# Using Biogas from Palm Oil Residues to Enhance Energy Access in Indonesia

By Joni Jupesta*

## Introduction

The United Nations Rio+20 Summit in Brazil in 2012 committed governments to create a set of sustainable development goals (SDGs) which should be integrated into the Millennium Development Goals (MDGs) after their 2015 deadline (Griggs et al, 2013). It clearly spells out that the framework for actions will be drawn from the outcome document, which will help reporting on the follow-up and implementation. The outcome from the Incheon meeting in March 2013 underlined that a framework for action is very important and should integrate an approach to the core sustainability challenges of climate change adaptation and mitigation, water management, food security, and sustainable energy in anticipation of the adoption of Sustainable Development Goals (SDGs). Implementation of this framework should be pursued by practitioners and institutions in different sectors and at different scales. The driving principles for these SDGs remain: reducing poverty and hunger, improving health and well-being, and creating sustainable production and consumption patterns (UNOSD, 2013).

The Asia Pacific region, where the world's major population and economic growth are, can show the global impact of sustainable development, partly due to the fact that this region includes an advanced economy such as in Japan and key emerging economies such as China, India and Indonesia. With the human population set to rise to 9 billion by 2015, definition of sustainable development must be revised to include the security of people and the planet (Griggs et al., 2013). Defining the integrated goals of SDGs brings enormous challenges such as the tradeoff between energy provision and food security in the context of biofuels (Jupesta, 2012). Further in developing countries, biofuels could become the solution for poverty alleviation and rural development. The global development agenda should also have a goal that explicitly focuses on improving agricultural systems and rural development in an integrated manner, to adequately address the need for changes that are required to make agriculture more productive and more sustainable. This paper focuses on the potential of biogas from palm oil waste to enhance energy access in Indonesia. With the fourth largest population in the world with 241 million inhabitants, Indonesia is the largest economy in the Southeast Asia region (BPS, 2013). This country showed consistent stable economic growth of 4.7% p.a, between 1990-2011 and is projected to grow at a 6.2% rate from 2011-2020; the highest among other ASEAN members (IEA, 2013).

## Energy Situation in Indonesia

In 2008, fuel and electricity subsidies amounted to 14 and 6 billion USD, respectively, equaling total central governmental capital and social spending. Oil and gas contributed to 31.5% of government revenues in 2006, but decreased to 20.4% in 2008, as a result of depleting oil resources and an oil production decrease from 9 x $10^9$ barrels in 1987 to half of that in 2007. For these reasons, the government enacted the so-called Mix Energy Policy (in 2006), to reduce dependency on oil by the use of a mixture of energy sources. It is expected to utilize local resources to make renewable energy (e.g., biofuel). The target was to reduce the share of fossil oil in providing energy from 52% of total energy consumption (as in 2006) to 20% by 2025. By that year, the remaining energy should come from coal (35%) and gas (30%), whilst renewable energy sources are hoped to provide 15% of total energy consumption.

Figure 1 shows the Mix Energy Policy based on Presidential Decree No. 5 (2006), which states that the share of renewable (geothermal and hydropower) will increase from 4% to 15% within 20 years. Biofuel was introduced with the objective of fulfilling 5% of the total energy consumption by 2025. Biofuel development could create at least 4 and 7 million jobs by 2010 and 2025, respec-

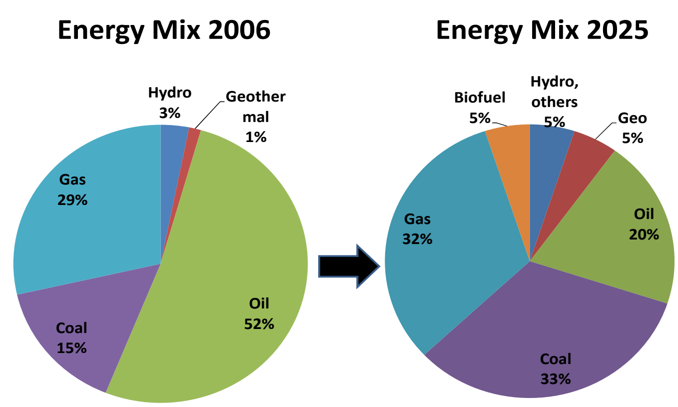


*Figure 1: Indonesia's Energy Policy Mix*

* Joni Jupesta is an Environment Advisor at PT. Sinar Mas Agri Resources and Technology (SMART) Tbk in Indonesia, and a Visiting Research Fellow at the United Nations University- Institute of Advanced Studies (UNU-IAS) in Japan. The views expressed are the views of the author and do not necessarily reflect the views of his affiliation.

tively (Jupesta 2012). However biofuel consumption is still relative low. This is due to low technical implentation and unfavourable pricing which makes industry reluctant to invest. In 2013, the government enacted new regulation shown in Table 1 to accelerate biofuel consumption in transportation, industry and power plants (ESDM, 2013). The biofuels here are biodiesel (BD), bioethanol (BE) and pure vegetable oil (PVO). The biofuel feedstock for biodiesel comes mostly from palm oil.

| | January 2015 | | | January 2020 | | | January 2025 | | |
|---|---|---|---|---|---|---|---|---|---|
| Sector | BD | BE | PVO | BD | BE | PVO | BD | BE | PVO |
| Transportation PSO | 10% | 1% | 10% | 20% | 5% | 20% | 25% | 20% | 20% |
| Transportation Non PSO | 10% | 2% | - | 20% | 10% | 3% | 25% | 20% | 5% |
| Industry and Commercial | 10% | 2% | 10% | 20% | 10% | 20% | 25% | 20% | 20% |
| Power Generation | 25% | - | 15% | 30% | - | 20% | 30% | - | 20% |

*Table 1: Obligation of Biofuel as Mixture with Oil Fuel (ESDM, 2013)*

From a demand perspective, the electrification rate in Indonesia is 73%. This leaves 27% of the population (~66 millions) still living without electricity access. This is mainly caused by the high infrastructure cost of grid connections due to the geography of the archipelago and the mountainous nature of some of the region. More than 103 million people in Indonesia (~42% of total population) still use biomass as cooking fuel (2010), which causes a negative externality, i.e., health problems due to indoor pollutants (IEA, 2013, and Bailies, 2005).

**Palm Oil in Indonesia**

Palm oil is the most important agricultural commodity in Indonesia and plays a significant role in the country's development. The palm oil sector produced 24.4 million tons of Crude Palm Oil (CPO) and 5.3 million tons of Palm Kernel Oil (PKO). It employs 5 million people and generated an income, by export, of US$ 19.1 billion in 2012. Palm oil plantations are owned by small land holders (45%), the private sector (47%) and the state (8%). CPO has many applications in the food industry e.g., cooking oil, and the non-food industry. e.g., biofuel; while PKO is a common ingredient in processed foods, soaps and personal care products. The average yield of palm oil ranges from 6 million ton/ha to 7.5 million ton/ha. This is, respectively 17.9, 14.6 and 11.15 times higher than those of soybean oil, rapeseed oil and sunflower oil with the same land area. Five percent of the palm oil produced globally is used as feedstock for biodiesel. The growth rate of palm oil plantations has gone up rapidly from 14,000 ha /annum (1967-1980) to 365,000 ha/annum (1991-2010). The projected global demand for palm oil products -crude palm oil and palm kernel oil- will grow 186% from 2010 to 2025. Table 2 shows the major producers of palm oil

| Countries | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|
| Indonesia | 16.800 | 19.200 | 21.000 | 21.000 | 22.100 |
| Malaysia | 15.823 | 17.735 | 17.566 | 16.993 | 18.880 |
| Thailand | 1.020 | 1.300 | 1.310 | 1.380 | 1.830 |
| Nigeria | 835 | 830 | 870 | 885 | 900 |
| Colombia | 780 | 778 | 802 | 753 | 765 |
| Ecuador | 385 | 418 | 448 | 380 | 460 |
| Others | 2.905 | 3.045 | 3.107 | 3.367 | 4.159 |
| Total | 38.548 | 43.306 | 45.103 | 44.758 | 49.094 |

*Table 2: Major Producers of Palm Oil in throusand tonnes (2007-2011) (Oil World, 2012)*

**Biogas from Palm Oil Residues**

The palm oil in Indonesia is located in rural areas, spread mostly on Sumatera and Kalimantan islands which have a relative low electricifcation rate compared with Java island. The main products produced from palm oil are CPO and PKO. However, residues such as fibre, shell, fronds, palm kernel cake and empty fruit bunches are also produced. Most palm oil producers are small land holders with less than 50 hectares. The empty fruit bunches and fronds can be coverted into paper, while fibre and shell could be used as boiler fuel to generate steam in the palm oil mill (Sulaiman, 2011). On the other hand, palm kernel cake is underutilized and has a low economic value compared with the other residues. Considering its significant protein and nutrient contents, palm kernel cake could have more value added as one of the feedstocks in cow farming.

In the integration of palm oil with cow farming, the feedstock for the farming could be secured from palm oil residues and biogas from cow manure could be utilized for the cooking and lighting of the household. The lighting here refers to mantle lamps and the cooking refers to the gas stove. This biogas can help overcome the lack of electricity access in the remote areas of palm oil farming in the Sumatera and Kalimantan islands. Figure 2 shows the integration of palm oil with cow farming. Having four cows could produce biogas to supply up to six hours of cooking and up to eight hours of one light. Table 3 shows an economic analysis of palm oil/cow farming integration for a small land holder with four cows.

While the grass is obtained for free directly from the farm, the palm kernel cake is obtained from the nearest palm kernel mill derived from the palm oil processing. The operational costs consist of transportation, mixing, munching and labor. The analysis shows that the integration will bring a net revenue of US$ 174.8 per month in addition to the biogas for household cooking and lighting. Further, the biogas could also reduce the dependency on biomass for cooking which causes indoor pollution. Indonesia still had 103 million people (~42%) who relied on biomass for cooking in 2011 (IEA, 2013).

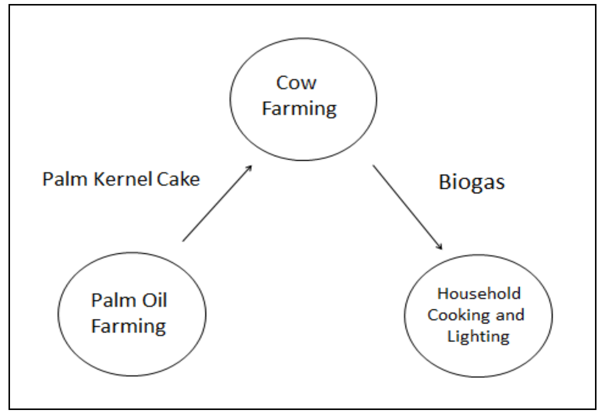


*Figure 2: Integrated Palm Oil/Cow Farming*

**Summary**

The post 2015 development agenda will incorporate Sustainable Development Goals as a continuation of the Millenium Development Goals. Energy access is still the top priority of the development agenda, with multiple objectives: poverty alleviation, income generation, gender equality, economic development, environment sustainability, etc. Lessons from Indonesia show that the integration of palm oil farming with cow farming could deliver several benefits: less air pollution from replacement of biomass with biogas for cooking and the economic benefit of suppling clean energy and a monthly income. In the case of the small land holder with four cows, the biogas produced could provide up to 6 hours of cooking and up to 8 hours of lighting by mantle lamp. With an average weight gain of 30 kg per month for one cow, the income benefit was US$ 174.8/month.

| | kg/ month | Price US$/kg | Total |
|---|---|---|---|
| **Material Cost** | | | 67.9 |
| Grass | 396 | - | - |
| Palm Kernel Cake | 288 | 0.16 | 46 |
| Paddy bran | 64 | 0.15 | 9.6 |
| Molasses | 28 | 0.1 | 2.8 |
| Salt | 7.2 | 0.1 | 0.7 |
| Urea | 7.2 | 0.35 | 2.5 |
| Ultra Mineral | 14.4 | 0.44 | 6.3 |
| Operational Cost | | | 9.9 |
| Total Cost | | | 77.8 |
| Revenue (Cow) | 120 kg | 2.1 | 252.6 |
| Net Revenue | | | 174.8 |

*Table 3: Economic Analysis of Palm Oil/Cow Farming Integration*

**References**


Bailis R., and Kammen D.M. 2005., Mortality and greenhouse gas impacts of biomass and petroleum energy futures in Africa, Science, Vol.308, No.5718, pp.98-103.

BPS (Bureau Central Statistic). 2013. Statistic Indonesia 2013, BPS, Jakarta.

http://www.bps.go.id/hasil_publikasi/SI_2013/index3.php?pub=Statistik Indonesia 2013

Griggs D., Stafford-Smith M., Gaffney O., Rockstrom J., Oehman M.C., Shyamsundar P., Steffen W.,

Glaser G., Kanie N., Noble I. , 2013. Sustainable development goals for people and planet. Nature 495, 305-307.

IEA. 2013. Southeast Asia Energy Outlook, IEA, Paris.

Indonesia Ministry of Energy and Mineral Resources (MEMR) webiste (accessed October 20th 2013). http://www.esdm.go.id/

IOPRI. 2013.Integration of Palm Oil with Cow Livestock, IOPRI, Medan.

Jupesta, J. 2012. Modeling Technological Change in the Biofuel Production System in Indonesia. Applied Energy, Vol. 90, No.1, pp. 211-217.

Oil World. 2013. Oil World Annual 2013. Oil World, Hamburg.

http://www.oilworld.biz/app.php?ista=978cc3cd20787d5a2dbe339685cb6547

RSPO website (accessed November 6th 2013) , http://www.rspo.org/

Steinfeld H., Wassenaar T. 2007. The role of Livestock Production in Carbon and Nitrogen Cycles, Annual Reviews Environmental Resource , 32: 271-294.

Sulaiman, F., Abdullah N., Gerhauser H., Shariff, A. 2013. An Outlook of Malaysian energy, oil palm industry and its utilization of wastes as useful resources. Biomass and Bioenergy 35, pp.3775-3786.

UNOSD website (accessed November 1st 2013). Bridging Knowledge and Capacity Gaps for Sustainability Transition: A Framework for Action.

http://www.unosd.org/content/documents/131Framework%20for%20Action.pdf

UNSDSN website (accessed October 28th 2013). Solutions for Sustainable Agriculture and Food Systems. http://prokum.esdm.go.id/permen/2013/Permen%20ESDM%2025%202013.pdf