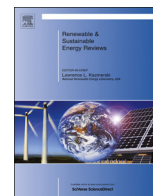




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## Quantifying environmental performance of biomass energy



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### ABSTRACT

The world needs an enormous amount of energy to maintain the future economic developments. India has facile ways to overcome the immediate demand on energy supply by renewable energy resources. It has a huge potential of biomass resources to reduce the dependence on fossil fuels and to produce electrical and heat energy. The biomass energy can contribute to social and economic development. It has been identified as an alternative for the future energy demand in India. As part of furthering the development of biomass technology, it is essential to understand the environmental merits and demerits of biomass. It also aims to increase the use of biomass energy for domestic purposes. The interest behind the review is boosted by the rapid development of biomass conversion techniques and continual increase of biomass energy generation. It has motivated the authors to collect the quintessential literature of environmental aspects of biomass energy. The objective of the research work is to quantify and focus on the environmental performance of biomass energy. It also deals with the environment monitoring and control, pricing, standard and regulations of the bio-energy for the future development.

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## 1. Introduction

The electrical form of energy has become virtually important for human activities [1]. Energy is a critical input for socio-economic development. The renewable energy resources are indigenous, non-polluting and virtually inexhaustible [2]. Over the last 50 years, the concentration of carbon dioxide in the atmosphere has increased by 30% and other Green House Gas (GHG) has also been increased alarmingly. As a result, the average surface temperature of the earth has increased by about 0.6 °C over last 100 years due to burning of fossil fuels. Over the next 20 years, global warming is expected to increase by 0.2° C per decade. The deforestation and land use pattern contribute to 15% of carbon emission every year. The adverse effect leads to increase the climate change fourfold between the year 1980 and 2010. In 2003, around 0.7 lakh deaths have occurred in Europe due to the diseases caused by rising temperatures [3]. As per world health organization's study in the European region, the premature death caused by air pollution was about 6 lakhs in the year 2010. The indoor air pollution also resulted an additional premature death of about 1.17 lakh which is five times more than that in the developed countries [4].

Bell and Davis reassessed the smog from combustion of coal in London. In 1952, more than 12,000 deaths have been reported due to the rigorous smog incident [5]. Main et al. evaluated the impact of particulate emissions and ambient Suspended Particulate Matters (SPM) levels from a coal fired steam power plant in the upwind and downwind directions. The result indicated that in the upwind direction the ground level SPM concentration was about 4% of the total downwind SPM concentrations [6]. The energy demand and economic growth are highly related to carbon emissions in developing countries. According to the Kyoto Protocol the fossil fuels account for more than two-thirds of the GHG emissions. The developed countries were responsible for over 50% of carbon dioxide (CO<sub>2</sub>) emissions [7].

Fossil fuels in the US provide for more than 85% of the all the energy consumed and are responsible for 99% of the CO<sub>2</sub> emissions [8]. India's per capita emissions will be well below that of a developed country's average for the next decade or two [9]. Arora et al. projected CO<sub>2</sub> emissions by highway vehicles in India. By 2040, the number of highway vehicles in India would have been 206–309 million. The corresponding annual CO<sub>2</sub> emissions are projected to be 1.2–2.2 billion metric tons [10]. Brimblecombe studied the air pollution and their effects and identified the poor air quality which is responsible for the adverse health effects even in ancient Greece and during the period of the Roman Empire [11]. Balaras et al. analyzed the environmental impact of European apartment buildings. The value of air borne emissions such as CO<sub>2</sub>, CO, NO<sub>x</sub>, SO<sub>2</sub> and CH<sub>4</sub> from buildings are 663.3 t, 0.6 t, 1.1 t, 3.8 t and 0.02 t respectively [12]. Fossil fuels, when burnt, produce a large amount of GHG i.e. CO<sub>2</sub> in the atmosphere. These GHGs trap sunlight and cause planet to warm. The burning of coal and oil increases the temperature and causes global warming [13]. Global warming and acidification potentials are estimated in terms of CO<sub>2</sub> and SO<sub>2</sub> equivalents [14].

Uwe Remme et al. analyzed and examined the potential technology pathways to reduce CO<sub>2</sub> emission in India. The aim is to reduce 50% of the global energy based CO<sub>2</sub> emissions by 2050 compared to 2005 levels. In 2007, the CO<sub>2</sub> emissions in India,

China and the United States of America (U.S.A) were 1.34 Gt, 6.25 Gt and 5.92 Gt respectively. India's CO<sub>2</sub> emission was much lower than that of China and the U.S.A [15]. With the fossil fuels gradually depleting and expiry, we are compelled to think in terms of searching for and developing alternative sources of energy. Biomass is one of the most abundant resources in the world [1]. To overcome the depletion of fossil fuel, the world is considering new effective biomass crops technologies for energy purposes. Behind the coal and oil biomass is the third largest energy resource in the world [16]. It can make a contribution in all sectors. One billion tons of residues of biomass were also used for biofuels production. It is providing nearly 10% of total CO<sub>2</sub> emission reduction [17]. Bioenergy is the energy which is contained inside plants and animals. It reduces dependency on fossil fuels. Biomass energy, for the most part, creates no harmful CO<sub>2</sub> emissions and receives tax credit from the US government and it is good for the environment [18]. Dai et al. mentioned that biomass energy reduces GHG emissions significantly [19]. Studies suggest that bio-fuels reduce GHG up to 65% [13].

Vandamme et al. explained implications of the use of biomass as a source for energy [20]. Van Swaaij et al. presented about biomass energy in the World Conference held in Rome. The remarkable activities such as research and development need for better implementation and use of biomass [21]. Biomass technologies are needed to substantially reduce emissions in Indian power [11]. It can play an important role in energy if the available resources are utilized in a sustainable way [7]. Research and development programs need to be comprehensively studied because a large number of environmental factors are involved in the biomass energy production in developing countries [22]. The objectives of the study are to know the following aspects such as: biomass scenario, use of biomass energy, development of biomass conversion techniques, the positive and negative aspects of biomass energy, the control of biomass emission, methods and approaches for environmental monitoring, policy, standard, regulations and economic of bio-energy development. This could provide positive effects on the swift development of biomass power projects and it also useful for the researchers and the experts in the area of bio-energy.

## 2. Biomass scenario

The global and Indian biomass energy status has been studied to identify the prospects of bio-energy as depicted below: According to Retka Schill of International Energy Agency, the top countries such as Brazil, the U.S.A and India are utilizing all sources of biomass for energy. The U.S.A and India each had a 16% share of global industrial biomass use for energy [23]. The size of biomass power plant is below 50 MW, where as the size of coal-fired plant is in the range of 100–1000 MW [24]. Vakkilainen et al. analyzed the global primary energy supply for the year 2009. The global biomass based energy supply accounted for 10.22% (52 EJ) of the global total primary energy supply (509 EJ) in 2009. The global primary energy supply in 2009 from oil, natural gas, nuclear, hydropower, biomass, coal and others was 171 EJ, 106 EJ, 29 EJ, 12 EJ, 52 EJ, 138 EJ and 1 EJ respectively [25]. Reddy et al. edited with prospects and challenges of energy in New York. A majority of the people used biomass fuels (wood, animal dung and crop

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