The Role of Woody Biomass in Mitigating Carbon Footprint: Case Study in Austria

Sadaf Milani [a], Lian Lian [b], Wen Tian

School of Transportation and Logistics, Dalian University of Technology 116024, Dalian, Lianoning, China

[a]sadafmilani@dlut.cn, [b]lian.lian@dlut.edu.cn

Abstract

The incremental trend in the world energy consumption as consequence of population and economic growth urged the authorities to develop sustainable energy resources in substitution for fossil fuel. Among all renewable energy sources, biomass is known as the most prevailing one, and woody biomass supply became a promising and widespread source of energy in EU. Renewable Energy policy promotion and the huge amount of wood residues supply potential in Austria motivated this country's authorities to apply woody biomass for biofuel and energy production. Considering the geographical features of Austria, almost half of this country is covered by forests. It has made Austria as a potential woody biomass supplier in EU until 2030.This study investigated the main factors' contribution in the woody biomass supply promotion in Austria. Moreover, it suggests that applying a comprehensive management system is an inevitable element for woody biomass exploitation and its further development.

Keywords

GHG, Renewable Energy, Woody Biomas

1. Introduction

In the last two decades, GHG emissions resulted from energy and transportation sectors are dramatically increased. Renewable energy resources have been introduced to mitigate the environmental negative impacts of fossil fuels consumption. Usually, energy demand and supply have important role on the countries' social and economic development. Therefore, making balance between producing energy and consumption is a crucial aspect of decision making.

Transportation, heating and electricity making the main proportion of whole energy system which conventionally supplying from fossil fuels such as oil, gas, petroleum and coal. Nevertheless, the main disadvantages of these primary energy sources are their scarcity and damaging impacts on environment known as greenhouse gas (GHG) emissions

Replacing renewable energy resources with their fossil fuels counterparts is a promising solution for alleviating the damaging impacts conventional fossil fuels in European countries.

2. Biomass Resources

There are various types of renewable energy sources, but biomass due to its specific characteristics, attracted more consideration. Usually, the biomass are comprising from agricultural residues, forest woody materials and municipal and industrial biological wastes. Moreover, growing specific crops for energy supply purposes is another alternative for producing biomass sources. Different biomass sources are usually available in most regions of many countries. Furthermore, unlike other renewable energy sources, they could be stored and converted to different kinds of energy, such as heat and

electricity on demand. In addition, the by-products of biomass conversion process, such as biofuel, chemical components and ash can be re-utilized. Therefore, according to World Bioenergy Organization (WBO), the substitution of fossil fuel with biomass can alleviate GHG emissions, which has a direct impact on climate change mitigation. Moreover, applying biomass as a renewable source of energy can reduce the need for importing fossil fuels in many countries. Normally, biomass conversion process use less energy than the amounts they generate. Thus, applying biomass resource can extremely reduce the imported fossil fuels and the susceptibility of European economy causing by the fluctuation in the foreign energy markets.

In terms of electricity generation, wind and solar energy sources, due to their innate characteristics do not have stable short-term electricity balance. Thus, to guarantee the constant power generation, large number of wind turbines and solar cells must be installed. Moreover, unpredicted imbalanced supply causing uncertainty on demand side. By contrast, biomass has less fluctuation in comparison to other renewable energy sources. In addition, biomass sources can play a supplement role in combination with solar and wind energy to mitigate their supply uncertainties. Biomass are the organic maters originated from plants, animals, or the wastes produced from organic sources. In the past two decades, global warming motivated many countries to step toward finding alternative solutions for mitigating the impact of greenhouse gases. Moreover, contribution of attractive financial support promoted the trends of power suppliers and transportation fuel producers towards applying bioenergy resource. These facts resulted in significant innovation in the field of biomass technology and developed different strategies in terms of exploiting biomass efficiently. [1] Has reviewed previous works in the field of biomass by taking into account its economic, social and environmental aspects by investigating its supply chain's components. In addition, it concluded that substituting biomass in boilers can mitigate GHG emissions significantly.

3. Woody biomass

Woody Biomass (WB) usually are derived from plants components, agricultural and forestry residues and municipal wastes. Among the abovementioned biomass resources, forest residues due to its specific characteristics became more prevailing in the recent years. Forestry residues are including logging slash (tops, branches, and other timber harvesting materials), forest thinning residues (understory brush and small diameter tree boles), sawmill residues from wood manufacturing operations (barks, sawdust, shaving and trim ends). Forest thinning residues are proposed to be removed from forest lands to reduce the self-ignition hazard. Meanwhile, these source of forest fuels are known as the main source of forest soil nutrient. Therefore, removing forest trees thinning residues must be done cautiously to avoid the potential damage to forest ecosystem.

Forest WB including trees top and branches derived from harvesting the timbers. These residues are not merchantable, and by employing a proper forest management they can be removed from the forest lands without damaging the forest ecosystem. The GHG emissions of burning WB are much less than those resulted by fossil fuel in combustion process. In addition, the carbon dioxide emissions caused by WB combustion is equal to the amount absorbed by trees during the growth period.

By applying a precise WB supply chain design, planning, and management a cost-effective and sustainable source of energy would be provided. [2] Concluded the positive contribution of biomass in the future energy supply by reviewing seventeen previous studies. Furthermore, according to this review paper, WB has been known as the major source of biomass for energy production up to about 115 EJ yr−1 by 2050. [3] Has shown the large potential of global biomass economic and technical potential in association with carbon capture and storage (CCS) by 2050. [4] Estimated the potential biomass supply in fifteen EU countries. This research concluded that domestic biomass is one of the most promising contributors of energy supply in Europe and there are no significant limitation in meeting the biomass utilization target. In addition, this study predicted that the demand of biofuel utilization in Europe will be increased over time. [5] Investigated the potential use of second generation of biomass (forest residues) in biofuel, and combined heat and electricity production in European countries. This study concluded that lowest carbon dioxide emissions are resulting from

the low carbon cost and high biofuel support. Therefore, the substitution of forest fuel for energy and transportation sector is highly based on the targeted biofuel supporting policy.

4. Woody biomass in Austria

In European countries, WB is a suitable renewable energy resource. It is one of the most important and widespread resources, which consequences about zero net carbon emission in conversion to bio-energy. Moreover, it exists in wide spread source of various shapes such as wood residues from forestry activities, saw dust of wood factories, paper, demolished wood from house waste, etc. [6]. In the last decade, many countries have focused on wood resources as a promising alternative for fossil fuels. Renewable fuels such as ethanol, methanol, hydrogen, biodiesel and Fischer-Tropsch (FT) liquid can be obtained from WB sources. Rich-biogas methane can be derived from WB combustion process which commonly used for power electricity generation. In addition, biogas is an alternative transportation fuel operating in the similar way as compressed natural gas. This kind of biofuel is already consumed by transportation sector in several European countries. Biogas carbon capturing process is a practical technique resulting in an enriched bio-methane in substitution with natural gas.

In many studies, it has been predicted that the WB application will be expanded in the near future [7]. Forest biomass is expected to play a significant role in Europe's renewable energy mix until 2020 .Forest fuel extraction result in more employment opportunities, also it reduces the energy supply dependency to abroad [8].The potential of the EU's WB including those provided directly from forests and of the secondary sources such as by-products and residues of the industries. Subsequently, Austria government has committed to reach one hundred percent heating and electricity from renewable energy by 2030. Biomass, as a source of renewable energy, playing a key role and biomass energy has emerged as a significant economic driver in this country. Due the fact that fifty percent of total Austria's land covered by forests, wood residues from forestry activities, and second wood producers are the most promising biomass source applied for energy generation and biofuel production purpose [9] focusing on large amount of degradable wood residues resulted by timbering and thinning trees can reduce the forest fire hazard. In addition, utilization of WB for energy generation purposes is expected to grow dramatically. [10] concluded that only half of the total WB potential sources in Europe is utilized. However, in most cases, there are not enough WB supply sites in the local level, so costly long-distance transportation would be required to fulfill the constant demand of plants.

According to [11], the spatial variability of energy demand in Austria is high. Therefore, dramatic increase in the number of bioenergy plants in Austria, and fulfilling the plants constant operation signify optimizing biomass supply chain in both economic and environmental aspects. Energy production and transportation sector contributing to 56% of total GHG emissions in Austria [12]. For mitigating the climate change, Austrian energy strategy have been established considering the fundamentals including : Promoting the energy efficiency in constructed dwelling, transportation sector and machines; Developing renewable energy in terms of electricity generation, heat and fuel (biofuel)production; and to protect the long term energy supply.

For mitigating the impact of GHG emissions, utilization of WB is known as a viable and economically feasible source of energy production in this country. In addition, in Austria, the Green Energy Promoting regulations lead to increasing demand on bioenergy resources especially forest fuel, thus such strategic tendency requires the fuel supply assurance by developing conversion plants .Austria's WB promotion have been started from '80s, but the positive trend toward employing this source of renewable energy increased in the past decade. According to the Austria's energy agency report, the main reasons contributed in WB development in Austria are including sustainable awareness, incremental trends in fossil fuels price, and Austrian responsibility towards the environmental issues.

Primarily, wood residues would be obtained from logging operations, land clearing companies, and urban wood wastes. Afterwards, pre-processing such as drying, chipping, and pelletizing transfer them into clean wood residues such as pellets, wood chips. Processing wood residues altering them

into homogeneous and easy tradable commodities. The original source of WB in Austria are including wood chips and pellets.

Wood Chips and Pellets

Wood chips are by-products of sawmills or are made from logging residues. Chipping process are usually applied on roadside nearby supply sites, or in the intermediate storage facilities. [13] Presented the comparison of various technology alternatives for wood chips to energy conversion, also this article has reviewed the efficiency of current technologies performance in the micro- and small-scale levels. This study concluded that in the small scale (regional) level, wood chips would be a suitable feedstock; particularly for heat production purpose. [14] Investigated the wood chips supply chain in Austria case. This study evaluated the wood chips supply and transportation costs by comparing two different logistics method. In addition, this research concluded the main factors influencing the WB supply chain productivity are including the transportation distance and loading volume. The cost of chipping process declines depending on the volume of wood residues. In Austria, wood chips standardized according to ONORM M7133.

Wood chips are generally inexpensive by itself, but its handling and transportation is expensive and complicated. [15] Depending on the proposed case wood chips transportation costs may be offset by the low cost of fuel. In contrast, pellets are densified and contain more energy than wood chips. Palletization is the process of drying and compressing wood residues under the high pressure and changing them into the cylindrical extruded pieces with 6-10 mm diameter. Although pellets production and conversion process is more expensive than wood chips, its transportation and handling costs are much lower [16].In addition, [17] explored the GHG emissions over the life cycle of pellets production, also it investigated the impact of fossil fuel substitution with pellets in the carbon dioxide emissions reduction. Palletization is a commercial technology and nowadays are used widely in European countries. [18] Presented an economic analysis for wood pellets supply and demand in Austria residential heating system. According to this study, it has been predicted that the wood pellets price will be increased as a consequence of incremental trend in demand side. The amount of moisture content of wood chips and pellets is about 30% and 10 % correspondingly.

5. Conclusions

This paper investigated the contribution of WB in Austria's energy supply. In the previous research works, WB was introduced as a carbon neutral feedstock in terms of energy production. Since the carbon dioxide resulted in WB combustion process will be captured by plant, it results in net zero carbon emissions. Therefore, WB is a promising alternative for fossil fuel substitution in terms of electricity generation, heat and transportation fuel production. However, the logistics activities, such as preprocessing at supply site, transportation, handling and conversion, disrupt the carbon balance in the WB supply chain. Therefore, evaluating carbon footprint and applying measures to minimize the carbon dioxide emissions in the proposed bio-based supply chain are inevitable.

There are wide range of techniques such as carbon capture and storage (CCS) as an efficient measure for carbon dioxide concentration reduction in association with biomass implementation [19]. Also, carbon dioxide emissions has been known as environmental cost [20]. Carbon dioxide emission costs representing its tax tradable emissions permit according to the country's regulation. The main proportion of the carbon dioxide emissions by WB combustion at conversion plants will be offset by the growing trees. This assumption is compatible with the current version of UNFCC reporting guidelines for the Kyoto protocol that consider WB as a carbon neutral source of energy [21].

In addition, the application of forest wood residues are environmentally more beneficial than their disposal through open burning process. Also, the removal of wood residues reduces the risk of volatile organic compounds growth, dust and nuisance in association with forestry operations. In addition, the removal of forest wood residues reduces the risk of forest damage from fire, and subsequently weaken the potential air toxic emissions.

There are different measures for the sustainable use of WB sources. For instance, continuous removing of biomass sources such as forestry residues declines the forest soil fertility. Therefore, reforestation, soil nutrient replacement are subjected to mitigate biomass evacuation. Moreover, negative impacts on environment is another aspect of unceasing removal of forest fuels. In consequence, for avoiding the forest soil erosion, losing its fertility, nutrient cycle, preventing wild life habitat and downstream flooding, employing an efficient management system is an essential aspect of WB supply chain. Economic and environmental cost assessment of WB supply counterbalance the retrieved advantage from this source of energy.

An efficient management system may determine the optimal characteristics of WB, such as quality, energy content, ash and contaminant, particle size and moisture [22]. Consequently, applying WB for energy seeks for a precise and comprehensive supply chain management. Without efficient WB management system, this promising renewable energy resource will not be efficiently exploited.

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