FOREST PRODUCTS

BestPractices
Assessment Case Study

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OFFICE OF INDUSTRIAL TECHNOLOGIES
ENERGY EFFICIENCY AND RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY

Benefits

- Provides a sound strategy for process improvement and energy efficiency
- Approximate annual cost savings of $1.2 million at Rittman mill
- Corporate procurement program for electric motors, power transmission and related industrial equipment has reduced the cost of purchasing these items and resulted in an improved motor management program

Applications

Energy is one of the primary operating expenses for recycled paperboard manufacturers. Periodic, system-level evaluations of a paper processing facility's industrial systems can reveal opportunities for significant improvements in energy efficiency and savings.

Carastar Industries Energy Assessment

Summary

In 2000, Carastar commissioned plant-wide energy assessments at two of its recycled paperboard mills, the Chesapeake Mill in Baltimore, Maryland, and the Rittman Mill in Rittman, Ohio. The assessments identified potential opportunities for systems and process efficiency improvements that could result in important energy savings and improved productivity. The projects would particularly improve the efficiency of plant steam systems and would substantially decrease dependence on purchased electricity and fuel. Annual cost savings at the Rittman mill were estimated at $1.2 million.

Company Background

Carastar is a major manufacturer of recycled paperboard and converted paperboard products. It was incorporated in 1980 through the consolidation of six corporations in the recycled paperboard industry previously related by common ownership and administration. Carastar operates over 100 facilities in the United States along with plants in Mexico and the United Kingdom. The company is divided into four business groups: the Mill Group, Industrial and Consumer Products Group, Custom Packaging Group, and Recovered Fiber Group.

Carastar manufactures its products primarily from recovered fiber derived from recycled paperstock. At its 16 paperboard mills, Carastar produces various grades of uncoated and clay-coated recycled paperboard both for internal consumption and for sale to customers in four principal markets:

(1) tubes, cores, and composite containers
(2) folding cartons
(3) gypsum wallboard facing paper
(4) miscellaneous specialty and converted products

In addition to the mills, Carastar's facilities include tube and core converting plants, composite container plants, folding carton plants, and specialty converting plants. The company's principal manufacturing activity is the production of uncoated and clay-coated recycled paperboard. In this manufacturing process, paperstock is reduced to pulp, cleaned and refined, then processed into various grades of paperboard. Approximately 32% of the recycled paperboard sold by Carastar's mills is consumed internally by its converting facilities; the other 68% is sold in other paper markets.

Large quantities of electricity, natural gas, coal, and oil are used in the production of recycled paperboard. Carastar purchases electricity and natural gas for

all its facilities, but also purchases significant quantities of fuel oil and coal for many of its recycled paperboard mills. Energy accounts for 15-25% of each mill's total operating expenses and is second only to raw material and labor in a mill's operating cost structure.

Caraustar has made a commitment to continually maintain and improve its paperboard mills. During the past 5 years, Caraustar has spent over $30 million annually in capital expenditures, primarily to expand and upgrade its paperboard production and converting capacity by acquiring and maintaining state-of-the-art machinery and technology. Caraustar continues to upgrade existing facilities with modern, cost-efficient, and more productive equipment.

Assessment Overview

Caraustar has historically monitored the cost/ton of paper produced in its Mill Group. As a result of this study, the company has also begun to document energy costs for the Industrial and Consumer Products and Packaging divisions. Of the two mills studied, the Chesapeake Mill produces uncoated recycled paperboard while the Rittman Mill produces gypsum wallboard and clay coated boxboard.

Caraustar conducted the plant-wide energy assessment in association with Sterling Energy Services, LLC. The project was partially funded by the Department of Energy's (DOE) Office of Industrial Technologies (OIT). OIT supports plant-wide energy efficiency assessments that will lead to improvements in industrial efficiency, waste reduction, productivity, and global competitiveness in association with OIT's Industries of the Future strategy. The assessment team conducted comprehensive plant energy efficiency reviews using a systems approach combined with industry standard practices. Opportunities for energy savings were identified and documented, then evaluated and prioritized based on potential for energy savings. Maintenance practices and operating procedures were also reviewed for their impact on energy efficiency.

Caraustar recognized that an energy study should involve identification/quantification of energy inputs to plant processes, assessment of process efficiency, and examination of process outputs (including waste and energy byproducts). Caraustar had already implemented detailed reporting practices for quantifying process inputs and outputs before initiation of the energy assessment. The primary focus of the energy assessment, therefore, was to evaluate the efficiency of the plant processes.

Assessment Implementation

The assessment team first developed complete lists of the energy-consuming production and mill utility processes (steam, compressed air, on-site power production). The team conducted detailed audits of the processes believed to have the greatest energy savings potential. The areas investigated included:

Steam systems
The generation, distribution, application, and condensate return of plant steam as well as operation and maintenance practices for steam systems were investigated. The steam consumption of various processes was also analyzed. Steam leaks and traps were identified and documented.

Cogeneration assessment
Caraustar's paperboard mills have excellent thermal and electric load profiles, and several, including Rittman, already operate combined heating and power systems. The Chesapeake mill was evaluated for the application of a backpressure steam turbine that generates electric power. Rittman was analyzed with a focus on improving the overall efficiency of its aging plant. Gas turbines with heat recovery steam generators were considered for both mills. Cogeneration applications were reviewed in conjunction with benefits that might also be available to the local electric utility.

Waste heat recovery
Sources of waste heat were identified and evaluated. Systems that could utilize waste heat from other processes were investigated, along with specific means by which heat recovery could be implemented and the potential side effects on the source and use processes.

Motor analysis
Electric motors account for approximately 80-90% of Caraustar's electric power consumption, and are therefore targets for significant energy efficiency improvements. Caraustar's existing motor database (based on DOE's MotorMaster+) was used to identify candidate motors for replacement with more efficient models. A corporate-wide motor efficiency program was developed that created a standard framework for evaluating motor rewind/replace decisions and facilitated the reduced-cost purchasing of high-efficiency motors, further increasing opportunities for efficient motor conversions.

Compressed air systems
Both mills' compressed air supply, distribution and storage systems, pressure and demand requirements, and operating and maintenance policies were reviewed. The merits of repairing compressed air system leaks and eliminating poor compressed air applications were also evaluated.

Lighting systems
A review of selected lighting systems was conducted to document any potential lighting efficiency improvements. Indoor/outdoor plant, warehouse, and office space lighting were reviewed.

Electric variable speed drive analysis
An analysis was conducted to assess opportunities for installing new electric variable speed drives for selected applications. Candidate applications include boiler draft fans and feed pumps, other process applications, and replacement of older drive technologies.

Seven specific systems and/or processes were evaluated in detail for efficiency improvements or cost reductions for the Chesapeake mill.[1] The Chesapeake mill was selected for the assessment because of its higher production costs and the similarity of operations with several other Caraustar mills. The energy assessment conducted at the Chesapeake mill has been used as a template for improvements at other Caraustar mills. The systems and processes evaluated at the Chesapeake mill included:

- Backpressure steam turbine generator
- Boiler feed pump steam turbine drive
- Boiler feed pump variable speed electric drive
- Paper machine #2 variable speed electric drive retrofit
- Vapor-absorption system boiler stack heat recovery
- Stock pulper fill water heat exchangers
- Improved insulation of steam pipes

Six systems and/or processes were also evaluated for efficiency improvements at the Rittman mill. These included:

- Project requirements analysis for mill cogeneration (replacement or retrofit of existing operations)
- Benchmarking mill operations' energy use
- Pulper fill water heat exchangers
- Modifications to steam injection stock heater
- Coater oven steam requirement efficiency or elimination
- Heat recovery for vapor-absorption system

[1] Caraustar closed the Chesapeake mill in the spring of 2000 because of overcapacity in the industry and other issues. In spite of this closure, Caraustar realized that the assessment's findings were valid for similar facilities.

Overview of Specific Actions Identified in the Assessment

Table 1 lists the systems and processes identified in the assessment of the Chesapeake Mill to have the greatest opportunity for energy savings. Table 2 provides assessment results for the Rittman Mill.

Table 1. Systems and Processes Evaluated for Energy Efficiency Improvements at Caraustar's Chesapeake Mill

System/Process	Estimated Project Implementation Cost	Estimated Annual Savings	Estimated Simple Payback (years)
Add steam turbine generator to existing steam boiler for electric power production	$ 300,000	$ 197,300	1.5
Change steam turbine-drive boiler feed pump from backup to primary pump	$ 0	$ 11,800	0
Install a variable speed drive (VSD) on the electric boiler feed pump (preferred option)	$ 15,000	$ 9,300	1.6
Upgrade to modern VSD on paper machine #2	$ 22,300	$ 10,330	2.2
Use boiler stack heat recovery with existing blowers for vapor-absorption system	$ 150,000	$ 78,930	1.9
Replace direct steam injection into pulpers with steam heat exchangers on fill water	$ 16,000	$ 55,500	0.3
Improve insulation on steam pipes	$ 3,200	$ 6,100	0.5

Table 2. Systems and Processes Evaluated for Energy Efficiency Improvements at Caraustar's Rittman Mill

System/Process	Estimated Project Implementation Cost	Estimated Annual Savings	Estimated Simple Payback (years)
Reconstruct powerhouse steam tubo-generators	$ 2,800,000	$ 1,130,000	2.5
Benchmark mill energy use	n/a	n/a	n/a
Replace direct steam injection into pulpers with fill water heat exchangers	$ 32,200	$ 27,150	1.2
Steam injection stock heater modifications (convert stock heaters to heat exchangers)	$ 150,000	$ 70,700	2.1
Eliminate coater oven steam requirements	n/a	n/a	n/a
Renovate vapor-absorption systems and use direct stack gas heat recovery from boilers	n/a	n/a	n/a

Results

The plant-wide studies concentrated on identification of energy efficiency improvements for Caraustar's Chesapeake and Rittman mills, with an extended focus on the development of efficiency concepts that could be transferred to other Caraustar facilities. Many of the efficiency measures identified and evaluated in this assessment will benefit other Caraustar mills as well as those of other recycled paperboard manufacturers. These include:

- Motor procurement and efficiency improvements
- Backpressure steam turbine generators
- Boiler feed pump variable speed drives
- Stack heat recovery to vapor-absorption systems
- Pulper fill water heat exchangers
- Steam pipe insulation

The application of these energy efficiency measures is being reviewed for other Caraustar mills. In addition to the efficiency measures identified, other measures were found that did not offer immediate benefits for either Chesapeake or Rittman, but should offer some benefits to other Caraustar locations. These measures include:

- Boiler forced draft fan variable speed drives
- Paper machine dryer section drive retrofits

Before initiating the two mill energy assessments, Caraustar had already undertaken a project to inventory electric motors at selected mills to identify savings opportunities that could be realized from implementation of a formal motor management program. The plant-wide energy assessment permitted the project team to accelerate the motor management effort. As a result, Caraustar has implemented a corporate procurement program for electric motors, power transmission, and related industrial equipment that has reduced the cost of purchasing these items and boosted the opportunities to improve the overall efficiency of each plant's motor inventory. The plant-wide energy assessment project has been an important component in extending Caraustar's focus on energy efficiency and cost reduction measures in all divisions.

Industry of the Future—Forest Products and Agenda 2020

*In November 1994, DOE's Secretary of Energy and the Chairman of the American Forest and Paper Association signed a compact, establishing a research partnership involving the forest products industry and DOE. A key feature of this partnership was a strategic technology plan-**Agenda 2020: A Technology Vision and Research Agenda for America's Forest, Wood, and Paper Industry**. Agenda 2020 includes goals for the research partnership and a plan to address the industry's needs in six critical areas:*

- *Energy performance*
- *Environmental performance*
- *Capital effectiveness*
- *Recycling*
- *Sensors and controls*
- *Sustainable forestry*

OIT Forest Products Team Leader: Valri Robinson (202) 586-0937

BestPractices is part of the Office of Industrial Technologies' (OIT's) Industries of the Future strategy, which helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together the best-available and emerging technologies and practices to help companies begin improving energy efficiency, environmental performance, and productivity right now.

BestPractices focuses on plant systems, where significant efficiency improvements and savings can be achieved. Industry gains easy access to near-term and long-term solutions for improving the performance of motor, steam, compressed air, and process heating systems. In addition, the Industrial Assessment Centers provide comprehensive industrial energy evaluations to small and medium-size manufacturers.

Project Partners

Caraustar
Rittman, OH

Sterling Energy Services, LLC
Atlanta, GA

For Additional Information, Please Contact:

OIT Clearinghouse
Phone: (800) 862-2086
Fax: (360) 586-8303
clearinghouse@ee.doe.gov

Visit our home page at
www.oit.doe.gov

Please send any comments, questions, or suggestions to
webmaster.oit@ee.doe.gov

Office of Industrial Technologies
Energy Efficiency
and Renewable Energy, EE-20
U.S. Department of Energy
Washington, D.C. 20585

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