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Energy Control by Information Flow

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Cost-benefit analysis of implementing an EnMS

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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 project uses the international standard ISO 50001 as a basis for implementing tailor-made Energy Management Systems (EnMSs) in the SMI sector. A handbook describing this sawmill-specific system, called SawEnMS, has been developed within the project. The purpose of this Technical Report is to describe a method that can be used to evaluate costs and benefits of an EnMS implementation at a sawmill, as well as any energy efficiency measure. The proposed method is based on the widely used Life Cycle Cost (LCC) methodology.

There is a high potential to achieve energy savings in the European SMI, for example by implementing state-of-the-art EnMSs. Some of the main barriers for energy savings in the SMI are lack of infrastructure and profitability of selling surplus energy products, such as bark, sawdust and chips. Other barriers are lack of knowledge on optimal utilization of the energy input, and low awareness about the energy saving potential. Implementation of an EnMS enables a higher awareness of the current energy use, and better understanding of the potential of future energy savings.

The title of the project – *Energy Control by Information Flow* – implicates that it is necessary on the technical side to better control the energy consumption and utilization in the SMI. This can be done by installing meters for systematic measurements. Measurements, however, are of no use if the personnel do not know how to handle the information. The information flow through communication and knowledge transfer are important factors to be successful in implementing an EnMS.

Implementation of EnMSs will enable more accurate analysis of energy saving measures. The motivations for the companies to participate in the project are both better control of processes and resources, but also the economic benefits of the achieved energy savings.

The project will generate important inputs for the participating countries to be implemented in the national action plans to meet the targets of the 2020 European renewable energy policy. Energy savings in the sawmilling industry sector will lead to surplus of biomass, since the sawmills are also large producers of biomass. Parts of this biomass can be utilized to replace fossil energy sources in Europe.

Abstract

An Energy Management System (EnMS) is a proven and efficient way to systematically reduce the energy use within a company. An EnMS implementation is usually very profitable, but analysing the financial effects of the implementation can be complicated. Single energy efficiency measures also have to be evaluated in terms of costs and benefits, but often decisions are based on simple methods such as payback period. To support the use of cost-benefit analyses and Life Cycle Cost (LCC) calculations in sawmills, this report describes the LCC method and provides examples of LCC calculations for two energy efficiency measures and for the EnMS implementation at a sawmill. A calculation tool developed as a part of SawEnMS, a sawmill-specific EnMS developed within the Ecoinflow project, is described. Furthermore, typical investments, annual costs and savings associated with an EnMS implementation at a sawmill are listed. By using the LCC method, sawmills can evaluate ideas for energy efficiency measures or the entire EnMS implementation in a simple way that does not have the drawbacks that more rough methods, such as payback period calculation (without taking interest rates etc. into account), may have.

Table of contents

1 Introduction

An Energy Management System (EnMS) is a proven and efficient way to systematically reduce the energy use within a company. If designed and implemented well, large savings of both energy and costs will come with relatively little effort, especially in energy-intensive industries where the potential to save energy often is high. Thus, implementing an EnMS is usually very profitable.

However, analysing an EnMS in economic terms can be difficult. Most companies that have implemented an EnMS will say that it has saved them money, but it is more difficult to say exactly how much. In addition to this, there are still rather few companies in the European sawmilling industry that have completed a full implementation of an EnMS, and economic data is often sensitive information. For these reasons, there is little information available on the economic side of EnMS implementation in this industry. An additional fact that complicates an estimation of the profitability of an EnMS is that the implementation process itself is associated with costs that are difficult to estimate and follow-up.

Purpose of the report

The purpose of this report is to support the economic evaluation of EnMS implementation and energy efficiency measures in sawmills, by presenting a method, examples and lists of typical costs and savings. The method can be used to evaluate both an EnMS implementation and energy efficiency measures in general, by comparing costs and savings over the lifespan.

Target group of the report

This report is primarily intended for sawmill staff involved in decision-making concerning energy efficiency.

Overview of the report

This report, along with an Excel tool developed within the context of this work, supplements SawEnMS, a simplified EnMS developed for sawmills. The report includes:

- an introduction to cost-benefit analyses and the Life Cycle Cost (LCC) methodology.
- a description of the LCC tool developed as a part of SawEnMS.
- lists of common costs and benefits associated with the implementation of an EnMS at a sawmill.
- an example of an LCC calculation for an EnMS implementation.
- two examples of LCC calculations for energy efficiency measures.

2 Cost-benefit analysis and LCC

A cost-benefit analysis is a method to compare the total anticipated costs with a certain project or undertaking, with the total expected benefits. It is typically used for evaluating a proposed idea economically. Costs and benefits are given monetary values, and the basic question is whether the benefits are larger than the costs and if the project is profitable enough to be carried through. Apart from just determining if benefits outweigh costs (and by how much), it can also be used to compare different projects or options.

The Life Cycle Cost method, which is proposed in this report, can be used to perform the analysis. It takes a slightly different approach than regular cost-benefit analyses by comparing the total cost over the life cycle of two or more options, for example comparing the total cost of an EnMS implementation with the total cost of not doing anything (business as usual).

Basically, the LCC method provides a basis for decision when it comes to investing, and a support for motivating an investment for decision-makers, by answering two basic questions:

- Is the investment profitable?
- *How* profitable is it?

A third question arises if there are different alternatives, i.e. more than one option:

- Which option is most profitable?

Since both costs and benefits (saving or revenues) may occur at different points in time during the calculation period, they need to be adjusted to the current monetary value, given a number of assumptions. Some options may require large investments now but smaller annual costs the coming years, whereas other options (such as doing nothing) may involve small or no investments, but lead to larger costs each year. A fair comparison therefore involves recalculating all costs and benefits to a common, comparable basis. In the LCC methodology, the Net Present Value (NPV) is calculated, i.e. the corresponding value of a future cost or investment today.

The terms and formulas used in this report are defined and briefly described below:

Investments

An initial investment associated with buying new equipment or initial staff hours for implementing for example an EnMS.

Annual costs

Annual costs are costs that occur every year, for example energy costs, maintenance costs, man hours for recurring activities, etc. Annual costs can be both fixed (e.g. fixed costs for electricity) or variable (energy use).

Lifespan

An investment is usually associated with a lifespan – the time before it needs to be replaced and a new investment is needed.

Calculation period

An LCC calculation needs to cover a time period long enough to value future benefits correctly. An investment may lead to savings for many years. For an investment in a specific equipment, the calculation period is usually equal to the lifespan. For an EnMS, the calculation period should be at least ten years.

Discount rate

The discount rate is the assumed interest rate used in the analysis, expressing how much less future costs/revenues are valued compared to costs/revenues today. A discount rate of 4 % means that a cost next year is valued to 96 % of the same cost today, and the same cost in two years as 92 % (0.96^2). The value is chosen based on the company's actual capital costs and required rate of return, the rate of return of other investments and the risk of the investment. In this analysis, real interest rate is used, meaning that the nominal discount rate is reduced by an anticipated inflation rate.

Depreciation and residual value

In the case of an investment in equipment, its value decreases each year. If its lifespan is longer than the calculation period, a residual value should be included in the analysis. In this analysis, linear depreciation is assumed, i.e. the value is decreased by the same amount each year, down to zero at the end of the lifespan.

Some investments are not associated with a depreciation and residual value in the same sense, such as initial man hours that will not be required more than once. In the Excel tool, this is handled by setting the lifespan equal to the calculation period.

Annual energy price increase

The price paid for energy is not constant, and thus the analysis will have to take this into account. This assumption is often associated with large uncertainties, since no one can predict how the prices will develop in the future. It may also be very different for different types of energy. One way to deal with this uncertainty is to run the analysis for a few different scenarios, to see how different values affect the result.

Net present value (NPV)

Based on an assumed discount rate, net present value represents the value of a future cost or revenue today. Since an analysis with many different investments and costs soon becomes complex, a calculation tool is usually used to do these calculations.

The net present value of a single investment is

$$x \cdot \frac{1}{(1+r)^n}$$

where *x* is the investment (the price paid today), *r* is the discount rate expressed as a decimal number (e.g. 0.04) and *n* is the number years from now until the investment is made.

The total net present value of costs/saving occurring every year is

$$x \cdot \frac{1 - \frac{1}{(1+r)^n}}{r}$$

where *x* is the annual cost/saving, *r* is the discount rate expressed as a decimal number (e.g. 0.04) and *n* is the calculation period. This formula is the result of discounting the same cost each year according to the previous formula, and summing them up, as illustrated in Figure 1.

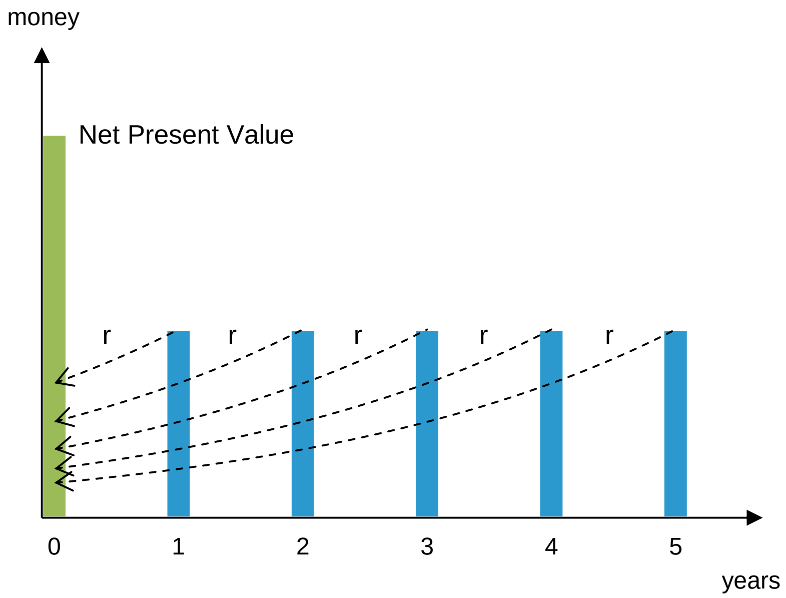

Figure 1. Illustration of the calculation of the net present value of costs/savings that occur every year. The nominal values (blue bars) are discounted into present values according to the arrows pointing to, and adding up, the green bar. The value of each cost/saving is decreased according to the discount rate *r*, and added up. The first year's cost is valued higher than the second's, which is higher than the third's etc.

3 Investments, costs and savings associated with an EnMS

This section lists typical investments, costs and savings that need to be taken into account when evaluating an EnMS implementation in an LCC analysis.

Investments and annual costs

Initially, the main costs for introducing and implementing an EnMS are staff hours. When the EnMS is in use and investments are being made, the costs will shift from man hours to investments in “hardware”. Once in place, man hours are also needed to maintain, revise and update the system.

Table 1. Typical investments and running costs associated with the implementation of an EnMS. In terms of size, investments in energy efficiency measures (marked in bold) will typically dominate.

Investments	Annual costs
Man hours for initial workshop(s) for responsible persons, including preparation and follow up, for workshop(s)	Man hours for administration of the system, following up and keeping things in order.
Man hours for appointing an Energy management team, having first meetings and planning the work	Man hours for regular meetings with Energy Team.
Man hours for developing an Energy policy	Man hours for updating/revising the Energy policy
Man hours and/or consultant fee for performing an Energy review	Man hours and/or consultant fee for updating/revising the Energy review
Man hours for setting up Energy targets	Man hours for following up/updating the Energy targets
Man hours for developing an Energy action plan	Man hours for updating/revising the Energy action plan
Man hours for developing Routines for energy efficiency/changing existing routines	Man hours for updating/revising routines and making sure they are followed
Man hours for developing routines for internal communication	Man hours for internal communication
Man hours for performing a first Night Owl Walk	Man hours for recurring Night Owl Walks
Investments for implementing energy efficiency measures	
Investments in new energy meters and/or monitoring systems	
Production stop for installing meters or new equipment, if necessary	
	Man hours and other costs for improved maintenance work

Annual savings

The main reasons to implement an EnMS are to save energy and money, and thus the main savings are reduced annual spending on energy. Other savings and/or increased revenues may come as a result of increased quality, an improved process etc. which is often a result of working systematically with a management system:

- Energy savings: electricity
- Energy savings: biofuel (if bought)
- Energy savings: fuel
- Increased revenue from selling surplus biomass (if self-produced)
- Increased production thanks to systematic improvements
- Increased product quality thanks to systematic improvements, e.g. in drying process
- Increased yield, e.g. in drying process

Since most sawmills use large amounts of heat that is "self-produced" with biofuel produced as a by-product in their processes, reduced use of heat does not mean reduced costs but increased revenues since more biofuel can be sold as a by-product.

Examples of achievable savings and benefits are in the drying where improved kiln control programs can save energy, both as electricity for fans and heat, and at the same time improve the productivity and the timber quality compared to traditional drying. Other examples are behavioural changes, such as turning off lights and equipment when not used, closing doors, turning of ventilation and heating in areas where no one is and eco-driving of forklifts.

4 Calculation tool

In order to support the use of Life Cycle Cost calculations of EnMS implementation and energy efficiency measures in sawmills, an Excel-based calculation tool has been developed and included in SawEnMS. The tool takes care of the mathematical side of the analysis and calculates the Life Cycle Cost of up to three different cases.

The tool includes four sections:

- General info
- Investments
- Annual costs
- Results

General info

In *General info* (Figure 2), the user enters basic information and assumptions. First, the project is given a name, and then up to three different cases are defined. In most cases, a "business as usual" option will be the first case, since this is the basis for comparison. Two basic financial assumptions are entered: the discount rate and the calculation period (see section 1 above for definitions and more information). Finally, the currency is defined.

General info

Project:	**EnMS implementation**
Case 1:	No EnMS
Case 2:	EnMS
Case 3:	-
Discount rate:	5%
Calculation period (years):	10
Currency	EUR

Figure 2. The General info section.

Investments

In *Investments*, all investments included in any of the cases are listed. For each investment, the year of the investment, the cost today and the estimated lifespan is entered (Figure 3). Investments may be both in the form of man hours and other investments, e.g. new equipment.

An investment is added as one "unit", and associated to each case by entering the number of units (In the yellow part of the table, see figure X). For example, one case can include the investment of two new machines, and another case just one. Man hours can also be entered in this way; with the cost of one hour as the investment, and the estimated number of hours (e.g. 100) needed for each case. It can of course also be entered as the total cost of "100 hours", and added as "1" investment. The calculation tool automatically calculates the Net PresentValue of the investment, the Net Present Value of the residual (if the lifespan is longer than the calculation period) and the resulting total Net Present Value.

It should be noted that the tool by default assumes that, if the lifespan is shorter than the calculation period, a new investment will be made (at the same current cost). Up to 15 reinvestments are handled. If there shall be no reinvestment, and no residual value, set the lifespan to equal the calculation period.

Investments

Investment	Unit	Year of first investment	Cost today (EUR/unit)	Estimated lifespan (years)
Man hours				
Initial workshop	hours	0	50	10
Appoint an Energy Management Team, first meetings	hours	0	50	10
Developing an Energy Policy	hours	0	50	10
Performing an Energy review	hours	0	50	10
Setting up Energy targets	hours	0	50	10
Developing an Energy Action Plan	hours	0	50	10
Developing Routines for energy efficiency	hours	0	50	10
Developing routines for internal communIcation	hours	0	50	10
Performing a first Night Owl Walk	hours	0	50	10
Informing all personel	hours	0	50	10
Other				
Consultant fee for Energy review	-			
Eco-driving	-	1	3 600	7
Kiln renovation A	-	2	20 000	10
Kiln renovation B	-	7	20 000	10
New kiln control system A	-	0	15 000	15
New kiln control system B	-	2	20 000	15

Figure 3. The first part of the *Investments* section, with some figures entered as an example.

No. of investments in each case				NPV/unit		
No EnMS	EnMS	-	Comment	Investment	Residual	Total
	32		8 persons 2 hours + 1 pe	50	0	50
	36		4 persons 3 hours 3 tim	50	0	50
	8		2 persons 4 hours	50	0	50
	160		2 persons 2 weeks	50	0	50
	16		2 persons 8 hours	50	0	50
	40		1 person 1 week	50	0	50
	40		1 person 1 week	50	0	50
	16		1 person 2 days	50	0	50
	12		2 persons 4 hours + 1 pe	50	0	50
	120		30 persons 4 hours	50	0	50
				0	0	0
				0	0	0
	1			5 865	1 579	4 287
	4			18 141	2 456	15 685
	5			14 214	8 595	5 619
	4		including decreased m	15 000	3 070	11 930
	10			18 141	5 730	12 411
				0	0	0

Figure 4. The second part of the *Investments* section, with some figures entered as an example.

Annual costs/savings

In *Annual costs/savings*, all annual costs and savings associated with each case are listed (Figure 5). Since an LCC calculation mainly deals with costs, savings are added as negative values. Similar to *Investments*, annual costs/savings are added in "units", where first the unit is defined (e.g. MWh or hours), the price per unit is set and the number of units associated with each case is entered (in the yellow part, see Figure 6). The tool calculates the Net Present Value factor, which is then multiplied with the price per unit and the number of units.

If relevant, an annual price increase can be set individually for each cost/saving. This may apply to for example energy costs and man hours, where an increase in the cost over the calculation period can be expected.

Annual costs/savings

Cost	Unit	Starts from year	Price today (EUR/unit)	Annual price increase
Energy				
Electricity	MWh	0	50	3%
Biofuel	MWh	0	0	2%
Fuel	MWh	0	100	4%
Fuel saving - eco-driving	MWh	1	100	4%
Kiln renovation, bioenergy	MWh	2	15	2%
Kiln renovation, bioenergy	MWh	7	15	2%
New kiln control system, bioenergy	MWh	0	15	2%
New kiln control system, electricity	MWh	2	15	2%
New kiln control system, bioenergy	MWh	0	50	3%
New kiln control system, electricity	MWh	2	50	3%
Reduced standby	MWh	0	50	4%
Maintenance/other				
Administration of the system	hours	0	50	2%
Regular meetings with Energy Team	hours	0	50	2%
Updating/revising the Energy Policy	hours	0	50	2%
Updating/revising the Energy review	hours	0	50	2%
Following up/updating Energy Target	hours	0	50	2%
Updating/revising Energy Action Plan	hours	0	50	2%
Updating/revising routines	hours	0	50	2%
Internal communication	hours	0	50	2%
Recurring Night Owl Walks	hours	0	50	2%
				2%

Figure 5. The first part of the *Annual costs/savings* section, with some figures entered as an example.

Annual units in each case				
No EnMS	EnMS	-	Comment	NPV factor
8000	8000		Cost today	9,0
25000	25000		Cost today	8,5
2000	2000		Cost today	9,5
	-400			8,5
	-1000		bio energy * 10 % savin	6,6
	-1250		bio energy * 10 % savin	2,3
	-500		bio energy, 5 % savings	8,5
	-2500		bio energy, 10 % saving	6,6
	-700		electricity, 35 % saving	9,0
	-2000		electricity, 40 % saving	7,0
	-96		5 % of equipment, 30 %	9,5
	80		2 weeks	8,5
	72		4 persons, 3 hours, 6 ti	8,5
	0			8,5
	40		1 week	8,5
	0			8,5
	360		1 person, 1 day / week	8,5
	0			8,5
	96		1 person 1 day / month	8,5
	24		(2 persons, 4 hours + 1	8,5
				8,5
				7,7

Figure 6. The second part of the *Annual costs/savings* section, with some figures entered as an example.

Results

In Results, the Net Present Values are summed up for each case, giving the total cost of over the calculation period for each case. The results are presented in a table and a graph (Figure 7).

The option with the smallest Life Cycle Cost is the most profitable. Since the Life Cycle Cost method is used, it will be clear how large the investments required for each option is in comparison to the total energy costs over the calculation period, and whether it is a good idea to pursue the option.

Once all data is entered and a result is presented, it is recommended to test the sensitivity of some assumptions. For example, what happens if the discount rate is 1 % higher or lower? What happens if a longer or shorter calculation period is used?

Results [kEUR]

	No EnMS	EnMS	-
Investments – man hours	0	24	0
Investments – other	0	267	0
Maintenance/other	0	287	0
Energy	5 487	3 630	0
Total	**5 487**	**4 207**	**0**
Diff, abs		**1280**	**5487**
Diff, %		**23,3%**	**100,0%**

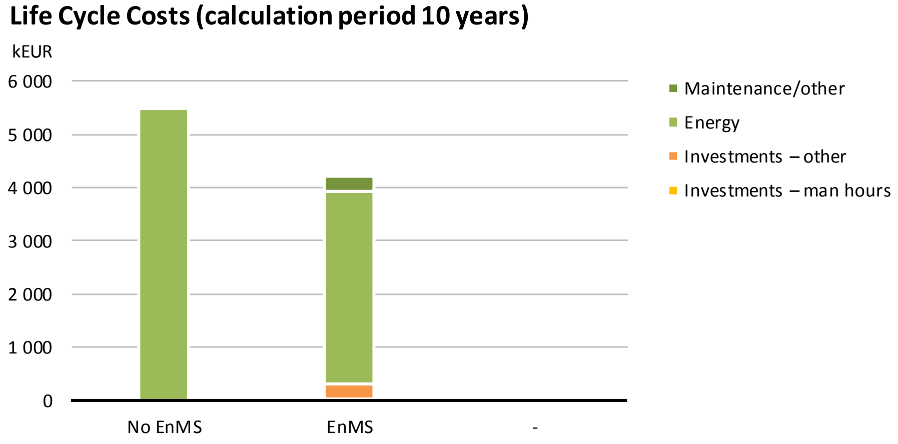

Figure 7. The Results section.

5 Example: EnMS implementation at a sawmill

This example shows how an LCC calculation can be used to estimate the financial implications of implementing an EnMS at a sawmill. It uses fictive figures, but is partly based on estimations from a real sawmill and from experiences from measured savings from real energy efficiency measures. The example is included in the SawEnMS LCC tool, where the numbers can be changed to suit other sawmills.

The example sawmill produces around 100 000 m^3 of sawn, dried wood. The baseline situation is a total energy use of 35 000 MWh/year or 350 kWh/m^3, distributed as:

- 8 000 MWh electricity
- 25 000 MWh biofuel (self-produced)
- 2 000 MWh fuel (diesel)

The analysis compares the business-as-usual case with a case where an EnMS is implemented, which leads to a number of energy efficiency measures. Each cost, investment and saving included in the analysis is described in the sections below. The fuel prices are set according to Table 2. The discount rate is set to 5 % and a calculation period of 10 years is used.

Table 2. Energy prices and annual price increase assumed in the example.

Energy carrier	Price	Annual price increase
Biofuel	0 (self-produced) 15 EUR/MWh if sold	2 %
Electricity	50 EUR/MWh	3 %
Fuel	100 EUR/MWh	4 %

Investments: man hours for implementing EnMS

The estimated man hours for the implementation of the EnMS is shown in Table X. It shall be noted that these figures are just rough estimations and will vary from sawmill to sawmill. The cost for a man hour is set to 50 EUR.

Table 3. Estimated man hours required for setting up the EnMS at the example sawmill.

Activity	Total hours	Comment
Initial workshop	32	8 persons 2 hours + 1 person 2 days
Appoint an Energy Management Team, first meetings	36	4 persons 3 hours 3 times
Developing an Energy Policy	8	2 persons 4 hours
Performing an Energy review	160	2 persons 2 weeks
Setting up Energy targets	16	2 persons 8 hours
Developing an Energy Action Plan	40	1 person 1 week
Developing Routines for energy efficiency	40	1 person 1 week
Developing routines for internal communication	16	1 person 2 days
Performing a first Night Owl Walk	12	2 persons 4 hours + 1 person 4 hours
Informing all personnel	120	30 persons 4 hours
Total	**480**	

Annual man hours for maintaining the EnMS

The estimated recurring man hours for maintaining the EnMS is shown in Table X. The cost of 50 EUR/hour is assumed to increase by 2 % per year during the calculation period.

Table X.

Table 4. Estimated annual man hours for maintaining the EnMS at the example sawmill.

Activity	Total hours per year	Comment
Administration of the system	80	2 weeks
Regular meetings with Energy Team	72	4 persons, 3 hours, 6 times
Updating/revising the Energy Policy	0	
Updating/revising the Energy review	40	1 week
Following up/updating Energy Target	0	
Updating/revising Energy Action Plan	360	1 person, 1 day / week
Updating/revising routines	0	
Internal communication	96	1 person 1 day / month
Recurring Night Owl Walks	24	(2 persons, 4 hours + 1 person 4 hours) twice per year

Energy efficiency measures – investments and savings

In this example, the EnMS is expected to lead to six main energy efficiency measures during a calculation period of ten years.

Table 5. Energy efficiency measures implemented in the example.

Measure	Investment (EUR)	Year	Lifespan (years)	Savings
Eco-driving	3 600	1	7	Fuel: 400 MWh/year (20 %)
Kiln renovation A: 4 kilns	20 000	2	10	Biofuel: 250 MWh/year per kiln (10% of total heat use)
Kiln renovation B: 5 kilns	20 000	7	10	Biofuel: 250 MWh/year per kiln (10% of total heat use)
New kiln control system A: 4 kilns	15 000	0	15	Biofuel: 125 MWh/year per kiln (5 % of total heat use) Electricity: 175 MWh/year per kiln (35 % of total electricity use)
New kiln control system B: 10 kilns	20 000	2	15	Biofuel: 250 MWh/year per kiln (10 % of total heat use) Electricity: 200 MWh/year per kiln (40 % of total electricity use)
Reduced standby	0 (included as man hours for Night Owl Walk)	0	-	Electricity: 100 MWh/year (assuming 5 % of the electricity use is on during 30 % of the year, and 80 % of this is saved)

Results

The results of the analysis are shown in Table X and Figure X. The business-as-usual case costs 5.5 million EUR over the ten-year period, whereas the EnMS case results in a cost of 4.2 million kEUR - about 23 % less. The investments needed are relatively small compared to the savings that result from reduced energy use.

Obviously the result will mainly depend on which energy efficiency measures that are implemented. However, this example results in an energy use reduction by 24 % after all the measures have been implemented. Over a ten-year period, that corresponds to an average reduction of 2,7 % per year – which is lower than the 3-4 % per year that many companies report as results of their EnMS implementation.

This example also shows that annual costs for maintaining the system (man hours for revising the energy review, communicating results, revising every aspect of the system, etc.) may be comparable to the actual investments in energy efficiency measures. However, both are small compared to the energy costs, which are greatly reduced as a result of the work and the investments.

Table 6. Calculated Life Cycle Costs in kEUR (calculation period 10 years).

	No EnMS	EnMS
Investments – man hours	0	24
Investments – other	0	267
Maintenance/other	0	287
Energy	5 487	3 630
Total	**5 487**	**4 207**

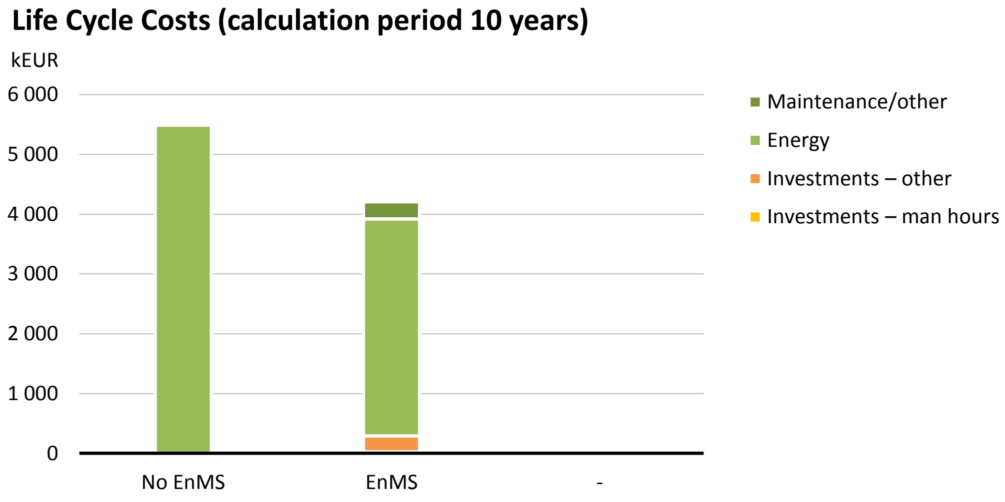

Figure 8. Calculated Life Cycle Costs.

6 Examples: energy efficiency measures

In this section two energy efficiency measures are analysed with LCC calculations. Both examples are included in the SawEnMS LCC tool.

Energy-efficient lighting in final sorting

This example is based on a real example at a sawmill. The sawmill investigated an idea of replacing the lighting in their final sorter premises with LED tubes, based on an offer from a supplier.

The basic data used in this example is:

- Original lighting: 450 standard T8 fluorescent tubes at 58 W each. With additional losses in ballasts etc., the average power is assumed to be 65 W per tube.
- LED lighting: 450 LED tubes mounted directly in existing fixtures, at 30 W each.

The lighting is on during about 65 % of the year, . The LED tubes are assumed to replace the existing tubes 1:1, with comparable light output (LED tubes usually have a lower lumen output than fluorescent tubes, but all light is directed downwards).

The investment is 100 EUR per tube including installation, 45 000 EUR in total, and the LED tubes have an expected lifespan of 80 000 hours. The existing T8 tubes cost only 3 EUR, with an expected lifespan of 15 000 hours. At the current number of hours per year, this means that the T8 tubes last about 2.6 years, whereas the LED tubes last 14 years.

A complete analysis should also include man hours for replacing the T8 tubes (which is done by sawmill personnel; installation of LED tubes was included in the offer from the supplier). This is assumed at 5 minutes per tube. The cost of a man hour is set to 50 EUR.

At an electricity price of 0.05 EUR/kWh, 5 % discount rate, 3 % electricity price increase and 10 year calculation period, the results are shown in Figure 9. The cost over ten years is decreased from 85 kEUR to 72 kEUR, suggesting that this measure should be carried through. However, other options, for example T5 tubes, technologies for reducing the hours of operation, reducing the light level etc. should ideally also be considered in a case like this.

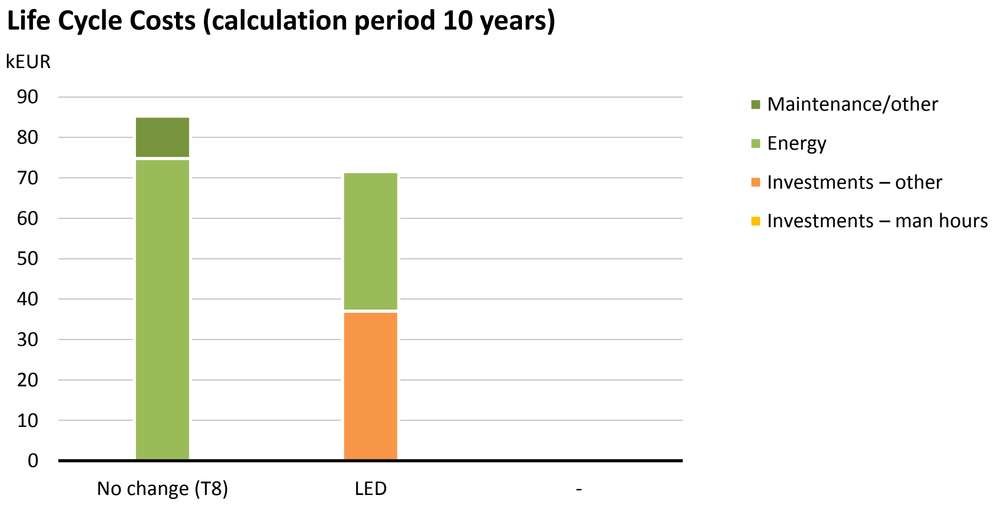

Figure 9. Life Cycle Cost for investment in LED lighting compared to business-as-usual (T8 fluorescent tubes).

Energy-efficient pumps

This is a general example, showing how the LCC of different options for replacing a pump can be carried out. An existing pump runs at an average power of 5 kW and is in operation all year around. Three options are compared:

1. Business as usual: keep the old pump
2. Invest in a new, more efficient pump. Investment 1200 EUR, estimated to reduce the electricity consumption by 30 %.
3. Invest in a new, more efficient pump with VSD (variable speed drive). Larger investment at 2600 EUR, but is estimated to reduce the electricity use even further, since the pump power is adjusted to the actual need at every moment. This is estimated to result in a further 40 % reduction.

Installation and maintenance costs are assumed to be small compared to the energy and investments, so they are left out. The investments are depreciated during the calculation period of ten years, i.e. the lifespan of the investments are also set to ten years.

At 5 % discount rate and an annual 3 % increase in electricity price, the LCC is found to be 20 kEUR for business-as-usual, 16 kEUR for the efficient pump and 11 kEUR for the VSD pump (figure 5).

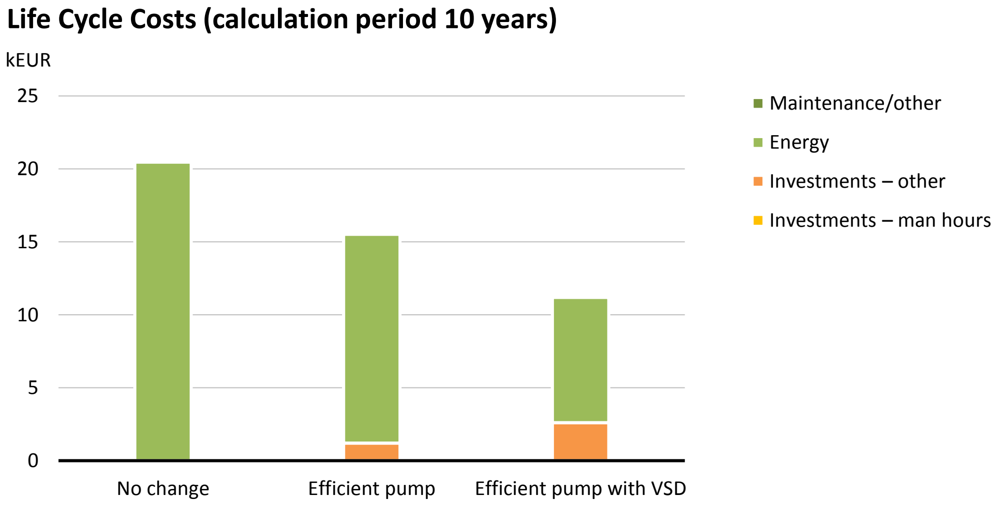

Figure 10. Life Cycle Cost for three different pump alternatives.

The LCC analysis therefore tells the Energy team that both investments are very profitable, but the pump with variable speed drive is the best option: despite its much larger investment, the reduced energy costs saves the company 9000 EUR over the course of ten years.

As a comparison, a simple payback period calculation would give the following result:

- Compared to business-as-usual, the efficient pump saves 680 EUR per year. At an investment of 1200 EUR, that gives a payback time of 1.8 years.
- Compared to business-as-usual, the VSD pump saves 1320 EUR per year. At an investment of 2600 EUR, that gives a payback time of 2.0 years.

The payback time of the efficient pump is thus shorter, which could lead to the conclusion that this option is most profitable. However, the LCC analysis showed that this was not actually the case. What the payback calculation does not capture is that savings are achieved throughout the lifespan of an investment.

Thus, calculating the payback time can be useful for quick estimations thanks to its simplicity, but it can also lead to false conclusion. An LCC calculation gives a more comprehensive picture, without necessarily being much more complicated to perform.

7 Conclusion

In this report, the LCC method was proposed for analysing the costs and benefits of the implementation of an EnMS and for analysing various energy efficiency measures at a sawmill. The LCC method gives the most comprehensive picture of how much savings in energy consumption are worth in the long run, since it compares the investment needed with the total energy cost over the lifecycle (calculation period). The payback method can sometimes be misleading, since it does not take savings during the entire lifespan into account.

The implementation of an EnMS is usually very profitable. If implemented well, the costs are small compared to the potential savings, which was illustrated by the calculation example in this report. The initial investment, mainly man hours for some members of staff working to set up the system, is a very small compared to the savings achieved in a few years.

The LCC tool developed specifically for this purpose can be used by sawmills for evaluating energy efficiency measure or the entire EnMS implementation financially. With some experience with the LCC method, it can be added as a routine before making investment decisions.