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An environmental impact assessment of exported wood pellets from Canada to Europe

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ABSTRACT

There have been increased interests on exporting wood pellets from Canada to Europe to meet the increased demand on biofuels in European countries. The wood pellet industry in Canada, especially in the west coastal region, has grown at an annual rate of more than 20% averaged over last 5 years due to the steady supply of wood residues. This paper attempted to analyze the fuel consumption and air emissions associated with the wood pellet production in British Columbia and export to Sweden based on a streamlined life cycle analysis, starting from tree harvesting for wood residue production to the shipping of wood pellets from Vancouver to Stockholm in Sweden. The results showed that about 7.2 GJ of energy is consumed for each tonne of wood pellets produced and shipped to Europe, representing about 39% of the total energy content of the wood pellets. Among those energies consumed over the life cycle, about 2.6 GJ is associated with long-distance ocean transportation. The ocean transportation is also the major contributor to environmental and health impacts, followed by the pellet production processes. The fossil fuel content, which quantifies the amount of fossil fuel consumed over the life cycle, for exported wood pellets ranged from 19% to 35%, depending on whether natural gas or wood residue is used in the drying operation during the wood pellet production stage. To reduce the fossil fuel content and the environmental impacts, wood residues should be used in the drying operation and, if possible, local market should be explored to reduce the energy consumption associated with wood pellet transportation over long distances.

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1. Introduction

The European Commission decided to double the financial contribution to renewable energy from current 6% to 12% in 2010 [1]. This increase, if effected, could result in a reduction of CO₂ equivalent emissions of about 230–260 million metric tonnes (8% more reduction than the target set by the Kyoto Protocol). Stimulated by the incentives and tax credits, biomass utilization for the production of electricity and for the

residential and district heating has been growing very rapidly in Europe, at an annual increase rate of about 25% [2,3].

Densification of wood residues into pellets for space and water heating has been practiced in Europe since the 1970s [2]. Pelletization creates a clean burning, convenient and energy-concentrated fuel from bulky fibrous waste such as sawdust and wood shavings. Wood pellet heating systems are considered as an essential component of European plans to reduce GHG emissions and are targeted by incentive programs

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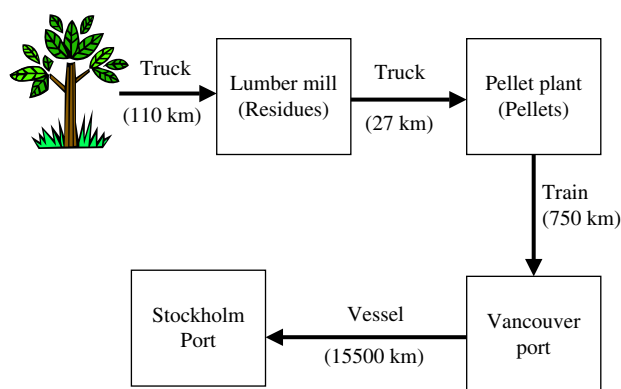


Fig. 1 – Production and transportation logistics of wood pellets from the Canadian forest to the European market.

in countries such as Germany, Norway and Sweden [3]. In North America there are an estimated 500,000 pellet burning stoves and furnaces with a total of about 650,000 tonnes of annual wood pellet consumption [4].

Canada is richly endowed with significant biomass resources. For example, the estimated thermal energy content of the annual biomass harvested in Canada is 5.1×10^9 GJ. This annual harvest is equal to 62% of the thermal energy derived from fossil fuels in Canada [5]. The development of this biomass resource, not just for energy but also for a variety of end uses, presents to Canada an opportunity to not only develop new and innovative industries but also sustainable energy and raw material supplies to reduce Canada’s reliance on non-renewable fuels and greenhouse gas emissions. The production of wood pellets has become a fast growing industry in Canada in recent years. Currently there are about 19 pellet manufacturing plants with an annual production capacity just over 1,000,000 tonnes of pellets, with most plants located in the east coast and west coast regions. Contrary to USA where almost all 800,000 tonnes of wood pellets produced there are consumed domestically, more than 80% of wood pellets manufactured in Canada are exported to Europe because the demand of wood pellets in Europe is much higher than what can be produced there (1,800,000 tonnes of wood pellets are produced in Europe annually) and the production of wood pellets in Canada is more than what is consumed locally. The transportation logistics of exported pellets from Canada to Europe is thus one of the important issues in the study of production and consumption of wood pellets in view

Table 2 – Total energy consumed for the production of sawdust in sawmills.

Type of energy	MJ tonne ⁻¹ wood pellets
Electricity	140.3
Natural gas	86.15
Heavy fuel oil	9.680
Middle distillates	14.46
Propane	0.2967
Steam	2.732
Wood waste	131.4
Total	385.0

of the important role played currently by the wood pellet exported from Canada to the global wood pellet market.

The purpose of this work is to analyze the net benefits of exporting wood pellets from Canada to Europe with the consideration of environmental impacts not only associated with the production of wood pellets but also with the transportation. In view of the fact that the emissions of greenhouse gases and air pollutants come not only from pellets burning but also from the production and transportation processes, one needs to conduct a streamlined life cycle analysis in order to determine whether biomass utilization via pelletization and exportation still remains sustainable.

In the current study, we focus on wood pellets produced in British Columbia located in the west coast of Canada because more than 2/3 of Canadian wood pellets are produced in this region. Furthermore, the production site selected for analysis is located in Prince George of British Columbia, where most pellet plants are situated in the close proximity. The port for ocean shipping to Europe is located in Vancouver of British Columbia. The Canadian wood pellets are shipped to Sweden, Netherlands, Belgium and all the countries in the north of Europe. However, this work considers only the port in Stockholm, which represents the most popular destination.

For a wood pellet plant located in Prince George, the whole wood pellet production and transportation process is illustrated in Fig. 1. Trees are harvested from the forest and then transported for an average of 110 km to the lumber mill where wood residues, including both shavings and sawdust, are collected and transported by trucks for an average distance of about 27 km to the pellet plant where wood residues are densified into wood pellets. After the production and packaging, the wood pellets, either in bulk or in bags, are transported from the plant to the Vancouver port by train, over a total average distance of

Table 1 – Emissions from tree harvesting.

Pollutant	g tonne ⁻¹ wood pellets
CO	63
CO ₂	1177
CH ₄	2.9
N ₂ O	1.6
NO ₂	294
VOC	4.6
PM	20.4
SO _x	27.9

Table 3 – Emission factors for HDV (GHGenius 3.2).

Pollutant	g GJ ⁻¹ fuel used	g tonne ⁻¹ km ⁻¹
CO ₂	67,667	108
CO	383	0.61
CH ₄	5.90	0.009
N ₂ O	0.95	0.0015
NO _x	794	1.26
SO _x	65.97	0.10
PM	40.09	0.06
VOC	58.95	0.09

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