INTERNATIONAL MARKET POTENTIAL FOR BIOMASS CONTAINER LOGISTICS

Laitinen, Tuuli[1]*; Karttunen, Kalle[2]; & Ranta, Tapio[1]
[1]Lappeenranta University of Technology
Bioenergy Technology, Sammonkatu 12, 50130 Mikkeli, Finland
[2]University of Helsinki
Department of Forest Sciences, P.O. Box 27, 00014 University of Helsinki, Finland
* e-mail: tuuli.laitinen@lut.fi

ABSTRACT: The higher demand of biomass can be satisfied by long-distance transport, but the low energy content of biomass increases the costs. New lightweight containers, like composite containers, provide a solution to transport biomass more effectively. For example, forest chips can be transported over long distances on road, rail, or waterway, without intermediate unloading and reloading. The aim of this study was to examine whether there is a market for these lightweight containers in biomass logistics. The study included an international expert survey for a limited group of bioenergy professionals and a deeper analysis of potential markets. Based on the survey, the current share of containers in biomass logistics is limited, but there is a potential for growth. The proper price, confidence on cost savings and easy integration with the current system could increase the share. The challenge is to minimize the costs of both the containers and the whole supply chain. Based on the analysis, the American and German markets are interesting especially due to their large size and high energy use. Smaller potential markets are found in Finland and Sweden, where the new container innovations could be used to replace or complement traditional biomass supply chains.
Keywords: biomass, container logistics, market analysis

1 INTRODUCTION

The EU has set the renewable energy target to 20% in 2020. Biomass could account for two-thirds of the renewable energy target by then. For this to become reality, biomass use will roughly have to double. Wood accounts for approximately 80% of the biomass used for renewable energy. Recent projections for 2030 quantify the sustainably realisable potential of wood for energy from EU forests as high as 675 million cubic meters per year, provided intensive wood mobilisation efforts are applied [1]. The higher demand of forest-based biomass could be satisfied by expanding the procurement area and transporting biomass from longer distances around the user-sites. However, the low energy content of biomass increases the transportation costs.

Lappeenranta University of Technology (LUT) has studied the possibilities of new lightweight containers for several years to increase the payload and lower transportation costs of biomass. The Finnish innovation, a composite container (Figure 1), is only half the weight of a traditional metal container, and it is made of a patented channel composite structure, which makes it lightweight and durable, with good corrosion and thermal resistance to reduce the freezing problems [2]. The cost benefits of composite containers can reach up to 20% when compared to traditional solid frame trucks in biomass logistics [3]. According to a combined availability and simulation study, the total costs of forest chip supply chains with traditional options were on average 5-19% more expensive than the costs of intermodal composite container supply chains, which were lower in all scenarios [4]. Based on the study, the most advantageous way to expand the procurement area for forest chips would be either to use composite container trucks or start using train transportation instead of trucks for longer distances. In traditional supply chains, train transportation and terminal operations could be improved by using the maximum-sized composite containers with interchangeability. The container concepts could complement the current systems and not necessarily replace the traditional ones. The cost-efficiency of container supply chain in biomass logistics has been studied only to some extent.

This study concentrates on the international market potential for new lightweight containers, like composite containers, in biomass logistics. The study includes an international expert survey for a limited group of bioenergy professionals and a deeper analysis of potential markets. The purpose of this study was to create a market outlook on containerized options based on expert opinions and statistical data. The aim was to obtain information where to head for market investments in the first phase, especially in the case of composite containers.

Figure 1. Composite container. Source: LUT.

2 METHODS

2.1 Expert survey

The survey was carried out by mapping the international use of containers and the container logistics potential in biomass industry. The sample included a limited group of bioenergy experts form IEA Bioenergy Task 40 network. The questionnaire was sent to 45 country-specific experts via Webropol online surveys. The questionnaire examined the current scope of container logistics, purchase decision factors, the need for additional services, the most important advantages of container logistics and the possible obstacles. Fourteen experts from eleven countries answered the questionnaire: Austria, Belgium, Brazil, Denmark, Finland, Germany, Italy, the Netherlands, Sweden and the United States. Though the percentage of responses (31%) was normal for questionnaires, the number of respondents was relatively small, meaning the survey results are for guidance only.

2.2 Market analysis

In the market analysis, the eleven countries who responded to the expert survey were analyzed in more detail. The aim was to estimate each country's market potential for biomass container logistics. The analysis included six main themes: economy, energy, natural resources, business, infrastructure and logistics. Under the main themes were eight different indicators: gross domestic product per capita, energy use, combustible renewables and waste, forest area, ease of doing business, container port traffic, the quality of infrastructure (roads, railroads, ports) and logistics performance. The country-specific indicators were scored, placed in a matrix and counted together. Finally, the total scores were compared with each other. The country with highest points reached the highest market potential and vice versa. The data was gathered from World Bank statistics [5] and the World Economic Forum [6]. In addition, each country’s climate and transport weight limits were taken into account.

3 RESULTS

3.1 Expert review

Based on the expert opinions, biomass transportation volumes are expected to grow in all reviewed countries. More than half of the respondents believed that container logistics is also going to grow, but experts had difficulties in estimating the current share of containers in biomass logistics. The share was estimated to be ten percent or less. The respondents were somewhat familiar with the biomass logistics business field, but only a few knew companies that use containers for biomass transportation. According to the responses, In Sweden and Denmark containers are used for biomass transportation to some extent. In Finland some small entrepreneurs subcontracting for large biomass suppliers use containers. Innofreight concept is familiar in Austria and Germany, where especially saw mills use Innofreight containers to transport wood chips. In the United States some containers may be used for pellet transportation, especially in the southeastern parts of the country.

According to the experts, the proper price is the most important factor that could motivate companies to choose containers for biomass logistics. Other important factors were easy integration with the existing system, the evidence of cost savings, positive user experiences in biomass logistics and the reliability of the service. The most valued additional services were transportation, loading and unloading. Biomass industry is likely to be more interested in overall service than individual containers.

Therefore, the responses emphasized the role of "door-to-door" service. Container-related factors (brand, material of containers, financing flexibility) or services (rental, maintenance, storage) were considered less important. These factors may interest more the transportation companies who offer transportation service with containers.

The most important advantages of containers were considered to be cost-effective long-distance transportation, the use of different transportation modes (road, rail, waterway) and optimized supply chain. All these advantages support transportation optimization and cost-efficiency in some way. Multimodal transportation raises interest internationally, but experts were concerned that the containers are too expensive for bulk goods, like biomass. The biggest challenge is the costs compared to traditional bulk transportation, especially on rail or waterway. Other challenges that were mentioned were the difficult unloading of current containers, the need of special equipment for handling, container availability for low value-added products and freezing problems with metal containers.

3.2 Market outlook

Based on the market analysis, the most potential markets for biomass container logistics are found in the United States, Germany, Finland and Sweden (Tables 1 and 2). These countries received the highest points in comparison of economy, energy, forest resources, business, infrastructure and logistics. The rest of the countries were less potential, but all of them had some positive features. The result does not mean that these markets should be excluded. Countries were evaluated in certain values only in order to obtain an overall picture of the market.

Table 1. Country-specific data from the years 2011−2012.The data was gathered from World Bank statistics [5] and the World Economic Forum [6].The figures in the table have been rounded.

Country	*Economy*	*Energy*		*Natural resources*	*Business*	*Infrastructure*		*Logistics*
	1.	2.	3.	4.	5.	6.	7.**	8.
Austria	47,226	32,624	16.7	38,920	29	350,461*	5.4	3.9
Belgium	43,413	55,948	5.5	6,788	33	11,036,307	5.8	4.0
Brazil	11,340	265,624*	30.6*	5,173,276	130	8,649,821	2.5	3.1
Denmark	56,210	17,512	20.6	5,460	5	741,314	6.0	4.0
Finland	46,179	34,255	23.6	221,570	11	1,326,840	5.9	4.1
Germany	41,514	307,160	9.9	110,760	20	16,305,231	6.0	4.0
Italy	33,049	165,138	5.7	92,270	73	10,144,726	3.9	3.7
Netherlands	46,054	77,550	4.7	3,650	31	12,110,727	5.9	4.0
Norway	99,558	29,875	5.5	101,414	6	349,733	4.0	3.7
USA	49,965	2,202,716	4.0	3,044,048	4	42,902,041	5.3	3.9

1. GDP per capita (US$)
2. Energy use (kt of oil equivalent)
3. Combustible renewables and waste (% of total energy)
4. Forest area (m²)
5. Ease of doing business index (1=most business-friendly regulations)
6. Container port traffic (TEU)
7. The quality of infrastructure index (1=low,7=high)
8. Logistics performance index (1=low, 5=high)

**Data for the year 2010*
***Average of roads, railroads and ports*

Both the United States and Germany have large energy markets and high level of infrastructure. The countries also have biomass potential and capacity to carry containers. In the United States, the energy use, forest area and container port traffic are on a totally different level than in the other analyzed countries. The share of combustible renewables and waste is limited, but even a small percentage of the total energy in the U.S. makes the country the biggest user of renewable energies. Due to the cold climate in the northern parts of the country and low vehicle weight limits in many states, composite containers' low weight and suitability for winter conditions could provide a competitive advantage.

Germany, in turn, is the largest market in the Europe. Only the climate is mostly mild in the Germany, and therefore, freezing problems are not a major issue. Finland and Sweden represent smaller potential markets. Both countries have rich forest resources, high proportion of combustible renewables and wastes, and cold climate. Both countries have also been struggling with freezing problems which could be solved with composite containers. Countries' infrastructure and ease of

doing business is quite similar. From the Finnish perspective, it would be natural to expand the market to Sweden, which is a near market and one of the biggest export markets.

Other analyzed countries had positive features but also weaknesses, which affected ranking. Denmark and Austria are interesting due to their high proportion of combustible renewables and wastes. Brazil is also high user of renewables and has rich forests, but the infrastructure is in poor condition in many areas. In the Netherlands, Belgium, Norway and Italy the share of renewables is much smaller. Often the low use of renewables is due to the low cost of other forms of energy. Country's own natural resources also influence the energy choice. Dutch and Belgian forest resources are low, while in the Norway the forests are difficult to mobilize due to the country's mountainous nature.

Table 2. Country ranking according to market potential for biomass container logistics. Eight variables are scored from 1−11. The best value received 11 points.

Country	1.	2.	3.	4.	5.	6.	7.	8.	Total	Ranking
USA	8	11	1	11	11	11	4	6	63	1st
Germany	3	10	6	7	6	10	10.5	10	62.5	2nd
Finland	6	4	10	8	8	4	8	11	59	3rd
Sweden	9	5	9	9	7	5	6	4	54	4th
Denmark	10	1	8	2	10	3	10.5	8.5	53	5th
Netherlands	5	7	2	1	4	9	9	8.5	45.5	6th
Belgium	4	6	3.5	3	3	8	7	7	41.5	7th
Brazil	1	9	11	10	1	6	1	1	40	8th
Norway	11	2	3.5	6	9	1	3	3	38.5	9th
Austria	7	3	7	4	5	2	5	5	38	10th
Italy	2	8	5	5	2	7	2	2	33	11th

1. GDP per capita (US$)
2. Energy use (kt of oil equivalent)
3. Combustible renewables and waste (% of total energy)
4. Forest area (m²)
5. Ease of doing business index (1=most business-friendly regulations)
6. Container port traffic (TEU)
7. The quality of infrastructure index (1=low,7=high)
8. Logistics performance index (1=low, 5=high)

4 CONCLUSIONS

Based on the expert survey, the international share of containers in biomass transportation is limited, but there is a potential for growth. The new container innovations could be used to replace or complement current traditional biomass supply chain solutions. The respondents appreciate the possible advantages of container logistics, but are concerned that the containers are too expensive for bulk goods, like biomass. The higher share of containers in biomass logistics would require a proper price, high level of confidence on expected cost savings and good potential to integrate the containers with the current system. The most important advantages of containers were considered to be cost-effective long-distance transportation, the use of different transportation modes and optimized supply chain. Direct shipment from producer to end customer and keeping products safe from the source to destination are also potential benefits. New opportunities arise from unit labeling possibilities and mixing cargo shipment from alternative suppliers and biomass sources. Economies of scale could lower the costs. One option is double-stack rail transportation which is a common form of intermodal transportation in North America.

Still, container logistics face challenges. According to the study, containers seem to be too expensive for most non-processed or minimally processed biomasses. Challenge is to reduce this price. The cost of containers may be too high when compared to bulk transportation on rail or waterway. In addition, containers are not suitable for large bulk streams, like for vessels. The current containers also need special equipment for handling and are difficult to unload. On the other hand, lightweight intermodal container supply chains can provide cost-competitiveness in forest chip logistics compared to traditional options [4]. Economics of scale is important not only for the production cost of composite containers but also for the cost-effectiveness of biomass supply chains. There are also concerns of container availability for low value goods, especially in the case of international containers. In the northern countries, the freezing problem has been a major factor against container systems. Therefore, the fact that biomass does not freeze in composite containers [3] raises doubts. In

order to increase the container use, container logistics should be demonstrated more and studied as a complementary and a replacing part of the biomass supply chains.

Based on the market analysis, American market is interesting with its high energy use, large transportation volumes and low vehicle weight limitation. In the Europe, Germany is an attractive market due to its large economy, high level infrastructure and bioenergy promotion. Smaller potential markets for biomass container logistics are found in the northern countries, like Finland and Sweden, which have good infrastructure (roads, railroads, ports), rich forests and high use of combustible renewables and waste. Cold climate is ideal for lightweight composite containers because the composite structure does not freeze in low temperatures like metal. From the Finnish perspective, marketing efforts should probably head to near markets in the first phase: domestic market, Sweden and Germany. According to the analysis, the largest market is found in the United States, but entering the market would need significant efforts and good partners.

All the analyzed countries had some positive features and therefore none of these markets should be excluded. Overall, the analysis gave a general picture of the biomass market attractiveness. The container logistics market could be approached by more detailed indicators such as the use of energy biomass per country, the use of different biomass products and the share of domestic biomass procurement, which could be a potential market for containers. The current and future share of different transportation modes in biomass procurement is also interesting, as the container logistics is particularly suitable for rail transportation. The number of countries in the analysis was limited and excluded some potential market areas, like for example Canada which has rich forest resources and biomass potential. Another large, interesting market area is Russia. Both countries have cold climate which could provide competitive advantage to composite containers. These market areas should be studied further.

5 REFERENCES

[1] European Commission. Agriculture and Rural Development. Bioenergy. Biomass potential. Updated February 4, 2014 [retrieved June 27, 2014]. From: http://ec.europa.eu/agriculture/bioenergy/potential/index_en.htm

[2] Karttunen, K, Föhr, J., Lättilä, L, Korpinen, O-J, Knutas, A., Laitinen, T. & Ranta, T. 2013. Metsähakkeen logistiikka komposiittirakenteisilla siirtokonteilla. Metsätehon tuloskalvosarja 1/2013. 29 p. (In Finnish).

[3] Föhr, J., Karttunen, K., Enström, J., Johannesson, T. & Ranta, T. 2013. Biomass freezing tests for composite and metal containers. 21st EUROPEAN BIOMASS CONFERENCE AND EXHIBITION. Bella Center - Copenhagen, Denmark. 03-07 June 2013.

[4] Karttunen, K., Lättilä. L., Korpinen O-J, & Ranta, T. 2013. Cost-efficiency of intermodal container supply chains for forest chips. Silva Fennica Vol. 47. No. (4). Article id 1047. ISSN 0037-5330.

[5] World Bank. Indicators. [Retrieved June 27, 2014]. From: http://data.worldbank.org/indicator

[6] Schwab, K., Sala-i-Martin, X. & Greenhill, R. 2011. The Global Competitiveness Report 2011-2012. The World Economic Forum, Geneva.