

# Press Release

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**For Immediate Release**  
Date: December 25, 2007

**Subject: Murray Simpson Completes Feasibility Study of **biowastes-to- renewable energy, organic foods, biofuels, and water independence technology** for New Zealand.**

**WaterSmart Environmental, Inc.** announces the completion of the feasibility study of its **wastes-to-renewable energy, organic foods, biofuels, and water independence technologies** for New Zealand.

WaterSmart Environmental is marketing its Kyoto Protocol compliant wastes-to-energy technology on an economic development platform to concentrated animal feeding operators and to municipalities. Animal farmers benefit by purchasing biodiesel, electricity, and natural gas (methane) at a 20% discount from retail. Municipalities also benefit by making biodiesel, electricity, natural gas, and potable water available to its citizens and businesses at a 20% discount from existing prices. The technology is marketed on a build-own-operate basis thereby eliminating the necessity for local sales and property tax increases since project financing is entirely secured from the financial marketplace. Municipalities that embrace the waste-to-energy technology automatically become zero waste-to-landfill communities.

The waste-to-renewable energy technology has been slowly developed over the last 10 years. It is just now being introduced to the international marketplace. The technology has the clear potential for making every single city throughout the world energy and fuels independent while reducing oil and natural gas imports. The technology will also permit every single city throughout the world to improve water and wastewater treatment infrastructure while creating jobs and investment opportunities. The waste-to-energy technology can also be applied to Sugar Cane Mills as well as Pulp & Paper Mills with equal success. Both types of mills become energy, food, fuels, and water independent while significantly increasing profits from routine operations. In the case of Sugar Cane Mills temporary and seasonal jobs turn into full time better paying jobs. **Widespread use of the technology carries with it the potential for contributing substantially to the reversing of global warming.**

**WaterSmart Environmental, Inc.** is a provider of waste-to-energy, food independence, water independence, and energy independence technologies and a manufacturer of highly engineered water purification components and systems. The company designs and builds a wide variety of water treatment equipment including packaged water and wastewater treatment plants, UltraPac™ aerobic package plants, OAT™ Process anaerobic digesters with associated energy production, aerators, filters, Pur-iSep™ and SmartWater™ oil/water and solids/liquids separators, RainDrain™ perimeter trench sand filters for stormwater runoff, dissolved air flotation separators, air strippers, complete skid assembled aqueous waste treatment plants, FilterFresh™ skid mounted potable water production plants, skid mounted wastewater treatment systems for laundromats, commercial laundries, and car/truck wash fa-

cilities with water reclamation and reuse, softeners, demineralizers, activated carbon treatment equipment, and water purifiers for domestic and international markets.

*Worldwide Promoters of Renewable Energy, Organic Foods, Biofuels,  
& Water Independence Technologies by and for the Common Man*



**PROPRIETARY AND CONFIDENTIAL**

# **FEASIBILITY STUDY**

## **New Zealand**

**BioWastes-To-Renewable Energy, Food, Biofuels, and Water Independence**



***WaterSmart Environmental, Inc.***  
**[www.watersmart.com](http://www.watersmart.com)**

## **WaterSmart Environmental, Inc.**

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*Promoting World Peace Through Economic Prosperity*

December 25, 2007

Dear Investor:

Over the past 20 years the government has transformed New Zealand from an agrarian economy dependent on concessionary British market access to a more industrialized, free market economy that can compete globally. This dynamic growth has boosted real incomes (but left behind many at the bottom of the ladder), broadened and deepened the technological capabilities of the industrial sector, and contained inflationary pressures. Per capita income has risen for eight consecutive years and reached \$26,000 in 2006 in purchasing power parity terms. Consumer and government spending have driven growth in recent years, and exports picked up in 2006 after struggling for several years. Exports are equal to about 24% of GDP, down from 33 percent of GDP in 2001. Thus far the economy has been resilient, and the Labor Government promises that expenditures on health, education, and pensions will increase proportionately to output.

The **BioWastes-To-Renewable Energy, Organic Foods, Biofuels, and Water Independence Technology** consists of the construction of 80 project buildings measuring 1 km x 1 km x 3 stories plus 5 additional larger project building measuring 2 km x 2 km x 200 m high. The smaller buildings will engage in agricultural production and processing activities to produce food products for the export markets to create visible cash flow that will repay debt financing requirements. Each of the 80 project buildings will employ 1,500 workers (120,000 total employees). The project buildings always include a hospital and educational facilities per the attached engineering drawing. In addition to the normal agricultural activities the larger buildings will engage in the construction of tidal generators, self fueling concrete ships, and self fueling locomotives. The steel requirements of these activities will be satisfied by the associated shipbreaking activities. The larger sized project buildings will employ 2,500 each (2,500 x 5 = 12,500) for a total of 120,000 + 12,500 = 132,500. This many new jobs will totally eliminate all unemployment throughout New Zealand. With Warm Regards I am

Very truly yours,

**WaterSmart Environmental, Inc.**



C. G. (Chuck) Steiner  
President and CEO

enclosures

CGS/mns

***Worldwide Promoters of Renewable Energy, Organic Foods, Biofuels,  
& Water Independence Technologies by and for the Common Man***



120' x 120' x 20'H Buried

LNG Storage Tank

120' x 120' x 20'H Buried

Liquefied Nitrogen Storage Tank

120' x 120' x 20'H Buried

Anaerobic Digester Feed Tank

120' x 120' x 20'H Buried

Potable Water Storage Tank

120' x 120' x 20'H Buried

Anaerobic Digester Tank

EAF Steel Recycling Process

300 Ton/Day Cement Manufacturing Facility

48' Wide Double Wall 3 Sides, Typ. For Employee Housing

24' Wide Double Wall 3 Sides, Typ. For Microalgae Photobioreactor

Hospital

Educational Facilities

Organic Foods Restaurant

Twin Cell Box Culvert Encased

Buried Piping Galley

100' x 400' Covered Computer Batched Concrete Plant And Precast Concrete Panel Manufacturing Facility

# Wastes-To-Renewable Energy Project Building Site Plan

## 1 km x 1 km x 3 Stories High

Construction Manager:  
BioWastePower Constructors  
A Division of WaterSmart Environmental, Inc.

TITLE	Site Plan		
PROJECT	Project Building		
JOB	New Zealand		
SCALE	NONE	DRAWN	B.E.H.
DATE	11/14/07	CHECKED	C.G.S.
REV.	DATE	DESCRIPTION	BY
			CHK

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# Nonrecourse Project Capital Cost Structure

## New Zealand

### BioWastes-To-Renewable Energy, Food, BioFuels, and Water Independence Plant

The total estimated capital and development costs of the design-build-own-operate wastes-to-renewable energy project total \$501,226,585 (plus funding broker commissions) utilizing both new and remanufactured process equipment. The major components of capital and other costs are as follows:

Item Description	Cost in US\$
Anaerobic Digester Feed Tank Constructed Cost <sup>1</sup>	2,000,000
Biodiesel Manufacturing Equipment Constructed Cost <sup>2</sup>	15,000,000
Building Size 1 km x 1 km x 2 stories high Constructed Cost <sup>3</sup>	75,000,000
Cement Kiln Constructed Cost <sup>4</sup>	12,000,000
Concrete Ready Mix Batch Plant Constructed Cost <sup>5</sup>	3,000,000
EAF Steel Recycling Process Equipment Constructed Cost	3,000,000
Fish Processing Equipment Constructed Cost <sup>6</sup>	500,000
LED Lighting Purchase Cost <sup>8</sup>	10,000,000
Liquefied Nitrogen Air Separation Equipment Procurement Capital Cost	15,000,000
Liquefied Nitrogen Delivery Equipment Procurement Capital Cost	500,000
Liquefied Nitrogen Storage Tank Constructed Cost	2,000,000
LNG (Liquefied Natural Gas) Storage Tank Constructed Cost	2,500,000
Methane Gas Compression Equipment Installed Capital Cost	10,000,000
Potable Water Storage Tank Constructed Cost	2,000,000
Photobioreactor Capital Equipment Constructed Cost <sup>7</sup>	100,000,000
Power Generation Equipment Procurement Cost <sup>9</sup>	56,650,000
Reverse Osmosis Equipment Procurement Cost	2,000,000
Sow procurement Costs	5,000,000
Two-Phase Anaerobic Digester Constructed Cost <sup>1</sup>	74,780,080
<b>Subtotal Project Costs</b>	<b>390,930,000</b>
Add 15% Contingencies	58,639,500
<b>Total Capital Costs</b>	<b>449,569,500</b>
Finance Charges	8,000,000
Interest During Construction	20,000,000
Administration/Legal	150,000
Permitting	20,000
Technology & Development Cost	284,559,700
Project Development Fee @ 3% of US\$449,569,500	13,487,085
Working Capital	10,000,000
<b>Total All Costs</b>	<b>785,786,285</b>

Nonrecourse Project Financing Will Be Structured As Follows:

Developer Equity as Technology, 70% <sup>10</sup>	284,559,700
Investor Equity as Cash, 30%	94,712,728

Finance	406,513,857
Loan Term, Years	10
Interest Rate	10%
Developer will contribute 70% equity in the project as the value of the technology. <sup>10</sup>	
Investor will contribute US\$94,712,728 cash and the balance will be financed.	

**With Following Notes:**

1. The anaerobic digester and its associated feed tank will be constructed of precast concrete panels. The panels will be manufactured by Wieser Concrete Products, Inc. and barge shipped to destination project site. The Wisconsin based precast concrete manufacturer POC is Phil Miller @ phone 800.325.8456 (see <http://www.wieserconcrete.com/about.html>).
2. The biodiesel production equipment will be designed and manufactured by California based R. C. Costello & Associates, Inc. The POC is Rocky Costello, P.E. @ phone 310.792.5870 (see <http://www.rccostello.com/>).
3. The low cost of the project building is made possible by the 100% internal recycling of inorganic wastes that are produced from the anaerobic digestion process. These inorganic wastes are combined with cement and water in the production of precast concrete panels. The special purpose project company will produce its own cement to further minimize construction costs. See attached WSE Engineering Drawing No. S-6099-1 for additional details. The POC at WaterSmart Environmental is Chuck Steiner @ 913.897.2727 (see <http://www.watersmart.com/>).
4. The cement kiln will be sourced through Canada based Cement Process Consulting, Ltd. The POC is Ken Postle @ phone 403.472.4519 (see <http://www.cement-process.com/index.htm>).
5. The concrete ready mix plant will be sourced through Canada based Cement Process Consulting, Ltd. The POC is Ken Postle @ phone 403.472.4519 (see <http://www.cement-process.com/index.htm>).
6. The fish production and processing equipment will be sourced through Colorado based Fisheries Technology Associates, Inc. The POC is Bill Mancini @ phone 970.225.0150 (see <http://www.ftai.com/>).

7. The enclosed photobioreactor consists of 2 miles long 12"Ø clear PVC pipe. A possible supplier is Harvel Plastics, Inc. but other sources will be considered prior to procurement (see <http://www.harvel.com/>).
  
8. The artificial lighting for the photobioreactor consists of 5 miles of high efficiency long lasting (10 years or more) light emitting diode (LED) lighting that will be wrapped barber pole fashion around the clear PVC pipe. A possible supplier is Light Waves Concept, Inc. but other sources will be considered prior to procurement (see <http://www.lightwavesconcept.com/>).
  
9. The power generation equipment will be sourced through UK based Combustion, Energy & Steam Specialists, Ltd. The POC is Mike Craigie @ phone +44 (0) 1856 851177 (see <http://www.cess.co.uk/>).
  
10. The seemingly high percentage of developer equity as technology is justified on the basis that it is the only economic development technology that simultaneously achieves:
  - 100% compliance with Kyoto Protocol thus helping to reverse global warming,
  - Distributed Biofuels (biodiesel and compressed natural gas or CNG) independence,
  - Distributed Food independence,
  - Distributed Renewable energy independence,
  - Distributed Water independence, and
  - Complete internal recycling of all byproducts and waste streams thereby producing a useful product—namely precast concrete products that will be used for constructing the project building itself as well as infrastructure roads, light rail transit surface transportation system, precast concrete potable water distribution system, precast concrete wastewater collection system, and precast concrete encased renewable energy power distribution system. In doing so the community initiative project will become the very first zero carbon and zero waste community in the world.

Climate Change has now become the most serious worldwide concern as the sustainability of our planet appears to be at rapidly increasing risk. Renewable Energy Technologies that address climate change are therefore in great demand. Technologies that address both climate change and substantial economic development are in even greater demand. The proposed waste-to-energy technology has required over 30,000 hours of research over a 10 year period to develop thus fully justifying the seemingly high percentage of developer equity as technology. It is the very first and only worldwide technology that is technically capable of simultaneous distributed energy independence, distributed food independence, distributed fuels independence, and distributed water independence with all in full compliance with Kyoto Protocol.

The proposed wastes-to-renewable energy technology consists of a suite of individual component technologies. The individual component technologies are:

- **Biodiesel Production With Associated Waste Processing.** The National Renewable Energy Laboratory (NREL) pioneered the very first production of biodiesel from microalgae. The research and development was carried out under the “Aquatic Species Program” (ASP) that consisted of the first production of a biofuel called “algal biodiesel” (see [http://www1.eere.energy.gov/biomass/pdfs/biodiesel\\_from\\_algae.pdf](http://www1.eere.energy.gov/biomass/pdfs/biodiesel_from_algae.pdf)). Under the referenced program Algal Biodiesel was produced through the growing of microalgae for their lipid content. The lipid content was then converted into biodiesel through chemical transesterification in the same manner that soybeans and other vegetable oils are now being converted into biodiesel. The ASP funding totaled \$25.05 million over a 20 year period that began in 1978. Continuation funding was ultimately terminated when it was officially determined that algal biodiesel could not be produced economically. The ASP obtained its research data from growing microalgae in warm open ponds (Salton Sea in Southern California) at a pH of 8.2 using atmospheric carbon dioxide. The Salton Sea is the recipient of agricultural runoff nutrients as well as additional nutrients contained in municipal sewage treatment plants discharges. The Middle Cordoba Province Project will produce microalgae within an enclosed photobioreactor that will operate at the optimum growing temperature of 35°C (95°F) and at the optimum growing pH of 9.4. Photosynthesis will occur 24/7 rather than just during daylight hours by using long lasting light emitting diode (LED) lighting. The photobioreactor will receive the total carbon dioxide output from both the anaerobic digester as well as the power generation equipment thus substantially increasing production over that obtainable from using carbon dioxide from the atmosphere. Microalgae production will be further increased by adding the micronutrients contained in the reverse osmosis concentrate stream thus substantially improving microalgae production. The total increase of these process modifications over that obtained by the National Renewable Energy Laboratory’s ASP is estimated at a factor of at least 1000 to 1. By producing the microalgae within an enclosed photobioreactor the technology becomes totally compliant with Kyoto Protocol since all discharges of greenhouse gases to the environment are eliminated.
- **Cement manufacturing as a technology has been practiced for many hundreds of years throughout the entire civilized world.**
- **Fish farming was first practiced by the Chinese over 100 years ago. Due to the over fishing of the oceans fish farming is now widespread throughout the entire civilized world.**
- **Precast concrete panels and piping have been manufactured for the last 50 years. The use of precast concrete panels has become quite popular in the building industry during the last 10 years.**
- **Liquefied Nitrogen and Liquefied Oxygen have been produced in the marketplace for the last 50 years. Names of today’s largest industrial suppliers consist of Air Liquide, Air Products & Chemicals, Inc., Cryogenic Industries, Inc., Gas Systems Corporation, and Praxair, Inc.**
- **Methane gas-to-methanol alcohol through synthesis gas (syngas) technology represents the standard method of producing methanol throughout the civilized world.**
- **Microalgae production through the use of a photobioreactor (use of artificial light rather than sunlight) is now being done at several research institutions. The technology has yet to be put into full scale commercial operation.**

- The anaerobic digestion of municipal solid wastes (MSW) was first accomplished by two-phase anaerobic digestion in 1996 (see <http://lib.kier.re.kr/caddet/retb/no66.pdf>). More recently the management of municipal solids wastes is being accomplished using conventional anaerobic digestion by Waste Management, Inc., a waste management company (see <http://www.wm.com/WM/environmental/Bioreactor/technologies.asp>).
- Pig farming and processing has been practiced around the world for the last 100 years.
- Precast concrete panels and precast concrete pipes have been manufactured for the last 50 years throughout the world.
- Renewable energy power generation has been practiced for at least 30 years in the EU and 20 years in the United States.
- Reverse osmosis treatment has been around on a commercial basis for over 30 years. During the last 5 years its marketplace costs have been halved and it is now considered very good and very affordable technology.

New Zealand Prefeasibility Study, December 31, 2007	Totals
Location: New Zealand	
Technology Provider: WaterSmart Environmental, Inc.	
<b>Project Developer:</b> Murray Simpson PO Box 37874 Parnell, Auckland 1033, New Zealand Phones: +64 9 520 9041, +64 21 680 107 Fax: +64 9 520 9049 email: murray@ecopowertrust.com	
Project Type: Economic Development through Design-Build-Own-Operate BioWastes-To-Renewable Energy, BioFuels, Organic Foods, and Potable Water Independence	
Project Dollar Size: US\$500 million for each 1 km x 1 km x 3 story high project building	
Number of project buildings required: 80	
Project Activities: Extensive Agricultural Production and Processing that additionally includes renewable energy, biofuels, and water production along with 100% recycling of all byproducts into precast concrete panels and piping for infrastructure development	
Jobs Creations Potential for each 1 km x 1 km x 3 story high project building: 1,500	
BioWastes Treated: Municipal Solid Wastes (MSW), Medical Wastes, Construction & Demolition Wastes, Foods Production & Processing Wastes, and Biodiesel Processing Wastes	
Local Population Served for each 1 km x 1 km x 3 story high project building: 50,000	
Residual Wastes to Landfill: Zero	
Greenhouse Gaseous Emissions to the Environment: Zero	
Climate Change Carbon Footprint: Zero	
Investor Internal Rate of Return: Optimal	
<h2 style="color: green;">Detailed Project Description</h2> <p>Extensive Agricultural Production in each project building will consist of a 10,000 sow farrow-to-finish operation that is sized to produce excess local marketplace demand for finished pork and a 50 hectare tilapia fish farming operation that is also sized to produce excess local marketplace demand for tilapia fish. On a total processed weight basis the amount of excess processed fish produced will be about 4 times that of processed pork. Processed Tilapia fish are worth about 1.5 times as much as processed pork and therefore more profitable. The excess processed pork and processed fish will be exported to distant markets to provide visible cash flow to the project. The worldwide demand for pork on a weight basis is about 4 times that of the worldwide demand for fish. With a world population approaching 7 billion the pork and fish output of a single project building calculates out to approximately 0.075% of worldwide demand of processed pork and tilapia fish. A total of <math>1 \div 0.00075 = 1,333</math> project buildings would therefore be required to satisfy worldwide demand for both pork and fish. Worldwide consumption of pork and fish data is attached. The marketing idea is to produce 100% of the local demand for pork and fish with the entire excess of each sold to export markets for visible sales revenue.</p> <p>In addition to agricultural production, each project building will produce Portland cement for the purpose of manufacturing precast concrete panels and piping for direct infrastructure development.</p> <ol style="list-style-type: none"> <li>1. In the production of cement considerable carbon dioxide gas is produced.</li> <li>2. When processing biowastes using anaerobic digestion both methane gas and carbon dioxide gas are produced.</li> <li>3. When generating renewable energy both water vapor and carbon dioxide gas are produced.</li> </ol>	

100% of the carbon dioxide gas produced during the production of cement, the processing of biowastes, and the generation of electricity will be routed to an enclosed photobioreactor for the purpose of producing Spirulina microalgae. 75% of the Spirulina microalgae will be used as animal feed in the production of tilapia fish and pork. The remainder 25% will be converted into biodiesel biofuel (B100) and sold locally to produce visible sales revenue.

Spirulina microalgae contain about 6% lipids (fats). The production of biodiesel produces about 6% lipid (fat) conversion into biodiesel biofuel from Spirulina microalgae. The 94% remaining biowastes are returned to the anaerobic digester to produce additional methane gas and carbon dioxide gas. The resulting methane gas produced can be used for power generation or sold as a biofuel. The resulting carbon dioxide gas produced from electricity generation will be automatically routed to the enclosed photobioreactor to enable production of additional Spirulina microalgae.

The economic development objective is to produce 100% of the local demand for electricity, 100% of the local demand for biodiesel biofuel, 100% of the local demand for natural gas (methane gas is a near equivalent to natural gas) biofuel, and 100% of the local demand for compressed natural gas (CNG) automotive biofuel. Biodiesel (B100) can be used as a direct replacement for petroleum diesel without equipment modification. CNG biofuel must be used in vehicles equipped for this fuel. Each project building will engage in the modification of gasoline automotive equipment to enable the use of CNG biofuel. Automobiles that operate on CNG biofuel enjoy extended useful life of the engine by a factor of 4 or more. Trucks that operate on biodiesel biofuel enjoy extended useful life of the engine by a factor of 2 or more. Each economic development project includes the infrastructure for local distribution of renewable natural gas. To the extent that methane gas is used for electricity generation, the production of biodiesel biofuel, and the production of CNG biofuel, each qualifies for renewable energy credits since all such uses are carbon neutral.

As background information, the production of ethanol from corn and biodiesel from beans has precipitated a massive food or fuel issue throughout the world causing the marketplace price of both corn and soybeans to increase dramatically. These increases have, in turn, caused the marketplace price of ethanol and biodiesel to increase as well the marketplace price of corn and soybean based food products. It is these increases in marketplace prices that have caused the food or fuel issue. With our business model, the production of biodiesel from Spirulina microalgae stays completely clear of the food or fuel issue as does the production of CNG biofuel from biowastes. To achieve total sales of the biofuels production outputs they will be sold at a 20% discount from existing retail. At this attractive pricing 100% of routine production will easily sell in the marketplace.

Because nutrients will be 100% recycled internally, each project building will produce substantial liquid fertilizer concentrate that will be distributed to area farmers in need on a no-charge basis. Excess liquid fertilizer, if any, would be eligible to sell to distant markets or possibly converted into value added products. To the extent that the local market does not make use of the liquid fertilizer concentrate the fertilizer product will be sold to international markets to increase additional visible cash flow to the project.

Because 100% of the water is recycled internally, potable water of the quality of bottled water will be distributed locally on a no-charge basis. Because water is required to process municipal solid wastes each project building will accept both sanitary wastewater and storm water for that purpose on a no-charge basis. Over time, additional stories will be added to each project building to enable additional agricultural activities that could include bananas, beets, black bass, beef cattle, beans, cassava, coffee, corn, cotton, dairies, lobster, onions, poultry, prawns, rice, shrimp, sugar cane, sweet potatoes, trout, and many other crops.

Throughout the prefeasibility study extensive efforts are made to provide balanced chemical equations and mathematical calculations, where appropriate, to permit extensive due diligence evaluations of the proposed sciences to be used.

No Charge For Potable Water

No Charge For Wastewater Treatment

No Charge for Stormwater Treatment

## Marketplace BioWastes-To-Energy Feedstocks

A determination of the amount of volatile solids (VS) is necessary in order to calculate the amount of methane gas that can be produced from the anaerobic digestion of biowastes. Eligible feedstocks consist of municipal solid wastes (MSW), medical wastes, and construction & demolition wastes. For the purpose of arriving at conservative waste figure availability, a total of 2 lbs/person/day will be used for the purpose of calculating total feedstock biowaste amounts for developing countries and a total of 5 lbs/person/day will be used for the purpose of calculating total feedstock biowaste amounts for developed countries. For an area population of 50,000 for each project building the available biowastes calculate out to  $50,000 \times 2 \text{ lbs/person/Day} = 100,000 \text{ lbs/day}$ , or when divided by  $2,000 \text{ lbs/Ton} = 50 \text{ Tons/Day}$  for developing countries and  $50,000 \times 5 \text{ lbs/person/day} = 250,000 \text{ lbs/Day}$ , or when divided by  $2,000 \text{ lbs/Ton} = 125 \text{ Tons/Day}$  for developed countries.

For undeveloped countries, the calculation for municipal solid wastes is as follows:

Assuming 25% moisture content  $50 \text{ Tons/Day} \times 75\% = 37.5 \text{ Dry Tons/Day}$   
 Assuming 80% organic content  $37.5 \text{ Dry Tons/Day} \times 80\% = 30 \text{ Organic Tons/Day}$   
 Assuming 80% volatile solids content  $30 \text{ Organic Tons/Day} \times 80\% = 24 \text{ Tons Volatile Solids/Day}$  or  $\times 2,000 \text{ lbs/Ton} = 48,000 \text{ lbs/Day}$ . This amount of waste translates into  $48,000 \text{ lbs Volatile Solids/Day} \times 12 \text{ cubic feet of methane/lb Volatile Solids} = 576,000 \text{ CFD of CH}_4$ . At  $24 \text{ cubic feet/lb}$ , the methane production translates into  $576,000 \text{ CFD CH}_4 / 24 = 24,000 \text{ lbs/2,000} = 12.0 \text{ Tons CH}_4/\text{Day}$  for undeveloped countries.

For developed countries, the calculation for municipal solid wastes is as follows:

Assuming 25% moisture content  $125 \text{ Tons/Day} \times 75\% = 93.75 \text{ Dry Tons/Day}$   
 Assuming 80% organic content  $93.75 \text{ Dry Tons/Day} \times 80\% = 75 \text{ Organic Tons/Day}$   
 Assuming 80% volatile solids content  $75 \text{ Organic Tons/Day} \times 80\% = 60 \text{ Tons Volatile Solids/Day}$  or  $\times 2,000 \text{ lbs/Ton} = 120,000 \text{ lbs/Day}$ . This amount of waste translates into  $120,000 \text{ lbs Volatile Solids/Day} \times 12 \text{ cubic feet of methane/lb Volatile Solids} = 1,440,000 \text{ CFD of CH}_4$ . At  $24 \text{ cubic feet/lb}$ , the methane production translates into  $1,440,000 \text{ CFD CH}_4 / 24 = 60,000 \text{ lbs/2,000} = 30.0 \text{ Tons CH}_4/\text{Day}$  for developed countries.

In addition to fresh municipal solid wastes, the project will directly collect an additional 10 lbs/person/Day from existing landfills, rubbish piles, and dumps for the twofold purpose of producing additional methane gas and reclaiming additional ferrous and nonferrous metals while getting rid of existing dump/landfill sites. This activity will increase the methane gas and carbon dioxide gas production from two-phase anaerobic digestion by a factor of 5/2 or 2.5 thus increasing the volatile solids from undeveloped countries from 24 Tons/Day to 60 Tons/Day and from developed countries from 60 Tons to 150 Tons/Day. The associated methane gas is increased from 12 Tons CH<sub>4</sub>/Day to 30 Tons CH<sub>4</sub>/Day for undeveloped countries and from 30 Tons CH<sub>4</sub>/Day to 75 Tons CH<sub>4</sub>/Day from developed countries.

The 60 Tons Volatile Solids/Day from undeveloped countries can be converted into CO<sub>2</sub> production by multiplying the Volatile Solids by 12 to determine cu. ft. of methane gas produced.  $\text{Cu. ft. of methane gas produced} \div 24 \text{ cu. ft./lb} = \text{lbs methane gas}$ .  $\text{Lbs. methane gas multiplied by } 1.375 = \text{lbs CO}_2 \text{ produced}$  or  $60 \text{ Tons VS/Day} \times 2,000 \text{ lbs/Ton} \times 12 = 1,440,000 \text{ cu. ft. CH}_4/\text{Day}$ .  $1,440,000 \text{ cu. ft.} \div 24 \text{ cu. ft./lb} = 60,000 \text{ lbs CH}_4/\text{Day}$ .  $60,000 \text{ lbs CH}_4/\text{Day} \times 1.375 = 82,500 \text{ lbs CO}_2/\text{Day}$ .  $82,500 \text{ lbs CO}_2/\text{Day} \div 2,000 \text{ lbs/Ton} = 41.3 \text{ Tons CO}_2/\text{Day}$ .

The 150 Tons Volatile Solids/Day from undeveloped countries can be converted into CO<sub>2</sub>

60 Tons VS/Day  
From MSW  
Undeveloped  
Countries

30 Tons CH<sub>4</sub>/Day  
From MSW  
Undeveloped  
Countries

150 Tons VS/Day  
From MSW in  
Developed Countries

75 Tons CH<sub>4</sub>/Day  
From MSW in  
Developed Countries

No charge for  
MSW disposal

US\$0.00/Day  
From MSW

<p>production by multiplying the Volatile Solids by 12 to determine cu. ft. of methane gas produced. <math>\text{Cu. ft. of methane gas produced} \div 24 \text{ cu. ft./lb} = \text{lbs methane gas}</math>. <math>\text{Lbs. methane gas multiplied by } 1.375 = \text{lbs CO}_2 \text{ produced}</math> or <math>150 \text{ Tons VS/Day} \times 2,000 \text{ lbs/Ton} \times 12 = 3,600,000 \text{ cu. ft. CH}_4\text{/Day}</math>. <math>3,600,000 \text{ cu. ft.} \div 24 \text{ cu. ft./lb} = 150,000 \text{ lbs CH}_4\text{/Day}</math>. <math>150,000 \text{ lbs CH}_4\text{/Day} \times 1.375 = 206,250 \text{ lbs CO}_2\text{/Day}</math>. <math>206,250 \text{ lbs CO}_2\text{/Day} \div 2,000 \text{ lbs/Ton} = 103 \text{ Tons CO}_2\text{/Day}</math>.</p> <p>Revenue collected for management of landfill wastes, municipal solid wastes, medical wastes, and construction &amp; demolition wastes: US\$0/Day/Ton. Never a charge, ever. This service always provided as a public service activity only.</p>	
<p style="text-align: center;"><b>Agricultural Food Production and Processing</b></p> <p>A 10,000 Sow Farrow-To-Finish farming operation will be provided for each project building that will produce about 22 pigs/sow/year. There is a potential to increase the number of pigs since the Dutch are now reporting upwards of 30 pigs/sow/year. The 10,000 sows therefore translate into <math>22 \times 10,000 = 220,000</math> pigs/year with possible future expansion possible. At a midterm weight of 100 lbs, each hog will generate wastes sufficient to produce 3.02891 cubic feet of methane gas per day (archived data from Premium Standard Farms, Kansas City) through anaerobic digestion for a total daily production of <math>3.02891 \times 220,000</math> or 666,360 cubic feet. At 24 cubic foot/lb, the methane production translates into <math>666,360/24 = 27,765 \text{ lbs}/2,000 = 13.9 \text{ Tons CH}_4\text{/Day}</math>.</p> <p>Pigs usually reach market weight between 5 and 6 months of age at approximately 260 to 280 pounds. During this time, the pigs are often fed several corn-soybean meal based diets that change in nutrient composition to meet their needs. Pigs weigh about 3 pounds at birth and stay with the sow until 21 days of age. At this time, they are placed on a grain diet. Pigs have unlimited access to feed and water at all times. Pigs will eat about 1 pound of feed per day at weaning and as much as 8 pounds of feed per day by market weight. Water intake is about 1 gallon per day up to 5 or 6 gallons per day by market weight. Just weaned pigs (21 days of age) need to be kept at about 80 to 85 degrees Fahrenheit and by market weight 65° F. Therefore, heating and cooling systems need to be in place throughout. A total of 2 MW of electricity will be required for the pig farming operations.</p> <p>For market hogs the pigs will consume about 3 to 4 percent of their body weight. A 200-pound hog will consume about 6 to 6.5 pounds each day.</p> <ul style="list-style-type: none"> <li>• Nursery pigs weighing about 10 pounds consume around 0.5 pounds</li> <li>• Feeder pigs weighing about 50 pounds consume around 1 to 2 pounds</li> <li>• Grower pigs (now referred to as hogs) weighing about 100 pounds consume around 3 to 4 pounds</li> <li>• Finisher hogs weighing about 150 pounds consume around 4 to 5 pounds</li> <li>• Hogs more than 200 pounds consume around 6 to 7 pounds</li> </ul> <p>United States retail pork prices are currently around US\$2.87/lb. The wholesale producer receives about 43% of this price or US\$1.46/lb. The above prices represent the average for the last 3 years. As a commodity there is no guarantee they will drift up or down but will likely continue to fluctuate as they have been for the last 50 years. Current marketplace dressed pork yields are over 2,750 lbs/year/sow. A 10,000 sow farrow-to-finish operation is estimated to produce 27,500,000 lbs of dressed pork/year or an average of 75,342 lbs/Day. At US\$1.46/lb the daily revenue is estimated at US\$110,000.00. Associated electricity requirements for temperature and humidity control are estimated at 2 MW. The exported pork product will be the first Organic Pork produced worldwide since all the principles for its production will be followed. Organic food is produced according to a set of principles and standards concerning such issues as pesticides, additives,</p>	<p style="text-align: right;">27.0 Tons VS/Day From Pig Farming</p> <p style="text-align: right;">13.9 Tons CH<sub>4</sub>/Day From Pig Farming</p> <p style="text-align: right;">2 MW Electricity Required</p> <p style="text-align: right;">US\$110,000/Day From Pork</p>

<p>animal welfare (medications) and sustainability. Organic pork will carry a higher marketplace value than non-organically produced pork similar to all organically produced food products.</p> <p>In terms of investor risk assessment, the existence of the very large pork commodity market is regarded as ample proof of probable visible cash flow from this specific food product.</p> <p>At a finished market weight of 250 lbs 220,000 pigs translate into 220,000 x 250 lbs = 55,000,000 lbs/year. 55,000,000 lbs/year ÷ 2,000 lbs/Ton = 27,500 Tons/year. 27,500 Tons/year ÷ 365 days/year = 75.34 Tons/Day.</p> <p>The processing of pork yields about 30% biowastes. The total processing wastes calculate out at 75.34 Tons/Day x 30% = 22.60 Tons/Day. When multiplied by 2,000 lbs/Ton, the amount of volatile solids = 45,200 lbs/Day. This amount of biowastes translate into 45,200 lbs Volatile Solids/Day x 12 cubic feet of methane gas/lb Volatile Solids = 542,400 cubic feet/Day (CFD) of methane gas (CH<sub>4</sub>). At 24 cubic feet/lb, the methane production translates into 542,400 CFD CH<sub>4</sub>/24 = 22,600 lbs/2,000 = 11.3 Tons CH<sub>4</sub>/Day.</p>	<p>22.6 Tons VS/Day From Pork Processing</p> <p>11.30 Tons CH<sub>4</sub>/Day From Pork Processing</p>
<p style="text-align: center;"><b>Additional Agricultural Food Production and Processing</b></p> <p>Will consist of a 50 hectare Tilapia fish farm at each project building for producing and thereafter processing organically grown Tilapia filets, mostly for the export fish market. Electricity requirements are estimated at 0.5 MW. The estimated raw fish produced per day is 670,000 lbs. At a filet yield of 42% a total of 281,000 lbs (140.5 Tons of Tilapia filets) will be produced/Day along with 389,000 lbs or when divided by 2,000 lbs/Ton = 194.5 Tons of biowastes/Day. At a commodity sell price of US\$2.18/lb, the daily revenue is estimated at 140.5 Tons/Day x 2,000 lbs/Ton x US\$2.18/lb = US\$612,580/Day</p> <p>It is virtually impossible to obtain a buyer commitment on a current basis in the form of a purchase agreement for a product that is 36 months away from coming into existence. In terms of investor risk assessment, the existence of the very large fish commodity market itself is regarded as ample proof of probable visible cash flow from this specific food product.</p> <p>The 194.5 Tons/Day of biowastes x 2,000 lbs/Ton = 389,000 lbs of Volatile Solids/Day. This amount of waste translates into 389,000 lbs Volatile Solids/Day x 12 cubic feet of methane/lb Volatile Solids = 4,668,000 cubic feet/Day (CFD) of CH<sub>4</sub>. At 24 cubic foot/lb, the methane production translates into 4,668,000 CFD CH<sub>4</sub>/24 = 194,500 lbs/2,000 = 97.3 Tons CH<sub>4</sub>/Day.</p>	<p>0.5 MW Electricity Required For Tilapia Fish Farming</p> <p>US\$612,580/Day From Tilapia Fish</p> <p>194.5 Tons VS/Day From Fish Processing</p> <p>97.3 Tons CH<sub>4</sub>/Day From Fish Processing</p>
<p><b>Subtotal Carbon Dioxide Gas Produced From Municipal Solid Wastes Processing:</b></p>	<p>41.3 Tons CO<sub>2</sub>/Day</p>
<p>The 60 Tons Volatile Solids/Day from Municipal Solid Wastes can be converted into CO<sub>2</sub> production by multiplying the Volatile Solids by 12 to determine cu. ft. of methane gas produced. Cu. ft. of methane gas produced ÷ 24 cu. ft./lb = lbs methane gas. Lbs. methane gas multiplied by 1.375 = lbs CO<sub>2</sub> produced or 60 Tons VS/Day x 2,000 lbs/Ton x 12 = 1,440,000 cu. ft. CH<sub>4</sub>/Day. 1,440,000 cu. ft. ÷ 24 cu. ft./lb = 60,000 lbs CH<sub>4</sub>/Day. 60,000 lbs CH<sub>4</sub>/Day x 1.375 = 82,500 lbs CO<sub>2</sub>/Day. 82,500 lbs CO<sub>2</sub>/Day ÷ 2,000 lbs/Ton = 41.3 Tons CO<sub>2</sub>/Day.</p>	
<p><b>Subtotal Feedstocks Volatile Solids From Pig Farming Wastes:</b></p>	<p>27.0 Tons VS/Day</p>
<p>The 27 Tons Volatile Solids/Day from Pig Farming Wastes can be converted into CO<sub>2</sub> production by multiplying the Volatile Solids by 12 to determine cu. ft. of methane gas produced. Cu. ft. of methane gas produced ÷ 24 cu. ft./lb = lbs methane gas. Lbs. methane gas multiplied by 1.375 = lbs CO<sub>2</sub> produced or 27 Tons VS/Day x 2,000 lbs/Ton x 12 = 648,000 cu. ft. CH<sub>4</sub>/Day. 648,000 cu. ft. ÷ 24 cu. ft./lb = 27,000 lbs CH<sub>4</sub>/Day. 27,000 lbs CH<sub>4</sub>/Day x 1.375 = 37,125 lbs CO<sub>2</sub>/Day. 37,125 lbs CO<sub>2</sub>/Day ÷ 2,000 lbs/Ton = 18.6 Tons</p>	<p>18.6 Tons CO<sub>2</sub>/Day From Pig Farming Wastes</p>

<b>CO<sub>2</sub>/Day.</b>	
<b>Subtotal Feedstocks Volatile Solids From Pork Processing Wastes:</b>	<b>22.6 Tons/Day</b>
The 22.6 Tons Volatile Solids/Day from Pork Processing Wastes can be converted into CO <sub>2</sub> production by multiplying the Volatile Solids by 12 to determine cu. ft. of methane gas produced. Cu. ft. of methane gas produced ÷ 24 cu. ft./lb = lbs methane gas. Lbs. methane gas multiplied by 1.375 = lbs CO <sub>2</sub> produced or 22.6 Tons VS/Day x 2,000 lbs/Ton x 12 = 542,400 cu. ft. CH <sub>4</sub> /Day. 542,400 cu. ft. ÷ 24 cu. ft./lb = 22,600 lbs CH <sub>4</sub> /Day. 22,600 lbs CH <sub>4</sub> /Day x 1.375 = 31,075 lbs CO <sub>2</sub> /Day. 31,075 lbs CO <sub>2</sub> /Day ÷ 2,000 lbs/Ton = 15.5 Tons CO <sub>2</sub> /Day.	<b>15.5 Tons CO<sub>2</sub>/Day From Pork Processing Wastes</b>
<b>Subtotal Feedstocks Volatile Solids From Tilapia Fish Farming Wastes:</b>	<b>1.4 Tons/Day</b>
The 1.4 Tons Volatile Solids/Day from Tilapia Fish Farming Wastes can be converted into CO <sub>2</sub> production by multiplying the Volatile Solids by 12 to determine cu. ft. of methane gas produced. Cu. ft. of methane gas produced ÷ 24 cu. ft./lb = lbs methane gas. Lbs. methane gas multiplied by 1.375 = lbs CO <sub>2</sub> produced or 1.4 Tons VS/Day x 2,000 lbs/Ton x 12 = 33,600 cu. ft. CH <sub>4</sub> /Day. 33,600 cu. ft. ÷ 24 cu. ft./lb = 1,400 lbs CH <sub>4</sub> /Day. 1,400 lbs CH <sub>4</sub> /Day x 1.375 = 1,925 lbs CO <sub>2</sub> /Day. 1,925 lbs CO <sub>2</sub> /Day ÷ 2,000 lbs/Ton = 0.96 Tons CO <sub>2</sub> /Day.	<b>0.96 Tons CO<sub>2</sub>/Day From Tilapia Fish Farming Wastes</b>
<b>Subtotal Feedstocks Volatile Solids From Tilapia Fish Processing Wastes:</b>	<b>194.5 Tons/Day</b>
The 194.5 Tons Volatile Solids/Day from Tilapia Fish Processing Wastes can be converted into CO <sub>2</sub> production by multiplying the Volatile Solids by 12 to determine cu. ft. of methane gas produced. Cu. ft. of methane gas produced ÷ 24 cu. ft./lb = lbs methane gas. Lbs. methane gas multiplied by 1.375 = lbs CO <sub>2</sub> produced or 194.5 Tons VS/Day x 2,000 lbs/Ton x 12 = 4,668,000 cu. ft. CH <sub>4</sub> /Day. 4,668,000 cu. ft. ÷ 24 cu. ft./lb = 194,500 lbs CH <sub>4</sub> /Day. 194,500 lbs CH <sub>4</sub> /Day x 1.375 = 267,437 lbs CO <sub>2</sub> /Day. 267,437 lbs CO <sub>2</sub> /Day ÷ 2,000 lbs/Ton = 133.7 Tons CO <sub>2</sub> /Day.	<b>133.7 Tons CO<sub>2</sub>/Day From Tilapia Fish Processing Wastes</b>
<b>Subtotal Carbon Dioxide Gas Produced From Pig Farming Wastes:</b>	<b>18.6 Tons CO<sub>2</sub>/Day</b>
<b>Subtotal Carbon Dioxide Gas Produced From Pork Processing Wastes:</b>	<b>15.5 Tons CO<sub>2</sub>/Day</b>
<b>Subtotal Carbon Dioxide Gas Produced From Tilapia Fish Farming Wastes:</b>	<b>0.96 Tons CO<sub>2</sub>/Day</b>
<b>Subtotal Carbon Dioxide Gas Produced From Tilapia Fish Processing Wastes:</b>	<b>133.7 Tons CO<sub>2</sub>/Day</b>
<b>Subtotal Carbon Dioxide Gas Produced From Electricity Generation:</b>	<b>247.0 Tons CO<sub>2</sub>/Day</b>
<b>Subtotal Carbon Dioxide Gas Produced From Cement Manufacturing:</b>	<b>67.2 Tons CO<sub>2</sub>/Day</b>
<b>Total Carbon Dioxide Gas Produced:</b>	<b>483.0 Tons CO<sub>2</sub>/Day</b>
<b>Subtotal Methane Gas Produced From Municipal Solid Wastes:</b>	<b>30.0 Tons CH<sub>4</sub>/Day</b>
<b>Subtotal Methane Gas Produced From Pig Farming Wastes:</b>	<b>13.5 Tons CH<sub>4</sub>/Day</b>
<b>Subtotal Methane Gas Produced From Pork Processing Wastes:</b>	<b>11.3 Tons CH<sub>4</sub>/Day</b>
<b>Subtotal Methane Gas Produced From Tilapia Fish Farming Wastes:</b>	<b>0.7 Tons CH<sub>4</sub>/Day</b>
<b>Subtotal Methane Gas Produced From Tilapia Processing Wastes:</b>	<b>97.3 Tons CH<sub>4</sub>/Day</b>
<b>Subtotal Methane Gas Produced From Biodiesel Processing Wastes:</b>	<b>97.1 Tons CH<sub>4</sub>/Day</b>
<b>Total Methane Gas Produced:</b>	<b>249.9 Tons CH<sub>4</sub>/Day</b>
<p style="text-align: center;"><b>Two-Phase Anaerobic Digestion</b></p> <p>All of the wastes associated with agricultural production will be managed through two-phase anaerobic digestion technology. Traditional anaerobic digestion (often referred to as conventional high rate anaerobic digestion) produces a biogas that consists of 1/3 carbon dioxide gas by volume and 2/3 methane gas by volume as a common gas mixture. Two-phase anaerobic digestion, however, produces the same gases as two distinct gases consisting individually of carbon dioxide gas and methane gas. The separation of the two gases permits each to be managed individually.</p> <p>In every anaerobic digester the ratio of carbon dioxide gas produced relative to methane gas is 1:2 on a volumetric basis. The molecular weight of methane gas (CH<sub>4</sub>) is 16 (12 for Carbon + 4 for Hydrogen) whereas the molecular weight of carbon dioxide gas (CO<sub>2</sub>) is 44 (12 for Carbon and 32 for Oxygen). 1 x 44 = 44 weight units for carbon dioxide gas and 2 x 16 = 32 weight units for methane gas. 44 divided by 32 = 1.375. Carbon dioxide produced relative to methane produced is therefore 137.5% on a mass basis. The actual weight of</p>	<p style="text-align: center;">Products Of Two-Phase Anaerobic Digestion</p> <p style="text-align: center;">Volatile Solids (VS) x 12 = cu. ft. CH<sub>4</sub></p> <p style="text-align: center;">cu. ft. CH<sub>4</sub> x 0.0423 = lbs CH<sub>4</sub></p> <p style="text-align: center;">lbs CH<sub>4</sub> x 1.375 = lbs CO<sub>2</sub></p>

methane gas produced may be found by multiplying its cubic feet by the factor 0.0423 lbs/cu. ft. to arrive at its actual weight in lbs. This weight may be multiplied by the factor of 1.375 (137.5%) to arrive at the corresponding weight of carbon dioxide produced in lbs. The amount of methane gas generated through two-phase anaerobic digestion may be found by multiplying the volatile solids weight of the biowastes in lbs by 12 to arrive at the cubic feet of methane gas produced in lbs.

Other sometimes handy mathematical relationships are:

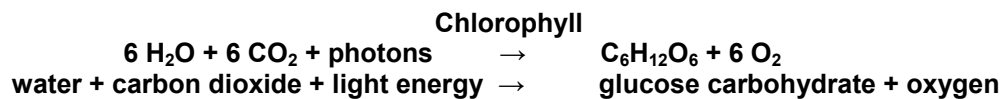
- 1 Ton VS/Day produces 24,000 CH<sub>4</sub>/Day from two-phase anaerobic digestion
- 1 Ton VS/Day produces 0.508 Tons CH<sub>4</sub>/Day from two-phase anaerobic digestion
- 1 Ton VS/Day produces 0.698 Tons CO<sub>2</sub>/Day from two-phase anaerobic digestion
- 1 Ton CH<sub>4</sub>/Day used for electricity generation produces 2.75 Tons CO<sub>2</sub>/Day
- 83,780 CH<sub>4</sub>/Day produces 1 MW of simple cycle electricity power generation

## Enclosed Photobioreactor for Spirulina Microalgae Production

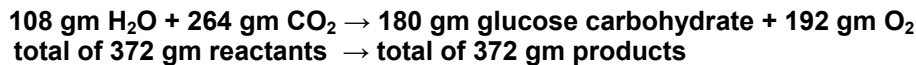
The enclosed photobioreactor consists of a 2,200,000 foot long 12"Ø clear schedule 40 PVC pipe spiral wrapped externally with ultra high efficiency long lasting (10 years +) light emitting diode lighting for continuous photosynthesis. A small portion of the Spirulina microalgae produced will be continuously recycled to the start of the photobioreactor to provide the required seed to enable continuous Spirulina microalgae production. Electricity requirements = 6.0 MW for the lighting and associated recirculation pumping equipment.

The photobioreactor will receive 100% of the carbon dioxide gas output of the two-phase anaerobic digester and 100% of the carbon dioxide gas output from electricity generation. In addition, it will receive 100% of the output of macronutrients from the reverse osmosis treatment equipment deployed downstream from the two-phase anaerobic digester. The Spirulina microalgae require both carbon dioxide and macronutrients to maximize their rate of growth. The photobioreactor will be operated at a temperature of 35°C (95°F) and a pH of 9.4 to further optimize Spirulina microalgae rate of growth. Please refer to attached WSE Drawing Nos. S-6099-1 and S-9900-1 for additional information.

Spirulina will be produced using photosynthesis in the same manner that has existed for billions of years in the oceans of the world. The photosynthesis reaction is:

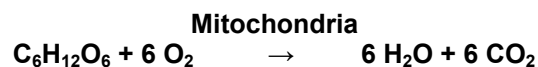


The chemical mass balance of the above equation becomes :



For each 264 grams of CO<sub>2</sub> reacted 180 grams of glucose carbohydrate and 192 grams of O<sub>2</sub> will be produced. For each ton of CO<sub>2</sub> reacted, 180/264 or 0.682 tons of glucose carbohydrates and 192/264 or 0.73 tons of O<sub>2</sub> will be produced. Glucose carbohydrates equate to Spirulina microalgae, a plant type material called phytoplankton.

Respiration occurs in the Mitochondria of cells. It is almost the exact opposite reaction to photosynthesis. These two reactions work together to maintain a biological balance on earth. The respiration reaction is:



One Ton CO<sub>2</sub>/Day  
Produces 0.682 Tons  
Of Glucose  
Carbohydrates/Day  
(Spirulina Microalgae)

It is generally believed that photosynthesis occurs only during periods of sunlight (or artificial light) and that respiration occurs only during periods of darkness. Horticulture studies have established that several, but not all, species of plants can be grown under continuous lighting. The same studies have established that photosynthesis and respiration can and do occur simultaneously under continuous lighting conditions. Plants are multi-cell and capable of learned behavior whereas Spirulina microalgae are single cell plants and therefore totally incapable of acquiring learned behavior. Spirulina microalgae can therefore be grown under continuous lighting conditions even though they have never been exposed to continuous lighting conditions for billions of years. Continuous lighting therefore approximately doubles total Spirulina growth relative to day/night growth rates.

The glucose produced during photosynthesis contains about 6% lipids (fats). Lipids are efficiently converted into biodiesel through a transesterification process. Each ton of CO<sub>2</sub> will simultaneously produce 0.68 tons glucose carbohydrates x 0.06 = 0.04 tons biodiesel and 1.0 – 0.04 = 0.96 tons of byproduct biowastes. 100% of the byproduct biowastes will consist of volatile solids. One ton CO<sub>2</sub>/Day can therefore produce 0.04 tons biodiesel/Day. At a specific gravity of 0.88 this is equivalent to 0.04 tons x 2,000 lbs/ton divided by 0.88 specific gravity = 90.91 gallons/day. The same one ton CO<sub>2</sub>/Day will produce 0.96 tons x 2,000 lbs/ton = 1,920 lbs volatile solids/day or 21.12 lbs volatile solids/gallon of biodiesel produced/day.

One Ton CO<sub>2</sub>/Day  
Produces 0.04 Tons  
Biodiesel/Day

One Ton CO<sub>2</sub>/Day  
Produces 0.96 Tons  
Volatile Solids/Day

One Ton CO<sub>2</sub>/Day  
Produces 90.91  
Gallons Of  
Biodiesel/Day

Each Gallon of  
Biodiesel Produced  
Produces 21.12 lbs of  
Volatile Solids

## Biodiesel Production

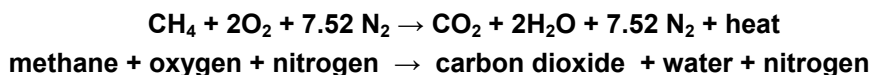
All biodiesel produced will fully comply with American Society for Testing and Materials (ASTM) Standard Specification D 6751-03. The referenced specification is attached to the prefeasibility study.

The amount of biodiesel produced is directly dependent on the amount of Spirulina microalgae produced. The amount of Spirulina microalgae produced is directly dependent on the amount of carbon dioxide gas that is added to the photobioreactor. Since carbon dioxide gas is produced by electricity generation, two-phase anaerobic digestion, and cement production, the total amount of CO<sub>2</sub> produced must be determined from each source.

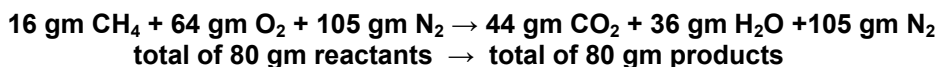
Source No. 1: Electricity Generation:

30 MW of electricity will be produced for the community initiative. Another 21.5 MW of electricity will be used internally for the photobioreactor, air liquefaction, methane gas compression, tilapia fish lighting, pig production, and general building use. The total amount of electricity produced therefore equals 30 MW + 21.5 MW = 51.5 MW.

When generating electricity CO<sub>2</sub> is produced according to the following combustion equation:



The chemical mass balance of the above equation becomes:



Please note that nitrogen is not a reactant as it does not participate in the reaction. For each ton of CH<sub>4</sub> used for electricity generation a total of 44/16 or 2.75 tons of CO<sub>2</sub> will be produced along with a total of 36/16 or 2.25 tons of H<sub>2</sub>O. 2.25 tons of H<sub>2</sub>O is, in turn,

1 Ton CH<sub>4</sub> Produces  
2.75 Tons CO<sub>2</sub> From  
Electricity Generation

1 Ton CH<sub>4</sub> Produces  
2.25 Tons H<sub>2</sub>O From  
Electricity Generation

1 Ton CH<sub>4</sub> Produces  
540 Gallons Of Water  
From Electricity  
Generation

equivalent to  $2.25 \text{ tons H}_2\text{O} \times 2,000 \text{ lbs/ton} = 4,500 \text{ lbs} \div 8.34 \text{ lbs/gallon} = 540 \text{ gallons of water}$ .

If 51.5 MW of electricity is produced to provide energy independence within the Community Initiative, a total of  $51.5 \text{ MW} \times 83,780 \text{ CH}_4/\text{Day}/\text{MW} = 4,314,670$  cubic feet of methane gas will have to be used each day. At 24 cubic foot/lb, the methane usage translates into  $4,314,670 \text{ cu. ft. CH}_4/24 = 179,778 \text{ lbs}/2,000 = 89.89 \text{ Tons CH}_4/\text{Day}$ . Since each ton of  $\text{CH}_4$  produces 2.75 Tons of  $\text{CO}_2$  the generation of 51.5 MW of electricity produces  $89.89 \times 2.75 = 247.0 \text{ Tons of CO}_2/\text{Day}$  due to the generation of electricity. Since each ton of  $\text{CH}_4$  produces 2.25 Tons of  $\text{H}_2\text{O}$ , the generation of 51.5 MW of electricity also produces  $89.89 \times 2.25 = 202 \text{ Tons of H}_2\text{O}/\text{Day}$ .

**Source No. 2: Two-Phase Anaerobic Digestion:**

To determine the amount of  $\text{CO}_2$  produced first requires a determination of the amount of  $\text{CH}_4$  produced as  $\text{CH}_4$  production directly determines  $\text{CO}_2$  production by a factor of 1.375.

To determine the amount of  $\text{CH}_4$  produced first requires the amount of volatile solids that are treated as each lb of volatile solids  $\times 12 = \text{cu. ft. CH}_4$  produced.

The volatile solids available from MSW processing are 60.0 Tons/Day as listed above.  
The volatile solids available from pig farming are 27.0 Tons/Day as listed above.  
The volatile solids available from pork processing are 22.6 Tons/Day as listed above.  
The volatile solids available from tilapia fish farming are 1.4 Tons/Day as listed above.  
The volatile solids available from tilapia fish processing are 194.5 Tons/Day as listed above.  
The total volatile solids available as listed above =  $60.0 + 27.0 + 22.6 + 1.4 + 194.5 = 305.5 \text{ Tons CH}_4/\text{Day}$ .  $305.5 \text{ Tons CH}_4/\text{Day} \times 1.375 = 420.1 \text{ Tons CO}_2/\text{Day}$ .

The project building will engage in the manufacturing of cement. Carbon dioxide is produced in cement making as a result of the production of a process ingredient called 'Clinker'. Clinker is made when limestone is heated to produce lime. Substantial amounts of carbon dioxide are simultaneously formed during this reaction. The final amount of carbon dioxide produced varies depending on the type of cement being made. Each project building will be manufacturing 300 Tons/Day of Portland type cement.

According to the *Annual Review of Energy and the Environment*, (Vol. 26: pp 303-329, November 2001) average  $\text{CO}_2$  emissions/Ton from cement production = 448 lbs. At a cement production rate of 300 Tons/Day the total carbon dioxide emissions =  $300 \text{ Tons/Day} \times 448 \text{ lbs CO}_2/\text{Ton} = 134,400 \text{ lbs/Day} \div 2,000 \text{ lbs/Ton} = 67.2 \text{ Tons CO}_2/\text{Day}$ . Adding this amount of  $\text{CO}_2$  to the above total of 420.1 Tons  $\text{CO}_2/\text{Day} = 487.3 \text{ Tons CO}_2/\text{Day}$  that will be produced from electricity generation, two-phase anaerobic digestion of volatile solids feedstocks, and cement production.

Since each ton of  $\text{CO}_2$  produces 0.682 Tons of Spirulina microalgae  $487.3 \text{ Tons CO}_2/\text{Day}$  produces  $487.3 \times 0.682 = 332.3 \text{ Tons Spirulina microalgae/Day}$ .

75% or 249.2 Tons Spirulina/Day will be used for feeding tilapia fish and pigs. The remaining 25% or 83.1 Tons Spirulina/Day will be used in the production of biodiesel (B100). 83.1 Tons Spirulina production is the equivalent of 25% of 487.3 Tons  $\text{CO}_2/\text{Day}$  or 121.8 Tons  $\text{CO}_2/\text{Day}$ . 249.2 Tons Spirulina production is the equivalent of 75% of 487.3 Tons  $\text{CO}_2/\text{Day}$  or 365.5 Tons  $\text{CO}_2/\text{Day}$ .

Since one ton  $\text{CO}_2/\text{Day}$  produces 0.682 Tons of Spirulina microalgae, 108.3 Tons  $\text{CO}_2/\text{Day}$  produces  $108.3 \times 0.682 = 73.86$  additional tons of Spirulina microalgae increasing its production from 295.5 Tons/Day to 369.4 Tons/Day.

Since one ton  $\text{CO}_2/\text{Day}$  produces 0.04 tons biodiesel/day, 121.8 Tons  $\text{CO}_2/\text{Day}$  produces  $121.8 \times 0.04 \text{ tons} = 4.87 \text{ tons biodiesel/Day}$ . At a specific gravity of 0.88 this is equivalent

51.5 MW Of Electricity Produces 247.5 Tons Of  $\text{CO}_2/\text{Day}$

51.5 MW Of Electricity Produces 89.89 Tons Of  $\text{CH}_4/\text{Day}$

332.3 Tons Spirulina Microalgae Produced/Day

18,381 Gallons Of Biodiesel Produced/Day

58.5 Tons  $\text{CH}_4/\text{Day}$  plus 38.6 Tons  $\text{CH}_4/\text{Day} = 97.1 \text{ Tons CH}_4$  Produced/Day From

<p>to 4.87 tons x 2,000 lbs/ton divided by 0.88 specific gravity = 11,073 gallons/day.</p> <p>Since each gallon of biodiesel produced generates 21.12 lbs of volatile solids, 11,073 gallons x 21.12 = 233,856 lbs. Volatile Solids/Day. 233,856 lbs Volatile Solids/Day ÷ 2,000 lbs/Ton = 116.9 Tons Volatile Solids/Day. The 116.9 Tons Volatile Solids/Day from biodiesel production can be converted into CO<sub>2</sub> production by multiplying the Volatile Solids by 12 to determine cu. ft. of methane gas produced. Cu. ft. of methane gas produced ÷ 24 cu. ft./lb = lbs methane gas. Lbs. methane gas multiplied by 1.375 = lbs CO<sub>2</sub> produced or 116.9 Tons VS/Day x 2,000 lbs/Ton x 12 = 2,806,272 cu. ft. CH<sub>4</sub>/Day. 2,806,272 cu. ft. ÷ 24 cu. ft./lb = 116,928 lbs CH<sub>4</sub>/Day. 116,928 lbs CH<sub>4</sub>/Day x 1.375 = 160,776 lbs CO<sub>2</sub>/Day. 160,776 lbs CO<sub>2</sub>/Day ÷ 2,000 lbs/Ton = 80.4 Tons CO<sub>2</sub>/Day.</p> <p>Since one ton CO<sub>2</sub>/Day produces 0.04 tons biodiesel/day, 80.4 Tons CO<sub>2</sub>/Day produces 80.4 x 0.04 tons = 3.22 tons biodiesel/Day. At a specific gravity of 0.88 this is equivalent to 3.22 tons x 2,000 lbs/ton divided by 0.88 specific gravity = 7,308 gallons biodiesel/day thus increasing biodiesel production from 11,073 GPD to 18,381 GPD.</p> <p>Since the basic waste-to-energy process fully satisfies electricity demand the excess methane gas will be beneficially used for:</p> <ol style="list-style-type: none"> <li>1. The production of methanol through syngas technology that is used as a required feedstock in the production of biodiesel biofuel,</li> <li>2. The production and sale of compressed natural gas (CNG) biofuel surface transportation fuel, and</li> <li>3. The production and sale of renewable natural gas biofuel to the marketplace.</li> </ol>	<p><b>Biodiesel Production</b></p>
<p><b>Pig and Tilapia Fish Feed Requirements:</b></p> <p>The 10,000 sow operation will produce 75.34 Tons/Day of finished hogs. It takes about 1.2 lbs of feed to increase a pig's weight by 1.0 pound. The 75.34 Tons of finished hogs will require 75.34 x 1.2 or 90.41 Tons of feed per Day. The production of tilapia fish is 335 Tons/Day. It takes about 1.2 lbs of feed to increase the fish weight by 1.0 pound. The 335 Tons of finished fish will require 335 x 1.2 or 402 Tons of feed per Day. Combined feed requirements are 90.41 + 402 = 492.4 Tons feed/Day. Spirulina microalgae production at 332 Tons feed/Day will mostly satisfy pig and tilapia fish feed requirements. As the MSW volume increases the volume of Spirulina microalgae will automatically increase. It won't take much of an increase in MSW volume to fully satisfy total feed requirements.</p> <p>If the percentage of Spirulina microalgae use is changed from 75%-25% to 90%-10% sufficient feed would be produced at the expense of reducing the production of biodiesel. The preferred initiative is to increase collection of MSW biowastes by excavating area landfills and dumps for the purpose of treating their contents with two-phase anaerobic digestion to increase the associated production of Spirulina microalgae. In so doing, the volume of biodiesel production could remain the same.</p>	
<p>Subtotal Methane (CH<sub>4</sub>) Gas Production From Municipal Solid Wastes (MSW):</p>	
<p>60 Tons/Day Total Volatile Solids x 2,000 lb/Ton x 12 Cubic Feet (CF)/lb = 1,440,000 cu. ft./Day. 1,440,000 cu. ft. CH<sub>4</sub>/Day ÷ 24 lbs/cu. ft. = 60,000 lbs. 60,000 lbs ÷ 2,000 lbs/Ton = 30 Tons CH<sub>4</sub>/Day</p>	<p>1,440,000 cu. ft. CH<sub>4</sub>/Day = 30 Tons CH<sub>4</sub>/Day From MSW</p>
<p>Subtotal Methane (CH<sub>4</sub>) Gas Production From Biodiesel Processing Wastes:</p>	
<p>4,659,366 cu. ft. CH<sub>4</sub>/Day ÷ 24 cu. ft./lb = 194,140 lbs. 194,140 lbs ÷ 2,000 lbs/Ton = 97.1 Tons CH<sub>4</sub>/Day</p>	<p>97.1 Tons CH<sub>4</sub>/Day From Biodiesel Wastes</p>
<p>Subtotal Methane (CH<sub>4</sub>) Gas Production From Pig Farming Wastes:</p>	

	27 Tons/Day Total Volatile Solids x 2,000 lb/Ton x 12 Cubic Feet (CF)/lb = 648,000 cu. ft./Day. 648,000 cu. ft. CH <sub>4</sub> /Day ÷ 24 lbs/cu. ft. = 27,000 lbs. 27,000 lbs ÷ 2,000 lbs/Ton = 13.5 Tons CH <sub>4</sub> /Day	648,000 cu. ft. CH <sub>4</sub> /Day = 13.5 Tons CH <sub>4</sub> /Day From Pig Farming Wastes
<b>Subtotal Methane (CH<sub>4</sub>) Gas Production From Pork Processing Wastes:</b>		
	22.6 Tons/Day Total Volatile Solids x 2,000 lb/Ton x 12 Cubic Feet (CF)/lb = 542,400 cu. ft./Day. 542,400 cu. ft. CH <sub>4</sub> /Day ÷ 24 lbs/cu. ft. = 22,600 lbs. 22,600 lbs ÷ 2,000 lbs/Ton = 11.3 Tons CH <sub>4</sub> /Day	542,400 cu. ft. CH <sub>4</sub> /Day = 11.3 Tons CH <sub>4</sub> /Day From Pork Processing Wastes
<b>Subtotal Methane (CH<sub>4</sub>) Gas Production From Tilapia Fish Farming Wastes:</b>		
	1.4 Tons/Day Total Volatile Solids x 2,000 lb/Ton x 12 Cubic Feet (CF)/lb = 33,600 cu. ft./Day. 33,600 cu. ft. CH <sub>4</sub> /Day ÷ 24 lbs/cu. ft. = 1,400 lbs. 1,400 lbs ÷ 2,000 lbs/Ton = 0.7 Tons CH <sub>4</sub> /Day	33,600 cu. ft. CH <sub>4</sub> /Day = 0.7 Tons CH <sub>4</sub> /Day From Tilapia Fish Farming Wastes
<b>Subtotal Methane (CH<sub>4</sub>) Gas Production From Tilapia Fish Processing Wastes:</b>		
	194.5 Tons/Day Total Volatile Solids x 2,000 lb/Ton x 12 Cubic Feet (CF)/lb = 4,668,000 cu. ft./Day. 4,668,000 cu. ft. CH <sub>4</sub> /Day ÷ 24 lbs/cu. ft. = 194,500 lbs. 194,500 lbs ÷ 2,000 lbs/Ton = 97.3 Tons CH <sub>4</sub> /Day	4,668,000 cu. ft. CH <sub>4</sub> /Day = 97.3 Tons CH <sub>4</sub> /Day From Tilapia Fish Processing Wastes
<b>Total Methane (CH<sub>4</sub>) Gas Generation from all sources:</b>		
		249.9 Tons CH <sub>4</sub> /Day
<b>OAT Process Power Generation Potential:</b>		
	249.9 Tons CH <sub>4</sub> /Day x 2,000 lbs/Ton = 499,800 lbs/Day. 499,800 lbs/Day x 24 cu. ft./lb = 11,995,200 cu. ft./Day. 11,995,200 cu. ft./Day ÷ 83,780 cu. ft./MW = 143 MW. 143 MW less 15% parasitic digester plant use = 122 MW Net	122 MW Net
<b>Two-Phase Anaerobic Digester Size Calculations:</b>		
	Volatile Solids = 249.9 Tons/Day x 2,000 lbs/Ton = 499,800 lbs/Day	
	VS:COD = 1:2, COD = 999,600 lbs/Day	
	Organic Loading lbs COD/Day/Cubic Foot = 6	
	Digester Size = 999,600/6 = 166,600 Cubic Feet	
	Digester Size In Gallons = 1,246,335 Gallons	
	Safety Factor = 1.5	
	Digester Size = 1,869,502 Gallons (120' x 120' x 20'H)	
	Estimated Constructed Cost At US\$40/Gallon = \$74,780,080	
	Building Size: 1 km (3,280') x 1 km (3,280') x 3 - 50' stories high w/3 side double wall construction to accommodate photobioreactor and employee housing = 50,000,000 total sq. ft. of precast concrete construction estimated @ US\$1.50/sq. ft. = US\$75,000,000. Project building will manufacture its own cement and will purchase a ready mix plant (3 concrete delivery/mixer trucks) to minimize precast concrete panel construction costs.	
	Remanufactured 300Tons/Day Cement Kiln Purchase Cost = US\$12,000,000	
	Remanufactured Ready Mix Batch Plant Purchase Cost = US\$3,000,000	
	Photobioreactor: 2,200,000 foot long 12"Ø Clear PVC schedule 40 pipe = US\$100,000,000 to includes ultra high efficiency long lasting (10 years +) light emitting diode (LED) lighting for photosynthesis @ US\$10,000,000 Electricity requirements = 6.0 MW	

	<b>10 MGY Biodiesel Manufacturing Equipment Cost Estimate: US\$15,000,000. Electricity Requirements = 0.5 MW</b>	
	<b>Two (2) 110 GPM 4:2:1 Array Reverse Osmosis Equipment Cost Estimate: US\$2,000,000</b>	
	<b>Digester Equalization Feed Tank Cost Estimate: \$2,000,000 w/Equalization Tank Size = 120' x 120' x 20' H, 2,000,000 Gallon Capacity</b>	
	<b>Potable Water Tank Cost Estimate: \$2,000,000 w/Equalization Tank Size = 120' x 120' x 20' H, 2,000,000 Gallon Capacity</b>	
	<b>Anaerobic Digester Feed Tank Cost Estimate: \$2,000,000 w/Equalization Tank Size = 120' x 120' x 20' H, 2,000,000 Gallon Capacity</b>	
	<b>Liquefied Nitrogen Storage Tank Cost Estimate: \$2,000,000 w/Equalization Tank Size = 120' x 120' x 20' H, 2,000,000 Gallon Capacity</b>	
	<b>Liquefied Natural Gas (LNG) Storage Tank Cost Estimate: \$2,500,000 w/Equalization Tank Size = 120' x 120' x 20' H, 2,000,000 Gallon Capacity</b>	
	<b>EAF Steel Recycling Process Equipment Cost: US\$3,000,000</b>	
	<b>12,000,000 CFD Compressed Methane Gas (CNG) Equipment Cost Estimate = US\$10,000,000. Electricity Requirements = 2 MW</b>	
	<b>221 Ton/Day Liquefied Nitrogen Air Separation Equipment Cost Estimate: \$20,000,000. Electricity Requirements = 10 MW</b>	
	<b>Liquefied Nitrogen Delivery Equipment: US\$500,000</b>	
	<b>10,000 Sows Procurement Cost Estimate @ US\$500/Sow = US\$5,000,000</b>	
	<b>220,000 pigs/year (603 pigs/day) Swine Processing Equipment Cost Estimate: US\$5,000,000</b>	
	<b>51.5 MW Natural Gas Fueled Combined Cycle Power Generation Equipment @ US\$1,260/kW = 51,500 kW x US\$1,100 = US\$56,650,000</b>	
	<b>Total Electricity Generation Requirements:</b>	
	<b>For each project building: 51.5 MW (includes projected demand for the next 20 years</b>	
	<b>For Photobioreactor = 6.0 MW</b>	
	<b>For Compressed Natural Gas (CNG) = 2 MW</b>	
	<b>For Liquefied Nitrogen (LN2)(LIN) = 10 MW</b>	
	<b>For Liquefied Oxygen = Included with Liquefied Nitrogen</b>	
	<b>For Tilapia Farming = 0.5 MW</b>	
	<b>For Pig Farming = 2 MW</b>	
	<b>For General Building use = 2 MW</b>	
	<b>Total Electricity Installed Capacity Requirements = 51.5 MW</b>	
	<b>122 MW potential less 51.5 MW used = 70.5 MW remaining. At 83,779 cu. ft./MW, 83,779 cu. ft. x 70.5 MW = 5,906,420 cu. ft./Day available to marketplace at US\$0.70/126.67 cu. ft. or US\$32,640/Day as CNG automotive fuel. If sold to a natural gas pipeline the revenue would be slightly less by about 10%. If</b>	

	Argentina increases the marketplace price of natural gas some sales to natural gas pipelines would be considered.	
<b>Schedule of Project Construction Costs:</b>		
	Anaerobic Digester Feed Tank: US\$2,000,000	
	Biodiesel Manufacturing Equipment: US\$15,000,000	
	Building Size: 1 km x 1 km x 3 Stories High Constructed Cost: US\$75,000,000	
	Cement Kiln Constructed Cost: US\$12,000,000	
	Concrete Ready Mix Plant Constructed Cost = US\$3,000,000	
	EAF Steel Recycling Process Equipment Constructed Cost: US\$3,000,000	
	LED Lighting Purchase Cost: US\$10,000,000	
	Liquefied Natural Gas (LNG) Storage Tank: US\$2,500,000	
	Liquefied Nitrogen Air Separation Equipment: US\$15,000,000	
	Liquefied Nitrogen Delivery Equipment: US\$500,000	
	Liquefied Nitrogen Storage Tank: US\$2,000,000	
	Methane Compression Equipment: US\$10,000,000	
	Photobioreactor: US\$100,000,000	
	Potable Water Storage Tank Constructed Cost: US\$2,000,000	
	Power Generation Equipment: US\$56,650,000	
	Reverse Osmosis Equipment: US\$2,000,000	
	Sow Procurement Costs: US\$5,000,000 Electricity Requirements = 2.0 MW	
	Tilapia Fish Farming Acreage: 50 hectares x 24' H Tilapia Fish Farming Production: lbs/day = 281,400 of tilapia filets Tilapia Fish Farming Electricity Requirements = 0.5 MW Fish Processing Equipment: US\$500,000	
	Two-Phase Anaerobic Digester: US\$37,390,000	
	Subtotal Project Construction Costs: US\$353,540,000	
	Add 15% Contingencies @ 53,031,000 = US\$406,571,000	
	<b>Total Project Construction Costs:</b>	<b>US\$443,961,080</b>
<b>Project Visible Cash Flow Revenue Streams:</b>		
	From Sanitary Wastewater – US\$0.00	
	From Municipal Solid Wastes – US\$0.00	
	From Agro Wastes – US\$0.00	
	From Animal Wastes – US\$0.00	
	From Electricity: 44 MW x 24 = 720 MWh/Day @ US\$45.00/MWh = US\$47,520/Day. This amount of electricity generation will provide the average demand load of the participating communities for the next 20 years.	US\$47,520/Day
	From Biodiesel: 18,381 GPD always priced at 80% of existing marketplace retail. Current retail is US\$1.67/gallon. US\$1.67 x 80% = US\$1.34. 18,381 x US\$1.34 = US\$24,630/Day.	US\$24,630/Day
	From Liquefied Nitrogen (LN <sub>2</sub> )(LIN): 244,003 GPD priced at US\$0.50/gallon = US\$122,000.00/Day.	US\$122,000/Day
	From Compressed Natural Gas (CNG) Fuel:	US\$32,640/Day
	From Processed Pork Exports: Retail pork prices are currently around US\$2.87/lb. The wholesale producer receives about 43% of this price or US\$1.46/lb. The above prices represent the average for the last 3 years. As a commodity there is no guarantee they will drift up or down but will likely continue to fluctuate as they have been for the last 50 years. Current marketplace dressed pork yields are over 2,750 lbs/year/sow. A 10,000 sow	

	farrow-to-finish operation is estimated to produce 27,500,000 lbs of dressed pork/year or an average of 75,342 lbs/Day. At US\$1.46/lb the daily revenue is estimated at US\$110,000.00.	US\$110,000/Day
	From Fresh Tilapia Filet Exports: US\$613,452 at a sell price of US\$2.18/lb	US\$613,452/Day
	Renewable Energy and other Credits based on estimated 36 MW Project Power Generation:	
	One Certified Emission Reduction Credit = 1 Tonne CO <sub>2</sub> Reduction. 51.5 MW Project Power Production x 24 hour/Day = 1,236 MWh/Day. 1,236 MWh/Day x 1,100 lbs CO <sub>2</sub> Reduction (using natural gas)/MWh ÷ 2,000 lbs/Ton = 680 Tons/Day = 248,000 T/Year x 2,000/2,204 = 225,226 Tonnes/Year @ US\$20 (range of US\$20-US\$40) = US\$4,504,000/Year ÷ 365 = US\$12,341/Day for years 2008-2012 delivery.	US\$12,341/Day
<b>Total Project Revenue Streams:</b>		<b>US\$962,583/Day</b>
<p>To the extent that electricity is generated, the combustion off gases (CO<sub>2</sub>, NO<sub>x</sub>, N<sub>2</sub>, and H<sub>2</sub>O) will be entirely used for Spirulina microalgae production. After Spirulina microalgae production has occurred the remaining Nitrogen gas (N<sub>2</sub>) will be liquefied and sold to the marketplace. The remaining N<sub>2</sub> gas stream will also contain Oxygen gas (O<sub>2</sub>) due to the respiration of microalgae during their production in the same manner that trees and plants give off oxygen. This oxygen will be simultaneously liquefied during the liquefaction of N<sub>2</sub> and subsequently distilled off, compressed, and subsequently used internally as a welding gas, to enhance cement manufacturing, to enhance fish farming, and for smelting iron into steel. Some of the Nitrogen Gas will be used as a protective blanket gas in the production of methanol through syngas technology. The methanol is produced as a required feedstock in the production of biodiesel.</p>		

**Additional Notes:**

1. Land Requirements: Estimate 300 hectare
2. Time to design-build-install-operate is estimated at 36 months.
3. Lighting for tilapia must be a daily cycle of:
  - 7.5 hours of total darkness
  - 0.5 hours of sunrise (begins at 6 a.m. w/3 ft-candles)
  - 15.5 hours of daylight (max 10 ft-candles)
  - 0.5 hours of sunset (begins at 10 p.m. w/3 ft-candles)
4. Sufficient building room remains to add a 10,000 beef cattle operation, a 10,000 milker dairy farm, and significant poultry operations along with all of the associated processing equipment to produce value added products consisting of dressed beef, milk, and other dairy products, broilers, and eggs. All of these activities represent future economic development activities.

# Nonrecourse Project Capital Cost Structure

## New Zealand

### BioWastes-To-Renewable Energy, Food, BioFuels, and Water Independence Plant

The total estimated capital and development costs of the design-build-own-operate wastes-to-renewable energy project total \$3,013,608,809 (plus funding broker commissions) utilizing both new and remanufactured process equipment. The major components of capital and other costs are as follows:

Item Description	Cost in US\$
Anaerobic Digester Feed Tank Constructed Cost <sup>1</sup>	2,000,000
Biodiesel Manufacturing Equipment Constructed Cost <sup>2</sup>	15,000,000
Building Size 2 km x 2 km x 200 m high Constructed Cost <sup>3</sup>	2,059,282,092
Cement Kiln Constructed Cost <sup>4</sup>	12,000,000
Concrete Ready Mix Batch Plant Constructed Cost <sup>5</sup>	3,000,000
EAF Steel Recycling Process Equipment Constructed Cost	3,000,000
Fish Processing Equipment Constructed Cost <sup>6</sup>	500,000
LED Lighting Purchase Cost <sup>8</sup>	10,000,000
Liquefied Nitrogen Air Separation Equipment Procurement Capital Cost	15,000,000
Liquefied Nitrogen Delivery Equipment Procurement Capital Cost	500,000
Liquefied Nitrogen Storage Tank Constructed Cost	2,000,000
LNG (Liquefied Natural Gas) Storage Tank Constructed Cost	2,500,000
Methane Gas Compression Equipment Installed Capital Cost	10,000,000
Potable Water Storage Tank Constructed Cost	2,000,000
Photobioreactor Capital Equipment Constructed Cost <sup>7</sup>	100,000,000
Power Generation Equipment Procurement Cost <sup>9</sup>	56,650,000
Reverse Osmosis Equipment Procurement Cost	2,000,000
Sow procurement Costs	5,000,000
Two-Phase Anaerobic Digester Constructed Cost <sup>1</sup>	74,780,080
<b>Subtotal Project Costs</b>	<b>2,375,212,172</b>
Add 15% Contingencies	356,281,825
<b>Total Capital Costs</b>	<b>2,731,493,997</b>
Finance Charges	40,000,000
Interest During Construction	60,000,000
Administration/Legal	150,000
Permitting	20,000
Technology & Development Cost	1,750,000,000
Project Development Fee @ 3% of US\$2,731,493,997	81,944,812
Working Capital	100,000,000
<b>Total All Costs</b>	<b>4,763,608,809</b>

#### Nonrecourse Project Financing Will Be Structured As Follows:

Developer Equity as Technology, 70% <sup>10</sup>	1,750,000,000
Investor Equity as Cash, 30%	550,000,000

Finance	2,463,608,809
Loan Term, Years	10
Interest Rate	10%
Developer will contribute 70% equity in the project as the value of the technology. <sup>10</sup>	
Investor will contribute US\$550,000,000 cash and the balance will be financed.	

**With Following Notes:**

1. The anaerobic digester and its associated feed tank will be constructed of precast concrete panels. The panels will be manufactured by Wieser Concrete Products, Inc. and barge shipped to destination project site. The Wisconsin based precast concrete manufacturer POC is Phil Miller @ phone 800.325.8456 (see <http://www.wieserconcrete.com/about.html>).
2. The biodiesel production equipment will be designed and manufactured by California based R. C. Costello & Associates, Inc. The POC is Rocky Costello, P.E. @ phone 310.792.5870 (see <http://www.rccostello.com/>).
3. The low cost of the project building is made possible by the 100% internal recycling of inorganic wastes that are produced from the anaerobic digestion process. These inorganic wastes are combined with cement and water in the production of precast concrete panels. The special purpose project company will produce its own cement to further minimize construction costs. See attached WSE Engineering Drawing No. S-6099-1 for additional details. The POC at WaterSmart Environmental is Chuck Steiner @ 913.897.2727 (see <http://www.watersmart.com/>).
4. The cement kiln will be sourced through Canada based Cement Process Consulting, Ltd. The POC is Ken Postle @ phone 403.472.4519 (see <http://www.cement-process.com/index.htm>).
5. The concrete ready mix plant will be sourced through Canada based Cement Process Consulting, Ltd. The POC is Ken Postle @ phone 403.472.4519 (see <http://www.cement-process.com/index.htm>).
6. The fish production and processing equipment will be sourced through Colorado based Fisheries Technology Associates, Inc. The POC is Bill Mancini @ phone 970.225.0150 (see <http://www.ftai.com/>).

7. The enclosed photobioreactor consists of 2 miles long 12"Ø clear PVC pipe. A possible supplier is Harvel Plastics, Inc. but other sources will be considered prior to procurement (see <http://www.harvel.com/>).
  
8. The artificial lighting for the photobioreactor consists of 5 miles of high efficiency long lasting (10 years or more) light emitting diode (LED) lighting that will be wrapped barber pole fashion around the clear PVC pipe. A possible supplier is Light Waves Concept, Inc. but other sources will be considered prior to procurement (see <http://www.lightwavesconcept.com/>).
  
9. The power generation equipment will be sourced through UK based Combustion, Energy & Steam Specialists, Ltd. The POC is Mike Craigie @ phone +44 (0) 1856 851177 (see <http://www.cess.co.uk/>).
  
10. The seemingly high percentage of developer equity as technology is justified on the basis that it is the only economic development technology that simultaneously achieves:
  - 100% compliance with Kyoto Protocol thus helping to reverse global warming,
  - Distributed Biofuels (biodiesel and compressed natural gas or CNG) independence,
  - Distributed Food independence,
  - Distributed Renewable energy independence,
  - Distributed Water independence, and
  - Complete internal recycling of all byproducts and waste streams thereby producing a useful product—namely precast concrete products that will be used for constructing the project building itself as well as infrastructure roads, light rail transit surface transportation system, precast concrete potable water distribution system, precast concrete wastewater collection system, and precast concrete encased renewable energy power distribution system. In doing so the community initiative project will become the very first zero carbon and zero waste community in the world.

Climate Change has now become the most serious worldwide concern as the sustainability of our planet appears to be at rapidly increasing risk. Renewable Energy Technologies that address climate change are therefore in great demand. Technologies that address both climate change and substantial economic development are in even greater demand. The proposed waste-to-energy technology has required over 30,000 hours of research over a 10 year period to develop thus fully justifying the seemingly high percentage of developer equity as technology. It is the very first and only worldwide technology that is technically capable of simultaneous distributed energy independence, distributed food independence, distributed fuels independence, and distributed water independence with all in full compliance with Kyoto Protocol.

The proposed wastes-to-renewable energy technology consists of a suite of individual component technologies. The individual component technologies are:

- **Biodiesel Production With Associated Waste Processing.** The National Renewable Energy Laboratory (NREL) pioneered the very first production of biodiesel from microalgae. The research and development was carried out under the “Aquatic Species Program” (ASP) that consisted of the first production of a biofuel called “algal biodiesel” (see [http://www1.eere.energy.gov/biomass/pdfs/biodiesel\\_from\\_algae.pdf](http://www1.eere.energy.gov/biomass/pdfs/biodiesel_from_algae.pdf)). Under the referenced program Algal Biodiesel was produced through the growing of microalgae for their lipid content. The lipid content was then converted into biodiesel through chemical transesterification in the same manner that soybeans and other vegetable oils are now being converted into biodiesel. The ASP funding totaled \$25.05 million over a 20 year period that began in 1978. Continuation funding was ultimately terminated when it was officially determined that algal biodiesel could not be produced economically. The ASP obtained its research data from growing microalgae in warm open ponds (Salton Sea in Southern California) at a pH of 8.2 using atmospheric carbon dioxide. The Salton Sea is the recipient of agricultural runoff nutrients as well as additional nutrients contained in municipal sewage treatment plants discharges. The project building will produce microalgae within an enclosed photobioreactor that will operate at the optimum growing temperature of 35°C (95°F) and at the optimum growing pH of 9.4. Photosynthesis will occur 24/7 rather than just during daylight hours by using long lasting light emitting diode (LED) lighting. The photobioreactor will receive the total carbon dioxide output from both the anaerobic digester as well as the power generation equipment thus substantially increasing production over that obtainable from using carbon dioxide from the atmosphere. Microalgae production will be further increased by adding the micronutrients contained in the reverse osmosis concentrate stream thus substantially improving microalgae production. The total increase of these process modifications over that obtained by the National Renewable Energy Laboratory’s ASP is estimated at a factor of at least 1000 to 1. By producing the microalgae within an enclosed photobioreactor the technology becomes totally compliant with Kyoto Protocol since all discharges of greenhouse gases to the environment are eliminated.
- **Cement manufacturing as a technology has been practiced for many hundreds of years throughout the entire civilized world.**
- **Fish farming was first practiced by the Chinese over 100 years ago. Due to the over fishing of the oceans fish farming is now widespread throughout the entire civilized world.**
- **Precast concrete panels and piping have been manufactured for the last 50 years. The use of precast concrete panels has become quite popular in the building industry during the last 10 years.**
- **Liquefied Nitrogen and Liquefied Oxygen have been produced in the marketplace for the last 50 years. Names of today’s largest industrial suppliers consist of Air Liquide, Air Products & Chemicals, Inc., Cryogenic Industries, Inc., Gas Systems Corporation, and Praxair, Inc.**
- **Methane gas-to-methanol alcohol through synthesis gas (syngas) technology represents the standard method of producing methanol throughout the civilized world.**
- **Microalgae production through the use of a photobioreactor (use of artificial light rather than sunlight) is now being done at several research institutions. The technology has yet to be put into full scale commercial operation.**

- The anaerobic digestion of municipal solid wastes (MSW) was first accomplished by two-phase anaerobic digestion in 1996 (see <http://lib.kier.re.kr/caddet/retb/no66.pdf>). More recently the management of municipal solids wastes is being accomplished using conventional anaerobic digestion by Waste Management, Inc., a waste management company (see <http://www.wm.com/WM/environmental/Bioreactor/technologies.asp>).
- Precast concrete panels and precast concrete pipes have been manufactured for the last 50 years throughout the world.
- Renewable energy power generation has been practiced for at least 30 years in the EU and 20 years in the United States.
- Reverse osmosis treatment has been around on a commercial basis for over 30 years. During the last 5 years its marketplace costs have been halved and it is now considered very good and very affordable technology.

New Zealand Larger Building Prefeasibility Study, December 25, 2007	Totals
Location: New Zealand	
Technology Provider: WaterSmart Environmental, Inc.	
<b>Project Developer:</b> Murray Simpson PO Box 37874 Parnell, Auckland 1033, New Zealand Phones: +64 9 520 9041, +64 21 680 107 Fax: +64 9 520 9049 email: murray@ecopowertrust.com	
<b>Project Type: Economic Development through Design-Build-Own-Operate BioWastes-To-Renewable Energy, BioFuels, Organic Foods, and Potable Water Independence</b>	
<b>Project Dollar Size: US\$3,013,608,809 billion for each 2 km x 2 km x 200m high shipbuilding-shipbreaking project building</b>	
<b>Number of shipbuilding-shipbreaking project buildings required: 5</b>	
<b>Shipbuilding-Shipbreaking Project Building Activities:</b>  1. Extensive Agricultural Production and Processing that additionally includes renewable energy, biofuels, and water production along with 100% recycling of all byproducts into precast concrete panels and precast concrete piping for infrastructure development, and  2. The construction and sale of self-biofueled trains and locomotives, and  3. The construction and sale of self-biofueled concrete ships, and  4. The breaking of ships with concurrent waste and metals management, and  5. The construction and sale of tidal generators	
<b>Jobs Creations Potential for each 2 km x 2 km x 200 m high shipbuilding/shipbreaking project building: 2,500</b>	
<b>BioWastes Treated: Biodiesel Processing Wastes, Construction &amp; Demolition Wastes, Foods Production &amp; Processing Wastes, Hazardous Wastes, Medical Wastes, Municipal Solid Wastes (MSW), and Petroleum Derived Shipbreaking Wastes</b>	
<b>Local Population Served for each 2 km x 2 km x 200 m high shipbuilding/shipbreaking project building: 50,000</b>	
<b>Residual Wastes to Landfill: Zero</b>	
<b>Greenhouse Gaseous Emissions to the Environment: Zero</b>	
<b>Climate Change Carbon Footprint: Zero</b>	
<b>Investor Internal Rate of Return: Optimal</b>	
<b>Note on Electricity Distribution:</b> At the completion of the project 100% of the Nova Scotia electricity requirements will be provided thus eliminating the necessity for continued use of electric utility grid supplied electricity. After complete BioWastes-To-Renewable Energy, BioFuels, Organic Foods, and Potable Water Independence project implementation all electricity will be distributed at a sustainable US\$0.045/kWh to all users regardless of kWh electricity usage amount or time of day when provided. Inexpensive electricity is absolutely necessary in every country to support meaningful industrial development. It is expected that the distribution of inexpensive electricity will strongly support much needed industrial development. Inexpensive electricity distribution is made possible by the extreme profitability of extensive agricultural production and processing in combination with extensive biofuels production.	
<h2 style="color: green;">Detailed Project Description</h2> <p>Extensive Agricultural Production in each project building will consist of a 100 hectare tilapia fish farming operation that is also sized to produce excess local marketplace demand for tilapia fish. The excess processed fish will be exported to distant markets to provide</p>	

visible cash flow to the project. With a world population approaching 7 billion the fish output of a single project building calculates out to approximately 0.15% of worldwide demand of tilapia fish. A total of  $1 \div 0.0015 = 666$  project buildings would therefore be required to satisfy worldwide demand for tilapia fish. Worldwide consumption of fish data is attached. The marketing idea is to produce 100% of the local demand for fish with the entire excess of each sold to export markets for visible sales revenue.

In addition to agricultural production, each project building will produce Portland cement for the purpose of manufacturing precast concrete panels and piping for direct infrastructure development.

1. In the production of cement considerable carbon dioxide gas is produced.
2. When processing biowastes using anaerobic digestion both methane gas and carbon dioxide gas are produced.
3. When generating renewable energy both water vapor and carbon dioxide gas are produced.

100% of the carbon dioxide gas produced during the production of cement, the processing of biowastes, and the generation of electricity will be routed to an enclosed photobioreactor for the purpose of producing Spirulina microalgae. 75% of the Spirulina microalgae will be used as animal feed in the production of tilapia fish. The remainder 25% will be converted into biodiesel biofuel (B100) and sold locally to produce visible sales revenue.

Spirulina microalgae contain about 6% lipids (fats). The production of biodiesel produces about 6% lipid (fat) conversion into biodiesel biofuel from Spirulina microalgae. The 94% remaining biowastes are returned to the anaerobic digester to produce additional methane gas and carbon dioxide gas. The resulting methane gas produced can be used for power generation or sold as a biofuel. The resulting carbon dioxide gas produced from electricity generation will be automatically routed to the enclosed photobioreactor to enable production of additional Spirulina microalgae.

The economic development objective is to produce 100% of the local demand for electricity, 100% of the local demand for biodiesel biofuel, 100% of the local demand for natural gas (methane gas is a near equivalent to natural gas) biofuel, and 100% of the local demand for compressed natural gas (CNG) automotive biofuel. Biodiesel (B100) can be used as a direct replacement for petroleum diesel without equipment modification. CNG biofuel must be used in vehicles equipped for this fuel. Each project building will engage in the modification of gasoline automotive equipment to enable the use of CNG biofuel. Automobiles that operate on CNG biofuel enjoy extended useful life of the engine by a factor of 4 or more. Trucks that operate on biodiesel biofuel enjoy extended useful life of the engine by a factor of 2 or more. Each economic development project includes the infrastructure for local distribution of renewable natural gas. To the extent that methane gas is used for electricity generation, the production of biodiesel biofuel, and the production of CNG biofuel, each qualifies for renewable energy credits since all such uses are carbon neutral.

As background information, the production of ethanol from corn and biodiesel from beans has precipitated a massive food or fuel issue throughout the world causing the marketplace price of both corn and soybeans to increase dramatically. These increases have, in turn, caused the marketplace price of ethanol and biodiesel to increase as well the marketplace price of corn and soybean based food products. It is these increases in marketplace prices that have caused the food or fuel issue. With our business model, the production of biodiesel from Spirulina microalgae stays completely clear of the food or fuel issue as does the production of CNG biofuel from biowastes. To achieve total sales of the biofuels production outputs they will be sold at a 20% discount from existing retail. At this attractive pricing 100% of routine production will easily sell in the marketplace.

Because nutrients will be 100% recycled internally, each project building will produce substantial liquid fertilizer concentrate that will be distributed to area farmers in need on a no-charge basis. Excess liquid fertilizer, if any, would be eligible to sell to distant markets

<p>or possibly converted into value added products. To the extent that the local market does not make use of the liquid fertilizer concentrate the fertilizer product will be sold to international markets to increase additional visible cash flow to the project.</p> <p>Because 100% of the water is recycled internally, potable water of the quality of bottled water will be distributed locally on a no-charge basis. Because water is required to process municipal solid wastes each project building will accept both sanitary wastewater and storm water for that purpose on a no-charge basis. Over time, additional stories will be added to each project building to enable additional agricultural activities that could include bananas, beets, black bass, beef cattle, beans, cassava, coffee, corn, cotton, dairies, lobster, onions, poultry, prawns, rice, shrimp, sugar cane, sweet potatoes, trout, and many other crops.</p> <p>Throughout the prefeasibility study extensive efforts are made to provide balanced chemical equations and mathematical calculations, where appropriate, to permit extensive due diligence evaluations of the proposed sciences to be used.</p>	<p>No Charge For Potable Water</p> <p>No Charge For Wastewater Treatment</p> <p>No Charge for Stormwater Treatment</p>
<p style="text-align: center;"><b>Marketplace BioWastes-To-Energy Feedstocks</b></p> <p>A determination of the amount of volatile solids (VS) is necessary in order to calculate the amount of methane gas that can be produced from the anaerobic digestion of biowastes. Eligible feedstocks consist of municipal solid wastes (MSW), medical wastes, and construction &amp; demolition wastes. For the purpose of arriving at conservative waste figure availability, a total of 2 lbs/person/day will be used for the purpose of calculating total feedstock biowaste amounts for developing countries and a total of 5 lbs/person/day will be used for the purpose of calculating total feedstock biowaste amounts for developed countries. For an area population of 50,000 for each project building the available biowastes calculate out to <math>50,000 \times 2 \text{ lbs/person/Day} = 100,000 \text{ lbs/day}</math>, or when divided by <math>2,000 \text{ lbs/Ton} = 50 \text{ Tons/Day}</math> for developing countries and <math>50,000 \times 5 \text{ lbs/person/day} = 250,000 \text{ lbs/Day}</math>, or when divided by <math>2,000 \text{ lbs/Ton} = 125 \text{ Tons/Day}</math> for developed countries.</p> <p>For undeveloped countries, the calculation for municipal solid wastes is as follows:</p> <p style="padding-left: 40px;">Assuming 25% moisture content <math>50 \text{ Tons/Day} \times 75\% = 37.5 \text{ Dry Tons/Day}</math>  Assuming 80% organic content <math>37.5 \text{ Dry Tons/Day} \times 80\% = 30 \text{ Organic Tons/Day}</math>  Assuming 80% volatile solids content <math>30 \text{ Organic Tons/Day} \times 80\% = 24 \text{ Tons Volatile Solids/Day}</math> or <math>\times 2,000 \text{ lbs/Ton} = 48,000 \text{ lbs/Day}</math>. This amount of waste translates into <math>48,000 \text{ lbs Volatile Solids/Day} \times 12 \text{ cubic feet of methane/lb Volatile Solids} = 576,000 \text{ CFD of CH}_4</math>. At <math>24 \text{ cubic feet/lb}</math>, the methane production translates into <math>576,000 \text{ CFD CH}_4/24 = 24,000 \text{ lbs/2,000} = 12.0 \text{ Tons CH}_4/\text{Day}</math> for undeveloped countries.</p> <p>For developed countries, the calculation for municipal solid wastes is as follows:</p> <p style="padding-left: 40px;">Assuming 25% moisture content <math>125 \text{ Tons/Day} \times 75\% = 93.75 \text{ Dry Tons/Day}</math>  Assuming 80% organic content <math>93.75 \text{ Dry Tons/Day} \times 80\% = 75 \text{ Organic Tons/Day}</math>  Assuming 80% volatile solids content <math>75 \text{ Organic Tons/Day} \times 80\% = 60 \text{ Tons Volatile Solids/Day}</math> or <math>\times 2,000 \text{ lbs/Ton} = 120,000 \text{ lbs/Day}</math>. This amount of waste translates into <math>120,000 \text{ lbs Volatile Solids/Day} \times 12 \text{ cubic feet of methane/lb Volatile Solids} = 1,440,000 \text{ CFD of CH}_4</math>. At <math>24 \text{ cubic feet/lb}</math>, the methane production translates into <math>1,440,000 \text{ CFD CH}_4/24 = 60,000 \text{ lbs/2,000} = 30.0 \text{ Tons CH}_4/\text{Day}</math> for developed countries.</p> <p>In addition to fresh municipal solid wastes, the project will directly collect an additional 10 lbs/person/Day from existing landfills, rubbish piles, and dumps for the twofold purpose of producing additional methane gas and reclaiming additional ferrous and nonferrous metals while getting rid of existing dump/landfill sites. This activity will increase the methane gas and carbon dioxide gas production from two-phase anaerobic digestion by a factor of 5/2 or 2.5 thus increasing the volatile solids from undeveloped countries from 24 Tons/Day to 60 Tons/Day and from developed countries from 60 Tons to 150 Tons/Day. The associated</p>	<p>60 Tons VS/Day From MSW Undeveloped Countries</p> <p>30 Tons CH<sub>4</sub>/Day From MSW Undeveloped Countries</p> <p>150 Tons VS/Day From MSW in Developed Countries</p> <p>75 Tons CH<sub>4</sub>/Day From MSW in Developed Countries</p>

<p>methane gas is increased from 12 Tons CH<sub>4</sub>/Day to 30 Tons CH<sub>4</sub>/Day for undeveloped countries and from 30 Tons CH<sub>4</sub>/Day to 75 Tons CH<sub>4</sub>/Day from developed countries.</p> <p>The 60 Tons Volatile Solids/Day from undeveloped countries can be converted into CO<sub>2</sub> production by multiplying the Volatile Solids by 12 to determine cu. ft. of methane gas produced. Cu. ft. of methane gas produced ÷ 24 cu. ft./lb = lbs methane gas. Lbs. methane gas multiplied by 1.375 = lbs CO<sub>2</sub> produced or 60 Tons VS/Day x 2,000 lbs/Ton x 12 = 1,440,000 cu. ft. CH<sub>4</sub>/Day. 1,440,000 cu. ft. ÷ 24 cu. ft./lb = 60,000 lbs CH<sub>4</sub>/Day. 60,000 lbs CH<sub>4</sub>/Day x 1.375 = 82,500 lbs CO<sub>2</sub>/Day. 82,500 lbs CO<sub>2</sub>/Day ÷ 2,000 lbs/Ton = 41.3 Tons CO<sub>2</sub>/Day.</p> <p>The 150 Tons Volatile Solids/Day from undeveloped countries can be converted into CO<sub>2</sub> production by multiplying the Volatile Solids by 12 to determine cu. ft. of methane gas produced. Cu. ft. of methane gas produced ÷ 24 cu. ft./lb = lbs methane gas. Lbs. methane gas multiplied by 1.375 = lbs CO<sub>2</sub> produced or 150 Tons VS/Day x 2,000 lbs/Ton x 12 = 3,600,000 cu. ft. CH<sub>4</sub>/Day. 3,600,000 cu. ft. ÷ 24 cu. ft./lb = 150,000 lbs CH<sub>4</sub>/Day. 150,000 lbs CH<sub>4</sub>/Day x 1.375 = 206,250 lbs CO<sub>2</sub>/Day. 206,250 lbs CO<sub>2</sub>/Day ÷ 2,000 lbs/Ton = 103 Tons CO<sub>2</sub>/Day.</p> <p>Revenue collected for management of landfill wastes, municipal solid wastes, medical wastes, and construction &amp; demolition wastes: US\$0/Day/Ton. Never a charge, ever. This service always provided as a public service activity only.</p>	<p>No charge for MSW disposal</p> <p>US\$0.00/Day From MSW</p>
<p style="text-align: center;"><b>Agricultural Food Production and Processing</b></p> <p>Will consist of a 100 hectare Tilapia fish farm at each project building for producing and thereafter processing organically grown Tilapia filets, mostly for the export fish market. Electricity requirements are estimated at 1.0 MW. The estimated raw fish produced per day is 1,340,000 lbs. At a filet yield of 42% a total of 562,000 lbs (281 Tons of Tilapia filets) will be produced/Day along with 778,000 lbs or when divided by 2,000 lbs/Ton = 389 Tons of biowastes/Day. At a commodity sell price of US\$2.18/lb, the daily revenue is estimated at 389 Tons/Day x 2,000 lbs/Ton x US\$2.18/lb = US\$1,225,160/Day</p> <p>It is virtually impossible to obtain a buyer commitment on a current basis in the form of a purchase agreement for a product that is 36 months away from coming into existence. In terms of investor risk assessment, the existence of the very large fish commodity market itself is regarded as ample proof of probable visible cash flow from this specific food product.</p> <p>The 389 Tons/Day of biowastes x 2,000 lbs/Ton = 778,000 lbs of Volatile Solids/Day. This amount of waste translates into 778,000 lbs Volatile Solids/Day x 12 cubic feet of methane/lb Volatile Solids = 9,336,000 cubic feet/Day (CFD) of CH<sub>4</sub>. At 24 cubic foot/lb, the methane production translates into 9,336,000 CFD CH<sub>4</sub>/24 = 389,000 lbs/2,000 = 194.5 Tons CH<sub>4</sub>/Day.</p>	<p>0.5 MW Electricity Required For Tilapia Fish Farming</p> <p>US\$1,225,160/Day From Tilapia Fish</p> <p>389 Tons VS/Day From Fish Processing</p> <p>194.5 Tons CH<sub>4</sub>/Day From Fish Processing</p>
<p><b>Subtotal Carbon Dioxide Gas Produced From Municipal Solid Wastes Processing:</b></p>	<p>41.3 Tons CO<sub>2</sub>/Day</p>
<p>The 60 Tons Volatile Solids/Day from Municipal Solid Wastes can be converted into CO<sub>2</sub> production by multiplying the Volatile Solids by 12 to determine cu. ft. of methane gas produced. Cu. ft. of methane gas produced ÷ 24 cu. ft./lb = lbs methane gas. Lbs. methane gas multiplied by 1.375 = lbs CO<sub>2</sub> produced or 60 Tons VS/Day x 2,000 lbs/Ton x 12 = 1,440,000 cu. ft. CH<sub>4</sub>/Day. 1,440,000 cu. ft. ÷ 24 cu. ft./lb = 60,000 lbs CH<sub>4</sub>/Day. 60,000 lbs CH<sub>4</sub>/Day x 1.375 = 82,500 lbs CO<sub>2</sub>/Day. 82,500 lbs CO<sub>2</sub>/Day ÷ 2,000 lbs/Ton = 41.3 Tons CO<sub>2</sub>/Day.</p>	
<p><b>Subtotal Feedstocks Volatile Solids From Tilapia Fish Farming Wastes:</b></p>	<p>2.8 Tons/Day</p>
<p>The 1.4 Tons Volatile Solids/Day from Tilapia Fish Farming Wastes can be converted into CO<sub>2</sub> production by multiplying the Volatile Solids by 12 to determine cu. ft. of methane gas</p>	

produced. Cu. ft. of methane gas produced ÷ 24 cu. ft./lb = lbs methane gas. Lbs. methane gas multiplied by 1.375 = lbs CO <sub>2</sub> produced or 2.8 Tons VS/Day x 2,000 lbs/Ton x 12 = 67,200 cu. ft. CH <sub>4</sub> /Day. 67,200 cu. ft. ÷ 24 cu. ft./lb = 2,800 lbs CH <sub>4</sub> /Day. 2,800 lbs CH <sub>4</sub> /Day x 1.375 = 3,850 lbs CO <sub>2</sub> /Day. 3,850 lbs CO <sub>2</sub> /Day ÷ 2,000 lbs/Ton = 1.92 Tons CO <sub>2</sub> /Day.	1.92 Tons CO <sub>2</sub> /Day From Tilapia Fish Farming Wastes
<b>Subtotal Feedstocks Volatile Solids From Tilapia Fish Processing Wastes:</b>	<b>389Tons VS/Day</b>
The 389 Tons Volatile Solids/Day from Tilapia Fish Processing Wastes can be converted into CO <sub>2</sub> production by multiplying the Volatile Solids by 12 to determine cu. ft. of methane gas produced. Cu. ft. of methane gas produced ÷ 24 cu. ft./lb = lbs methane gas. Lbs. methane gas multiplied by 1.375 = lbs CO <sub>2</sub> produced or 389 Tons VS/Day x 2,000 lbs/Ton x 12 = 9,336,000 cu. ft. CH <sub>4</sub> /Day. 9,336,000 cu. ft. ÷ 24 cu. ft./lb = 389,000 lbs CH <sub>4</sub> /Day. 389,000 lbs CH <sub>4</sub> /Day x 1.375 = 534,874 lbs CO <sub>2</sub> /Day. 534,874 lbs CO <sub>2</sub> /Day ÷ 2,000 lbs/Ton = 267 Tons CO <sub>2</sub> /Day.	267 Tons CO <sub>2</sub> /Day From Tilapia Fish Processing Wastes
<b>Subtotal Carbon Dioxide Gas Produced From Pork Processing Wastes:</b>	<b>15.5 Tons CO<sub>2</sub>/Day</b>
<b>Subtotal Carbon Dioxide Gas Produced From Tilapia Fish Farming Wastes:</b>	<b>1.92Tons CO<sub>2</sub>/Day</b>
<b>Subtotal Carbon Dioxide Gas Produced From Tilapia Fish Processing Wastes:</b>	<b>389 Tons CO<sub>2</sub>/Day</b>
<b>Subtotal Carbon Dioxide Gas Produced From Electricity Generation:</b>	<b>247.0 Tons CO<sub>2</sub>/Day</b>
<b>Subtotal Carbon Dioxide Gas Produced From Cement Manufacturing:</b>	<b>67.2 Tons CO<sub>2</sub>/Day</b>
<b>Total Carbon Dioxide Gas Produced:</b>	<b>483.0 Tons CO<sub>2</sub>/Day</b>
<b>Subtotal Methane Gas Produced From Municipal Solid Wastes:</b>	<b>30.0 Tons CH<sub>4</sub>/Day</b>
<b>Subtotal Methane Gas Produced From Tilapia Fish Farming Wastes:</b>	<b>0.7 Tons CH<sub>4</sub>/Day</b>
<b>Subtotal Methane Gas Produced From Tilapia Processing Wastes:</b>	<b>97.3 Tons CH<sub>4</sub>/Day</b>
<b>Subtotal Methane Gas Produced From Biodiesel Processing Wastes:</b>	<b>97.1 Tons CH<sub>4</sub>/Day</b>
<b>Total Methane Gas Produced:</b>	<b>249.9 Tons CH<sub>4</sub>/Day</b>

## Two-Phase Anaerobic Digestion

All of the wastes associated with agricultural production will be managed through two-phase anaerobic digestion technology. Traditional anaerobic digestion (often referred to as conventional high rate anaerobic digestion) produces a biogas that consists of 1/3 carbon dioxide gas by volume and 2/3 methane gas by volume as a common gas mixture. Two-phase anaerobic digestion, however, produces the same gases as two distinct gases consisting individually of carbon dioxide gas and methane gas. The separation of the two gases permits each to be managed individually.

In every anaerobic digester the ratio of carbon dioxide gas produced relative to methane gas is 1:2 on a volumetric basis. The molecular weight of methane gas (CH<sub>4</sub>) is 16 (12 for Carbon + 4 for Hydrogen) whereas the molecular weight of carbon dioxide gas (CO<sub>2</sub>) is 44 (12 for Carbon and 32 for Oxygen). 1 x 44 = 44 weight units for carbon dioxide gas and 2 x 16 = 32 weight units for methane gas. 44 divided by 32 = 1.375. Carbon dioxide produced relative to methane produced is therefore 137.5% on a mass basis. The actual weight of methane gas produced may be found by multiplying its cubic feet by the factor 0.0423 lbs/cu. ft. to arrive at its actual weight in lbs. This weight may be multiplied by the factor of 1.375 (137.5%) to arrive at the corresponding weight of carbon dioxide produced in lbs. The amount of methane gas generated through two-phase anaerobic digestion may be found by multiplying the volatile solids weight of the biowastes in lbs by 12 to arrive at the cubic feet of methane gas produced in lbs.

Other sometimes handy mathematical relationships are:

- 1 Ton VS/Day produces 24,000 CH<sub>4</sub>/Day from two-phase anaerobic digestion
- 1 Ton VS/Day produces 0.508 Tons CH<sub>4</sub>/Day from two-phase anaerobic digestion
- 1 Ton VS/Day produces 0.698 Tons CO<sub>2</sub>/Day from two-phase anaerobic digestion
- 1 Ton CH<sub>4</sub>/Day used for electricity generation produces 2.75 Tons CO<sub>2</sub>/Day
- 83,780 CH<sub>4</sub>/Day produces 1 MW of simple cycle electricity power generation

Products Of Two-Phase Anaerobic Digestion

Volatile Solids (VS)  
x 12 = cu. ft. CH<sub>4</sub>

cu. ft. CH<sub>4</sub> x 0.0423  
= lbs CH<sub>4</sub>

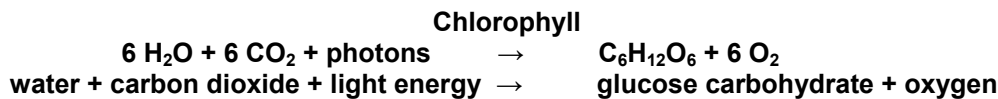
lbs CH<sub>4</sub> x 1.375  
= lbs CO<sub>2</sub>

## Enclosed Photobioreactor for Spirulina Microalgae Production

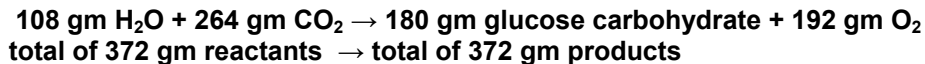
The enclosed photobioreactor consists of a 2,200,000 foot long 12"Ø clear schedule 40 PVC pipe spiral wrapped externally with ultra high efficiency long lasting (10 years +) light emitting diode lighting for continuous photosynthesis. A small portion of the Spirulina microalgae produced will be continuously recycled to the start of the photobioreactor to provide the required seed to enable continuous Spirulina microalgae production. Electricity requirements = 6.0 MW for the lighting and associated recirculation pumping equipment.

The photobioreactor will receive 100% of the carbon dioxide gas output of the two-phase anaerobic digester and 100% of the carbon dioxide gas output from electricity generation. In addition, it will receive 100% of the output of macronutrients from the reverse osmosis treatment equipment deployed downstream from the two-phase anaerobic digester. The Spirulina microalgae require both carbon dioxide and macronutrients to maximize their rate of growth. The photobioreactor will be operated at a temperature of 35°C (95°F) and a pH of 9.4 to further optimize Spirulina microalgae rate of growth. Please refer to attached WSE Drawing Nos. S-6099-1 and S-9900-1 for additional information.

Spirulina will be produced using photosynthesis in the same manner that has existed for billions of years in the oceans of the world. The photosynthesis reaction is:

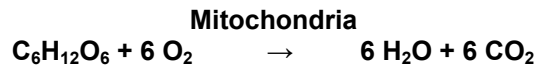


The chemical mass balance of the above equation becomes :



For each 264 grams of CO<sub>2</sub> reacted 180 grams of glucose carbohydrate and 192 grams of O<sub>2</sub> will be produced. For each ton of CO<sub>2</sub> reacted, 180/264 or 0.682 tons of glucose carbohydrates and 192/264 or 0.73 tons of O<sub>2</sub> will be produced. Glucose carbohydrates equate to Spirulina microalgae, a plant type material called phytoplankton.

Respiration occurs in the Mitochondria of cells. It is almost the exact opposite reaction to photosynthesis. These two reactions work together to maintain a biological balance on earth. The respiration reaction is:



It is generally believed that photosynthesis occurs only during periods of sunlight (or artificial light) and that respiration occurs only during periods of darkness. Horticulture studies have established that several, but not all, species of plants can be grown under continuous lighting. The same studies have established that photosynthesis and respiration can and do occur simultaneously under continuous lighting conditions. Plants are multi-cell and capable of learned behavior whereas Spirulina microalgae are single cell plants and therefore totally incapable of acquiring learned behavior. Spirulina microalgae can therefore be grown under continuous lighting conditions even though they have never been exposed to continuous lighting conditions for billions of years. Continuous lighting therefore approximately doubles total Spirulina growth relative to day/night growth rates.

The glucose produced during photosynthesis contains about 6% lipids (fats). Lipids are efficiently converted into biodiesel through a transesterification process. Each ton of CO<sub>2</sub> will simultaneously produce 0.68 tons glucose carbohydrates x 0.06 = 0.04 tons biodiesel and 1.0 – 0.04 = 0.96 tons of byproduct biowastes. 100% of the byproduct biowastes will consist of volatile solids. One ton CO<sub>2</sub>/Day can therefore produce 0.04 tons biodiesel/Day. At a specific gravity of 0.88 this is equivalent to 0.04 tons x 2,000 lbs/ton divided by 0.88

One Ton CO<sub>2</sub>/Day  
Produces 0.682  
Tons Of Glucose  
Carbohydrates/Day  
(Spirulina  
Microalgae)

One Ton CO<sub>2</sub>/Day  
Produces 0.04 Tons  
Biodiesel/Day

One Ton CO<sub>2</sub>/Day  
Produces 0.96 Tons  
Volatile Solids/Day

One Ton CO<sub>2</sub>/Day  
Produces 90.91

<p>specific gravity = 90.91 gallons/day. The same one ton CO<sub>2</sub>/Day will produce 0.96 tons x 2,000 lbs/ton = 1,920 lbs volatile solids/day or 21.12 lbs volatile solids/gallon of biodiesel produced/day.</p>	<p style="text-align: center;"><b>Gallons Of Biodiesel/Day</b></p> <p style="text-align: center;"><b>Each Gallon of Biodiesel Produced Produces 21.12 lbs of Volatile Solids</b></p>
<p style="text-align: center;"><b>Biodiesel Production</b></p> <p>All biodiesel produced will fully comply with American Society for Testing and Materials (ASTM) Standard Specification D 6751-03. The referenced specification is attached to the prefeasibility study.</p> <p>The amount of biodiesel produced is directly dependent on the amount of Spirulina microalgae produced. The amount of Spirulina microalgae produced is directly dependent on the amount of carbon dioxide gas that is added to the photobioreactor. Since carbon dioxide gas is produced by electricity generation, two-phase anaerobic digestion, and cement production, the total amount of CO<sub>2</sub> produced must be determined from each source.</p> <p><b>Source No. 1: Electricity Generation:</b></p> <p>30 MW of electricity will be produced for the community initiative. Another 21.5 MW of electricity will be used internally for the photobioreactor, air liquefaction, methane gas compression, tilapia fish lighting, pig production, and general building use. The total amount of electricity produced therefore equals 30 MW + 21.5 MW = 51.5 MW.</p> <p>When generating electricity CO<sub>2</sub> is produced according to the following combustion equation:</p> $\text{CH}_4 + 2\text{O}_2 + 7.52 \text{N}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} + 7.52 \text{N}_2 + \text{heat}$ <p style="text-align: center;">methane + oxygen + nitrogen → carbon dioxide + water + nitrogen</p> <p>The chemical mass balance of the above equation becomes:</p> $16 \text{ gm CH}_4 + 64 \text{ gm O}_2 + 105 \text{ gm N}_2 \rightarrow 44 \text{ gm CO}_2 + 36 \text{ gm H}_2\text{O} + 105 \text{ gm N}_2$ <p style="text-align: center;">total of 80 gm reactants → total of 80 gm products</p> <p>Please note that nitrogen is not a reactant as it does not participate in the reaction. For each ton of CH<sub>4</sub> used for electricity generation a total of 44/16 or 2.75 tons of CO<sub>2</sub> will be produced along with a total of 36/16 or 2.25 tons of H<sub>2</sub>O. 2.25 tons of H<sub>2</sub>O is, in turn, equivalent to 2.25 tons H<sub>2</sub>O x 2,000 lbs/ton = 4,500 lbs ÷ 8.34 lbs/gallon = 540 gallons of water.</p> <p>If 51.5 MW of electricity is produced to provide energy independence within the Community Initiative, a total of 51.5 MW x 83,780 CH<sub>4</sub>/Day/MW = 4,314,670 cubic feet of methane gas will have to be used each day. At 24 cubic foot/lb, the methane usage translates into 4,314,670 cu. ft. CH<sub>4</sub>/24 = 179,778 lbs/2,000 = 89.89 Tons CH<sub>4</sub>/Day. Since each ton of CH<sub>4</sub> produces 2.75 Tons of CO<sub>2</sub> the generation of 51.5 MW of electricity produces 89.89 x 2.75 = 247.0 Tons of CO<sub>2</sub>/Day due to the generation of electricity. Since each ton of CH<sub>4</sub> produces 2.25 Tons of H<sub>2</sub>O, the generation of 51.5 MW of electricity also produces 89.89 x 2.25 = 202 Tons of H<sub>2</sub>O/Day.</p> <p><b>Source No. 2: Two-Phase Anaerobic Digestion:</b></p> <p>To determine the amount of CO<sub>2</sub> produced first requires a determination of the amount of CH<sub>4</sub> produced as CH<sub>4</sub> production directly determines CO<sub>2</sub> production by a factor of 1.375.</p>	<p>1 Ton CH<sub>4</sub> Produces 2.75 Tons CO<sub>2</sub> From Electricity Generation</p> <p>1 Ton CH<sub>4</sub> Produces 2.25 Tons H<sub>2</sub>O From Electricity Generation</p> <p>1 Ton CH<sub>4</sub> Produces 540 Gallons Of Water From Electricity Generation</p> <p>51.5 MW Of Electricity Produces 247.5 Tons Of CO<sub>2</sub>/Day</p> <p>51.5 MW Of Electricity Produces 89.89 Tons Of CH<sub>4</sub>/Day</p>

To determine the amount of CH<sub>4</sub> produced first requires the amount of volatile solids that are treated as each lb of volatile solids x 12 = cu. ft. CH<sub>4</sub> produced.

The volatile solids available from MSW processing are 60.0 Tons/Day as listed above.  
The volatile solids available from tilapia fish farming are 1.4 Tons/Day as listed above.  
The volatile solids available from tilapia fish processing are 194.5 Tons/Day as listed above.  
The total volatile solids available as listed above = 60.0 + 27.0 + 22.6 + 1.4 + 194.5 = 305.5 Tons CH<sub>4</sub>/Day. 305.5 Tons CH<sub>4</sub>/Day x 1.375 = 420.1 Tons CO<sub>2</sub>/Day.

The project building will engage in the manufacturing of cement. Carbon dioxide is produced in cement making as a result of the production of a process ingredient called 'Clinker'. Clinker is made when limestone is heated to produce lime. Substantial amounts of carbon dioxide are simultaneously formed during this reaction. The final amount of carbon dioxide produced varies depending on the type of cement being made. Each project building will be manufacturing 300 Tons/Day of Portland type cement.

According to the *Annual Review of Energy and the Environment*, (Vol. 26: pp 303-329, November 2001) average CO<sub>2</sub> emissions/Ton from cement production = 448 lbs. At a cement production rate of 300 Tons/Day the total carbon dioxide emissions = 300 Tons/Day x 448 lbs CO<sub>2</sub>/Ton = 134,400 lbs/Day ÷ 2,000 lbs/Ton = 67.2 Tons CO<sub>2</sub>/Day. Adding this amount of CO<sub>2</sub> to the above total of 420.1 Tons CO<sub>2</sub>/Day = 487.3 Tons CO<sub>2</sub>/Day that will be produced from electricity generation, two-phase anaerobic digestion of volatile solids feedstocks, and cement production.

Since each ton of CO<sub>2</sub> produces 0.682 Tons of Spirulina microalgae 487.3 Tons CO<sub>2</sub>/Day produces 487.3 x 0.682 = 332.3 Tons Spirulina microalgae/Day.

75% or 249.2 Tons Spirulina/Day will be used for feeding tilapia fish and pigs. The remaining 25% or 83.1 Tons Spirulina/Day will be used in the production of biodiesel (B100). 83.1 Tons Spirulina production is the equivalent of 25% of 487.3 Tons CO<sub>2</sub>/Day or 121.8 Tons CO<sub>2</sub>/Day. 249.2 Tons Spirulina production is the equivalent of 75% of 487.3 Tons CO<sub>2</sub>/Day or 365.5 Tons CO<sub>2</sub>/Day.

Since one ton CO<sub>2</sub>/Day produces 0.682 Tons of Spirulina microalgae, 108.3 Tons CO<sub>2</sub>/Day produces 108.3 x 0.682 = 73.86 additional tons of Spirulina microalgae increasing its production from 295.5 Tons/Day to 369.4 Tons/Day.

Since one ton CO<sub>2</sub>/Day produces 0.04 tons biodiesel/day, 121.8 Tons CO<sub>2</sub>/Day produces 121.8 x 0.04 tons = 4.87 tons biodiesel/Day. At a specific gravity of 0.88 this is equivalent to 4.87 tons x 2,000 lbs/ton divided by 0.88 specific gravity = 11,073 gallons/day.

Since each gallon of biodiesel produced generates 21.12 lbs of volatile solids, 11,073 gallons x 21.12 = 233,856 lbs. Volatile Solids/Day. 233,856 lbs Volatile Solids/Day ÷ 2,000 lbs/Ton = 116.9 Tons Volatile Solids/Day. The 116.9 Tons Volatile Solids/Day from biodiesel production can be converted into CO<sub>2</sub> production by multiplying the Volatile Solids by 12 to determine cu. ft. of methane gas produced. Cu. ft. of methane gas produced ÷ 24 cu. ft./lb = lbs methane gas. Lbs. methane gas multiplied by 1.375 = lbs CO<sub>2</sub> produced or 116.9 Tons VS/Day x 2,000 lbs/Ton x 12 = 2,806,272 cu. ft. CH<sub>4</sub>/Day. 2,806,272 cu. ft. ÷ 24 cu. ft./lb = 116,928 lbs CH<sub>4</sub>/Day. 116,928 lbs CH<sub>4</sub>/Day x 1.375 = 160,776 lbs CO<sub>2</sub>/Day. 160,776 lbs CO<sub>2</sub>/Day ÷ 2,000 lbs/Ton = 80.4 Tons CO<sub>2</sub>/Day.

Since one ton CO<sub>2</sub>/Day produces 0.04 tons biodiesel/day, 80.4 Tons CO<sub>2</sub>/Day produces 80.4 x 0.04 tons = 3.22 tons biodiesel/Day. At a specific gravity of 0.88 this is equivalent to 3.22 tons x 2,000 lbs/ton divided by 0.88 specific gravity = 7,308 gallons biodiesel/day thus increasing biodiesel production from 11,073 GPD to 18,381 GPD.

Since the basic waste-to-energy process fully satisfies electricity demand the excess methane gas will be beneficially used for:

332.3 Tons  
Spirulina  
Microalgae  
Produced/Day

18,381 Gallons of  
Biodiesel  
Produced/Day

58.5 Tons CH<sub>4</sub>/Day

plus

38.6 Tons CH<sub>4</sub>/Day

= 97.1 Tons CH<sub>4</sub>  
Produced/Day From  
Biodiesel  
Production

<ol style="list-style-type: none"> <li>1. The production of methanol through syngas technology that is used as a required feedstock in the production of biodiesel biofuel,</li> <li>2. The production and sale of compressed natural gas (CNG) biofuel surface transportation fuel, and</li> <li>3. The production and sale of renewable natural gas biofuel to the marketplace.</li> </ol>		
<h3 style="color: green;">Tilapia Fish Feed Requirements:</h3>		
<p>The production of tilapia fish is 670 Tons/Day. It takes about 1.2 lbs of feed to increase the fish weight by 1.0 pound. The 670 Tons of finished fish will require 670 x 1.2 or 804 Tons of feed per Day. Spirulina microalgae production at 332 Tons feed/Day will mostly satisfy tilapia fish feed requirements. As the MSW volume increases the volume of Spirulina microalgae will automatically increase. It won't take much of an increase in MSW volume to fully satisfy total feed requirements.</p> <p>The preferred initiative is to increase collection of MSW biowastes by excavating area landfills and dumps for the purpose of treating their contents with two-phase anaerobic digestion to increase the associated production of Spirulina microalgae.</p>		
<h3 style="color: green;">Manufacturing Activities</h3>		
Self-Biofueled Trains & Locomotives	The shipbuilding/shipbreaking project building will be designed to accommodate the manufacture of 100 self-biofueled trains & locomotives per year at an estimated marketplace price of US\$3,500,000/unit. Visible revenue produced = US\$3,500,000 x 100 = US\$350,000,000/year or ÷ 365 = US\$958,900/Day.	US\$958,900/Day
Self-Biofueled Ships	The shipbuilding/shipbreaking project building will be designed to accommodate the manufacture of 10 self-biofueled ships per year at an estimated price of US\$250,000,000/unit. Visible revenue produced = US\$250,000,000 x 10 = US\$2,500,000/year or ÷ 365 = US\$6,849,315/Day. Maximum size of manufactured ship = 1,200 ft long x 120 ft wide.	US\$6,849,315/Day
Tidal Generators	The project building will be designed to accommodate the manufacture of 20 tidal generators per year at an estimated price of US\$500,000,000/unit. Visible revenue produced = US\$500,000,000 x 20 = US\$10,000,000,000/year or ÷ 365 = US\$27,397,260/Day. Tidal generators will be sold on a fully installed basis.	US\$27,397,260/Day
<b>Subtotal Methane (CH<sub>4</sub>) Gas Production From Municipal Solid Wastes (MSW):</b>		
	60 Tons/Day Total Volatile Solids x 2,000 lb/Ton x 12 Cubic Feet (CF)/lb = 1,440,000 cu. ft./Day. 1,440,000 cu. ft. CH <sub>4</sub> /Day ÷ 24 lbs/cu. ft. = 60,000 lbs. 60,000 lbs ÷ 2,000 lbs/Ton = 30 Tons CH <sub>4</sub> /Day	1,440,000 cu. ft. CH <sub>4</sub> /Day = 30 Tons CH <sub>4</sub> /Day From MSW
<b>Subtotal Methane (CH<sub>4</sub>) Gas Production From Biodiesel Processing Wastes:</b>		
	4,659,366 cu. ft. CH <sub>4</sub> /Day ÷ 24 cu. ft./lb = 194,140 lbs. 194,140 lbs ÷ 2,000 lbs/Ton = 97.1 Tons CH <sub>4</sub> /Day	97.1 Tons CH <sub>4</sub> /Day From Biodiesel Wastes
<b>Subtotal Methane (CH<sub>4</sub>) Gas Production From Tilapia Fish Farming Wastes:</b>		
	2.8 Tons/Day Total Volatile Solids x 2,000 lb/Ton x 12 Cubic Feet (CF)/lb = 67,200 cu. ft./Day. 67,200 cu. ft. CH <sub>4</sub> /Day ÷ 24 lbs/cu. ft. = 2,800 lbs. 2,800 lbs ÷ 2,000 lbs/Ton = 1.4 Tons CH <sub>4</sub> /Day	67,200 cu. ft. CH <sub>4</sub> /Day = 1.4 Tons CH <sub>4</sub> /Day From Tilapia Fish

		<b>Farming Wastes</b>
<b>Subtotal Methane (CH<sub>4</sub>) Gas Production From Tilapia Fish Processing Wastes:</b>		
	389 Tons/Day Total Volatile Solids x 2,000 lb/Ton x 12 Cubic Feet (CF)/lb = 9,336,000 cu. ft./Day. 9,336,000 cu. ft. CH <sub>4</sub> /Day ÷ 24 lbs/cu. ft. = 389,000 lbs. 389,200 lbs ÷ 2,000 lbs/Ton = 194.6 Tons CH <sub>4</sub> /Day	9,336,000 cu. ft. CH <sub>4</sub> /Day = 194.6 Tons CH <sub>4</sub> /Day From Tilapia Fish Processing Wastes
<b>Total Methane (CH<sub>4</sub>) Gas Generation from all sources:</b>		<b>249.9 Tons CH<sub>4</sub>/Day</b>
<b>OAT Process Power Generation Potential:</b>		
	249.9 Tons CH <sub>4</sub> /Day x 2,000 lbs/Ton = 499,800 lbs/Day. 499,800 lbs/Day x 24 cu. ft./lb = 11,995,200 cu. ft./Day. 11,995,200 cu. ft./Day ÷ 83,780 cu. ft./MW = 143 MW. 143 MW less 15% parasitic digester plant use = 122 MW Net	<b>122 MW Net</b>
<b>Two-Phase Anaerobic Digester Size Calculations:</b>		
	Volatile Solids = 249.9 Tons/Day x 2,000 lbs/Ton = 499,800 lbs/Day	
	VS:COD = 1:2, COD = 999,600 lbs/Day	
	Organic Loading lbs COD/Day/Cubic Foot = 6	
	Digester Size = 999,600/6 = 166,600 Cubic Feet	
	Digester Size In Gallons = 1,246,335 Gallons	
	Safety Factor = 1.5	
	Digester Size = 1,869,502 Gallons (120' x 120' x 20'H)	
	Estimated Constructed Cost At US\$40/Gallon = \$74,780,080	
<b>Building Size: 2 km (3,280') x 2 km (3,280') x 200 m high w/3 side double wall construction to accommodate photobioreactor and employee housing = 50,000,000 total sq. ft. of precast concrete construction estimated @ US\$5.50/sq. ft. = US\$275,000,000. Project building will manufacture its own cement and will purchase a ready mix plant (3 concrete delivery/mixer trucks) to minimize precast concrete panel construction costs.</b>		
	Remanufactured 300 Tons/Day Cement Kiln Purchase Cost = US\$12,000,000	
	Remanufactured Ready Mix Batch Plant Purchase Cost = US\$3,000,000	
<b>Photobioreactor: 2,200,000 foot long 12"Ø Clear PVC schedule 40 pipe = US\$100,000,000 to includes ultra high efficiency long lasting (10 years +) light emitting diode (LED) lighting for photosynthesis @ US\$10,000,000 Electricity requirements = 6.0 MW</b>		
<b>10 MGY Biodiesel Manufacturing Equipment Cost Estimate: US\$15,000,000. Electricity Requirements = 0.5 MW</b>		
<b>Two (2) 110 GPM 4:2:1 Array Reverse Osmosis Equipment Cost Estimate: US\$2,000,000</b>		
<b>Digester Equalization Feed Tank Cost Estimate: \$2,000,000 w/Equalization Tank Size = 120' x 120' x 20' H, 2,000,000 Gallon Capacity</b>		
<b>Potable Water Tank Cost Estimate: \$2,000,000 w/Equalization Tank Size = 120' x 120' x 20' H, 2,000,000 Gallon Capacity</b>		

	<b>Anaerobic Digester Feed Tank Cost Estimate: \$2,000,000 w/Equalization Tank Size = 120' x 120' x 20' H, 2,000,000 Gallon Capacity</b>	
	<b>Liquefied Nitrogen Storage Tank Cost Estimate: \$2,000,000 w/Equalization Tank Size = 120' x 120' x 20' H, 2,000,000 Gallon Capacity</b>	
	<b>Liquefied Natural Gas (LNG) Storage Tank Cost Estimate: \$2,500,000 w/Equalization Tank Size = 120' x 120' x 20' H, 2,000,000 Gallon Capacity</b>	
	<b>EAF Steel Recycling Process Equipment Cost: US\$3,000,000</b>	
	<b>12,000,000 CFD Compressed Methane Gas (CNG) Equipment Cost Estimate = US\$10,000,000. Electricity Requirements = 2 MW</b>	
	<b>221 Ton/Day Liquefied Nitrogen Air Separation Equipment Cost Estimate: \$20,000,000. Electricity Requirements = 10 MW</b>	
	<b>Liquefied Nitrogen Delivery Equipment: US\$500,000</b>	
	<b>Fish Procurement Cost Estimate = US\$5,000,000</b>	
	<b>51.5 MW Natural Gas Fueled Combined Cycle Power Generation Equipment @ US\$1,260/kW = 51,500 kW x US\$1,100 = US\$56,650,000</b>	
	<b>Total Electricity Generation Requirements:</b>	
	<b>For each project building: 51.5 MW (includes projected demand for the next 20 years</b>	
	<b>For Photobioreactor = 6.0 MW</b>	
	<b>For Compressed Natural Gas (CNG) = 2 MW</b>	
	<b>For Liquefied Nitrogen (LN2)(LIN) = 10 MW</b>	
	<b>For Liquefied Oxygen = Included with Liquefied Nitrogen</b>	
	<b>For Tilapia Farming = 0.5 MW</b>	
	<b>For General Building use = 2 MW</b>	
	<b>Total Electricity Installed Capacity Requirements = 51.5 MW</b>	
	<b>122 MW potential less 51.5 MW used = 70.5 MW remaining. At 83,779 cu. ft./MW, 83,779 cu. ft. x 70.5 MW = 5,906,420 cu. ft./Day available to marketplace at US\$0.70/126.67 cu. ft. or US\$32,640/Day as CNG automotive fuel. If sold to a natural gas pipeline the revenue would be slightly less by about 10%.</b>	
	<b>Schedule of Project Construction Costs:</b>	
	<b>Anaerobic Digester Feed Tank: US\$2,000,000</b>	
	<b>Biodiesel Manufacturing Equipment: US\$15,000,000</b>	
	<b>Building Size: 2 km x 2 km x 200 m High Constructed Cost: US\$1,475,000,000</b>	
	<b>Cement Kiln Constructed Cost: US\$12,000,000</b>	
	<b>Concrete Ready Mix Plant Constructed Cost = US\$3,000,000</b>	
	<b>EAF Steel Recycling Process Equipment Constructed Cost: US\$3,000,000</b>	
	<b>LED Lighting Purchase Cost: US\$10,000,000</b>	
	<b>Liquefied Natural Gas (LNG) Storage Tank: US\$2,500,000</b>	
	<b>Liquefied Nitrogen Air Separation Equipment: US\$15,000,000</b>	
	<b>Liquefied Nitrogen Delivery Equipment: US\$500,000</b>	
	<b>Liquefied Nitrogen Storage Tank: US\$2,000,000</b>	

	Methane Compression Equipment: US\$10,000,000	
	Photobioreactor: US\$100,000,000	
	Potable Water Storage Tank Constructed Cost: US\$2,000,000	
	Power Generation Equipment: US\$56,650,000	
	Reverse Osmosis Equipment: US\$2,000,000	
	Fish Procurement Costs: US\$5,000,000 Electricity Requirements = 2.0 MW	
	Tilapia Fish Farming Acreage: 50 hectares x 24' H Tilapia Fish Farming Production: lbs/day = 281,400 of tilapia filets Tilapia Fish Farming Electricity Requirements = 0.5 MW Fish Processing Equipment: US\$500,000	
	Two-Phase Anaerobic Digester: US\$74,780,080	
	Subtotal Project Construction Costs: US\$1,790,680,080	
	Add 15% Contingencies @ 268,602,012 = US\$2,059,282,092	
	<b>Total Project Construction Costs:</b>	<b>US\$2,059,282,092</b>
<b>Project Visible Cash Flow Revenue Streams:</b>		
	From Sanitary Wastewater – US\$0.00	
	From Municipal Solid Wastes – US\$0.00	
	From Agro Wastes – US\$0.00	
	From Animal Wastes – US0.00	
	From Electricity: 44 MW x 24 = 720 MWh/Day @ US\$45.00/MWh = US\$47,520/Day. This amount of electricity generation will provide the average demand load of the participating communities for the next 20 years.	US\$47,520/Day
	From Biodiesel: 18,381 GPD always priced at 80% of existing marketplace retail. Current retail is US\$1.67/gallon. US\$1.67 x 80% = US\$1.34. 18,381 x US\$1.34 = US\$24,630/Day.	US\$24,630/Day
	From Liquefied Nitrogen (LN2)(LIN): 244,003 GPD priced at US\$0.50/gallon = US\$122,000.00/Day.	US\$122,000/Day
	From Compressed Natural Gas (CNG) Fuel:	US\$32,640/Day
	From Fresh Tilapia Filet Exports: US\$1,226,900 at a sell price of US\$2.18/lb	US\$1,226,900/Day
	From Self-Biofueled Trains & Locomotives:	US\$958,900/Day
	From Self-Biofueled Ships:	US\$6,849,315/Day
	From Tidal Generators:	US\$27,397,260/Day
	Renewable Energy and other Credits based on estimated 36 MW Project Power Generation:	
	One Certified Emission Reduction Credit = 1 Tonne CO <sub>2</sub> Reduction. 51.5 MW Project Power Production x 24 hour/Day = 1,236 MWh/Day. 1,236 MWh/Day x 1,100 lbs CO <sub>2</sub> Reduction (using natural gas)/MWh ÷ 2,000 lbs/Ton = 680 Tons/Day = 248,000 T/Year x 2,000/2,204 = 225,226 Tonnes/Year @ US\$20 (range of US\$20-US\$40) = US\$4,504,000/Year ÷ 365 = US\$12,341/Day for years 2008-2012 delivery.	US\$12,341/Day
	<b>Total Project Revenue Streams:</b>	<b>US\$34,258,916/Day</b>
<p>To the extent that electricity is generated, the combustion off gases (CO<sub>2</sub>, NO<sub>x</sub>, N<sub>2</sub>, and H<sub>2</sub>O) will be entirely used for Spirulina microalgae production. After Spirulina microalgae production has occurred the remaining Nitrogen gas (N<sub>2</sub>) will be liquefied and sold to the marketplace. The remaining N<sub>2</sub> gas stream will also contain Oxygen gas (O<sub>2</sub>) due to the respiration of microalgae during their production in the same manner that trees and plants give off oxygen. This oxygen will be simultaneously liquefied during the liquefaction of N<sub>2</sub> and subsequently distilled off, compressed, and subsequently used internally as a welding gas, to enhance cement manufacturing, to enhance fish farming, and for smelting iron into steel. Some of the Nitrogen Gas will be used as a protective blanket gas in the production</p>		

<b>of methanol through syngas technology. The methanol is produced as a required feedstock in the production of biodiesel.</b>	
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**Additional Notes:**

- 1. Land Requirements: 1,200 hectare for Shipbuilding-Shipbreaking Project Building.**
- 2. Time to design-build-install-operate is estimated at 36 months.**
- 3. Lighting for tilapia must be a daily cycle of:**
  - 7.5 hours of total darkness**
  - 0.5 hours of sunrise (begins at 6 a.m. w/3 ft-candles)**
  - 15.5 hours of daylight (max 10 ft-candles)**
  - 0.5 hours of sunset (begins at 10 p.m. w/3 ft-candles)**
- 4. Sufficient project building room remains to add a 10,000 beef cattle operation, a 10,000 milker dairy farm, and significant poultry operations along with all of the associated processing equipment to produce value added products consisting of dressed beef, milk and other dairy products, broilers, and eggs. All of these activities represent future economic development activities.**

# PROJECT KEY PROFESSIONAL STAFF

## *Curriculum Vitae*

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**Employee: C.G. (Chuck) Steiner, BS, JD**

### **Education**

St. John's University, Collegeville, Minnesota. B.S. Degree in Chemistry, 1959

Wm. Mitchell College of Law, St. Paul, Minnesota. J.D. Degree in Law, 1969

### **Publications**

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Steiner, C. G., "Biofuels For Energy Independence", REFOCUS, (March/April, 2003).

Steiner, C. G., "Kyoto Protocol-compliant waste-to-renewable energy with zero air, water, and solids pollution", The Bulletin on Energy Efficiency, (December, 2004).

Steiner, C. G., "Waste-to-Energy Plan", Pollution Engineering, (March, 2005).

Steiner, C. G., "Biodiesel – The Probable Only Fuel of the Future, Renewable or Otherwise", Earthtoys - Emagazine, (October, 2005).

Steiner, C. G., "Economic Development Through Biomass Waste-To-Energy Technology", Earthtoys - Emagazine, (December, 2005).

Steiner, C. G., "Energy Independence For Everyone, To Include Food, Natural Gas, Biodiesel, And Water As Well", The Bulletin on Energy Efficiency, (December, 2005).

Steiner, C. G., "THERE'S GOLD IN THEM THAR WASTE HILLS", Earthtoys - Emagazine, (April, 2006).

Steiner, C.G., "Reversing Global Warming Through A Worldwide Waste-To-Energy Policy", Earthtoys - Emagazine, (October, 2006).

Steiner, C. G., "**SuperGreen** Buildings Technology With Zero Greenhouse Gas (GHG) Emissions To The Environment", Earthtoys - Emagazine, (December, 2006).

Steiner, C. G., "**SuperGreen™**, Self-Fueled, Double Hull, **Dual-Biofuel™** Powered SuperStrong Concrete Barges and Ships That Exhibit Zero Greenhouse Gas (GHG) Emissions and Include Onboard Ballast Water Treatment", Earthtoys - Emagazine, (February, 2007).

### **Patents**

Two-Phase Anaerobic Digestion Process Utilizing Thermophilic Fixed Growth Bacteria (US Patent No. 5,630,942)

### **Certifications**

40 Hour OSHA Course, 1990-1997

### **Memberships**

American Council On **Renewable Energy**

American Institute of Chemist (Professional Chemist - Accredited)

American Meat Institute

American Society for Testing and Materials

American Water Works Association

Global Village Energy Partnership

Incinerator Institute of America, Member T-6 Testing Committee

National Air Pollution Control Association

National Canners Association

USEPA Combined Heat and Power (CHP) Partnership

Wastewater Equipment Manufacturers Association

Water Environment Federation

### **Experience Summary**

Thirty Five years in design, marketing, new product development, plant operation, and general management of water purification equipment manufacturing and supply.

### **Employment History**

President, Chief Executive Officer, and Principal Scientist of WaterSmart Environmental, Inc., a manufacturer of water and wastewater treatment equipment and a worldwide provider of next generation waste-to-**renewable energy** and other climate change technologies.

Chief Process Engineer for Smith & Loveless, Inc., a manufacturer of water and wastewater treatment equipment.

Product Manager for Pielkenroad Separator Company, a manufacturer of particle/liquid separation equipment.

Director of Environmental Services for Geo. A. Hormel & Company with P&L responsibility over its two pollution control equipment manufacturing divisions.

Director of Marketing for Cherne Industrial, Inc., a national supplier of packaged laboratories for the water and wastewater treatment industry.

Director of Environmental Control for Fire Engineers, Inc., a manufacturer of solid waste disposal incinerators.

Department Manager for Twin City Testing & Engineering Laboratories, Inc., a large regional independent testing laboratory.

Chief Analytical Chemist for Federal Cartridge Corporation, a munitions manufacturer.

R&D Chemist for 3M Company, a diversified manufacturer.

From the Human Resources Department of

**WaterSmart**  
**Environmental, Inc.**

