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Combined management response and indicator based evaluation methodology of implementation of environmental management system at a wood pellet production industry

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Abstract. The sustainability factor stimulates industrial companies to be more active and precise in improving their performance in relation to energy efficiency and environmental indicators. One of the more widespread practises to introduce improvements in energy efficiency and environmental processes is through energy and environmental management systems. However until now, there is a lack of practical studies assessing the role of environmental management systems to the improvement of the wood fuel production sector. The paper describes an analysis of lessons learned based on combined management-response and indicator based analysis on the introduction of environmental management systems (in accordance with ISO 14001:2004) in an industrial enterprise. The chosen subject of this research is a wood pellet production facility located in Latvia. The research can be applied as a guideline for entrepreneurs in wood fuel production industry that are planning to implement energy and environmental management systems.

Key words: environmental performance, indicators, industry, Plan-Do-Check-Act.

INTRODUCTION

European Union member states have determined to reach both short-term and long-term goals in improving energy efficiency and increasing the use of renewable energy resources. The European Union energy and climate change package defines that energy consumption is to be reduced by 9% in 9 years from the results of energy efficiency *measures* (EU Climate and Energy package, 2010).

An efficient energy economy is possible by reviewing and defining the management of the system and the interaction among its engineering, economic and environmental issues with a common vision for sustainability of the energy sector – all which required a systematic approach. This means the creation, implementation and maintenance of a management system. The direct task of an energy management system is such, however environmental management systems can also provide contribution to better organization of the energy and environmental issues of any company.

The energy management model in principle does not differ much from the environmental management model whereby they both are based on continual improvement and the 'Plan-Do-Monitor-Act' cycle (also known as *Deming* circle)

(Gordić et al., 2010; Halila & Tell, 2013). The environmental management system according to ISO 14001 includes 5 basic elements: development of environmental policy at the enterprise with the commitment of senior management; environmental programmes developed with clear objectives and targets for environmental improvements; a clear, comprehensive system of implementation and operation; a system of checking and corrective action; a management review process to assure continuous improvement (Rondinelli & Vastag, 2000; ISO 14001 standart, 2005).

The environmental management scale includes 3 levels of operation:

- *Strategic (1st level).* Definition of environmental policy, setting environmental goals, division of roles and responsibilities, appropriate resource allocation.
- *Practical (2nd level).* Development and implementation of environmental management procedures, definition of action plans, how to define indicators, how to compare the current situation with the desired goals, etc.
- *Operational (3rd level).* Practical instructions on how to accomplish specific tasks, how to collect data, conduct calculations and evaluations, etc.

An additional level is the comparative level (level 0): evaluation of the accomplishments, utilizing a comparative analysis of indicators from other similar companies.

With pressures of competition, regardless of the size or activity of a company, certification of the energy efficiency of its activities is necessary to provide a testimony. The best such testimony is through internationally recognized systems like ISO 14001:2004 and EMAS in the sphere of environmental management. However there are alternative environmental management models such as the *Ekoscan* model which calls for the development a technically and financially viable Environmental Improvement Plan (EIP) (Heras & Arana, 2010).

In researching the interests of companies to implement environmental management systems, the following main reasons that motivate the companies have been mentioned in the scientific literature (Campos, 2012; Nguyen & Hens, 2013; Zhu, et al., 2013; Zobel, 2013; Testa et al., 2013; Liu & Rodríguez, 2014;To & Lee, 2014):

- Although studies are not conclusive, some argue that the introduction of such systems lead to real improvements in environmental performance;
- The fact that in some countries large companies do not choose to certify, might indicate that small – and medium-sized business might be more inclined in the hopes that this will increase their ability to have a competitive advantage;
- Some companies cite the interests in improving their reputation;
- Overall pressures from external stakeholders (other partner companies, the public, jurisdictions in which the enterprises hold their offices/production sites) is also mentioned;
- Socially conscious companies which are committed to environmental protection.

The most widely applied management system in Latvia is the quality management system ISO 9001. From around 700 registered companies in Latvia, over 130 of these have certified environmental management systems (ISO 14001 and EMAS). Due to the requirement of environmental management systems for continuous improvement, the impact of the companies activities on the environment needs to be continually improved

through the respective programme. Such activities include, a reduction in emissions by improving the efficiency of energy use, improving air filtration systems, reducing waste from production processes and office facilities. The goal of the present research is to develop a methodological approach for the implementation of environmental management systems (EMS) in a pellet production company, to perform an analysis of lessons learned on the introduction of environmental management systems (in accordance with ISO 14001:2004), including identification of key environmental aspects which need to be reviewed in more detail in a wood pellets industrial enterprise. This study is presented as a case study and thus looked at only one company and the specific methods and experiences gained from this case.

The authors have not conducted a separate study on whether companies using environmental management systems are generally more successful than those that do not. However many companies in Latvia have chosen to certify environmental management systems due to growing requests for such certification from international partners. Thus, it is evident, that the scope of the companies' activities and the range of partners increases upon establishment of such system, thereby one can assume that these additional partners and tenders provide more revenue to the company than they would if such partnership would not be established due to the lack of such environmental management certification. Additionally, increase of number of companies included in the study will not provide a picture of the results of implementation environmental management, as such results can only be monitored and reported upon after more than one year of implementation. This study shows the potential impact that the process of developing an environmental management system may have on a company. An exit study after one or more years of implementation could be prepared to study the results of implementation (i.e. in 2015).

METHODS

Evaluation methodology

The evaluation methodology is based on three basic modules (see Fig. 1):

- Company level – analysis of the current management of environmental factors at the company (1st level), environmental audit (2nd level), recommendations for potential activities on improving environmental performance (3rd level).
- Sectoral level – comparative analysis of the company's performance indicators in relation to the same categories of indicators in other companies in the same sector (zero level).

Within the framework of this research only the environmental management systems module is analysed. The main driver of the system both at the company and sector level is continual improvement.

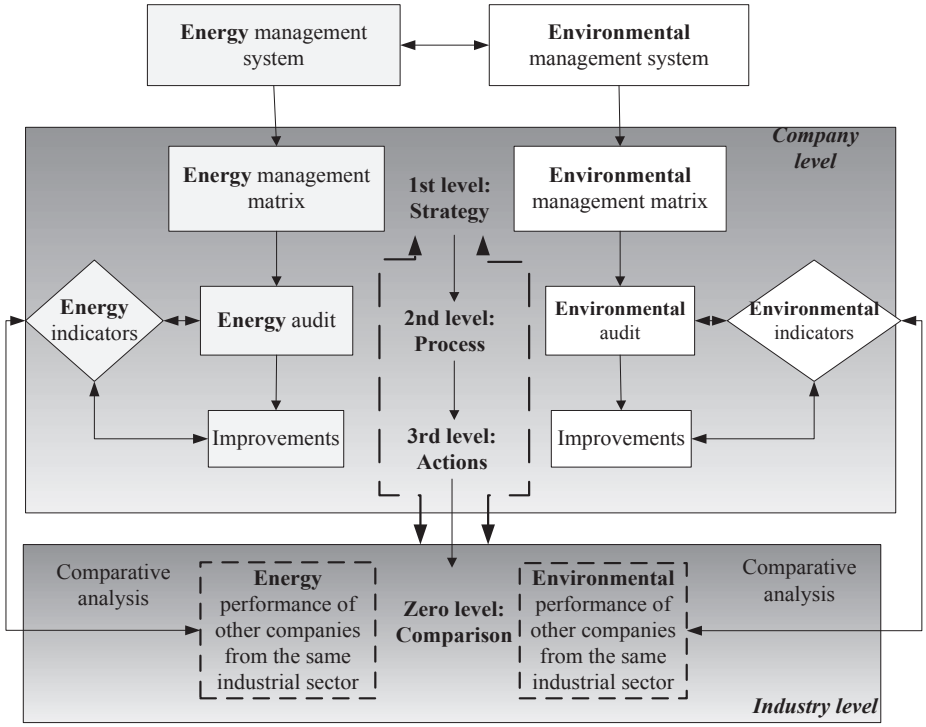

Figure 1. Evaluation algorithm of environmental management system at industry and sectorial level and its link with energy management system.

At the 1st level, the environmental matrixes are developed. The matrixes provide an effective way to gain insight into a current approach to environmental matters in a company. Each column of the matrix deals with one of six critical environmental management topics: environmental management policy, organising, staff motivation, tracking, monitoring and reporting systems, staff awareness/training and overall estimates of the level of investment needed for alternative options explored within the potential activities. The ascending rows, from 0 to 3, represent the increasingly sophisticated nature of the mentioned issues. The matrix shows the current status of a company's environmental management effort. It identifies those aspects where some further attention is required to ensure environmental management is developed in an effective way. Performance evaluation parameters are given in Table 1 (the defined matrix concept and the scale is partly based on (Gordić et al., 2010)).

Environmental audits are implemented at the 2nd level. The goal of the audit is to clarify the relationships between the performance of a company's results (production) and the environmental impact indicators, which are deemed the distinctive indicators. In case of environmental management, these indicators can reflect both the specific impact of production processes on the environmental (such as the level of emissions created to one unit of production), but also such indicators that are related to the energy efficiency of processes (such as the amount of electricity it takes to produce one unit). As energy use is one of the main realms of impact on the environment that any organization has a

direct effect on, it is inevitable that the use of an efficient and environmentally sound energy system is at least partially examined within the development of an environmental management system.

Table 1. Environmental management matrix

Score	Environmental management policy	Staff awareness and training, awareness of the public	Monitoring and reporting
3	Environmental management policy integrated in company vision and action plan. Regular review of progress by top management. Environmental management integrated into management structure.	Formal and informal channels of communication regularly exploited by environmental manager and staff at all levels. Promotion of sound environmental management within the organization and beyond (in the municipality within which the organization operates through different programmes).	Comprehensive targets set within programme, monitors impacts, identifies irregularities, tracks public opinion and any impact beyond its system's boundaries, adjusts environmental programme in periods of profitability for continued improvement
2	Formal environmental management policy exists to some extent in company vision and action plan, but no active commitment from top management	Environmental manager main driver of the programme with key employees responsible for main impact/risk areas in the organization. General induction staff training and awareness. General information available to public.	Monitoring and targeting conducted annually, but programme shows no adaptation to changes in the organization (i.e. monitoring and review is formalized)
1	No formal integration of environmental management concerns, but environmental manager tracks impact	Environmental manager conducts ad hoc awareness raising of key organization employees in problem areas.	Only general monitoring and target reports prepared based on the minimum available data (water, electricity, materials) without analysis of impact
0	Informal ad hoc responses to environmental issues	General rules on emergency situations and fire hazards in place. Engagement with employees and public in emergency situations.	Formal reports compiled on specific data as part of the organization's reporting to the national environmental inspectorate.

At the 3rd level, based on the audit results, proposals for activities to optimize and improve the processes are defined. The activities are normally arranged in several ways to allow the organization to select the most appropriate needs in accordance with their priorities as an organization: (1) to achieve maximum energy- and/or environmental effectiveness (the largest emissions reductions, the largest energy economy); (2) to select the optimal activities in relation to expenses or pay-back period; and (3) time period needed to implementation (from quick-fixes to long-term implementation processes). In most cases, organizations will be looking at a combination of these approaches depending on urgency of environmental risks that may become apparent, available

financial resources and impact that certain changes may have on production processes. It is highly essential that for each activity proposed for improvement, that there are specific indicators which are set to confirm that such improvement has been reached.

The zero level (optimal level) refers to the sector level and at this level a comparison of the specific company's indicators to the indicators of other companies within the same sector is anticipated (this part of the research has not been included in this article).

Description of case industry

The basic business of the researched company is the production and sale of industrial wood-chip pellets. The production of the wood pellets uses the chips, sawdust, branches and bark of both coniferous and deciduous trees. The pellets are made under high pressure thus making it possible to create the pellet without the use of any adhesive or other binding materials. The company has already created an integrated management system which attempts to address the requirements of two standards – ISO 9001:2008 quality management system, ISO 14001:2004 environmental management system.

The pellets produced are exported to European Union countries such as Denmark, Sweden, Belgium and the Netherlands, where they are used in power and cogeneration stations.

The technological scheme of production process at this company is illustrated in Fig. 2.

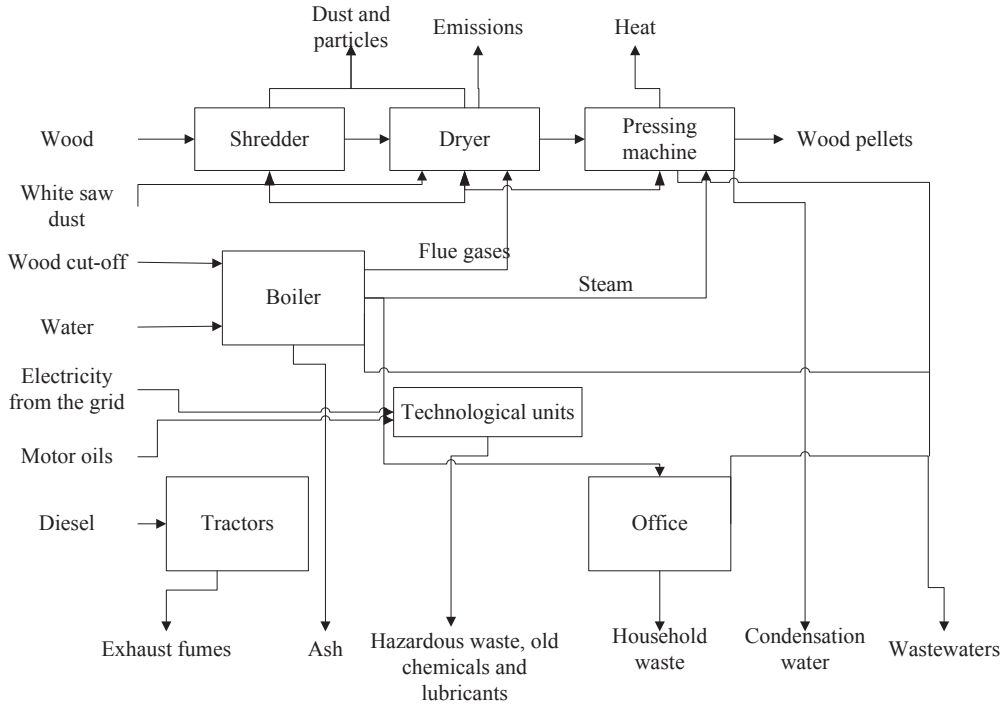

Figure 2. Technological scheme of the case industry plant.

A review of the environmental aspects which evolves from the company's activities is provided in the *Results and Discussion* section.

RESULTS AND DISCUSSION

Strategy level results: energy management and environmental management matrixes

Analysing the status of environmental management system in the wood pellet production company before implementation of the management systems, the overall situation in the field of environmental management can be defined as good, which is based on the following observations:

- The main environmental aspects are identified and addressed within the management system of the company.
- Clear procedures are developed and followed to monitor work processes from which the main environmental aspect may arise.
- Environmental manager is not included in the management group, although the quality system manager is. The integrated system in some areas may present problems in implementation as the approaches to issues which are both environmental- and quality-related are not connected in a comprehensive management response. Due to the organizational hierarchy, in the event of conflict between an action which affects both environment and quality, one can guess that quality argument may gain favorable position in any management decision.
- Internal communication on environmental aspects is structured through induction training and regular monitoring. External communication with the public indicates a clear mechanism developed for reporting incidents and concerns.

The indicative summary of the environmental matrixes is given in Fig. 3.

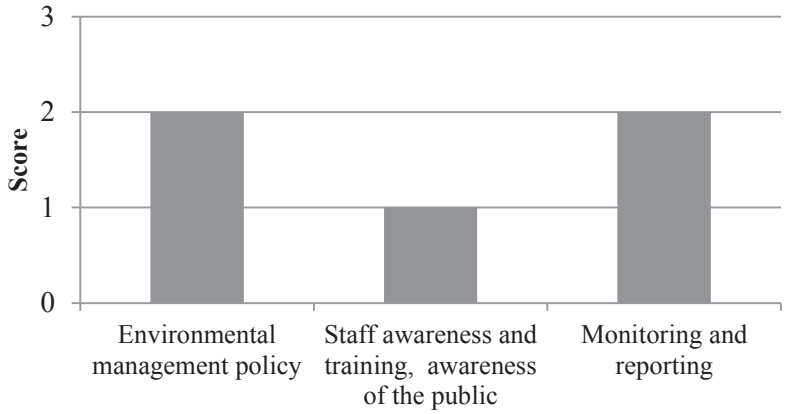

Figure 3. Resulting scores of the wood processing company environmental issues at the strategic level.

Environmental aspects are an essential element of the environmental management system, on the basis of which the environmental policy, its goals, tasks and subsequent monitoring and measurements are built. In order to identify environmental aspects, it is necessary to understand and evaluate the impact or hazards that the company's activities can potentially have. It is also important to understand how these various aspects

interrelate. Environmental aspects are divided into direct and indirect aspects and they arise from input (materials) and output (production, waste) flows (see also Fig. 2). The direct aspects of the company are listed in Table 2. These aspects are defined in three categories: (1) scale of aspect – global, regional or local; (2) degree of impact – volume or size of pollution, waste amount, etc.; (3) effect of aspect – reversible or irreversible harm on environment. Each aspect receives a rating from 1 to 3 where one denotes small impact, 2 – medium impact, 3 – significant impact. The selected scale from 1 to 3 is based on the guidelines of EMS according to ISO14001 standard. The positive side of this simple scale is that it is easily understood by all parties involving in planning, implementing and monitoring the programme – those introducing the system (consultants), the company employees at all levels, auditors and the public at large. The total valuation of the aspect is defined by multiplying the values from each category.

Table 2. Direct environmental aspects at the wood pellet production plant

Environmental aspect	Scale	Degree	Effect	Total score
Energy consumption (electricity)	2	2	1	4
Energy consumption (heat)	3	2	2	12
Water consumption	1	1	1	1
Diesel consumption	1	1	2	2
Motor oils/lubricants	1	1	3	3
Paper consumption	1	1	1	1
Municipal waste	1	1	1	1
Hazardous waste	1	1	3	3
Wastewater	1	1	2	2
Emissions to air	1	3	2	6
Noise	3	1	2	6
Odours	1	1	1	1
Risk of explosion and accidents	3	3	2	18

The maximum points are – 27, the minimum – 1. The critical aspects are those which have received the maximum points (27), or in this concrete case – 18 which was the highest number of points received. Important aspects are those ranging from 8 and 18 points, however, depending on the situation, this can change. The remaining aspects (under a 6 point total) still remain as aspects to be monitored, but are not deemed important for immediate action.

Process level results: environmental management indicators

The role of indicators in the optimization of environmental processes is highly recognised in research (Botta, & Comoglio, 2012; Comoglio & Botta, 2012; Dörr, Wahren, & Bauernhansl, 2013; Petrosillo, De Marco, Zvingule et al., 2013). Similar to the evaluation of other environmental processes (as project effectiveness, energy efficiency) the indicators used in environmental management also need to be (1) reliable; (2) comparable; and (3) indicative.

As far as the case of wood pellet production, the following criteria meets the above requirements:

Electricity consumption to one manufactured unit of product (hereinafter manufactured unit of product is 1 tonne of wood pellets);

- Heating (wood) consumption to one manufactured unit of product;
- Evaluation of the internal logistics fuel consumption and the motor oil and chemical consumption to one manufactured unit of product;
- Number of fire incidents per year;
- Number of accidents per year;
- Volume of emissions (NOx, CO, particles) to one manufactured unit of product;
- Amount of dust produced to one manufactured unit of product;
- Amount of ash to one manufactured unit of product;
- Amount of wastewater (from office and production processes) to one manufactured unit of product;
- Water consumption (from office and production processes) to one manufactured unit of product;
- Amount of hazardous and municipal waste (from office and production processes) to one manufactured unit of product;
- Noise level to one manufactured unit of product;
- Odour level to one manufactured unit of product.

In order to evaluate the efficiency of the environmental management system, the analysis of the indicators needs to take place before, and after introducing the environmental management system (Comoglio & Botta, 2012). In regard to the organization reviewed, the data after environmental management systems implementation is not yet available and thus this aspect is not included in this article.

Actions level results: improvement activities in the field of environmental management

Based on the prioritization of direct environmental aspects (see Table 2), some recommendations were made within the research on how to reduce negative impact of environmental aspects:

- *Risk of explosion and accidents*: The largest risk identified was that of fire hazard which is associated with different phases of the production processes and the flammable characteristics of the materials use. Recommendations were made to ensure regular monitoring and self-assessment of hazardous situation in the system.
- *Energy consumption (heat):* Since the boiler is not located within a building, it would be necessary to find ways on how to reduce heat loss from its surface.

Another way to minimize heat consumption would be to utilise the heat generated from pellets during the compression process. The pellet's temperature after compression is up to 70 ºC, and thus, by installing a recuperation apparatus, this heat can partially be recovered and used to heating the premises.

- *Emissions to air:* There is a fair amount of particles which come from the production process in the work atmosphere. An air filtration system could minimize the effects of these particles on the health of the workers, as well as make it possible to collect such particles for use in the technological process.
- *Noise:* Noise is generated mainly from the production units. It is possible to reduce this aspect by installing a sound insulation wall around the company's territory.

CONCLUSIONS

The paper describes an analysis of lessons learned based on combined management-response and indicator based analysis on the introduction of environmental management systems (in accordance with ISO 14001:2004) in a wood pellets production enterprise. The combined management-response un indicator-based Environmental Management System (EMS) evaluation methodology makes it possible to offer real improvements in industrial companies: a comparative analysis of indicators before and after the introduction of the EMS allows the company to set effectiveness for introducing the EMS, to evaluate both the reduction of environmental impacts and also the economic benefits of the expenses related to these reductions. At the same time the results of the research confirm that in case of the wood pellet production plant, energy planning system elements are more highly developed than those related to environmental management. This can be explained due to the fact that the company recognizes the direct economic benefits which stem from energy efficiency activities – they give a direct return in financial terms. The improvement of environmental factors, however, rarely produce large economic savings due to the current low environmental tax levels in Latvia (natural resource tax and GHG quota prices).

Lessons-learned from wood pellet production are the following:

- External pressures from large consumers place environmental issues and their certification in internationally-recognized standards at a high priority
- Energy issues are the main concern of companies in respect to the environment due to overall scale of the costs associated with this in the total production costs
- Upper management commitment to environmental issues is important, however engaged and knowledgeable middle-managers (in a medium-sized company) can also be enough to carry a good system, if such managers are trusted and given appropriate level of authority in the company.

In further studies work needs to be done on the inclusion of zero level evaluation in the research, specially taking into account the rapid development of the wood pellet industry in Latvia and the fact that the produce is primarily exported, which puts additional responsibilities on producers to follow international standards and maintain the certification of these quality and environmental management systems. The expansion of the analysed system with an energy management system would make it possible to estimate the impact of the energy management on the environmental

management of the company and vise versa. It would also be beneficial to include the investment part in the evaluation matrix and to calculate cost-efficiency of environmental activities.

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