UNOSD Expert Group Meeting
Sustainable Application of Waste-to-Energy in Malaysia

Mohd Ali Hassan
Faculty of Biotechnology and Biomolecular Sciences,
Universiti Putra Malaysia
43400 UPM Serdang Selangor Malaysia

alihas@upm.edu.my
The 3 stages of waste management

1. treatment to meet discharge standards
2. incorporate 3R strategies
3. zero-emission

Landfill, incineration

3Rs - reduce, reuse, recycle

Concept of zero-emission

w2w.. from waste to wealth

b2b.. from biomass to business!
· Merging the 3Ps
· Towards sustainability
  >>>> win-win-win strategy
· Consider the bigger picture
· Develop green technology

Sustainability & Green Technology

Profit

Sustainable Development

People

Planet

Biomass

Problem ➔ Profit
Biomass Resources in Malaysia

- **Wastes? >>> Biomass**
  - renewable organic matter
    - includes forest and mill residues, wood wastes, agricultural crops and wastes, animal wastes and MSW

- Abundant in Malaysia
  - ~ 70 million tonnes collected / year

- Available throughout the year
  - due to high sunlight intensity/time and high rainfall

- Main contributor of biomass is the palm oil industry (ligno-cellulosics)
Palm Oil Industry and Malaysian Socio-Economy

Facts and figures:

• 4.7 million hectares (~10% of Malaysia)
• (more than 50% of Malaysia is rainforest)
• (Malaysia is net carbon absorber/sink)
• 430 mills throughout Malaysia
• Highest oil yielding crop in the world
• Palm oil - Malaysia’s gift to the world!
• USD15 billion export in 2010
• More than 600,000 people employed
• Poverty alleviation
  - land ownership & stable income
  >>> FELDA’s success story (50 years!)

• **Sustainable Development**
  - 3Ps: Profit, People and Planet
  - challenge: “win-win-win” strategy
  - need to address the bigger picture
Malaysian Palm Oil Industry

Fresh Fruit Bunch
70 million tonnes

Palm Kernel Oil
2 million tonnes

Oil Extraction

Crude Palm Oil
15 million tonnes

Renewable Resources

Fiber
8 million tonnes

Shell
4 million tonnes

Empty Fruit Bunch
17 million tonnes

Fronds 80MT!
Trunks 15MT!

Palm Oil Mill Effluent
50 million tonnes
• Biofuel, B5 Programme
• ETP, NKEA Palm Oil and 8 EPPs (low hanging fruits)
• Focus on ↑GNI, ↑Jobs, ↓Carbon
• EPP#5 on Biogas Capture (400 mills by 2020)
• EPP#4 on OER (20.5% to 23% by 2020)
• 20mg/L POME discharge
• 0.15 g/Nm³ mill particulate emissions
## Potential Power Generation from Oil Palm Residues at Palm Oil Mills in Malaysia

<table>
<thead>
<tr>
<th>Type of Industry</th>
<th>Production (Million Tonne)</th>
<th>Residue</th>
<th>Residue product Ratio (%)</th>
<th>Residue Generated (Million Tonne)</th>
<th>Potential Energy PJ</th>
<th>Potential Electricity Generation (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil palm</td>
<td>59.8</td>
<td>EFB @ 65% MC</td>
<td>21.14</td>
<td>12.641</td>
<td>57</td>
<td>520</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fiber</td>
<td>12.72</td>
<td>7.607</td>
<td>108</td>
<td>1032</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shell</td>
<td>5.67</td>
<td>3.390</td>
<td>55</td>
<td>545</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Solid</td>
<td></td>
<td>16.670</td>
<td>220</td>
<td>2098</td>
</tr>
<tr>
<td></td>
<td></td>
<td>POME (3.5t/tCPO or 65% of FFB)</td>
<td></td>
<td>38.870</td>
<td></td>
<td>320</td>
</tr>
</tbody>
</table>
Methane Emission Mitigation

Methane from POME

Anaerobic Ponds 360,000 t/yr
Open Digesters 40,000 t/yr

Greenhouse Gases Emission (15%)

Global Warming Climate Change

Mitigation Methods (e.g. CDM Projects)

Biogas Plant
Bio-energy

Biomass Industries
Bio-products
FELDA Serting Hilir Mill Biogas CDM Project

About 380,000 tons CO₂ reduced in 10 years

Approved by UN CDM
9th March 2009
Renewable Energy (1 MW) to Grid

<table>
<thead>
<tr>
<th>Estimated Costs, RM (million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biogas capture (ponds or tanks)</td>
</tr>
<tr>
<td>Downstream processing (gas scrubber &amp; gas storage)</td>
</tr>
<tr>
<td>Gas engine @ 1000 kW</td>
</tr>
<tr>
<td>Total plant cost</td>
</tr>
<tr>
<td>Yearly maintenance and operation cost</td>
</tr>
</tbody>
</table>

Benefits and revenues generated:

- Internal office use and external lighting (“24/7”)
  >>> reduce diesel cost/usage during mill’s non-operating hours
- Sale of green electricity to TNB @ RM0.30/kWh ~ RM 1 million/yr
- Aeration system to remove remaining BOD
  increased POME treatment efficiency >>> water re-use >>> zero emission!
  + reduced land requirement (~70% of total mill area)
- Estimated sale of CER @€ 10 per tonne CO₂ ~ RM 1 million/yr

(Assumption: mill capacity of 60t FFB/hr and 320 days of operation)
Adding Value to Palm Biomass

- **Paradigm shift towards biomass**
  - Not waste
  - Renewable
  - Sustainable Resource

- **Uncertainties of biomass**
  - Technological proven?
  - Economically feasible?
  - Quality, quantity, availability?

↑ value ladder

fine chemicals
food
fiber
feed
furniture
fertilizer
fuel

Competing use of biomass!
Sustainable Palm Biomass Refinery

- Standardised biomass available “business as usual”
- Empty Fruit Bunch 16 million t/yr
- Palm Oil Mill Effluent 50 million t/yr

“zero emission”

waste-to-wealth

+ water recycling

Compost

Bioplastic (PLA) or Bioethanol

Pre-treatment and Saccharification

Fermentation in bioreactors

Biomass Energy

Biogas, CH₄ (+ Biohydrogen)

Bioplastic (PHA)

Sugars

Bio-acids

Water recycling
Current Issues and Opportunities

- **Carbon footprint** (~1 tCO₂e/tCPO)
- **Water footprint**
- **Energy efficiency**
- **Water footprint**
- **Roundtable for Sustainable Palm Oil (RSPO)**
- **Low-carbon economy**
- **Regional cooperation**
Towards Sustainable Palm Oil Industry in Malaysia

CDM provides a complete methane fermentation system and change lagoon area into a profitable area. CDM provides electricity from methane fermentation system for new business >>> towards zero emission and w2w! (remove “pain” from the industry)

1. Reduction of greenhouse gases emission by sealing the lagoons.
2. Prevention of undesirable smell and water pollution by modern treatment (+ water recycling).
3. Local employment can be encouraged from new business.

CDM provides profitable area for new business to which biomass energy can be supplied from palm oil industry at a reasonable price for new biomass business

Based on the economic growth in Malaysia, the development of new oil palm plantations in the tropical rainforest will soon be no longer feasible. In order to meet the increasing demand for palm oil in the future, palm oil industry must co-exist with other industries and people... >>> 3P (Profit, People, Planet)