USER'S MANUAL: CO-DIGESTION ECONOMIC ANALYSIS TOOL

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Model Objective:

The Co-Digestion Economic Analysis Tool (Co-EAT) 2016, for which this manual applies, has three primary objectives:

1. Provides an **initial** economic feasibility assessment for co-digestion of organic wastes at a Water Resource Recovery Facility (WRRF) using anaerobic digestion (AD) to manage wastewater solids. The analysis can also be conducted to assess the feasibility of co-digestion at facilities that do not yet use, but are considering, anaerobic digestion, including dairies and stand-alone digesters.
2. Compare the relative merits of three uses of biogas: heating, electrical generation, and compressed natural gas for vehicle fuel.
3. Provide a clear comparison of the economic implications of co-digestion, given multiple performance assumptions, and unique physical and cost parameters provided by the tool-user.

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 who are considering adding food waste or another organic feedstock into existing anaerobic digester systems at a water resource recovery facility, farm, or food processer. It will help to have input from people with technical and finance background to help with input and interpretation of results. It is intended to be used by utility and city managers with specific information provided by engineers, WRRF managers, and operators.

Background:

Many WRRFs have AD systems that have excess capacity, sometimes significant excess capacity. This is often a result of changes in service area population not rising to match design expectations. Having AD capacity could be an opportunity to create or enhance income streams for the facility while at the same time helping to divert organic material from landfills. This tool can help calculate the cost of upgrading a facility, the expected increase in biogas production, and the enhanced income from tipping fees and increased energy production.

Wasted food and similar organic materials make up more than 30% of the waste reaching landfills in the U.S.[1] In a landfill, organic materials produce methane, a potent greenhouse gas. Through anaerobic digestion, food waste can be transformed into a source of renewable energy as microorganisms break down the food waste and release biogas as a product.[2]

[1] **U.S. Solid Waste Characterization 20013.**
https://www.epa.gov/smm/advancing-sustainable-materials-management-facts-and-figures

[2] **Organics: Anaerobic Digestion.**
https://www.epa.gov/anaerobic-digestion/basic-information-about-anaerobic-digestion-ad#HowADworks

CO-DIGESTION ECONOMIC ANALYSIS TOOL (CO-EAT)

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

- Co-digestion at a wastewater treatment plan***t***[3]
- Co-digestion in a farm digester
- Digestion in a stand-alone digester

Many water resource recovery facilities have successfully implemented co-digestion of post-consumer food waste and other organic wastes with biosolids at their main wastewater treatment plant.[4] The following key benefits of digesting food waste and other organics 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.
- 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 co-digestion in their service area as a way to reduce the amount of landfills, generate renewable energy, and mitigate climate change. Currently, there are many wastewater treatment facilities with excess digester capacity that may be ideal for co-digestion. ***This Co-Digestion Economic Analysis Tool was developed to provide a way to make a quick assessment of the economic feasibility of adding external feedstocks (especially food waste) to an existing anaerobic digester system at a WRRF.***

Model Overview:

The Co-Digestion Economic Analysis Tool (Co-EAT) provides an initial look at the economic and physical feasibility of organic waste co-digestion at Water Resource Recovery Facilities (WRRF) for the purpose of biogas production, for increased fees from new feedstocks, and for changing the nature of biosolids/digestate. The *Co-Digestion Economic Analysis Tool (Co-EAT*) utilizes the current publicly-available data on the emerging practice of co-digestion at WRRFs.

Co-EAT can be used with existing or projected digesters, and will calculate results with no pre-existing digester in place, however the model was intended to help WRRF operators assess the viability of implementing 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 as real feedstocks will have specific characteristics that will effect digester system performance.

Co-EAT **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 Annual Worth 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 measured operating parameters instead of using model assumptions.

[3] **The Benefits of Anaerobic Digestion.**
https://www.epa.gov/anaerobic-digestion/environmental-benefits-anaerobic-digestion-ad

[4] **Food Waste to Energy: How Six Water Resource Recovery Facilities are Boosting Biogas Production**
https://www.epa.gov/anaerobic-digestion/food-waste-nergy-how-six-water-resource-recovery-facilities-are-boosting-

Model Components (see below for more detailed explanations):

1. Graphical User Interface
    - Home
    - 1 – Digester
    - 2 – Feedstocks
    - 3 – Economics
    - 4 – Biosolids
    - 5 - Heating
2. Excel Worksheets
    - Overview
    - 1. Current Parameters
    - 2. Future Parameters
    - 3. Comparison
    - 4. Biogas Use
    - 5. Digester and Ancillary Equip.
    - Input Variables
    - Data Sheet
    - Glossary
    - References

The following schematic, Figure 1, graphically depicts which components are considered as part of the tool. 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 of Feedstock
- Biogas Air Emissions Reductions
- Greenhouse Gas Emissions Reductions from Renewable Energy Generation
- Avoided Transportation Costs to Landfill

Figure 1. Schematic of Co-Digestion Economic Analysis Tool (Co-EAT) - Identifies key components of the model.

Model Outputs:

Co-EAT calculates the economic, environmental and operational outputs for an organic waste co-digestion system including:

- Fixed and recurring costs
- Solid waste diversion savings

- Capital investments
- Biogas production
- Avoided Utility/Vehicle Fuel Costs

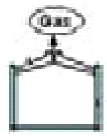
Collection

Feedstock Characteristics
- Food Waste
- Fats, Oils, & Grease (FOG)

Feedstock Receiving
- Landfill Tipping Fees
- Tipping Fee at Digester

Feedstock Processing
- Equipment
- Operations & Maintenance

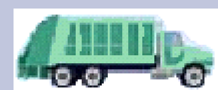
Digestion



Digester Infrastructure
- Excess Capacity
- Needed Capacity
- Ancillary Equipment

Operations & Maintenance
- Repair, cleaning, etc.
- Labor
- Operating Parameters

Effluent



Residual Management
- Transportation
- Tipping Fees

Biogas

Characteristics
Quantity
Value
- Heating
- Combined Heat and Power (CHP)
- Renewable Natural Gas (RNG)

Cleaning

Types of Organic Waste Considered:

- Food waste
- Fats, oils and grease (FOG)
- Other (If user has minimal feedstock characteristics, any organic feedstock can be modeled)

Using the Model:

The model is comprised of a graphical user interface (GUI) and several linked worksheets. The GUI provides an easy to follow, interactive variable input screen guiding the user through entering the necessary parameters to run the model. The worksheets are responsible for a majority of the calculations and organization of the data. The model can be customized according to individual circumstances, allowing the model to be applicable to many city's or organization's situation. It is designed to compare current operating parameters to future operating parameters. Providing "what if" scenarios to weigh different options for biogas use.

First Time Users

A first time user's tutorial can be found in Appendix B. The tutorial provides clear guidance that navigates users through their first use of the model.

Graphical User Interface (GUI)

The GUI provides a central location for the user to input data, Figure 2. The interface makes it easier to manage data and store it all in one place. The GUI performs two major calculations: annual heating demand and composite feedstock. Once data is entered and the 'Run' button clicked, the input variables are transported to the worksheets to perform calculations and generate an output. It should be noted that the GUI does not present the assumed variables located within the worksheets. The GUI only includes fields that require input from the user. It is recommended that the user becomes familiar with the assumed variables and calculations embedded in the worksheets to further tweak the model to their specific needs.

Figure 2. Home tab of the graphical user interface.

Excel Worksheets

The Excel Worksheets provide a majority of the calculations and organize the data. Through the open worksheets, the user has the ability to review the formulas and assumptions and/or copy and paste information to be compared to a later run. If default variables are change, it is possible to restore the worksheets back to default using the designated buttons located on each worksheet. If a value and/or formula is changed and not restored, this value and/or formula will be used for every run until the default formulas are restored.

Opening the Model

Once the model is downloaded from https://www.epa.gov/anaerobic-digestion/anaerobic-digestion-tools-and-resources#CoEAT, the model can be opened by double clicking the file. After the file loads, a selection screen will pop-up only if macros are enabled. Having macros enabled is required to run the GUI. To do so, please follow Microsoft's procedure for enabling macros. Once macros are enabled, the pop-up window appears. The user will be asked to start new or load previously saved data.

Collecting Data

The necessary data must be collected before using the model. If new was selected in the opening pop-up window, the GUI will start with the “Home” tab. Two buttons, “Print” and “Spreadsheet”, are located here allowing the user to either print or use a spreadsheet to collect all of the necessary data for the model. Some of the values on the “Co-EAT Input Data Sheet” are marked with an ‘X’ in the ‘Model’ column indicating the model has default values for these parameters which should only be used if the user does not have their own information.

Navigation

The GUI contains buttons (Perform Actions) and tabs (Receive Inputs). The button logic is displayed in Figure 3. The tabs are navigable using buttons or by clicking. The input boxes located in the tabs can be navigated using the ‘tab’ key or by clicking. Worksheets are accessible while the GUI is open. Data will not be imported into the worksheets until ‘Run’ is clicked. Once in the worksheets, the GUI can be accessed using multiple buttons located throughout the workbook. For example, the button named ‘Calculate Composite Feedstock’ takes the user back to the GUI. As illustrated in Figure 3, for data to remain in the GUI and be imported into the worksheet, the user must select run. If the GUI is closed using the ‘X’, all data in the GUI will be lost and not imported into the worksheets. Once the user returns to the worksheets, normal navigation of an Excel workbook is restored.

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

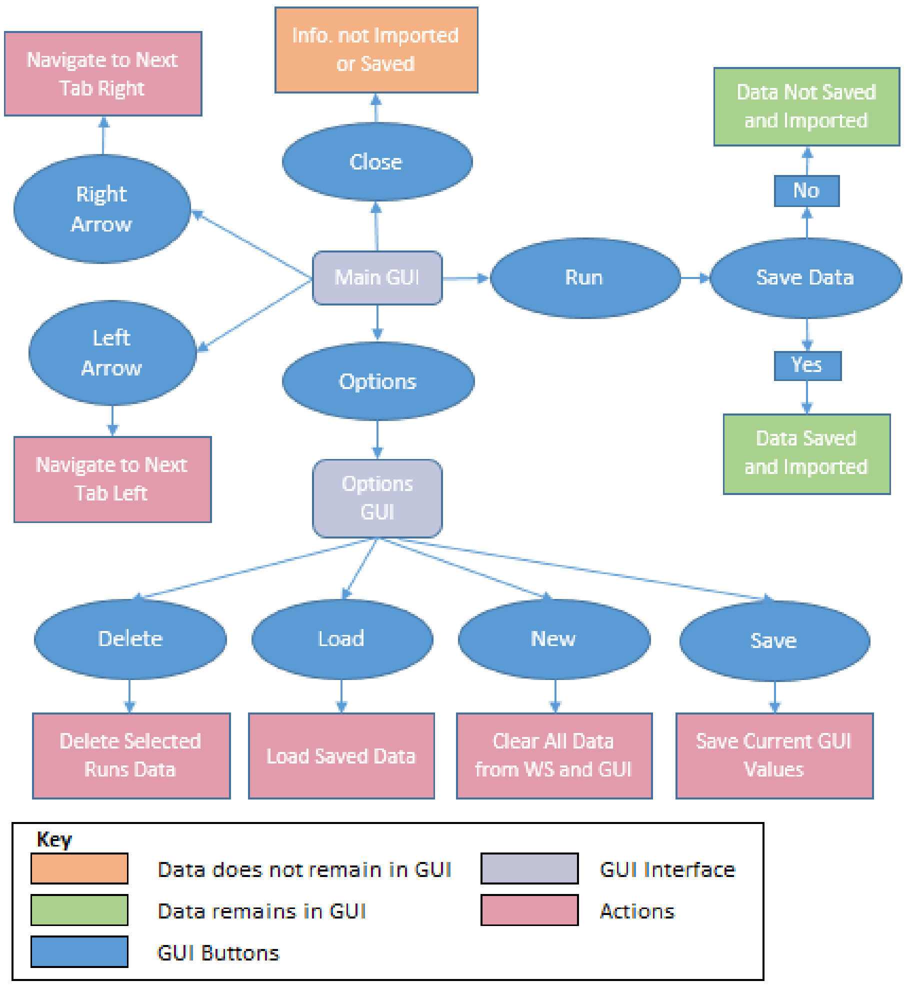


Figure 3. Logic diagram for the navigation of the main and options graphical user interface

Entering Your Data:

The GUI is the main location for entering data about your facility. “1. Current Parameters”, “2. Future Parameters”, and “4. Biogas Use” worksheets can also be used for entering data but is not required. Entered data is then used in calculations throughout the model to produce the output. Calculations for the current and future parameters are located at the bottom of the corresponding worksheets. Biogas use calculations are located in “4. Biogas Use" in the specific biogas use location, which is labeled on the left hand side of the worksheet.

Customizing the model:

All worksheets 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 worksheets.**

GUI Components:

Many of the model components in the GUI are briefly described below.

1. Digester	
Input information about the digester's physical parameters, annual operations and maintenance cost, and performance.	
Performance	The model uses percent volatile solids reduction as the metric for digester performance.

2. Feedstocks	
Input current and future feedstock information and calculate composite feedstock parameters. Percent solids of homogenized feedstock and hydraulic retention time are also entered here.	
Feedstock	User can select from a list of default feedstocks or input their own. The default feedstocks also contain all of the required feedstock parameters.
Time of Use	Current – Feedstock that is currently being digested and will **not** be digested with proposed feedstock Future – Proposed feedstock to be digested Both – Feedstock that is currently being digested and will continue to be digested along with proposed feedstocks
Percent Solids of Homogenized Feedstock	User can input the calculated present solids from the composite feedstock or enter their targeted percent solids. This value is used to calculate hydraulic retention time, available capacity, and other volume calculations.

3. Economics	
Input utility rates, feedstock tipping fees, and plant upgrade costs.	
Utility Rates	Utility rates are based on average rates and do not account for peak shaving. This assumption provides a conservative estimate for the value of avoided utility fees.
Project Upgrading Costs	Project upgrade costs can be calculated using the "5. Digester & Ancillary Equip." worksheet or directly input. The worksheet is accessible by clicking the 'Estimate Cost' button or navigating the workbook. Once in "5. Digester & Ancillary Equip.", the 'Return to Scenario Inputs/Import Total' button must be clicked to import the calculated value.

4. Biosolids	
Input information for biosolids disposal and/or revenue and determine future economics of biosolids.	
Percent Solids of Biosolids	Value used to calculate volume of biosolids produced. Should be the averaged value over the year.
Revenue or Cost	Revenue and/or cost are based on a $/ton basis. The user has the ability to alter the amount of biosolids that are sold or disposed for their future operations.

5. Heating

Input information about location, tank materials and dimensions, and feedstock quantity to calculate heating demand.

Location	Location is based on a U.S. 5-digit zip code. Zip codes are linked to the temperature difference between the average annual temperature and the digester operating temperature. Map located in Appendix A.
Digester Dimensions	Used to calculate the exposed surface area of the digester.
Tank Materials	The user can select from default tank materials to obtain a heat transfer coefficient for that material. The user can also input their own information.
Surface Area	Surface area is calculated based on a cylindrical tank with a flat roof and floor. The calculated surface area can be overwritten with an equivalent surface area if the digester is not cylindrical. In that case, the surface area would need to be calculated by hand.
Heat Transfer Coefficient	Heat transfer coefficients are available for many materials. The user can use the default values for the default tank materials or calculate and input their own.
Specific Heat of Homogenized Feedstock	Specific heat is used to calculate the amount of energy needed to raise incoming feedstock to operating temperatures. If value is unknown, it can be assumed the same as water.

Worksheet Components:

Each worksheet provides calculations modeling the different aspects of anaerobic digestion. The worksheet functions and calculations are briefly described below.

1. Current Parameters	
Calculations for biogas and biosolids generation, economics, and available capacity for the current operating conditions are found within this worksheet.	
Data	The data is brought into the worksheet from the GUI inputs. There is no need to alter the worksheets unless assumptions in the calculations do not match your facilities process. For example, if you would like to give a lower heating value to methane to calculate a more conservative estimate.
Digester Volume	The volume of the digester is calculated assuming a cylindrical digester with a flat floor. The model also takes into account volume consumed by objects within the digester. This volume is incorporated into the effective operating capacity percentage.
Feedstock	The composite feedstock values are brought in from the GUI. To make changes to the feedstock (say to compare different amounts and save them as separate files) use the “Calculate Composite Feedstock” button located next to the feedstock information.
Biogas	Biogas production is calculated using an empirically derived conversion constant based on % volatile solids destroyed.
Biosolids	Biosolids generation is based on the percent solids of biosolids and the amount of volatile solids destroyed.
Heating	Heating demands are calculated in the GUI and used to determine an economic value for biogas.

2. Future Parameters

Calculations for biogas and biosolids generation, economics, and available capacity for the future operating conditions are found within this worksheet. All of the calculations are the same as the current parameters worksheet but using the future values from the GUI.

Data	The data is brought into the worksheet from the GUI inputs. As previously mention, there is no need to alter the worksheets unless assumptions in the calculations do not match your facilities process.

3. Comparison

This worksheet compiles all of the important calculated information from the other worksheets and presents the data for comparison. The current conditions are compared to four future scenarios.

Current	The “Current” column displays the information calculated for the current operating parameters. This option assumes all of the biogas is used to heat the digester. Biogas is given value based on avoided natural gas for heating.
Future A	This column displays the information for future operating parameters assuming there will be no change in biogas use (Biogas will only be used to heat the digester in the existing boiler). Cost and incomes associated with accepting external feedstocks are included.
Future B	This column displays the same operating parameters as ‘Future A’ except that this scenario assumes all biogas will be used to run a combined heat and power engine (CHP). Value is given to the electricity generated and heat recovered by the CHP. Costs and incomes associated with accepting external feedstocks and purchasing a CHP are included.
Future C	Displays information for using the same operating parameters as the other future scenarios but assumes biogas will be used to meet the heating demand of the digester and any remaining biogas will be converted into vehicle fuel. Costs and incomes associated with accepting external feedstocks, a gas upgrading system, and truck upgrades are included.

3. Comparison Cont'd	
Future D	Displays the same information as 'Future C' except the model assumes all biogas will be used as vehicle fuel. Biogas value is based on the amount of gallon of gas equivalent (GGE) of biogas produced. Costs and incomes associated with accepting external feedstocks, a gas upgrading system, and truck upgrades are included.
Net Annualized Value	The net annualized value (NAV) of the projected cash inflows and outflows including initial capital costs, is calculated for each scenario.
Capital Costs	Fixed capital costs required to update and/or increase capacity of the digesters with additional costs (engineering and O&M costs) calculated as a percentage of capital cost.
O&M Costs	Cost may include operating personnel, collection containers and vehicles, processing equipment, digester cleaning, and disposal vehicles.
Revenue	Potential revenue streams from organic co-digestion are calculated based on organic waste volume and characteristics and known biosolids revenue. 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.

4. Biogas Use

This worksheet calculates the biogas value and costs for each of the scenarios described in the "3. Comparison" worksheet explanation. All of the assumptions for the calculations are found within this worksheet.

Capital Recovery Factor	Net annual value is based on annual costs. Calculating equivalent annual values for one-time expenditures requires a discount rate and analysis period to obtain a factor to multiply the one-time expenditure by.
Capital Costs	The cost associated with upgrading the digester to optimize performance and upgrading/installing a receiving station. Each of the future scenarios add costs depending on the scenario. An engineering factor is used to estimate costs for design and consultant work.
Biogas Options	The biogas options are described in the description of worksheet "3. Comparison". All assumptions an calculations are found in this worksheet.

5. Digester and Ancillary Equip.

This worksheet calculates costs not directly associated with the digester unit including three primary areas. The total cost calculated in this worksheet is then imported into the GUI.

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.
Feedstock processing	External feedstocks typically require some level of processing to optimize digestion. Processing includes various methods such as mixing, dewatering, grinding, sifting, etc.
Ancillary Equipment and Services	Other tasks required include engineering and environmental studies associated with siting and constructing the digesters.

Input Variables
This worksheet provides the user with a printable version of all of the input variables from the GUI and worksheets allowing the user to save and compare inputs of multiple runs. User can print this worksheet from "3. Comparison" or navigate to and print from the actual worksheet.

Data Sheet
This worksheet provides an "Items You Need Before You Get Started" list that contains all of the inputs of the GUI. Users can print this worksheet using the GUI or navigate to and print from the actual worksheet.

Glossary
This worksheet contains definitions for common terms used throughout the workbook.

Saving Data

All data input into the GUI can be saved using the 'Options' button or before the data is imported into the model. The saved data is stored in a hidden worksheet and can be loaded at any time using the 'Options' button or when first opening the model. Each run is saved under the name input for the facility name. There is no external file created for the saved information. To export the input data, navigate to the 'Input Data' worksheet and print, copy and paste to another workbook, or any other mean.

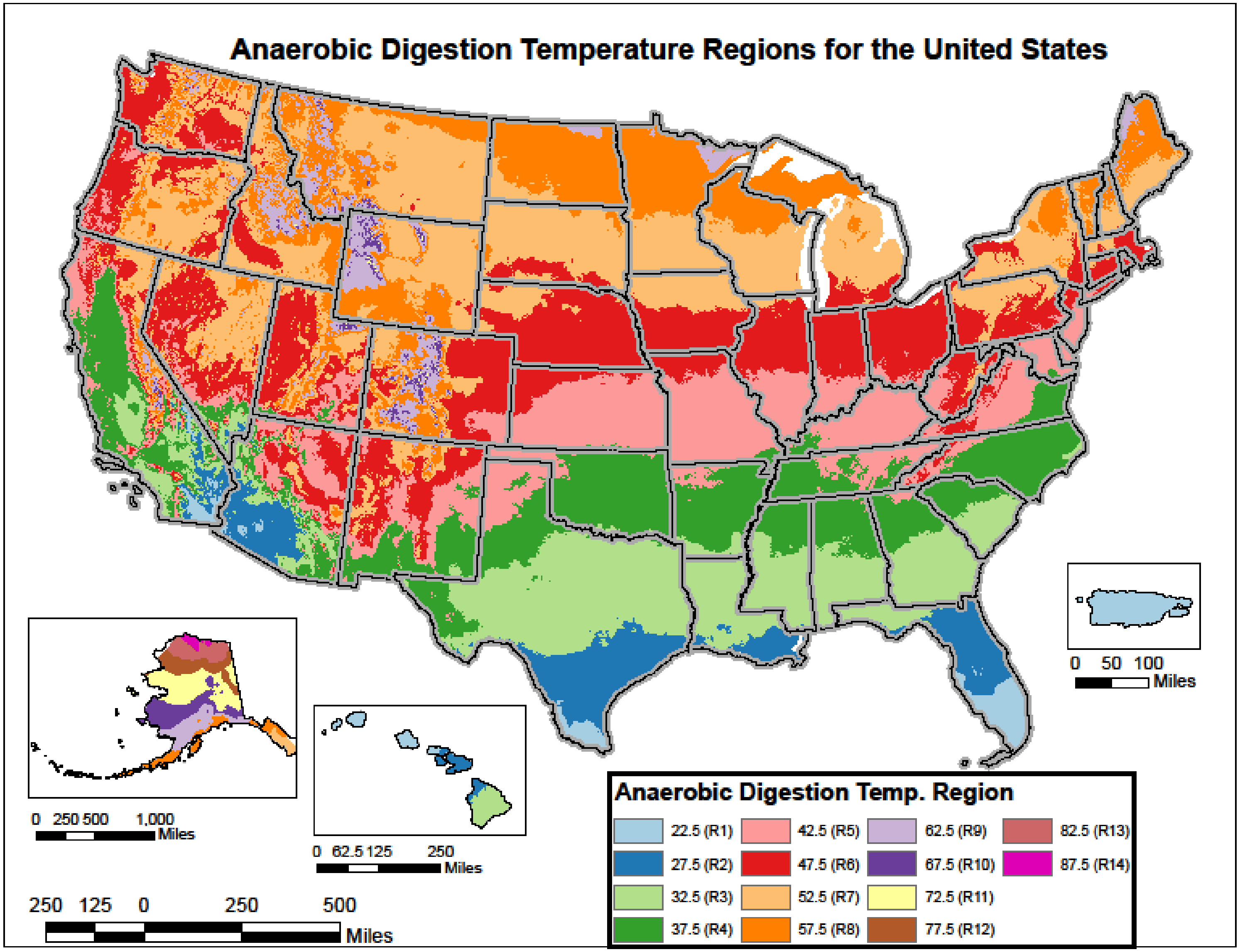
Results Interpretation

The main interpretation of the results is to determine if the economics of accepting external feedstocks is worth the investment by comparing the net annualized value of the current process and future process with varying biogas use options. This comparison can be found in "3. Comparison" in the 'Net Annualized Value' row. While this is the main result, other conclusions can be drawn from the model. Following is a list that includes a few of the alternative results:

- Amount of available capacity for external feedstock (Row 'Available Capacity' in "3. Comparison")
- Amount of digester volume that needs to be added for processing additional feedstock (Row 'Additional Volume Needed to Treat Feedstock' in "3. Comparison")
- Percent increase in biogas (Analysis Box in "3. Comparison)
- Percent increase in biosolids (Analysis Box in "3. Comparison)
- Percent increase in heating demand (Analysis Box in "3. Comparison)
- Size of CHP that can continuously run based on biogas production (Analysis Box in "3. Comparison)
- Determine how changing parameters of your biosolids handling affects your current process

This is not a comprehensive list and other results may be determined from the model's output.

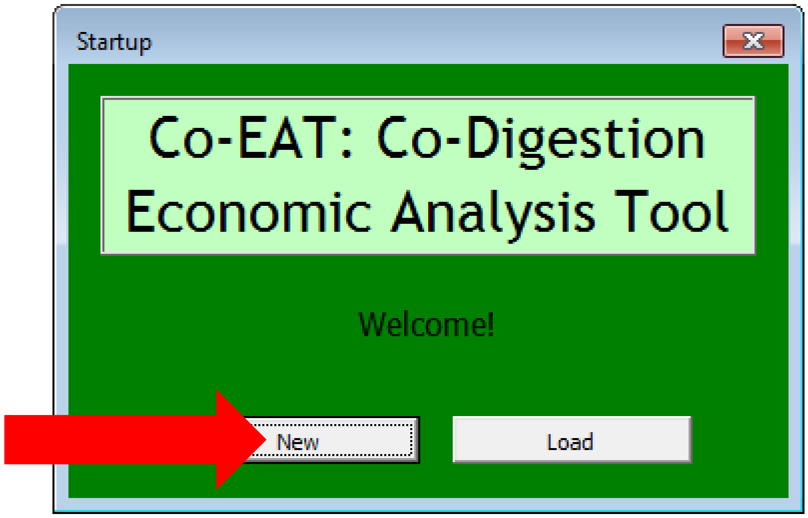
Appendix A



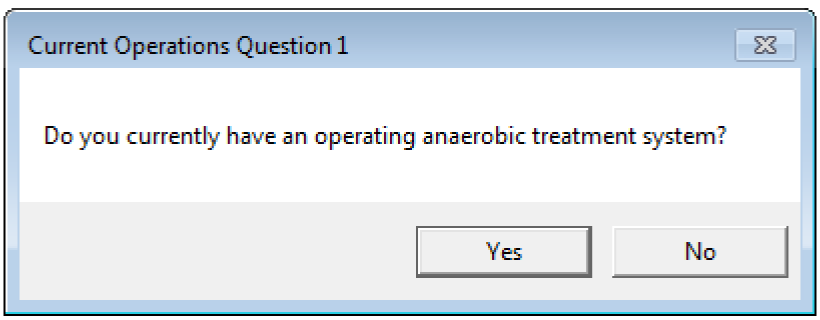
Appendix A. Anaerobic digestion temperature regions map for the United States. Temperature regions are based on the difference between a 98 °F digester operating temperature and the mean annual temperature.

Appendix B: First Time User Tutorial

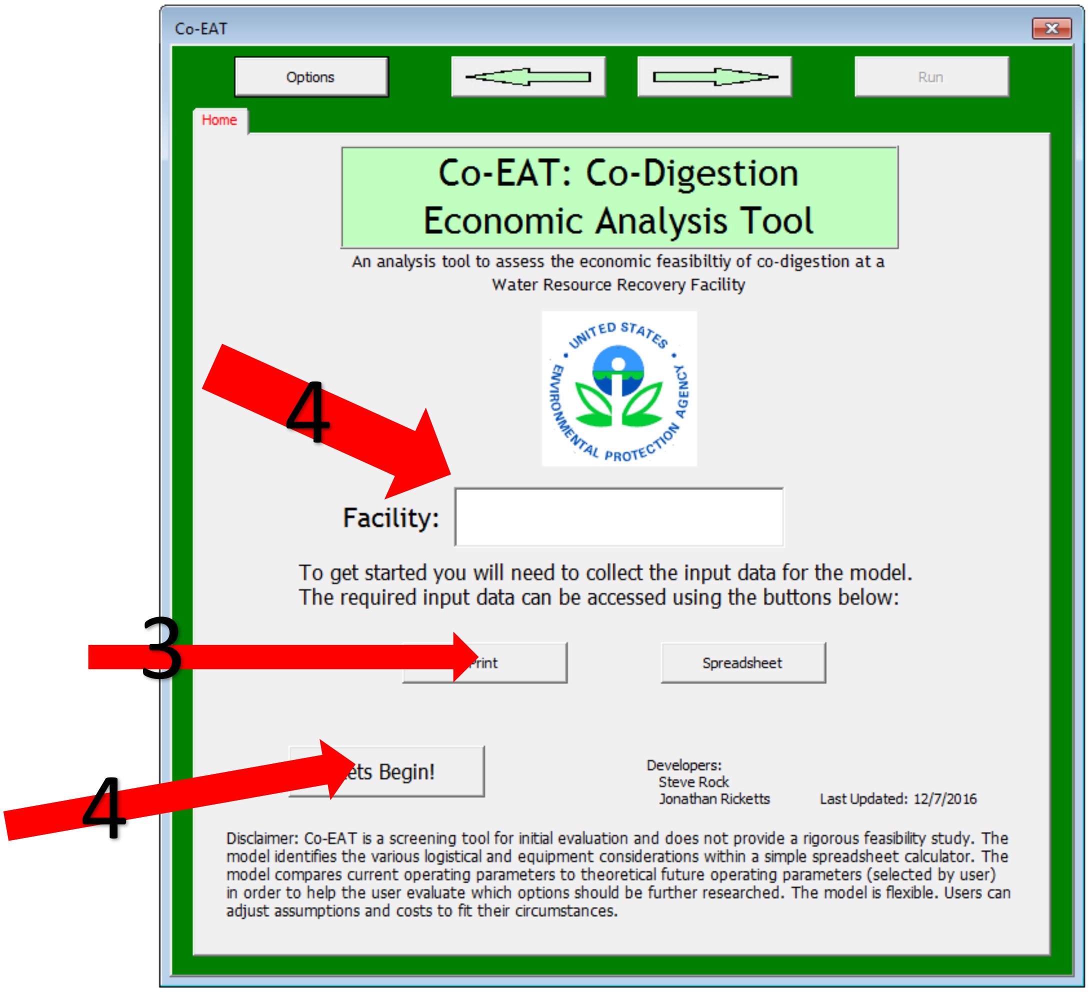
1. Select 'New' in the first pop-up window.



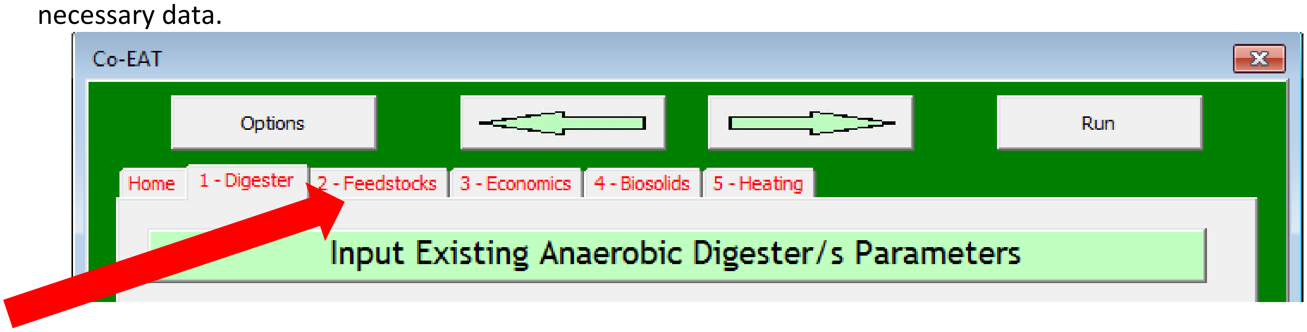
2. Answer the first question.



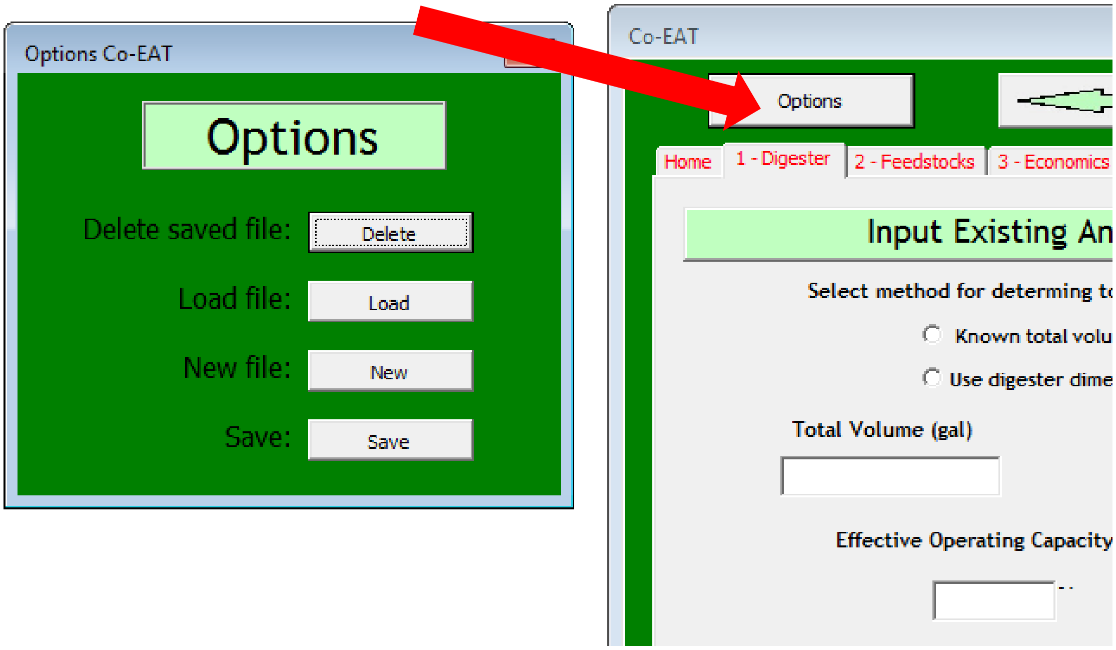
3. Print or locate the spreadsheet that provides a list of the required data to run the model. Retrieve the data.
4. Input the facility name and click ‘Let’s Begin!’



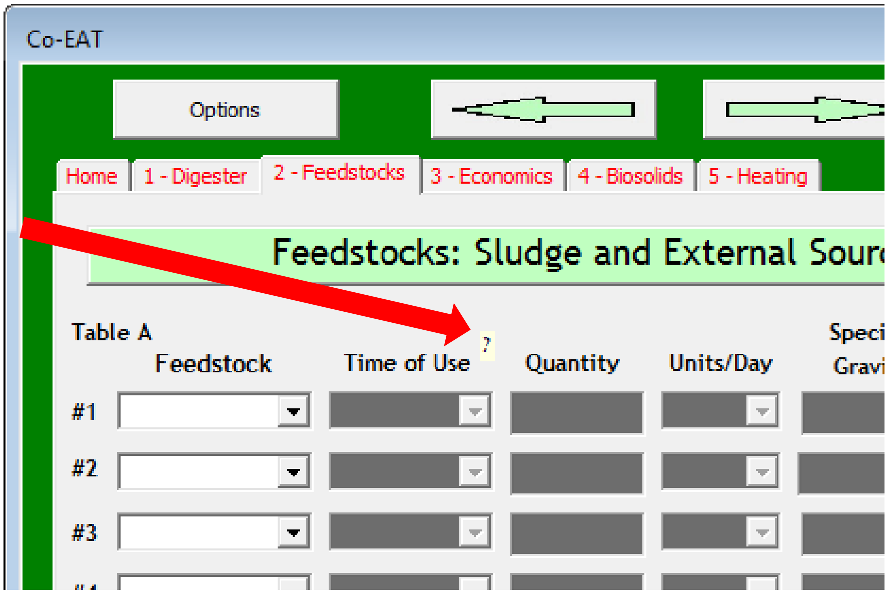
5. Multiple tabs will appear after ‘Let’s Begin!’ is clicked. Navigate through the tabs and input the necessary data.



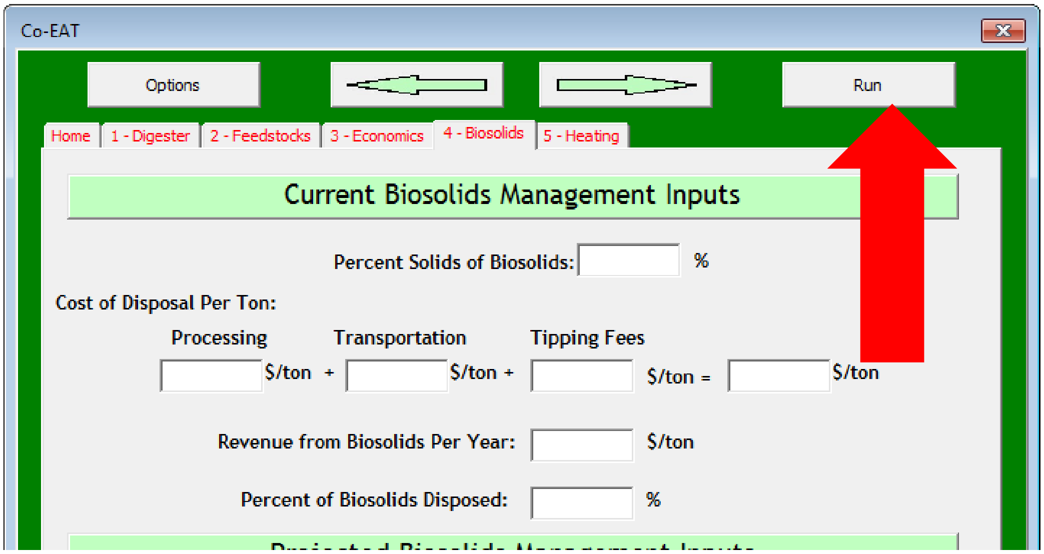
6. Use the 'Options' button, located in the top left corner of the GUI, to perform routine operations like save, load, and delete.



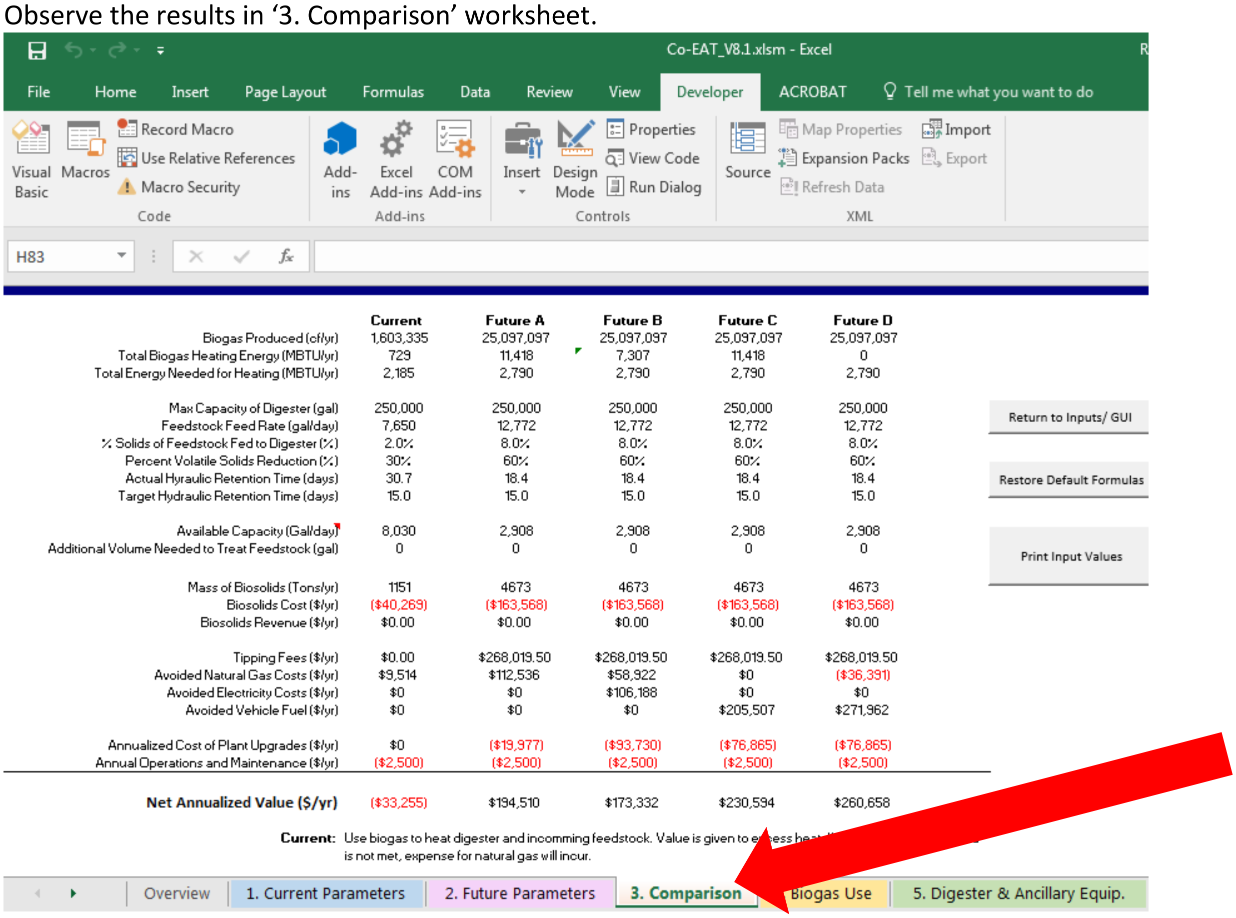
7. Use the buttons and explanations throughout the GUI to aid with inputting the data. Click the question marks next to variables to received further explanation of the variable.



8. Click 'Run', located in the top right corner of the GUI, to import the data and observe the results.



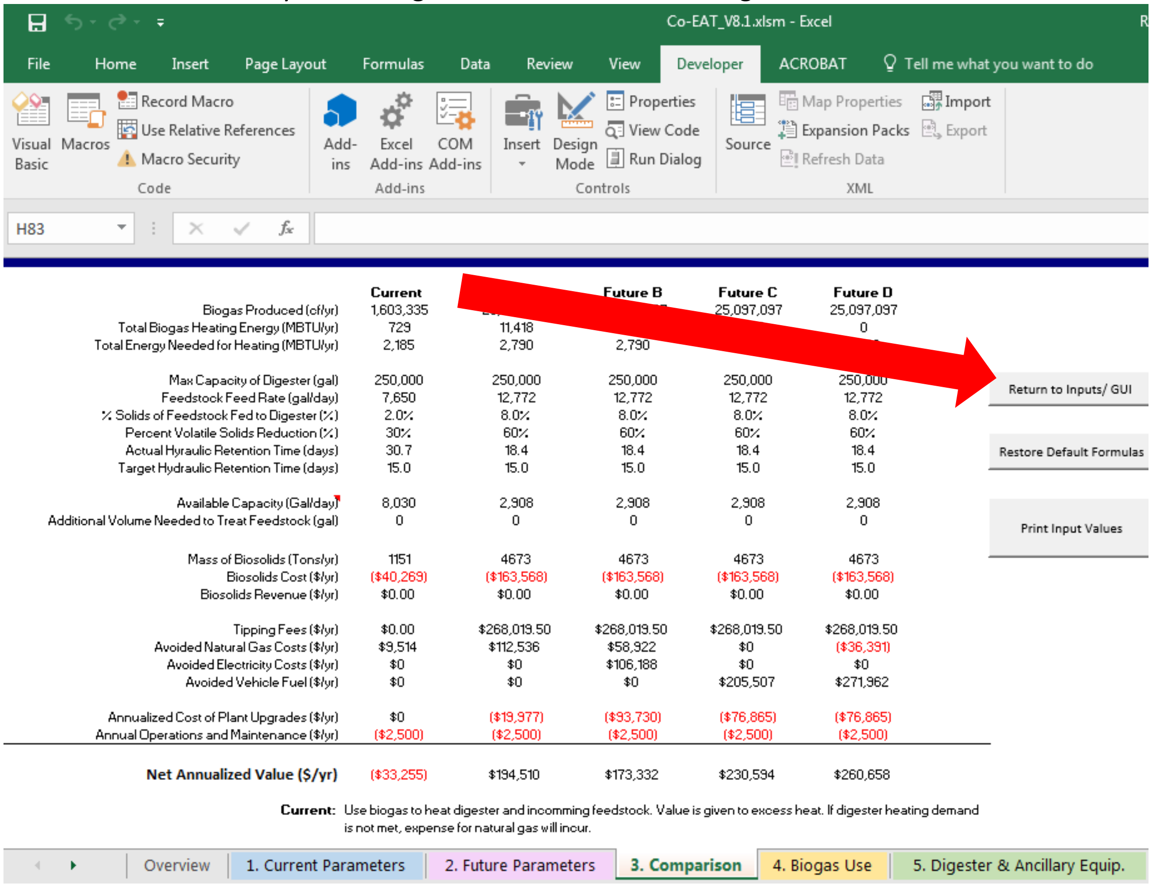
9. Observe the results in '3. Comparison' worksheet.



	Current	Future A	Future B	Future C	Future D
Biogas Produced (cf/yr)	1,603,335	25,097,097	25,097,097	25,097,097	25,097,097
Total Biogas Heating Energy (MBTU/yr)	729	11,418	7,307	11,418	0
Total Energy Needed for Heating (MBTU/yr)	2,185	2,790	2,790	2,790	2,790
Max Capacity of Digester (gal)	250,000	250,000	250,000	250,000	250,000
Feedstock Feed Rate (gal/day)	7,650	12,772	12,772	12,772	12,772
% Solids of Feedstock Fed to Digester (%)	2.0%	8.0%	8.0%	8.0%	8.0%
Percent Volatile Solids Reduction (%)	30%	60%	60%	60%	60%
Actual Hyraulic Retention Time (days)	30.7	18.4	18.4	18.4	18.4
Target Hydraulic Retention Time (days)	15.0	15.0	15.0	15.0	15.0
Available Capacity (Gal/day)	8,030	2,908	2,908	2,908	2,908
Additional Volume Needed to Treat Feedstock (gal)	0	0	0	0	0
Mass of Biosolids (Tons/yr)	1151	4673	4673	4673	4673
Biosolids Cost ($/yr)	($40,269)	($163,568)	($163,568)	($163,568)	($163,568)
Biosolids Revenue ($/yr)	$0.00	$0.00	$0.00	$0.00	$0.00
Tipping Fees ($/yr)	$0.00	$268,019.50	$268,019.50	$268,019.50	$268,019.50
Avoided Natural Gas Costs ($/yr)	$9,514	$112,536	$58,922	$0	($36,391)
Avoided Electricity Costs ($/yr)	$0	$0	$106,188	$0	$0
Avoided Vehicle Fuel ($/yr)	$0	$0	$0	$205,507	$271,962
Annualized Cost of Plant Upgrades ($/yr)	$0	($19,977)	($93,730)	($76,865)	($76,865)
Annual Operations and Maintenance ($/yr)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)
Net Annualized Value ($/yr)	($33,255)	$194,510	$173,332	$230,594	$260,658

Current: Use biogas to heat digester and incomming feedstock. Value is given to e ... ess hea ...
is not met, expense for natural gas will incur.

10. Return to the GUI at any time using the buttons located throughout the workbook.



	Current	[illegible]	Future B	Future C	Future D
Biogas Produced (cf/yr)	1,603,335	[illegible]	[illegible]	25,097,097	25,097,097
Total Biogas Heating Energy (MBTU/yr)	729	11,418	[illegible]	[illegible]	0
Total Energy Needed for Heating (MBTU/yr)	2,185	2,790	2,790	[illegible]	[illegible]
Max Capacity of Digester (gal)	250,000	250,000	250,000	250,000	250,000
Feedstock Feed Rate (gal/day)	7,650	12,772	12,772	12,772	12,772
% Solids of Feedstock Fed to Digester (%)	2.0%	8.0%	8.0%	8.0%	8.0%
Percent Volatile Solids Reduction (%)	30%	60%	60%	60%	60%
Actual Hyraulic Retention Time (days)	30.7	18.4	18.4	18.4	18.4
Target Hydraulic Retention Time (days)	15.0	15.0	15.0	15.0	15.0
Available Capacity (Gal/day)	8,030	2,908	2,908	2,908	2,908
Additional Volume Needed to Treat Feedstock (gal)	0	0	0	0	0
Mass of Biosolids (Tons/yr)	1151	4673	4673	4673	4673
Biosolids Cost ($/yr)	($40,269)	($163,568)	($163,568)	($163,568)	($163,568)
Biosolids Revenue ($/yr)	$0.00	$0.00	$0.00	$0.00	$0.00
Tipping Fees ($/yr)	$0.00	$268,019.50	$268,019.50	$268,019.50	$268,019.50
Avoided Natural Gas Costs ($/yr)	$9,514	$112,536	$58,922	$0	($36,391)
Avoided Electricity Costs ($/yr)	$0	$0	$106,188	$0	$0
Avoided Vehicle Fuel ($/yr)	$0	$0	$0	$205,507	$271,962
Annualized Cost of Plant Upgrades ($/yr)	$0	($19,977)	($93,730)	($76,865)	($76,865)
Annual Operations and Maintenance ($/yr)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)
Net Annualized Value ($/yr)	($33,255)	$194,510	$173,332	$230,594	$260,658

Current: Use biogas to heat digester and incomming feedstock. Value is given to excess heat. If digester heating demand is not met, expense for natural gas will incur.

11. Save the workbook to save the work you have completed.