Collaboration among Government, Public Utility and Regional Industrial Efficiency Alliance: Designating an Energy Champion Case Study at a Paper Plant

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ABSTRACT

Through a Comprehensive Energy Management joint demonstration project, Grays Harbor Paper (GHP) was able to see the value and import of the energy champion and as a result, cost-justified the staffing of this position. The energy champion's goal was to prove energy could be managed as a controllable expense. Development of business systems essential to managing energy such an energy policy, establishment of savings goals and the development of Key Process Indicators (KPI's) were foundational to this effort. Additionally the champion directly worked to decrease the facility's energy intensity (kWh per unit of output). The key steps to this effort were to: increase awareness of site energy usage; identify opportunities to curtail, conserve and improve the efficiency of energy use; and manage efforts to address such opportunities.

Both the top-down and bottom-up techniques were used to quantify the improvements in energy intensity. While there is a gap between the results of each of the techniques used, the resulting savings clearly justified the staffing of the energy champion position and the continuation of plant energy management and improvement projects. The results of this demonstration project are being used to inform two members of the TAG, who are participating in the development of the upcoming ISO 50001 Energy Management standard. This project also provided insight into the value of collaboration among government, public utility and regional energy efficiency groups.

Overview of Results

Four partners jointly funded a two-year energy champion position to form and lead the energy improvement team in the reduction of energy consumption at GHP. Key outcomes of the project include:

- The mill reduced its electrical energy consumption of 96 million kWh/yr by 5.3 percent or 5 million kWh[1].
- The mill implemented a number of documented measures around capital energy efficiency and operations/maintenance.
- Contributing to the mill's energy reduction were management system driven behavioral changes, which included:
    a. Incorporating energy into daily mill production meetings;
    b. Establishing and communicating the mill's new energy policy to all employees;

[1] See IEA Site Visit Summary -- W-014, validation report in Appendix A.

c. Assigning specific systems (compressed air, pumps, lighting, etc.) to in-house process experts;
d. Conducting system assessments;
e. Investigating the addition of permanent metering and plant data collection points to better manage energy uses; and
f. Providing staff training for lighting, compressed air, pumps, and steam systems.

The Partners

The four participating organizations – referred to elsewhere in this paper as *the partners* – included:

Bonneville Power Administration

The Bonneville Power Administration (BPA), headquartered in Portland, Oregon, is a federal agency under the U.S. Department of Energy. It serves the Pacific Northwest by operating an extensive electricity transmission system and marketing wholesale electrical power at cost from federal dams, one non-federal nuclear plant and other non-federal hydroelectric and wind energy generation facilities. BPA aims to be a national leader in providing high reliability, low rates consistent with sound business principles, responsible environmental stewardship and accountability to the region.

Grays Harbor Paper

Grays Harbor Paper (GHP), located in Hoquiam Washington, was founded in 1929, grew to become a large international pulp and paper company, and was abandoned in the early 1990s. The mill was reopened in 1993 as locally-owned Grays Harbor Paper LP. It currently employs more than 230 workers and produces up to 150,000 tons of paper a year. GHP uses electricity generated onsite by three steam-powered turbines owned by the local utility, Grays Harbor PUD. The turbines can produce approximately 17 megawatts of electricity, more than enough to power the mill. Electricity produced, but not consumed by GHP, is sold into the electrical grid.

Grays Harbor PUD

Grays Harbor PUD (PUD), located in Aberdeen, Washington, is an electric utility created in 1938 by the citizens of Grays Harbor County. The PUD provides electric energy services to homes, business, and industry at the lowest practical cost. The PUD supplied its first electrical power to customers in January 1940. Residential rates prior to its founding were $0.055 per kilowatt-hour (kWh); after the PUD began operation, rates were reduced to $0.0385 per kWh. It's interesting to note that electricity, which cost ratepayers more than 9 percent of their wages at the time of the PUD's founding, today costs less than 1 percent of the average wage.

Northwest Energy Efficiency Alliance

The Northwest Energy Efficiency Alliance (NEEA), located in Portland, Oregon, drives the development and adoption of energy-efficient products and services. Working together through NEEA, utilities in the northwest have a greater influence and lasting impact on the

marketplace. Through their unique collaboration, NEEA and the region's utilities have helped make the northwest a national leader in energy efficiency.

The Project: A Partnership to Develop an Energy Management System

In 2006, the four entities described above formed a partnership to develop and execute a comprehensive energy management system for GHP. Central to the project was the hiring of an energy champion to work onsite at GHP. In addition to the immediate paper mill demonstration project, the partnership was intended to advance the practice of industrial energy efficiency in the northwest.

The project included the following elements:

- **Awareness** – Building awareness of the importance of managing energy as a core business value at all levels of the organization.
- **Assessment** – Assessing and benchmarking the energy management practices of the facility.
- **Plan** – Developing a detailed comprehensive energy management plan that embraces NEEA's Continuous Energy Improvement energy management system as the backdrop against which specific projects and practices are undertaken.
- **Commitment** – Documenting agreement by GHP to execute the energy management plan in a manner consistent with its business requirements.
- **Execution** – Helping GHP carry out the detailed elements of the plan.
- **Measurement** – Validating the energy savings achieved, and modifying the plan to ensure it continues help GHP achieve energy savings.

Collaboration Benefits the Paper Industry

The partners worked together to advance energy management at GHP and, more broadly, to make a positive contribution to the cause of saving energy in the paper industry. This paper describes the six phases of the project, compares and contrasts two approaches – bottom-up and top-down – to analyzing energy savings, and shares key lessons learned.

Awareness. The awareness of energy management needs to occur at several levels of an organization and at different times during the implementation of the energy management program. The initial objective is for decision makers to be aware of the potential benefits of controlling energy spending as a manageable expense. Later in the program, functional managers must be engaged in developing an energy management strategy. Finally, all employees must participate in executing the management system.

Staff from the partners met with mill management to understand the facility's current approach to energy management and assess its overall fit for involvement with the project. The initial conversation indicated a desire by mill management to engage in the program, but it was clear the facility lacked the human resources needed to drive the program at all levels of the organization. The organizational structure at the mill spread the responsibility for energy-related issues across multiple individuals who, with respect to energy, operated independently of each other. Each functional group had engaged experts in specific systems, such as pumps and boiler

ID fan system, and while these ad hoc projects yielded good results, they were not executed in support of a defined strategy.

The partners continued to meet with mill management to outline the value of an energy management system and, in particular, a dedicated energy champion. The open communication and spirit of collaboration was well received by all parties. Each partner recognized the potential of a coordinated effort working toward a common goal. The heightened awareness that energy can be managed as a controllable expense led mill management to agree to an assessment of its current energy management system.

Another significant facet of awareness relates to employee engagement in the energy management program. The energy champion and mill management approached this in steps. In the first step, mill management assembled an energy team composed of key managers and systems technology experts. This group developed Key Performance Indicators (KPI) for energy productivity and assessed key systems to establish baseline performance.

The energy team worked to draft, revise and publish a comprehensive Energy Management Policy and Energy Management Plan. The partners collaborated in developing these documents, which are considered pivotal in communicating to workers the commitment of GHP to energy efficiency.

In March, 2007, having put in place the KPI's, a clear policy and an energy management plan, the partners presented the project to mill employees through a series of meetings. The coalition of local, regional, federal and energy interests underscored the amount of support mill management and staff would receive in this program.

The meetings made clear the connection between the targeted 10 percent reduction in energy intensity (energy consumption relative to unit of output) and controlling expenses. Employees provided positive and meaningful feedback to management. To punctuate the point that there are new energy efficient technologies available, each employee was given a compact fluorescent light bulb to take home. With an informed employee population and energy team empowered by a corporate energy policy, the partnership was positioned to make substantial improvements in the paper mill's energy intensity.

Assessment. GHP's assessment indicated that management was capable and willing to implement an energy management system, but that staff lacked the bandwidth to drive the program. The partners recognized the opportunity to demonstrate the value of a dedicated energy champion, and set out to assess the mill's current energy management practices.

GHP's energy usage was assessed using the EnVINTA One-2-Five® Energy tool, which provided a systematic approach to organizational processes regarding energy management. The diagnostic process looks at a range of management practices in 10 key areas as they relate to energy use, and maps out a path for improvement. The results are benchmarked against an international database[2], and provide a basis for measuring improvement[3]. The diagnostic process concludes by identifying the five most critical activities for management to pursue. During the assessment, a staff member recognized the close link between energy management and the existing management structure the company has in place, commenting, "The infrastructure that supports the company's quality management system could be used to support any continuous improvement system. In this case it is energy."

[2] Database of other firms that have assessed their energy management practices using EnVINTA One-2-Five.
[3] Used with permission (2009), EnVINTA, Norwell, MA.

Plan. One of the energy champion's first goals was to work with management to establish an energy policy. The partners shared the view that energy management is a process that can be approached and managed, similar to a safety, environmental or quality processes. One of their main goals was to integrate the energy management process into the rest of the mill's operations and culture. The energy policy allows energy efficiency to be considered in all aspects of the mill's business planning and operation, consistent with its sustainable business practice.

The mill generates a significant amount of renewable energy via turbines driven by two biomass boilers, so maximizing the production of green power was another objective of the energy policy. Setting and using KPIs is key to effective energy management, and was another main objective. Three other objectives of the policy were: (1) providing appropriate training and education to employees, (2) conducting internal annual reporting of energy usage and (3) communicating items in the energy management plan using standard procedures and protocol. Finally, the plan assigned the energy champion, who was responsible for coordinating the energy management process and ensuring that the requirements of the energy policy and improvement plan were maintained. The energy policy has served as an excellent roadmap to the mill's energy conservation and management efforts.

Commitment. The energy champion's success can be credited to the partners' shared commitment to the project. Management provided the resources, time, and leadership to integrate the role of energy champion into the mill's culture. The energy champion quickly became part of the mill's day-to-day operations, attending daily production meetings and setting up monthly energy project reviews. When appropriate, the energy aspects of daily decisions were reviewed and highlighted, often changing the decisions being made.

The formal energy management policy was developed by the mill's leadership, the partners, and the energy champion. The policy was shared with salaried workers first, and then with the mill's entire workforce.

KPI's, developed in early 2007, initially focused on (1) thermal energy (steam) per ton of paper produced, (2) electrical energy per ton of paper produced. They also began tracking (3) total electrical energy, (4) net electrical energy (Note: the mill typically operates one 6 MW extraction turbine and has two other condensing turbines onsite), and (5) condensate returned percent. These KPIs are updated graphically, presented and discussed at the daily production meeting. The energy champion helped develop secondary KPIs that are steadily being implemented.

The mill's various energy management initiatives were reviewed and tracked on a regular basis. During regular update meetings, projects were prioritized based on their financial return, and maintenance, operations and technical personnel were updated on their progress.

GHP's management designated experts for process areas (i.e., powerhouse, paper machines and paper finishing) and major systems (i.e., pumps, air compressors and lighting). Drawing upon the rich suite of training resources provided by NEEA, the U.S. Department of Energy (DOE) and equipment vendors, GHP ensured that each energy champion received the necessary instruction. Process experts continue to take ownership of decisions related to their systems, regardless of production area.

In addition to the formal training provided to all mill employees in March 2007, having a full-time onsite energy champion made it easy for mill personnel at all levels of the operation to receive informal training throughout the project. Because the mill operations management team is relatively small (+/-35 employees), most major decisions are communicated widely – and open

to discussion. On several occasions, the energy champion was able to alter or change decisions before they were implemented, based on discussions of their energy ramifications and available alternatives.

GHP's management made the important commitment to participate in energy-related audits set up by the partners and energy champion. During the year-plus period the energy champion was onsite, the following audits and surveys were performed:

- Pumping Systems Assessment,
- Air Compressor Survey,
- Air Compressor Analysis and Modeling,
- Paper Machine #2 Vacuum System Analysis,
- Steam Trap Survey, and
- EnVINTA One-2-Five® Energy Assessments (Initial and Follow-Up)

Each of these audits lasted from one to four days, and required mill personnel to work with the experts performing the work and the energy champion. Mill operations management typically attended the kick-off and closing meetings. Each survey delivered useful and valuable recommendations which are now in various phases of implementation, depending on available funds, engineering, or other resources.

As with most cultural changes, GHP did not see immediate, 100 percent 'buy-in' of the process. While most employees instantly recognized that using less electricity or steam would save the mill money, they did not always agree on whether the mill should invest its modest financial resources on energy savings projects when other traditional projects also needed to be funded. Mill management has been committed to supporting energy efficiency projects and has found that in most cases, such projects have also improved productivity, reliability, and quality.

The final area of commitment is the consistent dedication to changing employees' energy-wasting habits and routines. The energy champion and GHP's management jointly communicated the need for employees to treat their workplace just as they treat their own residences: turn off the light when you leave a room, turn down the temperature when you go home for the day, don't let water run unnecessarily. These are common-sense habits many people already practice. While the effort has succeeded in some areas, others have required more attention and may ultimately require automatic controls, such as timers and occupancy switches, to gain the maximum benefit.

The mill is steadily incorporating energy management practices into its day-to-day operations. The success of this project owes to the combined efforts of GHP's energy champion and the partners' commitment of finances, time, expertise, leadership, and resources.

Execution. From the mill's perspective, the addition of an experienced energy engineer to serve as energy champion was fairly easy to implement, and a resounding success. The energy champion easily integrated into the mill's organization, and was able to contribute almost immediately. Having a daily presence helped steadily influence how energy decisions were made and, more importantly, influenced many operational decisions where energy had not been considered in the past. The energy champion made steady progress in identifying potential energy efficiency projects and summarized them in a way that allowed management to effectively prioritize and track them. These projects originated from other employees, the energy champion, consultants, and the opportunities presented by failed equipment.

From the mill's perspective, one unexpected benefit of having an onsite energy champion was the seamless integration of both financial and technical support from all of the partners and DOE. The roadblocks that commonly occur when several organizations with different missions and goals attempt to work together never materialized. From the mill's point of view, this very positive outcome was very refreshing.

Measurement. In order to (1) validate the energy savings achieved, (2) modify the plan to emphasize what worked well, and (3) commit to further action, the project included a measurement phase. Energy savings was measured in two ways: a bottom-up observation using sub-metered efforts and a top-down approach using analysis of electrical energy utility metered data combined with other available data, such as paper production and electrical power generation.

Bottom-up energy savings analysis. The bottom-up measurement relied on sub-metering electrical energy consuming equipment and monitoring other key variables during an agreed-upon period that captured typical operating conditions in order to establish a baseline. Where applicable, the same approach was applied to establish post-project kWh/yr usage and kWh/yr savings for each implemented energy efficiency and operations and maintenance (O&M) measure[4]. The energy champion coordinated these sub-metering efforts following meetings with mill staff and requests for further investigation. Some sub-metering efforts were coordinated with DOE's pump systems Energy Savings Assessment, and with collaborative efforts to conduct detailed studies and onsite training of assigned process systems experts.

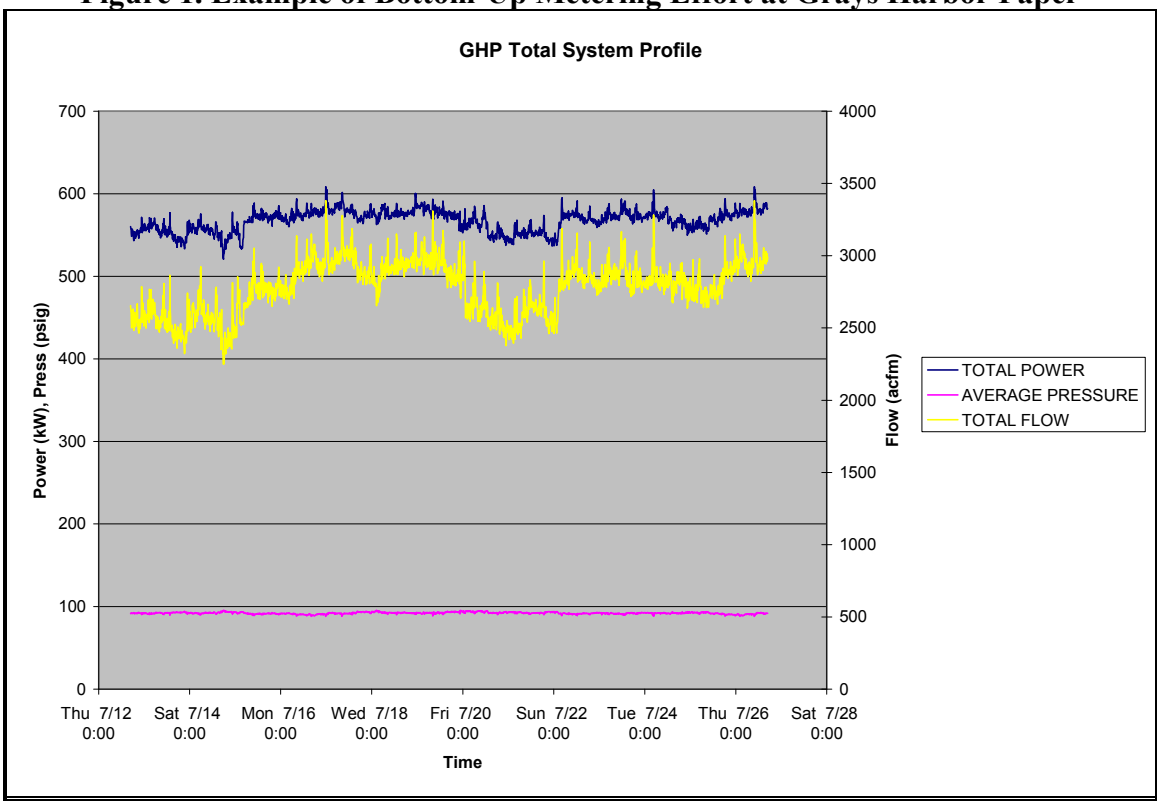
A sample list of such sub-metered equipment and systems includes:

- No. 8 Boiler 800 HP ID Fan
- Pulper-Pump Systems (930 HP Total)
- Paper Machine #1 and #2 Vacuum Pump Systems (2,350 HP Total)
- Mill-Wide Compressed Air System (1,000 HP Total)
- Paper Machine #1 700 HP Fan Pump
- Warehouse, Machine Shop and Other Area Lighting
- Hog Fuel 1,000 HP Grinder

One bottom-up measurement centered on the mill's compressed air system, which monitored electrical power and inlet pressure at each of the mill's air compressors as well as discharge pressures before and after all dryers. See Figure 1 below.

[4] See Appendix A for more details.

Figure 1. Example of Bottom-Up Metering Effort at Grays Harbor Paper



Observations from the bottom-up measurement provide an energy savings analysis from this collaboration. As of February 2009, four electrical energy efficiency capital projects have been submitted for utility incentives, implemented, and validated by the partners. Additionally, several O&M measures have been completed to date as well. **Taken together, these measures add up to a savings of approximately *5,093,160 kWh/yr* of electrical energy.** The measurement and verification plans the partners agreed on for these custom projects applied International Performance Measurement & Verification Protocol (IPMVP) Options A and B "Retrofit Isolation" in order to determine energy savings.

Approximately one dozen other cost-effective, capital-type electrical measures and several more O&M measures were identified during the energy champion's time at GHP. Through baseline metering, these measures have the potential to save an estimated additional 14,000,000 kWh/yr.

The bottom-up approach to analyzing savings provides good insight into the achievements of the partnership, but recognizes that the approach can miss energy savings that result from behavioral or non-project activities that either escape documentation or are difficult to quantify. As a result, a top-down savings methodology was also employed.

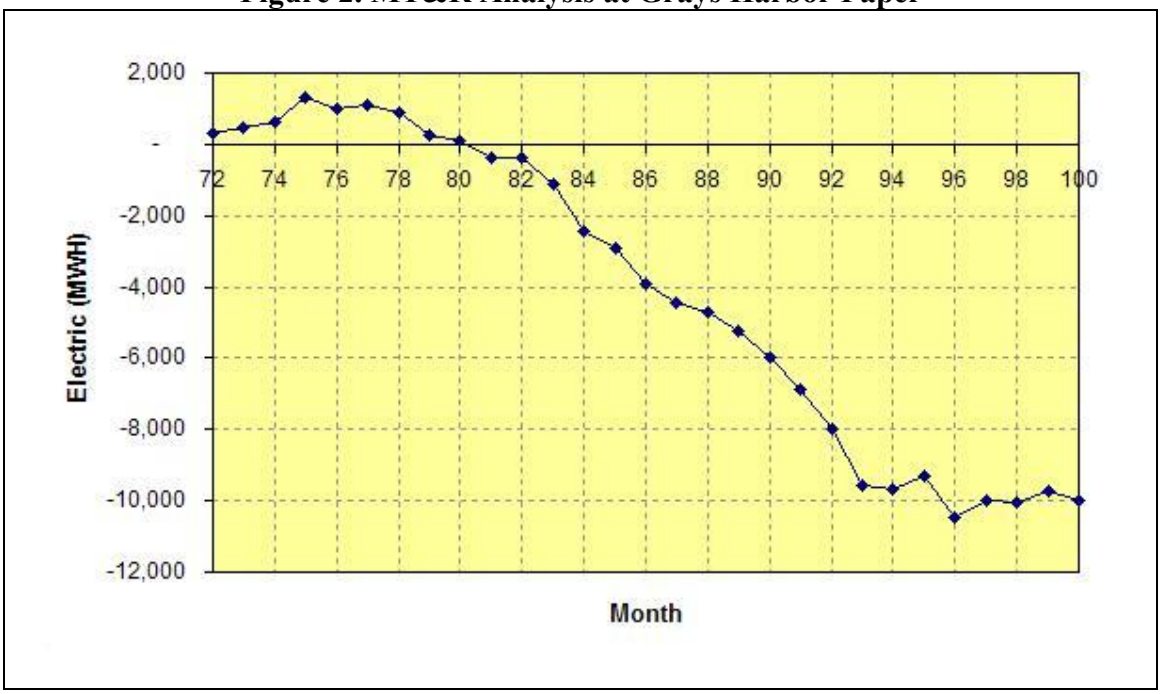
Top-down energy savings analysis. Two top-down or statistical analysis techniques were conducted to provide an alternative measurement methodology at GHP. The first technique used Prism Engineering's Measure Tracking & Reporting (MT&R) tool. The second used a tool of ECONorthwest, a consulting firm with offices in Portland, Oregon, and other western U.S. cities.

The MT&R analysis of GHP's mill-wide energy usage to paper machine tonnage production was conducted using the MT&R spreadsheet, which applies regression analysis with

cumulative sum of differences. This regression analysis is a single variable regression using the year prior to NEEA's Continuous Energy Improvement system project site work (October 2005 to September 2006) as its baseline. This analysis identified approximately 9.6 million kWh (1.1 aMW) of savings during the period when the energy champion was onsite implementing the energy management plan.

Figure 2 below shows the cumulative sum of energy savings from the project's start (October, 2006 – Month #74) to the final date for which the energy champion was onsite at GHP (April, 2008 – Month #100).

Figure 2. MT&R Analysis at Grays Harbor Paper



The one bottom-up and two top-down approaches established a range of likely annual energy savings for GHP and yielded the following results:

- Bottom-Up Analysis of Specific EEM and O&M Measures: 5.1 million kWh/yr
- Top-Down MT&R Analysis: 9.6 million kWh/yr
- Top-Down ECONorthwest Analysis = Inconclusive kWh/yr

Challenges to top-down energy analysis efforts at GHP include the use of primary metering data for the whole mill, recognizing that this approach includes ancillary loads serving the three turbine generators at the mill, and the addition of a significant (800 HP) new electrical load during the 2007-2008 time period. The additional load was an electric hog fuel grinder that replaced a 1,000 HP diesel generator.

The ECONorthwest Report also included analysis that was less conclusive, as indicted by the following excerpt:

> *"The results of the four models that examined the impact of the energy intervention on total energy use (models 1a through 1d) were inconclusive and even contradictory. We examined an alternative specification that considered energy consumption per unit of paper output. We found that while the elasticity of energy use (at the mean level of production) for the intervention was negative (– 8 percent), it was not statistically significant. Thus, we are unable to conclude with a standard level of statistical confidence that energy savings occurred at GHP during the intervention."*

Conclusions

Each approach to establishing facility-wide energy savings by implementing NEEA's Continuous Energy Improvement system has advantages and disadvantages. The bottom-up sub-metered approach is perhaps the best documented effort, although it can include its own set of assumptions; moreover, it does not factor in behavioral changes, such as when staff turns off equipment during slow production periods. The top-down MT&R analysis is relatively straightforward, although it may not adequately address relationships between mill-wide kWh usage, tonnage production, and ancillary loads. Other top-down efforts to examine energy savings may provide more tools for complex mathematical, statistical regression analysis but, as seen here, their results are inconclusive.

Lessons Learned

GHP learned several lessons from its year-plus experience of having an onsite energy champion – some of them expected and others a surprise. The expected lessons were that an experienced energy engineer was a valuable resource that helped jumpstart the energy management process, accomplishing several goals and projects during his time at the mill. As with other change management exercises, GHP found that it is much easier to change a piece of equipment than it is to change human behavior. While changing behavior on deliberate actions and procedures, such as planning a project or choosing a piece of equipment, have been very successful, changing the smaller, almost unconscious decisions people make multiple times every day – such as exiting a room without turning the lights off or walking by a running hose without shutting off the water – have been less successful, despite our best efforts.

Somewhat unexpectedly, almost every single energy savings project has led to improved reliability and quality in addition to the energy savings. While replacing old equipment with new often meets these criteria, the additional operational improvements have been better than anticipated. The other lesson the mill learned was how difficult it was to find a full-time, qualified energy engineer. The search for a replacement for the consulting energy engineer ended up taking more than a year, even with assistance of professional job recruiters and nationwide internet advertisements.

Other lessons learned. Having a person who is focused and accountable for energy intensity is valuable.

Working in a collaborative fashion, understanding the goals and objectives of the other parties, the public and NGO organizations, created a superior offering to the industrial customer.

The partners' collaborative approach provided a seamless interface to mill management.

With employees engaged and supported by management policies, practices and leadership, a focused energy champion can be a catalyst for long-lasting change in a company's energy intensity.

Continued Work at Grays Harbor Paper

While the mill continued steady implementation of the energy policy in the period between the consulting energy champion leaving and the present energy champion coming onboard, the generation of new projects and opportunities slowed significantly in the absence of technical resources. Currently, the pace of progress has picked up, with projects being added, prioritized, and implemented. During the past few years, the price of power has stayed relatively constant, while the price of generating steam has almost tripled. This increase in biomass cost has caused the mill to increase focus on reducing or maintaining the cost of generating steam, and also on reducing the use of steam in the various papermaking and powerhouse processes.

Audits and assessments of the entire steam system were recently performed, and there appears to be cost-effective ways to reduce thermal energy in both the powerhouse and paper machines. Many of the powerhouse savings are related to lowering boiler blow-down volumes, collecting previously unreturned condensate, and improving boiler and turbine operations through advanced controls. On the paper machine side, new press and dryer felt designs, preventing the over-drying of paper, isolating cold fresh-water leaks into the system, and better steam measurement have all led to as yet, unverified thermal savings.

With several short payback project choices, the mill is prioritizing its opportunities, looking not only at energy efficiency, but quality and reliability as well. A handful of medium-to-large ($50,000-$300,000) projects should be installed in 2009, with the help of energy rebate programs. To quantify the effects of process (behavior) changes, second-level KPI's supported by sub-metering are being developed. Two of the six goals developed by the mill's executive team this year are related to lowering electrical usage and lowering steam usage per ton of paper; clearly, there is awareness, at the top level within the organization, of the importance of energy efficiency. Regular communication of progress in energy-related practices is being shared, and an update for all employees is also being planned.

References

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Appendix A

Summary

	kWh/yr
Baseline	96,000,000
Capital	4,954,660
O&M	138,500
Total Reduction	5,093,160
Savings rate	5.31%

IEA Site Visit Summary -- W-014

Company Information		Evaluation Information		CEI Information	
Company	W-014	Evaluation By	Rick Ogle	Level of Engagement	Level 4 Practicing
Location	Washington	Evaluation Date	3/25/2009	Date Current Engagement Reached	7/31/2007
NAICS Code	322			Date of Current Enviste	April-06

Engagement Details

Description of Actions taken

O&M

Hogfuel Area Photo Eye Repair
Powerhouse Photo Eye Repair
Reduce #2PM Vac. seal water
PM area Sub-basement Lights Out

Capital Projects

PM1 Hydra Heater Circ Pump
Replaced 100-200 150W incandescent with 20W fluorescents. Replaced 400 150W incandescent with 20W CFL. Replaced 100 T8s with T5's
Air Compressor Mgmt System
Trim #1PM Fan Pump
Replace #2PM Vac. Pumps
#1 PM Couch Trim Pump

Number of Employees	235
Product Manufactured	Variety of recycled paper, including xerographic, laser copy, opaque, envelope and food grade paper
Production Process	
Annual Operating Hours	7900
Production Trends	
Process End-Use Metering	One primary meter for entire mill, need approximately 4 additional electric meters

Energy Use	Annual kWh	96,000,000	Annual therms	0	
Energy Systems Breakdown	Compressed Air		Motors		
	Refrigeration	0%	Steam		
	Other				
Types of Energy Used	Electric	25%	Gas	0%	
	Other - Hog	75%			

Estimated Energy Savings

O&M items completed	138,500 kWh
Capital projects completed	4,954,660 kWh

Comments

Future Projects:
1. #1 PM Saveall Break Pump VSD
2. #2 PM Saveall Break Pump VSD
3. #2 PM Flat Box Pump VSD
4. Finishing Area Lighting Upgrade
5. Repulper Rotor Replacement
6. BBB Pulper Rotor Replacement
7. #1 Calendar Pulper Energy Optimization

Utility Information

Utility Involved (Y/N)	Yes
Utility Name	Gray's Harbor PUD
Incentive Provided (Y/N)	No