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Life Cycle Assessment of the Wood Pellet Supply Chain with a Consideration of Bioenergy for Remote Communities in Canada

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Extended Abstract

In many remote communities in Canada, electricity and heat are generated mainly by fossil fuels. Most of these communities are powered by inefficient diesel generators. These diesel generators have a significant environmental impact due to fuel transportation and generator emissions, contributing to climate change. To prevent further environmental damage and provide more reliable and sustainable energy to remote communities, more emphasis should be placed on sustainable heat and power generation. (Mafakheri et al., 2020) This goal can only be accomplished by using renewable energy sources. An abundant energy source in Canada is biomass, a plant-based material utilized as a fuel to generate heat and electricity. Biomasses are dispersed resources with low energy densities and are challenging to store and transport. Thus, they must first be transformed into a solid fuel by pulverizing, drying, and compression to dry and dense with a high heat value. Wood pellets are excellent feedstock energy due to their high calorific value, low ash content, and low slagging rate, which we used for this study. We focus on the wood pellet supply chain's cradle-to-grave Life Cycle Assessment (LCA). In particular, the objectives are to compare the environmental impacts of wood pellets with those of fossil fuels as sources of energy for remote communities in Canada. The primary raw materials for wood pellet production in this study are the combination of Spruce, Pine, and Fir (SPF) as tree species which are the mixed group of harvesting species in Canadian forestlands. (Athena Sustainable Materials Institute, 2018) The functional unit is 1 tonne of wood pellet production which will be transported and combusted for producing bioenergy.

We used SimaPro (version 8.4.0.0) as an LCA software to compare wood pellets with fossil fuels in terms of environmental impacts. Ecoinvent 3 and Agri-footprint were used as the main libraries because of the nature of the feedstock in this study. TRACI 2.1 is used as an impact assessment methodology which is particularly suitable for North American case studies. The main stages considered for pellets LCA were harvesting, transportation (raw material and wood pellets), pellet production, and combustion. We collected data on Canadian harvesting operations, transportation facilities, pellet manufacturing units, and combustion facilities in the first step. Furthermore, a comparison of these four stages was performed in eight impact categories (Ozone depletion, Global warming, Smog, Acidification, Eutrophication, Carcinogenic, Non-carcinogenic, Respiratory effects, Ecotoxicity, and Fossil fuel depletion). Initial results (using SimaPro) show that pellet production and combustion have the highest environmental impacts, particularly when it comes to carcinogenic and ecotoxicity. Lastly, we compared wood pellets with fossil fuels to determine the efficiency of replacing traditional energy sources with bioenergy. Our preliminary results show that burning wood pellets perform better in many impact categories than fossil fuels, especially global warming potential (GWP) and ozone depletion (OD). For the wood pellet to be economically sound (cheap cost of coal-fired heat and the high cost of pellet manufacture) to replace fossil fuels, we have to improve the environmental aspects. For this purpose, we have to reduce impacts associated with pellet production units, mostly drying parts and improve conversion technologies such as low emission wood pellet stoves for the combustion stages. The harvesting stage can also improve biomass yields and understanding of fertilizer response to reduce environmental impacts.

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