Economic Feasibility of Biomass Utilization for Power Generation

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What is biomass and how is it formed?

$6H_2O + 6CO_2 \rightarrow C_6H_{12}O_6 + 6O_2$

Cellulose, H-cellulose, Lignin

Stored energy

Food for Human Being

Carbohydrate

House Hold & Industrial Use

MSW

Biomass 1

Biomass 2
Energy transformation

Energy

Biomass 1

MSW

Biomass 2

Source of Energy
Biomass is the Source of Fuels, Chemicals, Materials & Power

- **Fuels**
- **Chemicals**
- **Materials**
- **Power**

**Millions of years**

1. **Biogenesis**
2. **Metagenesis**
3. **Catagenesis**
Objective

Overall objective is to reduce millions of years to zero year.

Modern technology
Barriers of Biomass Utilization for Power Generation

Problem with Collection, transportation and storage

**Characteristics**
1. Flappy
2. Low density
3. Too moist

**Problems**
1. Collection
2. Transportation
3. Storage

**Pretreatment**
1. Drying
2. Pelletizing

Additional cost
### Problem with conventional technology

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</thead>
<tbody>
<tr>
<td><strong>Combustion steam cycle</strong></td>
<td>&lt;20%</td>
<td>High</td>
<td>Low</td>
<td>Large</td>
</tr>
<tr>
<td><strong>Gasification steam cycle</strong></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td><strong>Gasification engine cycle</strong></td>
<td>&gt; 35%</td>
<td>Moderate</td>
<td></td>
<td>Less than 50%</td>
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<tr>
<td></td>
<td>&gt; 60% (CHP)</td>
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</table>

- **Gasification engine cycle**
  1. Efficiency > 35%
  2. Efficiency > 60% (CHP)
  3. Investment – Moderate
  4. Land space - Less than 50%
Barriers ........Cont...

Problem with Governmental policies

Example - Malaysia

• Malaysian has policy to utilize biomass for power generation; however, it is slow process and is not friendly to private investor.

• Exporting huge oil palm biomass as pellet but not giving support to utilize it by private sectors for power generation.
Barriers ....... Cont...

Problem with Capital Investment
Example - Malaysia

Investor → Foreign Technology Provider
Expensive

Investor → Foreign tech and Local fabricator
Expensive

Power plant
How to make biomass power technology economically feasible?

- Double the overall efficiency half is the total requirement and costing.
- Investor friendly governmental policy.
- Investor must have expert human capital.
- Investor must have own fabrication facilities.
- Investor friendly financing policy.
How to multiply the efficiency?

Downdraft gasifier with catalytic hot gas cleaning

Clean gas

Gas engine

Efficiency, 90%

Overall $\eta_{el}$, 35%

Heat recovery, 30%

Efficiency, 40%

Total efficiency for CHP = 65%
Investor friendly governmental policy

• Government must give incentive to the investor and buy the privately produced electricity with reasonable price.

• Government must give national grid facilities to supply electricity.

• Malaysia has both of the facilities.
Cost down by the expert human capital and self-fabrication facilities

• If an investor can develop expert human capital and equipment fabrication facilities, the capital cost would be less than half for setting up a power plant.

• The investor should jointly work with University expert team to jointly develop the technology.
An example to show how the biomass power production is feasible.

Example: Malaysian palm oil mill

<table>
<thead>
<tr>
<th>Total FFB process Ton/day</th>
<th>CPO, Ton/day</th>
<th>EFB, Ton/day</th>
<th>Meso-carp, Ton/day</th>
<th>PKS, Ton/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>200 (20%)</td>
<td>220 wet (22% of FFB)</td>
<td>140 wet (14% of FFB)</td>
<td>60 wet (6% of FFB)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>66 dry (30% of wet)</td>
<td>84 dry (60% of wet)</td>
<td>51 dry (85% of wet)</td>
</tr>
</tbody>
</table>
### Example: Energy to be converted to electricity

<table>
<thead>
<tr>
<th>Total Biomass produced in a mill Ton /day</th>
<th>Total energy content MJ</th>
<th>Heat transfer to gas (90% eff) MJ</th>
<th>Heat transfer to electricity with 35% gas engine efficiency, MJ</th>
<th>Power plant can be built with 35% eff, MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>201</td>
<td>$3.5 \times 10^6$</td>
<td>$3.1 \times 10^6$</td>
<td>$1.1 \times 10^6$</td>
<td>$12.7$</td>
</tr>
</tbody>
</table>
Example: Heat recovery for steam and power production

<table>
<thead>
<tr>
<th>Total exhaust gas to be produced, Ton/d</th>
<th>Exhaust gas temperature, °C</th>
<th>Heat recovery MJ</th>
<th>Steam power, MW</th>
<th>Heat recovery in steam for mill, MJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1335</td>
<td>500</td>
<td>534000</td>
<td>3</td>
<td>7.9 x 10^5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total power production MW</th>
<th>Gross Annual revenue, RM, Million</th>
<th>Gross annual revenue from CPO RM, Million</th>
<th>15 MW Power plant CAPEX RM, Million</th>
<th>Payback period Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.7</td>
<td>64.5</td>
<td>140</td>
<td>80-90</td>
<td>2.3</td>
</tr>
</tbody>
</table>
Picture of Complete Gasifier
Figure 1. A schematic diagram of the prototype gas cleaning and conversion process for electricity generation.
Model of Biomass Power for Island of Maldives
Conclusion

- Biomass based power generation faces a number of challenges.
- The challenges can be overcome by combined effort of expert groups, investor and government.
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Thank You