

# Battery Materials Circularity

## Closing the Loop with Advanced Cathode Engineering

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# What we do

We produce **new**, active battery materials that are:

**Custom | Sustainable | High quality & High performance**

From spent **lithium-ion batteries** through our **Hydro-to-Cathode®** technology



NMC CATHODE

Ascend Elements directly **reintroduces** critical **battery materials** to the battery supply chain, **sustainably & efficiently.**

# Ascend Elements At-a-Glance

We are a Massachusetts-based **engineered battery materials company** producing sustainable, high-performance **precursor (pCAM)** and **cathode active material (CAM)**, using the **most efficient** closed-loop recycling **technology**.



**96 Patents Granted or Pending Worldwide**



**4 Facilities in North America**



**350+ Employees Globally**



**Services: Battery disassembly, battery discharging and recycling**



**Business Operations Globally Across N.A., UK, Europe and Korea**



**Products: Lithium Carbonate, pCAM, and CAM**

# The Vision: A Closed Loop

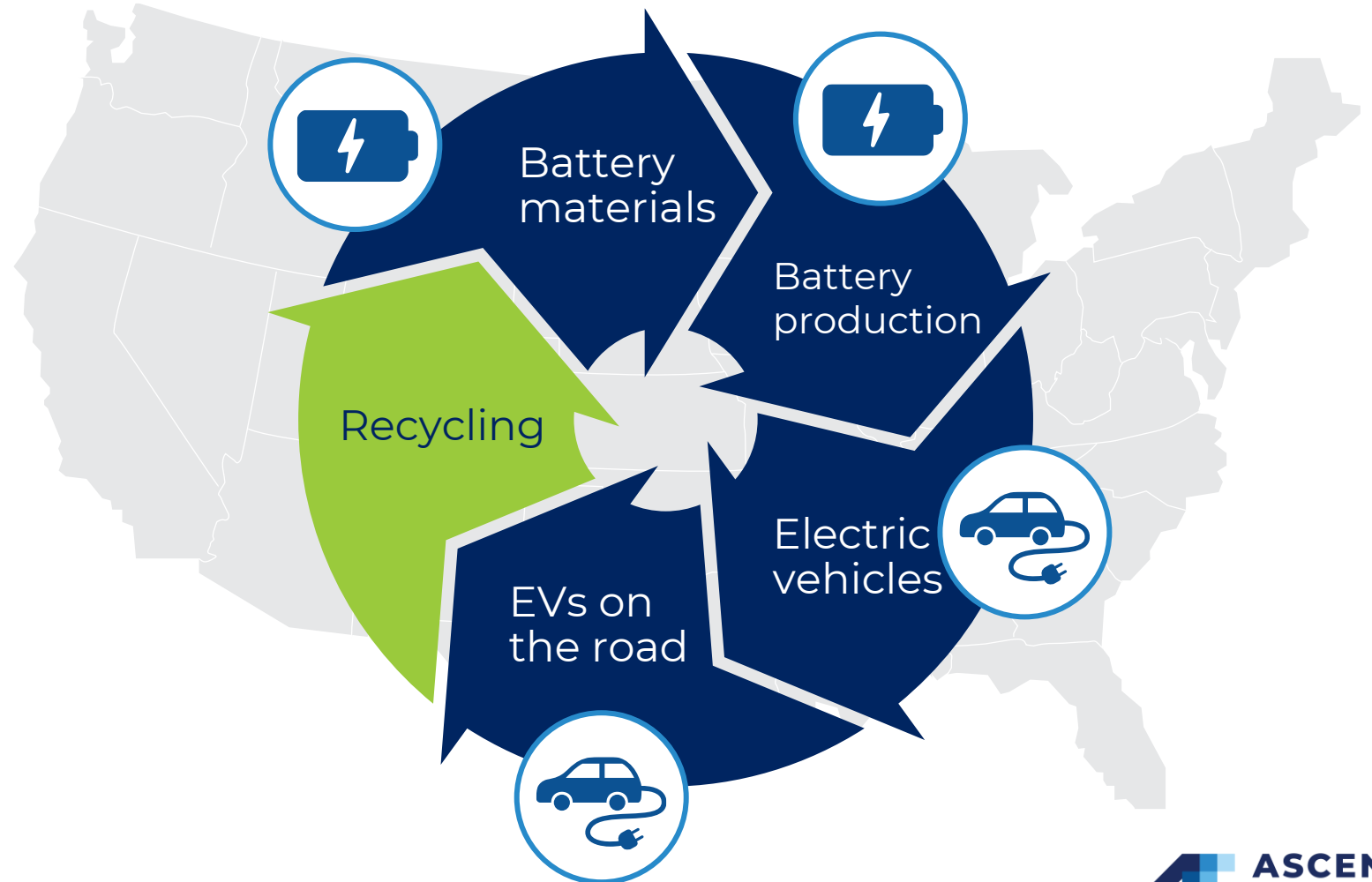
## DOMESTIC CIRCULARITY

Critical battery materials stay in the U.S. battery ecosystem.

Transportation costs and carbon emissions are minimized.

## RESULT:

- Circularity
- Energy independence
- Supply chain security





# The Reality: A Leaky Loop

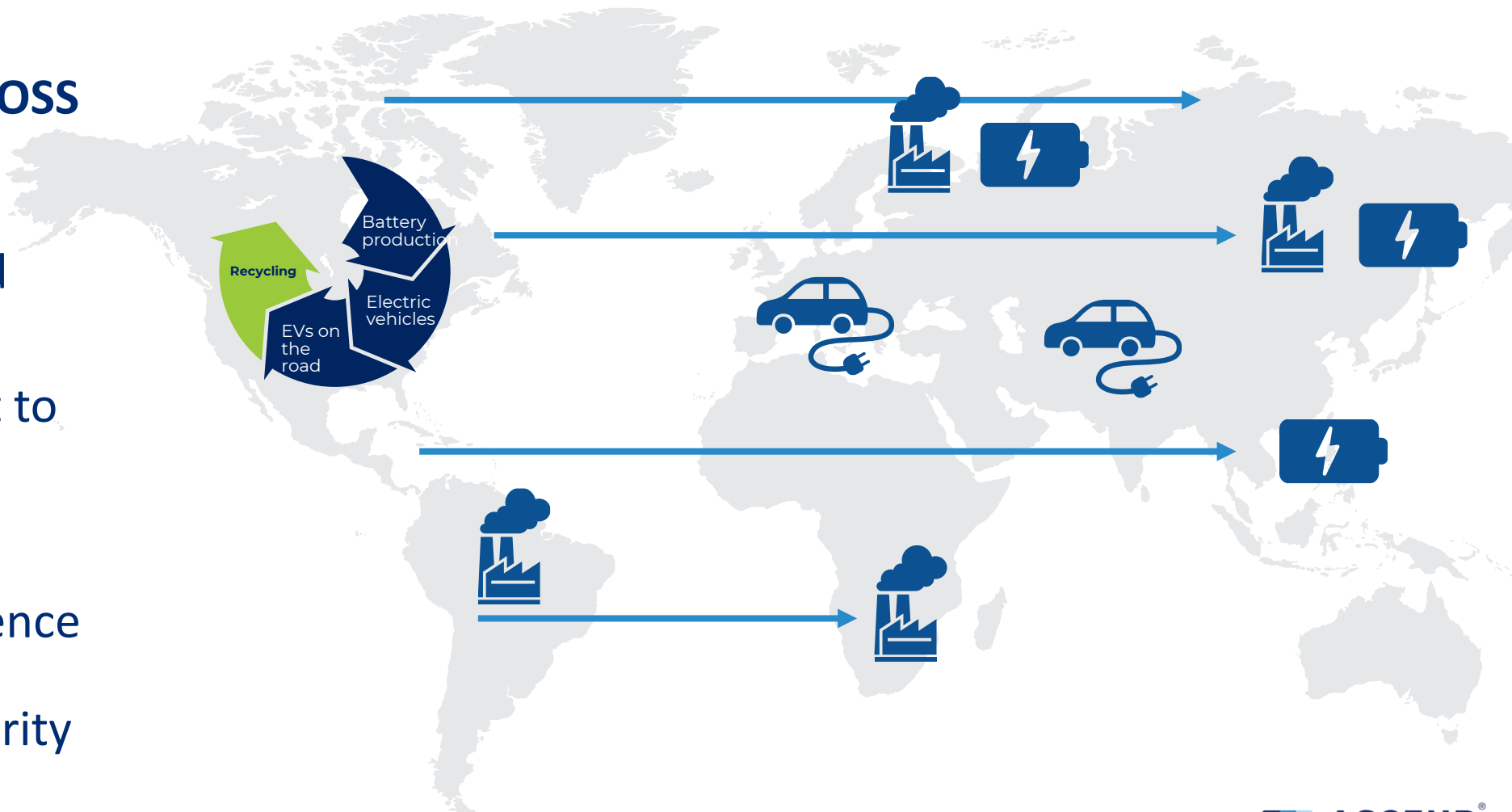
## CRITICAL MATERIAL LOSS

Black mass and metal salts “leak” out of the loop...and are shipped overseas.

Materials are also lost to other industries.

## RESULT:

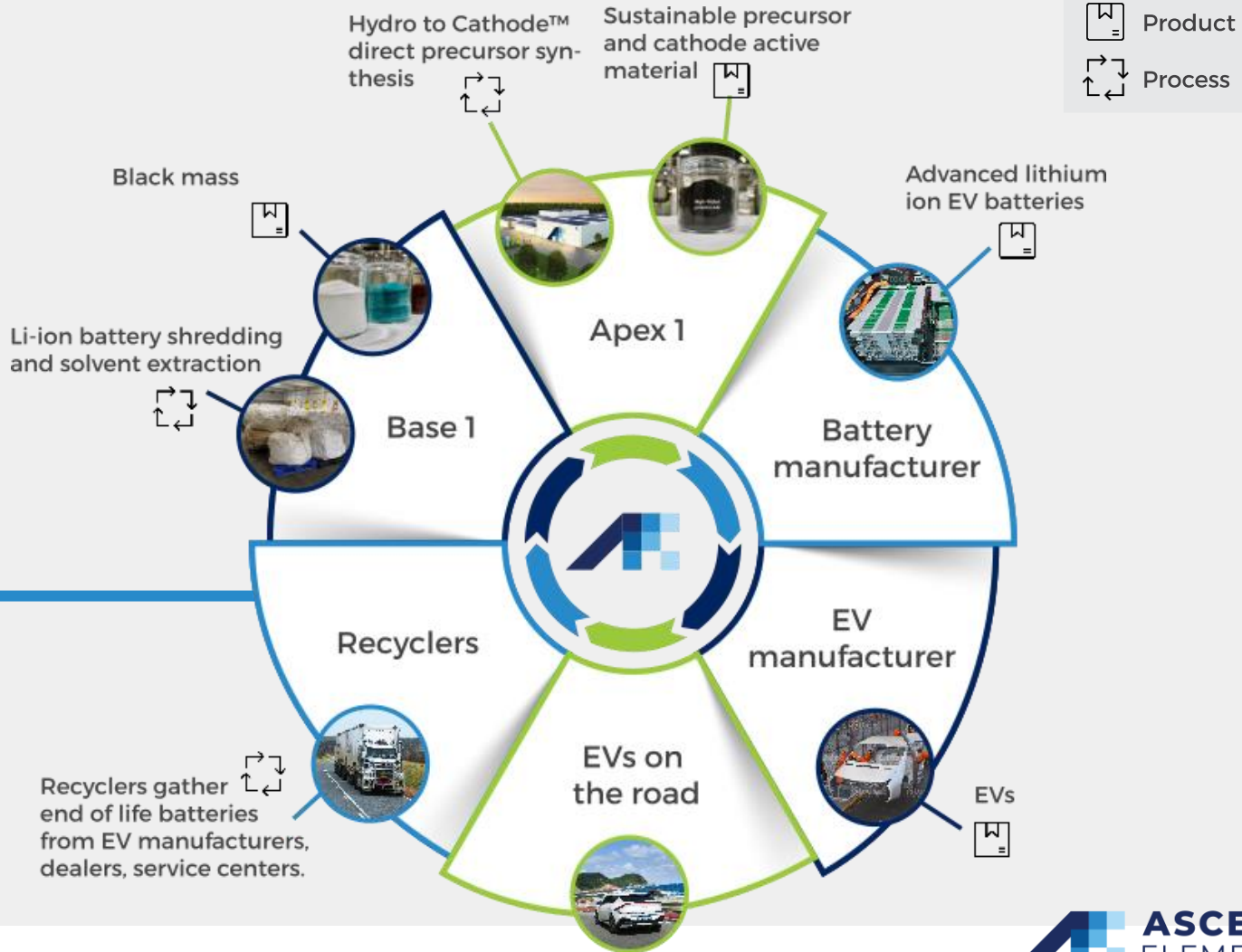
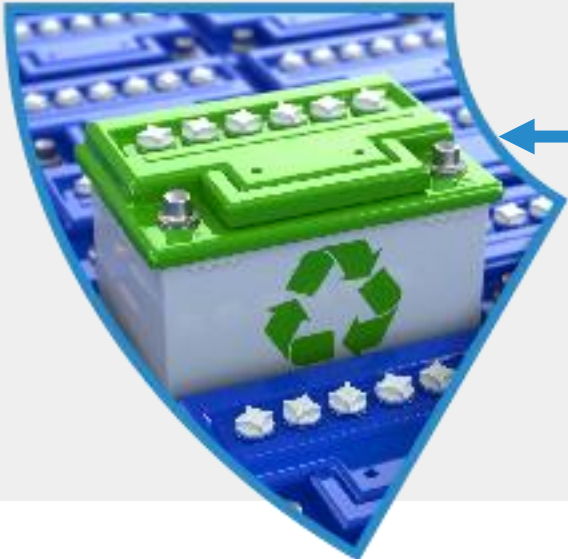
- Continued dependence on China
- Supply chain insecurity



# Let's Define Recycling

## RECYCLING ≠ CIRCULARITY

Recycling is a part of a closed-loop process. It is not a closed-loop process itself.



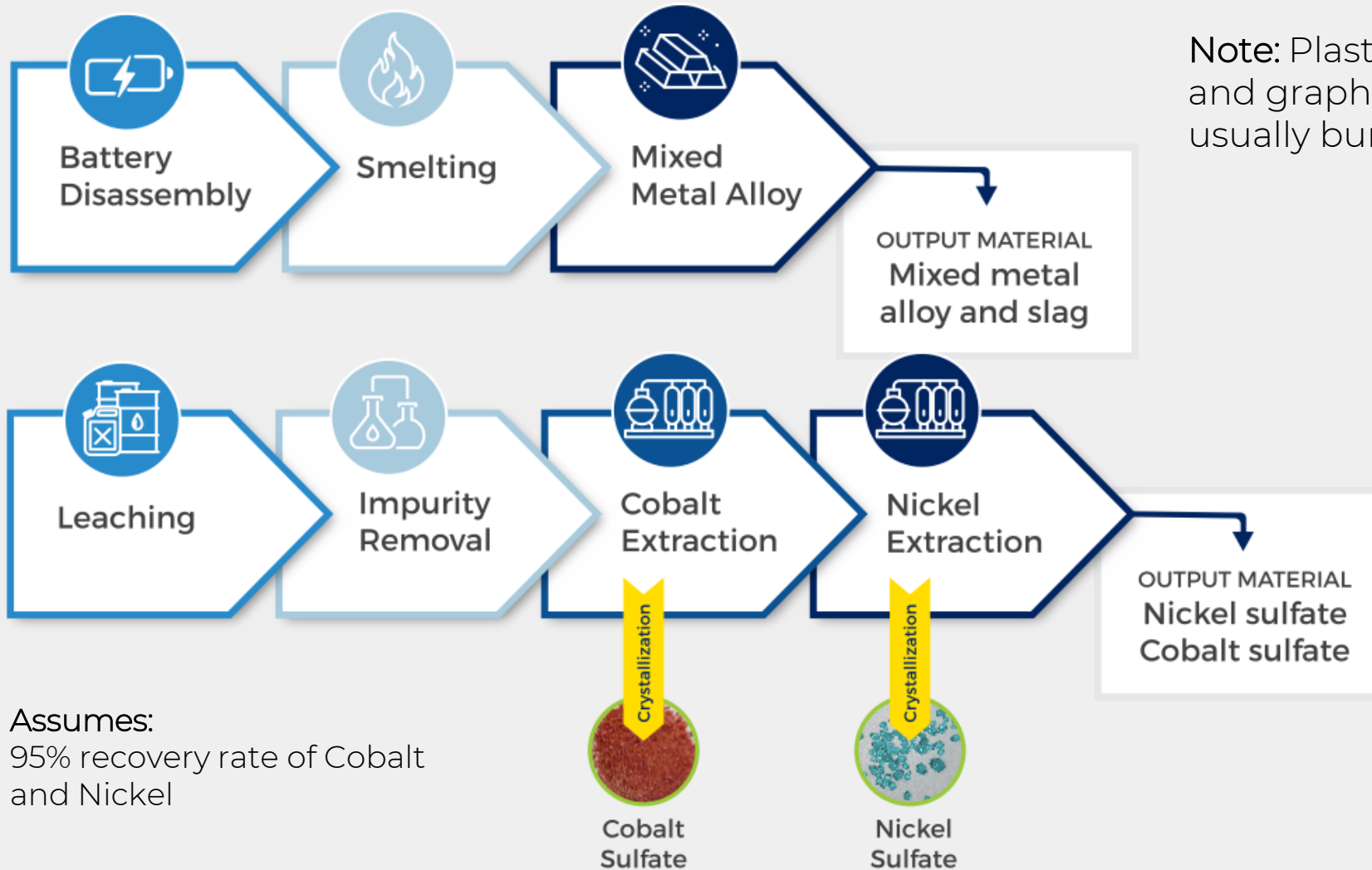
# A more efficient approach

What if you could **skip** the additional processing **step**?



# Output Materials by Process

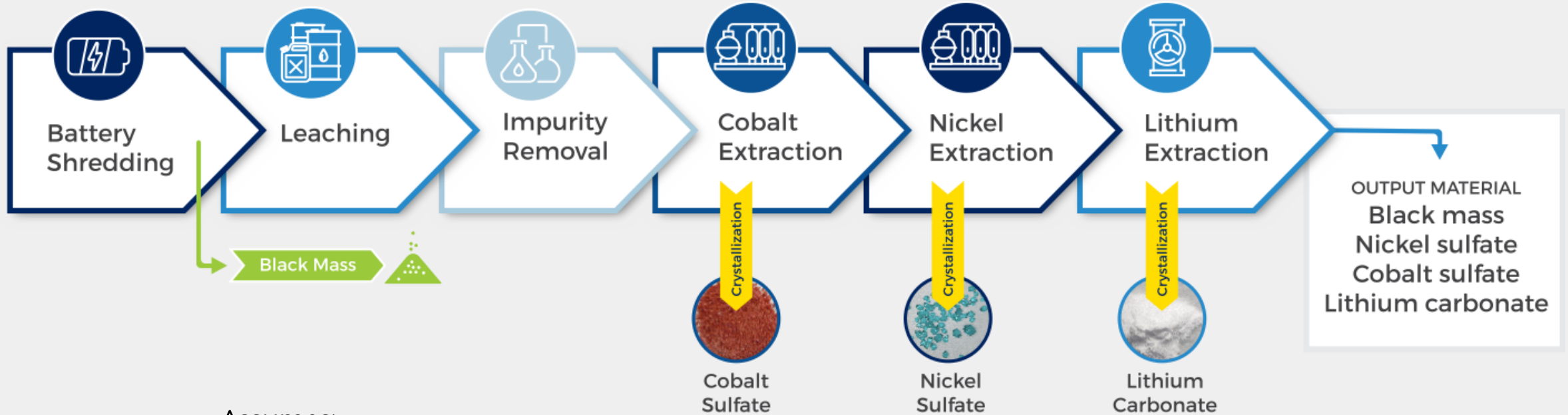
## Pyrometallurgy





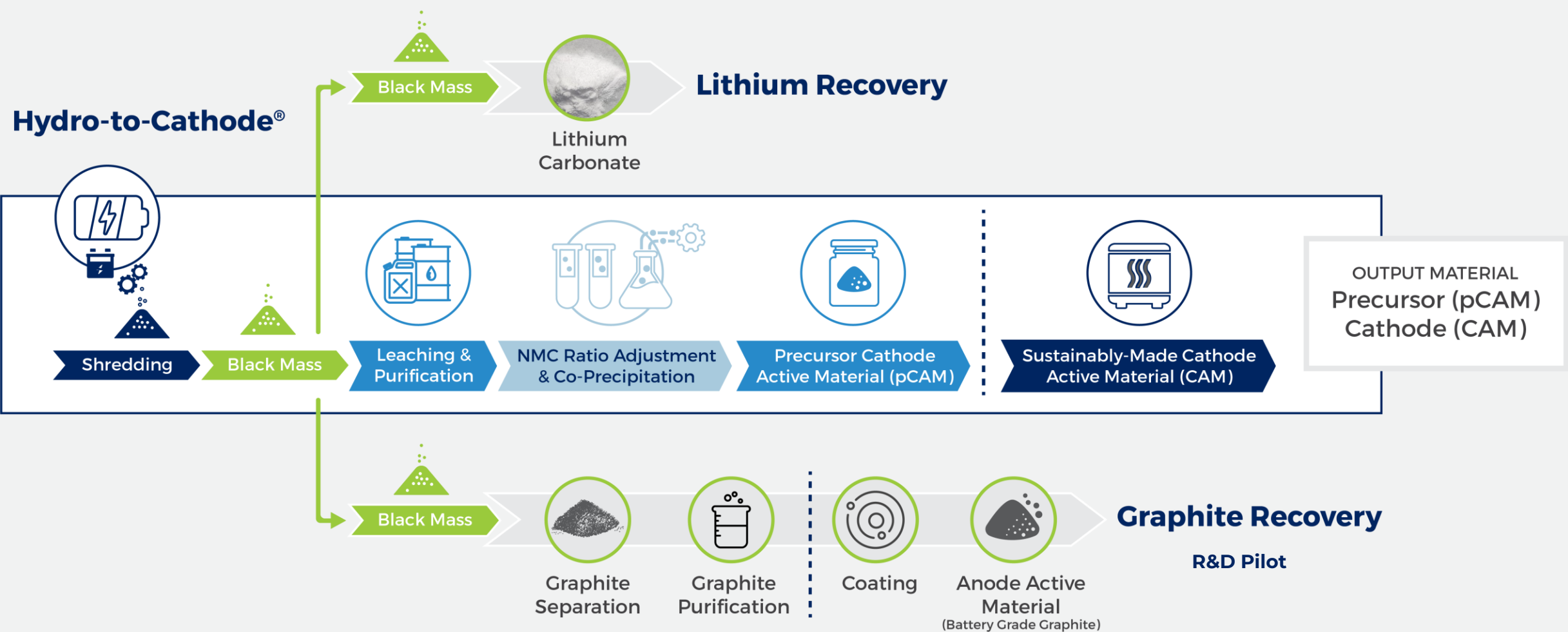
# Output Materials by Process

## Hydrometallurgy



Assumes:  
95% recovery rate of Cobalt  
and Nickel  
80% recovery rate of Lithium

# Hydro-to-Cathode<sup>®</sup> pCAM | Li | CAM



# Black Mass

## Produced in a recycling plant

- Raw material
- Low relative value
- Requires additional processing for battery use
- Contains all Cathode and anode materials
- Contains contaminants and water
- High impurity profile
- Impurities: >1000 ppm (almost ore grade)
- Often shipped overseas for processing
- Can be used by other industries



# Cathode Precursor (pCAM)

## Produced in a clean room

- Engineered material
- Higher relative value
- Crystal structure is customized to precise customer specs for:
  - Composition
  - Particle size
  - Particle distribution
  - Morphology
  - Porosity
  - Crystallinity
- Single digit ppm impurities (almost pharma grade)
- Purchased by Cathode manufacturers

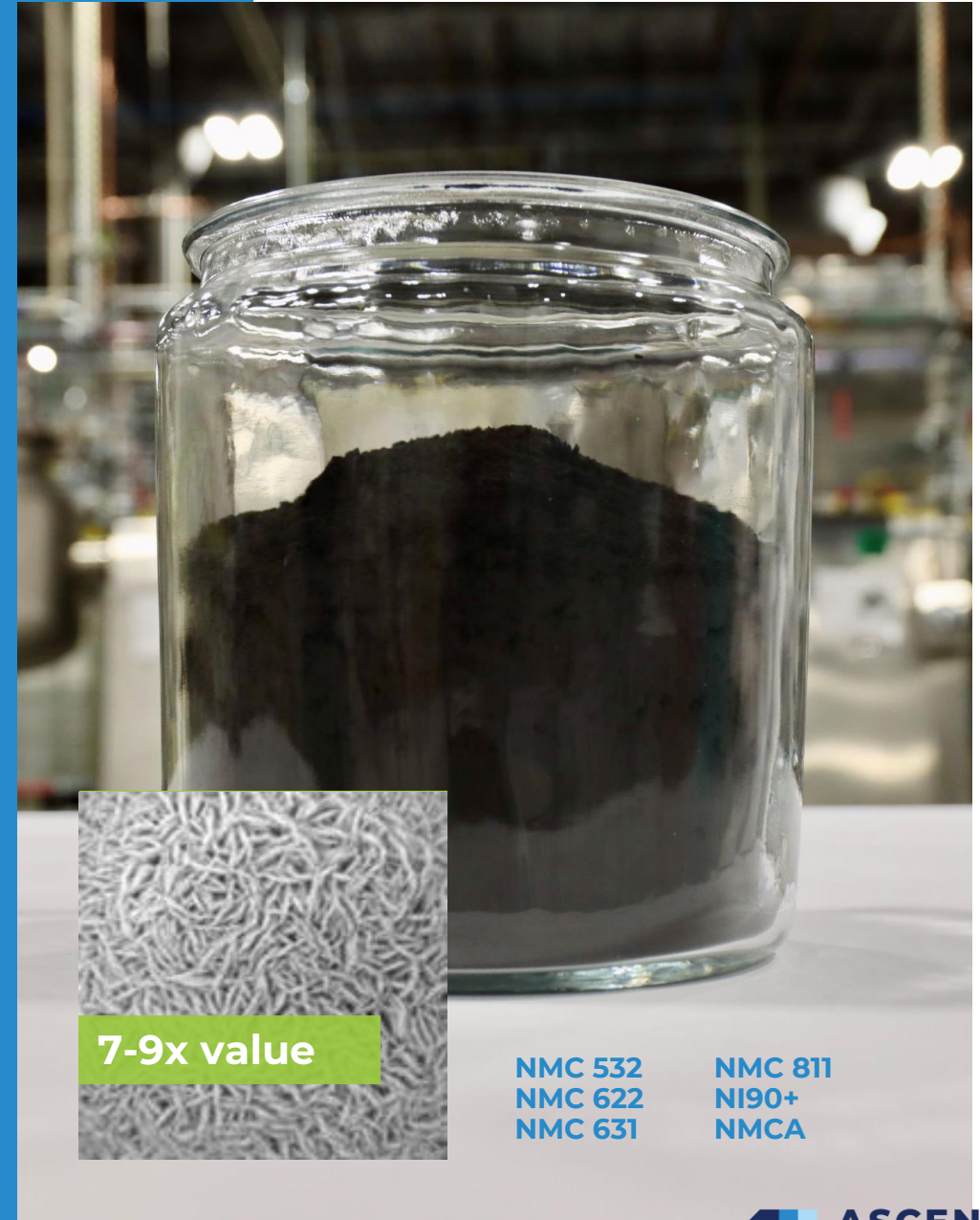




# Cathode Active Material (CAM)

## Produced in a clean room

- Engineered material
- Highest relative value
- Battery ready
- Many flavors: NMC 532, 622, 631, 811, Ni90+, Ni95+, NMCA
- Customized to precise customer specs for:
  - Composition
  - Particle size
  - Particle distribution
  - Morphology
  - Porosity
  - Crystallinity
- Single digit ppm impurities (almost pharma grade)
- Purchased by EV OEMs, battery makers
- High energy, high cycle life materials

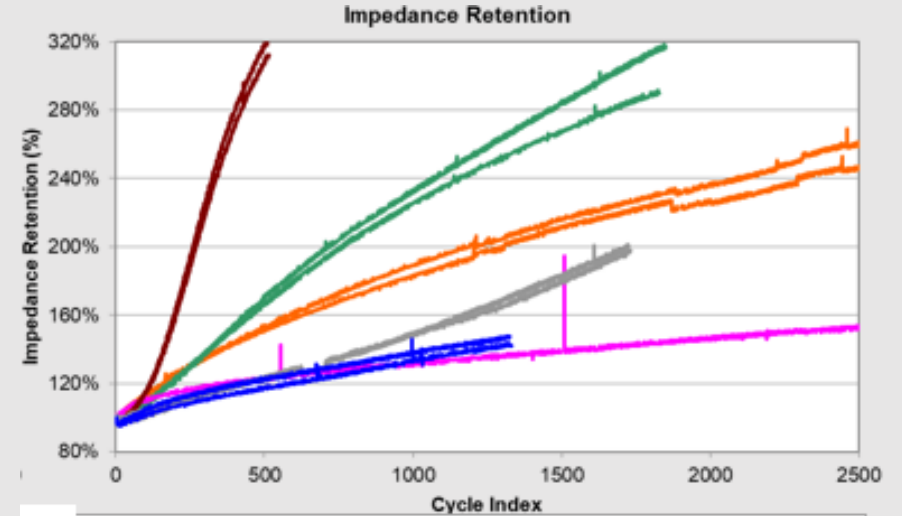
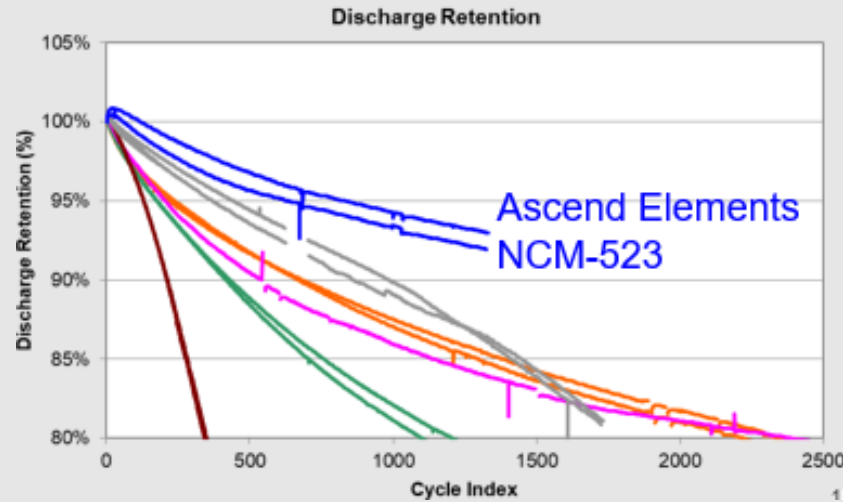


# Details on Performance

## Benchmarking Ascend Elements NCM 523

Ascend Elements cathode material in > 0.2 Ah XALT prototype pouch cells

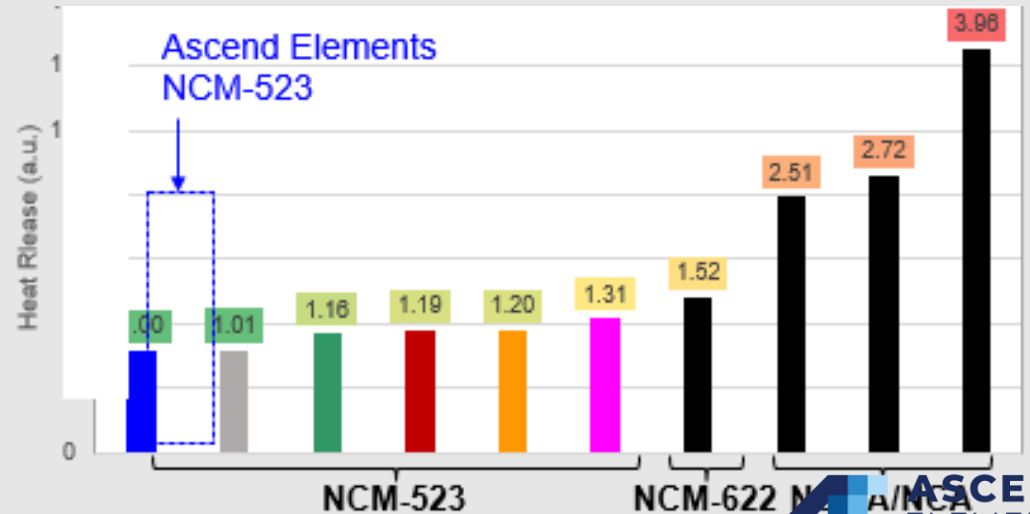
Test conditions:  
45°C, 1C/-1C,  
100% DOD



Ascend Elements Phase 3 NCM-523 has best cycle life and thermal stability of NCM-523 grades evaluated

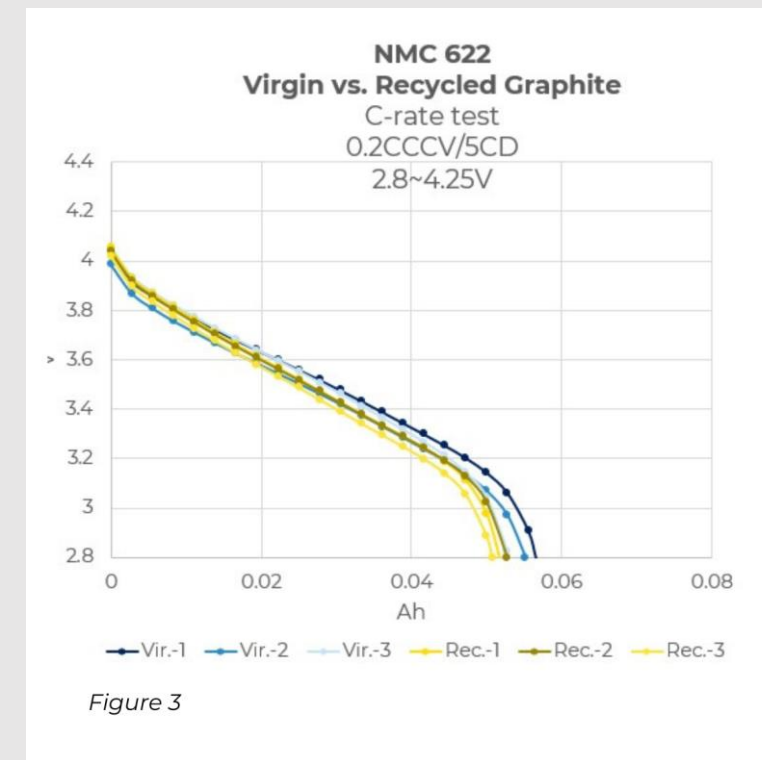
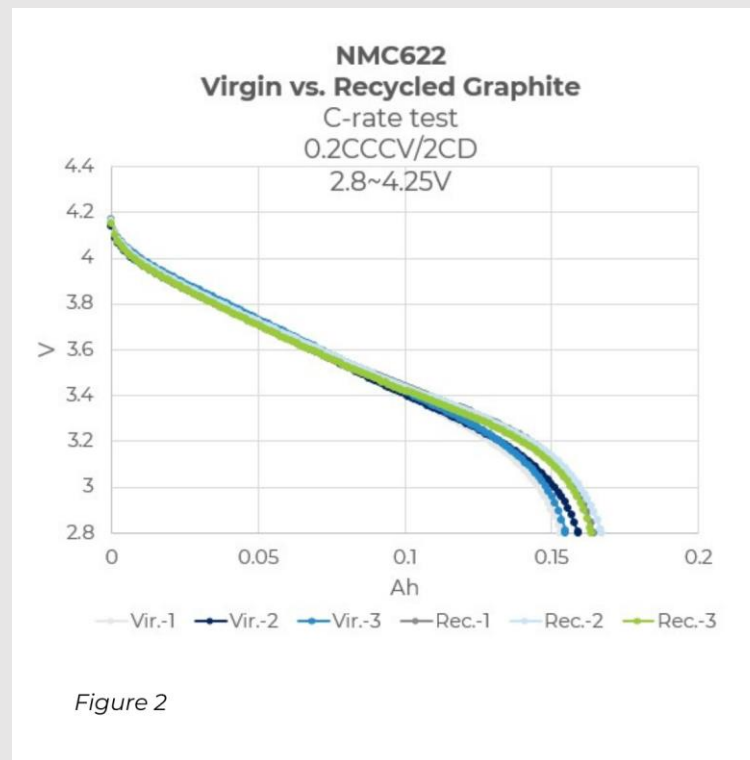
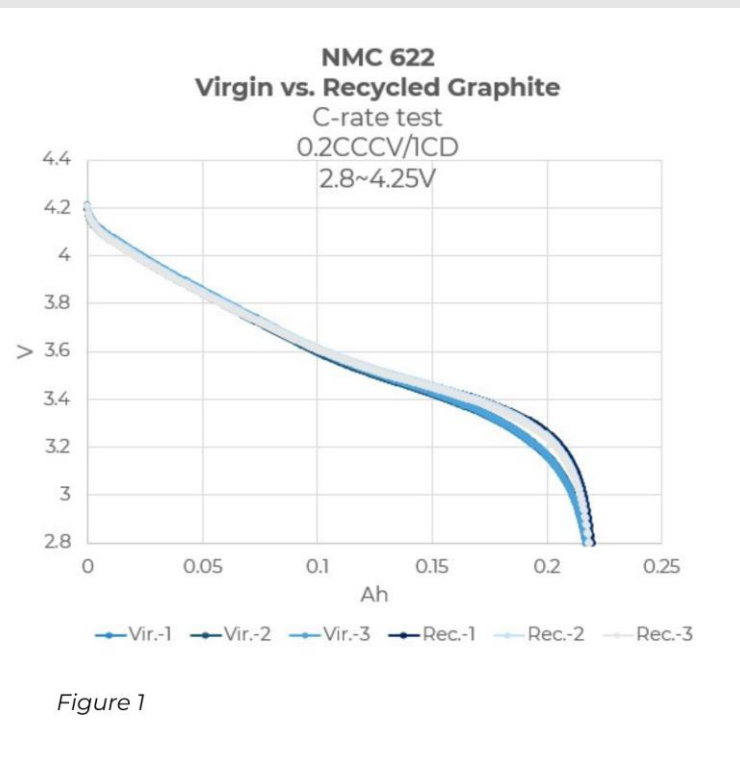
Thermal stability of cathode materials

Test conditions:  
Materials charged to 4.2V in > 0.2 Ah XALT prototype pouch cells



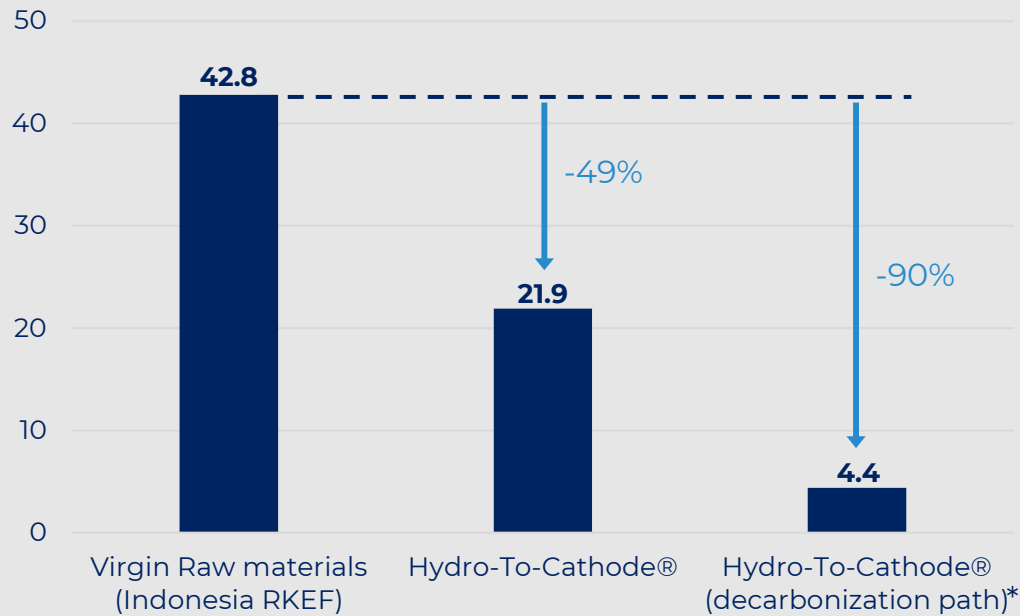
# Recycled vs. Virgin Graphite

## NMC 622 Pouch Cell: C-rate Testing



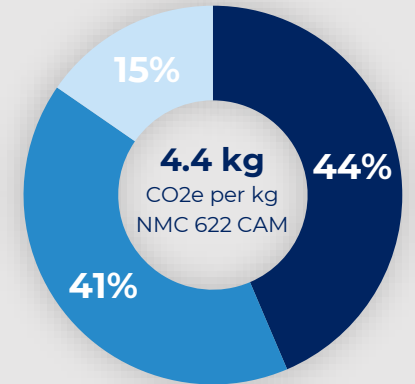
# NMC 622 CAM Life Cycle Assessment Results

## CARBON FOOTPRINT (kg CO<sub>2</sub>e/kg NMC 622 CAM)



## DECARBONIZATION PATH:

Carbon footprint of producing **1kg of NMC 622 CAM** using Ascend Elements Hydro-to-Cathode® (HtC) Technology:



## UP TO 90% REDUCTION

in CO<sub>2</sub> emissions compared to virgin raw material production

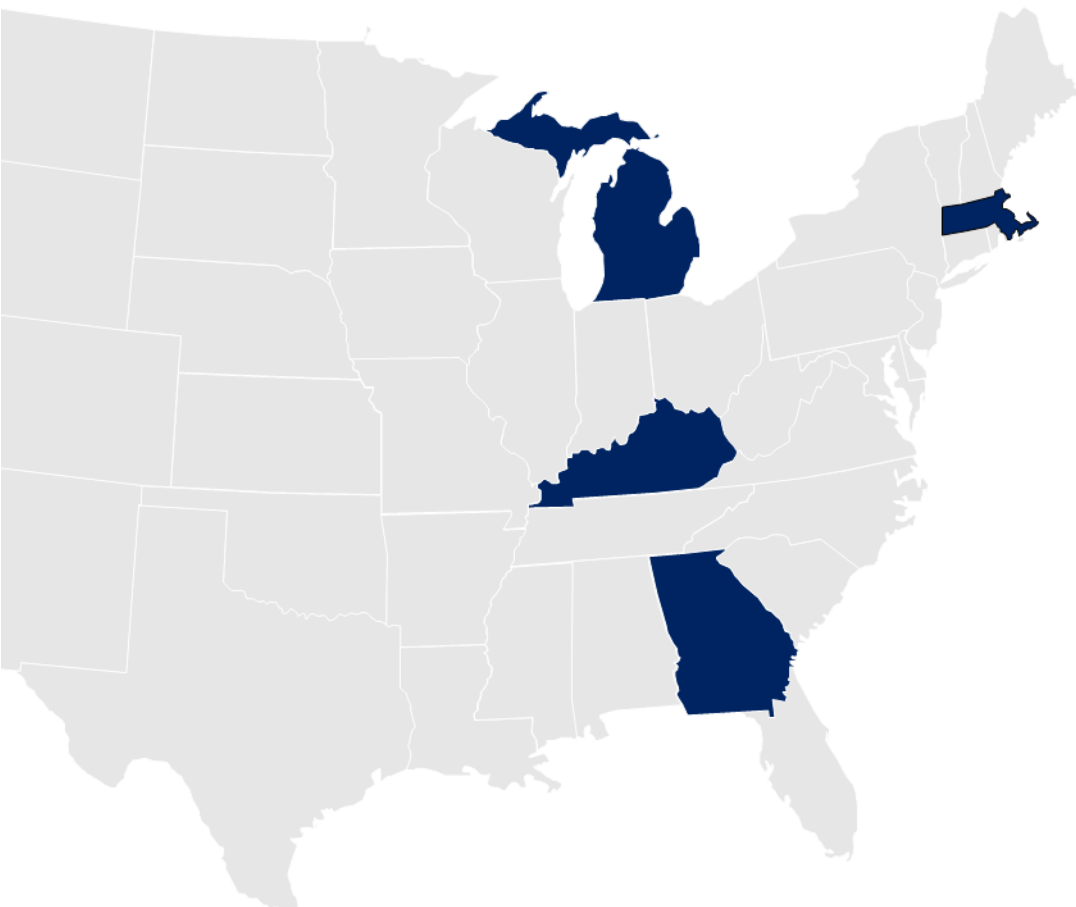
## 38,400 KG CO<sub>2</sub>e AVOIDED

for every one ton of NMC 622 CAM produced by Ascend Elements



NORTH AMERICA-BASED

# North American Business Operations



## Novi, MI – Cathode Sintering and Battery Lab

### Cathode NMC production

- Output: NMC Cathode
- Operational
- 6,300 sq. ft.



## Westborough, MA – HQ and Cathode Precursor Pilot

### NMC Precursor Production

- Output: NMC cathode precursor
- Operational
- 16,000 sq. ft.



## Hopkinsville, KY – Apex 1 Battery Material Plant

### Active Material, Precursor and Lithium Production

- Output: Lithium Carbonate / pCAM and CAM
- Operational Q4 2024
- 500,000 sq. ft.



## Covington, GA – Base 1 Commercial-Scale Recycling

### Pretreatment, Shredding and Lithium Extraction

- Intake: 30,000 metric tons/year
- Output: Blass Mass / Lithium Carbonate
- Capabilities:
  - Spent battery pretreatment & shredding
  - Lithium Carbonate production
- Operational 2022
- 154,000 sq. ft.



# Base 1 Facility

*Covington, GA*

Shredding scrap batteries into black mass and extracting lithium



- **\$50M INVESTMENT**
- **30,000 METRIC TONS / YEAR INPUT CAPACITY**
- **3,000 METRIC TONS / YEAR LITHIUM CARBONATE OUTPUT**
- **180 HIGH-QUALITY JOBS**
- **OPERATIONAL IN 2022**





# Recycling for all batteries

## **Able to accept all Li-ion batteries. (NMC, NCA, LCO, LMO, LFP)**

Regardless of format. Packs are disassembled to harvest valuable components.

Battery modules are discharged in aqueous solution and shredded.



## **Manufacturing Scrap**

- Coated anode and cathode foils
- Waste cells & modules
- Non-conforming product
- Cathode powder



## **Spent Batteries**

- Cells and modules
- Pouch, cylindrical, cans
- High voltage and low voltage packs

**Sorting of battery types is not required**

# Apex 1 Facility

*Hopkinsville, KY*

Transforming black mass into high value materials via **Hydro-to-Cathode®** direct precursor synthesis



- UP TO **\$1B** INVESTMENT
- **PRODUCING** PCAM, CAM, AND LITHIUM CARBONATE
- UP TO **400** HIGH-QUALITY JOBS
- OPERATIONAL IN **Q4 2024**

