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Practical Strategies to Reduce Pulp and Paper Mill Energy Use

Energy expert Dick Reese outlines the energy audit process and shares strategies identified by mills that have reached their energy reduction goals.

RICHARD REESE



It is difficult to plan more than a couple of years out when it comes to energy sources. This leaves frustrated mill managers with one solution: use as little energy as possible. Using less energy eliminates other problems such as qualifying for rebates, discounts, or tax breaks. It's a never-ending exercise—one can go through a mill thoroughly one year and come back two years later and find significant savings again.¹

All pulp and paper mills offer energy reduction opportunities, but company and mill culture are critical to developing an effective

energy reduction program. The best corporate energy programs have excellent management support (including the mill manager), include special capital funds for energy reduction projects, and require solid interdepartmental coordination. Energy auditors can benchmark energy performance and identify energy reduction opportunities, but mill personnel must buy in and make recommended changes.

Several paper mills in Wisconsin have achieved significant energy use reductions with technical assistance and financial incentives from Focus on Energy and the

US Department of Energy. Some paper mills would have shut down without implementing recommended energy reduction projects. Table 1 shows a few common discoveries during paper machine energy evaluations. Many of the energy reduction opportunities identified are “low hanging fruit” that can be implemented without capital expenditures.

Taking measurements with portable instrumentation during energy evaluations is important. Use of a portable flow meter during a recent evaluation identified several energy reduction opportunities that operating

TABLE 1: COMMON DISCOVERIES IN PAPER MACHINE ENERGY EVALUATIONS

- Steam and condensate system design and operation: syphon application, differential pressures, condenser operation, steam venting, condensate leaks, steam traps, etc.
- Low condensate return
- High pocket ventilation system supply air temperatures
- Poor hood balances
- Refining improvement opportunities: plate designs, splined rotors, etc.
- Chest and pulper agitation—applications of energy-efficient rotors and propellers, VFD, etc.
- Vacuum system issues: seal water application, pump condition, etc.
- Press dewatering improvement opportunities: loading, fabric design, conditioning, rewet, etc.
- High fresh water use per ton—use of clarified whitewater in showers, water system balances, heat recovery from effluent, recirculation of some treated effluent, etc.
- Less than optimum prioritization of recovered water streams
- Sheet runnability issues
- Variable frequency drive opportunities
- Inefficient pumps—oversized, poor condition, excessive seal water use, etc.
- Compressed air system improvements: system pressures, air leaks, VFD, etc.
- Lighting upgrade opportunities

personnel were not aware of. An example is monitoring cooling water flow and temperatures around paper machine dryer condensers. Steam flow to condensers is often much higher than best practice.

ENERGY EVALUATION CASE HISTORY

In April 2015, a Wisconsin mill with specialty paper machines completed an energy evaluation. The energy evaluation process included:

1. A kickoff meeting to review preliminary information and develop a schedule for the mill visit. The team agreed on a goal of identifying energy reduction projects that would provide more than US\$500,000 in annual energy savings.
2. Completion of paper machine energy scorecards to benchmark energy performance and identify energy reduction opportunities. These scorecards are Excel worksheets with questions related to energy performance, equipment, and operating procedures that affect energy use. Overall energy scorecard scores were 44 percent for one PM and 41 percent for another. The lowest scores were for energy monitoring, the grade scorecard, compressed air, and water systems. (The average score for PMs producing all grades is 50 percent.)
3. Review of previous studies of refining, clothing supplier reports, and compressed air system.

4. Machine walk-arounds and process measurements with portable instrumentation.
5. Working lunches with mill personnel to better understand operating procedures, discuss potential energy reduction projects, and develop a prioritized action list. The action list included 34 projects, including 10 “Priority 1” projects that could be easily implemented; 11 projects that required more time and investigation; and 13 projects that would require more investigation and capital funds.
6. An exit meeting to discuss energy benchmarks and recommended energy reduction projects.
7. A report summarizing the energy evaluation.

Mill management assigned an energy project coordinator to lead evaluation and implementation of the recommended energy reduction projects. Mill personnel reviewed all of the actions identified in the energy evaluation and implemented most of them.

The actions included four areas that needed more detailed evaluations (a mill water system study, steam and condensate system evaluation, paper machine room air balance, and a vacuum system study.) All four of these studies identified significant energy reduction opportunities that mill personnel decided to implement. Focus on Energy (see related article on page 16) provided incentives to pay one half the costs of all four studies.

Some of the major projects implemented after the energy evaluation included:

- Installed equipment to permit use of filtered whitewater on wet end showers on both paper machines.
- Installed energy-efficient pulper rotors in several stock preparation system pulpers.
- Installed high efficiency side-entry agitators in stock chests.
- Modified the mill compressed air system and lowered system pressure.
- Installed managed differential pressure control on the dryer steam and condensate systems.

In early 2018, the mill conducted a follow-up energy evaluation. Annual energy savings realized since the 2015 audit exceeded the goal of US\$500,000. The mill has received more than US\$650,000 in Focus on Energy incentive payments since 2013. Energy scorecard scores increased from 44 to 53 percent on one machine, and from 41 to 52 percent on another machine. The biggest improvements were on the compressed air scorecard, agitators and pumps, press sections, and energy monitoring.

The mill recently enrolled in the Focus on Energy Strategic Energy Monitoring program, which will include development of a mill energy model and improvement in energy measurements. The team developed a new energy action list of 36 items during the follow-up energy evaluation. The new

actions had few easy-to-implement changes and include some major capital projects. The proactive stance to reduce energy use taken by mill personnel has made the mill more energy efficient and competitive.

DEPARTMENTAL INTERACTIONS

Effective interactions between the paper mill and other mill areas are important to optimize overall mill energy performance.

For example, pulp mills usually have excess heat; transfer of heat to the PMs permits reducing steam use to heat whitewater in the paper mill. Interactions with the boiler plant are also important since condensate return from the paper machines and other interactions are important in optimizing steam generation cost. A boiler scorecard was added to paper machine energy scorecards in 2016 (See Step 2 of the process on page 13.)

Table 2 shows common discoveries in pulp mill and bleach plant energy evaluations; Table 3 shows common opportunities found in boiler audits; and Tables 4A and B list opportunities found in power generation audits.

Catherine DeVyre, an Australian business consultant, has stated, “The six most expensive words in business are ‘We’ve always done it that way.’” This adage certainly applies in pulp and paper mills.

TABLE 2: COMMON DISCOVERIES IN PULP MILL AND BLEACH PLANT ENERGY EVALUATIONS

- Inefficient use of high temperature waste heat sources
- Excessive use of hot water resulting in low hot water temperature and high steam use
- Very high bleach plant steam use (hot water heating and steam mixers)
- Waste heat recovery not in series to maximize volume and temperature of hot water generation (too much water and insufficient hot water)
- Evaporator surface condenser cooling water not used efficiently (low temperature and excessive volume)
- Oversized and fouled heat exchangers and condensers resulting in low U-values (poor heat transfer)
- Inefficient batch digester blow heat recovery (tuning, VFD, heat rejection rate, etc.)
- Brown and bleached washer shower flow rates not based on dilution factor control
- Inefficient use of hot water, filtrates, and whitewater on bleach plant washer showers and repulper dilution
- Excessive wire cleaning and water doctor shower water on brown stock and bleach plant washers
- Inefficient wintertime waste heat recovery
- Waste heat recovery not optimized to provide hot water to paper mill
- Poor steam stripping column performance requiring high total and effective steam ratio; ineffective use of reflux condenser heat recovery and stripped condensate reuse
- Low temperature heat sources going to mid-temperature (135 to 150°F) and hot water tanks

TABLE 3: COMMON OPPORTUNITIES FOUND IN BOILER AUDITS

- Recover heat to boiler makeup water
- Recover heat to boiler feedwater
- Recover heat to boiler combustion air
- DA tank or condensate tank vent condenser
- Minimize steam venting
- Optimize boiler blowdown rate
- Recover boiler blowdown heat
- Modify plant processes to reduce steam swings
- VFD on boiler fans and pumps
- Condensing economizer
- Boiler O₂ reduction
- Steam and condensate line insulation
- Failed steam traps

TABLE 4a: COMMON POWER GENERATION OPPORTUNITIES

- Repair leaky PRV
- Steam feedwater heater
- Maximize use of low pressure steam
- Steam coil air heater
- Thermocompressor
- Reduce turbine shaft leak-off steam
- Turbine modifications for higher efficiency and/or output

TABLE 4b: COMMON INTERNAL POWER GENERATION OPPORTUNITIES

Maximize generator steam flow:

- Repair leaky pressure reducing valve
- Reduce turbine shaft leak-off steam
- Turbine modifications for higher efficiency and/or output

Minimize extraction versus exhaust to maximize efficiency:

- Steam coil air heater: Use exhaust steam instead of extraction steam
- Thermocompressor: Reduce motive extraction steam
- Steam feedwater heater: Maximize exhaust steam pressure utilization
- Maximize use of low pressure steam

There are many myths related to energy use in pulp and paper mills that are sustained year after year. Many of these misunderstandings actually make it easier to find energy reduction opportunities in pulp and paper mills. (Reference 5 has a long list of pulp and paper mill energy myths.)

NEW TECHNOLOGIES

The Focus on Energy pulp and paper team continuously tracks new technologies that have potential to reduce energy use in pulp and paper mills. New technologies are considered emerging technologies if they have not been installed on more than 10 percent of potential applications in Wisconsin and have potential application to reduce energy consumption in several pulp and paper mills.

Some of the new technologies that have been successfully implemented in Wisconsin pulp and paper mills since 2014 are:

- Disk refiner upgrades with splined rotors
- Energy-efficient pulper rotors and extraction plates
- Kadant high efficiency thermocompressors
- Voith HydroSeal suction roll seal systems
- Kadant RotoFlex whitewater strainers
- Mechanical seals on rotating equipment with tanks to circulate seal water
- Compressed air systems with VFD and regenerative dryers

The goal is to evaluate these technologies and install successful technologies in other pulp and paper mills so they become energy best practices. Special incentives are offered to encourage installation of new technologies.

North Carolina State University developed and maintains a website that tracks energy policies and incentive programs in the United States: www.dsireusa.org. Energy programs and incentives can be accessed by entering the zip code of pulp and paper mill sites. While the Focus on Energy program only provides incentives for Wisconsin participating utility customers, the pulp and paper team is available for energy evaluations in other states.

CONCLUSION

There are opportunities to reduce energy use in all pulp and paper mills. Energy use varies widely between mills producing similar grades. The guidelines and suggestions

in this article can help mills benchmark energy consumption and identify improvement opportunities.

Mill operating personnel often do not fully understand process interactions and their impact on energy consumption. Focused energy evaluations can identify operating changes and capital projects with fast payback to reduce energy use. **361**

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Accessing Innovation: Partnering for Energy Projects

Cooperative funding strategies can make it possible for mill leaders to identify and support energy reduction opportunities and bring energy innovation into mills.

JAN BOTTIGLIERI

Saving energy means saving money. The problem: saving energy costs money, too.

As a very energy-intensive industry, pulp and paper manufacturers may find it particularly challenging to identify and fund energy reduction projects. Fortunately, local, state, and federal governments also reap the economic benefits of energy reduction—and many states have funding programs that incentivize projects at both the home and industry level.

FOCUS ON ENERGY

One such program is Focus on Energy, Wisconsin utilities' statewide energy efficiency and renewable resource program, which is funded by the state's investor-owned energy utilities and participating municipal and electric cooperative utilities. Focus on Energy works with eligible Wisconsin residents and businesses to install cost-effective energy efficiency and renewable energy projects. Wisconsin is the top state for forest products production, so Focus on Energy has plenty of experience funding projects in pulp and paper manufacturing facilities.

"Given the capital intensive nature of our mills, much of our capital spending is allocated to simply maintaining our facilities," says Steve Brooks, director, corporate energy for Verso, which has mills in Stevens Point and Wisconsin Rapids. "Focus on Energy provided the needed mechanisms to finance energy projects that not only provide environmental benefits through reductions in fuel and energy consumption, but importantly, help improve financial performance."

For states, the benefits of such a program are many. Capital expenditure in manufacturing creates jobs, supports local economies, and offers environmental benefits by focusing on cleaner energy and lower emissions.

In Wisconsin, the Focus on Energy program reduces the need to purchase coal and natural gas from other states, and lessens the need for additional power infrastructure. The energy and dollars saved through Focus on Energy have delivered more than US\$1 billion worth

of net economic benefits to Wisconsin since 2011, according to the program. Energy savings from completed projects, coupled with positive impacts across the state's economy, produced a US\$4.07 return for every dollar invested during 2015 and 2016.

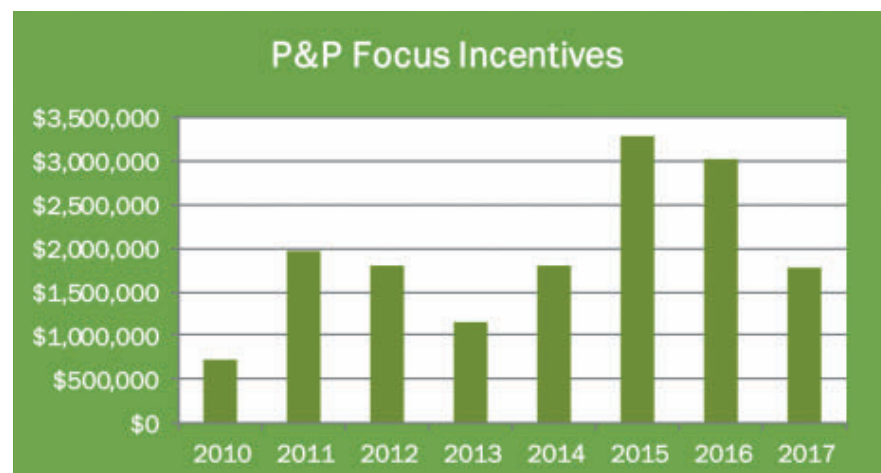


Fig. 1: Since 2010, Focus on Energy has provided incentives valued at about US\$16 million to the pulp and paper industry.

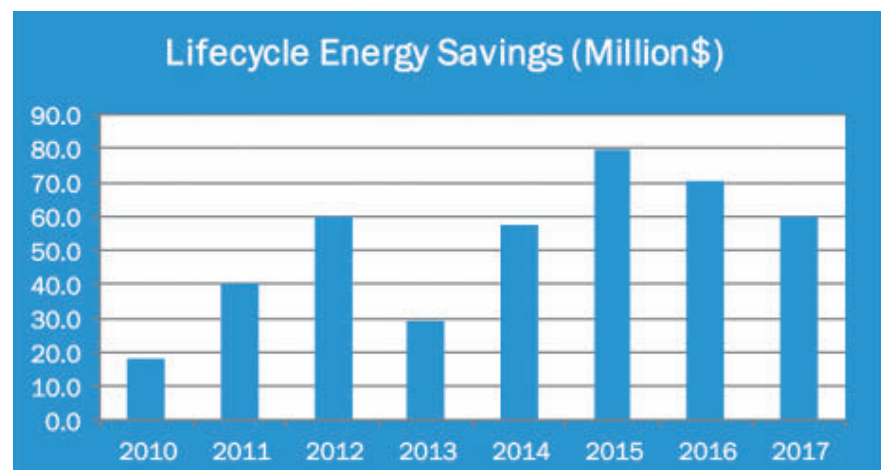


Fig. 2: Lifecycle energy savings for Focus on Energy-supported projects in the pulp and paper sector, 2010-2017.

Yet companies that want to take advantage of programs like Focus on Energy still may need assistance with identifying energy projects and in finding initial funding. CleanTech Partners, headquartered in Middleton, WI, is the implementer for Focus on Energy's Emerging Technologies program, and a sub-contractor to Leidos, an implementer for Focus on Energy's Large Energy Users Program. According to Masood Akhtar, president and founder of CleanTech Partners, the key was recognizing that a "one-size-fits-all" strategy doesn't work. "The pulp, paper, and packaging industry isn't just energy-intensive—it's also resource limited," he says. "Another challenge is that often, mills don't have the staff and/or required innovation-focused subject matter experts on hand. And frequently, no matter what potential benefits are finally identified, mills just don't have the capital available to throw into big energy projects."

To meet these challenges, Focus on Energy's Energy Advisors work with mills to "fill in the gaps" of expertise and funding. "We use various tools, such as technical assistance, subject matter expertise, grants, interest-free loans, and Strategic Energy Management," Akhtar says. "When appropriate, we form Corporate Energy Committees, which include representatives from industry and Focus on Energy, and meet quarterly or semi-annually to discuss the mill's short- and long-term needs."

The specialized knowledge that partners bring can be a huge benefit for mills. "You can have an internally-developed energy reduction program, but at some point you need some outside perspective," says Jack Williamson, general manager, Green Bay Packaging. "The Focus on Energy team can do that. They don't just come in, recommend one project, and you never see them again. If you use the program as it's intended, those folks become contacts

and resources. They're the outside support to keep you driving."

COOPERATION WORKS

According to John Nicol, program director, Energy Efficiency Services at Leidos, Inc., the cooperative system works for the pulp and paper industry. Since 2010, Focus on Energy has provided engineering time and project incentives valued at a total of about US\$16 million to the pulp and paper industry; the pulp and paper industry accounts for about 20 percent of the program's energy savings in the business sector (Fig. 1). The total lifetime financial savings for the Focus on Energy-supported projects in Wisconsin's pulp and paper sector is more than US\$415 million (Fig. 2).

"Focus on Energy has been a committed partner with Expera in supporting technological innovation that reduces both



Flambeau River Papers in Park Falls, Wisconsin.

environmental impacts and dependence on non-renewable resources,” says Steve Myers, vice president, operations for Expera Specialty Solutions. “The benefits of the energy efficiency projects implemented by Expera are much greater than reduced energy consumption. Focus on Energy delivers the necessary support manufacturers need to remain competitive in the global marketplace.”

Says Butch Johnson, owner, Flambeau River Papers LLC: “Without Focus on Energy, our mill would not be as energy efficient as we are

today; we wouldn’t be as green as we are today; and if you get right down to it, because of what FOE has been able to save our mill, in a very tough business—we might not be here today.”

When Smart Papers put its mill in Park Falls, WI, up for sale in 2006, Focus on Energy offered potential purchasers up to US\$350,000 in financing for energy-saving projects. Flambeau River Papers purchased the mill, and used this line of credit to finance five projects that included raw water tank heat recovery, PM 3 flash steam recovery,

identification and repair of compressed air leaks and failed stream traps, and wastewater treatment blower control.

The success of the first wave of projects led Flambeau River to identify and undertake a second wave of projects in 2014 (again with Focus on Energy). When all of the projects are completed, the mill expected to annually save a total of 2,017,000 kWh and 812,267 therms—enough to power 850 homes for one year and save the mill US\$523,155 in annual energy costs.

Reducing Energy Use: Advice From the Top

Paper360° asked executives who have led their mills through successful energy reduction projects to share their insights. Our respondents are:

- Steve Brooks, director of corporate energy, Verso Corporation
- William (Butch) Johnson, owner, Flambeau River Papers
- Jack Williamson, general manager, Green Bay Packaging

P360: WHAT FACTORS HAVE BEEN MOST CRITICAL TO THE SUCCESS OF YOUR ENERGY REDUCTION PROJECTS?

Brooks: Achieving success is a team sport—remove any of the players and the effort fails. In the case of energy reduction, success occurs at the intersection of corporate leadership committed to invest in efficiency projects, a technical partner that identifies energy best practices that can be economically implemented in the mill, and a mill team that will take ownership of projects and drive them to completion.

Johnson: First, simply being able to identify the potential energy savings—to pick out the low-hanging fruit. One of the first things that Focus on Energy worked on with us was putting together an energy conservation team, which really helped.

Next, as we completed our projects, we communicated results. Our customers were very happy with what we were doing on the environmental side, and our employees took pride in being able to cut costs and be good for the environment.

Williamson: Necessity! In today’s market where margins are getting tighter, you can’t operate without an energy directive. With that, you need leadership that can push change. If your team thinks you need to do things the same way you’ve always done them, it’s hard to improve. You have to have a change leadership.

P360: WHAT DO YOU KNOW NOW THAT YOU WISH YOU’D KNOWN BEFORE BEGINNING?

Brooks: We would likely have gotten an earlier start on this year’s energy projects had we known the flexibility of financing options available through Focus on Energy. Their team did a great job of helping to identify the best financial strategy to implement each project.

Johnson: There is always a fight over where the capital expenditures are going to be. But when we put the accountant’s touch to the energy projects we identified, many of them showed payback in a very short period of time—some less than a year. I wish we had jumped on some of them even earlier.

Williamson: If you’re not able to measure the impact of your projects, it’s going to be harder to see your success. So better energy metrics, and a better overall energy management concept before you start doing projects, is also helpful. You need your team committed to energy initiatives that they can help develop and champion.

INNOVATION AND METRICS

Improving energy efficiency has always been part of Verso’s strategy for reducing its costs and its environmental footprint, says Brooks. Innovation is part of that. “Last year we significantly changed the energy footprint of our pulp mill through a reconfiguration that resulted in the shutdown of obsolete equipment, providing both maintenance and energy cost savings. This year, we are moving forward with a list of energy projects that will save thousands of pounds of steam every hour,” he says.

“Another thing Focus on Energy did was to show our mill a bigger picture of what is going on not just nationally, but globally,” Johnson says. “We joined a Department of Energy program where we set our goal to reduce energy use by 25 percent over a 10-year period, and we did that. It absolutely helps to have specific benchmarks; 25 percent is a big number—but as you keep looking, you see the potential.”

Williamson agrees that metrics are important. “We are constantly working on improving our systems to define and track desired project outcomes,” he says. “Every energy reduction project we’ve done has met or exceeded its capital justification. We continue to build on an energy-focused operations and capital approach to running our business. Safety, environmental compliance, product quality—those initiatives are key to our business on a day-to-day perspective. We need day-to-day metrics that help every level of our organization make good energy decisions.”

Flambeau River’s latest project is in the wastewater treatment plant. “We’re going to reduce our electrical costs by being able to reduce the motors we’re using for the fine bubble diffusers; we think that’s going to be a sizeable number,” says Johnson.

“After all, if you’re not looking at new technologies, who knows how long your mill will be able to operate?” 