Availability of forest biomass in Chile for second generation biodiesel production

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I. Introduction

In late 2009 a consortium among the University of Chile through the Faculty of Forestry Sciences and Nature Conservation, Empresa Nacional del Petroleo (ENAP) and the Timber Consortium was formed to study the feasibility of producing biodiesel from the present forest biomass in Chile. It was possible evaluating about 2.6 million hectares that included plantations, the secondary growth of a part of native forest and the industrial waste from the processing of 44 million m^3 of wood per year.

Nowadays Chile has the chance to explore new frontiers related to the production of new sources of energy for the power generation and new fuels. There are many projects that have explored alternative and non-conventional sources of energy such as: wind energy, geothermal or solar and rejecting other initiatives like the Aysén hydropower program. However, the country has an important source of new resources that can be based on its forest potential. This potential includes plantations of exotic species such as radiata pine and *Eucalyptus* spp. and the native forest. Annual growth capacity of forest resources is approximately 50 million m^3 per year, which comprises 40 million m^3 from plantations and 10 million m^3 derived from the sustainable management of native formations.

The forestry has been very important, in terms of supporting their development and the expansion of projects based on plantations. *Eucalyptus* spp. and radiata pine plantations cover a surface above 2.3 million hectares. This significant surface could be expanded to 2 extra million hectares due to current land availability. 97% of all the industrial requirements of the current installed capacity are covered by plantations growing at a rate of about 42 million m^3 per year. Chile has the opportunity to create new knowledge and innovation able to lead a permanent transfer and to build critical mass focalized on second generation biofuel production from forest biomass. The current energy deficit exhibited by the country is relevant, so the optimum use of forest resources is a must.

The Biocomsa Consortium proposes a project intended to develop a supply chain of second generation biodiesel from forest biomass. To reach this challenge we started assessing the forest resource available and located between the VII and the X regions. This assessment included: standing timber and the generation of wastes derived from forestry industry, the searching of an optimal location for a second generation biodiesel plant, the transportation system and the associated logistic and the chemical and energetic characterization of the potentially available raw materials, an estimation of potential environmental impacts and to propose an adaptation of current technologies available in developed countries for the thermochemical conversion of biomass under the local conditions.

The objectives were: a) to create the scientific and technological basis for the development of second generation biodiesel industry in the country, b) to develop sustainable technologies to predict, quantify, harvest, handle and transport biomass for second generation biodiesel production, c) to develop sustainable technologies for the adoption of energy crops, d) to apply physical and chemical characterization of lignocellulosic material in order to develop proper pretreatments to optimize their transformation into biodiesel, e) to develop and to adapt processes for the production of biodiesel recognizing opportunities derived from products, f) to transfer the results of the project to the society and g) to create research and the development of permanent capacities for the sustainable production of second generation biodiesel.

2. Experimental

Digital aerial images and traditional data from physiological growth of plantations (hybrid models) were both considered. In the case of native forest, also the use of aerial images was performed and ground samples were taken to evaluate their growths. In the industrial field, data from the industry, which is about 36 million m^3 of raw material for transformation and it was determined that 9 million of m^3 were produced as wastes, industrial caps like sawmill, sawdust and other byproducts adopted from pulp and paper, plywood and veeners production.

The energy matrix of Chile shows that 68.9% of the total supply comes from non-renewable fossil fuels. 99% of oil, 80% of natural gas and 96% of the coal consumed in the country are imported, so the country is very vulnerable to price fluctuations in the international markets [1]. In the last decade, for example, Chile has significantly increased the consumption of regular diesel for over gasoline. Only in 2005, the road transportation consumed 3.6 million liters of diesel. The current energy system has safety and accessibility shortcomings, which prevents widespread and ongoing economic growth. Only hydropower and biomass are energy sources available in the country itself and their relative contributions in the energy matrix are 17% and 14%, respectively [2].

The imminent exhaustion of traditional sources of fossil fuels and its exploitation at low cost, their constant increasing prices and their deleterious effects of clime change demand a sustainable solution right now. The global fuel consumption generates huge amounts of greenhouse gases, which are released to the atmosphere, this type of pollution has caused a dramatic climate change on the planet, which has become a major problem worldwide. As a consequence, increased interest in less polluting technologies and potentially renewable and neutral carbon energy sources, in terms of CO_2 emissions, are more important every day.

3. Results and discussion

There is a surplus of forest growth (plantations contribute about 12 million m^3 approximately and 5 million m^3 are derived from industrial processing), giving a total of 10.6 million tons of raw material for biofuel obtaining purposes [3]. We can add 7 million m^3 from the management of native forest, which represents 4.6 million tons of additional wood. However the total of 15.2 million tons has news market competition due to expansion projects, sawing, plywoods and pulp and paper boards.

Biomass and their derived products should represent an important proportion of the energy matrix of developing countries such as Chile, they need to increase the use of energy to reach a developed condition. Prospections for the use of lignocellulosic biomass for energy purposes are promising due to their environmental benefits, furthermore the biomass based energy generation can constitute a new business for foresters [4].

Chile has a chance to compete in terms of productivity in biomass, especially energetic species or forest plantations have natural advantages here due to their fast growth, regarded as one of the highest in the planet. The country has a continental surface of 75.5 million hectares, excluding the Chilean Antarctic territory. 45% of this surface, i.e. 33.8 million hectares is suitable for forestry: 15.6 million hectares are native forests and forest plantations. The remaining 18.2 million hectares are protected areas, both in the hands of private and state [4]. It is estimated that the Chilean forestry sector could eventually meet 20% of the total projected energy demand in our country for the next 20 years through the generation of bioenergy.

The physical supply of energy from wastes derived from lumber industry in Chile would be about 1.4 million cubic meters between 2004 and 2006, and 1.8 million between 2019 and 2021 [5]. Agricultural wastes are not currently utilized. The forest industry residues are channeled to different customers, where the main ones are the pulp mills with 32.2% and board plants with 28.5% using waste as raw material in the manufacturing of chipboard and mops and pieces to consume energy [6]. As mentioned above, the primary forest industry initially turned its interest to industry waste wood for energy use, but as they are less accessible, it has encouraged large companies to look for residues from forest management of their own forests, a source of biomass fuel, something that although it has been evaluated, it has not resulted in the development of projects associated with the use of this energy source, i.e. biomass [6]. It can be noted that there are initiatives that arouse new interest and wood residues will bring pressure demand and a strong activation of trade based on these resources.

Biofuels present challenges, from the point of view of the energy process (product chain) and also from the point of view of sustainability of biomass for energy use. Lignocellulosic waste field is a current opportunity for the development of liquid biofuels, yes, we need jointly develop new bioenergy crops, open up new avenues of research to ensure a sustainable supply on time, and for this purpose, the consortium aims: a) designing integrated production systems, biomass generation, to improve the quality and productivity of the soil and thus achieve sustainable harvesting of bioenergy crops, b) ensuring the availability of biomass for energy through sustainable grow of species with high biomass yields and quality, optimizing the use of productive resources (irrigation, fertilizers, pesticides, etc.) and c) obtaning a logistic system for collection and preparation of raw materials, as well as for waste recovery plantation at reasonable costs.

4. Conclusions

There is a great potential of wood biomass for biodiesel fuel production through processes such as gasification and subsequent liquefaction (Fischer-Tropsch). However, we must evaluate expansion plans of the different business groups due to the costs of raw materials and transportation are extremely relevant.

As a key tool in the growth of domestic production of biofuels should develop strategic alliances and partnerships with Chilean and foreign companies and institutions to develop technology in the area, so, to fully exploit the vast experience that has been achieved, worldwide. It can thus overcome the challenges from the point of view of planning and coordination of the energy process and overcome technological barriers to commercial production of biofuels. Increased knowledge of existing technology for the generation and processing of biofuels is necessary as their adaptation to the national reality, due to the specific conditions of each crop can not be imported and applied directly.

Therefore the consortium aims to create permanent capabilities in research, development and innovation in services and oriented to the energy needs of the country's industry and products. The use of renewable energy as liquids derived from lignocellulosic biomass fuels, will have many positive effects in Chile. Besides giving a highly energy dependent country imported fuel security, it will have a positive environmental effect. On the other hand, involve import substitution, increase jobs, and enabling sustainable production, boosting the rural sector to develop new alternatives for energy crops. Additionally, production of own renewable energy, can maintain the quality and living standards, and that at least 70% of all goods and services generated by man, from oil and its derivatives; and therefore it is associated with the development of society, providing major independence in fuels, creating a cleaner system, with a safe fuel handling and storage.

5. References

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