Improving Energy Efficiency in Papermaking

Improving energy utilisation
Reducing carbon emissions
Finding efficiency solutions

COST Strategic workshop

Report and recommendations

COST Strategic workshop
9-11 June 2008
Hoofddorp, the Netherlands

“De Schoolmeester” a wind mill which was built in 1692 and engineered to produce packing paper. De Schoolmeester is the last daily producing paper wind mill in Europe and is a typical example of an Energy Neutral Paper Mill.

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Summary

Increasing energy prices have made the improvement of energy efficiency a top priority within the paper and board industry concerning its competitiveness. Also related to this topic is the increasing attention for sustainability by both the public as well as the government. Expected changes in restrictions on CO2 emissions further motivate the paper and board industry to find more sustainable and energy efficient alternatives for their current paper production processes. In spite of significant progress in the last few decades the need for adoption of existing Best Available Technologies (BAT) and development of new technologies is greater than ever. In the long run these BATs will have to be re-defined on the basis of developments which today are considered visions.

At a 3 days Strategic Workshop on "Improving Energy Efficiency in Papermaking", organised in the frame of the COST (European Cooperation in the field of Scientific and Technical Research) programme over 175 senior Paper Industry representatives, scientists, upcoming talents and recognised high profile speakers discussed the options the paper industry in Europe has in order to address its possibly greatest challenge of the future.
The COST workshop aimed on diffusing the knowledge on this topic by assembling industrial speakers of various parts of the paper production chain. This helped identifying best practices, creating new networks and allowed for discussions on future activities.

During the workshop four sessions were held.
The first session on Monday described the energy scene in which the European paper and board industry has its position and has to make its choices for the future. What is the current European and/or worldwide situation concerning energy use, energy markets, energy legislation and carbon emission trading? And what are possible energy related strategies for the European paper and board industry to maintain a competitive position in this changing scene?

On Tuesday two Parallel Sessions took place, Session A and Session B, in which respectively the current best available technologies and the potential new initiatives for innovative changes in the paper and board industry were discussed. In Session A optimisation options for usage of e.g. steam and advantages of implementation of many best practices such as dewatering with optimal felt design and high efficiency vacuum systems were presented. Session B provided future technological options which can further push paper production energy consumption to its thermodynamical minimum. Such options included e.g. fractioning of pulp to apply energy only to fibres in need of treatment, stratified forming and paper production at higher process temperatures.

The final session on Wednesday consisted of a discussion in which the discussed knowledge on current developments in the world and potential advantages of new innovations and best practices were related to each other in order to develop a road map for the coming 12 years.

Major conclusions of the workshop were:
- The EU policy of improving the energy efficiency by 20 % in the period 2005 – 2020 is not ambitious enough to maintain a competitive position for the European Pulp and Paper Industry. Significant achievements should be realised, including on the basis of novel business concepts.
- Technological research should be more and more combined with the socio-economic aspects and the development of accompanying new business models for the successful implementation of innovations.
- A number of more energy efficient technologies are already available or are close to market introduction; however, considerable scope for further improvements is available and must be continuously researched / developed over the upcoming 12 years.

Major technological challenges in the roadmap to be met in the upcoming years via R&D are:
- Integrated pulping technologies in conjunction with bio-refineries
- Introduction of high consistency and higher temperature paper production
- Novel fibre processing technologies
- Improved dewatering and drying technologies

Content

Introduction

Background

Increasing energy prices (see figure 1) are creating considerable strain on the profit margins of the paper and board industry (P&B).

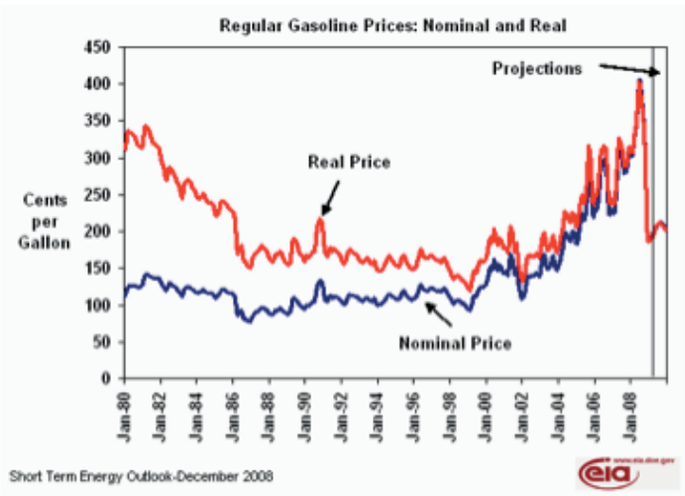


Figure 1: Increase in crude oil prices (source DOE)

Furthermore, increasing attention of the general public and governmental institutes for climate change is leading to legislative measurements creating strain on the usage of fossil fuels. In order to remain profitable, the paper and board industry needs to either reduce its overall energy usage or find alternative energy sources.

With energy efficiency as top priority, special attention should be paid to all means by which energy can be utilized more efficient in industrial processes. In view of the technological variety of their production facilities and the correspondingly broad spectrum of potentially successful approaches, a harmonised European initiative seems to be a crucial prerequisite for developing strategies which would allow the European paper and board industry to maintain its leading role in the world, also with regard to environmental compatibility.

Objectives

Despite the apparent need for innovations that increase the energy efficiency of paper production, relatively little research or funds for research is performed by the industry itself. One of the reasons is lack of knowledge in the wider industry regarding the enormous possibilities to improve efficiency by using current best-practice technology and new innovative technologies. The first step is therefore for all those connected to the paper production chain to gather their knowledge and work together on establishing a central repository of knowledge for the paper and board industry.

The goal of this workshop is to provide and share information regarding possible solutions that can increase the energy efficiency of our paper mills, and to decide which route we shall take towards a secure and energy efficient future.

The main sub-objectives of the workshop can be summarized as follows:

- To jointly generate a comprehensive catalogue of energy saving technologies and strategies in existing production plants of the p&b industry
- To bundle and promote existing knowledge of tools able to identify energy saving potentials in mills as a prerequisite for immediate improvements
- To develop a clear understanding of the gap existing between the energy consumption of state of the art technologies and those belonging to the industrial standard
- To identify and prioritize the most import and most promising research areas aimed at significant mid- and long-term improvements of energy utilization in the p&b industry
- To create a network of European researchers active in the area of energy management in major energy consuming industries also beyond the p&b industry.
- To assess and encourage technology transfer of results achieved in other industries which might be potentially instrumental in addressing the specific problems of the p&b industry.

[1] BAT in this document refers to best available technologies that are cost-effective

The workshop

The COST Strategic Workshop “Improving Energy Efficiency in Papermaking: improving energy utilisation . reducing carbon emissions . finding energy solutions - ” took place from 9th-11th June 2008 in Amsterdam, The Netherlands. The event which was co-organized by the COST Office (BE), Technische Universität Dresden (DE), the association of European Fibre and Paper Research Organisations (BE) and Kenniscentrum Papier en Karton (NL) which also provided the local organisation. The workshop was attended by more than 175 participants from 23 countries including industry representatives, scientists from universities and industrial research centres as well as students.

The programme had been put together by a programme committee consisting of Kari Edelmann (FIN), Werner Förster (BE), Proposer and Chairman Harald Grossmann (D,), Arie Hooimeijer (NL), Marco Lucisano (S) and Barry Read (UK).

The scientific programme which included some 40 oral presentations as well as a round table discussion was subdivided in 4 sessions which focussed on the following themes:

- General presentation describing the situation of energy utilization in Europe and the world
- Strategies for a more efficient utilization of energy in papermaking
- The potential of new or emerging papermaking technologies with respect to energy efficiency
- Trends, developments and prospects; the roadmap for 2020

The four themes formed a stepwise programme (see figure 2) during the three day workshop. By focusing on these 4 themes a roadmap was developed up to 2020, while also diffusing knowledge.

Figure 2: COST Workshop Structure

Session 1: "Setting the scene"

The energy consumption per capita has grown since millennia, but the impact of this development has become problematic only since the second half of last's century as a consequence of an even stronger increase of the total earth population There are strong indications that even an intensified search for new energy resources will not be able to keep pace with an unlimited increase in demand. About 37% of the total global energy use is by industrial users. The paper industry's contribution to the overall industrial energy consumption in Europe is about 7%, which emphasises the need for the industry sector to use energy in a responsible manner.

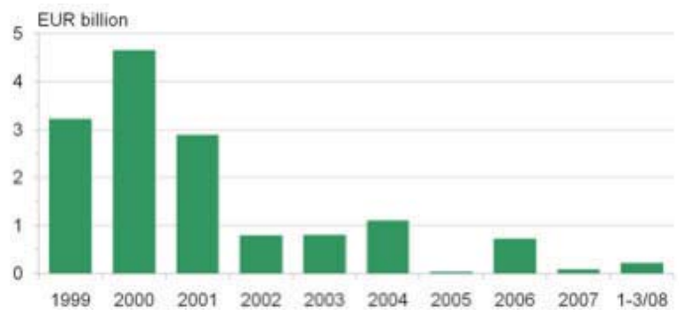


Figure 3: Profitibality of Finnish forest industry companies (profit before taxes and ROCE)

The growing trend towards reducing carbon emissions is driving industry, especially energy intensive industries (like pulp and paper) towards a low carbon economy and compels many papermakers to reduced energy technologies to manufacture "low Carbon footprint" products.

Current status of energy efficiency

Developments related to the focus on energy efficiency

The European climate and energy policy proposals are calling for drastic changes in all industrial sectors. The reduction of 20% green house gas emissions, an increase in energy efficiency of 20 %, a share of renewable energy sources of 20% and a share of bio fuels in transport of 10%, all by the year 2020 have been proposed and final approvals are expected to take place within a year. The high price of fossil energy and emissions trading puts the main feedstock of the paper and board industry at risk; the transformation of wood from a raw material into bio-fuels will increase the prices of biomass and/or reduce its availability.

The paper industry is thus faced with many challenges. Climate policy, emission trading, increasing and more volatile energy prices not only affect energy costs for the paper industry, but also its raw material costs/availability, making this industry extra vulnerable. Moreover, the paper business is nowadays a very low margin business (see figure 3) with harsh international competition. We are entering a new era of high energy and raw material costs. However, these developments also offer unique opportunities.

Therefore the key issue is to recognize and capture these opportunities!

Energy strategies

Energy costs more than you think. It is not only the energy bill, but also personnel costs, investment in installations and appliances, different outsourced maintenance contracts, transaction and procurement costs, management time, contract negotiation, environmental compliance costs (e.g. combustion installations, air pollution controls), greenhouse gas emissions management (e.g. EU ETS) or a loss of income due to power outages or other disruptions

Energy cost reduction can be achieved by e.g.:

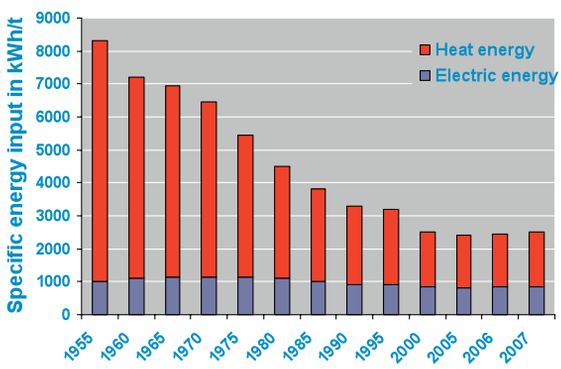
- Raising energy awareness at a corporate and individual level
- Monitoring and benchmarking of energy consumption
- Introducing energy management systems
- Developing energy strategies
- Implementing more energy efficiency measures / more efficient technologies
- Managing energy purchase contracts

Energy management: changing the mindset

Energy management shows healthy dividends for any business. Experience with energy management in many companies around the world has

[2]See presentation Edelmann "Energy legislation and carbon emission trading Rising energy cost challenges on paper industry"

demonstrated that energy efficient companies not only are more energy efficient, they also use water, resources and human resources more efficiently. Hence, superior energy management is good business. Recent research suggests that leaders in energy management are able to achieve superior financial performance.
Unfortunately, capturing the inefficiencies has been hampered by a lack of focus. Too often energy management is characterized as: decentralized, poorly coordinated, under-staffed or outsourced, focused on paying bills & running the powerhouse, reactive, undervalued, considered capital intensive, or non-controllable. Energy use is controllable by having the right mindset and approaches. Successful management recognizes the "human factor", creates an organization-wide system and programme for managing energy, delivers sustained reductions over time, is designed for continual improvement and relates itself to the core business of the organization.



Source: VDP, Papier 2008

Figure 4: Reduction in energy demand due to increased efficiency

In terms of changing mindsets, one could also reconsider the paper mills' business concept: is it the paper mill's objective to deliver the best paper quality at the right time? Or is it to provide a material which can serve the functionality the customer wants or to make money out of all elements of the fibre whilst delivering functionality to the customer? A change of mindset might also be needed in other aspects. Traditionally companies bought paper machines on output, speed and grammage, but times have changed and many are considering energy and water consumption as main criteria in the selection process (see figure 4). Energy should be an integrated part of the production process and should be taken into account in all decision making. The biggest opportunity in saving energy is to eliminate process steps, continuous agitators, pumps, valves and overcapacity (e.g. reserved power and maybe future growth).

Optimizing energy use over the value chain

Optimizing energy efficiency in one part of the value chain is obviously beneficial. However, the value chain (or value network) is complex and understanding the overall picture is a significant challenge. The optimal solution is determined by a series of complex variables including the business model and the technology deployment in the value chain. A future solution introduces more variables such as water, fibre, land use and metals, too.

There is a lack of understanding of the business model and methodologies to combine them. By combining different models and optimizing the overall balance to maximize the energy-eco-resource efficiency we arrive at an optimal sustainable solution(s).

Energy costs reduction

The energy strategy for paper mills these days is focused on keeping the energy cost competitive. Main contributors in achieving this are: reducing the use of the most expensive energy items like oil, gas and purchased electricity (e.g. by replacing fuel oil with forest residuals), improving the energy efficiency of production assets (by e.g. recovering excess heat in the 60-80 °C range for supplying to district heating systems). By adopting a structural coherent strategy to reduce reliance on fossil fuels, mill energy costs will be decoupled from increasing oil and gas prices and continue to reduce CO2 emissions.

Energy price management

Apart from energy savings, energy cost savings are increasingly important for energy intensive companies operating in global markets with ever increasing fuel and electricity prices. The focus on the price side of the energy equation shows how failure to manage energy prices impacts business in many different ways. One of the reasons organisations fail to manage the threat from rising energy prices is that they are torn between conflicting objectives. On the one side there is a tendency to fix prices in order to control absolute costs, on the other side, having the opportunity to reduce costs in falling markets requires leaving prices on the market. It is impossible to predict future energy price movements, so a better solution is to manage the risk, reducing the threat of future high energy prices by a better understanding of the energy markets. Press advantage by reducing risk as prices rise and increase market participation as they fall. Use market information not as a basis for purchasing decisions but to finesse them.

Energy neutral paper mill

Energy neutral can have several more meanings: e.g. without the use of fossil fuel, without CO2 emission, without CO2 tax or with no energy costs. Furthermore, in order to work towards an energy neutral mill, choices can be made on 3 levels: fuel use (sustainability), energy conversion (efficiency) and paper mill energy demand (economic use).(see figure 5)

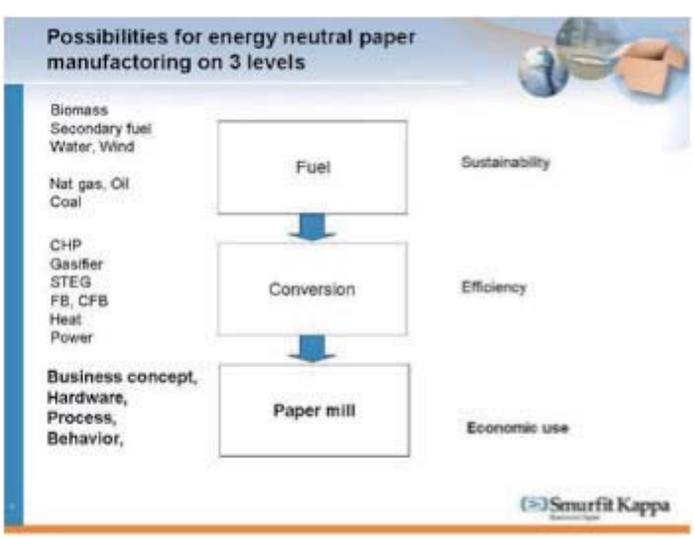


Figure 5: Achieving an energy neutral paper

A guideline towards becoming energy neutral is the Trias Energetica (see figure 6):

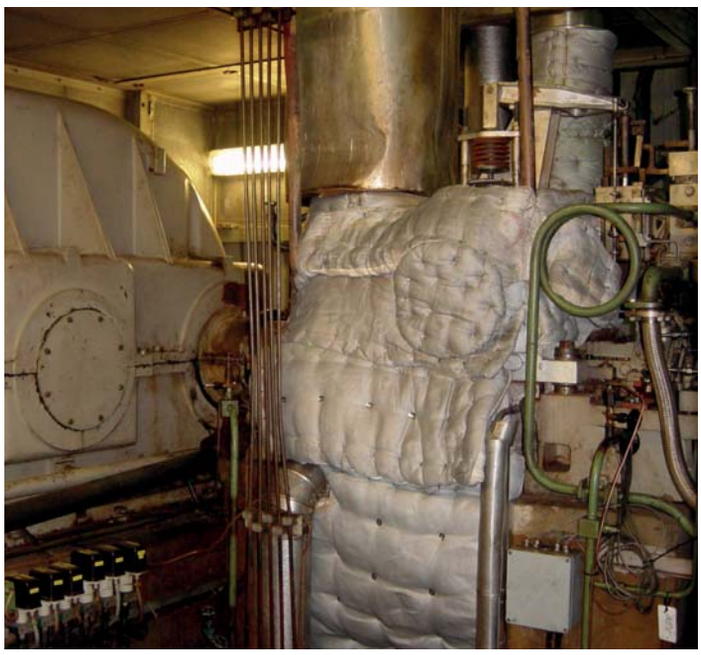
- Avoid energy use
- Use sustainable energy
- Use fossil fuels as efficiently as possible

Figure 6: The principles of Trias Energetica

Conclusions “Setting the scene”

Companies in the forest products industry, have both challenges and opportunities related to CO2 emissions and energy. The paper business is nowadays a very low margin business with harsh international competition. By their nature, the industries’ main raw materials are renewable wood fibers that carry their inherent carbon throughout their lives. What is not recycled for new products can, and is to a large extent, be utilized for energy generation internally in the mills or in external power and heat plants. With the latest energy price developments and the introduction of EU ETS it is evident that efforts in reducing CO2 emissions and reducing energy consumption is becoming increasingly important for the European paper and board industry.

Both, in view of its responsibility and in view of economical considerations the pulp & paper industry has a strong motivation to reduce the energy necessary for their products and processes to an as large as possible extent. The main challenges and corresponding strategies for papermaking are:

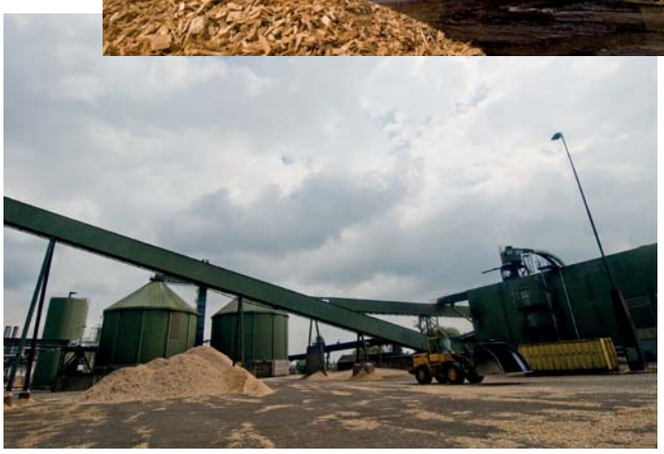


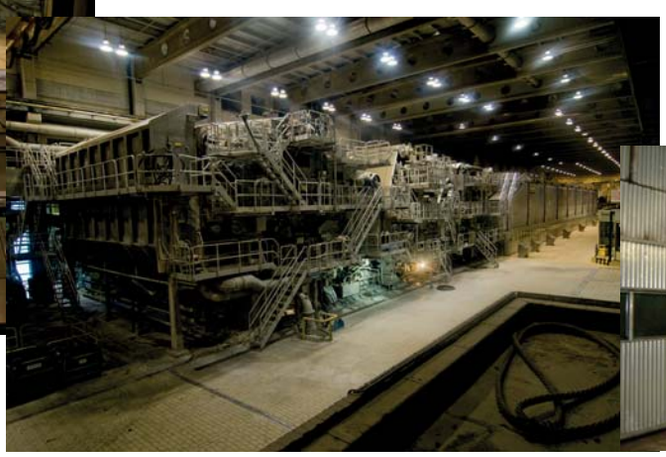
Increasing price of energy and wood

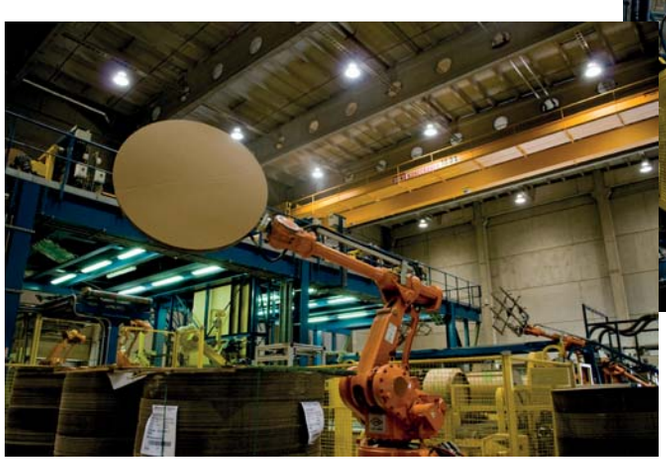
- Energy and raw material efficiency must be improved
- Energy (price) management to save energy and energy costs should be improved
- Sustainable and innovative bioenergy technologies should be integrated to forest industry sites.
- The use of round wood as feed material to bioenergy market should be avoided and the use of forest residues, solid recovered fuels and other biomass should be maximised.

New product and process concepts

- More from less is required
- Value chain optimisation is essential
- More value added products are needed





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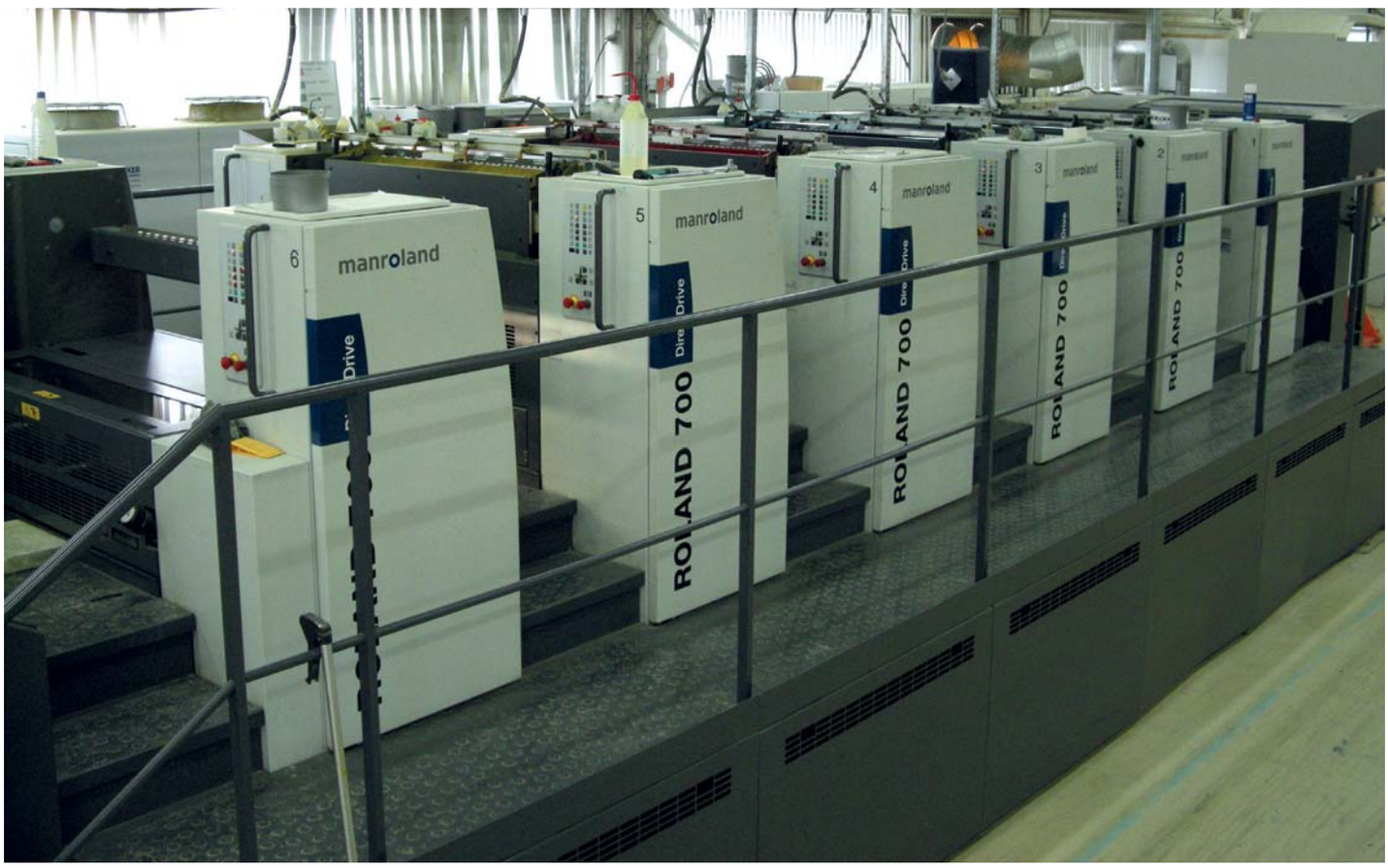
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Session 2A: "Best practices-What could be done better?"

High energy prices, strong competition and growing legislative pressure on using fossil fuels force the paper and board industry to improve the energy efficiency of their paper production. An important aspect in improving energy efficiency of production processes is ongoing optimisation. Optimisation can take place by either implementation of a new process/technology or by adjusting parameter settings of current practices. So what are the optimal settings or technologies for each paper production process?

Current best practices

Energy management and modelling of energy consumption

In the wake of the oil embargo in the 1970 and with the ongoing increases in energy prices, the use of the expression "energy management" became increasingly popular in the industrial sector. During the last 40 years the meaning of this term has become much clearer and the concept behind it gradually gained importance in virtually all industries. Today there is no longer any doubt that energy management can make a very substantial contribution to the overall profitability of a production plant by reducing the specific energy consumption in terms of kWh/t of product.

Energy management as it is understood and applied today therefore describes the sum of measures planned and carried out to achieve the objective of using the minimum possible energy while the comfort levels of the production environment and the production rates themselves are maintained or improved. Energy management concepts can be applied to a factory, to a production line, to an office building and to any kind of installation where energy use is required. In order to deal the energy issue in a more responsible way, all actions developed in the frame of energy management shall include the conservation, the recovery as well as the substitution of energy.

An energy management concept must be practiced as a continuous process in order to be successful. A major prerequisite is the general commitment of the entire staff of a mill at all levels. Once this is achieved the energy situation of the whole production site or of a specific part has either on a regular basis or on demand to be passed through a number of optimization steps which typically include

- The assessment of the (energetic) performance of the processes under consideration
- The definition of goals
- The creation and implementation of an action plan
- The evaluation of the progress achieved

Example: Monitoring electricity consumption

Goals

- Estimate the impact of operational practices on energy consumption
- Obtain information on the success of process design
- Evaluate potential and economics of equipment re-sizing
- Detect maintenance demands of process equipment in advance before any significant deterioration in performance occur

How it was done

- Data acquisition system was installed and connected through standard interfaces to the process automation system, the energy control system, measurements of the electrical network and different equipment registers
- A monitoring period of several months was used to capture all possible load situations
- Power consumption measurement was estimated using either correlation methods or type-specific load curves of electric motors.

Studies were undertaken in an effort to achieve the most cost-effective energy systems for particular applications.

Optimisation of current practices

For every process there is at least one set of parameters which provides the optimal energy efficiency. Unfortunately, in many paper mills this optimal setting is often not achieved. For example research average pumping efficiency for many mills is below 40%, and that for some pumps the efficiency was even below 10%. According to research by Voith optimisation can even lead to up to 18% reduction in energy consumption.

Figure 7a: Energy recovery

Figure 7b: vortex impeller

Reasons for lack of optimal energy efficiency are often lack of fundamental knowledge of the process, or lack of monitoring ability to determine which setting is best. So in order to improve the settings and thereby energy efficiency, thorough understanding of the processes is required as well as detailed monitoring in order to validate the efficiency improvement of the new parameter settings.

[3]See presentation Jonas Ericsson, Scanpump, about improved pumping efficiency

Examples of improvements which can be made under such conditions are:

- Reduced energy usage in the dryer section by systematically modelling this process, and determining optimal parameters for drying of different paper grades.
- Higher efficiency of pumps by variation in speed of the pumps, variation in pump sizes for different processes and implementation of most energy efficient pumps and electric motors.
- Less energy requirement for flow of pulp in closed channels. By using the developed semi-empirical model by VTT for estimating friction losses in fibre suspension flows one can avoid over dimensioning of the channels and gain better control of flow and flow induced instabilities.
- Optimisation of fuel usage and steam availability by using Model Predictive Control. This programme reduces fuel usage by simultaneously controlling various variables and "predicting" the consequences of its activities to find the optimal solution. This programme was already implemented by APC Solutions in Aylesford Newsprint.

Substituting current practices for new technologies

Improving process efficiency can also be accomplished by substitution of current practice by best practices. Many paper mills use technologies which are far less efficient than their best BAT counterparts. The savings in money by BAT through less energy usage or material losses are significant. Examples of such best practice technologies and their results are:

- Installing vacuum pumps with exhaust air heat energy recovery (with heat exchanger) by TURBAIR vacuum systems to reduce energy of wire section.
- Increase dewatering during the press section by using dewatering with the right felt design.
- Increase energy efficiency of steam usage by installing improved steam traps. Gardner Energy Management (GEM) has already successfully implemented several of their steam traps at Smurfit Kappa leading to increase in condensate return from 28% to 70%. Estimated saving per year are 300.000 €/a

Conclusions "Best Practices"

Current specific energy consumption in the paper industry (and many other industries) is still far away from the theoretical optimum, which means that the energy saving potential is significant. The question is how these opportunities can be identified and exploited? The complexity of the processes and process chains in paper production render revolutionary breakthroughs unlikely on the short term. But BAT technologies and targeted improvements of individual processes are a first step and are already today powerful tools to achieve substantial improvements.

Session 2B: "Next Practices-what could be done differently?"

Implementing more efficient technologies can go some way towards filling the gap between current energy efficiency and theoretical optimum efficiency (see Session 2A). However, in order for the European Paper Industry to remain competitive in a future, global market more radical innovative measures that reduce energy are required.

During the COST workshop, nine speakers presented new ideas suggesting energy-efficient evolution of the individual process steps in stock preparation and papermaking, including:

- Innovation needs of the present pulping methods
- State of the art fibre fractionation technologies that allow energy use for fibres that need treatment
- Chemical treatment of fibres and fractions
- Papermaking potential of fractions
- Potential of stratified forming technologies
- Low consistency refining
- Steam and air systems in the drying section

Three presentations focused on topics of generic interest, with discussions on:

- The use of life cycle assessment tools in evaluating the environmental impacts of energy efficient TMP process
- Best-practice approach to energy management
- Non-traditional waste derived fuels

Together these presentations cover the area "What could be done differently?"

Future innovations

Non-papermaking aspects of improving energy efficiency

The implementation of a local strategy to improve energy efficiency is a complex holistic task that requires a well-defined management approach. This should start with a shared assessment and understanding of the maturity level of the company for this activity. Keeping focus on top consumers and combining in-house ideas with those originating from external sources (e.g. consultants and suppliers) are two important steps. Additionally, looking outside the borders of the pulp and paper industry might be a key to assessing energy-saving approaches that have been developed in other process industries. Special attention should be given to the "sustainability phase" in which the results of an energy efficiency project are implemented and standardized in the company, becoming a new shared best practice for the entire operation.

Life Cycle Assessment studies are useful in analysing the environmental effects of energy efficiency improvements. Not only unit process improvement but also its effects in the whole value chain must be taken into account. The impact assessment should be extended from the cradle to grave. In some situations, depending on the local situation, (i.e the availability of bio fuels) CO2 emissions of the process may even increase as the consequence of energy efficiency improvement of mechanical pulping process. For example in the case of TMP production, if the efficiency of the TMP refining is significantly improved, the availability of the recovered steam available for paper drying is reduced.

Using non-traditional fuels can be one solution to the problems generated by the increasing cost (economic and Carbon Emission) of fossil fuels, an increase that cannot be recovered in the prices of the final products. Fuels derived from waste (see figure 8) can provide stable long term pricing and secure energy supply close to the point of utilisation. The importance of a correct choice of wastefuel and of a development of solid long-term strategies was discussed so that both the supplier and the end user carry the correct risks. Indeed, many forms of waste fuels are rich in biomass and are currently accompanied by a gate fee, which might contribute substantially to the economy of energy generation.

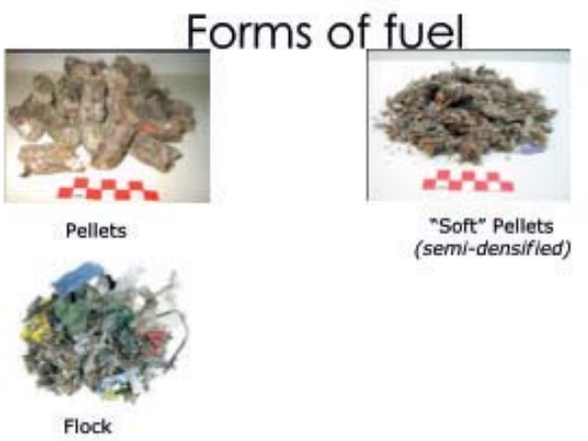


Figure 8 : Various forms of biofuel

For example, transformation of organic content contained in waste waters into biogas by anaerobic treatment delivers additional energy sources and reduces emissions.

Papermaking aspects of improving energy efficiency – Stock preparation and wet end

The profitability of many paper grades, containing mechanical fibres is seriously affected by the rising cost of energy. A breakthrough type innovation in the improvement of energy efficiency of the mechanical pulping process is required. In addition to or together with energy considerations, solutions should be developed to diversify the raw material base of mechanical pulps.

The best chemical pulp mills produce more energy than they consume. The energy output can further be increased through process improvements (such as in the recovery boiler) or by use of gasification techniques. Chemical pulp mills could serve as a platform for future bio refineries resulting in more value from wood raw material.

The advantage of fibre recycling processes is that it is resource efficient. However, means to reduce fibre losses and to recover fibres from alternative waste materials need to be developed. In general, resource intensity of fibre production methods should be cut down and one should be able to utilise also lower quality fibre raw materials.

Current low-consistency refining is a top energy consumer based on established technology with no dramatic evolution in the recent years. One promising innovative way to improve energy efficiency is compression refining. Yet, there are several current trends which might lead to lower energy consumption on a step-by step basis: ad-hoc designed fillings, improved machinery, use of chemicals and enzymes and improved systems control via variable-speed drives.

Fine tuned paper chemistry can help saving energy in refining of chemical pulp with enzymes and by realising the refining in the presence of proper counter ions (sodium instead of hydrogen). Water retention value (WRV) of the pulp affects drainage and solid content of the sheet after press. Chemicals and enzymes can be used to reduce WRV. Surface charge can be modified to result bulky sheet structure with good bonding so that less material is consumed to achieve rigid layered sheet structures. Total energy saving potential with chemicals requires research through the various process steps from refining to forming, pressing and drying.

In de-inking processes, fractionation of pulp into short and long fibre fractions and bleaching the fractions with different chemicals made it possible to reduce both energy and chemical consumption and furthermore higher pulp quality was achieved than without fractionation using less sophisticated process concept. Fractionation, especially when the selectivity is high enough, makes it possible to reduce energy consumption in reject refining of mechanical pulping. Today the consistency is however limited to 0.5 – 0.7 % that increases the volume of the fractionation unit processes. Special screen plate design and special cleaners may improve the performance of fractionation considerably. Typically, the fractionated pulps differ from each other with respect to bulk, tensile index and fibre roughness that make it possible to create stratified properties that cannot be done otherwise and reduce in this way the consumption of raw materials. Fractionation may also be used to extract high value fibres in bio refinery concepts.

Stratified forming techniques (see figure 9) can be used to produce sheet with improved properties with fewer fibres and less energy. The control of layer purity has been improved through the use of so called aqua vanes between the layers. Chemicals, fillers and fibres with different properties may be introduced in different layers.

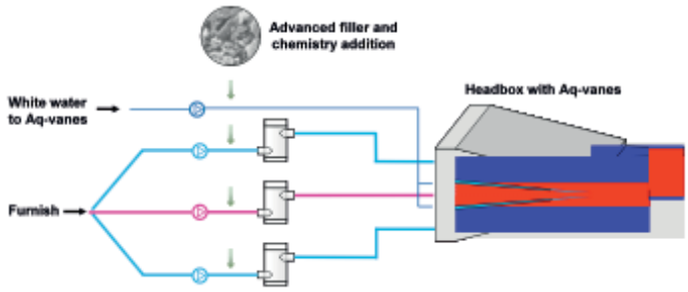


Figure 9: Stratified forming

Coarser or lower quality fibres may be hidden in the middle layer below high quality fibre surface layers and save energy through refining. The most promising results have been achieved with a super calendered (SC) paper concept using filler and chemical layering. Demonstration at pilot scale is required to verify work already performed at a laboratory scale.

Promising and innovative approaches for saving energy in stock preparation and papermaking are based on system solutions involving a number of unit operations. The energy efficiency of a top consumer as low-consistency refining processes may see radical improvements if refining is viewed as an integral part of a larger process approach. One example is selective refining and chemical treatment of furnish sub-streams after fractionation. A further step would involve the adoption of new technologies for stratified forming of paper. The energy consumption of these process systems cannot be compared directly with each of the conventional steps involved. Thereby the new approaches have a potential for opening new optimization windows, which would lead to lower energy consumption.

Papermaking aspects of improving energy efficiency – Drying

Steam and condensate systems used in the drying process use approximately 80% of the total steam demand in a paper mill. Examples of steam saving actions with short pay- back time are the conversion to stationary siphons and heat transfer bars.

The use of automated control systems supervising human intervention on process settings is another area with potential for major energy savings. A computerized system would guarantee consistency in the mode of operation by running the process as close as possible to the local best practice and could automatically reduce steam consumption during breaks in production. The adoption of an automated approach to steam utilisation offers levels of saving that could not be achieved by manual operator intervention.

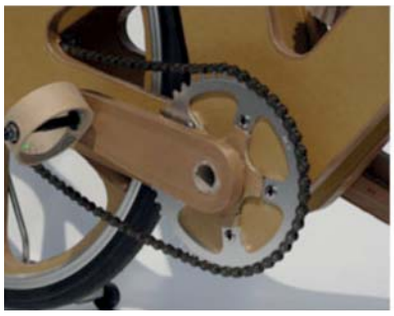
Air systems in the drying section are another area where the balance between runnability and energy consumption should be better understood and optimized. Understanding the operating parameters in these systems, as well as control technologies that optimize running conditions is important for reducing the energy consumption. New technologies offer possibilities to further improve the situation.

Increasing the dew point of the drying section reduces steam consumption. Studying the thermodynamics of air systems, the energy efficiency in the drying section can be improved by application of the optimal exhaust air conditions. One option, for certain grades, leading to energy savings is an increase of the process temperature in the drying hood. This has the side effect of improving of the quality of the exhaust energy, with positive repercussions on the economy of the rest of the system if this energy can be recovered and utilised.

Conclusions of “Next practices”

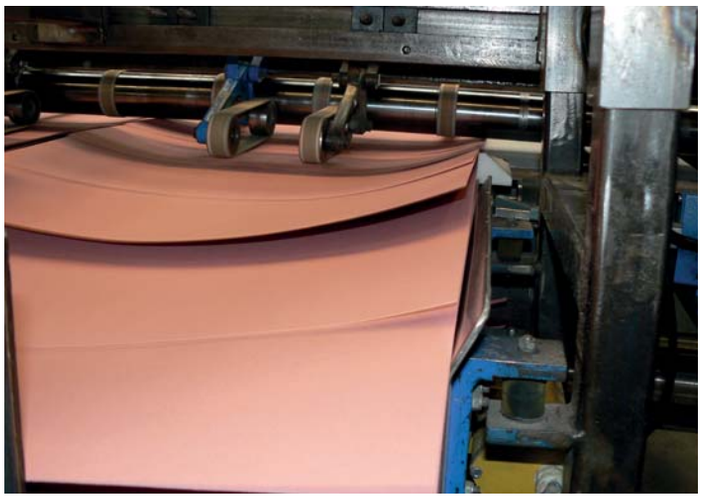
Further reducing the energy usage after implementation of current BAT requires innovative measures. These can be found on both a papermaking level as non-papermaking level. The first one provides examples such as dematerialisation, decreasing drying energy by decreasing WRV or increasing the dew point of the drying section, or using improved ways of refining. The second one provides examples such as using ‘Waste Streams’ as feedstock or fuel.

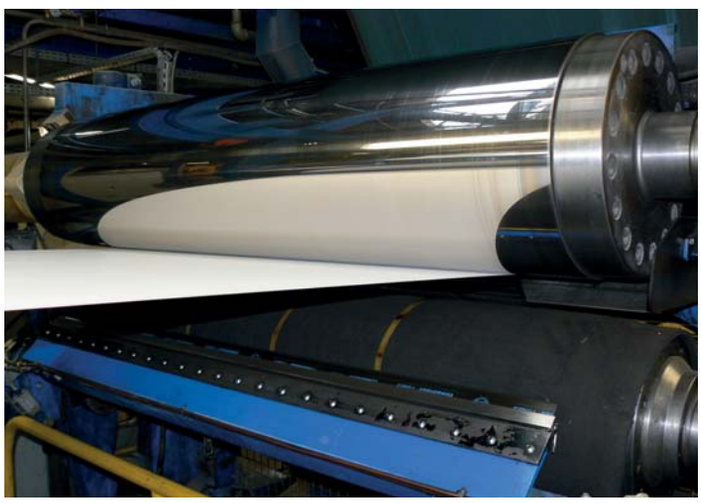
[4]See presentation Jonas Ericsson, Scanpump, about improved pumping efficiency




CARDBOARD BICYCLE


CARDBOARD BICYCLE





Session 3: "The Future; Trends, Developments and Prospects"

The meeting concluded with the definition of urgent research issues towards 2015 – 2020. A corresponding roadmap was defined on the basis of (oral) inputs concerning the "Energy Scene" as influenced by society, policies, economics and numerous technological options. This defined what can be done immediately without major investments and the potential impact of the installation of BATs.

Trends, Developments, Prospects

The Kyoto agreement and the targets set by the European Union will increase the demand of bio fuels. The demand for bio fuels has been estimated to grow up to 230 Mtoe by 2020 (million tons of oil equivalents). According to the plans, bio fuels will be mainly used for power generation and for transportation. Agricultural crops, forest residues, process waste and import outside EU are needed to satisfy the future bio fuel demand. Oil price, cost of CO2 emission allowance and market price of green electricity will all have effects on the market price of wood.

To ensure a secure future the pulp and paper industry must reduce the energy and raw material intensity of her processes and develop new value added products. Nowadays, the forest products industry uses about 380 Mm3 round wood (equivalent to 65 Mtoe) to produce materials for construction, packaging, printing and hygiene products. European PPI with her 1280 mills and 400 billion € annual turnover employs directly 279.000 and indirectly 4 million people.

Forest residues generated in harvesting round and fuel wood and the annual change rate of European forests represents a very large bio mass potential (about 800 Mm3/a). New methods and technologies are needed to improve the efficiency of harvesting in mountainous and other difficult areas.

Green electricity, bio diesel, bio ethanol, bio chemicals and bio materials represent new opportunities for PPI. Short term targets should however be focused on efficiency improvements of operations and on reduction of energy costs. Energy efficiency can be improved through adoption of Best Available Technologies (BAT) and development of new lower energy technologies (see figure 10). Environmental impacts and costs of energy solutions of products should be analysed with the principles of life cycle assessment (see presentation from KCL).

Roundtable discussion

The round table discussion was focused on the following three major topics:

- Enhancing of present technology and processes
- Strategic energy and business management concepts
- Development of breakthrough technologies

Enhancing of present technology and processes

Energy auditing and benchmarking is a quick way to outline the overall situation and improvement potential of a paper mill. Differences between the same category paper mills arise from different process operation and housekeeping and maintenance practises and monitoring and control systems, and from the use of different technologies. Usually old technologies are not as effective as their modern counterparts. The correct selection of electrical motors and the use of variable speed drive motors, where applicable, help to improve process efficiency. The chosen Process Parameters of identical unit operations can also have a profound effect on energy consumption. The following technologies and methodologies could be implemented without large capital investments:

- Correct dimensioning of processes and equipment
- Replacement of water ring pumps with turbo fans
- Improved performance of forming and pressing fabrics
- Dryer section hood performance and heat recovery
- Energy management and monitoring embedded in the automation system
- Use of process simulation for optimisation of process conditions
- Optimisation of steam use and supply
- Full integration of in-mill energy generation and utilisation (sites and processes, electri-

cal and thermal, material and product, waste and emissions) together with the out-side district (industry parks, households).

Figure 10: Potential Energy Savings in Paperproductions

Strategic energy and business management concepts

Forest based products, energy consumption of processes and 'energy products' such as green electricity and bio mass liquids should be regarded as equally important factors in defining the future business strategies. Monitoring of the energy balance embedded in the automation system, and monitoring of the product alternatives helps industry in maximising the economic yield and in minimising the environmental impacts of the operations in changing conditions.

It must also be stressed that energy consumption can also be effected by the choice of business concept. The simpler the process the less energy it will typically consume. Often energy is extensively used to increase product quality. Means to change the customer expectations is something to consider when reducing the energy dependence of papermaking processes. Following general topics for developing low energy business concept may be presented:

- Elimination of process steps versus product quality
- A mindset for investments in energy saving technologies and taking risks at paper mills. Increasing energy prices will enable return of investment in short terms.
- Products produced from fewer and lower quality raw materials
- Simplification of process chemistry (re-engineering papermaking)

Development of breakthrough technologies

Pulping and paper drying are the most energy intensive unit operation of papermaking. Substantial amount of energy is also consumed in heating the process, in running the PM and the air systems designed for web handling and water removal, and in pumping the fibre suspensions. Typically papermaking requires about 500 – 700 kWh/t electricity and about 5 – 6 GJ/t steam.

Thermo mechanical pulping may consume as much as 2800 kWh/t electricity, but in turn the yield of TMP pulp is very high compared with that of chemical pulps. Electricity is consumed for heating of wood chips, for separation of fibres from each other, for external and internal fibrillation fibres and for peeling of the outer cell wall layers of fibre. TMP is important raw material for wood containing paper grades. Most of the energy used in the process is turned into steam that is recovered and used for paper drying. A breakthrough type innovation in the improvement of energy efficiency of the mechanical pulping process is required to ensure economy of wood containing papers. However, the overall picture is not simple due to fibre quality demands and strong process integration between pulping and papermaking processes. On-line monitoring system for rapid comparison of energy efficiency and product quality is needed.

Improvement of the energy efficiency of the pulping process would reduce the steam supply from TMP-plant to the PM. In that case, extra steam must be produced for the drying process. Available fuel quality affects then on the quality / level of emissions.

Thus efficiency improvement of the fibrillation process should be followed with improvements in the secondary heat recovery and in reduction of steam consumption. In addition to or together with energy considerations, solutions should be developed to diversify the raw material base of mechanical pulps. Following areas should be explored aiming at revolutionary innovations:

Mechanical pulping – reduction of electricity consumption

- Pre-treatment of wood chips
- Energy efficient refiner technologies
- Development of selective fractionation methods for pulping
- Concepts for the utilisation of alternative wood species and / or fibre sources.

Chemical pulping

- Reduction of electricity consumption and increase of electricity production
- Separation of lignin and black liquor gasification
- Extraction of wood components for bio refineries

Fibre recycling processes

- Reduction of fibre losses
- Recovery of fibres from waste materials

Reduction of steam consumption

- Modification of fibre properties with enzymes and chemical treatments
- Heat recovery technique of forming and pressing sections
- Process chemistry of high temperature papermaking
- Reduction of steam consumption in the dryer section
- Integration of waste gasification and impingement drying

Papermaking process

- High consistency processing
- Integration of stratified forming with energy saving concepts

It must also be noted that the recent developments with the potential for significant enhanced energy efficiency are still some way from implementation. Investments in pilot plant demonstration will require venture capital.

Roadmap towards 2020

The objective of the Strategic Workshop was to identify the future research needs of the European Pulp and Paper Industry and to define the roadmap for the upcoming years.

Major conclusions are:

- The EU policy of improving the energy efficiency by 20 % in the period 2005 – 2020 is probably not sufficient to maintain a competitive position for the European Pulp and Paper Industry (and could have a negative effect on the industry).
- Significant achievements must be realised, on the basis of both novel business and technological concepts.
- Although a lot has been achieved in the past by incremental improvements, technological research should be more and more combined with the socio-economic aspects and the development of accompanying new business models for the successful implementation of innovations.
- A number of more energy efficient technologies are already available or are close to market introduction; however, considerable scope for further improvements is available and must be researched / developed over the upcoming 10 to 15 years.

Major technological challenges in the roadmap to be met in the upcoming years via R&D are:

- Integrated pulping technologies in conjunction with bio-refineries
- Introduction of high consistency and higher temperature paper production
- Novel fibre processing technologies
- Improved dewatering and drying technologies

Overview presentations at the workshop

Table 1: The schedule of the days and the presentations

"Setting the Scene"

"Welcome address"
Willem Emmen, Royal VNP, The Netherlands

"Introduction by the session chairman"
Arie Hooimeijer, KCPK, The Netherlands

"Energy and papermaking"
Harald Grossmann, TU Dresden, Germany

"Energy legislation and carbon emission trading; Rising energy cost challenges"
Kari Edelman, Kai Sipila, VTT, Finland

"CO2 reduction, business cases in Stora Enso"
Mikael Hannu, VP Energy StoraEnso, Sweden

"Setting your mind to energy efficiency"
Ernst Worrell, Ecofys, The Netherlands

"Energy in the value chain"
Petri Vasara, Poyry, Finland

"Future energy scenarios"
Mark Dickinson, Encore International, UK

"Energy Neutral Paper mill"
Math Clumpkens, Smurfit Kappa Roermond Papier, The Netherlands

"Introduction to tomorrow's programme"
Harald Grossmann, TU Dresden, Germany

Overview presentations at the workshop

Parallel Session "Best Practices"

"Introduction by the session chairman"
Harald Grossmann, TU Dresden, Germany

"Energy management"
Jussi Manninen, VTT, Finland

"Monitoring energy consumption"
Bernd Maur, "TS, Germany

"Energy optimisation through comprehensive process simulation"
Vinicius Lobosco, PaperPlat AB, Sweden

"Friction loss in closed channel flow of pulp"
Ari Jasberg, VTT, Finland

"Improved pumping efficiency"
Scanpump, UK

"Most efficient vacuum systems for dewatering"
Jorg Zurcher, MAN Turbo AG Switzerland

„Introduction by the session chairman"
Barry Read, The Fibre Technology Association, UK

"Energy efficient dewatering and pressing"
Hannes Vomhoff, STFI-Packforsk, Sweden

"Modern press clothing"
Michael Dick, Hembach, Germany

"Optimisation of fuel usage and steam availability in the power and steam plant at a paper mill"
Paul Austin, APC Solutions Consultant Perceptive Engineering Ltd, UK

"Steam traps & condensate systems"
Tim Gardner, Gardner Energy Management Ltd., UK

„Best Practices in The Netherlands, top ten energy saving opportunities"
Bruno Mulder, META BV, The Netherlands

"Mill experiences"
Barry Read, The Fibre Technology Association, UK

Parallel Session “Next Practices”

“Introduction by the session chairman”
Kari Edelmann, VTT, Finland

“Evaluating environmental impacts of new technologies-applying life cycle assessment”
Tiina Pajula, Finland

“Innovations in Mechanical Pulping”
Jaakko Jokinen, Poyry, Finland

“Energy efficient refining”
Eero Hiltunen, HUT, Finland

“The chemistry of saving energy”
Mikael Ankerfors, STFI-Packforsk, Sweden

”Energy saving using fibre fractionation and layered sheet forming”
Francois Julien-Saint-Amand, CTP, France

”Stratified forming “
Daniel Söderberg, STFI-Packforsk, Sweden

“Introduction by the session chairman”
Marco Lucisano, STFI-Packforsk, Sweden

“A generic best-practice approach to implement energy management in a pulp & paper company”
Dirk Den Haese, Siemens, Belgium

„Energy saving by novel de-inking technologies“
Erwin Hertl, Andritz AG, Austria

„Waste or refuse derived fuels“
Craig Ibbotson, Regen Fuels, UK

“Steam system efficiency”
Benno Duller, Kadant Johnson Systems International Ltd., NL

”Paper machine air systems as tools for improving energy efficiency”
Petri Norri, Metso, Finland

“Improving energy efficiency drying section and heat recovery”
Frans de Gram, Royal VNP, The Netherlands

“The Future”

“Introduction by the session chairman”
Gunnar Svedberg, STFI-Packforsk, Sweden

”Research for improved energy efficiency: ECOTARGET- A large scale European project”
Catharina Ottestam, STFI-Packforsk, Sweden

“Sustainability- chances for a change in paper making processes”
Christian Naydowski, Voith Paper, Germany

“Roundtable discussion Identifying the Future Research Needs of the European Paper Industry; A working session on defining the roadmap for the upcoming 12 years”
Panel members:
Mark Dickinson, Encore International, UK
Christian Naydowski, Voith Paper, Germany
Gunnar Svedberg, STFI-Packforsk, Sweden
Barry Read, The Fibre Technology Association, UK

Notes:

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