Connecticut Farm Energy Program

Energy Best Management Practices Guide

CONNECTICUT FARM ENERGY PROGRAM

A partnership between the USDA Rural Development and the Eastern Connecticut Resource Conservation & Development Area, Inc.

ctfarmenergy.org

Introduction

elcome to the Connecticut Farm Energy Best Management Practices Guide. This guide is intended for all Connecticut farmers who are interested in reducing their energy costs. Inside, you will find a mix of low-cost or no-cost tips you can implement immediately, as well as information about equipment upgrades you may wish to consider.

A farm energy audit can help you further determine which equipment is the best choice for your operation. An audit will include an estimate of how much energy and money you can save with specific equipment based on your usage patterns and costs. At the end of this guide, you will find resources for an energy audit, as well as funding sources to help cost share energy efficiency and renewable energy upgrades to you farm.

This guide was developed by EnSave, Inc. on behalf of the Connecticut Farm Energy Program (CFEP) which is a pilot program that is supported in collaboration with Eastern Connecticut Resource Conservation & Development Area, Inc. (RC&D) and USDA - Rural Development (RD). Other program partners include but are not limited to: USDA – Natural Resource Conservation Service (NRCS), Connecticut Department of Agriculture, and the Connecticut Clean Energy Fund.

CFEP serves as a resource of information on energy, grant opportunities, audits, and events for Ag producers & Ag based small business that are located in the 86 towns within the Eastern CT RC&D service

area of Hartford, Middlesex, New London, Tolland and Windham Counties.

CFEP aims to provide information as it pertains to energy and agriculture in Connecticut through the CFEP website, email updates, publications, as well as workshops and seminars it hosts.

CFEP provides REAP grant writing assistance to eligible Ag producers & Ag based small business in applying for USDA – Rural Development REAP (Rural Energy for America Program) Grants. REAP Grants, which are part of the Farm Bill, provide assistance to those who are eligible with Energy Efficiency and Renewable Energy projects.

The mission of the CT Farm Energy Program is to increase awareness about energy conservation and efficiency as it relates to Ag producers & Ag-based small businesses as well as to promote alternative and renewable energy on farms in Eastern Connecticut.

More information about the program can be found at www.CTFarmEnergy.org.

Table of Contents

Acknowledgements

The Connecticut Farm Energy Best Management Practices Guide was prepared by EnSave, Inc. on behalf of the Connecticut Farm Energy Program.

Guidance and support in reviewing this manual during the course of its production was provided by Eastern Connecticut Resource Conservation & Development Area, Inc., USDA Rural Development, USDA Natural Resources Conservation Service, Connecticut Department of Agriculture, Connecticut Clean Energy Fund and Working Lands Alliance.

COVER PHOTO: G. L. SWEETNAM

Definitions

ENERGY AUDIT: An energy audit is a document that analyzes the current energy use on an operation and recommends actions to increase energy efficiency. The audit report will contain a description of your farm's current baseline usage for various systems, specific recommendations to increase energy efficiency, and an explanation of the energy and cost savings you can expect from the recommendations. The American Society of Agricultural and Biological Engineers has a Standard for Conducting On-Farm Energy Audits; you should ensure any auditor for your farm is following this standard.

ENERGY ASSESSMENT: An energy assessment can mean different things to different people. To some, an assessment is synonymous with an audit, while others consider an energy assessment to be more basic than an energy audit. If you are considering an energy assessment, make sure you understand what you are getting.

FEASIBILITY STUDY: Before undertaking a costly project such as installing an anaerobic digester or a solar array, you will generally receive a feasibility study conducted by a renewable energy professional. This study will identify the potential for renewable energy on your farm, and will detail the costs of the system and expected payback. A feasibility study is an important step to ensure you are aware of the risks and benefits of a large investment such as renewable energy.

ENERGY CONSERVATION: Energy conservation refers to using less energy by changing a behavior. An example is turning off the lights when you leave a room, or turning down your thermostat. You have reduced your energy use, but you have also changed the amount of light or heat available to you. This guide contains many recommendations for energy conservation. Generally, conservation activities are low or no-cost, but may not save as much energy as efficiency measures.

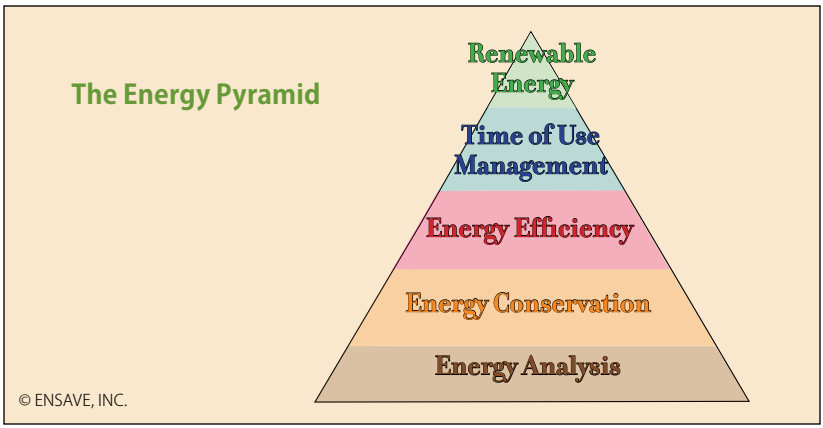
ENERGY EFFICIENCY: Energy efficiency refers to using less energy by changing equipment. If you replace your lights or furnace with a more efficient model, you have reduced your energy use without changing the

For information about energy savings opportunities for your farm, call EnSave at (800) 732-1399.

amount of heat or light available to you. This guide contains many recommendations for energy efficiency. Generally, energy efficiency measures have a cost, but the cost is worthwhile due to higher energy savings.

RENEWABLE ENERGY: Renewable energy refers to an energy source that can be replenished, such as energy from the sun, wind, earth, or water. Non-renewable energy sources, such as coal or oil, rely on a finite source of raw materials.

ENERGY PYRAMID: EnSave's Energy Pyramid provides a useful way to consider energy management on your farm. Starting at the base of the pyramid, with energy analysis, ensures you know what energy management tools you need before making an investment. The pyramid begins with the easiest and most cost-effective option, and gradually works its way up to the most complex and expensive options. Following the pyramid ensures you have considered the opportunities in each step before moving on to the next one. Reading this guide, or undergoing an energy audit is a good first step of energy analysis. Following your analysis, consider energy conservation and then energy efficiency. Once you have saved all the energy possible through those means, consider time-of-use management, or using energy at specific times in order to reduce load on the electric grid. Finally, consider renewable energy once you have ensured you have saved energy in other ways. This keeps you from using renewable energy to power an inefficient process. EnSave designs and implements agricultural energy efficiency programs and provides energy audits.



Dairy

Dairy farms have among the highest energy use of all types of agriculture. They use a lot of electricity for milking and milk cooling. Fortunately, there are many technologies dairy farmers can implement to significantly reduce their electric bill. Many of these technologies can also have an affect on cow comfort and the noise level in the barn. Most Connecticut dairy farms are smaller than the national average, but many energy efficiency opportunities are still cost effective on small to medium sized dairies.

Variable Speed Drive (VSD) on the Milking Vacuum Pump

VSD OPERATION

Milking vacuum pumps are sized to deliver the required maximum vacuum level to operate the milking and washing systems. Occasionally, when a milking unit falls off a cow's udder or when there is a temporary system leak, high levels of vacuum are needed for short intervals. Normal milking operation uses less than half the maximum vacuum available.

Before variable speed technology was used for vacuum pumps, dairy operators had to run their pumps at a constant high speed to perform adequately during the occasional short intervals of high vacuum need. The VSD determines exactly how much vacuum the system requires and regulates the speed of the pump. The result is a pump that runs at a much lower speed most of the time and requires substantially less electricity to do the job.

STABLE VACUUM

A constant vacuum level at the milking units is necessary to prevent bacteria from accessing the cows' teats. A VSD reacts quickly and maintains a stable level as well or better than conventional systems.

EQUIPMENT LIFE

A motor run at full speed will have a shorter life span than a motor that regularly runs at a lower speed. Since the VSD operates the vacuum pump at reduced RPMs, bearings and other internal components last longer and require less frequent maintenance. Pumps will require less frequent replacement.

NOISE REDUCTION

Conventional milking vacuum pumps running at full speed make a lot of noise, yet with a VSD installed the noise level is dramatically less because the motor is operating at slower speeds for most of the milking. Many farmers benefit from significantly quieter milking areas.

GREAT FINANCIAL INVESTMENT

The energy and money savings from installing a VSD varies from farm to farm, based on the size and type of vacuum pump, the type of milking system, and the milking time. On some dairy farms, the substantial energy savings have made the payback period on the installed cost of the VSD as short as two years. Quick payback makes the VSD one of the best investments a dairy farmer can make.

Milk Pump Variable Speed Drive

VALUE OF MILK PRE-COOLING

The speed of milk flow to the bulk tank is an important consideration in the milk cooling system design. Milk pre-cooling is widely used to maintain milk quality by cooling the milk quickly, reducing bulk tank compressor run time, and saving on electricity costs. Plate-type milk pre-coolers utilize cold water in a heat exchanger to absorb heat from the warm milk before it goes to the bulk tank. The efficiency of the plate cooler depends on the temperature of the cold water, the ratio of cold water to warm milk flowing through the unit, and the rate of flow of the milk. Plate coolers are sized to accommodate the volume of milk being pumped to the bulk tank.

HOW DOES A MILK PUMP VARIABLE SPEED DRIVE WORK?

Another factor in plate cooler efficiency is the evenness of the flow of milk through the unit. With standard milk pumps the milk can gush or trickle into the plate cooler, reducing heat exchange efficiency. A variable speed

drive (VSD) produces a steady flow of milk through the plate cooler and optimizes cooling. This improved performance reduces cooling costs in the bulk tank and helps maintain milk quality.

SIGNIFICANT SAVINGS

Manufacturers' tests have shown an average energy savings of 30% on the run time of the bulk tank compressor when the milk pump is controlled by a VSD with a plate cooler.

WHY SHOULD I INSTALL A VSD ON MY MILK PUMP?

Your milk will cool faster due to a constant flow rate through the plate cooler. Also, faster milk cooling inhibits growth of bacteria, preserving milk quality and flavor. Plus, lower bacteria counts often deliver higher milk premiums. Shorter compressor run times mean lower electric bills.

Ventilation

NEED FOR VENTILATION

Heat and moisture build-up in confined areas can adversely affect the health of animals and humans. Manure gases can contribute further to poor air quality. Research has shown that inadequate barn ventilation can result in a production drop of 6 to 14 pounds of milk per cow per day.

VENTILATION REQUIREMENTS

Barn ventilating systems need to accomplish the following tasks:

- Removal of excess moisture produced by cow confinement.
- Cooling of milking animals during warmer months. A heat-stressed cow produces less milk.
- Removal of noxious gases from manure pits under or near barns.

APPROACHES TO VENTILATION DESIGN

Different strategies can be effective for different locations and structures. Some barns are equipped with side "curtain walls" that can be opened up in warmer weather and closed for winter months. Other barns feature open end walls. "Greenhouse barns" with transparent roofs can create natural air circulation. Some structures feature an open ridge vent roof design.

Most agricultural ventilating systems rely on exhaust fans to remove moisture build-up. A common goal is to provide four complete air changes in the barn per hour. Properly sized and located air inlets are necessary for an effective and efficient system. Research indicates that milk production is optimized at an ambient air temperature of about 48 degrees Fahrenheit. For cow cooling in warmer weather, ventilation design depends on structural characteristics. In rectangular tie stall barns, "tunnel ventilation" has proved effective in producing air circulation. For larger free stall barns with higher ceilings, overhead circulating fans, mounted vertically, are generally used to keep air moving over animals.

Fan output is measured in cubic feet per minute (cfm). The size, horsepower, and design of the fan all affect how much air it will move. Cfm output also depends on the static pressure of the building. Static pressure is the force of air against the outside of the building that inhibits exhaust air. Electrical efficiency of a fan is rated in cubic feet per minute per watt (cfm/watt) of electricity. It is important to select high efficiency equipment. Fans of different manufacturers differ markedly in air delivery and energy efficiency. Tests of 36-inch exhaust fans recorded air varying from 6,400 cfm to 13,000 cfm. Energy efficiencies ranged from 8.3 to 18.6 cfm/watt. Fan blades coated with dust and debris move less air using more electricity.

Dairy Lighting

THE VALUE OF PROPER LIGHT LEVELS

Proper lighting can improve worker efficiency, safety, and comfort. It is an important consideration in the planning, construction, or maintenance of dairy facilities.

COST EFFECTIVE ENERGY EFFICIENT LIGHTING

Factors affecting efficiency include amount of light per watt and lamp life. Fluorescent, metal halide, and high-pressure sodium lighting systems are more expensive to purchase than incandescent fixtures and bulbs. However, the energy cost savings combined with longer lamp life offset these higher initial costs for energy-efficient lighting systems.

SELECTION CRITERIA

Other characteristics to consider when selecting a lamp type are starting temperature and warm-up. Incandescent and high-pressure sodium

lamps perform well at cold temperatures (-20° F). The minimum starting temperature for most fluorescent lamps is 50° F. Ballasts are available that allow fluorescent lamps to start at -20° F, but costs are higher than for standard ballasts.

Incandescent and halogen lamps do not have a warm-up period. Standard fluorescent lamps have a slight starting delay, but by using a quick starting ballast, the time can be reduced. All high intensity discharge lamps (HID) such as a high pressure sodium, have a warm-up period, which can range from one to 15 minutes. Quick starting high-pressure sodium lamps can be purchased, but they cost about twice that of regular HID. Fluorescent lamps are most often used in milking centers (parlors). In the holding area low-bay, high-pressure sodium fixtures are used. In tie-stall barns, fluorescent lamps are generally used over feeding areas. For free-stall barns with high ceilings, HID lamps have been proven to be the most economical.

Below are recommended illumination levels for various areas of the dairy. The unit of illumination is the "footcandle," (f-c) which is defined as one lumen falling on each square foot of work area. A lumen is a measure of the rate of flow of light from a source such as a lamp or the sun. These recommended illumination levels can be met with various types of lamps. In selecting the lamp type, the most important characteristics are light quality and energy efficiency. The quality of the lighting installation is influenced by the color of the light, light uniformity, glare, and reflection of the surfaces in the room.

Tips to Save Energy

Consider fluorescent lighting instead of incandescent lighting. Regularly turn off lights when they are not needed. Light only work areas, rather than entire buildings. Keep lamps, tubes, reflectors, and lenses clean. Install timers or motion sensors where appropriate.

Recommended Dairy Illumination

MILKING PARLOR
General Lighting:
20 footcandles (f-c)
Operator's Pit: 50 f-c

TREATMENT AND MATERNITY AREAS
General Lighting: 10 f-c
Treatment or Surgery: 100 f-c
Office: 50 f-c
Feeding area, tie-stall barn: 10 f-c
Feeding area, free-stall barn: 20 f-c

MILK ROOM
General Lighting: 20 f-c
Washing Area: 100 f-c
Bulk Tank Interior: 100 f-c
Loading Platform: 20 f-c
Utility/Equipment Room: 20 f-c
Holding Area: 10 f-c

Compressor Heat Recovery

HOW DOES COMPRESSOR HEAT RECOVERY WORK?

The process of cooling milk in a bulk tank or with a chiller utilizes one or more compressors to remove heat from the milk. Heat removed in this fashion is typically released into the air by condenser fans. A compressor heat recovery unit captures this "waste heat" and uses it to pre-heat water. Sometimes this removal actually improves compressor performance as well. A compressor heat recovery unit looks like a water heater tank and is capable of raising cold water to very warm temperatures of 110° to 130° F.

ENERGY SAVINGS

With a compressor heat recovery unit in place, the water heater has much less work to do. Since the incoming water is already preheated the electric or gas-fired water heater gets less use, and it is likely to last longer as well. Often a compressor heat recovery unit is the most cost effective piece of energy saving equipment that can be installed on a farm.

EXAMPLE

A dairy farm uses 225 gallons of 160-degree water each day to wash milk lines, milking units, and the bulk tank and to mix calf feed. Their well water temperature is 55 degrees. They have a 120-gallon electric water heater and they pay $0.10 per kilowatt-hour (kWh) for their electricity. The farm will save

13,780 kWh and $1,378 each year by installing compressor heat recovery. Larger operations can expect to see even greater savings.

BENEFITS OF COMPRESSOR HEAT RECOVERY UNITS

- Cools milk faster
- Improves long term milk storage
- Extends the life of the refrigeration system
- Can cut water heating costs by 50–75%, depending on the farm's size
- Producers often see a one to three-year payback

Milk Pre-Cooler

HOW DO MILK PRE-COOLERS WORK?

In a milking operation without milk pre-cooling, the milk comes from the cow at about 98° F, flows into a receiver, and is then pumped to the bulk tank. Compressors cool the incoming milk in the bulk tank to a storage temperature of about 38° F. The milk pre-cooler, often called a plate cooler, is a series of stainless steel plates installed in the milk line before the bulk tank. Cold water passes through a plate cooler in one direction and absorbs heat from the warm milk pumped through the plate cooler in the opposite direction. The plate cooler can reduce the temperature of the milk entering the bulk tank to within 4° F of the incoming cold water temperature.

PERFORMANCE FACTORS

Milk pre-cooler effectiveness depends on several factors. Colder water removes more heat than warmer water. The ratio of water volume to milk volume moving through the plate cooler also affects performance. Setting up the cooler to use twice as much water flow as milk flow is common. The greater the ratio, the more pre-cooling occurs. A third factor is the velocity of the milk moving through the cooler. The slower milk goes through the plate cooler, the more heat can be removed.

ENERGY SAVINGS

Milk cooling costs are usually one of the largest energy operating expenses for dairy producers. For example, a dairy farm that produces 3,000,000 pounds of milk per year and uses 112,000 kilowatt hours (kWh) of electricity at a cost of $0.10 per kWh can save as much as $800 (8,000 kWh) a year if a plate cooler is installed.

NON-ENERGY BENEFITS INCLUDE:

- Extends refrigeration equipment life by reducing load and run time.
- Increases milk quality by inhibiting bacterial growth through faster cooling.
- Saves electricity and money with faster cooling and shorter compressor run time.
- Increases milk production, which can also be realized when the warm water exiting the Pre-Cooler is used for stock watering.

SPECIAL CONSIDERATIONS

Work with your equipment dealer to ensure that your water supply meets your cooling needs. Water used in Milk Pre-Coolers must meet all local Health Department quality requirements.

Scroll Compressor

Dairy producers know the importance of cooling their milk quickly and keeping it cool until it is picked up. For many years reciprocating compressors have cooled milk in America's bulk tanks. Whether single or double acting, these reciprocating compressors historically have used a lot of electricity, required regular maintenance, and tended to be very noisy. It is now possible to replace an aging reciprocating compressor with a newer scroll compressor and experience several benefits from the switch.

USES LESS ENERGY

Scroll compressors require much less current than conventional reciprocating compressors and are even able to run on single-phase electricity. One study found that a 3-hp scroll compressor used 42.1 percent fewer kilowatt-hours than a 3-hp reciprocating compressor over a 36-day period (72 milkings).

RUNS MORE QUIETLY

Working in the milk house will be easier on your ears. Since there are only four moving parts (no pistons or discharge valves), scroll compressors run at lower decibel levels and vibrate less than reciprocating compressors. Under load the scroll compressor is quieter than a household clothes washer (approximately 65dBA with enclosure).

MORE DURABLE AND RELIABLE

With only four moving parts and no metal-to-metal contact, there are no seals to tear and no lubrication needed. Another important feature is that scroll compressors operate well in cool weather and do not require crank-case heaters. Finally, scroll compressors can start under any system load so there is no need for a start kit.

BETTER CONTROL OVER MILK QUALITY

It is crucial to keep milk cooled at a consistent temperature to prevent high bacteria counts. A scroll compressor delivers the consistent, dependable cooling necessary to sustain low temperature conditions in the bulk tank.

COMPETITIVELY PRICED AND EASILY AVAILABLE

Several manufacturers produce scroll compressors and are sold through farm and dairy equipment suppliers. Installation costs are comparable to conventional reciprocating compressors.

Energy Efficient Stock Waterers

THE NEED FOR RELIABLE STOCK WATERING

All livestock need access to drinking water. In northern climates keeping water from freezing in unheated barns and outdoor settings is critical. This need has usually been met by heating drinking water with an electric heater that often draws 1000 to 1500 watts.

THE ENERGY EFFICIENT ALTERNATIVE

Well insulated, plastic stock waterers have proven their ability to keep drinking water from freezing using 250 watts of electricity or even no electricity at all. One of the keys to making the energy-efficient and energy-free models work is proper sizing for the number of animals served. Since ground water temperature is usually around 50° F, it must drop about 20° F to reach the freezing point. If enough animals drink from the waterer, the incoming "warm" water will keep the unit from freezing. Proper insulation of the unit keeps this heat in the waterer. Many of these units have floating plastic covers which float on the water and seal the opening of the watering reservoir when animals are not drinking. Not all sites are suitable for energy-free models. It is particularly important to assure that electrical wiring not come in contact with livestock drinking water to prevent electric shock to animal or farmer.

Did You Know?

Several factors determine how much water a cow will drink: her size, milk yield, quantity of dry matter consumed, temperature of the environment as well as the water quality, availability of the water, and amount of moisture in her feed. For horses, bison, and other livestock, a primary waterer selection factor is the frequency of use. With minimal usage the waterers need to be better insulated and equipped with reliable heaters to ensure the floating cover does not freeze in place, preventing the animal from drinking.

Water Heating

Water heating can consume up to 20% of the energy used on a dairy farm. Having the properly sized water heater will help minimize water heating costs. Heaters should be chosen based on how much hot water is needed over a specific period of time. On dairy farms, this is usually how many gallons per cycle are required for the milking system and bulk tank. When considering a new water heater, choose the model with the highest energy factor (EF) rating for the fuel type used on the farm. If gas or oil is used, select a heater with an EF rating of 0.61 or more. If electric is used, look for an EF rating of 0.91 or more.

Solar Thermal Systems can be a cost-effective solution to heating (or pre-heating) water, especially during the warmest six months of the year. Using no fuel except sunlight, solar collectors can be mounted on south-facing roofs or on ground-mounted racks adjacent to the building where the hot water is needed. Generally speaking, a supplemental water heater will be needed to insure adequate hot water during winter months or cloudy days, but a properly-sized solar thermal system can cost-effectively provide 60-80% of your hot water needs. Like all renewable energy systems, the economics are most favorable when there is a steady, fairly predictable need for hot water over the course of the year. Since solar thermal systems produce at least 60% of their annual output in the six summer months (and can be adjusted to produce an even higher percentage), they are optimally suited to situations that require more hot water in the April – September time frame than in the winter months.

Greenhouses

A grower can save a substantial amount of energy by implementing steps to reduce heat loss in the greenhouse. Greenhouse energy savings can also be found by upgrading lighting, motors, refrigeration, and ventilation. While many Connecticut greenhouses are only used for a portion of the year, it may still be worthwhile to implement some of these steps. An energy audit or audit pre-consultation can better determine which actions are most cost effective for your particular situation.

TEMPERATURE MANAGEMENT

Many energy efficiency opportunities in greenhouse involve the optimal heating and cooling of a greenhouse. Proper management of the temperature inside a greenhouse is critical to avoid over or under-heating, and to ensure efficient use of whatever fuel is used to heat the space. In all cases, growers need to consider the effect planned changes to the greenhouse will have on plant health.

INFRARED PLUS ANTI-CONDENSATION TREATED FILMS

A combination infrared / anti-condensation treated film is a best choice for the inner layer of polyethylene film. While polyethylene film helps to retain heat, the condensation that forms on the inside reduces light and solar radiation and can affect plant health. Many times, a grower can see a reduction in heating energy use between 10 and 20 percent, and payback periods can be less than two years even if the greenhouse is only heated for a few months.

INSULATED SIDE WALLS

Adding foam insulation to the side walls, end walls, and perimeter of a greenhouse can result in heat energy savings. The insulating foam can be a one or two inch foam board, or spray foam. In either case, the foam should have a protective cover to prevent deterioration. If the foam is on the inside of the walls, it should have a reflective coating aimed to the inside in order to reflect the solar radiation back into the greenhouse.

GREENHOUSE HEAT CURTAIN

There are several types of curtains designed to manage heat in a greenhouse. Semi-porous aluminumized materials provide the best

combination of summer shading, winter heat retention, and also allow for removal of condensation. Porous curtains cut heat loss between 20-30% and allow water to drain. Aluminumized curtains reduce heat loss up to 65%, but can hold water if installed improperly.

SEALING AIR LEAKS

Holes and cracks, even small ones, can add up to significant heat loss and money wasted. Pay particular attention to doors, windows, and any point where the greenhouse cover attaches to the foundation or walls. Be sure to seal any leaks with caulk or weather stripping.

POLY FILM COVER ON GLASS HOUSES

A seasonal or permanent layer of poly film on your glass greenhouse can reduce heat loss. However, it can also lead to faster depletion of carbon dioxide and increased humidity. Consult with an energy efficiency expert or your local extension agent before you place a poly film cover on your greenhouse.

WIND BREAKS

If your greenhouse is located in an open, windy area without protection from wind, consider installing a temporary or permanent wind break. Wind breaks reduce infiltration losses from the prevailing winter wind. A temporary wind break can be a 10-12' snow fence located 40 to 60 feet away from the greenhouse. To create a permanent wind break, plant a mixture of coniferous and deciduous trees about the same distance from the greenhouse.

ELECTRONIC THERMOSTAT

Consider an electronic thermostat that can be programmed to automatically adjust the temperature throughout the day. This provides for greater precision and greater efficiency. No matter what thermostat you are using, keep it clean and make sure it is recalibrated annually for optimum accuracy.

REFRIGERATION

Greenhouse operators often have refrigerated coolers and freezers for their retail sales. Having modern refrigeration equipment and annual equipment maintenance can provide cost effective savings. Generally, more insulation around coolers and freezers located outdoors is often

worthwhile. When standard reciprocating compressors fail replace them with scroll compressors. Install timers or other controls on evaporator fans to reduce the run time on the compressor motors. On larger systems, consider floating head pressure controls and evaporator fan controllers.

✔ **Motors**: Refer to motor section at the end of this guide.

✔ **Lighting:** Refer to lighting section at the end of this guide.

HEATING

There are different methods of heating a greenhouse, and each has its advantages and disadvantages. Consider replacing old forced air units with higher efficiency condensing units. Depending on your operation there are alternative heating methods available like: floor heating, underbench heating, root zone heating, condensing boilers, ground–source heat pumps, and biomass boilers.

✔ **Ventilation:** Refer to ventilation section at the end of this guide.

Nursery

Open-air nurseries can benefit from many of the same technologies as greenhouses, except for the insulation and heating measures. Nurseries can also save both water and energy by managing their irrigation.

IRRIGATION

- Water only when necessary
- Test pumps every two years
- Move irrigation to off-peak hours to take advantage of lower electric rates
- Inspect wells to ensure there is no clogging or corrosion
- Add chlorine to irrigation lines monthly to kill bacteria and algae
- If running irrigation tapes or tubes on the surface, lift them periodically to keep debris from covering them and roots from pinching them
- Flush system regularly to remove blockages
- Regularly check for leaks, and fix all leaks immediately

DRIP IRRIGATION

Drip irrigation is 90% efficient as compared to sprinkler systems (80%). It is also more efficient than a flood system, as the water goes directly to the roots. A well-designed drip system has almost no run-off or evaporation. It can be routed along the surface or buried in the soil. It can be used to deliver herbicides, fertilizers and insecticides. When designing such a system, take into account the land's contour when determining pressure and flow requirements, as well as the need for regular flushing of the system. Filters may be needed to ensure a minimum amount of damage from blockages.

PUMP UPGRADES

Testing irrigation pumps for pumping efficiency is a good way of discovering if they are working at optimum efficiency, and can help determine if it is time to upgrade. Pump efficiency testing involves measuring gallons per minute, total dynamic head, and input horsepower. This information can then be used to determine if the pump is working efficiently. If the time is right for an upgrade, consider a NEMA premium efficiency motor.

VARIABLE SPEED DRIVES (VSDS) FOR PUMP MOTORS

A VSD is an electronic device that changes the frequency of the AC power going to a motor, varying the motor speed. When it is attached to a pump, the change in motor speed affects the flow and pressure of the water being pumped. VSDs are energy efficient because they regulate the flow of water to match demand, potentially eliminating the need for a flow control valve at the pump station. VSD installation is appropriate in some, but not all, irrigation operations. An irrigation engineer can determine whether or not a VSD makes sense for your irrigation system, as a number of factors such as piping, pumps, flow conditions over time, and operating hours are involved. Irrigation systems with dramatically varying flow rates tend to be good candidates.

SOIL MOISTURE SENSORS

Soil moisture sensors help conserve water by ensuring crops are watered only when necessary. There are three main types of sensors: tensiometers, gypsum blocks, and granular matrix sensors. The type of irrigation, soil, and crops on a farm will dictate which sensor will be most effective. Sensors should be placed near healthy crops with active root systems. There should be two sensors in the same location: a shallow one to read surface water levels, and another near the deeper roots. The average of the two readings will determine when to irrigate.

- ✔ **Refrigeration**: See Greenhouse Refrigeration section above
- ✔ **Motors:** Refer to motor section at the end of this guide.
- ✔ **Lighting:** Refer to lighting section at the end of this guide.
- ✔ **Ventilation:** Refer to ventilation section at the end of this guide.

Poultry (Turkeys & Broiler Chickens)

Poultry growers generally use a lot of energy, often second only to dairy. Like their counterparts in the dairy industry, there are ample opportunities for growers to reduce their energy use. Many times, upgrades can have a payback period of just a few years. An energy audit can help determine an estimated energy and cost savings based on your farm's particular situation.

CONTROLLERS

As little as fifty years ago, the poultry industry and its birds were very different. Birds tended to be heartier and could easily withstand temperature fluctuations.

Houses could be open-sided and basic. It also took 60 days to produce a four-pound broiler chicken. In today's industry it takes half that time to produce the same sized bird, one with more white meat and a better feed efficiency. Modern birds are unable to cope with temperature swings, and a bird's environment must be carefully monitored at all times to ensure the chickens are warm enough as chicks, cool enough when they are bigger, eating and drinking well, and growing to the appropriate weight.

Today's poultry houses require constant managing of temperature in order to maximize bird growth. Thermostats can often drift out of calibration, allowing for over (or under) heating of the house. Water, feed, and air quality conditions must also be checked on a regular basis.

These can be overwhelming tasks if the farm is comprised of more than one or two poultry houses. Installing controllers in the poultry houses makes these tasks easier.

Controllers can coordinate heating, ventilation, cooling, and lighting systems so they work in an integrated fashion. The house environment remains constant, allowing the birds to realize their maximum potential. In addition, such precision controls can help reduce energy costs by eliminating over-heating and over-cooling. Controllers are also PC compatible, so regular reports on temperature, feed and water conditions, and even bird weights can be sent directly to the office computer. The data can then be analyzed for trends and trouble areas.

BROODING CURTAINS

Brooding curtains are a common feature in poultry houses. Consisting of a long sheet of plastic, it spans the width and height of the house. It contains the chicks to a smaller portion of the house, allowing them to stay warm without the expense of heating the entire house. Problems arise when the curtain does not create a tight seal long the ceiling, walls, and floor. The cool air from the rest of the house seeps into the brooding area, leaching the moisture out of the litter pack and chilling the chicks. To solve this problem, ensure that the brood curtain is sealing tightly. If using bird boards, set them back a foot or so into the non-brooding part of the house. This will create a tighter seal and lessen the likelihood of leaks. Install a heavy conduit or pipe

in the bottom hem of the brood curtain for a tighter seal. Finally, make sure any holes in the brooding curtain are patched. A tight seal will not do much good if there is a gaping hole in the middle of the curtain.

INSULATION

Most brood curtains have little or no insulation value, and the value of a brooding curtain is highest when the rest of the house is properly insulated. The first step in lowering your heating costs should be to insulate your poultry house. If it does not have solid side walls, consider enclosing it or adding fiberglass batt insulation. Also, install or inspect your houses' vapor barriers for damage, as moisture reduces the insulation's effectiveness. Finally, check to see that there are no air leaks, and seal any crack with expanding polyurethane foam.

ATTIC INLETS

Ceiling (or attic) inlets are an effective way of keeping the flock warm during cooler months without increasing heating costs. They work similar to sidewall inlets, but are placed in the ceiling of the poultry house and draw heated air in from the attic.

Ceiling inlets work with the ventilation fans to provide clean air that has been naturally "pre-heated" in the attic. Daytime temperatures in attics can often spike as high as 25° F above the outside temperature. Even during colder months, the temperature in the attic will remain significantly higher than the outside.

By circulating pre-warmed air into the poultry house, less heat will be needed to keep the birds warm. The effectiveness of the ceiling inlets depends upon placement, the number of ventilation fans in use, and the static pressure in the house. While this can often be controlled by a static pressure inlet control machine, the number of inlets in use generally varies based on the age of the flock and the temperature outside.

While the ventilation fans tend to run more with ceiling inlets, the higher level of ventilation keeps the litter drier and the levels of ammonia lower. The relative humidity inside the house is also significantly lower, even during precipitation. While the ventilation fans will use slightly more energy, savings to counteract this will be seen in fuel (ie, propane and gas) usage.

Keep in mind that while daytime attic temperatures can be significantly higher than outside temperatures, it will regulate itself overnight. If it is 24° F outside, air drawn through the inlets will be a similar temperature. To combat this, keep the attic inlets closed on the non-brooding end. If moisture control is needed, opening just one or two will do the trick.

Do not worry if the attic inlets raise the house temperature by a degree or two temporarily. In most cases, this will cause more fans to come online and the air movement will cool the birds. As always, keep a watchful eye on the birds to ensure they are not overheating.

Most importantly, make sure that all poultry houses are tight. Check to ensure air will not leak in (or out) through holes in the walls or poorly sealing side- and end-wall doors. Only a tight house can be an energy efficient house.

CIRCULATION FANS

Hot air rises, and the hottest air in the poultry house will be near the ceiling. To keep chicks warm, circulation fans should be used to push hot air back down to the floor. The more uniform the house temperature is, the lower the total heating costs. The air must move gently around the floor, as fast-moving air will chill the chicks.

By slowly rotating the air to the floor, the chicks will stay warm, and the litter will remain dry. Another benefit of proper heat circulation is that the heaters will turn on and off less frequently. This will mean less wear and tear on the brooders, and less fuel will be needed to run them. Depending on the type of circulation fan installed, the fuel savings can be between 10% and 20%.

When installing circulation fans, make sure that the sensors controlling the heating system are not too high off the ground nor too close to the end walls or brooding curtains. This will give a "false" temperature reading for the floor of the house, causing it to be under-heated. If this is indeed the case and the sensors are moved, please note that any increase in fuel usage probably indicates that the house was not being properly heated from the start.

If using small box or basket fans, proper spacing is key. They must be far enough away from each other so the air doesn't move too fast, yet close enough so the air still circulates. Be sure that all cracks and leaks in the walls are sealed, and that the fans are regularly cleaned.

Types of Circulation Fans

There are many different types and sizes of circulation fans used in poultry houses. Most are basket fans, but box, paddle, and axial fans are also used to circulate air. Dropped ceiling houses can use 18" diameter 1/15 hp fans effectively. Open ceiling houses require larger fans due to exposed trusses and high ceilings.

END WALL DOORS

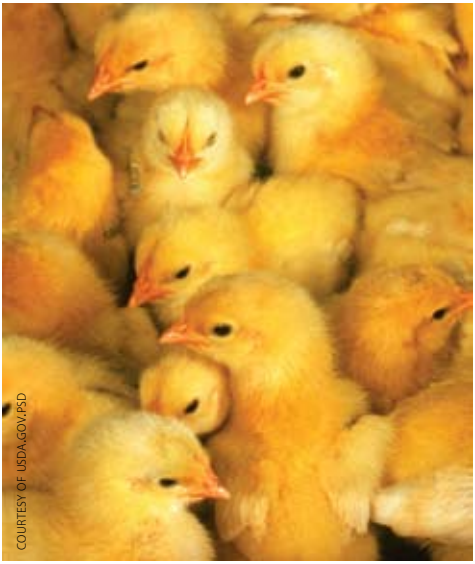
End wall doors are usually used only twice per flock, but can be a costly drain on the wallet if they are not performing properly. Warped, old, poor-sealing doors can allow air leaks, which negatively affect the temperature within the poultry house. This can lead to a downward spiral of higher heating costs, litter caking, less feed intake, and smaller birds.

A good door should be strong enough to withstand the elements, have a good seal to eliminate leaks, withstand the pressurization requirements of your house, and should have insulating properties. There are many products currently on the market, at a variety of prices. They have been installed in both new houses and in retrofits, and growers have been impressed with their performance. These doors are helping to reduce temperature variations, which helps to reduce the amount of propane being used to heat the house. A door that is durable, insulated, and seals well is an excellent investment, and will help save on heating and repair costs down the road.

SOLID SIDE WALLS

Historically, curtain side walls were thought to be the most efficient means of regulating poultry house temperatures. Arguments against closing a house entirely include fear of being able to regulate bird temperature during catastrophic power failures, an inability to air houses out between flocks, and supposed difficulty in decaking houses. However, it has been shown that solid walls help increase efficiency, both in regulating the

birds' environment and the farmer's energy usage. In most cases, these problems have clear solutions. For example, always ensure that backup generators are in working order. With totally enclosed houses, running a ventilation fan will air (and dry) the house out satisfactorily. It is generally acknowledged that it is the amount of time between flocks, and not exposure to the elements, that reduces the risk of infections or diseases.


COURTESY @ USDA.GOV.PSD

Finally, running tunnel ventilation fans during decaking, or decaking in one direction (from the tunnel fans to the tunnel inlet) seems to work very well. Those doing the decaking also benefit from fresher air.

Enclosing a poultry house can be expensive. When a farmer has multiple houses, the costs alone can make it seem as though the savings will not justify the expense. While it is recommended that all houses eventually be enclosed, there are temporary measures that will reduce fuel costs. One of the best options currently available is polypropylene-faced fiberglass batt insulation. It comes in 50-foot long rolls, and is fairly inexpensive and quick to install. In a traditional curtain-sided stud-wall house, the curtains are sealed at the top and bottom on the inside of the house. The fiberglass insulation is then rolled out over the surface of the stud wall, and attached to the house. Installation usually takes less than a day, and the fuel and energy savings are immediate. Farms often see a fuel savings of about 25%.

If making the commitment to install solid side walls, energy savings will vary depending on the type of house being renovated. Old 5-foot curtain sided houses might see a savings of up to 40%, while modern curtain sided houses with 24 inch openings, flaps, and insulation above and below the curtains may see a savings of around 15%. As always, fuel

and energy savings are dependent upon a tight house. Ensure that as the insulation is being installed, the fit is tight and secure. Repair any breaks and tears immediately.

RADIANT HEATERS

Radiant heaters are fired with propane or natural gas and are used in agricultural, commercial, and industrial settings, such as poultry houses, aircraft hangars, and retail stores. There are different types of radiant heaters. They include radiant tubes, quads, and circular heaters. Radiant tubes are metal and run lengthwise down the building or poultry house, and each section is generally 40 to 50 feet long. They are very efficient at emitting radiant heat over a large area. Quads and circular radiant heaters provide heat in a more localized fashion and more of these heaters are installed in a poultry house to provide uniform heating.

Unlike forced air heaters, which rely on convection of heated air to warm objects, no fans are required to deliver the heat to the floor. Heat is radiated quietly from the heater to the floor, and a reflector above the heater also helps direct the heat down towards the floor. Significant fuel savings are possible with radiant heaters as manufacturers typically recommend installing 15% fewer Btus of heating capacity for radiant heaters than forced air furnaces.

In poultry farms, one distinct advantage of radiant heating is that it does a better job of heating the litter pack. Since the heat is transferred directly to the floor of the house, this prevents the birds' body heat from being drained into the floor from their feet. The result is warmer birds and drier litter. Another advantage is that they can be mounted much higher in the house, so they do not need to be raised or lowered. They also heat the floor evenly, preventing the hot spots typically seen with pancake or radiant brooder heaters. The warmth spreads farther towards the side walls, meaning there is a larger comfort zone for the birds.

Some manufacturers also offer two-stage or dual-stage heating. The burner can be set at a higher or lower Btu output, depending on need. The higher setting is used only for times of severe cold. This will cut down on the amount of warm-up time and prevent temperature spikes, thus helping save fuel and extending equipment life.

Reflectors and radiant should still be cleaned periodically to maintain optimum heating efficiency. Having an intense heat source near the

ceiling can create a fire hazard if manufacturer's installation instructions are not followed explicitly. Be sure the ceiling is in good condition and check it frequently to ensure it is stable and not leaking insulation or other material onto the heater.

TUNNEL DOORS

Tunnel doors have had a rocky start in the evolution of poultry house technology. They were first developed in an attempt to solve the problem of keeping poultry houses warm and dry in the winter and still allow ventilation during the summer. While tunnel inlet curtains were effective in the summer, they had little to no insulation value (R-value), and often left birds in the brood end of the house significantly cooler.

Tunnel doors are built into the wall of the house and cover the evaporative cooling pads. They provide an easy and cost effective way to improve air flow and air mixing in the poultry house, and seal off the cold air coming through the cool pads during the winter months. During the summer, they are highly effective at maximizing air flow and eliminating dead air spots. The doors open upward into the house. The static pressure on the inside draws fresh, cool air through the cooling pads and up into the house, where it is then circulated with fans down to bird level. This ingenious method allows the cool air to come in, yet warm up enough first so it does not over-cool the birds. When first introduced around 2002, the idea made so much sense that many manufacturers began developing them. They came in many different forms and in many different materials. Unfortunately, these early models had several design flaws and reliability issues.

In the years since these problems surfaced, manufacturers of tunnel inlet doors have listened to the issues facing poultry growers and have taken steps to fix the initial problems. Most now offer metal hinges instead of plastic ones. Doors have also been resized to more adequately fit into currently existing houses. Many manufacturers have also increased R-values.

Tunnel doors remain a viable ventilation option, especially for houses in warmer climates where the right mix of air is critical. Be a wise consumer and compare the various options currently on the market. Make sure the hardware and equipment is of good quality. Proper installation is key with

this technology, so ensure that a qualified individual with prior experience with tunnel doors is available.

TUNNEL VENTILATION FANS

Tunnel ventilation fans are exhaust fans located at one end of the poultry house. Two large air inlets, with doors or louvers, are installed at the opposite end. When running, the fans draw air through the openings, down the house and out the fans, producing a wind tunnel effect. This is an efficient method of cooling birds during the warmer months, and can be combined with evaporative cooling in extreme heat.

On many farms, tunnel fans are turned off at night to save energy. When night air temperatures drop 20° to 25° F, it makes sense for growers to think it saves energy and money. But without the constant wind chill, larger birds cannot effectively shed their core body heat. A flock of 25,000 four-pound chickens can give off up to 1 million Btus of heat per hour. By turning off the fans, that heat remains in the house and overheats the birds. A few dollars might be saved initially by turning the fans off for the night, but poor feed conversion, lower bird weight, and increased bird mortality will reduce profits in the end. In order to keep profits and bird size high, choosing energy efficient fans makes sense.

VENTILATION FANS - GENERAL

The easiest way to select fans is to choose those that have been run through standardized tests, such as the ones done by the Bioenvironmental and Structural Systems (BESS) Laboratory at the University of Illinois. BESS Lab tests fans with accessories such as shutters, guards, and cones to determine the efficiency of each one. An energy efficient fan can cut electricity costs as much as half, and the payback can be as little as two to three years. The BESS Lab web site at **bess.illinois.edu** provides results from all of the fans tested.

Tips to Save Energy

To ensure maximum efficiency from your existing fans, keep them clean and well maintained. Dirty shutters can decrease airflow up to 40%. When cleaning the shutters, check the belts on belt-driven fans. Belt slippage reduces airflow and increases belt wear. Plan on replacing tunnel fan belts annually. Use cog-type fan belts, as they are typically 2% more efficient than v-belts.

Egg Layers

Since egg houses are not typically heated, the most significant energy usage, in the bird housing, is for ventilation. Ventilation fans are run nearly constantly in egg laying facilities. Ensuring you have the most energy efficient fans installed will provide you with the greatest energy saving opportunity.

✔ Please refer to the general ventilation section at the end of this guide for more information.

Vegetables/Field Crops

Farmers who have field crops do not have as much energy savings potential as other farm types, largely because they do not have much electricity use. Connecticut-sized producers also do not use as much diesel fuel as larger operations. Nevertheless, growers can benefit from looking at their irrigation patterns and motor use. If your farm has any outbuildings or shops, savings can also be found in lighting.

✔ **Irrigation:** Refer to the irrigation information in the nursery section.

✔ **Motors:** Refer to the motor section at the end of this guide.

DIESEL SAVINGS FOR TRACTORS

Tractors are an integral part of modern agriculture. They have allowed farms to increase exponentially in size and production. Unfortunately, they also consume vast amounts of diesel fuel. With today's skyrocketing fuel prices, it becomes increasingly important to reduce the amount of fuel used while maintaining current production levels and schedules. Luckily, there are some easy-to-implement steps you can take to reduce the amount of diesel fuel used without sacrificing production or quality.

PERFORM REGULAR MAINTENANCE

Regular maintenance will help tractors perform more efficiently with less fuel. Consider integrating these fuel saving practices into a regular maintenance schedule:

- Replace air and fuel filters regularly.
- Check tire pressures frequently, and replace worn tires.
- Use proper ballast for each operation.
- Do not idle diesel engines for more than 10 minutes.
- Clean dirty fuel injectors.
- Keep ground-engaging tools sharp.
- Use the right tractor for the job (match horsepower up to load).
- Combine trips whenever possible, by modifying equipment if necessary.

CONSERVATION TILLAGE PRACTICES

Conservation tillage is a term encompassing various practices to reduce the amount of tillage used in a field. Reducing the number of tillage passes made with a tractor means less fuel used. Additionally, conservation tillage can significantly reduce fuel, labor, and maintenance costs. Conservation tillage also decreases the amount of soil compaction, and soil, wind, and water erosion.

On fields where conditions permit, consider implementing one of the conservation tillage practices, such as ridge tillage or no-till.

Ridge tillage creates a permanent ridge in which to grow crops. As they are harvested, the crop residue remains, and is then pushed out of the way during the next planting. No-till does not use a tillage implement at all, but plants the crop directly into the previous year's crop residue.

While conservation tillage will help preserve the soil and will save diesel fuel, the adjustment in your farming practices will require new equipment and may increase your use of herbicides. Conservation tillage practices evolve over time, so check with a specialist before investing in a change to your farm.

REFRIGERATION

Many refrigeration systems can benefit from upgrades. Floating head pressure controls can significantly reduce energy use. Many systems have a fixed head pressure that is set to handle the worst conditions of cooling in the summer. By allowing the head pressure to float, the energy needed

Tips to Save Energy

"GEAR UP AND THROTTLE DOWN" This is a fuel saving practice for high horsepower tractors pulling lighter loads. Fuel can often be saved by running an under loaded tractor in a higher gear and a lower engine speed. Be sure to stay within the engine RPM working range as specified in the operator's manual, and be careful not to overload the engine.

to cool is reduced when the temperatures are lower than the maximum conditions.

Economizers can sometimes be used in refrigeration systems. If the outside ambient temperature is lower than the refrigeration temperature set point, then filtered outside air can be used to cool the product.

Walk-in coolers and freezers use evaporator fans to distribute the cool air from the refrigeration system. These fans operate continuously. Fan controllers will reduce the speed of the evaporator fans, which causes less heat from the fan motor enter the space and also reduces the energy to the motor. Keeping the fan operating at this reduced speed keeps temperature stratification from happening in the cooler if the fan was turned off.

WATER HEATING

Heaters should be chosen based on how much hot water is needed over a specific period of time. When choosing a water heater, select the model with the highest energy factor (EF) rating for fuel type used on the farm. If gas or oil is used, select a heater with an EF rating of 0.61 or more. If electric is used, look for an EF rating of 0.91 or more. In your existing water heater, inspect the system and repair any leaks. Insulate the water heater and the lines from the tank.

Orchards

Like farmers with field crops, orchard growers do not use as much energy as some other farm types. They can still benefit from reviewing their irrigation, motor, and diesel fuel use. If your orchard has any outbuildings or a retail space, savings can also be found in lighting. If your orchard stores product on-site using a refrigerated warehouse, there may be significant savings in the refrigeration.

- ✔ **Irrigation:** Refer to the irrigation information in the greenhouse section.
- ✔ **Motors:** Refer to the motor section at the end of this guide.
- ✔ **Diesel use:** Refer to the diesel information in the vegetables/field crops section.
- ✔ **Refrigeration:** Refer to the refrigeration information in the vegetables/field crops section.

Vineyards

Vineyards can benefit from reviewing their refrigeration, lighting, motors, and diesel use. If your operation has any outbuildings or a retail space, savings can also be found in lighting.

- ✔ **Irrigation:** Refer to the irrigation information in the greenhouse section.
- ✔ **Motors:** Refer to the motor section at the end of this guide.
- ✔ **Diesel use:** Refer to the diesel information in the vegetables/field crops section.
- ✔ **Refrigeration:** Refer to the refrigeration information in the vegetables/field crops section.

WINE TANK INSULATION

Wine cooling presents a major cost for any winery. Some estimate it can account for up to 50% of a winery's total electricity use. One of the best ways to cut back on energy use for refrigeration is tank insulation. Depending on the system chosen, an energy savings of up to 25% can be seen.

There are two types of insulation appropriate for wine tanks: spray-on insulation and rigid foam panels. Spray-on insulation is good for large applications, but is not aesthetically pleasing. The rigid foam panels, which can be used either as a retrofit or on new tanks, are made from expanded polystyrene laminated to aluminum sheets.

These foam panels also have a durable coating that can be white for external use or various colors for interior installations. The panels create a tight, easy-to-clean exterior that stabilizes interior temperatures.

Tips to Save Energy

When refrigeration equipment is insulated, it runs less, saving energy and money. Insulation also prevents mold growth and condensation on tanks, and eliminates ice formation.

Diversified Farms

Many Connecticut farms are small, diversified operations much like the kind found in generations past. It's not uncommon to find small operations that may have chickens, hogs, a few acres of crops, and perhaps a small greenhouse.

Often, these farms are intentionally designed for low production, with products sold at farmers markets. These operations have a very different energy use profile than their counterparts with larger operations. For instance, a small-scale poultry grower probably does not have the same chicken house set up as a commercial grower. The small diversified farm may have chickens in a coop rather than a poultry house, crops without irrigation, and a greenhouse that uses minimal temperature controls. This means these farms have lower energy use to begin with, simply because they are using energy for fewer things. Therefore, there are usually few energy efficiency opportunities on these farms beyond conservation activities. Still, farmers should read the sections on lighting, motors, and diesel use to see how they can reduce energy in those areas.

- ✔ **Lighting:** Refer to the lighting section at the end of this guide.
- ✔ **Motors:** Refer to the motor section at the end of this guide.
- ✔ **Diesel use:** Refer to the diesel information in the vegetables/field crops section.
- ✔ **Energy efficient stock waterers:** refer to the stock waterer information in the dairy section.

Christmas Trees

Christmas tree farms generally do not use much energy compared to other farm types. However, Christmas tree growers should review their use of lighting, motors, irrigation, and diesel use as there may be savings opportunities in those areas.

- ✔ **Lighting:** Refer to the lighting section at the end of this guide..
- ✔ **Motors:** Refer to the motor section at the end of this guide.
- ✔ **Irrigation:** Refer to the irrigation information in the greenhouse section.
- ✔ **Diesel use:** Refer to the diesel information in the vegetables/field crops section.

Equine

Since many equine operations have portable ventilation rather than permanent, lighting is the greatest energy efficiency opportunity on a horse farm. Please refer to the lighting section at the end of this guide for more information.

Maple Syrup

Today's maple syrup producer uses a fair amount of energy, even though the syrup operation is only active for a few months. There are several technologies that can save energy in the sugarhouse.

VARIABLE SPEED DRIVES (VSD) FOR SAP VACUUM SYSTEMS

In modern maple sap collection plastic tubes are used to bring the sap from the trees to a central collection tank. This process replaces the use of buckets hanging on the trees. With the tubing in place a motorized vacuum system is installed to pull the sap out of the tree and into the collection tank. Installing a VSD onto the vacuum system has the reported advantage of keeping a constant pressure in the pipeline and on each of the taps in the trees. It has been reported that this provides a healthier tap site on each tree.

By running continuously, at a slower speed, the vacuum motors use less energy and have less wear and tear because they no longer operate in an on-off, on-off cycle. There have not been any independent tests showing the energy savings of using vacuum pump VSDs for sap collection, although the pragmatic experience of maple syrup makers indicates energy savings can be realized.

REVERSE OSMOSIS

Reverse osmosis (RO) is a process used to concentrate the sugars in the maple sap before boiling the sap into syrup. Using the same equipment used to desalinate sea water, the concentration of sugars in the sap to be boiled provides energy and cost savings due to the significantly reduced boiling time needed to produce a gallon of syrup.

EVAPORATORS

Sap collected from maple trees is boiled in an evaporator pan to steam off the water leaving behind the concentrated sugars, thus making the syrup. Over the past few years there have been some significant advances in evaporator technology. The sap needs to be heated to boiling temperature, so the faster this can happen the less fuel is needed to evaporate the water. Evaporator pans are now being designed to utilize the heat being carried in the steam to preheat the sap, thus reducing the operating time of the heating system.

BOILERS

There are numerous pieces of agricultural equipment, such as lights, fans, and motors, where the operator's view of them is "They are still operating. I am not going to change them." This is also true for sap boilers. They will continue to work even though they are no longer working as efficiently as they did when they were new and not necessarily as efficiently as a newer model or different boiler altogether.

Gas and oil fired boilers should be serviced annually to keep them in top working order. If the burner is more than 20 years old it is very likely switching to a newer model will be a cost effective improvement.

While energy and financial savings can be achieved by installing more efficient boilers the overall cost effectiveness of making an investment in new boiler technology needs to be evaluated carefully. When compared to all of the other energy saving options for syrup makers, installing a reverse osmosis system will provide the greatest reduction in boiling time and therefore cost reduction. The second most cost effective, energy saving investment is with the evaporators. If a syrup producer has invested in an RO system and a new evaporator, it makes the payback for replacing the boiler system much, much longer and possibly not worth it at all.

Motors

The National Electrical Manufacturers Association (NEMA) was created in 1926 to provide a means of standardization for electrical equipment. In 1991, NEMA created NEMA Premium® motors, a designation given to motors which exceed energy efficiency standards set forth by the US Department of Energy (DOE). This designation can only be given to manufacturers who belong to NEMA. Electric motors have a significant impact on total energy operating costs. Electric motors convert electrical energy into mechanical energy. Like all electromechanical equipment, motors consume "extra" energy in order to make the conversion.

WHAT MAKES A MOTOR EFFICIENT?

Efficiency is a measure of how much total energy a motor uses in relation to the rated power delivered to the shaft. NEMA Premium® electric motors have higher efficiencies, lower electrical power consumption and costs, and higher system reliability than standard motors. When installing a new motor or retrofitting existing motors to save money and energy, consider using a NEMA Premium® motor. While NEMA Premium® motors may cost more initially, the payback is significant over their operating life in most applications, especially in areas where electricity prices are continually rising.

COST SAVINGS FOR ENERGY EFFICIENT MOTOR

The following is an example of the savings if an existing 50 hp motor were replaced with the same sized motor with the lowest energy efficiency requirements of the DOE compared with a motor with the highest energy efficiency - a NEMA Premium® motor. Assuming an annual run time of at

least 2,000 hours, the least energy efficient motor would save around $618 (at $0.10 / kWh) a year. In this example the lowest energy efficient motor costs approximately $1,450 and the most efficient motor costs $1,800. By investing another $350 to purchase a NEMA Premium® motor the savings would jump to $738 annually. This small additional investment would be repaid in less than three years. Here's the math. ($738 - $618 = $120 extra savings each year with the more efficient motor. Divide the extra cost of $350 ($1,800 - $1,450) by the additional savings to find the 2.9 year payback.)

OTHER BENEFITS

Premium efficiency motors are also usually made to higher manufacturing standards and stricter quality controls than regular efficiency motors. This can often mean the motor will last longer, with fewer maintenance costs and less downtime.

☞ **For more information on NEMA Premium®, please visit:**
www.nema.org/gov/energy/efficiency/premium

☞ **For product specifications and definition, please visit:**
www.nema.org/stds/complimentary-docs/upload/MG1premium.pdf

Tips for Buying a New Motor

When purchasing a new motor, there are three important factors to consider:

1) If the motor will be running for extended lengths of time

2) How high the electric bill is in your local area

3) Selecting the right sized motor for your application

If the motor is only running sporadically, a retrofit to a NEMA Premium® motor or other motor will not make economic sense. However, the longer the motor runs, the greater the potential for savings and in new installations NEMA Premium® motors are the standard.

Energy Efficient Lighting

Lighting is one of the simplest, easiest, and most cost effective energy efficiency upgrades that can be made on the farm. Many farmers don't realize the impact energy efficient lighting can have on their energy costs, and are pleasantly surprised at the short payback period for many lighting projects. Nearly all farms use lighting in some form, and nearly all farms can benefit from increasing the energy efficiency of their lighting.

T-8 and T-12 Lighting

TRADITIONAL T-12 STANDARD FLUORESCENT LIGHTING

Traditional 1 1/2 inch T-12 fluorescent bulbs and ballasts have been in use for generations. Our parents and grandparents learned to put up with their flickering white light and noisy humming in exchange for significant savings over the even older technology found in incandescent bulbs. Traditional T-12s lasted far longer and used much less energy than incandescents and were well received when they were introduced commercially in the late 1930's.

EFFICIENT T-5 AND T-8 FLUORESCENT LIGHTING

Today's 1 inch T-8 bulbs and 5/8 inch T-5 bulbs and corresponding electronic ballasts replaces the traditional T-12 with its transformer type magnetic ballasts and delivers an array of benefits. The T-5 and T-8 both deliver less noise, more light per watt, better color rendering, no flickering, cooler operation, and most importantly, electric cost savings.

T-8s are commonly available in 4' or 8' lengths with the 4' lights using 32 watts to produce the same amount of light as the traditional 40 watt T-12. The T-8's efficiency can be traced to electronic ballasts that use solid-state circuitry to provide the right voltage and current to the gasses encased in a glass tube, which boasts a slimmer profile than the T-12.

Now, T-5 bulbs, or bulbs that are 5/8" diameter are available, which are even more efficient than their predecessors while still maximizing the light output per bulb. They are mainly used in commercial applications, as they have higher initial investment costs in terms of their fixtures and bulbs. However, because T-5 bulbs are so thin, their fixtures are smaller

and can be put into more applications where a smaller footprint is important. The bulb length can also be made shorter, as lengths range from 6 to 60 inches.

OTHER BENEFITS

The noisy hum and erratic flicker associated with old-fashioned T-12 fluorescent lights are both eliminated by the electronic ballasts that drive the T-5 and T-8. The T-8 also has a higher color rendition index which delivers a light spectrum closer to natural light than the white light from the T-12. The T-5 has an even higher color rendition index.

T-8s are natural replacements for the older style T-12s. The switch out requires that both the old magnetic ballast and the old T-12 bulb be replaced at the same time by the modern electronic ballast and the new T-8 bulb. Typical payback time is 2–4 years depending on use. Because the T-5 is currently offered in metric dimensions, it is ideal for new installs as opposed to retrofits.

Compact Fluorescent Lighting

REPLACEMENT RECOMMENDATIONS

Indoor light fixtures using incandescent bulbs (lamps) are inexpensive to buy and install, but are extremely expensive and inefficient to run. Very small, very efficient compact fluorescent lamps (CFLs) deliver the same lighting level, but use only 1/3 the amount of electricity. A ballast modifies electricity for use by the fluorescent tube. Compact fluorescent lamps with magnetic bases are similar to conventional fluorescent fixtures. When they start, they flicker slightly.

Modular compact fluorescent lamps have two separate parts. The lamp or tube snaps into the base. Since the base can last up to four times longer than a typical tube, modular units let you replace only the part that fails first. This fixture typically provides a better long-term value.

New fixtures of many different types are also available that use energy efficient compact fluorescent lamps as original equipment. While replacement costs for compact fluorescent lamps are somewhat higher than for incandescent lamps, their rated lamp life is usually ten times longer. This dramatically longer lamp life provides the clear advantage in total maintenance cost reduction.

DIMMABLE CFLS ARE NOW AVAILABLE

Advances in lighting technology occur regularly. If the lighting situation calls for dimming the lights, as in poultry broiler house operations, then dimmable CFLs can provide significant energy and dramatic cost savings over incandescent lights.

For example, replace your 100-watt incandescent lamps with 32-watt hard-wired compact fluorescent lamp and ballast assemblies with protective jar housings. The replacement lamps may cost ten to twelve dollars. The ballast should last through several lamps. The jar housing may last indefinitely and it will make the unit moisture resistant and easier to clean. The 32-watt compact fluorescent has slightly more light output than a standard 100-watt incandescent (1900 vs 1700 lumens). The jar style fixtures are typically mounted so that they hang down.

There are now other styles of CFLs that have a lower profile for areas with low ceilings.

Cold Cathode Fluorescent Lighting

Cold Cathode Fluorescent Lights (CCFL), one of the newer forms of fluorescent lighting, resemble incandescent light bulbs on the outside, but differ on the inside in that they have no filament. Incandescents create light by applying a voltage to a filament, but this is wasteful as only 10% of the energy is converted to light, while the rest is dissipated as heat.

Compact fluorescent lights (CFLs) work by applying a voltage between heated electrodes at either end of the tube, creating an electric arc discharge. Even under the best of conditions, electrodes accumulate damage from the arc, vaporizing material in the process, which is deposited on the inside of the tube. CCFLs operate at a much higher voltage than CFLs, eliminating the need for heating the electrodes (hence the name cold cathode), and making CCFLs 10–30% more efficient than CFLs. The voltage of CCFLs is about 5 times higher than CFLs, while the current is 10 times lower. The lifetime of CCFLs is about 50,000 hours. The lumen production per watt is about half of CFLs. CCFLs are similar to normal fluorescent (or "hot cathode") lights in many respects.

Unlike traditional fluorescent lamps, however, CCFLs have the ability to dim without any special dimming ballasts. The real advantages of CCFLs

are seen in comparison to incandescent lights. CCFLs can operate using as much as 65–80% less energy than comparable incandescent lamps and last up to 25 times longer. This proven technology has been successfully applied to conventional lighting in a variety of applications, including laptop computers, copiers, cell phones, and flat panel displays. CCFLs are available in a variety of bulbs, wattages, colors, and styles. The soft-starting of the cathodes makes for extraordinary life, great illumination, and significant energy savings. They are UL listed for indoor and outdoor use and are also fully dimmable. The bulbs also fit into incandescent sockets, making upgrades from incandescent bulbs as simple as changing a light bulb.

High Pressure Sodium Lighting

High Pressure Sodium Lighting (HPS) is an excellent choice for barn yards and other exterior areas. These yellowish lights are also suitable for indoor areas where color rendition is not important. Units inside a barn should be wired together on a common photocell in a bright area of the barn to minimize the operation hours of these fixtures. Indoor fixtures should also have enclosed and gasketed optics to protect the lamp and reflector, and

increase the life and light output of the fixture. This will also reduce the time required to clean the fixture as only the lens will need to be wiped down.

LAMP LIFE

High Pressure Sodium Lights are long lasting with an expected life of about 24,000 burning hours or six years for photo-controlled fixtures.

HIGH PRESSURE SODIUM LIGHTS VS. MERCURY VAPOR LIGHTS

High Pressure Sodium lights are more energy efficient and produce more light per watt than Mercury Vapor Lights (MV). A smaller wattage HPS bulb will produce as much as, if not more light (measured in lumens) than, a larger wattage MV bulb.

Yard Lighting Example

EXISTING LIGHTS: 175 watt MV yard light
RUN TIME: 10 hours per day, 365 days per year
REPLACEMENT LIGHTS: 100 watt HPS light
COST OF ELECTRICITY: $0.10 per kilowatt-hour
SAVINGS: 274 kWh and $27.40 per year

Freestall Lighting Example

EXISTING LIGHTS: Twenty-five 400 watt MV lights in a freestall barn
RUN TIME: 10 hours per day, 365 days per year
REPLACEMENT LIGHTS: Twenty-five 250 watt HPS lights
COST OF ELECTRICITY: $0.10 per kilowatt-hour
SAVINGS: 13,688 kWh and $1,368.80 per year

Renewable Energy Opportunities

COURTESY OF THE CONNECTICUT CLEAN ENERGY FUND

Using renewable energy can reduce your energy costs because you are offsetting some of what you would pay for electricity, diesel, propane, or natural gas with energy you generate yourself. Renewable energy also has less of an environmental impact than energy generated by burning fossil fuels. Because of its benefits, many states are encouraging residents to implement renewable energy projects. In Connecticut, there are several opportunities for grants and financing, and the state has a goal to secure 27% of its electricity from renewable sources by 2020.

However, renewable energy can often be costly. Before you investigate renewable energy, make sure you have made your operation as efficient as possible and done all you can to conserve the energy you already use. It doesn't make much sense to invest in a solar panel or wind turbine to power a barn that is full of air leaks and has outdated fans and lights.

The information below will help give you a sense of some renewable energy opportunities for your farm. We have included links to some other sources of information, should you wish to investigate this further.

Wind Energy

Wind turbines convert the kinetic energy from wind into mechanical power that runs a generator. You may have driven by a wind farm with acres of large wind turbines providing power to the electric grid. The same technology can be used on a smaller scale to generate electricity for your farm. Small wind turbines are available for farmers who wish to offset some or all of their power use.

☞ **More information about wind energy can be found from the American Wind Energy Association, which has a good list of questions and answers about small-scale wind: www.awea.org/smallwind/toolbox2/factsheets_home.html**

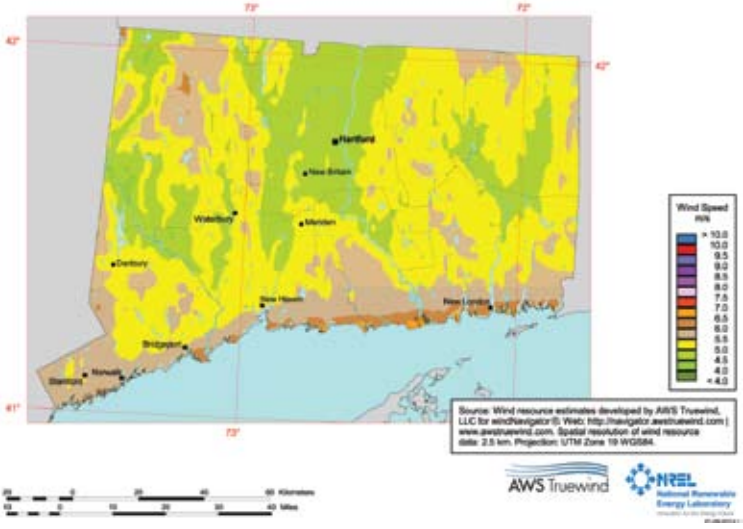
☞ **The U.S. Department of Energy also has a good resource about small wind: www.windpoweringamerica.gov/pdfs/small_wind/small_wind_guide.pdf**

The map on page 53, from the U.S. Department of Energy, shows mean annual wind speeds at an 80 meter height. Areas with an average annual wind speed of at least 6.5 meters/second are considered to have suitable resources for wind development.

While this map primarily considers commercial-scale wind development, the map gives you a sense of the areas in Connecticut that have the best potential for wind. In this case, the areas shaded in brown and yellow have greater potential than the green areas.

However, wind activity can vary substantially on the micro level, so you should get a professional evaluation of your wind energy potential if you are seriously considering installing a turbine. A professional can install

Connecticut Annual Average Wind Speed at 80m



an anemometer to measure wind speed and determine whether your location is a cost-effective location for a wind turbine.

GRANTS FOR WIND PROJECTS

The Connecticut Clean Energy Fund provides grants for wind projects that represent good, economically-attractive installations. For the next two years (July 2010 – June 2012) the program will be a competitive "Request for Proposals" type of program, where project applications will be evaluated for technical feasibility, economic attractiveness, permitting/licensing status and other criteria. The "best" projects will be given grants designed to make the project competitive with conventional electric costs, including a reasonable return on the owner's investment.

☞ **Information about the wind program is expected to be available on the CCEF website (www.ctcleanenergy.com) in late 2010.**

Solar Energy

Every hour, more energy from sunlight strikes the earth than the entire human population uses in a whole year. The sun's heat and light provide an abundant source of energy that can be harnessed in many ways. There are a variety of technologies that have been developed to take advantage of solar energy. These include concentrating solar power systems, passive solar heating, daylighting, photovoltaic systems to generate electricity, solar hot water, and solar process heat and space heating and cooling.

☞ **The U.S. Department of Energy has a good primer on some common solar applications for farms: www.energysavers.gov/your_workplace/farms_ranches/index.cfm/mytopic=30006**

SOLAR PHOTOVOLTAIC (PV) CELLS

PV cells are the technology used to convert solar energy into electrical power. Packaged together, PV cells are called an array. A solar array can be installed in many places, although the efficiency of the system is affected by climate conditions. Most modern PV cells are about 10% efficient in converting sunlight. Your solar system can either be off-grid, meaning the array generates only for your home and is not tied to the electric grid, or it can be tied to the grid, meaning you can sell excess power back to your electric company. With the increase in utility demand for clean energy sources, many people find a grid-tied system to be beneficial. Still, a solar PV system can be costly, so investigate the payback period and make sure you are saving energy in other ways before investing in a PV system.

☞ **The Connecticut Clean Energy Fund has a listing of eligible residential solar installers—this list is a good place to start searching for a vendor. You should make sure a potential vendor has experience with installing systems similar to the one you want: www.ctcleanenergy.com/Portals/0/Solar%20PV%20ProgramContractors_08-1-10x.pdf**

Similar to the wind RFP program, the Connecticut Clean Energy Fund will be launching a competitive grant program for solar photovoltaic systems. Please check the website for details.

SOLAR HOT WATER

A solar water heater can be a cost effective way to provide hot water for

your farm. The solar water heater has two components, a storage tank and a solar collector. An active system has circulating pumps and controls, while a passive system does not. There are several sub-categories of solar heating systems within the passive and active designation.

Solar hot water can cut water heating expenses by 50-80%. However, before committing to a solar water heater you should first check with a reputable installer to make sure the system makes sense for you farm's needs, and that you are comfortable with the payback period.

☞ **The U.S. Department of Energy's Energy Efficiency and Renewable Energy has a good resource about solar water heating:** **www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12850**

☞ **The Connecticut Clean Energy Fund has a rebate available for commercial solar hot water systems:** **www.ctcleanenergy.com/YourBusinessorInstitution/SolarThermalIncentiveProgramCommercial/tabid/519/Default.aspx**

This program is funded by the federal American Recovery & Reinvestment Act, and is open to everyone in Connecticut as long as the funding lasts. Rebates are available to qualifying projects on a non-competitive, first-come, first-served basis.

PASSIVE SOLAR

A farm can make good use of "passive" solar design, by maximizing the

sun's heat and light instead of using mechanical systems. These systems are generally fairly simple and low-cost, so they can be a good choice for the farm. A good example is a solar (also called energy-free) stock waterer, which uses the sun's energy rather than electricity to heat livestock drinking water. Farms can also include renovating a building to add a skylight or south-facing windows to maximize light and heat, especially if the farm is planning a renovation anyway. To reduce the sun's heat, strategically placed awnings and landscaping should be considered. A solar greenhouse can be a good option for a small grower to extend the growing season without relying on fuels to heat the space.

☞ **The National Sustainable Agriculture Information Service has a free online publication for those interested in learning more about a solar greenhouse: attra.ncat.org/attra-pub/solar-gh.html**

Geothermal

Geothermal energy converts the heat from just below the earth's surface into a usable energy source. On a home or farm, the most common geothermal technology is using a geothermal heat pump to heat or cool spaces. Unlike wind or solar, which are largely dependent on temperature and climate, the temperature a few feet below the earth's surface is relatively constant despite major fluctuations in the air temperature.

A geothermal heat pump (also known as a ground-source heat pump) uses the earth as a heat source in cold weather by drawing up the warmer temperature from the earth. In warm weather, the pump sends warm air back in to the earth in order to provide cooling. This type of heat pump is much more energy efficient than an air source heat pump, because the earth's temperature is much more constant than outside air temperatures. A heat pump must have a heat exchanger installed in contact with the ground or ground water, in order to extract or dissipate heat.

Like a refrigerator, they work by transferring heat from a "source" to a "sink". A ground source heat pump can be used to heat a building in winter taking heat from the ground (the source) and releasing it in the building (the sink), and, by reversing the process, cool it in the summer. Because these systems have a relatively high capital cost, they are best suited to applications where heating or cooling is required year-round.

A geothermal heat pump can save between 40-70% of your heating

and cooling costs compared to a conventional system according to GeoExchange, a trade group for the geothermal industry.

The Connecticut Energy Efficiency Fund (administered by CT Light & Power and the United Illuminating Company) provides a rebate for an air-source heat pump for heating water. While not as efficient as a geothermal heat pump, they can still provide significant savings compared with conventional electric, oil or gas-fired water heaters. See www.ctenergyinfo.com/energy-programs.htm for more information about the CEEF programs.

☞ **The Connecticut Clean Energy Fund has a rebate available for commercial geothermal heat pumps: www.ctcleanenergy.com/YourBusinessorInstitution/GeothermalIncentiveProgramCommercial/tabid/521/Default.aspx**

☞ For more information about geothermal heat pumps, the U.S. Department of Energy's Energy Efficiency & Renewable Energy has a good resource about the various types of systems available: **www.eere.energy.gov/basics/renewable_energy/geothermal_heat_pumps.html**

There are other ways to use geothermal energy besides heat pumps, although most others are used in large-scale commercial applications or to generate electricity for power plants. Some greenhouses have installed direct-use geothermal applications although most of these have been large greenhouses in the Western U.S., which is a better fit for direct-use geothermal. Connecticut has no economically-feasible sources for these direct geothermal energy systems.

Biomass Technologies

Biomass is a term used for any type of renewable, non-fossil fuel that comes from organic matter. Common biomass types include wood, paper, yard clippings, agricultural residues, switch grass, and animal waste. Often,

biomass uses organic waste material which has to be disposed of anyway and turns it into usable energy. Biofuel is biomass that has been converted to liquid or gas. Ethanol and biodiesel are the most common biofuels in use throughout the U.S.

Biomass can be used to generate power for the electric grid. For the farm, the most familiar example is a methane digester (a type of anaerobic digester) which solves the manure-disposal issue on dairy farms while also generating an income for the farmer. As of April 2010, the Environmental Protection Agency reports there are two methane digesters on Connecticut dairies. There are several firms that specialize in conducting feasibility studies for anaerobic digesters. A feasibility study is essential considering a digester can be a multi-million dollar investment, and digesters are not appropriate for all farms.

☞ **The National Sustainable Agriculture Information Service has a good primer on methane digesters: attra.ncat.org/attra-pub/anaerobic.html, as does the U.S. Department of Energy: www.energysavers.gov/your_workplace/farms_ranches/index.cfm/mytopic=30002. The U.S. Environmental Protection Agency's AgStar program promotes methane digesters, and has a variety of resources, conferences, and publications: www.epa.gov/agstar/index.html**

On a smaller scale, many farms, homes, and businesses have found biomass heating (using a corn or wood pellet-fired stove) to be an economical alternative to fossil fuels like propane. Farmers have the option of also growing and marketing their own biomass heating products as a supplement to other agricultural production. As an example of this, the Hudson Valley Grass Energy project in New York takes leftover hay and converts it to pellet fuel: **www.hvge.org**

☞ **This article from the Union of Concerned Scientists presents more information about types of biomass used on the farm: www.ucsusa.org/clean_energy/technology_and_impacts/impacts/growing-energy-on-the-farm.html, as does the Connecticut Clean Energy Fund: www.ctcleanenergy.com/BasicsofCleanEnergy/TypesofCleanEnergy/Biomass/tabid/145/Default.aspx**

The Connecticut Clean Energy Fund will provide grants for qualifying biomass systems through a competitive RFP-type program that will be announced late in 2010, similar to the wind and solar photovoltaic programs described above.

Funding Sources

There are several resources for the farmer interested in accessing funding for energy audits, energy efficiency projects, or renewable energy projects.

RURAL ENERGY FOR AMERICA PROGRAM (REAP)

REAP is a federal program through USDA Rural Development. To foster rural economic development and growth, Congress passed the Rural Energy for America Program (REAP) known as Section 9007 of the 2008 Farm Bill. Rural small businesses and agricultural producers can apply for grants, (25% of total eligible costs) guaranteed loans (75% of total eligible costs) and combination grant and guaranteed loan (75% of total eligible costs) for financing renewable energy projects and energy efficiency improvements or grants for a stand alone feasibility study.

Eligible renewable energy projects include projects that produce energy from: wind, biomass, anaerobic digester, ocean, solar, geothermal, hydrogen and hydroelectric. The renewable energy project can produce any form of energy, including heat, electricity, or fuel. The minimum project size for a renewable energy project is $10,000.

Eligible energy efficiency improvement projects include improvements to a facility, building, or process that reduces energy consumption, such as retrofitting, lighting, or insulation, or purchasing or replacing equipment and motors with more efficient units. Energy efficiency projects must replace something that already exists. The minimum project size for an energy efficiency project is $6,000.

Projects cannot involve residential use. Project purchases incurred prior to submitting an application are not eligible. For all projects: the system must be located in a rural area or community of less than 50,000 persons, must be technically feasible, must meet environmental requirements and must be owned by the applicant.

Once a year a NOSA is posted to solicit applications and awards are made several months after the deadline.

For more information about REAP, visit Rural Development's Southern New England web page at www.rurdev.usda.gov/ma/

CONNECTICUT FARM ENERGY PROGRAM

The Connecticut Farm Energy Program (CFEP) is a pilot program that is supported in collaboration with Eastern Connecticut Resource Conservation & Development Area, Inc. (RC&D) and USDA - Rural Development (RD). The Connecticut Farm Energy Program serves as a resource for Energy & Agriculture as it relates to Agricultural Producers & Agricultural based small business in Connecticut. While also providing REAP Grant writing assistance to eligible Agricultural Producers & Agricultural based small business who are located in the 86 towns that Eastern Connecticut RC&D Area, Inc. provides assistance to within: Hartford, Middlesex, New London, Tolland and Windham Counties.

☞ **Visit their web page at www.CTFarmEnergy.org**

ENVIRONMENTAL QUALITY INCENTIVES PROGRAM (EQIP) AGRICULTURAL ENERGY MANAGEMENT PLANS

This program through the USDA Natural Resources Conservation Service (NRCS) provides financial assistance for agricultural energy management plans (AgEMPs). The main component of these plans is a farm energy audit. AgEMPs can be used as audits to support REAP applications, and the financial assistance offered by the state means producers pay less than market rate for these plans. AgEMPs are provided by certified technical service providers (TSPs), private contractors who are specialists in the field.

☞ **To learn more about the AgEMPs, visit www.ct.nrcs.usda.gov/programs/eqip/CAP-energy.html or contact the USDA service center nearest you.**

ENVIRONMENTAL QUALITY INCENTIVES PROGRAM (EQIP) PROGRAMS BENEFITING ATMOSPHERIC RESOURCES

Connecticut NRCS offers cost-share for practices that benefit atmospheric resources. The program covers:

- Practices to minimize or reduce emissions of fine particulate matter, odors, and/or greenhouse gases
- Energy conservation and energy efficiency practices
- Odor control, reduction of methane emissions

Many of the equipment and practices mentioned in this guide may be eligible under this program.

☞ **For more information, visit www.ct.nrcs.usda.gov/programs/eqip/arqm.html or contact the USDA service center nearest you.**

CONNECTICUT DEPARTMENT OF AGRICULTURE VIABILITY GRANTS FARM REINVESTMENT GRANT

This grant offers producers up to $40,000 towards construction of new buildings, refurbishing an existing building for the purposes of diversification, or construction of a new greenhouse. A 50% cash match is required. Applications are due April 30, and more information can be found here: **www.ct.gov/doag/cwp/view.asp?a=3260&q=398988**

CONNECTICUT DEPARTMENT OF AGRICULTURE VIABILITY GRANTS FARM TRANSITION GRANT

This grant offers up to $49,999 for any farm production project except the purchase of plants or animals. Energy efficiency upgrades are an eligible category. A 50% cash match is required. Applications are due the second Friday in November, and more information can be found here: **www.ct.gov/doag/cwp/view.asp?a=3260&q=419410**

CONNECTICUT CLEAN ENERGY FUND

The Connecticut Clean Energy Fund offers several incentives applicable to agriculture, including incentives for geothermal heat pumps and solar thermal. The "your business or institution" section of their website lists all the incentive programs available: **www.ctcleanenergy.com/CleanEnergyIncentives/tabid/57/Default.aspx**

CONNECTICUT ENERGY EFFICIENCY FUND

The Connecticut Energy Efficiency Fund is the result of a partnership with the state's utility companies and is funded by a small charge on customers' bills. **www.ctsavesenergy.org/programs/business.php**

Services differ slightly depending on whether you are a Connecticut Light & Power customer or a United Illuminating Company customer. Rebates and financing is available for a range of equipment, including lighting, refrigeration, HVAC, motors, variable frequency drives, and more.

NORTHEAST SARE (SUSTAINABLE AGRICULTURE RESEARCH & EDUCATION)

The SARE program offers a variety of grants, including grants to farmers who implement an innovative idea in sustainable agriculture. They also have a database of past projects where farmers can learn about projects other farmers have tried. Northeast SARE covers Connecticut, and is administered through the University of Vermont. **www.nesare.org**

ENERGY STAR

The Energy Star program is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy. Energy Star helps consumers by labeling energy efficient products, and offers rebates and tax credits for qualifying energy efficient equipment. The appliance rebate program for Connecticut has closed for 2010, but more funding may be available later.

☞ **Information on tax credits can be found at: www.energysavers.gov/financial/70010.html**

☞ **In addition, the U.S. Department of Energy has a general resource for saving energy on the farm: www.energysavers.gov/your_workplace/farms_ranches/index.cfm/mytopic=30001**

ENSAVE

EnSave, Inc. provides farm energy audits for REAP and AgEMPs, and can help connect farmers with incentive opportunities that may be available.

☞ **More information can be found at: www.ensave.com**

DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY (DSIRE)

The DSIRE database allows users to find information about several publicly-run energy efficiency or renewable energy incentives, and is searchable by state. **www.dsireusa.org**




CONNECTICUT FARM ENERGY PROGRAM

1066 Saybrook Road, PO Box 70
Haddam, Connecticut 06438
860-345-3977
www.CTFarmEnergy.org