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Producing Biogas from Palm Oil Mill Effluent in Southeast Asia—the Green Elephant in the Room?

Rachel Hoo, Leow Foon Lee and Melissa Low

SYNOPSIS

Methane (CH_4) emissions from palm oil wastewater, more commonly known as biogas released from palm oil mill effluent (POME), represents a significant source of greenhouse gas (GHG) emission. POME releases biogas, which consists of 60–70 per cent methane and 30–40 per cent carbon dioxide (CO_2) when it is treated in open ponds. Given the large palm oil plantations in Malaysia and Indonesia, not to mention other agricultural activities in Southeast Asian countries, methane capture in the agroindustry has the largest potential for carbon capture in the region. This is especially important given that the Global Warming Potential (GWP) of CH_4 is 28 times that of CO_2. This policy brief explores the methane mitigation potential through biogas capture and utilisation in Southeast Asia's clean energy transition.

KEY POINTS

- Biogas recovery from the agroindustry represents a huge untapped market in Southeast Asia, with Thailand being the largest biogas player in this region at present.
- Methane mitigation through biogas capture at 850 palm oil mills in Indonesia alone would contribute to approximately 41 million tCO_2e reduction. This is equivalent to about 80 per cent Singapore's total land-based GHG emission in 2014. However, as of 2019, less than a tenth of palm oil mills in Indonesia are equipped with biogas capture.
- According to UNFCCC's search tool on registered Clean Development Mechanism (CDM) projects, biogas projects in Southeast Asia represents about half the total biogas projects registered globally. However, the collapse of carbon market prices in 2012 caused those biogas projects in Southeast Asia dependent on carbon revenues to cease operations, with many companies ending up in serious financial difficulties.
- CDM was a proven tool to facilitate methane mitigation through biogas capture in Southeast Asia. With emerging carbon markets from the airline industry, carbon mitigation from the agroindustry, especially palm oil, which can be used to produce aviation biofuel, could be a strategic approach for carbon offsetting.
- Enhanced emissions reduction policy instruments with government and carbon market backing are required to restore confidence among agroindustry players in the economic viability of biogas.

INTRODUCTION

Palm oil is a key export commodity of Southeast Asia, and the region has great potential to develop biogas opportunities from the perspective of its carbon reduction potential. The region has explored biogas development as a method for waste management in the agroindustry since the early 1980s. However, the high capital investment and operational cost made biogas capture unattractive for investment; until incentives were introduced in 2000s. Thailand's Provincial Electricity Authority and Metropolitan Electricity Authority introduced the Very Small Power Producer Scheme (VSPP) in 2002, which offered the option for small developers of renewable energy to sell electricity to the national grid. This driver,

Energy Studies Institute
29 Heng Mui Keng Terrace,
Block A, #10-01, Singapore 119620
Tel: (65) 6516 2000 | Fax: (65) 6775 1831
esi.nus.edu.sg

A Research Institute of NUS National University of Singapore

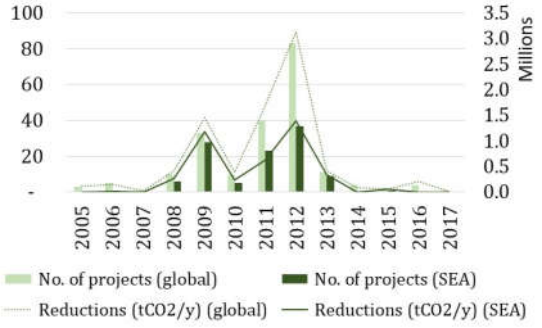
alongside carbon market incentives, promoted biogas commercial development in the tapioca starch and palm oil industries in Thailand.

Malaysia and Indonesia together produce nearly 90 per cent of global palm oil supply. Biogas capture in palm oil mills in Malaysia was facilitated when the government mandated all existing mills and new mills to have biogas capture by 2020 under the Palm Oil National Key Economic Area (NKEA) of the National Economic Transformation (ETP) program. The biogas captured in Malaysia's palm oil industry is generally used for renewable electricity generation. The National Renewable Energy Policy and Action Plan introduced in 2011 also identified biogas as one of the main sources of renewable energy. Under this plan, electricity generated from biogas can be sold to the national grid under the Feed-in Tariff (FiT) mechanism. In recent times though, logistical constraints in grid connectivity have weighed on the economic feasibility of these projects, especially those located remotely or in areas with surplus electricity generation.

Meanwhile, biogas development in neighbouring country Indonesia has been lagging. FiT was introduced in Indonesia in 2014 for renewable energy companies to sell power to State Electricity Company (PLN). However, the economic feasibility of biogas is undermined by the low FiT, the high cost of grid connection and the limited base load power demand in remote palm oil regions where embedded generation is the norm for industry. Biogas dissemination in Indonesia remains more commonly used for meeting domestic energy needs in cooking and lighting in rural area, for instance, the Biogas Rumah (BIRU) programme by Hivos. In Singapore, biogas is generated from the treatment of poultry waste. More recently, Singapore's water agency, the Public Utilities Board, has been exploring the generation of biogas from waste water sludge at water reclamation plants for electricity generation.

According to UNFCCC's search tool on registered Clean Development Mechanism (CDM) projects, the biogas projects registered in Southeast Asia represents more than half the total number of projects registered globally at 53 per cent. This represents 51 per cent of total GHG emissions mitigation out of 4.14 million tCO_2e annually. There are 43 biogas projects registered in Thailand; 26 in Indonesia; 21 in Malaysia; 13 in Vietnam; 3 in Cambodia; 3 in the Philippines; 1 in Lao People's Democratic Republic; 1 in Singapore; and 1 in Papua New Guinea. The number of projects found was based on the keyword 'biogas' used in the search tool. Of these, most biogas projects registered in Malaysia, Indonesia and Thailand are generated from wastewater residues of agroindustry and farming activities. Although biogas projects registered accounts for only 3 per cent of all CDM projects, CDM is the major stimulus for biogas projects, according to a 2014 commentary published by PG Taylor et al in *Nature Climate Change*. This is especially the case when Kyoto Protocol was in effect from 2008 to 2012, before the carbon market collapsed in 2013–14 due to an oversupply of carbon credits, as shown in Figure 1.

Figure 1. Biogas Projects registered under CDM (2005 – 2017)



Source: UNFCCC's search tool on registered Clean Development Mechanism (CDM)

ANALYSIS

Biogas Capture to Boost Industry

In the past two years, crude palm oil prices have fallen sharply. Europe and India are re-evaluating palm oil imports due to environmental and political reasons, and there is an increased demand for certified sustainable palm oil. As a result, the industry is reportedly looking to boost yield and cut costs by delaying expansion and replanting plantations to help boost earnings. Although a report published last May by the Singapore Institute of International Affairs looking at palm oil and biofuels noted the potential demand for sustainable palm oil in China, optimising the biomass value chain will also have a positive impact on the environmental

performance of the palm industry. Biogas development could be one of those low-hanging fruits among the choices that the industry should consider tapping on. Furthermore, financial incentives exist in Southeast Asian countries to promote the development of renewable energy. For example, under Thailand's VSPP, Thai biogas developers were allowed to sell electricity at an average price of THB2.8 per kWh to the grid. An extra incentive of up to THB0.50 per kWh was introduced later in 2006. At the same time, under the CDM mechanism, the Certified Emission Reductions (CERs) of biogas had a decisive comparative advantage over other renewables due to its high GWP. These factors further accelerated biogas adoption in Thailand. By 2012, most palm oil mills in Thailand already had biogas systems installed.

In Malaysia, other than FiT, tax incentives and the Green Technology Financing Scheme (GTFS) also encouraged green technology uptake, including biogas capture and utilisation in palm oil mills. FiT rate revision in 2014 with an increment from RM0.32 per kWh to RM0.40 per kWh further facilitated biogas uptake. However, there is no restrictions or regulations on the release of biogas into the atmosphere. In 2016, 92 out of 450 palm mills had biogas facilities in Malaysia. Malaysia aims to have all palm mills equipped with biogas capture by 2020. However, logistical constraint has caused difficulties for remotely located palm oil mills to adopt biogas. While the government continues to release FiT quota for biogas, biogas players are also exploring alternative biogas utilisation.

Meanwhile in Indonesia, biogas capture in the agroindustry is not yet a government priority. The lack of a biogas development target and financial challenges have hindered biogas development. On 4 February 2019, an experimental pilot project for capturing biogas from POME and utilising it for electricity generation was conducted by the Agency for the Assessment and Application of Technology (BPPT) at Riau, Indonesia. However, whether this utilisation pathway is an effective tool to promote biogas, especially in remote palm oil mills in Indonesia is still uncertain. According to BPPT in March 2019, less than 10 per cent of the 850 palm oil mills are equipped with biogas capture equipment.

Biogas and Green Power

There is significant potential in Southeast Asia to promote a circular economy in which organic wastes from the agroindustry—including those from the palm oil industry—are recycled into renewable gas or other bioproducts. The Global Potential of Biogas report published by the World Biogas Association in July 2019, noted that just 2 per cent of global wastes and feedstocks suitable for the production of biogas are currently being used and that these feedstocks—food waste, sewage, animal waste, crops and crop residues—are widely and readily available. The report estimates that the biogas recovery from these readily available feedstocks, with existing technologies deployable immediately, can potentially produce up to 14,000 TWh energy, which is capable of meeting up to 9 per cent of current global primary energy needs. This amount of potential energy generation is also equivalent to 23–32 per cent of the world's current coal consumption. The report also estimates that output from the process known as digestate could substitute some 5–7 per cent of global inorganic fertiliser use, suitable for fertilising 82 million hectares of land, which is equivalent to the combined area of arable land of Indonesia and Brazil.

In addition, biogas installations can deliver the greatest impact in terms of greenhouse gas emission reductions of any renewable energy technology. CH_4 has a GWP 28 times higher than CO_2. Therefore, its mitigation can reduce total emissions by 25–40 times the level of an equivalent capacity of solar or wind power. For every palm oil mill equipped with biogas capture, approximately 40,000–50,000 tCO_2e can be abated annually, equivalent to carbon avoidance of 50 MW solar PV plant. Capturing POME methane at 850 mills in Indonesia will cut 41 million tCO_2e, equivalent to about 80 per cent of land-based CO_2e emitted in Singapore in 2014. This is a significant amount given that this measure only represents GHG emission reduction from one feedstock in a single industry.

Emerging Carbon Markets

In January 2019, airlines began monitoring CO_2 emissions under the International Civil Aviation Organisation's (ICAO) Carbon Offsetting and Reduction Scheme for

International Aviation (CORSIA). As of 16 July 2019, out of 192 member states of the organisation, 81 member states (76.63 per cent of international aviation activities) intend to participate voluntarily in CORSIA from 2021 to 2026. The International Air Transport Association (IATA) estimated that under this scheme, aggregated CO_2 offset demand of 2.6 $GtCO_2e$ could be created between 2021–2035. CORSIA is also generating demand for sustainable aviation fuels (SAF) and lower carbon aviation fuels (LCF), of which Malaysia and Indonesia palm oil could contribute towards. The landmark Paris Agreement of COP21 in December 2015 has also promised a new "Sustainable Development Mechanism" (Article 6.4) envisaged to facilitate emissions reductions transfers which mimics that of CDM. It is hoped that this new market will generate renewed interest from the biogas industry to generate credits as it did under the CDM.

However, for markets to work, ambitious pledges and emissions reduction policy instruments need to be in place. In the region, Singapore was the first to implement a carbon tax in 2019 at S$5/$tCO_2$, aligning to the country's submitted Intended Nationally Determined Contribution (INDC) to the UNFCCC on reducing its GHG emissions intensity by 36 per cent by 2030 based on 2005 levels. This carbon tax, which it operates as a Fixed Price Credit Based (FPCB) system, acts as a building block to facilitate use of carbon credits. This could be a model for the rest of Southeast Asia, as they develop their new NDCs and low-emissions development strategies for submission in 2020 ahead of COP26.

CONCLUSION

Ultimately, biogas is a useful way of ensuring that excess methane—which is a greenhouse gas—from the production of crude palm oil is put to work, generating energy instead of being released to the air and contributing to global warming. Although POME methane mitigation will not remove the damage of forest clearing, it has co-benefits for mill owners, local communities and those affected by climate change. Green power and heat production from biogas can be one of the reliable and consistent forms of renewable energy. Biogas-to-power projects also represent good financial return opportunities if the risks are properly managed.

Currently, biogas released from the agroindustry is like a green elephant in the room—its huge potential for GHG emission reduction in this region remains unfulfilled. The potential of a carbon market based on biogas capture and utilisation in the agroindustry deserves more government attention in Southeast Asia where more can be done towards exploring regional GHG mitigation collaboration. This effort would be viewed positively by both the industry and the international community.

WHAT TO LOOK OUT FOR

- Enhanced climate commitment by countries in the upcoming five-yearly Nationally Determined Contribution (NDC) update by the end of 2020, which could include policy interventions to prioritise biogas uptake in the agroindustry as a mitigation strategy.
- Conclusion of the Article 6 negotiations by the 26th Conference of the Parties to the UNFCCC to be held from 9–19 November 2020, to provide guidance to countries developing domestic or linked carbon markets, where biogas industry as one of the biggest carbon capture in the region will have a role to play.

Rachel Hoo, PhD and Melissa Low are Research Fellows at the Energy Studies Institute, National University of Singapore. Leow Foon Lee is an Adjunct Principal Research Fellow at ESI.

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