Emerald Dairy

Emerald, Wisconsin

Anaerobic Digester - Innovation Through Utilizing Outputs

"The carbon footprint is here to stay, and I believe it will greatly increase over the next few years. Studies have shown over 70 percent of the people in the world believe there is global climate change and that mankind is at least partially responsible. Agriculture should view this as a great opportunity as we'll be looked upon to help solve this problem, and I think the marketplace will reward us for that."
John Vrieze

Summary

Emerald Dairy is located in the Town of Emerald, in St. Croix County, Wisconsin. Emerald Dairy is one of three dairies that are owned by John Vrieze. The other two dairies are Baldwin Dairy and Emerald Dairy II. Emerald Dairy is currently milking just over 1100 cows. The dairy has an anaerobic digester system that takes the manure from the cows and creates outputs that are completely used on-site. As a result, the dairy has lowered its need to import outside products to the dairy. The two overall goals for the dairy are 1) to have a zero or negative carbon footprint and 2) to profit as much from the outputs of the digester and other renewable energy technologies as from the milk produced at the dairy. The dairy is currently working cooperatively with Integrated Separation Systems, Inc. to develop new bio-energy technology for the farming sector.

History and Background

John Vrieze was born and raised in northeastern St. Croix County and began farming on a 50 cow dairy farm. In 2002, John Vrieze first decided to look into how he could implement techniques to his dairies that would help reduce their impact on climate change while at the same time increase his profits. It is his overall goal to export calories without importing nutrients and resources from outside the dairy and to have a carbon neutral dairy operation. In 2007, he was appointed to be a member of the Wisconsin Governor's Global Warming Task Force. Through the task force it is his goal to implement new innovative ways for the agricultural sector of Wisconsin to prosper and profit from the growing consumer interest in climate change and other environmental issues.

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Prepared by Eric Anderson, West Central Wisconsin Regional Planning Commission, and Andrew Dane, Barron & Chippewa County University of Wisconsin-Extension.

Funding was provided, in part, by the Agricultural Marketing Resource Center (www.agmrc.org).

Operation

Emerald Dairy produces 160,000 pounds of milk a day. Combined, the three dairies employ 48 employees, of which 20 are at Emerald Dairy. All of the milk produced at the dairy is sold to Lake Country Dairy in Turtle Lake, WI.

In 2004, a mixed plug flow anaerobic digester was purchased from GHD, Inc. The majority of the anaerobic digester is located underground with roughly two feet above ground. The digester, which operates at mesophyllic temperatures, is 160 feet by 68 feet and 14 feet deep. It is filled with 12.5 feet of manure and 18 inches of biogas. It can hold the waste of up to 4,000 cows and has a life expectancy of between 30 and 40 years. There are 50,000 gallons of manure inputted into the digester every day. The manure moves underground from the cow area to the digester area where it is held at 100 degrees Fahrenheit. Fifteen percent of the biogas that is produced goes into heating the digester to maintain the required temperature. The manure takes 21 days to travel through the digester system. After the 21 day cycle is complete, the initial output is 160,000 cubic feet of biogas per day and the remaining excess is 94 percent liquid and six percent solid. The solid is pressed to eliminate moisture and the remaining solids are used as bedding for the cows at the dairy. The biogas created through the anaerobic digestion process is cleaned up and converted to "natural" natural gas. The dairy produces enough bio-gas to provide a community of 3,500 people with one quarter of its natural gas requirements. At this time, 3M purchases the compressed biogas from the dairy to help contribute to their green energy portfolio.

The dairy produces enough bio-gas to provide the Village of Baldwin (pop. 3,500) one quarter of its need for natural gas.

There is an existing covered lagoon on the dairy that acts as the end of the anaerobic digester process. The lagoon serves as a storage facility for the liquid after the solids are pressed out. The liquids are then used for fertilizer. During the storage process, the lagoon produces methane, which is twenty times more potent than CO_2 in terms of impacting climate change. The dairy receives carbon credits when the methane is burned from the lagoon.

The dairy is currently working with Integrated Separation Solutions (ISS) to create a process to eliminate the need for lagoons on the property. ISS staff makes frequent visits to the dairy and often works at the dairy during the week to analyze

Category
Anaerobic digester

Project Start Date
2004

CO2 and N20 reductions
Ongoing study

Financial savings
Currently breaking even

Initial investments
Digester =$1M
Gas Clean Up facility =$1M
Water treatment =$1.3M

Possible adjacencies
Aquaculture, Bio-diesel, Greenhouse

Project Funding
Bank, Private investors, Self financing, University of Minnesota, and WI Dept. of Commerce

Project status
Ongoing

Contacts
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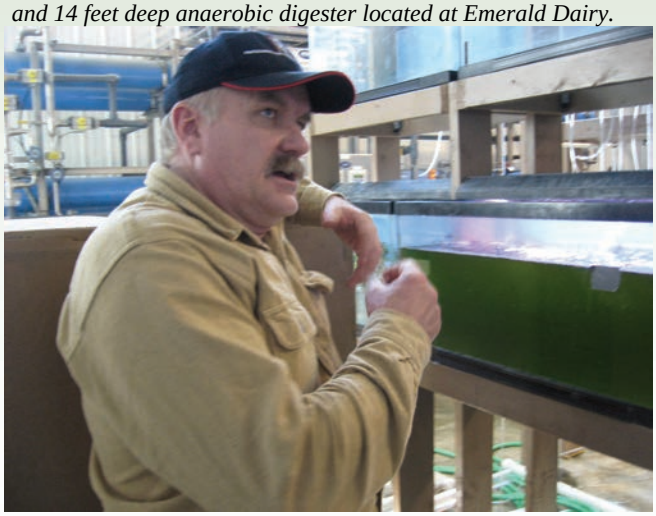
(left to right) John Vrieze from Emerald Dairy, Emerald Dairy II, and Baldwin Dairy in St. Croix County, WI. The goal is to profit as much from the outputs from the anaerobic digester as from the milk that is produced from the dairies. / The 160 feet long, 68 feet wide and 14 feet deep anaerobic digester located at Emerald Dairy.



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(clockwise from left) The machinery used for the ultra filter phase, phase 2, of the process after the manure leaves the digester and the bedding is created./ The final phase, phase 4, consists of reverse osmosis, which treats the water and gets it ready to discharge or incorporate into other by-products. / The bio-algae reactor that will be used to grow algae on the dairy.

results of the water treatment system. At this time, the process is taking the 94 percent liquid and producing liquid organic nitrogen, which is commonly called "tea water". The overall goal is to transform the "tea water" into a productive by-product that can be used on the dairy operation and to eliminate the need for lagoons. ISS has developed a process whereby the "tea water" is transformed into both concentrated fertilizer and treated water.

The process consists of four phases: 1) drum filtration, 2) particle conditioning, 3) ultra filter, and 4) reverse osmosis. Due to the dynamics of this project, ISS owns the equipment and if it is successfully accomplished, it will be the first such example in the U.S. At this time, the dairy is going through the process of obtaining a permit from the EPA to discharge the distilled water which will cost $.01/gallon to discharge. The concentrated fertilizer is being used to fertilize the fields and has fewer environmental impacts than traditional fertilizer. As a result of this process, the amount of fertilizer purchased by the dairy has decreased 95 percent. The dollar amount saved varies by year due to the changing price of commercial fertilizer. As a part of the process, a large percentage of the phosphorous is extracted. The dairy is in the process of analyzing the ability to process the phosphorous and sell it as pellets.

The dairy is also in the process of introducing algae to the treated water in an algae bio-reactor. This will allow the algae to grow and to be used for a variety of uses. The current goal is for the algae to be pressed into oil, which can be processed into bio-diesel. The dairy is

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currently producing bio-diesel at the facility from used vegetable oil from restaurants in Baldwin. The bio-diesel is being used in the trucks that are transporting the biogas from the digester to Baldwin. Another opportunity for the algae is to use it as feed to raise fish on the dairy. The dairy is currently in a pilot process of raising tilapia fish, with a goal of having 30,000 to 40,000 fish on-site. Also, plans are to use the thermal heat from the distilled water for an on-site greenhouse to grow a variety of fruits and vegetables.

Government and Community Relations

Initially, there was a small but noticeable opposition to the project. This stemmed from concerns from neighbors over the production of bio-diesel on the dairy. These concerns were curbed by discussing the project in detail and educating the public on the project as a whole. Since the installation of the digester and bio-diesel production system, there have been no complaints from the public. The dairy has been working with the EPA on obtaining a permit to discharge distilled water on the property. The EPA initially had concerns with the ammonia levels in the waste water. It is anticipated that the permit will be granted in the first half of 2008. Through the process, the dairy has been able to create a wetland on the property which includes a pond. This wetland area has helped increase the quality of groundwater while at the same time has brought back an ecosystem that has been nearly eliminated in many agricultural areas.

The dairy is currently experimenting with algae oil for bio-diesel. Other opportunities include raising fish and a greenhouse, both on-site.

Energy and GHG Reduction

The dairy is now creating more energy than it is consuming. The goal is to sell or use the extra energy at retail rates and not at wholesale values. Due to the ongoing activities on the dairy, the dairy receives carbon credits. The dairy is merchandising the carbon credits through a broker who trades them on the Chicago Climate Exchange (CCX). The dairy is currently in the process of determining the reduction of N2O reductions from the dairy. It is anticipated that there will be a significant reduction of N2O in addition to CO2 reductions associated with the project.

Costs and Funding

The cost of the project as a whole has exceeded $3 million. The digester was purchased in 2004 for $1 million. The gas clean up facility and the water treatment system both also cost roughly $1 million each. The dairy received low interest loans from a Wisconsin Department of Commerce grant program administrated through the West Central Wisconsin Regional Planning Commission. This financing included a two percent, $300,000 loan for the water treatment system, and a four percent, $100,000 loan for the lagoon cover. Additional funding came from banks, private investors, self financing, and the University of Minnesota.

Due to the technology investments, the profit per cow slightly decreased during the initial two years. Currently, the dairy is in a two year period of breaking even after the installation of the new investments. The dairy is anticipating an increase in profit per cow during the next two years due to project financing and the anticipated increase in energy prices. The hope is that the dairy will experience a net profit of $100 per cow annually. At the same time, if carbon footprinting is encouraged or required on dairy packaging, it is anticipated by the dairy that they will hold a market advantage due to their early investments in reducing their carbon footprint.

A net increase in profit per cow of $100 a year is expected to occur during the next two years due to project financing and the anticipated increase in energy prices.

Challenges and Barriers

The challenges and barriers existed mostly in the beginning of the process and will probably occur again during the introduction of this concept to the dairy industry. The challenges included acquiring venture capital having limited knowledge of the subject. As mentioned above, some funding was available through low interest loans through the State of Wisconsin and other lenders.

John Vrieze finds the subject of climate change and how it is relates to his industry very interesting and important, and a significant part of the future of the dairy industry. Most of the learning that he did was self taught, but also consisted of learning through tours, meeting with people, and conferences. He sees another challenge that exists is the continued education of consumers regarding how their purchasing habits can limit global climate change. Research is showing, however, that more and more consumers are increasingly interested in how their purchasing habits impact the global environment.

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Recommendations and The Future

After owning a partially above ground anaerobic digester, the dairy would recommend a complete underground system. This would help save money due to insulation and would be physically out of site.

The next steps for the dairy are to continue working toward a zero carbon footprint and then proceeding on to achieve a negative carbon footprint. One option is to install wind turbines to produce electricity for the dairy. Another goal for the dairy is to discharge and use the excess treated water that is created through the reverse osmosis process. A current idea being tested is growing algae with some of the water that comes out at 100 degrees Fahrenheit and with that algae incorporate an on-site fish farm at the dairy.

At the State level, Mr. Vrieze is proceeding with discussions regarding the idea of placing carbon footprint information on dairy products. This would work similar to the nutritional guidelines now found on the back of food products. It would allow the consumer to view what the carbon footprint is for an individual dairy product. Mr. Vrieze feels that it is important to educate farmers about the opportunities and challenges that may come about as a carbon cap and trade or similar system is put into place to address climate change in the U.S.

> Continued discussions will focus on placing carbon footprint information on dairy products and how this can benefit the Wisconsin dairy industry.

Looking to the future, there has also been discussion regarding a local pipeline network in this part of St. Croix County. The network would be constructed to transport biogas from surrounding dairies to a central

(clockwise from bottom) The milk producing process along with the utilization of the variety of outputs from the manure begins with the cows at Emerald Dairy which produce 90,000 pounds of milk a day. / The goal is to eliminate the need for the existing lagoon on the dairy as seen here. / The dried solids that are created from the manure after it leaves the digester is blown into a holding area and used as bedding at Emerald Dairy.

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"Tour, tour, and tour some more. Spend an adequate amount of time researching new things by using the Internet or going to seminars and classes. Eventually this technology will become common to our industry, but as it's developing there will need to be some amount of time spent on education."
John Vrieze

The dairy industry in Wisconsin is estimated at $20.6 billion a year and employs approximately five percent of the state's workforce. Tapping into avenues to profit from cow waste and addressing climate change may help increase profits for Wisconsin dairy farmers, increase employment and economic development opportunities in rural areas, and position Wisconsin dairies to better compete against out of state dairy operations.

gas treatment facility. Such a system could serve at least two purposes. First, it would make it significantly more feasible to sell biogas that is produced on local dairies to nearby communities for heating during the winter months. Second, a large gas pipeline already extends from Texas to Minneapolis and over through Baldwin. A scenario is that the local pipeline network would feed into the larger pipeline. This type of interconnection would create additional markets for local dairies to sell their biogas to.

The ongoing activity at Emerald Dairy shows how innovation can occur through utilizing outputs. The dairy has not stopped at the installation of an anaerobic digester. It has taken the outputs from the digester and has found ways to use them as tools to decrease costs and increase overall profit. The dairy is on the path of reaching their goal of profiting as much from the anaerobic digester as it does from milk production.

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