The impact of transportation costs on the profitability of heat and power generation with wood products

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1. Introduction

International markets for wood biomass are currently emerging. Due to the corresponding environmental benefits, the domestic wood combustibles are an important energy resource, although certain measures must be taken to make the supply chain more cost-effective and efficient.

One of the major contributors to the costs of wood products is transportation, which is determined by the geographical location of forests and energy crops. Within this paper techno-economic parameters of all substantial process steps along the biomass value chain are estimated. The potential for logs and chips, which includes justifiable transportation distances for these kinds of biomass, will be analyzed. To reach these objectives a simulation model has been developed. The results may be used for socio-economical resource allocation and planning of future energy plants.

2. Key words

Chips, HPS (heat and power station), logistic chain, logs, trasnsportation costs.

3. Motivation

The production of heat and electricity is nowadays influenced by the effect of climate change through the exhaust gases derived from the combustion of fossil fuels. The use of wood as raw material from tree plantations, natural woods and agricultural and industrial wastes represents a solution to diminish the CO_2 concentration and thereby reduce the Greenhouse effect. The construction of Bio Heat and Power Stations (HPS) to be fueled with biomass in form of wood-based products like chips or logs constitutes an interesting step to both producing clean energy and promoting the agricultural and wooded areas.

However biomass transport from fields to HPSs contributes significantly to the production costs due to the low energy density of wood as well as its large volume. These both parameters make biomass use an excessively costly energy activity especially with regard to the most cost-sensitive step of the biomass value chain: transportation [1]. In order to minimize these costs and make wood products economically competitive regarding fossil fuels a complete logistic analysis from an economic point of view has been accomplished.

4. Objectives

The wood products analyzed in this work are chips and logs considered apart from pellets or briquettes resulting from a densification process. The production costs of this second group of wood products are higher although their energy per mass unit is also higher. Due to this reason the subject of this study was only focused on the two firstly above-mentioned biomass fuels, which are comparable regarding their final applicability for energy generation on an industrial scale and regarding relatively short transportation distances. For both fuels the corresponding biomass value chains have to be scrutinized by economically analyzing each of the steps happening from felling the trees up to their conversion into energy.

The forests and some cultivation lands like those of fruit trees and other wood crops represent a significant resource of wood

biomass in many areas predominantly located in temperate and tropical regions of the world. The energy use of these biomass stocks could worldwide signify a relevant contribution to the reduction of Greenhouse gases and the diversification of any national energy mix.

Wood logs and wood branches are the most extended and important biomass source derived from forest areas. Other possible options would include the short rotation plantation and the rests of agricultural and industrial activities, thereby completing the whole bio-energy range for provision of wood to the respective logistic chains. Short rotation plantations constitute a very promising alternative although its still high production costs induced by the cost intensive cultivation processes continue to limit its consumption for power and heat generation. Therefore the wood fraction derived from forest areas and woods as well as the wood agricultural wastes will solely be considered for the purposes of the present study.

5. Methodological process

Economic and technical data for each element belonging to the biomass value chain have been collected so that the profitability of the energy generation process in direct competition with that of oil-derived fuels can be assessed for the biomass obtained in areas situated around the HPS. These data are especially related to transportation but they likewise involve the parameters concerning all the value chain for the logistic chains of logs and chipped branches. Data were achieved from different sources reaching from scientific papers published in international journals up to documents and books acquired from governmental and private institutions and foundations

Another decisive aim accomplished in the course of this investigation consisted in establishing a model based on a region centered around the HPS, thereby determining the area comprising those forests and cultivation fields which are at such a distance that biomass transportation can be considered as economically competitive. Within a given district and for its corresponding biomass resources a spatial allocation of the productive areas should be realized by identifying a cluster of energy producers along with their corresponding catchment area where biomass appears to be competitive with fossil fuel-based energy generation.

In order to elaborate all the collected data a simulation tool has been implemented thereby modeling the economic reality involved in the process of heat and power generation from biomass resources.

6. Contributions

There exist two different logistic chains for collecting the wood biomass and then converting it into power and heat. The logs as condensed energy carriers and the branches resulting from lopping processes in forests and agricultural areas constitute the basis of the current provision of wood. The analysis of both value chains raises certain advantages and disadvantages regarding the wood transportation by truck and its corresponding profitability.

The analysis of the potentiality of the energy production in certain forestry and agricultural regions advises the implementation of decentralized biomass-based heat and power generation. The system will be constituted by a set of spread nodes, each acting as a HPS within a grid configuration.

The results of the simulation model used inevitably point out to a necessary approval or - if already existent - an increase of subsidies and incentives regarding biomass-fired heat power plants. Moreover, the heat produced at the HPS should be conducted to a potentially growing industrial sector built up around the facility, thus taking advantage of synergies between energy generation and other industrial activities (tourism, tin industry, etc).

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