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Review

Production and utilization of fuel pellets from biomass: A review

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ABSTRACT

Bioenergy is the largest contributor of global renewables, simultaneously providing energy security to billions and stimulates rural development. The growing industrial demand of wood pellets for bioenergy coupled with sustainability issue have encouraged many to produce fuel pellets from non-woody biomass. The production and utilization of fuel pellets from varied feedstocks have therefore opened up opportunities and challenges for the existing technologies. The paper presents a state-of-the-art review on production and utilization of fuel pellets from biomass. This includes different aspects of pellet making process including pre-possessing of biomass for pelletization, influence of process parameters on pellet quality and various ways to utilize pellets. Finally the review ends with a discussion on the economic feasibility of fuel pellets for energy utilization.

1. Introduction

In the year 2017, the world primary energy consumption increased to 13.5 billion tons of oil equivalent which is about 565 EJ (exajoules), along with a decadal average growth rate of 1.7% per year [1]. Therefore, renewable energy is becoming inevitable in the view of ever-increasing energy need, depleting fossil fuel reserves, and environmental concerns. It is expected that the renewable energy market will gain momentum in near future, after the Paris agreement-2015, a commitment to fight climate change. This is a first worldwide climate agreement, a binding treaty that aims to limit climate change to a temperate increase of under 2 °C compared to pre-industrial level [2]. The sustainable development goals of the United Nations also underline the importance of energy. 'Affordable and clean energy' in Goal 7 and 'Climate action' in Goal 13, highlight the significance of new and renewable energy to transform the world [3]. So, the energy sustainability goes hand-in-hand with the sustainable development that meets the needs of the present without compromising the ability of future generations to meet their own needs [4]. It is expected that renewable energy will play a significant role in the world's future energy mix. Furthermore, renewables are non-depleting, clean and thus sustainable.

Till date, the renewable energy is contributing of about 19.3% to global final energy consumption as per REN21's 2017 report (Fig. 1) [5]. Solar, wind, hydro, biomass, geothermal are the important sources of renewable energy. Among renewables, biomass energy shares the largest, which accounts for 9% (~51 EJ) of total primary energy supply in the world, out of which 55.4% relates to traditional use (cooking and heating) of biomass and waste resources in developing countries [6]. Slade et al. [7] estimated with reasonable assumptions that biomass has the potential to contribute up to ~100 EJ (~70 EJ from energy crops and ~30 EJ from wastes) in global energy supply. Moreover, biomass is referred to as a carbon neutral fuel because there is no net addition of carbon dioxide in the atmosphere unlike fossil fuels [8]. The use of agricultural residues and organic wastes as fuel substitutes will reduce emissions due to open burning and landfill disposal, respectively and thus, become a source of income for all stakeholders. In this context, biomass has significant potential to be used as a renewable and sustainable source for bioenergy production.

Biomass can be transformed into solid, liquid and gaseous form using modern technologies, and thus becomes an efficient and clean energy supplier for all sectors such as heat, power and transport fuel [9]. There are two routes for biomass conversion, namely the biochemical route and the thermochemical route. The biochemical conversion process uses enzymes, bacteria or other microorganism to convert lignocellulosic biomass into liquid biofuels. In the thermochemical conversion process, biomass converts to any form of energy in presence of heat and with control supply of oxygen. In comparison to biochemical route, thermochemical route has certain advantages, such as utilization of entire biomass, faster kinetics, and flexibility in the feedstock [10]. We focus only on thermochemical route for biomass conversion in the present review (Fig. 2). There are three main thermochemical pathways, such as direct combustion, gasification, and pyrolysis. Direct combustion of firewood is the main energy source among rural areas of developing countries in Asia and Africa for

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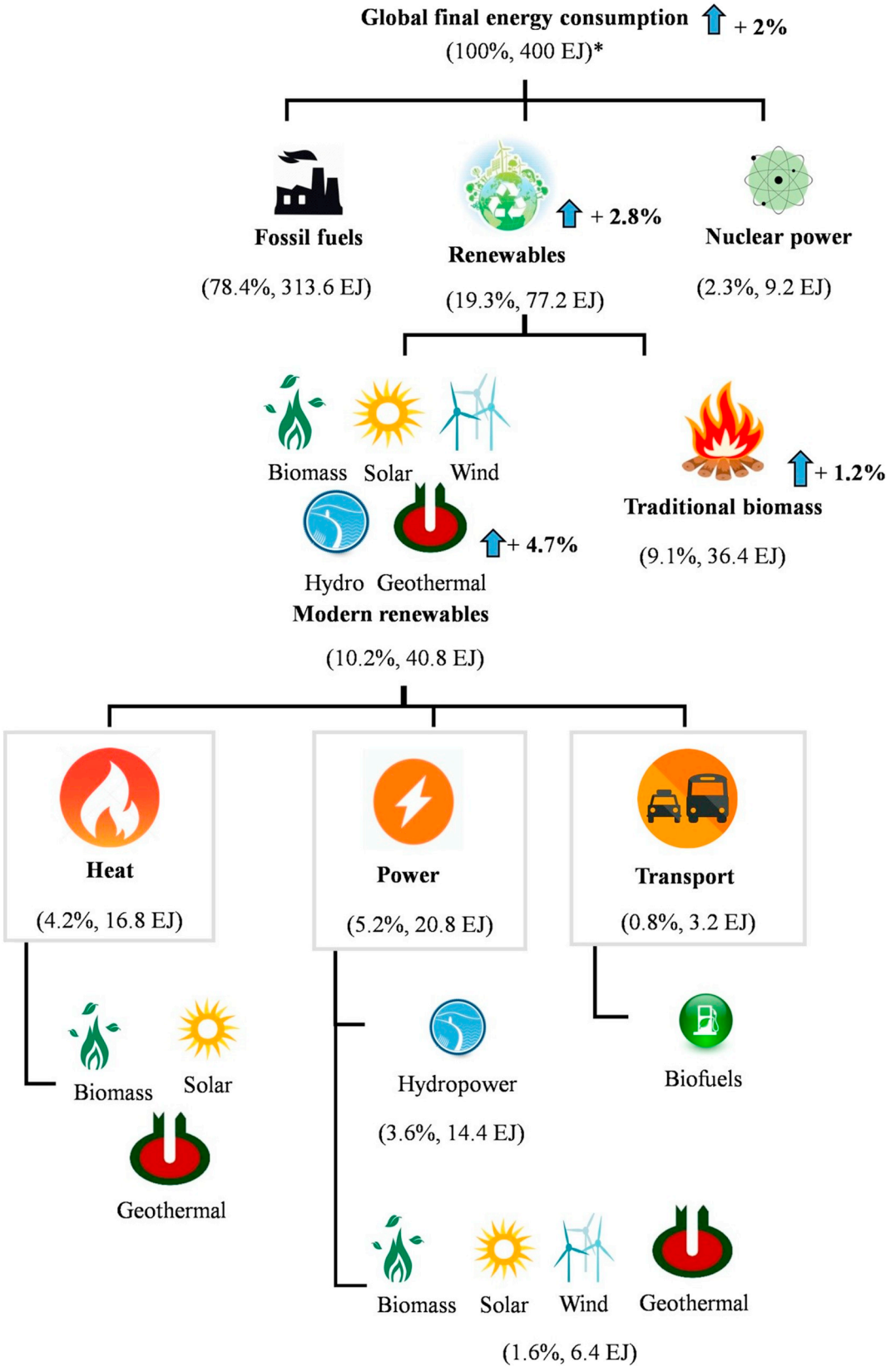

Fig. 1. Global final energy consumption and share of renewables. (Numbers in parentheses indicate the value in percentage as well as in exajoules, arrow marks indicate the average decadal growth rate.
Values are adapted from REN21's 2017 report [5].)