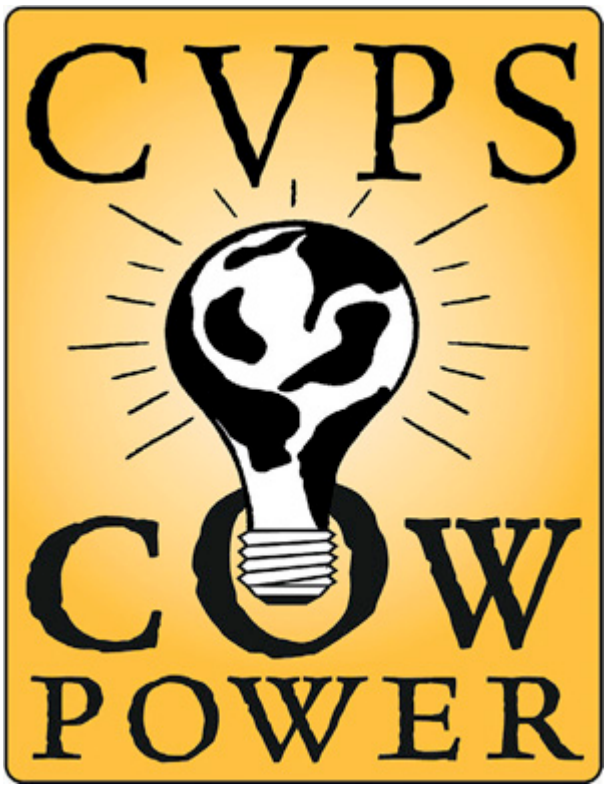

A collection of commonly discussed Q&A's about the CVPS CowPower program

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What is CowPower? Summary information about the program

Can you provide a general description of the program in totality?

The program provides grant money for installing methane digesters, helps broker additional support through state and federal agencies, provides technical assistance, and hooks the farm to the grid as a power supplier.

The program also pays the farmer a production incentive in addition to the grant money, and in addition to a payment for the price for energy. The $0.04/kilowatt-hour production incentive is passed on 100% to the farmers producing Cow Power, or is paid into the CVPS Renewable Development Fund (RDF) if there is more demand than supply and when RECs are not available on the market. The RDF provides grants to farmers, and funds a project coordinator who works with the farmers through the entire process from early evaluation, to actually building their project.

The process of anaerobic digestion picks up where the cows leave off! Dairy cows eat mostly corn silage and hay silage. These crops get their energy from the sun. Solar energy helps grow the crops that farmers use to feed the cows on the dairy farm. However, cows are not 100% efficient at using the energy in the feed. So, after the cows get rid of their waste, it is automatically collected by the farm throughout the day, mixed with the wash water for the milking equipment and pumped into the anaerobic digester. It's a large tank, like a swimming pool, with a cover, that is insulated to help keep it at 100 degrees Fahrenheit, the same temperature as a cow. The same naturally occurring bacteria in the cow's rumen continue to digest the organic compounds in the waste, and turn it into biogas. Biogas is about 60% methane gas, and about 40% carbon dioxide. It is the methane gas portion, which is used as a fuel, to run an engine which is connected to a generator to produce electricity.

How long does this process take?

The process is continuous. Cows are always eating, and the waste flows continuously through the anaerobic digester. The waste spends about 3 weeks being digested in the system to produce biogas. As the fresh farm waste is pumped into the digester, the oldest waste is forced out of the opposite end of the digester.

Does it last longer depending on what season we're in?

The digester is designed to hold 3 weeks of farm waste. On a 1,000 cow dairy farm, that would be about 600,000 gallons. The tank is a fixed volume. If more waste is added, for example if the farm grows larger, then the waste would spend less time in the digester.

The energy production depends on the number of cows producing waste, what they are fed and their feed efficiency. We see some fluctuation due to the weather.

What is the leftover manure used for?

The manure that has been processed in the digester is separated into solid and liquid fractions. The liquids are stored to be used as fertilizer during the crop growing season. The solids, which are plant fibers like grass, corn stalk fibers, grain hulls, etc, are used to replace sawdust on the farm which is normally purchased as bedding for the cows.

Does CVPS actively seek out farmers or do the farmers approach CV?

For the most part we know the farmers in Vermont who are interested, or who could create a viable project and we actively work with these farmers. Sometimes, we also hear from other farmers, and help them complete a feasibility analysis to put the costs and revenues in perspective. Mike Raker is our full time project coordinator in Vermont, who works every day with farmers to identify and solve the challenges to developing their projects. Mike does the initial feasibility analysis, he works with the farms on grant applications, he works with vendors, contractors, and virtually all aspects of the projects.

At Central Vermont Public Service, we complete the initial feasibility study for our Vermont dairy farmers, as well as help them through the permitting, grant and construction/interconnection process.

How does CVPS compensate farmers for their electricity?

The farms in the CVPS Cow Power program are compensated for their electric generation separately from the renewable and environmental attributes of the system. CVPS Cow Power collects the $0.04/kWh premium from the voluntary participants in CVPS electric service territory in Vermont. That money is paid as a production incentive to the farms producing energy for the program. As of January 2010 we have six farms in the program. They are paid this premium quarterly.

Farms within CVPS' service territory (three of the farms) have historically been paid a market based rate for the energy through the CVPS Power Supply department. They were paid monthly for the energy, based on the hourly locational marginal price (LMP) as published by the New England Power Pool (NEPOOL) GIS system. Over the last five years this has averaged $0.067/kWh. At present (February 2010) we are working with our farmers to find a new power supply arrangement because the LMP has been depressed, averaging below $0.04/kWh.

Farms are paid the two payments. For CV Farms, that's been an average of $0.107/kWh.

Farms outside CVPS' territory have a power supply agreement with their local distribution utility. The Cow Power premium is a separate contract. These farms have a variety of arrangements including net metering plus, and fixed price power contracts in addition to the Cow Power premium, which purchases and retires the Renewable Energy Certificates, Methane destruction and other attributes of the generation system.

Why does CVPS think Cow Power has not become more relevant across the country? Have there been discussions to expand and begin a larger scale program nationwide?

There is a national effort called the 25X25 program that is looking to produce 25% of the nation's energy (electric and transportation) from farms and forests by the year 2025. See www.25x25.org. One challenge to greater penetration of programs like the Cow Power program is the price paid to farmers for the electrical energy they produce. In New England, the average wholesale price for electricity is about $0.06/kWh. However, in many areas of the Country, where coal is the main source of fuel to generate electricity, wholesale electricity prices may be $0.02 to $0.04/kWh. A farm of about 1,000 cows would like to earn about $0.12/kWh to install an anaerobic digester and the electric generation equipment.

It's also a challenge to interconnect a generator in a rural area to the electric grid. Most electric distribution systems generate power in a city, and they don't have generators in rural areas. Instead, they run miles of electric wires to bring power to the country. The electric systems were never designed to have a generator at the other, remote end of the system. So, it can create an engineering challenge for local electric utilities to redesign the electric system to accept new generators. As a result, utilities have not generally been receptive to these relatively small systems installed by dairy farmers.

Since CVPS is an electric utility, we wanted to identify how we could overcome these barriers of interconnection, and our electrical engineers were able to design a safe and effective interconnection that works for the farm and the utility.

There has been a great deal of interest from across the country, and around the world to learn from the system we created in Vermont, in order to develop farm based renewable energy in a more widespread fashion.

Also, the Innovation Center for US Dairy (www.usdairy.com/sustainability/), which was recently highlighted in USDA Secretary Tom Vilsack's speech to the Copenhagen Summit, is currently committing more money to farm digester projects across the United States.

Does CVPS think that Cow Power is the most efficient form of alternative energy?

We believe Cow Power is unique in a couple of ways. Cow Power takes something that was considered a waste, and turns it into a renewable resource, without destroying the fertilizer value, and creates a byproduct that the farmers can use as a bedding replacement for their animals.

Cow Power systems produce renewable energy about 96% of the time. They are producing their design peak about 75- 80% of the time. Systems like Wind Turbines and Solar Photo Voltaic produce energy about 30% of the time and 12% of the time respectively.
So CowPower is more available when we need it.

However, we don't have enough cows in Vermont to replace all of our energy needs. We should be looking at all sources of renewable energy, not just one.

Where does CVPS think the United States would be financially and economically if the majority of American citizens were using an alternative form of energy such as Cow Power?

We believe in the short term, renewable energy will cost more. However, its all relative. As we start to use up our fossil fuel resources such as oil and coal, these fossil resources will become more expensive, eventually more expensive than renewable forms of energy. I think by investing in cost effective renewable energy now, we are pushing off the day we will run out of fossil resources, and starting to hedge the cost of energy, by setting renewable prices now, and reducing our dependence on fossil energy.

History of farm methane generation and CVPS Cow Power

Why was the program initiated and who came up with the idea to develop digesters on farms in Vermont?

The first project was undertaken by a highly motivated and innovative farmer in Vermont, the Blue Spruce Farm. They started the project as a means to better manage the nutrients in the manure, reduce odor and weed seeds, produce renewable energy for a premium cost and provided an alternative to sawdust animal bedding. They were a pioneer in Vermont.

We have six operational digesters in the CVPS Cow Power™ program, as well as two experimental systems in Vermont operating under the Net Metering law in a separate electric utility's service territory. There is also one new digester operating under a similar program to the CVPS CowPower™ program in another Vermont utility service territory.

In the 1990's, Vermont was lucky enough to obtain a $625,000 grant from Senator Jim Jeffords through a Federal Ear mark. That effort didn't build any digesters, but assisted with research on the various hurdles to implementation. This effort was led by the Vermont Agency of Agriculture and the Vermont Department of Public Service.

In 2003, CVPS coordinated a team of people to create the CVPS Cow Power™ program, as the direct result of customer demand for new renewable energy projects, and farmers interest in building anaerobic digesters.

Who invented CowPower?

The technology that turns farm waste, and organic waste into a biogas is not new. Cows are anaerobic digesters turning crops into milk, and meat. Using that biological model, digester designers have created a system on a farm that can take farm waste, with the naturally occurring microbes that live in a cow's stomach, that will continue to break down the organic materials for up to three weeks, and produce a biogas, that contains methane. Using that methane to fuel an engine was first done in the US in the late 1970's, after the first energy crisis. Over the years the technology has improved, but it is very expensive. There have been some very large farms that have installed the systems since the 70's as a means to avoid neighbors' complaints over odor. However, what we did at CVPS that is unique, that had never been done before, is to work directly with dairy farmers, digester designers, the Agency of Agriculture, lenders, economic development authorities, and the electric utility to overcome the hurdles to increased development of these types of systems. The main thing we did was to find a way to connect the electric utility customers who were interested in supporting local renewable energy development directly to the dairy farmers who wanted to build systems. This is what it took to increase the price the farmer earned for the renewable electricity they produced. We also identified State and Federal programs that could provide grants for the early adopters, to make it more affordable. These grants are tax dollar based, and since there are incredible societal benefits like odor reduction and greenhouse gas reduction, it seemed an appropriate use of these funds. CVPS also helped by providing a full-time project coordinator to help the farmer through the entire process of evaluating technologies, applying for grants, wading through the permitting process and all other aspects of the projects.

CVPS didn't invent the technology, but we created the program that identified the challenges, and created a means to overcome those hurdles to increase the amount of farm based renewable energy.

When was the idea of manure being used for an alternative form of energy discovered, and when and where did it first begin to take place?

The process of organic waste producing biogas is naturally occurring. It happens in a swamp where old weeds decay at the bottom of the swamp and produce swamp gas. The idea is thousands of years old it's been said that the Romans used their waste to produce biogas to heat water. Some people in developing countries like China and India have a small system to produce gas for cooking from household waste.

The first farm digester was installed in Pennsylvania around 1980, and the first one in Vermont was built in 1982 at the Foster Brothers Farm in Middlebury Vermont. The technology has improved quite a bit since then, but the process is still quite similar. Over the last five years, more digesters have been built across the United State. In Europe, where energy prices are very high, there are thousands of digesters producing energy on farms.

The technology is not new, but the idea of the CVPS Cow Power tariff is new, a way for people to volunteer to provide a little extra money to support a local farmer, producing renewable energy, with great environmental benefits such as methane destruction, odor reduction, and weed seed destruction.

What was CVPS' role in developing the CowPower program?

The Cow Power program was developed from a concept in 2003 that came out of a meeting with a few people at CVPS. We wanted to come up with a source of renewable energy for Vermont, but not follow the rest of the world that was focused on Wind and Solar. Program manager David Dunn had an understanding of anaerobic digesters on farms and proposed the idea. CVPS gave him the 'green light' to develop a plan for implementation and a variety of CVPS employees chipped in to make it a reality. At different times during the planning process we had customer service representatives, billing employees, accountants, lawyers, rate makers, engineers, line crews, system planners and engineers and many others putting in hard work on the project.

We also had a dairy farmer who was interested, and we worked directly with them, along with the other parties in Vermont, including the Department of Public Service, the Agency of Agriculture, Lenders, Environmental Groups, and many others. We also commissioned a marketing study of our customers, to see how interested they were in renewable energy and to learn if they would pay more for new sources of energy and how much would they would be willing to pay.

We worked directly with the Audet family at Blue Spruce Farm (Bridport,VT), the various Vermont groups for support, and our employees at CVPS to create a program, simultaneously with the farm digester and generation system. Interestingly enough, we put all the pieces of the Cow Power voluntary tariff together, which was first available to customers in October 2004. The farm started building their digester in the spring of 2004, and went on line January 2005, after we already started collecting money from our customers to pay for the premium energy produced by the farm.

We then created the CVPS Renewable Development Fund which provides grants for future farm projects, and funds a full time project coordinator to work with farmers. CVPS works to spread the word about the CowPower program in Vermont and across the country. CVPS' goal is to have people copy what we've done, improve on what we've accomplished, and tailor a program that suits their unique, local needs. Dunn speaks locally and internationally to increase the number of

customers who contribute to the CowPower program, so that future farmers will have that revenue stream to pay for their systems.

We hope to have three new systems in 2010 and continue to grow the program, along with the number of customers contributing to the Cow Power program. Many of our commercial customers have seen increases in customers' awareness of their products and their green image by enrolling in the Cow Power Program. For example, The Vermont Clothing Company,(http://weweregreenbeforegreenwascool.org/articles.htm) whose business increased 30% after they signed up for 100% Cow Power. Their customers like that their products are manufactured with 100% Cow Power. (Add Mary Meyer, Long Trail & GMC here?)

Methane Production

How is the substrate collected?

Manure is automatically collected from the dairy barns, and milking equipment wash water is collected by the same systems. Off farm substrates are delivered by truck.

What is done with the effluent?

Farms typically have sufficient land to use the liquid effluent as a valuable fertilizer. They find that post digester liquids are more beneficial to the crops, and don't burn growing plants. This is particularly valuable when using the liquid between hay cuttings.

Can you tell me if methane production is unique to hay/grass-fed animals, or if other types of manure could also produce methane?

Methane is produced by methanogenic bacteria breaking down organic materials, so other animal manure, human waste, food waste, crops, etc will produce methane under the proper conditions. Those conditions include, but are not limited to the right temperature and pH creating an environment where the methanogens thrive, most importantly an anaerobic environment.

Could you also take human waste and integrate that into the same system as the cow manure to produce methane?

Yes this is true, however you have to safely, and legally deal with the effluent. The effluent is roughly the same volume as what you put into the digester. So, you need to have an effective and proper way to use the effluent. Digester will kill pathogens, but the effluent is not sterile, so things like human waste, post-consumer food waste, etc., may contain pathogens that need to be dealt with.

Hypothetically speaking, if I were to collect a sample of manure today and let it sit for 21 days, are there any points along the 21 days that changes occur?

Manure, if it's kept at the same temperature as the host animal (100 degrees for a cow) will start producing biogas after a few days, and for the remainder of the 21 days.. but it would continue at a diminishing rate.. You just get most of the biogas in the first 21 days. Gas production peaks in the first week through second week, then starts to diminish slightly at first then rapidly.

The process in a farm digester is a continuous flow, not a batch process. In the lab, it's easier to create a batch, where you keep it sealed in flask or vessel for a few weeks with a way to allow the gas to expand. On the farm new manure is fed in several times a day, and the oldest manure gets pushed out the opposite end. The volume of the digester dictates the retention time (21 days).

The odor reduction happens over the three weeks. The volatile fatty acids are generally what smell the worst. They are a feedstock for the methanogenic bacteria. So when these volatile components are consumed, the odor is reduced over time…

How much methane is produced in the 21 days that the manure is in the digester?

A typical plug flow digester produces enough gas to operate a 1 kW generator continuously with every five cows. So, 1,000 Cows would operate a 200 kW generator continuously. I understand that there is 110 ft. 3/day produced by a digester for each cow.

The digester is designed to hold approximately 21 days worth of waste produced by the farm, that is animal waste, and milking equipment wash water. The digester typically built by the farms is a plug flow, so fresh waste is pumped into one end of the digester, and the oldest waste is pushed out of the end of the digester. It's a continuous process, rather than a batch process.

Are there plans to involve smaller farms?

Yes, we are working to find other digester vendors who can scale a system to be cost effective on smaller dairy farms, even if they only produce gas for hot water, not produce electricity. Guy Roberts of Avatar in Vermont is building a small modular system, and another company, CH Four Biogas is working on a smaller scale system. We expect to see a CH Four system on a 200 Cow dairy in 2011.

Are there significant economies of scale for bigger methane digesters?

On a larger farm, the cost to build a system is about $1,200 to $1,600 per cow. Smaller farms see an increased cost per cow to build a digester, so the payback is generally extended.

However, there are newer vendors who might be able to reduce costs to smaller farms in the 200 to 500 cow range. The 6 farms in the CVPS Cow Power program range from 600 to 1,500 cows. We will see a new system on a 400 cow farm in 2010, and hope to encourage new vendors to provide solutions to smaller farms in the future.

The farms in CVPS Service territory sell all the electricity the anaerobic digester system will produce, minus station service of the generator and manure handling equipment. And, they buy back the energy they need for the farm operations.

It will be interesting to see technology advance, and perhaps an increase in sales will help reduce the system costs for farmers. We have not seen that yet, but with efforts across the country to increase farm digester development, we may see more competition, which could result in lower overall costs for the farmers.

Animal welfare

How are dairy cows typically housed and fed?

Our farm projects range from 600 Cows to 1,500 Cows, on the operating systems, two experimental systems are on 240 cows and 150 Cow farms.

Dairy Cows in Vermont are typically fed a high percentage of forage (Corn Silage and Hay Silage, Dry Hay), with concentrates to balance out the nutrients. Farms typically bed with kiln dried hardwood sawdust trucked to Vermont from Canada.

Most dairy farmers with 200 cows and above have confined housing freestalls with a focus on cow comfort and efficient ventilation, lighting, feeding, etc.

Digester design, operation, and costs

Who designed the digesters being used in Vermont?

Seven digesters operating on farms across Vermont were designed by GHD Inc of Chilton Wisconsin. One is designed by Avatar Inc, and another is designed by Stanley Weeks, a consultant to the Vermont Agency of Agriculture. In 2010, we expect to see two new designs, CH Four Biogas from Ontario, and RCM, from California.

Who constructs the digester at the farm?

A combination of farm labor, vendor supplied labor, and local contractors install the digesters and supporting equipment and structures.

Who runs the digester day to day?

The operating systems are managed day to day by farm owners. In the future, we may see service company's manage the operation and maintenance.

Where are the digesters located and what about this environment allows for their successful implementation?

Anaerobic digesters have been implemented on many very large scale dairies across the country, mainly as a means to reduce odors and neighbor complaints. These farms, generally milking over 5,000 cows, could fund these systems as a cost of doing business.

However, in Vermont the average farm is 125 cows, with the largest milking 1,500 cows. We needed to do something different.

What substrate are the digesters designed to use?

Digesters are primarily designed for animal manure, but all of the farms are incorporating other organic substrates ranging from whey to ice cream, with other food processing residuals. Each farm is has a different mix, and the organic substrates offer increased energy production, with

relative low volumetric and nutrient increases. The initial digester design should consider the addition of other substrates.

What is the design life of the digester?

20 years on the digester, less on the generation and other manure handling equipment.

What does it cost to install a Cow Power System on a farm?

We have six farms producing renewable energy for the CVPS Cow Power™ program. The average cost for all of the equipment necessary is about $1,400 per cow. So, for a 1,000 Cow Dairy farm, that would be $1,400,000. There are several grant programs available through the Federal Government, the State Government, and the CVPS Renewable Development Fund which in total cover about 45% of those costs. The farmer then has to borrow the rest.

The farm earns money for the energy they produce. Plus, they earn $0.04/kilowatt hour paid by the people who are signed up for Cow Power, plus the farm doesn't have to purchase sawdust, and they use the heat from the generator to heat the digester and reduce their hot water costs in the dairy for washing the milking equipment. The farms are able to pay for their systems in 6 or 7 years with the money they earn and save.

Were any of the operation and maintenance costs above expectation? Below? If so, which and why?

Yes, engine operation and maintenance costs are higher than expected, which we believe is due to the high concentration of hydrogen sulfide, and the lack of availability of small, low cost gas scrubbing equipment. Original estimates of $0.015kWh to $0.020/kWh have doubled to $.030kWh to $.040kWh to maintain the combined heat and power engine system.

What is the average temperature inside the digesters (with heating system)?

The digesters that we have in Vermont are kept at the mesophyllic range or roughly 100 degrees Fahrenheit, using the waste heat from the engine-generator.

How does the heating system inside the digester work?

The heating system is hydronic, meaning that it uses hot water recovered from the engine water jacket and exhaust, and is controlled by zones in the concrete digester tank. The tank is insulated to reduce heat loss.

Is the biogas cleaned?

Scrubbing biogas can be very expensive. We are currently looking at several new products on the market that create a lower cost system. Our farmers use a refrigerated barrel to chill the gas to dry it, and reduce some hydrogen sulfide in the process. Most of the scrubbing is done be the engine oil, which is changed every three weeks or about 500 hours.

How is the manure mixed inside the digester?

There are a variety of means to mix the manure in the digester. The systems made by GHD use a passive mixing system that they patented using the biogas itself. Some designs incorporate propeller or paddle mixing systems.

Is it necessary to separate solids from manure?

All of the existing farm digester systems prior to 2010 in Vermont are whole manure, modified plug flow digesters. The digesters only separate manure after digestion. They recover the plant fibers to use as animal bedding in the freestall barns. All of the manure and milk house wash water is put into the digester.

How do the engines run on methane?

The engines are modified to use the low BTU biogas, which is about 60% CH4 (Methane). The engines are designed for natural gas. They are spark ignited reciprocating engines. The primary supplier in the U.S. is Martin Machinery of Latham Missouri/US. They package engine generators that they modify for biogas fuel. They also provide the switchgear and engine control package, the engine coolant, and the exhaust gas heat recovery system that is used to heat the digester and offset farm purchase of fuel for hot water.

Does the electricity get distributed directly from the farms to the customer's homes or does it have to go back to a sub-station first?

The energy is generated at the farm. The generator is driven by an engine that is fueled by the biogas produced by the anaerobic digester at the farm. That energy is pushed onto the CVPS electric distribution system, and immediately is blended with all other energy sources.

Unfortunately there is no way to guide energy that is produced to any specific end user. Energy on the system flows in all paths to the user. All Cow Power energy is used locally and doesn't flow back to the substation. In the future as we see more distributed generation in Vermont, we may see energy flow back through the substation up to the transmission system, however, generation is currently smaller than loads on a given distribution circuit.

Technically, what does "on the grid" mean?

The grid is a term that covers all the electric system components from the transmission system, substations, and distribution systems that transport energy from generators to electric users.

What type of cost does the farmer have to put forth to start up methane production on the farm? Do some smaller farms participate in a cooperative agreement to "pool the wastes" into the same cow power plant?

Farmers in Vermont, from 600 to 1500 milking cows invest on average about $1,400 per milking cow to install all of the equipment. Grant funding covers 40% to 50% of most projects, cutting the money the farmers need to borrow effectively in half. We are looking into cooperative digesters, but transporting manure to and from the farm is very expensive, and often causes the project to not be cost effective. We are completing a feasibility study on such a project, where in

addition to renewable electric generation, the project could sell heat, in the form of hot water to a local business. This may help pay for the increased transportation costs.

How efficient is the process of burning the gas, and spinning the generator? How much of the energy is converted into heat?

The engine used on the dairy farms is a spark ignited reciprocating engine. It is very similar to a gas engine in a car or truck. These engines are about 25% to 40% efficient at putting energy into the crankshaft and spinning a generator. The remainder of the energy in the biogas is turned into heat in the exhaust, water jacket and oil. That energy is recovered from the water jacket and exhaust and used to heat the digester to 100 degrees F, and also used to heat the milking facility and office, and the hot water used to wash the milking equipment. Some energy is not recovered, but overall efficiency is about 80% or better.

How much of the energy is used to power the plants? Of that how much comes from the process?

Farmers are able to produce a great deal of energy with an anaerobic digester system. Typically at least twice as much energy as they need to run the dairy operation and all of the associated buildings and homes. The actual digestion process is not very energy intensive. For example, a 1,000 cow Dairy will produce about 1,600,000 kWh per year, 200,000 is used to run the digester and associated equipment, 1,400,000 kWh can be exported to the grid for our Cow Power customers.

How much does it cost to maintain one of the plants? How much would it cost to close down the facilities?

Operation and maintenance of the engine generator and associated equipment is about $0.03-$0.04/kWh produced. So, for the 1000 cow dairy example we used above, about $45,000-$60,000 per year. We are not sure how much it would cost to close down the facilities. The facilities consist of a large underground concrete tank for manure storage, and a small building to house the engine, generator, and associated equipment. We don't imaging there would be significant costs to cease operation should the farmer choose to do that. They could probably sell much of the equipment for a salvage value.

CowPower energy production

On the "How Energy Happens" part of your website do you mean that the 30 gallons of manure a cow produces a day can power 2 light bulbs for 24 hours period (i.e., 24hrs of cow manure = 24 hours running 2 light bulbs)?

The volume of manure, and the equipment wash water from the milking system cleaning, will total about 30 gallons per cow / per day. The total daily volume with produce 200 Watts, 24 hours a day, 7 days a week..

What is the total annual production of electricity of all the farms enrolled in CVPS Cow Power?

The six of our farms together produce about 11,000,000 kWh annually or 11,000 mWh.

How many typical households could that power?

A typical CV residential customer uses about 6000 kWh per year, however a typical Cow Power customer uses about 3,000 kWh per year, more efficiency minded I guess. So, using 11,000 MWh per year, it would serve between 1,800 and 3,700 homes per year.

How does CVPS know that Blue Spruce Farm generates enough power to service 300-400 customers?

We know this based on how much the electric meter at the farm measures their energy production in kilowatt-hours. For example, if a farm produces 1,600,000 kWh in 2010, and the average Cow Power customer purchases 4,000 kWh/year, they can then provide enough power for 400 Cow Power customers.

I understand that the average cow can produce 60 pounds of manure everyday, with that, how many cows would it take to power the average household?

Cows, generally produce 20 to 30 gallons of waste per day on a dairy farm, which is mostly water. Water is 8.33 lbs/gallon.

Based on the modified plug flow anaerobic digester design we see mostly in Vermont, it takes about 5 Cows to produce 1 kW of electric generation capacity.

In Vermont, the average home uses about 500 kWh in energy per month. Peak capacity is about 4 kWh (i.e. electric dryer or electric water heater).

It takes about 5 cows to produce the energy used by an average Vermont home.

Given the current evolution of anaerobic digester technology, farms with 500 cows or more will see the best return on their investment in the technology. However, technology is evolving to be more cost effective for smaller farms; we are experimenting with two new systems in Vermont. One is targeted at the 300-500 cow dairy farms; the other is looking to supply digesters for the 100-300 cow dairy farms. So, in time, I believe, most dairy farms will be able to afford a digester. Smaller farms may not invest in electric generation since it is quite expensive, however, they can use the biogas to heat water for cleaning milking equipment, and heating certain areas of the milking facility and offices.

CowPower customer enrollment

What is CVPS' total customer base?

There were 158,848 customers as of February 1, 2010.

What percentage of CVPS customers are currently enrolled in Cow Power?

As of January 2010, there are approximately 2.6% of the residential customers signed up for CVPS Cow power with a range of 1.5% to 4.8% across the regions that CVPS serves. There are about 3,695 customers voluntarily signed up for the program.

What was the rate of enrollment for 2009?

Cow Power enrollment declined in 2009 as you would expect given the financial recession. While we gained new Cow Power supporters, we also lost others. However, we gained customer demand through new commercial customers, which is now our primary marketing focus. We added Middlebury Cooperative Insurance, Harrison Concrete Construction, Long Trail Brewery, March Billings Rockefeller, MarineEngine.com, Mary Meyer Corporation and the new Middlebury College Environmental Center, so energy demand is growing.

What are CVPS' enrollment goals for Cow Power?

We have switched our enrollment goals from number of customers, to kilowatt hour sales. Our target is to keep customer demand ahead of Cow Power farmer's energy supply to maintain farmer and lender enthusiasm for our program.

How much does CowPower cost the consumers?

When CVPS customers sign up to support these Cow Power farmers, it costs an extra $0.04/kWh. These systems are more expensive than very large generation systems like Vermont Yankee or Hydro Quebec which supply most of the energy for Vermont. It's our Cow Power customers, who voluntarily pay the premium, to help our farmers pay for their investment in this technology, help produce renewable energy locally, and reduce greenhouse gasses, like Methane, which have an impact on Global Warming. The program would not work if we didn't have Cow Power supporters in Vermont.

What does CVPS estimate the percentage is of people in Vermont and in the United States that are currently using an alternative form of energy in their homes?

We currently have 2.6% of our Customers supporting the Cow Power tariff. We estimate the number across the U.S. is much smaller than that. It's a voluntary effort, so we think the idea is just catching on.

Do the customers receive their power directly from the farm?

Electricity generated from various sources in Vermont co-mingle once it is injected into the high voltage system. Electricity from cow power generators is indistinguishable from electricity generated by hydro, or nuclear once it's moving through our distribution system. Energy flows in all paths from the generators to the users.

Even if a family didn't feel that they could spare the extra cost, could they support Cow Power through a group's participation?

Yes, we have a few colleges and churches enrolled in the program and many of their members support their involvement.

How many customers to date are signed up to receive cow power electricity, percentage wise?

We have about 3,695 customers signed up to support our Cow Power projects as of January 2010. In January, they purchased about 1,400,000 kWh. These customers range from very small residential accounts purchasing 50 kWh/month up to our largest account, Green Mountain College in Poultney Vermont that purchases about 100,000 kWh/ month.

Since we have about 159,000 customers overall, we have about 2.6% of our residential customers and about 1 % of our commercial customers signed up.

Environmental impact of CowPower

In total (with all 6 farms) how much methane does Cow Power remove from the atmosphere annually as expressed in metric tonnes of CO2 equivalents?

Farms that process their farm waste in an anerobic digester prior to storage reduce their methane emissions from the manure storage pit by approximately 3.4 Metric Tons of Carbon Dioxide equivalents per cow, per year. AgRefresh estimates about 16,200 MT CDE for all six farms.

How would that be expressed in number of cars removed from the road?

According to http://www.epa.gov/cleanenergy/energy-resources/calculator.html it would be equivalent to about 3,095 cars removed from the road.

I'm interested in calculating my carbon footprint associated with my electric usage. Can you provide a current carbon emissions rate for the CVPS system expressed in pounds of CO2 per kWh or similar units?

CVPS' power mix supplies 0.1 lB/kWh of Carbon Dioxide Equivalent. The New England average is 1.1 lB/kWh.

Our power supply is very low carbon emitting. For example, if your annual power usage is 6,000 kWh, your carbon output would be 600 pounds of carbon due to your electric usage.

Are any carbon offsets claimed for the digester(s), and if they are, what information can you offer about that?

The CVPS Cow Power program collects a $0.04/kWh premium from participating retail customers that is paid to the producing farmers, for all of the attributes of the project, such as odor reduction, weed seed destruction, Renewable Energy Certificates and Carbon Credits. All of these attributes are retired in the name of the contributing customers. If the value of Carbon increases in the future, the Carbon Credits may be marketed differently.

CowPower support

Were there any subsidies or incentives which were applied to the project?

USDA Rural Development/Renewable Energy Grants of 25% Competitive
Vermont Clean Energy Development Fund $250K
CVPS Renewable Development Fund $150K
Vermont Agency of Ag $75K,
USDA NRCS for some

What is CVPS' role in bringing the various state & federal agencies into the mix for each farm? Which federal programs help support Cow Power?

CVPS has been instrumental at pulling together all the grant opportunities for the farmer, as well as working with lenders to help them understand the technology and the Cow Power program. USDA has two programs historically that have helped our farmers. Through USDA Rural Development there have been Renewable Energy Grants available from the Farm Bill. We have also seen some funding from USDA Natural Resources Conservation Service, and the EQIP program.

Looking at the federal programs you mention, how does AgSTAR as a "joint" program of the EPA, USDA, and Dept of Energy fit into this? Or does it fit into this? I see that there's a link to the REAP program from the AgSTAR website. Do the grants for farmers come from the USDA and the tracking of digesters & technical assistance come from AgSTAR?

AgSTAR has been in existence for a long time. However, they have not been instrumental in our projects here in Vermont. They share a great deal of valuable information about systems though, so it was useful in researching what systems were out there when we were building the Cow Power program from scratch. We don't get technical assistance from AgSTAR. They are more like a repository of contact information. They don't provide the detailed project coordination and grant application support for our farmers like our project coordinator, Mike Raker does.

Future of CowPower

Does CVPS or any other energy company see a future where Cow Power can have a significant impact on the nation's renewable energy plans?

Given the current state of the art of digester design, only the largest of the nation's dairy farms will be able to build a cost effective anaerobic digester system on their farm. When new technology is released, it often carries with it a higher price in order for the developer to recoup early engineering and development costs, and overcome lower adoption rates by the technology purchaser. However, over time as volume increases, and development costs are recovered, costs can moderate. You can compare this to the PC industry, where just a decade ago, a PC cost $4000..and now much better systems are under $750. We will see this type of technology shift in coming years. New designs, competition, and increased interest in the technology will improve performance, reduce costs, and increase overall penetration of the technology.
In Vermont, we have ten systems installed and interconnected to the electric distribution grid. We have focused in great detail on the hurdles of getting more systems installed not only in Vermont, but how this could be duplicated across the country. Farmers need a fair price for

energy, taking into account the value of odor reduction, greenhouse gas reduction, and the value of local generation.

Given the current technology, we believe Cow Power systems could provide 5% of the nations power supply. Remember this power supply would be considered baseload power supply, in that the systems have a greater than 75% Capacity Factor. If you compare that to wind with a capacity factor of 30% or solar with a capacity factor of 13%, you can see more value. As the technology moderates in price, smaller and smaller dairy farms will be able to afford the technology, and the penetration will increase, providing a greater percentage of the energy in the country. Also, newer digester technology will take organic wastes that are currently dumped into landfills or processed in wastewater treatment facilities (i.e. food waste) and co-digest them to increase energy production significantly, and provide fertilizer nutrients for the farmer's crops. This may bring the total energy produced by farmers up to 10% or 15%.

One of the latest developments in partnership with dairy farmers is the production of algae. Algae need nutrients and carbon dioxide to grow rapidly. The effluent from a farm digester is rich in nutrients, and the exhaust of the generator has a great deal of carbon dioxide. Using these two digester waste streams, a farmer will likely be able to grow a significant amount of algae, which contains oil that can be processed into bio diesel, and the algae is a food supplement for animals. This would offset not electrical energy, but fossil fuel use, which would reduce the greenhouse gas emissions of the farming equipment, and reduce transportation costs. A Cow Power farm in Vermont uses 80,000 gallons of diesel fuel, and if they could get this from algae, it could save the farmer over $200,000 per year, ultimately resulting in less fuel that needs to be imported from the Middle East.

How many farms does CVPS expect to have online by the end of 2010?

Our goal is to have nine farms in the program by the end of 2010.

Cow Power is currently a premium energy service. Will users of this energy source ever see a more balanced, competitive price, specifically to encourage its use?

CVPS believes that over time, we will see a higher price for energy generated by fossil fuels. We will see higher prices for oil, natural gas, and coal as people identify the true costs not only of extracting the fuel, but the environmental impacts of burning fossil fuels, particularly on our climate. If the nation identifies a mandatory Carbon Cap and Trade, and CO2 emissions are taxed, then the energy produced by high carbon emitting sources such as coal and oil, will cost more. Then, we may see the price that currently looks like a premium, be lower than fossil generated electricity in the future, since it would not be levied a carbon tax, since the fuel is renewable based on solar energy grown crops, that are fed to cows, and that byproduct is what is produces electricity, not fuel dug up from deep in the earth adding new CO2 to our atmosphere.

Is Cow Power making as much progress as CVPS had hoped? When do you see Cow Power becoming a major alternative energy source in America?

Cow Power is progressing as we had hoped for in Vermont. We have six farms, which if you look at Vermont compared to other states, and the percentage of dairy farms, we have made better progress in the last five years than anyone. But we are not ready to stop pushing these projects. We hope to see three new projects this year. We would very much like to see five percent of our energy come from Cow Power in Vermont. If the technology becomes less

expensive over the next decade, there may be more than five percent provided by farms and if these farms partner with food processors, they may be able to increase that energy production even more, say to ten percent, which would be huge. We hope by 2025 that 10% of Vermont's energy is coming from farmers, plus a significant portion of biodiesel from Algae grown from the digester effluent, and consuming carbon dioxide from the engine exhaust.

Common misconceptions

"my concern …is the welfare of the animals used for cow power"

It is in the best interest of the dairy farmers to keep the cows comfortable, healthy, and well fed, because those animals live longer, require less medical intervention, and produce the most high quality milk. I have visited several hundred dairy farms throughout the Northeast, and can say that the welfare of the dairy cows is a key focus of each dairy farmer participating in the Cow Power program. A healthy content dairy cow will be more likely to produce a calf every year, produce more high quality milk and milk products, and will remain part of the dairy herd for a longer time. Our farm partners know that the animals they raise for the farm are the most important part of their business. Focus on great nutrition, a healthy living environment, and humane treatment are integral parts of a well run dairy farm, large or small.

People often believe that since the Cow Power farms are presently the largest farms in Vermont, that when a farm is "large", it therefore forgets these business foundations of humane animal treatment? Humane treatment is key, and not based on farm size, but on a well managed, successful dairy farm. I can say in my personal experience, I have seen the full gamut of dairy farm management, from poor to excellent, and it is not inherently related to farm size. Did you know that Vermont's largest farms are small by comparison to the rest of the country. There are farms with tens of thousands of animals on dairy farms to our west.

"Cow power requires cows to spend their entire lives cooped up inside on a concrete floor"

CVPS Cow Power does not require anything of the dairy farms with respect to animal housing. The type of housing is a choice of the farm, and freestall housing is typical on farms of 150 cows or more in Vermont. When I personally visit a Cow Power farm, and compare it to a non cow power farm, I would never use the term "cooped up". The cows are kept indoors, and this is for several reasons, not the least of which is the humane treatment of the cows.

With any barn housing style the cows are kept indoors during the cold weather months, for example November through March. In smaller barns, the tie stall or stanchion variety, the cows are literally chained in place, with food and water within their reach. These barns are more crowded, the cows are restricted, and often have very poor air quality for the cows and the farmers. If the animals are let out of the barn for cleaning chores, they are subject the dangers of icy conditions, which can cause injury. In a freestall barn, the cows have the ability to roam around freely, and have unlimited access to fresh feed, and warmed water. They have access to a comfortable bed to sleep on, and the chance to socialize with other cows in their group. Milking in a tie stall barn has been considered by many as inhumane to the person doing the milking.

For the Spring, Summer and Fall, the cows in most freestall barns are indeed kept indoors. If you visit a Cow Power farm, you will notice that the cows in a modern freestall barn do not walk on bare concrete floors, instead the floors are lined with continuous rubber mats, to reduce the stress on the animals feet, and joints. When dairy cows are put out on pasture, their wastes cannot be managed, and this can impact surface water quality. The cows don't typically have easy access to fresh water while on pasture, or a completely balanced diet. The animals are also subject to bad weather, including temperatures above 70 degrees. A high producing dairy cow can easily become heat stressed at temperatures above 70 degrees. In a freestall barn, the Cows are provided lots of fresh air, fresh water, are shaded by a barn roof with open sidewalls to the outdoors. Ventilation keeps them cool, and not heat stressed, which can reduce reproductive failures, and other complicatons including reduced milk production.

As I stated above, a healthy, comfortable content cow is of prime concern for dairy farmers. Freestall barns provide a healthy, comfortable environment for dairy cows. You can see this first hand by visiting a dairy farm, and watching the animals.

"fed grain that makes them more, well, 'productive' for CVPS"

Dairy cows are fed grain, but it is a small portion when compared to the forage these animals are fed. Dairy cows ration include a high percentage of forage, such as corn silage and grass haylage. Other ingredients are added to balance the diet. The diet is typically balanced by a trained nutrition specialist for each animal depending on age, and milk production levels. This is true of all dairy farms, regardless of housing type. If a high producing dairy cow was not fed some feed concentrate, she would could lose a significant amount of weight, wasting away while trying to produce milk, and nurture the growing calf inside. It would be inhumane to not feed a balanced ration. It is not appropriate to say dairy cows are fed grain to increase Cow Power production. Dairy cows are fed to maintain their health. They are like athletes, and treated as such by consuming a balanced ration for their body type and production level.

Interesting facts

- CVPS Cow Power(tm) was the nation's first farm/manure to energy project by any utility in the country.

- As far as we know, it's also the first manure-to-energy program that helps run an environmental college (Green Mountain College), a local Brewery (Long Trail Brewing Company), an office of the US Forest Service (in Rutland), a National Park (Marsh-Billings-Rockefeller National Historic Park in Woodstock) and New England's largest Alpaca Farm! (Cas-Cad-Nac farm)!

Milking 1,000 Holstein Dairy Cows equals:

- Manure produced daily 30,000 gallons
- Digester volume 1,000,000 gallons, cost of system $1.5 million US for all equipment including genset and switchgear
- Energy produced 1,300,000 kWh annually, at $0.10/kwh or $130,000

- Fibers recovered for animal bedding saving farm $100,000/year
- Cost to operate/maintain engine $0.025/kWh or $32,500/year

- In Vermont, a digester that would handle all the manure from a 1,000 cow dairy, plus some whey from a local cheese manufacturer would cost about $1.75 million US. The price of concrete and steel are very high, and this is the majority of the cost, along with the engine generator, which is about $200,000 for a 300 kVA engine/generator. It costs about $25,000 per year to maintain this system.

- Electricity can power the farm and surrounding area, odor is significantly reduced, the waste heat can heat water for the dairy, or heat the offices or nearby buildings. A byproduct fiber can be mechanically separated to be used as bedding for the animals in barns, or maybe pelletized as a heating fuel.

- There is great potential to maximize the use of agricultural products, by products and wastes. Locating a digester next to a food processor, and building the digester of sufficient size to mix both animal manure and other organic materials, can result in greater energy production. Remember, however, that although the manure is stabilized after processing, there still needs to be farm fields to spread the nutrients as fertilizer for crops.

- The generators run at about 70% capacity factor. So for the 1000 cow dairy, producing 200 kW, about 1,200,000 kWh are produced per year. IN Vermont, the value is about $0.115/kwh for an annual revenue of $138,000. That dairy is also saving about 10,000 gallons of fuel oil, or about $40,000 in water heating costs, and they use a screw press to recover undigested fibers for animal bedding, offsetting about $100,000 in sawdust purchases normally used for bedding.

- After solids are separated for bedding, the liquid manure is a better fertilizer for the crops grown to feed the cows. Nutrients are more available, and the liquid does not burn growing crop foliage. It can be irrigated on growing crops, increasing production and yield.