farm to plate

STRENGTHENING VERMONT'S FOOD SYSTEM

Energy Success Stories

Vermont's dairy farmers and processors are making significant progress in saving and producing energy.

WWW.VTFARMTOPLATE.COM

Greetings Vermont Dairy Farmers,

You are receiving this booklet as an update to the Farm Energy Handbook published almost 10 years ago which provided potential renewable energy alternatives for dairy farms. The world of renewable energy is changing rapidly and this booklet provides many success stories from farmers in Vermont.

Direct and indirect energy costs have wide impacts throughout Vermont's food system. The Energy Success Stories showcase farms, businesses, vendors, installers, and technical assistance providers that have made a difference with energy efficiency savings and renewable energy production.

I hope that you will read the success stories included in this booklet and determine if renewable energy production fits your farming operation. Agriculture provides great beauty, nutritious food and can also provide energy through renewable sources to Vermont. Your dedication to agriculture and now the implementation of renewable energy technology is the backbone of our state.

Chuck Ross, Secretary of Agriculture, Food and Markets

Support for this project was generously provided by the Northeast Dairy Sustainability Collaborative

www.cabotcheese.coop www.benjerry.com www.organicvalley.coop www.stonyfield.com www.sustainablefoodlab.org

On the cover: Ayers Brook Goat Dairy solar PV- Aegis Renewable Energy; heat distribution manifold at Jericho Settler's Farm- Chris Callahan; Guascor engine- Vermont Agency of Agriculture; Brace Farm- Greg Nesbit Photography; Blue Spruce Farm wind turbine- Aegis Renewable Energy; sunflowers processed into biodiesel at Borderview Farm- VSJF; McKnight Farm solar array- Catamount Solar; Roger Rainville and BioPro- Chris Callahan; Paul Betz and Central Boiler eClassic- Chris Callahan.

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Vermont's food system is growing dramatically and the **Farm to Plate Network** is here to support it every step of the way. The Farm to Plate Network—which now numbers over 350 organizations across the state—is collaboratively working together to meet the 25 goals of the Farm to Plate Strategic Plan.

The Energy Cross-Cutting Team of the Farm to Plate Network explores and promotes strategies related to the expansion of on-farm energy production (e.g., bioenergy, solar, wind) as well as the deployment of energy efficiency improvements for farms and food system businesses. The Energy Cross-Cutting Team draws on the expertise of staff from **Efficiency Vermont**, **University of Vermont Extension**, **Vermont Agency of Agriculture**, **USDA Natural Resources Conservation Service**, **Vermont Sustainable Jobs Fund**, and several private consultants.

We would like to thank:

- **Chris Callahan**, Agricultural Engineer at the University of Vermont, for chairing the Energy Cross-Cutting Team and writing the Biomass Success Story.
- **Alex DePillis**, Senior Agricultural Development Coordinator at the Agency of Agriculture, for writing the solar, wind, and digester Success Stories.
- **JJ Vandette** and staff at Efficiency Vermont for preparing the two efficiency stories.
- **Sarah Galbraith**, Vermont Bioenergy Initiative, for writing the biodiesel Success Story.

All Energy Success Stories are on the web at: **www.vtfarmtoplate.com**

Energy Success Stories

Efficiency on a Dairy Farm

Brace Farm Inc.

Ferrisburgh, VT

Highlights: $7,600 in first year savings ● $94,000 in lifetime savings ● 58,300 kWh in annual electricity savings ● Close relationship with the equipment vendor and Efficiency Vermont led to major cost savings and business improvements

Brace Farm Inc. is a small dairy that has been owned and operated by the Brace family since 1984. The current owners, Alex and Michelle Brace, took over operations from Alex's father in 2006. Brace Farm consists of two main buildings, including a tie stall barn where the cows are milked and a separate free stall barn that houses the dry cows. Twice per day, 140 head of Holsteins are milked, and over four million pounds of milk per year are shipped via the St. Albans Cooperative Creamery.

Collecting, cooling, and shipping this volume of milk is an energy-intensive process, and keeping the barns lit and properly-ventilated also adds to the energy requirements of the farm. However, **Alex Brace has taken significant steps to manage his energy use and to use energy more efficiently, all while maintaining milk production and preserving the longevity of his equipment.**

Plate Cooler Saves Energy by Precooling Milk

One of the first energy efficiency projects that Alex implemented was the installation of a plate cooler, which is a heat exchanger that uses water to precool milk, reducing the energy required by the refrigeration system to cool the milk in the bulk tank. This project, as with many others involving his milking equipment, was a collaborative effort between Alex and his equipment vendor, Todd Reed of *Reed's Equipment* (Vergennes). Todd helped size the plate cooler properly and worked with Efficiency Vermont, which helped cover a portion of the equipment costs. By installing this plate cooler, the Brace Farm is now saving 13,811 kWh annually, which amounts to approximately $1,750 per year.

Heat Recovery Unit Saves Energy by Capturing Waste Heat

Every dairy farmer knows that proper sanitation and high milk quality go hand-in-hand. In order to ensure that his milking equipment is sanitized properly, Alex has to have a constant supply of hot water. To reduce the energy required to heat his 120 gallon hot water tank, Alex purchased a new heat recovery unit. This unit captures the waste heat

Alex and his son Dustin in the barn.

Project Summary

	Annual kWh Savings	Customer Savings in First Year	Customer Savings Over Life of Project
2010			
Plate Cooler	13,811	$1,747	$18,663
2011			
Ventilation	4,339	$550	$5,502
Vapor Proof Lights	26,246	$3,482	$52,223
2012			
Milk Pump Variable Frequency Drive	7,658	$1,008	$10,078
Heat Recovery Unit	6,287	$827	$8,273
GRAND TOTAL	**58,341**	**$7,614**	**$94,739**

from his bulk tank compressor to pre-heat the water so that the hot water heater doesn't have to work as hard. Alex replaced his old tank (which had sprung a leak), and Efficiency Vermont helped subsidize the cost with a $1,000 rebate on the cost of the equipment. "This equipment is a no-brainer," says Alex, "and it's very cost-effective."

Energy Efficient Exhaust Fan Improves Ventilation

To ensure his cows were comfortable and the air in the barn was being exchanged properly, Alex determined that one section of his barn needed to exhaust more air. He purchased an energy efficient exhaust fan for the tie stall barn, and Efficiency Vermont was able to provide some financial assistance to purchase a more efficient fan model. With his barn properly ventilated, his herd is exposed to less heat stress, which keeps his milk production more stable through the summer months.

Variable Frequency Drive Decreases Electricity Use

More recently, Reed's Equipment helped install a variable frequency drive (VFD) on the milk pump at Brace Farm, which allows the pump to run at different speeds depending on actual need. When not running at full capacity, less electricity is used. Efficiency Vermont helped subsidize the cost of this installation, as well. This new VFD holds the vacuum level better, which allows for milking times to be faster—and is better for the cows, too.

New vapor-proof lighting in the dry cow barn.

Photo credits: Gregory Nesbit Photography

Durable Vapor-Proof Lighting Provides Even Light Distribution

Alex also took advantage of the rebates that Efficiency Vermont offers for agricultural lighting. He installed energy efficient vapor-proof lighting that was both more efficient than his old lighting and provided better light distribution. "The light output is great," says Alex. He also changed out the older, less-efficient lighting in his shop.

Looking to the future

Alex and Reed's Equipment are discussing the installation of a variable speed milk transfer unit, which will slow the flow of milk through the plate cooler in order to maximize the heat exchange and will further reduce the burden on the compressors cooling the bulk tank.

Alex explaining how the variable frequency holds the vacuum level on his milk pump.

Efficiency Resources

▶ **Efficiency Vermont Agriculture webpage:**
www.efficiencyvermont.com/For-My-Business/Solutions-For/Agriculture-Farms

▶ **Efficiency Vermont Agricultural Energy Efficiency Rebate Form:**
www.efficiencyvermont.com/For-My-Business/Ways-To-Save-and-Rebates/Agricultural-Lighting-Equipment/General-Info/Overview

▶ **Efficiency Vermont Agriculture Loan:**
http://efficiencyvermont.com/For-My-Business/Solutions-For/Agriculture-Farms/general-info/financing

▶ **Natural Resources Conservation Service's Environmental Quality Incentives Program (EQIP):** www.nrcs.usda.gov/wps/portal/nrcs/main/vt/programs/financial/eqip/

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Efficiency Vermont

www.efficiencyvermont.com

With funding support from the Northeast Dairy Sustainability Collaborative:

Cabot Creamery Cooperative, Ben & Jerry's, Stonyfield, Organic Valley, Vermont Agency of Agriculture, and coordinated by the Sustainable Food Lab

Efficiency at a Dairy Processor

Commonwealth Dairy

Brattleboro, VT • www.commonwealthdairy.com

Highlights: $150,000 in first year savings • $2.1 million in lifetime savings • 1.5 million in annual kWh savings • Refrigeration system, compressed air system, motors, lighting, heating, and ventilation optimized

When German Company Ehrman AG partnered with *Commonwealth Yogurt, LLC* to expand to New England, they were impressed by Vermont's approach to energy efficiency. That, coupled with a wealth of dairy farms and yogurt enthusiasts, was enough to convince them to break ground in Brattleboro in 2009. Today, the Ehrmann Commonwealth Dairy team sells yogurt under the local brand name *Green Mountain Creamery* and they also make private label yogurt products for retailers throughout the region and beyond. **A major overhead expense is energy, including propane and electricity. Maintaining an energy efficient facility is imperative for any manufacturer and has become even more important in the increasingly competitive yogurt market.**

Laying the Groundwork Early for Maximum Energy Savings

By consulting with *Efficiency Vermont* from the beginning, Commonwealth was able to make strategic choices that continue to benefit them today—and they haven't stopped there. Though their facility is widely considered to be state of the art due to their extensive control systems and the latest in processing equipment, Commonwealth continues their pursuit of efficiency.

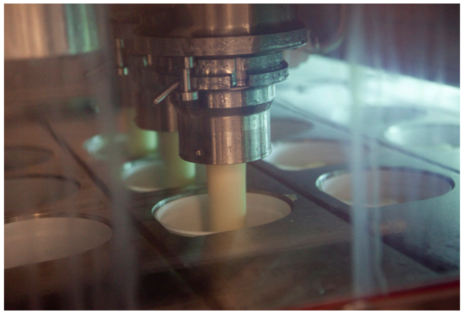
One notable improvement was catalyzed by working with their Efficiency Vermont account manager to assess and adjust their compressed air system, which yielded an annual savings of $22,300. Commonwealth was in need of a backup compressed air system, and after an analysis, recognized that their existing compressed air system was oversized. They purchased a smaller compressed air system for their daily operation and were able to use the existing larger system as the backup. Commonwealth uses compressed air for many parts of their process such as their pneumatic valve clusters—these move product from one point in the process to another—and they pressurize all of their tanks with clean, filtered air in order to keep the product as fresh as possible.

Another notable component of Commonwealth's efficiency projects was the inclusion of a water-cooled chiller system with variable speeds. This more efficient refrigeration

Commonwealth employees in front of the milk storage silo.

Project Summary

	Annual kWh Savings	Customer Savings in First Year	Customer Savings Over Life of Project
2011			
New Construction *(HVAC, lighting, motors, occupancy sensor, variable frequency drive)*	1,203,328	$116,649	$1,684,489
2012			
Compressed Air System	232,332	$22,296	$285,325
2013			
Facility Expansion *(HVAC economizer, lighting, occupancy sensor, variable frequency drive motor control)*	7,658	$1,008	$10,078
GRAND TOTAL	**1,525,181**	**$150,698**	**$2,112,033**



Filling Greek yogurt containers.

system allowed Commonwealth to meet the requirements of their processes all while using less energy. Other energy efficiency efforts that were undertaken include efficient motors, lighting, heating, and ventilation. **Regardless of the size of the operation, employing energy efficiency strategies at a dairy processing facility is most effective when implementing energy saving techniques across various levels of production.**

From Overhead to Investment—Putting Energy to Work, Wisely

These ongoing efficiency measures have opened up significant cash flow for Commonwealth, enabling them to expand their operations, distribute more yogurt, and hire more people. Commonwealth is also collaborating with other businesses to ship whey byproducts as biofuel. The byproducts are being used as animal feed for a nearby farmer and in a local biodigester. This effort not only decreases the pressure on the local wastewater treatment facility but it also helps reduce the waste stream and increases the sustainability of their business operations.

Energy can be a significant portion of operating costs for dairy processors and using this energy more efficiently can have a great impact on a processor's bottom line. "Financially speaking, managing our energy and reducing our usage is hugely important to the success of our company. Energy is one of the top, if not the top, overhead cost that we're faced with," says Commonwealth Dairy's CFO, Ben Johnson. "I know when I am starting any new project in the facility, trying to engage the Efficiency Vermont team to get a good review of what we're trying to do is part of the project kick off. This allows us to get good suggestions on something we could actually act on, if appropriate."

> *"Balancing energy efficiency and capital expenditures is a challenge, which is why the Efficiency Vermont team is such a valuable resource. Efficiency Vermont understands that businesses must realize a payback on their capital investments and they do a great job of laying out the data and presenting the payback realistically."*
>
> —Ben Johnson, CFO, Commonwealth Dairy

Photo credits: Gregory Nesbit Photography

Commonwealth's Clean In Place (CIP) process.

Efficiency Resources

- **Efficiency Vermont Manufacturing webpage:** http://efficiencyvermont.com/For-My-Business/Solutions-For/Manufacturing
- **Efficiency Vermont Ways to Save and Rebates:** www.efficiencyvermont.com/For-My-Business/Ways-To-Save-and-Rebates
- **Focus on Energy, Dairy Processing Industry Energy Best Practice Guidebook:** www.focusonenergy.com/sites/default/files/dairyprocess_guidebook.pdf
- **Energy Efficiency Improvement and Cost Savings Opportunities for the Dairy Processing Industry:** www.energystar.gov/buildings/sites/default/uploads/tools/Dairy_Guide_Final_With_LBNL_Number.pdf?a026-5abd

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Efficiency Vermont

www.efficiencyvermont.com

With funding support from the Northeast Dairy Sustainability Collaborative:

Cabot Creamery Cooperative, Ben & Jerry's, Stonyfield, Organic Valley, Vermont Agency of Agriculture, and coordinated by the Sustainable Food Lab

Solar PV on a Dairy Farm

McKnight Farm

East Montpelier, VT • www.facebook.com/McKnightFarmVT

Highlights: 95 kW (AC) of installed capacity • ≈120,000 kWh generated annually • Payback period = 6 years • Fixed rack solar PV systems and trackers are common throughout Vermont

McKnight Farm, an organic dairy that milks more than 200 cows and sells beef, requires a lot of electricity to make compressors, refrigeration, water pumping, and ventilation systems work. To eliminate this significant recurring expense, owner Seth Gardner invested in a solar photovoltaic project that would meet all of his farm's electricity needs.

Solar photovoltaics, also called panels or PV for short, are made of a semiconductor material that directly turns the photons in sunlight into electricity. A complete solar PV system consists of four things: solar panels, a way to mount the solar panels (either on a roof or on the ground), the electronic conversion equipment (i.e., an inverter), and the electrical synchronizing and safety equipment to connect the electricity to the utility's network. With well over 2,000 installations, solar PV is far and away the most common type of renewable energy installation in Vermont. Farmers have two ways to be compensated for the electricity generated by their solar PV systems: the *Sustainably Priced Energy Development (SPEED) Program* and *net metering*.

Vermont SPEED

Solar PV systems are the most common type of renewable energy installation in Vermont, but they only account for 4-5% (> 40 megawatts) of the installed capacity of all renewable electricity systems. This is rapidly changing, however, as Vermont SPEED incentives for solar PV projects—$0.257 per kilowatt-hour for 25 years—have triggered a wave of "solar farms," including 21.4 *megawatts* (MW) of SPEED-approved projects on 10 solar farms in 2013 alone—with another 40 MW in applications that did not receive approval. Since dairy farms have about 60% of the total cropland in Vermont, many farmers are investigating larger solar PV systems on a portion of their land.

Net Metering

Although SPEED does allow projects of 150 kilowatts or lower, as a practical matter most SPEED solar projects are rated at over 2 MW. Farmers can pursue small and medium-sized projects via net metering. A net metered project means that the renewable electricity generated by the consumer is applied as a credit—capped at $0.20 per kilowatt-hour—to offset electricity that would normally be purchased from the utility. Electricity generation in excess of the consumer's use during a billing period is credited to their account for future use. Solar energy generators in *Green Mountain Power* territory can receive an additional $0.06 credit per kilowatt-hour.

McKnight Farm solar array in East Montpelier, showing about one quarter of the 1.5-acre array, which is rated at approximately 95 kilowatts power output. The system was built by Catamount Solar.

Photo Credit: Catamount Solar

Gardner began planning his solar PV project for offsetting his farm's electricity use in spring 2012, and received a certificate of public good from the Public Service Board in September 2012. McKnight Farm benefitted from something that's uncommon in most states: "group" net metering. Group net metering allows energy generators to share their credits across multiple meters at the farm, or they can be set up by a group of neighbors or relatives to share the production of a single system. The only requirement is that all the group beneficiaries are in the same utility service area.

Siting Considerations

In some instances, a barn roof is perfect for solar PV if there is enough space, a south-facing orientation, and a strong enough structure. Ground-mounted systems are increasingly common and are generally of two types: trackers or fixed racks. Trackers (e.g., *AllSun Trackers*) are poles that support a set of panels and a mechanism that continually moves the panels to point directly at the sun during the course of a day. Fixed racks consist of steel posts driven into the ground, forming fixed rows of panels angled at 30 degrees and generally facing due south. The choice between trackers and fixed racks is context-specific. For example, trackers generate more electricity, especially later in the day, but generally require more land and may cost more. Farmers should weigh cost, conversion efficiency, land access, geographical factors (e.g., soil type), and other concerns when making a decision. To date, all SPEED projects except the *South Burlington Solar Farm* are fixed rack systems, but hundreds of net metered trackers are also generating electricity across Vermont.

Working with *Catamount Solar*, Gardner chose a site with good access to the sun and that was already maintained as a buffer between organically managed acreage and the adjoining conventional acreage. Gardner chose a fixed rack ground-mounted system because fixed racks are simpler and lower cost than trackers. To have enough area of solar panels to be able to generate the equivalent of his farm's total annual electricity usage required 1.5 acres of land for 416 panels. Because the site selected had very thin soil cover—with ledge only inches below ground—Catamount and Gardner chose to pour concrete blocks and mount the racks with the panels by drilling into the concrete. All of this work was completed between early November and the end of December.

To pay for this project, Gardner received a $255,000 loan from VEDA's agricultural loan organization, the *Vermont Agricultural Credit Corporation* and a $36,000 rebate from the State of Vermont. The system is also eligible for a $85,620 federal tax credit. According to Catamount, the system is expected to produce about 120,000 kWh annually, valued at $25,200. Including the tax credits and depreciation value, the system payback is expected to be 6 years. Most of the electricity generated is allocated to the meter for the milking barn, with about 20% going to the freestall area, and the rest to the house.

Producing Food and Energy

Whether using trackers or fixed racks, it is possible to use the area around the panels for farming if you plan ahead. For cropping or hay, consider the spacing and height necessary to run your planting and harvesting equipment. For pasture, consider the strength of the poles when livestock might rub against them, and consider the necessary height to avoid damage from grazing sheep, cows, horses, or other livestock.

Steers on pasture underneath solar panels mounted on livestock-tough poles in South Deerfield, MA.

Photo Credits: Hyperion Systems, LLC

The dual land use pole and spline mounting system patented and installed by Hyperion Systems, LLC, Amherst, MA, demonstrates the possibility of baling hay between rows of solar panels on a farm in South Deerfield, MA.

Solar Resources

▶ **Background Information for Net Metered Projects:**
http://psb.vermont.gov/utilityindustries/electric/backgroundinfo/netmetering

▶ **Find a Solar Installer in Your Area Through Renewable Energy Vermont:**
www.revermont.org/main/?s=Solar

▶ The **Database of State Incentives for Renewables & Efficiency** (DSIRE) is the best source of information on financing:
www.dsireusa.org/incentives/index.cfm?re=0&ee=0&spv=0&st=0&srp=1&state=VT

Prepared by

ALEX DEPILLIS

VERMONT
AGENCY OF AGRICULTURE, FOODS & MARKETS

http://agriculture.vermont.gov

With funding support from the Northeast Dairy Sustainability Collaborative:

CABOT CREAMERY COOPERATIVE, BEN & JERRY'S, STONYFIELD, ORGANIC VALLEY, VERMONT AGENCY OF AGRICULTURE, AND COORDINATED BY THE SUSTAINABLE FOOD LAB

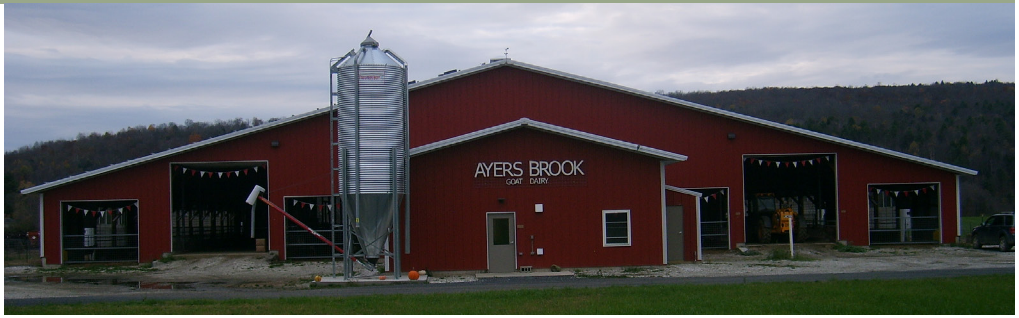
Energy Success Stories

Solar PV on a Dairy Barn

Ayers Brook Goat Dairy

Randolph, VT • www.vermontcreamery.com/ayers-brook-goat-dairy

Highlights: 150 kW (AC) of installed capacity • ≈200,000 kWh generated annually • Minimal changes to the roof structure required • Largest PV installation on a barn in Vermont



Ayers Brook Goat Dairy's new barn in Randolph, central Vermont, is designed to house 500 goats, including state-of-the-art facilities for milking, breeding, and for raising goats for the dairy and for the region's goat farmers.

Upon retirement, Carol and Perry Hodgdon sold their 116-acre Randolph cow dairy farm to Evergreen Conservation Partners—a partnership of the *Castanea Foundation*, *High Meadows Fund*, and the *John Merck Fund*. Evergreen Conservation Partners then leased the land to *Vermont Creamery*, Vermont's largest goat cheese producer.

The vision of Vermont Creamery co-founders, Bob Reese and Allison Hooper, is for the new *Ayers Brook Goat Dairy* to serve as a catalyst for growing Vermont's goat dairy industry. Ayers Brook milks about 230 goats in season—and has a goal of milking 500 goats—to supply the Vermont Creamery facility in Websterville with a steady supply of local goat milk. The number of farms raising goats and selling goat products in Vermont has increased 106% over the past 15 years, from 221 in 1997 to 457 in 2012. The vision for Ayers Brook also included permanently protecting the land with a conservation easement with the *Vermont Land Trust*, providing a national venue for teaching and training, and offering high-quality replacement stock to the region's goat farms.

The 572 solar panels, here shown almost fully installed, use the one-third-acre south-facing roof, mounted on a frame designed by Aegis Renewable Energy. The image was captured using a remote-controlled helicopter.

Photo Credit: top- Vermont Agency of Agriculture; bottom- Aegis Renewable Energy

Large *solar photovoltaic* arrays on barns are unusual in Vermont because there is typically room on the ground that can be re-purposed for solar panels. Large ground-mounted solar PV systems (e.g., fixed rack systems like *McKnight Farm* has, or trackers) are increasingly common on land owned by Vermont farmers. For some projects, this means that the land is taken out of agricultural uses for the lifetime of the project. For others, the ground-mounted solar PV arrays are developed in a way that allows livestock to graze under and around the installation (e.g., sheep graze around the *Ferrisburgh Solar Farm*).

At Ayers Brook, the quality of the bottomland, the conservation easement, and the new 14,000 square-foot, south-facing barn roof all pointed to a roof-mounted solar array. With the *federal tax credit*—equal to 30% of expenditures—set to expire in 2016, Bob and Allison decided to move forward with the project and hired *Aegis Renewable Energy* (Waitsfield). However, the barn roof structure was designed to minimize roosting places for birds, and consists mostly of widely spaced rafters rather than trusses and purlins. Aegis worked with structural engineers to analyze the roof structure and develop a simple modification to the trusses to bring the roof into code compliance for the added load of the array. To mount the solar panels, Aegis designed a roof-mounted metal frame to span the 12-foot distance between each rafter. To account for the additional roof load of five pounds per square foot, the barn designer (*Lester Buildings*), with the builder (*BCI Construction, Inc.* of Orwell, Vermont) reinforced a small section of truss near the peak of the roof. **The Ayers Brook 150-kilowatt array, installed in July 2014, is the largest barn-mounted solar project in Vermont.**

Siting Considerations

When considering a new barn project, or even a significant expansion, you can work with structural specialists and the solar installer to find out what it would cost to make the roof's supporting structure "solar ready." Sometimes all it takes is putting the relevant people in touch early enough in the project. In general, if you are building a new barn you should try to have a clean, unpenetrated roof surface with good southern exposure and orientation.

For large projects over 100 kW you should consider bringing three-phase power to the site since it can maximize the investment in the solar array and will benefit the farm with all other electrical needs such as vacuum pumps and manure pumps.

In this case, payments on the loan are more than paid for by the savings. Some of the power is *net metered* to the adjoining farmhouse meter, and the rest goes to the Vermont Creamery facility in Websterville. **The total cost of the project was $525,000, and that was reduced by 30% using the *federal investment tax credit* and by 7.2% by the Vermont business investment tax credit. The project has a payback period of 17.5 years at full cost, which is reduced to 11 years with federal and state tax credits.**

Solar Energy and Energy-Efficiency — a Happy Marriage

Ayers Brook scoped out options for efficient lights and ventilation. With technical assistance and financial incentives from *Efficiency Vermont*, they installed LED (light-emitting diode) fixtures in the freestall and elsewhere, and incorporated as much natural light as possible. Over half of the estimated electricity savings will come from the lighting design. The other big savers are automated, insulated side curtains, along with "chimneys" that are weather-controlled and exhaust air out of the building. Altogether, compared to a typical barn scenario, **this energy-efficient equipment and design is estimated to save Ayers Brook over $10,000 per year.**

Ventilation controls provide optimal animal comfort and vary the air flow according to the conditions.

As with anything the Ayers Brook does, the point is to make the goats comfortable, with as much natural light as possible, and optimal temperatures, year-round. Ayers Brook found a way to marry this goal to state-of-the-art energy systems.

Photo Credits: kid- Aegis Renewable Energy; others- Vermont Agency of Agriculture

Miles Hooper, crop and operations manager of Ayers Brook Goat Dairy, shows off the solar roof, along with some of the dairy's goats. On this fall day, the insulated curtains are about half-way open.

Solar Resources

- **Background Information for Net Metered Projects:**
  http://psb.vermont.gov/utilityindustries/electric/backgroundinfo/netmetering
- **Find a Solar Installer in Your Area Through Renewable Energy Vermont:**
  www.revermont.org/main/?s=Solar
- The **Database of State Incentives for Renewables & Efficiency** (DSIRE) is the best source of information on financing:
  www.dsireusa.org/incentives/index.cfm?re=0&ee=0&spv=0&st=0&srp=1&state=VT

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http://agriculture.vermont.gov

With funding support from the Northeast Dairy Sustainability Collaborative:

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Wind Energy on a Dairy Farm

Blue Spruce Farm

Bridport, VT • www.bluesprucefarmvt.com

Highlights: 100 kW of installed capacity • ≈150,000 kWh generated annually • Unique partnership with Green Mountain Power facilitates community-scale wind energy installation

The Audet Family has operated Blue Spruce Farm since 1958 and currently milk about 1,500 cows that produce over 30 million pounds (3.6 million gallons) of milk per year. Dairy operations consume quite a bit of electricity. To offset this cost, Blue Spruce Farm was the first participant in the *Green Mountain Power* (GMP) *Cow Power program*, which uses anaerobic digestion to turn manure generated on the farm into about 2.4 million kilowatt-hours of electricity per year. Additionally, in 2013 the Audets partnered with GMP to host a 100 kW wind turbine under a unique arrangement that required no cost from the farm. In exchange for locating the wind turbine on their farm, the Audets receive 10% of the electricity, while the remaining 90% is sent on to the grid. As GMP focuses on building small-scale renewable energy projects in their service territory it may be possible for more Vermont farmers—who own a significant amount of Vermont's land area—to partner with the utility.

Just after Memorial Day in 2013, the Audet family hosted a community celebration of the installation of a 100-kilowatt wind turbine. A portion of the electrical output of the turbine is allocated to the local school.

Vermont's Wind Resource

Vermont's wind resource varies a lot from one place to another due to wind direction, ground obstructions, surface roughness, as well as elevation in relation to the surrounding topography. The strongest wind resources are generally located at higher elevations and that is where Vermont's four large installations—*Kingdom Community Wind*, *Sheffield Wind*, *Georgia Mountain Community Wind*, and *Searsburg Wind Farm*—are located. But Vermont also has nearly 200 small-scale net metered wind projects—ranging in size from 0.95 kilowatts (kW) of generating capacity to 100 kW—that are powering homes, schools, businesses, and farms. Farmers can get a first approximation of average annual wind speed on their land using the *Renewable Energy Atlas of Vermont*.

Installers may also put up an *anemometer tower* to measure wind speed at the eventual height of the blades, but this can cost upwards of $30,000. For the Blue Spruce Farm wind turbine, contractor *Aegis Renewable Energy* (Waitsfield) used a wind site analysis tool developed by *AWS Truepower*. This analysis tool is based on decades of data collection and predicted an average annual wind speed of 11.5 miles per hour (5.14 meters per second) at 120 feet (37 meters) above the ground.

Because of Vermont's abundant hills and trees, it pays to have a tall wind turbine (i.e., the taller the turbine, the stronger and smoother the wind). At 120 feet tall, the *Northern Power Systems* wind turbine model 100-24—manufactured in Barre—is well-suited to this moderate wind resource. Each of the three blades is almost 40 feet long, and the turbine includes a mechanism to detect the wind

The Energy Atlas shows 10-11 mile per hour wind speed (purple overlay) at 100 feet above ground at Blue Spruce Farm in Bridport.

Photo Credit: Vermont Agency of Agriculture speed and direction in order to face the blades into the wind. The generator for this turbine starts generating power at seven mph (or three m/s), but wind speeds of 10-20 mph are the bread and butter of this turbine's output profile.

The Northern Power 100-24 is designed for low maintenance. It is gearless and the generator uses permanent magnets to create the electrical field. No gear box also means the NP 100-24 is very quiet. Maintenance personnel climb a ladder inside the turbine to access the generator and blades.

Erecting the turbine was a three-stage process: beginning in early February 2013, Aegis Renewable Energy broke ground for the foundation and began digging trenches for underground electrical service. The contractor first excavated a 15-foot deep hole for the foundation, built the bolt cage assembly and forms for the concrete, and then poured the foundation, which required about 30 yards of concrete.

The concrete foundation cured for 28 days, after which assembly and erection of the tower, nacelle (generator housing), and rotor were completed in two days. Finally, commissioning and utility interconnection took another day and a half. In its first six months, the turbine has operated without interruption. Aegis estimates the turbine will produce about 150,000 kilowatt-hours per year—enough electricity for about 20 Vermont homes.

A below-ground pad of reinforced concrete is connected to a ring of rods (the "bolt cage"), visible in the photo, that rise to a few inches above ground level. This ring will also be encased in concrete, except for the top few inches, onto which the tower is bolted. Also shown are the electrical conduits, which will come up through the concrete floor inside the tower.

Blue Spruce Farm also operates one of the first manure digesters in Vermont, under a separate limited liability corporation. Marie Audet is an active advocate of on-farm energy production.

Photo Credits: Aegis Renewable Energy

Wind Resources

- **Background Information for Net Metered Projects:** http://psb.vermont.gov/utilityindustries/electric/backgroundinfo/netmetering
- **Find a Wind Installer in Your Area Through Renewable Energy Vermont:** www.revermont.org/main/?s=wind
- **AWS Truepower Provides Site-Specific Estimates for a Fee:** www.awstruepower.com
- **Northern Power Systems Manufactures Wind Turbines in Vermont:** www.northernpower.com

Prepared by

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http://agriculture.vermont.gov

With funding support from the Northeast Dairy Sustainability Collaborative:

Cabot Creamery Cooperative, Ben & Jerry's, Stonyfield, Organic Valley, Vermont Agency of Agriculture, and coordinated by the Sustainable Food Lab

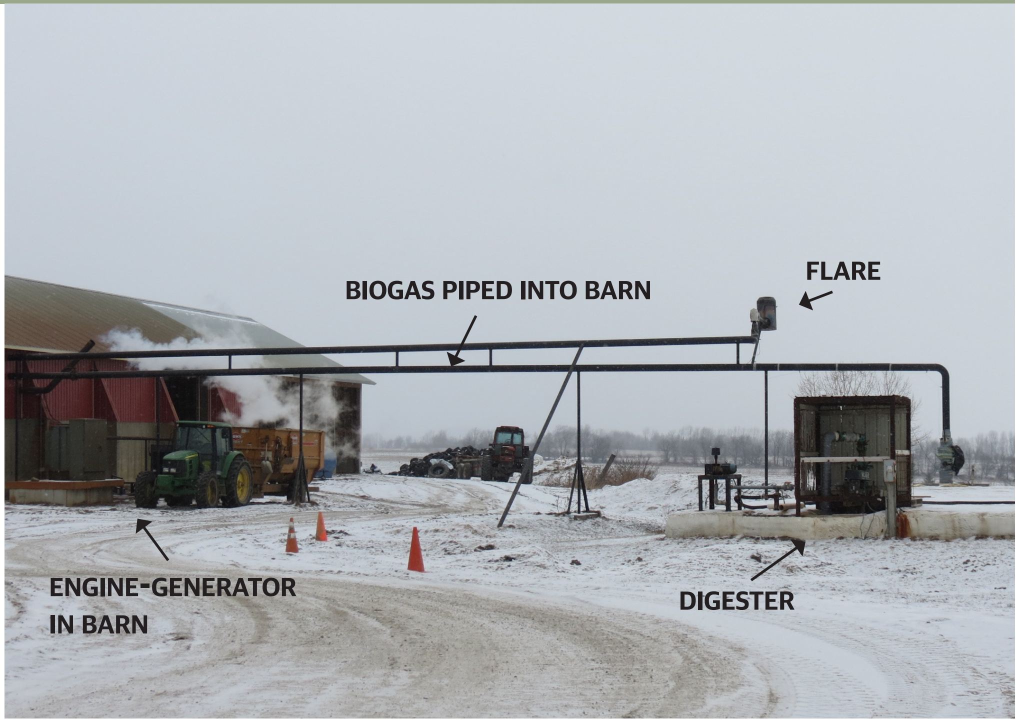
Digester on a Dairy Farm

Maxwell's Neighborhood Farm

Coventry, VT

Highlights: 225 kilowatts of installed capacity ● 1.75 million kWh of electricity generated per year ● 7-year payback ● Cow Power farm generates electricity and uses waste heat for greenhouse

Lois and Maurice Maxwell started Maxwell's Neighborhood Farm in 1957. Four sons (Stewart, Bradley, Anthony, and Jeffrey) and a grandson, Matthew, now operate the approximately 800 cow dairy. The Maxwells pursued a methane, or anaerobic, digester as a way to diversify their operation at a time of low milk prices. Methane digesters are oxygen-free tanks or containers that use microorganisms (i.e., different types of bacteria) to transform biomass like cow manure into "biogas" (e.g., methane and carbon dioxide), while retaining the manure slurry. This biogas can then be fed to a gas engine to generate electricity, or to a boiler to generate heat. In 2008 the Maxwells partnered with the *Green Mountain Power Cow Power program* to build a digester system and incorporated it as *Maxwell's Neighborhood Energy*. There are currently 12 dairy farms enrolled in the Cow Power program.



The engine-generator is housed in the building at the left. To right is the digester, part of which can be seen protruding above the ground. A pipe emerging from the digester carries biogas to the engine, and another pipe can be seen leading to the flare, used to burn the biogas in case the engine is not able to take the biogas.

Equipment Costs, Energy Payments, and System Payback

The total cost of this project was about $1.8 million. A $100,000 grant from GMP was coupled with a $357,990 grant and a $326,770 loan guarantee from the *USDA Rural Energy for America Program* (REAP), $250,000 from the *Vermont Clean Energy Development Fund*, and $75,000 from the *Vermont Agency of Agriculture*. Because the farm was connected to Vermont Electric Coop through *single-phase electric power*—and the engine-generator is *three-phase electric power*—over $78,000 was paid to upgrade 1.6 miles of utility lines. Maxwell Neighborhood Energy is paid for the electricity generated by the *Vermont SPEED program*, at the farm methane rate of $0.14 per kilowatt-hour. In addition, customers enrolled in the Cow Power program pay an additional 4 cents per kilowatt-hour for the environmental attributes of the energy produced, and this money goes to the farmer.

With the combination of electricity sales, reduced heating costs, and animal bedding savings and sales, the Maxwells believe the system will be paid off in a little over seven years. However, Vermont dairy farmers with digesters and technical assistance providers also caution that digester equipment, particularly the engine-generator, require significant attention to detail and technical issues need to be addressed promptly to avoid long-term problems.

Digester Characteristics

Maxwell's Neighborhood Energy worked with GHD (now *DVO*) for the *digester design and installation*, Martin Machinery for the 225 kW *Guascor* engine-generator package, and many subcontractors.

Guascor engines are commonly used with methane digesters in Vermont.

The digester measures 72 feet wide by 96 feet long by 16 feet deep, and is a U-shaped configuration. It holds almost 800,000 gallons and is large enough to retain incoming manure for about three weeks. The Maxwells also contract with a food processing facility in Maine for additional liquids to put in their digester (about 10% by volume) and this boosts gas production by about one-third.

After three weeks in the digester the manure odor is virtually neutralized. Liquid separated from the manure during the digestion process becomes easier to spread—and odorless. And the fertilizer value present in the manure going into the digester is still available after this "aging" process. Biogas from the digester is cooled to remove moisture, and sent to the 225-kilowatt engine-generator, which can produce enough electricity for about 200 homes. During this process, methane produced from animal waste—a greenhouse gas 20 times more powerful than carbon dioxide—is captured and destroyed. If there is too much gas, or the engine is being serviced, gas is sent to a flare to be burned off.

Additional Benefits

The engine-generator includes heat exchangers that deliver useful amounts of heat for space heating beyond the heat needed to keep the digester warm. The Maxwells decided to transfer some of the digester's excess heat through plastic piping in the ground over to a greenhouse—installed in the winter of 2013. These pipes heat both the ground and the air inside the greenhouse.

The greenhouse heated by the digester is 36 feet by 72 feet.

Matt Maxwell manages the greenhouses and grows greens all fall and winter. As spring approaches, he transitions from greens to tomatoes. For about six weeks, Matt is able to sell beautiful, ripe, early-season tomatoes for about four dollars a pound into the local market.

As Matt readily points out, selling electricity is only part of the picture. Matt also harvests peat-moss-like bedding from the digester. The bedding suits the cows very nicely, and while it saves money compared to buying sawdust, it's hard to put a price on the peace of mind that comes from knowing that they don't have to skimp on bedding and that their cows are well cared for and healthy. This bedding can also be used as a soil amendment in the greenhouse. Matt is able to compost some of the bedding and sell it to landscaping companies and other gardeners. The Maxwells also save on wood and other purchased sources of heat that used to heat the maintenance shop and the milkhouse, since the heat from the engine-generator is now displacing those fuels.

Photo credits: Matt Maxwell, except Guascor engine (Vermont Agency of Agriculture)

As the Maxwells worked with the system designers and equipment providers, they made sure to include heat recovery and distribution systems. The engine's heat exchangers deliver heat for milkhouse water heating, for heat in the maintenance shop (saving 4-to-5 cords of wood or $800-$1,000 each winter), for the engine room, for drying separated manure solids, and for the greenhouse (pictured above).

Methane Digester Resources

- **Green Mountain Power's Cow Power Program:**
  www.greenmountainpower.com/innovative/cow
- **EPA's AgSTAR Program:**
  www.epa.gov/agstar
- **Clean Energy Development Fund Feasibility Studies of Vermont Digesters:**
  www.vtenergyatlas-info.com/biomass/methane-digesters/reports-links
- **DVO Anaerobic Digesters:**
  www.dvoinc.net

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VERMONT
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With funding support from the Northeast Dairy Sustainability Collaborative:

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On-Farm Heating with Biomass

River Berry Farm

Fairfax, VT • www.riverberryfarm.com

Highlights: 220,000 BTU/hr biomass boiler • $13,000-21,000 installed cost • 12-14 year payback period • 5,910 pounds of CO_2 avoided • Advanced pollution controls in new boilers reduce emissions

David and Jane Marchant of *River Berry Farm*—an organic vegetable and fruit producer in Fairfax—were early adopters of biomass heating when they installed a corn and pellet furnace in one of their greenhouses in 2008. The furnace required manual lighting and, whenever a strong wind blew, the fire could be snuffed out, making it a real labor burden. Although it was rated for 165,000 BTU/hr input and had a relatively low initial installation cost of $5,200, the furnace never seemed to actually produce a reasonable amount of heat. The Marchants also had a variable load in the greenhouse that peaked at night and was non-existent during the middle of a sunny day inside the greenhouse. This made for a frustrating relationship with the appliance. "I kept thinking, there has got to be a better option," recalls David, "It was a real labor burden, and you couldn't count on it."

This biomass heating demonstration was part of a *UVM Extension project* aimed at trialing several furnaces in agricultural heating applications with funding support provided by the *High Meadows Fund*. According to Chris Callahan, Ag Engineer with UVM Extension who assisted with some of the design and performance assessment, "The main lessons learned from these early installations were to buy high quality fuel, seek improved automatic ignition controls, invest in a good chimney and install it well, and know the actual heat output rating of the unit." Modern biomass heating appliances generally include a fuel storage bin, an auger for feeding fuel to the appliance, the appliance itself (boiler or furnace) with an ignition system, a combustion chamber, a heat exchanger, and a heat distribution system. They also incorporate some means of controlling combustion, fuel feed rate, and air flow and often include emissions control measures and automated ash removal.

Boilers Can Provide Advantages Since Hot Water Can be Used in Many Applications

Based on their early experiences and bolstered by a commitment to long-term sustainability and reduced fossil fuel dependence, the Marchants hosted another demonstration project on their farm. This time, they opted for a higher-rated *boiler* rather than a furnace. Boilers produce hot water, rather than hot air, which allows more options for distributing the heat.

The Central Boiler Maxim 250 boiler installed at River Berry Farm in Fairfax, VT. These boilers may look like outdoor wood boilers common around Vermont, but they are EPA Phase II qualified due to improved emissions controls.

The new system also had an automated propane ignition system. The selected boiler was a *Central Boiler Maxim 250* with a 250,000 BTU/hr input rating, efficiency of 87.8%, and EPA Phase II Hydronic Heater qualification. "The boiler makes hot water which we can use in multiple greenhouses by plumbing it to them in insulated PEX piping. Once in the greenhouse, we convert to hot air with a hot water fan coil, put it in the ground for root-zone heating or on the benches in our mat-heating system for starts," says David, "I like it. I keep trying to find something wrong with it, but I can't. The payback period is a bit longer due to higher initial costs, but you have to expect that."

The basic system cost was approximately $13,000 for the boiler, bin, pad, and plumbing to a hot water fan coil. The other heat distribution systems included in-ground PEX, heat exchange, and plumbing for a bench heat system and added approximately another $5,000. The system is more automated and reliable than the earlier furnace was, but the higher initial costs and the fact that the system is only used 3 months out of the year do prolong the payback period to about 12 years when compared with a propane furnace. If the system was used for 6 (space heating) or even 12 months (wash water, pasteurization) of the year the payback would be halved or quartered, respectively.

"In addition to the financial payback, the carbon emissions avoidance is also of interest to many people," says Callahan, "In River Berry Farm's case, the Maxim is helping them avoid 5,910 pounds of net CO_2 emissions per year which is about equivalent to 5,000 miles car travel or the CO_2 sequestered by half an acre of pine forest." The *EPA Phase II qualification* of the unit refers to the emissions of criteria pollutants (e.g., sulfur oxide and nitric oxide). The same analysis that shows the net CO_2 emissions reduction also suggests the net criteria pollutant emissions are also reduced when using the biomass boiler compared to propane.

Paul Betz uses the Central Boiler eClassic to heat two greenhouses with cord wood.

Biomass heating is being used in other greenhouses as well. Paul Betz was interested in using his woodlands to fuel his greenhouses at High Ledge Farm in Woodbury. With the installation of a Central Boiler eClassic 2300 cord wood boiler he is doing just that. "Despite what the sales people will tell you, they are finicky to get lit, and require some babysitting for longer, reliable burn times," cautions Paul, "Once it is going, it does what it's supposed to do, which is burn clean and make hot water." **The system cost about $21,226 and saves about $1,500 per year resulting in a payback period of about 14 years.**

Paul also has two other pointers that will help anyone using a biomass boiler. "Don't skimp on the insulated piping. While I was shocked at the $13.00 a foot price, I should have gone for it. I got some for $6.95, and the insulation is not adequate, and since it's not a filled pipe, if the outer sleeve gets nicked, it will fill with water and defeat the insulation" Regarding heat distribution, Paul notes "When buying the exchangers, be sure to check the BTU ratings carefully. When they are listed they give the ratings for steam, not hot water. The end result is the exchangers can be a little undersized when connected to a hot water boiler."

A less expensive underground insulated PEX tubing option (left) is wrapped in foiled bubble wrap and has space between the insulation on the pipe as well as the outer wall. Cost is approximately $7.00/ft. The solid EPS insulated PEX tube (right) is more expensive at $11.00/ft but has demonstrated reduced heat loss and pipe to pipe heat transfer. Water infiltration is a concern on the foil wrapped version on the left due to the open area that exists.

The table to the right compares biomass fuels and other fuels generally used in Vermont. The key considerations when making a fuel choice are generally: Cost per delivered unit ($/gal, $/ton); energy content (BTU/gal, BTU/ton); boiler or furnace availability and cost; system reliability and automation; and emissions. It is important to note that fuel prices can and have experienced high volatility with rapid and significant increases at times. These changes will affect how one fuel compares to another. Using the fuel comparison calculator listed in the Resources can help clarify that impact.

Photo credits: Chris Callahan

Fuel	BTU Content	Cost	Delivered Heat Cost (per million BTU)	Pros	Cons
Cord Wood	18-20 million BTU/cord	$160 – 200/cord	$11.1 @ 85% efficiency	Readily available & familiar; can generally be sourced on farm.	Manual handling; batch loading
Wood Pellets	8,600 BTU/lb	$294/ton	$20.1 @ 90% efficiency	Automated feeding with auger and bin; available in bags and (in some locations) bulk delivery.	Higher cost per BTU than cord wood; limited bulk delivery options currently
Wood Chips	9.9 million BTU/ ton	$56/green ton	$15.9 @ 65% efficiency	Inexpensive.	Generally high moisture compared to other fuels; limited small scale appliance availability.
Corn	8,500 BTU/lb	$300/ton	$23.9 @ 90% efficiency	Can be grown on farm; automated feeding with auger and bin.	Can form clinkers more easily than other biomass fuels.
Grass Pellets	8,600 BTU/lb	$250/ton	$16.1 @ 90% efficiency	Can be grown on farm; automated feeding with auger and bin when densified.	Relatively high ash content, needs automated removal system; clinkers possible.
Propane	92,000 BTU/gal	$2.80/gal	$33.8 @ 90% efficiency	Common, easy to use; no ash.	Not renewable; net CO_2 and greenhouse gas contributor.
Fuel Oil	129,500 BTU/gal	$4.00/gal	$34.3 @ 90% efficiency	Common, easy to use; no ash.	Not renewable; net CO_2 and greenhouse gas contributor.
Biodiesel	118,296 BTU/gal	$4.18/gal	$39.3 @ 90% efficiency	Fuel oil replacement can be sustainably produced.	Some seals and materials may need to be changed.

Biomass Heating Resources

Penn State, An Introduction to Biomass Heating: www.bioenergy.psu.edu/pdf_files/Fact%20Sheet%20IntroBiomassHeat.pdf

Michigan State University, Heating Buildings and Business Operations with Biomass Fuel: A Planning Guide: http://web2.msue.msu.edu/bulletins/Bulletin/PDF/E3044.pdf

Biomass Energy Resource Center: www.biomasscenter.org/

Maxim M250 Furnace: www.maximheat.com/models

Penn State, Energy Cost Comparison Charts: http://extension.psu.edu/natural-resources/energy/energy-use/resources/making-decisions/comparison-charts

UVM Extension, Biomass Furnaces for Greenhouse Vegetable Growers: http://www.uvm.edu/vtvegandberry/Pubs/Greenhouse_Furnace_Project_Report.pdf

Renewable Energy Vermont: www.revermont.org/main/technology/bioenergy/biomass/

Central Boiler E-Classic 2300: www.centralboiler.com/e-classic2300.html

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Cabot Creamery Cooperative, Ben & Jerry's, Stonyfield, Organic Valley, Vermont Agency of Agriculture, and coordinated by the Sustainable Food Lab

On-Farm Biodiesel Production

Borderview Farm

Alburgh, VT

Highlights: Cost of biodiesel production = $2.29 per gallon ● Seed meal used as a co-product for livestock feed or crop fertilizer ● Central processing facility and shared equipment use maximizes efficiency for neighboring farms

Roger Rainville's dairy-turned-energy farm in Grand Isle County is a place where area dairy farmers, organic growers, and landowners have made biodiesel from their own locally-grown sunflower seeds.

In 2008, when diesel prices rose from $4 to $5 per gallon, Rainville began experimenting with farm-scale biodiesel production. With guidance from University of Vermont (UVM) Extension and grant funding from Vermont Sustainable Jobs Fund's Vermont Bioenergy Initiative, Rainville began planting sunflowers on a portion of his 214 acres and installing biodiesel processing equipment. Oilseed sunflowers (as opposed to confectionary sunflowers that are grown for eating) are the most popular oilseed crop in Vermont, with hundreds of acres planted statewide. The crop is grown in rotation with grains and grasses and yields high quantities of oil.

Harvesting, Cleaning, and Pressing

Following harvest with a combine, a seed cleaner and grain dryer are used to prepare the seeds for storage in a 200-ton grain bin prior to processing. A flex auger system moves the seeds from the storage bin into hoppers on each press, and screw augers push the seed through a narrow dye at the front of the press. Extracted oil oozes from the side of the barrel and is collected in settling tanks while pelletized meal is pushed through the dye at the front and is stored in one-ton agricultural sacks. The oil can then be used as culinary oil for cooking or further refined into biodiesel. The leftover seed meal is used for livestock feed, fuel for pellet stoves, or fertilizer for crops.

Roger Rainville with BioPro 190 automated biodiesel processor at Borderview Farm.

Biodiesel Processing

The small-scale biodiesel production facility at Borderview Farm is an 800 square foot insulated and heated building (the space does not need to be heated, but the oil should be stored where it will not freeze) that houses an oil press, a BioPro 190 automated biodiesel processor, a methanol recovery system, and a set of dry-wash columns for cleaning the fuel. The clean oil at the top of each settling tank is added to the BioPro 190 processor along with lye, methanol, and sulfuric acid. The automated processor runs through several stages of processing in about 48 hours (esterification, transesterification, settling, washing, and drying), with one break after 24 hours to remove the glycerin byproduct. Safety equipment in the processing facility includes personal protective equipment like aprons, gloves, eye protection, a ventilation system, gas detectors, and spill containment materials. At Borderview Farm a set of standard operating procedures hangs on the wall and blank check-sheets are in a binder to make the process easy to repeat. The finished biodiesel is stored in 250 gallon pallet tanks making distribution to different farms easier. The installed capacity of the facility can process 100 tons of seeds from 138 acres of sunflowers per year, yielding 10,500 gallons of biodiesel and 64 tons of sunflower meal (assuming the state average yield of 1,500 pounds sunflower seeds per acre and operation of 24 hours per day for 260 days per year).

Rainville switched from purchasing diesel for five tractors and one truck to making his own biodiesel. He wanted to be independent of imported fuel, and liked creating a new way for farmers to diversify. "Using land for making biodiesel is not the most economical option compared to some other crops, but it's about creating opportunities to try something different," says Rainville.

Sharing Infrastructure Through the Farm Fresh Fuel Project

In 2012 a group of ten farmers working in cooperation with Rainville and UVM Extension—called the *Farm Fresh Fuel project*—grew 90 acres of sunflowers for development of biodiesel. Cooperating farmers were required to plant, fertilize, weed, and harvest the sunflower crop. Farmers worked to share equipment to accomplish this task. The seed was brought to Rainville for conversion into biodiesel. Rainville did the harvesting for all farms, bringing about 56,721 pounds of seed to Borderview Farm.

Seeds from the ten growers yielded about 3,000 gallons of biodiesel and about 20 tons of meal for livestock feed. The biodiesel and meal were then redistributed to the growers based on the relative volume of sunflower seeds they contributed. One participating dairy farm, Sunset Lake Farms, is using the biodiesel to heat office space, the milking parlor, and water for cleaning and sanitizing equipment, and fed the meal to milking cows at a rate of 3 pounds per day, saving about $3,000 on fuel and feed costs.

Homegrown biodiesel for tractor fuel.

Rainville's annual biodiesel use has ranged from 500 to 3,000 gallons per year. At current prices (over $4 per gallon for diesel and $2.29 per produced gallon of biodiesel) biodiesel has saved him from $500 to $4,000 per year in fuel costs. He also emphasizes energy independence as an added benefit. Plus, any growers that also raise livestock can use the meal, which is leftover after the oil is extracted, as part of their feed rations. Rainville recommends talking with an animal nutritionist to blend this into feed at the right ratio, since sunflower meal has a high fat content.

When asked what advice Rainville would give others who want to make their own biodiesel, he says, "Ask questions, ask questions, ask questions. And ask them again!"

Photo credits: VSJF

Oilseed sunflowers at Borderview Farm, Alburgh, 2013.

Biodiesel Resources

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(802) 524-6501 | heather.darby@uvm.edu

University of Vermont Extension
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Vermont Bioenergy Initiative:
http://vermontbioenergy.com

UVM Extension Oilseeds Program:
www.uvm.edu/extension/cropsoil/oilseeds

Oilseed Production in the Northeast:
www.uvm.edu/extension/cropsoil/wp-content/uploads/OilseedManualFINAL.pdf

On-Farm Oilseed Enterprises: Break-Even Economics:
http://vermontbioenergy.com/bioenergy-resources

Oilseed Profit and Loss Calculator:
http://vermontbioenergy.com/oilseed-cost-profit-calculator

Biodiesel Processor:
www.springboardbiodiesel.com/biopro190/biopro190

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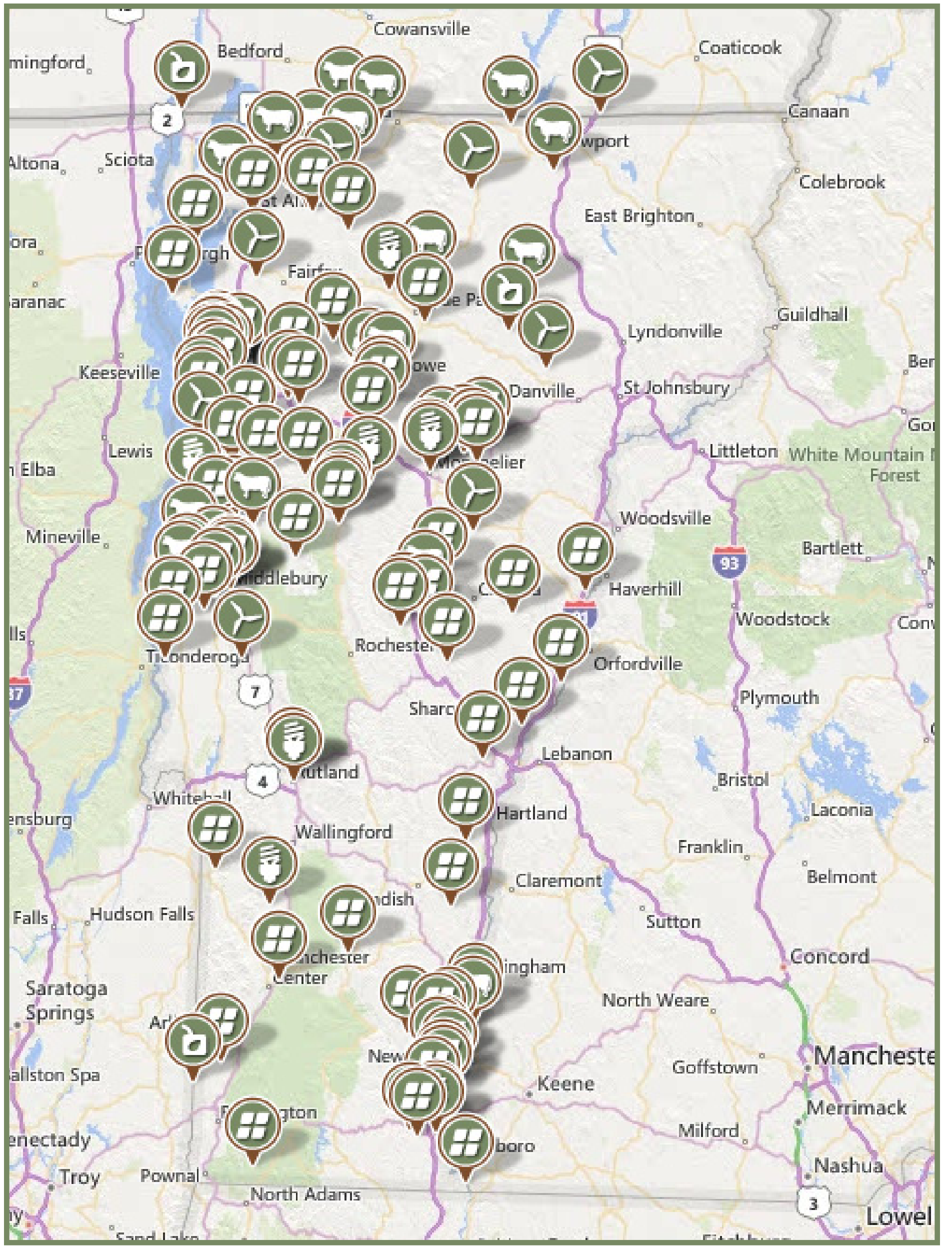
CABOT CREAMERY COOPERATIVE, BEN & JERRY'S, STONYFIELD, ORGANIC VALLEY, VERMONT AGENCY OF AGRICULTURE, AND COORDINATED BY THE SUSTAINABLE FOOD LAB

NOTES



Solar sites

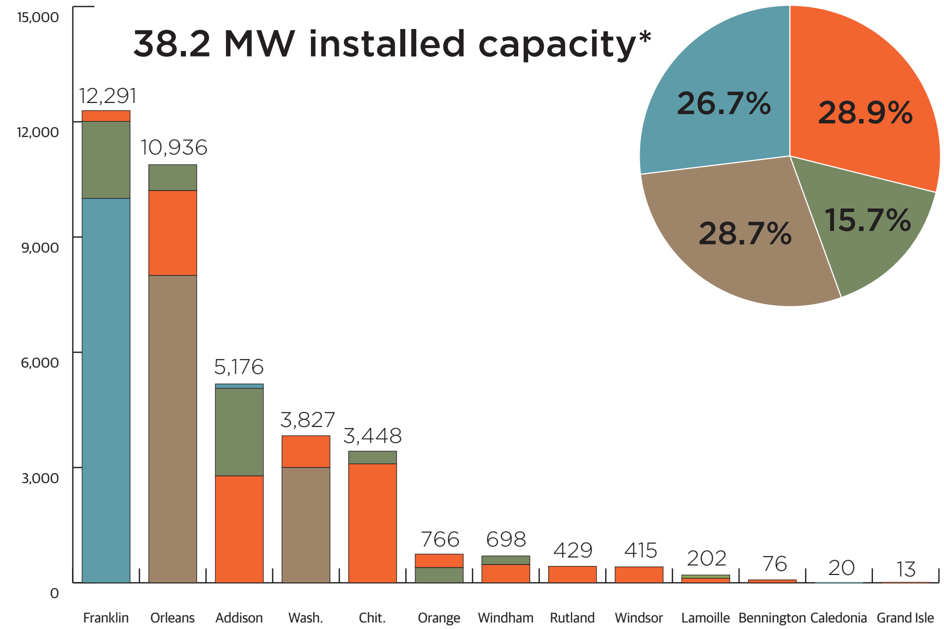
Wind sites

Cow power

Biodiesel

Technical Assistance Providers

Food system businesses are major renewable energy generators!



11,062 kW installed capacity of solar

11,000 kW installed capacity of landfill methane

10,238 kW installed capacity of wind

5,995 kW installed capacity of cow power

*As of January 2015

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