



**AgEcon** SEARCH  
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search  
<http://ageconsearch.umn.edu>  
[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

April 2008

E.B. 2008-03

# **Inputs for Biogas Economic Assessment**

**By**

**Brent A. Gloy**

**\$\$\$** Agricultural Finance and Management at Cornell  
**\$\$\$** Cornell Program on Agricultural and Small Business Finance **\$\$\$**  
Department of Applied Economics and Management  
College of Agriculture and Life Sciences  
Cornell University, Ithaca, New York 14853-7801

It is the Policy of Cornell University actively to support equality of educational and employment opportunity. No person shall be denied admission to any educational program or activity or be denied employment on the basis of any legally prohibited discrimination involving, but not limited to, such factors as race, color, creed, religion, national or ethnic origin, sex, age or handicap. The University is committed to the maintenance of affirmative action programs which will assure the continuation of such equality of opportunity.

# Inputs for Biogas Economic Assessment

By Brent A. Gloy<sup>1</sup>

The following worksheets itemize the inputs that you will need to conduct an economic assessment of your biogas project. The inputs are designed for use with two Microsoft Excel spreadsheets. The spreadsheets are available on the Cornell Manure Management website: [www.manuremanagement.cornell.edu/](http://www.manuremanagement.cornell.edu/) and the Cornell Program on Agriculture and Small Business Finance website: [www.agfinance.aem.cornell.edu/](http://www.agfinance.aem.cornell.edu/).

The inputs are used to create pro-forma financial statements for the biogas project and conduct a discounted cash flow analysis of the project. A basic understanding of financial concepts is required to understand and interpret the outputs of the spreadsheets. These tools should only be used for an initial analysis of a biogas project. A more thorough analysis is required to establish the expected profitability of the project.

Two tools have been developed. The first tool is designed for use with FarmWare 3.1 which was developed by the United States Environmental Protection Agency and available for free download at: [www.epa.gov/agstar/resources/handbook.html](http://www.epa.gov/agstar/resources/handbook.html). This analysis uses the outputs of FarmWare 3.1 to conduct a financial analysis. This worksheet does not guide the user through the inputs required to conduct a FarmWare assessment.

The second tool allows the user to input more detailed information about their specific anaerobic digestion project. The tool requires that the user possess information about the capital and operating costs for the project. It utilizes a variety of assumptions to create estimates of the biogas and electrical generation potential of the project. Users should carefully consider the validity of the assumptions utilized in the assessment before making investment decisions. In other words, these tools should be used with caution and no warranty is made regarding the validity of outputs obtained and decisions made based upon the model. The assessment does not consider the impact of any taxes that may be generated or saved by the project. These values may significantly alter the profitability of the project. The spreadsheets do not currently consider inflation or allow for changing prices over time. These assumptions can be modified with modest alterations to the spreadsheets.

In both spreadsheets users should be careful to enter parameter values that correspond to the units listed in the spreadsheet. The spreadsheet will not identify inappropriate units or entries that are unrealistic.

---

<sup>1</sup> Brent A. Gloy is an Associate Professor, Department of Applied Economics and Management, Cornell University, Ithaca, NY.

## Inputs for FarmWare 3.1 Assessment

- 1) Enter the number of animals from which manure will be processed in the digestion system. FarmWare also asks for this information and users should make every effort to report this information as accurately as possible because it will influence the amount of manure collected and ultimately the amount of energy generated by the system. This assessment does not estimate production from heifers. Do not include the number of young stock in your estimates of dry cows.

The number of lactating dairy cows: \_\_\_\_\_

The number of dry cows: \_\_\_\_\_

- 2) Enter the amount of biogas, methane, and BTU's estimated by FarmWare. These values are output in the FarmWare assessment.

Total biogas (cubic feet/year): \_\_\_\_\_

Total Methane production (cubic feet/year): \_\_\_\_\_

BTU's/year: \_\_\_\_\_

- 3) Enter the total collectable manure, collectable manure solids, and collectable volatile solids produced by the operation. These values are estimated by FarmWare and are included in the output reports.

Collectable manure (lbs/day): \_\_\_\_\_

Collectable volatile solids (lbs/day): \_\_\_\_\_

Collectable total volatile solids (lbs/day): \_\_\_\_\_

- 4) Enter the energy production estimates produced by FarmWare. The energy generated will be used to calculate energy savings and energy sales. The generator capacity will be used to estimate NYSERDA capacity incentives (if applicable). The annual operating and maintenance costs are estimated by FarmWare at 5% of total capital costs.

Total electrical generation (kWh): \_\_\_\_\_

Generator capacity (kW): \_\_\_\_\_

Thermal conversion efficiency of generator (%): \_\_\_\_\_

Annual operating and maintenance costs (\$'s per year): \_\_\_\_\_

5) Enter the items of the capital budget. FarmWare produces an estimated capital budget for the project. The categories in the spreadsheet represent the typical categories produced by FarmWare. However, some entries will vary depending upon the specification of the system in FarmWare. There are two lines available for you to add additional items. The user must also identify the percent of the capital items that are assigned to the digester and the generating equipment. This assessment is necessary to estimate the NYSERDA capacity incentives. If you are not interested in participation, the percentage assessment does not matter, but must total to 100% for all of the expenses to be considered in the capital budget. You must also enter the years over which the equipment will be depreciated. This is used to calculate depreciation expenditures. Note that FarmWare does not consider the opportunity cost of any land utilized by the system. Next, enter the working capital required by the system. Working capital represents the amount of funds that must be held to make necessary incremental payments for labor, supplies, etc.

Item	Amount	Years of Depreciation	Percent of Expense for Digester	Percent of Expense for Generation Equipment
Digester				
Engineering				
Engine generator				
Basin				
Secondary Storage				
Others (FarmWare)				
Others (User)				
Total	Calculated	XXXXXX	XXXXXXXX	XXXXXXXX
Working Capital		XXXXXX	XXXXXXXX	XXXXXXXX

- 6) Determine whether you will participate in the NYSERDA capacity incentive grant program. Enter the dollar value of any additional grants received for the project. Do not include NYSERDA performance incentives in this item. The grants are treated as negative expenditures in the analysis. As such the cash flows for the grants will be captured at the end of the first year.

Enter a 1 if you will participate and a 0 if otherwise: \_\_\_\_\_

Enter the value of any additional grants received (excluding NYSERDA performance incentives (\$'s): \_\_\_\_\_

- 7) Enter the days of inventory that will be held for various inventory items. These values will be used in conjunction with the expenditure items estimated above to calculate the amount of inventory, accounts payable, and accounts receivable.

Fuels, supplies, etc. (days): \_\_\_\_\_

Accounts receivable (days): \_\_\_\_\_

Accounts payable (days): \_\_\_\_\_

- 8) Enter the annual energy use of the farm not including the digestion system. This value is required to estimate the energy savings that are generated by the system. Likewise, enter the annual energy use of the AD system.

On-farm power use prior to system (kWh/year): \_\_\_\_\_

Power use of AD system (kWh/year): \_\_\_\_\_

- 9) Enter the price that the farm pays for electricity purchased from the grid. In some cases additional calculations may be required to arrive at these prices. The value should not include any "standby" or "demand" charges that will still be charged to the farm after the digester is operational. The price that is received for electrical sales to the grid the next input. Again, additional calculations may be necessary to obtain the net value that the farm receives for sale to the electrical grid. The utility should be able to provide the farm with an accurate measure of all of these items.

Purchase price for electricity (\$'s/kWh): \_\_\_\_\_

Sale price for electricity (\$'s/kWh): \_\_\_\_\_

- 10) Indicate whether the system will participate in the NYSERDA performance incentive program.

Enter a 1 if participating and a 0 if not: \_\_\_\_\_

11) Enter the price for any carbon credits sold as a result of system installation and the type of manure storage system that best describes your current manure system. The price of carbon credits should be reported net of any costs associated with selling the credits. The type of existing manure system is used to estimate the credit. This assessment assumes that credits will be sold on the Chicago Climate Exchange (CCX) and that the actual amount of methane destroyed is greater than the “ex ante” estimate of the CCX. For more information see the CCX website: [www.chicagoclimateexchange.com](http://www.chicagoclimateexchange.com). It may be possible to generate additional credits under alternative assumptions and it may also be possible to claim credits for electricity produced. These values are not estimated in the spreadsheet. If you do not wish to consider carbon credit sales enter a value of \$0 for the price per ton.

Net price of carbon credits (\$’s/metric ton of carbon equivalent): \_\_\_\_\_

Type of existing manure handling system (anaerobic lagoon or liquid/slurry manure storage): \_\_\_\_\_

12) Enter information regarding how the project will be financed including the percentage of debt applied to personal property (7 year property from the capital budget section), real property (20 year property from capital budget section), and the term of the loans. Enter the interest rates that correspond to each type of financing. This information will be used to establish the loan amortization schedules. The discount rate is also required. This value will be used to discount the future cash flows generated by the project. Because the assessment does not consider inflation the discount rate should reflect the “real” discount rate. Enter the terminal value multiple associated with the project. This will be used to establish a value for the project at the end of 10 years.

Percent of personal property (7 year) financed (%): \_\_\_\_\_

Term on personal property (years): \_\_\_\_\_

Rate on personal property (%): \_\_\_\_\_

Percent of real property (20 year) financed (%): \_\_\_\_\_

Term on real property (years): \_\_\_\_\_

Rate on real property (%): \_\_\_\_\_

Discount rate (%): \_\_\_\_\_

Terminal value multiple: \_\_\_\_\_



## Inputs for AD Assessment

- 1) Enter the number of animals from which manure will be processed in the digestion system. FarmWare also asks for this information and users should make every effort to report this information as accurately as possible because it will influence the amount of manure collected and ultimately the amount of energy generated by the system. This assessment does not estimate production from heifers. Do not include the number of young stock in the estimates of dry cows.

The number of lactating dairy cows: \_\_\_\_\_

The number of dry cows: \_\_\_\_\_

- 2) Enter the items of the capital budget. The categories in the capital budget are designed to be inclusive of the types of items that would be required for an AD system. The user must identify the percent of the capital items that are assigned to the digester and the generating equipment. This assessment is necessary to estimate the NYSERDA capacity incentives. If you are not interested in participation, the percentage assessment does not matter, but must total to 100% for all of the expenses to be considered in the capital budget. You must also enter the years over which the equipment will be depreciated. This is used to calculate depreciation expenditures. All capital expenses associated with engineering and project development are treated as 7 year property for depreciation and financing purposes. The amount assigned to the generation equipment is based upon the proportion of the total capital expenses associated with generation. Next, enter the working capital required by the system. Working capital represents the amount of funds that must be held to make necessary incremental payments for labor, supplies, etc.

Item	Amount	Years of Depreciation	Percent of Expense for Digester	Percent of Expense for Generation Equipment
Land				
Building				
Site Work				
Power Wiring				
Manure Piping				
Generator				
Boiler				
Digester Tank				
Pumps				
Controls				
Total Materials	Calculated	XXXXXX	XXXXXXXX	XXXXXXXX

Capital Costs Continued

Project Development		Calculated	Calculated	Calculated
Engineering		Calculated	Calculated	Calculated
Construction Management		Calculated	Calculated	Calculated
Consulting		Calculated	Calculated	Calculated
Total Other	Calculated	Calculated	Calculated	Calculated
Working Capital		XXXXXX	XXXXXXXX	XXXXXXXX

- 3) Determine whether you will participate in the NYSERDA capacity incentive grant program. Enter the dollar value of any additional grants received for the project. Do not include NYSERDA performance incentives in this item. The grants are treated as negative expenditures in the analysis. As such, the cash flows for the grants will be captured at the end of the first year.

Enter a 1 if you will participate and a 0 if otherwise: \_\_\_\_\_

Enter the value of any additional grants received (excluding NYSERDA performance incentives (\$'s): \_\_\_\_\_

- 4) Enter the days of inventory that will be held for various inventory items. These values will be used in conjunction with the expenditure items estimated above to calculate the amount of inventory, accounts payable, and accounts receivable.

Fuels, supplies, etc. (days): \_\_\_\_\_

Accounts receivable (days): \_\_\_\_\_

Accounts payable (days): \_\_\_\_\_

- 5) Enter the assumptions required to generate the biogas production estimates. Example parameter values are shown in parentheses.

Volatile solid (VS) conversion to biogas (%): \_\_\_\_\_ (30%)

Cubic feet of biogas produced per pound of VS converted (cf/lb): \_\_\_\_\_ (16)

BTU's per cubic foot of biogas (btus/cf): \_\_\_\_\_ (625)

- 6) Enter the assumptions required to generate the revenue and biogas production associated with other waste streams placed in the digester. Tipping fees should be entered net of any associated disposal costs borne by the farm. The amount of additional wastes placed in the digester should be estimated on the basis of tons per day.

Tipping fees per ton of additional wastes net of disposal costs (\$'s/ton): \_\_\_\_\_

Tons of additional wastes per day (tons/day): \_\_\_\_\_

Volatile solids content of the additional wastes (%): \_\_\_\_\_

VS conversion to biogas (%): \_\_\_\_\_

Cubic feet of biogas produced per pound of VS converted (cf/lb): \_\_\_\_\_

BTU's per cubic foot of biogas (btus/cf): \_\_\_\_\_

- 7) Enter the thermal conversion efficiency of the electrical generating equipment and the percent of time that the electrical generation system will be on-line. These values determine the size of the generation equipment and the amount of electricity produced by the system. The analysis assumes that when the system is not on-line, biogas will be sent to a flare.

Thermal conversion efficiency of generator (%): \_\_\_\_\_ (25%)

Daily on-line percent (%): \_\_\_\_\_ (90%)

- 8) Enter the annual energy use of the farm not including the digestion system. This value is required to estimate the energy savings that are generated by the system. Likewise, enter the annual energy use required by the AD system.

On-farm power use prior to system (kWh/year): \_\_\_\_\_

Power use of AD system (kWh/year): \_\_\_\_\_

- 9) Enter the price that the farm pays for electricity purchased from the grid. In some cases additional calculations may be required to arrive at these prices. The value should not include any "standby" or "demand" charges that will still be charged to the farm after the digester is operational. The price that is received for electrical sales to the grid the next input. Again, additional calculations may be necessary to obtain the net value that the farm receives for sale to the electrical grid. The utility should be able to provide the farm with an accurate measure of all of these items.

Purchase price for electricity (\$'s/kWh): \_\_\_\_\_

Sale price for electricity (\$'s/kWh): \_\_\_\_\_

10) Indicate whether the system will participate in the NYSERDA performance incentive program.

Enter a 1 if participating and a 0 if not: \_\_\_\_\_

11) Enter the price for any carbon credits sold as a result of system installation and the type of manure storage system that best describes your current manure system. The price of carbon credits should be reported net of any costs associated with selling the credits. The type of existing manure system is used to estimate the credit. This assessment assumes that credits will be sold on the Chicago Climate Exchange (CCX) and that the actual amount of methane destroyed is greater than the “ex ante” estimate of the CCX. For more information see the CCX website: [www.chicagoclimateexchange.com](http://www.chicagoclimateexchange.com). It may be possible to generate additional credits under alternative assumptions and it may also be possible to claim credits for electricity produced. These values are not estimated in the spreadsheet. If you do not wish to consider carbon credit sales enter a value of \$0 for the price per ton.

Net price of carbon credits (\$’s/metric ton of carbon equivalent): \_\_\_\_\_

Type of existing manure handling system (anaerobic lagoon or liquid/slurry manure storage): \_\_\_\_\_

12) Enter the annual expenses that will be incurred to operate the digester. The expenses can be estimated as a percent of total capital (FarmWare uses 5% of total capital) or can be broken out by category.

Operating repairs and maintenance as a percent of capital (%): \_\_\_\_\_

OR

Property taxes (\$’s/year): \_\_\_\_\_

Insurance (\$’s/year): \_\_\_\_\_

Office (\$’s/year): \_\_\_\_\_

Oil and Fuel (\$’s/year): \_\_\_\_\_

Accounting and Legal (\$’s/year): \_\_\_\_\_

Labor (\$’s/year): \_\_\_\_\_

13) Enter information regarding how the project will be financed including the percentage of debt applied to personal property (7 year property from the capital budget section), real property (20 year property from capital budget section), and the term of the loans. Enter the interest rates that correspond to each type of financing. This information will be used to establish the loan amortization schedules. The discount rate is also required. This value will be used to discount the future cash flows generated by the project. Because the assessment does not consider inflation the discount rate should reflect the “real” discount rate. Enter the terminal value multiple associated with the project. This will be used to establish a value for the project at the end of 10 years.

Percent of personal property (7 year) financed (%): \_\_\_\_\_

Term on personal property (years): \_\_\_\_\_

Rate on personal property (%): \_\_\_\_\_

Percent of real property (20 year) financed (%): \_\_\_\_\_

Term on real property (years): \_\_\_\_\_

Rate on real property (%): \_\_\_\_\_

Discount rate (%): \_\_\_\_\_

Terminal value multiple: \_\_\_\_\_

## OTHER A.E.M. EXTENSION BULLETINS

EB No	Title	Fee (if applicable)	Author(s)
2008-02	Creating Renewable Energy From Livestock Waste: Overcoming Barriers to Adoption		Gloy, B.
2008-01	Strategic Marketing Conference Proceedings 2007		Schmit, Todd
2007-20	New York Economic Handbook 2008	(\$10.00)	Extension Staff
2007-19	Dairy Farm Business Summary, New York Dairy Farm Renters, 2006	(\$16.00)	Knoblauch, W. and L. Putnam
2007-18	Dairy Farm Business Summary, Southeastern New York Region, 2006	(\$12.00)	Knoblauch, W., Putnam, L., Kiraly, M., Walsh, J., Hulle, L. and S. Hadcock
2007-17	Municipal Approaches to Energy Conservation and Renewable Energy Production: A Resource for Community Energy Initiatives		Lindabury, S., Schmit, T., Howe, R. and T. Schusler
2007-16	Income Tax Management and Reporting For Small Businesses and Farms: 2007 Reference Manual for Regional Schools	(\$20.00)	Bouchard, G. and J. Bennett
2007-15	Fruit Farm Business Summary: Lake Ontario Region, New York 2006		White, G., DeMarree, A. and J. Neyhard
2007-14	Dairy Farm Business Summary, Central Valleys Region, 2006	(\$12.00)	Knoblauch, W., Karszes, J., Radick, C., Wickswat, C., Manning, J., Balbian, D., Allhusen, G., Buxton, S. and L. Putnam
2007-13	Dairy Farm Business Summary, Intensive Grazing Farms, New York, 2006	(\$16.00)	Conneman, G., Grace, J., Karszes, J., Degni, J., Munsee, D., Putnam, L., Staehr, A. and C. Kyle
2007-12	Quantifying the Contributions to Dairy Farm Business Risk: Implications for Producer's Risk Management Strategies		Schmit, T., Chang, H., Boisvert, R. and L. Tauer

Paper copies are being replaced by electronic Portable Document Files (PDFs). To request PDFs of AEM publications, write to (be sure to include your e-mail address): Publications, Department of Applied Economics and Management, Warren Hall, Cornell University, Ithaca, NY 14853-7801. If a fee is indicated, please include a check or money order made payable to Cornell University for the amount of your purchase. Visit our Web site (<http://aem.cornell.edu/outreach/materials.htm>) for a more complete list of recent bulletins.