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Prospective for power generation of solid fuel from hydrothermal treatment of biomass and waste in Malaysia

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Abstract

There is growing interest for utilization of biomass and waste for the significant environmental benefits, energy security and long-term fuel sustainability. Malaysia has enormous biomass resources that is currently under-utilized for electricity generation. The variation in the chemical composition, moisture and alkali contents across different biomass feedstocks requires pre-treatment to avoid problem during thermochemical conversion processes. On the other hand, the problem associated with municipal solid waste limit the application for useful fuel due to heterogeneous in nature and high moisture content. This paper reviews the prospective waste to energy technologies in Malaysia using hydrothermal treatment for production of solid fuel from biomass and municipal solid waste. The selection of thermochemical conversion technologies will be based on the fieldwork, characterization and laboratory experiments, environmental and economic evaluations. The overall objectives are to enhance the physical and chemical properties of the biomass and waste and to increase the thermal efficiency of power plant as part of nation renewable energy mix to reduce dependency to fossil fuels particularly coal. The effective use of biomass and waste can supply the required fuel for future electricity generation.

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Keywords: Biomass; Municipal solid waste; Power generation; Renewable energy; Malaysia; Pre-treatment; Thermal conversion

1. Introduction

The share of fossil fuels still exceeding 90% by 2040 and remain dominant in Malaysia's energy mix. The oil and gas sector has long formed an important part of Malaysia's economy. Since 2013, Malaysia became a net oil importer although Malaysia export oil and gas previously due to rising domestic consumption and declining production. There is consideration to shift from gas to coal-fired generation as source of coal is cheaper even though production of coal

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is limited where most of coal demand is imported from Indonesia, Australia, Russia, and South Africa [1]. Electricity generation from coal will overtaking natural gas as the main source of power generation by representing almost 60% of the power mix with installed capacity about 85 GW in 2040[1]. Malaysia is expected to increase the coal fired capacity from 4.6 GW between 2016 to 2020 to 15.2 GW by 2023[2]. Hence, it is inconsistent with the commitments to lower CO_2 emissions and obligations to the Paris Agreement following the 21st Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC). The renewable energies have been set by the Malaysia government to increase capacity to 2080 MW by 2020 and 4000 MW by 2030 excluding hydro energy. Financial incentives such as feed-in tariffs (FiT) and tax exemptions have been in place for investors attraction [1].

Nomenclature

MSW	Municipal Solid Waste
CO_2	Carbon Dioxide
NO_x	Nitrogen Oxides
SO_x	Sulphur Oxides
Kg	kilogram
GWh	Gigawatt-hour
Wt.%	weight percent
ºC	Degree Celsius
MPa	Mega-pascal
HT	Hydrothermal treatment
EFB	Empty Fruit Bunch
Cl	Chlorine
Ca	Calcium
P	Phosphorus
Mg	Magnesium
K	Potassium
Fe	Iron
Mn	Manganese
Na	Sodium

Biomass or bio renewable sources are defined as any biological origin that available on a renewable basis that are divided into three group which are solid fuels such as straw and log processing residue, wet agriculture wastes and vegetable crops like vegetable and perennial crops and forestry that specifically grown for energy. The similarity of biomass characteristics with fossil fuels make it unique to be used for power, heat, and fuel generation. The municipal solid waste is mix of discarded materials thrown into garbage including plastic, glass and metals hence do not qualify as biomass.

Rubber, oil palm, rice, cocoa and coconut are the main plantations in Malaysia and 18 million tons of palm oil or 41% of world palm oil are produced as one of the largest palm oil exporter of the world [3]. Around 77% of biomass from oil palm residue, 9.1% from rice and 8.2% from forestry residues while the remaining 5.7% consist of wood based MSW, rubber, cocoa, and coconut residues. 55% of these residues are field-based where it is generated in the field and move to the power plant and 45% residue from mills or process-based [3].

Malaysia is projected to increase the MSW generation rate to 1.90 kg/capita/year in 2025 with the population increase and economic growth. The MSW generation is projected to be double from 21,918 tonnes/day in 2012 to 51,655 tonnes/day in 2025 [4]. In Malaysia, the unsanitary land-filling remain the widely practice of MSW disposal. Utilization of MSW by waste to energy technologies remain unprofitable due to higher operating and maintenance cost, seasonal variance and high moisture content in Malaysian MSW [5]. In 2012, 62% of the MSW composition consist of organic waste, 12% from plastic, 7% paper, 6% metal and 10% others [4]. The aim of this paper is to review the prospective of thermal waste to energy technologies by hydrothermal treatment in Malaysia based on waste type, composition, generation rate and energy contents.