Renewable and Sustainable Energy Reviews 51 (2015) 682–698

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Assessing the lignocellulosic biomass resources potential in developing countries: A critical review

Kifayat Ullah [c,*], Vinod Kumar Sharma [b], Sunil Dhingra [a], Giacobbe Braccio [b], Mushtaq Ahmad [d], Sofia Sofia [d]

[a] Biomass Energy Technology Applications. The Energy and Resources Institute, India Habitat Centre, Lodhi Road, 11003 New Delhi, India
[b] Technical Unit for Technologies Development Trisaia (UTTRI), ENEA Research Centre Trisaia, 75026 Rotondella (MT), Italy
[c] Department of Biosciences, COMSATS Institute of Information Technology, Park Road, Chak Shahzad, Islamabad, Pakistan
[d] Biofuel & Biodiversity Lab, Department of Plant Sciences, Faculty of Bilogical Sciences, Quaid-i-Azam University, Islamabad, Pakistan

ARTICLE INFO

Article history:
Received 4 December 2014
Received in revised form
10 May 2015
Accepted 28 June 2015

Keywords:
Raw materials
Conversion technologies
Biofuel
Policies
Socio-economic aspects

ABSTRACT

This review paper analyses the potential environmental impacts and economic viability of producing biofuel from lignocellulosic biomass resources in various countries of the world. In many developed and developing countries, lignocellulosic biomass is a significant feedstock for bioenergy used in industrial sector for power generation but the fact remains that the detail study on current status of lignocellulosic utilization for bioenergy industry is still estimated and partial. In this context, the present study focuses its efforts to have country based database able to provide a detail and comprehensive information on country specific agricultural policies, residue production and their utilization in different energy sectors. Much more information will have to be gathered on the use and availability of residues, and also, taking into consideration the strong need for R&D on lignocellulosic resources based biofuel production, a comprehensive survey of innovative technologies based on both thermochemical and biochemical processes, able to convert lignocellulosic biomass resources into green biofuel, is discussed.

Contents

Abbreviations: SVO, Straight Vegetable Oils; CO_2, Carbon dioxide; CO, Carbon monoxide; GHGs, Green House Gasses, g/km, gram per kilometer; NOx, Nitrogen oxides; VOCs, Volatile organic compounds; EU, European Union; RPR, Residue to Product Ratio; FAOSTAT, Food and Agriculture Organization Corporate Statistical Database; OMCs, Oil Marketing Companies; INR, Indian National Rupees; FFVs, Flex fuel vehicles; E10, Ethanol 10%; USD, United State Dollar; R&D, Research and Development; FT, Fischer Tropsch; DME, dimethyl ether; H_2, Hydrogen; WTW, Well to Wheels; GJ/t, Giga joule per tonne; Mott, Mott Corporation; TRI, Thermochemical Recovery International; MW, megawatt; EFT, Emerging Fuels Technology; SNG, Synthetic natural gas; TUD, Technical University of Denmark

* Corresponding author. Tel.: +92 3339328026.
E-mail address: kifayat.dawar@comsats.edu.pk (K. Ullah).

http://dx.doi.org/10.1016/j.rser.2015.06.044
1364-0321/

1. Introduction

Undoubtedly, the primary energy consumption in world has increased to manifolds (~38%) since 1990s. Such high demand and finite reserves not only cause shortage of primary energy but also lead to the problem of increasing GHGs emissions in the world. In 2009, 43% of CO_2 emissions from fuel combustion were produced from coal, 37% from oil and 20% from gas. Two sectors, electricity and heat generation and transport, produced nearly two-thirds of global CO_2 emissions. The major sectors are in which accounts for global CO_2 emission are shown in Fig. 1.

Electricity and heat sector relies heavily on coal, the most carbon-intensive of fossil fuels. Most of the developing countries like Australia, China and South Africa produce between 68% and 94% of their electricity and heat through the combustion of coal. The energy sector particularly the transport sector is the major consumer of oil. Around 70% of world oil is refined into transport fuels, while the rest goes into fuel oil for power generation and heating, feedstock for petrochemicals, lubricants, waxes, etc. [1]. The transport sector accounts for around 20% of global energy use and 23% of energy related CO_2 emissions. The total CO_2 emission from fuel combustion is 28.9 billion tonnes, out of which transport sector accounts for 6.5 billion tonnes (23%) and that of road transport generates 4.8 billion tonnes of CO_2 which is almost 17% of the total CO_2 emission in the world [2]. In current scenario, developing countries have contributed to great extent in consuming the primary energy and therefore, CO_2 emission is growing at a faster rate (+3.3%) in developing countries whereas there is a sharp fall (−6.5%) in the emissions in the developed countries [3].

The current energy problem can be addressed if alternate and renewable energy fuels will be used for primary energy needs. Understanding the same, several countries have initiated their steps forward in this direction. Being the transport sector is one of the major consumers of primary energy and responsible for large amount of GHG emissions, both developed and developing countries have worked out their biofuels policies for large scale production of biofuels to address this challenge.

It is stated correctly that biomass as an energy source has many advantages because the use of biomass is essentially carbon neutral and because it provides a convenient way of storing energy in contrast to other renewable energies. However, a large part of the world's agricultural land would have to be devoted to energy crops if they were to supply a substantial amount of our energy needs. Recently, a hybrid hydrogen–carbon process for the production of liquid hydrocarbon fuels was proposed wherein biomass is the carbon source and hydrogen is supplied from carbon-free energy such as solar, nuclear, wind, etc.

The advantage of this process would be that the land area needed to grow the biomass is <40% of that needed by other routes that solely use biomass to support the entire transportation sector [4,5]. Taken together, it is stated [6] that "Biomass can provide a significant but nevertheless limited amount of energy that is inadequate to sustain our modern society's needs". In contrast, it was claimed that the key factor for bioenergy from specialized bioenergy crops would be the type of agricultural management system applied to produce food.

An important aspect of global energy scenarios is the assumption, that the amount of biomass that are utilized currently is so limited that a scenario based on biomass as the major source of

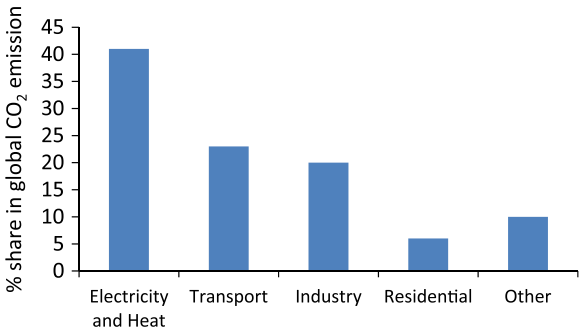

Fig. 1. World CO_2 emission by sector in 2009 Source [1].