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Wood pellets production costs and energy consumption under different framework conditions in Northeast Argentina

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ARTICLE INFO

Article history:
Received 8 September 2009
Received in revised form
14 December 2010
Accepted 21 December 2010
Available online 14 January 2011

Keywords:
Renewable energy
Wood pellets
Energy consumption
Production costs
Sensitivity analysis

ABSTRACT

The development of cleaner and renewable energy sources are needed in order to reduce dependency and global warming. Wood pellets are a clean renewable fuel and has been considered as one of the substitutes for fossil fuels. In Argentina, large quantities of sawmill residues are still unused and wood pellets production could be seen as both, as an environmental solution and an extra economical benefit. The general aim of this study was to determine the wood pellets production costs and energy consumption under different framework conditions in northeast Argentina. The specific costs of wood pellets for the different scenarios showed relative lower costs comparing to the ones reported in other studies, ranging from 35 to 47 €/$Mg_{pellets}$. Raw material costs represented the main cost factor in the calculation of the total pellets production costs. A lower specific production cost was observed when 50% of the raw material input was wood shavings. The specific electricity consumption per metric ton of pellet was lower in scenarios with higher production rate. Lower heat energy consumption was observed in scenarios that have a mixed raw material input. The most promising framework condition for Northeast Argentina, in terms of costs effectiveness and energy consumption could be acquired with production rates of 6 Mg/h with sawdust and wood shavings as raw material. However, simultaneous increment of the electricity by 50% and raw material price by 100% may increase the specific costs up to 50%.

1. Introduction

There is a continuous growth of the global energy consumption and this raises urgent problems that should be solved in the short term. During 2006, 79% of the global final energy consumption belonged to fossil fuels sources [1]. The larger part of mineral oil reserves is located within a few countries, making a volatile energy supply. In addition, the use of fossil fuels causes numerous environmental problems, such as local air pollution and greenhouse gas emissions [2].

In 2006, about 18% of global final energy consumption came from renewable energy sources [1]. The development of cleaner and renewable energy sources from biomass feedstock could be seen as part of a solution to the fossil fuels dependency and global warming. One advantage is that biomass is worldwide available and it may be produced and consumed on a CO_2-neutral basis [3–5].

Wood pellets are a clean renewable fuel, mostly produced from highly compressed sawdust, planer shavings and bark. This fuel has been considered as one of the substitutes for fossil fuels like coal and oil for heating and cogeneration [6]. Large volumes of pellets are nowadays produced for the large-scale generation of heat and power, in order to replace coal with sustainable energy resources. However, wood pellets may also be utilized in domestic furnaces and medium scale boilers. In general trade flows are between neighboring

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doi:10.1016/j.biombioe.2010.12.029

countries, but long distance trade is also occurring. Common international trade flows include export of wood pellets from Canada, Eastern Europe and Brazil to Sweden, Belgium, the Netherlands and the United Kingdom [7].

Some regions may have much larger biomass availability for wood pellet production than others. In Latin America, wood processing industries are not fully developed and large amounts of mechanical wood processing industry by-products are still underused. At the moment, in Argentina, mechanical wood processing by-products are to a very limited extend utilized by the pulp and paper and by the particle board industries. Large quantities of sawmill residues are still unused and wood pellets production could be seen as both, as an environmental solution and an extra economical benefit. However, wood pellet production costs need to be assessed in detail before to start a pellet production plant [8].

Wood pellets production costs are influenced by several factors, such as biomass and electricity price. A better economic and sustainable analysis of a wood pellet project could be acquired if production costs and energy consumption are assessed under different framework conditions. Therefore, the general aim of this study was to determine the wood pellets production costs and energy consumption under different framework conditions in Northeast Argentina.

2. Methodology

2.1. Study site

According to the last forest inventory (1998), Argentina had 780.396 ha of forest plantations [9]. In 2006, the total amount of harvested biomass from plantations was 9.9 million Mg[1] (fresh) and the total roundwood consumed was 7.6 million Mg [10]. The main plantation forest region of Argentina is situated in the northeast of the country (Fig. 1) and represents 70% of the total forest plantations [9]. The region is represented by the province of Misiones, Corrientes and Entre Ríos. The main tree species are *Pinus elliotii*, *Pinus taeda* and *Eucalyptus* sp.

In developed countries as well as in developing countries there is a lack of data regarding annual residues production. The reason could be that residues production is seen as a peripheral activity and is not taken account in the whole forest supply chain. However, preliminary calculations made by the author and based on conversion factors sources from literature [11] showed a potential availability of 4 million Mg/year of wood mechanical processing industry by-products.

2.2. Production costs assessment

In this study, the different types of cost present in a wood pellet production process were divided into two groups: capital costs and operating costs. The capital costs include annual capital costs (annuity) and service and maintenance costs.

The annual capital cost Cc (€/year) was calculated with the following formula:

[1] Mg refers to megagram that equals 1 ton.

Fig. 1 – Map of Argentina the northeast region where the main forest plantations are situated.

$$Cc = CRF\ Ic \quad (1)$$

where *CRF* is the capital recovery factor and *Ic* is the investment costs. The investment costs were all the costs related to general construction, purchase and installation of different equipment parts needed for the wood pellet plant.

The capital recovery factor was calculated using the following formula:

$$CRF = \frac{i(1+i)^n}{(1+i)^n - 1} \quad (2)$$

where i is the interest rate (decimal) and n is the utilization period in years.

In this study an interest rate of 7% was considered for the CRF calculation.

Service and maintenance costs for the different units of the wood pellet plant were calculated as a percent of the investment costs. Thek and Obernberger [8] and Mani [12] suggested average maintenance values, taken into consideration wear and tear of machinery parts.

The operating costs were related to the manufacturing process such as cost of the raw material, heat costs for drying, electricity consumption costs and personnel costs.