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A critical analysis on biogas production and utilisation potential from palm oil mill effluent

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ABSTRACT

The conventional method used for palm oil mill effluent (POME) treatment is associated with several environmental issues that affect the sustainable production of palm oil. Integrated POME treatment with a closed anaerobic digester is identified as a practical cleaner production approach to mitigate global issues on energy security and climate change and enhance the sustainability of the industry. This paper discusses the potential of capturing biogas to the palm oil industry and Malaysia's renewable energy (RE) and greenhouse gases (GHG) emissions targets. Approximately 75% GHG reduction could be achieved for every t of crude palm oil produced from palm oil mill with biogas capture. In total, 1750 million m^3 biogas with GHG savings of 19.5 million t CO_2eq can be achieved annually, if all palm oil mills in Malaysia capture the biogas. A 540 MW installed capacity or 37 million MMBtu in the form of bio-compressed natural gas (Bio-CNG) or biomethane, can supplement the nation's energy mix for the sustainable energy generation. These contribute towards enhancing the sustainability criteria and economic performance of the palm oil mills by adopting cleaner production technology of POME treatment for circular economy and better market access of palm oil products. Future work should emphasise on nationwide biogas implementation through synergising and strengthening private commitments and the government supports.

1. Introduction

Palm oil is the major commodity in the global oil and fats industry, contributing significantly to the socio-economic of producing countries, including Malaysia. As the world's second largest producer and exporter of palm oil, Malaysia produced and exported 19.14 million t of crude palm oil (CPO) and 16.22 million t of palm oil, respectively, from 96.09 million t of fresh fruit bunches (FFB) in 2020 (Parveez et al., 2021). Despite its huge market success, the industry faces numerous issues on sustainability, particularly associated with environmental impacts and greenhouse gases (GHG) emissions from palm oil mill effluent (POME). POME is the single-largest portion generated from palm oil mills, estimated at $>$ 60 million t are generated annually (Choong et al., 2018). Due to its high generation volume and organic content, POME is a major source of environmental pollution, particularly to water if discharged untreated or inefficiently treated. The conventional open ponding through anaerobic digestion (AD) used for POME treatment is relatively less effective with release of biogas to atmosphere. Biogas contains GHG, mainly methane (CH_4) that contributes significantly to the GHG emissions from palm oil mills. Sustainable management of POME is required to minimise its environmental impacts and to create economic value chains of the resource.

Several current solutions have been initiated at various development levels, including simultaneously treating and reusing POME efficiently, in maximising POME utilisation for resource recovery. Biogas can be efficiently produced and captured via high-rate anaerobic bioreactors which improve POME treatment. The combination of high rate bioreactor and membrane-polishing technology demonstrated a zero effluent discharge concept which generates biogas, biofertiliser and reclaimed water (Muzzammil and Loh, 2020). Reutilization of POME via

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