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A Renewable Future Driven with Malaysian Palm Oil-based Green Technology

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Abstract

Renewable energy has been identified globally as a key driver to achieve economic growth while ensuring minimal environmental harm. Simultaneously, the current development of green technology and its related policies have enhanced the growth of renewable energy in the country. The Malaysian palm oil industry, with 4.69 million hectares of planted land has a tremendous opportunity in supplying renewable energy in the form of biomass-based bioenergy and biogas from methane capture of palm oil mill effluent (POME). It is estimated that these palm based materials could generate up to 1260 MW of energy. This amounts to nearly 10% of the maximum energy demand of electricity in Malaysia. Therefore, oil palm-based biomass can be expected to play a prominent role in the future when the demand for renewable energy is expected to increase rapidly.

Keywords

Palm oil, biomass, empty fruit bunch (EFB), palm oil mill effluent (POME), bioenergy, biogas

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1. Introduction

Renewable energy has been identified as the future to power world growth. From the European Union's Renewable Energy Directive (RED) [1] in 2009 to the US Renewable Fuels Standard 2 (RFS 2) [2] in 2010, it has been acknowledged that renewable energy could be a key driver in maintaining the delicate balance of economic development that would be anticipated to grow alongside the exponential rise of the global human population and climate change. Among the various forms of renewable energy of interest are biofuels, biomass, wind, solar, hydroelectricity and geothermal sources [3]. In order to harness the potential of renewable energy into reality, the term 'green technology' has thus been coined.

2. Green Technology and Malaysia

In Malaysia, the national agency entrusted to promote green technology is the Malaysia Green Technology Corporation. It defines green technology as products, equipment or systems which satisfy the following criteria: [4]

- *Minimizes the degradation of the environment*
- *Reduces the greenhouse gas emissions*
- *Safe for use and promotes healthy and improved environment for all forms of life*
- *Conserves the use of energy and natural resources and;*
- *Promotes the use of renewable resources*

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The recently concluded International Greentech & Eco Products Exhibition & Conference Malaysia (IGEM 2010) [5] is further evidence that Malaysia is ready to ride on the wave of green technology with an endorsement and support from the Government efforts to green Malaysia. Touted as the largest event of its kind in the region, more than 500 exhibition booths showcased both local and international technology and services.

3. Malaysian palm oil industry's potential

Besides having good solar radiation exposure due to Malaysia's location on the Equator and the expansive rivers to power hydroelectric dams, Malaysia is also blessed with an abundance of biomass, biofuel and methane capture potential from its palm oil industry which is the nation's main plantation commodity. With nearly 4.70 million hectares [6] of planted land and 416 mills [6] operating across the country, the Malaysian palm oil industry is expected to generate over 19.8 million tonnes of Empty Fruit Bunches (EFB, wet weight) and 60 million tonnes of palm oil mill effluent (POME). *Appendix 1, 3*

Currently nearly 80% of Clean Development Mechanism (CDM) projects in Malaysia are from the palm oil industry [7], including renewable energy-related projects such as biomass from empty fruit bunches and the generation of biogas from capturing methane from the palm oil mill effluent ponds. However, with only 5% of the mills in Malaysia involved in such projects, green technology utilisation for methane capture (in palm oil mills) remains an attractive option untapped.

4. Supporting Legislations and Policies

The Malaysian Renewable Energy Act is also anticipated soon. [8] This development should provide the momentum for additional incentives for the palm oil industry. These are some of the key drivers for the industry from the proposed Act: [8, 9, 10]

i. *Biofuels - the Government under Budget 2011 has announced the Programme of Blending of Biofuels with petroleum diesel (B5) to be implemented by June 2011*
ii. *Use of biomass: not necessarily for fuel but for other purposes. New industries may emerge to capitalize on the "Green Technology" funds that will be available for new technology adoptions.*
iii. *Feed in Tariff (FiT) mechanism - which allows electricity generated from renewable energy by independent providers to be sold to utility companies. It is also expected to further increase the tariff rate from the current RM0.21 per kilowatt hour. Biogas from palm oil mill effluent and biomass would then have a more attractive value, making it a more attractive option to millers.*
iv. *Formation of a Sustainable Energy Development Authority (SEDA) to oversee the implementation of renewable energy.*

Through the incentives to encourage the Malaysian palm oil industry venture into methane capture and biomass utilization for energy generation, it is hoped that the Renewable Energy Act would help drive the green technology initiative amongst the palm oil industry in Malaysia.

5. Economic Transformation Programme (ETP)

In addition to the above, the palm oil industry has also been identified by the Malaysian Government's Economic Transformation Programme (ETP) as one of the major economic pillars that would spearhead the economic growth by 2020. The ETP was launched in October 2010 by the Prime Minister of Malaysia, YAB Dato' Sri Mohd Najib bin Tun Abdul Razak as a comprehensive effort that will be able to transform Malaysia into a high-income nation by 2020. [11]

The ETP roadmap has identified that the palm oil industry will raise its Gross National Income (GNI) contribution from the current RM52.7 billion to RM178 billion by 2020 and this will be achieved through the implementation of eight core entry point projects (EPP). [11]

One such EPP has being identified to develop the biogas at palm oil mills where it is estimated that this EPP will generate an estimated RM2.9 billion in GNI in 2020 while creating 2,000 job opportunities. The second EPP involves commercialising the second generation biofuels from oil palm biomass (in the form of empty fruit bunches, fronds and trunks) and is estimated to generate an additional RM3.3 billion in GDI and the creation of 1,000 new jobs. In total, RM6.2 billion and 3,000 employment opportunities are

now waiting to the tapped and developed from palm oil-based green technology by 2020. [11]

6. Renewable Energy Sources from Oil Palm

There are two major sources from oil palm that can be used for renewable energy – oil palm biomass (which includes empty fruit bunches, tree fronds, trunks, fibres and shells) and palm oil mill effluent (POME) from palm oil mills:

a. Bioenergy Potential from Oil Palm Biomass

The use of palm biomass has been aptly defined in one of MPOB's publication as the road to zero waste [12]. Little is known that the palm oil industry generates almost 94% of the biomass feedstock in Malaysia, while agricultural and forestry by-products such as wood residues, rice and sugar-cane contribute the remaining 6%.
It is estimated that the total potential oil palm biomass from 4.69 million hectares of oil palm in Malaysia in 2009 is 77.24 million tonnes per year comprising 13.97 million tonnes of oil palm trunks, 44.84 million tonnes of palm fronds, 6.93 million tonnes of EFB, 4.21 million tonnes of oil palm shell and 7.29 million tonnes of mesocarp (all dry weight). *Appendix 1*

Currently, oil palm biomass is mostly used for the purpose of compost and fertiliser, mulching mats, plywood and veneer from oil palm trunks, oil palm fibre-filled automotive upholstery parts, dampening sheets for automotive industry using oil palm fibres, moulded particleboard, pulp and paper from empty fruit bunches (EFB), moulded pulp products for food packaging, containers from EFB, medium density boards, furniture, oil palm lumber, activated carbon, compostable plastic film and palm-based biomass briquettes which can be used as solid fuel. The lignocellulosic materials in the biomass can be converted into value-added products such as bioethanol, fine chemicals and polymers by means of thermal, thermochemical, chemical and biological conversion processes. [12, 13]

Oil palm biomass, in particular EFB has tremendous potential to produce renewable energy, especially in our current climate where the emphasis is on industries to reduce their carbon emissions and the preference on cleaner sources of energy. In using EFB as a source for electricity generation, the Malaysian palm oil industry can not only avoid emissions from the transportation and disposal of EFB, it can reduce the use of electricity from fossil fuels too (from the National Electricity Grid) and in the process reducing its generated greenhouse gas emissions [14]. With the availability of 6.93 million tonnes of EFB (dry weight) in Malaysia in 2009, this is equivalent to 345 MW of potential power. *Appendix 2*

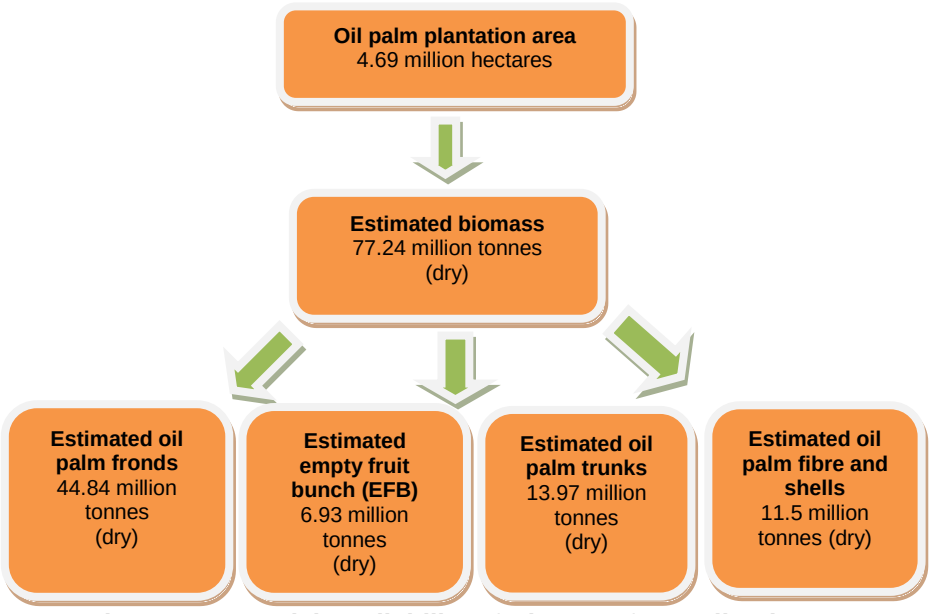

Figure 1: Potential Availability of Biomass from Oil Palm

b. Bioenergy Potential from POME

Through the results of Life Cycle Assessment (LCA) studies of palm oil, it was recognised that methane from the open ponding system of palm oil mills, on average, contributes up to 52% of the total LCA CO_2 equivalent emissions. The LCA GHG emission savings of palm biodiesel improves to almost 80% when methane is captured [14]. Thus it is essential to both the environment and the industry to capture the emissions whenever possible to dramatically reduce its carbon footprint.

This methane emission can be captured through the utilisation of green technologies to produce biogas, which is a form of renewable energy. Based on one tonne of POME discharging about 28 m^3 of biogas, the biogas generated from all mills will be about 1688 million m^3. With a total production of 90 million tonnes of fresh fruit bunches (FFB) in Malaysia in 2009, the potential energy is 1.97 million MWhr of electricity. This is equivalent to 274 MW of potential power. *Appendix 3*

7. Conclusion

In conclusion, it can be estimated that both the palm oil biomass and POME in Malaysia can generate up to 1260 MW, using 2009 statistics as a yardstick. This is already at an impressive rate of 9% of the maximum demand of electricity in 2008/2009 (14,245 MW) [15]. The palm oil millers pursuing the development of bioenergy can also benefit from local Malaysian incentives under the Small Renewable Energy Programme (SREP) as well as international incentives from Clean Development Mechanism (CDM) funding. With the development of the soon to be enacted Renewable Energy Act of Malaysia that will be expected to encourage more participation of independent power producers, palm oil biomass and POME is expected to play a key role in delivering a significant portion of Malaysia's renewable energy source, especially via the SREP. As of February 2010, palm biomass and biogas had already contributed 66% of the energy under the approved SREP projects [15]. Truly, there can be indeed a renewable future from the Malaysian palm oil industry, powered by palm oil biomass and POME.

Biomass Fact Sheet for the Malaysian palm oil industry
(Based on 2009 data derived from MPOB's Malaysian Oil Palm Statistics 2009 and MPOB calculation methodologies)

No	Data and calculation	Estimated amount
1	**Oil palm planted area in 2009** [6]	4.69 million hectares
2	**Estimated oil palm frond (OPF) availability in Malaysia** **Pruning** *estimated 12 tonnes/hectare (dry weight) during pruning. By taking an average of 75% of the palm trees aged 7 years and above which are due for pruning, the estimated OPF is: 12 x 0.75 x 4.69 = 42.21 million tonnes **Replanting** **estimated 14 tonnes/ha (dry weight) during replanting. Taking into consideration 4% hectarage due for replanting, the estimated OPF during replanting is: 14 x 0.04 x 4.69 = 2.63 million tonnes Total OPF availability = 42.21 + 2.63 = **44.84 million tonnes**	44.84 million tonnes
3	**Estimated empty fruit bunch (EFB) availability in Malaysia** [12] FFB yield x planted area : 19.20 x 4.69 = 90.05 million tonnes EFB is assumed to be 22% of FFB : 90.05 x 0.22 = 19.8 million tonnes EFB dry weight is 35% of total weight 0.35 x 19.9 = **6.93 million tonnes of EFB**	6.93 million tonnes
4	**Estimated oil palm trunk (OPT) availability in Malaysia** Taking into consideration 4% of planted area due for replanting and a basic calculation of OPT per hectare is 74.48 tonnes (dry weight), the estimated biomass from OPT is: 187,600 hectares (4%) x 74.48 tonnes = **13.97 million tonnes of OPT**	13.97 million tonnes
5	**Estimated oil palm shell availability in Malaysia** Shell is estimated to be 5.5% of FFB [12] : 0.055 x 90.05 = 4.95 million tonnes Dry weight is 85%of total weight [12] : 0.85 x 1.09 =**4.21 million tonnes of shell**	4.21 million tonnes
6	**Estimated mesocarp fibre availability in Malaysia** Fibre is estimated to be 13.5% of FFB [12] : 0.135 x 90.05 = 12.16 million tonnes Dry weight is 60% of total weight [12] : 0.60 x 12.16 = **7.29 million tonnes of fibre**	7.29 million tonnes

Appendix 2

Biogas potential from EFB Fact Sheet for the Malaysian Palm Oil Industry
(Based on 2009 data derived from MPOB's Malaysian Oil Palm Statistics 2009 and MPOB calculation methodologies)

No	Data and calculation	Estimated Amount
1	**Empty fruit bunch (EFB) availability** [6, 12] FFB yield x planted area : 19.20 x 4.69 = 90.05 million tonnes EFB is assumed to be 22% of FFB : 90.05 x 0.22 = 19.8 million tonnes EFB dry weight is 35% of total weight : 0.35 x 19.9 = 6.93 million tonnes	19.8 million tonnes (wet basis) 6.93 million tonnes (dry weight)
2	**Estimated Total Power Output** [15] Estimated energy at 25% thermal efficiency	**986 MW (wet basis)** **345MW (dry weight)**

Appendix 3

Biogas potential from POME Fact Sheet for the Malaysian Palm Oil Industry
(Based on 2009 data derived from MPOB's Malaysian Oil Palm Statistics 2009 and MPOB calculation methodologies)

No	Data and calculation	Amount
1	**Estimated POME in Malaysia** When 1 tonnes of FFB is processed in the mill, 0.67 tonnes of POME is generated [16,17] Thus the estimated POME generated from 90.05 million tonnes of FFB in Malaysia is: 0.67 x 90.05 million tonnes = **60.3 million tonnes**	60.3 million tonnes of POME
2	**Estimated biogas production in Malaysia** Biogas production is 28m^3 for every m^3 of effluent: [16,17] 28 x 60.3 million tonnes = **1688.4 million m^3**	1688 million m^3 of biogas
3	**Estimated total heat value in Malaysia** Biogas CV at 35^{0}C = 20MJ m^3 [17] 1688 x 20 million MJ* (calorific value of biogas at 35^{0}C) = 33,760 million MJ To convert into MWhr, 1 MWhr = 1MJ/3,600 [17] Thus 33,760 million MJ = 9.38 million MWhr	33,760 million MJ or 9.38 million MWhr
4	**Estimated Total Power Output in Malaysia** 21% of heat input: 0.21 x 9.38 million MWhr [17] = 1.97 million MWhr Assuming power plant operating 300 days/year or 7,200 hours/year: [17] 1.97 million MWhr /7200 hr = **274 MW**	**274 MW**

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