UNIVERSITY of GUELPH OAC

Food, Agricultural & Resource Economics FARE

Economic Models for Environmental Sustainability – Anaerobic Digesters and a Complimentary Energy Decision Support Tool

By: Rob Anderson

Anaerobic Digestion

- Anaerobic digestion uses anaerobic bacteria to breakdown organic material, in the absence of oxygen to produce biogas
- Biogas which is approximately 40% methane can be used to replace fossil fuel derived energy
- Organic materials used in AD systems emit significant greenhouse gases (GHG) when not treated, and mitigation of these emissions is an additional environmental benefit

The Motivation

- Ontario's Green Energy Act aims to increase the use of renewable energy sources to combat climate change.
- The Ontario Power Authority's Feed In Tariff Program provides a comprehensive guaranteed pricing structure for renewable electricity production
- The economics of anaerobic digesters for Ontario farmers is not very well known

Economic Feasibility Model for Anaerobic Digesters in Ontario

- Provides custom information to specific projects
- Estimates yearly cash flows to give the user a multi period forecast of the finances of there project
- Key variables are easy to alter, does not require sorting through calculations to change these values
- Can potentially provide policy information by determining the impact of changes in specific variables through the use of sensitivity analysis.

Highlights of Original Spreadsheet

- Two cases; single fuel case (methane only) , and dual fuel case (methane plus diesel fuel) which both have a continuous operation scenario, and a peak hours operation scenario
- Estimates the potential electricity capacity
- Estimates the capital cost of the system
- Estimates the annual revenue generated
- Estimates annual costs
- Calculates the payback period

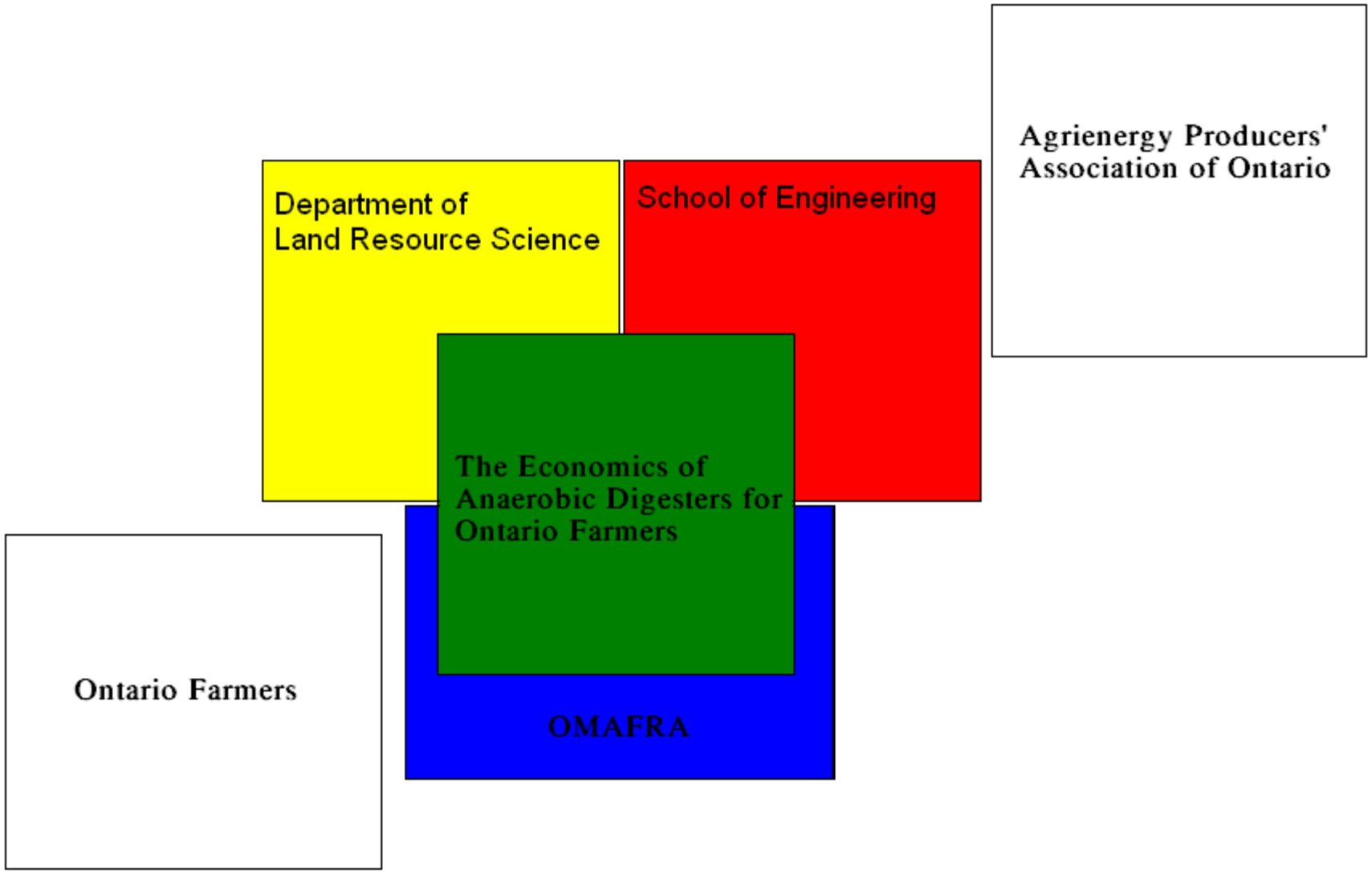
Overview of Additions

- Multi-period cash flows
- Accounts estimates such as inflation, financing, equipment wear, and costs for repairs
- Accounts for changes in Feed-in Tariff (FIT) prices, income and property taxes and claiming capital cost allowance (CCA).
- Allows for project duration and opportunity cost to be included
- Calculates net present value, internal rate of return, payback period, average yearly net income, average return on equity and average return on investment

How the Economic Feasibility Calculator Works

- Central User Inputs
- Loan Amortization Schedule
- Advanced User Inputs
- Support Information
- Calculation Sheet 1
- Calculation Sheet 2
- Calculation Sheet 3
- Summary Sheet

Collaboration Diagram



Life-cycle Assessment of Greenhouse Gas Emissions and Economics of On-Farm Anaerobic Digesters

- Conducting on farm measurements and an environmental assessment of AD considering all aspects of its life-cycle.
- This proposed project will expand research from two on-going projects providing a unique opportunity to develop a critical mass on AD expertise in Ontario.
- Capital investment and operating costs as well as revenue streams for a sub-set of the twenty five AD systems to be installed in Ontario over the next 2 years will be assessed.
- Evaluation of the impact of existing AD energy policies that generate environmental attribute, and assessment of the impact of green policies (i.e. carbon offset credits) on AD financial feasibility will also be carried out.

UNIVERSITY of GUELPH OAC

Food, Agricultural & Resource Economics FARE

Complementary Energy Decision Making Tool

Visit: www.poultryindustrycouncil.ca/education/cedst.php and Tell Us your Story!

Energy Efficiency & Conservation

Wind Energy

- Wind Required Information
- Wind Impacts
- Wind Technology
- Wind Program Information

Solar Energy

- Solar Required Information
- Solar Technology
- Solar Program Information
- Solar Impacts

Farmer/User

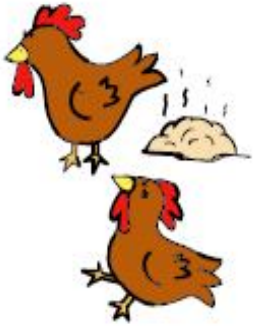
Person/Resources

Farm and Land

- Farm & Land Specifications
- Farm & Land Information

Biomass

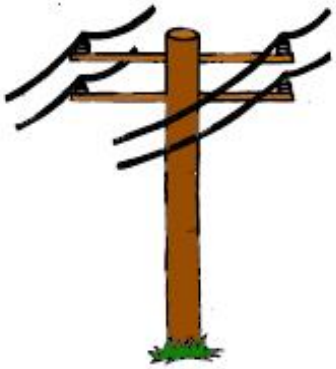
- Biomass Required Information
- Biomass Technology
- Biomass Impacts



Program

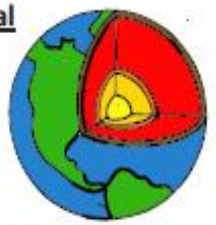
- Program Specifications
- Program Purpose
- Program Characteristics

Other



- Government
- Poultry Industry Council
- Hydro
- University

Geothermal

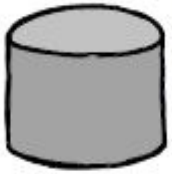


Geothermal Technology

Server

- Server Specifications
- Server Needs

Data Storage



- Data Types
- Data Organization
- Data Operations

Thank You!

Funding Provided by:

OMAFRA

Project:

Life-cycle Assessment of Greenhouse Gas Emissions and Economics of On-Farm Anaerobic Digesters

Project Leader:

Claudia Wagner-Riddle

Payback Period

Calculated:

- Payback Period = Initial Investment/Average Net Income
- Payback Period = Equity of Investment/Average Net Income
- The year in which the cumulative cash flow equals zero

Criteria:

If payback is less then or equal to a specific time frame then it is a good investment

Notes:

Gives equal weight to all cash flows before the payback date and none to any after it

Net Present Value

- $NPV=\sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_0$

NPV=Net present value
t= the number of years since the initial investment
C_t= Cash flow in year t
C_o= Initial investment
r = Discount rate = Opportunity cost

Criteria:
If value is greater then zero, it is a good investment
Notes:
Dependent on the discount rate (r), which can be subjective.

Internal Rate of Return

- Internal Rate of Return= the value of the discount rate at which the Net Present Value is equal to zero.
- Criteria:

If the Internal Rate of Return is higher then the opportunity cost, (r) then it is a good investment.

Notes:

Same with Net Present Value, dependent on the value given to the opportunity cost (r).

Indexed Contract Price

$$CP_y = (1 - PE) \times \left(TCP_{BD} \times \frac{CPI_x}{CPI_{BD}} \right) + PE \times \left(TCP_{BD} \times \frac{CPI_y}{CPI_{BD}} \right)$$

where:

CP_y	is the Indexed Contract Price applicable in calendar year "y" during the Term;
CPI_x	is the CPI applicable in the month of December immediately preceding the calendar year "x", where "x" is the year that is the earlier of (i) year "y" and (ii) the calendar year corresponding to the Milestone Date for Commercial Operation, as such date was established on the Contract Date prior to any adjustment for Force Majeure or NTP Delay;
TCP_{BD}	is the Total Contract Price;
CPI_{BD}	is the CPI applicable to the month in which the Base Date occurs;
CPI_y	is the CPI for the month of December immediately preceding the commencement of calendar year "y"; and
PE	is the Percentage Escalated expressed as a decimal figure.

Calculations for CPI_x and CPI_y

- CPI_{BD} and PE are imputed by user
- TCP_{BD} is determined by Spreadsheet calculations
- CPI_X for the first year is taken from CPI_{BD} and the previous years CPI_y for all remaining years
- CPI_Y is calculated using the expected rate of inflation.
- Expected rate of inflation=$(CPI_y-CPI_x)/CPI_x$
- CPI_y= Expected rate of inflation*CPI_x+CPI_x