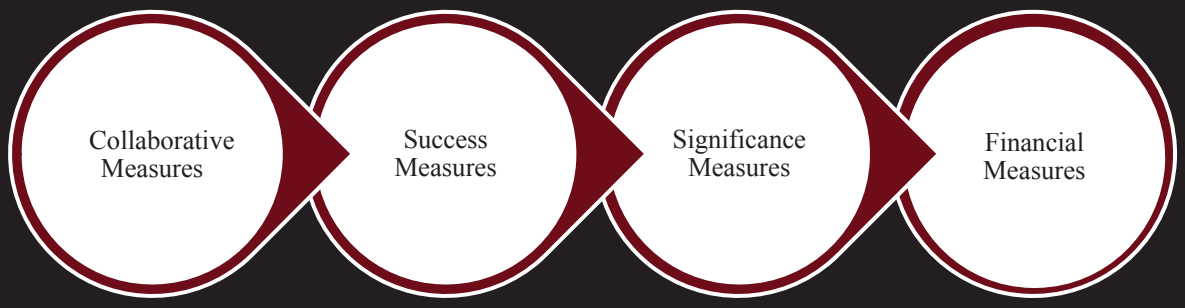


Round 3: Application Form

Local Government Innovation Fund

Step One: Fill out this Application Form in its entirety.

Step Two: Fill out the online submission form and submit your application materials. All supplemental application materials should be combined into one file for submission.

LGIF: Applicant Profile	
Lead Applicant	Middleport Village
Project Name	Wastewater Treatment Plant Bio-Reactor/ElectroCell Feasibility Study
Type of Request	Grant
Funding Request	$90,000
JobsOhio Region	Southeast
Number of Collaborative Partners	0

Office of Redevelopment
Website: http://development.ohio.gov/Urban/LGIF.htm
Email: LGIF@development.ohio.gov
Phone: 614 | 995 2292

Lead Applicant	Middleport Village	**Round 3**	
Project Name	Wastewater Treatment Plant Bio-Reactor/ElectroCell Feasibility Study	Type of Request	Grant

Lead Applicant

Mailing Address:	Address Line 1	659 Pearl Street			
	Address Line 2				
	City	Middleport	State	OH	Zip Code	45760
City, Township or Village	Middleport	Population (2010)	2,530
County	Meigs	Population (2010)	23,770
Did the lead applicant provide a resolution of support?	☑ Yes (Attached) ☐ No (In Process)		

Project Contact

Complete the section below with information for the individual to be contacted on matters involving this application.

Project Contact	Faymon Roberts	Title	Village Administrator
Mailing Address:	Address Line 1	659 Pearl Street			
	Address Line 2				
	City	Middleport	State	OH	Zip Code	45760
Email Address	froberts@village.middleport.oh.us	Phone Number	(740) 992-2827

Fiscal Officer

Complete the section below with information for the entity and individual serving as the fiscal agent for the project.

Fiscal Officer	Susan Baker	Title	Clerk
Mailing Address:	Address Line 1	659 Pearl Street			
	Address Line 2				
	City	Middleport	State	OH	Zip Code	45760
Email Address	clerk@village.middleport.oh.us	Phone Number	(740) 992-3037
Is your organization registered in OAKS as a vendor?	☐ Yes ☑ No		

Lead Applicant	Middleport Village	Round 3	
Project Name	Wastewater Treatment Plant Bio-Reactor/ElectroCell Feasibility Study	Type of	Grant

Single Applicant	
Is your organization applying as a single entity?	☑ Yes ☐ No
Participating Entity: (1 point) for single applicants	**1**

Collaborative Partners	
Does the proposal involve other entities acting as collaborative partners?	☐ Yes ☑ No

Applicants applying with a collaborative partner are required to show proof of the partnership with a partnership agreement signed by each partner and resolutions of support from the governing entities. If the collaborative partner does not have a governing entity, a letter of support from the partnering organization is sufficient. Include these documents in the supporting documents section of the application.

In the section below, applicants are required to identify population information and the nature of the partnership.

Each collaborative partner should also be clearly and separately identified on pages 4-5.

Number of Collaborative Partners who signed the partnership agreement, and provided resolutions of support.	0
Participating Entity: (5 points) allocated to projects with collaborative partners.	**0**

Population		
The applicant is required to provide information from the 2010 U.S. Census information, available at: http://factfinder2.census.gov/		
Does the applicant (or collaborative partner) represent a city, township or village with a population of less than 20,000 residents?	☑ Yes ☐ No	
	List Entity	
	Middleport	
	Municipality/Township	Population
	Municipality	2,530
Does the applicant (or collaborative partner) represent a county with a population of less than 235,000 residents?	☐ Yes ☑ No	
	List Entity	
	County	Population
Population: (3-5 points) determined by the smallest population listed in the application. Applications from (or collaborating with) small communities are preferred.	**5**	

Section 2 Collaborative Partners

Lead Applicant	Middleport Village	Round 3	
Project Name	Wastewater Treatment Plant Bio-Reactor/ElectroCell Feasibility Study	Type of Request	Grant

Nature of Partnership (2000 character limit)

As agreed upon in the partnership agreement, please identify the nature of the partnership, and explain how the main applicant and the partners will work together on the proposed project.

List of Partners

The applicant applying with collaborative partners (defined in §1.03 of the LGIF Policies) must include the following information for each applicant:

- **Name of collaborative partners**
- **Contact Information**
- **Population data (derived from the 2010 U.S. Census)**

If the project involves more than 12 collaborative partners, additional forms are available on the LGIF website.

Lead Applicant	Middleport Village	Round 3	
Project Name	Wastewater Treatment Plant Bio-Reactor/ElectroCell Feasibility Study	Type of Request	Grant

Collaborative Partners Number 1								
Address Line 1					Popuation			
Address Line 2					Municipality /Township		Population	
City		State		Zip Code	County		Population	
Email Address					Phone Number			
Resolution of Support	☐ Yes ☐ No				Signed Agreement	☐ Yes ☐ No		

Collaborative Partners Number 2								
Address Line 1					Population			
Address Line 2					Municipality /Township		Population	
City		State		Zip Code	County		Population	
Email Address					Phone Number			
Resolution of Support	☐ Yes ☐ No				Signed Agreement	☐ Yes ☐ No		

Collaborative Partners Number 3								
Address Line 1					Population			
Address Line 2					Municipality /Township		Population	
City		State		Zip Code	County		Population	
Email Address					Phone Number			
Resolution of Support	☐ Yes ☐ No				Signed Agreement	☐ Yes ☐ No		

Collaborative Partners Number 4								
Address Line 1					Population			
Address Line 2					Municipality /Township		Population	
City		State		Zip Code	County		Population	
Email Address					Phone Number			
Resolution of Support	☐ Yes ☐ No				Signed Agreement	☐ Yes ☐ No		

Lead Applicant	Middleport Village	Round 3	
Project Name	Wastewater Treatment Plant Bio-Reactor/ElectroCell Feasibility Study	Type of Request	Grant

Collaborative Partners Number 5								
Address Line 1					Population			
Address Line 2					Municipality /Township		Population	
City		State		Zip Code	County		Population	
Email Address					Phone Number			
Resolution of Support	☐ Yes ☐ No				Signed Agreement	☐ Yes ☐ No		

Collaborative Partners Number 6								
Address Line 1					Population			
Address Line 2					Municipality /Township		Population	
City		State		Zip Code	County		Population	
Email Address					Phone Number			
Resolution of Support	☐ Yes ☐ No				Signed Agreement	☐ Yes ☐ No		

Collaborative Partners Number 7								
Address Line 1					Population			
Address Line 2					Municipality /Township		Population	
City		State		Zip Code	County		Population	
Email Address					Phone Number			
Resolution of Support	☐ Yes ☐ No				Signed Agreement	☐ Yes ☐ No		

Collaborative Partners Number 8								
Address Line 1					Population			
Address Line 2					Municipality /Township		Population	
City		State		Zip Code	County		Population	
Email Address					Phone Number			
Resolution of Support	☐ Yes ☐ No				Signed Agreement	☐ Yes ☐ No		

Lead Applicant	Middleport Village	Round 3	
Project Name	Wastewater Treatment Plant Bio-Reactor/ElectroCell Feasibility Study	Type of Request	Grant

Collaborative Partners Number 9								
Address Line 1					Population			
Address Line 2					Municipality /Township		Population	
City		State		Zip Code	County		Population	
Email Address					Phone Number			
Resolution of Support	☐ Yes ☐ No				Signed Agreement	☐ Yes ☐ No		

Collaborative Partners Number 10								
Address Line 1					Population			
Address Line 2					Municipality /Township		Population	
City		State		Zip Code	County		Population	
Email Address					Phone Number			
Resolution of Support	☐ Yes ☐ No				Signed Agreement	☐ Yes ☐ No		

Collaborative Partners Number 11								
Address Line 1					Population			
Address Line 2					Municipality /Township		Population	
City		State		Zip Code	County		Population	
Email Address					Phone Number			
Resolution of Support	☐ Yes ☐ No				Signed Agreement	☐ Yes ☐ No		

Collaborative Partners Number 12								
Address Line 1					Population			
Address Line 2					Municipality /Township		Population	
City		State		Zip Code	County		Population	
Email Address					Phone Number			
Resolution of Support	☐ Yes ☐ No				Signed Agreement	☐ Yes ☐ No		

Lead Applicant	Middleport Village	Round 3	
Project Name	Wastewater Treatment Plant Bio-Reactor/ElectroCell Feasibility Study	Type of Request	Grant

Identification of the Type of Award	Feasibility Study
Targeted Approach	Efficiency

Project Description (4000 character limit)

Please provide a general description of the project. The information provided will be used for council briefings, program, and marketing materials.

In 2008 the Village of Middleport identified a three phase approach to make the village's wastewater utility sustainable. This three phase approach will allow the village to achieve the following goals:

(1) To produce a negative carbon footprint
(2) To produce renewable energy for the village's wastewater treatment plant
(3) To create permanent revenue source for the village's wastewater utility
(4) To meet future EPA nutrient removal guidelines for wastewater treatment plants

In 2009 the village completed the Solar Bee Project, the first phase in making the wastewater utility sustainable. The project installed four solar powered mixers in the village's wastewater lagoon system. The four solar powered mixers allowed the village to save approximately 1,016,000 kw-hr/yr of electric for a total of $60,900.00/yr at current prices.

The second phase in making the village's wastewater utility sustainable involves the installation of a hydro-generator in the wastewater treatment plant outfall. This project will create a renewable energy source which will supply electric for the wastewater treatment plant for 24 hours per day and approximately 320 days per year. By harnessing this untapped resource, the Village will be producing a portion of its own electricity and further reducing its carbon footprint.

The third phase in making the village's wastewater utility sustainable involves the conversion of one of its two 11.4 acre wastewater treatment plant lagoons into a bio-reactor. The bio-reactor will be used to grow algae that will be converted into commercial bio-fuel. The bio-fuel will be used to power an "ElectroCell" that will treat a portion of or all of a second lagoon to achieve stringent effluent standards and not require final effluent quality to be a function of the algae lagoon treatment capacity. If there is sufficient treatment through the algae / bio-cell system during dry and warm weather conditions, the bio-diesel can be sold and the revenues generated will be a permanent revenue source for the Village' wastewater utility. This phase will also complete the goal of creating a negative carbon footprint. The revenues from the sale of commercial bio-fuel or raw bio-algae will be used for wastewater utility operating expenses and much needed infrastructure improvements.

The third phase will also allow the village to meet Goal #4 relative to future EPA nutrient removal guidelines. By using bio-algae for nutrient removal, the village will be in compliance with strict new future rules at reduced cost to citizens of the Village of Middleport. The ElectroCell technology will utilize the high volume, low intensity mixing of the existing solar powered "Solar Bee Mixers" installed in the first phase of environmental compliance with energy reduction. The second lagoon will provide for complete mixing and reduce any stratification of the lagoon. The ElectroCell technology utilizes pumped flow from the second lagoon and treats the water through a square wave pulse of electricity that is powered from a generator being operated on the bio-diesel supplied from the algae. The ElectroCell technology is currently applied to agricultural applications such as manure lagoons and is certified by the Pennsylvania Department of Environmental Protection (DEP) as a nutrient credit technology. The technology is self contained, innovative and currently awaiting additional research and development for wider uses in the wastewater treatment technology.

The ElectroCell technology destroys harmful pathogens and releases oxygen into the second lagoon's wastewater. Additional costs will be saved by eliminating the requirement for chlorine addition to control

Lead Applicant	Middleport Village	Round 3	
Project Name	Wastewater Treatment Plant Bio-Reactor/ElectroCell Feasibility Study	Type of Request	Grant

Past Success	✓ Yes ☐ No
Past Success (5 points)	**5**

Provide a summary of past efforts to implement a project to improve efficiency, implement shared services, coproduction, or a merger. (1000 character limit)

In 2009 the village completed the Solar Bee Project, the first phase in making the wastewater utility sustainable. The project installed four solar powered mixers in the village's wastewater lagoon system. The four solar powered mixers allowed the village to save approximately 1,016,000 kw-hr/yr of electric for a total of $60,900.00/yr at current prices. The 1,016,000 kw-hr/yr in electric savings is equal to 92 homes or 115 cars and thereby reduced equivalent carbon dioxide emissions by about 697 tons per year.

Scalable/Replicable Proposal	☐ Scalable ✓ Replicable ☐ Both
Scalable/Replicable (10 points)	**5**

Provide a summary of how the applicant's proposal can be replicated by other local governments or scaled for the inclusion of other local governments. (1000 character limit)

The Bio-Reactor technology is currently being utilized at several facilities across the United States to produce bio-fuel for commercial sale. The ElectroCell technology is currently applied to agricultural applications such as manure lagoons, is certified by the Pennsylvania Department of Environmental Protection as a nutrient credit technology, and has been in operation in the Pennsylvania agricultural community since 2005.

It is anticipated that further evaluation and application of this technology will provide an innovative and cost effective tool in municipal and wastewater treatment. The technology is self contained, innovative and currently awaiting additional research and development for wider uses in the wastewater treatment technology.

See Algae Bio-Fuel Case Studies in Supporting Documents.

Probability of Success	✓ Yes ☐ No
Probability of Success (5 points)	**5**

Provide a summary of the likelihood of the grant study recommendations being implemented. Applicants requesting a loan should provide a summary of the probability of savings from the loan request. (1000 character limit)

Probability is high with the ElectroCell technology as a backup treatment system if the algae treatment efficiency is reduced due to temperature and reduced detention time due to the wet weather flows from a combined sewer system. Effluent compliance has a reasonable chance of success. The algae production of bio-diesel will be inhibited by temperature and the full biological treatment of combined sewer peak flows. The avoided cost of the environmental cost for compliance is significant and will allow the Village of Middleport to provide green technology at a reduced cost to the customers.

Lead Applicant	Middleport Village	Round 3	
Project Name	Wastewater Treatment Plant Bio-Reactor/ElectroCell Feasibility Study	Type of Request	Grant

Performance Audit Implementation/Cost Benchmarking	✓ Yes ☐ No
Performance Audit/Benchmarking (5 points)	5

If the project is the result of recommendations from a performance audit provided by the Auditor of State under Chapter 117 of the Ohio Revised Code or a cost benchmarking study, please attach a copy with the supporting documents. In the section below, provide a summary of the performance audit or cost benchmarking study. (1000 character limit)

Several facilities across the United States are being utilized to produce bio-fuel for commercial sale.

See Algae Bio-Fuel Case Studies in Supporting Documents.

Economic Impact	✓ Yes ☐ No
Economic Impact (5 points)	5

Provide a summary of how the proposal will promote a business environment (through a private business relationship) and/or provide for community attraction. (1000 character limit)

The project will allow the village to reduce utility costs, generate additional sewer utility revenue, and therefore charge affordable sewer utility rates to residents. Upon completion of the construction of the project, the bio-algae produced could be sold as bio-diesel, the agar part of the algae could be sold to cosmetic and animal feed manufacturers, and the final end product could be sold as fertilizer. The village anticipates being able to produce 15,000 gallons of bio-diesel per lagoon acre. The village will use one 11.4 acre lagoon for bio-diesel production and therefore anticipates producing 171,000 gallons of bio-diesel per year. Assuming a cost per gallon of only $2.00 the village would generate $342,000 of additional revenue per year. The village would also reduce the electric utility costs for the wastewater treatment plant by 16%. Currently the electric utility costs for the wastewater treatment plant are $3,028.76 per year and those would be reduced by $483.00 per year.

Response to Economic Demand	✓ Yes ☐ No
Response to Economic Demand (5 points)	5

Provide a summary of how the project responds to substantial changes in economic demand for local or regional government services. The narrative should include a description of the current service level. (1000 character limit)

Electric costs for the village have been increasing for several years due to increasing production and distribution costs to the electric provider who serves Middleport. The project will decrease electric costs to the village by using the ElectroCell technology to generate a portion of the electric required by the treatment plant and reduce electric utility costs by 16.0%.

Budget Information

General Instructions

•Both the Project Budget and Program Budgets are required to be filled out in this form.

•Consolidate budget information to fit in the form. Additional budget detail may be provided in the budget narrative or in an attachment in Section 5: Supplemental Information.

Project Budget:

- The Project Budget justification must be explained in the Project Budget Narrative section of the application. This section is also used to explain the reasoning behind any items on the budget that are not self explanatory, and provide additonal detail about project expenses.
- The Project Budget should be for the period that covers the entire project. The look-back period for in-kind contributions is two (2) years. These contributions are considered a part of the total project costs.
- For the Project Budget, indicate which entity and revenue source will be used to fund each expense. This information will be used to help determine eligible project expenses.
- Please provide documentation of all in-kind match contributions in the supporting documents section. For future in-kind match contributions, supporting documentation will be provided at a later date.

Program Budget:

- Six (6) years of Program Budgets should be provided. The standard submission should include three years previous budgets (actual), and three years of projections including implementation of the proposed project. A second set of three years of projections (one set including implementation of this program, and one set where no shared services occurred) may be provided in lieu of three years previous if this does not apply to the proposed project.
- Please use the Program Budget Narrative section to explain any unusual activities or expenses, and to defend the budget projections. If the budget requires the combining of costs on the budget template, please explain this in the narrative.

Return on Investment:

- A Return on Investment calculation is required, and should reference cost savings, cost avoidance and/or increased revenues indicated in the budget projection sections of the application. Use the space designated for narrative to justify this calculation, using references when appropriate.

For Loan Applications only:

- Using the space provided, outline a loan repayment structure.
- Attach three years prior financial documents related to the financial health of the lead applicant (balance sheet, income statement, and a statement of cash flows).

Lead Applicant	Middleport Village	Round 3	
Project Name	Wastewater Treatment Plant Bio-Reactor/ElectroCell Feasibility	Type of Request	Grant

Project Budget

Sources of Funds

LGIF Request:	$90,000
Cash Match (List Sources Below):	
Source:	
Source:	
Source:	
Source:	
In-Kind Match (List Sources Below):	
Source: Village	$10,000
Source:	
Source:	
Total Match:	$10,000
Total Sources:	$100,000

Uses of Funds

	Amount	Revenue Source
Consultant Fees:	$100,000	LGIF, In-Kind Match
Legal Fees:		
Other:		
Other:		
Other:		
Other:		
Other:		
Other:		
Other:		
Other:		
Total Uses:	$100,000	
Local Match Percentage:	10.00%	

* Please note that this match percentage will be included in your grant/loan agreement and cannot be changed after awards are made.

Local Match Percentage = (Match Amount/Project Cost) * 100 (10% match required)

☑ 10-39.99% (1 point) ☐ 40-69.99% (3 points) ☐ 70% or greater (5 points)

Project Budget Narrative: Use this space to justify expenses (1200 character max).

Section 4 Financial Information

Lead Applicant	Middleport Village	Round 3	
Project Name	Wastewater Treatment Plant Bio-Reactor/ElectroCell Feasibility Study	Type of Request	Grant

Program Budget

Actual ✓ Projected	FY 2009	FY 2010	FY 2011
Expenses	**Amount**	**Amount**	**Amount**
Salary and Benefits	$216,438	$269,065	$273,667
Contract Services	$94,629	$87,450	$79,364
Occupancy (rent, utilities, maintenance)			
Training and Professional Development			
Insurance			
Travel			
Capital and Equipment Expenses	$0	$223,802	$233,595
Supplies, Printing, Copying, and Postage	$88,764	$108,484	$76,917
Evaluation			
Marketing			
Conferences, meetings, etc.			
Administration			
***Other -** Debt Payments	$61,764	$94,875	$92,066
***Other -**			
***Other -**			
TOTAL EXPENSES	$461,595	$783,676	$755,609
	Revenues	**Revenues**	**Revenues**
Contributions, Gifts, Grants, and Earned Revenue			
Local Government: Charges for Services	$405,192	$429,011	$466,812
Local Government: Miscellaneous	$0	$175	$0
Local Government:			
State Government	$25,000	$232,295	$212,089
Federal Government			
**Other -*			
**Other -*			
**Other -*			
Membership Income			
Program Service Fees			
Investment Income			
TOTAL REVENUES	$430,192	$661,481	$678,901

Lead Applicant	Middleport Village	Round 3	
Project Name	Wastewater Treatment Plant Bio-Reactor/ElectroCell Feasibility Study	Type of Request	Grant

Program Budget

Actual ☐ Projected ✓	FY 2012	FY 2013	FY 2014
Expenses	**Amount**	**Amount**	**Amount**
Salary and Benefits	$294,230	$318,886	$346,023
Contract Services	$80,158	$82,563	$84,557
Occupancy (rent, utilities, maintenance)			
Training and Professional Development			
Insurance			
Travel			
Capital and Equipment Expenses	$100,000	$2,500,000	$0
Supplies, Printing, Copying, and Postage	$77,686	$80,017	$82,418
Evaluation			
Marketing			
Conferences, meetings, etc.			
Administration			
***Other -** Debt	$111,813	$111,813	$95,088
***Other -** New Debt (OWDA Loan)			$111,625
***Other -**			
TOTAL EXPENSES	$663,887	$3,093,279	$719,711
	Revenues	**Revenues**	**Revenues**
Contributions, Gifts, Grants, and Earned Revenue			
Local Government: Charges for Services	$480,816	$495,241	$510,098
Local Government: Sale of Bio-Fuel			$342,000
Local Government:			
State Government			
Federal Government			
**Other -* LGIF	$90,000		
**Other -* OWDA		$2,500,000	
**Other -*			
Membership Income			
Program Service Fees			
Investment Income			
TOTAL REVENUES	$570,816	$2,995,241	$852,098

Lead Applicant	Middleport Village	Round 3	
Project Name	Wastewater Treatment Plant Bio-Reactor/ElectroCell Feasibility Study	Type of Request	Grant

Program Budget

Use this space to justify the program budget and/or explain any unusual revenues or expenses (6000 characters max).

-Salary and Benefits assumes 11% annual increase for 2012 thru 2014
-Contract Services assumes 1% annual increase for 2012 thru 2014 and 16% reduction in electrical costs for the wastewater treatment plant
-Supplies assumes 1% annual increase for 2012 thru 2014
-Capital Expenses include $100,000 feasibility study cost in 2012 and $2,500,000 in construction expenses for Bio-Reactor/ElectroCell Project in 2013
-New debt payment is for OWDA construction loan for Bio-Reactor/ElectroCell Project
-Charges for Services assumes 3% annual increase for 2012 thru 2014
-Other revenue includes $90,000 LGIF in 2012 and $2,500,000 in OWDA construction loan financing for Bio-Reactor/ElectroCell Project in 2013
-Sale of bio-fuel assumes production of 15,000 gallons per acre (11.4 acre lagoon), so 171,000 gallons per year at $2.00 per gallon

*See 2009-2016 Past Financial Data and Financial Projections spreadsheet in Supporting Documentation.

Section 4: Financial Information Scoring

- [x] (5 points) Applicant provided complete and accurate budget information and narrative justification for a total of six fiscal years.
- [ ] (3 points) Applicant provided complete and accurate budget information and for at least three fiscal years.
- [ ] (1 point) Applicant provided complete and accurate budget information for less than three fiscal years.

Lead Applicant	Middleport Village	Round 3	
Project Name	Wastewater Treatment Plant Bio-Reactor/ElectroCell Feasibility Study	Type of Request	Grant

Return On Investment

Return on Investment is a performance measure used to evaluate the efficiency of an investment. To derive the expected return on investment, divide the net gains of the project by the net costs. For these calculations, please use the implementation gains and costs, NOT the project costs (the cost of the feasibility, planning, or management study)--unless the results of this study will lead to direct savings without additional implementation costs. The gains from this project should be derived from the prior and future program budgets provided, and should be justified in the return on investment narrative.

Return on Investment Formulas:

Consider the following questions when determining the appropriate ROI formula for the project. Check the box of the formula used to determine the ROI for the project. These numbers should refer to savings/revenues illustrated in projected budgets.

Do you expect cost savings from efficiency from the project?

☐ Use this formula: $\frac{\text{Total \$ Saved}}{\text{Total Program Costs}} * 100 = \text{ROI}$

Do you expect cost avoidance from the implementation of the project/program?

☐ Use this formula: $\frac{\text{Total Cost Avoided}}{\text{Total Program Costs}} * 100 = \text{ROI}$

Do you expect increased revenues as a result of the project/program?

☑ Use this formula: $\frac{\text{Total New Revenue}}{\text{Total Program Costs}} * 100 = \text{ROI}$

Expected Return on Investment = $\frac{\$342{,}000}{\$111{,}625} * 100 =$ 306.38%

Return on Investment Justification Narrative: In the space below, briefly describe the nature of the expected return on investment, using references when appropriate. (1300 character limit)

Total Program Costs represents annual debt payment for OWDA Construction Loan ($111,625) and Total New Revenue represents annual sale of bio-fuel ($342,000). Return on investment does not include 16.0% annual savings in electric at wastewater treatment plant.

Expected Return on Investment is:

☐ Less than 25% (10 points) ☐ 25%-74.99% (20 points) ☑ Greater than 75% (30 points)

Questions about how to calculate ROI? Please contact the Office of Redevelopment at 614-995-2292 or lgif@development.ohio.gov

Section 4 Financial Information

Lead Applicant	Middleport Village	Round 3	
Project Name	Wastewater Treatment Plant Bio-Reactor/ElectroCell Feasibility Study	Type of Request	Grant

Loan Repayment Structure

Please outline the preferred loan repayment structure. At a minimum, please include the following: the entities responsible for repayment of the loan, all parties responsible for providing match amounts, and an alternative funding source (in lieu of collateral). Applicants will have two years to complete the project upon execution of the loan agreement, and the repayment period will begin upon the final disbursement of the loan funds. A description of expected savings over the term of the loan may be used as a repayment source.

Applicant demonstrates a viable repayment source to support loan award. Secondary source can be in the form of a debt reserve, bank participation, a guarantee from a local entity, or other collateral (i.e. emergency, rainy day, or contingency fund, etc).

☐ Applicant clearly demonstrates a secondary repayment source (5 points)

☐ Applicant does not have a secondary repayment source (0 points)

Lead Applicant	Middleport Village	Round 3	
Project Name	Wastewater Treatment Plant Bio-Reactor/ElectroCell Feasibility Study	Type of Request	Grant

Scoring Overview

Section 1: Collaborative Measures

Collaborative Measures	Description	Max Points		Applicant Self Score
Population	Applicant's population (or the population of the area(s) served) falls within one of the listed categories as determined by the U.S. Census Bureau. Population scoring will be determined by the **smallest** population listed in the application. Applications from (or collaborating with) small communities are preferred.	**5**		5
Participating Entities	Applicant has executed partnership agreements outlining all collaborative partners and participation agreements and has resolutions of support. (Note: Sole applicants only need to provide a resolution of support from its governing entity.	5		1

Section 2: Success Measures

Past Success	Applicant has successfully implemented, or is following project guidance from a shared services model, for an efficiency, shared service, coproduction or merger project in the past.	**5**		5
Scalable/Replicable Proposal	Applicant's proposal can be replicated by other local governments or scaled for the inclusion of other local governments.	**10**		5
Probability of Success	Applicant provides a documented need for the project and clearly outlines the likelihood of the need being met.	**5**		5

Section 3: Significance Measures

Performance Audit Implementation/Cost Benchmarking	The project implements a single recommendation from a performance audit provided by the Auditor of State under Chapter 117 of the Ohio Revised Code or is informed by cost benchmarking.	**5**		5
Economic Impact	Applicant demonstrates the project will a promote business environment (i.e., demonstrates a business relationship resulting from the project) and will provide for community attraction (i.e., cost avoidance with respect to taxes)	**5**		5
Response to Economic Demand	The project responds to current substantial changes in economic demand for local or regional government services.	**5**		5

Section 4: Financial Measures

Financial Information	Applicant includes financial information (i.e., service related operating budgets) for the most recent three years and the three year period following the project. The financial information must be directly related to the scope of the project and will be used as the cost basis for determining any savings resulting from the project.	**5**		5
Local Match	Percentage of local matching funds being contributed to the project. This may include in-kind contributions.	5		1
Expected Return	Applicant demonstrates as a percentage of savings (i.e., actual savings, increased revenue, or cost avoidance) an expected return. The return must be derived from the applicant's cost basis.	**30**		30
Repayment Structure (Loan Only)	Applicant demonstrates a viable repayment source to support loan award. Secondary source can be in the form of a debt reserve, bank participation, a guarantee from a local entity, or other collateral (i.e., emergency fund, rainy day fund, contingency fund, etc.).	5		0
			Total Points	72

Village of Middleport Wastewater Treatment Plant Bio-Reactor BUDGET	
Sources of Funds	**Amount**
LGIF Request	$ 90,000
Match Contribution (10%)	$ 10,000
Total	$ 100,000
Uses of Funds	**Amount**
Consultant Fees for Study	$ 100,000
Total	**$ 100,000**

HAZEN AND SAWYER
Environmental Engineers & Scientists

11311 Cornell Park Drive, Suite 135
Cincinnati, OH 45242
513 469-2750
513 469-2751 Fax

September 4, 2012

Faymon Roberts
Village Administrator
Village of Middleport
237 Race Street
Middleport, Ohio 45760

RE: Wastewater Treatment Plant Bio-Reactor
Engineering Services

Dear Mr. Roberts,

As we discussed by phone, this letter outlines a proposed fee for the feasibility study, preliminary design and final design for the Wastewater Treatment Plant Bio-Reactor project. The purpose of the study will be to determine feasible options for development of an Energy Efficiency Strategy for the Village of Middleport. Our fee estimate is based on our current knowledge of the project, which is still in the conceptual stage at the present time. We would propose a fee of $100,000 for the feasibility study and a fee of $600,000 for the preliminary and final design. We anticipate a 12 month schedule for the feasibility study and a 14 month schedule for preliminary and final design. The schedule includes the following milestones:

Milestone	Duration	Fee
Feasibility Study	12 Months	$100,000
Preliminary Engineering Report	4 Months	$175,000
30% Design Review	3 Months	$127,500
60% Design Review	3 Months	$127,500
90% Design Review	3 Months	$127,500
100% Design Review	1 Month	$ 42,500
Total	**30 Months**	**$700,000**

The above schedule is predicated on receiving Notice to Proceed on October 15, 2012 with completion of the feasibility study by October 2013. Once the feasibility study is completed, a detailed scope of work can be developed and the above fee estimates can be modified to reflect the scope change.

We appreciate the opportunity to assist the Village in securing funding for this project and look forward to working with the Village.

If you have any questions or need additional information, please let us know.

Very truly yours,

HAZEN AND SAWYER, P.C.

Edward J. Brown

Edward J. Brown, P.E.
Project Manager

Village of Middleport
Wastewater Treatment Plant Bio-Reactor
Feasibility Study
Fee Estimate - February 29, 2012

Task	Description	Cost
1	Middleport Effluent Compliance and Cost - Baseline Information Characterization of Existing Collection System and Lagoon System Characterize Influent flow loadings and temperatures Establish Utility Baseline Costs Establish Anticipated flows and loadings Following Collection Upgrade	$10,000
2	Confirm Project Rationale and Application of Key Process Objectives	$5,000
3	Feasibility of Algae Bio-Diesel for Energy and Nutrient Compliance State of Knowledge/Supporting Research Site visits and technology assessment for Middleport application Alternative selective matrix Bench scale analysis Pilot testing Establish Design considerations for Middleport Full scale potential of technology in Middleport Application	$30,000
4	Feasibility of ElectroCell for Energy Requirements and Effluent Polishing State of Knowledge/Supporting Research Site visits and technology assessment for Middleport application Alternative selective matrix Bench scale analysis Pilot testing Establish Design considerations for Middleport Full scale potential of technology in Middleport Application	$30,000
5	Nutrient Compliance Apply pilot testing to full scale performance Determine algae performance reduction and polishing requirements Establish ElectroCell Effluent polishing requirements	$10,000
6	Return on Investment Pilot data with existing utility cost offset Potential for revenue generation	$5,000
7	Final Report	$10,000
	Total	**$100,000**

Village Offices

237 Race Street
Middleport, OH 45760

April 26, 2012

Ohio Department of Development
77 S. High Street
P.O. Box 1001
Columbus, OH 43216-1001

To Whom It May Concern:

I, the Fiscal Officer for the Village of Middleport, do hereby certify the Village of Middleport will provide 10% of the cost of the feasibility study, or $10,000.00 in local matching funds to potential Local Government Innovation Funds.

Sincerely,

Susan Baker

Susan Baker
Fiscal Officer

Linda S. Broderick

Linda S. Broderick, Notary Public, State of Ohio
My Commission Expires 05-15-2016
Recorded in Meigs County

RESOLUTION NO. 78-12

A RESOLUTION SUPPORTING THE WASTEWATER TREATMENT PLAN BIO-REACTOR FEASIBILITY STUDY PROJECT AND THE VILLAGE'S APPLICATION TO THE OHIO DEPARTMENT OF DEVELOPMENT FOR FUNDING FROM THE LOCAL GOVERNMENT INNOVATION FUND.

WHEREAS, the Village of Middleport seeks to study the feasibility of constructing a bio-reactor at the existing wastewater treatment plant; and,

WHEREAS, THE VILLAGE OF Middleport intends to apply for Local Government Innovation Fund financing for the feasibility study; and

WHEREAS, The Village of Middleport feels that the project has the potential to create a new source of revenue for the village; now, therefore,

BE IT RESOLVED, by the Council of the Village of Middleport, Ohio:

SECTION I: That the Village Administrator of the Village of Middleport be and is hereby authorized to apply for Local Government Innovation Fund financing for the project on behalf of the village of Middleport, Ohio.

SECTION II: That the Village of Middleport intends to provide 10% of the cost of the feasibility study, or $10,000.00, in local matching funds to the Local Government Innovation Fund financing potentially awarded.

SECTION III. That the dedicated source of payment of the 10%/or $10,000.00 match will be Sewer Capital Improvement funds.

SECTION IV. That this resolution shall take effect and be in force from and after the earliest period allowed by law.

Approved this 27th day of February 2012. Vote: Yeas 6 Nays 0

APPROVED: _____
Mayor

ATTEST: _____
Fiscal Officer

PAST FINANCIAL DATA AND FINANCIAL PROJECTIONS
MIDDLEPORT VILLAGE SEWER UTILITY

	Last Three (3) Years			Bio-Reactor/ElectroCell Planning/Design	Bio-Reactor/ElectroCell Construction	First Full Year		
Rates	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Minimum Bill (2,000 Gal)	$ 18.38	$ 23.67	$ 26.63	$ 27.42	$ 28.24	$ 29.09	$ 29.96	$ 30.86
Volume Rate (Per 1,000)	$ 4.97	$ 6.40	$ 7.20	$ 7.40	$ 7.62	$ 7.85	$ 8.09	$ 8.33
Residental Rate (4,500 Gal)	$ 30.81	$ 39.67	$ 44.63	$ 45.92	$ 47.30	$ 48.72	$ 50.18	$ 51.68
Rate Adjustment		28.8%	12.5%	3.0%	3.0%	3.0%	3.0%	3.0%
Median Household Income	$ 26,016.00	$ 26,016.00	$ 26,016.00	$ 26,016.00	$ 26,016.00	$ 26,016.00	$ 26,016.00	$ 26,016.00
Affordability Index	1.4%	1.8%	2.1%	2.1%	2.2%	2.2%	2.3%	2.4%
Cash Balance	$ 282,352	$ 160,157	$ 83,948	$ (9,123)	$ (107,161)	$ 25,226	$ 138,507	$ 229,962
Revenues	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Charges for Services [1]	$ 405,192	$ 429,011	$ 466,812	$ 480,816	$ 495,241	$ 510,098	$ 525,401	$ 541,163
Miscellaneous	$ -	$ 175	$ -	$ -	$ -	$ -	$ -	$ -
Other Financing Sources [2]	$ 25,000	$ 232,295	$ 212,089	$ 90,000	$ 2,500,000	$ -	$ -	$ -
BioFuel [3]	$ -	$ -	$ -	$ -	$ -	$ 342,000	$ 342,000	$ 342,000
Total Revenues	**$ 430,192**	**$ 661,481**	**$ 678,901**	**$ 570,816**	**$ 2,995,241**	**$ 852,098**	**$ 867,401**	**$ 883,163**
Expenses	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Personal Services [4]	$ 131,994	$ 160,988	$ 178,256	$ 197,865	$ 219,630	$ 243,789	$ 270,606	$ 300,373
Employee Fringe Benefits [5]	$ 84,444	$ 108,077	$ 95,411	$ 96,365	$ 99,256	$ 102,234	$ 105,301	$ 108,460
Contractual Services [6]	$ 94,629	$ 87,450	$ 79,364	$ 80,158	$ 82,563	$ 84,557	$ 86,610	$ 88,726
Supplies and Materials [7]	$ 88,764	$ 108,484	$ 76,917	$ 77,686	$ 80,017	$ 82,418	$ 84,890	$ 87,437
Capital Outlay [8]		$ 223,802	$ 233,595	$ 100,000	$ 2,500,000	$ -	$ -	$ -
Debt Payments	$ 61,764	$ 94,875	$ 92,066	$ 111,813	$ 111,813	$ 95,088	$ 95,088	$ 95,088
New Debt Payment [9]	$ -	$ -	$ -	$ -	$ -	$ 111,625	$ 111,625	$ 111,625
Total Expenses	$ 461,595	$ 783,676	$ 755,610	$ 663,887	$ 3,093,279	$ 719,710	$ 754,120	$ 791,708
Net Cash Position	**$ (31,403)**	**$ (122,195)**	**$ (76,709)**	**$ (93,071)**	**$ (98,038)**	**$ 132,388**	**$ 113,281**	**$ 91,455**

[1] Assumes 3% annual increase for 2012 thru 2016

[2] Assumes $90,000 LGIF planning grant in 2012 and $2,500,000 in OWDA construction loan financing for Bio-Reactor/ElectroCell Project in 2013

[3] Assumes production of 15,000 gallons per acre (11.4 acre lagoon), so 171,000 gallons per year at $2.00 per gallon

[4] Assumes 11% annual increase for 2012 thru 2016

[5] Assumes 1% annual increase for 2012 thru 2016

[6] Assumes 1% annual increase for 2012 thru 2016 and 16% reduction in electrical costs for the wastewater treatment plant

[7] Assumes 1% annual increase for 2012 thru 2016

[8] Includes $100,000 feasibility study cost in 2012 and $2,500,000 in construction expenses for Bio-Reactor/ElectroCell Project in 2013

[9] New debt payment for OWDA construction loan for Bio-Reactor/ElectroCell Project

Biofuels from Wastewater: State of the Industry

Fernando Sarmiento, P.E.
fsarmiento@greeley-hansen.com; 602-778-8475

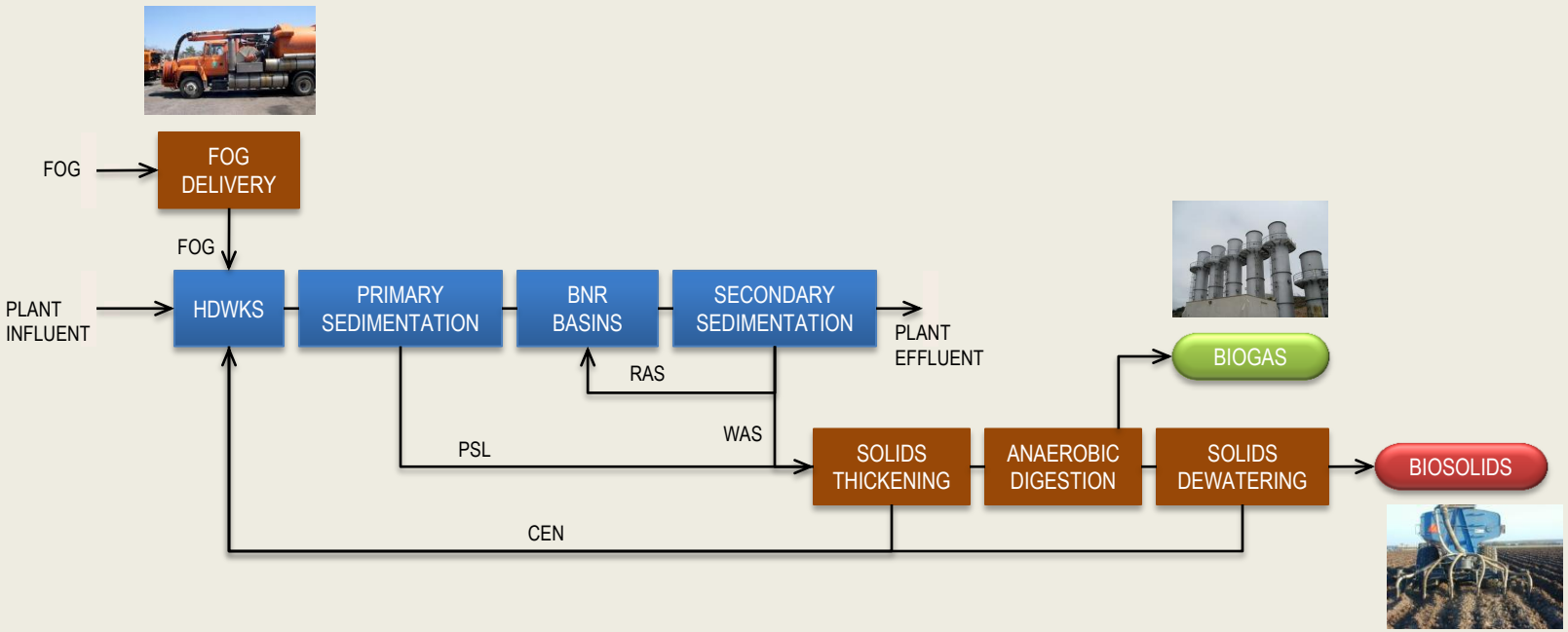
August 31, 2011

GREELEY AND HANSEN

Presentation Overview

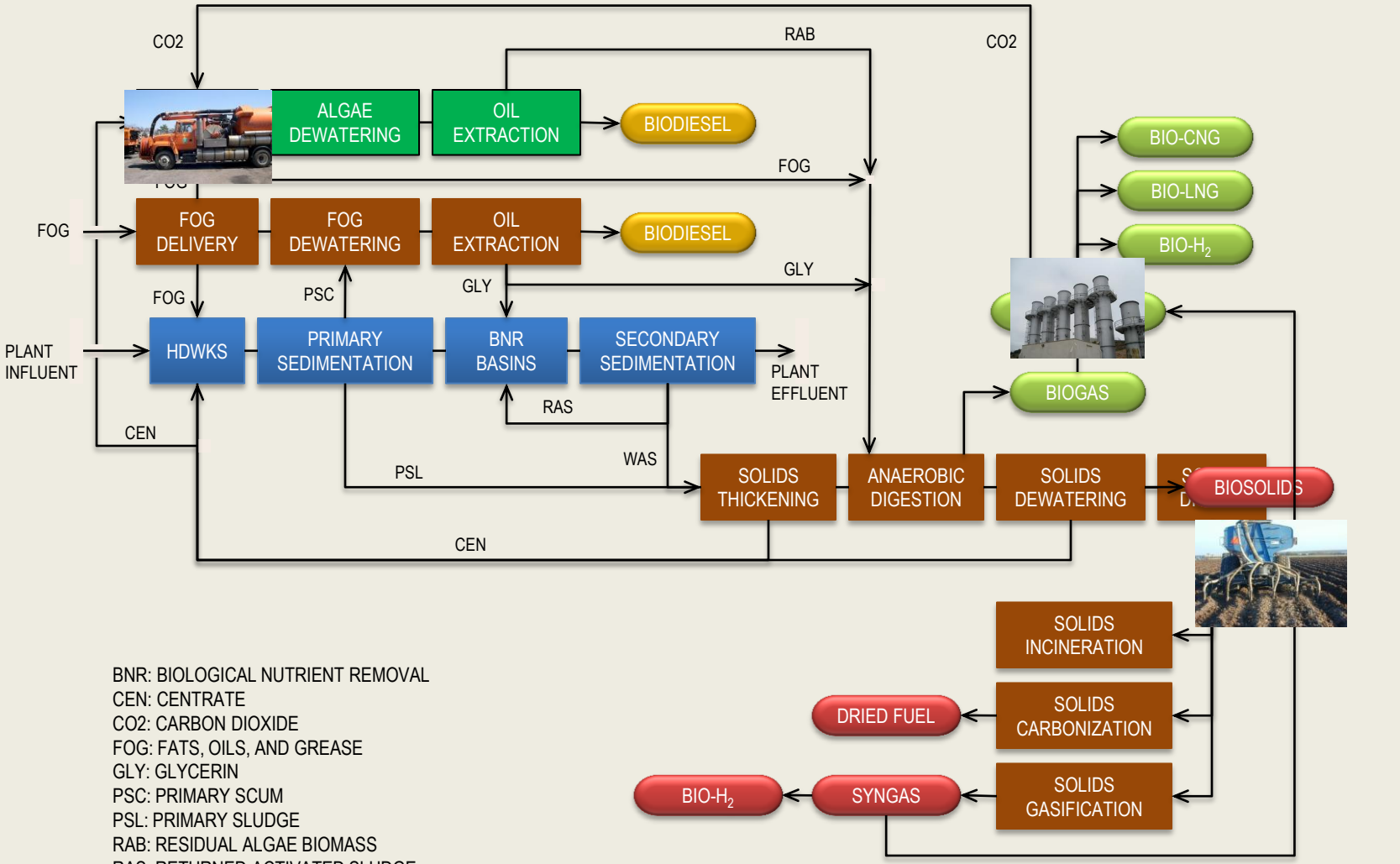
- Wastewater Treatment Plant
  - Conventional
  - Future
- Biofuels from Wastewater
  - Biogas (Digester Gas)
  - Biosolids (Dried Solids)
  - Biodiesel (FOG and Algae)
- Summary

Conventional WWTP



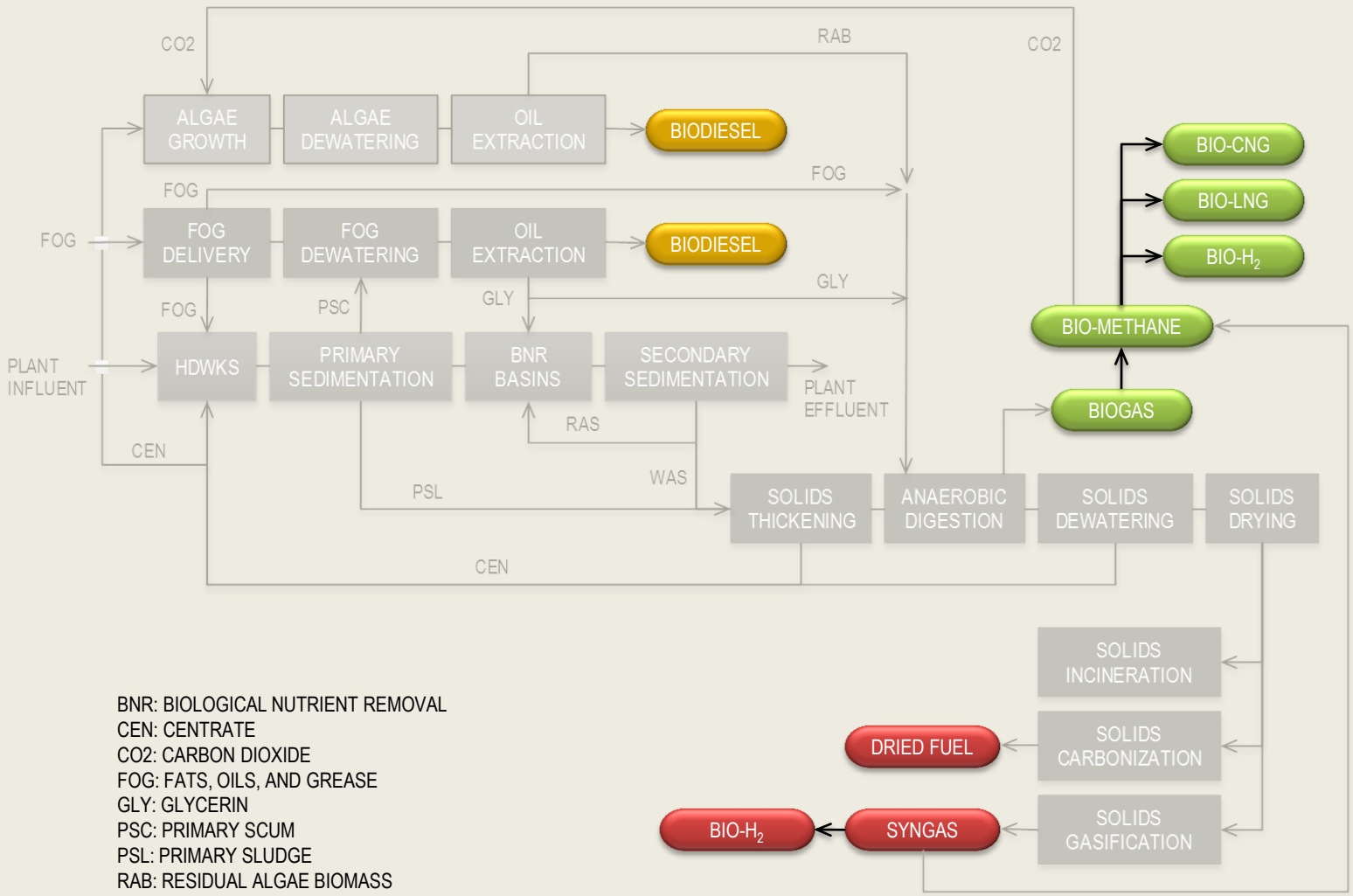
BNR: BIOLOGICAL NUTRIENT REMOVAL
CEN: CENTRATE
FOG: FATS, OILS, AND GREASE
PSL: PRIMARY SLUDGE
RAS: RETURNED ACTIVATED SLUDGE
WAS: WASTE ACTIVATED SLUDGE

Future WWTP…



BNR: BIOLOGICAL NUTRIENT REMOVAL
CEN: CENTRATE
CO2: CARBON DIOXIDE
FOG: FATS, OILS, AND GREASE
GLY: GLYCERIN
PSC: PRIMARY SCUM
PSL: PRIMARY SLUDGE
RAB: RESIDUAL ALGAE BIOMASS
RAS: RETURNED ACTIVATED SLUDGE
WAS: WASTE ACTIVATED SLUDGE

Future WWTP…



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RAS: RETURNED ACTIVATED SLUDGE
WAS: WASTE ACTIVATED SLUDGE

Biofuels from Wastewater

- Dried Fuel
- Syngas
- Bio-Hydrogen

Dried Solids

WWTP Biofuels

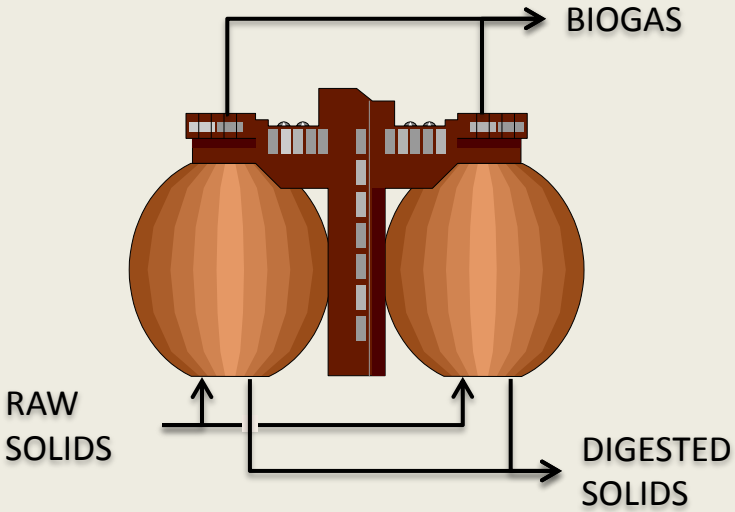
- Bio-Methane
- Bio-CNG
- Bio-LNG
- Bio-Hydrogen

Biogas

Biodiesel

- FOG-Based
- Algae-Based

Biogas – Background/Relevance



Anaerobic Digestion

Biodegradation of Volatile Content in Raw Solids

Biogas

CH_4: 60-65%

CO_2: 35-40%

<u>Traditional Uses</u>

- Flaring
- Process/Space Heating
- Power Generation
- Co-Generation (CHP)

Biogas – Background/Relevance

Biogas Heating Value	600 BTU/CF
Natural Gas (NG) Heating Value	1,000 BTU/CF
Typical WWTP Biogas Generation	1.0 CF/person/day
Typical Biogas Power Generation	2.2 watts/person

544 WWTPs > 5 MGD; w/ Anaerobic Digestion → 340 MW Potential Electricity Generation → 2.3M Tons CO_2 Annual Emissions Offset = 640,000 Acres of Forest

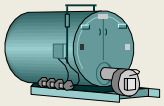
= 430,000 Cars CO_2 Emissions

Source: EPA Combined Heat and Power Partnership (CHPP), 2007

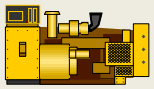
Biogas – What We Know

Traditional Uses

Flaring

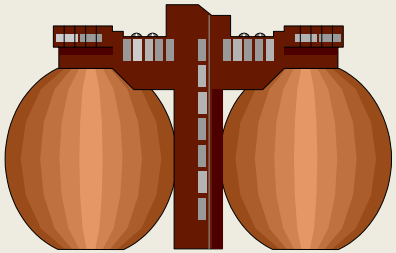


Heating



Co-Generation

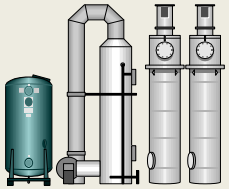
Anaerobic Digestion



BIOGAS

60-65% CH_4
35-40% CO_2
H_2S, Water,
Siloxanes

Biogas Cleaning



BIO-METHANE

95-98% CH_4

NG Pipeline Injection

Vehicle Fuel Use

- Liquid Scrubbing
- Granular Media Adsorption
- Iron Exchange
- Pressure Swing Adsorption (PSA)
- Membrane Separation

Uses Gaining Attention

NG Pipeline Injection

- United States
  - Standards Determined by Utility Owning NG Pipeline
  - Growing Interest Driven by Renewable Energy Credits and Self-Generation Incentives
- Europe
  - National Standards on Pipeline Quality Gas
  - Bio-Methane Injection Into NG Grid: 25% Annual Market Growth

Vehicle Fuel Use

BIO-METHANE

95-98% CH_4
NG Quality

GGE=Gasoline Gallon Equivalent

BIO-CNG

2,500-5,000 psig
Storage/Fueling Facilities
Vehicle Conversion
GGE = 127 CF CNG

BIO-LNG

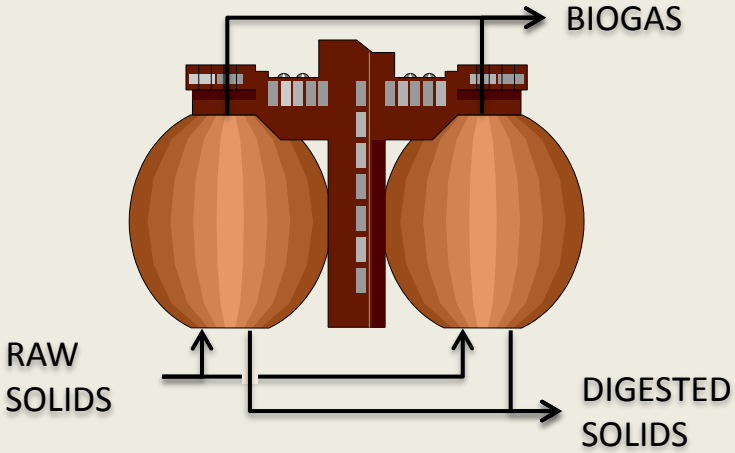
Cryogenic Process
Costs More to Produce
More Complex/Expensive Vehicles
GGE = 1.5 gallons LNG

- United States
  - No Known WWTP Bio-Methane Used as Vehicle Fuel
  - Five Known Landfills Using Bio-Methane to Fuel their Fleets
- Europe
  - Kristiantad, Sweden: About 340,000 CF/day of Bio-Methane Used as Vehicle Fuel in Public and School Buses
  - Lille Metropolis, France: Over 400 Bio-Methane Fueled Buses

Biogas – Future Directions

- Need to Better Understand Biogas Cleaning Technologies
  - Process Reliability
  - Relative Effectiveness
  - Treatment Costs
- More Work Required to Evaluate Vehicle Emissions When Using Bio-Methane
- Regional Initiatives
- Include Biogas as Renewable Energy Option in Federal and State Policies
  - Financing and Incentive Programs
  - Improved Public Perception and Awareness

Dried Solids – Background/Relevance



Raw Solids

Primary Sludge
Waste Activated Sludge

About 80% of Energy in Plant Wastewater Influent

Biosolids (Digested Solids)

Stabilized Solids (Pathogen and Vector Attraction Reduction)

About 45% of Energy in Plant Wastewater Influent

Wastewater Solids:
0.1-0.2 lb/person/day ➡ 7,100,000 dry tons/year

Source: EPA, 2004

Dried Solids – Background/Relevance

Dried Raw Solids Heating Value	8,000 BTU/lb
Dried Digested Solids Heating Value	4,500 BTU/lb
Coal Heating Value	10,000-15,000 BTU/lb

31 kWh
Ave Daily
Energy Use
per Home

⟷

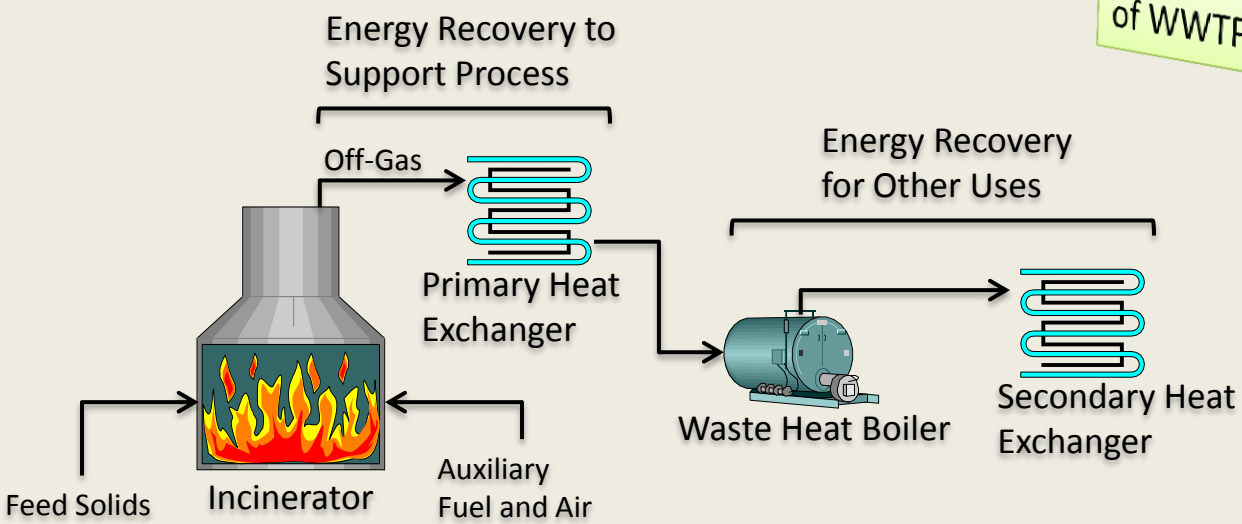
13 lbs
Biosolids
Energy
Equivalent

Source: Renewable Energy Resources: Banking on Biosolids, NACWA, 2010

Dried Solids – What We Know

Solids Incineration

Used by About 22% of WWTPS



Process Features

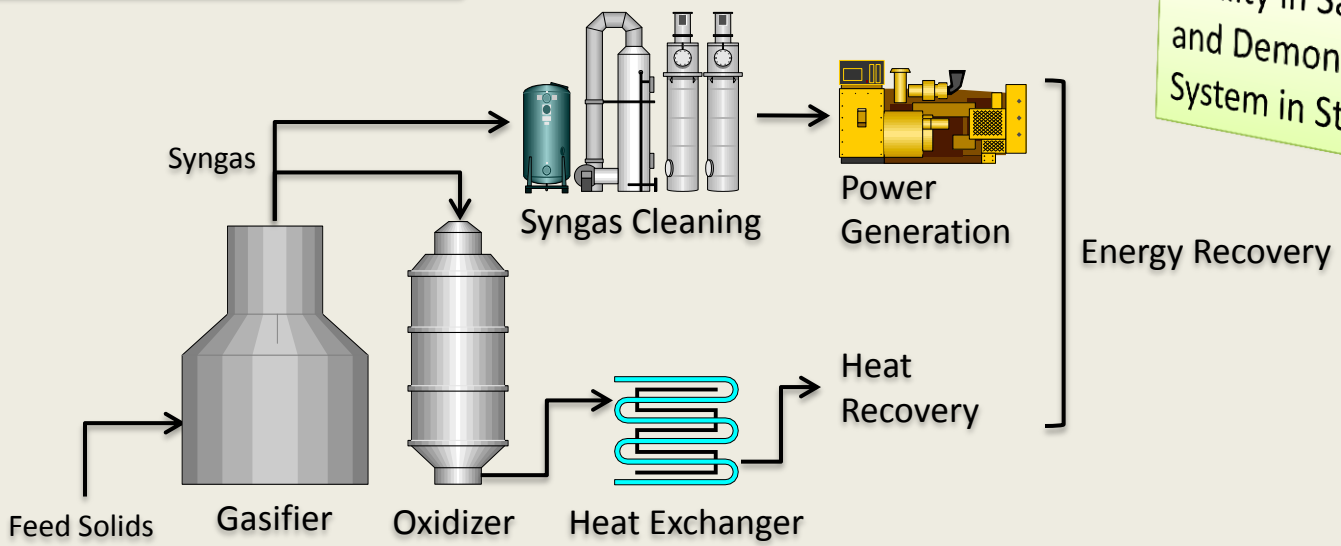
- Combustion with Excess Air
- Forms CO_2, Water, and Ash
- Significant Mass Reduction

Energy Recovery

- Heat Recovered from Off-Gas
- Support Process (Air Pre-Heating)
- Process/Space Heating Needs
- Power Generation (Steam Turbines)

Dried Solids – What We Know

Solids Gasification



Facility in Sanford, FL and Demonstration System in Stamford, CT

Process Features

- Oxygen-Starved Conditions
- High Temperatures (~1500 ^{o}F)
- Forms Syngas (Synthetic Gas)
- Syngas: CO and H_2

Energy Recovery

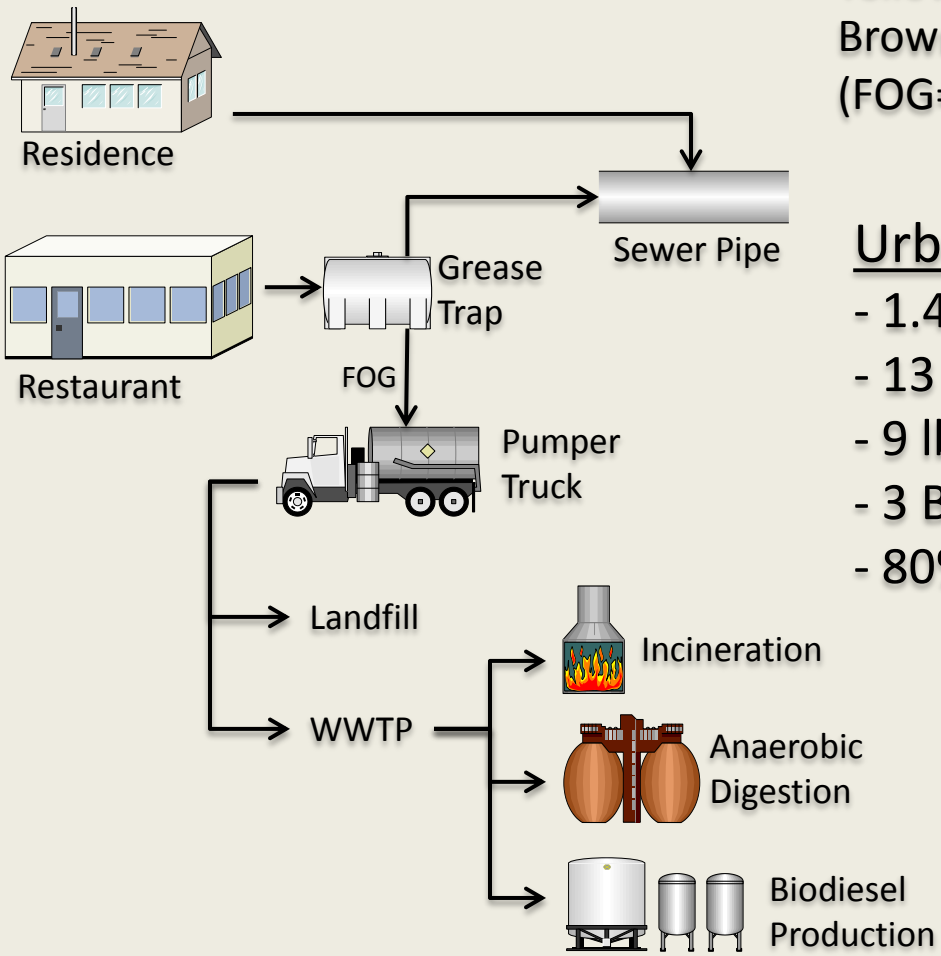
- Heat Recovery from Syngas Oxidation
- Process/Space Heating Needs
- Syngas Cleaning/Power Generation
- Early Stages of Implementation

Dried Solids – Future Directions

- Solids-to-Energy Likely to be Enhanced by
  - Development of Inter-Utility Partnerships for Implementation of Regional Facilities
  - Policies on Distributed Renewable Energy and Energy Recovery Projects
  - Rise of Industrial Energy Prices
- Development of Successful Track Record for Currently Operating Systems
- Include Biosolids as Renewable Energy Option in Federal and State Policies
  - Financing and Incentive Programs
  - Improved Public Perception and Awareness

Biodiesel – Background/Relevance

FOG-Based Biodiesel



Yellow Grease: Used Frying Oils
Brown Grease: FOG from Grease Traps
(FOG=Fats, Oils, and Grease)

Urban Areas

- 1.4 Restaurants/1,000 People
- 13 lbs FOG/person/year
- 9 lbs Yellow Grease/person/year
- 3 Billion gal Waste Oil/year (U.S.)
- 80% Sewer Spills Caused by FOG

Sources:
- Urban Waste Grease Resource Assessment, NREL, 1998
- EPA Biodiesel Partnerships, 2006

FOG-to-Biodiesel – What We Know

- Growing Use of FOG in Co-Digestion Applications (Biogas Production Enhanced)
- FOG-to-Biodiesel Technology is Currently Being Commercialized
- FOG-to-Biodiesel Projects at WWTPs
  - San Francisco Public Utility Commission (SFPUC), CA Pilot Facility: 100,000 gal Biodiesel/year
  - East Bay Municipal Utility District (EBMUD), CA
  - City of Pacifica, CA
  - Five Marin County Sanitary Districts, CA
  - Eastern Municipal Water District (EMWD), CA

Biodiesel – Background/Relevance

Algae-Based Biodiesel

CO_2

Water

Nutrients

Algae Growth System

Dewatering/ Separation

Algae Biomass

Early Stages of Development

Oil Extraction Process

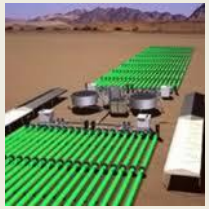
Biodiesel

Open Ponds

Large Surface Area and Shallow Water Depth

Photobioreactors

Enhanced Production per Volume and Surface Area



Potential in WWTPs

- Water and Nutrients in Plant Effluent and Centrate Sidestream
- CO_2 from On-Site Emissions and Bio-Methane Production
- CO_2 from Nearby CO_2 Emitters (Power Plants)

Algae-to-Biodiesel – What We Know

- Algae Industry Still in Early Stages of Development
- Water/Wastewater and Algae Industries Looking for Synergies
- Intense Research Ongoing
  - Private Entities
  - Universities (ASU, UofA)
- Federal Funding through the Department of Energy
- Algae-to-Biodiesel Projects at WWTPs
  - Hornsby Bend WWTP, Austin, TX
  - Rockaway WWTP, New York, NY
  - Erie WWTP, Erie, PA

Biodiesel – Future Directions

- Most Utilities Unaware of FOG-Related Sewer System O&M Costs
  - Need to Quantify Life-Cycle Cost of FOG and Savings from Beneficial Reuse
- FOG-to-Biodiesel Technologies to Overcome Challenges with “Brown Grease” Contaminants
- Commercialization of Algal Biodiesel
  - Reduce Costs and Real State Footprints
  - Identify Best Strains for Commercial Production
  - Development of Low-Cost Systems for Algae Harvesting, Dewatering, and Oil Extraction
- Pilot Studies and Demonstration Projects

Summary

- Biosolids and Residuals = Valuable Resources
- Biofuels from Wastewater
  - Digester Gas or Biogas
  - Dried Wastewater Solids
  - Biodiesel (FOG and Algae)
- Challenges for Energy Recovery
  - Technological
  - Financial
  - Legislative
  - Public Perception and Awareness
- Emerging Technologies Gaining Traction (Bio-Methane, Gasification, FOG-to-Biodiesel, Algae-to-Biodiesel)

Questions?

Fernando Sarmiento, P.E.
fsarmiento@greeley-hansen.com
602-778-8475

Turning waste into power

Austin plant will run on electricity from gas

Updated: Tuesday, 28 Aug 2012, 12:06 PM CDT
Published : Monday, 27 Aug 2012, 5:45 PM CDT

- Leslie Rhode

Advertisement

AUSTIN (KXAN) - One of Austin's wastewater treatment plants will soon be powered by 100-percent renewable energy. The Hornsby Bend Wastewater Treatment Plant in East Austin has a brand new 60,000-pound biogas generator. It will use methane gas created by the sewage treatment process at the plant to power the plant and more.

"This generator produces so much electricity that it runs the entire treatment process here at Hornsby Bend, and the water department will get a credit, because the generator produces more than it will actually need to use," said Austin Energy spokesman Carlos Cordova.

Plant officials said the biogas generator will be able to produce 700 kilowatts of power. That is more than the 500 kilowatts needed to run the treatment plant. The leftover energy will be fed back into the power grid, and Austin Water will get a credit for it.

"According to Austin Energy estimates it's about the equivalent of the power needed for 370 residential homes in Austin will be provided here with no outside fuel -- all produced by methane gas," said Orren West, plant division manager.

The new biogas generator has another green energy advantage. Austin Energy officials said the clean generation will reduce carbon dioxide emissions by 2,867 tons or the equivalent of taking away five million vehicle miles traveled in Austin.

The generator was paid for by federal stimulus money. It is currently being installed at the Hornsby Bend Wastewater Treatment Plant, and an Austin Energy spokesman said it should be up and running by the beginning of November 2012. The plant's division manager calls it an exciting addition for the plant and for the taxpayers.

There's more. The final product at the wastewater treatment plant is dillo dirt. It will be used as compost for gardening projects all over the city.

April 2011, Vol. 23, No.4

A new frontier

While gas companies, universities, high-tech research firms, and even NASA have waded into the waters of algae-based biofuels, many wastewater utilities have stood along the shoreline watching others as they make the leap. But a few have realized the technology's potential, growing algae at their wastewater treatment plants in order to remove nutrients.

They also convert these autotrophic organisms into biofuel that in the far-off future could be used to power the plants or commercialized to raise revenue for their operations.

Since September, the Rockaway Wastewater Treatment Plant in Queens, N.Y., has been engaged in such a project with the assistance of HydroQual Inc. (Mahwah, N.J.), Biohabitats Inc. (Baltimore), the University of Arkansas (Little Rock), and Blackrock Energy Corp. (Williamsburg, Va.). The New York City Department of Environmental Protection (DEP) invested $387,000 into the project, installing an Algal Turf Scrubber®, a patented technology that consists of two 100-m (350-ft) metal sloped troughs. One trough receives 150 L/min (40 gal/min) of effluent, while the other receives 76 L/min (20 gal/min). According to a DEP press release, the troughs' design is meant to mimic a "stream ecosystem by varying flow currents and using sunlight to promote algae growth." After sufficient algal growth occurs, usually within a 10- to 14-day time frame, the algae are gathered and the water is removed using wet–dry vacuums. The algae are shipped and converted into butanol by scientists at the University of Arkansas.

So far, the plant has produced 1 L of butanol.

"I know one liter doesn't sound like a lot of biofuel, but it is, considering that it was made inside a lab with just lab equipment," said Jamie A. Hestekin, an assistant professor of chemical engineering at the University of Arkansas. "The butanol that we gave them was fuel grade. You could probably run a car on it for about 8 miles [13 km]."

"As far as I know, no one else has made this much [using algae]," said John McLaughlin, director of ecological services at DEP.

Part of an overall plan

The project at Rockaway is part of the Jamaica Bay watershed protection plan, which includes upgrades at other wastewater treatment facilities in New York City, an oyster and eelgrass pilot restoration project, wetlands restoration at Paerdegat Basin, and green infrastructure projects.

When the department put together the watershed protection plan, it focused on "green technologies that had a big stormwater focus, but we were told that nothing was off the table," McLaughlin said. So DEP decided to move forward with the algae project at Rockaway, he said, because it saw algae as a green technology that treated effluent and could be a source for renewable energy.

The contract was signed last summer, and the algal turf scrubber was operational from September to December.

"Right now we're going through a seasonal shutdown," McLaughlin explained.

Even though the algae can still grow in cold temperatures, it has gotten so cold in New York City that the ponds that feed the algal turf scrubber have frozen over.

At press time, McLaughlin had expected the plant to be back up and running by this month.

Not a simple formula

The process to convert algae to butanol can be complicated. "We've used two methods," Hestekin said.

Scientists at the University of Arkansas have worked with a standard butanol technology that has been around for almost 100 years, and they have used a newer method that began in the 1990s. With the newer method, the anaerobic fermentation process to convert algae to butanol is broken down into two steps. The first, Hestekin said, is acid-genesis, whereby the starches and carbohydrates in the algae are hydrolyzed and extracted and then made into organic acids. Electrodeionization is used to extract pure butyric acid from this fermentation. In the second step, which is solvent-genesis, the organic acids are made into butanol.

Hestekin said a lot of algae are required to make a little butanol.

"Alga is about 85% to 90% water," Hestekin said. The water is removed from the alga, and it is possible to do this by drying it on the turf scrubber. "Of the dry stuff, 15% to 40% is sugar. Of the sugar, 40% can be converted to butanol," Hestekin said. "So keeping that in mind, if you had 100 pounds [45 kg] of wet algae, you would probably get about 1 to 2 pounds [0.45 to 0.9 kg] of biofuel out of it."

But Hestekin also pointed out that this final product is still a lot compared to how much biofuel can be extracted by corn, another popular renewable fuel resource.

"Standard yield for corn to ethanol is 1 acre [0.4 ha] makes 330 gallons [1250 L] of ethanol per year," Hestekin explained. "If you assume a growth rate on the algal turf scrubber system of 30 g/m^2 day, the maximum yield of butanol is that 1 acre makes 1500-plus gallons [5700 L] of butanol per year. Since butanol is at least as good of a biofuel as ethanol, this means almost 5 times greater fuel production.

That's great, given that the algae on the 1 acre is also serving to clean up wastewater."

Moving forward

McLaughlin said DEP plans to evaluate the algae biofuel project for the next 2 years to collect more butanol and improve the data. If it continues to have positive results, it may eventually expand it to other wastewater treatment plants within the system. But it has to keep in mind the geography of New York City and how it could limit the installation of the algal system at other locations.

"In most places where land is plentiful, you can build at any scale," McLaughlin said. "But in New York, we can't go farther out. We can only go up."

McLaughlin said there also is maintenance to consider. "For the most part, the system is self-maintained, but there are occasional leaks, and there is pump wear and tear," he said.

McLaughlin said for now the hope is to produce enough butanol to use it as an energy source to offset existing fuel costs at the Rockaway plant.

Hestekin said the team at the University of Arkansas also plans to continue to collect data, and it is pursuing other partnerships.

"We're working with Statoil in Norway as part of a consortium with other universities, like William and Mary and the University of Maryland," Hestekin said. "They are highly interested in the Chesapeake Bay and open-water areas."

Hestekin said the team isn't working with any other municipalities or wastewater treatment plants.

"New York is very forward-looking and thinking in this way," Hestekin said. "They're the only ones really doing this. As scientists, we're used to having far-off ideas of how something can be taken to the next step, but DEP is very big into making this work and getting as much biofuel as possible."

— LaShell Stratton–Childers, *WE&T*

Innovation & Job News

Sewage treatment plant under construction will generate biofuel and discharge cleaner water

THURSDAY, FEBRUARY 09, 2012

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ENERGY, SUSTAINABILITY

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A sewage treatment plant being built in Central PA will use waste to produce electricity and reduce the amount of harmful chemical elements that end up in the Susquehanna River.

The Milton Regional Sewer Authority serves an area about 20 miles south of Williamsport. Its main customer is a plant where the giant food company ConAgra makes grocery staples including canned pasta and microwaveable dinners. ConAgra sends the plant about 2 million gallons of sewage a day, twice what's generated from all of the authority's other customers combined.

The new plant is expected to be done by July 2014. In its new setup, waste from the ConAgra plant will generate methane gas, which will power a generator. This generator is expected to produce twice the electricity the treatment plant needs to operate. George Myers, the plant's superintendent, says the authority's current electric bill is about $30,000 per month, but it will sell power back to the grid once the new plant is operating. "We're pretty fortunate to be involved with this," he says.

The plant will also have a machine called a sludge dryer, which removes the water from sewage. The methane-generated heat will go to this sludge dryer, and the dried waste will be converted into pellets that can be used for fuel or fertilizer.

The new system at Milton will also remove more nitrogen and phosphorus from wastewater before it's discharged into a tributary of the Susquehanna River. This is significant because high amounts of these chemicals lead to excessive growth of algae.

Source: George Myers, Milton Regional Sewer Authority

Writer: Rebecca VanderMeulen

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The Green Machine: Algae Clean Wastewater, Convert to Biodiesel

RIT researchers take algae out of the lab

Feb. 17, 2011
by Susan Gawlowicz
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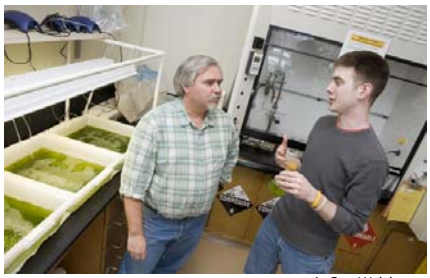

A. Sue Weisler

Professor Jeff Lodge and graduate student Eric Lannan explore algae as a biodiesel fuel.

Note: Audio available for this story

Let algae do the dirty work.

Researchers at Rochester Institute of Technology are developing biodiesel from microalgae grown in wastewater. The project is doubly "green" because algae consume nitrates and phosphates and reduce bacteria and toxins in the water. The end result: clean wastewater and stock for a promising biofuel.

The purified wastewater can be channeled back into receiving bodies of water at treatment plants, while the biodiesel can fuel buses, construction vehicles and farm equipment. Algae could replace diesel's telltale black puffs of exhaust with cleaner emissions low in the sulfur and particulates that accompany fossil fuels.

Algae have a lot of advantages. They are cheaper and faster to grow than corn, which requires nutrient-rich soil, fertilizer and insecticide. Factor in the fuel used to harvest and transport corn and ethanol starts to look complicated.

In contrast, algae are much simpler organisms. They use photosynthesis to convert sunlight into energy. They need only water—ponds or tanks to grow in—sunlight and carbon dioxide.

"Algae—as a renewable feedstock—grow a lot quicker than crops of corn or soybeans," says Eric Lannan, who is working on his master's degree in mechanical engineering at RIT. "We can start a new batch of algae about every seven days. It's a more continuous source that could offset 50 percent of our total gas use for equipment that uses diesel."

Cold weather is an issue for biodiesel fuels.

"The one big drawback is that biodiesel does freeze at a higher temperature," says Jeff Lodge, associate professor of biological sciences at RIT. "It doesn't matter what kind of diesel fuel you have, if it gets too cold, the engine's not starting. It gels up. It's possible to blend various types of biodiesel—algae derived with soybeans or some other type—to generate a biodiesel with a more favorable pour point that flows easily."

Lannan's graduate research in biofuels led him to Lodge's biology lab. With the help of chemistry major Emily Young, they isolated and extracted valuable fats, or lipids, algae produce and yielded tiny amounts of a golden-colored biodiesel. They are growing the alga strain Scenedesmus, a single-cell organism, using wastewater from the Frank E. Van Lare Wastewater Treatment Plant in Irondequoit, N.Y.

"It's key to what we're doing here," Lodge says. "Algae will take out all the ammonia—99 percent—88 percent of the nitrate and 99 percent of the phosphate from the wastewater — all those nutrients you worry about dumping into the receiving water. In three to five days, pathogens are gone. We've got data to show that the coliform counts are dramatically reduced below the level that's allowed to go out into Lake Ontario."

Assemblyman Joseph Morelle, whose district includes Irondequoit, applauds RIT's initiative. "Innovations developed at great academic institutions such as RIT will be key to solving many of the challenges we face, from revitalizing the upstate economy to the creation of clean, renewable energy sources for the future. Professor Lodge and Eric Lannan's research bridges the gap between cost efficiency and environmental conservation and is a perfect example of how old problems can yield to new and creative solutions."

Lodge and Lannan ramped up their algae production from 30 gallons of wastewater in a lab at RIT to 100 gallons in a 4-foot-by-7-foot long tank at Environmental Energy Technologies, an RIT spinoff. Lannan's graduate thesis advisor Ali Ogut, professor of mechanical engineering, is the company's president and CTO. In the spring, the researchers will build a mobile greenhouse at the Irondequoit wastewater treatment plant and scale up production to as much as 1,000 gallons of wastewater.

Northern Biodiesel, located in Wayne County, will purify the lipids from the algae and convert them into biodiesel for the RIT researchers.

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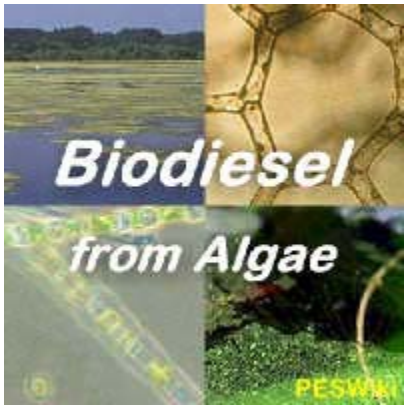
Biofuel Algae Systems Membrane liners & construction for algae biofuel applications. www.coloradolining.com

AdChoices

Directory:Biodiesel from Algae Oil

From PESWiki

The advantages of deriving biodiesel from algae include rapid growth rates, a high per-acre yield; and algae biofuel contains no sulfur, is non-toxic, and is highly biodegradable. Some species of algae are ideally suited to biodiesel production due to their high oil content--in some species, topping out near 50%.



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Overview

- **Algae: 'The ultimate in renewable energy' (http://www.cnn.com/2008/TECH /science/04/01/algae.oil/index.html#cnnSTCVideo)** - Some types of algae are about 50 percent oil, suitable for biodiesel. The U.S. government has been experimenting with algae off and on for 18 years. There may be hundreds of thousands of species not yet identified. (*CNN*; March 25, 2008)

About Algae

- **Oilgae.com (http://www.oilgae.com/)** - Biodiesel from Algae Oil – Info, Resources, News & Links Algae range from small, single-celled organisms to multi-cellular organisms, some with fairly complex differentiated form. Algae are usually found in damp places or bodies of water and thus are common in terrestrial as well as aquatic environments. Like plants, algae require primarily three components to grow: sunlight, carbon-di-oxide & water. Photosynthesis is an important biochemical process in which plants, algae, and some bacteria convert the energy of sunlight to chemical energy. The existing large-scale natural sources are of algae are: Bogs, marshes & swamps - Salt marshes and salt lakes. Microalgae contain lipids and fatty acids as membrane components, storage products, metabolites and sources of energy. Algae contain anywhere between 2% and 40% of lipids/oils by weight. There are three well-known methods to extract the oil from oilseeds, and these methods should apply equally well for algae too: 1. Expeller/Press 2. Hexane solvent oil extraction 3. Supercritical Fluid extraction

Biomass Yield

- **Algal Biomass Yields versus Phytomass Yields of Tropical Crops (http://biopact.com/2007/01 /in-depth-look-at-biofuels-from-algae.html)**

These are the yields obtained in stable cultures during an entire year, as reported by the Aquatic Species Program. All other results from that program show either unstable growth or yields obtained over short periods of time (often, during winter months when algae productivity drops significantly, the Aquatic Species Program discontinued the cultures.)

Metric Tons/Hectare/Year

M. minutum (algae), 1989.....35.8
M. minutum (algae), 1989.....30.3
M. minutum (algae), 1990.....38.3
Algae (no species mentioned), 1978.....43.8
Algae (no species mentioned), 1978.....51.1
Sugarcane.....79.2 [Brazilian average, 2005]
Sorghum.....70 [Average for Andhra Pradesh, India, 2005]
Cassava.....65 [Nigeria, 1985]
Oil palm.....50 [Global average, including low yields in Africa; in Malaysia, average yields are 75 MT/ha/yr]
Arundo Donax.....50 [Grown in sub-tropics, Handbook of Energy Crops]

Oil Yield

- **Cultivating Algae for Liquid Fuel Production (http://oakhavenpc.org/cultivating_algae.htm)**

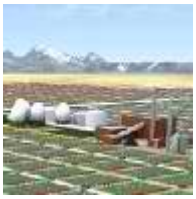
Gallons of Oil per Acre per Year
Corn 15
Soybeans 48
Safflower. 83
Sunflower . . . 102
Rapeseed. . . 127
Oil Palm 635
Micro Algae . .1850 [based on actual biomass yields]
Micro Algae . .5000-15000 [theoretical laboratory yield]

Videos

- **Videos:Algae as Fuel** - A collection of videos and video links regarding the turning of algae into oil, hydrogen, ethanol and other useful fuels. (*PESWiki*; April 19, 2008)

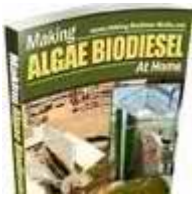
Featured

- Top 100:
  Using Algae to Capture Carbon and Produce Biodiesel and Food - A2BE Carbon Capture is developing bio-secure, scalable, climate adaptive, and highly cost-effective technology for producing valuable fuel and food from CO2 using algal photosynthesis and bio-harvesting in a system they call Algae@Work. (*PESWiki*; May 23, 2008)



Do It Yourself

- Store (http://freeenergynews.com/Store/) : DIY > Biodiesel > **from Algae** >
  Making Algae Biodiesel at Home (https://www.e-junkie.com /ecom/gb.php?ii=96320&c=ib&aff=36586&ev=7f8abe6be0) - Downloadable 650-page book provides detailed instructions on how to sustainably produce clean oil from algae -- in your back yard -- enough to supply your transportation and home power needs. This is not a simple, afternoon venture, but a serious, long-term commitment.



- Feature / Store (http://EnergyStork.com) : Emergency Prep / Alt. Fuel > Biofuels > Algae > **for Biodiesel** >
  New book explains how to build Open Ponds for growing algae for biodiesel (http://pesn.com/2010/09/03/9501698_Build_open_ponds_to_grown_own_algae/) - David Sieg has completed yet another e-book in his excellent series on making your own biodiesel from algae and other biomass. This book focuses on the methods of cultivating algae in open ponds (https://www.e-junkie.com/ecom/gb.php?ii=798186&c=ib&aff=36586&cl=17582) , both small-scale for home applications, or large-scale for commercial applications. (*PESN*; Sept. 3, 2010)

- **Making Algae Photobioreactors at Home (http://www.making-algae-biodiesel.com)** A download with step-by-step instructions on making an algae test bioreactor. You can easily test 10 different algal strains,

or 10 different variables at the same time. "When I went looking for a algae photobioreactor for my own studies, I saw similar PBR's selling for $10,000 -$20,000 USD or more. So I built one."

Companies

- **AlgaeLink (http://www.algaelink.com/)** Retailer of photobioreactors and commercial algae cultivation equipment. Offers full support for operations, potential distributorship opportunities.
- **Aquaflow Binomic Corporation (ABC) (http://www.aquaflowgroup.com/)** - harvests algae directly from the settling ponds of standard Effluent Management (EM) Systems and other nutrient-rich water. The process can be used in many industries that produce a waste stream, including the transport, dairy, meat and paper industries.
- **Aquatic Energy (http://www.aquaticenergy.com/)** - An Alternative Energy company specializing in the Louisiana Gulf area for turing algal oils into biofuel.
- **Aurora BioFuels, Inc. (http://www.aurorabiofuels.com/)** A renewable energy company exploring new sources of feedstock for the production of biofuels. In particular, Aurora utilizes microalgae to generate bio-oil, which can be converted into biodiesel.
- **Blue Marble energy (http://www.bluemarbleenergy.net/)** - A company that converts algae biomass to energy by creating, centralizing, and harvesting wild algae blooms.
- **Circle Biodiesel & Ethanol Corporation (http://www.circlebio.com)** : Clean energy company (http://www.circlebio.com) specializing in renewable energy (http://www.circlebio.com) and manufacturing and consulting for algae biodiesel (http://www.circlebio.com/algae_biodiesel_photobioreactors.htm) and algae biofuel (http://www.circlebio.com/algae_biodiesel_photobioreactors.htm) processors for algae oil (http://www.circlebio.com/algae_biodiesel_photobioreactors.htm) , biodiesel processors (http://www.circlebio.com/biodiesel_processors_biodiesel_plants.htm) , jatropha oil (http://www.circlebio.com/jatropha_biodiesel.htm) , bioethanol (http://www.circlebio.com /ethanol_plants_ethanol_stills.htm) , ethanol stills (http://www.circlebio.com /ethanol_plants_ethanol_stills.htm) and methane digesters (http://www.circlebio.com /methane_digesters.htm) for the production of methane biogas (http://www.circlebio.com /methane_digesters.htm) .
- **Dynamic Biogenics (http://www.dynamicbiogenics.com/)** - Developer and manufacturer of low-cost, scalable, portable algae bioreactors that utilize high yield algae that can be used for biofuels, ethanol, livestock feed and other bio-products. Units can be retrofitted to flue stacks or operated independently.

- **GreenFuel Technologies (http://www.greenfuelonline.com/)** Emissions-to-Biofuels™ (E2B™) process harnesses photosynthesis to grow algae, capture CO2 and produce high-energy biomass. Retrofitting fossil-fired power plants and other anthropogenic sources of carbon dioxide, the algae can be economically converted to solid fuel, methane, or liquid transportation fuels such as biodiesel and ethanol.
  - **Algae-Filled Greenhouses Aim to Take in CO2 and Turn out Biofuel (http://blogs.discovermagazine.com/80beats/2008/10/21/algae-filled-greenhouses-aim-to-**

take-in-co2-and-turn-out-biofuel/) - GreenFuel Technologies (http://www.greenfuelonline.com/) announced plans to build the first $92 million 247 acre complex of greenhouses as a commercial-scale algae farm, to recycle carbon dioxide from factories and power plants. (*Discover Magazine*; Oct. 21, 2008)

- **GreenShift (http://www.greenshift.com/biodiesel.php?biopage=10)** has a license agreement with Ohio University for its patented bioreactor (http://www.gs-cleantech.com/product_desc.php?mode=3) process based on a newly discovered iron-loving cyanobacterium (blue-green algae), through their subsidiary Veridium (http://www.veridium.com/) , for the purpose of air pollution control of exhaust gas streams from electrical utility fossil-fueled power generation facilities. Once the algae grow to maturity, they fall to the bottom of the bioreactor and are harvested for fuel or fertilizer.

- **Green Star Products (http://www.greenstarusa.com/)** - GSPI's HAPS Algae Systems & GSPI's Biodiesel Technology: A Real Solution To Peak Oil & Global Warming

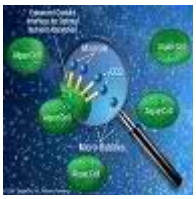
- **Infinifuel Biodiesel (http://www.infinifuel.com/)** - Wabuska Nevada is home to the world's first geothermally powered and heated biodiesel plant. We have over 300 acres to grow oilseed and develop algae ponds on site.

- **Inventure Chemical (http://www.inventurechem.com/)** - Pioneered the processes that allow biofuel developers to ultimately make the dream of affordable biofuels a reality by the application of cost effective conversion and processing methods working with a variety of feedstocks - from algae produced from CO2 emissions to exotic and not so exotic oil seeds and biomass.

- **Kai BioEnergy (http://www.KaiBioEnergy.com/)** - Kai BioEnergy Corp. (KAI) is an alternative biofuel company competitively positioned to become a leading large scale commercial producer of economical biodiesel crude oil from micro-algae biomass using KAI's patented and proprietary cost efficient open reactor technology and fully integrated continuous production system.

- **LiveFuels (http://www.livefuels.com/)** - A national alliance of labs and scientists dedicated to transforming algae into biocrude by the year 2010. Working on breeding various strains of algae, driving down the costs of harvesting algae and extracting fats and oils from the algae. Theoretically, the U.S. could grow enough algae on 20 million acres to replace imported oil.

- **OriginOil (http://www.originoil.com/)** - Novel technology at the microscopic scale can enhance the efficiency of algae production as a high-yield, cost-competitive replacement for petroleum. In the growth phase, nutrients are fractured and injected into algae culture. In the extraction phase, fracturing breaks the tough outer membrane of the algae in an energy-efficient manner.



  - OriginOil, Inc. (OOIL), the developer of a breakthrough technology to help transform algae, the most promising source of renewable oil, into a true competitor to petroleum, announced today the recent filing of its second patent application.

The patent application, "Apparatus and Method for Optimizing Photosynthetic Growth in a Photo Bioreactor," discloses OriginOil's invention of a system designed to increase and optimize photosynthetic growth of an algae culture. This system, known as the Helix BioReactor™, is the core algae growth system that will be used in OriginOil's prototypes, pilots and full-scale production systems.

"The key to dependable, high algae yield is continuous lighting of multiple growth planes," said Nicholas Eckelberry, Director of Development and an inventor of the Helix Bioreactor. "In a natural pond, the sun only illuminates one growth plane, down to about half an inch below the surface. In contrast, the Helix Bioreactor features a rotating vertical shaft with very low energy lights arranged in a helix or spiral pattern, which results in

a theoretically unlimited number of layers. Additionally, each lighting element is engineered to produce specific light waves and frequencies for optimal algae growth. By giving algae only the light it needs, throughout the growth tank, all of the time, we're growing algae quickly and cost-effectively." (*Press Release*; May 27, 2008)

- **PetroAlgae (http://www.petroalgae.com/)** - Commercializing an environmentally-friendly algae developed by a research team at ASU that generates over two hundred times more oil per acre than crops like soybeans. Using a cost-effective, modular cultivation process that can be massively scaled, PetroAlgae will produce renewable feed stock oils for use in applications such as transportation fuels (e.g. biodiesel), heating oil, and plastics.

- **PetroSun (http://www.petrosuninc.com/)** - Through their wholly owned subsidiary Algae BioFuels and industry partner Electratherm, is committed to becoming a worldwide leader in the development and deployment of renewable energy resources.

- **Seambiotic (http://www.seambiotic.com/)** - As they have already developed and produced algae, their main goal is to market algae as a nutritional supplement for humans as well as animals and bio-energy concentrating on a few marine unicellular algae containing high value products.

  - **Algae-based Biofuels from Power Plant Emissions, Redux (http://www.treehugger.com/files/2008/06/algae-biofuels-coal-plants-redux.php)** - Inventure Chemical (http://www.inventurechem.com/) and Seambiotic (http://www.seambiotic.com/) have announced that they have formed a joint venture to construct a pilot commercial biofuel plant with algae created from CO2 emissions as a feedstock. The plant will use algae strains that Seambiotic has developed coupled with conversion processes developed by Inventure to created ethanol, biodiesel and other chemicals.(*TreeHugger*; June 20, 2008)

- **Solazyme (http://www.solazyme.com/)** - Devoted to harnessing the energy-harvesting machinery of various species of algae to produce valuable products. The Company utilizes proprietary genetic engineering methods to develop and optimize commercially relevant biochemical pathways for production of hydrocarbons (for energy and specialty chemicals) & bioactive compounds.

- **Solena Group (http://www.solenagroup.com/)** - Uses high temperatures to gasify algae and other organic substances with high-energy outputs.

- **Solix Biofuels (http://www.solixbiofuels.com/)** - A developer of massively scaleable photo-bioreactors for the production of biodiesel and other valuable bio-commodities from algae oil. Solix' closed photo-bioreactors allow fossil-fuel power plant exhaust to be captured through the growing system. The algae growth rates increase in the presence of the carbon dioxide that would otherwise be emitted into the atmosphere.

- *****Texas Clean Fuels (http://sites.google.com/site/txclfs/) **- Founded by Harvard inventor & entrepreneur, Jonathan Gal, TCF provides technology licensing, equipment, & consulting services to algae producers throughout the USA. Using our technology, producers can achieve a production cost of less than $20 per barrel for crude algae oil.**

- **Valcent Products (http://www.valcent.net/)** - Has developed a high density vertical bio-reactor for the mass production of oil bearing algae while removing large quantities of carbon dioxide (CO2) from the atmosphere. This new bio-reactor is tailored to grow a species of algae that yields a large volume of high grade vegetable oil, which is very suitable for blending with diesel to create a bio-diesel fuel.

3.16 Minutes **Vertical Algae biofuel Growing**
Valcent's own video of Vertigro (http://www.valcent.net/s/Home.asp) . (*You Tube* (http://www.youtube.com/watch?v=_ToojK_MJd0) Feb. 1, 2008)

Research & Development

- **'First Economical Process' For Making Biodiesel Fuel From Algae (http://www.sciencedaily.com/releases/2009/03/090325222006.htm)** - One of the problems with current methods for producing biodiesel from algae oil is the processing cost. Researchers from New York say their innovative process is at least 40 percent cheaper than that of others now being used. (*Science Daily*; March 31, 2009)

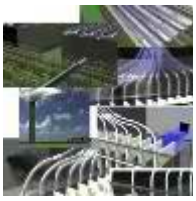
- **Success For First Outdoor, Large-Scale Algae-To-Biofuel Research Project In Nevada (http://www.physorg.com/news152456129.html)** - The first real-world, demonstration-scale project in Nevada for turning algae into biofuel has successfully completed the initial stage of research at the University of Nevada, Reno. The project is on track to show the process is an economical, commercially viable renewable energy source in Nevada. (*PhysOrg*; Jan. 29, 2009)

- **CEHMM Investigates Algae as a Biodiesel Feedstock (http://www.cehmm.org/)** -The CEHMM biodiesel project is a research and development project investigating biodiesel production processes and the propagation, harvesting, and extraction of oil from both brine and fresh water algae. (*BIOfuel Blog*

War (http://www.biofuelwar.com/2008/07/algae-biodiesel-nears-commercial-scale-in-new-mexico/) ;July 9, 2008)

- **Green Star Announces Algae Breakthrough (http://www.businesswire.com/portal/site/home/email/headlines/?ndmViewId=news_view&newsLang=en&div=428291328&newsId=20080522005337)** - Biotech Research, Inc., a consortium partner of Green Star (http://www.GreenStarUSA.com/) , has confirmed a daily growth rate increase of 34% using the "Montana Micronutrient Booster (MMB)" formula for a micronutrient formula to increase the growth rate of algae biomass. This growth rate booster can increase the total biomass quantity in a harvest algae growth cycle by well over 100%. (*Business Wire*; May 22, 2008)

- **GreenShift's CO2 Bioreactor** - Patented process uses algae to consume greenhouse gas emissions from fossil-fueled power plants, giving off pure oxygen and water vapor. Light from concentrated solar panels is conducted into the algae chambers via fiber optics. Once the algae grows to maturity, it is harvested for conversion into ethanol and biodiesel fuels.



- **There's Oil in That Slime (http://www.physorg.com/news115568990.html)** - A group at the University of Minnesota are in the race to turn algae into a commercially viable energy source by developing ways to grow mass quantities of algae, identifying promising strains and figuring out what they can make from the residue that remains after the oil is removed. (*PhysOrg*; Nov. 29, 2007)

In the News

- Biofuels > Algae > **Biodiesel** >
  Solar + Water + C02 = Diesel? (http://www.greentechmedia.com/articles/read/solar-water-c02-diesel/) - Joule Biotechnologies and its competitors are attempting to utilize proprietary microorganisms that turn photons, water, and C02 directly into drop-in fuels. Their systems have a "solar converter" which can be thought of as solar walls (but not cells) that absorb photons while managing optical density so their proprietary bugs get all the photons they need. (*GreenTechMedia*; March 5, 2010)

- **Hawaiian Marine Algae (http://newenergynews.blogspot.com/2008/06/hawaiian-marine-algae.html)** - Cellana (http://www.cellana.com/) , a joint venture of HR Biopetroleum and Royal Dutch Shell is doing a pilot project to grow and refine algae for biofuels. The company is already producing transport fuels and is building a bigger, demonstration plant. First commercial operation: 3 years. (*NewEnergyNews*; June 27, 2008)

- **15 Algae Startups Bringing Pond Scum to Fuel Tanks (http://earth2tech.com/2008/03/27/15-algae-startups-bringing-pond-scum-to-fuel-tanks/)** - Despite the fact that algae-to-biofuel startups have been taking their sweet time bringing a pond scum fuel product to market, some inroads have been made

recently. (*Earth2Tech*; March 27, 2008)

- **OILGAE TEST DRIVE: Algae Power Hits the Road (http://www.inhabitat.com/2008/04/15/oilgae-the-next-biofuel-from-algae/)** - Algae produces 30 times more energy per acre than corn or soybeans and can grow in salt water, our worlds most abundant source. There are several startups bringing pond scum to fuel tanks, among them Solazyme who were caught driving around Sundance Film Festival this year with an oilgae-powered car. (*Inhabitat*; April 15, 2008)

- **WMU Researchers Create Biofuels from Waste Oil & Algae (http://www.renewableenergyworld.com/rea/news/story?id=52163)** - Researchers at Western Michigan University (WMU) are working to develop two biofuel production processes; Bronco Biodiesel, is to perfect a process to convert trap grease, used vegetable oil from restaurants and other facilities and the second project will attempt to find a viable algae strain that could be used for both waste treatment and as a feedstock for biodiesel or ethanol production. (*Renewable Energy World*; April 15, 2008)

- **US Algae Association Hosts Forum (http://www.greencarcongress.com/2008/02/us-algae-associ.html)** - The US National Algae Association is hosting a business plan and networking forum on 10 April in The Woodlands, Texas, at which early stage algae production companies will showcase their ventures in front of an audience of algae researchers, entrepreneurs, investors and lenders. (*Green Car Congress*; Feb. 21, 2008)

- **Algae grows in the dark (http://www.greencarcongress.com/2008/02/solazyme-ups-so.html)** - Solazyme (http://www.solazyme.com/) is growing algae in fermentation tanks, sustained by sugar, rather than photosynthetically in the open. Their focus is on large-scale, high-density, cost effective cultivation of algae and production economics. (Green Car Congress*; Feb. 11, 2008)*

- **Biofuel Microalgae Research (http://www.greencarcongress.com/2008/02/texas-am-system.html)** - Texas AgriLife Research and General Atomics (http://www.ga.com/atg/APS/bio_fuels/index.php) have received a $4 million grant for research aimed at developing microalgae-derived biodiesel fuels to support US domestic and military needs. This includes evaluating algae strains, developing and testing algae production systems and algae/oil separation systems. (*Green Car Congress*; Feb. 4, 2008)

- **Biodiesel algae grows in winter (http://www.autobloggreen.com/2008/02/02/green-star-products-grows-biodiesel-algae-in-cold-montana-winter/)** - Green Star Products (http://www.greenstarusa.com) says it has grown algae in outdoor environments where temperatures dropped to -18 degrees Celsius and that saw plenty of snowfall. This sort of "controlled algae growing environment at an affordable capital and maintenance cost" is something that "has eluded engineers for more than three decades." (*AutoblogGreen*; Feb. 2, 2008)

- **Florida Tech Receives Grant for Algal Biofuels Research (http://www.greencarcongress.com/2008/01/florida-tech-re.html)** - The Florida Tech-Aurora Biofuels (http://www.aurorabiofuels.com/) research focuses on developing biodiesel from microalgae, with animal feed co-products to improve the economics. They will test algal strains for long-term outdoor production viability and develop a low-cost

sedimentation process to harvest the algae. (*Green Car Congress*; Jan. 28, 2008)

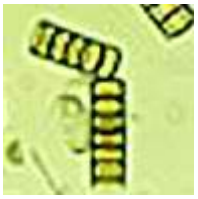
- **First Algal Biodiesel Tested (http://www.greencarcongress.com/2008/01/solazyme-introd.html)** - Solazyme (http://www.solazyme.com/) has road tested Soladiesel, its first algal biodiesel, and is currently producing thousands of gallons of algal oil. Solazyme also has signed a feedstock agreement with Chevron and is researching production of algal biocrude oil designed to match light sweet crude oil. (*Green Car Congress*; Jan. 22, 2008)

- **PetroSun BioFuels to Build 30M Gallon Algal Biodiesel Plant (http://www.greencarcongress.com/2008/01/petrosun-biofue.html)** - PetroSun BioFuels Refining has entered (http://www.marketwire.com/mw/release.do?id=808685&k=petrosun) into a joint venture to construct and operate a biodiesel plant in Arizona using algal oil feedstock produced by PetroSun BioFuels. The residual algae biomass will be processed into ethanol. Construction should commence during the third quarter of 2008. (*Green Car Congress*; Jan. 10, 2008)

- **Aquatic Energy Planning for 5M Barrels of Algae Fuel (http://www.ecogeek.org/content/view/1269/)** - Aquatic Energy (http://www.aquaticenergy.com/) is harvesting algae in Lousiana and turning it into BioDiesel, by taking CO2 from local industry and pumping it into algae ponds which are harvested every three to five days. One acre of soy can produce 1 barrel of biodiesel a in a year, while algae produces between 1500-2000 barrels. (*EcoGeek*; Jan. 9, 2008)

- **Better BioDiesel to Acquire GeoAlgae (http://www.renewableenergyaccess.com/rea/news/story?id=51050)** - Better BioDiesel (http://www.betterbiodiesel.com/) has announced the execution of a letter of intent (LOI) with GeoAlgae Technologies (GAT), a vertically integrated energy technology company with a focus on producing low cost, renewable feedstock for the production of biodiesel using feedstock from geologic resources. (*Renewable Energy Access*; Jan. 8, 2008)

- **Joint Venture for Algal Biofuel Production (http://www.greencarcongress.com/2007/12/shell-and-hr-bi.html)** - Shell and HR Biopetroleum (http://www.hrbiopetroleum.com/) have formed a joint venture—Cellena—to build a pilot facility in Hawaii to grow marine algae and produce vegetable oil for conversion into biofuel. Construction will begin immediately on the demonstration facility that will grow only non-modified, marine microalgae species in open-air ponds. (*Green Car Congress*; Dec. 11, 2007)



- **Coal-to-Liquids Algae Bioreactor (http://www.greencarcongress.com/2007/11/coal-to-liquids.html)** - Linc Energy (http://www.lincenergy.com.au/) has formed a joint venture with BioCleanCoal (http://biocleancoal.com/) to develop an algae bioreactor for the conversion of process CO2 into oxygen and biomass. It will allow Linc Energy to produce clean ‘green’ power and oil (diesel) from Underground Coal Gasification (UCG). (*Green Car Congress*; Nov. 21, 2007)

- **Commercial Algae-to-Biodiesel Facility (http://www.greencarcongress.com/2007/11/gspi-and-btr-to.html)** - Green Star Products (http://www.greenstarusa.com/index.html) and Biotech Research will build a 100-acre commercial algae facility adjacent to an existing biodiesel plant and will use the CO2 emitted from the plant’s boilers to provide a portion of the needs of the algae facility. The algae oil produced will be turned into biodiesel through the existing plant facilities. (*Green Car Congress*; Nov. 13, 2007)

- **Developing 'Algae to Oil' for Many Applications (http://www.renewableenergyaccess.com/rea/news/story;jsessionid=D76AC4D13A72D58F270F1CA73B243319?id=50499)** - International Energy (http://www.internationalenergyinc.com/) has launched its "algae to oil" research and development

initiatives to produce renewable diesel and jet fuel based entirely on the photosynthesis of algae, which have the unique capability of taking carbon dioxide and converting it into a high-density natural oil. (*Renewable Energy Access*; Nov. 7, 2007)

- **Chevron and NREL to Research Fuel from Algae (http://www.greencarcongress.com/2007/10/chevron-and-nre.html)** - Chevron and the National Renewable Energy Laboratory have agreed to study technology to produce liquid transportation fuels using algae. Although NREL's past research on algal biofuels focused on biodiesel, the lab has been interested in kerosene-like fuel and military jet fuels. (*Green Car Congress*; Oct. 31, 2007)

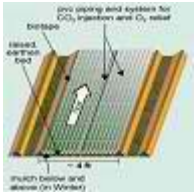
- **The Greenest Green Fuel (http://www.popsci.com/popsci/science/ee6d4d4329703110vgnvcm1000004eecbccdrcrd.html)** - Looking for a clean fuel that grows anywhere, needs only sunlight and water, and could produce enough oil to free the U.S. from its petroleum addiction? Here's one start-up's plan for converting oil from algae—yes, algae. (*Popular Science*; Jul. 2007)

- **Algae Research and Development Center Begins Operation (http://www.renewableenergyaccess.com/rea/news/story;jsessionid=00A460DB0826F09F53A1597C5518A0C7?id=50105)** - The Vertigro (http://www.valcent.net/s/Ecotech.asp?ReportID=182039) process is now mass producing rapidly-growing algae to be used as biofuel feedstock, proving that a closed loop bioreactor system can successfully produce algae over an extended period. Production partners in Portugal and South Africa have signed on. (*Renewable Energy Access*; Sep. 28, 2007)

- **2nd generation algae bioreactors (http://www.autobloggreen.com/2007/09/23/algaelink-introduces-2nd-generation-algae-bioreactors/)** - Dutch company AlgaeLink (http://www.algaelink.com/) will intoduce their latest photo-bioreactors designed to grow algae for biodiesel production at Biodiesel Expo in England in October. The company claims its equipment can produce 6x more algae than other systems and its algae culture can grow in cold water. (*AutoblogGreen*; Sep. 23, 2007)

- **Algae Feedstock in Plasma Reactor (http://biz.yahoo.com/iw/070913/0301808.html)** - W2 Energy will test various algae products in its biomass plasma reactor (BPR), for plasma assisted conversion of biomass to liquid fuel. It efficiently produces green energy, both fuel (sulfur free diesel) and electricity, using the plasma as a high temperature catalyst. (*Yahoo! Finance*; Sep. 13, 2007)

- **Lower-Cost Algae Production System (http://www.greencarcongress.com/2007/08/companies-to-in.html)** - Diversified Energy (http://diversified-energy.com/) has a license for an algae production system invented by XL Renewables (http://www.xlrenewables.com/) called Simgae (for simple algae), which utilizes common agriculture and irrigation components to keep costs to a minimum. Oil production costs are estimated at $0.08 – $0.12/pound, compared to feedstock oils from $0.25 – $0.44/pound. (*Green Car Congress*; Aug. 28, 2007)



- **Algae Biodiesel Startup (http://www.greencarcongress.com/2007/08/imperium-backin.html)** - Inventure (http://www.inventurechem.com/) has developed technology that it says can process a variety of fresh and salt water algae species and generate biodiesel and ethanol from the same algae mass. The company claims that its process generates near the theoretical maximum triglyceride and fatty acid conversion yields to fatty acid methyl or ethyl esters. (*Green Car Congress*; Aug. 22, 2007)

- **DOE Grant for Research on Algae to Biodiesel (http://www.renewableenergyaccess.com/rea/news/story;jsessionid=81F39CADC18171F91C268F1BDC01A79F?id=49412)** - Community Fuels (http://www.communityfuels.com/) has been awarded a Research Grant from the Department of Energy SBIR/STTR Program to evaluate two processes to use agricultural waste as a resource for commercial-scale algal oils development and production into biodiesel. The results will potentially unlock a low-cost feedstock for the biodiesel industry. (*Renewable Energy Access*; Jul. 24, 2007)

- **Solazyme to supply algae oil (http://www.insidegreentech.com/node/1279)** - Solazyme (http://www.solazyme.com/) is to start supplying oil derived from algae feedstock to biodiesel maker Imperium Renewables (http://www.imperiumrenewables.com/) . Solazyme does not feel it is at commercialization economics with the technology yet, but said the company is a lot closer than many people believe algae is currently. "We'll be delivering agreed-upon quantities [to Imperium] this year." (*Inside Greentech*; Jun. 6, 2007)

- **LiveFuels biocrude by 2010 (http://www.insidegreentech.com/node/1247)** - LiveFuels (http://www.livefuels.com/) plans to cost-effectively produce large amounts of biocrude oil derived from algae by 2010. The company plans to then sell the oil to others, or as last resort, to refine it itself. Avoiding costly bioreactors and genetically modified algae, the company plans to grow vast amounts of biomass very cheaply in open ponds. (*Inside Greentech*; May 31, 2007)

- **GreenStar Algae Demonstration Facility (http://www.greencarcongress.com/2007/05/greenstar_produ.html)** - Green Star Products (http://www.greenstarusa.com/) has completed Phase I of its microalgae demonstration pond, to resolve operational problems which have plagued the algae production industry. GSPI's Hybrid Algae Production System incorporates the controlled environment of closed photobioreactors with the inexpensive construction of an open pond system. (*Green Car Congress*; May 11, 2007)

- **BioKing commercializes small algae bioreactors (http://www.insidegreentech.com/node/1073)** - Netherlands-based BioKing (http://www.bioking.nl/) today introduced new, small scale photo-bioreactors (http://www.algaefuels.org/) designed to produce algae for biodiesel production. "With our fast growing algae and our advanced photo-bioreactor, it only takes four days to be in full production and to collect the first algae. And the cost of biodiesel feedstock will only be 5-10 cents a liter.►►? (*Inside Greentech*; Apr. 23, 2007)

- **NRG Energy testing GreenFuel's algae system (http://www.insidegreentech.com/node/1036)** - NRG Energy (http://www.nrgenergy.com/) and GreenFuel Technologies (http://www.greenfuelonline.com/) have started testing GreenFuel's algae-to-biofuels technology at a 1,489 megawatt coal power plant in Louisiana. The process uses algae to capture and reduce flue gas carbon dioxide (CO2) emissions into the atmosphere, which can then be converted into biofuels. (*Inside Greentech*; Apr. 13, 2007)

- **Biodiesel from Algae in Argentina (http://www.treehugger.com/files/2007/03/biodiesel_from_1.php)** - Argentine company Oil Fox (http://www.oilfox.com.ar/ingles/principal.htm) announced they would produce biodiesel from algae oil for commercial use at 50% less cost than biodiesel produced from soy. They will grow four species of algae in "secret►►? pools (to avoid industrial espionage, they claim), to produce 240 thousand tons of biodiesel. (*TreeHugger*; Mar. 20, 2007)

- **Consortium to Construct Algae-to-Biodiesel Demonstration Plants (http://www.greencarcongress.com/2007/03/consortium_to_c.html)** - Green Star Products (http://www.greenstarusa.com/) and its consortium of independent companies will begin (http://www.csrwire.com/News/7834.html) construction of two demonstration algae-to-biodiesel production facilities in the US and abroad, scheduled to be in production by late summer 2007. (*Green Car Congress*; March 15, 2007)

- **Harvesting algae blooms from the open ocean (http://biopact.com/2007/03/harvesting-algae-blooms-from-ocean.html)** - AlgoDyne Ethanol Energy (http://www.algodynecorp.com/) has developed a new process to harvest biomass from marine algal blooms, that occur in almost all oceans of the world, often caused by man-made nutrient pollution. It could yield huge amounts of biomass usable for ethanol and biodiesel production at virtually no cost. (*Biopact*; Mar. 1, 2007)

- **Making Biofuel from Pond Scum (http://www.renewableenergyaccess.com/rea/news/story;jsessionid=1D673CFD24D01078E8771AE518CAD526?id=47237)** - Algae could produce 100 times more biodiesel per hectare than either canola or soy. It can grow on desert land and doesn't require much rain. Solix Biofuels (http://www.solixbiofuels.com/) has a strain that produces up to 50 percent of its body weight in fat and over half a batch can be harvested for oil production every day. (*Renewable Energy Access*; January 26, 2007)

- **PetroSun field testing Algae biodiesel (http://www.marketwire.com/mw/release_html_b1?release_id=210192&tsource=3)** - PetroSun (http://www.petrosuninc.com/alternative-energy.html) announced that field testing of the cultivation of algae for biodiesel production is in the final stage prior to construction of a commercial facility. This stage will consist of producing adequate algae paste to test biodiesel manufacturers under consideration by subsidiary Algae Biofuels. (*Market Wire*; Feb. 1, 2007)

- **Scientists research algae biodiesel production (http://www.nmsu.edu/~ucomm/Releases/2007/january/algae_biodiesel.htm)** - NMSU is investigating the best ways to grow and harvest certain species of algae, which produce a much higher level of oil than soybeans or canola, as a feedstock for biodiesel production. The tremendous reserves of brackish water, mild climate and abundant sunshine in New Mexico make good conditions for algae farmers. (*NMSU News Releases*; January 8, 2007)

- **Want alternative energy? Try pond scum (http://news.com.com/Want+alternative+energy+Try+pond+scum/2100-11386_3-6145197.html?tag=st.prev)** - Algae is much faster than plants in converting inorganic substances into organic matter, and can be continuously harvested using only waste gas from power plants for fuel. A handful of start-up companies and countless academic programs (http://oed.colostate.edu/) are exploring ways to divert these gases into systems for growing algae, which can then be processed into ethanol and biodiesel. (*CNET News*; December 27, 2006)

- **World first wild algae bio-diesel test drive (http://www.scoop.co.nz/stories/SC0612/S00039.htm)** - The world's first wild algae bio-diesel, produced in New Zealand by Aquaflow Bionomic Corporation (http://www.bio-diesel.co.nz/) , was successfully test driven in Wellington by the Minister for Energy and Climate Change Issues. "We believe we are the first company in the world to test drive a car powered by wild algae-based bio-diesel.‿ explained an Aquaflow spokesperson. (*Scoop*; December 15, 2006)

- **CSU Lab Teams With Solix to Mass Produce Oil From Algae (http://www.newsinfo.colostate.edu/index.asp?url=news_item_display&news_item_id=373795755)** - Colorado State University engineers are working with Solix Biofuels (http://www.solixbiofuels.com/) to commercialize technology that can cheaply mass produce oil derived from algae and turn it into biodiesel. Solix officials plan to commercialize the technology over the next two years, for growing algae on unused land adjacent to power plants and ethanol plants. (*Colorado State University*; December 07, 2006)

- **APS, Greenfuel win Award (http://thefraserdomain.typepad.com/energy/2006/12/arizona_public_.html)** - Arizona Public Service Company (http://www.aps.com/) and its partner GreenFuel Technologies (http://www.greenfuelonline.com/) were recognized (http://www.aps.com/general_info/newsrelease/newsreleases/NewsRelease_358.html) with the Emissions Energy Project of the Year award at the 8th Annual Platts Global Energy Awards in New York. GreenFuel's Emissions-to-Biofuels™ technology uses an algae bioreactor system connected to the smokestack of APS' Redhawk 1,040 megawatt power to recycle carbon dioxide emissions, thereby reducing the amount of CO2 dispersed into the air, and then converts the algae into renewable biofuels. (*The Energy Blog*; December 02, 2006)

- **Green Star Products to Build 90 Algae Biodiesel Reactors (http://www.greenstarusa.com/news/06-11-13.html)** - Green Star Products has signed an agreement with De Beers Fuel Limited (http://www.infinitibiodiesel.com/) of South Africa to build 90 biodiesel reactors that will use Greenfuel Technologies' (http://www.greenfuelonline.com/) algae bioreactor (http://web.mit.edu/erc/spotlights/alg-all.html) for feedstock. Each reactor will be capable of producing 10 million gallons of biodiesel each year for a total of 900,000,000 gallons per year, which is 4 times greater than the entire U.S. output in 2006. (*Green Star Products*; Nov. 13, 2006)

- **A biodiesel hotbed in Nevada (http://www.insidegreentech.com/node/318/print)** - A tiny company called Infinifuel (http://www.infinifuel.com/) is about to begin producing biodiesel powered by geothermal energy. The access to unlimited quantities of warm water also makes the site ideal for experimentation with algae production as a biofuel stock. "If this works, it could yield up to 15,000 gallons of biodiesel an acre, much better than the 50 to 150 gallons averaged today." (*Inside Greentech*; November 13, 2006)

- **Alliance To Make Algae-To-Biocrude by 2010 (http://www.livefuels.com/page1.html)** - Funded by LiveFuels (http://www.livefuels.com/) , the scientific alliance will be led by Sandia National Laboratories, a DOE laboratory, focused on producing biocrude oil by the year 2010. Thriving on sunlight and CO2, algae can be grown in fresh or brackish water on marginal lands unsuitable for food crops. (*LiveFuels*; October 12, 2006)

- **Valcent Products develops bio-reactor for algae oil production (http://www.valcent.net/news_detail.sstg?id=36)** - Vertigro vertical bio-reactor (http://biopact.com/2006/10/global-green-to-earn-exclusive-world.html) is a C02 sequestration system for the mass production of algae that consume C02 using sunlight for photosynthesis. Global Green Solutions (http://www.globalgreensolutionsinc.com/s/NewsReleases.asp?ReportID=152410&_Type=News-Releases&_Title=Global-

Green-To-Earn-Exclusive-World-Rights-For-A-Bio-Fuel-Oil-Production-T...) is funding further development of the technology that is estimated to yield up to 4,000 barrels of oil per acre, per year, at an estimated cost of $20 per barrel, of high grade vegetable oil suitable for bio-diesel fuel. (*Valcent Products*; October 04, 2006)

- **Widescale Biodiesel Production from Algae (http://www.unh.edu/p2/biodiesel/article_alge.html)** - Some species of algae are ideally suited to biodiesel production due to their high oil content (some well over 50% oil), and extremely fast growth rates. Algae farms would let us supply enough biodiesel to completely replace petroleum as a transportation fuel in the US (as well as its other main use - home heating oil) - but we first have to solve a few problems. (*Michael Briggs, University of New Hampshire*)
- **NZ firm makes bio-diesel from sewage in world first (http://www.nzherald.co.nz/section/story.cfm?c_id=1&ObjectID=10381404)** - Marlborough-based **Aquaflow Bionomic (http://www.bio-diesel.co.nz/)** yesterday announced it had produced its first sample of bio-diesel fuel from algae in sewage ponds. It is believed to be the world's first commercial production of bio-diesel from "wild" algae outside the laboratory - and the company expects to be producing at the rate of at least one million litres of the fuel each year. (*The New Zealand Herald*)
- **Biofuel Developer to Join US Research Hot-House (http://www.scoop.co.nz/stories/SC0608/S00067.htm)** - Marlborough-based biofuel developer, Aquaflow Bionomic Corporation, has made another breakthrough as the first New Zealand company to be invited to join the prestigious Girvan Institute of Technology in the United States. Aquaflow recently announced it was the first in the world to commercially produce bio-diesel fuel from algae sourced from Marlborough sewerage ponds. The Girvan Institute is a non-profit, public benefit corporation established to speed up the development of cutting edge technologies into useful products and services. (*Scoop*; August 30, 2006)
- **New company to produce biodiesel from algae (http://www.treehugger.com/files/2006/06/new_company_to.php)** - Algae is capable of producing 30 times more oil per acre than the current crops now utilized for the production of biofuels. Algae biofuel contains no sulfur, is non-toxic and highly biodegradable. Algae BioFuels (http://www.algaebiofuels.com/) , a subsidiary of PetroSun Drilling (http://www.petrosuninc.com/alternative-energy.html) , will be engaged in the research and development of algae cultivation as an energy source in the production of biodiesel. (*Treehugger*; July, 2006)
- **Kwikpower International Plc has acquired Advanced Biofuel Technologies Inc. (http://www.bizjournals.com/tampabay/stories/2006/06/19/daily39.html)** - Advanced Biofuel holds the license to an oil-producing micro algae developed at the U.S. Department of Energy's National Renewable Energy Laboratory in Golden, Colo. (*Tampa Bay Business Journal*)
- **Oil Production from Algae (http://www.fao.org/docrep/w7241e/w7241e0h.htm)** - Algal oils possess characteristics similar to those of fish and vegetable oils, and can thus be considered as potential substitutes for the products of fossil oil. Direct extraction of microalgal lipids appears to be a more efficient methodology for obtaining energy from these organisms, than is the fermentation of algal biomass to produce either methane or ethanol. (*Food and Agriculture Organization of the United Nations (FAO)*)
- **Future of Algalculture & Algal-Biodiesel (http://www.needfulprovision.org/projects/biodiesel.php)** - Preparedness Systems International, with technical support from Needfull Provisions Inc, has developed the foundations of a system based on microalgal biotechnology that converts manure effluent into biodiesel. See U.S. Patent No. 5,121,708. (*Needful Provision, Inc.*)
- **Nanoforce Incorporates Subsidiary Energy Farms in New Mexico (http://www.primezone.com/newsroom/news.html?d=98883)** - Energy Farms is developing methods to cultivate and harvest small photosynthetic organisms in refinery waste for the production of biodiesel. "Micro-algae as a biomass feedstock for the production of biodiesel is an area of intense research at Energy Farms." (*PrimeZone Media Network*)
- **Nature's Oil Production Cycle (http://www.salt.org.il/geo.html)** - Essentially, after being transported in the heavy salt brine streams to great depth, algae proteins hydrolysed and pyrolysed, are the origins of oil. This is an ongoing process, and occurs rapidly, indicating that world's oil resevoirs are continually being 'topped-up'. (*Salt Mrbloch Archive*)

- **Plankton to Provide Clean New Oil (http://www.greaseworks.org/modules.php?op=modload&name=News&file=article&sid=297&mode=thread&order=0&thold=0)** - A system for producing energy from marine algae, to replace fossil fuels and reduce pollution, has been developed by Spanish researchers and will be operational in late 2007, according to its backers. Bernard Stroiazzo-Mougin, president of Biofuel Systems SL (BFS), the Spanish company developing the project, told IPS that "the system will produce massive amounts of biopetroleum from phytoplankton, in a limited space and at a very moderate cost." (*Inter Press Service News Agency*; August 4, 2006)
- **Biofuels from algae - new breakthrough claimed (http://biopact.com/2006/07/biofuels-from-algae-new-breakthrough.html)** - A popular vision on biofuels of the future is that aquatic micro-organisms (algae and plankton) can be used as a biomass feedstock. U.S. Office of Fuels Development funded a program from 1978 through 1996 under the National Renewable Energy Laboratory known as the "Aquatic Species Program". The focus of this program was to investigate high-oil algaes that could be grown specifically for the purpose of wide scale biodiesel production. (*Biopact*; July 22, 2006)
- **Growing algae for biofuels in the Negev desert (http://biopact.com/2006/08/growing-algae-for-biofuels-in-negev.html)** - Algatech (http://www.algatech.com/about.htm) in the southern Negev is turning a collective focus towards biofuels made from algae. Currently focused on products for the nutraceutical and cosmeceutical industries, Algatech's 25-strong production facility based in Kibbutz Ketura will soon begin collaborating with Israeli-US start-up GreenFuel Technologies Corporation (http://www.greenfuelonline.com/) to work towards a common goal: developing cost effective, energy efficient fuel made from micro-algae feeding off of carbon dioxide emissions. (*Biopact*; August 17, 2006)
- **XL TechGroup creates PetroAlgae (http://www.xltg.com/html/news/archive/280906_a.asp)** - PetroAlgae (http://www.petroalgae.com/) is commercializing a proprietary, environmentally-friendly algae that generates over two hundred times more energy per acre than traditional biofuel crops like soybeans. Using a cost-effective, modular cultivation process that can be massively scaled, PetroAlgae will produce renewable feed stock oils for use in applications such as transportation fuels (e.g. biodiesel), heating oil, and plastics. The algae can be grown in many areas, including those regarded as wasteland. The algae mature within 24 hours, permitting daily harvesting, and 50% of its weight is usable oil. To harvest, the oil is simply pressed from the algae. (*XL TechGroup*; September 28, 2006)

Comments

See Discussion page

Discussion Groups

- **Biodiesel from Algae (http://biodiesel.infopop.cc/eve/ubb.x?a=tpc&s=447609751&f=719605551&m=932606061)**
- **oil from algae (http://groups.yahoo.com/group/oil_from_algae/)** at Yahoo
- **Biodiesel from Algae (http://www.biodieselnow.com/forums/13.aspx)** at BioDieselNow Forums
- **oilalgae.com (http://www.oilalgae.com/)**
- "Vertigro and Biodiesel from Algae Resource (http://vertigro2day.blogspot.com/) "

Skeptics

- **An in-depth look at biofuels from algae (http://biopact.com/2007/01/in-depth-look-at-biofuels-from-algae.html)** - This article shows that actual biomass yields for algae obtained in the field are disappointingly low. The yields indicated are real results, not projected, preferred of imagined results.

Several companies have issued press releases about technologies using closed photobioreactors to produce

Logan Utah Wastewater Lagoons To Be Transformed Into Algae Biofuel and Fertilizer Producing Facility

John Laumer
Business / **Corporate Responsibility**
August 27, 2009

Logan Utah, Environmental Department operated regional wastewater treatment plant - 460 acres of lagoons, and 240 acres of wetlands. Image credit:Logan UT Environment Department.

For years I've been reading press releases about impractical-sounding inventions for growing algae in arrays of plastic tubes, genetically modifying algae to optimize biofuel yield, and so on. Pretty much all of it is decades from even pilot scale proof of concept, and most of it missing the cost saving potential of finding industrial and public works synergies.

All the more reason to be impressed by the elegant thinking displayed by USU Energy Dynamics Laboratory researchers and Logan UT officials who propose converting a series of presently polluting wastewater lagoons into an algal bio-fuel (methane) and fertilizer (phosphorus) production facility. If the project succeeds - and I see no reason why it shouldn't - an existing waste facility is made to double as a productive industrial process, discharge permit limits for phosphorus will be met more cost-effectively, and downstream drinking water reservoirs will be better protected.Salt Lake City Tribune covered the story in detail (see Logan to turn sewage lagoons into algae farm: Energy-rich plant feeds off pollutants):Just a few excerpts to give you a flavor.

> For the past several years, detergents and agricultural runoff have turned Logan's five wastewater lagoons into a phosphate-filled soup, posing a menace to sensitive wildlife habitat downstream and racking up costly clean-up bills....A collaborative project between the city and the Utah State University Research Foundation will use the ponds to grow algae, which might not only fix the phosphate problem for little money but produce energy. The city has won a $500,000 state grant to begin converting the 460-acre lagoon complex into an algae farm as a small-scale pilot project..

Here's the money quote:

> The algae cultivated in the lagoons is to be converted to methane and used as fuel for electrical generation and the phosphorus would be extracted to sell to fertilizer manufacturers and other industries.
>
> Issa Hamud, Logan's environmental director, said the city was spending at least $250,000 every year to aerate the lagoons to prevent algae growth and was facing the prospect of building a $180 million treatment facility as a permanent solution to the phosphorus problem.

Now...let's look at this on a much larger scale.

There are numerous rural and suburban waste treatment lagoon systems that could do the same thing, using existing infrastructure, already paid for by local, state, and Federal taxpayers. Hence. this idea is ripe for scale up all over the USA and beyond.

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Better fertilizer

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