**Thermochemical Graphite Synthesis from Carbonized Biomass**

*Group P1*

**The Global Issue**
- 20% of global CO2 emissions come from the transportation sector.

**Our Solution**
- Help replace fossil fuel vehicles with electric vehicles (EV) by manufacturing the graphite that is used in EV batteries.

**Graphite Demand**
- Canada and the US have designated graphite as a critical mineral which highlights the need for a secure, domestic supply.
- Currently, China dominates the global graphite supply chain.

**Bio-Graphite**
- Current graphite synthesis methods use fossil fuels which are environmentally degrading and energy intensive.
- Our approach is to make bio-graphite from pine trees which is a renewable resource and requires less energy.

**Pre-treatment**
- Biomass is chipped to less than 1 mm and dried.

**Carbonization**
- Biomass is carbonized into biochar in the Carbonization Kiln at 650°C under inert conditions.
- Off-gas from the Carbonization Kiln is combusted to provide heat to the Carbonization and Graphitization Kilns.

**Graphitization**
- Reduced iron is added to the biochar and it is graphitized at 1200°C under inert conditions.

**Acid-Washing**
- Graphite and iron are mixed with aqueous HCl in 3 CSTRs in series to form soluble iron chloride.

**Flotation**
- Air is sparged through the Flotation Tank to separate solid graphite particles from the aqueous HCl and iron chloride solution.

**Product Washing and Drying**
- Graphite is washed with water to remove trace HCl contamination. Both graphite and iron chloride are dried by flue gas from upstream units.

**Economics**
- Lifetime of the Plant: 30 years
- NPV: $290.78 MM
- IRR: 22.2%
- Cost of Capital: 5.3%
- Graphite Selling Price for NPV Break-Even: $2,676/tonne

**Sensitivity Analysis Table:** Effect of changing cost of capital and graphite selling price on plant NPV ($MM)

<table>
<thead>
<tr>
<th>Graphite Price ($/tonne)</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
<th>25%</th>
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</tbody>
</table>

**Acknowledgments:**
- Dr. Jim Lim, Mr. Sergio Berretta, Dr. Jonathan Verrett, Dr. Joe Sagues, and Dr. Kevin Kung

**Recommendation:** Proceed with pilot plant construction

**CAPEX**
- $96.87 MM

**OPEX**
- $23.13 MM

**Raw Materials**
- $7.43 MM

**Insurance & Local Taxes**
- $0.65 MM

**Utilities**
- $2.58 MM

**G&A**
- $2.85 MM

**Maintenance**
- $4.61 MM

**Labour**
- $5.00 MM

**Working Capital**
- $4.61 MM

**Indirect Plant Costs**
- $9.31 MM

**Direct Plant Costs**
- $68.32 MM

**Fees & Contingency**
- $14.64 MM

**Busses, cars, and trucks** account for 75% of this.

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**Graphite Price ($/tonne)**

- 5%
- 10%
- 15%
- 20%
- 25%

**Graphite Demand**

Locate next to sawmill for cheaper raw materials. Pine is low in ash content which is beneficial for high purity graphite.

**Bi-Pine Biomass**

104,166 tonne/year

Cost: $50/tonne

99% Pure Graphite

9,294 tonne/year

Sell: $5,000/tonne