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Energy-efficient pellet production in the forest industry—a study of obstacles and success factors

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Abstract

With an expanding market for upgraded biofuel in many countries, it is important to develop efficient production methods for upgrading wet biomass. The possibilities for heat recovery can be improved if the upgrading process is integrated with other energy-intensive processes, as for example a pulp mill or a sawmill, in a biofuel combine. This work evaluates obstacles and success factors for forming such biofuel combines with the forest industry. Case studies and calculations on theoretical cases have been used together with literature references to evaluate how a biofuel combine can be realised and to compile obstacles and success factors for a combine.

It could be seen from the case studies that an excess of by-products and waste heat, together with an existing need for investments are important driving forces for the formation of biofuel combines in the forest industry. The market was also identified as an important factor, which can be both an obstacle and a success factor depending on the situation. It was concluded that the existence of a small-scale pellet market near the plant is important for economic feasibility when sawdust is used as raw material. The conditions for the biofuel combine are different depending on the form of ownership. When a pulp mill or sawmill owns the pellet factory, it was concluded that minimising the risk by using well-known technologies can be an important factor for the realisation of the combine.

Keywords: Pellet production; Biofuel combine; Energy efficiency; Forest industry; Success factors

1. Introduction

Biofuels play an increasingly important role in the transition towards a CO_2-lean energy system. Assuming that biofuel available at a reasonable cost is a limited resource, both from an economic and ecologic point of view, it is important that handling, upgrading and utilisation of the fuel are all efficient, so that the potential of the biofuel can be fully exploited. The production of pellets from sawdust, bark, wood chips or other wood residues is one way of upgrading biomass to a fuel with a higher energy density, which makes it easier to transport, store and combust. Sweden uses by far the most pellets in Europe, with an annual consumption of 1 million tonnes/year, and the market for fuel pellets is growing in several European countries, such as Denmark, Austria, Finland and Germany [1–5].

In Sweden, wet biomass is often used as raw material for pellet production, whereas the production in some countries, such as Finland and Austria, is based on dry wood from the forest industry. However, to increase production, the producers will have to use wet material and drying will be necessary [1–5]. When wet biofuel is dried and further upgraded to pellets, significant amounts of heat are needed in the drying process. Normally, biofuel-fired flue gas dryers are used in stand-alone drying processes. In a biofuel combine[1] where waste heat can be used as heat source for the drying, the losses of biofuel in the upgrading process can be minimised compared to stand-alone biofuel

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[1]In this work, a biofuel combine is defined as the drying and production of upgraded biofuel, localised so that the waste heat from the forest industry can be used in the biomass upgrading process or vice versa.

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upgrading. In earlier work by the authors [6–8], it was concluded that biofuel combines for pellet production in pulp mills and sawmills are energy efficient and can increase the amount of pellets that can be produced from available biomass by about 15–20% compared to stand-alone pellet production, lowering the global CO_2 emissions by approximately 30–50 kg CO_2/MWh pellets. The production cost for pellets in an integrated process was, according to these studies, comparable with stand-alone production.

Integrated drying of biofuel demands relatively new technologies and it is important to consider both the economic and environmental factors as well as the operating experiences for different types of drying techniques. An important factor for a company when investing in a new process is the risk. Previous studies of the pulp and paper industry [9–11] have indicated that the companies are risk averse and that old industries often "fail to grasp the leadership in new technologies". According to Laestadius [10], this is due to the fact that the companies often deal with very large investments where they cannot afford to fail. This rationally motivated carefulness then spreads to other types of investments as well. This pattern can be assumed to be valid for the pulp industry as well as for the paper industry, and might be partly true for sawmills, since they are part of the forest industry as well and are often owned by the same companies or are part of the same group of companies.

Roos et al. [12] investigated drivers and barriers behind the development of the bioenergy market. They identified integration as one critical factor for bioenergy implementation, along with advantages of scale, competition in the bioenergy sector and with other business, national policy and local policy and opinion. They state that: "The wood fuel market is very integrated with the forest sector". However, they do not closely examine the different forms of biofuel combines in forestry. Earlier studies of existing Swedish pellet production plants combined with industry have covered a heat and power plant in Skellefteå that is integrated with a pellet factory [13–16].

The objective of the present work is to identify obstacles and success factors for the formation of a bioenergy combine between the forest industry and a pellet plant. As compared to other related studies, this study concerns biofuel combines in the forest industry and focuses on the forming of such combines. This paper complements earlier studies by the authors, which focused on technical aspects of integrating pellet production into the forest industry [6–8], with a more detailed economic analysis of the integrated pellet plant and case studies of two Swedish examples of pellet production in co-operation with the forest industry.

2. Theory and methods

To evaluate how bioenergy combines can be formed, case studies were used. Conclusions about driving forces, obstacles, strengths and weaknesses are based on the information received from the case studies and from literature. Since the profitability of the pellet factory is crucial for an investment decision [6,17,18], the case studies are complemented with an evaluation of the uncertainty of the economic feasibility, which will help in evaluating under which conditions a biofuel combine is feasible.

2.1. Case studies

Case studies are chosen as the method for evaluation of the non-technical questions in this research. The case study methodology is suitable when "how" and "why" questions are asked, and when the circumstances of the process cannot be controlled [19]. In order to assure validity and credibility, different sources of information have been used, such as interviews, direct observation at the sites, Web sites, newspaper articles, etc. The informants from the companies have also been able to study and comment on drafts of this study in order to increase the validity. A problem in this type of case study is that important information is often kept confidential.

From case studies, no statistical results can be achieved and the results cannot be generalised to other cases outside of the study. Instead, the results can be compared to theories and previous research [19]. This can help to support or disprove an existing theory.

Two biofuel combines were visited where pellets are produced in combination with forest industries: a sawmill with integrated pellet production and a pulp mill with integrated production of bark pellets. On each site two persons with knowledge about the pellet production and the formation of the biofuel combine were used as informants. These people were interviewed in a conversational, open-ended manner. The results from the interviews and direct site observation, together with official statistics from the mills, newspaper articles and Web sites, were used to compare the situations at the mills to theoretically developed hypotheses. This way, it is possible to evaluate obstacles and success factors for the biofuel combines.

The sawmill produces 101,000 m^3 boards and 45,000 tonnes of pellets annually. The pellet production facility was built in the sawmill in 1994 and is owned by the same company. About 20–25% of the sawdust used for pellet production comes from the sawmill, the rest comes from other sawmills in the region. Bark from the sawmill is used as an energy source for biomass drying as well as for the board-kiln dryers. The biomass is dried in a rotating drum dryer with flue gases from the combustion of bark.

The pulp mill has a capacity of 750,000 tonnes of pulp and produces 35,000 tonnes of bark pellets annually. The pellet production facility was built in 1997 and is owned by the same company. The bark used for pellet production is a by-product from the pulp production. The pulp mill also has excess heat, which is partly used to dry the bark. The biomass is dried in an indirect steam dryer using medium pressure steam from the pulp process.