Alternative Energy Innovation

by Tamara Scully

It makes sense that farmers have become leading innovators in the alternative energy sector. Across the Northeast, the farming community has been actively involved in developing and implementing viable ways of decreasing dependency on fossil fuels and turning to renewable, sustainable sources to power farms.

Audits

The first step in any quest for energy sustainability is to find out exactly how much energy is currently being used on the farm. Energy audits help to define where, how and how much energy is being utilized, and to recommend ways of increasing energy efficiency. From non-incandescent light sources to insulation and energy-efficient appliances to energy-saving devices, there are many relatively inexpensive steps that can be taken to reduce energy use.

A more complex look at on-farm energy use involves a life cycle audit. Eric Garza, University of Vermont, has conducted life cycle audits on several diverse farms in the Northeast. These audits attempt to quantify the net energy used on the farm to produce the farm’s output. For example, making hay requires inputs in the form of seed, fuel, fertilizer and man-hours, all to produce an energy source (feed) for livestock.

In a life cycle audit, the goal is to establish the overall energy resources, both direct and indirect, used in production. It can lend insight into practices in which the return on investment, at least from an energy use standpoint, is high. By modifying energy-zapping practices, the energy footprint of the farm is lowered.

“The value of these audits is that they force farmers to look at a broader spectrum of energy use besides just the electricity, diesel and gasoline they use, or other direct fuels,” Garza explained. “For many farms, particularly smaller farms, indirect energy use—embodied energy in machinery, building materials or farm inputs—is often the majority of energy used in an operation.”

Renewable energy sources

Instead of using coal, oil and natural gas, farmers are increasingly turning to renewable sources of energy, often by capturing energy directly from the earth. Water, wind and geothermal are renewable energy sources that can generate electricity and provide heating and cooling with less environmental impact than traditional fossil fuel use.

“There are hundreds of examples of farmers across New York and the Northeast that are finding simple and affordable ways to reduce energy consumption,” said Violet Stone, Cornell Small Farms Program coordinator and New York Sustainable Agriculture Research & Education outreach coordinator. “Now in its sixth year, our sustainable farm energy field day series has featured 30 farmers producing everything from vegetables to livestock to dairy products. These farmers are erecting solar panels and wind turbines, harvesting biomass or pressing oilseed crops, and building earth-cooled barns and thermal greenhouses.”

Solar energy is what farming is all about. Whether growing vegetables or grazing livestock, a farmer is converting solar energy into food calories. Solar has arguably been one of the most accessible sources of alternative energy production for small farmers. Small applications, such as using solar panels to power electric fences, are becoming commonplace.

Although regulations and funding opportunities vary by state and tend to fluctuate, many farmers have been able to take advantage of incentives to install solar projects—whether roof-mounted or freestanding panels—and generate their own electricity. The major concern is the availability of an unshaded, southern-facing exposure. Solar installations, particularly those that are not roof-mounted, can be faced with zoning and setback regulations.

With wind power, the main concern is having a site with a reliable supply of wind at a speed that makes it feasible to generate enough electricity to justify the installation of the system. Zoning regulations are not always wind turbine-friendly, and they can be controversial due to their potential impact on birds and bats.

Most wind and solar systems are connected to the electric grid—although systems can be designed to be fully off the grid—and the power generated is net metered. When the alternative system is generating more power than is being used by the farm, the excess is credited and banked. When the system doesn’t generate enough to meet the farm’s energy needs, any banked credits are used to offset the excess energy needed.

Conor Kays, formerly of Alternative Power Solutions and currently a solar specialist with VP Supply Corp., presented a 2013 Cornell Small Farms alternative energy webinar. Kays stressed the importance of wind speed, as well as siting the turbine without obstructions. The minimal property requirement is typically about 5 acres, he said. Wind speeds can vary greatly throughout the year and should be taken into consideration when picking an annual reset date with the utility company to ensure the maximum benefit from any excess energy generated.

Unless either system is connected to batteries, power will not be available if the grid goes down, Kays said. Batteries can be expensive, and for many a generator may be a more feasible...
option. Fully off-the-grid systems do exist, but are less common.

Many on-farm systems combine energy sources. On Jonathan Barter’s 210-acre livestock farm in New York, a 350-watt wind turbine and 400-watt solar panels combine to power a pumping system complete with battery backup, allowing him to efficiently supply water to his pastures.

Geothermal energy takes advantage of the earth’s heat. It can come from underground reservoirs of hot water, some shallow and some deep, or from the soil near the surface, which maintains a constant temperature of about 50 to 60 degrees Fahrenheit. Geothermal applications can use groundwater directly to provide heat, use the heat from the water to generate electricity, or use the ground’s heat to power heating and cooling apparatuses.

Aside from heating and cooling a building, geothermal energy is being used on farms in several innovative ways, including crop drying and heating greenhouses. In aquaculture, geothermal heat is utilized to warm the water for the fish. Dairy farms can use geothermal energy to cool milk.

Hydropower uses energy from flowing water to generate electricity or mechanical energy. A turbine or waterwheel takes the energy from the water and transforms it into rotational energy, which can be further refined into electricity via an alternator or generator. Once common, small-scale hydroelectric power generation, or microhydro, can be a viable option if adequate flowing water is available.

Energy crops

Farmers can harness the power of farm byproducts or grow a crop that can be utilized as a power source. Biofuels are energy sources made from living things, such as crops, or from waste produced by living things, such as manure, compost or animal fats.

Penn State Extension researchers are studying the production of high-quality pellets as a fuel source. The pellets, which are burned to produce heat, can be made from perennial grasses, field hay, oat straw, corn stover and even distillers grains.

Creating biomass pellets requires several steps. The biomass feedstock must be ground and pressed or extruded. The moisture level of the material needs to be controlled and may require a binding agent. The equipment is not inexpensive, but incorporating this process on a small farm can be feasible.

Sarah Galbraith, program manager of the Vermont Bioenergy Initiative (VBI), said that the program is involved in several initiatives researching grasses for heating fuel. Switchgrass test plots exist across the state, with researchers determining the best varieties to grow in Vermont for energy generation.

“Vermont Technical College in Randolph has a mobile pelletizer for making grass into pellet fuel,” Galbraith said. She also noted that Renewable Energy Resources, working with Meach Cove Farms in Shelburne, is “developing a briquetter for making grass into briquettes, which are another type of densified grass fuel.”

Other crops can be used to produce biomass energy, such as short-rotation trees like willow, poplar and other rapidly growing species that can be cut and harvested numerous times before requiring replanting. These require minimal inputs and less tilling and prevent more soil erosion than corn or other annual crops.

While many are familiar with growing corn to produce ethanol, other crop-to-fuel oil options exist. Oilseed crops, such as sunflower, soybean and canola, can be processed into straight vegetable oil and used in diesel engines, or they can be further refined into biodiesel. Algae, which contain lipid oils, are also being studied as a biofuel source and could potentially be used in small-scale on-farm production. VBI is involved in research efforts to select the best varieties and best practices for growing algae for biodiesel.

“Currently, a private lab is partnered with Nordic Dairy Farm and Fiddlehead Brewing to use refuse from the farm and brewery in the algae growing medium. The algae will then be pressed to extract the oil, and the oil will be converted to biodiesel,” Galbraith said.

Making biodiesel

“Often, biofuels are spoken of as biodiesel or vegetable oil, and the two are used interchangeably,” said Douglas Schaufler, research assistant at Penn State University. This is inaccurate, “Straight vegetable oil [SVO] is just that.”

Biodiesel is the result of SVO undergoing transesterification. This chemical reaction is catalyzed by lye. Added alcohol, typically methanol, reacts with the SVO to produce biodiesel. Glycerin is a byproduct of this process and is being studied as a livestock feed additive.

Oilseed pressing results in both oil and meal. According to Chris Callahan, agricultural engineer at University of Vermont Extension, 1 ton of sunflower seeds yields 38 percent oil and 62 percent meal after pressing. The meal can then be used as livestock feed, fertilizer or weed suppressant, and can also be burned in pellet form. SVO itself can be used in diesel engines, depending on the oilseed. Diesel engines typically need to use diesel fuel when starting or stopping, switching to SVO after warming up.

VBI projects include Farm Fresh Fuel, a group of 10 farmers in Grand Isle County, Vermont, who are growing their own oilseeds, which are processed into biodiesel on Roger Rainville’s Borderview Farm in Alburgh, Vermont. Another Vermont farmer collects used cooking oil and combines it with oil from his oilseed crops to produce biodiesel for his farm and neighboring farms.

Resources

State-specific resources include:

- Connecticut Farm Energy Program: www.ctfarmenergy.org
- GreenStart (New Hampshire): www.greenstartnh.org
- Massachusetts Agricultural Energy Grant Program: http://1.usa.gov/1he87s
- NYSERDA: www.nyserda.ny.gov
- Penn State Extension: http://extension.psu.edu/natural-resources/energy
- Rhode Island Farm Energy Program: www.rifarmenergy.org/funding.htm
- VBI: www.vermontbioenergy.com

Other helpful resources:
- eXtension: http://bit.ly/1mqSDLj
- FarmEnergy.org: www.farmenergy.org
- Institute for Energy and the Environment at Vermont Law School: www.agenergysolutions.org
- Union of Concerned Scientists: http://bit.ly/1he8NKH

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Farm byproducts

Anaerobic digesters, which are gaining in popularity on dairy farms, utilize the omnipresent waste product of manure to create biogas, which is captured and converted into electricity to power the farm. Anaerobic digesters rely on microbial action to process manure or other biodegradable waste products into solid and liquid components, plus biogas. The solid components can be used for animal bedding or compost, and the liquids can be applied to fields as fertilizer.

To increase the efficiency of anaerobic digestion, the heat generated when the biogas is converted into electricity can potentially be reclaimed and reused on the farm in other applications. The Cornell Department of Biological and Environmental Engineering is studying the feasibility of taking reclaimed heat and using it to power an absorptive chilling system. These systems use heat to cool water via a thermochemical process. The chilled water is run through dairy cow water beds to keep the cows cool.

Compost provides another source of biofuel on the farm. Heat from compost can be extracted and used to heat greenhouses, buildings or water. There are commercial systems in which the heat from compost is recovered and used to replace propane or oil heating systems. At Jasper Hill Farm in Greensboro, Vermont, heat captured from compost is used to heat water, which is then used in the anaerobic digesters.

Jay Armour of Four Winds Farm in Gardiner, New York, was featured in a Cornell Small Farms Program alternative energy webinar on April 4, 2014. Armour heats his greenhouse with a composted mix of horse and cow manure. Slightly aged manure is loaded into cement-walled bins running the length of the greenhouse and capped with fully aged manure, which traps the gases being released from the active compost pile. The heat from the compost warms the greenhouse and allows for production of greens during cold

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”Even on our best ground, Mother Nature can win. I would never gamble on a loss, and I would never be without crop insurance.”

Lynn and Peggy Murray, along with their son and daughter-in-law, have over 800 milking and dry cows. Their farm, Murcrest Farms, LLC, is located 12 miles southeast of Watertown on the edge of the Tug Hill where there is a lot of snow in the wintertime and it affects weather patterns in the summertime, too. Murray says, “Some years the rains seem to divide and go around us, and other years it can rain here at the main farm and not on other parts of the land. It can be really variable.”

Crop insurance isn’t just for corn and soybeans & can provide a safety net for dairy and livestock farmers in a number of other ways:

- **Corn Grain & Silage crop insurance** (Sign-up/policy change date is March 15)
- **Winter wheat and barley crop insurance** (Sign-up/policy change date is **September 30**)
- **Forage Production** (Sign-up/policy change date is **September 30**)
- **Forage Seeding** (Sign-up/policy change date is **July 31** for Fall-seeded Forage)
- **Pasture, Rangeland, Forage Rainfall Index (PRF-drought coverage only)** (Sign-up/policy change date is **November 15**)

Contact a crop insurance agent to get started. To locate an agent, ask a neighbor or go to www.rma.usda.gov/tools/agent.html
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weather. The compost warms up to about 135 degrees Fahrenheit and is able to keep the greenhouse at 50 to 55 degrees Fahrenheit when the outside night temperatures are just below freezing. Armour’s home-made system allows him to produce vegetable transplants for farm use and to sell. The finished compost is also used in field applications or can be sold, creating an additional income stream.

Get renewed
Whether you’re contemplating a large renewable energy project, such as an anaerobic digestion system or a wind turbine, opting to grow your own fuel crop for pellets or biodiesel, or utilizing existing farm byproducts or materials such as compost to decrease energy inputs, alternative energy systems can be implemented on many small farms.

“For many farmers, choosing energy conservation practices and renewable energy isn’t just about being good stewards; it’s also about stabilizing rising energy costs and creating energy security,” Stone said. “In New York, we are fortunate to have NYSERDA [New York State Energy Research and Development Authority], an organization that funds renewable energy projects. There are plenty of resources available to help a farmer or homesteader get started with a sustainable energy design that meets individual needs.”

Whether they’re making the most of existing farm waste streams, growing crops to fuel their energy needs, or producing their own energy from the natural elements of sun, wind, water and geothermal heat sources, farmers are demonstrating yet another way in which farming can play a major role in protecting the environment.

The author is a freelance contributor based in New Jersey. Comment or question? Visit www.farmingforumsite.com and join in the discussions.