Chapter 6
How to Increase the Efficiency of Biomass Energy Investments

Hasan Dinçer, Duygu Yavuz, and Natalia Sokolinskaya

Keywords Biomass energy · Energy investments · DEMATEL · Energy economics · Sustainable energy

6.1 Introduction

Renewable energy usage has a positive contribution to both social and economic improvements of the countries (Dong et al., 2022; Kafka et al., 2022; Martínez et al., 2022; Mukhtarov et al., 2022; Sun et al., 2022). The main superiority of these projects is that carbon emission problem can be minimized (Carayannis et al., 2022; Dinçer, Aksoy, et al., 2022; Dinçer, Yüksel, & Martínez, 2022; Dinçer, Yüksel, Mikhaylov, et al. 2022; Li, Yüksel, & Dinçer, 2022; Yüksel & Dinçer, 2022; Zhang et al., 2022). This situation has a powerful influence on the decrease of environmental pollution. Additionally, energy independence can be provided with the help of renewable energy projects (Eti et al., 2023; Haiyun et al., 2021; Li, Yüksel, & Dinçer, 2022; Mikhaylov et al., 2022; Yüksel et al., 2022). Hence, the countries current account balance is affected in a very positive manner from this situation. There are different types of renewable energy projects that are solar, wind, geothermal, hydropower and biomass (Eti et al., 2022; Fang et al., 2021; Kayacık et al., 2022; Yuan et al., 2021).

Today, the most widely used materials as biomass fuel are corn grain (ethanol) and soybean (biodiesel). The raw material of biomass consists of biological materials and wastes that absorb solar energy, and the energy obtained from these materials is called biomass energy. When we look at renewable energy sources, biomass energy is an energy source that can be stored continuously and uninterruptedly. In addition,

H. Dinçer (✉) · D. Yavuz
The School of Business, İstanbul Medipol University, Istanbul, Turkey
e-mail: hdincer@medipol.edu.tr; duygu.yavuz@std.medipol.edu.tr

N. Sokolinskaya
Financial University under the Government of the Russian Federation, Moscow, Russia

H. Dincer, S. Yüksel (eds.), *Economic Development and the Environmental Ecosystem*, Contributions to Economics,
https://doi.org/10.1007/978-3-031-26596-9_6

biomass energy is a type of energy that is environmentally friendly and contributes to the region economically with its employment-increasing effect (Yuan et al., 2008). Electricity generation using biomass as an energy source is based on two basic ideas. The first type of change is thermochemical transformation, and the second type is biochemical change. Combustion, pyrolysis, gasification and liquefaction are a few stages that make up the thermochemical conversion process. The metabolic exchange process can be staged at various points as digestion and fermentation. Both of these processes use waste and other biological resources as fuel sources (Angenent et al., 2004). Basic properties of energy obtained from biomass;

- It is the second most common energy consumption source in the world after fossil fuels.
- The option of using renewable energy sources is the best choice in terms of the amount of raw materials that can be used.
- It is advantageous in that it can be used with other types of energy sources and converted into other forms of energy.
- Compared to other types of renewable energy, it is superior in terms of both consistency and storage capacity.
- It can be found in all conditions and at any time.
- It is a type of energy that has been used for a very long time, so the technology for its production and conversion has also been around for a very long time.

Biofuel applications represent the most promising energy source when compared to other energy sources. The number of contexts in which biofuels produced from biomass can be used is constantly increasing. The three biofuel categories are as follows:

- Solid Biofuels (Biochar, Biobriquette)
- Liquid Biofuels (Biogas, Biosynthesis Gas, Biohydrogen)
- Gas Biofuels (Biodiesel, Bioethanol, Bio methanol, Bio-oil)

In terms of raw materials used in the production process, biofuels are divided into one of two categories, depending on whether they are also used for food. The first category is biofuels, which are obtained as a by-product of agricultural production and serve as a source of raw materials for the manufacture of plant products suitable for consumption as food (Banowetz et al., 2008). The vast majority of biofuels produced fall into this category and are therefore referred to as “first generation biofuels”. “Second generation biofuels” are so-called because they are made from lignocellulosic biomass that was not originally intended for use. Banowetz, However, the cost of the equipment used in the conversion process is quite high. Therefore, the production of second generation biofuels is not economically feasible (Cook & Beyea, 2000).

6.2 Energy Production from Biomass

Today, there are both contemporary and traditional approaches to biomass energy. It is the traditional form of energy derived from biomass from forests. Traditional biomass includes animal and plant wastes used as fuel, in addition to wood that is burned as fuel. The use of direct combustion techniques and various means of combustion during the conversion of biomass material to increasingly higher levels of energy is the primary distinguishing feature of the traditional use of biomass for energy production. Modern sources of biomass include poplar, eucalyptus, willow, forest and wood industry waste, plant and animal waste from the agricultural sector, agro-industrial waste, and waste from urban areas (Demirbas & Demirbas, 2007).

The processing of biomass-by-biomass conversion techniques results in the conversion of biomass products into gaseous, solid and liquid fuels. At the end of the cycle, primary products such as biodiesel, biogas, pyrolytic gas-like fuel and bioethanol and by-products such as hydrogen and fertilizer are collected. Biomass energy is obtained through the use of anaerobic decomposers producing methanol, biodiesel, ethanol and the production of biofuels containing their derivatives (Jåstad & Bolkesjø, 2022). This allows the production of starch, sugar and oil containing plants as well as the use of biogas for cellulose, combustible solid waste, electricity and heat. Both the physical and chemical structures of fossil fuels and the structures of biomass consisting of biomass are different from each other. Biomass conversion methods currently in use are analyzed according to three main categories;

- Physical processes
- Chemical processes
- Biological processes

6.3 Bioenergy Resources

Biomass, a collective term for all organic compounds produced by plants directly through photosynthesis and indirectly through animal wastes formed by the digestion of these organic materials, is well known. Photosynthesis is the process by which plants take carbon dioxide (CO2) from the air and convert it into structural components of the plant, including cellulose, hemicellulose, lignin, and carbohydrates. In the light of these explanations, it is clear that plants are the primary source of bioenergy (Gan, 2007). As an added advantage, it can be used as a source of bioenergy in the form of domestic, industrial and commercial organic and inorganic waste (Scarlat et al., 2011). Due to the prevalence and breadth of the idea of plants and litter, it is difficult to classify bioenergy sources; In the light of these definitions, they are categorized under the following headings;

Forest Origin Resources: Both natural and man-made forests cover about 30% of the planet. Any garbage left in these forests can be used to generate bioenergy. Bioenergy can be produced from anywhere in a forest, including leaves, branches

and even dead trees. A practice known as energy forestry, which uses different types of forest and wood waste, has contributed to an increase in bioenergy production in recent years (Junginger et al., 2008).

Agricultural Resources: Energy from agricultural sources, including agricultural waste, animal waste, and by-products and resources from agricultural production. There has been a worldwide increase in agricultural production for energy needs. It has become quite common in this field, especially in America and some Far East countries. Sunflower, rapeseed, soybean, cotton, corn and beet are just a few of the oily plants that can be produced within the scope of energy-oriented agricultural production activities to produce bioenergy. As the need for bioenergy grows, more and more land is being farmed and farmers are increasingly turning to this type of crop. Bioenergy is produced from agricultural by-products such as animal carcasses and manure. Animal manure, which is used as fertilizer after drying in the sun, is also an important source of bioenergy in our country. It can be converted into biogas, which is used as a source of bioenergy, and the by-products can be used well as fertilizer for crops (Ferreira et al., 2009).

Industrial and Municipal Wastes: The industrialization that has increased in recent years throughout the world and all kinds of industrial waste brought by this industrialization and all kinds of waste generated in urban life have the potential to be considered as a bioenergy source. To put it more clearly, all kinds of organic and inorganic wastes generated in our homes and all kinds of junkyard, park and garden wastes, fruit and vegetable market and market wastes, purification and sorting wastes and pet wastes generated as a result of municipal services can be evaluated in bioenergy production. In addition, wastes produced or released by hospitals and industrial establishments in the city can also be considered as a source of bioenergy. Considering the negative effects of industrial wastes on the environment, the evaluation of these wastes in bioenergy production gains a special importance (Domac et al., 2005).

6.4 Bioenergy Products

The idea of developing bioenergy in the modern sense started in the 1970s in the world. Liquid fertilizer and animal feed obtained from the last wastes released as final products are not meant here. It refers to energy supply, which is the main target of bioenergy production. For this reason, in this chapter of the study, the types of bioenergy products obtained in bioenergy production will be emphasized. These products are biogas, biodiesel and bioethanol.

Biogas: It is obtained as a result of fermentation of plant and animal wastes and urban wastes whose organic part is decomposed in an airless environment. As a result of this process, methane, CO2 and H2 are produced as products. Methane from these resulting products is used as a renewable energy source for heating, by converting it into electrical energy as biogas or directly. Biogas production around the world is mostly provided by anaerobic production methods from one type of

animal manure. With this method, it has become an important source in meeting the energy needs of large animal farms and rural population, especially in rural areas. Such a strategy; It is applied in countries such as Brazil and Argentina where large farms from European countries and especially Denmark, USA, China and South American countries are common. In recent years, the use of urban household waste as biogas, especially in metropolitan cities, has become widespread in many countries.

Biodiesel: Biodiesel can be defined as an alternative diesel fuel obtained by processing resources such as vegetable and animal oils by chemical or thermal methods. Its production is carried out by two methods as thermal and chemical; chemical method is preferred. Chemical method; thinning (dilution), micro-emulsification, pyrolysis and transestrification are examined in sections. Oily agricultural products such as rapeseed, safflower, soybean, coconut, hemp and sunflower can be used as a source, as well as biodiesel production from frozen oils and fish oil. It can also be produced from seaweed and waste cooking oil. The use of biodiesel is encouraged in many countries. The increasing use of vehicles and the fight against environmental pollution caused by this situation constitute the main reason for these incentives. Especially in European Union countries, governments have been forced to create policies with various goals. For this reason, biodiesel production and consumption has increased significantly in recent years in all European countries, especially in Germany, Italy and Austria. Production and consumption have increased in the USA and other American continent countries, especially in Brazil and Argentina, as well as in Asian countries such as China, Indonesia, Malaysia and Japan. In addition, 2% biodiesel use became mandatory with the Kyoto Protocol and 10% after 2010 (Schröder et al., 2008).

Bioethanol: Bioethanol; cereals, molasses, fruits, sugar cane pulp, cellulose and other plant sources are produced biologically by the fermentation of sugars by microorganisms and can then be obtained by distillation. Production is not a new type of energy. The first cars produced by Henry Ford and Nikola Otto and their internal combustion engines were powered by ethanol. The use of bioethanol produced from cereals in the transport sector is theoretically considered to be a carbon neutral process and beneficial for the environment. However, considering the carbon emission in the production processes of its source grains, although it is not a completely neutral process, it is a process with lower carbon emissions than gasoline. Bioethanol constitutes 85% of the biofuel market and its production has increased even more after 2000 years. The United States and Brazil are leaders in this field, producing together approximately 86% of bioethanol worldwide. The majority of the remaining production is made by the European Union countries and China (Fischer & Schrattenholzer, 2001).

6.5 The Effects of Bioenergy Policies on Different Sectors

As a type of renewable energy, bioenergy is an energy source that has a direct relationship with many different fields in its production and has an impact capacity with its consumption. It has a share in the positive or negative effects of energy consumption. Similarly, due to its agricultural, animal and forest origin, it sometimes has a direct and sometimes indirect relationship with these sectors. Therefore, these two sectors have the capacity to affect all sectors and fields that are in contact. In this section, the relationship between bioenergy production and different fields and the positive and negative aspects of this relationship will be discussed. Possible problems that may be encountered in case of widespread production will be tried to be determined theoretically.

The Impact of Bioenergy on Rural Development: Mostly plant, animal and forest products are used as a source of bioenergy around the world. Therefore, the supply of bioenergy has a direct impact on the agricultural sector. The need for raw materials will cause a deficit in agricultural production. This will lead to an increase in production and will allow an increase in employment in this field. Meeting the need for bioenergy resources will lead to increases in production, as well as the use of products produced for food purposes as a resource and the increase in demand in this area will increase price levels and subsequently increase the income of farmers. In addition, planning errors, low-productivity and low-yield products cause fertile land areas to decrease day by day. The idle state of productive agricultural lands constitutes a negative situation in terms of national wealth and rural development (Rose et al., 2014).

Developing policies that will ensure the most efficient use of these areas will be encouraging for farmers to utilize productive agricultural areas. In addition, the use of agricultural wastes as a source of bioenergy will become a new type of income for producers. For this purpose, bioenergy appears to be an important alternative that encourages investments. Since the bioenergy resource is rural and many investments avoid the cost of resource transportation, it establishes facilities in these areas where access to resources is easier and meets the need for labor in these areas (Giampietro, 2008).

The Effect of Bioenergy on Food Security: Global food crises and hunger problem in different parts of the world; demonstrates the importance of the food security problem. In particular, international organizations working in this field and local governments carry out various policies. Ensuring food safety, which is an indispensable element for the continuation of life, struggles to control the factors that negatively affect food supply, access to food and access to food, and struggles to eliminate or minimize the negative effects of these factors on food safety. Bioenergy has the potential to affect food security in two different ways. First of all, with the spread of energy-oriented agriculture, the competition between energy-oriented agriculture and food-oriented agricultural production has emerged (Smeets & Faaij, 2007). The transition of agricultural areas, which are produced for food purposes, to agricultural production for energy purposes, adversely affects the

dimension of food supply. Secondly, bioenergy affects food security in terms of food prices. It has been stated that if the agricultural lands used for food purposes turn to agricultural production for energy purposes, it will cause a contraction in the food supply. This will cause food prices to rise. It has been observed that the use of food for energy purposes adversely affects food supply security and causes a contraction in food supply. It is seen that there is an inverse relationship between bioenergy and food security depending on resource use, and each increase in bioenergy use globally has a suppressive effect on food security.

Impact of Bioenergy on Energy Security: Energy is very important in terms of being effective in all production activities of a country and directly affecting growth and development. Economic stability is among the leading causes of foreign trade deficit and budget deficits. Gathering the global distribution of common energy resources to certain regions has become one of the most important topics for many countries to ensure energy supply security (Gonzalez et al., 2012). The vital importance of energy security, R&D studies on domestic production and alternative energy sources have gained importance. When all energy security definitions and indices are examined, it is seen that domestic production has a positive effect on ensuring energy security. For this reason, bioenergy is an important factor in terms of energy security in terms of being renewable and being produced from domestic sources. The increase in bioenergy supply will increase the rate of domestic production in energy supply. The increase in domestic energy supply will also have a positive effect on food security (Roos et al., 1999).

6.6 Conclusion

Bioenergy investments have crucial advantages. It improves the socio-economic structure of the rural area and provides local job opportunities. It prevents migration. It provides new job opportunities. It provides strategic and economic contribution to countries by reducing foreign dependency in oil. It benefits public health as combustion products are cleaner. It ensures the protection of the environment and our natural energy resources. It supports the sustainability of energy. The development of oilseed agriculture is an alternative to exhaustible and limited energy resources. It reduces the emission of harmful greenhouse gases in the use of biodiesel and reduces CO emissions by 50%. There is a decrease in air pollution. It has an anti-toxic effect and does not contain sulfur.

On the other side, the use of bioenergy stimulates the agricultural sector and supports rural development. Although it is thought to reduce poverty, if it is not done in a sustainable way, it poses a significant threat to food security (Mutran et al., 2020). When Bio-Fuel is produced in an uncontrolled and unbalanced way, more farmland is needed, farmland required for food production is used for the production of fuel raw materials, local agricultural people lose their land, which leads to unemployment, economic problems and the food problems that may result from them, deforestation and erosion, will have negative consequences such as increased

global warming (Bhuiyan et al., 2022; Dinçer et al., 2023; Eti et al., 2022; Kou et al., 2022; Xu et al., 2022).

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