

# Agricultural Energy Management Plan

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Primary Enterprise: Dairy  
Acres: 300  
Wednesday, February 17, 2016



**EnSave**

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Wednesday, February 17, 2016

Joe Dairy  
Butterfat Acres  
100 Lactose Lane  
Dairyland, USA 00000

Dear Mr. Dairy:

Enclosed is your completed Agricultural Energy Management Plan (AgEMP, or Plan). This Plan has been developed in accordance with Conservation Activity Plan Code 128 of the U.S. Department of Agriculture's Natural Resources Conservation Service (USDA NRCS).

Before moving forward with any recommendations in your plan, we encourage you to contact your local USDA NRCS and USDA Rural Development offices to ensure your farm is eligible to apply for any funding available through the NRCS Environmental Quality Incentives Program (EQIP) and the USDA Rural Development Rural Energy for America Program (REAP). In the 'Resources' section of this Plan, we've also included some helpful information and websites that can lead you to local utility and state programs where additional funding might also be available.

On behalf of all of us at EnSave we want to thank you for the opportunity to help you evaluate your farm's energy use and energy saving opportunities. This Energy Management Plan will help you determine the best way for you to increase your farm's energy efficiency and profitability. Even if you are not able to implement all of the recommendations immediately, this plan will serve as a guide for future decisions and improvements.

I will be calling you in a few weeks to discuss the Energy Plan with you. In the meantime, please feel free to contact me if you have any questions.

Sincerely,

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# SUMMARY

## Overview

EnSave conducted an energy data collection at Butterfat Acres on Friday, February 5, 2016. This plan has been developed with the use of FEAT™, a product of EnSave and provides a plan to increase the facility's energy efficiency. This Agricultural Energy Management Plan (AgEMP) covers the primary energy uses identified for this location.

This plan is organized into several sections. The first section summarizes the state of the facility and the overall recommendations, followed by an explanation of the current energy use based on 12 months' usage. The plan then provides a description of the equipment evaluated and recommendations for increased energy efficiency. CAP 128 requires a discussion of all energy-using equipment on the farm, even if no cost effective recommendations are found. Therefore, your plan may contain details about systems analyzed that did not result in energy savings opportunities. Finally, this plan includes information sheets with more detail about equipment and recommended technologies, as well as links to various internet resources about funding sources. Appendix A includes a summary table of all the recommendations.

An average electricity cost of \$0.11 per kWh and an average cost of \$1.53 per gallon of propane were used; however, if Butterfat Acres' actual costs are different from these documented values, the energy cost savings would vary accordingly.

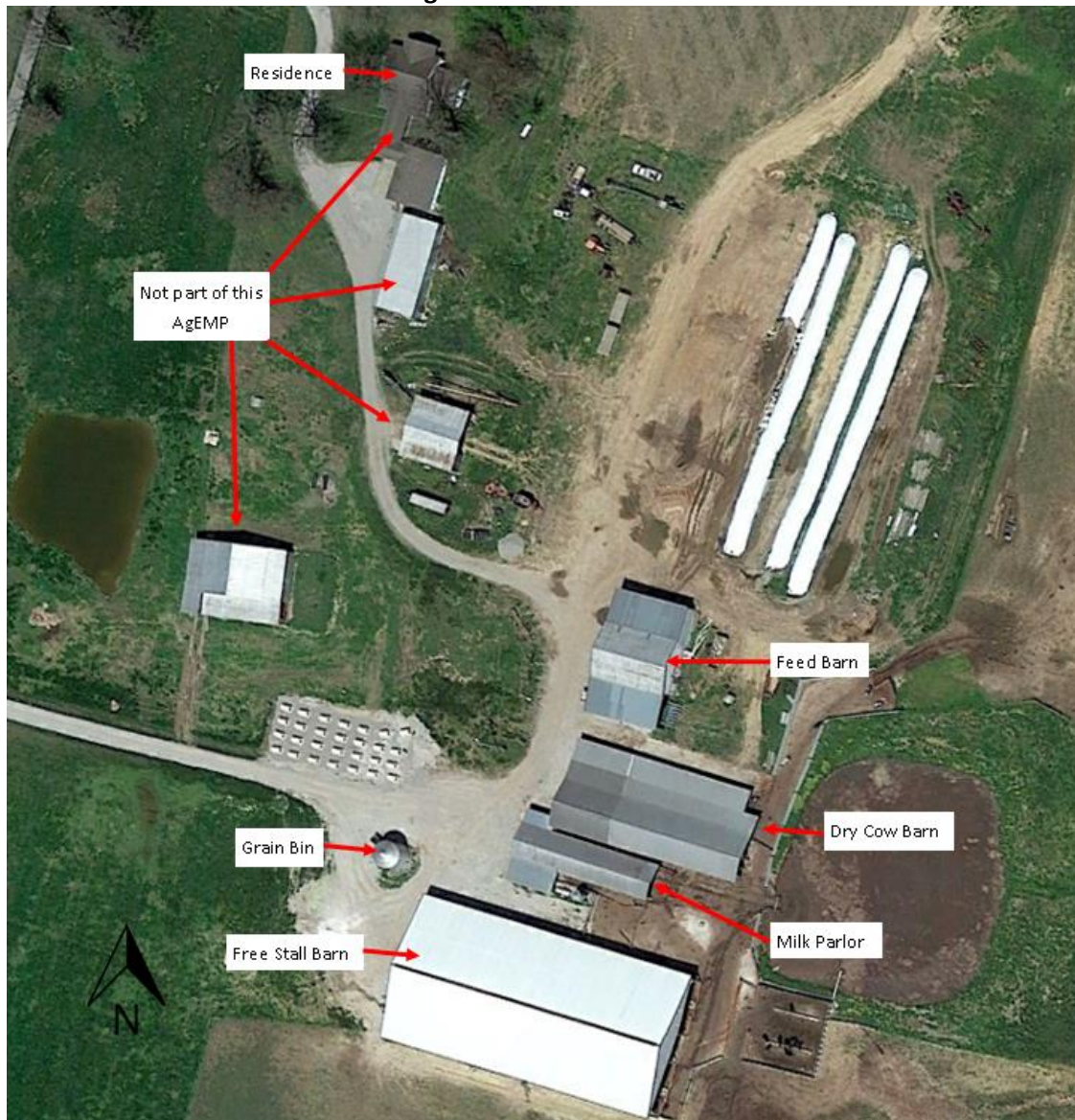
Butterfat Acres operates a 180 cow dairy farm that produces approximately 4,586,400 pounds (lbs.) of milk per year and is approximately 28 years old. Existing energy efficient equipment on the farm includes the linear T8 fluorescent lights installed in the parlor and the tank room. The farmer noted that he would like the plan to evaluate the farms lighting, milk cooling and vacuum pump motors. These measures were reviewed and those found to be cost effective can be found in Table S.1.

Recommended equipment or changes in management may be eligible for federal assistance through USDA NRCS and USDA Rural Development, as well as local assistance through your utility company or state government. The first step after deciding to move forward with any recommendations should be to explore these funding opportunities. Links to these resources are provided at the end of this plan. For a current listing of eligible measures, and to determine if any funding assistance is available, please contact your NRCS representative.

## Aerial View

Figure AV.1 provides an aerial view of the farm. All associated buildings are labeled.

**Figure AV.1. Aerial View**





## Significant Findings

This plan focuses on opportunities for Butterfat Acres to improve its energy efficiency and prioritizes these opportunities based on simple payback period. Payback periods shown in our analysis may be reduced if financial assistance is obtained through USDA, energy utility rebate program, or other sources. The recommendations identified are for lighting, heating, compressor heat recovery (CHR), a plate cooler and a variable frequency drive (VFD).

Bottom Line: Installation of all the recommended energy efficient equipment identified will result in annual energy cost savings of approximately \$4,013. This represents about 32.0% of the baseline annual energy costs of \$12,548.

## ENERGY EFFICIENT EQUIPMENT EVALUATION

### Summary of Recommendations

Tables S.1, S.2, and S.3 summarize the benefits for all recommended measures. These tables are presented as required by *NRCS Conservation Activity Plan Code 128*. See Appendix A for a detailed listing of all measures recommended. Energy saving equipment lowers usage costs by performing the same or greater work with lower energy inputs. Detailed explanations of energy efficiency equipment are provided later in this plan.

Actual site specific cost quotations may affect payback period and eligibility for the *NRCS EQIP Program*.

**Table S.1. Summary of Energy Improvements**

Measure	Estimated Reduction in Energy Use			Estimated Costs, Savings, Payback, and Prioritization for Implementation		
	Electricity Savings (kWh)	Propane Savings (gal)	Energy Savings (MMBtu)	Energy Cost Savings [b]	Implementation Cost [a]	Est. Payback in Years [a]/[b]
General Lighting	8,496	0	29	\$912	\$2,659	2.9
Hot Water	11,043	0	38	\$1,185	\$3,949	3.3
Refrigeration: Milk Cooling	7,901	0	27	\$848	\$3,700	4.4
Milk Harvest	9,280	0	32	\$996	\$10,700	10.7
Air Heating and Building Environment	0	48	4	\$73	\$870	11.9
<b>Totals</b>	<b>36,720</b>	<b>48</b>	<b>130</b>	<b>\$4,013</b>	<b>\$21,878</b>	<b>5.5</b>

Note:

1. Estimated useful life for equipment can be seen in each respective section and in the appendix.
2. Totals are rounded after summations. Accuracy of the individual items is calculated to four decimal places and then rounded to the significant digits shown.

**Table S.2. Overall Energy Savings of Recommendations**

Resource Type	Current Use	Current Use (MMBtu)	Savings	Savings (MMBtu)	Savings (%)
Purchased Electricity (kWh)	100,724	344	36,720	125	36.5 %
Propane (gal)	1,135	104	48	4	4.2 %
<b>Totals</b>	<b>N/A</b>	<b>448</b>	<b>N/A</b>	<b>130</b>	<b>29.0 %</b>

**Table S.3. Estimated Annual Reduction of Pollutants**

		Greenhouse Gas (Estimated Values)			Air Pollutant Co-Benefits (Estimated Values)	
Measure	Energy Savings (MMBtu)	CO <sub>2</sub> (lbs)	N <sub>2</sub> O (lbs)	CH <sub>4</sub> (lbs)	SO <sub>2</sub> (lbs)	NO <sub>x</sub> (lbs)
Hot Water	38	15,340.8	0.2	0.2	36.3	12.6
Milk Harvest	32	12,892.2	0.2	0.2	30.5	10.6
General Lighting	29	11,802.3	0.2	0.2	27.9	9.7
Refrigeration: Milk Cooling	27	10,975.4	0.2	0.1	26.0	9.0
Air Heating and Building Environment	4	603.5	0.0	0.1	0.0	0.5
<b>Totals</b>	<b>130</b>	<b>51,614.2</b>	<b>0.8</b>	<b>0.7</b>	<b>120.6</b>	<b>42.3</b>

Note:

1. Environmental Benefits are reduction estimates, values are as per <http://cometfarm.nrel.colostate.edu/>

The measures recommended are based on energy savings analysis, related energy cost savings, and the estimated cost to implement. Simple payback periods (in years) are shown in the respective measure tables.

Simple payback period is equal to the estimated cost to implement (\$) divided by the estimated annual cost of energy saved (\$/year) and is expressed in number of years. This method does not account for more complex financial considerations such as loan interest and fees, tax rates, depreciation or any other potential cost impacts. When the payback period is less than or equal to the expected useful life (EUL) of the measure (in years), the measure is recommended. Estimated cost to implement an energy saving measure is based on market research; actual costs to your location may vary. The simple payback period can be re-calculated as needed to account for quoted project costs and/or financial assistance.

For the purposes of this plan, the following terms are defined as:

- *Recommended* – a measure is recommended for implementation when the estimated energy savings over the expected useful life of the measure exceeds the estimated cost to install the measure.
- *Not recommended* – a measure is not recommended for implementation when the estimated energy cost savings over the expected useful life of the measure is less than the estimated cost to install the measure.
- *Expected Useful Life (EUL)* – the number of years that a measure is expected to remain in service. These values are taken from industry accepted standards such as the Database for Energy Efficient Resources, Technical Reference Manuals and other similar resources. The EUL of most energy efficiency measures ranges from 10 to 20 years.

There may be other factors to consider when making decisions to implement measures recommended or considered. These may include aspects such as operational performance, through-put, operation and maintenance costs, labor costs, livestock productivity, etc. These considerations are beyond the scope of this energy plan. Any new equipment should be properly reviewed for site-specific needs, concerns and applicability.



Information on operational schedules and run times is based on input from the producer. Note that savings calculations are based on conditions at the time of the site visit. Changes to equipment or operation following the time of the site visit are not reflected.

### Current vs. Projected Electricity Use

Figures EU.1 and EU.2 reflect electricity use from January 2015 to December 2015. During the twelve month period evaluated, Butterfat Acres used approximately 100,724 kilowatt-hours (kWh) of electricity. The total cost of electricity was \$10,810.

The peak months typically coincide with hot weather and are the result of increased milk cooling and ventilation loads. The actual monthly electricity use is depicted in Figure EU.1.

**Figure EU.1. Twelve Month Electricity Use**

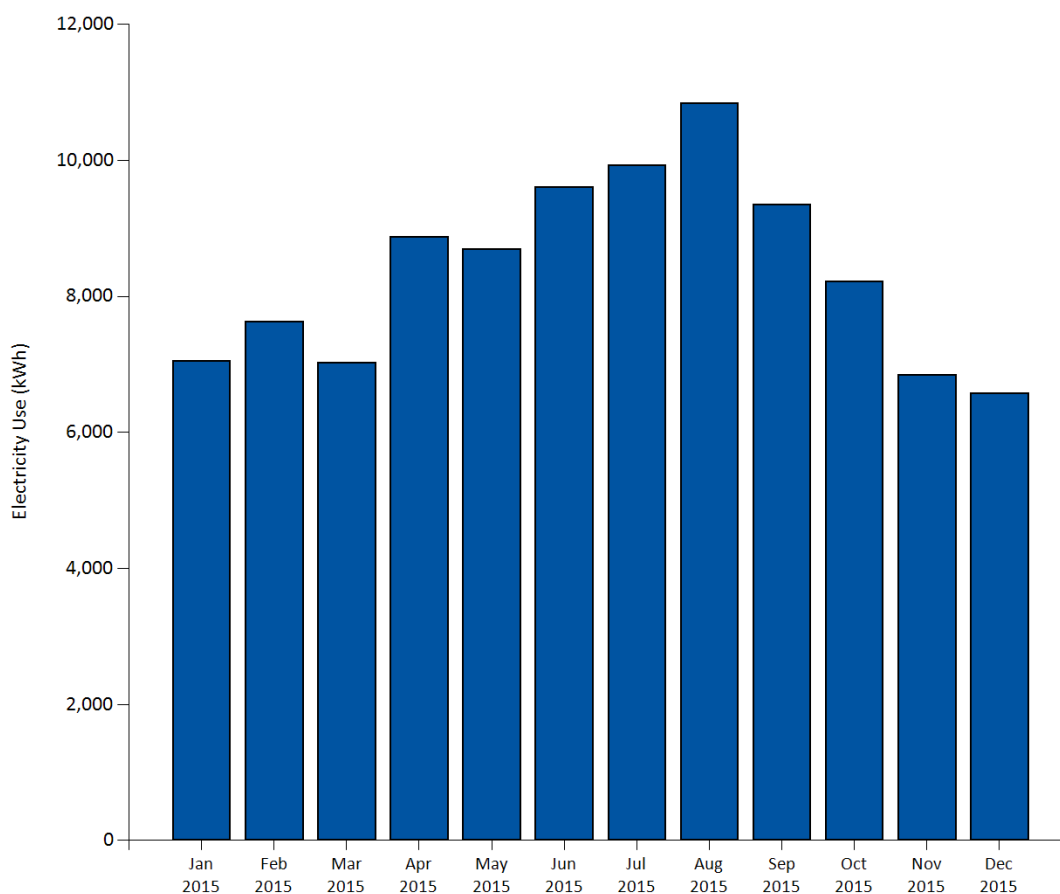


Figure EU.2 illustrates the end uses of the electricity used on the farm. Motor usage does not include the milk transfer pump and vacuum pump motors, as they are included in the milk harvest section. Miscellaneous uses include small electrical end uses such as repair shop tools. Average dairy farm miscellaneous electricity usage is approximately 5%, and the higher than average miscellaneous electricity usage may be due to increased shop tool usage. For a detailed listing of equipment associated with each measure category, see the appropriate section.

The electricity use by measure is depicted in Figure EU.2.

**Figure EU.2. Electricity Use Breakdown**

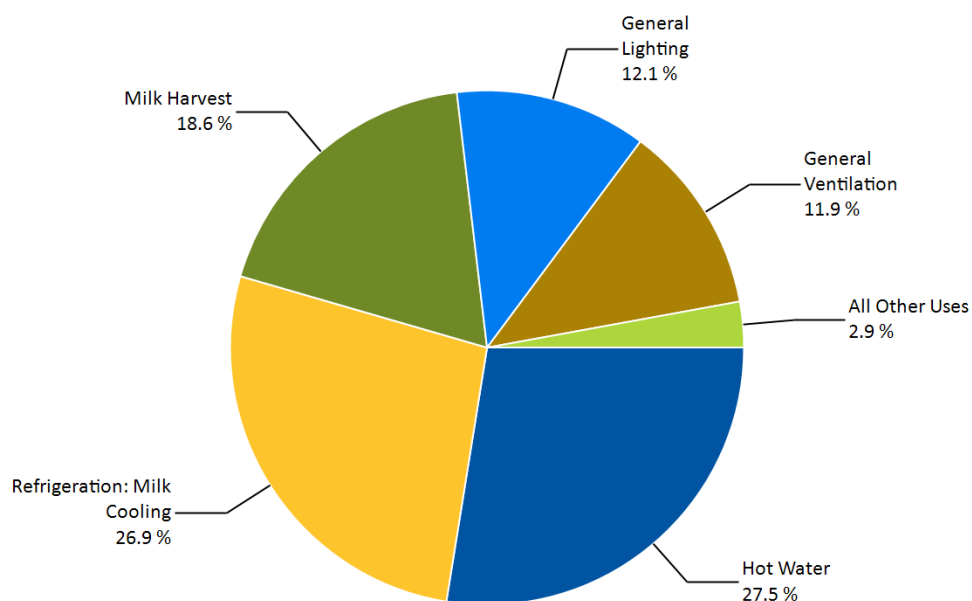
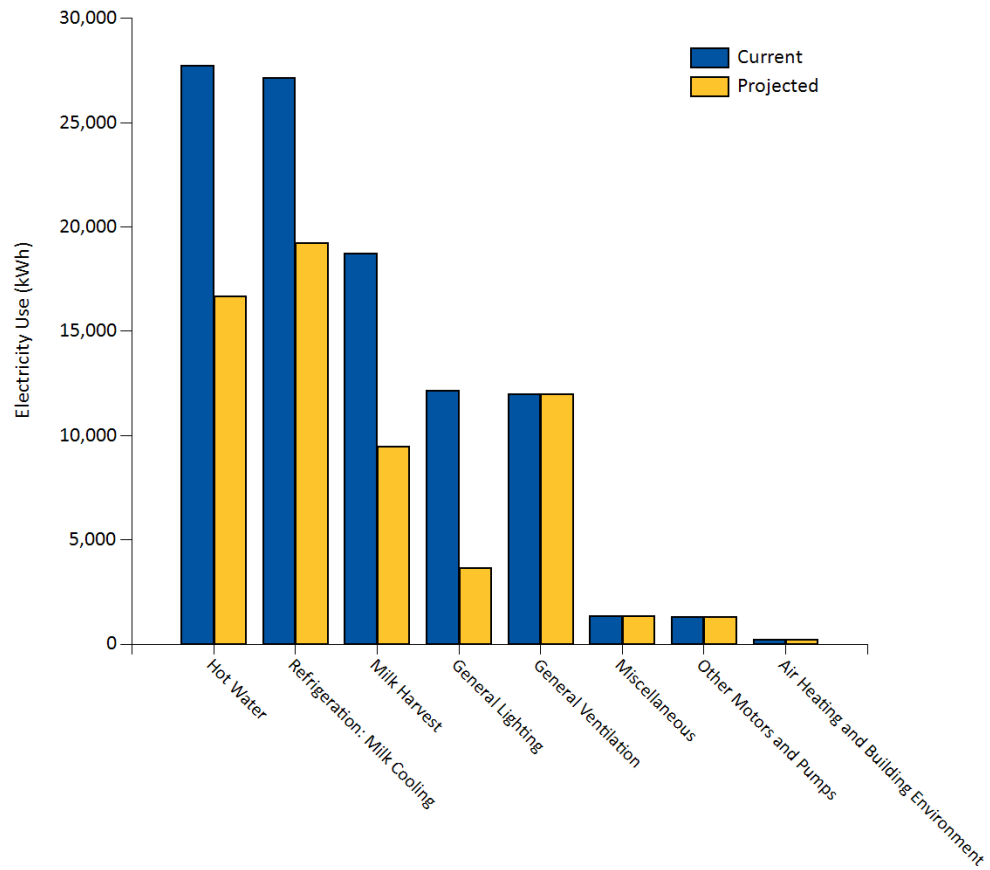


Figure EU.3 shows a comparison of the estimated current and projected electricity use after the installation of all recommended measures.

**Figure EU.3. Comparison of Annual Current and Projected Electricity Use**



## Current vs. Projected Propane Use

Figures PU.1 and PU.2 reflect propane use from January 2015 to December 2015. During the twelve month period evaluated, Butterfat Acres used approximately 1,135 gallons (gal) of propane. The total cost of propane was \$1,739.

The twelve-month history of propane deliveries are depicted in Figure PU.1. Monthly propane deliveries may not reflect actual monthly propane usage. Propane is used solely for space heating on the farm.

**Figure PU.1. Twelve Month Propane Deliveries**

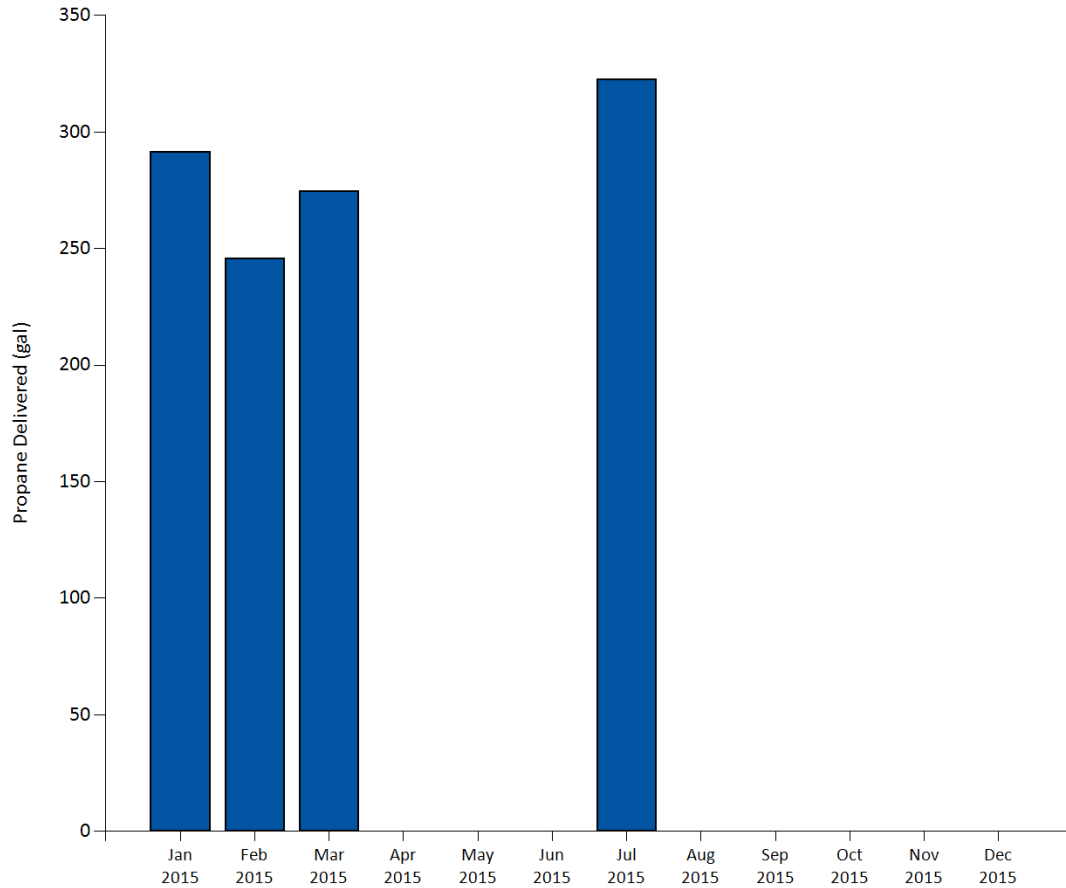
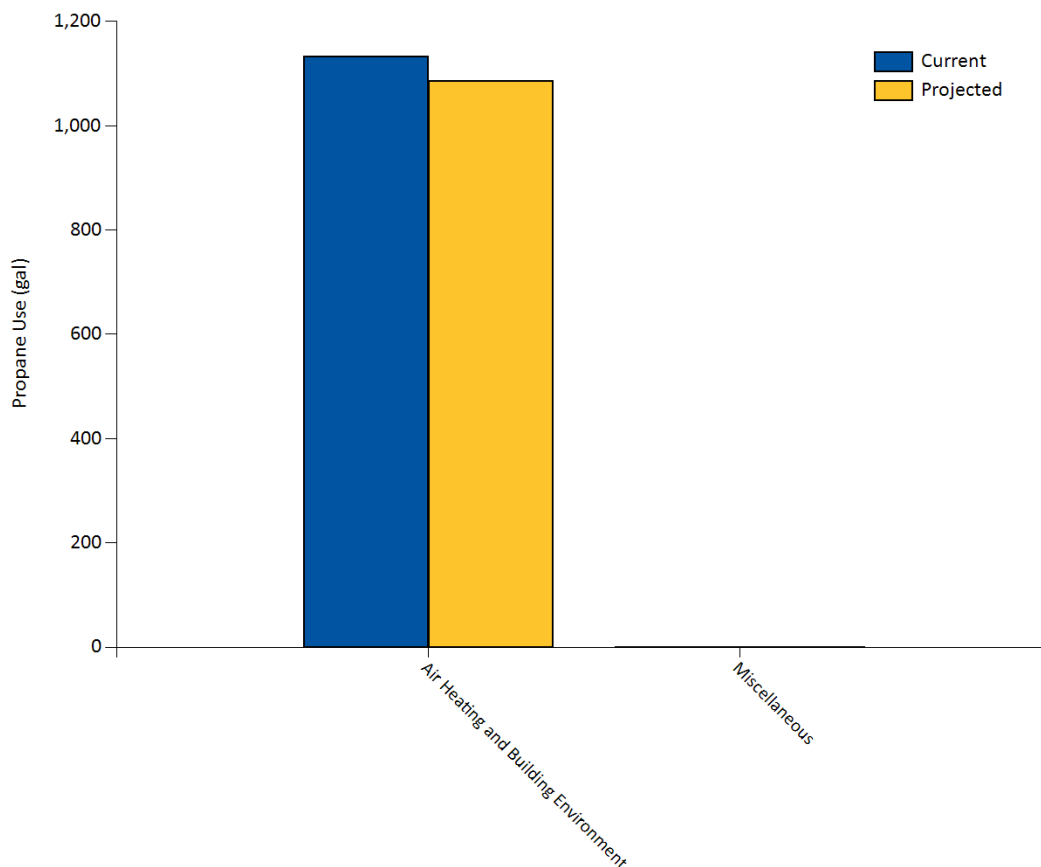


Figure PU.2 shows a comparison of the estimated current and projected energy use.

**Figure PU.2. Comparison of Annual Current and Projected Propane Use**



## On-Site Energy Generation

Butterfat Acres currently operates one 60 kW diesel generator for back up and emergency purposes, and is only run otherwise for testing, upkeep, and maintenance purposes. The generator serves as an emergency power supply and was not in operation for a significant period of time during the twelve month period assessed. The generator was not evaluated for energy saving opportunities due to low run-time. Energy saving measures are calculated based on purchased electricity cost.

Table EGEN.1 contains the existing generator details.

**Table EGEN.1. Current Generator Inventory**

Equipment Description	Manufacturer / Model	# Generators	Resource Type	Output (kW)	Annual Run Hours
Generator	Generac	1	Diesel (gal)	60	52

## Milk Harvest

Butterfat Acres currently operates two alternating, 10 HP rotary lobe vacuum pumps. The vacuum pump operates for approximately 6 hours per day during milking, and an additional 1 hour for the wash cycles. The milk transfer pump is 1.5 HP and operates about a quarter of the milking time. Butterfat Acres has a total of 16 milking units.

Tables MH.1 and MH.2 contain the current milk harvest equipment.

**Table MH.1. Vacuum Pump Inventory**

Equipment Description	Milk Parlor	Run Frequency	Vacuum Pump Type	# Milking Units	Motor Manufacturer / Model	# Motors	Motor HP	RPM Rating	Annual Run Hours (per Motor)	Est. Annual Use (kWh)
Main Parlor Vacuum Pump	1	Alternating	Rotary Lobe	16	Dayton / 1TMY9	1	10	1500 - 2700	1,274	9,023
Backup Vacuum	1	Alternating	Rotary Lobe	16	Dayton / 6K885K	1	10	1500 - 2700	1,274	9,023

**Table MH.2. Milk Transfer Pump Inventory**

Equipment Description	Milk Parlor	Common Receiver Tank?	Motor Manufacturer / Model	# Motors	Motor HP	RPM Rating	Annual Run Hours (per Motor)	Est. Annual Use (kWh)
Main Parlor Transfer Pump	1	Yes	Westfalia Surge	1	1.5	1500 - 2700	637	721

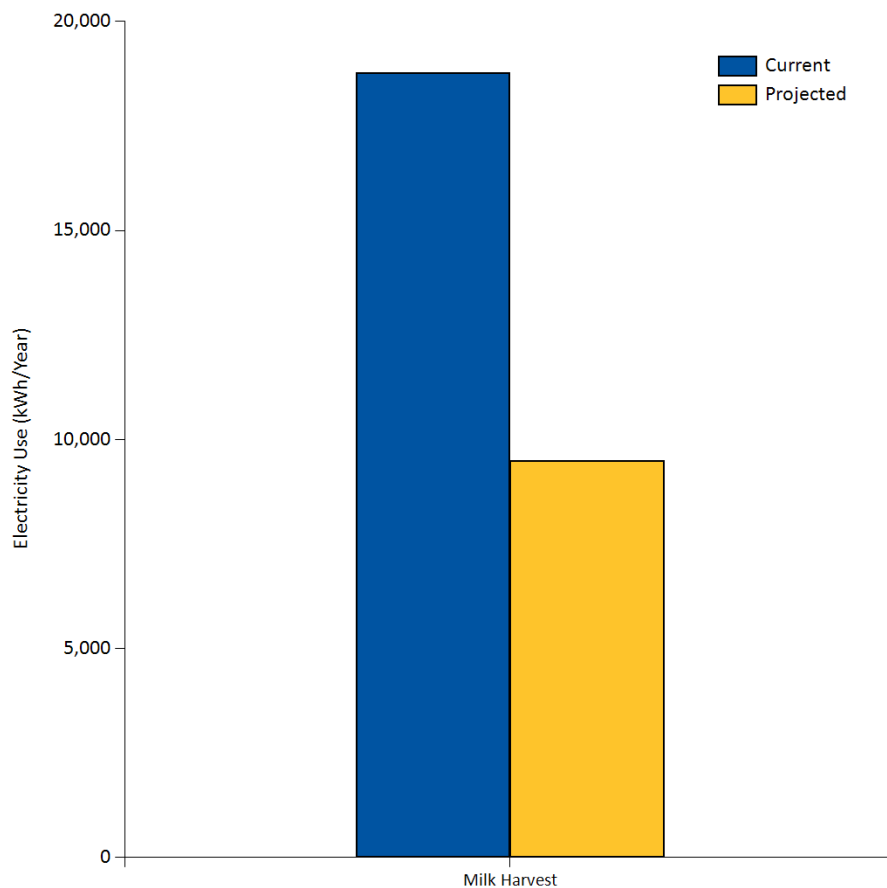
We evaluated installing a variable frequency drive (VFD) on the milk vacuum pump motors. This equipment determines the amount of vacuum needed in the parlor and adjusts the speed of the pump motor to deliver what is needed. The energy savings comes from reduced demand on the vacuum pump. Savings for installing a VFD assume a power requirement of 0.25 HP per milking unit during milking. Wash cycles typically require the full power of the motor.

We recommend installing a VFD on the vacuum pump motors. The motors will need to be replaced with inverter duty motors. To ensure that the VFD does not create harmonic distortion with your electricity provider, make sure the installer checks for harmonic distortion and installs any required mitigation equipment necessary such as harmonic filters. The Institution of Electrical and Electronics Engineers (IEEE) Standard 519 provides guidelines for designing electrical systems with linear and non-linear loads. Also, check with a licensed electrician to determine if the farm's wiring will accommodate a VFD.

We do not recommend replacing the milk transfer pump motor due to the long payback period. Motor efficiencies used for calculations are listed in Tables MH.4 and MH.5.

Figure MH.3 shows a comparison of the estimated current and projected energy use. Table MH.4 provides economic details. Table MH.5 lists evaluated equipment options that were evaluated but not recommended.

**Figure MH.3. Milk Harvest: Comparison of Annual Electricity Use**



**Table MH.4. Milk Harvest: Recommended Energy Saving Equipment**

Equipment Description	Current Equipment	Recommended Equipment	# to Install	Est. Annual Electricity Savings (kWh)	Est. Annual Cost Savings (\$)	Est. Implementation Cost (\$)	Est. Payback (Years)	EUL (Years)
Main Parlor	2 vacuum pumps not using a VSD.	1 variable speed drive capable of supporting a 10 HP vacuum pump, Digital phase converter. 2 inverter duty vacuum pump motors.	1	9,280	\$996	\$11,900	12.0	15.0



**Table MH.5. Milk Harvest: Evaluated Equipment Not Recommended**

Equipment Description	Current Equipment	Considered Equipment	# to Install	Est. Annual Electricity Savings (kWh)	Est. Annual Cost Savings (\$)	Est. Implementation Cost (\$)	Est. Payback (Years)	EUL (Years)
Main Parlor Vacuum Pump	10 HP, TEFC, 1500-2700 RPM, 89.50% Efficiency motor.	10 HP, TEFC, 1500-2700 RPM, NEMA Premium®, 91.7% minimum nominal efficiency motor.	1	216	\$23	\$1,200	51.7	15.0
Backup Vacuum	10 HP, TEFC, 1500-2700 RPM, 89.50% Efficiency motor.	10 HP, TEFC, 1500-2700 RPM, NEMA Premium®, 91.7% minimum nominal efficiency motor.	1	216	\$23	\$1,200	51.7	15.0
Main Parlor Transfer Pump	1.5 HP, TEFC, 1500-2700 RPM, 84.00% Efficiency motor.	1.5 HP, TEFC, 1500-2700 RPM, NEMA Premium®, 86.5% minimum nominal efficiency motor.	1	21	\$2	\$520	233	15.0

## Refrigeration: Milk Cooling

Butterfat Acres cools around 12,600 lbs of milk per day from approximately 100° Fahrenheit (F) to about 37° F using a transfer pump and two bulk tank scroll compressors.

Table MC.1 contains the current milk cooling equipment. Energy Efficiency Ratio (EER) is a measure of cooling output per unit of energy input (BTUs / Watt-hour) at a specific operating condition. When installing cooling compressors, be sure to select those with the highest EER for your application. A larger EER value reflects increased energy savings.

**Table MC.1. Bulk Tank Compressor Inventory**

Equipment Description	Manufacturer / Model	Milk Parlor	Refrigerant	# Compressors	Compressor Type	Compressor HP	EER (Btu / Wh)
Bulk Tank Compressor	Copeland / CRNQ-050E-PFV-970	Main Parlor	R-22	2	Scroll	5	9.9

Note:

- The EER value of the bulk tank compressor was determined from its performance data, as listed by the website: [www.emersonclimate.com](http://www.emersonclimate.com). The existing compressor was rated at an evaporating temperature of 30° F and a condensing temperature of 120° F.

We recommend installing a water-chilled plate cooler. This device is a heat exchanger that uses water to reduce the temperature of the milk before it enters the bulk tank, reducing the compressor run time and saving energy. A plate cooler will cool the milk to within 12°F of the incoming water temperature.

There are considerations that should be made when installing a well-water plate cooler. An adequate water supply is necessary for the plate cooler to operate properly. The common flow rate is about two times the flow of the milk through the plate cooler, and the amount of cooling from the plate cooler increases as the flow rate ratio of water to milk increases. Therefore the farm would require approximately 2,930 gallons of water per day for the plate cooler.

The water exiting the plate cooler can be recycled and used to water the cows, although some states have regulations against recycling waste plate cooler water. Check your state regulations before installing a well-water plate cooler.

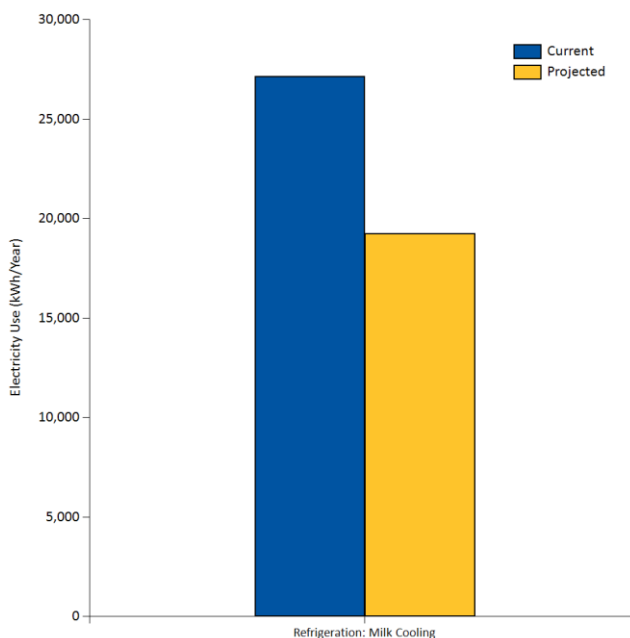
We do not recommend replacing the existing bulk tank compressors due to long payback period. However, if Butterfat Acres is interested in compressor replacement, we recommend replacing the existing compressors with the most efficient digitally controlled compressors available.

We have determined that installing a milk pump variable frequency drive (VFD) and upgrading the bulk tank compressors from reciprocating to more energy efficient compressors would only slightly improve the energy efficiency of the milk cooling system. Therefore, it would not be cost effective for Butterfat Acres to install this equipment because the payback would exceed the life of the equipment.

A supply water temperature of 67°F was used to calculate milk cooling usage and savings.

Figure MC.2 shows a comparison of the estimated current and projected energy use. Table MC.3 provides economic details. Table MC.4 lists equipment that was evaluated but not recommended.

**Figure MC.2. Refrigeration: Milk Cooling: Comparison of Annual Electricity Use**



**Table MC.3. Refrigeration: Milk Cooling: Recommended Energy Saving Equipment**

Equipment Description	Current Equipment	Recommended Equipment	# to Install	Est. Annual Electricity Savings (kWh)	Est. Annual Cost Savings (\$)	Est. Implementation Cost (\$)	Est. Payback (Years)	EUL (Years)
Main Parlor	None	Plate Cooler, 5,800 lbs./Hour Capacity or Less	1	7,901	\$848	\$3,700	4.4	15.0

**Table MC.4. Refrigeration: Milk Cooling: Evaluated Equipment Not Recommended**

Equipment Description	Current Equipment	Considered Equipment	# to Install	Est. Annual Electricity Savings (kWh)	Est. Annual Cost Savings (\$)	Est. Implementation Cost (\$)	Est. Payback (Years)	EUL (Years)
Main Parlor	2 compressors with inefficient compression.	2 compressor retrofit kits providing a minimum EER of 12.	2	4,148	\$445	\$4,990	11.2	10.0
Main Parlor	1 milk transfer pump not attached to a variable speed drive.	Variable speed drive for the milk transfer system with a digital phase converter.	1	3,010	\$323	\$9,280	28.7	15.0

Notes:

- Energy savings for each recommended piece of equipment assume that all other recommended equipment has been installed.
- Condensing units and fans must be properly maintained and in good operating condition to insure uniform airflow through the condenser to maximize the energy efficiency ratio.
- We also recommend making sure the refrigerant lines are properly insulated and the condensing units are cleaned periodically following the manufacturers specifications.

## Lighting

Tables L.1 and L.2 contain the current lighting inventory.

**Table L.1. Current Lighting Inventory**

Location / Equipment Description	# Fixtures	Fixture Type	Bulb Wattage	Annual Run Hours	Total Fixture Wattage	Est. Annual Use (kWh)
Free Stall Barn Lights	7	Standard Incandescent	100	2,912	100	2,038
Security Lights	3	Standard Metal Halide	200	364	232	253
Dry Cow Barn Lights	16	Standard Incandescent	100	2,912	100	4,659
Feed Barn Lights	5	Standard Metal Halide	200	2,912	232	3,378
Commodity Shed Lights	10	Standard Incandescent	100	364	100	364

**Table L.2. Current Linear Fluorescent Inventory**

Location / Equipment Description	# Fixtures	Fixture Type	# Bulbs / Fixture	Length of Bulbs (ft)	Bulb Wattage	Annual Run Hours	Total Fixture Wattage	Est. Annual Use (kWh)
Main Parlor Lights	2	T8	4	4	40	2,912	168	978
Tank Room Lights	2	T8	2	4	40	2,912	84	489

Butterfat Acres has an opportunity to improve the energy efficiency of its lighting system. See *General Lighting: Recommended Energy Saving Equipment* tables for details on fixture types and wattages. Recommended fixtures are sized to provide equivalent lighting levels to the existing fixtures.

We recommend replacing the existing free stall barn, dry cow barn, feed cow barn and commodity shed incandescent lights with light emitting diode (LED) fixtures. LEDs are semiconductor light sources that utilize solid state technology to emit light. LEDs have a longer lifespan than most other lighting

technologies on the market, have among the highest luminous efficacy ratings, and do not contain mercury.

Due to the wide range of light efficacies in the LED industry, an average light efficacy of 65 lumens/watt is used for fixtures under 30 watts and an average light efficacy of 100 lumens/watt is used for fixtures 30 watts and greater to calculate the mean lumen output of the proposed LED fixtures.

Due to the lack of wattage uniformity and a wide range of wattages for LED products, the recommended LED fixtures have a wattage range of +/- 3 watts. This range should be considered when selecting specific LED fixtures for your site to meet the estimated energy savings within this evaluation.

Most LED fixtures are dust and moisture resistant, and therefore, there is generally no need to enclose them in vapor proof enclosures. The dust and moisture resistance of the particular fixture selected and installed should be verified with the equipment dealer.

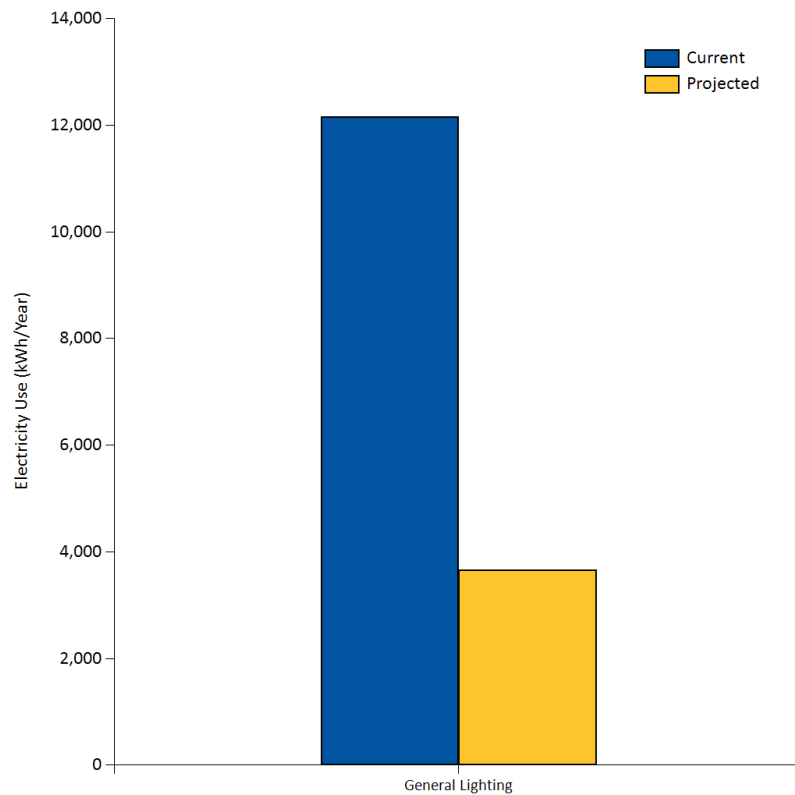
We recommend choosing LED fixtures that are listed on the DesignLights™ Consortium (DLC) Qualified Product List. All lights on the list have met quality standards set by the DLC. The DLC Qualified Product List can be found here: <http://www.designlights.org/qpl>.

We generally recommend installing vapor-proof fixtures to keep strip fluorescent fixtures protected. We also recommend installing vapor-proof lamp guards for standard incandescent bulb sockets when replacing them with compact fluorescent lamps to keep the new bulb protected. We also recommend the installation of photocell, occupancy and daylight harvesting sensors where appropriate in the facility, which will further reduce electrical usage in those areas by reducing the runtimes of the lighting fixtures. An example would be to install occupancy sensors in bathrooms and hallways where there is infrequent use.

We do not recommend replacing the exterior metal halide security lights due to the long payback period. The linear T8 lights in the parlor and tank rooms are considered energy efficient and were not evaluated for replacement.

Figure L.3 shows a comparison of the estimated current and projected energy use. Table L.4 provides economic details. Table L.5 lists equipment options that were evaluated but not recommended.

**Figure L.3. General Lighting: Comparison of Annual Electricity Use**



**Table L.4. General Lighting: Recommended Energy Saving Equipment**

Location / Equipment Description	Current Equipment	Recommended Equipment	# to Install	Est. Annual Electricity Savings (kWh)	Est. Annual Cost Savings (\$)	Est. Implementation Cost (\$)	Est. Payback (Years)	EUL (Years)
Free Stall Barn Lights	100W Standard Incandescent (100 Total Input Watts)	10W Light Emitting Diode (10W Total Input Watts)	7	1,835	\$197	\$161	0.8	10.0
Dry Cow Barn Lights	100W Standard Incandescent (100 Total Input Watts)	10W Light Emitting Diode (10W Total Input Watts)	16	4,193	\$450	\$368	0.8	10.0
Commodity Shed Lights	100W Standard Incandescent (100 Total Input Watts)	10W Light Emitting Diode (10W Total Input Watts)	10	328	\$35	\$230	6.5	10.0
Feed Barn Lights	200W Standard Metal Halide (232 Total Input Watts)	85W Light Emitting Diode (85 Total Input Watts)	5	2,140	\$230	\$1,900	8.3	10.0
<b>Totals</b>				<b>8,496</b>	<b>\$912</b>	<b>\$2,659</b>	<b>2.9</b>	<b>N/A</b>

**Table L.5. General Lighting: Evaluated Equipment Not Recommended**

Location / Equipment Description	Current Equipment	Considered Equipment	# to Install	Est. Annual Electricity Savings (kWh)	Est. Annual Cost Savings (\$)	Est. Implementation Cost (\$)	Est. Payback (Years)	EUL (Years)
Security Lights	200W Standard Metal Halide (232 Total Input Watts)	85W Light Emitting Diode (85 Total Input Watts)	3	161	\$17	\$1,140	66.2	10.0

The lighting recommendations and considerations represent one of several energy efficient lighting options. The recommended fixtures are commonly available and are among the most energy efficient lighting choices for the particular application. If you decide to pursue a different lighting type, we can evaluate the energy and cost savings of the alternative.

The farm is currently using fluorescent lights. Fluorescent lights are regulated under the Resource Conservation and Recovery Act. It is illegal to dispose of these lights in the trash. Please contact your local waste district regarding the proper disposal of fluorescent lamps. Additional information is provided in the *Resources* section.

## Ventilation

Table V.1 provides an overview of the farm's ventilation equipment. Fan types include low volume high speed (LVHS) fans and high volume low speed (HVLS) fans.

**Table V.1. Current LVHS Circulation Inventory**

Location / Area Description	Manufacturer	Model	# Fans	Fan Style	Diameter	Motor HP	Run Hours	Thrust (lb <sub>f</sub> )	Power (kW)	Efficiency (lb <sub>f</sub> /kW)	Est. Annual Use (kWh)
Dry Cow Barn Fans	Schaefer	N/A	6	Basket	20 - 23in.	0.25	952	4.14	0.493	8.4	2,816
Free Stall Barn Fans	Schaefer	AO Smith	10	Panel	50 - 53in.	1	952	22.3	0.967	23.1	9,206

If Butterfat Acres were to increase the size of their fans to maximize the airflow and energy savings potential, we would recommend working with a ventilation specialist to determine if the required air flow is optimized cow comfort. It is also good practice to develop proper maintenance and monitoring techniques that will help to detect problems early and help determine solutions for creating more efficient ventilation systems.

Circulation fans are typically rated based on the force per rated power (lbf/kW) at zero pressure (0.0 inches H<sub>2</sub>O gauge); the higher the force per rated power, the higher the efficiency. Exhaust fan efficiency is rated in two ways: 1) efficacy in cfm/watt, (cubic feet of air moved per watt of power rating) and 2) by airflow ratio - this ratio gives an indication of the fan's ability to continue to push air when there is wind blowing against the fan or there is an increase in the static pressure inside the structure. Fans with higher efficacies are better performing fans, and fans with higher airflow ratios are better suited for structures with higher static pressures.

It is often more cost effective to buy a more expensive, more efficient fan because lower operating costs over the fan's lifetime will exceed the initial higher cost.

We do not recommend replacing the current fans due to the long payback period.

Table V.2 lists equipment options that were evaluated but not recommended.

**Table V.2. General Ventilation: Evaluated Equipment Not Recommended**

Equipment Description	Current Equipment	Considered Equipment	# to Install	Est. Annual Electricity Savings (kWh)	Est. Annual Cost Savings (\$)	Est. Implementation Cost (\$)	Est. Payback (Years)	EUL (Years)
Dry Cow Barn Fans	20 - 23in. Basket Circulation Fan (4.14 lbf, 0.49 kW, 8.40 lbf/kW), Running 952 Hours / Year	20 - 23in. Basket Circulation Fan (4.26 lbf, 0.35 kW, 12.10 lbf/kW)	6	811	\$87	\$1,950	22.4	15.0
Free Stall Barn Fans	50 - 53in. Panel Circulation Fan (22.30 lbf, 0.97 kW, 23.10 lbf/kW), Running 952 Hours / Year	50 - 53in. Panel Circulation Fan (22.30 lbf, 0.93 kW, 24.00 lbf/kW)	10	381	\$41	\$10,000	245	15.0

Notes:

- To be eligible for incentives, fans must be tested by BESS Lab <http://www.bess.uiuc.edu/> or the Air Movement and Control Association (AMCA) <http://www.amca.org/>.

## Water Heating

Tables WH.1 and WH.2 contain information on the hot water and wash basin equipment.

**Table WH.1. Water Heater Inventory**

Equipment Description	Manufacturer / Model	Milk Parlor	Capacity (gal)	Hot Water Temp. (°F)	CHR?	Resource Type	Est. Annual Energy Use
Hot Water Tank	Rheem Marathon	Main Parlor	65	175	No	Electricity (kWh)	27,736

**Table WH.2. Wash Sink Inventory and Miscellaneous Use**

Milk Parlor	Type	(A) Length / Diameter (in)	(B) Width (in)	(C) Avg. Fill Depth (in)	# Daily Hot Washes / Rinses	# Daily Warm Washes / Rinses	Est. Gallons Used Daily
Main Parlor	Receiver Vat	30	24	18	2	0	110.1645

Butterfat Acres heats approximately 260 gallons of water per day from 67° Fahrenheit (F) to 175°F. They currently use an electric water heater. We recommend the installation of compressor heat recovery units (CHR) in the refrigeration system at the main parlor. These devices are insulated storage tanks that use waste heat from chilled milk to pre-heat water to approximately 110°F before it enters the conventional water heaters. The energy savings comes from the reduced heating required in the conventional water heater.

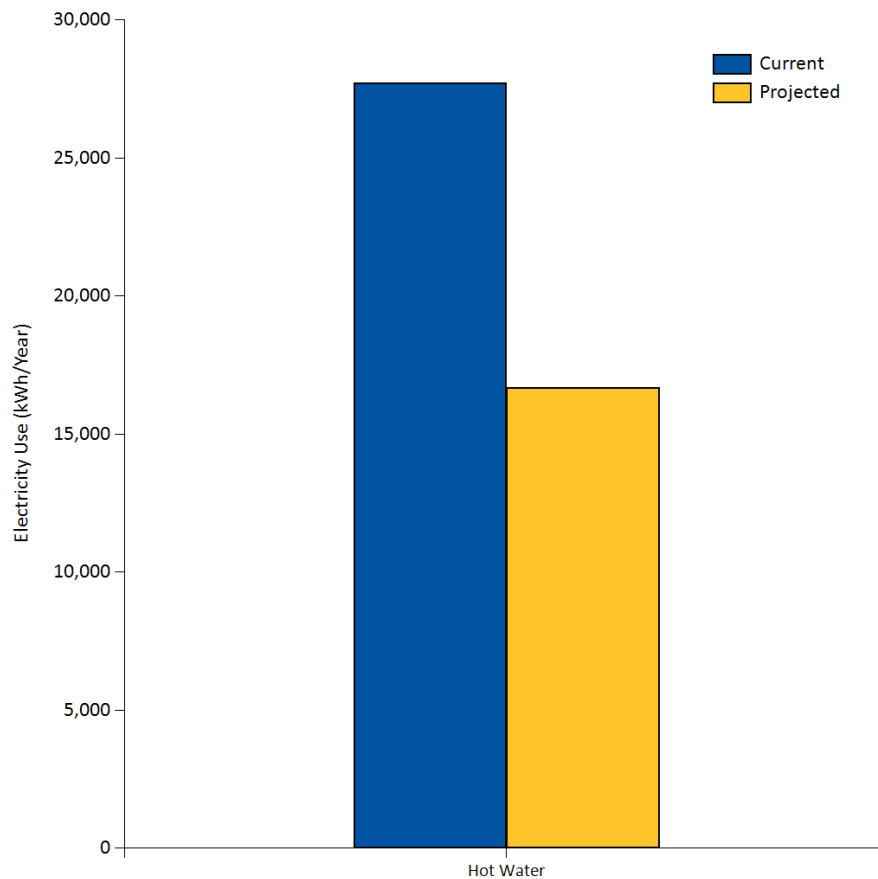
The actual number of heat recovery units and their location will depend on the operating hours of the compressor and the configuration of the existing system. Please contact your EPA certified refrigeration



technician to determine the preferred and practical number of CHR units that will operate most efficiently with your system.

Figure WH.3 shows a comparison of the estimated current and projected energy use. Table WH.4 provides economic details for the recommendation.

**Figure WH.3. Hot Water: Comparison of Annual Electricity Use**



**Table WH.4. Hot Water: Recommended Energy Saving Equipment**

Equipment Description	Current Equipment	Recommended Equipment	# to Install	Est. Annual Electricity Savings (kWh)	Est. Annual Cost Savings (\$)	Est. Implementation Cost (\$)	Est. Payback (Years)	EUL (Years)
Hot Water Tank	Hot Water Heater	Compressor Heat Recovery System	1	11,043	\$1,185	\$3,949	3.3	14.0

## Stock Watering

There are no activities or equipment at this site that are applicable to this section.

## Air Heating and Building Environment

Tables SH.1 and SH.2 provide a list of the heaters evaluated on the farm.

**Table SH.1. Current Heating Fuels Heater Inventory**

Location / Area Description	Manufacturer / Model	Total # Heaters	Heater Type	Ignition Type	Resource Type	Input Rating (Btu/Hour)	Run Hours	Output Rating (Btu/Hour)	Est. Hourly Use	Est. Annual Use
Parlor Radiant Heater	N/A	1	Radiant	Pilot Light	Propane (gal)	60,000	910	58,000	1	537
Parlor Forced Air Heater	L.B. White Guardian	1	Forced Hot Air	Electronic	Propane (gal)	60,000	910	60,000	1	596

**Table SH.2. Current Electric Heater Inventory**

Location / Area Description	Manufacturer / Model	Total # Heaters	Heater Type	Watts	Run Hours	Est. Annual Use
Portable Space Heater (Emergency Use Only)	N/A	1	Radiant	1,500	168	214

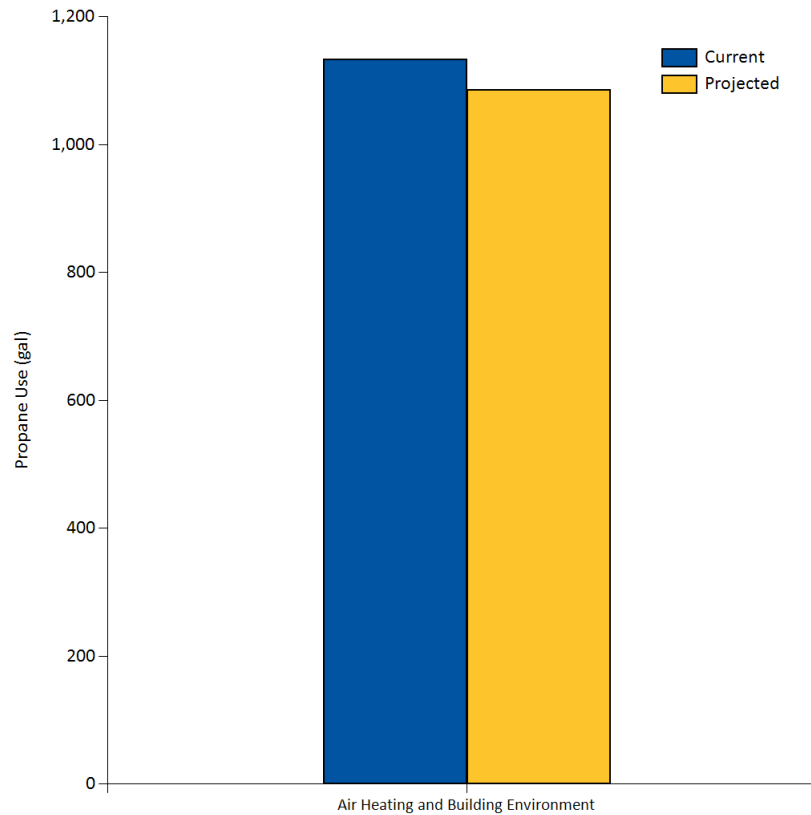
We recommend replacing the pilot light radiant heater (60,000 btu) in the parlor room with an electronic ignition radiant heater (58,000 btu).

The existing parlor forced air heater is considered energy efficient for its application and was not evaluated for replacement.

The existing portable space heater, used for emergencies, does not operate a sufficient number of hours to warrant replacement and was not evaluated.

Figure SH.3 shows a comparison of the estimated current and projected energy use. Table SH.4 provides economic details for each recommendation found to be cost effective.

**Figure SH.3. Air Heating and Building Environment: Comparison of Annual Propane Use**



**Table SH.4. Air Heating and Building Environment: Recommended Energy Saving Equipment**

Equipment Description	Current Equipment	Recommended Equipment	# to Install	Est. Annual Propane Savings (gal)	Est. Annual Cost Savings (\$)	Est. Implementation Cost (\$)	Est. Payback (Years)	EUL (Years)
Parlor Radiant Heater	Radiant Heater with Pilot Light and Input Rating of 60,000 Btus / Hour	Radiant Heater with Electronic Ignition and Input Rating of 58,000 Btus / Hour	1	48	\$73	\$870	11.9	20.0

## Controllers

There are no activities or equipment at this site applicable to this section.

## Air Cooling

There are no activities or equipment at this site applicable to this section.

## Other Motors and Pumps

Table M.1 provides a list of the motors analyzed.

**Table M.1. Current Motor Inventory**

Equipment Description	Manufacturer / Model	# Motors	Motor HP	Annual Run Hours	Motor Estimated Annual Electricity Use
Feed Auger Motor	Leland Faraday / MB6K17FB3A	1	1.5	55	62
Wash Down Motor	Franklin / 1125007403	1	1.5	182	206
Fuel Tank Pump Motors	Tuthill	2	0.25	28	13
Grain Bin Fan	N/A	1	5	11	38
Well Pump Motor (Submersible)	N/A	1	1	728	559
Agitator motors	Mueller / K01075AAAF	2	0.25	728	371
Parlor Gate Hydraulic Motor	N/A	1	1	91	70

Butterfat Acres has very little opportunity to improve the efficiency of its motors by upgrading to motors that meet the National Electrical Manufacturer's Association (NEMA) Premium® standards. Therefore, there are no cost effective recommendations to upgrade any of the existing motors. Proper maintenance and monitoring techniques will help to detect problems early on and determine solutions for creating a more efficient system.

We estimate motor efficiencies using the research and guidelines supplied by NEMA. NEMA currently does not evaluate submersible motors or motors less than 1 Horsepower (HP), so no recommendations can be made for these motors.

To minimize energy consumption of motors, always replace a burned out motor with the most energy efficient motor available. We recommend using NEMA Premium® standard motors where possible. For more information on NEMA Premium®, see

<http://www.nema.org/Policy/Energy/Efficiency/Pages/NEMA-Premium-Motors.aspx>.

Table M.2 lists equipment options that were evaluated, but not recommended.

**Table M.2. Other Motors and Pumps: Evaluated Equipment Not Recommended**

Equipment Description	Current Equipment	Considered Equipment	# to Install	Est. Annual Electricity Savings (kWh)	Est. Annual Cost Savings (\$)	Est. Implementation Cost (\$)	Est. Payback (Years)	EUL (Years)
Wash Down Motor	1.5 HP, TEFC, 1500-2700 RPM, 84.00% Efficiency	1.5 HP, TEFC, 1500-2700 RPM, NEMA Premium®, 86.5% minimum nominal efficiency	1	6	\$1	\$520	814	15.0
Parlor Gate Hydraulic Motor	1 HP, TEFC, 1500-2700 RPM, 82.50% Efficiency	1 HP, TEFC, 1500-2700 RPM, NEMA Premium®, 85.5% minimum nominal efficiency	1	2	\$0	\$500	1,900	15.0
Feed Auger Motor	1.5 HP, TEFC, 1500-2700 RPM, 84.00% Efficiency	1.5 HP, TEFC, 1500-2700 RPM, NEMA Premium®, 86.5% minimum nominal efficiency	1	2	\$0	\$520	2,713	15.0
Grain Bin Fan	5 HP, TEFC, 1500-2700 RPM, 87.50% Efficiency	5 HP, TEFC, 1500-2700 RPM, NEMA Premium®, 89.5% minimum nominal efficiency	1	1	\$0	\$700	7,675	15.0

## Waste Handling

Cow waste is scraped out using a tractor, placed into a lagoon and later spread onto fields. None of the non-stationary equipment involved in this process is eligible for evaluation in this AgEMP.

## Material Handling

A total mixed ration (TMR) of feed, consisting of corn silage, hay and ground feed, is mixed and delivered to the cows using a tractor. None of the non-stationary equipment involved in this process is eligible for evaluation in this AgEMP.

## Crop and Feed Storage

The farm stores corn in a silo that is equipped with a drying fan and a feed auger motor. This equipment can be found in the *Other Pumps and Motors* section. Hay and ground feed is stored in the commodity shed.

## Water Management

The water source used for agricultural purposes is a well. Electric motors used for water management are listed in the *Other Motors and Pumps* section. NEMA Premium efficiency standards do not apply to submersible electric motors and thus there are no efficiency recommendations for these pumps.

## Miscellaneous Electrical Use

The dairy has minor electrical uses that are not accounted for in the previous sections. These uses include grain auger motors, shop tools, alley scrapers, and milk agitators. These motors may operate every day, yet there are two reasons it is not justifiable to replace these motors based on energy savings:

- They do not operate a sufficient number of hours annually to justify replacement. Typically a motor needs to run a minimum of 2,000 hours annually to justify replacement.
- Most of these motors are small and do not consume enough energy to justify replacement.

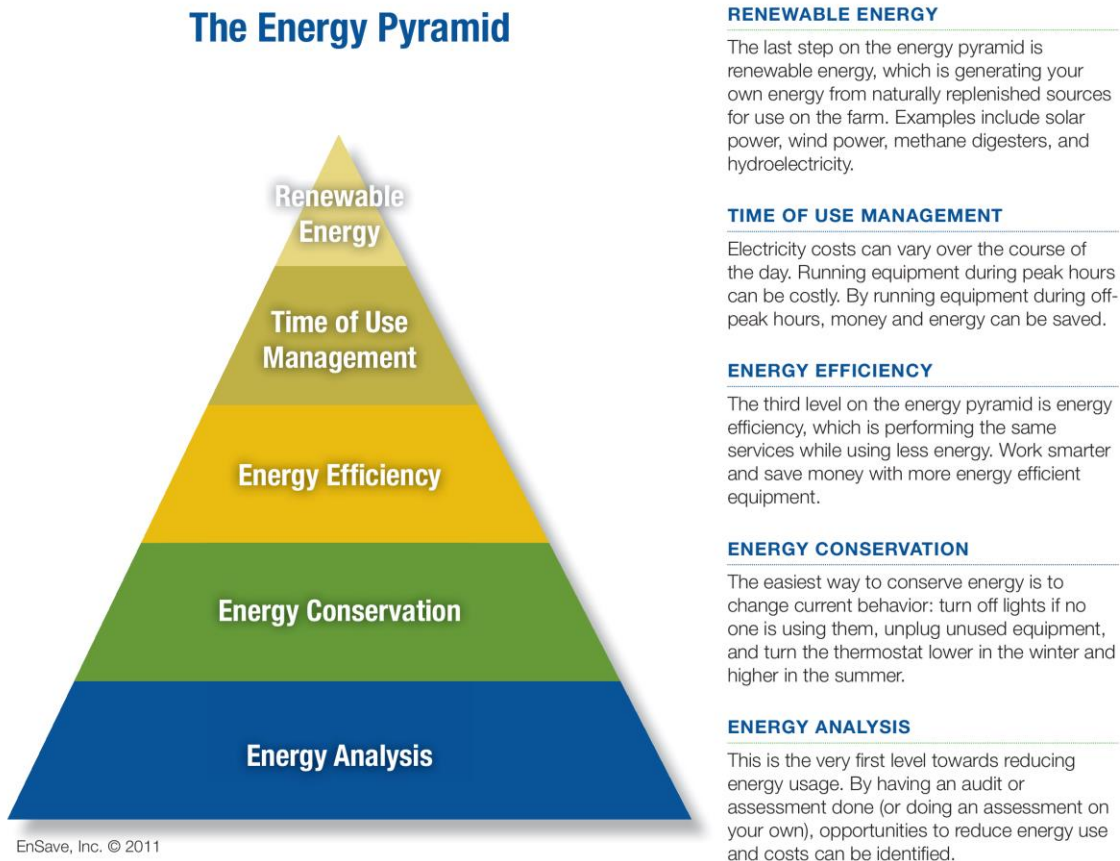
## Low Cost Energy Saving Tips

Some energy savings potential requires minimal investment other than labor. Examples include combining trips and eliminating unnecessary energy use by turning off lights and shutting down engines during periods of inactivity. Another example of a low cost energy saving measure is periodic cleaning of fan blades in dusty environments (e.g., every 3 to 4 weeks) and maintaining belt tension on belt driven fans. This may increase existing fan efficiency by 10% or more without replacement. These actions can increase the useful life of fans.

# ENERGY PYRAMID

EnSave uses an energy pyramid as a model to outline the steps necessary for reducing energy usage. Figure EP.1 shows the energy pyramid.

Figure EP.1. Energy Pyramid



The energy pyramid is a concept used to help guide farmers. The energy pyramid has been proven to be very effective, and it serves as a road map to show where a farm is on their way to energy independence.

The next step for the farm would be to implement the energy efficiency measures recommended.

## STATEMENTS AND DISCLAIMERS

### Disclaimer

The intent of this energy evaluation is to estimate energy savings associated with recommended energy conservation measures at Butterfat Acres. This plan is not intended to serve as a detailed engineering design document. Detailed design efforts may be required to implement several of the improvements evaluated as part of this Plan. As appropriate, costs for those design efforts are included as part of the cost estimate for each measure.

Energy savings and equipment costs presented in this document are estimates and are based on information gathered during the process of developing this energy plan. Actual savings and costs may vary from estimates due to a variety of factors including changes in energy usage and energy costs, equipment costs, product availability, and geographic location.

As a result, EnSave, Inc. is not liable if projected energy or cost savings are not actually achieved. All savings and cost estimates are for informational purposes and are not to be construed as a design document or as guarantees. Butterfat Acres shall independently evaluate any advice or direction provided. In no event will EnSave, Inc. be liable for the failure of the customer to achieve a specified amount of energy savings, the operation of the customer's facilities, or any incidental or consequential damages of any kind in connection with this plan or the installation of recommended measures.

### Statement of Vendor Neutrality

EnSave's goal is to help our clients save energy and conserve natural resources. EnSave does not represent any equipment manufacturer or dealer. Any quotes or manufacturer literature included are intended as illustrations only.

The presence or absence of any trade or company names should not be interpreted as any reflection on the quality of the company or its products.



## RESOURCES

The following resources provide additional information on ways to save energy at your facility.

1. *Best Practices Guide: Energy Savings for Dairy*, published by EnSave, Inc.
2. *Variable Speed Drive for the Milking Vacuum Pump*, published by EnSave, Inc.
3. *Milk Pre-Coolers*, published by EnSave, Inc.
4. *Compressor Heat Recovery*, published by EnSave, Inc.
5. *Dairy Farm Lighting*, published by EnSave, Inc.
6. *Energy Efficient Fan Ranking Guide: Ventilation Fan Simple Payback Calculator, page 3*, published by EnSave, Inc.
7. *NEMA Premium® Motors*, published by EnSave, Inc.
8. *Managing Mercury on the Farm*, published by EnSave, Inc.

## INTERNET RESOURCES

The following resources provide additional information on ways to save energy at your facility.

1. NRCS Environmental Quality Incentives Program,  
<http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/>
2. USDA RD Rural Energy for America Program (REAP) Information,  
<http://www.rurdev.usda.gov/Energy.html>
3. Database of State Incentives for Renewables & Efficiency (DSIRE), <http://www.dsireusa.org/>
4. National Renewable Energy Laboratory, <http://www.nrel.gov/>
5. Lamp Recycling, <http://www.epa.gov/osw///hazard/wastetypes/universal/lamps/index.htm>
6. Bioenvironmental and Structural Systems Laboratory (BESS Labs), <http://www.bess.uiuc.edu/>
7. U.S. Energy Information Administration, <http://www.eia.gov/tools/faqs/>

## **Appendix A: Detail Listing of Estimated Annual Energy Efficiency Improvements**

Table A.1 provides a detailed listing of all recommended measures. This is provided for NRCS purposes as needed. Note that for some measures the quantity is in the “# to Install” column and for others it is included in the description of the “Recommended Equipment”.

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**Table A.1. Detail Listing of Estimated Annual Energy Efficiency Improvements**

											Environmental Benefits				
				Estimated Reduction in Energy Use			Estimated Costs, Savings, Payback, and Prioritization for Implementation				Greenhouse Gas (Estimated Values)			Air Pollutant Co-Benefits (Estimated Values)	
Location / Equipment Description	Current Item	Recommended Item	# to Install	Est. Annual Electricity Savings (kWh)	Est. Annual Propane Savings (gal)	Energy Savings (MMBtu)	Implementation Cost [a]	Energy Cost Savings [b]	Est. Payback in Years [a]/[b]	Expected Useful Life (Years)	CO <sub>2</sub> (lbs)	N <sub>2</sub> O (lbs)	CH <sub>4</sub> (lbs)	SO <sub>2</sub> (lbs)	NO <sub>x</sub> (lbs)
Dry Cow Barn Lights	100W Standard Incandescent (100 Total Input Watts)	10W Light Emitting Diode (10W Total Input Watts)	16	4,193	0	14	\$368	\$450	0.8	10.0	5,825.3	0.1	0.1	13.8	4.8
Free Stall Barn Lights	100W Standard Incandescent (100 Total Input Watts)	10W Light Emitting Diode (10W Total Input Watts)	7	1,835	0	6	\$161	\$197	0.8	10.0	2,548.6	0.0	0.0	6.0	2.1
Hot Water Tank	Hot Water Heater	Compressor Heat Recovery System	1	11,043	0	38	\$3,949	\$1,185	3.3	14.0	15,340.8	0.2	0.2	36.3	12.6
Main Parlor	None	Plate Cooler, 5,800 lbs./Hour Capacity or Less	1	7,901	0	27	\$3,700	\$848	4.4	15.0	10,975.4	0.2	0.1	26.0	9.0
Commodity Shed Lights	100W Standard Incandescent (100 Total Input Watts)	10W Light Emitting Diode (10W Total Input Watts)	10	328	0	1	\$230	\$35	6.5	10.0	455.1	0.0	0.0	1.1	0.4
Feed Barn Lights	200W Standard Metal Halide (232 Total Input Watts)	85W Light Emitting Diode (85 Total Input Watts)	5	2,140	0	7	\$1,900	\$230	8.3	10.0	2,973.3	0.0	0.0	7.0	2.4
Main Parlor	2 vacuum pumps not using a variable frequency drive (VFD).	1 VFD capable of supporting a 10 HP vacuum pump, Digital phase converter.	1	9,280	0	32	\$10,700	\$996	10.7	15.0	12,892.2	0.2	0.2	30.5	10.6
Parlor Radiant Heater	Radiant Heater with Pilot Light and Input Rating of 60,000 Btus / Hour	Radiant Heater with Electronic Ignition and Input Rating of 58,000 Btus / Hour	1	0	48	4	\$870	\$73	11.9	20.0	603.5	0.0	0.1	0.0	0.5
<b>Totals</b>				<b>36,720</b>	<b>48</b>	<b>129</b>	<b>\$21,878</b>	<b>\$4,014</b>	<b>5.5</b>	<b>N/A</b>	<b>51,614.2</b>	<b>0.7</b>	<b>0.7</b>	<b>120.7</b>	<b>42.4</b>

