Financial Model Presentation

Techno-Economic Assessment & Financial Payment Regime

Deep Seabed Mining Payment Regime

Workshop #3: Exploring a Financial Model and Related Topics

Wednesday, April 19 – Friday, April 21

Grand Copthorne Waterfront, Singapore

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Disclaimer

• Not “only” model, not “industry” model, just “a” model to show interdependencies between variables (Priority #2, ISA, July 2015)

• Some assumptions are substantiated, others are for sake of comparison or simplicity.

• Model is based on #32 variables introduced in London (2016) during the workshop #2;

• Indicated values within a tolerance of +/- 25%.

• Values are subject to future environmental, financial and exploitation regulations.

• The proposed financial payment regime is from a total-cost perspective.

• Similar input is requested from other contractors, which would support the timely development of a financial payment regime.
Methods
Techno-economic assessment (TEA)

1. Decide on project boundaries;
2. Decide on realistic development schedule;
3. Determine capital expenditures & operational expenditures from a total-cost perspective;
4. Forecast commodity prices;
5. Identify uncertain model inputs and assign a probability distributions;
6. Develop economic model in Excel;
7. Apply Monte Carlo Risk Analysis software (Oracle Crystal Ball ®) and model +10,000 simulations;
8. Results: Compare Internal Rate of Return (IRR) vs Hurdle Rate (HR).
1.a Project boundaries of this model

• Commercially oriented venture (not strategic project!)
  ✓ Project needs to show investment potential (IRR) compared to other investment opportunities (HR)
  ✓ Step-by-step de-risking strategy to attract investors according to reporting standards
  ✓ Focus on being the low-cost producer to increase competitiveness
  ✓ Timing is everything: E.g. Regulatory delays are detrimental

• Three million tonnes of (dry) polymetallic nodules (E.g. 4 Mtpa wet)

• Four-metal operation (Ni, Cu, Co, Mn)

• Vertically integrated project consortium from seabed to market, as no market will exist for intermediates in the nearby future
1.b De-risking: Reporting standards
Techno-economic assessment (TEA)

1. Project boundaries
2. **Realistic schedule**
3. Capital expenditures & operational expenditures from a total-cost perspective
4. Forecast commodity prices
5. Identify uncertain model inputs and assign a probability distributions
6. Develop economic model in Excel
7. Apply Monte Carlo Risk Analysis software (Oracle Crystal Ball ®) and model 10,000 simulations
8. Results: Compare Internal Rate of Return (IRR) vs Hurdle Rate (HR)
2. Schedule

Most contractors would be in this phase

Contract with conditions based on draft EIA and plan for feasibility testing.
Techno-economic assessment (TEA)

1. Project boundaries
2. Realistic schedule
3. Capital expenditures & operational expenditures from a total-cost perspective
4. Forecast commodity prices
5. Identify uncertain model inputs and assign a probability distributions
6. Develop economic model in Excel
7. Apply Monte Carle Risk Analysis software (Oracle Crystal Ball ®) and model 10,000 simulations
8. Results: Compare Internal Rate of Return (IRR) vs Hurdle Rate (HR)
3. Case study input (1/3)

<table>
<thead>
<tr>
<th>Project timing and phases</th>
<th>Variability</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-feasibility</td>
<td>4 years</td>
<td>-</td>
</tr>
<tr>
<td>Feasibility</td>
<td>5 years</td>
<td>-</td>
</tr>
<tr>
<td>Construction</td>
<td>3 years</td>
<td>-</td>
</tr>
<tr>
<td>Production phase-in period</td>
<td>2 years</td>
<td>Uniform (1-3y)</td>
</tr>
<tr>
<td>Operational mine life</td>
<td>25 years (net)</td>
<td>Uniform (20-30y)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project production data</th>
<th>Variability</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual tonnes of nodules collected</td>
<td>3 x 10^6 tpa (dry) or +/− 4 x 10^6 tpa (wet)</td>
<td>-</td>
</tr>
<tr>
<td>Metal ore content(^a)</td>
<td>Ni = 1.30%; Cu = 1.10%; Co = 0.21%; Mn = 27.00%</td>
<td>-</td>
</tr>
<tr>
<td>Recovery / Yield</td>
<td>Ni = 95%; Cu = 95%; Co = 85%; Mn = 90%</td>
<td>-</td>
</tr>
<tr>
<td>Annual tonnes of metal produced</td>
<td>Ni = 37,050 tpa; Cu = 32,400 tpa; Co = 6.375 tpa; Mn = 769,500 tpa</td>
<td>-</td>
</tr>
</tbody>
</table>
### 3. Case study input (2/3)

<table>
<thead>
<tr>
<th>Capital expenditures</th>
<th>Variability</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-feasibility</td>
<td>35 x 10^6 USD</td>
<td>-</td>
</tr>
<tr>
<td>Feasibility</td>
<td>325 x 10^6 USD</td>
<td>-</td>
</tr>
<tr>
<td>Collection system(s) capex</td>
<td>584 x 10^6 USD</td>
<td>Triangular (+/-25%)</td>
</tr>
<tr>
<td>Surface vessel(s) capex</td>
<td>692 x 10^6 USD</td>
<td>Triangular (+/-25%)</td>
</tr>
<tr>
<td>Processing plant capex</td>
<td>2.415 x 10^9 USD</td>
<td>Triangular (+/-25%)</td>
</tr>
<tr>
<td>Recapitalization estimates</td>
<td>Included</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annual operational expenditures</th>
<th>Variability</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection system(s) opex</td>
<td>Incl. in Surface vessel(s) opex</td>
<td>-</td>
</tr>
<tr>
<td>Surface vessel(s) opex</td>
<td>325 x 10^6 USD</td>
<td>Triangular (+/-25%)</td>
</tr>
<tr>
<td>Processing plant opex</td>
<td>670 x 10^6 USD</td>
<td>Triangular (+/-25%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Financial project data</th>
<th>Variability</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hurdle rate</td>
<td>18%</td>
<td>-</td>
</tr>
<tr>
<td>Depreciation schedule</td>
<td>25 years, straight-line</td>
<td>Uniform (20-30y)</td>
</tr>
<tr>
<td>Inflation commodity prices</td>
<td>0.0%&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Inflation operational costs</td>
<td>0.0%&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-</td>
</tr>
</tbody>
</table>
3. Case study input (3/3)

<table>
<thead>
<tr>
<th>Regulatory costs</th>
<th>Variability</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration license application fee</td>
<td>0.5 x 10^6 USD</td>
<td>-</td>
</tr>
<tr>
<td>Exploration license annual fee</td>
<td>47.0 x 10^3 USD</td>
<td>-</td>
</tr>
<tr>
<td>Exploitation license application fee</td>
<td>1.0 x 10^6 USD</td>
<td>-</td>
</tr>
<tr>
<td>Exploitation annual fee</td>
<td>0.1 x 10^6 USD</td>
<td>-</td>
</tr>
<tr>
<td>Ad-Valorem royalty (light vs full)</td>
<td>2 - 4%</td>
<td>Uniform (0-6%/2-8%)</td>
</tr>
<tr>
<td>Environmental bond</td>
<td>Total cost – Incl. in Ad-Valorem</td>
<td>-</td>
</tr>
<tr>
<td>Environmental liability trust fund</td>
<td>Total cost – Incl. in Ad-Valorem</td>
<td>-</td>
</tr>
<tr>
<td>Seabed sustainability fund</td>
<td>Total cost – Incl. in Ad-Valorem</td>
<td>-</td>
</tr>
<tr>
<td>Corporate tax rate of the sponsoring State(s)</td>
<td>25% [Weighted Avg.]</td>
<td>Uniform (20-30%)</td>
</tr>
</tbody>
</table>

<sup>a</sup> weight percentages

<sup>b</sup> The cost escalation is offset by the price escalation

<sup>c</sup> The corporate tax will be payable in the different countries where the consortium will be operational. [E.g. (Pre-)Processing plants in different locations]
Techno-economic assessment (TEA)

1. Project boundaries
2. Realistic schedule
3. Capital expenditures & operational expenditures from a total-cost perspective
4. Forecast commodity prices
5. Identify uncertain model inputs and assign a probability distributions
6. Develop economic model in Excel
7. Apply Monte Carlo Risk Analysis software (Oracle Crystal Ball ®) and model 10,000 simulations
8. Results: Compare Internal Rate of Return (IRR) vs Hurdle Rate (HR)
4.a – US Historical Inflation rate (1987-2016)

Price deflation (2016 = 100%)

Cumulative deflator index

Year

Historical Inflation Rate (used by GSR - based on Consumer Price Index)

Polymetallic Nodules Moving Averages [Deflated in USD/tonne]

Maximum/Minimum of 10-year moving average, incl. trend

thirty years representing 1.5 commodity cycles
Techno-economic assessment (TEA)

1. Project boundaries
2. Realistic schedule
3. Capital expenditures & operational expenditures from a total-cost perspective
4. Forecast commodity prices
5. **Identify uncertain model inputs and assign a probability distributions**
6. Develop economic model in Excel
7. Apply Monte Carlo Risk Analysis software (Oracle Crystal Ball ®) and model 10,000 simulations
8. Results: Compare Internal Rate of Return (IRR) vs Hurdle Rate (HR)
5. Assigning probabilities and ranges

Example: The probability of a commodity price being high, is the same as it being low. (symmetrical)

Example: The probability of the capex being X is highest, while it may be X-5, or X+5, although this probability is much lower.
Techno-economic assessment (TEA)

1. Project boundaries
2. Realistic schedule
3. Capital expenditures & operational expenditures from a total-cost perspective
4. Forecast commodity prices
5. Identify uncertain model inputs and assign a probability distributions
6. Develop economic model in Excel
7. Apply Monte Carle Risk Analysis software (Oracle Crystal Ball ®) and model 10,000 simulations
8. Results: Compare Internal Rate of Return (IRR) vs Hurdle Rate (HR)
6. Economic model in Excel
**CONTRACTOR**

Annual Tonnes of Nodules Collected [DRY]

<table>
<thead>
<tr>
<th></th>
<th>3,000,000 dry tonne nodules/annum</th>
</tr>
</thead>
</table>

**CAPITAL EXPENSES AND DURATION (CAPEX)**

[Investment costs are uniformly divided over the dev. years]

<table>
<thead>
<tr>
<th>Investment cost</th>
<th>Development Period</th>
<th>Equity vs Debt</th>
<th>Residual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>mln USD</td>
<td>Years</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Pre-Feasibility Phase [PFS]</td>
<td>15</td>
<td>6</td>
<td>100%</td>
</tr>
<tr>
<td>Feasibility Phase [FS]</td>
<td>325</td>
<td>4</td>
<td>100%</td>
</tr>
<tr>
<td>Design &amp; Build - Collection System</td>
<td>584</td>
<td>3</td>
<td>40%</td>
</tr>
<tr>
<td>Design &amp; Build - Surface Vessels</td>
<td>692</td>
<td>3</td>
<td>40%</td>
</tr>
<tr>
<td>Design &amp; Build - Processing plant</td>
<td>2,415</td>
<td>40%</td>
<td>15%</td>
</tr>
<tr>
<td>Total (All-In)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operational costs</th>
<th>Operational costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>mln USD/annum</td>
<td>USD/tonne</td>
</tr>
<tr>
<td>Collection System</td>
<td>125,0</td>
</tr>
<tr>
<td>108</td>
<td></td>
</tr>
<tr>
<td>Processing Plant</td>
<td>125</td>
</tr>
<tr>
<td>Depreciation of Design &amp; Build CAPEX</td>
<td>125</td>
</tr>
<tr>
<td>Total</td>
<td>1,139</td>
</tr>
</tbody>
</table>

Recapitalization Estimates

<table>
<thead>
<tr>
<th>Working Capital Percentage of Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA</td>
</tr>
<tr>
<td>NA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SCHEDULE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Years</td>
<td></td>
</tr>
<tr>
<td>Start of Exploration contract</td>
<td>1</td>
</tr>
<tr>
<td>Start of Exploitation contract</td>
<td>7</td>
</tr>
<tr>
<td>Start of Production</td>
<td>14</td>
</tr>
<tr>
<td>Production Phase-In Period</td>
<td>200</td>
</tr>
</tbody>
</table>

**FINANCIAL PROJECT DATA**

<table>
<thead>
<tr>
<th>Rate [%]</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Financing Cost Early-Stage Equity</td>
<td>52,00%</td>
</tr>
<tr>
<td>Financing Cost Mid-Stage Equity</td>
<td>40,00%</td>
</tr>
<tr>
<td>Financing Cost Late-Stage Equity</td>
<td>15,00%</td>
</tr>
<tr>
<td>Financing Interest Rate</td>
<td>7,00%</td>
</tr>
<tr>
<td>Weighted Average Cost of Capital [WACC]</td>
<td>13%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rate [%]</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation of costs [Goods &amp; Services]</td>
<td>0,00%</td>
</tr>
</tbody>
</table>
### TENURE PERIOD
- Operational Mine Life: 35 years [Equals the depreciation period]

### Exploration
- Exploration License Application Fee: 300,000 USD [Paid before PFS]
- Annual admin fee during Exploration License: 47,600 USD/annum [Paid as from exploration license] (NA)

### Exploitation
- Exploitation License Application Fee: 1,000,000 USD [Paid before FS]
- Annual admin fee during Exploitation License: 300,000 USD/annum [Paid as from exploration license]
- Minimum Fixed fee during Exploitation License: 1,000,000 USD/annum [As from production, minimum fee]

### Financial Payment Regime (Total Cost)
- Ad-Valorem before payback period - "Light": 2.0% of (Basket) Revenue [As from production start]
- Ad-Valorem after fixed Period - "Full": 4.0% of (Basket) Revenue [After X years]
- Switch from "light" to "full": 8 years [After discounted payback]
- Social Discount Rate: 2.27% [%]

### Seabed Sustainability Fund
- Rate [%]: 0.0%
- Maximum (min USD): 0

### Environmental Liability Trust Fund
- Rate [%]: 0.0%
- Maximum (min USD): 0

### Environmental Bond
- Rate [%]: 0.0%
- Maximum (min USD): 0

### Sponsoring State
- Corporate income Tax Rate [%]: 0.0%
- % of profit declared in SS: [Possibly a mix of countries]
- Administrative Tax [%]: 0.0%
- % of (Basket) Revenue: [Laws and admin. measures for enforcement] (56)

### Revenues

<table>
<thead>
<tr>
<th>Content</th>
<th>Recovery/Yield</th>
<th>USD Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manganese</td>
<td>2.7%</td>
<td>55%</td>
</tr>
<tr>
<td>Nickel</td>
<td>1.32%</td>
<td>55%</td>
</tr>
<tr>
<td>Cobalt</td>
<td>2.25%</td>
<td>85%</td>
</tr>
<tr>
<td>Copper</td>
<td>2.2%</td>
<td>90%</td>
</tr>
</tbody>
</table>

Inflation of revenue from starting point (2017) [Avg 20% excl. trend]

Rate [%]: 0.00%
Techno-economic assessment (TEA)

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7. Monte Carlo Risk Analysis [VIDEO]
Techno-economic assessment (TEA)

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8. **Results:** Compare Internal Rate of Return (IRR) vs Hurdle Rate (HR)
8.a – Internal rate of return vs. hurdle rate

Operational phase: Risks that remain throughout the project

Development phase: Risks that can be de-risked during PFS & BFS

IRR > HR = Project Go-Ahead

Weighted Average Cost of Capital (WACC)

Net Present Value (NPV)
8. b – Impact of discounting [Example Interest rates]
8.c – Cumulative vs. discounted cashflow

![Cumulative vs. discounted cashflow graph](image-url)
8.d – Cumulative discounted cashflow
8.e – Opportunity cost & Power of discounting

• There is always an opportunity cost – Investors have alternative investment opportunities with different risk & return.

• A higher risk = higher discount rate => major effect on long-term projects.

• Also income obtained via royalties (in case of the ISA) needs to be discounted. However, using a “social discount rate” (SDR). We have used an average SDR according to Drupp et al. (=2.27%)
8.f – Social discount rate

Results
Probability of IRR achieving the HR

- Forecasting scenario: 10y Moving average incl. trend
- Number of trials: 1,000
- Displayed: 994
- Red: Below 18% IRR
- Blue: Above 18% IRR
- Range: 13-23%
Financial Payment Regime
## Financial payment regime: Options (San Diego 2016)

<table>
<thead>
<tr>
<th>Unit-based royalty</th>
<th>Ad-valorem-based royalty</th>
<th>Profit-based royalty</th>
</tr>
</thead>
</table>
| • Fixed rate: USD/tonne  
• Multiplied with unit, or in this case production | • Fixed percentage: %  
• Multiplied with production  
(+ Simple, straightforward, transparent  
(+ Determine basket of metals, measure production, measure grade of mined resource, set-up source for metal prices  
(+ Outcome associated with fluctuations of metal prices  
(- Increased administration compared to production-based royalty | • Fixed percentage: %  
• Multiplied with profit  
(+ Mostly used in mature industries  
(+ Outcome associated with fluctuations of metal prices  
(- Requires heavy administration, cost codes for reporting, auditing of the entire value chain, moving outside the jurisdiction of the ISA  
(- not transparent due to possible transfer pricing |

(+ Very simple, straightforward, transparent  
(+ Only measure production  
(- Outcome not associated with fluctuations of metal prices  
(- least economically efficient  

**Initial system**  

**After industry matures***
Financial payment regime: Formula

\[ \text{Turnover (Mouth of Mine)} = Q_{PN} \times [(Ni\%_{PN} \times Ni \ P_{LME}) + (Cu\%_{PN} \times Cu \ P_{LME}) + (Co\%_{PN} \times Co \ P_{LME}) + (Mn\%_{PN} \times Mn \ P_{CRU})] \]

In which
- \( Q \) = Quantity mined [tonne]
- \( PN \) = Polymetallic Nodules
- \( P_{LME} \) = Average price for Ni, Cu and Co on London Metal Exchange [USD tonne\(^{-1}\)]
- \( P_{CRU} \) = Average price of Mn through Metal Bulletin or CRU [USD tonne\(^{-1}\)]
- \( Ni \) = Nickel
- \( Cu \) = Copper
- \( Co \) = Cobalt
- \( Mn \) = Manganese
Transitional ad-valorem royalty (San Diego 2016)
Transitional ad-valorem royalty (San Diego 2016)

A transitional ad-valorem royalty would incentivize first movers proving the industry, as future capital would be less expensive. [Possibly for a certain period of time]
Given no data is available on the exact discounted break-even point for each contractor, a fixed period should be mentioned in the exploitation contract.
IRR in function of ad-valorem rate (Total-cost)
Questions?

Thank you