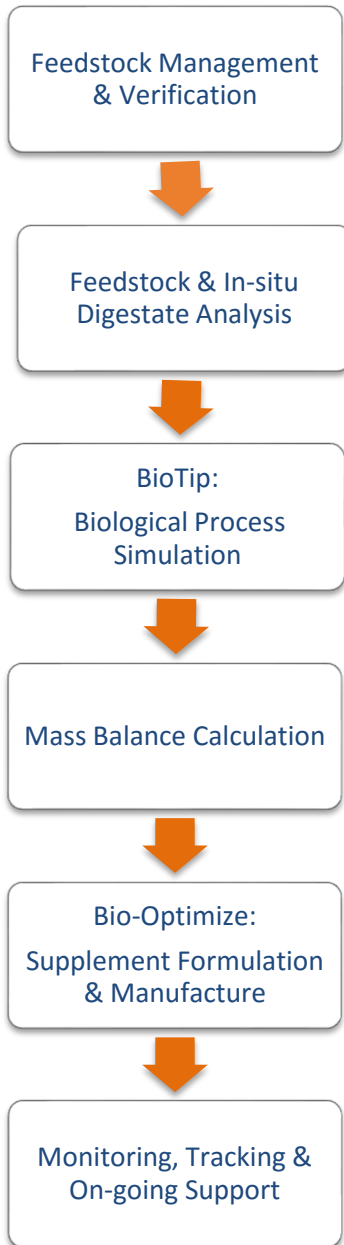


# Dr. Digester Scientific Services

*Un-locking the Potential of your  
Biogas Plant*

# Overview



Dr. Digester Biological Services, a wholly owned division of Yield Energy Inc., is focused on providing world-class preventative maintenance & biogas optimization services to Anaerobic Digester facilities across North America.

By utilizing proven methodologies for analyzing the key parameters of an operating anaerobic digester, we are able to identify the precursors of biological instability & limitations to biogas generation (e.g. rising  $H_2S$  &  $NH_4$  levels, unbalanced organic acid levels & lack of or missing micronutrients etc.). We then provide specific operational recommendations to eliminate current & future limitations to optimizing biogas production.

The core of our service offering is a sophisticated biological simulation system called BioTip. BioTip was developed & validated by our science & engineering partner in Germany, FITEC in concert with a world-renowned University & Biogas Centre of Excellence. BioTip allows us to predict the future biological stability and ideal operating parameters of a given anaerobic digester based on the defined feedstock inputs and operating conditions.

## References:

1. Randy Van Berkel, President  
Vandermeer Greenhouses, Ltd.  
2021 Four Mile Creek Road RR3 Niagara on the Lake,  
Ontario, Canada, L0S 1J0, Telephone: 905-468-2827
2. Clarence Van Staalduinen, President  
Bayview Flowers Ltd.  
3764 Jordan Road, Jordan Station  
Ontario, Canada, L0S 1S0, Telephone: 905-562-7321

# Feedstock Analysis

There are 2 critical components necessary to understanding Feedstock and their implications in biogas plant operation:

- **1. Physical Composition:** Non-Digestible Fraction and Contaminants (egg shells, bones, metal, plastics and glass)
- **2. Chemical Composition:** Carbohydrates, Fats, Proteins, Organic Total Solids, Total Solids and Moisture Content

## Example: Input Substrates

	Input Mix	Total Solids (TS %)	Contaminants (% TS)	Amounts (Tonnes/day)
1	Corn Silage	47.6%	<1 %	.75
2	Mixed Pet Food	91.5%	<1%	.8
3	Grape Pomace	34.7%	<1%	2.0
4	Expired Grocery Store Food Waste	35.6%	15.4%	6.5
	Total			10.05

## Example: Compositional Analysis of Substrates

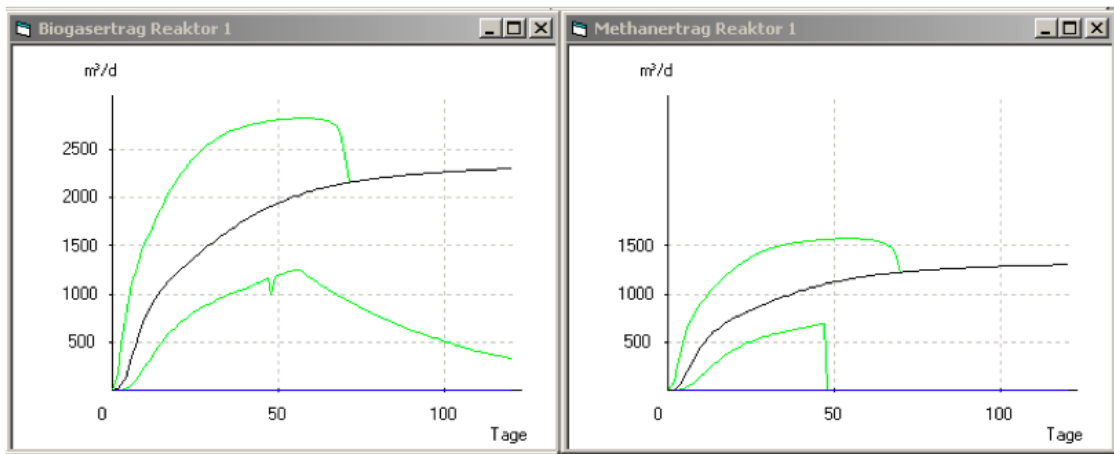
		oTSv	Proteins % oTSv	Fats % oTSv	Carbohydrates % oTSv
1	Corn Silage	47.19%	5.68	2.61	91.71
2	Mixed Pet Food	76.13%	30.95	15.36	53.69
3	Grape Pomace	48.28%	5.8	3.93	90.27
4	Grocery Store	85%	27.0	17.0	56.00

Data from Lab Analysis, Yield Reference Data and Calculations

oTSv – Volatile Organic Total Solids

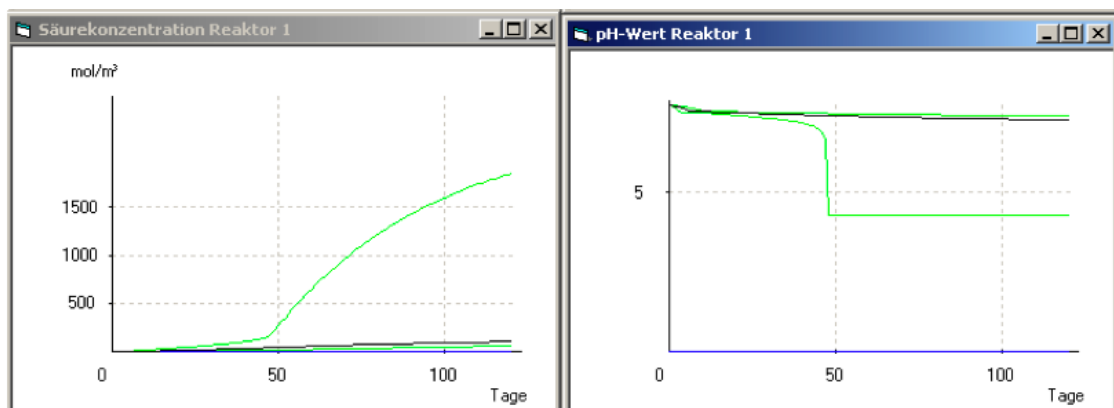
# BioTip: AD Simulations

- BioTip is a proprietary computer simulation toolkit utilized by Yield Energy
- All of the Feedstock Data and Lab Analysis Data are inputs into the Simulation Toolkit.
- The BioTip Simulations transform batch feedstock data into a continuous operating system.
- The program deals with 'what if' scenarios and predicts system stability by concurrently modelling the 4 phases of biogas formation and their feedback loops
- BioTip predicts the outcomes (e.g. biogas output) and biological stability which then indicates remedies and/or changes in feedstock quality or quantity, before problems and lost revenue occur
- Green Lines represent the upper and lower (max and min) operating scenarios
- Black Line represents the average probability of the two green lines



Example: Biogas Production Curve

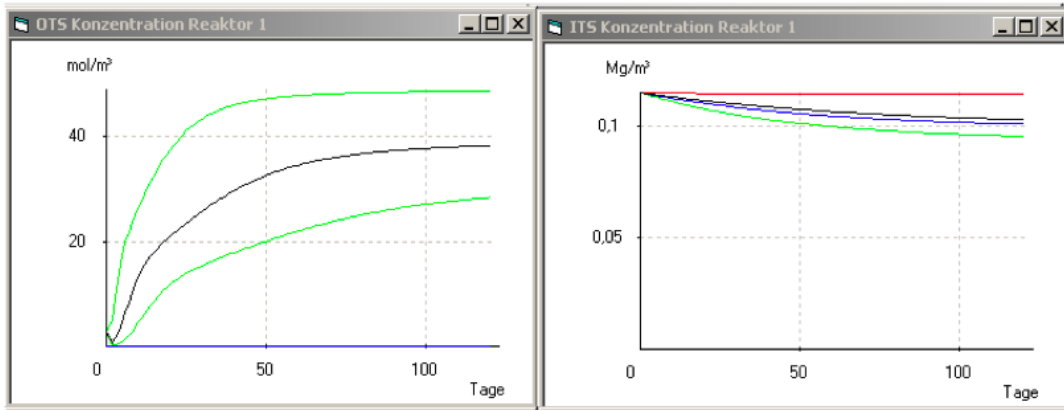
Example: Methane Concentration Curve



Example: Fatty Acid Concentration

Example: pH Curve

# BioTip: AD Simulations



Example: Organic Total Solids Curve

Example: Inert Solids Curve

Example: BioTip<sup>tm</sup> Simulation Results

#	Parameter	Simulation	Simulation	Simulation	Simulation
	Amounts according Table 1.1	100%	150%	200%	
1	Digester temperature	39	39	39	°C
2	Biogas yield	1400	2005	2575	m <sup>3</sup> /d
3	Methane yield	895	1284	1640	m <sup>3</sup> /d
4	Biogas yield 2 <sup>nd</sup> digester	75	170	295	m <sup>3</sup> /d
5	Methane yield 2 <sup>nd</sup> digester	54	125	225	m <sup>3</sup> /d
6	Total biogas	1475	2175	2870	m <sup>3</sup> /d
7	Total methane	946	1409	1865	m <sup>3</sup> /d
8	Methane concentration	65	65	65	%
9	Organic acids	2,1- 2,8	3,6 - 5,1	5,2 - 8,2	g/L
10	pH	7,8	7,8	7,8	
11	Stable up to inhibition level	7	7	7	
12	TS digester 1	5,8	5,9	6,0	%
13	oTS load	18	27	37	mol/m <sup>3</sup>
14	NH4-concentration	4,5	4,5	4,5	g/L
15	Efficiency CHP	38%	38%	38%	%
16	Electrical output CHP	132	196	260	kW

# Mass Balance Calculation

- Mass Balance Calculations are fed by the data from our feedstock analysis and the BioTip simulation results.
- The Mass Balance Results will generate all the necessary process inputs and outputs of the biogas plant (e.g. dilution water, waste water, biogas output, energy generation, compost output etc.)

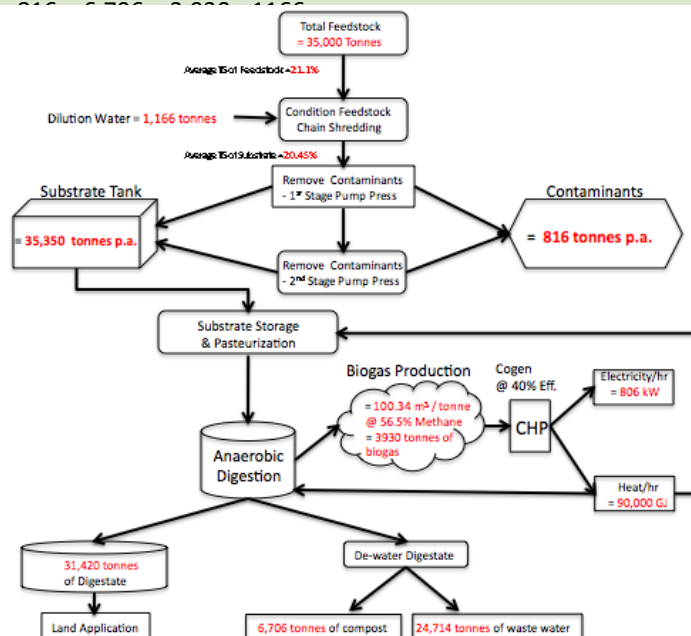
Example: Mass Balance – Table & Graphical Representation

Component	Quantity	Measure
Total Feedstock (TF)	35,000	Tonnes/year
Dilution Water (Dw)	1,166	m <sup>3</sup> /year
Waste Water (Ww)	24,714	m <sup>3</sup> /year
Contaminants (Cont)	816	Tonnes/year
Solid Fraction of Digestate (Comp)	6,706	Tonnes/year
Quantity of Biogas	3,930	Tonnes/year

## Mass Balance

$$TF = Ww + Cont + Comp + Biogas - Dw$$

$$35,000 = 24,714 + 816 + 6,706 + 3,930 - 1,166$$



# In-Situ Digestate Analysis

Used to determine the level of fatty acids/inhibitors that slow or stop the methane production processes in your digesters and provide guidance on specific corrective actions.

	Units
<b>Total Solids</b>	
<b>Volatile Organic Acids /Total Inorganic Carbon</b>	
<b>Acetic Acid</b>	mg/kg
<b>Propionic</b>	mg/kg
<b>Iso-butyric Acid</b>	mg/kg
<b>Butyric</b>	mg/kg
<b>Iso-valeric</b>	mg/kg
<b>Valeric</b>	mg/kg
<b>Iso-caproic</b>	mg/kg
<b>Caproic</b>	mg/kg
<b>HAC Equivalent</b>	mg/kg
<b>Ammonium-N</b>	%
<b>Conductivity</b>	mS/cm
<b>Volatile Solids (Dry Weight)</b>	%
<b>pH at 12°C</b>	

# Bio-Optimize Supplement Formulation & Manufacture

## **Step 1: Substrate and Digestate Testing**

BioTip™ simulations , feedstock and in-situ digestate testing help our technicians identify missing/required nutrients necessary for optimal bacterial populations and maximum biogas production.

## **Step 2: Bio-Optimize Supplement Formulation**

Nutrient formulations are manufactured according to the precise concentrations determined through substrate and digestate testing and simulation studies.

## **Step 3: Dosing Schedule**

Provided detailed instructions on when and how to dose the digester tanks with the Bio-Optimize supplement. Provide monthly recommendation on frequency and quantities.



*All of our supplements are formulated and manufactured locally to ensure quality and efficacy.*



# Feedstock Management Services (FMS)

The “right” feed stocks are critical to the operational and financial success of any anaerobic digester plant.

Another valuable service we offer to existing Dr. Digester clients is the procurement & management of feed stocks.

As part of this service, we will survey the available sources for the most compatible feed stocks that meet the biological & financial criteria established by the client. The right feedstock will deliver both the optimal biogas potential and the highest tipping fees and are consistent with the facilities current pre-processing capabilities. Working with both the suppliers of feed stock and the anaerobic digester community we can match the right feedstock with the right AD facility.

## **FMS Service Summary**

- Find & negotiate for compatible feed stocks
- Initial feedstock characterization including physical audits & chemical testing
- On-going quality assurance through quarterly audits & tests
- Negotiate contracts including tipping fees, quantities, delivery schedules & term



# On-Going Maintenance & Support

## **1. On-call support:**

- 6am – 9pm daily
- Monday to Saturday

## **2. On-site support:**

- Minimum 2 days per month
- “As needed basis”

## **3. On-going testing & monitoring**

- Daily tracking & graphing of key plant parameters

## **4. Monthly Facility Operations Review**

- In-depth presentation of the performance of your biogas facility, focusing on the key parameter trends, preventative actions taken and resulting biogas/energy production

## **Consultants**

### **THOMAS A. FERENCEVIC – Director of Dr. Digester Scientific Services**



Tom is a founding partner and Technical Director for YIELD Energy Inc.

Tom has had extensive biogas plant operational training at facilities in Germany and Austria on multiple technology platforms and feed stocks from agricultural to packaged food wastes.

Tom has given biogas technology courses in Edmonton, AB and Moncton, NB for the Composting Council of Canada as well as presented at the 2009 National Composting Conference in Vancouver, BC.

Tom has also presented at the Growing the Margins Biogas Conference in 2009.

Tom continues to attend training courses in both Europe and Canada as well as participates at international biogas conferences to bring the most current science and technology to our clients.

### **ROLFE M. PHILIP – West Coast Director Dr. Digester Environmental Services**

Rolfe is a founding partner and VP Business Development for Yield Energy Inc.

Rolfe has worked closely for the past year in developing the Dr. Digester business model & processes. Rolfe recently presented to an anaerobic digester working group at the BioCycle Show in San Diego, this past April.



**Yield/Fitec Biogas Plant: Berthelsdorf, Germany**