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Optimal Biomethane Injection into Natural Gas Grid – Biogas from Palm Oil Mill Effluent (POME) in Malaysia

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Abstract

The Malaysian government aims to facilitate the renewable energy (RE) sector by introducing the National Renewable Energy Policy and Action Plan during 2010. 4,000 MW of installed RE capacity is targeted by 2030, with 410 MW biogas capacity. Palm oil mill effluent (POME), agro-based industries and farming industries are identified as potential sources of biogas. It was studied that more than 500 kt of biomethane could be produced yearly if all the POME is treated anaerobically. The utilization of biomethane has remained unexplored for its injection into natural gas grid. This papers aims to identify the potential of POME biomethane injection into natural gas grid by using the BeWhere model, a techno-economic spatial explicit model. The locations, capacity and technology of biogas refinery plants will be identified based on cost minimization of the full supply chain of biogas production. The result shows that 135 - 227 biogas plants were selected, supplying 40% - 67 % residential fossil gas demand, under different carbon price implementation and fossil gas subsidy scenarios.

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Keywords: biogas, biomethane injection, POME, renewable energy (RE), BeWhere

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1 Introduction

The National Renewable Energy Policy and Action Plan was established by the government of Malaysia during 2010 [1]. The policy aims to increase RE in power generation mix of the country, to facilitate RE industry development, to ensure RE generated at reasonable price, to ensure environmental sustainability for future generation and to improve awareness on the importance of RE [2]. To move towards that direction, Ministry of Energy, Green Technology and Water (KeTTHA), Malaysia sets a target of near to 4,000 MW of installed renewable energy capacity by 2030, accounting to 10 % of nation energy mix. The total installed capacity of RE has reached 3.5 % during 2013 [3].

The RE to be potentially explored includes biogas, biomass, municipal solid waste (MSW), small hydro and solar photovoltaic. For biogas potential, the maximum potential can be achieved from POME, agro-based industries and farming industries. A total capacity of 410 MW from biogas is targeted by 2028. It is assumed that the lifespan of the production plant is 25-30 years [2].

Since Feed-in-Tariff (FiT) for electricity generated from renewable source, for example biogas was introduced, biogas capturing and converting it into electricity is gaining popularity among the palm oil operators, despite reducing greenhouse gases emission. For example, Sungai Kerang Palm Oil Mill (211,475 m^3), Syarikat Cahaya Muda Perak (232,745 m^3) and United Plantations Berhad (226,641 m^3) [4]. However, the potential of upgraded biogas, biomethane injection into natural gas grid remains unexplored. This paper thus aims to identify the optimal planning for biomethane injection into natural gas grid.

Nomenclature

RE	renewable energy
POME	palm oil mill effluent
KeTTHA	Ministry of Energy, Green Technology and Water of Malaysia
MW	megawatt
GWh	gigawatt hour
MSW	municipal solid waste
FiT	feed-in-tariff
GHG	greenhouse gases
FFB	fresh fruit bunch
mmBtu	one million British thermal unit

2. Methodology

The model adopted in this study is the BeWhere model, a geographic explicit techno economic model [5-7] which find the optimal location of new bioenergy plants by minimizing the costs and the emissions of the entire supply chain. In this study, the model has been implemented with the biogas technology having palm oil mill effluent (POME) produced in Peninsular Malaysia, as potential feedstock. The goal is to identify the optimal locations of biogas refineries plants as well as the corresponding biomethane injection infrastructures. The biogas supply chain is presented in Figure 1. The scope of this study focus on palm oil mill effluent (POME) as feedstock and injection of biomethane into natural gas grid as biogas utilization. After being collected, the feedstock is transported from the palm oil mills to the biogas plants through truck or train. Biogas (50 – 62.5 % CH_4) generated from anaerobic digestion of POME is then upgraded to biomethane (90 - 97% CH_4) by adopting a specific upgrading technology, which capacity is endogenously determined in the optimization procedure. The obtained biomethane (101kPa) is then compressed to meet the gas pressure of natural gas grid (240 – 345 kPa) prior to injection.