



Thermochemical Graphite Synthesis from Carbonized Biomass

Group P1

Alex Frainetti Andrew Liu Priyanthika Adinamozhi Grace Simpson Scott Brooks Hartej Gosal Jasmin Gebauer-Barrett Jackson Buckle

The Global Issue

20% of global CO₂ emissions come from the transportation sector.

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



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

Our Solution

Canada and the US have designated graphite as a critical mineral which highlights the need for a secure, domestic supply.

Graphite Demand

Graphite demand is projected to increase 5-10 times in the next decade.

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.

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



Sierra Nevada, California

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

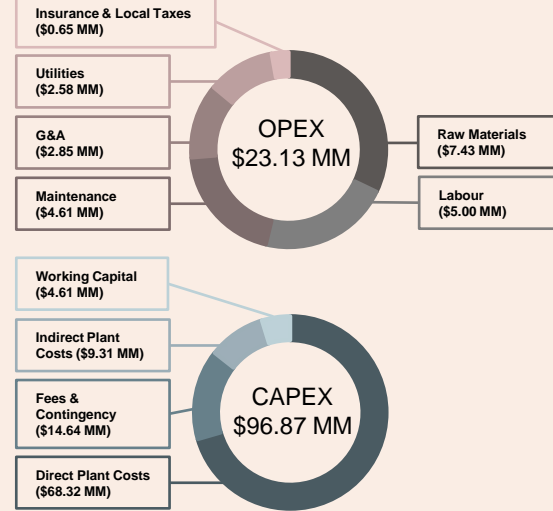
Graphite and iron are mixed with aqueous HCl in 3 CSTRs in series to form soluble iron chloride

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)

Graphite Price (\$/tonne)	Cost of Capital				
	5%	10%	15%	20%	25%
1,000	-285.28	-195.83	-156.12	-135.02	-122.11
3,000	47.52	-13.09	-39.13	-52.17	-59.45
5,000	308.64	128.03	50.54	11.31	-11.23
7,000	568.31	266.93	137.60	72.01	34.17
9,000	827.97	405.81	224.63	132.67	79.54

Pine Biomass
104,166 tonne/year
Cost: \$50/tonne



99% Pure Graphite
9,294 tonne/year
Sell: \$5,000/tonne

Recommendation: Proceed with pilot plant construction