"TURNING INFORMATION INTO ENERGY SOLUTIONS FOR INDUSTRY"

Energy Matters

INDUSTRIAL TECHNOLOGIES PROGRAM

Spring 2003

ISSUE FOCUS:
Assessments and Optimizations Lead to Energy Improvements

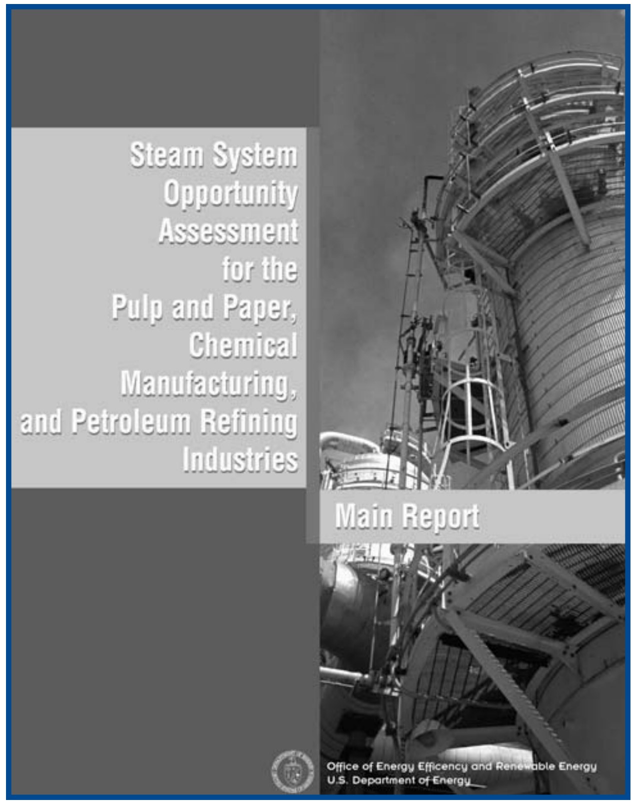
IN THIS ISSUE

Building a company-wide energy assessment. See page 6.

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean abundant, reliable, and affordable

Steam Assessment Gauges Energy Savings Potential for Industries

Steam energy accounts for a significant amount of the total industrial process energy use in U.S. industries. Because U.S. industries represent an important national interest and a large portion of the nation's overall energy use, it is important not only to understand how these industries use energy, but especially how they generate and use steam.



An analysis of steam generation and steam improvement opportunities in three target industries.

Combining data from the Manufacturing Energy Consumption Survey 1994 (MECS) with energy use estimates for key processes and products, the report *Steam System Opportunity Assessment for the Pulp and Paper, Chemical Manufacturing, and Petroleum Refining Industries* (recently published by the Industrial Technologies Program) provides an analysis of the steam generation and steam improvement opportunities in the three target industries.

According to MECS data, the amounts of fuel used to generate steam in the target industries were:

- Pulp and paper manufacturing: 2,221 trillion British thermal units (Btu)
- Chemical manufacturing: 1,540 trillion Btu
- Petroleum refining: 1,675 trillion Btu.

The report also estimates the amount of steam generated by fuel, the amount of steam purchased, and the total amount of steam available to these industries. The amount of steam as a percentage of total energy used by each industry was also determined:

- Pulp and paper manufacturing: 84%
- Chemical manufacturing: 47%
- Petroleum refining: 51%.

Pulp and Paper Industry

Manufacturing plants in the pulp and paper industry vary by size, level of integration, process technology, wood type, and final product type. The energy used by fully integrated plants can be combined with total industry production to estimate the total thermal energy used by the pulp and paper industry. This method assumed that a fully integrated pulp and paper plant uses the same amount of energy to produce a ton of product that an equivalent supply chain of plants that are not integrated would use. Ideally, the energy data reported in the MECS is consistent with the results of this bottom-up view of the process energy use.

The estimated steam energy requirements for these 14 major pulp and paper products are presented in Figure 1. The product steam energy use requirements varied between 4 and 483 trillion Btu.

The sources of the steam in pulp and paper manufacturing include recovery boilers (at chemical pulping facilities), power boilers, and waste heat recovery boilers.

(continued on page 2) ▶

Energy Matters
is published quarterly by the U.S. Department of Energy's (DOE) Industrial Technologies Program.

Information contained in the newsletter can be reproduced without permission provided due acknowledgement is given (the U.S. Department of Energy's Energy Matters newsletter) and a copy of the publication is supplied to the editor.

Comments?

Contact:

David Wagman, Energy Matters Editor, at 303-275-3602, e-mail david_wagman@nrel.gov or Karen Atkison, Associate Editor at 303-275-3730, e-mail karen_atkison@nrel.gov
1617 Cole Blvd., MS 1609
Golden, CO 80401

For new subscriptions, go to **www.oit.doe.gov/bestpractices/explore_library/energy_matters.shtml**

For address/subscription changes, please contact the editor.

 continued from page 1

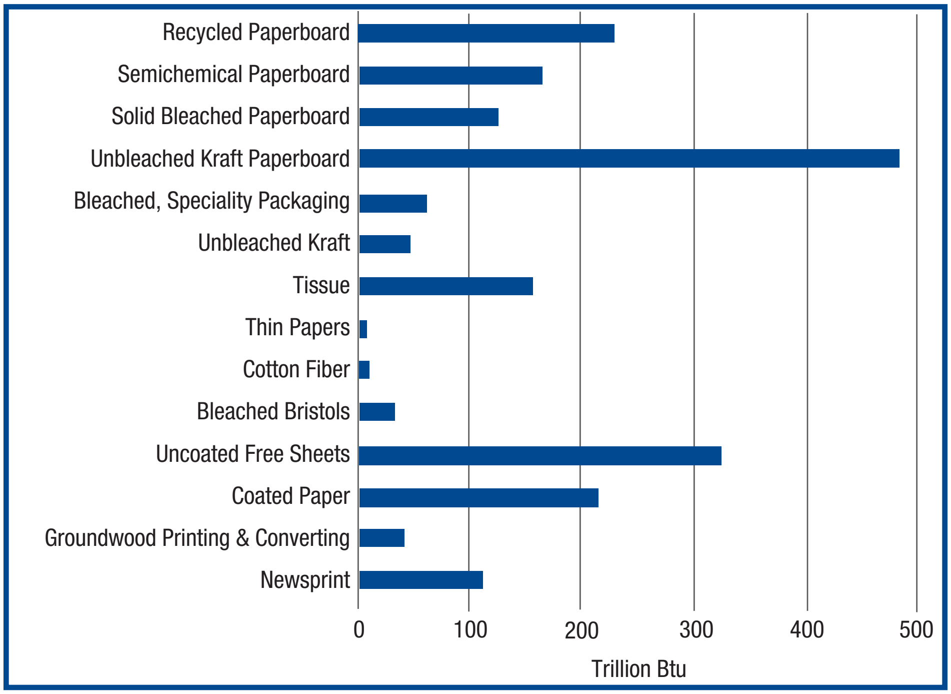


Figure 1. Estimated steam energy use for major pulp and paper products.

There is approximately 370,000 million Btu per hour (MMBtu/hr) of boiler capacity in the pulp and paper industry. Approximately half of this boiler capacity is fired by waste fuels. Most of the boiler capacity for pulp and paper plants is in the pressure range of 300 to 1,000 pounds per square inch (psig). Boilers larger than 250 MMBtu/hr account for over half of the boiler capacity in this industry.

Chemical Manufacturing Industry

The chemical manufacturing industry uses a significant amount of energy to manufacture chemical products for consumer and industrial markets. However, the processes used by chemical manufactures to produce these products are typically considered competitive information, making it difficult to assess energy use in this industry from a process perspective. Consequently, a different

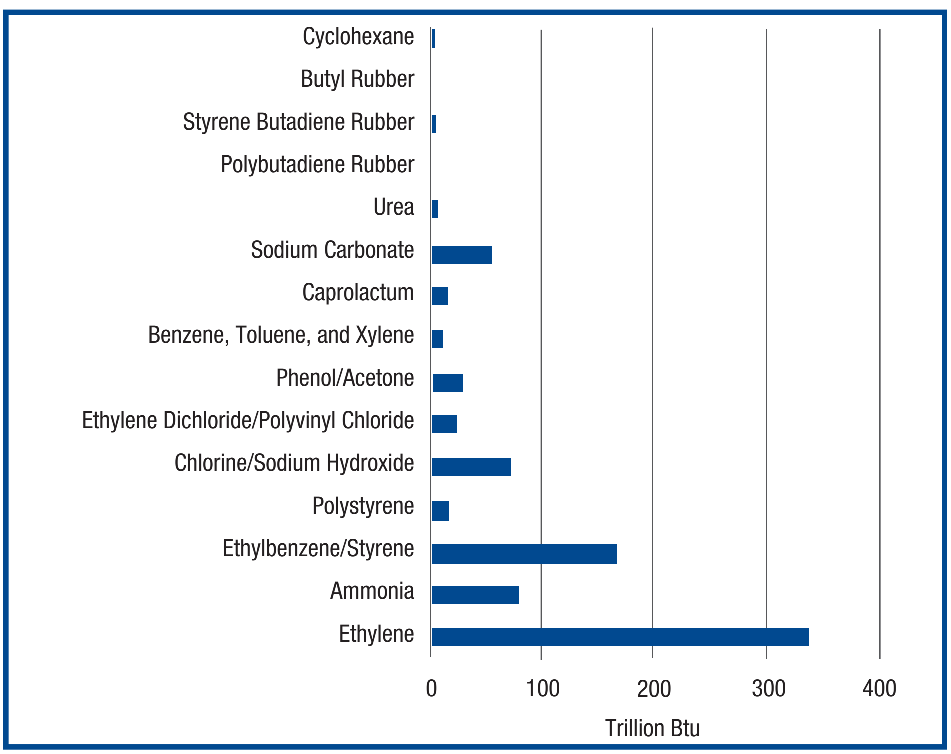


Figure 2. Estimated steam energy use for major chemical products.

approach to assessing chemical industry steam generation and use is required. Because a relatively small number of chemical products account for most of the industry's energy use, evaluating the processes used to manufacture these high energy-use chemical products can provide a reasonably accurate assessment of how energy—specifically steam energy—is used.

The chemical industry produces over 70,000 products. In 1994, the chemical industry used about 3,273 trillion Btu of energy, of which steam energy accounts for roughly 1,540 trillion Btu. Within the chemical industry, there are nine 4-digit SIC segments that account for 1,210 trillion Btu of fuel used to generate steam, which is approximately 79% of the industry total. Within these nine SIC segments, there are 20 chemical products whose process steam energy requirements account for 832 trillion Btu of steam.

The estimated steam energy requirements for these 20 major chemicals are shown in Figure 2. The steam energy requirements for these 20 products varied between 0.3 and 343 trillion Btu.

The sources of steam in the chemical manufacturing industry include boilers and process heat recovery heat exchangers. The estimated boiler capacity in the chemical manufacturing industry is about 500,000 MMBtu/hr. Over half of this capacity, about 280,000 MMBtu/hr, is accounted for by boilers above 100 MMBtu/hr. However, small boilers between 10 and 50 MMBtu/hr account for about 120,000 MMBtu/hr of industry capacity, illustrating the wide distribution of boiler size across the industry. Natural gas is the dominant fuel type, accounting for about 205,000 MMBtu/hr of industry boiler capacity. About 60% of the boiler capacity lies in the pressure range between 300 and 1,000 psig.

Petroleum Refining Industry

The petroleum refining industry uses energy to convert crude oil into many different products, some of which are used directly by consumers, while others are feedstock for other industries. Production data for these petroleum refining processes can be combined with process energy data to estimate overall industry energy use. Additionally, the component energy types, including direct-fired, electric, and steam, can be disaggregated from the energy data for each refining process. This allocation allows the total steam use within the industry to be estimated. This steam use estimate can then be compared to the amount of fuel used to generate steam as indicated by MECS.

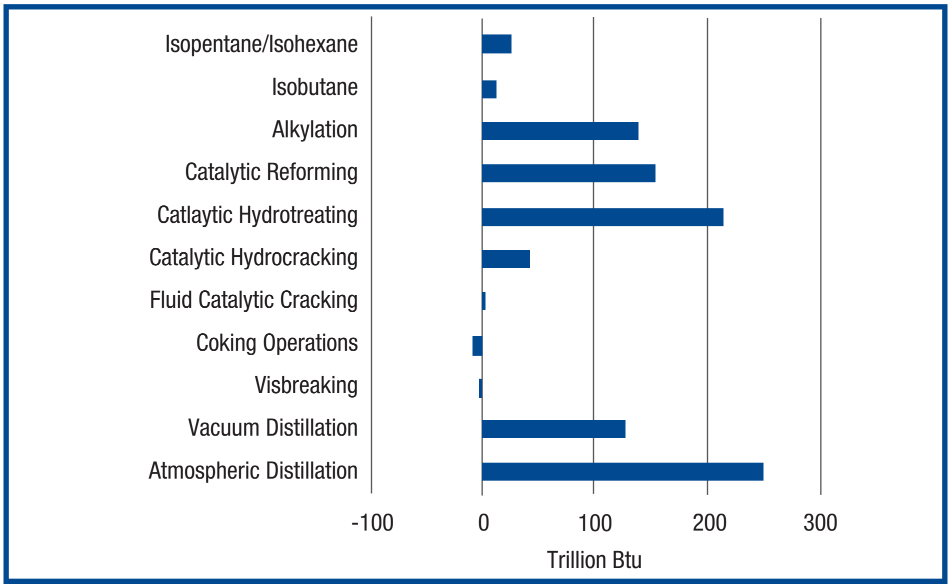


Figure 3. Estimated steam energy use for major petroleum refining processes.

There are 11 major refining processes that represent the principal end uses of steam in the petroleum refining industry. The estimated steam energy requirements for major petroleum refining processes are presented in Figure 3. Process steam energy-use requirements vary between 0.5 and 246.1 trillion Btu. Note that visbreaking and coking operations are net steam producers.

The major sources of steam generation in the petroleum refining industry are boilers and heat recovery steam generators. The estimated boiler capacity in the refining industry is about 210,000 MMBtu/hr. Boilers that generate more than 250 MMBtu/hr account for about 100,000 MMBtu/hr, or roughly 48% of the industry's total boiler capacity. Most of the boiler capacity in the petroleum refining industry is fired by byproduct fuels such as refinery gas and coke. In terms of steam system pressure, about 60% of the total industry boiler capacity is at 300 psig or less. Most of the remaining boiler capacity is between 300 and 1,000 psig.

Potential Savings Estimates

The report estimates the potential savings available from implementing steam system improvements in the pulp and paper, chemical manufacturing, and petroleum refining industries. To develop these savings estimates, 30 performance improvement opportunities were identified that cover the most significant ways to improve steam system performance and efficiency in these target industries.

To assess the energy savings available from implementing steam system improvements, it was determined that eliciting expert opinion would be the most effective approach. Expert judgment was elicited by sending questionnaires to qualified experts. The major types of data requested were:

- Fuel savings
- Percentage of facility for which each opportunity is feasible
- Payback period
- Reasons for implementing the improvement.

The results of this effort indicate that fuel savings from individual steam system improvements range from 0.6% to 5.2%. The payback periods for these steam system improvements range from 2 to 34 months; the majority are less than 24 months. The percentages of facilities for which these improvements are feasible range from 3.4% to 29.4%.

Overall industry fuel savings, which are the combination of estimates for fuel savings and the percentage of facilities for which an opportunity is feasible for each of the 30 opportunities, range from 0.02% to 3.0%. The data showing overall fuel savings for the major areas of a steam system are shown in Figure 4.

When combined, the total potential fuel savings from these steam system improvement opportunities totaled over 12% for each industry. Table 1 indicates that the total estimated energy savings potential for these

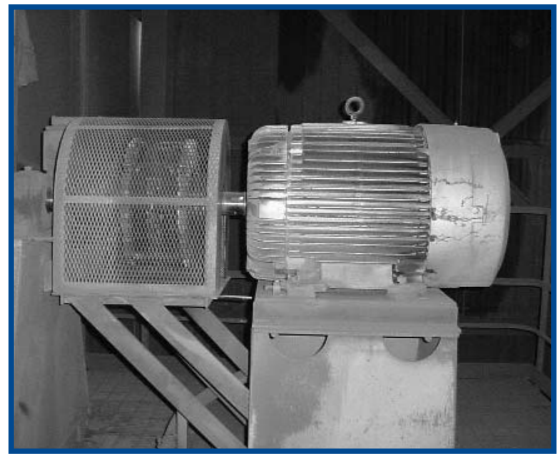
(continued on page 10) ▶

Fan System Optimization Improves Production, Saves Energy at Cement Plant

In 1999, Ash Grove Cement Company implemented an optimization project on a fan system in its Durkee, Oregon, cement plant. Because of a severe vibration problem, the plant's fan system would often fail and required frequent repairs to the ductwork and adjoining machinery. Working with MagnaDrive plant personnel replaced the fan's belt drive with an Adjustable Speed Drive (ASD) system to improve fan system control and lower its energy consumption. This change eliminated the vibration problem and improved the system's airflow control and energy efficiency.

The project yielded annual maintenance and energy cost savings of $16,000 and energy savings of 175,000 kilowatt-hours (kWh). In addition, the fan system's improved reliability allowed the plant to achieve its desired production level. The total project cost was approximately $13,500, which gave the Durkee plant a simple payback of 10 months.

Proper optimization of a fan system can have substantial benefits that go beyond energy savings. In the case of the Ash Grove plant, the design of the baghouse's fan system led to excessive vibration. This excessive vibration imposed heavy maintenance costs on the plant and seriously hindered the plant's productivity. Replacing the existing belt-driven drive with an ASD eliminated the source of the system's maintenance burden, which improved the plant's productivity and reduced its energy consumption. The ASD allowed for the energy savings and better performance by accurately matching the appropriate fan speed to the system demand. The new drive also allows the system to operate reliably because, instead of being controlled by dampers, which caused the original vibration problem, airflow is now controlled by the ASD. This type of drive can be applied in many ventilation or fan systems that require variable output to meet changing load patterns. In addition, an ASD can improve the performance of other systems such as blowers, pumps, compressors, grinders, mills, and conveyors.



New mechanical ASD installed on the baghouse fan system.

Take a look at what others in your industry have done to increase their energy savings by reading their case studies. You can view these documents at **http://www.oit.doe.gov/bestpractices/case_studies.shtml.** Or, order a document from the Industrial Technologies Program Clearinghouse. You can e-mail the Clearinghouse at Clearinghouse@ee.doe.gov, or call 800-862-2086. ●

Performance Optimization Tips: A Symptoms Approach to Identifying Efficiency Improvement Opportunities

By Don Casada, Diagnostic Solutions, LLC, Knoxville, TN

Previous *Energy Matters* articles (1, 2) broached the subject of the need to focus efforts for both reliability and energy purposes on those systems with the greatest potential for improvement or savings opportunities. As an example, the fact that a relatively small percentage of the motor population was responsible for most of the energy consumption in U.S. industry implied the need to focus system–(not component–) level evaluations on large equipment that runs a lot.

But in many industrial facilities, many big pieces of equipment run most of the time. In this article, we'll focus on pumping systems, and use a different approach—the presence of certain symptoms—to further prescreen opportunities for savings.

The goal of prescreening is to identify and prioritize the systems where we're most likely to find significant opportunities for improvement or savings. Although the symptoms we will discuss are specific to pumping systems, analogous conditions exist in other fluid handling systems, such as fan systems.

Pumping systems share a number of common features with people, and readers might find it helpful to consider them in an analogous sense. For example, both people and pumping systems:

- Are composed of a variety of components
- Require external sources of energy and energy conversion devices to keep them going, and
- Have a device that keeps fluid moving, but at a rate and pressure controlled by other components and factors.

It also turns out that symptoms, both in people and in pumping systems, can be helpful indicators of health.

Symptoms in People

While we are encouraged, particularly as we get older, to get periodic checkups of one form or another, we still rely on symptoms to serve as primary indicators of physical and mental health.

In some cases, the symptoms are acute and obvious. I recently conducted an unplanned verification of several laws of physics; in particular, the relationship between potential and kinetic energy.

A 4-inch-diameter poplar limb which I had just cut hit the ground and in a combative demonstration of its resilience, sprung and knocked out from beneath me the unsecured ladder upon which I was perched. Up until this arboreal rebellion, I was about 20 feet off the ground, chainsaw in hand. Recognizing that this situation was in reality a once-in-a-lifetime experimental opportunity (of the variety that often culminates a lifetime), I quickly ensured that a major source of external thermodynamic and kinetic energy (the chainsaw) would not confuse the experimental results (I tossed it off to the side). Even though this was an unplanned test, I was able to quickly develop an experimental hypothesis (that it was going to hurt when I hit the ground). That my hypothesis was accurate was borne out in short order by a sequence of verbal emissions and mechanical gesticulations, which were validated by an independent observer (my wife and erstwhile ladder anchor).

Now, before you call me stupid, just how many physics experiments have you conceived, performed, analyzed, and had independently verified in 1.1 seconds?

On the other hand, some symptoms are chronic in nature. Headaches, sinus congestion, and sore joints are things some of us regularly tolerate, but persistent nagging may ultimately spur a visit to the doctor.

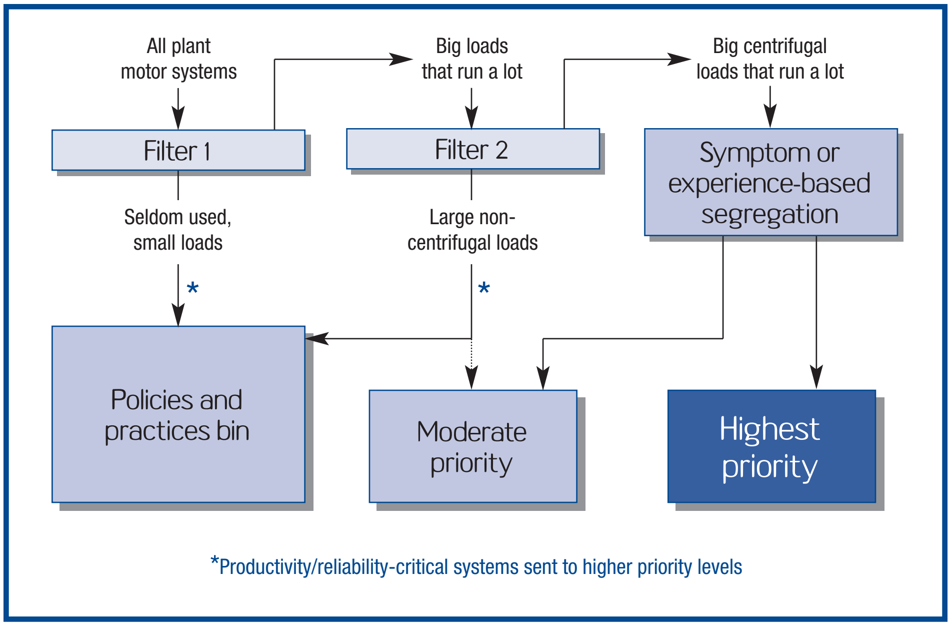
The existence of symptoms isn't proof-positive that we have a serious health problem. Even my experimental fall only resulted in a couple of cracked ribs and a few bruises to body and ego (although my wife did suggest that there was ample evidence of pre-existing brain damage). Likewise, plugged sinuses can be extremely annoying, but we can learn to live with them. But overall, the presence of certain physical symptoms suggest the possibility that something is wrong, and the more symptoms that are present, the greater the likelihood that it is serious.

It might finally be noted that some of our symptoms are quite obvious to ourselves and others, while other symptoms are more subtle and require greater attention to detect. And of course, in some cases, a serious condition can exist even though there are no apparent symptoms.

Symptoms in Pumping Systems

Pumping systems that are ill—in the sense they are wasting energy—often have their own symptoms; as with people, some are acute and obvious, while others more closely fit the chronic category. The patterns or symptoms discussed below have been found useful in the prescreening process. The existence of one of these symptoms doesn't guarantee a significant savings opportunity, just that it is more likely; and the more symptoms that are present, the greater the likelihood.

Throttled valves. Valves that are consistently throttled to control flow rate, pressure, level, temperature, or some other parameter in the system provide direct evidence that fluid energy is being dissipated. Significant losses from throttling are common in process industries such as petrochemicals and paper, although I've observed heavily throttled valves even in raw water pumping applications.



Prescreening helps to select the Vital Few for further review.

Open bypass lines. Open bypass or recirculation lines are sometimes used for control purposes. In a few cases, a combination of concurrent throttling and bypass flow control is found. Needless to say, opportunities to achieve energy reductions in those situations are usually excellent.

Multiple parallel pumps with the same number of pumps always operating. Multiple pumps are used in parallel to provide redundancy and/or to provide flexibility in responding to changing load conditions. If two pumps are installed for redundancy, but both normally operate, there is a strong likelihood that the pumps were not well-sized or that they have degraded. Alternatively, if multiple pumps were installed to provide flexibility in operations, but the same number always run, it is worth asking whether the expected variability in demand really doesn't exist, or if the number of pumps needed for the maximum load condition are continuously run as a matter of course.

Continuous pump operation in a batch environment. Pumps that run continuously when the fundamental nature of the system requirement is of a batch nature may simply be left running even when they aren't needed. One example of this would be a pump that runs 24 hours a day even though the load that requires the pump is only present during one or two shifts.

Frequent cycling of pumps in a continuous process. Some pumps cycle on and off, typically to maintain level or inventory. If pumps in such service cycle frequently so that they only run a relatively small amount (for example 40% of the time), there are likely to be energy and demand cost savings opportunities, not to mention the likelihood of improving pump, motor, and motor starter life.

As pumps depart from their design or best efficiency point, both static and dynamic loads associated with unstable flow conditions increase. Reduced seal, wear ring, or bearing life can be a result. While other factors, such as poor alignment, a generally harsh environment, or mechanical imbalance can also affect these elements, at least an increased likelihood exists that off-design operation is a factor.

Systems that have undergone a change in function or demand. Although this is not a symptom, per se, it is always useful to consider the history behind the system. In cases where system requirements increase with time, pumps are normally upsized to meet the growing demand. On the other hand, if requirements drop, the pump that was presumably properly sized will now be oversized.

The existence of one or more of the symptoms outlined above suggest that a system is more likely to have savings opportunities than one with none of the symptoms. However, systems with none of these symptoms can still be sick. I have run across

(continued on page 11) ▶

Pump System Optimization Saves Energy, Improves Productivity at a Paper Mill

In 2000, Daishowa America implemented a project on the effluent pumping system at its paper mill in Port Angeles, Washington. Chronic maintenance issues and rising energy costs led personnel at the mill to review the pumping system for energy efficiency opportunities. This review allowed mill personnel to devise a system-level project that decreased the pumping system's energy consumption. The project involved installing Adjustable Speed Drives (ASDs) on two of the system's three pumps. The ASDs' replaced the system's control scheme, which previously relied on bypass and throttling valves. This upgrade allowed the system to operate more effectively, yielding annual energy savings of $32,000 and 700,000 kilowatt-hours (kWh).

The project also eliminated problems that led to excessive maintenance costs, resulting in an annual $10,000 maintenance savings. The total project cost was $75,000. Total annual savings were $42,000, which yields a simple payback of just over 21 months.

Having the proper control scheme in place is critical for a pumping system to operate efficiently. Relying on bypass and throttling valves to control a pumping system can lead to energy waste and excessive maintenance requirements. At the Port Angeles mill, using bypass and throttling valves caused mill personnel to operate the pumps at a greater capacity than was necessary, and in ways that placed great stress on the process piping and internal system components. Operating the pumps this way led to energy waste by moving 2,200 gallons per minute in excess of the process's requirements.

The project on the Port Angeles mill's effluent pumping system reduced the system's flow rate by 31% and allowed one pump to operate at variable load, reducing energy consumption.

Take a look at what others in your industry have done to increase their energy savings by reading their case studies. You can view these documents at **http://www.oit.doe.gov/bestpractices/case_studies.shtml.** Or, order a document from the Industrial Technologies Program Clearinghouse. You can e-mail the Clearinghouse at Clearinghouse@ee.doe.gov, or call 800-862-2086.●

Caraustar Industries Energy Assessment Provides a Company-Wide Model

In 2000, Caraustar in partnership with DOE conducted 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 were estimated at $1.2 million and $370,000 at the Rittman and Chesapeake mills, respectively.

Table 1 lists the systems and processed 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 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

Caraustar is a major manufacturer of recycled paperboard and converted paperboard products. Caraustar operates over 100 facilities in the United States along with plants in Mexico and the United Kingdom. Caraustar manufactures its products primarily from recovered fiber derived from recycled paperstock. At its 16 paperboard mills, Caraustar produces various grades of uncoated and clay-coated recycled paperboard both for internal consumption and for sale to customers in four principal markets. In addition to the mills, Caraustar's facilities include tube and core converting plants, composite container plants, folding carton plants, and speciality converting plants.

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

(continues) ▶

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 turbine-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

Energy accounts for 15% to 25% of each mill's total operating expenses, and is third 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 to convert capacity by acquiring and maintaining state-of-the-art machinery and technology.

Assessment Overview

Caraustar has historically monitored the cost per 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.

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) Industrial Technologies Program. 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.

Assessment Implementation

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

The areas investigated included:

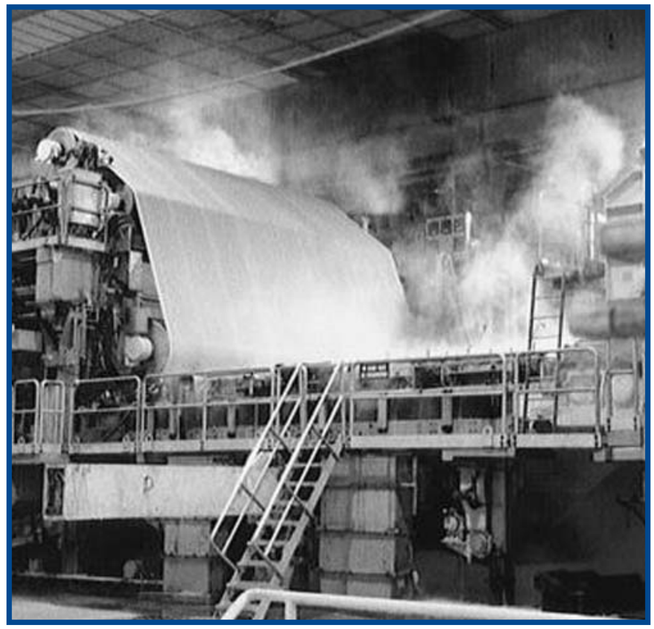
- Steam systems
- Cogeneration assessment
- Waste heat recovery
- Motor analysis
- Compressed air systems
- Lighting systems
- Electric variable speed drive analysis.

Seven specific systems and processes were evaluated in detail for efficiency improvement or cost reductions for the Chesapeake mill.

(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.)

The systems and processes evaluated at the Chesapeake mill included:

- Backpressure steam turbine generator
- Boiler feed pump variable speed electric drive
- Boiler feed pump steam turbine 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.



Paperboard production may be significantly improved with energy saving measures initiated through a detailed evaluation process.

Six systems and 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.

Actions Identified in the Assessment

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 energy 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.

(continued on page 11) ▶

New Reference Manual Available for Compressed Air Systems

The Compressed Air Challenge® (CAC), an Industrial Technologies Program Allied Partner, has published a new manual, *Best Practices Manual for Compressed Air Systems*. The 350-page manual provides "how to" information and reference data, and will help you implement recommendations that will achieve peak performance and reliability from your compressed air system at the lowest operating cost.

The CAC is an educational organization that promotes the efficient generation and use of compressed air. It is a not-for-profit voluntary collaboration of industrial users; manufacturers, distributors and their associations; facility operation personnel and their associations; energy efficiency organizations; and utilities. The CAC has been an Allied Partner since August 2002.

As an Allied Partner, the CAC's activities include working with DOE and other sponsors to promote Compressed Air Challenge training workshops; supporting AIRMaster+ software enhancements; developing operator-level training and certification; and encouraging participants and sponsors to identify case study candidates.

The CAC's newly published best-practices manual, which includes more than 150 pages of original text and 200 pages of reference data appendices, will help you:

- Reduce your company's energy and repair costs
- Improve system reliability
- Increase productivity
- Reduce unscheduled downtime.

In addition, the manual will help you know what is essential when analyzing existing systems, or designing new ones. You will learn what is important in the compressor room, the auxiliary equipment, and distribution system to satisfy the variety of end uses in any manufacturing plant. And the manual provides guidance in determining how to compile and use measurements to audit your own system, calculate the cost of compressed air, and even how to interpret electric utility bills.

The manual also offers easy-to-find best practice recommendations for selecting, installing, maintaining and operating all the equipment and components within your entire compressed air system.

To find out more about reserving a copy, visit the Compressed Air Challenge website at www.compressedairchallenge.org, or call Patricia Vazquez at 301-888-2358. To learn more about the Allied Partner program, contact the OIT Clearinghouse at 800-862-2086 or via e-mail, Clearinghouse@ee.doe.gov.●

Energy Matters EXTRA

In the Spring issue of Energy Matters Extra we offer additional information on how energy assessments can reveal cost- and energy-saving opportunities. From the Energy Matters Extra Web page you can access our Plant-Wide Assessment Case Study page. There you'll find how various companies have assessed their industrial plants and how they have saved money, improved production and efficiency, and reduced environmental impact. Frequently, projects can be replicated across many industries. Find out which projects could help your company

We've also included extra information and links to the Process Heating Assessment and Survey Tool (PHAST), the BestPractices Steam Resources CD, the Steel Industry of the Future CD, Compressed Air system improvement training, and the new *Fan Sourcebook*. Log on to Energy Matters Extra at **http://www.oit.doe.gov/bestpractices/energymatters/emextra/**●

Steel Industry of the Future CD Now Available

U.S. steel manufacturers seeking to gain a competitive edge now have a new resource to help them become more energy and process efficient. Steel Industry of the Future: Resources and Tools for Energy Efficiency and Cost Reduction Now, a new CD published by DOE, provides a wealth of information and tools on technical R&D and best energy management practices.

This new CD contains details on innovative energy efficiency technologies, energy analysis software tools, hands-on tips, plant energy assessment information, training opportunities, financial assistance, and much more. In addition, helpful links to Internet sites provide expanded access to even more resources.

The information, resources, and tools on the CD are organized and presented to help steel manufacturers and plant personnel make decisions to cut costs and emissions, increase productivity, and form competitive partnerships.

Plant personnel serve different roles in running plant operations and production. To help meet the varying needs of plant staff, the CD content is organized to address the specific needs of a variety of audiences. Whether you are a CEO, CFO, Plant Manager, Technical Officer, R&D Manager, Operations and Engineering staff, or Service Provider, the Steel CD offers content tailored to answer your needs.

The CD also offers a quick-access quiz. Plant personnel taking the quiz can keep track of their answers and rate their plant against industry best practices. After each answer, the user obtains a response with specific ideas for plant improvements, as well as which BestPractices resources will be most helpful.

To order your copy of Steel Industry of the Future: Resources and Tools for Energy Efficiency and Cost Reduction Now, contact the DOE's Industrial Technologies Clearinghouse at 800-862-2086 or via e-mail, Clearinghouse@ee.doe.gov.●

Compressed Air System Project Improves Efficiency and Production at Harland Publishing Facility

In 1999, a project was implemented on a compressed air application at the testing facility of the John H. Harland Corporation printing plant in Atlanta, Georgia. Inspired by a review conducted by DOE Allied Partner, Air System Management, the project reconfigured a new type of printing machine to consume less compressed air and require lower pressure to operate effectively.

The project's implementation allowed the site to significantly reduce the amount of compressed air the new printing machines required, and to discontinue use of the machines' onboard compressors. The project was replicated throughout the company the following year. The total cost of the project was $300,000 and its success allowed Harland to avoid buying additional compressors at a cost of over $500,000. By not buying additional compressors, Harland avoided spending $200,000 annually on energy and maintenance and avoided consuming 2.9 million kilowatt-hours (kWh) of electricity. In addition, the project's implementation improved the new printing machine's performance, resulting in better product quality and reduced production cycle time.

Configuring end-use applications so that they use the minimum amount of compressed air at the lowest necessary pressure is an effective way to control compressed air energy costs. In the case of Harland's check printing facility, a new printing machine's initial configuration more than doubled the entire site's compressed air demand. After a review, Harland personnel realized that redesigning the new machines to consume less air at lower pressures would be more cost-effective than increasing compressor capacity company-wide.

Printing machine redesign and measures to reduce end-use requirements allowed Harland Publishing to achieve greater efficiency through reduced compressed air demand.

Adding compressor capacity should be done when truly necessary. In Harland's case, assumptions regarding the minimum pressure level and volume needed for an application could have doubled compressor capacity throughout the company. Instead, the review indicated that the printing machine could operate satisfactorily with the company's existing compressed air capacity if it was redesigned. Optimal configuration of compressed air end-use equipment saves energy and improves productivity.

The BestPractices team supports plant assessments and demonstration projects. Take a look at what others in your industry have done to increase their energy savings by reading their case studies. You can view these documents at **http://www.oit.doe.gov/bestpractices/case_studies.shtml.** Or, order a document from the Industrial Technologies Program Clearinghouse. You can e-mail the Clearinghouse at Clearinghouse@ee.doe.gov, or call 800-862-2086.●

Chemical and Refining Industries a Focus of Texas Technology Showcase

More than 470 energy professionals, government officials and researchers from across the country convened in Houston in March for the 2003 Texas Technology Showcase. The three-day event provided an opportunity to see energy-efficient process technologies and best energy management practices that are now emerging in the chemical and refining industries.

The U.S. Department of Energy and the Texas Industries of the Future sponsored the event, and showcased 7 chemical producers and refiners in the Houston area. Some companies presented energy reduction technologies via educational sessions while others hosted tours of their Houston-area facilities. Showcase companies profiled during the event included: Calpine, Chevron Phillips Chemical Company, Dow Chemical, ExxonMobil, Merisol, Rohm and Haas Texas Inc., and Valero Energy Corporation.

There was also a powerful roster of speakers at the event. Jim Gallogly, president and CEO, Chevron Phillips Chemical Company LP, was the keynote speaker. In his presentation, "From Smokestacks to Emerald Cities," Gallogly focused on telling the chemical industry's story better and on the importance of having a better story to tell.

Other speakers included David Garman, assistant secretary, Energy Efficiency and Renewable Energy, U.S. Department of Energy; Chairman Robert J. Huston, Texas Commission on Environmental Quality, and Commissioner Victor Carrillo, Texas Railroad Commission. Garman, Huston, and Carrillo discussed legislative and related issues, detailing national and Texas developments.

Other highlights from the 2003 Texas Technology Showcase included:

- It provided a forum for industry, political and governmental leaders to work together, showcase industry best practices, new technologies, and partnerships that will change the way the chemical and refining industries tackle emissions reduction and improve efficiency
- Government, industry and researchers had the chance to tour Houston-area petrochemical facilities and see first-hand how the Showcase companies are working to improve energy efficiency and address environmental concerns
- It facilitated communication between petrochemical companies to discuss

(continued on page 11) ▶

Steam Assesment Gauges Energy Savings *continued from page 3*

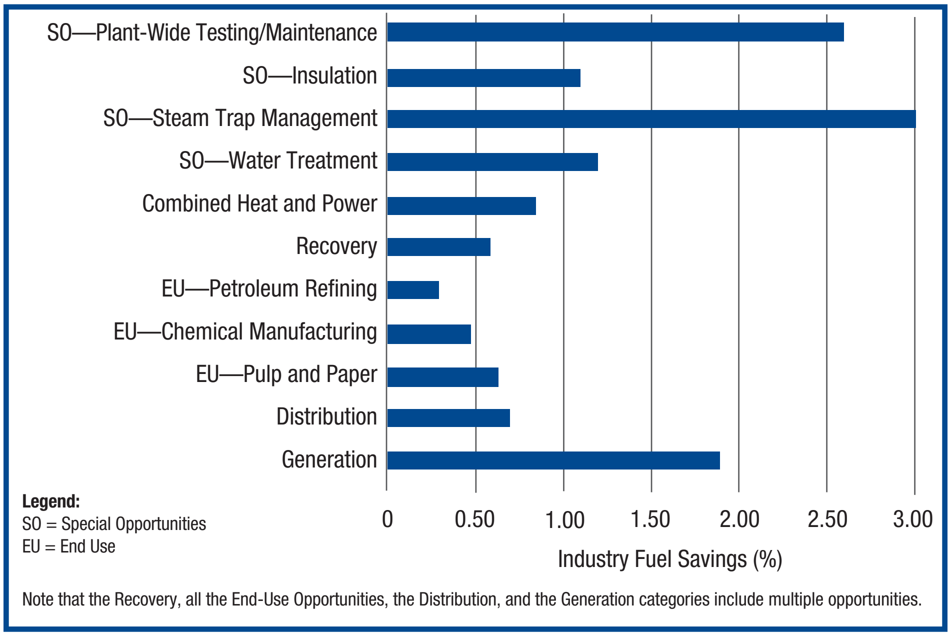


Figure 4. Total industry fuel savings for each part of the steam system.

30 steam system improvement opportunities is 674 trillion Btu.

This data illustrates two key results.

- Individual fuel saving opportunities can be significant, especially because facilities can often implement several steam system improvements. Because most payback periods are less than 2 years, these improvements are generally worth considering.
- Total potential energy savings associated with steam improvements are significant, amounting to over 12% for each target industry.

The BestPractices Steam program has developed a number of software tools and resources that can be used to identify the types of steam improvement opportunities illustrated in the Steam Assessment. These tools include:

- The Steam System Scoping Tool (SSST), a simple self-assessment tool that can be used to assess the major steam system best practice areas
- The Steam System Survey Guide, a technical reference document that provides details on how to calculate the magnitude of potential steam savings for key improvement areas
- The new Steam System Assessment Tool (SSAT), a spreadsheet-based steam system opportunity assessment tool that can be used to demonstrate the magnitude—energy, cost, and emission savings—for major steam system improvment opportunities
- The 3E-Plus Insulation Appraisal software, that can be used to determine energy, cost, and emissions savings associated with improving insulation on steam piping systems.

The BestPractices Steam program also offers a 1-day Steam System Training course on a regional basis, and will be developing a Steam Tool Certification Training program in the near future.

To download a complete copy of the Steam Assessment, visit **http://www.oit.doe.gov/cfm/fullarticle.cfm/id=691.**●

TABLE 1. TOTAL POTENTIAL STEAM SYSTEM ENERGY SAVINGS BY INDUSTRY

Industry	Industry Fuel Savings (%)	Fuel Used to Generate Steam (Trillion Btu)	Savings Potential (Trillion Btu)
Pulp and Paper	12.5	2,221	278
Chemical Manufacturing	12.4	1,540	191
Petroleum Refining	12.2	1,675	205
Total			**674**

Updates Energize Decision Tools for Industry CD

A newly updated version of the Decision Tools for Industry CD is now available, featuring an even more robust portfolio of assessment tools. The CD includes updates to the highly useful MotorMaster+ software (version 4.0) and AirMaster+ software programs (version 1.0.9), and two new tools: the Steam System Assessment Tool (SSAT) and the Process Heating Assessment and Survey Tool (PHAST).

The SSAT software can be applied to your steam system to demonstrate the energy, cost, and emissions savings of key potential improvement opportunities. The SSAT is a reliable screening tool that contains the key features of typical steam systems, including boilers, steam turbines, condensate systems, and deaerators.

SSAT offers a graphical model of a generic steam system for up to 3 steam pressure headers (high, medium, and low). You can enter data for your own plant conditions, including fuel type and cost, electricity, water costs, initial boiler efficiency, header pressures, and turbine efficiencies. The tool allows you to evaluate "what if?" scenarios for a wide range of key improvement opportunities.

PHAST provides an introduction to process heating methods and tools to improve thermal efficiency of heating equipment. Use the tool to survey process heating equipment that uses fuel, steam, or electricity, and identify the most energy-intensive equipment. You can also perform an energy (heat) balance on selected equipment (furnaces) to identify and reduce non-productive energy use. Compare performance of the furnace under various operating conditions and test "what-if" scenarios.

Also updated on the same CD is the Steam System Scoping Tool (version 1.0d) to include Visual Basic as well as Excel user options.

The software suite offered on the Decision Tools for Industry CD also includes 3E Plus, designed to help determine whether boiler systems can be optimized by insulating boiler steam lines. The software allows you to calculate the most economical thickness of industrial insulation for a variety of operating conditions.

To obtain your copy of the Decision Tools for Industry CD, contact the DOE's Industrial Technologies Clearinghouse at 800-862-2086 or clearinghouse@ee.doe.gov.●

A Symptoms Approach
continued from page 5

systems with savings potential of 40% or more even when none of these symptoms was present.

But since all of us have a finite amount of time, and hopefully our time is worth something to someone, it is incumbent upon us to use it wisely. I've personally found the symptom-based prescreening to be very helpful, and hope you might find it beneficial as well.

Diagnosis and Prescription

When the symptoms of health problems or energy opportunities appear to warrant it, measurements and analyses are often performed to establish the magnitude of the problem. If the magnitude is significant enough, the evaluation of possible treatments may be pursued.

But it is important to recognize that there is no panacea in either the human or the energy system domains. The best treatment for an ailment in humans may depend on multiple factors such as age, other health problems, and our ability to pay the costs. Likewise, external factors such as the electric rate structure, implementation costs of alternatives, current and anticipated company financial health must be considered.

So how do we quantify the potential savings opportunities in systems that appear to be worth exploring? And even more fundamentally, what do we do with all the systems that don't fit our prescreening criteria—either because they're small, don't operate a lot, or don't exhibit any of these symptoms?

We'll try to address those questions in future articles.

References

1. RCM—Gateway to a World Class Maintenance Program, Anthony M. (Mac) Smith, *Energy Matters*, January/February, 2000.

2. Performance Optimization Tips—The Vital Few, Don Casada, *Energy Matters*, September/October, 2000.

Caraustar
continued from page 7

For plant-wide assessment program information, contact Grace Ordaz of the Department of Energy's Industrial Technologies Program by phone at 202-586-8350 or by e-mail at grace.ordaz@ee.doe.gov. For technical details about the assessments, visit **www.oit.doe.gov/bestpractices/factsheets/amcast.pdf**, or contact Bob Leach of the Oak Ridge National Laboratory by phone at 865-946-1352 or by e-mail at leachre@ornl.gov.

BestPractices Steam Resources CD Available

The BestPractices Steam Resources CD offers steam-savvy users all the latest BestPractices steam information on one pocket-sized CD.

If it has to do with steam, it's on this new CD: market assessments and tip sheets, standalone software tools, information on BestPractices services, even contacts and ideas for networking and training.

If you are looking for ways to increase your plant's productivity, reduce energy costs, and decrease emissions through steam efficiency, this CD is a good source to get you started.

To order your copy of the BestPractices Steam Resources CD, contact DOE's Industrial Technologies Clearinghouse at 800-862-2086 or clearinghouse@ee.doe.gov.

Texas Showcase
continued from page 9

strategies for joint projects and partnerships that would help reduce emissions, waste, and costs while improving energy efficiency.

Sponsors of the 2003 Texas Technology Showcase who promoted the event to their membership, mailing lists, customers, and others included: American Institute of Chemical Engineers; American Petroleum Institute; Center for Energy and Environmental Resources at the University of Texas; Council of Industrial Boiler Owners; East Harris County Manufacturers Association; Greater Houston Partnership; National Petrochemical & Refiners Association; South Texas Section of the American Institute of Chemical Engineers; State Energy Conservation Office of the Texas Comptroller of Public Accounts; Texas A&M University Industrial Assessment Center; Texas Chemical Council; Texas Commission on Environmental Quality; and the Texas Council on Environmental Technology.

More information on the Texas Technology Showcase is available at **www.showcasetexas.org**

About the Office of Energy Efficiency and Renewable Energy

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. By investing in technology breakthroughs today, our nation can look forward to a more resilient economy and secure future.

Far-reaching technology changes will be essential to America's energy future. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a portfolio of energy technologies that will:

- Conserve energy in the residential, commercial, industrial, government, and transportation sectors
- Increase and diversify energy supply, with a focus on renewable domestic sources
- Upgrade our national energy infrastructure
- Facilitate the emergence of hydrogen technologies as a vital new "energy carrier."

The Opportunities

Biomass Program
Using domestic, plant-derived resources to meet our fuel, power, and chemical needs

Building Technologies Program
Homes, schools, and businesses that use less energy, cost less to operate, and ultimately, generate as much power as they use

Distributed Energy & Electric Reliability Program
A more reliable energy infrastructure and reduced need for new power plants

Federal Energy Management Program
Leading by example, saving energy and taxpayer dollars in federal facilities

FreedomCAR & Vehicle Technologies Program
Less dependence on foreign oil, and eventual transition to an emissions-free, petroleum-free vehicle

Geothermal Technologies Program
Tapping the earth's energy to meet our heat and power needs

Hydrogen, Fuel Cells & Infrastructure Technologies Program
Paving the way toward a hydrogen economy and net-zero carbon energy future

Industrial Technologies Program
Boosting the productivity and competitiveness of U.S. industry through improvements in energy and environmental performance

Solar Energy Technology Program
Utilizing the sun's natural energy to generate electricity and provide water and space heating

Weatherization & Intergovernmental Program
Accelerating the use of today's best energy-efficient and renewable technologies in homes, communities, and businesses

Wind & Hydropower Technologies Program
Harnessing America's abundant natural resources for clean power generation

To learn more, visit ***www.eere.energy.gov***

Coming Events

Fundamentals of Compressed Air Workshop, Denver, CO

- Aug 19, 2003

For more information, contact Roy Tiley, (410) 997-7778

Nevada Energy Fair , Elko, NV

- Aug 25 - Aug 29, 2003

For more information, contact Michael Canty, Mining Team Lead, (202) 586-8119

North American Die Casting Association (NADCA)

- Sep 15 - Sep 18, 2003

For more information, contact Harvey Wong, Metal Casting Team Lead, (202) 586-9235

Motor Systems Management End User Training, Charleston, WV

- Sep 24, 2003

For more information, contact Roy Tiley, (410) 997-7778

Pump, Steam and Compressed Air Training, Houston, TX

- Oct 27 - Oct 29, 2003

For more information, contact David Salem, Chemical and Petroleum Team, (202) 586-8710

BestPractices

The Industrial Technologies Program's BestPractices initiative and its *Energy Matters* newsletter introduce industrial end users to emerging technologies and well-proven, cost-saving opportunities in motor, steam, compressed air, and other plant-wide systems.

INFORMATION CLEARINGHOUSE

Do you have questions about using energy-efficient process and utility systems in your industrial facility? Call the Industrial Technologies Program's Information Clearinghouse for answers, Monday through Friday 9:00 a.m. to 8:00 p.m. (EST).

HOTLINE: 800-862-2086

Fax: 360-586-8303, or access our homepage at www.oit.doe.gov/clearinghouse.

DOE Regional Office Representatives

- David Godfrey, Atlanta, GA, 404-562-0568
- Scott Hutchins, Boston, MA, 617-565-9765
- Brian Olsen, Chicago, IL, 312-886-8479
- Jack Jenkins, Denver, CO, 303-275-4824
- Chris Cockrill, Seattle, WA, 816-873-3299
- Joseph Barrett, Philadelphia, PA, 215-656-6957

This document was produced for the Office of Energy Efficiency and Renewable Energy at the U.S. Department of Energy (DOE) by the National Renewable Energy Laboratory, a DOE national laboratory.
DOE/GO-102003-1720 • Spring 2003

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 20% postconsumer waste

Energy Matters
National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, CO 80401-3393