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Renewable Energy

Fueling and Feeding America Through Renewable Resources

A Stepwise Guide to Prepare for Dairy Farm Energy Audit

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EXPERT REVIEWED

Introduction

Equipment essential for a dairy farm operation — including vacuum pumps, cooling compressors, ventilation fans, motors for feed mixing and feed and manure handling, commercial dryers for towels, lighting, and refrigeration — consumes a lot of energy. Few agricultural operations use more power (ATTRA – Dairy Farm Energy Efficiency, 2010). Indiana has about 184,000 milk cows that produce 4,151 million pounds of milk annually (USDA NASS 2017).

In keeping with the department's efforts to reduce fossil energy usage in agricultural production, USDA REAP grants and loans have provided farmers with opportunities to purchase newer, more energy-efficient dairy technologies. To access those funds, farmers are required to utilize the services of a reputable energy auditor to conduct a comprehensive energy audit of their existing dairy system. The auditor compiles a report describing measures that can save energy and money. Purdue University has experience conducting on-farm energy audits and helping provide documentation required by USDA REAP grants and loans programs.

This bulletin provides a step-by-step guide for preparing a dairy farm energy audit with the Purdue Renewable Energy and Energy Efficiency Program. It also discusses how an energy audit — following procedures provided in an ASABE Standard, "Performing On-Farm Energy Audits" (ANSI/ASABE S612 JUL2009) — is conducted.

What the producer must do

The energy audit begins with the farmer ("client") contacting the Purdue Renewable Energy and Energy Efficiency Program via the website at https://extension.purdue.edu/renewable-energy/on-farm-efficiency.shtml. The client is then connected with a Purdue Extension Specialist.

The client signs an agreement upon engagement, which describes the roles of the client and the auditor, and stipulates that information given to the auditor is valid and accurate. Fees are discussed and agreed to, and a site visit is scheduled.

It is fundamental that the producer accompany the auditor on a walk-through of the facilities accorded for the audit, such as the milk house, animal housing, feed and equipment rooms.

To initiate an audit, the client needs to take the following steps:

a. Specify type, size, milking schedule, and production levels of the operation and other factors that may affect energy use or costs (i.e., milking or parlor system, number of milking cows, amount of milk cooled per year, average volume of hot water use per day, kWh peak rate, long-day lighting, feeding systems, and ventilation).

b. Detail concerns and objectives for the enterprise (i.e., describe why an on-farm energy audit is sought and the audit's specific objectives.) (CAPS - Code 128, 2014).

c. Provide an aerial map or equivalent drawing showing the farm operation; it should include all the structures being audited (i.e., animal housing, shops, processing, etc.) (CAPS - Code 128, 2014).

d. List the usage and costs for the prior year's energy consumption shown by energy resource (i.e. propane, natural gas, diesel, wood, and/or electricity bills.) (CAPS - Code 128, 2014, see figure 1).

e. During this visit the producer should support the auditor by gathering information about the equipment installed and providing insights about the farm's operational aspects, such as:

- Numbers of each type of equipment and/or operation (i.e., number of milking units, number of milkings per day, number of pipeline washings per day, number of milking days per year, number of block heaters, days of block heater use per year, number of lamps per type per location, number of hours used per type per year, number and size and models of fans, number of hours fans run per year (actual or estimated), fan temperature setpoints, electric motors used in feed mixing and handling, number of batches of milking towels laundered and dried, etc.).
- Duration of equipment use and/or operation (i.e., vacuum pump hours per washing, hours of block heater usage per day, hours per milking).
- Operational temperatures (i.e., milk temperature in pipeline, pre-cooled milk temperature, milk storage tank temperature, well/inlet water temperature, water heater set point temperature, fan set point temperature, heater set point temperature).
- Point out motors' nameplates for the registration by the auditor, and provide manuals (i.e., vacuum pumps, compressor, centrifugal pumps, PTOs, fans, heat exchangers, etc.), if possible.
- Pipeline lengths and diameters.
- When questioned by the auditor, report the existence of auxiliary items to enhance management, such as thermostats, timers, VSD, heat recovery units, pre-cooling, and manual overrides of automatic systems.
- Philosophy and desires of the producer regarding energy usage.

What the Purdue Auditor does with your data

The data collected is taken to campus and serves as input for our Farm Energy Audit Calculator. The auditor will first summarize fuel bills, electric bills and milk production documentation. The summary will provide an average fuel cost (per gallon propane, or therm natural gas) and electricity cost per kWh based on billing history. These costs will then be converted in a cost per standard energy unit ($/MMBtu) and adjusted according to the respective thermal energy efficiency of the engines powered by each fuel source type (Figure 1).

Summary tables (Figure 2) are generated, and list energy savings suggestions containing the following:

a. Location;
b. Existing system energy usage;
c. Proposed system energy usage;
d. Energy and cost savings;
e. Cost of replacement; and
f. Simple payback calculation, in years.

This procedure will be repeated for all the energy consumers being analyzed by the audit, i.e., milking

Source Energy	Energy in MMBtu	Total cost of Energy	Cost $/MMBtu	Avg Efficiency of machine	MMBtu's Utilized	Effective Cost $/MMBtu
Electricity (0.1239 $/KWh)	1087.15	$39,490.90	$36.33	90%	978.43	$40.36
Diesel (2.35 $/gal)	3447.55	$62,679.19	$18.18	35%	1206.64	$51.95
Gasoline (2.67 $/gal)	57.46	$1,347.72	$23.46	25%	14.36	$93.83
Propane (1.28 $/gal)	1491.79	$22,570.03	$15.13	85%	1268.02	$17.80
Wood (50.00 $/face-cord)	640	$1,600.00	$2.50	55%	352	$4.55

Figure 1. Energy cost summary.

Location	Existing Lighting				Proposed Lighting				Savings & Payback				
	Existing Lighting	No. of Fixtures	Bulbs / Fixture	Usage (kWh/yr)	Proposed Lighting	Watts / Bulb	Usage (Hrs/Yr)	Usage (kWh/yr)	Savings (kWh/yr)	Savings ($/yr)	Replace Cost/Unit	Ttl Cost to Replace	Payback (Years)
Maternity	Incandescent	10	1	2,920	CFL	23	2920	672	2,248	$279	$2	$20	0.1

Figure 2. Summary table produced using Farm Energy Calculator.

process, cooling and storing milk, heating water, lighting and ventilation, manure handling, etc.

It is important to note that these are not a design for the installation, but rather a compendium of possibilities and relative long-term benefits. (CAPS - Code 128, 2014).

Your audit report

The audit report features the following:

a. An executive summary table of the audit conducted and the total calculated energy usage (new and with proposed changes).

b. A front cover containing the client's name and location, and the report's job, date, title and authors.

c. An introduction that discusses the farm's operation, including herd size, milking schedule, milk production, and an overview of the existing systems and energy unit costs. Depending on the project scope as defined in the agreement upon engagement, the number of pages will vary. The report will contain all the aspects detailed above, displayed in straightforward tables, and describe the existing and new systems' energy performance calculations as well as the energy savings out of this comparison. Photos of the existing system, calculation outputs, and aerial views, as detailed above, are components that make up this report as well.

d. Energy savings out of the implementation of long-day lighting and/or robotic milking are also available if accorded in the agreement statement.

Post-audit monitoring after your new equipment installation

It is important to conduct post-audit monitoring after the installation and use of new equipment to verify that the actual savings incurred are within the range of the savings predicted. Also, post-audit monitoring provides firsthand knowledge of how to set up and run equipment to optimize throughput while minimizing energy usage. It also enables the farmer to determine best operating practices in the use of the equipment, such as routine maintenance during milking operations. Note that for post-audit monitoring to be useful, a year of data of the energy consumption and operating conditions of equipment needs to be collected.

Data discussed in the "What the producer needs to do" section must be routinely collected during/after operating the new equipment to make a good post-audit analysis of equipment operations. To measure the performance of the new system, another round of performance calculations needs to be run and then cross-checked with the first audit outputs.

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Terminology and definitions

LP – liquid propane

NG – natural gas

1 kilowatt-hour = 3,412 Btu (based on U.S. consumption, 2013)

1 therm of natural gas = 100,000 Btu (based on U.S. consumption, 2013)

1 gallon diesel = 139,690 Btu (based on U.S. consumption, 2013)

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