

# AGRICULTURAL BIOMASS POTENTIAL IN TURKEY

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**Abstract**– The vegetal biomass potential of Turkey is investigated in this study. The vegetable derived biomass is considered to be field, garden, and vegetable crops. The contribution of each species on the biomass energy potential is studied. For the related issues, the data published by Ministry of Energy and Natural Resources of Turkey for the production period of 2012–2014 are used. The available vegetable residue in the country is estimated to be equal to 142.4 mtons/year. The total biomass potential of the country is found to be approximately 15.9 toe/year.

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**Index Terms**– Agricultural, biomass potential, energy equivalent, Turkey

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## I. INTRODUCTION

Biomass can be derived from woody products, agricultural and animal residuals, organic municipal solid waste, residuals from food processing, and aquatic plants. These materials are converted into solid, liquid and gas fuels by means of biomass conversion techniques mainly including direct combustion, pyrolysis, gasification, carbonization, anaerobic digestion, fermentation, biophotolysis. Direct combustion is the oldest method known. The combustion is much prominent method for the world's bio-energy production with respect to other biomass thermo-chemical conversion technologies at present [1].

Turkey has an area of over 78.35 million hectares; nearly half of its territory is utilized by the agricultural land [2]. The share of agriculture in the gross domestic production in Turkey is 9.3% [3]. Turkish biomass market seems to be reaching hundred MW<sub>e</sub> installed capacity in recent years. Energy imports of the country are growing as a result of social and economic development.

There are many literature works made on biomass and related issues of Turkey. The main technology options for biomass are summarized in [4]. Analyzing energy exploitation of biomass potential provides beneficial information in terms of type, quantity, and regional distribution. Ozturk and Bascetincelik [5] made a study for agricultural biomass potential in Turkey considering the data period of 2002–2003. In 1999, the biomass share of the total energy consumption of the country was 10% according to the study [6]. Turkey's domestic energy consumption accounts for about 37% of total energy consumption. Of this, about 52% is from biomass-based fuels [7]. Balat [8] depicted that the total biomass energy potential of Turkey was about 32 Mtoe of which 17 Mtoe was approximately the amount of usable biomass potential of Turkey. Kar and Tekeli [9] estimated the annual dry agricultural residue potential to be about 360 Tg (Teragram), which is equivalent to 260 Tg of crudelike fuels. It is claimed that the available agricultural residues can provide 467–623 petajoules/year, which is equal to 22–27% of energy

consumption of Turkey. Gokcol et al. [4] investigated the importance of biomass energy in Turkey, and the potential of biomass and its utilization are presented, as well. A recent study of Bilgen et al. [10] presents a perspective for potential and technology of bioenergy in Turkey. The study reveals that biomass energy continues to be the main source of energy for climate change mitigation and energy sustainability in Turkey. Saka and Yilmaz [11] analyzed the vegetal derived biomass potential of the Marmara region, and they further studied the faunal derived biomass potential of the same region in [12]. Yilmaz and Saka [13] also investigated the faunal and vegetal exploitable biomass potential of the Southeastern Anatolian region. In this paper, the agricultural biomass potential of Turkey is investigated. It is also commented on the potential technologies to be installed or commissioned in the country.

## II. METHODS

This study is based on the data published by Ministry of Energy and Natural Resources of Turkey [14]. The agricultural production values which were provided from Republic of Turkey Ministry of Food, Agriculture and Livestock were based on the data of Directorates of Provincial Food Agriculture and Livestock. The statistics of the data were processed by Turkish Statistical Institute and prepared to be ready-to-use. 153 vegetable species are taken into account to be 56 for field, 56 for garden, and 41 vegetable crops, respectively. The calorific values of each species were calculated in the laboratory. As a result, the analyses made quantified the biomass potential for each geographical region of Turkey. The residual derived from the agricultural production and the energy equivalents were illustrated later on.

## III. RESULTS AND DISCUSSION

Turkey is composed of seven geographical regions which are namely, the Eastern Anatolian region, the Southeastern Anatolian region, the Black Sea region, the Central Anatolian region, the Mediterranean region, the Aegean region, and the Marmara region.

The country produces annually 142,418,566 tons vegetable of which 67% is the field production, nearly 14% is the garden production, and the remaining is the vegetable crops production. The agricultural productions in the provinces of the country are demonstrated in Figure 2. The pie charts shown on them exhibit the productions based on the species. The green, brown and pink colors indicate the productions for the field, garden, vegetable crops, respectively. The change in the size of the pie also shows the largeness of the production realized in the province. Each province has been colored according to the production range given in the map.

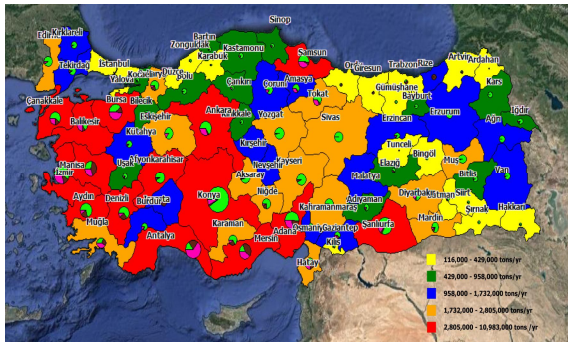


Figure 2. Agricultural biomass map of Turkey

Figure 3 shows the share of each region on the Turkey's annual production. The production rates in the western part of the country are higher relative to the eastern part. The garden vegetables are mostly produced in the Mediterranean, the Aegean, and part of the Marmara regions. The Central Anatolian region contributes largely to the field vegetable productions. Among the field vegetables, wheat, barley, maize, sunflower, cotton and sugar beet are prevalingly grown in Turkey. Grape, apple and citrus fruits are the most produced garden vegetables. Tomato, cucumber, pepper, onion, watermelon, and melon are the most widespread in the vegetable crops production. The red colored regions show the regions having high biomass potential. However, it will be useful to determine the residual quantity and the energy potential.

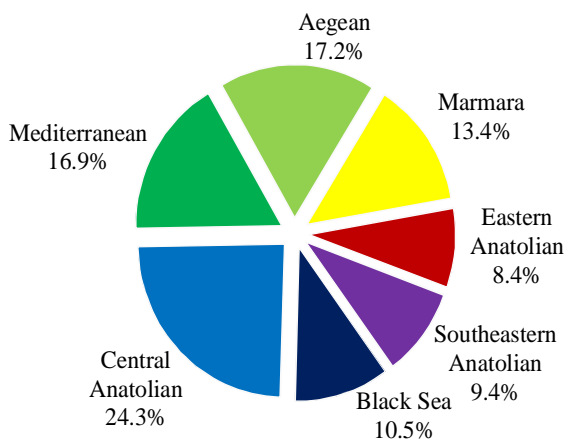


Figure 3. Annual agricultural production in the regions

Figure 4 indicates the annual residual obtained from the agricultural production. The annual residual amount is calculated to be 142.4 million tons. The energy value of this residual is estimated to be 15.9 million toe per year. The colored regions in Figure 5 indicate the energy potential in each province. The legends given in the figure show the interval in toe per year. Konya has the greatest potential and is followed by Şanlıurfa and İzmir. In Turkey, there are 34 licensed companies on operation for biodiesel and 3 companies for bioetanol but there is no direct conversion technology already in use in the country. New plants are under installation in Edirne, Manisa, Kocaeli, Bolu, and Osmaniye with a cumulative capacity of 20.8 MW<sub>e</sub>. Additionally, it is planned to be commissioned in Şanlıurfa, Gaziantep, Kilis, Diyarbakır, Adana, Balıkesir. On the other hand, the most of the installed plants produce biomass from the municipal wastewater, garbage or manure.

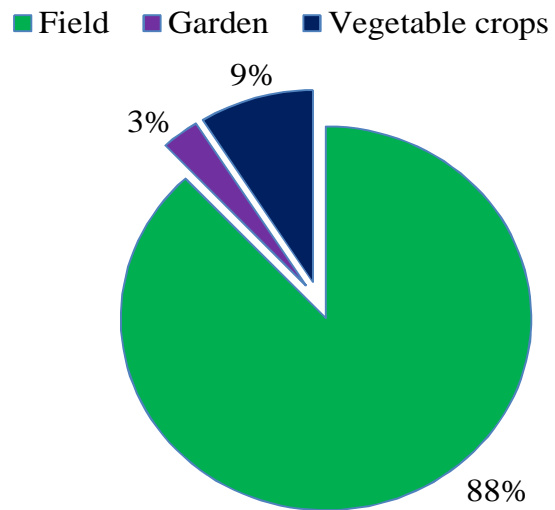


Figure 4. Annual agricultural residual share

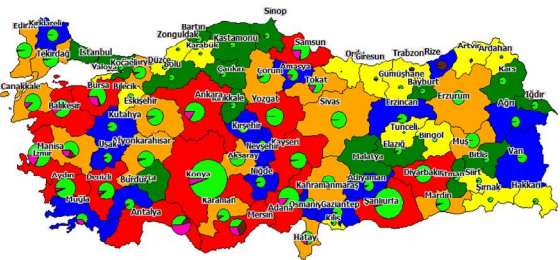


Figure 5. Energy share in provinces (toe/yr)

## CONCLUSION

In this study, it is focused on the agricultural biomass potential of Turkey. It is shown to be equivalent energy value of 15.9 toe/year. The regional vegetable production is illustrated with a pie chart. It is seen that the potential in the Central Anatolian and Aegean regions are evaluated to be highest. It is shown to be

the field residual amount is much higher than those of the garden and the vegetable crops. Finally, the biomass energy share for each province has been clearly demonstrated in a map.

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