ONLINE ISSN 2069-7430
ISSN-L 1841-4737
PRO LIGNO
www.proligno.ro
Vol. 9 N° 4 2013
pp. 82-88

RENEWABLE BIO-ENERGY FROM WOODEN BIOMASS IN TURKEY

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Abstract:

Use of wood for energy production is a relatively new issue in Turkey. Bio-energy production, biomass energy, however, is located in residential, agricultural, and animal waste is also considered as biomass energy. In this study, the potential to produce bio-energy from wood and regions to which this potential is evaluated based on the amounts of General Directorate of Forestry average of the years 2007-2009. The calculation of the potential for bio-energy generation from forest residues and the amount of wood chips has taken into account. Several estimates show that wood-based power stations to meet Turkey's demand for bio-energy have the potential to exceed of 3% or 5%. Therefore, the basic policy of the country to use its resources should be seen. Turkey started to use renewable energy to get its benefits. What should be underlined here is that the technology required for generating energy from wood should be obtained and created by domestic efforts and operations. Otherwise, Turkey will be dependent on foreign countries and technologies for bio-based energy. Northern and southern region of Turkey are proper area to establish bio-energy plants due to raw material advantage. Government should encourage private sector for bio-energy investments.

Key words: *forestry; forest policy; bio-energy; forest industry; Turkey.*

INTRODUCTION

Energy is an important factor in shaping the development of countries. It has a wide range of use and especially within the last 20 years, as a result of using fossil fuels for energy consumption and economic and environmental problems; renewable energy resources have started attracting attention. Renewable energy resources and types can be listed as hydraulic, geothermal, solar, wind, sea wave, and tidal flow, ocean thermal, and sea flow and biomass energies. Biomass energy out of these renewable energy resources is amongst the resources currently available in Turkey.

Biomass energy is obtained from wood and wood waste, plant and animal wastes, domestic, and urban and agricultural waste. The energy generated from biomass resources is called bioenergy. Bioenergy resources play an important role in reducing the effects of greenhouse gases (Demirbas 2001, Turker and Kaygusuz 2001). Further, bioenergy resources are also of utmost value in terms of biological diversity. On the other hand, as everyone is aware, fossil fuels are still the main source of energy widely used all around the world (Firbank 2008, Tunc *et al*. 2009). Further, the damage fossil fuels have on the environment is apparent and well-known. The adverse effect of fossil fuels on our world has become a common knowledge and has gained the attention of countries and societies. Another disadvantage of fossil fuels is the unstable price increase (Elauria *et al*. 2003). This instability is damaging both for the economies of countries and their energy policies. The sudden and unexpected price increases have also accelerated the pursuit for new energy resources (Belen and Atas, 2009). Moreover, the rapid increase in population, industrialization and the increase in energy demand to reach higher living standards have also directly raised the demand for energy. As a result of this increasing necessity to diversify energy resources, renewable energy resources have become an important issue to be considered.

Today, 80% of the energy demand in the world is covered by nonrenewable resources, in other words fossil fuels such as coal, petrol and natural gas (Erturk *et al*. 2006, Ucgul and Akgul 2010). The distribution of fossil fuel reserves, in terms of their petrol equivalent is as indicated: 68% coal, 18% petrol and 14% natural gas (Demirtas and Gun 2007). The large portion of nonrenewable resources amongst all energy resources is also challenging for the energy policies of countries and forcing decision makers to consider the requirement to benefit from renewable energy resources. In this respect, converting biomass into energy by scientific methods and technologies means possessing an environment-friendly, renewable and safe energy resources (Akkaya *et al*. 2002, Kaya *et al*. 2008, Angelis-Dimakis 2010). Further, energy is not obtained merely by burning the biomass, but it can also be transformed into other energy forms like hydrogen, methanol, ethanol, etc. and make a major contribution to the countries' economies and technological advancement levels (Geray 2007, Akgul and Camlibel 2008, Bilen *et al*. 2008, Sullivan *et al*. 2011).

Since renewable energy resources do not cause any atmospheric pollution, they are considered as clean energy. When environmental problems and environmental quality are only considered from atmosphere, air and water pollution or carbon emissions aspects, it is evident that renewable energy resources do actually generate clean energy (Junfeng and Runqing 2003, Balat 2005, Akesen and Ekizoglu 2010). According to the European Forestry Commission's Reports (2009), the main renewable energy resource in Europe is wood. Therefore, forest products industry had to comply with decisions taken and policies determined outside of their sectors. The legal precautions determined by the EU Commission has allocated certain legal responsibilities to member states as well as Baltic countries and Belarus, Ukraine and other neighboring countries to EU member states. The most significant responsibility amongst these is the establishment of a Biomass Action Plan. Although the strong political support provided as a result of these action plans contributed to the growth of wood energy markets, they also caused decrease in demand observed in forest products industry.

In this study, the current and future value and importance of the wood energy in meeting the energy demand in Turkey is discussed and the latest developments in this area and the possible results of using energy generated from wood in Turkey have been considered.

BACKGROUND

There are many predictions and assumptions for the future with regards to energy. It is assumed that conventional, fossil based energy resources such as petrol, coal and natural gas shall be completely consumed within the next 100 years (Saracoğlu 1997, Turker and Kaygusuz 2001, Kum 2009). Another assumption is that the fossil energy resources will not be able to meet the requirements of humanity in the near future. Therefore, beginning with scientific circles, all societies have started considering finding alternative energy resources (Karadag *et al*. 2009, Solomon 2010). However, it should be noted that in today's world, mostly conventional energy resources, in other words, petroleum products, coal, wood, hydroelectric and nuclear resources are widely used. If energy is to be obtained from these conventional resources, this electricity can be used for both industrial applications and domestic purposes a – in a controlled manner, b - at the requested amount and – at the requested time (Erturk *et al*. 2006, Raymer 2006).

Renewable energy resources are listed as; wind, solar energy, geothermal energy and biomass energy (Kaya *et al*. 2008, Bhattacharya *et al*. 2003, Yildirim and Candan 2011). The energy age, which was under the dominance of petrol and coal continued for two centuries until the petrol crisis in 1973. This crisis caused an insecure atmosphere regarding energy resources to occur. Thus, renewable energy resources started drawing the whole world's attention. Soon, many countries, mainly European countries and USA initiated studies and researches related with this subject. The drop of petrol prices in mid - 1980's caused this trend to slow down however, concepts such as "energy safety" and "diversification of energy", which emerged during the petrol crisis became one of the major elements of energy policies (Ugur 2005, Haskok 2005, Smeets and Faaij 2007). Right at this point, diversification of energy resources became a hot topic all around the world and shaped energy policies. Therefore, pursuits for new and alternative resources focused mostly on renewable energy resources. Initiatives and attempts for finding renewable energy resources first started in the USA and then followed by European Union countries (Dam *et al*. 2007, Karadag *et al*. 2009). Again the increase in petrol prices, the public becoming more and more aware of environmental problems and the general willingness to prevent environment pollution, to stop damaging the nature, to decrease the effects of greenhouse gases and mainly developed countries, but in general, all countries' urge to reduce dependency on foreign resources enhanced the importance and significance of renewable energy resources (Kaygusuz 2002, Bhattacharya *et al*. 2003, Smeets and Faaij 2007, Shen *et al*. 2010, Kulekci 2009). Currently 14% of the worldwide energy requirement is generated from biomasses. It is the fourth most used energy source after petrol, natural gas and coal (Belen 2010).

All plant and animal based substances, which are mainly composed of carbohydrate compounds are all considered as biomass energy resources and the energy generated from these resources is called the biomass energy. (Ugurlu 2006). Resources that are included in the biomass energy are forest wastes, agricultural wastes, energy plants, animal wastes, (organic) waste, algae, energy forests and vegetable and animal oils (Karayilmazlar *et al*. 2011). One of the most important resources of biomass is wood. The highest amount of carbon dioxide emissions are caused by fossil fuels, whereas these emissions are absorbed mainly by plant growth (Zengin *et al*. 2005). Globally, forests have the potential to bond 0,75 gigatons (GT) carbon annually, which is a significant portion of the 8 GT carbon emitted to the atmosphere each year. On the other hand, the disforestation caused by agriculture, human dwelling and energy use adds 1,6 GT to the atmospheric carbon concentration. (Smeets and Faaij 2007, White 2002).

Turkey is rich in forest and forest products and therefore has a high potential for generation of biomass energy (Demirbas 2001, Yildirim and Unsal 2012). Further, it also has a high capacity of manufacturing wastes and thin wooden material wastes such as shrubs, bushes, brushwood which do not have any industrial value and which need to be collected and removed in order to fight forest fires and for technical forestry applications such as pest control, forest tending, renewal and improvement which can be used for generation of biomass energy. From this wooden biomass, fuel can be obtained by methods such as size diminishing-crushing and grinding, drying, filtration[1], pelletizing and briquette formation[2] and transformation (Turker and Turker 1997, Karayilmazlar *et al*. 2011, Ucgul and Aygul 2010).

During incineration of flammable materials and the results of this process point out to two important values. The first value is the calorific value of the fuel and the second one is the damage it caused to the environment (Bozkurt and Goker 1987, Bozkurt and Goker 1996). The calorific values of all fuels used for generation of energy and wood and also lower calorific values of main tree types are shown in Table 1.

Table 1

Heat values and temperature values of tree species

Raw materials	Heat values (Kcal/kg)	Tree species	Heat values (Kcal/kg)
Butane gas	12.000	Pine	5.066
Fuel oil	10.000	Beech	4.802
Anthracite	7.800	Spruce	4.726
Mine coal	7.000	Fir	4.651
Kok coal	6.000	Birch	4.505
Lignite coal	4.200	Oak	4.356
Wood (damp)	3.000	Maple	4.183
Turd	2.300	Poplar	4.129
		Hornbeam	4.062

As indicated in Table 1, wood has lower calorific value than petrol and coal. In general, 4.000-5.100 kcal can be obtained from burning 1 kilogram solid wood obtained from various tree types (Bozkurt and Goker 1996).

[1] Filtration is physical refinement of non-soluble hard substances such as sand, clay and residual matters in the water, chemical purification of organic substances liberated in water with taste, color and odor and to obtain a water that does not contain any residues and that is clear as a result of these treatment processes.

[2] Pellet is a substance with an approximate diameter of 6-10mm that is obtained from pressurizing of wood shavings milled and obtained from wood wastes. Briquette has dimensions around 5-20cm

ONLINE ISSN 2069-7430
ISSN-L 1841-4737
PRO LIGNO
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Vol. 9 N° 4 2013
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Trees absorb CO_2 from the atmosphere when growing through photosynthesis and accumulate carbon within their organic structure and they emit oxygen during this process (Bozkurt and Goker 1987).

Therefore, approximately 49% of the mass of wood is carbon. An average tree grows as a result of photosynthesis and for 1 meter cube volume increase; it absorbs 1.000kg of CO_2 from the atmosphere and emit 7.272kg of O_2 to the atmosphere (Yildiz 2011). Accordingly, wood can be considered as a preferable resource for energy generation.

FOREST PRODUCTS INDUSTRY AND WOOD-BASED ENERGY SECTOR

Forestry is the main sector that uses wood as a raw material. However, due to the policies for benefiting mainly from local resources and reducing dependency on foreign resources becoming preeminent within the last years in the energy policies of countries increased the importance place on generating energy from renewable energy resources. Contrary to other renewable energy resources (solar, wind, biofuel etc.), the forest products industry now has a new competitor regarding energy generation from wood based resources and therefore, the forest products industry started interfering with policies regarding energy generation from wood.

Generation of energy from biomass is not a prevalent procedure in Turkey yet, even though Turkey has a high potential in this regard (Yildirim and Candan 2011). However, the examples in many European countries, especially the discussions regarding bioenergy plants for board products industry are pressuring the forest products industry since this industry is already having difficulties meeting the current demand for raw materials. Further, these discussions and plans are now welcomed by the forest products industry since they will take an important share from the currently available raw material supply (Yildirim and Unsal 2012). The generation of energy from biomass is likely to cause difficulties and challenge the supply of raw materials requested by certain industries and factories such as wood-based panel factories which use wooden raw materials.

Timber factories, which are included in the forest products industry that generate bioenergy from wooden wastes together with solid tree materials do not exist in our country due to lack of efficiency however, modern timber factories that are common in Europe use 500.000 cubic meter out of 1 million cubic meter wood processed annually for the production of their main product; timber and a major part of the remaining wastes is used as raw material for fiberboard and particleboard factories, which are also included in the industry. The barks and other materials not suitable for panel production are either used as pellets or again transformed into energy when burnt at power plants belonging to the same timber factory. The electricity generated compensates the energy requirement of the factory and further can be offered to be used by neighboring dwellings.

The fuel wood production in Turkey in the last three years was around 6.1 million stere, wood wastes that were not used for product was 3.5 million stere and brushwood was 0.4 million stere, equaling to 10 million stere in total (GDF 2011). According to stere conversion table (GDF 2011), the dry weight of 1 stere wood is approximately 0.4 kilograms thus; the total woody biomass generation potential in Turkey is around 4 million kg. The distribution of wood/forests that can be utilized as biomass belonging to Regional Forest Directorates (wastes in the forest and brushwood) are shown in Fig. 1.

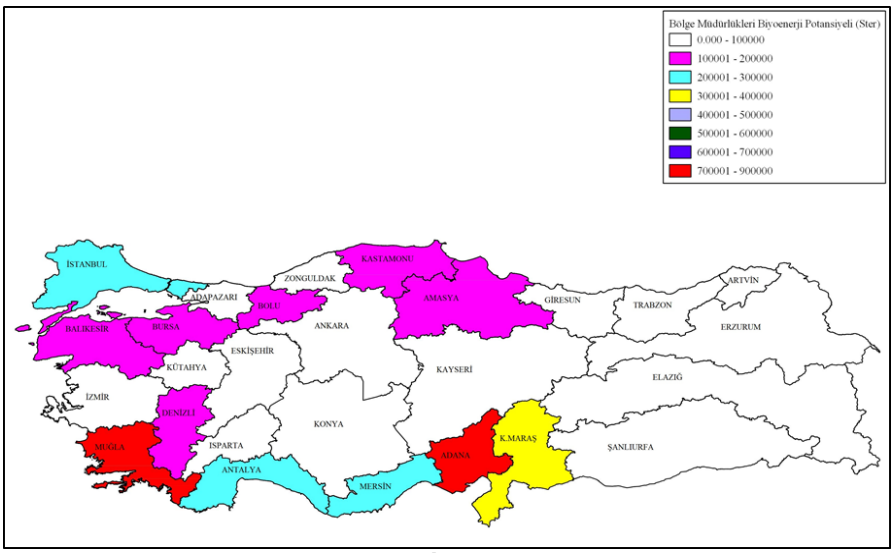

Fig. 1

Wood production areas that have the potential of bioenergy production in Turkey.

As can be seen from Fig. 1, regionally, Mugla and Adana Forest Directorates have the highest potential for woody energy in Turkey. However, there are many areas suitable for the generation of woody energy in the northern and southern parts of the country. These areas, when the density of their population is considered, do require energy plants to be built.

CONCLUSIONS AND SUGGESTIONS

Wind and solar energies have been preferred due to their reduced carbon emission. Turkey started to use renewable energy to get its benefits. Wood generates lower pollution than coal and petrol during burning process. If main priority is to protect environment, technological advancements for energy generation from wood should be monitored and applied. If the priority is to meet the energy demand quickly, the legal foundation should be created and the related licenses should be issued. At this point, reports regarding these plants should be requested from universities and research institutions. The plants that cannot satisfy the necessary conditions should not be allowed to operate or its operations should be suspended.

In conclusion, in both Turkey and the world, renewable energy resources and technologies will have an important share in the energy market of the future. It will also generate interesting and exciting investment opportunities. What should be underlined here is that the technology required for generating energy from wood should be obtained and created by domestic efforts and operations. Otherwise, just like in petrol and natural gas, Turkey will be dependent on foreign countries and technologies for bio-based energy. Northern and southern region of Turkey are proper area to establish bio-energy plants due to raw material advantage. Government should encourage private sector for bio-energy investments.

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