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Biomass and bioenergy: An overview of the development potential in Turkey and Malaysia

Munir Ozturk[a,*], Naheed Saba[b], Volkan Altay[c], Rizwan Iqbal[d,e], Khalid Rehman Hakeem[f], Mohammad Jawaid[b,*], Faridah Hanum Ibrahim[g]

[a] Centre for Environmental Studies, Ege University, Bornova, Izmir, Turkey
[b] Lab. of Biocomposite Tech., Inst. of Trop. Forestry & Forest Products, Univ. Putra Malaysia, Malaysia
[c] Biology Department, Faculty of Science & Arts, Mustafa Kemal University, Hatay, Turkey
[d] Faculty of Computer Science and Information Technology, Universiti Putra Malaysia, Selangor, Malaysia
[e] Department of Computer Science, Iqra University, Karachi, Pakistan
[f] Dept. of Biological Sciences, Fac. of Science, King Abdulaziz University, Jeddah, Saudi Arabia
[g] Faculty of Forestry, Universiti Putra Malaysia, Serdang-Selangor, Malaysia

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ABSTRACT

Among renewable energy sources, the share of biomass in total energy consumption in Turkey is increasing. Fuelwood and animal waste biomass are extensively used for heating and cooking in urban and rural areas. It has been estimated that Turkey has recoverable energy potential mainly originating from agricultural, livestock breeding, wood and forest processing, and municipality wastes. Annual production of wastes in the country amounts to 30 million tons. Turkey also produces 1.5 million tons of biodiesel, 3 million tons of bioethanol and 2.5–4.0 billion m^3 of biogas per year. In Turkey, total biomass production is expected to reach a level of 52.5 Mtoe by 2030. Malaysia produces annually approximately 168 million tons of biomass, including timber, oil palm waste, rice husks, coconut trunk fibers, municipal and sugarcane wastes. Every year, nearly 58 million tons of palm oil mill effluent are produced in Malaysia. It has been estimated that the country has the potential to generate around 15 billion m^3 of biogas annually. Estimates also show that Malaysia can produce more than 2400 MW of biomass and 410 MW of biogas, however, only 773 MW of the total potential was harnessed until 2011. The National Biomass Strategy 2020 proposes a scenario according to which an additional 20 million tonnes of oil palm biomass could be utilized by the year 2020 for higher value uses, which could significantly contribute to improving Malaysia's economy. Both countries have good potential to use biomass resources, but political backing and sustainable planning are necessary. In this review article, we try to compare future energy scenarios, renewable energy and biomass potentials of Turkey and Malaysia, while providing an insight into data on different biomass availability and its probable contribution to both nations' economies.

1. Introduction

Energy is the primary requirement in almost all aspects of living and in all countries, it is responsible for the existence of ecosystems, human civilizations and life itself. Since time immemorial, societies and regions of the world have adapted to various environmental conditions, and determined their own energy resources and energy utilization. As the standards of life accomplished in nations are often a function of energy-related factors, the sustainability of energy production is turning out to be a global necessity because energy resources, in any form, are obtained from the environment, and wastes from energy processes are typically returned back to it. The key components of sustainable development and energy requirement go hand in hand. Energy sustainability is recognized as the decisive factor in attaining an overall sustainable development of a country [1–4].

Renewable energy sources are sufficiently abundant to potentially provide for all of the world's energy needs foreseen over the next century [5–7]. Forestry, agricultural and other organic wastes (e.g. municipal solid waste) will be sufficient to provide between 50 and 150 EJ/year. Apart from this, the remaining amount could be attained from energy crops, excessive forest growth, and enhanced agricultural productivity [8], as shown in Fig. 1.

Globally, there is an urgent demand for bioenergy, excluding traditional biomass in the new policies scenario between 2010 and

* Corresponding authors.
E-mail addresses: munirozturk@gmail.com (M. Ozturk), jawaid_md@yahoo.co.in (M. Jawaid).

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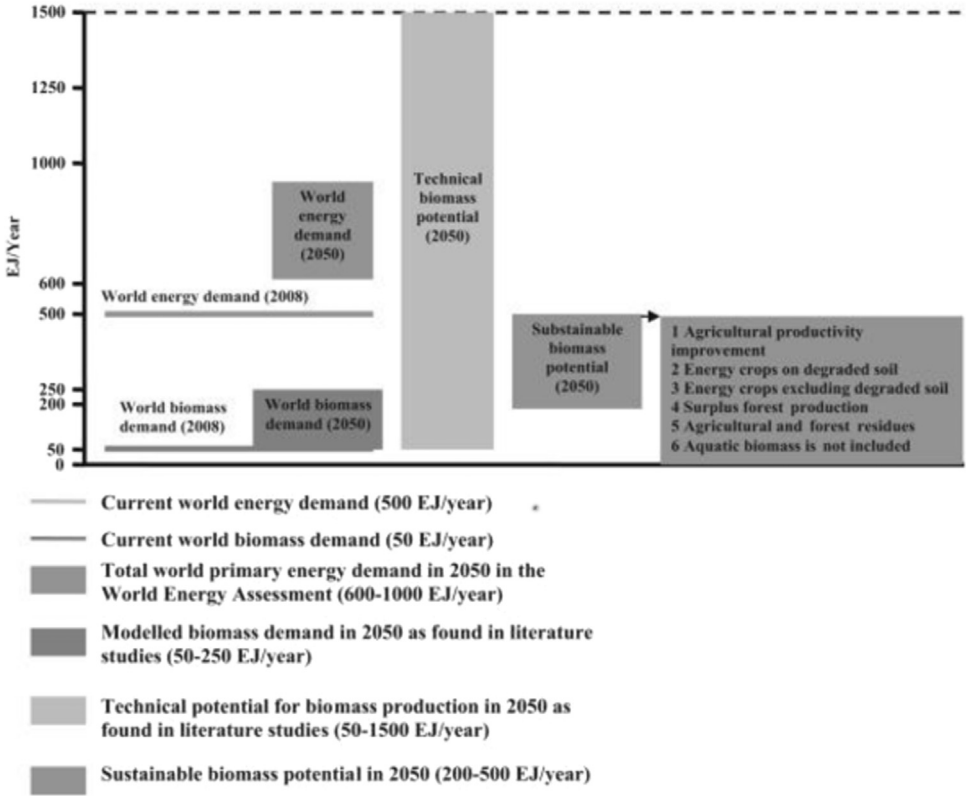

Fig. 1. Global bioenergy sources [8] **(With permission).**

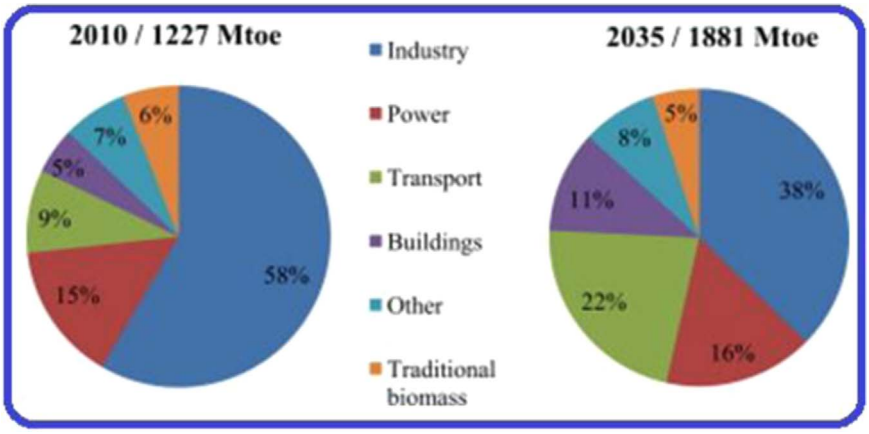

Fig. 2. World bioenergy use by sector and use of traditional biomass in the new policies scenario (2010 and 2035) [9] **(With permission).**

2035. This will grow at an average rate of 3.3% per year. It will increase from 526 Mtoe (million tons of oil equivalent) in 2010 to nearly 1200 Mtoe to 2035. The industrial sector is reported to be the primary consumer of bioenergy in 2010 with 196 Mtoe, and it is anticipated that, by 2035, its bioenergy consumption will exceed 300 Mtoe [9]. However, the power sector will account for a larger share of bioenergy consumption in 2035 (Fig. 2) [9].

Sustainable renewable energy sources, such as biomass, solar (both thermal and photovoltaic), hydro, wind, geothermal, and marine energy sources, are expected to play an essential role in the world's future energy supply [10]. Biomass, as an energy source, has an advantage over other sources of renewable energy, as it can be stored and is readily available all year round from various sources. It has been estimated that, in 2008, overall 10% of the global primary energy supply was contributed by biomass alone [11,12], and further developments will lead to two to six-fold increases by 2050 [13,14]. World biomass energy estimations for 2020 are displayed in Fig. 3 [14].

Biomass is considered to be a distinctive and promising type of "green" energy source. It is found abundantly in nature and it can be conveniently generated in most non-urban settings [15,16]. Broadly classified into two types, i.e., natural and derived materials, most common types of biomass sources include, but are not limited to, agricultural crop wastes and their processing residues, wood itself and the wastes resulting from logging, animal dung, residues from food processing, aquatic plants and algae, as well as municipial solid waste. Further, biomass resources have been subdivided into three categories [17–19]:

Wastes: agricultural production wastes, crop residues, agricultural processing wastes, urban organic wastes, urban wood wastes, and mill wood wastes.
Forest products: wood, trees, shrubs and wood residues, logging residues, sawdust, bark, etc., from forest clearing.
Energy crops: starch crops (corn, wheat and barley), sugar crops