ENERGY MANAGEMENT GUIDELINES IN PULP AND PAPER PRODUCTION

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Forest products industry is one of the major industrial consumers of energy. Worldwide, the final energy use in the pulp and paper industry amounted to 6 ExaJoules in 2003 (*i.e.* 6% of the total industrial energy use). In Europe, the total primary energy consumption attained the level of 1.3 ExaJoules in 2003. The pulp and paper industry, including recycling processes, also produces energy, as well as by-products that can be used for energy generation. It already generates enough to cover approximately 50% of its own energy needs. A significant share of this energy is renewable CO_2 neutral biomass.

Energy costs, energy supply and climate change are other important issues impacting the future of the forest-based industry. They will have impacts on the manufacturing costs, as well as on the allocation of investments around the globe.

It seems, however, that at an industrial level crucial knowledge on the state-of-the-art is still missing. The chain of the energetic sector very often lacks a correct management strategy and, therefore, it is not optimally efficient.

Climate change mitigation policy will add extra force to all these developments and the companies (not only from the papermaking sector) will move forward towards the application of modern, conscious management strategies.

Keywords: papermaking, paper industry, pulp and paper production, recycling, energy, energy management, management strategy, energy management guidelines

INTRODUCTION

Forest products industry is one of the major industrial consumers of energy. Worldwide, the final energy utilization in the pulp and paper industry amounted to 6 ExaJoules in 2003 (6% of the total industrial energy use). In Europe, the total primary energy consumption was around 1.3 ExaJoules in 2003. The pulp and paper industry, including recycling processes, also produces energy, as well as by-products that can be used for energy generation. It already provides enough to cover approximately 50% of its own energy needs. A significant share of this energy is renewable CO_2 neutral biomass.[1]

Energy costs, energy supply and climate change are other important issues impacting the future of the forest-based industry. They will also influence the manufacturing costs, as well as the allocation of investments around the globe. The increasing focus on biomass as an energy source may, on the one hand, lead to competition on the raw material markets for the existing industries and, on the other, it will open new markets for other parts of the forest cluster. Bio-markets of different sectors and industries will be interlinked. The expected increasing demand for bio-energy will have a high impact on the environment and might lead to the alternative purpose of recovered paper. Climate change mitigation policy will add extra force to all these developments.[1]

Renewable energy policies are likely to affect the demand for forest products, compared to other competing non-wood products. Finally, the already rapid globalization of raw material production and trade for the forest products industry completes the picture of interlinked developments and challenges to come. The forest products industry has the potential to play a leading role in these developments, by optimizing the use of raw materials, by increasing energy efficiency, saving energy costs, improving the recycling processes,

producing bio-energy itself and expanding its business into bio-refinery products. In the long run, the industry could even develop into a clean energy supplier, if residues are efficiently used. Besides the emerging technologies, completely new process designs and processing techniques could bring considerable and long-term energy efficiency improvements in paper production. Energy and forest policies around the globe set the stage for these developments and need to be well-integrated and carefully balanced. Here, governments, industries, institutions and society have an important role to play.[2]

Review of European electricity and gas prices

The first six months of 2006 saw a stabilization of electricity prices, particularly in the period of April to June. However, the very hot and dry weather in July caused a number of operational problems for some plants, so that an associated increase in prices as higher cost units was registered. Some increase was also recorded in the forward prices for 2007 (which remain quite stable, around €50-55/MWh). The reduced prices of carbon certificates, which fell from around 30€/tonne to less than €20/tonne, may have contributed to this stabilization. Retail prices continue to increase in the majority of the Member States, as previous rises of wholesale prices continue to feed through end-user bills. In some cases, regulated tariffs have prevented this, causing, however, difficulties for the affected suppliers, which culminated in the events in Spain, in June 2006, when the companies had to restrict their buy prices on the wholesale market, to reflect end-user prices.

In Western European countries, the prices for 2007 fell slightly in the second quarter of 2006, to around €53/MWh, however, most of this reduction was reversed in July. Day-ahead prices in the second quarter fell significantly from winter levels, being around €40/MWh in May and June.

Latest estimates of prices for moderately-large users (24 GWh/year) continue to increase and, on the average, now exceed €60/MWh. The data recorded for smaller customers indicate an increase even to €120/MWh before tax.

In the new Member States of Central Europe, the wholesale prices were relatively stable in the second quarter, sharply rising in July. Again, the market in the Czech Republic was the most affected. Prices in Poland remained subdued, due to congestion for the main exporters. Exports from Poland were restricted in the hottest days. Retail prices also rose somewhat, the industrial prices being of approximately €60/MWh, similar to those in Western Europe. Household and small commercial prices have also been rapidly increasing, up to almost €100/MWh, very similar to those recorded in other parts of the European Union.

Border prices continue to reflect the movements in the oil price. Gas prices for imports from Russia and Algeria are now at the level of roughly €20/MWh, and will probably remain constant, while oil prices remain at current levels.

Market prices were very high in the UK and Belgium during the winter of 2005-06, with a peak over €40/MWh released in December 2005. Since then, the wholesale prices were somewhat reduced to a level around €30/MWh. Price increases have been less pronounced in the Netherlands in the winter period, so that they appear more aligned with the border prices in Germany, remaining closer to €20/MWh. There is clear evidence of the infrastructure bottlenecks between the Netherlands and Belgium. However, the prices for the winter of 2006-07 suggest that they will rise on the wholesale energy markets, including that of the Netherlands. Price levels of €35-40/MWh are expected in the next winter.

For more detailed info on prices, the "Review of European Electricity and Gas Prices", available on the website of EU,[3,4] is recommended.

Trends

The pulp and paper industry, also including recycling processes, is in a unique position, both in terms of improving energy efficiency and reducing CO_2 emissions. The sector, having the ability to become a net supplier for a series of energy products, may become an important factor for removing the CO_2 from the atmosphere. However, this will not happen overnight and will involve a fundamental rethinking of the sector's strategy.

The beginning of the 21st century brought many rapid changes in this industrial branch. The increase in energy prices is one of the most significant. Energy is now the second

largest cost factor after raw materials. Some factors, such as:

- increasing energy prices,
- climate policies, which will start affecting business practices,
- increased environmental policies,
- competition for market share,
- competition for investment funds within company,
- new products and innovation, push papermakers to start thinking seriously of modern energy management strategies.

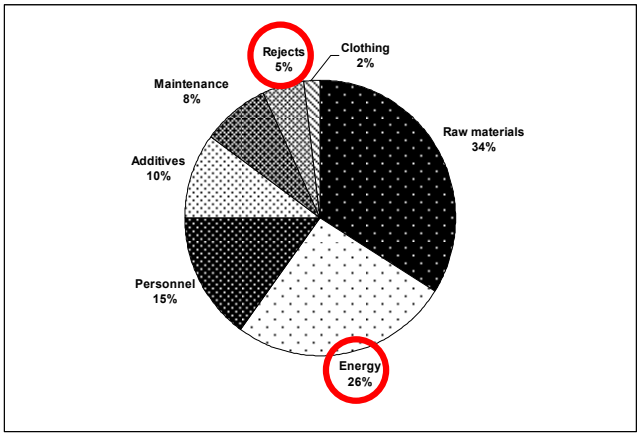

Figure 1: Share of annual cost of a typical recycling paper mill in the Netherlands (Source VNP 2006)

Some companies are better equipped than others to respond to these challenges and control costs. However, modern energy managements should consider not only increasing energy costs as the main issue, but also personnel and technical maintenance, investment in installations and applications, different outsourced maintenance contracts, transaction and procurements costs (management time, contract negotiations), environmental compliance costs (*e.g.* combustion installations, air pollution controls), greenhouse gas emissions management, losses of income due to power outages or other disruptions. If energy costs reduction is to be achieved, some issues should be fulfilled:

- day-to-day decisions on the work floor and management,
- understanding energy use,
- energy monitoring and benchmarking,
- developing an energy strategy,
- implementing an energy management system,
- implementing energy efficiency measures,
- modern energy management.

Unfortunately, most paper mills nowadays make no effort to improve their energy control. The reason is very often simple: because that is the way it has always been done in this respect. Very often, companies suffer from lack of a suitable personnel, organizational support, information, funds and continuity. According to the CFO Magazine, 75% of the high-level decision makers view electricity costs as the least controllable category of business costs, which is a serious mistake. Energy has a cost that can be controlled; this, however, can be a challenge for paper industry, in particular for the recycling sectors. A successful management delivers sustained reductions over time, being designed for continual improvement. It is also related to the core business of the organization. Businesses with formal energy management programs attain their energy and cost savings by a systematic approach. Such an approach can be achieved by a good planning of the target to be attained, as well as by implementation, continuous monitoring and adjusting actions.[2,5,6]

Energy management

"Wood and paper products are uniquely renewable and recyclable products that help reducing greenhouse gas emissions by absorbing CO_2 from the atmosphere" – this statement was made by Teresa Presas, Chair of the International Council of Forest and Paper Associations (ICFPA). The industry is committed to innovative energy solutions that meet the challenge of climate change, increase efficiency, reduce dependence on fossil fuel and expand the use of renewable

energy sources; it is believed that fibers from sustainably managed forests bring a positive contribution to the world's future energy supply. To achieve this, industry needs suitable policies and management strategies that support research and innovation, promote demonstration projects and improve the investment climate, specifically in this sector.

Modern energy management, directing and accelerating energy savings without major investments, has three major components:

- mindset: shifting responsibility for energy efficiency from staff to line management,
- target setting: based on national and company benchmarks, target setting for most relevant energy-wise process units at a mill level,
- best practices: exchanging best practices and expertise between paper mills.

If energy management is to become a successful factor, there are certain goals that need to be carefully fulfilled by the whole company, such as:

- commitment of top management,
- clear and measurable targets,
- information and management systems,
- regular assessment and tracking of performance,
- involvement of the organization at all levels,
- stable organization,
- allocated resources and time,
- continuous program,
- excellent communication,
- networking,
- external sparring partners,
- recognition.

A successful management based on the afore-mentioned factors creates an organization-wide system and program for managing energy, delivers sustained reductions in time and, once committed to continuous improvement, finally relates itself to the core business of the organization. A company with such a management program can easily realize energy savings, cost savings and greenhouse gas emission reductions.[5,7,8]

Guidelines for energy management

Once known that a strategic approach to energy management can produce twice the savings – for the bottom line and the environment – of typical approaches, EPA's Energy Star partnership offers a proven energy management strategy that helps in measuring the current energy performance, setting goals, tracking savings and rewarding improvements.

Based on the successful practices of Energy Star's partners, these guidelines for energy management can also assist, among others, the paper industry in improving its energy and financial performance. Based on a systematic approach involving four major factors – targeting, implementation, monitoring and adjustment – the guidelines consist of the issues presented in Figure 2.

Commitment to continuous improvement (1st step)

First of all, it is crucial to make commitment to continuous improvement. To this end, a clear message on the importance of energy management has to be created and disseminated. At this point, communication within the company is absolutely necessary, after which the responsibilities have to be clarified and assigned properly, and a dedicated team needs to be created for preparing the guidelines of the corporate energy policy. Regardless of the size or type of organization, the common element of a successful energy management is commitment. Organizations commit to allocating staff and funding, with a view to continuous improvement.

A critical component of successful energy programs is the appointment of an energy director, to help an organization achieve its goals by establishing energy performance as a core value. The energy director is not always an expert in energy and technical systems. Successful energy directors understand how energy management helps the organization achieve its financial and environmental goals and objectives. Depending on the size of the organization, the energy director role can be a full-time position or an addition to other responsibilities. The energy director's key duties often include:

- coordinating and directing an overall energy program,
- acting as the point of contact for senior management,
- increasing the visibility of energy management within the organization,
- drafting of an energy policy,

- assessing the potential value of improved energy management,
- creating and leading the energy team,
- securing sufficient resources to implement a strategic energy management,
- assuring accountability and commitment from the core parts of the organization,
- identifying opportunities for the improvement and application of implementation (staff training included),
- measuring, tracking, evaluating and communicating results,
- obtaining recognition of achievements.

If the energy director does not report directly to a senior manager, it is often helpful for a member of senior management to serve as an "executive ally". Upper management involvement is a key component of successful programs. Having an ally provides a direct link to upper management and helps to formalize the commitment to continuous improvement.

Decisions affecting energy use are taken every day by people. Creating an energy team helps to integrate energy management. Besides planning and implementing specific improvements, the team measures and tracks energy performance and communicates with the management, employees and other stakeholders. The size of the energy team will vary, as depending on the organization size. In addition to the energy director, who leads the team and, possibly, to the dedicated energy staff, the involvement of a representative from each operational area, such as:

- engineering,
- purchasing,
- operations and maintenance,
- building/facilities management,
- environmental health and safety,
- corporate real estate and leasing,
- construction management,
- contractors and suppliers,
- utilities,

significantly affects the energy use.

To provide the company with a successful energy management, an energy policy should be developed and implemented. It formalizes senior management's support and articulates the organization's commitment to energy efficiency for employees, shareholders, community and other stakeholders.

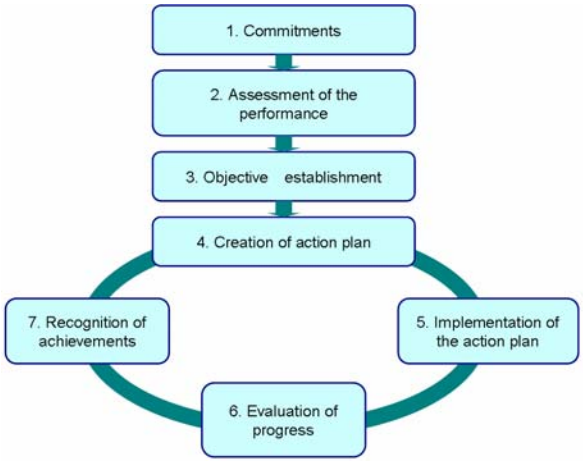

Figure 2: Energy management strategy by Energy Star

Based on the experience of other Energy Star partners, successful organizations have energy policies that:

- state the objective – have a clear, measurable objective that reflects the organization's commitment, culture and priorities,
- establish accountability – institute a chain-of-command, define roles in the organization and provide the authority for personnel to implement the energy management plan,
- assure continuous improvement – include provisions for evaluating and updating the policy to reflect the changing needs and priorities,
- promote goals – provide a context for setting performance goals by linking

energy goals to the overall financial and environmental objectives of the organization.[7,9]

Assessment of performance (2nd step)

On the second place within the guidelines, there lies the assessment of performance. This involves gathering of most recent data and establishing baselines on the energy intensity/efficiency level, by means of benchmarks ("What you don't measure, you can't manage"). In this phase, energy use analysis is of special importance, as well as the technical assessments and audits. Assessing performance represents a periodic process of evaluating energy use for all major facilities and functions within the organization and of establishing the baselines for measuring the future results of efficiency efforts. A simple example can be provided in this respect – not the energy is needed, but the service:

- you do not want to use energy, but make a tonne of paper;
- you are interested in a sufficiently light level, not in consuming electricity to achieve this.

The basis for benchmarking is the specific energy consumption index (1):

$$SEC = \frac{E}{P}$$

where: SEC = specific energy consumption
E = energy consumption by the sector
P = production by the sector.
The second is the energy efficiency index (2):

$$EEI = 100 \cdot \frac{\sum_{i=1}^{n} P_i \cdot SEC_i}{\sum_{i=1}^{n} P_i \cdot SEC_{i,BP}} = 100 \cdot \frac{E_{tot}}{\sum_{i=1}^{n} P_i \cdot SEC_{i,BP}}$$

where: EEI = energy efficiency index
n = number of products to be aggregated
SECi = actual SEC-value for product i
SECi, BP = best practice SEC-value for product i
P_i = production quantity for product i
E_{tot} = total actual energy consumption for all products

To evaluate energy performance, good information on how, when and where energy is being used, has to be collected and analyzed. The collection and tracking of this information is necessary for establishing baselines and for managing the energy use.

The collected data should be complete and accurate, with a view to further analysis and goal setting.

- The appropriate level of detail should be determined – the level and scope of data collection will vary from a paper mill to another. Some may choose to collect data from submeters on individual processes, while others may only look at the utility bill.
- The inventory of all energy purchased and generated on-site (electricity, gas, steam, waste fuels), both in physical units (kWh, mMBtu, Mcf, lbs of steam, etc.) and on cost basis, should be performed.
- Documentation of all energy uses – for the above-identified sources, energy bills, meter readings and other used data should be collected and documented. Energy data may reside in the accounting department, to be held centrally or for each facility, or can be acquired by contacting the appropriate utilities or energy service providers. At least two years of monthly data or a more frequent interval, if available, should be collected.
- To normalize and benchmark, it may be necessary to collect non-energy related data for all facilities and operations, such as building size, operating hours, etc.

When data are properly collected, the tracking system should be established. It is a system for tracking performance, possibly ranging from a simple spreadsheet to detailed databases and IT systems. The design of a tracking system will be shaped, largely, by the level and scope of information to be tracked and by the frequency of data collection. Tracking systems should be easy to use, update and maintain, for communicating energy performance to the other parts of the organization and to motivate change. Developing formats that express energy performance information in easily understandable ways within the organization should be also considered. A good tracking system should make such reporting easy.[2,6-8]

Goal setting (3rd step)

Another point in the guidelines for energy improvement is to set the right goals for determining the scope (what will be included in the energy policy, time frame, stretch target) and for estimating the potential for

improvement (review performance data, benchmarking, best practices). Performance goals drive energy management activities and promote continuous improvement. Setting clear and measurable goals is critical for understanding the intended results, for developing effective strategies and achieving financial gains. Well-stated goals guide daily decision-making and are the basis for tracking and measuring progress. Communicating and posting goals can motivate the staff to support energy management efforts throughout the organization. Typically, such goals are developed by the energy director, together with the whole energy team.

Setting goals helps establish the tone for improvement throughout the organization, as well as measure the success of the energy management program. It makes it easier to identify progress and setbacks at a facility and foster ownership of energy management, and creates a meaningful sense of purpose. Finally, it establishes schedules for upgrade activities and identifies possible milestones.

Establishing appropriate and realistic target dates for goals assures that they are meaningful and may promote changes. A combination of short- and long-term goals can be the most effective technique: [7,8]

- short-term goals – annual goals provide the necessary markers for tracking and reporting progress on both regular and on-going basis;
- long-term goals are usually organization-specific and may be shaped according to the internal rates of return, internal planning horizons and guidelines, organizational strategic plans, and/or commitments to voluntary environmental initiatives.

Creation of an action plan (4th step)

At this level, the definition of technical steps and targets plays the major role for the determination of the company's roadmap for energy management, inventory of energy efficiency measures, site assessments, selection of the most effective, optimal measures and finally the development of energy plans. Also, the determination of the roles and resources and the division of responsibilities are performed in this stage.[10,11]

Unlike the energy policy, the action plan is regularly updated, most often on an annual basis, to reflect the recent achievements, changes in performance and shifting priorities. While the scope and scale of the action plan is often dependent on the organization, the definition of the technical steps and targets, and the determination of roles and resources represent a basic starting point for creating a plan. Setting an inclusive strategy that establishes the roles and actions throughout the paper mill can help to integrate the good energy management practices.[5,7,8]

Defining technical steps and targets involves:

- determination of a company-wide roadmap for energy management,
- inventory of energy efficiency measures,
- site-assessments,
- selection of the most effective and cost-effective measures,
- development of energy plans (corporate/plant).

Determining roles and resources:

- establishment of a corporate energy manager,
- plant or site-energy managers,
- determine responsibilities,
- allocate time and funds for EMS,
- determine procedures for resource allocation.

Implementation of the action plan (5th step)

The implementation phase involves creating a communication plan, raising awareness, tracking and monitoring motivation. People can make or break an energy program. Gaining the support and cooperation of key people at different levels within the paper mill is an important factor for a successful implementation of the action plan in many organizations. Reaching the goals frequently depends on the awareness, commitment and capability of the people who will implement the projects defined in the action plan. In addition to implementing the technical aspects of the action plan, the following aspects should be considered:

- creation of a communication plan – for developing targeted information for key audiences on the energy management program;
- the tools may include: company-wide campaigns, newsletter/posters, intranet, success stories, weekly/ monthly results to management;

- rise of awareness – to build support at all levels of your organization for energy management initiatives and goals;
- enlargement of capacity – through training, access to information and transfer of successful practices, procedures and technologies, you can expand the capacity of your staff;
- motivation – creates incentives that encourage staff to improve energy performance to achieve goals;
- monitor progress regularly.[7,8]

Evaluation of progress (6th step)

Evaluating progress includes formal review of both energy use data and of the activities carried out as part of the action plan, compared to the previously established performance goals. The evaluation results and information gathered during the formal review process are used by many organizations to create new action plans, identify the best practices and set new performance goals.

Progress evaluation includes two main factors. The first is the measurement of results, which will permit to compare the current performance *versus* the established goals, while the second is to review the action plan, which will clarify what worked well and what did not, in order to identify the best practices.

Regular evaluation of energy performance and the effectiveness of energy management initiatives will also allow energy managers to:

- measure the effectiveness of the projects and programs implemented,
- take informed decisions about future energy projects,
- reward individuals and teams for accomplishments,
- document additional savings opportunities, as well as non-quantifiable benefits that can be applied for future initiatives.

Recognition of achievements (7th step)

The final stage of a modern energy management is the recognition of achievements, which should definitely provide awards for operation and technical people (assuming success, of course).

Providing and seeking recognition for energy management achievements is a proven step for sustaining the momentum and for program supporting.

Providing recognition to those who helped the organization achieve these results motivates staff and employees, and brings positive exposure to the energy management program. The individuals, teams and facilities within the organization can be the key for sustaining support and momentum for energy management initiatives. Rewarding particular efforts sets an example for what constitutes success and helps motivate employees through increased job satisfaction. Recognition can strengthen the morale of everyone involved in energy management.

Receiving recognition from outside sources validates the importance of the energy management program to both internal and external stakeholders, and provides positive exposure for the organization as a whole. External recognition can be obtained from government agencies, media and other third party organizations that can reward achievement. Good work deserves to be acknowledged. Recognition from a third party can provide validation for an organization's energy management program. Not only does it provide satisfaction to those involved in earning the recognition, but also it can enhance an organization's public image. A solid reputation contributes to a company's competitive advantage by making the organization more attractive to customers, students, current and potential employees, lenders, business partners and other stakeholders.[5,7,8]

CONCLUSIONS

Many papermakers ask themselves the question: "Where does my system stand?" The answer can be found very quickly, only simple assessment of the energy management (if it exists) of the company being necessary. Many different systems already exist, so there is nothing new to be discovered on this topic, a good example being mentioned above – the Energy Star Matrix, which outlines the key activities for energy management.

Papermakers should identify the steps needed to fully implement the energy management elements and record them, compare their program to the guidelines by identifying the degree of implementation that can closely match the organization program of their companies, then identify the steps

needed to fully implement the energy management elements.

Decision making policy is a crucial issue in energy management. Purchased energy and energy-related capital investments represent major production costs in the pulp and paper industry. The variety of corporate philosophies and structures across the industry preclude generalizations about how decisions are made, relating to these costs. Some companies have very decentralized structures, with even relatively major energy or non-energy related investment decisions taken at a mill level. In other cases, capital budgets and decision making are centralized and investments require approval from division and/or corporate headquarters.

Traditionally, pulp and paper companies have maintained skilled staff with responsibilities ranging from energy purchases to operation of on-site heat and power generation, and energy demand management. However, a general trend in this and in other industries is to reduce the staff dedicated to energy, with greater reliance on outside specialist consultants. One positive effect is that good ideas may potentially spread more rapidly throughout the industry. At the same time, there are fewer people on-site with the plant-specific experience, which is often crucial to identify the best opportunities to improve efficiency.

Energy related investments compete with other investments for capital. The relatively low fuel and electricity prices prevailing since the mid-1980s have reduced the profitability of investments in energy efficiency improvements. In addition, some capital may have to be spent on investments required by regulation. In practice, this means that shorter paybacks are required for pure cost-cutting measures. However, many of the best opportunities for improving efficiency will also lead to improved productivity, product quality, environmental performance, or other benefits. For example, the introduction of a variable speed drive might save electricity, while affording better process control. Providing multiple benefits will increase the likelihood that technical innovations will be implemented. In connection with this, the multiple-stage production processes offer more energy saving options, which correspond to pulp and paper production and, in particular, to paper recovery.

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