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Strategic energy management in energy-intensive enterprises: a quantitative analysis of relevant factors in the Austrian paper and pulp industry

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ABSTRACT

Increasing energy prices and market volatilities force energy intensive industries to implement energy management systems in order to ensure competitiveness. In this paper, we focus on the strategic level of energy management, specifically, on the analysis of the internal and external conditions that form the basis for strategic development. For this, we selected the case of the Austrian paper and pulp industry. We applied a hybrid method by combining an analysis of strengths, weaknesses, opportunities and threats with an analytic hierarchy process which was based on a survey of expert opinion. The results show that cost-related factors predominate. According to our analysis, the four most important factors are all directly linked to energy costs, energy efficiency, and the energy market. Experts pay little attention to environmental issues or to energy market volatilities. Apart from that, the combination of an analysis of strengths, weaknesses, opportunities and threats with an analytic hierarchy process promises to be a valuable tool for strategic energy management. This is especially true for energy intensive companies and/or sectors, since it enables decision makers to take strategic decisions based on a systematic understanding of the main issues.

1. Introduction

The paper and pulp industry is characterized by both highly energy-intensive production processes as well as by the generation of large amounts of energy outputs as a side-product (Laurijssen et al., 2012). For example, in 2006, 6% of total global industrial energy use was consumed by the pulp and paper industry. In 2007, the corresponding figure was 5%. i.e., 6.87 exajoules[1] (EJ) (Abdelaziz et al., 2011; Kong et al., 2013; Trudeau et al., 2011).

The paper and pulp industry has been highly motivated when attempting to deploy sophisticated energy management techniques in order to optimize energy supply, improve energy efficiency, or identify possibilities for cascading energy within production processes. Over 20 years ago, Collins (1992) pointed out that up to 60% of the production energy needed could be saved by recycling waste paper, thus generating a clear cost advantage. A number of different approaches, guidelines and strategies for increasing energy efficiency, or for saving energy have since been developed. For example, Abdelaziz et al. (2011) and Kong et al. (2013) define three approaches for improving energy efficiency: (i) energy saving via management, (ii) energy saving via technology, and (iii) energy saving via policies/regulations. A strategic approach to energy management can magnify potential efficiencies. For example, Stawicki et al. (2010, 524) present energy management guidelines consisting of seven steps, based on the US Environmental Protection Agency's (EPA) Energy Star partnerships. These outline the key activities needed for successful energy management. The starting point is given by the initial commitment to continuous improvement, which then forms the basis for the subsequent strategic steps, entailing assessing performance and establishing objectives. Once objectives are defined, an action plan can then be derived and implemented, progress evaluated, and achievements recognized.

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[1] Note: The largest industrial energy user is the chemical industry with a total global industrial energy use of about 29.2 EJ in 2007. (Trudeau et al., 2011).

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When it comes to technical energy optimization in the pulp and paper industry, frequent areas of research are cogeneration or combined heat and power systems (CHP) (Marshman et al., 2010), waste water treatment (Sandberg, 2010), assessing the potential of new energy conversion technologies (Laurijssen et al., 2012), and (somewhat less frequently) bio-refinery units (Moshkelani et al., 2013). In order to study the potential available for improving energy efficiency, Fleiter et al. (2012) developed scenario analyses and assessed 17 different technologies in the pulp and paper sector. They found that the technologies with the highest energy saving potential are heat recovery in paper mills, and the use of innovative paper drying technologies. They concluded that significant savings potential is still available, especially where system boundaries are extended beyond company level so as to allow for the inclusion of cross-cutting technologies. A related scenario analysis by Szabó et al. (2009) also reveals that as far as carbon is concerned, significant reduction potential remains within the paper and pulp industry.

What the majority of these studies and approaches on optimizing energy utilization have in common is their strong focus on technological improvements in efficiency at the operational level (e.g. Fleiter et al., 2012; Moshkelani et al., 2013; Sandberg, 2010). Apart from few exceptions (e.g. Dobes, 2013; Laurijssen et al., 2012), there seems to be a clear lack of studies concerning the strategic dimension of energy management, particularly with respect to energy intensive areas such as the paper and pulp industry. This corresponds to the findings of Backlund et al. (2012) who identified energy management as a crucial component of the 'extended energy efficiency gap'. Thollander and Ottosson (2010) also found that a considerable share of Swedish mills in the pulp and paper industry, and in the foundry industry, have no long-term energy strategy. Hence, they concluded that there is still a large untapped potential with respect to the creation of a cleaner, more environmentally sound form of production in the sector.

Thus, the intention in this study is to concentrate on strategic energy management in an energy intensive industry, and in particular, on the analysis of the internal and external conditions that form the basis for strategy development in energy management. For this, the case of the Austrian paper and pulp industry has been selected. It is the objective of this paper to identify the most important factors that determine the strategic planning options for energy management in the Austrian paper and pulp industry. The reported study applies a hybrid method which entails integrating the traditional analysis of industry strengths, weaknesses, opportunities, and threats (i.e. a SWOT analysis) into an analytic hierarchy process (AHP). The purpose, of course, is to gain a better understanding of the relative importance of the respective factors. To the best of our knowledge, such an approach has not been taken before with respect to strategic energy management in energy intensive industries. We thus expect this approach to become a suitable tool for strategic energy management, not only for companies within the paper and pulp industry, but also for other energy intensive enterprises.

On the basis of secondary data and literature, and in order to provide a better general understanding of the industry, we summarize the current situation of the paper and pulp industry in Austria in the following section. In Section 3, we then present our methodological approach, i.e. an integrated SWOT/AHP analysis based on expert judgement. Section 4 presents the results of the analysis. First the strengths, weaknesses, opportunities and threats for the Austrian case are discussed in terms of a standard SWOT analysis. The factors identified are then quantified via AHP. Section 5 rounds up the paper and offers some conclusions.

2. The paper and pulp industry in Austria

The paper industry has a long history in Austria, and dates back to the first paper mill in the 15th century (Austropapier, 2009). In 2013, Austria produced about 4,8 million tonnes of paper and 2 million tonnes of pulp (Austropapier, 2014). The pulp and paper industry is an important element in the Austrian economy. In 2013, about 8000 people, or 0.2% of Austrian employees, were directly employed in this sector. Furthermore, a number of people are working in related sectors which are dependent on or connected to the paper and pulp industry. These include the wood or transport industry, waste paper procurement, printing and advertising, and the packaging industry. Taking all these sectors into account, the paper industry is considered to be a significant factor in the job market, and subsequently in the entire economy. Apart from that, paper mills also tend to be located in peripheral regions. Thus, they are often among the most important regional employers (Austropapier, 2014).

The Austrian paper and pulp industry comprises 21 companies with 23 mills (Austropapier, 2014). The Association of the Austrian Paper Industry, 'Austropapier', represents the interests of all 21 producers of paper, carton, or pulp. Austropapier is also a member of the Confederation of the European Paper Industries (CEPI).[2]

The capacity structure of the companies is not particularly uniform: According to official statistics,[3] the three largest companies in terms of production capacity account for more than one third (34% or 1840 kt) of the annual Austrian production. Eleven medium-sized firms, with an annual production capacity of 100–490 kt, account for another 61% (3333 kt/year) of the total production, while the remaining nine smaller firms have a comparatively low production output of less than 6%, or 312 kt/year.

According to Austropapier (2014), the product range is quite heterogeneous, and apart from pulp includes different kinds of paper such as graphic paper, paper and paperboard for packaging, or special types of paper (for example, paper for beverage labels). About 87% of the paper, and 25% of the pulp produced is exported, mainly to countries within Europe (in 2013, this amounted to 3456 kt of paper, and 328 kt of pulp). The most important export countries for paper are Germany (937 kt), Italy (455 kt) and Poland (260 kt), and for pulp, Italy (137 kt), Germany (100 kt) and Slovenia (33 kt).

A general description of the industrial production activities and processes in the Austrian paper and pulp industry is given is given in Fig. 1.

The largest cost drivers in the paper industry are raw material costs (40%), labor costs (20%) and energy costs (15%). Since the local availability of raw materials such as wood is decreasing, much of the resource input has to be imported. The total demand for wood added up to 8.3 million board feet in 2013, of which 40.6% were covered by imports (Austropapier, 2014).

The production of paper is a very energy intensive process. For the German case, which, with regards to technology used, is similar to the Austrian position, Fleiter et al. (2012) calculated that paper production accounts for 76% of total energy demand in the paper industry, while about 10% of the energy demand is needed for the production of chemical pulp and for recovered fiber pulp, and 4% for the production of mechanical pulp. They also note that chemical or mechanical pulp is produced directly from wood; whereas

[2] See www.cepi.org (September 24, 2014).

[3] See www.austropapier.at for a list of Austropapier members, including data about production capacity and employees (October 6, 2014).