Methane Capture and Use Potential at Palm Oil Mills in Indonesia

Methane Expo 2013
Vancouver, Canada
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- Palm oil production and relevant factors
- Generation, characteristics and management of products, subproducts and wastes
- Methane use potential scenarios
- Transaction options in Indonesia
- Key barriers and conclusions
List of Abbreviations

- **BOD**  Biochemical Oxygen Demand
- **CH₄**  Methane
- **COD**  Chemical Oxygen Demand
- **CO₂**  Carbon Dioxide
- **CO₂e**  Carbon Dioxide Equivalent
- **CPO**  Crude Palm Oil
- **EFB**  Empty Fruit Bunch
- **FFB**  Fresh Fruit Bunch
- **GHG**  Greenhouse Gas
- **POME**  Palm Oil Mill Effluent
Indonesia palm oil production

• ~2 million km²; 17,500+ islands; ~250 million people (2012 est.)
• GHG emissions: 1.8 billion tons CO₂e (2005)
• 1ˢᵗ palm oil producer in the world (2ⁿᵈ = Malaysia)
• 2012 production = ~25 million tons CPO (~18 million tons for export)
• Main plantation areas:
  – Sumatra (~65%)
  – Borneo (~30%)
Indonesia palm oil sector structure

• Organizations:
  – Indonesia Palm Oil Board (IPOB)
  – Indonesian Palm Oil Association (GAPKI)
  – Indonesian Sustainable Palm Oil (ISPO)
  – Mills are members of RSPO

• Structure:
  – 50% State-Owned Companies
  – 50% private
  – ~600 mills (~400 in Sumatra)
Representative mills in Indonesia

- Nominal production capacity of 30, 45, 60 and 90 tons/hr
- Process between 200,000 and 600,000 tons/yr of FFB
- Privately owned mill have higher productivity levels.
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Palm oil fruit

Fresh Fruit Bunch (FFB)
~ 100 fruits/FFB

Empty Fruit Bunch (EFB)

Mesocarp → palm oil + fiber
Endocarp → shell
Kernel → kernel oil
Indonesia palm oil products, sub-products and waste generation

General characteristics:
- **CPO** = 20-25% of FFB w/w (product)
- **POME** = 45-65% of FFB m³/t (effluent) or ~2.4 m³ POME/ton CPO
- **EFB** = 20% of FFB w/w (EFB = 20% stalk + 80% spikelets) (used as fertilizer or incinerated)
- **Fibers** = 10-13% of FFB w/w (can be used in boilers)
- **Shells** = 5-7% of FFB w/w (can be used in boilers)
- **Biomass** = 35-40% of FFB w/w
- Also biomass at the plantation: fronds, trunks
Characteristics and management of POME

POME characteristics:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Average</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>4.1</td>
<td>3.3-4.6</td>
</tr>
<tr>
<td>POME – COD (mg/L)</td>
<td>50,000</td>
<td>30,000-80,000</td>
</tr>
<tr>
<td>POME – BOD (mg/L)</td>
<td>25,000</td>
<td>15,000-40,000</td>
</tr>
<tr>
<td>TS (mg/L)</td>
<td>45,000</td>
<td>16,000-95,000</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>20,000</td>
<td>1,500-50,000</td>
</tr>
</tbody>
</table>

- POME characteristics are unique for each mill and depend on production levels, extraction process, and characteristics of the FFB
- Multiple conventional anaerobic lagoons with depth greater than 3m, often 4-6 m
## Direct methane emissions from POME in Indonesia

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Production - CPO</td>
<td>25 million tons/year</td>
</tr>
<tr>
<td>Wastewater generation</td>
<td>2.5 m³ per ton of CPO</td>
</tr>
<tr>
<td>Chemical Oxygen Demand</td>
<td>50 kg/m³</td>
</tr>
<tr>
<td>Lagoon use</td>
<td>95%</td>
</tr>
<tr>
<td>Methane conversion factor</td>
<td>0.8</td>
</tr>
<tr>
<td>Max methane producing capacity</td>
<td>0.25 kg CH₄/kg COD</td>
</tr>
<tr>
<td><strong>Direct methane emissions</strong></td>
<td>~ 12.5 million tons of CO₂e</td>
</tr>
</tbody>
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Methane use scenarios

The methane captured can be used to generate:

- thermal energy in boilers
- electricity for the mill and/or to sell to the local grid

Viability depending on mill’s characteristics:

- electricity versus thermal energy needs
- shell generation
- capacity of the existing boiler
- distance to the grid
Scenario 1: Use existing boilers

- Cost of digester and new burner: ~US$ 1.1 million
- O&M expenses: ~US$ 130,000
- Annual net revenues: ~ US$400,000
- Almost two thirds of the revenues come from selling the shells which are currently burned in boilers
Scenario 2: Sell electricity to LV grid

- Total investment cost: ~US$2.6 million
- O&M expenses: ~US$ 450,000
- Price to sell electricity: 0.147 USD/kWh
- Electricity generation: ~7,500 MWh/year
- Net revenues: US$ 1 million per year
Scenario 3: Sell electricity to MV grid (20kV)

- Total investment cost: ~US$ 2.9 million
- O&M expenses: ~US$ 450,000
- Price to sell electricity: 0.108 USD/kWh
- Electricity generation: ~7,500 MWh/year
- Net annual revenues: ~US$ 600,000
# Summary of analysis

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Total cost</th>
<th>IRR</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - use biogas in existing burner and sell shells</td>
<td>1,050,000</td>
<td>37%</td>
<td>3,187,736</td>
</tr>
<tr>
<td>2 - use biogas to generate electricity and sell to the low voltage grid (interconnect to nearest town)</td>
<td>2,615,862</td>
<td>37%</td>
<td>7,886,289</td>
</tr>
<tr>
<td>3 - use biogas to generate electricity and sell to the medium voltage grid (interconnect with nearest 20 kV line)</td>
<td>2,897,181</td>
<td>19%</td>
<td>3,663,249</td>
</tr>
</tbody>
</table>
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Alternative transaction options for biogas projects in Indonesia

1. The POM owner develops and finances the project by himself and utilizes expert consultants/EPC contractor to design, build, and operate the facility over time on a fee for services basis.

2. The IPP developer Builds, Owns, and Operates the facility for 10-15 years before Transferring (BOOT) the plant back to the POM owner and assuming all technology risks and responsibilities for arranging financing typically on a project finance basis.

3. The IPP developer enters into a Joint Venture (JV) arrangement with the POM owner whereby the mill owner provides land, access to the site, use of the waste stream, and a corporate guarantee in return for a negotiated share of the profits.

4. Special Purpose Biogas Company established to develop, own and operate multiple, bundled biogas project opportunities on a project finance basis.

5. Joint Venture Investment Company in Concert with an owner of multiple POMs to develop bundled biogas project assets.
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Key barriers and challenges to biogas projects from POME

- Incomplete legal and regulatory framework
- Limited models of successful biogas projects and successful projects to prove concept
- Project developers and financial institutions lack understanding of each other’s requirements and constraints
- Not their primary line of business - dilution of facility resources
- Bad experience, particularly with covered lagoons - failure of some CDM projects
- Access to the grid - revenue stream is key in making the project feasible
Conclusions

• Large replication potential in Indonesia (1st palm oil producer in the world, current use of open lagoons for POME)

• Viability of biogas projects – Best option depends on mills characteristics:
  – generate electricity for the mill or sell to the local grid (low- or medium-voltage)
  – generate thermal energy in boilers

• Need to bundle viable projects
Indonesian Government to Revoke Palm Oil Licenses Without Sustainable Credentials

March 11, 2013

The Indonesian government is ready to revoke the licenses of palm oil companies in the country if they do not have an Indonesian Sustainable Palm Oil certificate by 2014, a high-level official at the Agriculture Ministry said on Thursday.

"Because it is mandatory, there will be sanctions. We could revoke the licenses of palm oil companies that do not have the ISPO," said Gamal Nasir, director general for plantations at the ministry.

The Indonesian government introduced the ISPO several years ago, setting a standard to ensure that palm oil producers will not add to deforestation and destruction of carbon-rich peat lands because of their activities.
Thank you!

For more information, please contact:

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