



Best Practices Guide

Energy Savings Opportunities for Dairy

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ENERGY EFFICIENCY AND CONSERVATION

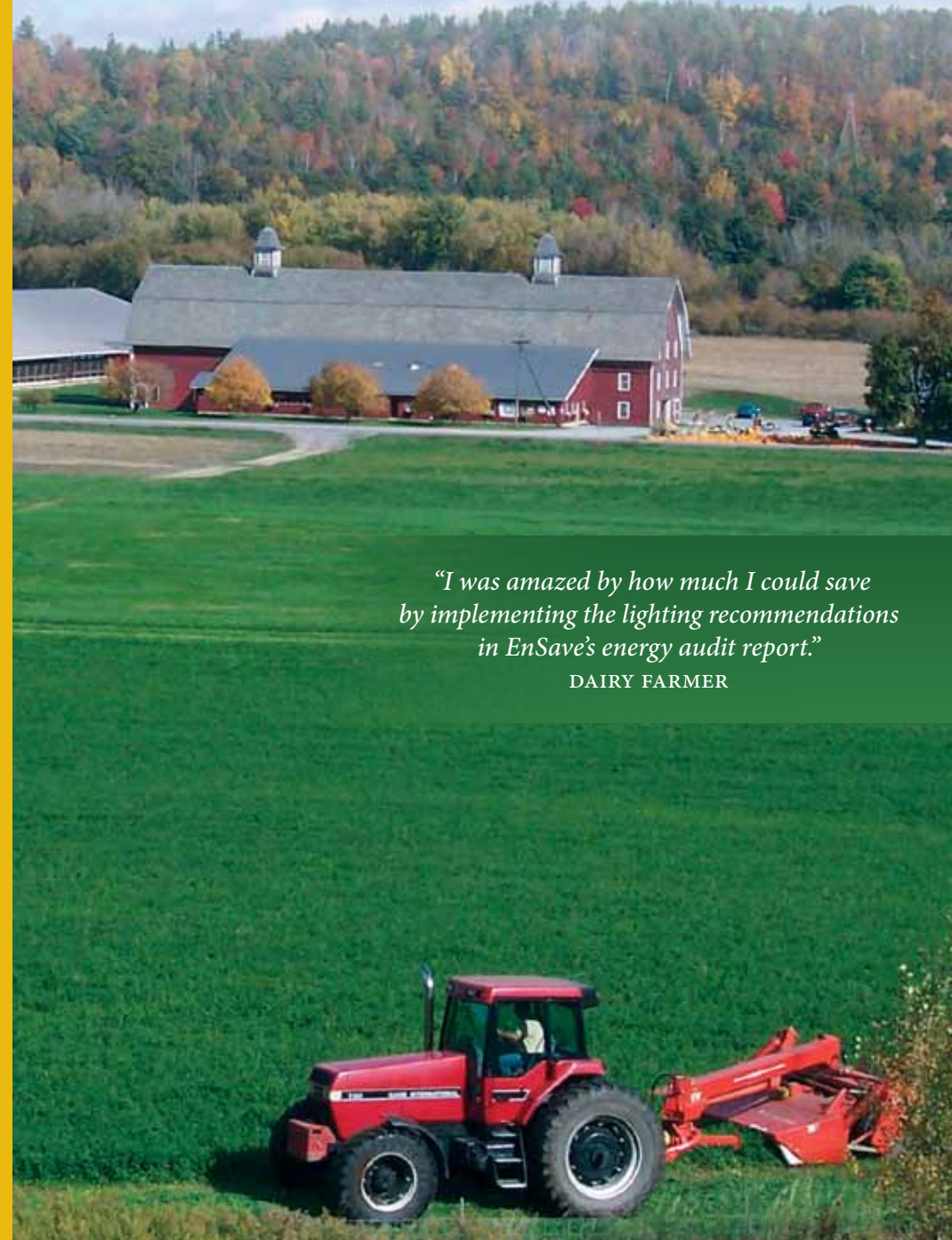
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Welcome to EnSave's Best Practices Guide.

We have prepared this guide to help dairy producers begin the path toward energy independence.



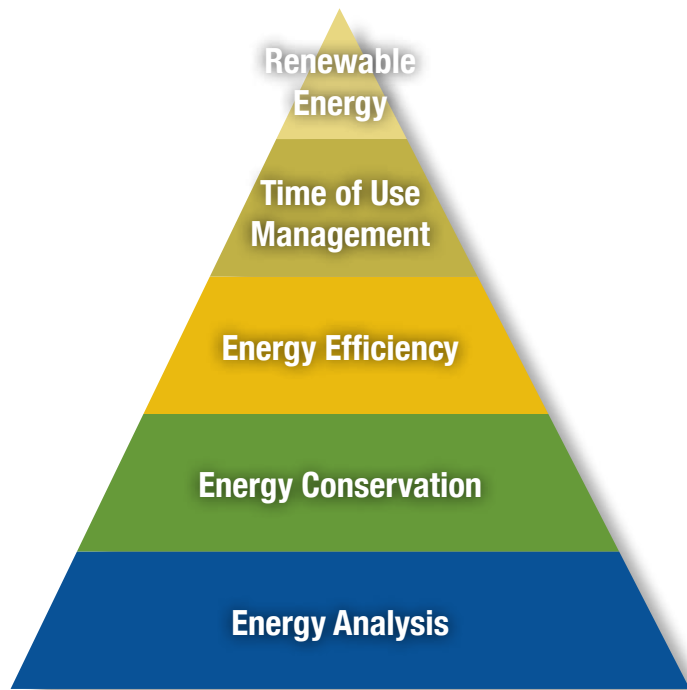
"I was amazed by how much I could save by implementing the lighting recommendations in EnSave's energy audit report."

DAIRY FARMER

The Energy Pyramid

The energy pyramid is a useful concept designed to help people understand the process of using energy efficiently. In some cases too much emphasis is put on renewable energy to solve the nation's energy needs. Rather than being the first course of action, renewable energy should be considered only after a farm has considered all other steps of the pyramid.

The energy pyramid illustrates the steps in the process of becoming more energy independent, from the simplest and least expensive technique to the most complex.



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Using Energy Efficiently

Farmers who are hoping to make their farms more energy efficient should consider all the steps in the energy pyramid, from the simplest and least expensive technique to the most complex.

RENEWABLE ENERGY

The last step on the energy pyramid is renewable energy, which is generating your own energy from naturally replenished sources for use on the farm. Examples include solar power, wind power, methane digesters, and hydroelectricity.

TIME OF USE MANAGEMENT

Electricity costs can vary over the course of the day. Running equipment during peak hours can be costly. By running equipment during off-peak hours, money and energy can be saved.

ENERGY EFFICIENCY

The third level on the energy pyramid is energy efficiency, which is performing the same services while using less energy. Work smarter and save money with more energy efficient equipment.

ENERGY CONSERVATION

The easiest way to conserve energy is to change current behavior: turn off lights if no one is using them, unplug unused equipment, and turn the thermostat lower in the winter and higher in the summer.

ENERGY ANALYSIS

This is the very first level towards reducing energy usage. By having an audit or assessment done (or doing an assessment on your own), opportunities to reduce energy use and costs can be identified.

Throughout this brochure, you will find helpful ideas that address each step of the pyramid, from bottom to top. They are arranged according to their relevance on the pyramid, and color coded for easy reference.



Get in Touch

If you have any questions about the energy pyramid or would like to learn more about how these ideas can work on your farm or facility, contact EnSave, Inc. today.

65 Millet Street | Suite 105 | Richmond, Vermont 05477
www.ensave.com | (800) 732-1399

Farm Energy Audits

EnSave provides farm energy audits for producers across the United States. An energy audit analyzes current energy use and provides recommendations for energy conservation and energy efficiency. There is a tremendous opportunity on the farm to save energy and money by developing a cost-effective plan to upgrade or add energy efficient equipment.

1. We conduct an initial interview with the farmer to gather information about the operation and explain the audit process.
2. A local data collector visits the farm to verify and collect information about energy use
3. Our energy engineers complete a thorough data analysis
4. We deliver an audit report with energy analysis and recommendations
5. We follow up with the farmer to answer questions, review the plan's recommendations, and discuss opportunities for implementation.



We provide several types of energy audits in order to best serve each farmer, and to meet specifications required by various government cost-share programs. EnSave provides farm energy audits for all types of agriculture, including dairy, poultry, swine, greenhouses, and others. We can review electric energy savings as well as propane, natural gas, and diesel. Our farm energy audits serve as a decision-making tool farmers can begin using immediately in order to take control of their energy costs.

Can Your Farm Benefit from an Energy Audit?

Complete the 7-point survey below. If your score is greater than 3, you may benefit from an energy audit. For more details or questions, call an energy expert at EnSave for a free consultation.

Dairy Questionnaire	Yes = 0	No = 1
1. Do you have a vacuum pump variable speed drive in your milking system?		
2. Do you have a plate cooler in your cooling system (used to cool the milk using ground water)?		
3. Do you have scroll compressors in your bulk tanks?		
4. Do you have a compressor heat recovery unit or FreeHeater?		
	Yes = 1	No = 0
5. Are some of your circulation fans older than 5 years?		
6. Are there any large motors on the farm that are old and run for more than 5 hours per day?		
7. Would you like to upgrade to energy efficiently lighting? Do you have incandescent lights, mercury vapor, metal halide lamps, T12 fluorescent on the farm?		
Total Score From Both Columns		

If your score is greater than 3, you may benefit from an energy audit!





Tractor & Implement Maintenance

Regular maintenance and other practices will help tractors perform more efficiently and reduce fuel use. Consider integrating these fuel saving ideas 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 over 10 minutes
- Clean dirty fuel injectors
- Keep ground-engaging tools sharp
- Use the right tractor for the job (match the horsepower to the load)
- Combine trips whenever possible, by modifying equipment if necessary

Gear Up/ Throttle Down

If using a high horsepower tractor while pulling lighter loads, fuel can be saved by running it 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 do not overload the engine.

Preventative Maintenance

Reduce Bills

If the time is not right for an upgrade, some simple preventative maintenance can often help reduce bills in the short term, and help extend the life of the equipment. Here are some ideas that can be implemented today.

Keep Equipment Clean Remove dust, soot, and debris from equipment to allow it to do more work with less effort. This extends its life and reduces energy usage.

Inspect Regularly Equipment should be checked regularly. Replace parts that are showing excessive wear before they break and cause irreparable damage.

Fix Leaks Leaks in any fluid system waste energy and money. Regular inspection helps identify leaks and keeps your fluid systems running efficiently.

Efficient Fluorescent Lighting

Incandescent light bulbs are inefficient, converting only 10% of the energy they use to light, with the rest wasted as heat. There are many types of fluorescent lights available that are much more energy efficient.

Compact Fluorescent Lamps (CFLs) deliver the same amount of light as incandescent bulbs, but use only 1/4 of the electricity. Installing CFLs may cost a little more initially, but they can last up to 10 times longer. Cold Cathode Fluorescent Lamps (CCFLs) can last up to 25 times longer and have around the same efficiency as CFLs.

T-8 and T-5 lights with electronic ballasts replace the older T-12s and have several benefits. In addition to using about 20% less energy, the T-8 and T-5s generate less noise, more light per watt, better color rendering, minimal flickering, cooler operation, and provide electric cost savings.

Plate Coolers

In dairy operations without milk pre-cooling, milk typically comes from the cow at about 98° F, flows into a receiver, and is then pumped into the bulk tank. Compressors then cool the milk to a storage temperature of about 38° F.

A milk pre-cooler, or plate cooler, is a set of stainless steel plates installed in the milk line before the bulk tank. Well water passes through the plate cooler in one direction and absorbs heat from the warm milk pumped through the plate cooler in the opposite direction. Milk cooling costs account for some of the greatest energy expenses on a dairy farm. For example, a dairy farm that produces 3 million pounds of milk per year can save about \$800 annually.



Low-Cost Tips

- ✓ **Turn off lights when not in use**
- ✓ **Light work areas, not the entire building**
- ✓ **Use daylight when possible**
- ✓ **Install dimmable ballasts to control light levels**
- ✓ **Keep reflector shields and lenses clean**



Benefits of a Plate Cooler

- ✓ **Extends equipment life by reducing load and run time**
- ✓ **Increases milk quality by inhibiting bacterial growth**
- ✓ **Saves electricity and money**



Ventilation

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

Most agricultural ventilation systems rely on exhaust fans to remove moisture build-up. A good ventilation system should 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.

Fans from different manufacturers differ markedly in air delivery and energy efficiency. When upgrading or replacing existing fans, be sure to use the most efficient fans possible.

Low-Cost Tips

- ✓ **Clean fan blades, motors and controls**
- ✓ **Lubricate pivot points of shutters and inlets**
- ✓ **Check all wiring from service entrance box to point of use**



NEMA Premium® Motors

When installing a new motor or replacing an old motor, consider using a NEMA Premium® motor. While they may cost more initially, they are often cheaper to operate in the long run.

When purchasing a new motor, take into account the length of time the motor will run, how high electric bills currently are, and the right sized motor for the job. If the motor is only running sporadically, a retrofit to a NEMA Premium® motor may not make sense. However, the longer the motor runs, the greater the potential for savings. In new installations, NEMA Premium® motors are the standard.

Premium efficiency motors are usually made to higher manufacturing standards, and stricter quality controls. **FOR MORE INFORMATION, visit: www.nema.org/gov/energy/efficiency/premium/**

Low-Cost Tips

- ✓ **Select the right size motor for the job**
- ✓ **Inspect all motors on a regular basis**
- ✓ **Clean motors regularly**
- ✓ **Replace V-type belts with notched belts**

Milk Transfer Pump VSD

Many farmers use plate coolers, which use either glycol or ground water to absorb the heat from the milk before transferring it to the bulk tank. The plate cooler's efficiency depends on the cold water temperature and the flow rates of both the milk and the water.

Standard milk pumps can't provide a constant flow of milk into the cooler, reducing the efficiency. A variable speed drive (VSD) on the milk transfer pump will produce a steady flow of milk through the plate cooler, optimizing cooling.

This improved performance reduces cooling costs associated with bulk tank compressors while maintaining milk quality. 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 coupled with a plate cooler.



Low-Cost Tips

- ✓ **Conduct regular maintenance, including cleaning evaporator and condenser coils**
- ✓ **Check insulation on supply and return refrigerator lines and re-insulate where appropriate**

Scroll Compressor

For many years reciprocating compressors have cooled milk in bulk tanks. These compressors are inefficient, require regular maintenance, and are noisy. Scroll compressors use dual spinning scrolls to compress refrigerant. As the scrolls spin, they create ever-smaller gas pockets and generate greater pressure. Suction is continuous and pulse-free.

Scroll compressors use significantly less energy than reciprocating compressors. One study found that a 3-hp scroll compressor saved 41% more electricity than a 3-hp reciprocating compressor. They are also quieter. With only four moving parts and no metal-on-metal contact, there are no seals to tear and no lubrication needed. They also work well in cool weather and can start under any system load. Installation costs are comparable to conventional reciprocating compressors.



Benefits of a Scroll Compressor

- ✓ **Saves energy and money**
- ✓ **Lasts longer than other compressors**
- ✓ **Cools consistently**



VSDs for Irrigation Systems

A variable speed drive (VSD) is an electronic device that changes the frequency of the AC power going to a motor, varying its speed. This then affects the flow and pressure of the water being pumped. VSDs are energy efficient because they regulate water flow to match demand, eliminating the need for a flow control valve at the pump station.

VSDs for well and booster pumps are not useful in all applications, and an irrigation engineer should always be consulted before installation. Situations where VSDs may be useful include:

- Booster pumps for irrigation where incoming pressure and discharge demand vary
- Dramatic varying flow rates
- Steep pump curves

Low-Cost Tips

- ✓ **Water only when necessary**
- ✓ **Move irrigation to off-peak hours to take advantage of lower time-of-use electric rates**



Irrigation Pump Upgrades

Testing irrigation pumps for pumping efficiency is a good way of learning if they are working at their optimum efficiency, and can help determine if it is time for a pump upgrade.

Pump efficiency testing measures gallons pumped per minute, total dynamic head (pumping water level and operating pressure), and input horsepower. This information determines if the pump is working efficiently, or if it is time to upgrade. Prior to upgrading, consider the following:

- Upgrade to a premium efficiency motor. It will last longer and cost less to run. Use the right size motor for the job.
- Replace/repair the pump impeller/bowl.
- Make sure the impeller and bowl are properly adjusted to ensure the proper amount of water is pumped.

Low-Cost Tips

- ✓ **Test well and pump at least every two years**
- ✓ **Inspect the well to ensure there is no clogging or corrosion**

Energy Star® Qualified Washers

Dairies do several loads of laundry a day, so there is energy savings potential from switching to an Energy Star® clothes washer. Energy Star® is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy that helps save money and protect the environment with energy efficient products.

Energy Star® qualified washers use 40% less energy than standard washers. Most full-sized Energy Star® washers use 18–25 gallons of water per load, compared to 40 gallons used by a standard machine. They also extract more water during the spin cycle, which saves energy by reducing drying time and wear and tear on fabric.



To buy an Energy Star® qualified washer, just look for the Energy Star® label or go online and review the list of qualified washers at: www.energystar.gov.

Stock Waterers

In cold climates, keeping livestock drinking water from freezing during the winter is critical. Electrically heated stock waterers have traditionally kept water from freezing, drawing 1,000 to 1,500 watts of electricity.

However, 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. Since the year-round ground water temperature is about 50° F, the air temperature must fall to 20° F to freeze solid. If enough animals drink from the waterer, the incoming water will keep it from freezing.

The unit's insulation helps to keep the heat in the water. Many units have plastic covers that float on the water and seal the opening of the reservoir when not in use. Not all sites are suitable for the energy-free models.



Did You Know?

- **Many factors determine how much water a cow drinks, including size, milk yield, feed, temperature, and water quality and availability.**
- **With low usage, the waterers must be well insulated and have reliable heaters so the floating cover will not freeze in place.**



Compressor Heat Recovery

When cooling milk in a bulk tank or with a chiller, compressors are used to remove the heat from the milk. The heat removed is usually released back into the air by condenser fans. By installing a compressor heat recovery unit, this otherwise wasted heat can be reused to heat water.

Benefits of a Compressor Heat Recovery Unit

- ✓ **Can extend life of refrigeration system**
- ✓ **Improves compressor performance**
- ✓ **Cuts water heating costs by close to 50%**

A compressor heat recovery unit can raise water temperatures as high as 110° F. Since the incoming water is pre-heated, the water heater has less work to do and will likely last longer as a result. In addition, these units can often help improve compressor performance.

A compressor heat recovery unit can be one of the most cost effective purchases a dairy farmer can make. For example, a dairy farm using 225 gallons of heated water every day can save as much as \$1,300 on their annual electricity costs. Larger farms could see even more savings.



Water Heaters

Water heating can consume up to 20% of the energy used on a dairy farm. Having a 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.

Use the highest Energy Factor (EF) rating for fuel type used on the farm. If gas is used, select a heater with an EF rating of 0.8 or more. If electric is used, look for an EF rating of 0.91 or more.

Low-Cost Tips

- ✓ **Inspect system and repair for leaks**
- ✓ **Insulate water heater and lines from tank**

Milk Vacuum Pump VSD

A Variable Speed Drive (VSD) is a digital controller that regulates the speed of the milking vacuum pump motor. Before variable speed technology, dairy operators had to run their pumps at a constant high speed to perform adequately during the short intervals of high vacuum need.

The VSD measures how much vacuum the system requires and regulates the speed of the pump motor. The result is a pump and motor that work only as hard as they need to, which leads to substantial energy savings.

The energy and cost savings from installing a VSD varies based on the horsepower of the pump and the number of milkings. Many farms find a VSD to be a good investment.



Benefits of a Milk Vacuum Pump VSD

- ✓ **Cuts electricity use**
- ✓ **Maintains a constant vacuum level**
- ✓ **Provides a quieter working environment**

High Pressure Sodium Lighting

High pressure sodium lighting is an excellent choice for barn yards and other exterior areas. These yellowish lights are also suitable for indoor areas where color rendition is not important.

High pressure sodium lights are long lasting with an expected life of about 24,000 burning hours or six years for photo-controlled fixtures. They are very energy efficient and produce more lumens per watt than mercury vapor bulbs.

Units inside barns should be wired to a common photocell in a bright area to minimize operating hours. Indoor fixtures should also have enclosed and gasketed optics to protect the lamp and reflector, and increase the life and light output of the fixture. This will reduce the time required to clean the fixture as only the lens will need to be cleaned.





Did you know?

- **Mercury is extremely toxic to the nervous system**
- **Mercury evaporates at room temperature, making it easy to inhale**
- **Land tainted with mercury can lower its property value significantly**

Mercury

Mercury is an odorless, silvery liquid with a metallic luster. It expands and contracts with temperature and pressure changes, which makes it perfect for use in vacuum gauges (manometers).

The mercury in manometers can become tainted with water, dirt, or cleaning solutions. It is also considered hazardous waste, so mercury disposal can be dangerous and even deadly if not properly done. When possible, replace manometers containing mercury with non-mercury gauges.

An acceptable alternative is a digital gauge. It can be powered by the same source as the vacuum pump or auto-washer so it can be turned on and off with the system. Digital gauges can also make it easier to run a milking system at an efficient pressure level, thus reducing milking time and energy consumption.

3-Phase Power Conversion

There are two main types of 3-phase power converters:

1. Rotary 3-phase converters are reliable, last the longest, and produce balanced 3-phase power.
2. Static phase provides 3-phase power long enough for a motor to start up. They can be used after the motor starts, but only at 2/3 the rated horsepower.

When using converters, ensure the voltages are being balanced. Damage from overloading or overheating could result otherwise. While variable speed drives (VSDs) can be adapted to work as a 3-phase power converter, it is not recommended. They are short-lived, do not produce balanced 3-phase power, and can burn out equipment. They are for use with motors only, and should not be used to power multiple loads.



Time of Use Management

Dairies often have the opportunity to reduce their electricity costs by participating in demand response programs offered by their utility.

Electric utilities must maintain the ability to supply sufficient electricity to the grid during periods of extremely high demand. These periods typically occur in the middle of hot summer weekdays when air conditioning and refrigeration loads are at their peak. Thus, utilities often provide incentives to their customers for reducing electric use during these times.

We recommend contacting your electric utility to determine what opportunities exist for reducing electric costs through Time of Use Management.

Renewable Energy

It is recommended that, before pursuing a renewable technology, current operations be as energy efficient as possible.

However, once a farm has implemented all cost effective energy efficient equipment, renewable energy projects may make sense.

EnSave offers services to help you decide what your next steps should be regarding renewable energy.

For resource information on wind energy, photovoltaic and thermal energy, geothermal, and other renewable energy technology, call EnSave at (800) 732-1399.



A Dairy Farm Can Cut Costs By:

- **Shifting milking times to off-peak hours**
- **Shifting pressure washing, conveyer use, and silo unloading to off-peak hours**
- **Using timers to shift irrigation and electric water heating to off-peak hours**



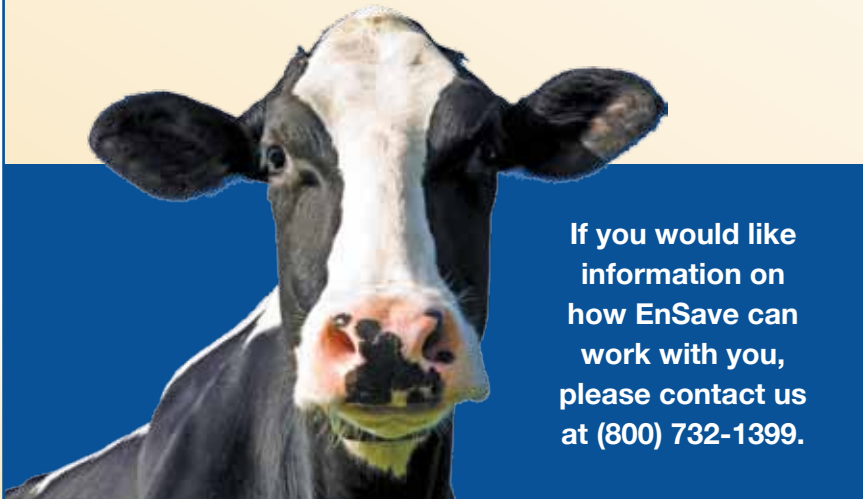
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About EnSave

EnSave is the leading agricultural energy efficiency consulting firm in the United States. We help our clients achieve their energy efficiency goals while also helping farmers save energy and reduce their environmental impact. The inspiration for our work is the hard working men and women on the farm, and we strive to provide solutions that strengthen the farm and provide long-term viability.

Our passion is helping American agriculture become more sustainable and profitable through energy efficiency and resource conservation.

EnSave does not represent or recommend any equipment manufacturer or dealer. Our goal is to help our clients save energy and conserve resources. Please consult a licensed professional before installing any new equipment on your farm.



If you would like information on how EnSave can work with you, please contact us at (800) 732-1399.



EnSave, Inc. | 65 Millet Street, Suite 105 | Richmond, VT 05477
1 (800) 732-1399 | www.ensave.com