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KSH CONSULTING
A CONSULTING CONCEPT

**ENERGY AUDITS AND
COST REDUCTION POTENTIAL**

KSH
Consulting



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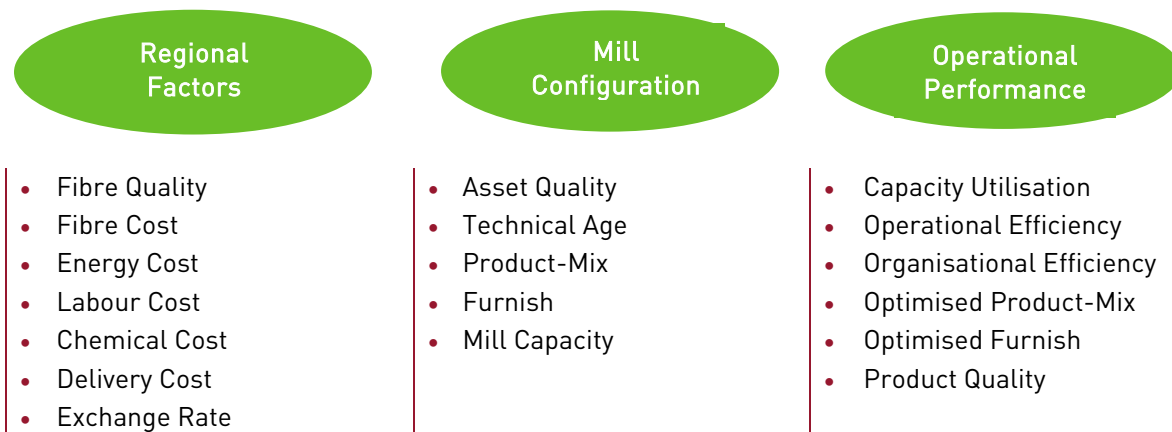
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INTRODUCTION

Three main drivers impact the cost performance of a mill: regional factors, mill configuration and operational performance (Figure 1). Regional factors typically determine 15% to 25% of the cost variability between different mills. However, a company has little control on it since it is driven by the plant location. The biggest driver of cost performance is the mill configuration, which typically accounts for more than 50% of mill-to-mill differences. Operational performance is typically the smallest cost determinant. However, it is the only cost factor that can be managed and improved on the short-term since the mill location and configuration are largely determined at the time of initial investment and cannot be easily changed.

Figure 1
Drivers of Cost Performance



In September 2003 Hydro-Quebec created a “*Programme d’analyse et de démonstrations industrielles – Grande entreprise*”, whose aim it is to save up to 79 GWh of power consumption between 2003 and 2006. Of this amount 60 GWh has been allocated to “demonstration” opportunities and the remaining 19 GWh to “analysis” initiatives.

A budget of \$1.5 and \$1.825 million respectively has been allocated for funding “demonstration” and “analysis” type initiatives as noted below:

- ▶ **Analysis Initiatives:** for energy qualifying projects, financial aid is provided to identify energy efficiency improvement potential of an industrial site.



- **Demonstration Initiatives:** for qualifying projects, financial aid is provided to demonstrate new technology that has a high potential to reduce specific power consumption of existing processes and is the first installation of its type in an industrial sector.

Also in September 2003, Hydro-Quebec created a “*Programme d’initiatives industrielles – Grande entreprise*” whose aim is to save up to 100 GWh of power consumption between 2003 and 2006. A budget of \$8.5 million has been allocated for financial assistance in realizing power savings initiatives.

Eligibility for power savings projects is limited to:

- replacement of existing inefficient electrical power consuming equipment; and
- the addition of new equipment to reduce specific power consumption of existing processes.

OBJECTIVES

KSH Consulting, as part of its consulting practice, offers mill optimisation services. These services are designed to assist our customers in assessing the current situation and future competitive position of their existing mills and then formulating plans, which will maximise the short-term and long-term value of these assets.

KSH Consulting has designed its “Energy Audit and Cost Reduction Potential” to specifically concentrate on short-term opportunities for process islands and develop an operating strategy, which would yield an immediate improvement in operational performance. The focus is on maximising efficiency, capacity and short-term profitability by adjusting flexible and “low investment” parameters.

In general, the specific objectives for an energy audit for a mill are as follows:

- reduce specific water and energy consumption to the greatest degree possible without adversely affecting product quality and economic operation;
- identify process improvement projects and categorize them by rate of return and potential process improvement; and
- work with mill personnel to increase overall plant knowledge for all members of the organization.



GENERAL METHODOLOGY

Global Approach

KSH Consulting favours a systematic approach in order to capture all energy reduction opportunities, thermal as well as electrical. It is comprised of several steps as follows:

- perform a mill audit in sections – check existing P&I diagrams and verify in-mill, obtain historical data , interview personnel;
- prepare an overall energy and water consumption balance overall for each department, winter/summer);
- benchmark mill and specific mill departments energy consumption against industry standards;
- identify process/areas with high energy consumption, potential solutions, energy savings, perform simple payback calculations and conceptual capital costs; and
- identify projects requiring more detailed study.

Water Balance

In conjunction with the global approach described above, KSH Consulting also recommends carrying out a water balance of the mill in order to reduce fresh water consumption in the mill. Indeed, fresh water intake from the river (15°C on yearly average) once introduced into the mill, has to be heated to process temperature (50 °C). This thermal energy will be significant. Reducing the amount of fresh water consumed will allow the reduction of the required thermal energy. For a mill of 300,000 tpy of paper, a reduction of 10 m³/t of paper represents an annual saving of 440,000 GJ or \$3.5 million (based on a steam cost of 8 \$/GJ).

The water balance, once developed, will allow us to:

- determine energy inputs to the system (e.g. steam heating points), identifying which ones can be reduced;
- identify all effluent points in the mill and determine if potential exists for recycle or if residual heat can still be viably transferred to another stream;
- determine if process temperatures can be reduced without affecting production;
- determine where fresh water (hot or cold) water can be replaced with recycled streams (i.e. cooling water, white water, etc.);



- reduce effluent flow where possible (through spill analysis, broke management and/or general housekeeping). The result will be increased process temperatures that may reduce steam consumption; and
- segregate water system to ensure that cold streams cascade down appropriately in the process.

SCOPE OF SERVICES

Process Validation

The first step in this planning process is to perform a technical audit of the process island. This phase is principally based upon data gathering and evaluation at the site which is supplemented by our internal database.

Although the consultant's knowledge of the process island situation should be gained from an independent assessment of the island rather than the opinions of mill management and operating personnel, it is absolutely necessary that a close working relationship be established at the management and operations level within the mill. Through observation, walk-through, interviews and operating data collection, the situation of the process island is validated from both a historical and current perspective.

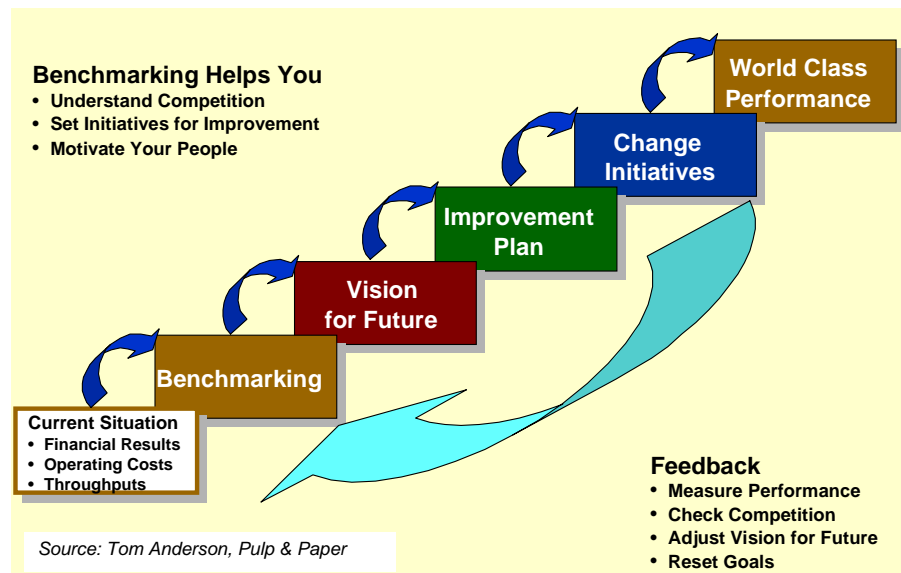
- Process design.
- State of the equipment.
- Character and content of operations information measurement.
- State of organisation and rationalisation of accountability and responsibility.
- Substantiation of unit process operating parameters and material flows and efficiency.
- Mill output related to mill requirements.



Benchmarking

To establish a vision for future development, the process island characteristics and operating performance must be benchmarked against industry standards. Typical examples for analysis of opportunities are listed in Appendix 1. This analysis along with KSH's expert opinion will allow a proper assessment of the current island situation and the gap that exists relative to industry standards. Benchmarking provides the required feedback to the project team to develop a vision of what the island needs to become, to establish realistic targets and to develop and implement the key change initiatives required to move forward (Figure 2).

Figure 2
Benchmarking - How Does It Add Value



Data gathered during the mill visits will be benchmarked against industry standards, particularly for the following:

- specific electrical energy consumption (kWh/t product);
- specific thermal energy consumption (GJ/t product or GJ/t water evaporated); and
- specific water consumption (m³/t product).



Performance Improvement Program (PIP)

A performance improvement program (PIP) for the process island is designed to provide an operating strategy, which should yield an immediate improvement in operational performance. The focus is on maximising efficiency, capacity and short-term profitability by adjusting flexible, “low investment” parameters, such as:

- ✔ operating conditions;
- ✔ operating procedures;
- ✔ raw material inputs;
- ✔ labour utilisation and organisation;
- ✔ information processing;
- ✔ financial issues (purchasing, inventory, and production scheduling plans); and
- ✔ high return mechanical replacement (debottlenecking).

The analysis not only provides a short-term plan for improving the economic efficiency of the process island; the analysis and data it collects establishes the limiting parameters of the island from a process quality, organisation and mechanical perspective.

Natural consequences of the PIP analysis are therefore, a prioritised list of efficiency improvement projects including expected returns, a short and intermediate term capital spending plan and organisational recommendations.

TEAM

A team composed of senior specialists with superior experience in technical and economic analysis and planning renders the proposed services. All senior members of the team have long-standing experience in mill and process optimisation.



COMPANY PROFILE

General

KSH Solutions Inc. (KSH) is a Canadian consulting, engineering and EPCM services company, founded in 1923 in Montreal, having global reach and extensive experience in the pulp and paper and forest sector. Operating world-wide, KSH has the skills, experience and organisation needed to assist clients improve their asset performance and to develop and execute capital projects of all sizes and complexities, with its consulting, engineering and construction management expertise. In addition, with its European partner and key shareholder, MAN Ferrostaal in Germany, KSH offers its clients the ability to implement their projects under a turnkey / EPC contract customized to the clients' needs.

Built from its long history and strong presence in North America, KSH has expanded its capabilities by providing expertise and services on projects in Europe, Asia, Australia and South America, giving the company a global perspective, as well as the knowledge, track record, and ability to execute projects anywhere in the world.

The entire group provides access to a vast network of resources and offices giving KSH the support to evaluate, undertake and execute projects anywhere in the world.

KSH Consulting is the consulting arm of KSH Solutions Inc. Our mission is to assist clients in making positive, lasting and substantial improvements in their performance.

We have the global insights, consultants and tools to offer objective and sound solutions to various business problems for companies engaged in the pulp and paper and wood processing industries, governments, financial institutions, investors, lenders and sector organisations.

Our integrated services cover the whole supply chain, from raw material to end-use markets, and focus particularly on the following areas:

- ▶ ***Resource, Energy and Environmental Management:*** studies pertaining to resource supply, demand, cost, and end-use; regional resource comparisons; audits and benchmarking of forest, environmental and energy management practices; development of corporate strategies for sustainable development; development of regional resource management and master plans; and, government policy advice on sustainable developments.
- ▶ ***Product Management:*** rationalisation and optimisation of existing product-mix; product and manufacturing process design; process and product trial management and product launch assistance.



- ✔ **Marketing:** market analyses, market research, development of marketing plans and market launch strategies, customer satisfaction studies and introduction to key buyers.
- ✔ **Logistics:** distribution logistics planning and optimisation.
- ✔ **Mill Development:** performance audits, benchmarking, optimisation programs and long term development plans for existing assets and mills. Operations, maintenance, and plant management assistance.
- ✔ **Technology Management:** assistance in R&D activity planning, technology assessment and selection, strategic alliance/technology transfer assistance and technological risk management.
- ✔ **Investment Analysis:** opportunity and feasibility assessments, due diligence, asset valuations, business plan development, financial analysis and planning, lender's consultant, owner's consultant, strategic alliance identification, as well as economic and sector studies.

SELECTED EXPERIENCE

KSH Consulting has recently carried out three energy reduction audits (both thermal and electrical) for pulp and paper mills located in Quebec. Two of these three mills were able to receive financial aids from Hydro-Quebec.

Technical Assistance – Energy Reduction Initiatives (2006). A series of projects were developed at this North American East Coast, bleached TMP mill with the goal of a 15% reduction in manufacturing costs. KSH Consulting was mandated to assist the mill in their efforts regarding a replacement of a MC pump for savings in electricity and bleaching chemicals; optimization of DTPA dosing points; investigation of improved refiner controls; substitution of $Mg(OH)_2$ for NaOH in peroxide bleaching; pulp machine vacuum pump improvements; WinGems simulations to identify ways of reducing heat loss at the pulp machine; technical review of the dryer and press section for increasing capacity. The mills objectives were reached within three months. *(Kathadin, Port Cartier, 5BE-001)*

Technical Assistance – TMP Heat Recovery (2006). The TMP mill operates at 480 t/d, which has no facility to produce clean steam from the contaminated steam produced by the pressurized refiners. Some of this energy is recovered in the form of hot water and the balance is released to the atmosphere. KSH Consulting audited the mill to assess the potential to use the existing assets (idled evaporators) for use as a re-boiler to make clean steam. KSH also reviewed the existing turbo generator operation and identified potential uses low-pressure steam from a future TMP reboiler. *(Kathadin, Port Cartier, 5B8-001)*



Energy Audit for an Integrated Pulp and Paper Mill (2005). KSH Consulting was mandated by a Canadian pulp and paper company to carry out a mill-wide energy audit at an eastern Canadian integrated mill that produces 500,000 tonnes per year of newsprint, directory paper and carton board. The audit included a 700 tpd TMP mill, a 600 tpd DIP mill, the paper machine and all main mill services (air compressor, power station, water treatment, etc.) Performance of all process departments was benchmarked against industry standards with respect to electricity consumption, thermal energy consumption and water consumption. Opportunities for energy reduction were identified and evaluated with respect to conceptual capital costs, potential savings, return on investment and potential financial assistance (for electric utility). *(Stadacona, 5B!-001)*

Global Evaluation of Energy Reduction Potential for Cleaning and Screening Systems. This mandate was awarded by a pulp and paper mill as part of the “Programme d’initiatives industrielles Mieux consommer – Grandes entreprises” of Hydro-Québec. This mandate consisted of simplifying a screening and cleaning systems with a view to reduce electricity consumption while maintaining and even improving product quality.

Global Energy Consumption Reduction Study. This mandate was awarded to KSH by a fine paper mill with a view to establish an overall analysis of the energy consumption at the mill. The overall objective was to identify areas that consume steam the most and to recommend necessary modifications in order to reduce steam consumption at the mill

Development Plan for an Energy Island in Czech Republic (2003). This mandate was awarded by an independent energy producer to create a development plan for an energy island of a pulp and paper mill in the Czech Republic. The objective of this plan was to assist the energy producer in preparing his offer for energy services to the mill.

Design of an Energy Saving Program Related to Motor and Drive Systems (1995). This project aimed at deriving and recommending to Hydro-Québec a framework and form of intervention to drive the optimization of electric energy consumption for motor and drive systems in industrial markets. *(Hydro-Québec)*

Strategic Plan for a Newsprint Mill (2003). A newsprint mill serving the export market had problems in fiber supply and product quality. The mill awarded KSH Consulting the mandate for a long term development plan. The mandate included an analysis of the present situation for the whole supply chain from the fiber to the finished product. Further, it included the identification and analysis of development options, technically, commercially, and economically. *(Abitibi-Consolidated, Stephenville, 566-001)*



Study to Upgrade Mechanical Pulping Systems (2002). A coated groundwood paper mill located in the US Midwest had to rely on stone groundwood pulp, TMP, and purchased kraft to furnish its paper machines. KSH was mandated to identify various options to upgrade the mechanical pulping systems in order to provide the additional pulp required at the mill, and perform a technical and economic analysis to determine the optimal scenario. *(Stora Enso, Biron Division, 551-001)*

Benchmarking and Optimization Study from Log Yard to Digester (1995). This study involved a technical audit of the log yard area to the digester of this state-of-the art UFS paper mill. The operations parameter of the existing systems were analysed and benchmarked against the best operations in North America, South America and Scandinavia. Based on the established benchmarks, an optimization program was developed to improve the mill situation. In a first step, potential projects and operational improvement options were identified as well as the associated capital cost on an order of magnitude basis. In a second step, the best alternatives were selected and the associated capital investment and benefits were estimated with a better accuracy. *(Domtar Inc.)*

Energy Saving Program for a Kraft and Paperboard Mill (1995). An integrated paperboard mill jointly with its electrical power supplier mandated KSH to perform a technical audit of the mill to identify potential opportunities to reduce power consumption. The report described the identified energy saving measures, the associated savings in dollars and associated benefits such as reduced labour, quality improvements, etc. The capital investment required to implement the proposed measures was also estimate]

Production Improvement Program for a Newsprint Paper Machine (2001). A newsprint producer located in Thailand was operating its paper machine at the limits of its design capacity and at a high overall efficiency. KSH was awarded the mandate to assess the opportunity of increasing the speed of the machine. The required modifications were identified and the project economics in terms of capital investment and financial returns were analysed. *(Pan Asia)*

Performance Improvement Program for a CGW/UGW Paper Mill (1999). Technical audit of two small paper machines specializing in CGW and uncoated high bright papers and related process islands. The paper machine performance was analyzed and low cost solutions to improve efficiency and production were proposed. *(Tembec, St. Raymond)*



TOOLS AND MODELS

In addition to our global insights, analytical skills and database, the proposed study team has access to various models to support its analytical process. Some of the models that are used are as follows:

- ✔ distribution logistics optimisation;
- ✔ financial model;
- ✔ furnish optimisation model;
- ✔ conceptual cost estimating;
- ✔ manufacturing cost estimating;
- ✔ cash cost curves;
- ✔ econometric modelling; and
- ✔ mass and energy balance.



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Appendix 1 **Examples of Opportunities**

Opportunity No. 1 (High Delta P Cleaners)

- In many pulp and paper mills, especially in the stock preparation area ahead of the paper machine, the cleaners are usually old and operate at a high pressure differential. These energy demand is usually very high on these systems.
- By replacing these cleaners by those with low pressure differential, significant energy savings could be achieved. For example, an integrated newsprint mill was able to save \$500,000 a year, for an investment cost of \$211,000, resulting in a payback of less than 6 months.

Opportunity No. 2 (Vibrating Knotters)

- Replace vibrating knotters that are located ahead of the washers in the kraft pulp line by a combi-system of pressure knotter and primary screen. This system could be placed after the washers, permitting the mill to eliminate one stage of screening (primary stage).
- This system allows the mill to achieve substantial savings, since several motors could be eliminated. For example, a kraft mill could realize savings of 14 kW/tonne by making these changes.

Opportunity No. 3 (Screening System)

- Reconfiguration of Screening System of Medium Consistency Mixed Stock : by replacing conventional baskets with high capacity wedge wire baskets, electricity energy savings in the order of \$200,000 per year could be achieved.

Opportunity No. 4 (TMP Plant)

- Almost without exception, Quebec mills operate “open cycle” process water systems, i.e. they use large amounts of fresh “make-up” process water and discharge similar amounts of process water as treated effluent.
- Similarly, most effluent treatment plants use atmospheric cooling towers to remove heat from the effluent prior to secondary treatment to reduce the temperature typically from a 60°C to 35°C.



- Make-up process water at a yearly average of 10°C needs to be heated to between 60°C and 80°C.
- From an energy savings stand point, it is self evident that heating “make-up” process water by cooling effluent would be more beneficial than removing energy from the effluent and rejecting it to the atmosphere.
- Similarly, implementation of technologies that reduce fresh water consumption will reduce energy losses to the environment.

Opportunity No. 5 (Water System and Heat Exchangers)

- Thermo-mechanical pulp mills for newsprint production are major consumers of electricity, typically 2,600 kWh/t. This creates a large potential for energy savings.
- Examples of technologies that may be considered to reduce the specific energy consumption are given below:
 - ▶ debottleneck the process to maximize the production rate through each line of refiners;
 - ▶ increase refining intensity in the primary refiner;
 - ▶ low energy refiner plates;
 - ▶ low consistency refining after the latency chest;
 - ▶ screen room upgrade/shut down mainline cleaners.
- Eligibility of these technologies for the Hydro-Quebec program would have to be determined on a case by case basis.
- For example, a non-integrated mill has achieved an annual saving of \$178,000 per year by installing a spiral heat exchanger, resulting in a payback of 10 months.

Opportunity No. 6 (Process Pumps)

- Storage towers for pulp, white water, broke etc. for which the level varies in the course of mill operations present a opportunity for energy savings where “time of day” power usage could be optimized.
- Pump(s) installed on the bottom of these towers are typically fixed speed and are designed for the highest head situation (i.e., low tank level). At high tank levels the control valve at the discharge of the pump has to close-back, to maintain a constant pressure at the destination. Energy is lost in this situation.



- The solution is to install a variable speed drive on pumps located on these towers. At a high tower level the pump speed is reduced resulting in an energy savings.

Opportunity No. 7 (Feed Water Pumps)

- Most boiler feed water pumps for high pressure boilers are driven at constant speed.
- Due to ASME code requirements which determine the discharge pressure required to allow water supply to the steam drum at all operating conditions, feed water level control valves are provided for high pressure drop during normal operation, i.e. 100% of the time.
- A variable speed driven pump would be beneficial in reducing boiler feed water pumping requirements while respecting the ASME code requirements with respect to pressure.

Opportunity No. 8 (White Water Recirculation)

- The recirculation and reuse of paper machine white water helps to reduce thermal energy consumption and loss of high value fibres.
- White water can be reused in other areas of the process, such as in certain showers of the paper machines.
- For example, a non-integrated mill was able to achieve an annual saving of \$333,000 (steam and fibres) with the implementation of a project to recirculate vacuum pumps seal water installation to be used on paper machine showers. Capital investment for the project (piping, filter and tanks) amounted to \$300,000, resulting in a payback of 11 months.