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THE IMPORTANCE OF CLEANTECH BUSINESS FOR THE DEVELOPMENT OF FUTURE WOOD PRODUCTS INDUSTRIES

Cleantech refers to processes which help reduce the environmental load caused by humans. For the present, the wood products sector has been considered a part of the concept of bioeconomy in Finland. This study aimed to analyse the possibilities for closer collaboration between the wood products sector and cleantech. An in-depth interview of 10 experts mostly from outside the wood products sector was carried out. In addition, a web questionnaire sent to 228 experts representing in particular the forest and wood sector received 62 answers. The results revealed many opportunities and benefits that are not being maximized in terms of collaboration between the wood products and cleantech sectors. Timber construction and wood product manufacturing process know-how are among the areas showing the strongest possibilities for closer integration with cleantech. People outside the forest sector seem to be more open to collaboration between cleantech and wood-based industries than those in the forest sector. China, followed by other Asian and European countries, offers virtually unlimited markets for cleantech solutions, and wood may assume a prominent role in those markets.

Keywords: Bioeconomy, cleantech, sustainability, timber construction

Introduction

The global trend for sustainability demands a shift from the exploitation of non-renewable resources to the utilisation of renewable ones. This creates the demand for new products and services which are quite often made of wood [Metsäalan strateginen ohjelma 2012]. At present, the majority of the natural resources used are non-renewable. Due to pollution of the soil, air, and water, as well as the extinction of many species and the depletion of raw materials, the world is facing great sustainability challenges. The development of technology is an attempt to tackle these challenges and as a result, some traditional products and industrial processes may be conceptually re-organised in terms of

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sustainability. For instance, forest-based industries have a wealth of know-how and technologies which could be applied to other sectors in order to improve their environmental profile.

Megatrends are global development paths which influence large parts of the human population. Megatrends linked to the forest sector include population growth, ageing, urbanisation, climate change, loss of biological diversity, pollution, the rising cost of non-renewable resources, and the increased utilisation rate of renewable resources. Furthermore, digitalisation and overall technology development may be considered megatrends influencing the forest sector. All these may be categorised under the umbrella of sustainability. Since the world population is increasing and there is the desire for further economic growth, clean and resource-efficient processes and products need to be developed [Lovio 2013]. The so-called sixth wave of the economy focuses on smart energy production technologies [Wilenius and Kurki 2012] such as environmental technologies, biotechnologies, nanotechnologies, and health service technologies. The change in paradigm towards resource efficiency leads to, among other things, an increase in the price of the main raw materials and stricter environmental legislation [Wilenius and Kurki 2012].

Finnish forest-based industries have faced challenges in terms of profitability and product markets over the past 10 years. Forests are, however, still the most important natural resource in Finland. Therefore, finding new business areas that can utilise the forest resources in a profitable and sustainable manner is a challenge of great national importance.

The environmental performance of wood is, by many measures, superior in comparison to competing construction materials. Even though wood is the only renewable, industrially-utilised construction material, it is surprisingly also the only construction material from which consumers and dealers require transparent certification of sustainability. From an energy efficiency viewpoint, wood product manufacturing processes are very competitive since bark, dust, and chips provide factories with more energy than needed in the production processes. Wood products also store carbon for their entire life cycle. Carbon dioxide emissions generated by the construction of concrete buildings are almost three times higher than those of wooden buildings [Ruuska and Häkkinen 2012]. Globally, construction and building activities consume 50% of natural resources and cause 40% of greenhouse gas emissions, energy consumption, and waste production [Metsäalan strateginen ohjelma 2012]. Building construction is the most significant single end use of wood products; in the case of Finland, up to 80% of domestic wood product consumption eventually ends up in building construction. The Finnish wood products sector consists to a very large extent of small and medium-sized firms. This sector is also characterised by a low rate of internationalisation and networking, production orientation, and a slow pace of renewal [Metsäalan strateginen ohjelma 2012].

In addition to its positive environmental performance attributes, wood is technically a unique construction material. It combines many material properties, such as heat and sound insulation, load-bearing capability, and suitability as interior design material. The load-carrying capacity of wood is maintained even in high temperatures. When burning, the strength of wood reduces as a result of charring at a predictable, constant velocity irrespective of temperature. The effects of wooden structures and surfaces on indoor air quality, as well as physical and mental health, are as yet not fully known. However, current knowledge indicates that the effects of wood are positive [see: Simonson et al. 2001, Muilu-Mäkelä et al. 2014].

Climate change and other environmental concerns have changed consumer behaviour and policy making in Europe. The bioeconomy has rapidly taken a primary role within sustainability discourse. The bioeconomy refers to economic growth based on the sustainable use of renewable resources. Many countries, as well as the European Commission, have devised their bioeconomy strategies. The official aim of the Finnish bioeconomy strategy is to increase the output of the bioeconomy sector from €60 to 100 billion by 2025 and create 100,000 new jobs [Suomen biotalousstrategia 2014]. The Finnish bioeconomy strategy largely relies on the forest sector.

As a difference to the bioeconomy which is based on the idea of the economically sustainable utilisation of biomass, the term cleantech refers to technology development. According to Lovio [2013], cleantech includes processes, services and products that offer more environmentally-friendly solutions than competing processes or products. Vanhanen et al. [2012] state that cleantech is neither an industrial nor economic sector, but more likely a set of solutions which cross many conventional sectors. Cleantech has advanced the most in the fields of emission and waste control, measurement, treatment, cleaning, and environmental restoration [Lovio 2013]. Even during the economic recession, the turnover of Finnish cleantech companies steadily increased with an annual rate of 10-15%, clearly more on average than other sectors of Finnish industries. The marketing brand Cleantech Finland, owned by the Confederation of Finnish Industries, was established almost ten years ago. Now Cleantech Finland (www.cleantechfinland.com) is composed of a network of approximately 80 companies as a part of the organisation Export Finland. The Finnish government relies heavily on the future development of the cleantech business; with 40% of public research, development and innovation (RDI) funding allocated to the support and development of cleantech.

One of the objectives of the Finnish Bioeconomy Strategy is to create a strong competence base for the bioeconomy [Suomen biotalousstrategia 2014]. This is partially supported by the current analysis of the synergies between wood products industries and cleantech businesses. So far, the role of wood in cleantech businesses has been insignificant. Cleantech companies strive to minimise the environmental footprints and energy consumption of industrial

processes and consumers. Exactly the same objectives prevail in, for example, the Finnish house-building industries, where wood is the dominant raw material in single-family houses and a material as to which there are great expectations as regards multi-storey houses.

The objective of this article is to analyse the relationships between the bioeconomy and cleantech, particularly the synergy, means, challenges and advantages of closer collaboration between wood products industries and cleantech businesses.

Materials and methods

The current knowledge from the literature and through internet searches was gathered, reviewed, and analysed. In addition, two different experimental data sets were collected. The first data set was accumulated using semi-structured in-depth interviews of 10 experts mostly from the cleantech sector ('interviewed respondents'). The questions concerned Cleantech Finland, the strengths of Finland in cleantech, the relationship between the wood products industries and cleantech, funding possibilities, and export support. The interviews were carried out in the period September-December 2014. The other data set was collected using an internet questionnaire (Webropol) which was sent to 229 respondents from the forest and wood products sectors ('Webropol respondents'). Altogether 62 responses were obtained (a response rate of 27%) from the industrial and public sector. Besides background information (organisation size and type, and product categories), the questions from the Webropol survey covered the growth expectations of the companies, the concepts of bioeconomy and cleantech, the utility of the cleantech brand for wood products, and the relevant geographic markets for wood-based cleantech products. The respondents were requested to express how far they agreed or disagreed with the given statements using the Likert scale 1-5 (strongly disagree – strongly agree). The questionnaire was accessible from December 2014 to January 2015.

Respondents of the Webropol survey mostly represented the wood products industry, government organisations, and universities. The respondents from the companies (31 in total) were divided between large (7 responses from companies with more than 250 employees), medium-sized (13 responses from companies with 10-250 employees), and small (11 responses from companies with 1-9 employees) companies. Only one response was obtained from the pulp and paper industry, 17 from the wood products industry, and 13 from other companies (consultancy, machinery manufacture, etc.). The respondents from the public sector (31 in total) worked mostly in research and development organisations (22), but also in educational organisations (6) and government administration (3).

The responses both from the in-depth interviews and the Webropol questionnaire were analysed qualitatively. The Webropol questionnaire allowed

quantitative analysis based on the mean values and standard deviation of the variables studied. An independent two-sample t-test was used to determine statistically significant differences between the respondent groups. In the t-test, the assumption of equal variances in both groups existed.

Results and discussion

Global relevance of cleantech

Cleantech is sometimes misunderstood as only a Finnish phenomenon and a marketing brand of the Finnish forest and wood products sectors. In reality, the relevance of cleantech is globally acknowledged as a toolbox to mitigate climate change [e.g., Parad et al. 2014]. Global collaborative institutions, such as the International Cleantech Network, aim at creating new business opportunities, improving competitiveness, and creating new value for companies, institutions, and local cooperatives in terms of cleantech solutions.

Finland and Sweden are relatively similar as regards cleantech businesses. Both countries encompass a wide range of clean technologies and services. The other Nordic countries, on the other hand, are mainly focused on the energy sector in cleantech [see: Strategi för… 2011; Cleantech Strategic… 2013; Om oss… 2015]. Brand management, networking, and business collaboration are carried out through similar organisations 'Cleantech Finland' and 'Cleantech Inn' in Finland and Sweden, respectively. In Denmark, the 'Copenhagen Cleantech Cluster' focuses on supporting the growth and internationalisation of small and medium-sized cleantech companies, as well as the brand management of Danish cleantech, particularly in the energy sector [Energistrategi 2050… 2011; Andersson et al. 2012]. Furthermore, in this study most of the interviewed respondents recognized the strong cleantech sectors in Sweden and Denmark. Cleantech is also of great importance in several other European countries. In the expert interviews 4 respondents out of 10 highlighted Germany as an important cleantech market.

Interestingly, the interviewed respondents representing sectors other than the forest sector had rather a positive attitude towards the idea of the joint marketing brand 'Nordic Cleantech', whereas the Webropol respondents from the forestry sector were much more doubtful regarding the benefits of such a brand. Although the Nordic countries are the global frontrunners of cleantech, the resources in individual countries are small. The global aim of cleantech is a cleaner world. Therefore, collaboration in global marketing and building a joint 'Cleantech Nordic' brand might provide these countries with competitive advantages, particularly in big markets outside Europe, such as China, India, or Brazil. The potential market for cleantech in such countries is so big that meeting demand without international collaborative business networks is very difficult.

The interviewed respondents indicated a contradiction between the circular economy policy targets of the European commission aimed at the decreased utilisation of all raw materials and the Finnish bioeconomy strategy aimed at increased (though sustainable) use of biomass. It was also noticed by the interviewed respondents that the concept of cleantech varies according to time and location. For instance, the definition of 'environmentally-friendly energy production' differs between nations, cultures, societies, and even between researchers. Western populations are turning towards a kind of modern subsistence economy: 3D printing, urban agriculture, local goods, and other trends reduce the dependence of individuals on logistics and industrially manufactured imported goods. The current predominantly large scale industrial production may eventually suffer from this development. New technologies and cultures bring production back to the end users, and the role of individuals in production chains will strengthen as decentralisation becomes more common.

China has really ambitious political objectives in cleantech. In order to clean this highly polluted country, China plans to invest over 500 billion euros in cleantech development by 2020, as its objective is to be the world's leading country in cleantech [Lin 2014; Parad et al. 2014]. According to one of the interviewed respondents, there are now already more cleantech companies listed in China than anywhere else. The boost to cleantech in China is based on the unbearable pollution problem derived from rapid industrialisation and urbanisation. China is also the only nation already building large-scale eco-cities, however it needs international partners to find solutions to its ecological challenges. Since wood has a good reputation in China, it would be an enormous business opportunity to provide the Chinese with wooden eco-city solutions based on European competence. Such projects would attract clean water and energy solutions, waste management solutions, etc. In the expert interviews, 3 respondents out of 10 admitted that the Chinese market is so large that other Asian countries or Russia might be easier to access and handle. The environmental problems are thus far not as visible in Russia as in China. Furthermore, environmental and industrial legislation does not provide as strong a support for cleantech development in Russia as in China.

Cleantech as a part of the Finnish wood products sector development

According to the interviewed respondents, the relatively small size of Finland was also considered advantageous: a small country can be dynamic and react quickly to fluctuating market needs. This is not, however, necessarily true since cleantech competence is strongly concentrated in Finland. Only a few large companies possess the majority of the know-how. If there is reluctance in process or product development, these companies can paralyse the development of the whole business. In addition, small and medium-sized enterprises in Finland specialising in wood products are traditionally relatively unwilling to grow or expand into international markets. Newer companies and younger

entrepreneurs are more interested in growth and internationalisation. Forest-based industries, in general, are considered to be a conservative sector relying on a production-based approach instead of a solution-based service approach. Forest-based industries, which are dominated by large companies in Finland, process huge material streams in rather conventional ways but typically react slowly to new ideas.

The views of both the interviewed and Webropol respondents strongly indicate that the most promising synergy potential between the cleantech and wood products industries lies in wood-based construction. The same conclusion was drawn by Lovio [2013]. Tightening environmental standards, norms, and laws, supported by economic incentives, can facilitate the development of competitive cleantech products and services both to foreign and domestic markets. Since approximately 40% of public RDI funding in Finland is allocated to cleantech development, access to these public funding instruments may provide immediate benefits for the wood products sector.

According to the interviewed respondents, it would be sensible to determine cleantech as a crucial part of the wood product company strategy in order to be able to profile itself as a cleantech company. However, it is not feasible to forget or reject the existing brands, including the bioeconomy, since they will most likely be useful in future marketing. The usefulness of the brands is also dependent on the market or customer in question.

Of the 31 company responses from the Webropol survey, altogether 75% profiled their company as a bioeconomy company. 53% of the companies even profiled themselves under cleantech, although there were no member companies of Cleantech Finland among the respondents. This indicates a rather liberal attitude towards cleantech within the Finnish wood products sector despite its reputation as a conservative business. Based on the data collected in this study, however, it is evident that the potential benefits of cooperation with Cleantech Finland are not known or understood well enough among the respondents' companies. The reason for this poor awareness is most likely insufficient communication. Thus, in order to create cooperation and expand both business sectors, more communication is needed between the cleantech and forest industries.

Some of the interviewed respondents strongly supported the idea of closer collaboration between the wood products sector and cleantech businesses. According to their opinions, such collaboration would create successful new clusters which could develop innovative products and services for the markets, for example, solutions to reduce oil dependency. Some of those interviewed also had quite a neutral attitude towards the benefits of closer collaboration between the cleantech and wood products sectors. Both small and large wood products companies often prefer their own individual brands instead of general marketing brands such as cleantech.

Market value of the Cleantech brand

There has been much discussion concerning the positive environmental attributes of wood in Finland and their benefit for the wood products industries. However, it has thus far proven difficult to run a profitable business. Consumers of the future are expected to be more environmentally-conscious and willing to invest more money in environmentally-friendly products compared with consumers of today [e.g., Aquilar and Vlosky 2007]. For the present, ecological aspects affect small purchases more than strategic investments, such as homes. According to the interviewed respondents, it is also true for cleantech markets. In most cases, income level determines willingness to pay for environmentally--friendly products. In low income areas, basic needs have to be met regardless of their friendliness to the environment. Consumers in wealthier nations can make choices on an environmental basis. Eco-friendliness was also seen as a possible threat: consumers may demand it, but it will not necessarily bring any real benefit, i.e., added value for the producer.

The Webropol survey also mapped the respondents' opinions regarding the benefits of the bioeconomy and cleantech branding on different geographic markets with the following questions (tab. 1):

1. Is the cleantech or bioeconomy brand useful from the viewpoint of competitiveness in your company? (Respondents from companies)
2. Is the cleantech or bioeconomy brand useful from the viewpoint of competitiveness in industry? (Respondents from the public sector)

Table 1. Mean values and standard deviations of responses to the question: *Is the cleantech or bio-economy brand useful from the viewpoint of your company's competitiveness?* (company respondents) / *Is the cleantech or bio-economy brand useful from the viewpoint of the competitiveness of industries?* (public respondents). Scale 1-5 (totally useless – very useful). The difference between the mean values of the company and public answers was tested using a t-test, the significance denoted by *p*-value

	Cleantech brand					Bio-economy brand				
	companies (N = 16)		public (N = 31)			companies (N = 22)		public (N = 31)		
	mean	S.d.	mean	S.d.	*p*	mean	S.d.	mean	S.d.	*p*
Finland	3.80	1.15	3.55	0.93	0.428	4.14	0.77	3.90	1.14	0.408
EU	4.25	1.06	4.55	0.57	0.215	4.41	0.67	4.29	0.78	0.566
Russia	2.80	1.26	2.97	0.95	0.617	2.95	0.86	2.94	0.89	0.946
North America	3.40	1.35	4.19	0.87	0.020	3.48	0.87	3.87	0.86	0.020
South America	2.93	1.16	3.19	0.95	0.422	2.95	0.74	3.10	0.87	0.536
China	3.00	1.25	3.84	1.13	0.028	3.05	0.89	3.48	1.09	0.143
Mean value	3.36		3.72			3.50		3.60		

Both the bioeconomy and cleantech branding were estimated to be equally useful by the Webropol respondents irrespective of the given geographic area. In general, there was a minor difference between the company respondents' and

public respondents' opinions: respondents from the companies considered bioeconomy branding slightly more beneficial, whereas the attitude in the public sector was somewhat against cleantech branding. Branding, *per se*, was estimated as most beneficial in the Finnish and European markets, and clearly less important in the Russian, South American, and Chinese markets. It appears that the respondents from companies in particular are not fully aware of the scale of cleantech investments and its huge societal relevance in China, for instance.

The Webropol respondents from the public sector recognised the usefulness of both the cleantech and bioeconomy brands in North America more readily than the respondents from the companies. In the case of China, the corresponding difference was discovered only for the cleantech brand.

China, India, Russia, Europe, and North America were seen as the most important markets for combined cleantech and wood product solutions among the interviewed respondents. The predominant view among these respondents was that it is not reasonable to categorize one industrial sector strictly under one brand, but to approach different market segments with divergent marketing strategies. Nevertheless, the differences in attitudes towards eco-friendliness between consumer segments may be bigger than the differences between the countries. The segmentation of consumers according to their potential consumption of cleantech products using anticipatory consumption imaging [see: Christensen et al. 2004] was seen as important. The cleantech brand, *per se*, has created growth in new markets, which indicates the strategic viability of the brand. This chance should be used as efficiently as possible and wood products provide the cleantech market with novel business opportunities.

According to the Webropol respondents, the cleantech brand was considered relatively beneficial or beneficial in all the given wood product categories. The following question was asked (tab. 2):

3. Which product categories would benefit from marketing under the cleantech brand?

Wooden houses and engineered wood products (LVL, glulam, and plywood) were assessed as the most positive categories by the respondent groups in the Webropol survey. The pulp and paper industries already have existing cleantech collaboration, thus their cleantech branding has not as much novelty value as the branding of wood products.

Surprisingly, the benefits obtainable from cleantech marketing were assessed as less significant for wooden doors and windows than for other wood product categories in the Webropol survey. Single assessment values 1 and 2 (poor or relatively poor potential) were given to all the product categories, but most often for sawn timber, doors, windows, and parquets. No statistically significant differences existed between the public and company respondents in any product category.

Table 2. Mean values and standard deviations of responses to the question: *Which product categories would benefit from marketing under the cleantech brand?* Scale 1-5 (no benefit – very beneficial). The difference between the mean values of the company and public answers was tested using a t-test, the significance denoted by *p*-value

	Companies (N=31)		Public (N=31)		
	mean	S.d.	mean	S.d.	*p*
Wooden houses	4.14	1.16	3.94	1.15	0.500
Engineered wood products*	3.90	1.08	3.90	1.35	0.983
Wood-based panels	3.79	1.29	3.61	1.36	0.601
Sawn timber	3.76	1.38	3.61	1.43	0.690
Wood pulp	3.72	1.33	3.42	1.12	0.340
Paperboards	3.59	1.30	3.58	1.12	0.986
Parquet	3.45	1.27	3.52	1.29	0.838
Doors	3.48	1.18	3.45	1.31	0.924
Windows	3.43	1.23	3.45	1.18	0.942
Papers	3.34	1.20	3.39	1.15	0.890
Mean value	3.61		3.55		

*Engineered wood products refers to glulam beams, laminated veneer lumber (LVL), and cross-laminated timber (CLT).

Regarding the collaboration potential between the cleantech and bioeconomy brands, challenges were also identified by the interviewed respondents. Although in many cases the same enterprises may be easily seen as part of cleantech and the bioeconomy, sometimes these two concepts may be impossible to merge. The rapid conceptual change in terminology, especially in the bio-based sector, was considered a challenge. According to some respondents, it is disturbing that consumers' minds are confused by the media and policy makers using vaguely defined but fashionable terms, such as bioeconomy, bio-commerce, clean economy, sustainable development, green growth, and circular economy.

Steps to be taken in wood products industries

The Webropol respondents predicted which future measures were the most critical for the wood products sector. The following question was asked (tab. 3):

4. What is the meaning of the following measures for the development of your business (respondents from companies) / of your activities (respondents from the public sector)?

All the Webropol respondents emphasised the meaning of competence development and internationalisation. It is notable that finding new business opportunities is more important for the respondents from the public sector than those from companies. Obviously in this study, the respondents from the public sector, often being RDI professionals, focus heavily on recognising new business opportunities in their work. They also considered international networking and

the development of demonstration facilities more important issues than the respondents from the companies did.

Table 3. Mean values of responses to the question: *What is the meaning of the following measures for the development of your business?* Scale 1-5 (very small meaning – very meaningful). The difference between the mean values of the company and public answers was tested using a t-test, the significance denoted by *p*-value

	Companies (N=31)		Public (N=31)		
	mean	S.d.	mean	S.d.	*p*
Personnel competence development	4.36	0.78	4.32	0.79	0.867
Production efficiency	4.29	0.76	–	–	–
International networking	4.11	0.58	4.48	0.77	0.044
RDI within own organisation	4.07	0.87	4.26	0.93	0.443
Increasing value-added	4.04	1.93	–	–	–
Finding new business opportunities for wood	3.96	1.07	4.52	0.85	0.032
RDI with other firms or RDI organisations	3.93	0.92	4.55	0.72	0.005
Profile of environmentally-friendly partner	3.86	0.80	4.13	0.88	0.223
Finding new export markets	3.79	1.03	3.68	1.19	0.712
Development of demonstration facilities*	3.59	1.12	4.23	1.09	0.033
Support for export activities	3.39	1.29	3.58	0.99	0.530
Investment incentives	3.11	1.37	–	–	–
Mean value	3.90		4.18		

*Demonstration facilities are reference projects or objects offering the possibility of product development and cooperation with other companies or RDI institutions.

The modern processes used in forest industries were perceived by the interviewed respondents as a huge potential for cleantech. Finland is considered to have a great competence in the value networks of both the chemical and mechanical forest industries, and the cleantech features can actually be found in the existing industrial processes. However, the entire forest sector or some industrial sub-sector of it should not be fully branded as cleantech, but it should opt for some strategic products, processes, or services. Such areas could be found, for instance, within timber construction or modern production monitoring techniques, for example, in the pulp and paper industries or in the sawmilling industry. Timber construction fulfils many attributes of cleantech with regard to raw material sustainability, carbon sequestration, recyclability, as well as the energy efficiency of the production and engineering processes. These attributes provide the timber construction sector with a vast potential for the export of products and production processes, advantages which, for the present, have not been widely exploited.

The interviewed experts agreed that wood and other raw materials should not be set against each other but new markets should be sought through value innovations. These innovations refer to novel markets which add value both to the customer and the manufacturer [Kim and Mauborgne 2005]. In particular, the

wood products sector should pay more attention to customer preferences and needs and, hence, learn how to supplement and develop the conventional production-oriented business strategy.

Public procurements were seen as important drivers for cleantech by the interviewed respondents. Calls for tender should not define the technologies needed but the desired final solutions. Thus, producers of new technology have a chance to participate in bidding and entering markets with their innovative products.

With regards to the development of multi-storey timber construction, creating healthy, sustainable, and comfortable living environments for people should be the key issue instead of the simple production of houses. Cleantech, as well as digitalisation, are enabling techniques necessary for such living environments.

Conclusions

This study indicates that:

- People outside the forest sector are more open to collaboration between cleantech and wood-based industries than people from the forest sector.
- Cleantech is a process-based concept, whereas the bioeconomy takes a raw-material-oriented approach. Thus, no major contradiction between the two concepts exists, and collaboration should be the rule rather than the exception.
- It might be beneficial to launch a global joint marketing brand 'Nordic Cleantech' among the Nordic countries, since these countries have rather limited resources yet similar strategies and interests in terms of cleantech development.
- China, followed by other Asian and European countries offer virtually unlimited markets for cleantech solutions, and wood may have a prominent role to play in entering those markets.
- The most encouraging subsectors in the Finnish wood products industries to be branded as cleantech in selected markets are: 1) the high-tech timber construction business as a part of the construction value network, and 2) process know-how in wood product manufacturing.
- An interesting topic for future research would be to analyse the means to organise win-win collaboration between the cleantech and the wood-based sectors so that challenges related to traditional competition-based business might be met.

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