In support of the G8 Plan of Action

In collaboration with WBCSD

Energy Efficient Technologies and CO_2 Reduction Potentials in the Pulp and Paper Industry

- A Workshop in the Framework of the G8 Dialogue on Climate Change, Clean Energy and Sustainable Development-

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This document contains the proceedings of the workshop on Energy Efficient Technologies and CO_2 Reduction Potentials in the Pulp and Paper Industry, which took place on 9 October 2006, at the International Energy Agency in Paris. This workshop was organised in collaboration with WBCSD and is part of a series of industrial sector activities in the G8 Plan of Action. The goal of the workshop is to better quantify the global potential for energy efficiency and CO_2 emissions reduction in the Pulp & Paper sector and to discuss various approaches to overcome the barriers to improvements. This document reflects the presentations and discussions of the participants at the workshop. The views expressed in this paper do not necessarily represent those of the IEA or IEA policy. A CD-ROM with the workshop presentations is available from the IEA Secretariat in Paris.

Summary

The pulp & paper industry is the 4th largest industrial consumer of energy, consuming 5.9 ExaJoules of final energy in 2003 (6% of total industrial energy use). Unlike other industrial sectors, the pulp and paper industry also produces energy as by-product and already generates approximately 50% of its own energy needs from biomass. In the long term the industry could even develop into a clean energy supplier if biomass residues are used efficiently. Both existing technologies and new technologies can be applied to achieve significant energy efficiency gains. Important improvements have been made and there is a strong focus on energy efficiency in the industry.

Important differences in energy use of pulp and paper making exist between countries. They can be explained by a range of factors such as product mix, typical processes used, plant size, technology, plant age, feedstock quality, fuel prices and management attention for energy efficiency. Benchmarking can be complemented by a range of country level indicators for proper analysis of status and trends. The goal of our indicators analysis is **not** benchmarking on a plant or machine level, but a cross country comparison of energy intensity.

Energy costs, energy supply and climate change are amongst the core issues impacting on the future of the forest products industry. They will have impacts on manufacturing costs, as well as on the allocation of investments around the globe. The increasing focus on biomass as an energy source may on the one hand increase wood prices for existing industries, but on the other hand open new markets to other parts of the forest cluster. Co-production of pulp and other biomass products may result in new business models and high overall energy efficiency.

The pulp and paper industry is in a unique position, both in terms of improving energy efficiency and reducing CO_2 emissions. The sector has the ability to become a net supplier of a range of energy products and it can become an important actor in removing CO_2 from the atmosphere. However this vision will not happen overnight, and it will imply a fundamental rethinking of the sector's strategy.

The proceedings from this workshop will be presented at the *International Seminar on Energy and the Forest Products Industry* to be held in Rome on October 30 and 31. A refined analysis on country comparisons of energy use in the pulp and paper industry will be included in the April 2007 IEA publication *Indicators for Industrial Energy Efficiency and CO_2 Emissions.* This publication will be an input for the G8 2007 summit in Germany. We aim to work together with industry on a more detailed analysis on energy efficiency and to improve existing data. The next step will then be to make a detailed analysis of future technology potentials to increase energy efficiency and reduce CO_2 emissions. We will look to governments and industry for support to advance this project.

Key Messages

Country comparisons on energy efficiency and CO_2 emissions

- Data on energy use by product in the pulp and paper industry does exists amongst different companies, consultants, countries and associations, but they do not provide a full picture and the data quality is unclear and often confidential. IEA statistics include energy use in pulp, paper and printing. Separate energy use figures for pulp and paper production are available from some national statistics offices.
- Important discrepancies exist between IEA statistics and national data sources. National data sources are not necessarily comparable.

- Accounting of energy use in the industry can be distorted by energy sales to the grid and supply to district heating systems, if such sales are not subtracted from energy use.
- Strong demand growth for higher quality papers, which are more energy intensive, can mask energy efficiency gains in countries that produce these grades of paper.
- Outside of Europe energy consumption figures are often reported in gross caloric value (GCV) while IEA statistics are reported in net caloric value (NCV). Gross caloric values are 5-10% higher than net caloric values. Mixing of indicators based on GCV and NCV should be avoided.
- Similarly, some data is reported in terms of air-dried tonnes of product, while other data is reported in terms of bone-dry or oven-dried tonnes. The difference can be a further 5-10%.
- A comparison of energy consumption across countries should take into consideration the different process energy needs for different grades of paper and different pulping processes. Some countries produce mostly simple products that require less energy, while others produce more high quality products that require more energy. Energy used for the production of recycled paper also needs to be included.
- FAO provides comprehensive statistics on pulp and paper production, but categories for different paper grades do not match what is required for a more detailed indexed comparison of energy use by different paper grades. Categories used by different jurisdictions are not always comparable.
- There is a need to collect better CHP data that account for fuel input, electricity and steam production, and the type of technology (back-pressure turbines or combined cycles) in the pulp and paper industry. This will result in a better assessment of remaining CHP potentials. Different CHP accounting practices further complicate the country comparison.
- Several types of indicators are needed that account for the process efficiency (compared to best available technology) and for the systems efficiency (accounting for recycling, CHP and energy co-product supply benefits). A CO_2 indicator is also needed and can be built on the WBCSD protocol.

Technology and systems

On technology and systems issues, the presenters at the workshop made the following remarks, giving first indicators on technology issues.

- Significant energy efficiency gains can be achieved if existing mills are retrofitted with existing energy efficient technology. Energy efficiency gains from using the latest technology differ depending on whether they are greenfield mills or retrofits.
- There is a significant potential for additional excess heat recovery systems. The use of available excess heat in a more consistent way could lead to substantial steam / heat savings. Use of recovered heat depends on the need of lower grade heat. In cold areas (Scandinavia, Canada, etc.), heat is needed to increase the temperature of incoming streams (water, air, raw materials), especially during the

winter. In warmer areas (parts of Asia, South America, Southern USA, etc) there is not necessarily a use for all recovered heat.

- CHP deployment suffers from power market distortions, regulatory uncertainty and the fact that CHP is a non-core issue for most companies.
- Technological efficiency gains are reduced by structural changes that increase energy use. For example, paper machine speeds have increased significantly and special types of tissue require considerably more energy than conventional products. Even though energy use is increasing with increasing speed, development of processes and machinery has well compensated this trend. For printing and writing grades (and for other grades as well) energy use has decreased per surface area produced.
- A range of new technologies are under development that can increase the energy efficiency of the plant, such as black liquor gasification, lignin extraction and the biorefinery concept. The focus is on Kraft and soda pulping.
- Lignin removal is of interest (e.g. energy efficient mills) in cases where an excess of steam exists or can easily be achieved (e.g. process integration). It can also be used for de-bottlenecking of the recovery boiler when the pulp production in a mill is to be increased.
- Black liquor gasification offers an opportunity for a range of products. It can be combined with CO_2 capture and storage. While developments in Sweden and the US are promising, there was no consensus if this technology is the best way forward.
- So far efforts to reduce power consumption in mechanical pulping substantially have failed. As a consequence the focus is on heat recovery from the refining process. Optimisation of the grinding process has improved pulp quality and reduced energy use. The system is commonly used in North America and in other countries, too. It is one of the products of Metso Automation. A co-operation agreement has been recently signed between Paprican and Metso Automation to develop the product further.
- The question of financing investment risk is an important issue for costly demonstration plants. Strong competition and globalisation result in risk aversion. Industry requires support for the uptake of new technology.
- Potential to retrofit paper machines with energy efficiency equipment is limited by the design of the paper machine. However retrofits and plant operation can influence the energy efficiency significantly.
- Integrated pulp and paper mills can be more efficient than stand-alone mills. Integration offers synergy potential e.g. excess steam produced at the pulp mill can be utilised in the integrated paper mill. Stand-alone market pulp mill can be as efficient as an integrated mill if it can sell excess steam, electricity and/or lignin to local community/other industrial users and national grid. However the logistics of feedstock (wood and waste paper) and product transportation can limit the potential to use integrated mills and to aim for economies of scale.
- In many cases, big paper machines are more efficient than small machines. However certain producers, notably in China and India, opt for small mills that allow more flexibility in the product mix, which is more suited for local market

circumstances. In recent years, several very large more efficient mills have been built in China.

- Many Chinese pulp mills rely heavily on non-wood feedstocks. These feedstocks require more pulping energy because of their high silicon content that results in scaling of the heat exchangers in the recovery boilers. To some extent good plant maintenance can reduce these losses. Moreover black liquor losses from small-scale mills result in energy inefficiencies and polluting effluents.

International coordination

- The IEA Industrial Energy-Related Technology Systems (IETS) Implementing Agreement is a good forum for international collaboration on benchmarking methods and technology information for advanced technologies in the pulp and paper industry and for systems integration.
- China is looking to OECD countries for advice on improving its energy efficiency in the pulp and paper industry. Joining the IETS IA is one option.
- The proposed IEA country level indicators for pulp and paper will be further refined, drawing on the advice and data resources of the workshop participants.

Summary of presentations

G8 Programme – Robert Dixon, IEA

IEA activities under the Plan of Action for the G8 Dialogue on Climate Change, Clean Energy and Sustainable Development were presented. Goal is to deliver a final report to the G8 summit in Japan in 2008. The analysis of industrial energy efficiency and CO_2 emissions reduction potentials is part of this body of work.

Key Messages on Sustainable Forest Products Industry, Carbon and Climate – James Griffiths, WBCSD

WBCSD is a coalition of 192 leading global companies with a shared commitment to Sustainable Development. The sustainable forest products industry (SFPI) working group account for 50% of global sales in this sector. This working group is a global platform for leading companies to collaboratively define sustainability in the forest products industry.

The industry is capital intensive, making it difficult and expensive to change technology in response to short-term policy measures. Breakthrough technologies are needed to significantly reduce energy consumption within the industry. Improvements in energy- and carbon-intensity can be accelerated by public policies that promote faster turnover of capital stock. Biomass energy is an important strategy to mitigate CO_2 emissions. However such policies could significantly impact the forest products industry. Policies must secure adequate supplies of fresh fibre. The carbon life cycle benefits associated with forest products should be accounted for. The recovery of used wood and fibre should be optimised.

Useful WBCSD publications for the industry include: UNFCCC 2005/2007 advocacy tool prepared by NCASI and a new Biomass publication which has just been released.

Pulp & Paper industry and energy indicators in the G8 industry task – Dolf Gielen, IEA

The short-term goal of the IEA G8 industry task is to publish an analysis of Indicators for Industrial Energy Efficiency and CO_2 Emissions in April 2007 that builds on the outcome of sector workshops. A discussion paper on Energy Use, Technologies and CO_2 Emissions in the Pulp and Paper Industry was presented as a starting point for a dialogue with industry experts on how to best look at energy efficiency and CO_2 reduction in the Pulp and Paper industry.

A country comparison of energy use in the pulp and paper industry was presented. Countries in this analysis represent over 80% of global paper and paperboard production and 90% of wood pulp production. The energy intensity of countries was compared based on an index that weighs the product mix and the physical energy intensity of production processes relative to best available technologies (BAT).

The IEA analysis of steam and electricity consumption versus BAT in the main pulp and paper producing countries suggests significant room for improvements in many countries. Certain countries have achieved significant efficiency gains over the last decade. The preliminary data suggest a factor of two difference between the best and worst countries. However a number of participants stressed that the method used needs to be refined further, with more detailed analysis of the product mix and a new indicator that accounts for recycling and CHP credits. Also the energy consumption data must be validated. The preliminary country results are not suited to draw far-reaching conclusions.

The IEA projects that the pulp and paper industry will consume 7 – 10 EJ of energy by 2050. In both the ACT scenarios with ambitious global CO_2 reduction policies, the sector becomes a net CO_2 sink with emissions reduction of 0.5 Gt CO_2 per year compared to the Baseline scenario. It is assumed that all black liquor boilers are replaced with gasifiers by 2050 and 75% of these gasifiers are equipped with CO_2 capture and storage.

Status and Global Trends

Energy efficiency developments in Europe, North and South America – Jaakko Jokinen, Poyry Consulting

This presentation covered energy efficiency in the European, North and South American pulp and paper industry. In order to compare energy efficiency across regions and countries, there is a need to include differences in the production profiles of countries. This task is further complicated by the fact that there is no one reliable source of energy data for the industry. Poyry has a database for benchmarking of individual plants and paper machines.

Poyry Consulting uses technical age as a tool to evaluate (not measure, only evaluate) energy efficiency across countries and regions. As older technology will no longer keep up with best available technology, this tool provides a good indicator for comparing energy efficiency of plants and countries. This tool showed that the average technical age of printing and writing paper plants in North America is 18 years; in Latin America 15 years and approximately 12-13 years for Europe. The lower the technical age the higher is the expected energy efficiency of that region.

Although paper making technology has developed significantly, improvements in the quality and strength of printing paper has also meant that some of the energy efficiency gains have been offset by higher energy requirements for producing these higher quality papers. Global demand for paper has been driven by better quality papers which require more energy.

Heat recovery systems are also another important area for improving energy efficiency in the industry. In North and South America many plants do not have heat recovery systems, while in Europe most pulp plants are equipped with these systems due to the extensive use of district heating which is not needed in South America. In North America, the remote location of many mills makes such heat recovery systems less attractive.

The cost of energy also plays an important factor in energy efficiency across regions. Motivated by high energy prices the European pulp and paper industry have made greater efforts at improving energy efficiency, while in South America the abundance of cheap hydro power has made energy efficiency less important. Motivation for energy efficiency is also another important factor to consider when comparing efficiencies across countries and regions. The Kyoto protocol has led European and Canadian pulp and paper companies to focus more on improving energy efficiency.

Current energy efficiency in the Chinese Pulp & Paper industry – Li Zhoudan, China Light Industry Cleaner Production Centre

China is the 2nd largest paper producer and consumer in the world. In 2005, the output of paper and paperboard amounted to 56 million tons, while consumption reached 59 million tons. There is a wide gap between China's energy intensity in the pulp and paper sector and that of developed countries. The main reason for this difference is the large portion of non-wood pulp, which is more energy intensive and not present in other developed countries. Bamboo, sugar cane, reeds, wheat straw and rice straw are the main sources of other fibers. Other influences include process, technology used, capacity and management skill. As part of the 11th Five- Year Plan, China has implemented a forest-paper integration project that would increase the availability of domestic woods for pulp production.

In an effort to reduce the environmental impact and energy consumption in pulp production, China has increased the volume of pulp production from waste paper and today accounts for 64% of total pulp production. This has caused energy intensity in the Chinese pulp and paper industry to decline. Average energy consumption in waste paper pulp production in China is much more than the 2 GJ / ton level in Europe. This represents a significant potential for improving energy efficiency.

Average capacity size of Chinese pulp and papers mills is very small. Small mill sizes make many energy efficiency solutions uneconomical. With regard to technologies, many of the small pulp and paper mills are still using technologies from the 1960s and 1970s. In an effort to reduce the number of small mills, China has introduced a minimum size of 34,000 tons for new pulp mills and announced the closure of all pulp mills with capacity of less than 10,000 tons. There is a push to develop larger mills which use the latest technologies.

Benchmarking energy use and GHG emissions – Thomas Browne, Paprican

An update of the IEA Benchmarking project was presented. The goal of this project is to provide a consistent reporting methodology across jurisdictions. The project defines: what to measure, data requirements, process areas and product grades. It is recommended that data be collected on energy produced and consumed and fibre produced and consumed. Energy is then allocated to different areas and products. The IETS project aims to provide a consistent measurement and reporting method for existing mills, not set a standard for mills to meet. Finland, Sweden, Norway, Canada and the USA are involved in this project, as well as CEPI. A final report is due at the end of 2006.

An overview of the 2002 Paprican analysis on energy use in the Canadian pulp and paper industry was also given. This project surveyed 50 Canadian mills of which 45 are still in operation today. The best performing mill was 2 times better than the worst mill (of the 45 still in operations). The other 5 mills which have since closed were 3-4 times less efficient. Higher energy prices in recent years have made these mills unprofitable to keep in operation. Where possible, mills with multiple production lines were included in this analysis.

The best mills are not always the newest mills. There are new mills with heat recovery systems that were badly managed that performed worse then older well managed mills. Some of the older mills were better managed and more careful with energy use than newer mills which, although were designed with more energy efficient technology, suffered from poor energy management. Therefore technology data alone do not suffice to assess the energy efficiency of pulp and paper plants.

From a policy perspective, it is essential to have good data, measured and reported according to similar methods, in order to make sensible comparisons.

Technologies to improve energy efficiency and reduce CO_2 emissions

Improvement potentials in chemical pulping: Black liquor gasification – Rikard Gebart, Lulea University of Technology

An estimated 30% of all diesel and gasoline consumption in Sweden could be replaced by synthetic fuel from pulp mills. Black liquor gasification is the key to producing this synthetic fuel. Black liquor is an energy rich by-product from kraft pulp production which is currently burned in a recovery boiler to produce electricity and steam for the pulp mill. Gasification allows for greater energy recovery, notably in power generation. However production of transportation fuels seems a better option in economic terms. There are 2 different processes for black liquor gasification: high temperature and low temperature. In Sweden the high temperature process is being developed to produce Methanol, DME or synthetic diesel.

This technology is a few years from becoming commercial. A national Swedish research program that started in 2001 is aimed at answering important questions about availability and maintenance costs; scale up and process optimisation; mill integration; high temperature chemistry and kinetics; and material selection for reactor and green liquor systems. By 2030 black liquor gasification is estimated to yield an additional 15 TWh of synthetic fuel from 30 TWh of biomass. Production costs are expected to be lower than conventional gasoline and diesel prices. Two demonstration plants of 45 and 65 MW are expected to start operation in 2009. Commercialisation of this technology is expected to follow quickly if the demo plants are successful.

Energy efficiency improvement in mechanical pulping – Pekka Ahtila, Helsinki University of Technology

Energy efficiency improvement in mechanical pulping depends on the total energy efficiency of the mill. In general, mechanical pulping is only one part of the mill. The total energy efficiency of the mill first needs to be analysed. Only 1-2% of energy used in mechanical pulping is used to release the fibre. Comment from P Axegård: Other theoretical estimates are closer to 10%. More than 90% of the electricity used in mechanical pulping is transformed to heat. The main source of energy efficiency gains is heat recovery. Many mills do not have heat recovery systems and therefore represent an essential potential in those mills. The key question then is how to best integrate a mill to benefit from heat recovery.

Integrated mechanical, chemical, recycled pulp and paper mills provide the best solution for improving efficiency, as heat recovered can be used in chemical pulp and paper making processes. These large integrated mills allow the maximum energy efficiency and minimize CO_2 emissions. Stand alone mechanical pulp mills do not offer the potential needed to make investments in heat recovery systems attractive. If there is no heat recovery then efficiency will be low. Energy prices are another important aspect for improving energy efficiency. High energy prices are an incentive for the industry to find solutions for energy savings.

Advanced paper making technologies – Risto Talja, Metso Paper

Energy use in paper production (per surface area produced) has decreased significantly since 1970. Depending on the type of paper product, unit electricity consumption has fallen by 14.7% to 27.6% between 1970 and 2005. Demand for process heat use has fallen by 14.4% to 32.1% over the same period. Paper machine technology has focused on increasing production (speed), a trend which has slowed down energy efficiency gains. Greater speed means more paper produced per hour, but also greater energy losses. Improvements in process design could help to improve energy efficiency.

In the case presented, heat used in paper drying accounts for 68% of heat demand on the paper machine. Increasing the solids content on the press section will significantly reduce the amount of energy required on the dryer section. An increase of 1% in solids decreases the amount of water needed to be evaporated on the dryer section by 4-4.5%.

An overview of an OptiDry vertical impingement unit was given. This system can reduce the drying time from just over 9 seconds for a conventional dryer to just over 4 seconds. By using more gas and less steam the OptiDry system reduces CO_2 emissions by 20%, if the steam is produced with coal. Total energy use is approximately the same.

Energy conversion: increasing the use of CHP systems – Jean Pierre Durnicki, Turbomach and Paolo Vezil, Metso Paper

Turbomach is a supplier of CHP equipment. A combined heat and power (CHP) unit can increase the overall efficiency to 90%. Higher efficiency means lower emissions per unit of energy produced, compared to stand-alone heat and power generation.

A case study was discussed for CHP use in a tissue mill. The application of a CHP gas turbine unit was seen to have the following benefits: 1) significant energy savings; 2) highly reliable electrical supply on continuous full load operation; 3) increase in the thermal efficiency of the drying process; 4) environmentally friendly; and 5) gas turbine supplies a clean hot gas directly usable in the drying process. It should be noted that hot gas is only used for tissue drying; other paper types will require different CHP configurations.

Comment from Jaakko Jokinen: It should be understood that the technology described here is a very special tissue paper production technology called TAD (through air drying). The share of TAD tissue on the global tissue production is marginal, most being produced in the US. In this respect the Turbomach/Metso case is not a representive CHP case for paper industry as a whole.

Integrated energy systems, alternative fuels and processes

Voluntary efforts against Global Warming by the Japanese Pulp and Paper Industry – Yoshihiro Hayakawa, Oji Paper

A voluntary action plan was established by the Japanese Paper Association in 1997 and set as its 2 main goals to reduce fossil fuel consumption by 10% (per until of output) from 1990 levels and expand forest plantation by 550,000 hectares by 2010. These goals were revised in 2004 and now aim to: reduce fossil fuel consumption by 13% (per unit of output) from 1990 levels; reduce CO_2 emissions (per unit of output) by 10% over 1990 levels and expand forest plantation by 600,000 hectares. The plan covers 88% of total paper and paperboard production in Japan.

Data collection has been an important issue in the monitoring of this plan. There was a need to harmonize the methodology for accounting and comparing of energy consumption data. An important result of this voluntary action has been the introduction of biomass waste as a fuel to replace fossil fuels.

Lighter paper reduces overall energy and resource needs, but increases the energy needs per tonne of product. This is not properly captured by energy efficiency indicators. The industry is applying life cycle inventory method for assessment of its energy efficiency. This method is different from the energy indicators that are currently used for the national target setting, the details of latter method are not known. The quality of public energy use data for pulp and paper making is questioned.

Status of Bio-refinery development in the US – Lori Perine, AFPA

Agenda 2020 is a technology alliance between the forest products industry, government and academia. Biorefinery is one of seven technology platforms within Agenda 2020. There are three key elements within the biorefinery programme: 1) Value Prior to Pulping (VPP); 2) New Value Streams (NVS); and 3) Sustainable Forest Productivity (SFP). Lignocellulosic ethanol is an important component of the VPP part of the programme. The focus is on optimising hemicellulose extraction and its use for ethanol production. Enzyme costs are currently the main obstacle.

Gasification is the dominant technology platform being evaluated under the NVS. There are 2 primary value streams from syngas produced via gasification: power generation and the manufacture of liquid fuels and/or chemicals. In the US there is good geographical overlap between pulp and paper mills and petroleum refineries. Agricultural waste products can also be used to produce biofuels and chemicals.

A commercial scale biorefinery is currently being studied in Southeast Arkansas and has the potential to replace 1.6 PJ of natural gas and 80 GWh of purchased electricity per year. This plant would combine fermentation and gasification to produce ethanol and FT-synfuels (mainly synthetic diesel). The conversion efficiency to biofuels would be about 40%. Plant size of up to 39 Mt/yr is being studied, about 20 times the size of a large pulp mill. The results from this study are expected to be released in November 2006.

Status of Bio-refinery development in Europe – Peter Axegard, STFI

There are 3 areas of significant energy relevance for the pulp and paper industry in Europe to develop into a bio-refinery: 1) energy exports from modern mills; 2) lignin removal from black liquor; and 3) black liquor gasification. There are also significant opportunities for production of value added chemicals from forest residues and process liquors in a future pulp mill biorefinery. Today modern Kraft pulp mills already produce surplus energy that is sold to other industrial users; to local district heating systems or as power to the grid. As an example a modern Kraft mill produces 3.1 GJ of surplus fuel and 540 kWh or power / ton of pulp.

In the future lignin removal from black liquor and black liquor gasification offer future opportunities for the pulp and paper industry to become a biorefinery. The technology for lignin removal is currently at the demonstration phase in Sweden (more detail is given in the next presentation). Black liquor gasification, which also offers a large potential, is still at an early phase and requires further technological development. (see black liquor gasification presentation above)

Programs to improve energy efficiency in Sweden's Pulp & Paper industry KAM and FRAM – Thore Berntsson, Chalmers University of Technology (not present due to illness and presented by Peter Axegård, STFI

KAM programs looked at ways to increase efficiency in Kraft pulping. These projects took place from 1996-2002 and had a total budget of 12 M€. Although the projects analysed all aspects of Kraft pulping, energy efficiency turned out to be the key focus. A large potential for energy savings was identified in upgrading existing mills. Removal of excess lignin, pressurized black liquor gasification and process integration were seen to offer potential improvements and required further research. FRAM (2002-2008) further develops energy efficiency measures, lignin removal and the use of lignin as a biofuel.

The main results of the studies on energy efficiency are that modern pulp mills, both existing type mills and future reference mills, have large amounts of usable excess heat. Excess heat is today normally rejected through cooling at typically 40-60°C. The actual temperature level of this heat is partly higher, 90-120 ° C. Through process integration measures (e.g. new heat exchanger networks and some other adjustments) excess heat at these higher temperature levels can be collected and used in the evaporation plant to reduce steam consumption. In this way the total steam consumption of a market pulp mill can be reduced by 25-40%, depending on the conditions.

In a modern plant reduced steam consumption leads to an excess of steam that can be used for increased electricity production through condensing turbines or lignin removal and then sold to third parties. Techno-economic studies have shown that increased electricity production can be an economically attractive measure at the relatively high prices for electricity which exist today and, indeed, can be expected in the future. Lignin removal is a less economically interesting option, unless lignin prices (e.g. as chemicals) rise above future energy prices. An economically interesting option for lignin removal is for de-bottlenecking of the recovery boiler in a situation where pulp production in a mill is to be increased. The steam balance can be kept through steam savings using process integration.

Energy transition in the paper chain – Gerrit Jan Koopman, Royal VNP

The Dutch pulp and paper industry has initiated a Energy Transition for the Paper Production Chain project to halve the amount of energy used per tonne of end product by 2020. Royal VNP believes that innovation will be important for the future survival of the Dutch pulp and paper industry. Many mills in Western Europe have already closed and investments are needed to remain competitive in the future.

Two teams were asked to identify the options available for reaching the ambitious target of halving energy use of end products by 2020. There was a science team and a consultant team. The final result of this competition led to 5 programs for innovation and energy reduction being developed. The programs include: 1) energy management; 2) energy neutral paper; 3) supply chain of the future; 4) multi-purpose biorefinery; and 5) paper without water.

CHP – Simon Minett, COGEN Europe

COGEN Europe aims to promote the development and use of CHP plants in Europe. Despite higher efficiencies and lower environmental impacts CHP use is still very low and the share of cogeneration in Europe is only 10%. In the pulp and paper industry a potential exists to triple CHP power generation. Current regulation is a major obstacle to increasing CHP use. Industry is reluctant to make investments if the risk associated is considered too high. There is significant potential to increase CHP capacity in the European pulp and paper industry, especially in Finland, Germany, Sweden and Spain.

However, the EU Directive on CHP may help to improve the regulation and support systems for CHP and this may then allow for greater use of CHP in the European pulp and paper industry.

Paper recycling and Energy – Marco Mensink, CEPI

The new European Declaration on recovered paper aims to increase the recycling rate from 59.6% in 2004 to 66% by 2010. This would increase the total amount of recovered paper collected to 64 million tons by 2010. The utilisation rate of recovered paper would rise from 47% in 2004 to 51.4% in 2010.

Paper recycling adds value. The pulp and paper industry adds about 9 times more value to the EU economy than for the same amount of wood used for bioenergy. Therefore making paper deserves priority over biofuels production. The recycling of paper allows the fibre to be used several times adding value each time.

Less energy is required to produce recycled pulp than virgin pulp. Approximately 0.4 MWh (1.44 GJ) of energy is required to produce 1 tonne of recycled pulp, while 2.5 MWh (9 GJ) of energy is required for each tonne of virgin pulp.

A holistic approach to paper recycling is required as there is no recovered paper without virgin fibres. The quality and grades of paper will set the standard. The key question is to "develop" the ideal paper mix of recycled and virgin grades on a world scale. Consumer patterns, energy and raw material costs, land use, new technologies such as biorefinery will change this balance for both virgin and recovered pulp.