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SP Technical Research Institute of Sweden	SP	SE
Thünen Institute	TI	DE
L'Institut Technologique Forêt Cellulose Bois-construction Ameublement	FCBA	FR
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BSW Timber	BSW	UK
Mühlböck	Muehlboeck	AT
Bergkvist-Insjön AB	Bergkvist	SE
Amber Wood LTD	AmberWood	LV

List of authors:
Joey Montagut, FCBA

Preface

This report is part of the European project Ecoinflow. The main objective of *Ecoinflow* is to reduce the annual energy use in the European sawmilling industry (SMI) by 1 TWh through international engagement, collaboration and knowledge transfer. The purpose of this Technical Report is to describe the best practices observed in sawmills in term of energy savings with the most technical and financial details as possible.

The aim of WP 3 is to establish a relevant framework for comparing energy consumption in sawmills and to identify key success factors that lead to an efficient use of energy and resource in production. In order to evaluate energy efficiency and possible energy savings, a sector-wide best industry practice has been established. The best performing companies define the best industry practice in energy saving and can be used to compare the specific performance of other ones. The benchmarking exercise has included all sawmills participating in the project.

This report offers an opportunity to share the best practices implemented in sawmills.

Abstract

This report presents the best practices identified in sawmills which participate in the project. The different members of the consortium have visited more than 40 sawmills all over Europe (England, France, Germany, Italy, Latvia, Norway and Sweden). During those visits, the members have collected detailed information on what seemed to be best practices in term of energy saving. Some of the data are quite specific with detailed information, while others are missing some information as the practises have been implemented through common sense without financial elements or technical details.

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1 Introduction

In the Ecoinflow project, one of the main objectives is to share information on how to save energy, specifically suited for the European sawmilling industry.

The best practices and case studies that you are about to read come from a work that has been conducted within the framework of the ECOINFLOW project.

The following best practices and case studies provide a detailed summary of topics from the input obtained through the visit of sawmills participating in this project. These various practices are classified by key sectors of sawmills energy business:

- energy management,
- process,
- drying,
- boiler.

Each best practice is built in a common presentation frame:

- background and issues,
- presentation of the plan and its implementation,
- potential gain.

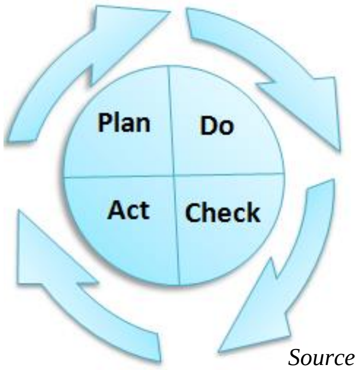
Levels of investment required (both human and financial), are specified thanks to visual criteria, from low to high. The return on investment is estimated according to the following criteria: short, medium and long term.

2 Energy management: how to implement an EnMS

Before going on technical point and to analyse sub-processes, the main thing to start with is to have a full accordance from the leading department of the firm and to decide to build a precise action plan for energy saving.
In the Ecoinflow project, one of the main objectives is to develop an Energy Management System (EnMS) specifically suited for the European sawmilling industry. A handbook helping implementation in sawmill has been established during the project and a final version is scheduled to be released in January 2015.
The sawmill-adapted EnMS is called SawEnMS and consists of a handbook directed to staff at sawmills involved in energy management, a website with additional information, and a set of document templates and calculation tools designed to help sawmill to implement the necessary EnMS steps.

2.1 Background and issues

Efficient energy management helps companies to achieve savings, reduce their energy consumption and strengthen their competitiveness. As energy savings are everyone’s concern, a programme as comprehensive as possible should be introduced to the whole company’s staff. This management method, based on a process of continuous improvement, is being developed in accordance with an efficient management programme (see virtuous circle: Plan, Do, Check and Act). Technical measures are insufficient unless they are supplemented by organisational measures earlier in the decision-making process.



Source : Internet

The virtuous circle of the continuous improvement approach

2.2 Presentation of the plan and its implementation

The core of SawEnMS is a set of seven steps that are designed to ensure that the most important parts of an EnMS will be performed, and that they will be tackled in the right order. The idea is to perform each step once in a first implementation process, and then revisiting the steps continuously (at least once a year) to maintain the system. The figure below shows an illustration of this concept, working like an infinite spiral leading to continuously increased energy efficiency.

ISO 50001 defines the different parts of an EnMS that are required for a certified system, without specifically stating exactly how and in which order to do things – which decision is up to each company. SawEnMS therefore proposes a systemised way to approach EnMS for a company without previous experience within this field, through the set of guided steps appropriate for sawmills. The steps are based on previous experience from sawmills and other companies that already have implemented EnMS and know-how from experts and revisers of certified systems. In line with the key ideas mentioned in the previous section, the number of steps was deliberately kept as small as possible while still retaining the most important concepts of an EnMS that will be able to impact the energy use.

The seven steps of SawEnMS are:

1. **Energy Management Team:** form a team that will work with energy management.
2. **Energy Policy**: establish the importance of and commitment to energy efficiency on company level.
3. **Energy Review:** map the current energy use.
4. **Energy Targets:** based on the results from the Energy review, set short- and long-term targets.
5. **Energy Action Plan:** based on findings from the Energy review, list ideas for energy efficiency measures, prioritise and make a plan for reaching the Energy targets.
6. **Energy Efficiency Routines**: establish energy efficiency as part of various routines used at the company.
7. **Internal Communication**: involve all staff in the work with energy efficiency.

All of the steps above must be agreed between the energy management team and the top management of the company. The energy management team should be appointed by the top management and should have the mandate and power to lead the energy management work. However, it is always the top management that has the ultimate responsibility for the work at sawmill, which means that there must be a close cooperation and information exchange between the top management and the energy management team.

Energy management involves the entire operational side of the company at all levels and must contribute to the adoption of simple measures at minimal cost:

Monitoring the energy supplier

- Analysing the data provided by the supplier (monthly load curve: the basic information for the month and a list of overruns). Analysing the causes enables corrective actions to be developed (e.g. centralised shutdown of the power supply at the end of a shift, crushers shut down at peak hours);
- Optimising the contract in accordance with consumption and forecast changes (installed power, type of contract, overruns, downward slides, tariff changes by groups and taxes, machine investment, etc.).

Monitoring energy consumption

- Appointing a person responsible for energy control;
- Installing an electricity meter on each machine, enabling regular monitoring of energy costs and the prioritising of corrective actions;
- Monitoring the consumption of individual vehicles: sawmills have a relatively large fleet of vehicles. The consumption ratio per fork-lift truck can help to identify any downward or abnormal related to the station, the driver, the age of the vehicle, etc.

Monitoring production

- Introduction of a shutdown monitoring system: shutdowns often lead to overconsumption of energy (decreased productivity, increased non-compliance, etc.)
- Establishing working groups to consider the dynamics of progress: maintenance plan, training, awareness programme for operators, etc.

Monitoring logistics flows

- Introducing a system for monitoring logistics flows within the company in order to optimise them: limiting journeys (particularly without a load), installing automatic ferries (autoclaves, planing machine), and optimising routes.

2.3 Potential gain

It is difficult to calculate the potential gain as it depends on the degree of involvement of the firm

Examples observed during visits to sawmills:

- Revision of the energy contract for the winter period: savings of 20 000 euros (over 3 months). It is possible to make savings by working on the energy supplying and to be sure that the power supplied to your firm feet perfectly with your needs.
- Monthly monitoring with a list of overruns, monitoring the cause of downward trends (sawmills no. 13 and no. 17). It’s possible to have electrical profile from the electrical supplier. This option is generally not free but it gives you good information on what’s going on during a working day and allows you to react in time if you visualise abnormal high consumptions (peaks) or consumption that shouldn’t appear (during the night or the week-end). Consequently you can reorganise the production in order to decrease the consumption level. For example, for special transformation units of pellets, regarding the differences of price scale fixing of electrical power, the manager has decided to make a planning of the machines. The machines work mostly when the electricity is cheaper and when the tariff is higher, they stop one machine on tree. In another case, it allows a firm to shift the machines to avoid peaks consumption and by dividing the running of the machine, it was possible to reduce the power subscription with the electrical supplier and then make huge saving along a year, without investment.
- Consulting with new energy suppliers (sawmill no. 11);
- Tailored consumption meter (sawmills no. 3 and no. 4);
- Centralised shutdown of the power supply on completion of shift (sawmills no. 1 and no. 16);
- Hire an employee dedicated to energy (sawmill no. 3),
- Analyse shutdowns of each machine (times, causes, preferred actions), progress group, software for monitoring troubleshooting maintenance (sawmills nos. 4, 7, 8, 9 and 13);
- Shutdown of machinery during peak hours in winter (sawmill no. 5: crushers; sawmill no. 10: heat pump);
- Monitoring consumption of vehicles (sawmills no. 9, no. 13 and no. 17);
- Reduce speed of forklift trucks (sawmill no. 12: reduce speed from 30 to 10 km/h).

- Other improvements:

Energy management results in higher motivation of the staff involved in the process of continuous improvement and leads to improved working conditions.
This approach also allows an evaluation of the electrical carbon footprint and enhances the company’s environmental involvement.

- Points to note:

Measuring the effectiveness of corrective actions taken is not always formalised.

In France, the Energy Savings Certificates are doubled if the company has introduced an Energy Management System and is ISO50001 certified.

- Reproducibility:

The concept of an EnMS has very high reproducibility though.

To summarise (Investment level from 1 to 3):

Human investment: ✋ to ✋✋✋ Return on investment: ⌛ to ⌛⌛⌛ Costs: € to €€€

Some sawmills have already started with something that looks like similar to an EnMS; with quantified objectives, deadlines, return on investment, energy team, etc. and it's works well. In the following paragraphs you will find description on best practices implemented in sawmill we have visited during the project.

3 Energy savings in the workshop

3.1 Variable Frequency Drives VFD

3.1.1 Background and issues

The operation of electric motors can account for up to 70% of the industry's consumption. By adjusting the rotation speed of the motors to the required output, it is possible to achieve a substantial reduction in energy needs and, therefore, in the consumption of equipment fitted with electric motors (debarkers, band saws, canters, edgers, compressors, sorting lines, etc.).
In the light of constantly increasing operating costs, sawmill can profit from the replacement of one of its main motors with the installation of an adapted variable-frequency drive (VFD).

3.1.2 Presentation of the plan and its implementation

The installation of a VFD optimises performance and enables the equipment involved in the process to be accurately regulated.
In particular, a VFD provides:

- Savings related to a reduction in the power used (during start-up and during long-term operation),
- Savings in energy consumption arising from the constant adjustment of speed in line with requirements.

Variable frequency drives for production machinery

3.1.3 Potential gain

Energy savings as a result of the technology: 20 to 30% depending on the characteristics.

Set-ups observed during visits to sawmills:

Sawmill numbers	**Relevant equipment**	**Comments**
1	Band saw	Replacement motor
2 ; 4 ; 5	Canter, compressor	Purchase of new equipment
12	Boiler, aspirator, edger and finger joint machine	
9	Conveyor	Limits speed if there are no products
15	Planing machine	Propulsion speed of machine with VFD
16	Edger, compressor and sorting line	Purchase of new equipment
17	Log yard, band saw, edger line	Two speed on the band saw

- Other improvements:
  - Improved flexibility and regularity of cut;
  - Winter sawing: band speed adjusted in line with the level of frost penetration of the wood (control on band saw console);
  - Reduction of pressure irregularities and mechanical stress by the provision of stability and accuracy;
  - Reduced operating costs (increased working life of tools: period between sharpening doubled, reduced maintenance costs, reduced stoppage times, etc.);
  - Productivity increased by better balance of propulsion speed.

- Points to note:
  - This equipment is likely to produce harmonic currents. They have to be countered by installing anti-harmonic filters.
  - A compressor with a variable frequency drive will have little effect unless air leak detection is carried out at the same time.
  - Halving the output of a pump or fan by using a variable frequency drive means dividing its energy consumption by 8.

- Reproducibility:

This operation can be used in any sawmill. However, priority should be given to high power motors with a significant annual operating time that have not previously been fitted with a VFD (compressors, cyclones, pumps, fans, etc.).
It is advisable to carry out a feasibility study before undertaking this type of investment.

- In addition:

A variable frequency drive can be paired with a high-efficiency motor to increase savings in electricity consumption. In France, investment aids (Energy Savings Certificates) can represent up to 30% of the purchase price of the motor.
A soft start management system can be used to reduce consumption peaks when installations are started up.

To summarise (Investment level from 1 to 3):

Human investment: ✋ Return on investment: ⌛⌛ Costs: €€

3.2 Heat exchanger on air compressor

3.2.1 Background and issues

Compressed air, produced by the compressors using electricity, can account for up to 15% of a company's energy costs.
Present in all sawmills to ensure the operation of many key production machines (debarkers, band saws, edgers, etc.), the compressors convert a large proportion of their absorbed energy into heat. With some integrated energy recovery systems, 75% of this energy can be reused.

3.2.2 Presentation of the plan and its implementation

For most compressors currently found on the market, the heat recovery systems are integrated in the compressor block (see photo below). The installation can be carried out by the manufacturer of the compressor (usual case), by a specialist company or by the sawmill itself.

Source: FCBA

Heat exchange system for the compressor

The recovery process can be adapted to suit any existing compressor by adding a duct and a fan.
The energy recovered can be reused as hot water (heating, drying, etc.).

3.2.3 Potential gain

Energy savings as a result of the technology: 20% (recovery of the heat).

<u>Cases observed during visits to sawmills</u>:
Heating for the band saw operator's booth (sawmill no. 5), the maintenance room and the crosscut workshop (sawmill no. 2), the sharpening workshop (sawmills no. 9 and no. 17) and the planing room (sawmill no. 18).

- <u>Other improvements:</u>

The investment provides greater comfort, which is much appreciated by the operators concerned and creates a very positive image of a company that is concerned about the working conditions of its staff.

- Points to note:

Due to loss of pressure, this process will not be appropriate if the compressor is a long way from the location intended to receive the heat produced.
17% of industrial fuel consumption is lost in residual heat[1] of more than 100°C, according to studies by ADEME.

- Reproducibility:

This operation can easily be used in any sawmill or enterprise with a compressed-air compressor.

In France for example:
It is possible to receive a bonus for installing a heat exchanger. This is paid by the energy suppliers within the framework of the "**Energy Savings Certificates**" (ESC) programme. This bonus can vary from one supplier to another.

To summarise (Investment level from 1 to 3):

Human investment: ✋
Return on investment: ⌛⌛
Costs: **€ to €€**

[1] Residual heat: This is the heat resulting from a process that remains unused by the process

3.3 Capacitor bank

3.3.1 Background and issues

The motors need active and reactive power to function. When a certain consumption limit is exceeded, reactive power results in financial penalties as it disrupts the energy suppliers' network. It also causes losses due to the Joules effect, voltage drops at the end of the line, a fall in active power, etc. The users of industrial networks know from experience that a poor cos φ can be much more expensive (if below 0.9).
At a European level, the calculation shows that by raising the power factor to 0.95 (cos φ), the reactive energy compensation would mean a potential energy saving of 48 TWh per year.

3.3.2 Presentation of the plan and its implementation

The power supply to the motors is fitted with a bank of capacitors that totally or partially eliminates the reactive power by correcting the installation's power factor at the motor's terminals. The capacitor bank should be complemented by harmonic filters as required.
In general terms, these implementation measures can be divided into the following stages: analysis of invoices, taking action, analysis of the network structure, determination of the requirements, sizing the bank and putting it into operation and finally, measuring the impact.

Capacitor bank for a canter line

This system is financially viable in France in the following 2 cases:

- Yellow tariff (from 36 to 250 kVA): invoicing by kWh consumed and in kVA for subscription
- Green tariff (above 250 kVA): invoicing for the reactive power measured (November to March[2])

3.3.3 Potential gain

- In France, energy savings as a result of the technology:

[2] Gimélec believes that extending the invoice period from 5 months to 12 months in line with other EU countries should encourage the widespread adoption of these measures

For GREEN TARIFF subscribers (more than 250 kVA): cancellation of invoicing for reactive energy
For YELLOW TARIFF subscribers (from 36 to 250 kVA): 15% reduction in the contract power (kVA)
For all: reduction in active energy loss in the region of 3%.

- Average return on investment: 12 to 18 months[3]

Cases observed during visits to sawmills
Sawmill no. 16: no costs related to reactive energy over a one-year period following the installation of a capacitor bank appropriate for the electrical equipment
Sawmills no. 2, no. 6, no. 10 and no. 13: sawmills fitted with capacitor banks, savings not calculated

- Other improvements: this system provides a convergence of interest throughout the value chain:
  - Optimisation of the power factor at the point of the network in question (it is possible, for example, to provide the installation with a reserve of power without changing subscription);
  - Reduced disruption to the installation (heating, equipment breakdowns, defect in the process, etc.);
  - Increased working life of the equipment;
  - Reduced size of cables, processors and Joules losses.

- Points to note:

On networks polluted by harmonics, the addition of a capacitor bank amplifies the level of harmonics. It is therefore imperative to resolve the dual problem of energy compensation and harmonic disruption for the installers (in the long term this could lead to the destruction of the capacitors and generate resonance on the network or even be the cause of equipment malfunctioning).
Reactive energy contributes to increased power consumption, higher electricity bills and greater CO_2 emissions into the atmosphere.

- Reproducibility:

This system can be used in any sawmill or enterprise whose power supply generates reactive energy.

- In addition:

The manufacturers offer software enabling users to decide, in a few clicks, on the capacitor bank that is best suited for installation in accordance with the electrical data, together with on-site measures to determine the most appropriate installation.

To summarise (Investment level from 1 to 3):

Human investment: ✋
Return on investment: ⌛⌛ **to** ⌛⌛⌛
Costs: **€€ to €€€**

[3] Source: Gimélec: http://www.schneider-electric.fr/documents/solutions-ts/efficacite-energetique/14-brochure_cer_bat.pdf

3.4 Compressed air (tracing leaks)

3.4.1 Background and issues

In primary wood processing companies, many equipment consume compressed air (debarkers, jacks, conveyors, etc.). Compressed air, produced by the compressors using electricity, can account for up to 15% of a company's energy costs. However, this type of installation generally has a low performance ratio (around 10% at 7 bar), resulting in a relatively high pneumatic kWh value.

Air leakage rates average from 20 to 25%. These leaks can represent between 40 and 50% of the compressor's electricity consumption. Eliminating leaks is therefore a factor in energy savings.
Paradoxically, compressed air is the least monitored and least maintained network in the enterprise.

3.4.2 Presentation of the plan and its implementation

Sawmills have developed strategies to trace leaks in order to reduce the impact of the company's inadequately functioning compressed air circuits.

- First of all, staff are made aware of the need to trace leaks;
- The aim is then to discover, if possible, the energy impact (quantity, quality, optimum pressure level, etc.) of each sector and to prioritise monitoring actions;
- With the existing system, as many leaks as possible must be identified and repaired:
    - Regular inspection of the network (inspection by ear if the machines have been stopped, or during the night when the workshop does not work, otherwise using an ultrasonic sensor.) Replace joints, connections, etc.
    - Frequency:
        - from once a month to a minimum of once every 6 months for the network
        - annually for the machinery

Some examples providing a reduction in the impact on the performance of a compressed air system[4] :

- Introduce a preventive maintenance visit (in house or using an external enterprise);
- Avoid the use of bellows as far as possible (preferably use aspirators or brushes), otherwise use low output bellows (according to regulations, the maximum is 4 bar);
- Adjust the pressures to the precise level required (most machines operate correctly at 6 bar);
- Oversizing the diameter of the pipes in the distribution network improves the air reserves and reduces the speed of the air and, therefore, losses;
- Complete the network: a few metres of extra pipes will reduce losses by lowering the speed of the air;

[4] http://www2.ademe.fr/servlet/KBaseShow?sort=-1&cid=96&m=3&catid=16081: Energy savings in compressed air systems – Further Advice can be consulted on the ADEME website

- Use hand-operated closing valves or electrical isolation of the suction when the equipment is not functioning;
- Use an isolation valve on the network to limit leaks when the workshops are shut down;
- Combining an all-or-nothing compressor with an electronic variable speed drive compressor: this combination enables the compressor's idling speed to be reduced;
- Place a valve at the end of the network to purge the water from the circuit (potential savings: up to 15%);
- Use an adsorption air "drier" to obtain consistent air quality;
- Only one sawmill has undertaken a full dedicated study (conclusion: oversized installation, air drier, leak detection).

Air "drier" for compressed air compressor

3.4.3 Potential gain

Energy savings as a result of the technology: up to 40% of overall savings.

- Other improvements:
  - Fewer production quality problems due to leaks;
  - Better production time (actuator chambers filled more quickly).

- Difficulties encountered:

These measures rely principally on staff motivation, without which there is no feedback. A certain lack of interest is noticeable, particularly if the necessary repairs are not carried out swiftly.

- Point to note:

Reducing the pressure by 1 bar can reduce the production costs of compressed air by 7%.

- Reproducibility:

Each enterprise has its own system, which should be maintained appropriately. The installation of a variable speed drive compressor is possible at any industrial site able to obtain Energy Savings Certificates (ESCs).

To summarise (Investment level from 1 to 3):

Human investment: ✋ **to** ✋✋✋ Return on investment: ⌛ Costs: **€ to €€**

3.5 Lighting

3.5.1 Background and issues

Lighting is a cost factor that is poorly understood by companies because it is embedded in the overall cost of electricity consumption. Efficient lighting adapted to suit the environment has a number of positive effects: principally in terms of energy savings, but also in improved working conditions and greater profitability from higher productivity.
In general, operating and maintenance costs can represent up to 90% of the overall cost for lighting, while the remaining 10% consists of investments.

3.5.2 Presentation of the plan and its implementation

Sawmills have become aware of the need to gradually change their lighting equipment during maintenance operations and know overall costs of replacement.

- Enterprises are gradually moving from a conventional form of halogen lighting to the use of LED spot lamps. The fluorescent tubes with electronic ballast consume 2 to 3 times less than the ferromagnetic ballast (prohibited in Europe since 2005), while reducing the unit consumption of the lamp for an additional 50% of working life;
- In order to increase the energy gains of these lamps, a system is being developed for the programming of operating hours in line with actual working hours;
- The companies have sectored lighting allowing limited use;
- In addition, the sawmills have presence detectors and/or timers and/or twilight detectors controlling lighting in line with the exterior luminous intensity;
- Some sawmills prefer natural lighting and install skylights.

Bank of "neon lights" and skylights

3.5.3 Potential gain

Energy savings: from 20 to 30%, depending on the characteristics.

<u>Examples in sawmills visited:</u>
Sawmill no. 5: twilight detector (LUMANDAR: €250/item) and Sodium lamps (140 W instead of 1500 W) with low intensity light. The return on investment is estimated at several months;
Sawmills no. 6 and no. 8: workshops fitted with skylights (no artificial light) and offices with large windows.
Sawmill no. 7: they worked specially on outdoor lightings for buildings. They installed presence-controlled lighting linked with a program that turn off/on the lights depending on the time of the day. In addition with economical consideration, this permit to reduce accident as lighting is automatic. The investment is minor and the return on investment is immediate and there is no technical difficulty

<u>Cases studies in Sweden:</u>
Sawmill no.SW1: a study was done on reducing energy for lighting through voltage reduction. After switching on the fluorescent tube lamps, the voltage is lowered; in this case from 237 volt to 193 volt. The lighting level was reduced, but the staff experienced no negative side effects.
The saving is evident as shown in the table below:

Electricity use before	228 150 kWh/year
Electricity use after	129 589 kWh/year
Savings	98 561 kWh/year

This represents 43% of electricity saving used for lighting. There was no investment needed, but a monthly fee to the supplier of the equipment. The fee was lower than the savings however, thus sawmill saved money from day one.

<u>Sawmill no.SW2:</u> traditional fluorescent lighting was replaced with Ceramic Discharge Metal-halide (CDM) lamps. These lamps are small, give a distinct, contrast-rich and natural light with good colour rendering.
With this technology; electricity used for lighting in log sorting and final sorter was reduced from 1260 to 489 Watts. During the year, it represents approximately 2780 kWh saved or 151 euros. In addition to that, light level increased from 1500 to 2500 lux, so the visibility was increased. Staff (operators, truck drivers) experience improved and more comfortable lighting. CCTV monitoring is improved.
CDM lamps cannot be turned on directly after being switched off, e.g. after a power loss. Therefore, a solution for back-up lighting may be needed for security reasons.

<u>Sawmill no.SW3:</u> with the same technology, this sawmill increased the light level from 600 to 1500 lux and the electrical power was reduced from 630 to 236 Watts, which represents during a year approximately 1260 kWh saved or 68 euros.

- <u>Other improvements:</u>
    - Increased productivity (improved production conditions);
    - Environmental benefits (fewer lamps need to be changed, collected, processed, etc.).

- <u>Points to note:</u>

The success of these measures depends largely on the involvement of the staff: without this, the positive effects may be undone (on-going education in compliance with instructions).

More than 70% of the information we receive is through our eyes[5].

- Reproducibility:

The best systems should be adapted to the specific requirements of each enterprise (desired luminosity, layout of the building, etc.).

To summarise (Investment level from 1 to 3):

Human investment: ✋ **to** ✋✋ Return on investment: ⌛ **to** ⌛⌛⌛ Costs: € to €€

[5] Source : http://www.syndicat-eclairage.com/upload/energie/30.pdf

3.6 Suction

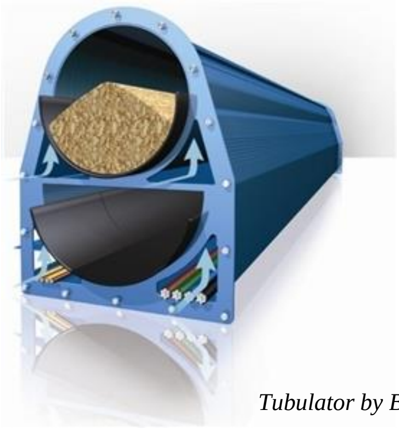
3.6.1 Background and issues

When wood is being sawn, it is necessary to use a suction unit or a scraper system to evacuate sawdust, chips and other waste.
The most frequently used method in sawmills is the suction unit, which both filters and deposits related waste in one or more silos.

3.6.2 Presentation of the plan and its implementation

In order to decrease the consumption of electricity caused by suction, sawmills have selected a number of different solutions, whose effects can be cumulative:

- Automatic or hand-operated closing valves: these valves are engaged in line with the operation (or non-operation) of the interconnected machinery. In this way, the overall output is dependent on the number of machines operating at the same time, rather than on all of the machines connected to the suction network (sawmills no. 9, no. 10 and no. 17);
- Conveyor systems fitted with scrapers: particularly for shavings or bark, but also for fresh sawdust after sawing (sawmill no. 17);
- Variable flow rate cyclones: an electronic variable speed drive is installed on the main motor of the suction unit responsible for extracting wood particles, meaning that the level of extraction can be adjusted in line with the actual needs.
- The Tubulator: consists of carrying sawmill by-products to the inside of a tube via a conveyor belt maintained by a current of air provided by the fans. On account of its higher speed, this system can, according to the manufacturer, transport up to 40% more products (sawmill no. 17).


Tubulator by BRUKS

Transport of sawmill by-products via a Tubulator

3.6.3 Potential gain

Energy savings as a result of the technology:

- ➢ Electronic closing valves: Not provided
- ➢ Conveyor belt with scrapers: Not provided

- Electronic variable speed drive: up to 50% of overall savings[6]
- Tubulator: up to 50% additional capacity[7]

- <u>Other improvements:</u>
  - Reduced noise when the collection is carried out nearest to the extraction;
  - Reduction in the dust and noise associated with a low maintenance cost (Tubulator).

- <u>Points to note:</u>

Tubulator: The system must be operated every 30 minutes in winter to avoid possible clogging. It can therefore only be used when the volumes to be carried are relatively substantial.
If the distance between the point of emission of the particles and the extraction point is multiplied by 2, the energy costs of ventilation are multiplied by 4.

- <u>Reproducibility:</u>

Each enterprise can use systems that best suit the quantities to be transported.

To summarise (Investment level from 1 to 3):

Human investment: ✋✋ Return on investment: **⌛⌛ to ⌛⌛⌛** Costs: **€€ to €€€**

After the workshop, we had a look on the kiln drying system that represents a really high part of the energy consumption level in wood industry.

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6 Source: CNIDEP sawmill energy

7 Source manufacturer Bruks

4 Kiln drying

4.1 Heat recovery unit on drier

4.1.1 Background and issues

During the drying process, one of the major sources of energy loss is the air extracted from the drier. With the increase in energy costs, the manufacturers try to recover this heat to pre-heat the air entering the drier.
The main factors to be considered before investing in a heat recovery system are the temperature levels, flow rates, the availability of the source and the risks of corrosion and clogging. The heat requirement has to be defined by an energetic diagnostic.

4.1.2 Presentation of the plan and its implementation

For most existing heat recovery systems, the recovery of energy is provided by air-air heat exchangers. These plates retransmit the heat from the extracted air to the air entering the drier. In this way, the thermal energy provided by the drier can be recovered according to the climatic conditions inside and outside of the drier.

Heat recovery unit of a drier

<u>Examples observed during visits to sawmills:</u>

- Heat recovery units placed on the roofs (sawmills nos. 3, 4, 5, 14 and 17);
- Recovery of hot water leaving the drier for the canteen located nearby (sawmill no. 6).

4.1.3 Potential gain

Energy savings as a result of the technology[8] : 5 to 15% for heat energy.

In all cases, this exercise is difficult to carry out because the efficiency of the heat recovery units depends on the external weather conditions as well as on the drying conditions inside the cells.

[8] Source: drier manufacturers

In France: it is possible to receive a bonus for installing a heat recovery unit. This is paid by the energy suppliers within the framework of the "**Energy Savings Certificates**" (ESC) programme. This bonus can vary from one supplier to another.

Case study in Norway:
Installation of heat exchangers in progressive kilns: a Norwegian company would like to install heat exchangers in three progressive wood drying kilns with a total production capacity of approximately 100.000 m^3.
The yearly energy consumption for the kilns is estimated at 23.14 GWh (thermal and electrical energy).
A plate heat exchanger was placed on top of the roof, close to the already existing ventilation (see picture below).

The average estimated thermal power savings are 142 kW with this installation. In the case of sawmill, under the different economical elements:

Estimated yearly energy savings	2.52 GWh thermal energy
Cost of equipment including installation and labour	180 000 €
Energy price (thermal energy	29.9 € / MWh
Yearly energy saving	2 520 MWh
Yearly cost saving	75 348 €
Return on investment	2.4 years

The energy savings provided by the technique is between 10 to 20 % of thermal energy. For this particular case the average was 12 %.
In addition to direct energy savings, the firm increased the capacity of the kilns, due to reduced energy consumption per dried volume m^3.

The energy saving will vary throughout the year with outdoor climate, and drying climate and sawn timber moisture content inside the kiln.

- Other improvements:

Improved drying quality with the arrival of air at a consistent temperature.

- Points to note:

The heat recovery units require extensive development after they are installed, as well as regular maintenance. Some sawmills are considering the return on investment (e.g. sawmills no. 5 and no. 7).

17% of industrial fuel consumption is lost as residual heat[9] at more than 100°C according to studies by ADEME.

- Reproducibility:

This system is proposed as an option for use on many new driers and can be adapted to suit driers currently in operation.

To summarise (Investment level from 1 to 3):

Human investment: ✋ **to** ✋✋ Return on investment: ⌛⌛⌛ Costs: **€€ to €€€**

[9] Residual heat: The heat left over from a process that is not used by the process

4.2 Variable frequency drive for drier ventilation

4.2.1 Background and issues

The drying unit has the highest impact in sawmills in terms of energy consumption.
Enterprises are endeavouring to find effective and simple systems to enable them to optimise costs while maintaining a high-quality level of drying. As ventilation requirements vary throughout the drying cycle, efforts to ensure energy efficiency depend principally on the adapting to the kinetics of the ventilation.

4.2.2 Presentation of the plan and its implementation

Summary of the case of sawmill no. 5:
Each drier has a bank of fans (6 per drier in the case in question), the operation of which remains consistent and invariable throughout the drying cycle. By using variable frequency drives (VFDs), it is possible to vary their performance according to the actual needs at different stages of drying. Accordingly, a programmable logic controller linked to a computer controls the speed of the motors. The VFDs reduce speed between the start of drying (100%) and the end (50%). The rotation speed of the fans that cause the air to circulate in the drier varies on account of the VFDs and in accordance with the information received from the various constant measurement devices (a number of humidity probes in the wood and sensors for the temperature of incoming and outgoing air).

Some of the variable frequency drives for the driers

It is possible to increase energy savings by adapting the drying to peak hours. Using this system, sawmill no. 5 has programmed the driers differently in winter mode. During the 3 winter months, the peak hours are billed at premium price (4 hours per day). The cycle's computerised programming will halve the rotation speed of the fans during the hours when the billing rate is highest. In this way, the energy bill is reduced by decreasing the requirement for subscribed power.
Comment: It is advantageous to have a VFD controlling the extractors by varying the opening of valves in line with the temperature and humidity.

4.2.3 Potential gain

Energy savings as a result of the technology: 25%.

Example of energy savings calculation without taking account of the "peak hour" winter tariff (saw mill no. 5):

Drier fan power (236 kW)	Estimated energy saving (approx. 25% of the nominal power)
Annual consumption	Annual consumption saving
1,903 MWh	475 MWh

Other examples observed during visits to sawmills

- Variable frequency drives (sawmills nos. 3, 9, 10, 11, 14 and 18): savings not calculated
- 4 to 5% decrease in speed of air movement over the first few hours and the last three hours: savings estimated at €2,000 (sawmill no. 11).

- Other improvements:

The investment provides an improvement in drying quality by adapting the cycles to actual needs (therefore a decrease in drying faults).

- Points to note:

Equipment such as the variable speed drive is likely to cause harmonic currents, which disrupt the network. It is possible to counter these currents by installing anti-harmonic filters.
The power absorbed (and therefore the electricity cost) is proportional to the speed cubed.

- Reproducibility:

This operation can easily be used in any sawmill or enterprise with one or more driers. The investment is in proportion to the number of fans to be equipped.

- In addition:

The angle of the blades can be adjustable, optimising the required air flow rate in line with the kinetics of the drying.

To summarise (Investment level from 1 to 3):

Human investment: ✋✋ Return on investment: ⌛⌛⌛ Costs: **€€€**

5 Wood-fired boiler - Cogeneration

5.1 Background and issues

In order to deal with the recurrent increases in energy prices and optimise fuel resources produced by sawmills, manufacturers are looking closely at an energy supply solution using wood. This non-fossil energy source, available on site in significant quantities, provides long-term economic visibility as well as the opportunity to structure and boost the non-recoverable products of the sawmill industry.

5.2 Presentation of the plan and its implementation

The aim is to replace current boilers (gas, fuel oil, etc.) with a boiler fuelled by wood. The boiler provides the heat (water or steam) for the driers or granulation units (pellets).
In France, in larger installations (over 5 MW), it is possible, subject to validation in the form of an ERC[10], to add a turbine for the production of electricity (cogeneration) sold to EDF at preferential rates.

<u>Set-ups observed during visits to sawmills in France:</u>

Sawmill number	Number of boilers/site	Fuel			Destinations of the energy produced		
		Bark	**Shred**	**Dry chips Dry shavings**	**Pre-driers Driers**	**Building**	**Granulation**
3	1	X	X		X		X
4,17	2	X			X		
5 11, 14, 15 9, 13	2 1 1	X X		X X	X X X	X X X	
6	2	X		X	X	X	

5.3 Potential gain

Energy savings as a result of the technology[11]: 5 to 15%.

<u>In France:</u> it is possible to receive a bonus for installing a heat recovery system. This is paid by the energy suppliers within the framework of the "**Energy Savings Certificate"** (ESC) programme. This bonus can vary from one supplier to another.

- <u>Other improvements:</u>
    - Reduced dependence on fossil fuels
    - Reduced environmental impact
    - Sustainability of PCS[12] outlets

[10] ERC : Energy Regulatory Commission setting the feed-in tariffs (bidding process)

[11] Source : drier supplier

- Points to note:

The decree of 27 January 2011 stipulates limits for dust emissions and a requirement to submit an annual operating report containing, in particular, the supply plan for the installation.
Sawmill-related activities have a zero carbon balance: CO_2 emissions linked to the burning are compensated for by the amount of CO_2 absorbed during tree growth.

- Reproducibility:

This system is one of the priorities in the development of renewable energy.

To summarise (Investment level from 1 to 3):

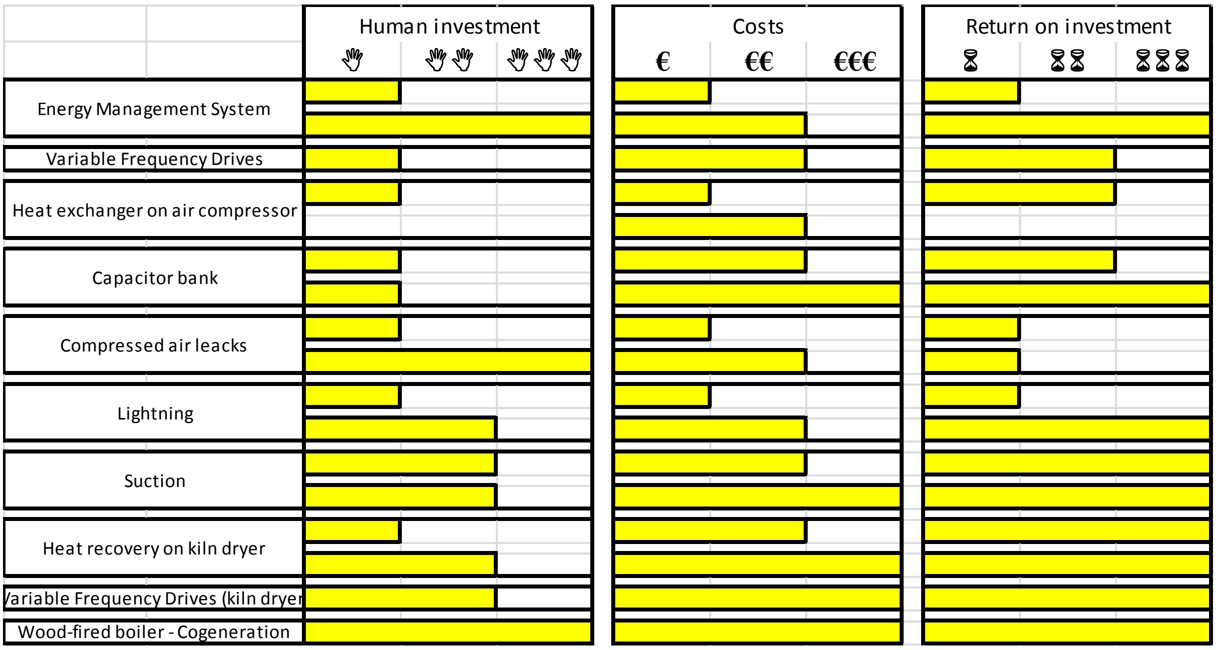
Human investment: 🖐🖐🖐 Return on investment: ⧗⧗⧗ Costs: **€€€**

[12] PCS : *Produits Connexes de Scierie* – Sawmill by-products

6 Results and conclusions

Many best practices detected during the sawmill visits have been implemented with common sense without any analysis on investment, return on investment, technical needs, etc.

The table below show an overview of the different stages a sawmill can work on to reduce energy consumption. Investment, both human and financial is progressive.



Today a major part of the sawmills know that energy management is essential to maintain market share and to increase benefits. In France, for example, some sawmills told us that for the next years, there will be two major challenges; lack of raw material and energy cost.

Energy represents between 3 and 10% of the turnover and some best practices can be implemented without any investment or with state subsidies.

In the future, working without taking account of energy will not be possible anymore.