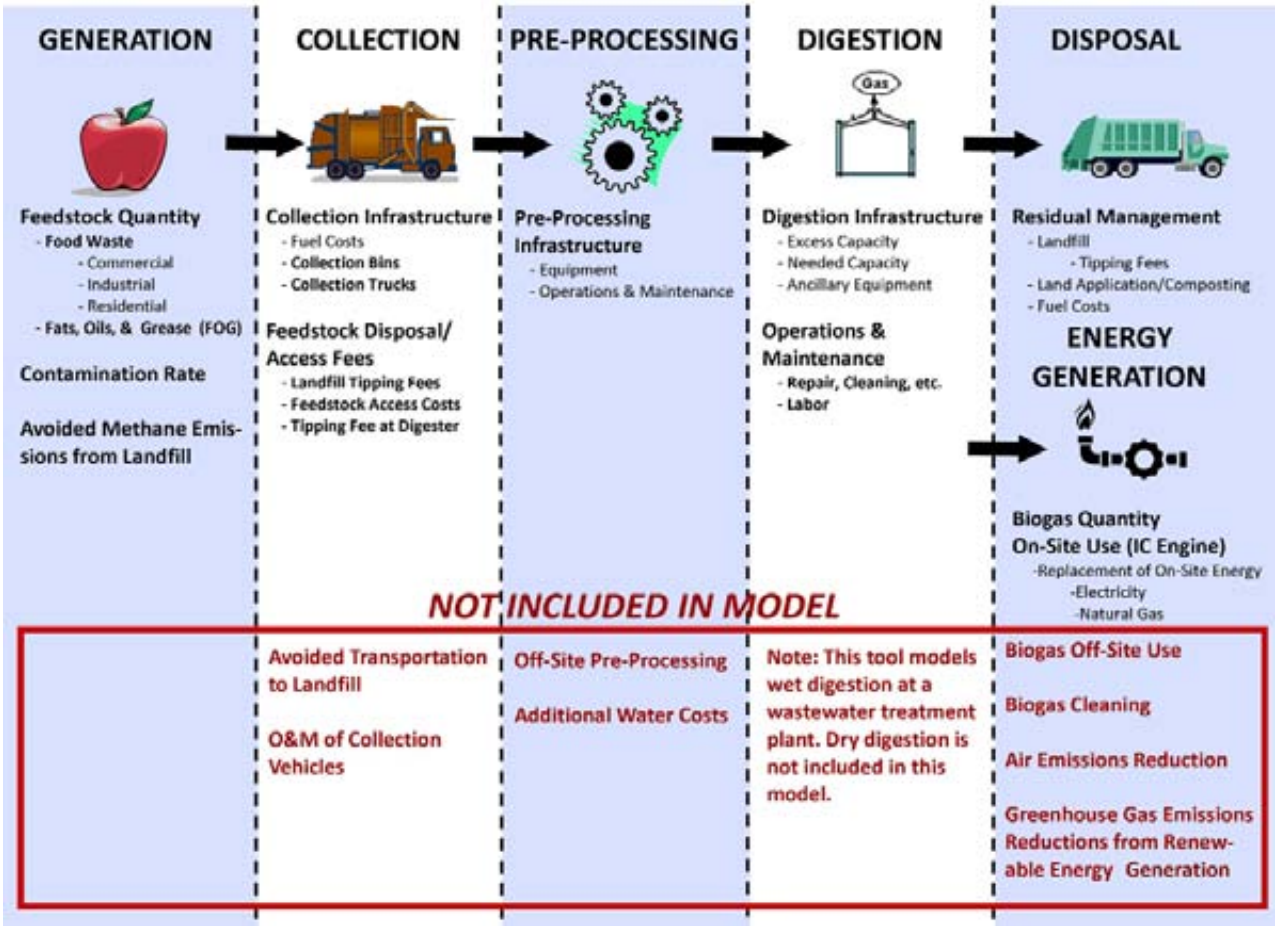

Figure 1. Schematic of Co-Digestion Economic Analysis Tool (CoEAT) - Identifies key components of the model as well as components that are not considered as part of the tool.

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Model Outputs:

CoEAT calculates the economic, environmental and operational outputs for a food waste co-digestion system including:

- Fixed and recurring costs
- Solid waste diversion savings
- Capital investments
- Biogas production and associated energy value

Types of Organic Waste Considered:

- Residential food waste
- Commercial food waste
- Fats, oils and grease (FOG)
- Food processing waste - fruit, vegetables, breads, rendering byproducts
- Dairy waste - milk solids
- Agricultural – fruit/vegetable trimmings

Using the Model:

The model is comprised of several linked worksheets, each of which addresses a unique aspect of a food waste co-digestion system. The model identifies costs and equipment requirements from the point of generation through collection, pre-processing, digestion, and disposal/land application of the residual.

The model can be customized according to individual circumstances, tailoring calculations to be more applicable to a city's or organization's parameters. The model can also be used to run "what if" scenarios and compare the results of different approaches

The model includes explanations and references so you can work through it without having to use significant outside reference materials.

Entering Your Data:

The "User Inputs" worksheet is for entering data on your community's (a) Food Waste Feedstock, (b) Solid Waste and Wastewater Infrastructure, and (c) Financial Data. The data entered on this worksheet is then used to calculate outputs throughout the rest of the model.

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Customizing the model:

The other model worksheets support the "User Input" worksheet and contain assumptions and default values that provide the underlying functionality of the model. Once familiar with the inputs, outputs and data used to calculate values, **you can customize the model for individual circumstances by modifying data in the other worksheets.**

Model Components:

Each of the Model components is briefly described below.

1. Feedstock Parameters	
Food Waste Feedstock Estimate: The model estimates food waste feedstock using one of the following three options:	
Option 1 - Food Waste Source Type:	Calculates household food waste availability based on per capita generation and non-household food waste based on type of non-household facilities and a per-capita calculation (from USDA data). Option 1 also incorporates non-household fats, oils, and grease (FOG). If intending to digest FOG, remember to select a FOG receiving station when building the digester.
Option 2 - Generating Establishments:	Calculates household food waste availability based on a per capita generation. Option 2 incorporates non-household food waste availability based on the number and type of food waste-generating facilities and results in a more accurate estimate of the availability of non-household food waste compared to the per-capita method. Option 2 also incorporates non-household FOG. If intending to digest FOG, remember to select a FOG receiving station when building the digester.
Option 3 - Custom Feedstock Audit:	Allows user to input specific quantity of feedstock.

2. Food Waste Feedstock Data	
This worksheet contains data from several sources that allow calculation of feedstock generation rates and availability including: ▪ Residential food waste	**U.S. Department of Agriculture:** 1. Population-based feedstock availability source data from studies of the amount of food available for consumptions along with the associated amount of

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▪ Commercial food waste ▪ Fats, oils and grease (FOG) ▪ Food processing waste - fruit, vegetables, breads, rendering byproducts ▪ Dairy waste - milk solids ▪ Agricultural – fruit/vegetable trimmings	wastage [lbs/capita/year]. 2. Studies of retail loss rates for perishables; e.g., how much food waste of each type a supermarket generates [lbs/capita/year]. **Massachusetts Dept. of Environment:** 3. Study of food waste generation by facility; e.g., resorts, hospitals, restaurants, prisons, supermarkets).

3. Transportation and Processing

This worksheet calculates the transportation and disposal costs associated with collecting and processing food waste feedstock and managing resulting biosolids. Considerations include feedstock collection infrastructure, transportation, access costs, and tipping fees.	***Data for this aspect of a food waste co-digestion program varies widely by community*** and the worksheet contains data to estimate costs. Identify the specific circumstances of the community and work with solid waste managers to consider: ▪ Effective Source Separated Organics (SSO) collection is complex and multi-faceted potentially requiring separate equipment and labor resources. ▪ SSO collection requires customization for the community according to an in-depth food waste feedstock audit and analysis. The model includes basic SSO collection costs such as transportation costs and avoided landfill tipping fees. ▪ Avoided feedstock landfill tipping fees - food waste that is co-digested instead of landfilled will increase diversion rates and lower landfill tipping fees. ▪ Feedstock access cost or revenue - obtaining some food waste may require fees or even result in revenue.

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4. Pre-processing and Ancillary Equipment	
This worksheet calculates costs not directly associated with the digester unit including three primary areas:	1. FOG Receiving Station: Necessary if the facility will be collecting and processing FOG, a high-value feedstock that will require separate handling and pre-processing. 2. Feedstock Pre-processing: The food waste typically requires some level of preprocessing to optimize digestion. Pre-processing includes various methods such as grinding, sifting, etc. 3. Ancillary Equipment and Services: Other tasks required include engineering and environmental studies associated with siting and constructing the digesters.
5. Digester Sizing	
This worksheet calculates the number of digesters needed to support the potential feedstock available from these two sources: 1. Food waste 2. Wastewater (This component identifies existing digesters that can be used for co-digestion and the capacity surplus or deficit to determine any required capital costs.)	**Capacity:** The digester capacity required is based on the food waste feedstock volume and characteristics. Some municipalities will have existing anaerobic digesters and, of those, many will have excess capacity that can be used to digest food waste. "Needed Capacity" represents the digester capacity required to process the commingled food waste and wastewater biosolids.
	Cost ▪ Cost to meet needed capacity ▪ Engineering, planning and permitting costs ▪ Annual operations and maintenance costs Fixed capital costs required to add digester capacity with additional costs (engineering and O&M costs) calculated as a percentage of capital cost.

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7. Financial Model Output

This worksheet calculates financial data associated with codigestion implementation including capital costs, O&M costs, and revenue streams.

Capital Costs:	Fixed capital costs required to add digester capacity with additional costs (engineering and O&M costs) calculated as a percentage of capital cost.
O&M Costs:	Costs for implementing and maintaining the system are calculated based on food waste volume and characteristics, and digester capacity requirements. Cost may include collection containers and vehicles, processing equipment, digesters, and disposal vehicles.
Revenue:	Potential revenue streams from food waste codigestion are calculated based on food waste volume and characteristics, and the associated biogas potential. Other potential benefits like renewable energy credits (REC) and net metering are location-specific. As such these potential benefits are difficult to anticipate and calculate and not calculated in the Model. Nonetheless, they could be meaningful financial factors in the feasibility analysis and therefore the model will allow the user to add the data manually.
Net Present Value (NPV):	The net present value (NPV) of the projected cash inflows and outflows including initial capital costs, is calculated for the project.

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