Case Study: Bagasse Cogeneration Development in Thailand’s Sugar Industry

For How2Guide for Bioenergy
**Business Units of MITR PHOL GROUP**

Mitr Phol has 7 business units, including Thai Sugar Business, China Sugar Business, ASEAN Business, Energy Business, Particle Board Business, Logistic Business and Australia Business.

<table>
<thead>
<tr>
<th>Business Unit</th>
<th>Details</th>
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</table>
| **Thai Sugar Business** | 6 Thai Sugar mills  
- Crushing Capacity: 175 k TCD  
- Refinery Capacity: 7.72 k Ton/Day  
- Liquid sugar 400 Ton/Day |
| **Wood Substitute Material Business** |  
- Particle board: 400 k m³  
- MDF: 300 k m³ |
| **Energy Business** |  
- 6 Power Plants: 410 MW  
- 4 Ethanol Plants: 1,160 k Liter/day |
| **China Business** | 7 China Sugar Mills  
- 1 Pulp & Paper Factory  
- 1 Power Plant: 32 MW  
- Crushing Capacity: 87.5 k TCD  
- Refinery Capacity: 2.6 k Ton/Day  
- Pulp & Paper: 60 k Ton/Day |
| **ASEAN Business** |  
- Lao Sugar mill: Crushing 5 k TCD  
- Lao Power Plant: 9 MW |
| **Logistics Business** | UST: Port and warehouse service provider |
| **Australia Sugar Business** |  
- 4 Sugar mills  
- Crushing Capacity: 33.5 k TCD  
- Power Capacity 44 MW |

Note: Plant capacity based on 2012/13
Biomass in Thailand
Thailand Biomass-Based Power Generation Potential

Potential Electricity Capacity (MW)


- Palm oil residues: 43 MW
- Coconut: 43 MW
- Distillery slop: 49 MW
- Corn cob: 54 MW
- Rice husk: 100 MW
- Wood residues: 950 MW
- Biogas: 1185 MW
- Bagasse: 1900 MW
Power Cogeneration in Sugar Mills

Sugar Cane -> Sugar Mill -> Sugar

- Juice 73%

Bagasse 27%

Bagasse Storage -> Fuel -> New Power House

Power and Steam

Excess Power -> National Grid
How does a High Pressure System Work?

High Pressure Boiler and TG

280 kg. Bagasse

16 bar 360° C

Sugar Mill

0.56 ton steam @ 16 bar

0.45 ton steam @ 1.2 bar

35 kWh

1 ton Cane

Sugar Mill

0.65 ton steam @ 100 bar

35 kWh

1 ton Cane

High Pressure Boiler and TG

Low Pressure Boiler and TG

280 kg. Bagasse

100 bar 510° C
Energy Balance Comparison

High Pressure Boiler and TG

- Process Steam: 65%
- Process Used Power: 14%
- Exported Power: 12%
- Loss: 9%

Low Pressure Boiler and TG

- Process Steam: 66%
- Process Used Power: 22%
- Exported Power: 10%
- Loss: 2%
Development of Co-Generation in Thailand’s Sugar Industry

1992
First SPP regulation was announced

1997
First SPP by sugar mills

2001
Start feasibility study of high pressure co-generation

2004
- First high pressure co-generation in sugar mills
- First PPA achieving firm contract

2012
First 105 bar 525°C co-generation in sugar mills
Comparison of Electricity Output from different sugar mills

<table>
<thead>
<tr>
<th></th>
<th>kWh/Ton Cane</th>
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<tbody>
<tr>
<td>Thailand Average</td>
<td>17</td>
</tr>
<tr>
<td>Dan Chang Y2004</td>
<td>72</td>
</tr>
<tr>
<td>Dan Chang Y2012</td>
<td>85</td>
</tr>
<tr>
<td>Phu Luang 2013</td>
<td>100</td>
</tr>
<tr>
<td>World Best</td>
<td>130</td>
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</tbody>
</table>
MITR PHOL COMPLEX OVERVIEW

**Particle Board**
54,000 T/y

**Ethanol Plant**
500,000 L/d

**Bio-Energy (Power Plant)**
- 400,000,000 KWh/y
- 2,500,000 Tons Steam/y

**Sugar Mill**
3,500,000 TC/y

**Cane Crushing Capacity**
32,000 T/D

**PPA with EGAT (Firm)**
- 27 MW+
- 10 MW

**Carbon Credits**
- 93,000 (tCO₂/yr)
- 102,000 (tCO₂/yr)

**Steam Generating Capacity**
- 710 Ton/hr
- 600 Ton/hr

**Power Generating Capacity**
- 64 MW
- 76 MW
Major Technical Attractions

• First high-pressure boiler turbo-generator in ASEAN sugar industry

• Boiler efficiency over 90 % (LHV basis)

• Cogeneration thermal efficiency over 70 %

• High flexibility in operation

• High electricity export to the grid: 6 times more

• Multi-fuel firing capability

• Water-cooled vibrating grate furnace

• Modern monitoring & control system (DCS)
Favorable Environmental Impacts

Stack emission: Cleaner air
- Particulate: 20 - 50 ppm (120)
- NOx: 120 - 160 ppm (350)
- SOx: 0 - 8 ppm (320)

Solid waste: Recycle back to farm
ashes from boiler can be used as soil improvement substance.

Global Warming: Reduce green house gas
- Grid emission factor: 500 kg CO₂/ 1 MWH
Socio-Economic Benefits

Increased business activities in the local community

More jobs have been created

Created value added to many agricultural waste

New technology transfer to the industry

Reduction of the nation’s import of fossil fuel for power generation
Challenges

- Technical Challenges
- Operation Challenges
- Financial Challenges
- Management Challenges
Technical Challenges: Seasoning Operation

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<tr>
<th></th>
<th>Crushing</th>
<th>Remelting</th>
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</thead>
<tbody>
<tr>
<td>Steam Consumption, ton/hr</td>
<td>550</td>
<td>160</td>
</tr>
<tr>
<td>Power Consumption, MW</td>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td>Bagasse Production, ton/day</td>
<td>8700</td>
<td>0</td>
</tr>
<tr>
<td>Operation Period, months</td>
<td>4 (Dec-Mar)</td>
<td>8 (Apr-Nov)</td>
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What capacity should the biomass power plant be?
Operation Challenges: Fuel Handling System

- Bottleneck
- Storage area
- Moisture control
- FIFO system
- Dust control
- Transportation

How to handle thousands ton of biomass storage?
Financial Challenges

Security arrangements:

- Mortgage of all land, building and equipment to the bank
- Assignment of PPA (DCB vs. EGAT) 21 yrs firm contract
- Assignment of Utilities Supply Agreement (DCB vs. Mitr Phol)
- Corporate guarantee of the loan
- All risk insurance for equipment & all assets in the name of the creditors

Exchange Rate Risk

- All foreign contracts had been converted to local currency loan.

Project Implementation Risk

- Fix price lump sump
- Fix time turnkey

Income

- Energy payment, indexed to natural gas price
- Capacity charge, indexed to Dollar exchange rate
- Carbon credit from CDM project
## Management Challenges

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<thead>
<tr>
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<th>Current</th>
<th>New Scheme</th>
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<tr>
<td><strong>Main Concern</strong></td>
<td>Internal production</td>
<td>External customer</td>
</tr>
<tr>
<td><strong>Efficiency</strong></td>
<td>Less priority</td>
<td>Major concern</td>
</tr>
<tr>
<td><strong>Engineering</strong></td>
<td>In-house</td>
<td>Out-source</td>
</tr>
<tr>
<td><strong>Investment</strong></td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td><strong>People</strong></td>
<td>Sugar industry</td>
<td>Power plant</td>
</tr>
<tr>
<td>• Recruitment</td>
<td></td>
<td></td>
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<tr>
<td>• Compensations</td>
<td></td>
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<tr>
<td><strong>Communication</strong></td>
<td>Informal</td>
<td>Formal</td>
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Need a new management concept!
Key Success Factors Implementing Large Scale Biomass Power Plant

- Close to the major source of feed stock
- Own most of its feed stock (> 80%)
- Co-generation configuration (use process steam)
- Being supported by strong Government policy
- Having economies of scale
- Strong support from top management
Questions & Comments