

Opportunities and Challenges in the Emerging Bioenergy Business: The Case of the Finnish Sawmill Industry

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Abstract

The resources of currently dominant fossil fuels are limited, and their use causes greenhouse gas emissions. Consequently, the public interest within the European Union has changed toward using renewable energy. Finland's forest industry is one of the world leaders in producing and utilizing wood-based bioenergy. Hence, it is of interest to evaluate new value-creation opportunities and the consequent challenges that face the Finnish sawmill industry. In order to identify the strategic resources that enable developing competitive advantages in the emerging bioenergy field, we applied the natural resource-based view of strategy to the sawmill industry. In the empirical part, qualitative semi-structured interviews with managers of 23 sawmills based on the Delphi methodology were conducted in two phases. We identified partnerships with local community heat plants as a strategic resource for providing new business opportunities, apart from raw material availability and existing technologies. Although the Finnish sawmills have a long tradition in energy production, most energy-related investments have been made only during the past decade, and the sawmills would be keenly interested in increasing the efficiency of using their by-products through new investments. In conclusion, the Finnish sawmill industry being the local producer of wood-based bioenergy can support meeting the ambitious national target for renewable energy production for 2020. However, the volatile bioenergy policy changes act as a major factor of uncertainty in predicting the future development of the business environment and further increase the risk level for future investments.

Keywords: opportunities, challenges, bioenergy, Finnish sawmill industry.

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Introduction

Driven by globalization, industrialization, economic growth, and expanding population, the demand for global energy has grown rapidly, especially in emerging markets. According to the International Energy Agency (2010), fossil fuels account for 80% of world energy use. However, the resources of dominant fossil fuels are limited, and their usage is associated with the increased emission levels of greenhouse gases. Therefore, renewable energy usage has gained popularity as a way to address these concerns. Biofuels have been regarded as the most viable alternative to fossil fuels because they are an eco-friendly source of renewable energy and the only renewable source that can replace fossil fuels in all energy markets (Bauen et al. 2009). Bioenergy has thus emerged as a sustainable energy alternative in both the long term and the short term. It can be derived from a wide range of feedstock—e.g., wood-based biomass, energy crops, biogas, and the organic fractions of recovered fuels. Forests play a significant role in reducing carbon dioxide accumulation. Therefore, the use of forest- or wood-based biomass makes a substantial contribution to a sustainable supply of energy (Bauen et al. 2009).

Finland is one of the world leaders in utilizing renewable energy. In 2010, renewable energy accounted for 26.3% of total energy consumption in Finland (Statistics Finland Energy 2011). Bioenergy is the most important source of renewable energy and accounts for 85% of Finland's renewable energy production, equivalent to 20% of Finland's total energy consumption (Finnish Environment Institute 2006). Wood is the most important source of bioenergy in Finland, and the forest industry is the main producer of wood-based bioenergy in Finland, representing about 80% of bioenergy production

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and consumption in the country (Paper and Wood Insights 2006). Sawmilling is the oldest industry in the Finnish forest-based sector, and Finland is one of the biggest producers of sawn goods in Europe (Kuisma 2008). The primary by-products generated by sawn wood production of sawmills, such as bark, sawdust and chips, can be used to produce bioenergy by sawmills or can be sold to power plants or pulp mills. At present, most of the primary by-products are sold to the pulp and paper industries (PPI), as well as the wood-based panel industries (Mäkelä et al. 2011). For instance, the main use of sawmill chips at the moment is for making paper pulp. However, the demand for many of the PPI products has started to level off or decrease in developed markets. Therefore, the demand for sawmill by-products is also expected to decrease in the PPI (Mäkelä et al. 2011). Moreover, these primary by-products can be processed into secondary by-products such as wood pellets and wood briquettes to produce energy by bioenergy firms.

The business environment of the Finnish sawmill industry has experienced dramatic changes since the 1990s, which is reflected in reduced cost competitiveness of firms. Consequently, maintaining sustainable competitiveness in the traditional sawmill industry has become more challenging than before. To create a sustainable competitive advantage (SCA), the Finnish sawmill industry needs to develop new value-creation strategies (Lähtinen and Toppinen 2008). Sawn wood production by sawmills generates considerable amounts of by-products, which can be used to produce bioenergy to generate firm-level value added and support local livelihoods, in addition to promoting social sustainability. Hence, along with manufacturing mass-produced lumber based on raw material-oriented strategies (Lähtinen and Toppinen 2008), sawmills have recently invested more resources in their bioenergy production.

In the past few years, there have been only a few business and economic studies with a focus on the development of bioenergy production in the forest sector. Pätäri et al. (2008) explored the sources of SCA and the value-creation opportunities at the interface between the PPI and the energy industry in Finland. Moreover, Pätäri (2009) identified the key company- and industry-level factors for the PPI that affect their bioenergy businesses. Meanwhile, the business success of the Finnish non-integrated sawmills has been studied from the perspective of the use of production resources. Lähtinen and Toppinen (2008) evaluated the effects of cost- and value-added components on the firm-level financial performance of the Finnish large- and medium-sized (LM) sawmills. The categorization of LM sawmills was based on the reports of Balance Consulting (e.g., 2007) regarding the Finnish firms that operate in the sawmilling, planning, and impregnation of wood (NACE class DD.20.10). In these reports, sawn wood manufacturers were categorized as LM sawmills according to their financial and employment values. In terms of employment, the average number of workers at an LM sawmill was 60 persons (Balance Consulting 2007). Compared to the Finnish sawmill industry as a whole, LM sawmills represented approximately one-quarter of the Finnish sawmill industry in terms of turn-

over, production volume, and employment in the 2000s (e.g., Lähtinen and Toppinen 2008). Lähtinen et al. (2009) assessed the firm-level strategic resource usage decisions made on the business performance of the Finnish LM sawmills according to Barney's (1991) resource-based view (RBV). However, none of the previous studies focused on the sources of SCA, or the value-creation opportunities, or the consequent managerial challenges that arise at the interface between sawn wood and the emerging bioenergy production. The purpose of this study is to fill these gaps.

Theoretical Background

The dynamic capability theory (DCT) and the natural resource-based view (NRBV), both of which were built on the RBV (e.g., Barney 1991, Hart 1995, Teece et al. 1997, Barney et al. 2011), served as theoretical background for the data analysis of our study. The objective was to identify the strategic resources that enable maintaining and developing competitive advantages in the emerging bioenergy business of the Finnish sawmills. The RBV of the firm is a business management tool, which is used to determine the strategic resources available to a company. It deals with the concept that by using the internal resource base and core competencies, business managers will be able to formulate a strategy to create SCA in firm's markets and industries (Barney 1991). The RBV highlights the link between the resources and competitive advantage of firms. Resources are the inputs used by firms in their production processes. Capabilities are the abilities of firms to deploy resources. When the four criteria of resources and capabilities—namely valuable, rare, imperfectly imitable, and non-substitutable (VRIN)—are met, firms will achieve SCA and therefore lead to superior performance in the markets. In short, the sustainable competitiveness of a firm is derived from its ability to assemble and exploit an appropriate combination of resources. The RBV also emphasizes the need for an ideal fit between the external business environment of a firm and its internal capabilities. To achieve business success, firm managers should be able to choose a strategy that allows the firm to utilize its resources and capabilities optimally, relative to the opportunities in the external environment.

The traditional RBV is a static view of dynamic processes of a firm required for achieving SCA. In the course of market globalization, the sources of competitiveness have changed from static efficiency and physical production factors to more dynamic processes that require continuing learning and making innovations (Porter 1994, Teece 2007). To achieve good business performance, firms must flexibly adapt to changing market conditions and be able to exploit uniquely and rationally their internal resources (Barney 1991). According to a later study by Barney (1997), sustainable competitiveness of a firm is achieved by continuously developing existing resources and creating new resources in response to dynamic market conditions.

A recent development of the RBV is referred to as the DCT, which has emphasized the ability of a firm to integrate, build, and reconfigure internal competencies under rapidly changing and complex external environments (Teece et al. 1997, Verona and Ravasi 2003). Dynamic capabilities include

the abilities to detect and assess environmental change, to exploit knowledge, to innovate, to manage a range of multiple product development schedules, to transcend technology cycles, and to integrate technologies across disparate units. Examples of dynamic capabilities include the creation of new products and the formation of alliances. The central premise of an offshoot of the dynamic capabilities perspective suggests that the resources of a firm need to fit in with the environment and change over time to maintain their market relevance and deliver competitive advantage (Teece et al. 1997). In short, the RBV tends to focus on the types of resources and the characteristics of these resources that make them strategically important, whereas the DCT focuses on how these resources need to change over time to maintain their market relevance.

The role of the natural environment of the core capability development of a firm was examined by Hart (1995), who extended the RBV to include the opportunities provided and also the constraints imposed by the natural environment. The NRBV of a firm is a theory of competitive advantage that is based on the VRIN presumption and simultaneously considers the firm to be interconnected with its natural environment. The NRBV connects environmental challenges and the resources of a firm, which are operationalized through three interconnected strategic capabilities: pollution prevention, product stewardship, and sustainable development. All three strategic capabilities contribute to competitive advantage by lowering production costs or by pre-empting limited resources (Hart 1995). In the context of climate change, it requires the organizational culture of firms for the improvement in operational energy efficiency and technological capabilities of reducing carbon emissions to contribute to competitive advantage. Accordingly, applying the tenets of the NRBV to corporate strategic decision-making in response to the challenges and opportunities presented by climate change would be very useful.

The theoretical framework of our study is shown in Figure 1, which describes the strategic management process of a firm from the internal resource and capability perspective. It also has a simultaneous focus on the external business environment and natural environment. The internal perspective covers the strategic decisions on resource deployment and capability building to generate above-average returns at the firm level (Barney 1991). In general, the resources of a firm are classified into two categories: tangible resources and intangible resources. Lahntinen et al. (2009) identified the resource pool of the Finnish sawmills to comprise five tangible resources (geographic location, raw material, labour, factory and machinery, finance and strategy) and six intangible resources (management expertise, personnel know-how, collaboration, organization culture, technological know-how, reputation and services). To achieve SCA, firms should choose a strategy to obtain the VRIN resources. The resources and capabilities of a firm are linked to the business environment via its business processes that consist of a group of activities, such as material purchasing, product manufacturing, and service provision (Porter 1985), which are implemented in combination to achieve strategic goals. As a founda-

tion for the interplay between a firm and its environment, after receiving and analyzing the information about the business environment, managers must have a clear understanding of the business environment to make strategic decisions about using internal firm-specific resources in business processes. In the present study, we hypothesized that the increasing external pressure on energy resources driven by climate change would act as a triggering force that affects the strategic management of sawmills.

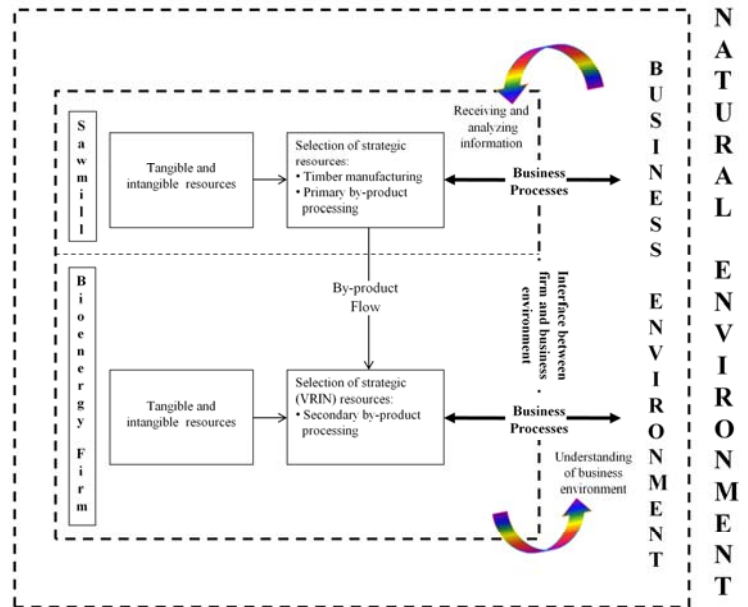


Figure 1. Theoretical framework of the study (modified from Lahntinen 2007).

Materials and Methods

In this study, the focus in data-gathering was on the Finnish non-integrated medium-sized sawmills (i.e., LM sawmills) whose core business is sawn wood manufacturing. These sawmills are privately owned and not part of the three multinational forest industry companies in Finland, namely: Stora Enso, UPM-Kymmene, and the Metsaliitto Group. In the 2000s, LM sawmills produced approximately 3 million cubic meters of sawn wood, employed almost 2000 workers and generated turnover of 600–700 million euros (Balance Consulting 2007, Lahntinen and Toppinen 2008). Such purposive sampling was based on the assumption that the business of these sawmills would be most closely linked to utilizing their by-products for bioenergy production. However, because of sample selection constraints, our results should not be generalized beyond this segment of the sawmill industry in Finland.

The focus in data analysis was on the managerial perceptions in these sawmills, including the managerial understanding of the factors that facilitate or hinder future development in bioenergy production of sawmills. Therefore, we conducted two rounds of semi-structured, qualitative interviews

based on the Delphi-type multiple-round questionnaire method to gather expert opinions on the current state and future perspectives toward 2020. The first-round data were obtained from the sawmill managers who were responsible for the firm-level strategic decision-making (including chief executive officers, production managers, etc.) in the autumn of 2010. In line with the RBV and based on 14 structured questions and one open-ended section, the purpose of the first-round interview study was to analyze the main resources for bioenergy businesses of the Finnish sawmills. The process of data-gathering started by contacting 25 sawmill managers by phone to inquire about their willingness to participate in the study. This was followed by asking those who were willing to participate to first familiarize themselves with our semi-structured questionnaire, and then to complete it in a telephone interview.

The second-round data-gathering was completed in the autumn of 2011 by using five sets of questions with a 5-point Likert-scale. The purpose was to identify further the relative importance of different processes and the related strategic resources in the bioenergy value chain of sawmills. Moreover, the major factors that affect the future of bioenergy business for the Finnish sawmills were examined. Porter's (1985) value chain approach was used to analyze the survey data. In this round, the same 25 sawmill managers were initially contacted again for interviews, and a summary of collective feedback received from the first-round interviews was provided for them. However, by this time two sawmills had ceased their operations; therefore, the sample size was reduced to 23. In the final phase of the survey—i.e., the conclusion and reporting round—the results and the conclusions of the study were again reported to the participants after finishing the thorough analysis of the second-round questionnaire's answers. The entire Delphi survey was conducted in Finnish, which is the native language of the interviewees and all the respondents.

The Delphi method has been utilized as a valuable foresight tool in numerous fields of study, although it has sometimes been criticized for not being objective or scientific enough (Sackman 1974). Ever since the different modifications of Delphi emerged in the 1950s, it is probably the best-known predictive research method with its own name (Linstone and Turoff 1975, Landeta 2006). The key characteristics of a traditional Delphi study are iteration, participant and response anonymity, controlled feedback, and group statistical response (Landeta 2006). Iteration in this case means the participating experts are consulted at least twice on the same question and are thereby given the opportunity to change their opinions.

Because this happens anonymously, there is no fear of losing face, and undue social pressure can be avoided. So the personality and status of the participating experts should not influence their responses. The idea behind controlled feedback is that all the panellists are given feedback between each questionnaire round, which informs them of the consensus opinion of the panel. Finally, the Delphi answers can be processed quantitatively and statistically in a group statistical response, and all the opinions contribute to the final

outcome (Dorsman et al. 2011). These five key features are often prerequisites for defining a procedure such as Delphi (Landeta 2006, Pätäri 2009).

More recently, many researchers have adapted the consensus-based Delphi design, which emphasizes the range of quality ideas the process generates. Because the Delphi method is used for gaining information from special focus groups formed by experts, it can be applied to study issues with a high level of uncertainty, such as current issues and future predictions on the production and investments in bioenergy. According to Linstone and Turoff (1975), the strength of the Delphi approach is the ability to make explicit the limitations on the particular design and its application. In this study, the design of the Delphi was very simple and therefore its application was quite easy. The respondents were greatly experienced and very knowledgeable about the topic, and the obtained results of our study met the aims of the study, so the validity of the applied method can be considered to be good. Moreover, the reliability of the information is most likely to be quite high because of the simplified and narrow structure, in addition to the exact execution of the survey.

Results

In the first round of the survey, 18 out of 25 managers participated in the interviews, which yielded a response rate of 72%. According to the results of the first-round interviews, 11 out of 18 sawmills were involved in selling their bioenergy products rather than using bioenergy, whereas the remaining seven sawmills produced bioenergy only for internal use. Thus, the share of commercial bioenergy production in the sample was 61%. In terms of turnover, the share of bioenergy for the 11 bioenergy-selling sawmills ranged from 0 to 10%. Among those sawmills involved in bioenergy production, most of them produced heat, but some of them were also involved in the combined heat and power (CHP) production, and wood briquettes processing. Other firms, bioenergy companies, and municipalities were mentioned as the main customers. In this study, bioenergy companies are those companies that deliver bioenergy products and services, including wood pallets, wood briquettes, heat, electricity, biodiesel, bioethanol, and biogas, as their primary focus. In addition, public or private utilities that employ workers specifically for bioenergy activities (e.g., supplying water, heat, electricity, etc.) and companies that support bioenergy services are included. With respect to the resource usage at sawmills, the empirical results of the present study were fitted into the theoretical resource categorization introduced by Lähtinen et al. (2009). The interviewed managers indicated that raw materials, technological know-how, personnel know-how, collaboration and services were the most important resources for bioenergy production by their mills, whereas the least-emphasized resource was the marketing of bioenergy products.

In the second round of the survey, all managers of the remaining 23 mills participated in the interviews, which gave a response rate of 100%. The value chain approach, which was based on the modified value chain model of Porter (1985), was used to analyze the survey data at this stage. The modified value chain constitutes six primary activities related

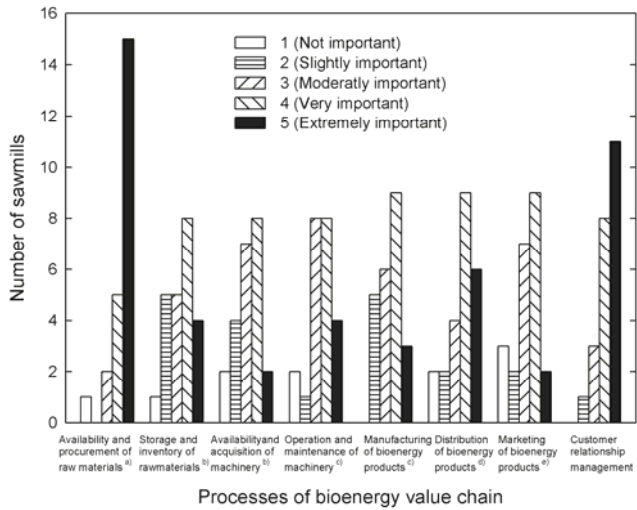


Figure 2. Distribution of responses regarding relative importance of processes in the bioenergy value chain. Embodiment of processes are indicated by superscript letters according to: a) raw material procurement, b) inbound logistics, c) bioenergy production, d) outbound logistics, e) marketing and sales, f) end-user services.

to the bioenergy business, including raw material procurement, inbound logistics, bioenergy production, outbound logistics, marketing and sales, and end-user services. We obtained more detailed and concrete information on the insights of managers into the relative importance of processes in the bioenergy value chain in the second-round questionnaire. We achieved this by dividing the bioenergy value chain into eight stages, as shown in Figure 2.

According to the sawmill managers, the availability and procurement of raw materials and customer relationship management were the most important processes in the bioenergy value chain. Apart from these two processes, all the other processes (distribution of bioenergy products, storage and inventory of raw materials, operation and maintenance of machinery, manufacturing of bioenergy products, marketing of bioenergy products, and availability and acquisition of machinery) were considered to be almost equally important.

The perceived relative importance of forms of cooperation is illustrated in Figure 3. Among the different forms of collaboration between the bioenergy-selling sawmills and their partners, long-term cooperation was considered to be the most preferred, whereas business partnerships were less preferred; those of informal cooperation and short-term cooperation were the least preferred forms of cooperation.

When examining the connection between value chain processes and forms of cooperation in addition to their respective importance, we found that the most favourable value chain activity and its accompanying form of cooperation was raw material procurement and long-term cooperation. These were followed by other combinations, as presented in Table 1. This result clearly indicates long-term cooperation was the most desired form of cooperation, with 88.5% of all given combinations of value chain processes and forms of

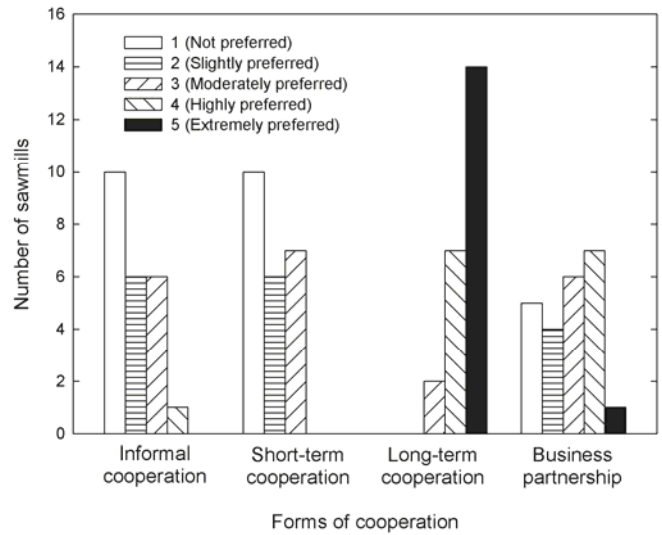


Figure 3. Perceived relative importance of forms of cooperation between the bioenergy-selling sawmills and their partners.

cooperation. The remaining 11.5% of the responses preferred business partnership as the primary form of cooperation.

When asked about the factors affecting the future of bioenergy business for the Finnish sawmills, the managers uniformly stated that sufficient and stable demand for bioenergy and governmental energy policies and financial support were the most important factors. In addition, prices of raw materials, prices and subsidies of bioenergy, prices and taxation of fossil fuels, vicinity of potential markets, quality of customer relationships and available outbound logistics also played important roles in developing the bioenergy business. Among the management of 23 sawmills, 13 of the managers (57%) intended to continue the investments in bioenergy production only if these reached the desired objectives, whereas nine of the managers (39%) planned to continue with bioenergy investments regardless of the realization of their desired objectives. Only one manager (4%) decided not to continue with bioenergy investments. The reasons pointed out for not having the bioenergy investment plan were the lack of demand, and the lack of resources or financial support. In contrast, the reasons for having such plan varied from elevating the utilization rate and the upgrading degree of by-products to improving the profitability or ensuring the energy supply of the firm. According to those managers who had investment intentions, the planned investments were mainly aimed at expanding bioenergy production capacity of sawmills and starting up novel bioenergy production facilities, such as the CHP plants.

Based on the observed differences between the emphasized and the actual required resources for increasing bioenergy production, there are lots of business opportunities for sawmill firms to develop their bioenergy businesses in cooperation with bioenergy firms. Again we used the modified value chain model to analyze the resource complementarity

Table 1. Shares of most preferred combinations of value chain processes and forms of cooperation.

Form of cooperation	Value chain processes	Share (%)
Long term cooperation and	Availability and procurement of raw materials	37
	Manufacturing of bioenergy products	14.2
	Storage and inventory of raw materials	8.6
	Distribution of bioenergy products	8.6
	Customer relationship management	8.6
	Availability and acquisition of machinery	5.7
	Machinery operation and maintenance	2.9
	Marketing of bioenergy products	2.9
	<i>Value chain processes pooled</i>	88.5
Business partnership and	Distribution of bioenergy products	5.7
	Manufacturing of bioenergy products	2.9
	Machinery operation and maintenance	2.9
	<i>Value chain processes pooled</i>	11.5
<i>Cooperation pooled</i>	<i>Value chain processes pooled</i>	100

between the Finnish sawmills and the Finnish bioenergy firms. Figure 4 shows the activities in the bioenergy value chain, in which the final goal of these activities is to achieve a profit margin for both industries through their successful collaboration.

For raw material procurement, sawmill managers have wide knowledge of raw material (hereafter referred to as sawlogs) properties, much experience in buying sawlogs from the roundwood markets, and extensive information on the roundwood suppliers. Their close cooperation with skilled forest contractors and forest owners secures the access of sawmills to sufficient amounts of sawlogs of the right species at competitive prices. Apart from their skills at raw material procurement, sawmill managers have extensive

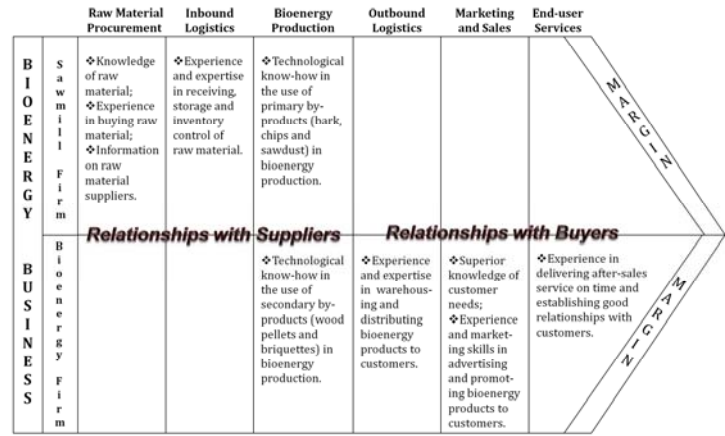


Figure 4. Value chain of bioenergy (modified from Porter 1985).

experience and expertise in managing raw material freight logistics from forests to sawmills for final product manufacturing, which is called inbound logistics. A sawmill with efficient control of its inbound sawlogs is likely to get the upper hand over its competitors. In bioenergy production, the existing technology of using primary by-products of sawmills to produce bioenergy was considered to generate value added and create a basis for SCA. In cooperation with sawmills, bioenergy firms can use secondary by-products that are derived from primary by-products to produce bioenergy products.

When bioenergy is produced, it must be sold and delivered to customers in a cost-effective way that still meets the expectations of the customers. This process includes the activities of outbound logistics, marketing and sales, and end-user services. Superior knowledge of customers is regarded as the VRIN resources for firms (Korhonen 2006). Skills of the bioenergy firms in distributing, marketing, and servicing bioenergy products, coupled with their close relationships with local bioenergy buyers, help ensure a thorough understanding of their customers and efficient sales of product. All these production resources were also emphasized in our sample as strategic resources to create value added. They comprised a crucial part of the dominant strategy of the Finnish sawmills in cooperation with bioenergy firms. From the collaboration perspective, the first three activities in the chain appear to deal mainly with the relationships with raw material suppliers, and thus they are best undertaken by sawmills. By contrast, the last three activities seem to deal mainly with the relationships with bioenergy buyers, so they are best provided by bioenergy firms.

According to the results of two rounds of data collection, we summarized the most promising value-creation opportunities and the consequent managerial challenges for developing bioenergy business at the Finnish sawmills. As listed in Table 2, these opportunities and challenges were examined from the perspective of market demand, role of energy policies, internal resources, and other preconditions for new investments. Based on this analysis, it seems that the opportunities are more numerous than the perceived challenges, but some important obstacles still exist in expanding bioenergy business of sawmills.

Table 2. *Opportunities and challenges for bioenergy business of the Finnish sawmills.*

Industry Factors	Opportunities	Challenges
Market Demand	<ol style="list-style-type: none"> 1) Due to environmental concerns, increasing demand for energy, and rising prices of fossil fuels, there has been a boom in renewable energy in recent years; 2) Potentially fruitful opportunities for sawmills for initiating value-creation businesses by producing bioenergy in collaboration with the energy industry. 	<p>Because of the cyclical nature of the sawmill industry, reliance of the bioenergy production on sawmills as raw material suppliers implies that the bioenergy business also becomes vulnerable to downturns in demand in business cycles.</p>
Policies	<ol style="list-style-type: none"> 1) Renewable energy policy as the main driver of growth in renewable energy use (the European Union RES setting the target for Finland to increase the share of renewable energy to 38% by 2020); 2) Finland's long-standing government policy support for bioenergy (environmental taxes, investment support and subsidies)—tax exemption for biofuels and a heavy tax on fossil fuels in the heating sector as the most effective policy instruments; 3) A new feed-in scheme introduced in Finland in 2011 supports wind, biogas, and wood-based power generation (MEE 2011). 	<ol style="list-style-type: none"> 1) In Finland, environmental taxes on fossil fuels are levied only in the heating sector, but not in the electricity generation and transmission sectors; 2) Finland's political decision, such as "renewable energy package," that supports the use of energy wood in biogas production as a factor of distorting the competition among energy producers, is especially harmful to the Finnish non-integrated sawmills; 3) The volatile bioenergy policy changes would pose challenges for predicting the development of the business environment and further increase the risk level of investments.
Availability of Raw Material	<ol style="list-style-type: none"> 1) Internal supply of wood fuels for sawmills at a competitive price will facilitate processing into energy products (Mäkelä et al. 2011); 2) The structural change of the forest industry in reducing the demand for sawmill by-products in traditional applications (e.g., in the PPI) could promote the use of by-products in bioenergy production and thus open up collaboration opportunities between the sawmill industry and the energy industry. 	<ol style="list-style-type: none"> 1) Uncertainty in the sawn wood markets has increased because of Russia's political decision to limit its roundwood exports; 2) Uncertainty of pellet prices prevents the expansion of the traditional sawmill industry into Finland's pellet markets (see Mäkelä et al. 2011).
Technological Know-How	<p>Finland is one of the world leaders in using wood-based fuels in energy production, with globally recognized technological and logistical know-how.</p>	<ol style="list-style-type: none"> 1) The same technological and logistical solutions might be replicated by competitors outside Finland; 2) To make smaller sawmill units become more profitable, there is still some space for improvements in bioenergy technology.
Forms of Collaboration	<p>Partnerships with district heating plants of the local community were emphasized as a strategic resource to create competitive advantages for bioenergy business of sawmills.</p>	<p>A similar collaboration form might be replicated by competitors outside Finland.</p>
Impacts on Profits	<p>Although the share of bioenergy in Finnish sawmill value creation is rather small, it will affect the financial performance of sawmills overall.</p>	<p>Low share of bioenergy might make some sawmills lose their interest in increasing bioenergy production.</p>
Investments	<ol style="list-style-type: none"> 1) The Finnish forest industry has invested heavily in bioenergy, and the share of bioenergy is projected to increase (Kallio et al. 2007); 2) Finnish municipalities have a long tradition in investing in wood fuel plants and started to invest in biomass heating systems in the 1990s; 3) The Finnish non-integrated sawmills have made large investments in bioenergy production, including plants, machinery, pipes, and other infrastructure. The sawmill managers, especially those with the biggest share of bioenergy, are interested in investing in new bioenergy branches and enlarging bioenergy business by using by-products to increase efficiency and profitability. 	<ol style="list-style-type: none"> 1) Investments in bioenergy are risky and capital intensive; 2) Relatively high investment costs are an obstacle for small-scale CHP and pellet production; 3) Most of the bioenergy investments made by the Finnish sawmills have occurred during the past 10 years, indicating that an innovative business may not yet have established a steady position in the sawmill industry.

Discussion

The limitations of using fossil fuels in energy production call for seeking alternative, renewable, and sustainable sources of energy. Producing wood-based bioenergy is regarded in both the long term and the short term as a sustainable energy provision alternative. Finland is one of the leading countries for utilizing wood-based bioenergy, and the forest industry is the largest producer of wood-based bioenergy in Finland. Some Finnish sawmills have invested in bioenergy production to diversify their business and increase the firm-level value added, especially in the past decade. Although it is commonplace that producing bioenergy is emphasized as a new business option for sawmills in discussions, it is not a new issue for the Finnish sawmills and there are already many unutilized value-creation opportunities in this emerging bioenergy business.

In a similar approach to that of Hart's (1995) NRBV, this article analyzed the resources of the Finnish sawmills in developing bioenergy business. Methodologically, we carried out two rounds of semi-structured interviews by applying the Delphi method and analyzed interview data according to the value chain approach (Porter 1985). The aim was to investigate the sources of SCA at the intersection of the Finnish sawmill and energy industries and the perceived importance of factors that affect the future of the bioenergy business, as well as the consequent value-creation opportunities and managerial challenges. The data-gathering focused on the Finnish non-integrated medium-sized sawmills. The response rates for the first- and second-round interviews in a purposive sample of 25 companies were 72% and 100%, respectively.

In the first-round interviews, raw materials, technological know-how, personnel know-how, collaboration and services were identified as the strategic resources of bioenergy business of the Finnish sawmills. Thus, these resources might serve as the sources of creating SCA. Wood raw material is naturally a critical resource because the availability, procurement, price, and efficient use of wood raw material substantially affect the production costs and financial success of sawmills. In the case of bioenergy production of sawmills, the acquisition of good-quality sawlogs of the right species and dimensions at moderate costs creates value added for sawmills (Lähtinen and Toppinen 2008). However, in today's rapidly changing world, traditional cost-benefit advantages alone can no longer ensure SCA. Fierce competition requires superior cost leadership or increased innovations—not only product innovations but also service innovations—to differentiate organizations from one another.

Product innovations are based on acquiring new technological know-how by a firm, which was also regarded as an important source of SCA by our respondents. Personnel know-how was found to be very important linked to production technologies. With the rapid development of the global economy and the intense competition within a global market, enterprise management mode has been changed from product-orientation to service-orientation. Thus, many com-

panies are turning to the quality of customer service offering to make them distinct from their competitors. Superior customer services are a good tool for firms to create competitive advantages because they cannot be purchased from the markets and they are also difficult to be imitated by competitors. Exceptional customer services can become strategic resources and core competencies that form the basis for SCA of sawmills. In addition to raw materials, technological know-how, personnel know-how and services, collaboration with the suppliers of wood raw materials, and partnerships with district heating plants of the local community were emphasized by the managers as strategic resources to create SCA for bioenergy business of sawmills. Similar results were found in a previous study by Lähtinen et al. (2009), which identified that a strategic emphasis on raw materials, technological know-how, collaboration, reputation, and services impacted positively on the overall competitiveness of the Finnish sawmills.

In addition to exploring strategic resources and different value chain processes, one of the primary aims of the study was to investigate the possible connections between these two factors. According to the second-round interview data, the most important processes in the bioenergy value chain were availability and procurement of raw materials and end-user services. This suggests that there were indeed some connections between the emphasized resources and processes. The most obvious connection perhaps lay between the resources and the processes related to raw materials and end-user services. Wood raw material is a very important resource for sawmills, and thus the process related to the availability and procurement of raw material is also very important. Without wood raw material, sawmills cannot produce sawn wood or sawn wood-based bioenergy products. And energy generated by bioenergy production can be sold to customers to earn profits. If sawmill firms or bioenergy firms do not provide good customer service or possess well-functioning customer relationships, they will not be able to survive in the markets in the long run. Thus, the resources connected to these value chain processes are vital to developing a competitive advantage.

Apart from these two processes, all other processes in the bioenergy business of sawmills were also valued as being quite important. However, in practice, a sawmill manager may not have sufficient knowledge or possession of resources to follow all the strategic management processes (Hitt et al. 2005). Therefore, it might be wiser for sawmill management to focus its resources on the processes that the mill masters best, and collaborate with the partners in the processes with which they are most familiar. In the value chain of bioenergy generation, the first three activities (raw material procurement, inbound logistics, and bioenergy production) seem to deal mainly with the relationships with raw material suppliers, which are traditionally undertaken by the procuring sawmills. In contrast, the last three activities (outbound logistics, marketing and sales, and end-user services) seem to deal mainly with the relationships with bioenergy buyers, based on the customer-driven approach. Therefore, there is a higher likelihood that these latter activities are best undertaken by bioenergy firms.

Based on this study, the future plans and decisions on bioenergy production and investments for the managers of sawmills were closely related to the external factors that affect the bioenergy business. Sufficient and stable demand for bioenergy, governmental energy policies, and availability of financial subsidies were particularly important. In contrast, vicinity of potential customers, quality of customer relationships, and available outbound logistics were more intrinsic to the management of sawmills, whereas all the other factors (i.e., demand for bioenergy, policies, subsidies, taxes, and prices) were mainly controlled by governments and markets. Government subsidies in various forms seem to be essential in the advancing small-scale bioenergy business. Nevertheless, according to our respondents, the operational preconditions for new investments have not been met in Finland yet. Many managers argued that by-products of sawmills were treated less fairly compared to other biofuels or wind power. In addition, some sawmill managers even argued that some of the government's financial support systems and subsidies had negative impacts on the bioenergy business of sawmills because they skewed the bioenergy markets. They argued that this was especially the case when other bioenergy producers were supported more intensively than private sawmills. Furthermore, one major argument among the respondents was that the authorities and decision-makers should favour local energy suppliers and energy sources more clearly. In other words, they wanted the policy-makers to create demand for the bioenergy business of sawmills, which would be "economically healthy, beneficial, and rational at the regional level." The message can be condensed into one respondent's comment: "There is a lot of bioenergy available, if they just want to make use of it."

Conclusions

Over the past two decades, maintaining sustainable competitiveness in the Finnish forest industry has become more challenging because of increasing competition in export markets. Faced with the ambitious national targets for renewable energy by 2020, the Finnish sawmill industry could provide a local-level contribution for renewable energy production, and also enhance local livelihoods and social sustainability, especially in rural areas. This study aimed at identifying the value-creation opportunities for the bioenergy business of Finnish sawmills and exploring the future challenges that influence the firm-level business success, from the managerial perspective. In particular, our findings on the need for new forms of cooperation, especially long-term cooperation at the crossroads between the sawmill industry and the energy industry, are worth considering. However, it is advisable for public authorities in the future to try to find balanced and equitable ways to reduce investment risks for different kinds of bioenergy producers, including sawmills. Perhaps sawmill managers should also try harder to find new partners and move into more intensive collaboration forms in the areas that are outside their core competencies. These business partners could prove to be crucial in having better knowledge and competencies of, *inter alia*,

outbound logistics or bioenergy marketing. These were the stages in the bioenergy value chain that were identified in our study to be out of reach by strategic resources possessed by sawmills.

No doubt, the emerging bioenergy business offers promising avenues of value creation for both sawmill and energy sectors because of their complementary resources and knowledge that range from raw material procurement to biorefining. As the local producer of wood-based bioenergy, the Finnish sawmill industry can strongly support meeting the ambitious national target for renewable energy production for 2020. Nevertheless, increasing bioenergy production to meet larger demands in the energy markets and managing both internal resources and external investment risks also brings new challenges for management. For instance, as raw material suppliers for bioenergy production, sawmills have an internal supply of wood fuels, but uncertainty in the sawn wood markets and the cyclicity of the sawmill industry also makes the bioenergy business vulnerable to sawmill business cycles. Moreover, the volatile bioenergy policy changes were considered a major factor of uncertainty that poses challenges for forecasting the future development of the business environment and further increases the risk levels of investments in bioenergy capacity.

With regard to the resource usage decisions about the bioenergy business of the Finnish sawmills, the results of this future-oriented Delphi study are largely consistent with previous findings made in this field (Lähtinen et al. 2009, Pätäri 2009). However, there are some grounds for future research. First, the main message in the value chain analysis is about the identified resource complementarity between the Finnish sawmills and the Finnish bioenergy firms. However, the question of how are profits and risks shared in the collaboration was beyond the scope of our work and it would merit further investigation. Second, among the factors that affect the future bioenergy business of the Finnish sawmills, governmental energy policies, financial support and subsidies, demand, and prices of bioenergy were considered to be the most significant. However, these factors are usually out of reach of sawmills. Consequently, there is a need for finding a more stable and sustainable solution to the scope and level of public financial support and subsidies for bioenergy production. Therefore, an attempt should be made in future studies to examine more closely the actual effects of both national and international policies—e.g., the implementation of feed-in tariffs and subsidies for wood-based bioenergy on the profitability of the bioenergy business of sawmills by using quantitative methods.

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Appendix 1: Emerging Bioenergy Business at the Finnish Sawmills First-Round Questionnaire (Autumn 2010)

1. Is the energy produced by your sawmill sold outside? (If it is not sold outside, it means the energy is used internally by your company.)

(Bioenergy production in this context refers to the process of producing bioenergy from sawmill by-products or other wood biomass. For example, heat generation is part of the sawmill business.)

Yes

No *(If your answer is "No," please move on to Question 12.)*

2. Does your company produce heat, combined heat and power (CHP), wood pellets, wood briquettes, or other bioenergy products?

3. How long has your company sold bioenergy outside the company?

Since year _____

4. What kind of raw materials do you use to produce bioenergy for sale?

5. Who are the most important customers to which your company sells the bioenergy products?

6. In addition to production equipment and machinery and financial resources, what other production factors are required for bioenergy production by your company?

(Other production factors include, e.g., the location of your company, management expertise, personnel know-how, etc.)

7. Does your company have cooperation in bioenergy production with, for example, other companies, or the municipality?

Yes

No *(If your answer is "No," please move on to Question 9.)*

8. What kind of cooperation does your company have with your partners? What kind of partners does your company cooperate with?

(Forms of cooperation include informal cooperation, such as participation in joint events and projects; short-term cooperation; long-term cooperation; and business partnership, such as joint investments and venture, as well as business associates.)

9. What was the share of bioenergy sales in your company's turnover in 2009?

_____ %

10. What kind of investments has your company made for promoting bioenergy production? When were those investments made?

11. Have the subsidies from government or the establishment of feed-in tariffs for bioenergy affected your investment activities? If yes, how have they affected your investments?

12. Does your company have a bioenergy investment plan for the future?

Yes

No *(If your answer is "No," please move on to Question 15.)*

13. What are the reasons for your future investment plan for bioenergy production?

14. What kind of bioenergy investments do you plan to make?

a. Expansion of your current production capacity:

Yes

No

b. Development of a totally new type of bioenergy production:

Yes

No *(If your answer is "No," please move on to Question 15.)*

c. Will the new bioenergy investments be the production of heat, CHP, wood pellets, wood briquettes, or pyrolysis oil?

15. Are there any special questions or viewpoints you would like to bring up in this context?

Appendix 2: Emerging Bioenergy Business at the Finnish Sawmills
Second-Round Questionnaire (Autumn 2011)
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1. How important are the following value chain processes to your company's bioenergy business?
(Scale of importance is from 1 to 5: 1 = not important, 2 = slightly important, 3 = moderately important, 4 = very important, 5 = extremely important)
- a) ___ Availability and procurement of raw materials
 - b) ___ Storage and inventory of raw materials
 - c) ___ Availability and acquisition of machinery
 - d) ___ Operation and maintenance of machinery
 - e) ___ Manufacturing of bioenergy products (including upgrading products)
 - f) ___ Distribution of bioenergy products
 - g) ___ Marketing of bioenergy products
 - h) ___ Customer relationship management
2. How does your company prefer the following forms of cooperation in your bioenergy business?
(Scale of importance is from 1 to 5: 1 = not preferred, 2 = slightly preferred, 3 = moderately preferred, 4 = highly preferred, 5 = extremely preferred)
- a) ___ Informal cooperation (e.g., participation in joint events and projects)
 - b) ___ Short-term cooperation (less than one year)
 - c) ___ Long-term cooperation (more than one year)
 - d) ___ Business partnership (e.g., joint investments and ventures, business associates)
3. Which process (see Question 1) and what kind of cooperation (see Question 2) would be especially beneficial to your company's bioenergy business? Please provide an answer on the following line: e.g., 1c/2b.
-
4. How important are the following factors to your company's future bioenergy business (present -> 2020)?
(Scale of importance is from 1 to 5: 1 = not important, 2 = slightly important, 3 = moderately important, 4 = very important, 5 = extremely important)
- a) ___ Media and public opinion
 - b) ___ Governmental energy policies and financial support
 - c) ___ Reduction in production of the pulp and paper industry
 - d) ___ Prices of raw materials
 - e) ___ Prices and taxation of fossil fuels (including peat)
 - f) ___ Prices and subsidies of bioenergy
 - g) ___ Sufficient and stable demand for bioenergy
 - h) ___ Vicinity of potential customers
 - i) ___ Quality of customer relationships (reliability, continuity, satisfaction, etc.)
 - j) ___ Input of private investors and sponsors
 - k) ___ Finding suitable partners for cooperation
 - l) ___ Firm's geographic location
 - m) ___ Development of manufacturing technology
 - n) ___ Available inbound logistics
 - o) ___ Available outbound logistics
 - p) ___ Personnel know-how
 - q) ___ Availability of competent workforce
 - r) ___ Marketing of bioenergy products

Appendix 2: Emerging Bioenergy Business at the Finnish Sawmills
Second-Round Questionnaire (Autumn 2011)
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5. Choose a proposition that best describes your company's situation:
- a) ___ *“If our company reaches the desired objectives (including material, technical, financial, and political objectives, etc.) in the future, we will start or continue our investments in bioenergy production.”*

 - b)___ *“Even if our company does not reach the desired objectives (including material, technical, financial, and political objectives, etc.) in the future, we will start or continue our investments in bioenergy production.”*

 - c) ___ *“Our company does not intend to start or continue any investments in bioenergy production.”*