Final Public Release Report for DOE-Sponsored Energy Savings Assessment Conducted at Dairyman's Land O' Lakes Plant:

Overview

Land O'Lakes is the largest dairy facility in the United States. The facility processes 14 million pounds of milk per day and produces cheese, evaporated milk, powdered milk, and whey protein concentrates.

The facility's energy-intensive equipment includes three gas-fired steam boilers, five gas-fired driers, five evaporators, ten air compressors (1,000 HP total), and thirteen refrigeration compressors (3,275 HP total). The facility has a stand-by, 6 MW condensing steam turbine. It was installed and used briefly during the 2001 California energy crisis.

Based on its 2005 energy usage and its current energy costs, Land O'Lakes will spend over $24 million for gas and electricity in 2006.

Source	Annual Usage	Hourly Usage	Unit Cost	Annual Cost
Natural gas	1,222,884 MMBtu	139.6 MMBtu/h	$13.50/MMBtu	$16,509,000
Electricity	90,741 MWh	10,358 kW	$0.085/kWh	$7,173,000
Total				$24,222,000

The plant's natural gas fuel usage is summarized in the table below.

Equipment	Rated Heat Input (MMBtu/h)	12/05 Heat Input (MMBtu/h)
Boiler 7	124.0	94.0
Boiler 6	74.0	0.0
Boiler 5	74.0	0.0
Drier 1	20.0	16.9
Drier 4	17.7	8.1
Drier 5	12.0	8.2
Drier 6	10.0	3.0
Plant 4 drier	28.0	23.3
Totals:	359.7	153.5

Boiler no. 7 is rated at 450 psi and 100,000 lbs per hour. The boiler is currently operated at 150 psi.

Objective

The Land O'Lakes assessment was part of the DOE's objective to provide U.S. industries with technical assistance to enable them to reduce fuel expenditures.

The objective of the Land O'Lakes Energy Savings Assessment (ESA) was to

- Perform an abbreviated Energy Savings Assessment using the Department of Energy's suite of Steam Tools, and
- Train the staff in the use of the Steam Tools so that they can identify additional energy savings opportunities after the Energy Savings Assessment.

Approach

The approach to the Land O'Lakes ESA was designed to support the overall objectives of the ESA program. Specifically, the ESA specialist and plant team

- Identified opportunities and best practices using the Steam System Scoping Tool
- Modeled the steam system using the Steam System Assessment Tool
- Used SSAT to estimate savings from opportunities identified in SSST
- Identified insulation-related opportunities using E3 PLUS

Additional activities included:

- Reviewed a third-party proposal to utilize boiler flue gases to pre-heat combustion air to gas-fired drier no. 4.
- Reviewed boiler and drier gas consumption and performed screening-level calculations for a potential combined heat and power application.

Steam System Model

The SSAT system model included boiler no. 7, the plant's single, 150 pound steam header, and associated components. Boiler nos. 5 and 6 were not included because they are infrequently used. Similarly, the 6 MW stand-by steam turbine was excluded.

Frequent changes in process steam demands interfered with repeated efforts to model the steam system in a steady-state condition. Thus, some of the values in SSAT reflect transient conditions. The plant team will work with its process operations group to coordinate activities so that it can create a steady-state model.

The plant does not have meters for steam, feedwater, make-up water, or condensate return. A ten-minute check of make-up water consumption (based on tank levels) agreed with the flow estimates computed in SSAT. The plant plans to install some meters to improve its ability to model the system and to identify further savings opportunities.

Energy Savings Opportunities

The potential energy savings opportunities are summarized below. The summary includes estimated time horizons for implementation of the opportunities. The opportunities are categorized as near-term, medium-term, or long-term according to the general guidelines below.

- **Near-term opportunities** include actions that can easily be attained in less than one year. Examples include improvements in operating activities, equipment maintenance, and relatively low cost actions or purchases.
- **Medium-term opportunities** would typically require one to two years to implement and would require additional engineering and economic analysis. Examples include capital equipment purchases and moderate changes to the plant's steam system or processes.
- **Long-term opportunities** typically require two to five years to implement. Examples include new technologies or significant changes to either the steam system or the plant's processes.

Energy Savings Opportunities

No.	Opportunity	$/year	MMBtu/yr	Time Horizon
1	Implement Steam Trap Maintenance Program	278,000	19,852	Near-term
2	Implement Steam Leak Maintenance Program	18,000	1,259	Near-term
3	Improve Insulation	35,000	2,592	Near-term
4	Heat boiler make-up water using process waste heat	416,000	30,815	Medium-term
5	Change boiler efficiency (reduce O_2 fm 4.5% to 3.0%)	113,000	8,370	Near-term
	Totals:	860,000	62,888	

1. Implement Steam Trap Maintenance Program

The plant team estimated that the facility contains 220 steam traps. The estimated savings are based on the number of traps, their maintenance history, and the steam trap failure assumptions shown on the Inputs page of the SSAT program. Annual savings are estimated at $278,000 based on the gas at $13.50/MMBtu. This is a near-term savings opportunity.

2. Implement Steam Leak Maintenance Program

The plant team and ESA specialist noted a moderate number of steam leaks during the ESA. The estimated annual savings of $18,000 are based on the steam leakage assumptions shown on the Inputs page of the SSAT program. This is a near-term savings opportunity.

3. Improve Insulation

This near-term savings opportunity contains three components: the 150 pound steam header, the boiler economizer, and a hot water tank used in the production process.

No.	Insulation Improvement Opportunity	$/year	MMBtu/yr	Time Horizon
1	Improved insulation on 150# header	16,000	1,185	Near-term
2	Add insulation to boiler economizer casing	11,000	815	Near-term
3	Add insulation to process hot water tank	8,000	592	Near-term
	Totals:	35,000	2,592	

Steam Header - The team observed insulation improvement opportunities near the deaerator tank, the mud drum, and feed water piping. The savings estimate is based on the insulation improvement assumption shown on the Projects Input page of the SSAT program.

Economizer – The team observed insulation improvement opportunities on the boiler economizer casing. The team used three different savings estimation methods to demonstrate the capabilities of the DOE Steam Tools:

- E3 Plus insulation program
- E3 Plus and SSAT using marginal steam production costs
- E3 Plus and SSAT Project 1 – Steam demand savings

Hot Water Tank - The team observed an opportunity to add insulation to a process hot water tank. The team used the three methods described above to estimate the annual savings.

4. Heat Boiler Make-up Water Using Process Waste Heat

The plant uses a significant amount of energy to heat boiler make-up water in the deaerator. There are no other feedwater heaters, and there appears to be little or no condensate return.

There is an opportunity to capture waste heat from the plant processes (e.g., evaporator stream sent to cooling tower) or plant auxiliaries (e.g., waste heat from air and refrigeration compressors) and use it to heat the make-up water. The project would require one or more heat exchangers, piping, valves, and insulation. A pump may be required.

The team used SSAT and manual calculations to estimate the annual savings.

This medium-term opportunity might be relatively simple to engineer and implement; therefore, there is a chance that Land O'Lakes could realize significant savings in 2006.

5. Change Boiler Efficiency (reduce O_2 fm 4.5% to 3.0%)
The plant team will discuss this potential opportunity with its boiler technician. The plant needs to evaluate the potential to lower the boiler excess oxygen while complying with its 9 ppm NOx emissions limit.

The team used SSAT to evaluate the potential savings.

The $860,000 annual savings opportunities during the Energy Savings Assessment equate to a 5.2% annual saving in natural gas expense.

Other Potential Opportunities

Combined Heat and Power
The SSAT results indicate that Land O'Lakes may be a good candidate for a gas turbine based combined heat and power system. A combined heat and power analysis is beyond the scope of this abbreviated energy savings assessment; however, informal, screening level calculations were provided to Land O'Lakes.

Use Boiler Exhaust to Pre-Heat Combustion Air in Gas-Fired Drier
Land O'Lakes is evaluating a proposal to utilize the waste heat from boiler no. 7 to pre-heat the combustion air in gas-fired drier no. 4.

Replace Motor-Driven Air Compressors with Steam Turbine-Driven Compressor
Land O'Lakes is planning to replace multiple, motor-driven air compressors with a steam turbine-driven air compressor. As part of this project, the boiler pressure will be raised to its 450 psi rating. Land O'Lakes can evaluate this opportunity using SSAT.

Management Support and Comments

The Dairyman's Land O'Lakes plant team took an active interest in the energy savings assessment and training. They will use the DOE Steam Tools to help them identify and quantify ways to reduce their $24,000,000 annual energy bill.

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