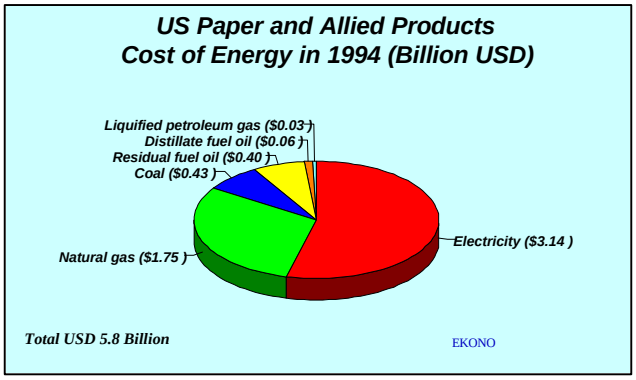
ENERGY OPTIMIZATION
More than Lower Operating Costs

Paper Industry Energy Use

The paper and allied products were the third largest industrial energy user group in 1994 with a total consumption of about 26 million Btu per ton of paper. Purchased fossil fuels and electricity represent 55% of the total demand. At average energy prices the energy bill amounts to 5.8 billion USD, or 12% of manufacturing costs for pulp and paper mills.



Energy conservation has traditionally been considered as a cost reduction measure in the pulp and paper industry. Concerns about ambient air quality and the sustainable use of resources have recently increased the interest in energy use as well. Regulations on carbon dioxide emissions are on the horizon and will most likely have a profound effect on energy planning and optimization in every industrial sector - including pulp and paper.

CO_2 Emissions

The Kyoto agreement requires the participating countries to lower their greenhouse gas (GHG) emissions by 2010 to 6-8% below the 1990 level. Carbon dioxide released from the burning of fossil fuels is the most significant source of GHG. Since trees are a renewable raw material, the emissions from burning woodwaste or pulping liquor do not count as a net release of carbon dioxide. The table below illustrates typical CO_2 emission factors for purchased energy used in the pulp and paper industry. The key measures to lower GHG emissions include conservation of energy and chemicals, changes in fuels and more efficient power generation.

Typical CO_2 Emission Factors

Fuels, kg CO_2/GJ in steam	
- Biofuels	0
- Natural gas	62
- Heavy fuel oil	90
- Coal	107
Purchased power, kg CO_2/MWh	
- Hydro and nuclear power	0
- Condensing power with coal	1,070
- Single stage gas turbine with heat recovery	290
- Average in the USA	580
- Average in Canada	220
Chemicals (average US), kg CO_2/t	
- Sodium hydroxide	930
- Chlorine	990
- Chlorine dioxide	9,900

EKONO's Expertise in Energy Optimization

EKONO has served the North American pulp and paper industry for more than 30 years by supplying specialized energy, process and environmental engineering. Since the early 1970's we have carried out more than 100 energy conservation studies. In the energy field our strengths are:

- Our staff has thorough understanding of pulp and paper business and interrelationships between energy, operating costs, product quality and plant reliability. We believe that our staff has superior chemical engineering skills to quickly and cost effectively identify and evaluate energy conservation opportunities.
- No-capital and low-capital improvements are an essential part of an energy improvement program. We can provide an unbiased opinion
- We have benchmarking data on environmental and energy use. This includes the most recent technologies applied in North America and in Scandinavia. We keep updated on environmental regulations, actual mill performance and market trends such as eco-labeling. Understanding of future needs, e.g. global warming and CO_2 emissions, is essential for successful investment planning.
- We use and continually refine our modeling tools - e.g., process simulation tools, energy balance models, boiler models and power house optimization tools.

Energy Optimization Program

The ISO 14000 standard requires that the Environmental Management System (EMS) be an integral part of the overall company management plan with its objectives and goals aligned with the business goals. In the same way, the goals and objectives of the ***Energy Management System*** should be in line with the business strategy. Key requirements for an efficient energy management program include:

- An organization with clear responsibilities and accountability on energy related matters
- Support from the senior management team that understands the importance of energy efficiency and long term planning
- Clear and realistic energy efficiency goals and objectives with measuring sticks that can be used to track the performance
- An energy reporting system that can form a basis for tracking of energy efficiency.

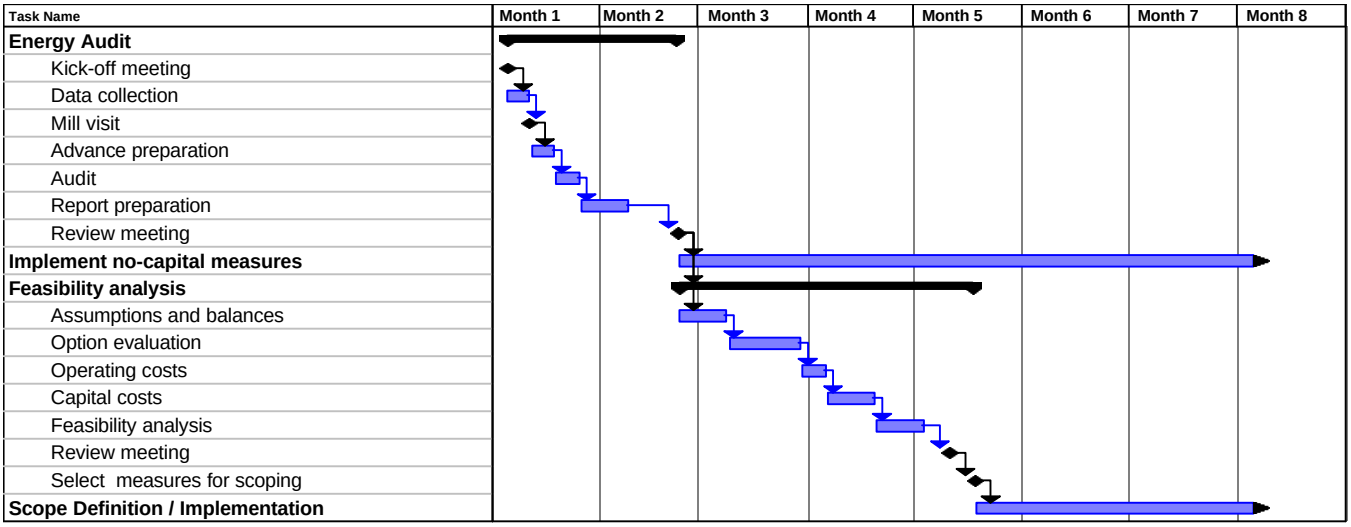
An Energy Audit is the first step towards defining these requirements. The key objective of the Audit is to provide a quick assessment of mill's energy situation conducted by a qualified team of professionals. Typically the key objectives of this audit include:

- Definition of energy conservation opportunities and realistic long term energy targets
- Benchmarking of mill's energy use and comparison to BAT
- Identification of non-capital and capital energy improvement projects.

The audit is typically followed by an immediate implementation of the identified no-capital measures and a feasibility study to develop scope for other selected improvements.

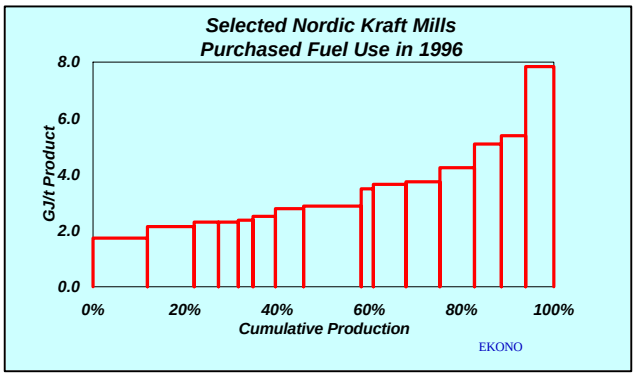
Work Program for a Typical Energy Audit

Task	Product
Kick-off Meeting • Define objectives and task • Define the team • Define schedule and budget	Audit plan List of information required
Collection of the Required Information • General information • Production data • PI&Ds • Energy Data	Mill information
Mill Visit • Review of information collected • Understand mill operations • Additional information required	Detailed audit program
Preparatory Work • Key balance calculations • Preliminary improvement ideas	Overall mill balance
Energy Audit • Kick-off meeting with mill staff • Mill tours • Departmental meetings • Daily audit team wrap-up • Wrap-up with mill staff	Preliminary conclusions
Audit Report • Summary • Assumptions • Fuel, electricity and water use • Energy balances • Improvement recommendations • Benchmarking	Audit report



Benchmarking

Benchmarking and assessment of realistic energy efficiency goals is one of the key objectives for an Energy Audit. Understanding one's cost competitive position in relation to other similar mills as well as the achievable energy consumption level is an important step in identifying the savings potential and improvement strategy. Often a comparison to mills located in countries with high energy prices and energy efficient mills provides a good benchmarking point. The figure below illustrates the 1996 purchased fossil fuel use in selected Nordic kraft mills producing market pulp and paper products. Graphs like this provide a powerful tool to compare a mill's energy consumption to other similar mills.



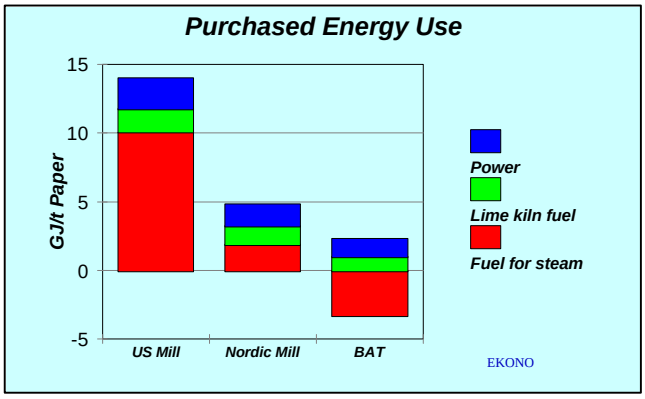
However, a comparison to other mills does not always take into consideration the mill-specific circumstances and consequently does not provide a realistic target for energy use and generation. Energy conservation potential should also be compared to the best available energy technologies.

The table and the graph at right illustrate energy balances in similar pulp and fine paper mill complexes in the US and in Scandinavia, together with a consumption level achievable with Best Available Technology (BAT). Both mills produce bleached kraft pulp and fine (woodfree) paper. Energy data in the table is per ton of fine paper.

The Nordic mill has almost 9 GJ/tp lower purchased fuel demand compared to the North American counterpart. More than 75% of this is caused by the differences in steam generation from black liquor and hogfuel. The North American mill uses cascade evaporators versus a low odor recovery boiler employed at the Nordic mill. However, both mills are significantly above the BAT level in the evaporator and digester area heat consumption. The BAT mill has practically nil net purchased energy demand, as the excess steam equals the purchased power and lime kiln fuel.

Comparison of Energy Use for Fine Paper Manufacturing (EKONO files)

	US Mill	Nordic Mill	BAT Mill
Heat consumption, GJ/t			
- Digester	2.1	1.9	1.7
- Bleaching	1.2	0.5	0.4
- Pulp dryer	0.0	0.0	0.0
- Evaporation	4.0	4.1	3.4
- Recovery	1.3	1.3	0.7
- Other	0.2	0.2	0.5
- Power generation	2.6	2.7	3.1
- Paper machine	6.7	6.2	5.0
Total	18.1	16.9	14.8
Heat generation, GJ/t			
- Recovery boiler	7.6	11.1	12.8
- Hogfuel boiler	1.4	4.1	4.3
Total	9.0	15.2	17.0
Outside fuel need, GJ/t			
- For steam generation	10.1	1.9	-2.4
- Lime kiln	1.7	1.3	1.0
Total	11.8	3.2	-1.4
Power balance, kWh/t			
- Pulp mill usage	620	590	540
- Paper mill usage	690	600	600
Total use	1,310	1,190	1,140
- Own fuel generation	690	740	820
- Purchased	620	440	320
Total supply	1,310	1,190	1,140



Energy Project References

During the last few years EKONO has been very actively participating in energy related projects. The references below include recent selected energy projects.

- Several ***Energy Audits*** in pulp and paper mills both in North America and Scandinavia. The specific objectives of these audits include: identification of improvement opportunities in energy and water systems, setting energy efficiency targets and evaluation of new boiler requirements. Most recent clients include two Georgia-Pacific mills, Port Townsend Paper and two UPM-Kymmene mills.
- ***Feasibility Studies*** on energy conservation opportunities require a more comprehensive evaluation and result in Class 25 capital and operating cost estimates for the alternatives. Recent clients include Malette Kraft, Smooth Rock Falls, ON; Alabama River Pulp, Perdue Hill, AB; Confidential Client, Midwestern US; Weyerhaeuser, Grande Prairie, AB and Longview, WA; Buckeye Technologies, Foley, FL and Georgia Pacific, Woodland, ME.
- The Cluster Rule promulgated by the U.S. EPA in early 1998 requires the US pulp mills to comply with the MACT I portion, i.e. condensate treatment, of the rule during the next 3-8 years. The scope of work for EKONO has typically included development of methanol balances, identification of condensate treatment options, energy optimization and development of capital and operating cost estimates. As an example EKONO was retained by Georgia-Pacific to carry out a ***Cluster Rule Study*** at their Palatka, FL; Port Hudson, LA; Ashdown, AR; Cedar Springs, GA; Woodland, ME; Monticello, MS and Crossett, AR mills.
- The Kyoto agreement requires countries to lower their ***Carbon Dioxide Emissions*** to 6-8 % below the 1990 level. In November 1997, NCASI retained EKONO to (1) identify energy-saving technologies of potential use to facilities producing pulp, paper, paperboard, lumber or wood panels and (2) to illustrate an approach for estimating the costs and effectiveness of these technologies.
- ***Environmental Performance, Legislation and Technology in Pulp and Paper Industry*****.** This annual multi-client study documents the actual performance in selected areas of the world, both with respect to air and to water emissions. Environmental standards are compared as well as trends in the legislation. Available technology for emissions reduction is reviewed, together with an assessment of the results achieved and the viability of various technologies. (1994 - 1997, updated annually)

Recent Articles on Energy and Environment by EKONO Personnel

THE IMPACT OF KYOTO REQUIREMENTS ON FOREST INDUSTRY. Heikki Mannisto. Advanced Tech Symposium, Vancouver, B.C., November 17, 1998.

AIR AND EFFLUENT QUALITY IMPROVEMENTS THROUGH CONDENSATE STRIPPING. Daniel C. Taflin, Pertti O. Winter and Ben Krzysik TAPPI 1997 Pulping Conference in San Francisco, October 1997 and 1998 International Environmental Conference and Exhibit, April 5-8, 1998, Vancouver , B.C.

WHY ENERGY CONSERVATION? Heikki Mannisto and Eva Mannisto. TAPPI Engineering Conference in Nashville, TN, Oct. 6 - 8, 1997.

FEASIBILITY OF EPA'S ADVANCED TECHNOLOGY TIERS. Eva Mannisto, Heikki Mannisto, and Kim Roos. TAPPI 1997 Environmental Conference and Exhibit, Minneapolis, MN, May 1997

HOW GREEN IS THE FUTURE FOR PULP AND PAPER? Heikki Mannisto, Eva Mannisto and Marten Krogerus. Papermaker Magazine in May 1996

TECHNICAL AND ECONOMIC FEASIBILITY OF A LOW EFFLUENT BLEACHED KRAFT MILL. Heikki Mannisto Envirotech Sympo '96, Vancouver, B.C. April 2, 1996

CURRENT ENVIRONMENTAL PERFORMANCE OF THE PULP AND PAPER INDUSTRY. Marten Krogerus, Eva Mannisto and Heikki Mannisto. TAPPI Minimum Effluent Mills Symposium, Atlanta, GA, January 22-24, 1996.

WHO CAN AFFORD TO SAVE WATER? George Wohlgemuth, Eva Mannisto and Heikki Mannisto. TAPPI Minimum Effluent Mills Symposium., Atlanta, GA, January 22-24, 1996.

WHO COULD BE ECO-LABELLED: AN INTERNATIONAL COMPARISON OF THE PULP AND PAPER INDUSTRY'S ENVIRONMENTAL PERFORMANCE. Liisa Kaar, Eva Mannisto and Marten Krogerus. ECOPAPERTECH Conference in Helsinki, Finland, June 6-9, 1995

GREEN MARKETING - ARE YOU FIT FOR ECO-LABELLING? AN INTERNATIONAL COMPARISON OF THE PULP AND PAPER INDUSTRY'S ENVIRONMENTAL PERFORMANCE. Liisa Kaar, Eva Mannisto and Marten Krogerus. PRIMA 95 - 26th Annual Conference in Stockholm, Sweden, May 19-17, 1995.

EKONO Inc.
11061 NE 2nd St., Suite 107
Bellevue, WA 98004
Tel. (425)455-5969, Fax: (425)455-3091

DUOPLAN Oy
P.O. Box 75
FIN-00511 Helsinki, Finland
Tel: 358-9-39331, Fax: 358-9-393-3696