

# Connecticut Farm Energy Program



CONNECTICUT  
FARM ENERGY PROGRAM

## Energy Management Best Practices Guide



### CONNECTICUT FARM ENERGY PROGRAM

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

[ctfarmenergy.org](http://ctfarmenergy.org)

# Introduction



## **Welcome 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 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: Connecticut Department of Agriculture, Clean Energy Finance and Investment Authority & Connecticut Clean Energy Fund (both part of Energize Connecticut) and USDA Natural Resources Conservation Service (NRCS).

CFEP serves as a clearinghouse of information both on assistance and funding for energy projects as they relate to AG producers and AG based small business across Connecticut.

CFEP aims to provide information as it pertains to

energy and agriculture in Connecticut through the CFEP website, email updates, publications, workshops and events it hosts and participates in.

CFEP serves as a resource of information on energy in relation to grant opportunities, loans, audits, educational opportunities and events for AG producers and AG based small business located in Connecticut.

CFEP also provides technical assistance in the form of grant writing to eligible Connecticut AG producers and rural small businesses 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 Connecticut Farm Energy Program is

to provide technical assistance to AG producers and increase awareness about energy conservation & efficiency while promoting alternative & renewable forms of energy on Connecticut Farms.

**For more information about the program, please visit the Connecticut Farm Energy website at [www.CTFarmEnergy.org](http://www.CTFarmEnergy.org).**

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# Definitions

**ENERGY AUDIT:** An energy audit is a document that analyzes the current energy use on an operation and recommends cost effective measures 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 the scope of work involved.

**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

**The American Council for an Energy Efficient Economy has multiple resources about various energy efficiency topics:  
[www.aceee.org/consumer](http://www.aceee.org/consumer)**

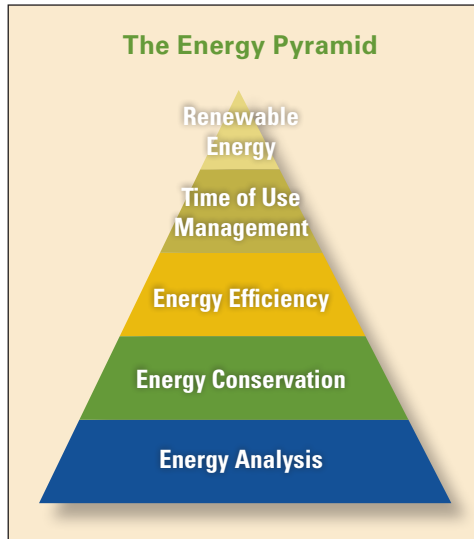
efficient model, you have reduced your energy use without changing the amount of heat or light available to you. This guide contains many recommendations for energy efficiency. Generally, energy efficiency measures have a cost, but the cost is worthwhile due to higher energy savings.

**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.



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# Dairy

Dairy farms have among the highest energy use of all types of agriculture. Fortunately, there are many technologies dairy farmers can implement to significantly reduce their utility bills. Many of these technologies can also have an effect 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 cost 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. Depending on the site, energy savings from installing a VSD can offset installed costs in as little 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 flow rate of milk through the unit. A variable speed drive (VSD) on the milk transfer pump maximizes plate cooler efficiency by providing a steady, even flow of milk through the heat-exchanger to maximize heat exchange efficiency.



## **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 is necessary for worker safety and comfort and can improve worker efficiency. It is an important consideration in the planning, construction, or maintenance of dairy facilities. Significant energy savings opportunities are available to switch from incandescent and older T12 fluorescent fixtures to high-efficiency fluorescent lighting and in some cases LED lighting.

### COST EFFECTIVE ENERGY EFFICIENT LIGHTING

Factors affecting efficiency include amount of light per watt and lamp life. Fluorescent, metal halide LED, 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 quick-start ballasts, the time can be reduced. All high intensity discharge lamps (HID) have a warm-up period, which can range from one to 15 minutes. Pulse-start metal halide lamps boast shorter start time and lower total fixture wattage over most HID fixtures. High-output T5 and T8 fixtures are also a viable alternative to traditional HID lighting and produce more high-quality light at lower wattages than traditional HID fixtures such as high pressure sodium. LED fixtures are an emerging alternative to HID lamps, though these lights are largely untested for use in dairy applications.

Fluorescent lamps are commonly used in milking areas such as the parlor and milk house as well as low-bay holding areas for cows. For free-stall barns with high ceilings, pulse-start HID lamps and 6-lamp T5HO 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 or LED 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. Financial incentives are available for energy efficient lighting and lighting controls. Visit [EnergizeCT.com](http://EnergizeCT.com) or call 877-WISE-USE to learn more.

## 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

## Water Heating

Water heating can consume as much as 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. Rebates and tax incentives may also be available for premium efficiency equipment. Visit [EnergizeCT.com](http://EnergizeCT.com) for more information.

Solar Thermal Systems can be a cost-effective solution to heating (or pre-heating) water, especially during the warmest 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 40% or more 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, such as on a dairy farm.

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. Significant energy savings in water heating can also result from compressor heat recovery systems.

## 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

- Can cut water heating costs by 50–75%, depending on the farm’s size
- Extends the life of the refrigeration system
- Cools milk faster
- Improves long term milk storage
- Producers often see a payback in less than five years

## 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 crankcase 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.

## 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.



### 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.

# 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.

## GREENHOUSE ENERGY CURTAIN

Installing an energy curtain to the ceiling of a gable or arch greenhouse can result in significant heating energy savings. The curtain closes off part of the ceiling, creating an attic space. This conserves heat in three ways:

- The curtain creates an insulating air layer between the curtain and the roof
- It reduces the volume of air in the greenhouse that needs to be heated
- It reflects the radiated heat back into the greenhouse

## REFRIGERATION

Greenhouse operators often have refrigerated coolers and freezers to store their products. There are several no-cost and low-cost measures that can be implemented to keep refrigeration systems running efficiently:

- Make sure the door seals well, and replace any worn weather-stripping
- Install strip curtains on the door to minimize heat gain when the door is open
- Use LED lights in the cooler to reduce heat load associated with lighting
- Clean evaporator and condenser coils regularly
- Ensure that walk-in coolers have a minimum of R-25 insulation value in the walls and ceilings, and that walk-in freezers have a minimum insulation value of R-32 in the walls and ceilings and R-28 in the floor

Walk-in coolers and freezers typically run their evaporator fans constantly. Significant energy savings can be realized by installing evaporative fan controls. These controls either slow the fans or turn them off once the cooler reaches its set temperature.

Refrigeration compressors can often be replaced by more energy efficient compressors. Scroll compressors are some of the most energy efficient compressors available. The most efficient models are digitally controlled and have capacity modulation.

In colder climates, outside air economizers can be a good energy efficient option. They utilize outside air when the outside air is below the set temperature of the cold storage area, reducing the run time of the conventional refrigeration system.

Floating head pressure controls are an energy efficient option for larger refrigeration systems. They modulate the head pressure of the compressors to match ambient conditions, resulting in significant energy savings. Floating head pressure controls are typically most effective when used in conjunction with a control system that utilizes variable speed drive condenser fans.

## 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.

## 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 placing 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 mix 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.

## 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.

Financial incentives are available for many motor controls. Visit [EnergizeCT.com](http://EnergizeCT.com) or call 877-WISE-USE to learn more.

### **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**

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.

Poultry house 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 contain the chicks to a smaller portion of the house, allowing them to stay warm without the expense of heating the entire house. A tight seal is required to keep cool air from seeping into the brood chamber 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. Poultry producers may also find significant energy savings in installing an insulated brood curtain to reduce heat loss out of the brood chamber.



## INSULATION

One of the first steps in lowering your heating costs should be to consider insulating your poultry house. If the house does not have solid side walls, consider enclosing it and adding insulation. Also, install or inspect your houses' vapor barriers for damage, as moisture reduces the insulation's effectiveness. Finally, check that the houses are well-sealed and seal any cracks with spray foam. An energy audit can help estimate the cost-effectiveness of installing new insulation or renovating from curtain sidewalls.

## 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.

Attic inlets can offer significant advantages in temperature and moisture control by pulling warm, dry air in from the attic rather than directly from the outside. The performance of attic inlets is highly dependent on the air sealing of the house. Static pressure control within a poultry house is necessary to ensure that attic inlets function properly.

### **CIRCULATION FANS**

As air around the birds is warmed by the heaters it will tend to rise toward the ceiling. Circulation fans can significantly improve bird health and reduce heating costs by gently sending warm, dry air near the ceiling of a poultry house back down to the floor where it is needed. Proper care should be taken in the design of the fan system to ensure adequate circulation and avoid over-circulation which could cool the birds.

### **END WALL DOORS**

End wall doors are usually used only twice per flock, but can be a costly drain on the wallet if they do not seal properly. Warped, old, or cracked doors can allow air leaks, which negatively affect the temperature within the poultry house. This can lead to higher heating costs, litter caking, lower feed intake, and smaller birds.

A good door should be strong enough to withstand weathering, provide a good seal to eliminate leaks, withstand the pressurization requirements of your house, and should have good insulating properties. High-quality, insulating end doors are available for both new and retrofitted houses and have been well-received by growers. These doors help to reduce temperature variations, which in turn helps to reduce the amount of propane 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. However, it has been shown that solid walls help increase efficiency, both in regulating the birds' environment and the farmer's energy usage. Many producers are understandably cautious about giving up the safety factor of having curtains in the event of a power outage. This problem can be solved with a reliable, well-maintained generator set to automatically start in case of an outage.

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. Many producers begin by tacking the existing curtain in place and fitting foam or batting insulation over the former curtain opening. As funds become available the old curtain and new insulation can be sealed in with hard sheathing materials such as wood and metal.

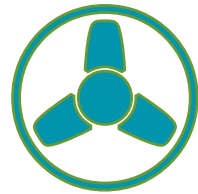
Energy savings from installing solid sidewalls will vary depending on the type of house being renovated. Old 5-foot curtain sided houses might see a savings of up to 40%, while modern curtain sided houses with 24 inch openings, flaps, and insulation above and below the curtains may see a savings of around 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. Rather than heating the air in a room, radiant heaters work by transmitting heat directly to the floor, objects, and occupants of the heated space. This helps save heat from being wasted when warm air is circulated out of the building. There are different types of radiant heaters. They include radiant tubes, quads, and circular heaters. Radiant tubes run lengthwise down the building

## 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.



or poultry house, and are 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 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, allowing the air to warm up enough first so it does not over-cool the birds. Manufacturers of tunnel inlet doors have taken steps to fix initial reliability and functionality issues. Most now offer metal hinges and frames instead of plastic ones. Doors have also been resized to more adequately fit into currently existing houses and 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 mistakenly turned off at night to take advantage of cooler outside temperatures and save energy. However, 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



### 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.

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, it is recommended that producers choose the most energy efficient fans possible whenever installing or replacing old fans.



### **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. The BESS Lab web site at [bess.illinois.edu](http://bess.illinois.edu) provides results from all of the fans tested.

### **POULTRY HOUSE LIGHTING**

For poultry production, lighting is extremely important for stimulating birds to eat and drink to promote good health and growth. Significant advancement has been made in Light Emitting Diode (LED) lighting for poultry. One-to-one retrofit LEDs can save as much as 80% on lighting costs over incandescent bulbs. LEDs designed for poultry houses can last years in the harsh environment, allow for excellent dimming performance without sacrificing bulb life, facilitate easy wash-down with a hose, and produce light in specific spectrums that birds see. Poultry LEDs are, however, a developing technology which is reflected in the price of each light. Even so, the payback for replacing incandescent lights with LEDs typically falls well within the expected lifetime of the bulb.

Compact fluorescent (CFL) and Cold cathode fluorescent lights (CCFL) are a less-costly replacement for incandescent lighting. Fluorescent lights are readily available, fairly inexpensive, and provide good energy savings over incandescent bulbs. Dimming will shorten the life-expectancy of any fluorescent light, even those which are rated for dimming, and dust from the poultry house can over-heat the bulb if they are not cleaned regularly. To facilitate cleaning, fluorescent lights with a smooth bulb over the curled tube are recommended.

# 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 almost continuously in egg laying facilities. Ensuring you have the most energy efficient fans installed will provide you with the greatest energy saving opportunity.

Similar to broiler operations, lighting efficiency can be a cost-effective investment for egg layer farms. Though typically lights are used less for egg layers than they are for broilers, many of the same principles apply. In addition to high energy savings, LED lights designed for poultry can match desired light spectrums to best stimulate desired bird behavior, can last for years, and can be dimmed effectively. Compact fluorescent lighting offers similar energy savings to LEDs over incandescent lights though cost less to install at the expense of performance as compared to LEDs.

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





# Vegetables/Field Crops

In the production of field crops there are both direct and indirect energy inputs. These include the use of fuel and electricity to power field equipment and irrigation systems, and the embedded energetic cost of pesticides and fertilizers. In particular, nitrogen fertilizers have a high energetic cost, which NRCS estimates to be 20,000 Btu per pound on nitrogen. Also, growers can benefit from looking at motor use, or if the farm has any outbuildings or shops, savings may 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 when 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. Tillage operations tend to be the most fuel intensive field operations, therefore reducing the number of tillage passes can significantly reduce fuel use per acre. Additionally, conservation tillage can reduce labor and maintenance costs, as well as improve soil quality and health. Consult with NRCS, University Extension, or other qualified agronomists in your area to determine a reduced tillage system that will work for you.

While conservation tillage will help preserve the soil and will save diesel fuel, the adjustment in these farming practices will likely require new equipment and may increase the use of herbicides.

## REDUCING NITROGEN INPUTS

The cost of nitrogen fertilizer is tied to the price of petroleum and natural gas and can often be a significant cost for farms. One way to reduce the amount of nitrogen fertilizer used on the farm is to use natural nitrogen from either manure or “green manure” crops. Adding legumes, which are nitrogen-fixing, to a crop rotation can provide a nitrogen credit to the following crop and reduce the amount of nitrogen fertilizer needed. Consulting with an expert for nutrient recommendations is also a good idea to make sure application rates are appropriate and do not exceed crop needs.

## 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



### 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.



needed 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 0.80 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.

Though most common on dairy operations, ideally any water heater near large compressors or similar equipment may benefit from waste-heat recovery to preheat water. Renewable energy such as solar water preheaters may also be applicable for farms with a large hot water demand. For farms with sparing hot water usage, instant hot water heaters provide good energy savings by heating water as needed, rather than storing large amounts of water at high temperature in a tank for extended periods of time. The EF rating of these systems can be over 0.95 though they may be limited by flow rate and high equipment and installation costs.

# 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. Refrigeration controls can also make your equipment more efficient and incentives are available to offset the cost. Visit [EnergizeCT.com](http://EnergizeCT.com) or call 877-WISE-USE to learn more.

# 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.

- ✓ **Lighting:** Refer to the lighting section at the end of this guide.
- ✓ **Radiant heating:** Refer to the radiant heating information in the poultry section.
- ✓ **Energy efficient stock waterers:** Refer to the stock waterer information in the dairy section.

# Maple Syrup

Maple syrup production is an energy intensive process. It takes approximately 40 gallons of sap to produce one gallon of syrup. The water has to be removed from the sap, and this is done conventionally by boiling the water from the sap.



## REVERSE OSMOSIS

Reverse osmosis is a process used to concentrate the sugars in sap before boiling the sap. The sap is run through membranes that remove some of the water. This process significantly reduces the amount of water that needs to be evaporated, thus reducing fuel usage. The RO system also reduces the amount of time needed to boil the sap.

## 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.



## STEAM AWAY

A steam away is a device that uses the heat from the steam coming off the evaporator to preheat the sap before it enters the evaporator. There are also air injectors that add air to the sap, making it boil at a slightly lower temperature. The steam away reduces the temperature needed to bring the sap to boiling temperature.

## BOILERS

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.

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# Honey

Honey production often involves small end-use equipment such as heaters and separating equipment. When equipment burns out it is recommended to purchase the most efficient replacements possible as energy savings usually overcome initial cost increase fairly quickly. Honey processing facilities use many of the same types of equipment and lights found in other small-scale processing plants and are common on small diversified farms.

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



# Goat Farms

Goat farms for meat or goat milk and goat cheese can benefit from many of the same energy efficiency measures as other types of agriculture, especially in areas such as lighting. Though typically smaller than Holstein dairy farms, goat milking farms can benefit from many of the same energy-efficient technologies for milk harvest, milk cooling, and water heating.

- ✓ **Dairy:** Refer to the dairy section for more information on milking equipment.
- ✓ **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.

# Farm Stores

Many farms now have stores where visitors can purchase items produced on site directly. The most common opportunities for energy-saving in farm stores is in lighting though depending on the selection of items available there may be opportunity to improve the energy efficiency of refrigeration systems or small motors. Installing high-efficacy lighting with occupancy sensors or upgrading to energy-efficient appliances can dramatically reduce running costs in farm stores.

- ✓ **Lighting:** Refer to the lighting section at the end of this guide.
- ✓ **Motors:** Refer to the motor section at the end of this guide.
- ✓ **Refrigeration:** Refer to the greenhouse refrigeration section.

# Cheese Processing

Cheese processing and similar facilities often find the most energy saving in lighting and a combination of motors or refrigeration systems. Often production facilities utilize high-bay lighting and may have significant opportunity to install new high-efficiency fluorescent lighting. As the technology develops, LED lighting has also shown promise for high-output and HID replacement applications. Periodically motors on processing equipment and exhaust fans may need to be replaced, in which case purchasing a premium efficiency motor or high-efficiency fan can quickly offset initial investment costs over conventional equipment. Facilities with cold-storage may also see significant savings in upgrading their refrigeration systems.

- ✓ **Lighting:** Refer to the lighting section at the end of this guide.
- ✓ **Motors:** Refer to the motor section at the end of this guide.
- ✓ **Refrigeration:** Refer to the greenhouse refrigeration section.

# 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 they 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](http://www.nema.org/gov/energy/efficiency/premium)

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

Small Business Energy Advantage, an Energize Connecticut program brought to you by your utility company, provides incentives of up to 40 percent of the installed cost for energy-efficient lighting upgrades. Low or no-interest financing is also available. For more information visit [EnergizeCT.com](http://EnergizeCT.com) or call 877-WISE-USE.

## LED Lighting

Light Emitting Diode (LED) lights are the newest form of lighting and are still undergoing development. Standard replacements for common incandescent lights are already widespread. For example, a 100 watt incandescent bulb may be replaced by a 12 watt LED. LEDs have the longest rated lifetime of any commercially available bulb and suffer very little lumen loss over the course of their lifetime. LEDs also dim lower and more smoothly than other commercial forms of lighting and do not experience shortened lifetimes from dimming, though for dimming applications the dimmer switch will need to be replaced with one designed for LEDs. LEDs are largely available as one-to-one screw-in retrofits for small standard incandescent bulbs.

Linear fluorescent and HID replacement LED fixtures are also becoming available. There are known safety issues with retrofitting existing linear fluorescent and HID fixtures with LED bulbs since LEDs are largely not compatible with the ballasts required for fluorescent and HID bulbs. Therefore, it is important to work with an electrician when installing high-wattage LEDs and replace the entire fixture when replacing high-output lights.

## 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. An electronic ballast modifies electricity for use by the fluorescent tube. Older compact fluorescent lamps with magnetic bases are similar to conventional fluorescent fixtures and flicker on startup.

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. Normally, CFLs with a standard ballast will burn out very quickly if put on a dimmer. Dimmable CFLs with modified ballasts are available; however, dimming even these lights has proven to shorten their life expectancy.

## Cold Cathode Fluorescent Lighting (CCFL)

Cold Cathode Fluorescent Lights, 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. Incandescent lights 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 Intensity Discharge (HID) Lighting

Many producers have opportunity for improving the efficiency of high-output lighting fixtures, such as those used for yard lights and freestall lighting for dairy farms. These lights commonly consist of mercury vapor (MV), metal halide (MH), and high pressure sodium (HPS) with wattages typically ranging from 150-400 watts. In enclosed areas such as freestall fluorescent fixtures are common energy-efficient replacements for HID fixtures. In areas where fluorescent lights are not applicable such as light poles, pulse-start metal halide (PSMH) lights can be an energy efficient alternative. MV and MH fixtures need more wattage to start up than to actually light the bulb. PSMH lights reduce the startup energy required, reducing the overall wattage of the fixture without sacrificing light output.

# General Ventilation

Most farms use fans to cool livestock and workers as well as circulate fresh air into enclosed spaces. The efficiency of circulation fans used is rated in terms of pounds of thrust per kW of energy required by the fan motor (lb/kW). Exhaust fans are generally used to expel heat and foul air from buildings. These fans create a difference in static pressure inside and outside of the building. Exhaust fan efficiency is rated in terms of the cubic feet of air moved per minute (CFM) per watt of energy required (CFM/Watt) and is often dependent on this static pressure change.

Farm-duty ventilation fans can be expensive to replace but worth the extra money to buy an efficient fan. Whenever buying new fans, EnSave recommends buying the most energy efficient fans available. The energy savings from an efficient fan will quickly offset any initial savings realized by purchasing a less expensive and less efficient fan. The fans generally recommended represent the midpoint between the minimum efficiency threshold and the highest efficiency fan as grouped and tested by Bioenvironmental and Structural Systems (BESS) Laboratory.

General measures to increase ventilation energy efficiency include:

- Establish a periodic fan cleaning schedule (every 3 to 4 weeks). Tests performed by the University of Georgia showed that dirty fan housings, shutters, and blades can reduce air flow and efficiency by up to 27%. Air flow also directly affects humidity levels, flock health, and performance.
- Inspect and replace worn belts and pulleys. Tests performed by the University of Georgia showed a 10-30% drop in fan output, mainly from worn belts.
- Stage the tunnel fans so that the newer, more energy efficient fans are the first to turn on if all of the fans are not needed.
- Install fan covers over unused fans during the heating season.
- Straighten bent cones and repair shutters that are not closing properly.

# Renewable Energy Opportunities



COURTESY OF THE CONNECTICUT FARM ENERGY PROGRAM

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 long-term contracts, financing, and grants, 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.

## Net Metering

Net Metering is a method of measuring the energy consumed and produced by a customer's generating facility. Net Metering allows a customer to reduce the amount of energy purchased from an energy supplier and to provide a value for the excess energy (exported energy to the Grid) produced by their generator.

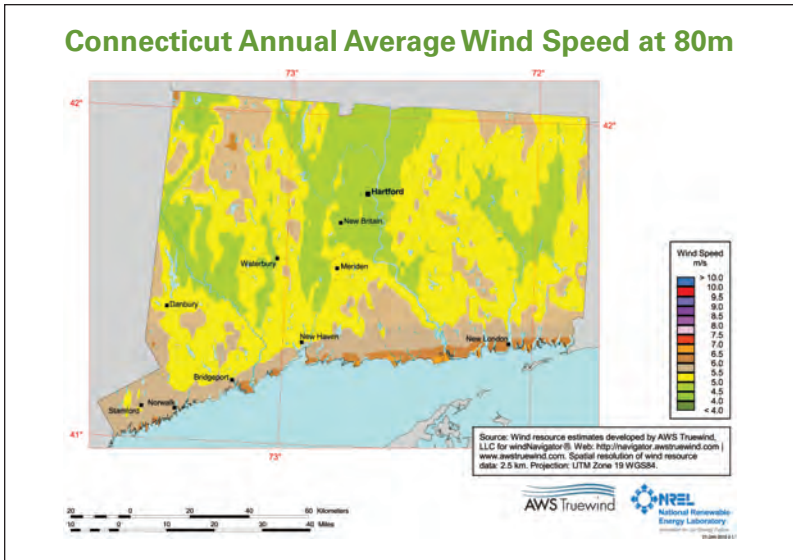
 **For more information, visit [www.ct-p.com/FAQ/Billing/Metering/Net\\_Metering](http://www.ct-p.com/FAQ/Billing/Metering/Net_Metering) or [www.uinet.com](http://www.uinet.com)**

### WHAT IS VIRTUAL NET METERING?

Virtual net metering allows customers who operate behind-the-meter generation (Customer Host) to assign surplus production from their generator to other metered accounts, (Beneficial Accounts) that are not physically connected to the Customer Host's generator. This 2013 Connecticut legislation includes Agriculture Customers as part of VNM and details of the program will be rolled out in 2014. In the meantime visit <http://energizect.com/government-municipalities/programs/virtual-net-metering> to learn more.

## 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/Resources/Content.aspx?ItemNumber=873&navItemNumber=588](http://www.awea.org/Resources/Content.aspx?ItemNumber=873&navItemNumber=588)

👉 The U.S. Department of Energy also has a good resource about small wind: [www.windpoweringamerica.gov/pdfs/small\\_wind/small\\_wind\\_guide.pdf](http://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 an anemometer to measure wind speed and determine whether your location is a cost-effective location for a wind turbine.

## INCENTIVES FOR WIND PROJECTS

The Clean Energy Finance and Investment Authority provides innovative financing products in partnership with a variety of financial institutions. Connecticut also offers competitive procurement opportunities which allow bids to be submitted for consideration of a 15 year contract. These programs are referred to as the zero emission renewable energy contract (ZREC) and low emission renewable energy contract (LREC).


 **More information about CEFIA and other opportunities is available at [www.energizect.com](http://www.energizect.com)**

## 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.

### 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 Clean Energy Finance and Investment Authority administers a residential solar program and maintains a list of eligible residential solar installers for their program—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. Visit [www.energizect.com/small-solar](http://www.energizect.com/small-solar) for more information.**



### 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: <http://energy.gov/energysaver/articles/solar-water-heaters>**

### 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: [www.attra.ncat.org/attra-pub/solar-gh.html](http://www.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](http://www.ctenergyinfo.com/energy-programs.htm) for more information about the CEEF programs.



👉 **The Clean Energy Finance and Investment Authority has financing available for geothermal heat pumps. C-PACE for commercial projects and SMART-E for residential projects. Please visit [energizect.com](http://energizect.com) for more information.**

👉 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: [http://energy.gov/sites/prod/files/guide\\_to\\_geothermal\\_heat\\_pumps.pdf](http://energy.gov/sites/prod/files/guide_to_geothermal_heat_pumps.pdf)



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 Clean Energy Finance and Investment Authority currently offers an open RFP to support anaerobic digester projects. Please visit [www.ctcleanenergy.com/rfp](http://www.ctcleanenergy.com/rfp)**

👉 **The National Sustainable Agriculture Information Service has a good primer on methane digesters: [attra.ncat.org/attra-pub/anaerobic.html](http://attra.ncat.org/attra-pub/anaerobic.html). 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](http://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: <http://hvgenenergy.wordpress.com>

👉 **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](http://www.ucsusa.org/clean_energy/technology_and_impacts/impacts/growing-energy-on-the-farm.html)**

👉 **The Innovation Center for U.S. Dairy has a resource about Biogas Capture and Transport: [www.usdairy.com/Sustainability/Greenhouse%20Gas%20Projects/Pages/BiogasCaptureandTransport.aspx](http://www.usdairy.com/Sustainability/Greenhouse%20Gas%20Projects/Pages/BiogasCaptureandTransport.aspx)**

👉 **The U.S. Environmental Protection Agency has a resource for qualified biomass/wood pellet heaters that are cleaner burning than the alternatives: [www.epa.gov/burnwise/owhlist.html](http://www.epa.gov/burnwise/owhlist.html)**

The Clean Energy Finance and Investment Authority will provide low cost financing opportunities for qualifying biomass systems.

# Funding Sources

There are several resources for a farmer interested in accessing assistance and/or funding for energy audits, feasibility studies, energy efficiency and renewable energy projects. Below is a summary of each of the resources currently available to Connecticut farms for such assistance. It is best to check with these agencies and programs directly as funding availability and program offerings are subject to change.

## **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 technically feasible, must meet environmental requirements and must be owned by the applicant. If you do not qualify as an agricultural producer but as a rural small business, you must be located in a rural area. Each 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](http://www.rurdev.usda.gov/ma)**

**CONNECTICUT FARM ENERGY PROGRAM**

The Connecticut Farm Energy Program (CFEP) is a 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 and agriculture as it relates to agricultural producers and agricultural-based small business in Connecticut while also providing REAP grant writing assistance to eligible agricultural producers and agricultural based small businesses located in Connecticut. To date the Connecticut Farm Energy Program has secured \$643,971 in grants and loans for Connecticut farms and rural small businesses through the REAP Program. Visit their web page at [www.CTFarmEnergy.org](http://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.nrcs.usda.gov/Internet/FSE\\_DOCUMENTS/stelprdb1046337.pdf](http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046337.pdf) or contact the USDA service center nearest you.

**ENSAVE, INC.**

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](http://www.ensave.com)

**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.nrcs.usda](http://www.nrcs.usda).

[gov/wps/portal/nrcs/detail/ct/programs/?cid=nrcs142p2\\_011038](http://gov/wps/portal/nrcs/detail/ct/programs/?cid=nrcs142p2_011038) or contact the USDA service center nearest you.

### **CONNECTICUT DEPARTMENT OF AGRICULTURE VIABILITY GRANTS PROGRAM – 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](http://www.ct.gov/doag/cwp/view.asp?a=3260&q=398988)

### **CONNECTICUT DEPARTMENT OF AGRICULTURE VIABILITY GRANTS PROGRAM – 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](http://www.ct.gov/doag/cwp/view.asp?a=3260&q=419410)

### **CLEAN ENERGY FINANCE AND INVESTMENT AUTHORITY**

CEFIA was established by Connecticut's General Assembly on July 1, 2011 as a part of Public Act 11-80. This new quasi-public agency supersedes the former Connecticut Clean Energy Fund. CEFIA's mission is to help ensure Connecticut's energy security and community prosperity by realizing its environmental and economic opportunities through clean energy finance and investments. As the nation's first full-scale clean energy finance authority, CEFIA leverages public and private funds to drive investment and scale-up clean energy deployment in Connecticut. For more information, visit: [www.ctcleanenergy.com](http://www.ctcleanenergy.com)

### **ENERGIZE CONNECTICUT**

Energize Connecticut helps you save money and use clean energy. It is an initiative of the Energy Efficiency Fund, the Clean Energy Finance and Investment Authority, the State, and your local electric and gas utilities, with funding from a charge on customer energy bills. Energize Connecticut supports various energy efficiency and renewable programs that provide financial incentives and financing to help Connecticut consumers reduce the energy used in their homes and businesses. [EnergizeCT.com](http://EnergizeCT.com)

### **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](http://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. Energy Star offers a directory of EnergyStar rebates and special offers searchable by zip code at [www.energystar.gov/index.cfm?fuseaction=rebate.rebate\\_locator](http://www.energystar.gov/index.cfm?fuseaction=rebate.rebate_locator) Information on tax credits can be found at: [www.energystar.gov/index.cfm?c=tax\\_credits.tx\\_index](http://www.energystar.gov/index.cfm?c=tax_credits.tx_index)

**DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY**

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](http://www.dsireusa.org)

**FINANCING OPTIONS**

*REAP Loan:* please refer to the REAP information on page 59.

*C-PACE:* Connecticut Property Assessed Clean Energy (C-PACE) is an innovative program that is helping commercial, industrial and multi-family property owners access affordable, long-term financing for smart energy upgrades to their buildings. C-PACE allows building owners to finance qualifying energy efficiency and clean energy improvements through placing a voluntary assessment on their property tax bill. Property owners pay for the improvements over time through this additional charge on their property tax bill and the repayment obligation transfers automatically to the next owner if the property is sold. Similar to a sewer tax assessment, capital provided under the C-PACE program is secured by a lien on the property, so low-interest capital can be raised from the private sector with no government financing required.

*FSA:* The Farm Service Agency is responsible for the administration and delivery of disaster assistance, USDA commodity programs, and low interest loans as a lender of first opportunity. In FY2013 the Farm Service Agency provided over \$3.1 million in program assistance and nearly \$4.4 million in loans to producers. These programs are designed to help ensure the long term viability of Connecticut agriculture. In addition to those programs, producers can record acreage and crop diversity for their insurance purposes through the agency at one of the five offices across the state.





**CONNECTICUT**  
FARM ENERGY PROGRAM

## **CONNECTICUT FARM ENERGY PROGRAM**

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