Energy Saving Potentials in Pulp and Paper mills - Experiences in Germany

Dipl.-Ing. Christopher Soldwedel

Energy consumption and energy costs are still among the most important factors for a profitable and cost effective paper production in Germany as well as in India and other countries. In Germany the specific energy consumption in pulp and paper mills has been reduced significantly in the last 50 years (average heat -70 %, electricity -20 %). The reasons are improved paper production technologies and more efficient production and use of steam and electricity. In the last couple of years prices for fuels (e.g. gas and oil) and electricity have been rised considerably in Germany. Also legal taxes on fuels and electricity and the EU carbon emission trading system caused further financial burdenings for pulp and paper industry in Germany. In addition costs for disposal of waste from paper production rised.

Therefore German pulp and paper mills are more than ever forced to realise all profitable energy saving potentials and continuously optimise their energy efficiency to be successful on their business. Against this background the important factors of influence on the energy concept in pulp and paper mills are outlined. Suitable and profitable strategies to produce heat and electricity in pulp and paper mills e. g. with combined heat and power systems (CHP), different fuels, use of waste are demonstrated. Energy saving potentials in steam and power generation, production and auxiliary equipment within existing paper mills are discussed by examples. Furthermore experiences in elaboration and realisation of energy strategy and energy saving concepts in German pulp paper mills are outlined. Some of the experiences in German paper mills might be directly transferred to Indian mills.

INTRODUCTION

Energy is one of the most important production factors in pulp and paper mills in Germany, in India and worldwide.

Eproplan GmbH - Consulting Engineers

Schoettlestrasse 34 A, D 70597 Stuttgart

Germany

The paper industry in Germany has made considerable efforts to reduce their specific energy consumption over the past 50 years (figure 1). In this process the average specific heat demand in paper production was reduced about 70 % and the average specific electricity demand about 20 %.

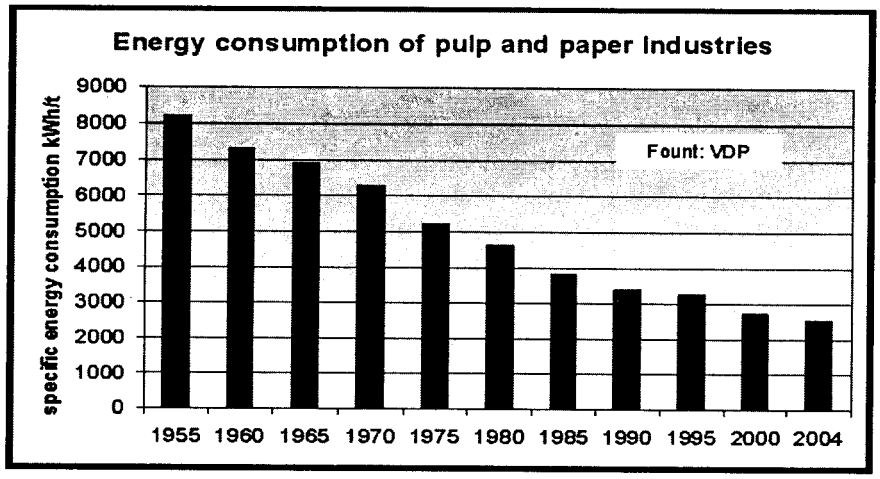

Fig. 1 : Development of the specific use of energy in the German paper industry

Nevertheless the importance of energy consumption and energy costs for the German paper industry has strongly increased in the recent past. Primary reasons for this development are the following:

- Strongly increased electricity prices. The price for the base-load at the EEX energy exchange has increased by almost 60 % since the beginning of 2005.
- Strongly increased fuel prices. The price for natural gas – currently one of the main fuels for the paper industry in Germany – has increased by over 60 % since the beginning of 2005.
- Introduction of the carbon dioxide (CO_2) emission trading in Germany in 2005. The maximum price for one tonne of CO_2 amounted about 30 € in 2006.

The optimum energy strategy and the rational use of energy are essential

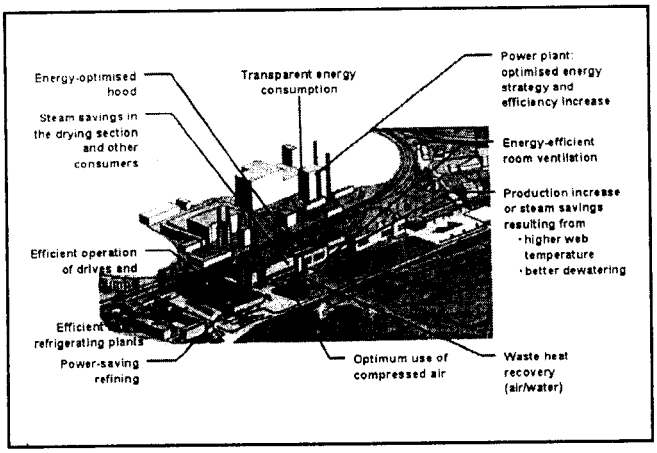

Fig. 2 : Starting points for energy savings and reducing the costs of energy

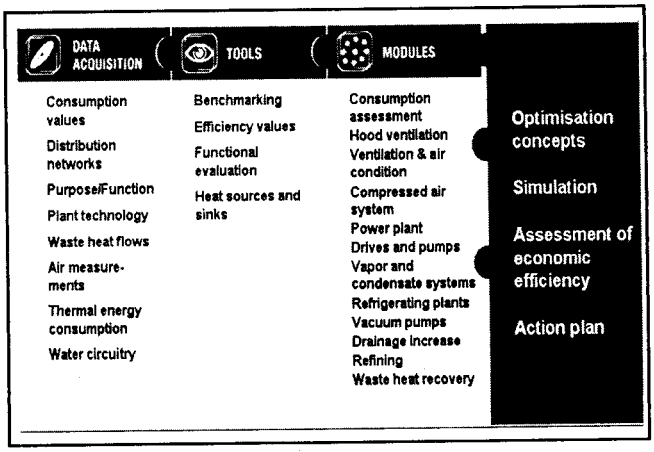

Fig. 3 : Systematic approach for evaluation of energy saving potentials

elements that counteract these restraints. As numerous feasibility studies and energy saving projects in German pulp and paper mills show, there are still considerable energy saving potentials in mills. These potentials are also caused e.g. by increased line speed, changed product line, newly developed units.

Starting points for reducing energy consumption and energy costs

Basically in pulp and paper mills there are the following starting points to reduce energy consumption and energy costs:

- Savings due to procurement of energy (fuels, electricity)
- Savings by optimising the existing plants (heat and power generation, distribution networks, production plants)
- Savings by optimising the papermaking (generating and production plants)

Systematic approach for evaluation of energy saving potentials

A standard situation in paper mills is, that the use of energy is rather complex and not transparent. Typically there are limited possibilities to measure the energy consumption of individual consumers. The specific use of energy for individual plants varies considerably and differs depending on type and plant technology. Therefore,

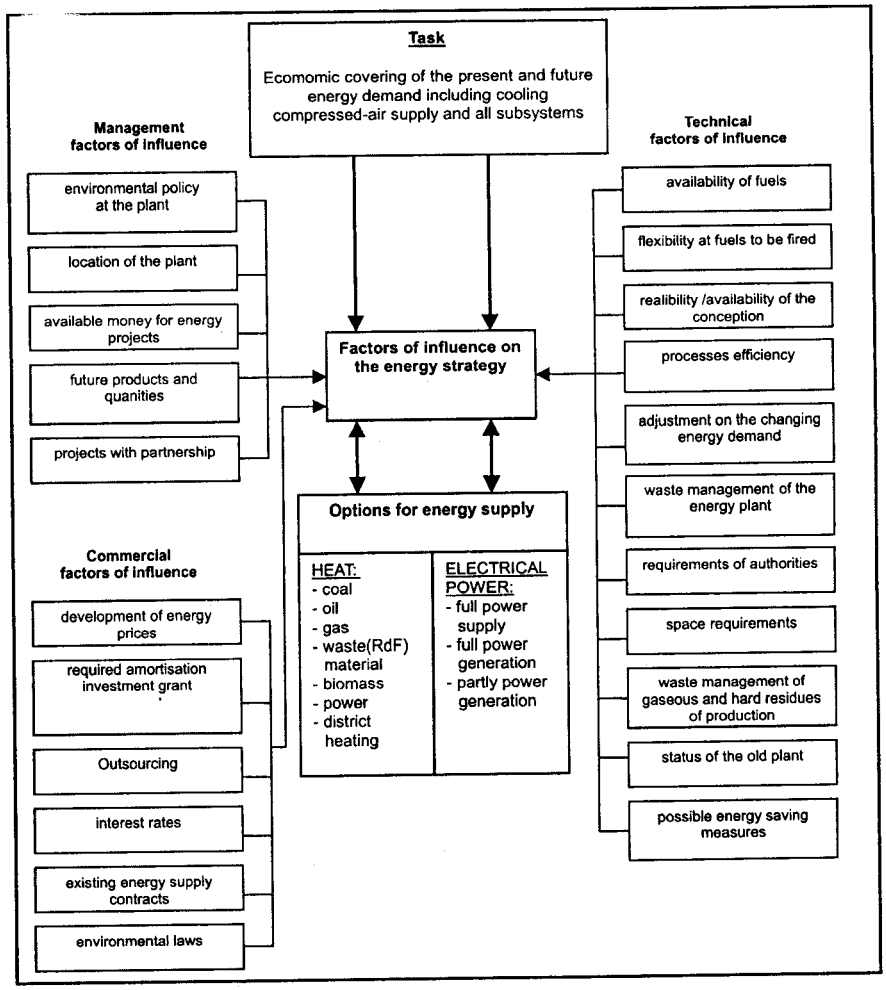

Fig. 4 : Factors of influence on the energy strategy

an extensive analysis of the processes of the individual consumers will form the essential basis for identifying and evaluating energy saving potentials.

The process analysis should include the entire energy situation of the plant including all components and systems from the generation to the individual consumer (figure 3). The important steps of a process analysis include:

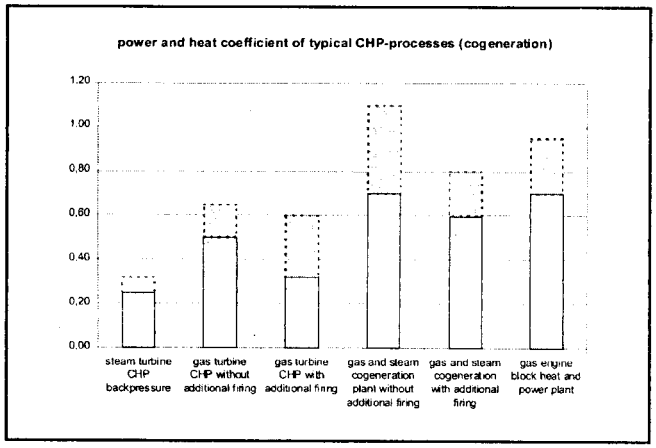

Fig. 5 : Power to heat coefficient of typical CHP-processes (cogeneration)

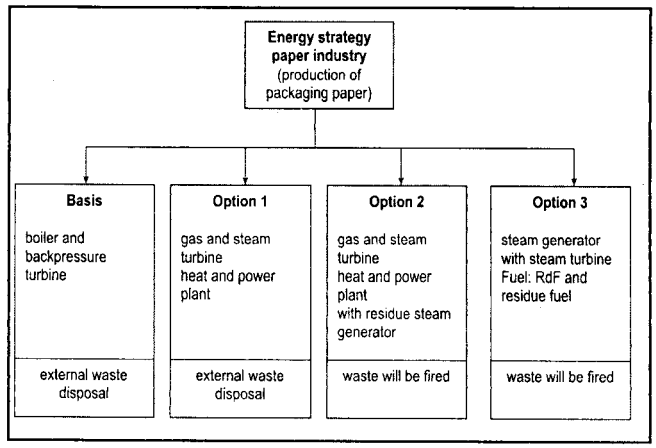

Fig. 6 : Selection of suitable energy strategies for a paper mill (example)

- Recording the current state
- Data analysis (energy balances, benchmarking of components and partial systems, evaluating of process integration)
- Process modelling and simulation
- Identifying and evaluating optimisation potentials
- Preparing an action plan

The Energy Strategy

The energy strategy is the basis for an economical and reliable supply of a paper mill with heat and electricity. This strategy is influenced by technical, management and commercial factors (figure 4).

In numerous paper mills in Germany combined heat and power systems (CHP) are operated to provide steam and electricity. Their conception has to be fitted on the demands of the individual paper mill. An important parameter is the power to heat coefficient of the paper mill. Comparing the power to heat ratio of the production with typical cogeneration processes (figure 5) it can be seen that for all kind of papers suitable cogeneration cycles are available.

As an example the figures 6 and 7 demonstrate selection and evaluation of different energy strategies for a paper mill which produces packaging paper under German constraints.

To optimise the actual situation and energy strategy (basis) in this paper mill with gas fired boilers, backpressure turbine and external disposal of production waste, several options with advanced technologies are investigated. The results (figure 7) outline that by upgrading of the CHP cycle and additional use of waste as fuel e. g. combined with coal and lignite in this plant profitable advantages are obtained under the actual conditions with high and still increasing gas and electricity prices. At the same time the demand on fossil fuels can be reduced significantly with the new strategies.

Energy saving measures (case studies)

In the course of numerous analyses in German and European paper mills, saving potentials have been determined in different areas of the mills. Subsequently energy saving measures in several important areas are outlined:

Steam and condensate system

The actual state in the existing steam and condensate system often can be described as follows:

- High specific heat loss in the end condensers
- Constant cooling water flow in the end condensers
- Condensate undercooling
- Badly or non-insulated piping network, tanks etc.
- Leakages in piping network

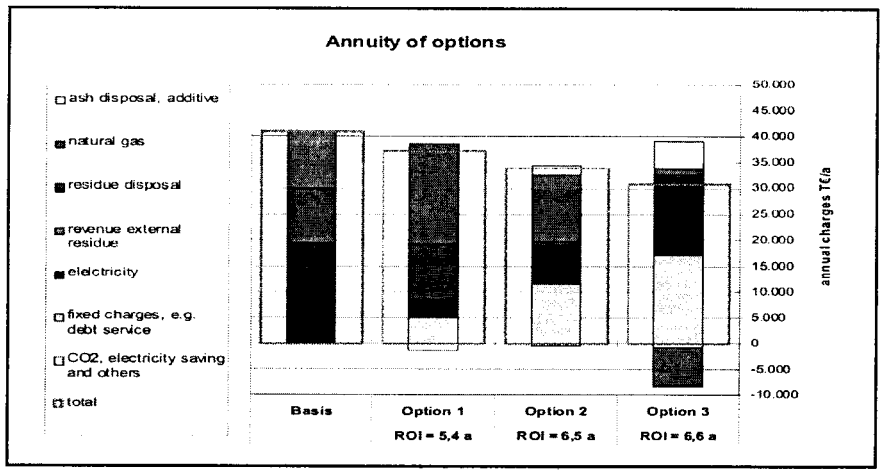

Fig. 7 : Economical evaluation of different energy strategies for a paper mill (example)

- Defectively working controls, instruments and fittings

The following options are available for the system optimisation:

- Using thermo compressor before the end condensers
- Modernization/ replacement of drainage systems (e.g. using rotating siphons)
- Controlling cooling water volume
- Insulation
- Maintenance of controls, instruments and fittings

Hood ventilation system

The actual state in many cases can be described as follows:

- Moisture content of exhaust air is considerably lower than the maximum possible value (e.g. 90 g/kg of dry air at about 80 °C instead of the possible 200 g/kg of dry air at 65 °C)
- Heat recovery potentials are not completely used
- Small ratio fresh-air to exhaust air
- Leakages and open hoods
- Uncontrolled exhaust air mass flow

The following options are available for the system optimisation:

- Reducing the exhaust air mass flow by means of control, minimising loss due to leaks and thus increasing the moisture content
- Upgrading the heat recovery system

Press section

Usually, the potentials for increasing the dry content lie within the following ranges:

- When installing shoe presses: 2 -4 %
- When installing steam showers: 1 - 2 %

Based on this, the potential efficiency increase in the production or the generation of steam lies within the following ranges

- When installing shoe presses: 5 - 15 %
- When installing steam showers: 4 - 8 %

Due to the high investment costs the economic efficiency of a shoe press will improve in combination with a planned increase in production. Another potential measure to increase the dry content is by increasing the head box temperature.

Motors / Drives

Regarding motors and drives the following points have to be emphasised:

- Motor driven systems are major power consumers (share of 69 % in the industry)
- Up to 95 % of costs of a motor during its product life result from the energy consumption.

The actual state often can be decribed as follows:

- Oversized design
- Changes in operation compared with the design conditions
- Slow-down for power adjustment
- Use of fan belt drives
- Bypass flow

The following options are available for the system optimisation:

- Frequency controlled system instead of a throttle controlled system
- Transmission: transition to flat belt drives/ direct drives
- Use of high efficient motors
- Use of multisystems

Project example

It has to be considered that the entire saving potential is often made up of a number of individual measures. Often, small improvements that do not require any investments will result in notable savings. Based on the analyses carried out, the following saving potentials in numerous cases exist:

- Electricity demand : 0.5 – 3 %
- Steam demand : 5 - 15 %

For example to illustrate these energy saving potentials results of an investigated paper mill in Europe are outlined summarised:

- Grades : woodfree coated paper
- Number of suggested measures: 38
- Saving potentials
  - o Steam 255.000 t/a 25 %
  - o Power 15.600 MWh/a 1,6 %
  - o Carbon dioxide 75.000 t/a
- Saving potentials that result from measures which do not require any investment
  - o Steam 21.000 t/a 2,3 %
  - o Power 5.400 MWh/a 0,6 %
  - o Carbon dioxide 5.700 t/a

Almost all suggested energy saving measures have payback periods less than 3 years (figure 8).

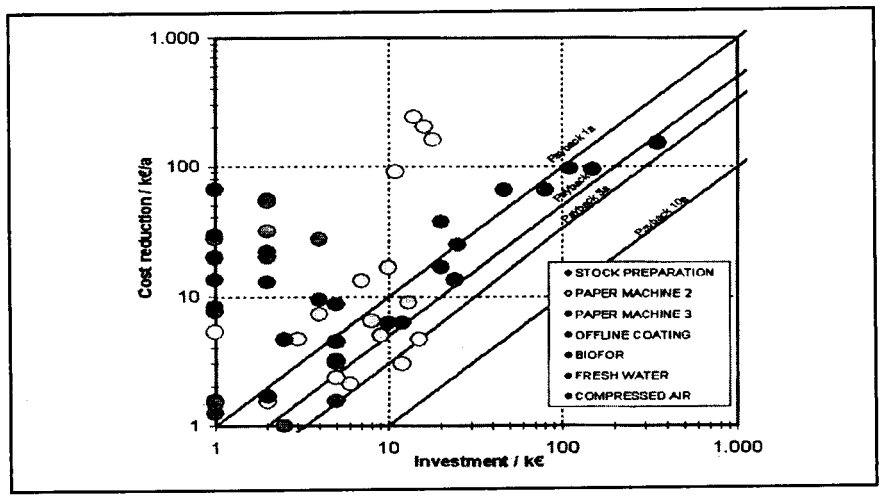

Fig. 8 : Economic efficiency of analysed saving potentials

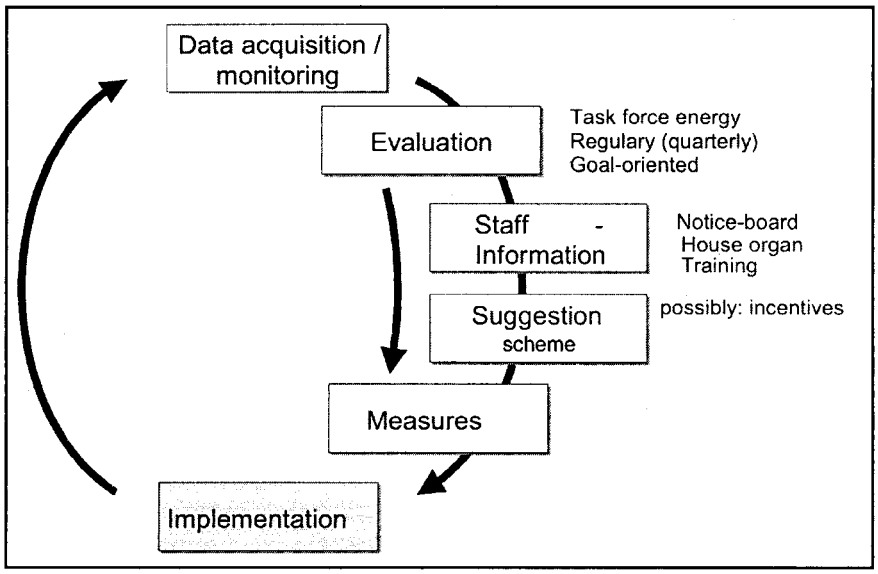

Fig. 9 : Implementation energy saving potentials

Realisation of existing energy saving potentials

The following points have to be considered to implement energy saving measures successfully:

- o Parts of the existing potentials will only be successfully available, if all important areas in the paper mill are investigated (e.g. heat integration)
- o Since the process in paper mills is rather complex, measures within a certain system of the mill can influence the function of other systems. Therefore, the impact on the existing process must always be determined before the measures are implemented.

The measures will always be successfully implemented if the paper mill manages to start the energy saving process with a specific suitable project organisation (figure 9). Individual consumption metering will help to ensure a lasting success. In German paper mills there has already been some success in this due to the introduction of the CO_2 emission trading.

Summary and forecast

For environmental and economic reasons the energy strategy and the energy saving issue is a permanent challenge for the paper industry in Germany. With an integrated system analysis it is possible to develop an economical and reliable energy strategy and to identify potentials that allow to decrease the energy consumption and thus the costs of energy. The use of energy in paper mills is complex and mostly not transparent. Hence, the identification and evaluation of potentials require a comprehensive and detailed examination of the processes by experts.

The energy strategy of numerous German paper mills so far is mainly based on natural gas to generate heat and power. Since the prices of natural gas and electricity in Germany have increased very much German paper mills nowadays proof the following options of economical supply.

- Increasing cogeneration
- Additional use of waste out of production and RDF (Refused derived Fuel) for power and heat generation also in combination with coal and lignite

In many German paper mills there are still existing considerable energy saving potentials in heat and power generation, networks and production plant. The overall potential of energy saving measures is often made up of a number of individual measures. However, small improvements that do not require any investments will often result in notable savings in absolute terms. Based on the analyses carried out, the following saving potentials besides the energy strategy do normally exist:

- Power requirement : 0.5 - 3 %
- Steam requirement : 5 - 15 %

The energy saving measures will always be successfully implemented if the paper mill manages to start an energy saving process with a specific project organisation. Individual consumption metering will help to ensure a lasting success.

The specific energy consumption in many Indian mills is much higher than in developed countries e. g. German mills. With respect to this and the experiences with pulp and paper mills in Germany it can be concluded that there are high energy saving potentials in pulp and paper mills in India with reasonable payback periods. Therefore the experience with energy strategies and energy saving projects in Germany and European mills should be transferred to Indian mills.

The authors and their company are presently preparing a value added energy saving project for Indian paper mills together with Indian partners within the GTZ Indo-German cooperation Energy Programme.