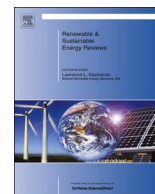




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Review on the renewable energy and solid waste management policies towards biogas development in Malaysia

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ABSTRACT

The development of renewable energy is of paramount importance towards the energy security and environment integrity of Malaysia. The Malaysia government has been implementing various policies that could facilitate the advancement of renewable energy technology and increase its contribution to the national energy mix to reduce the country dependency on fossil fuels. On the other hand, due to rapid urbanization and population growth, there is also increasing concern over the high production rate of organic waste. Among the renewable energy available, biogas is of great interest due to its ability to treat organic waste and generate power addressing both concerns simultaneously. This paper aims to review some of the important policies on renewable energy followed by the emphasis on solid waste management policies towards effective implementation of biogas generation from municipal solid waste. The biogas network is divided into three phases on a life cycle basis, namely MSW as feedstock, biogas production and biogas utilization. Under each phase, several important stages were identified. Analysis was performed to identify the role of currently implemented policies as well as the lacking support and challenges. It was envisioned that with proper SWM policies, in terms of waste collection, waste segregation and allocation of resources, which can be further complemented with more financial initiatives and technical support under the RE policies, the biogas development in Malaysia can progress more efficiently. Several supportive actions needed were derived from the analysis and presented in three figures, representing each of the phase, which could constitute a solid biogas framework.

1. Introduction

Malaysia is a transition country which is experiencing rapid urbanization and population growth. The population is expected to reach 33.4 million by year 2020 and 37.4 million by year 2030 [1]. The development leads to two major concerns, which are solid waste management (SWM) and energy security. In the case of MSW, the

production rate is 0.5–0.8 kg/ person-day and is expected to exceed 9 Mt /yr by 2020 [2,3]. The energy demand on the other hand, is predicted to increase by 4.7% annually [4] where the electricity consumption having an annual growth rate of 8.1% [5].

In year 2000, under the eighth Malaysia Plan (MP), the Fifth Fuel Diversification Policy was launched and Renewable Energy (RE) was included to be the fifth major energy source, following oil, gas, coal and

Abbreviations: RE, Renewable energy; 3Rs, Reduce, Recover, Recycle; ABC, Action plan for a Beautiful and Clean Malaysia; Biogen, Biomass generation and demonstration project; CDM, Clean Development Mechanism; CER, Certified emission reduction; CETDEM, Center for Environment, Technology and Development Malaysia; DECs, Dedicated energy crops; EE, Energy efficiency; EFB, Oil palm empty fruit bunches; EPP, Entry Point Projects; ETP, Economic Transformation Program; FFB, Oil palm fresh fruit bunches; FIT, Feed-in tariff; FV, Fruit and vegetable waste; FW, Food waste; GHG, greenhouse gases; GTFS, Green technology financial schemes; GW, Green waste; IPP, Independent power producers; ITA, Investment tax allowance; KeTTHA, Ministry of Energy, Green technology and Water Malaysia; KW, Kitchen waste; LFG, Landfill gas; MHLG, Ministry of Housing and Local Government; MIPV, Malaysia building integrated photovoltaic technology application project; MP, Malaysia plans; MPOB, Malaysia Palm Oil Board; MPSJ, Subang Jaya Municipal Council; MSW, Municipal solid waste; NKEA, National Key Economic Areas; NSWMD, National Solid Waste Management Department; OPP, Outline perspective plan; POME, Palm oil mill effluent; PTM, Malaysia energy center; PV, Photovoltaic; REBF, Renewable energy business fund; SEDA, Sustainable Energy Development Authority; SREP, Small renewable energy program; SWM, Solid waste management; TNB, Tenaga Nasional Berhad; UM, University of Malaya

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hydropower. Following this, there has been continuous implementation of RE-promoting policies and actions, such as the Small Renewable Energy Program, National Green Policy 2009, National RE Plan 2010, Renewable Energy Act 2011, Feed-in Tariff (FiT) mechanisms, RE business fund and Green Technology Financial Schemes under different Malaysia Plans.

The RE resources included energy from biomass, solar, mini-hydro power, municipal waste and biogas. Among these resources, biogas is important as it can offer a win-win situation towards the nation effort to achieve energy security while combating waste accumulation. Biogas is the product from anaerobic digestion (AD) of organic waste where it can be utilized to generate electricity. The major sources for biogas in Malaysia are palm oil mill effluent (POME), livestock manure and municipal solid waste (MSW) [6,7]. The electricity potential from biogas is estimated to be 100 MW by 2015 [8] with an energy reserve of 410 MW by 2030 and of 360–400 MW by 2020 [9]. However, according to Malaysia Sustainable Energy Development Authority (SEDA), to date, the cumulative installed capacity for biogas is only 6.48 MW and 6.36 MW (from landfill/ agricultural waste) by 2015. There is high RE potential from biogas which could be harvested from MSW and this could be better achieved if there are more supporting policies. The harvesting of biogas from MSW is highly dependent on the solid waste management (SWM) policy as it involves effective waste segregation and collection for a stable supply of feedstock for biogas production. RE policy is also important to provide legal structure and financial incentives to encourage the installation of AD plant, which is usually costly.

Several authors had performed excellent reviews and analysis on the development of energy policies in Malaysia. For example, [10] on Malaysia energy strategy towards sustainability, [9] on sustainable power generation in Malaysia to 2030, [6] on Malaysia's RE policies and programs with green aspects, [11] on RE policies and initiatives for sustainable energy future, and [12] on selection of RE sources for sustainable development of electricity generation. These papers highlighted the potential energy and important role of biogas in the RE mix but seldom overlapped their discussion with the SWM policy. In this paper, the authors aim to explore the niche where SWM and RE policies can be complementing to effectively utilize MSW as a source of biogas and facilitate the development of a sound biogas framework.

This paper is arranged into several sections. The first section provided an overview on the RE policies and SWM policies that are related to biogas development respectively. The second section presented the potential sources of biogas but with emphasis on MSW. This is followed by an analysis on the research gap to facilitate biogas development, namely from the aspect of supply and demand, technical issue, financial initiative and social concerns. Recommendation and supporting policies are provided to improve on the implementation gap as derived from the analysis in Section 3. It was envisioned that with proper SWM policies, in terms of waste collection, waste segregation and allocation of resources, which can be further complemented with more financial initiatives and technical supports under the RE policies, the biogas development in Malaysia can progress more efficiently as to benefit from a resource-oriented bio-economy.

2. Overview on the Malaysia's renewable energy and solid waste management policies

2.1. Renewable energy policies and plans under the Malaysia's government

Power and electricity generations in Malaysia are highly dependent on finite resources such as oil, natural gas and coal [8] which is unsustainable as studies showed that reserves for oil will be exhausted within 15 years from now [6] whereas electricity production by gas will be significantly reduced by year 2030 [13]. As mentioned, there is an annual growth rate of 8.1% for energy consumption. In year 2008, the

RE is officially included to be one of the major energy source besides oil, gas, coal and hydro. In this section, several important policies that facilitate the RE framework are presented.

2.1.1. An Overview of the development of RE policies in Malaysia

The successful implementation of biogas and any other RE technologies is dependent on the government RE policy that favours RE development. The Eighth Malaysia Plan (2001–2005) introduced the Five Fuel Diversification Policy which first included RE as the fifth source of energy after oil, gas, coal and hydro. The RE available in Malaysia includes solar PV, biomass, biogas, municipal solid waste (MSW) and wind energy. The 8th MP had a target to utilize RE to contribute 5% of the total energy mix by 2005 but only 0.3% was achieved [14].

This target was then brought forward to the 9th MP (2006–2010) with greater emphasis on energy efficiency [15] and a series of programs were initiated, including the Small Renewable Energy Power Program (SREP) (2001–2010) which successfully installed 12 MW to national grid, the BioGen project (2002–2010) and the establishment of Malaysia Building Integrated Photovoltaic Technology Application Project (MIPV) (2005–2010) [10]. Furthermore, companies employing RE technology could also benefit from incentives based on energy efficiency, RE resources uses and green buildings under the 9th MP budget [10]. Despite such efforts, RE still constituted less than 1% of the total energy mix supply [14].

The 10th MP introduced the New Energy Policy circling on energy pricing, strategic supply developments, end use energy efficiency, energy governance and regulation as well as management of change and affordability [16]. In 2009, the National Green Technology 2009 was implemented with the aim to increase energy supply from RE into the national energy mix to 5.5% by 2015. In addition to that, the RE act 2011 also introduced the feed-in tariff (FiT) mechanism which benefits RE developers and also contributing to the RE fund. Others financial aids available include Renewable Energy Business Fund (REBF), Green Technology Financial Scheme (GTFS) as well as Renewable Energy and Energy Efficiency Scheme [10,11].

The recently announced 11th MP (2016–2020) also highlighted green growth for sustainability and resilience as one of the six main strategic trusts where energy is one of the core aspects in natural resource management. One of the focus area is to adopt the sustainable consumption and production (SCP) concept. Under this plan, waste to landfill is treated as resource that can be reused through recycling and recovery, for power generation, and other waste to wealth initiatives. The plan aims to transform to a resource and energy efficiency society by creating green markets, increasing share of RE in energy mix, enhancing demand side management, encouraging low carbon mobility and managing waste holistically [17].

2.1.2. The national green technology policy 2009

The National Green Technology Policy stated green technology (GT) to be the driver to accelerate the national economy and promote sustainable development. GT is defined as technology that minimizes the degradation of the environment, has zero or low GHG emission, improved environment, conserves the use of energy and natural resources and promotes the use of RE. RE is one of the green technology. This policy had five main strategic thrusts to encourage RE development, which are Institutional Framework, Green Technology Development, Human Capital Development, Green Technology Research and Innovations as well as Public Awareness [11,15,18]. Under thrust 2, a Green Technology Financing Scheme (GTFS) is available for GT operators. The fund provided a maximum of RM 100 million with tenure up to 15 years being available to company practicing green technology for energy, water and waste management [19]. The GTFS fund has been increased by RM 2 billion in Budget Malaysia 2013 with extension of application till 31 December 2015 [20]. Furthermore, the Malaysia government will also bear 2% of the

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