Waste Management of Coal Fired Power Plant

Potential Utilization of Bottom Ash

A Case Study of Tanjung Bin Power Plant
Content

Part 1: Introduction of Malakoff

Part 2: Tanjung Bin Coal Fired Power Plant

Part 3: Potential Utilization of Bottom Ash
our vision
To be a leading Power & Water Provider

our mission
In striving to enhance stakeholders’ value and achieve our vision, we seek to:
• Develop and utilise local expertise;
• Share knowledge and spur the growth of the power and water sectors; and
• Promote innovation in all aspects of our business.

MALAKOFF

corporate values
• Integrity
• Teamwork
• Innovation
• Excellence
• Harmony
Overview of Malakoff

- Core businesses: Power generation, water desalination, power plant O&M services, electricity distribution, project management
- Staff strength > 700; more than one third engineers
- Privatized in 2007 by major shareholder MMC Corporation Berhad

NETT CAPACITY OF 5,020 MW

Malakoff 5,020 MW 25%
TNB & other IPPs 14,703 MW 75%
Malakoff Shareholders

- MMC Corporation Berhad ("MMC")
- Employees Provident Fund
- Kumpulan Wang Persaraan (Diperbadankan)
- Standard Chartered IL & FS Asia Infrastructure Growth Fund Company Pte Limited
- SEASAF Power Sdn Bhd
Our Key Strengths

1. Leading IPP in Malaysia with strong track record.

- Premier power generation company in Malaysia.
- International-standard Long-term PPAs and high credit quality counterparties.
- Established management team with unparalleled expertise in development and operations.
- Strong, local Shareholder Group committed to tap growth opportunities.
Our Key Strengths

2. Positioned to Leverage on Growth Opportunities

- Strong outlook for power and water demand in key markets.
- Upside potential from existing and identified new projects.
- Solid capital structure to fund growth opportunities.
- Active pursuit of renewable energy projects (solar, biogas, wind).
Malaysian Portfolio

Port Dickson Power Station
- 25% (440 MW) Open cycle gas turbine (peaking plant)

Kapar Power Station
- 40% (2,420 MW) Coal, oil and gas-fired (baseload and peaking plant)

GB3 Power Plant
- 75% (640 MW) Combined cycle gas turbine (baseload plant)

Prai Power Plant
- 100% (350 MW) Combined cycle gas turbine (baseload plant)

Lumut Power Plant
- 93.75% (1,303 MW) Combined cycle gas turbine (baseload plant)

Tanjung Bin Power Plant
- 90% (2,100 MW) Coal-fired (baseload plant)

Under-construction: Tanjung Bin Energy (1,000MW) Supercritical Coal-fired plant
Power & Desalination Plants Overseas
Leveraging existing experience from developing and acquiring assets in Malaysia.

Focus on Power and Water Concessions as an Equity Investor and/or O&M Operator in the Middle East, North Africa and South Asia.

To date, equity ownership of over 330 MW and 194,000 m³/day.

O&M services to Shuaibah Phase III IWPP in Saudi Arabia with capacity of 900MW & 800,000 m³/day.

O&M services (together with Hyflux) for 200,000 m³/day water desalination plant in Algeria.
Operation & Maintenance Services
Malakoff operates and maintains its own power plant through its wholly owned O&M arm, Teknik Janakuasa Sdn Bhd (TJSB).

O&M Services include:
- O&M Training Services and Technical Support
- Supply of O&M Specialists
- Implementation of O&M tools and methodologies
- Project Engineer
- Owner’s Engineer
- Technical Due Diligence
- Project Development and Design Review
## O&M Portfolio

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Configuration</th>
<th>Generating Capacity (MW)</th>
<th>Generation Type</th>
<th>COD</th>
<th>O&amp;M Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segari Energy Ventures</td>
<td>6 x 143.3 (GT)</td>
<td>1303</td>
<td>CCGT (Once-through)</td>
<td>1996</td>
<td>15</td>
</tr>
<tr>
<td>Lumut Power Plant (LPP) Malaysia</td>
<td>2 x 221.5 (ST)</td>
<td></td>
<td>OCGT</td>
<td>2001</td>
<td></td>
</tr>
<tr>
<td>GB3 (LPP Block 3) Malaysia</td>
<td>3 x 143.3 (GT)</td>
<td>651</td>
<td>CCGT (Cooling Tower)</td>
<td>2002</td>
<td>21</td>
</tr>
<tr>
<td>Malaysia</td>
<td>1 x 221.5 (ST)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prai Power Plant, Malaysia</td>
<td>1 x 230 (GT)</td>
<td>350</td>
<td>CCGT (Single Shaft)</td>
<td>2003</td>
<td>21</td>
</tr>
<tr>
<td>Malaysia</td>
<td>1 x 120 (ST)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Tanjung Bin Power Malaysia</td>
<td>3 x 700 (Coal)</td>
<td>2,100</td>
<td>Coal Fired</td>
<td>2006</td>
<td>25</td>
</tr>
<tr>
<td>Total O&amp;M Portfolio</td>
<td></td>
<td>4,404</td>
<td></td>
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</tr>
</tbody>
</table>

### International

<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>Az Zour, Kuwait</td>
<td>5 x 160 (GT)</td>
<td>800 MW</td>
<td>OCGT</td>
<td>2008</td>
<td>5</td>
</tr>
</tbody>
</table>

### O&M Via Subcontracting

<table>
<thead>
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<th>Plant Name</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Shuaibah-III</td>
<td>3 x 300 (thermal)</td>
<td>900 MW</td>
<td>IWPP</td>
<td>2009</td>
<td>20</td>
</tr>
<tr>
<td>Water and Electricity Company, Saudi Arabia</td>
<td>880,000 m3/day</td>
<td></td>
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</tbody>
</table>

### O&M Via Partnership

<table>
<thead>
<tr>
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<th>COD</th>
<th>O&amp;M Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Souk Tleta, SWRO Plant, Algeria</td>
<td>13 x RO Train</td>
<td>200,000 m3/day</td>
<td>IWP</td>
<td>2009</td>
<td>20</td>
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</tbody>
</table>

### Completed O&M Contract

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Configuration</th>
<th>Generating Capacity (MW)</th>
<th>Generation Type</th>
<th>COD</th>
<th>O&amp;M Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gebeug</td>
<td>3 x 36 (GT)</td>
<td>108</td>
<td>COGEN</td>
<td>1999</td>
<td>5</td>
</tr>
<tr>
<td>Kerteh</td>
<td>6 x 36 (GT)</td>
<td>216</td>
<td>COGEN</td>
<td>1999</td>
<td>5</td>
</tr>
</tbody>
</table>
Part 2: Tanjung Bin Coal Fired Power Plant (CFPP)
## Plant Highlights

<table>
<thead>
<tr>
<th>Type of Plant</th>
<th>Conventional Thermal Power Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Fuel:</td>
<td>Pulverized Coal</td>
</tr>
<tr>
<td>Start Up Fuel:</td>
<td>Light Fuel Oil</td>
</tr>
</tbody>
</table>

### Plant Capacity

- **Generation Net Capacity**: 3 x 700 MW

### Owner

| Tanjung Bin Power | Teknik Janakuasa Sdn. Bhd |

### O&M Contractor

#### Commercial Operation Dates

- **Unit 1**: 28 September 2006
- **Unit 2**: 28 February 2007
- **Unit 3**: 31 August 2007

### Transmission Works

- **Substation**: Bukit Batu 500/275kV
- **500kV Transmission Line**: Tanjung Bin to Bukit Batu (approx. 70km)
- **275kV Transmission Line**: Tanjung Bin to Y-junction (approx. 10km)
The largest privately owned Coal fired power plant at the tip of the Eurasian continent.

Mukim Serkat, Daerah Pontian, Johor Darul Takzim

1°20’05.41”N, 103°32’28.45”E
Typical Process Flow of CFPP
Coal Combustion Byproducts - Ash

Fly Ash

Bottom Ash
Bottom Ash in Malaysia

- Bottom Ash - classified under Scheduled Waste SW 104 (Environmental Quality Act)
  - Dust, slag, dross or ash containing aluminum, arsenic, mercury, lead, cadmium, chromium, nickel, copper, vanadium, beryllium, antimony, tellurium, thallium or selenium excluding slag from iron and steel factory.

- Fly Ash
  - Easily marketable due to better engineering and commercial value

- Bottom Ash & residual Fly Ash are stored in ash pond

- Lifetime capacity of ash pond is reduced over time, leading to building of more ash pond
  - Current practiced by almost all CFPPs
Coal Ash Storage: Ash Pond
CFPP Challenges in Malaysia

- Usage of Fly Ash is pronounced but development on the utilization of Bottom Ash still uncharted
- Regulation requirements
- CFPP involvement into non-core business investment
- Bottom Ash product **barriers to entry** (intellectual property, product differentiation, economies of scale, marketing channel)
Global Bottom Ash Utilization
UK Regulation: A Comparison

- Environment Agency’s stand:
  - Power generation by-products are considered as waste in all circumstances

- Many applications using have been exempted from waste management licensing, promoting the use of Fly Ash and Bottom Ash

- Approvals are given on case-by-case basis – Contractor wishing to utilize Fly Ash and Bottom Ash have to submit their proposals including the Environmental Risk Assessment (ERA) for approval
Global Coal Ash Utilization: UK

Aerial view of a brick manufacturing plant

Brick manufacturing facility
Global Coal Ash Utilization: US

Bottom Ash Application in US in 2007

Source: American Coal Ash Association (ACAA)

Road base material
Global Coal Ash Utilization: Europe

Utilization of Coal Combustion Product in Europe (2009)

- Cement raw material
- Concrete addition
- Non-aerated concrete blocks
- Grouting
- Reclamation, Restoration
- Blended cement
- Aerated concrete blocks
- Bricks + ceramics
- Other uses
- Temporary stockpile

Lightweight concrete block

Source: European Coal Combustion Products Association (ECOBA)
Global Coal Ash Utilization: India

- Dry ash extraction-cum-disposal in the form of ash mound
- Conversion into ash mound or recreational park in the vicinity of Power Plant
Wastes to Opportunities

**Case for change:**
- Ash pond lifetime depletion
- Proven development in other countries
- Abundant availability of materials
Potential Opportunities Malaysian CFPP

- Substitute for raw materials for concrete block, paver brick, lightweight concrete
- Substitute for sand, steel slag or quarry dust
- Aggregate replacement in road construction

Key Success Factor

- Continuous support from Authorities
- Smart partnership with technology provider
- Understanding the demand in construction sector
- Sustainable strategy (cost leadership vs. product differentiation)
# Environmental Benefit

## Key Features

<table>
<thead>
<tr>
<th>Natural resources</th>
<th>Substitute for river sand</th>
</tr>
</thead>
</table>
| Ash storage       | Sustainable solution for ash dumping issue  
|                   | Avoidance of new landfill requirement |

## Carbon Emission Reduction

<table>
<thead>
<tr>
<th>Product</th>
<th>GHG Emission (tonne CO2e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom Ash Brick</td>
<td>0.501</td>
</tr>
<tr>
<td>Cement/Sand Brick</td>
<td>2.718</td>
</tr>
<tr>
<td>Clay Brick</td>
<td>52.249</td>
</tr>
</tbody>
</table>

Source: Based on typical brick manufacturing production, Malakoff Corporation Berhad
## Technological Benefit

<table>
<thead>
<tr>
<th>Key Features</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Application</strong></td>
<td>Alternative for sand usage in construction industry</td>
</tr>
<tr>
<td><strong>Strength enhancement</strong></td>
<td>Improved compressive strength as compared to sand brick (if brick product)</td>
</tr>
<tr>
<td><strong>Product differentiation</strong></td>
<td>Low density of Bottom Ash creates lighter product</td>
</tr>
</tbody>
</table>
# Economic Benefit

<table>
<thead>
<tr>
<th>Key Features</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product Cost</strong></td>
</tr>
<tr>
<td><strong>Green funds</strong></td>
</tr>
<tr>
<td><strong>Ash Pond</strong></td>
</tr>
</tbody>
</table>
**Iskandar Development Region, Johor**

- It is estimated to have 1.35 million people by 2025 or 43% of Johor's population of 3.17 million.
- It has been designated by the Malaysian Government to be a prime hub for nine economic clusters which will be given special focus and offer excellent investment opportunities such as in manufacturing and services.

**RAPID Project, Johor**

- It is expected to draw RM120 billion in investments during the next five to six years.
- Poised to trigger economic activities for Pengerang, creating thousands of jobs in view of the massive spin-offs from ancillary and supporting services.

**Singapore**

- Rapid Transport System (RTS), which would connect Singapore with Johor Bahru in southern Malaysia.
- Construction of a new underground road tunnel between Malaysia and Singapore is under study.

2: NST July 16, 2012
3: Singapore Infrastructure Market Q2 2012
Opportunities for Bottom Ash as construction product is still untapped – option for Malakoff green product

Driven by an initiative to provide solution in Bottom Ash waste storage issues faced by CFPP

Strategic location of Tanjung Bin CFPP as an inherent opportunity

Malakoff is identifying and pursuing attractive opportunities due to benefit in:

- Environmental quality
- Avoidance of future Bottom Ash landfill area
- Savings on natural resources (earth materials, energy)

In line with Malakoff CSR commitment in Environment, Community Services
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