Technical Resource Manual

for

Dairy Farms

August 12, 2020

Comprehensive Services Program

DREMC Representative

Teresa Merlo

Table of Contents

Introduction

The purpose of this resource manual is to promote the efficient use of electrical energy at dairy farms. Duck River Electric Membership Corporation (DREMC) requested that the Comprehensive Services Program (CSP) team compile this information to improve the energy efficiency for their members' dairy farms. CSP is a partnership between DREMC and Tennessee Valley Authority (TVA) that provides engineering and technical services that promote the efficient use of electrical energy for commercial and industrial members. Some of the services provided by CSP are Energy Audits, Power Quality Studies, Electrical Metering, Lighting Recommendations, HVAC Sizing/Replacement Analysis, Infrared Studies, Power Factor Studies, and Ultrasonic Testing/Compressed Air Leak Scans. Our mission is to serve the people of the Tennessee Valley to help the region thrive and grow.

Electric Billing

The electric bill for commercial members consists of several charges. These are primarily the customer charge, demand charge (based on peak kilowatts), energy charge (based on used kilowatt-hours), and fuel cost adjustment.

- **Customer Charge:** The customer charge is fixed and covers the utility's administrative expenses. Grid access and facilities charges cover utility fixed costs.
- **Demand Charge:** The demand is the average electrical load (measured in kW), measured over 30 minutes. The demand charge is the charge for the highest kilowatt demand recorded during the billing period.
- **Energy Charge:** The energy charge is the charge for the use of energy during the billing cycle (measured in kilowatt-hours).
- **Fuel Cost Adjustment:** A fuel cost adjustment charge is added to the energy rate and is based on the cost of fuel purchased to generate electricity such as coal and natural gas.

Most dairy farms are billed by either a GSA-1 or GSA-2 rate structure. Constraints for the following GSA-1 and GSA-2 rate classes for DREMC members are listed below:

GSA-1 rates are applied to members when the contract demand or actual demand is less than 60 kW and the energy takings for one month are less than 15,000 kWh.

GSA-2 rates are applied to members when the contract demand or actual demand is greater than 60 kW and less than 1,000 kW or the energy takings for one month are greater than 15,000 kWh.

Example billing showing how the customer, demand, energy, and fixed charges are applied are shown for the GSA-1 and GSA-2 rate structures in the following examples.

Electric Billing Example

The following examples are based on the current rate structures and statement of amounts for DREMC for May 2020. The rate structures and statement of amounts are subject to change and are shown here to provide an understanding of how an electric bill is currently determined by the GSA-1 and GSA-2 rate structures.

GSA-1 Billing Example

GSA-1 member with an energy consumption of 5,000 kWh and 30 kW.

Charge Type	**$ Amount**				
Customer Charge	$42.98	x	1	=	$42.98
Grid Access Charge	$1.02	x	1	=	$1.02
First 1,000 kWh	$0.09863	x	1,000	=	$98.63
Next 2,000 kWh	$0.09874	x	2,000	=	$197.48
Over 3,000 kWh	$0.09249	x	2,000	=	$184.98
				Total	$525.09

GSA-2 Billing Example

GSA-2 member with an energy consumption of 16,000 kWh and 75 kW with a 12-month demand maximum of 90 kW.

Charge Type	**$ Amount**				
Customer Charge	$103.00	x	1	=	$103.00
Facilities Charge	$1.00	x	90	=	$90.00
kW, 0-20	$6.00	x	20	=	$120.00
kW, 21-1,000	$14.07	x	55	=	$773.85
1st 7,500 kWh	$0.07851	x	7,500	=	$588.83
Additional kWh	$0.05523	x	8,500	=	$469.46
				Total	$2,145.13

Energy Saving Opportunities

- The replacement of existing lighting with lower wattage LED lamps/fixtures is typically one of the easiest and most cost-effective ways to reduce energy costs. Over the past few years, the pricing for LED lighting has decreased while LED lighting has become more reliable in terms of operation and lifespan.
- Stagger the use of electrical equipment with high electrical loads when possible to reduce demand costs.
- Turn off any equipment that is not necessary to reduce electrical consumption.
- Clean fans, louvers, shutters, and dampers regularly to ensure proper ventilation, which allows for the proper airflow and helps conserve energy. Dirty ventilation fans are far less efficient to operate and use more energy per volume of airflow.
- Replace standard fan belts with cogged V belts, which are more efficient and allow for less belt slippage to occur.
- When replacing ventilation fans, it is recommended to compare efficiency ratings of the fan. The efficiency ratings are typically listed in CFW/watt. The higher the ratio the more efficiently the fan will operate.
- Insulate the dairy barn to the optimum insulation level that is appropriate for your barn. Use insulation materials that are appropriate for your facility that will not degrade or deteriorate quickly. Use an appropriate vapor barrier to decrease the likelihood of the insulation becoming wet, which diminishes the insulation effectiveness and lifespan. Ensure the barn is airtight except for the use of ventilation equipment. This will allow less heat to escape during the winter months.
- Use attic inlets for ventilation supply air. Ceiling (or attic) inlets are an effective way of keeping the herd warm during cooler months without increasing heating costs. They work similar to sidewall inlets but are placed in the ceiling of the dairy barn and draw heated air in from the attic.
- Hot air rises, and the hottest air in the dairy barn will be near the ceiling. Ensure that there are enough circulation fans to more evenly distribute the heat inside the barn during winter months. This could improve the health of the herd while reducing the amount of electrical energy or fuel required for heating.
- When replacing motors, select premium-efficiency motors.
- Consider a milking vacuum pump system that is powered by a variable speed drive motor (VSD). 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 while maintaining control to allow a high vacuum when the situation arises. Additionally, the VSD milking vacuum pump can more easily maintain a stable vacuum, which can help prevent bacteria from accessing the cows' teats.[1]

- Add a milk pre-cooler before the bulk tank. 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. 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 from the milk going to the bulk tank. Special considerations apply to the cooling water. 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.[2]

- A variable speed drive for the milk transfer pump is another energy savings opportunity. The consistency of milk flow to the bulk tank is an important consideration in the milk cooling 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. Plate coolers are sized to accommodate the volume of milk being pumped to the bulk tank. With standard milk pumps, the milk can gush or trickle into the plate cooler, reducing heat exchange efficiency. A variable speed drive (VSD) produces a steady flow of milk through the plate cooler and optimizes cooling. This improved performance reduces cooling costs in the bulk tank and helps maintain milk quality. 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. Your milk will cool faster due to a constant flow rate through the plate cooler. Also, faster milk cooling inhibits the 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.[3]

[1] Connecticut Farm Energy Program – Energy Best Management Practices Guide p. 8
[2] Connecticut Farm Energy Program – Energy Best Management Practices Guide p. 15
[3] Connecticut Farm Energy Program – Energy Best Management Practices Guide p. 9, 10

- Consider installing a compressor heat recovery unit. The process of cooling milk in a bulk tank or with a chiller utilizes one or more compressors to remove heat from the milk. The 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. 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.**[4]
- The benefits of a compressor heat recovery unit include:
    - Faster milk cooling
    - Improved long-term milk storage
    - Extended life of the refrigeration system
    - Possibility of reducing water heating costs by 50 to 75%, depending on the farm's size.[5]
    - Producers often see a one- to three-year payback
- Replace aging reciprocating compressors with energy-efficient scroll compressors. 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 including increased energy efficiency, quiet operation, higher reliability, and better milk cooling control.
- Contact DREMC for more information on the Comprehensive Services Program and energy efficiency recommendations that are customized for your dairy farm.

Disclaimer

This report was prepared by TVA representatives as a service of DREMC. DREMC and TVA partner to provide services to assist commercial and industrial members in the efficient use of electricity. Although this analysis has been performed using standard engineering methods and calculations, actual conditions may differ from those estimated in this report due to differences in the operation of equipment, weather, etc. No warranty or guarantee of any kind is given regarding the information contained in this report. Any use made of this report or any information contained in it shall be at the user's sole risk

[4] Connecticut Farm Energy Program – Energy Best Management Practices Guide p. 13
[5] Connecticut Farm Energy Program – Energy Best Management Practices Guide p. 15

and responsibility. DREMC and TVA do not endorse any suppliers of equipment or services that are referenced in this report for specifications or prices.