Green Graphite
TECHNOLOGIES

Sustainably Transforming Graphite for use in Lithium-ion Batteries

NAATBatt LITHIUM BATTERY RECYCLING WORKSHOP VII
Montréal, QC Canada
August 7–9, 2024

Company Snapshot

Vision	Be the leading global solution for producing battery-grade graphite from **Natural Flake Graphite** (NFG) & **Recycled Li-ion Batteries** (LiBs)
Business Model	JV Operator & Technology Licensor
Founded	2021 (following 8 years of R&D)
Location	Montréal QC & Kingston ON

Gillian Holcroft, B.Eng., M.Eng.

Co-Founder & CEO

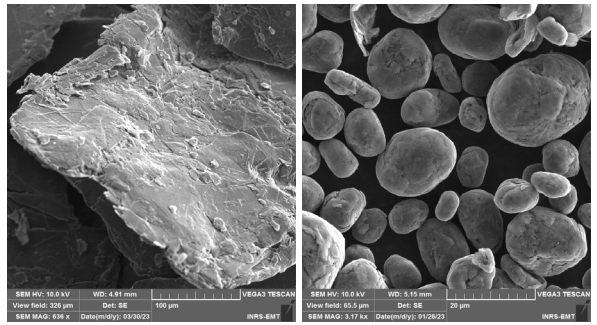
Kevin Watson, PhD., MBA

Co-Founder & CTO

Patented Technologies

GraphPure™

→ Mined Natural Flake Graphite

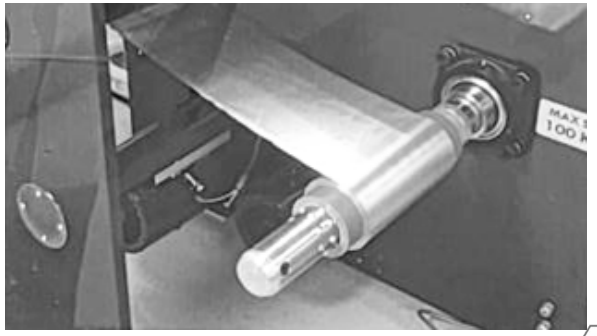


GraphRenew™

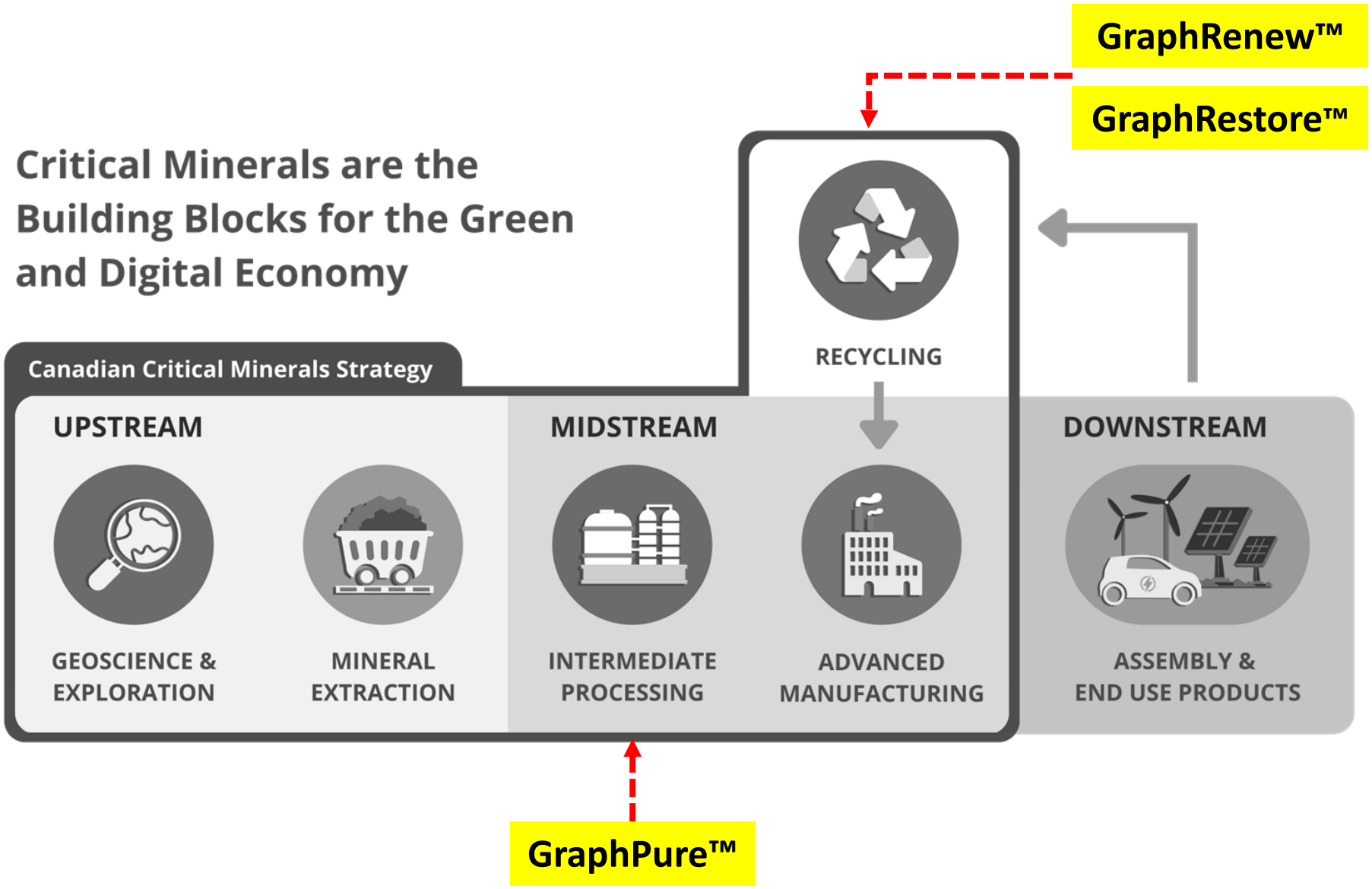
→ Spent Graphite from LiB Recyclers

GraphRestore™

→ Production Scrap from Gigafactories



Patented Technologies



Key Features

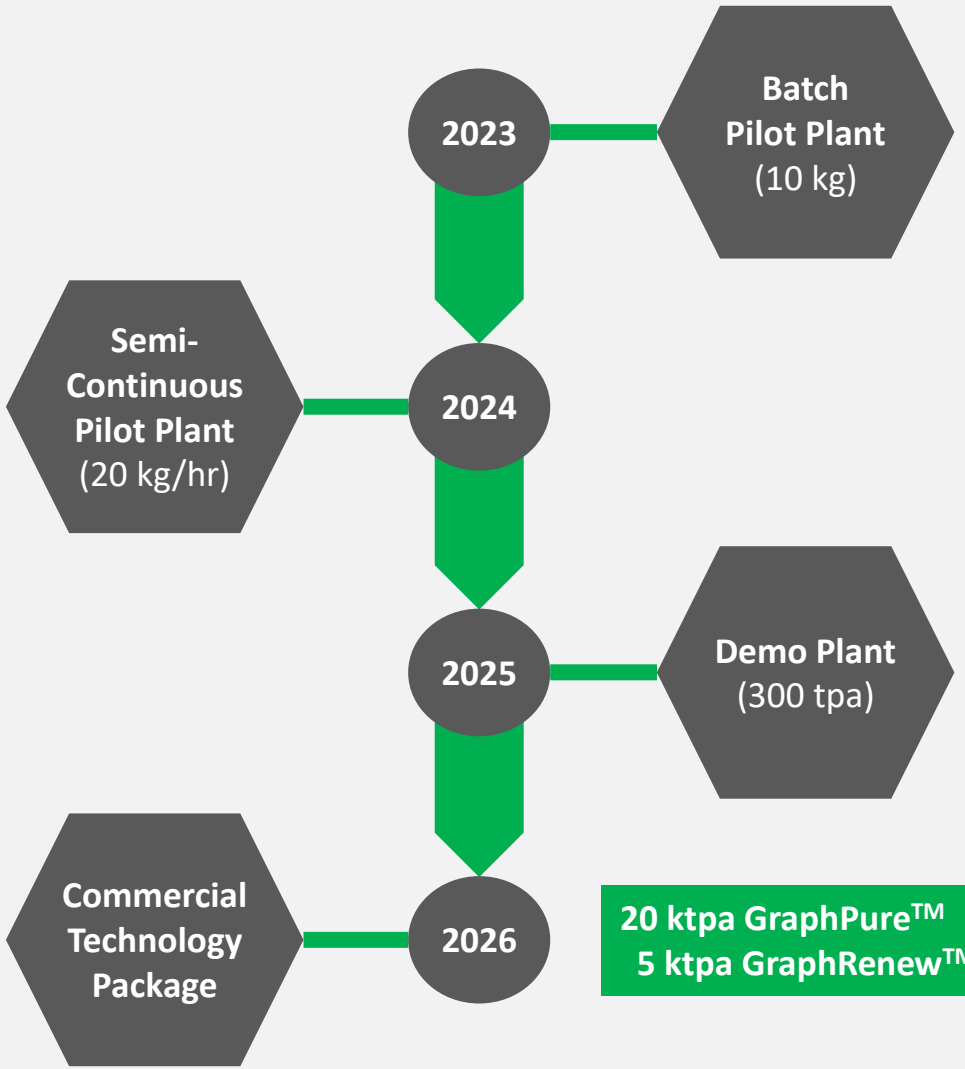
Cost-effective Eco-friendly Solutions

- Techno-economics for various scenarios
- In-situ reagent regeneration
- Use of renewable energy
- Potential for zero carbon footprint
- Minimal waste generation

Enabling Technologies

- GraphPure™ removes purification bottleneck
- Enables domestic supply chains
- No need to ship to and from China
- GraphRenew™ allows graphite recovery
- Enables circular economy

Timeline & Funding



- Technologies proven at lab & pilot-scale (10 kg)
- More than $9M secured for pilot phase
- Systematic technology scale-up plan
- Demo Plant (300 tpa) basic engineering done
- Capex/Opex completed for GraphPure

Global Industry Support

Graphite Miners

NOUVEAU MONDE GRAPHITE

MRC Mineral Commodities

Eagle Graphite

Industry Leaders

KPM Kingston Process Metallurgy Inc.

TARGRAY

RAIN CARBON INC.

LiB Recyclers

AQUA METALS

Cirba® Solutions

COHERENT

ecobat SOLUTIONS

GreenLIB

Lithion

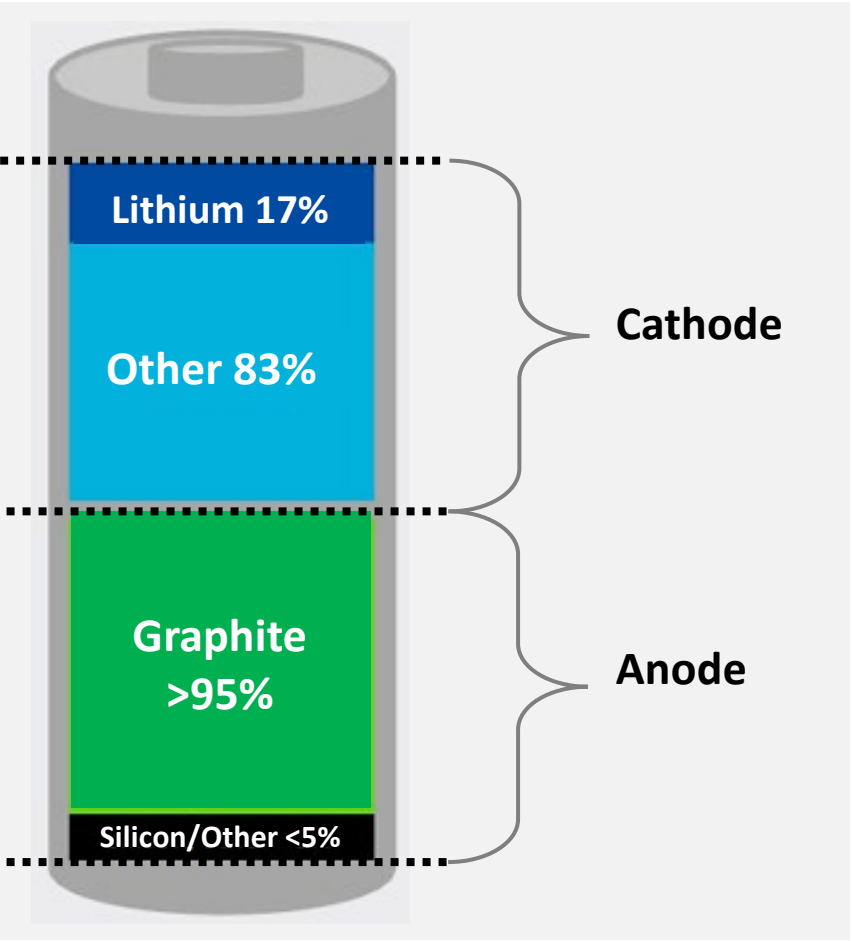
Li-Cycle®

NTH CYCLE

REDWOOD MATERIALS

Primobius

GraphRenew – Why?



Graphite is a Critical Mineral

- >95% of LiB anode is graphite
- Projected LiB demand = massive looming supply gap
- LiB recyclers focused on recovering more valuable metals
- (Li, Ni, Co, and Mn from cathode)

Spent graphite typically sent to a smelter for burning or to landfill

→ **Not consistent with circularity in Critical Mineral supply chains**

GraphRenew Development (2021-2023)

OBJECTIVES

- Investigate recovery of graphite from **Black Mass Residue** produced by LiB recyclers
- Evaluate various processing stages, sequences and operating conditions
- Select most promising option and develop conceptual process flowsheet
- Produce purified graphite meeting LiB spec >99.95 wt% C

BM – Feed As Received

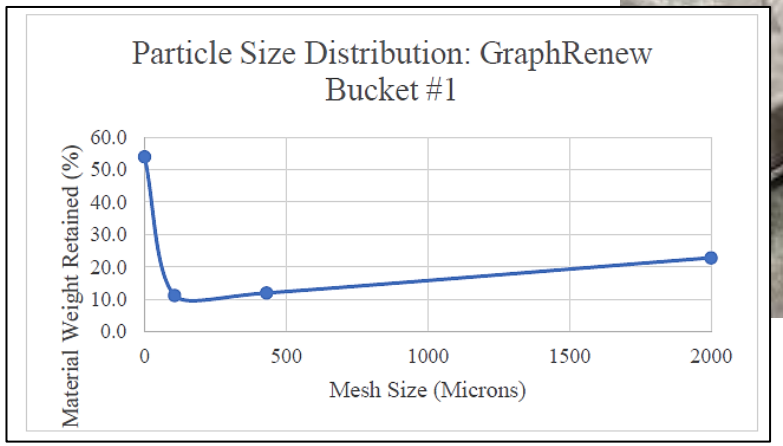
BM – Feed <1mm

GraphRenew Development (2021-2023)

FEED PREPARATION

- Different options explored
- Sieving, deagglomeration, magnetic separation
- Particle size distribution (PSD) measured
- Different samples characterized

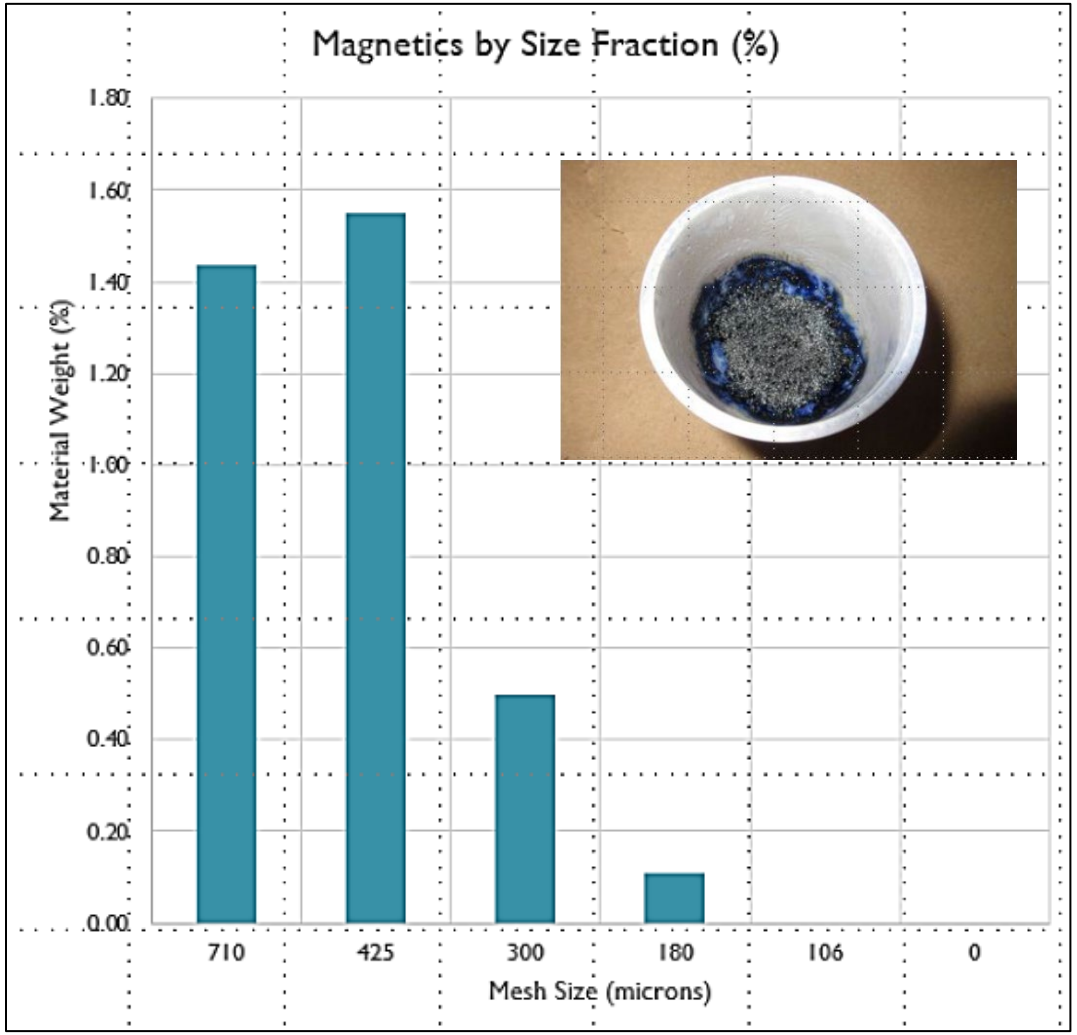
Figure 8 - Bucket #1 <106um, 106um>431um, 431um>2mm, >2mm



GraphRenew Development (2021-2023)

FEED CHARACTERISTICS

- Purity ranged from 46 – 87 wt% C
- (for < 1 mm size)
- Magnetics ranged from 0.50 – 17.9%
- (Depending on sample and size fraction)
- Average magnetics of 0.83% overall



GraphRenew Development (2021-2023)

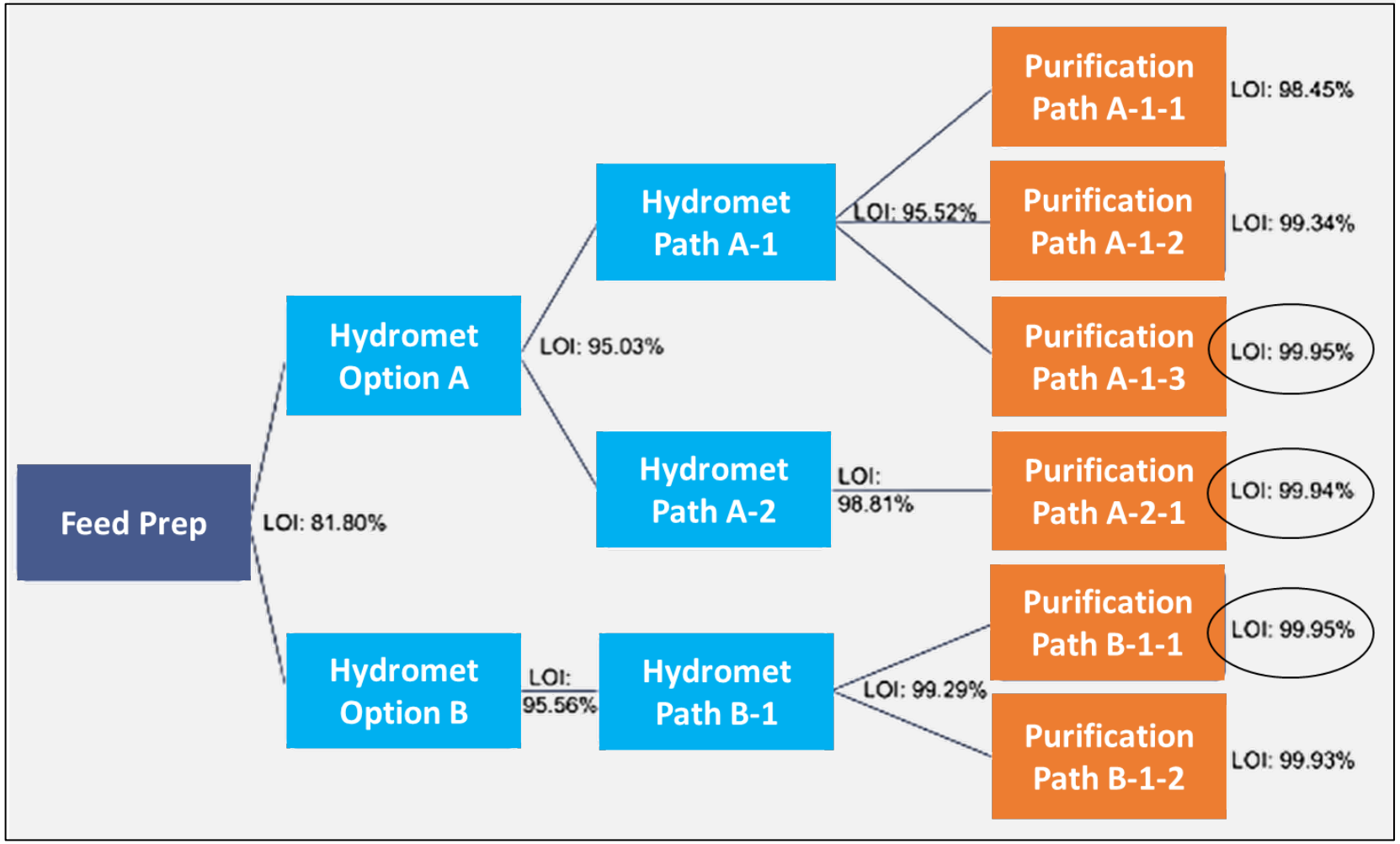
PROCESSING SEQUENCE

- Loss on ignition (LOI) used to measure wt% C
- LOI measured at each stage
- **Pre-purification Hydromet** processes investigated
- **Final Purification** processes investigated
- Different operating conditions evaluated

GraphRenew Development (2021-2023)

TEST SEQUENCE
(Example 1)

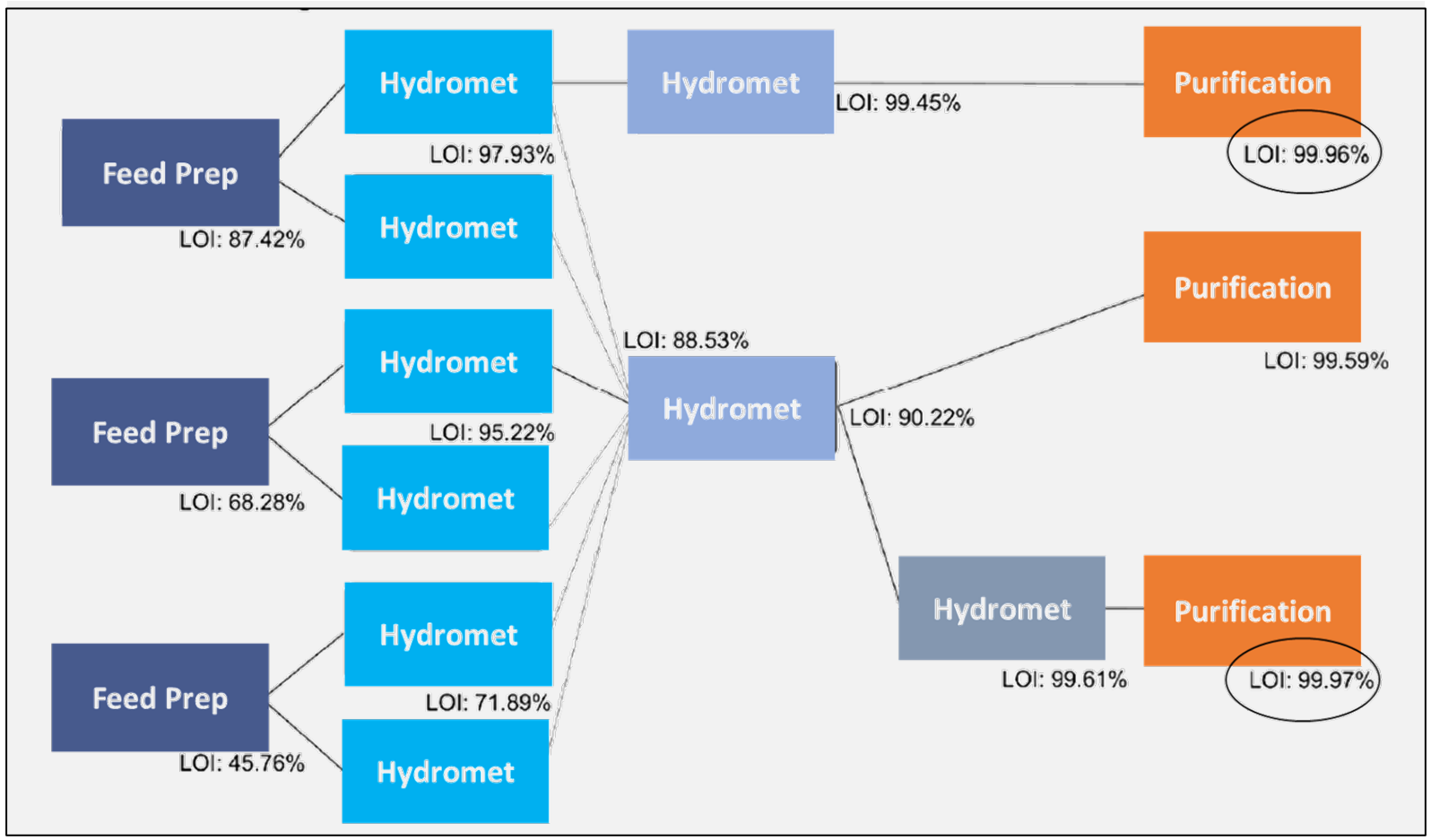
- Optimization of operating conditions
- Selection of optimal sequence



GraphRenew Development (2021-2023)

TEST SEQUENCE
(Example 2)

- Wide range in feed purity
- Even low purity feed can reach spec
- Minimum purity required before final purification



GraphRenew Development (2021-2023)

OTHER RESULTS

- Some aspects require careful considerations in process development
  - Contaminants from battery types with different chemistries (non-LiB)
  - HF release
- Composition of raw and purified black mass residue
  - Metals
  - Carbon black
- Typical graphite characterization
  - Key characteristics are maintained
- Preliminary coin cell results are promising

GraphRenew Development (2024-2026)

FUTURE PLANS

- Demonstrate commercial viability of GraphRenew™
- **Semi-continuous pilot plant (20 kg/hr)** being installed and commissioned
- Treat bulk feed samples of 500 kg
  - Black mass residue from LiB recyclers
  - Manufacturing scrap from LiB manufacturers
- Characterize regenerated graphite
- Adjust properties to LiB specifications
  - PSD, surface area, tap density
- Test electrochemical performance

GGT Competitive Advantages

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