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A review on paddy residue based power generation: Energy, environment and economic perspective

S.M. Shafie *

School of Technology Management and Logistics, College of Business, University Utara Malaysia, Sintok, 06010 Kedah, Malaysia

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ABSTRACT

Today's world is mostly dependent on fossil fuel for power generation. The dependency in fossil fuel is leading the world into a complex crisis comprising the insecurity of supplies, environment impact and also the fluctuation of fuel price. With a view to tackle this crisis, scientists are shifting their interest on new energy sources like biomass resources, solar, tidal and geothermal energies. Among these, biomass resources have been around for domestic use for a long time, but have not yet been utilised for industrial-scale power generation. Whereas other renewable sources have a long way to go in the path to technological advancement to be utilised in a mass scale and compete with fossil fuel as a cost-effective alternative. The most potential biomass resource is lignocellulosic biomass, which includes paddy residue. Paddy residues are widely abundant agricultural wastes which have a high potential for utilisation in energy industries. The major challenges for the proper utilisation of paddy residues in power generation are management, lack of economic study, and lack of collection network. Lastly, the economic, environment and energy policies play an important role for developing paddy residues as a fuel for energy industries.

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* Tel.: +60 17 4994562.
E-mail address: shafini@uum.edu.my

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1. Introduction

Biomass supplies have a great capability in sustainable energy promotion. According to Appleyard [1], in 2011, biomass reported for 8.4% of the overall energy used in Europe, while in some Baltic countries, the consumption is over 25%. The most potential biomass resource is lignocellulosic biomass, which includes agricultural and forest residues, municipal solid waste, manure, grasses, bio-energy crops, aquatic plants, paper and cotton wastes [2,3]. All these types of feedstock are bio-fuel feedstock. The production process of these plant feedstocks is already learned and in close future perhaps will be applied as a renewable energy supply [4]. The utilisation of this feedstock can be sustainably produced using modern technology coupled with energy policy [5]. Recently, world leaders have seriously taken an action to combat climate change with less dependence on fossil fuels in daily activities. The research in biomass residue in Canada stated that market supports and policy endorsement have a huge impact on the variety of bio-energy feedstock and GHG emissions [6]. Miller [7] suggested that the strategies towards clean energy use are market regeneration to stimulate the value of cost-effective energy efficiency and renewable energy, and technology commercialisation to bring down the charge of new wave clean energy technologies with near term promise. Besides that, the major obstacles of biomass adoption are achieved by the right to create a proficient logistic scheme, the bulk density, seasonality of production and the variation of quality [8].

Many researchers found paddy residue is one of the most potential lignocellulosic biomass resources for a variety of energy types such as electricity [9,10], heat/thermal [11], and ethanol [12]. The large amount of available paddy residues has resulted in an extensive search for its utilisation [13].

The aim of these paper is to extensively review the potential of paddy residue in electricity generation on energy, economic and environmental perspectives. In this paper, a detailed logistic management of paddy residue for its use in a power plant as a co-fuel is analysed from cost-effectiveness and environmental impact perspective. Firstly, the potential of paddy residue available in this world is examined. The current rice husk and rice straw managements are discussed in detail. Besides that, energy, economy and environment have become the key issues in implementing the bio-energy process using paddy residue as the main fuel. The available technology and current policy application are thoroughly reviewed. The current policy in paddy residue-based power generation is also discussed in this paper. Lastly, the conclusion is made regarding the economic, environmental and policy aspects towards paddy residue consumption in energy industries.

1.1. Potential and management of paddy residue

Paddy is produced in vast areas of the world as rice is the primary staple food for more than half of the world community, where Asia is the highest producing and consuming region [14]. Paddy residue consists of paddy straw and rice husk. In decreasing the universal reliance on fossil fuels, paddy residues, which are the most generous agricultural wastes from the paddy industry, have a crucial part to act [15]. Fig. 1 shows the world's paddy residue production from 2000 to 2013 [16]. However, most regions in the world have a potential for increasing the production of agricultural residues through the development towards a high input agricultural management [17]. Annually, the paddy residue production is about 1,370,000 million tonnes. About 90% of the paddy production are from Asian countries, and Southeast Asia provides 29% of the paddy production. South Asia definitely has a relevant possibility of absorbing huge agro-wastes to generate electricity for rural supply and rural development [9]. Over 100,000 rice mills are in operation in Southeast Asia, generating over 19 million tonnes of rice husks every year. These huge amounts could have produced around 16,720 MW of power if utilised. Fig. 2 shows the contribution for each region in the world towards paddy residue production for: (a) world production, and (b) Asian production.

The majority of world paddy residue production is not being utilised for power generation. In India, the farmers are in a hurry to sow the next crop and therefore, they dispose the straw

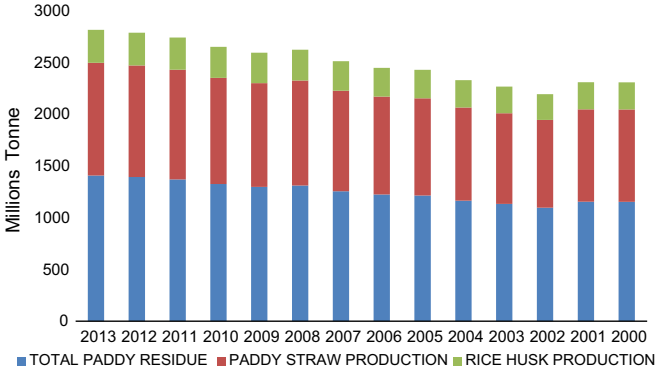

Fig. 1. World paddy residue production from 2000 to 2013.

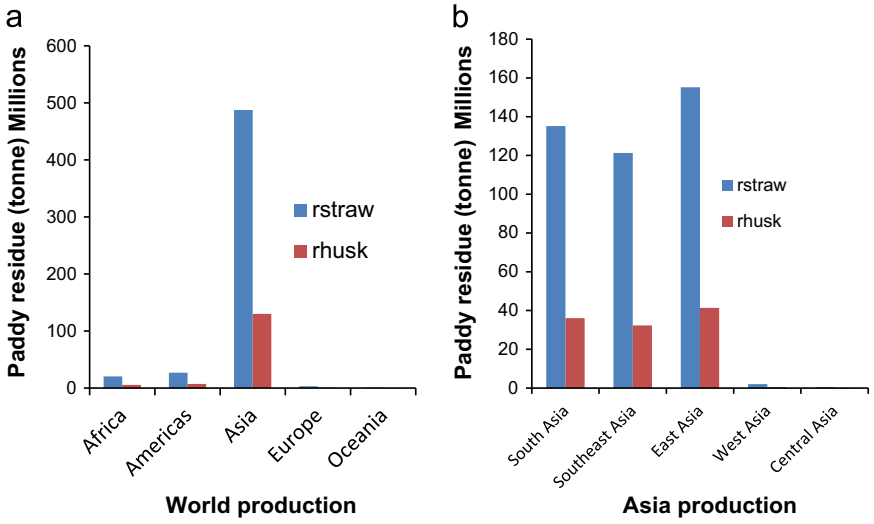

Fig. 2. Contribution for each region in the world toward the paddy residue production.

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