

# Recycled Battery Materials: How To Catch The Green Wave (and Stay On It). A User's Perspective.

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**STERLING  
ACUMEN**

Building and scaling critical minerals supply  
chains for the energy transition.

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# Recycled Battery Materials: How To Catch The Green Wave (and Stay On It). A User's Perspective

## Agenda

- Presenting Sterling Acumen
- Ascertain Demand With End Users' Positioning in Batteries Recycling
  - Compliance vs. best-in-class. The circularity claim
  - Integration levels and style
- Build Collaboration and Strategic Partnerships Across the EV Supply Chain
  - Doing too much, too fast vs. R&D paralysis
  - Diversification
- Risks Allocation Across the Supply Chain Must Follow the Premium
  - Price risk, ESG risk and technology risk
  - Mind the gap in the value chain

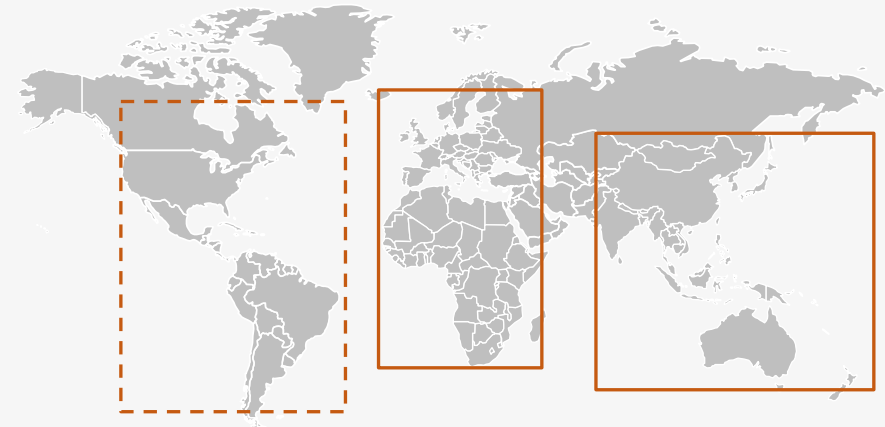


# Presenting Sterling Acumen

## We Help Participants In The Critical Minerals Value Chain From Mining to Manufacturing In Building Resilient And Sustainable Supply Chains

- Unique blended experience in physical commodities (mining to manufacturing), capital markets, and risk management. Legal, financial and commercial problem solver
- Original ability to transfer knowledge, we come-up with creative and novel solutions, and take effective actions
- We craft and execute bespoke engagements depending on clients' needs and position in the value chain
- Independent, not conflicted. We take on engagement only if we can dedicate time and attention
- Outreach capability upstream and downstream
- Great partnerships builders
- Dispute resolution (arbitration and mediation work)

## Our Work Covers All Relevant Regions As We Grow



- Illustrative engagements :
  - Commercial and financial transactions due diligence
  - Risks assessment and mitigation
  - Contracts negotiations (e.g., offtakes, sourcing and marketing, structuring, partnerships deals)
  - Strategy and growth acceleration
  - Let's talk!



# Ascertain Demand With End Users' Positioning In Batteries Recycling

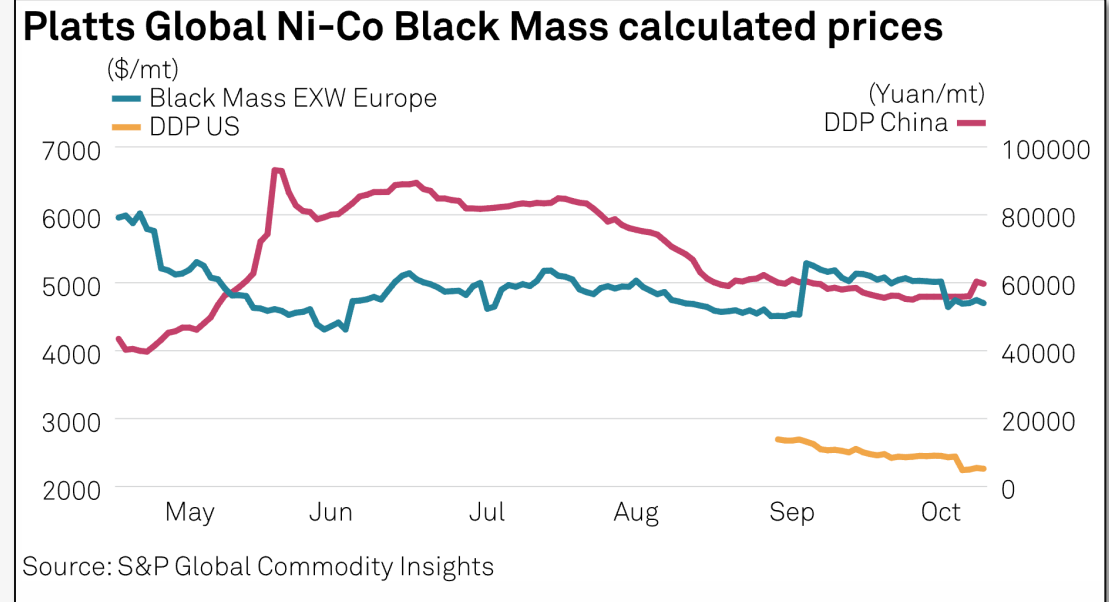
# The Li-Ion Battery World: A State Of Careful Optimism

## Li-ion Batteries For Electric Vehicle and Energy Storage Solutions Deployment Depends On Raw Materials and Cell Costs Of Production

### How Certain Is The Critical Raw Materials Demand For Energy Storage?

- **Lithium supply chain at risk** of disruption on surging battery demand
- Oversupply, bearish sentiment to keep **pressure on cobalt**
- **EU-Asia black mass trade flow** to continue in short-term
  - Higher payables achievable in SE Asia and Korea due to higher recycling capacity
  - Black mass payables below 70% at current metals price environment command a higher implied recovery rate
- Northvolt announces first Na-ion product, **completely free of critical raw materials**
- tozero and Huayou Cobalt announce **partnership agreement in li-ion battery recycling**
- German constitutional court ruling in November **blocked the government from transferring 60 billion euros** in unused funds from the pandemic towards green initiatives

### Is Trade Still A Mean Of Convergence?



# Battery Materials Recycling Regulations Are In The Works

## Are The Costs Of New Assurances Sustainable For Black Mass to Compete With Raw Materials?

EU Critical Raw Materials Act	From 2030	The European Union should extract 10%, recycle 15% and process 40% of its annual needs by 2030 for 16 'strategic raw materials' Recycling <i>target</i> was updated in November to 25% of consumer waste collected. Implementing act expected 2027.
EU Batteries Regulation  For EV and LMT (Light Means of Transport e.g., scooters, e-bikes) sold in the EU	From Aug. 2025	<ul style="list-style-type: none"> <li>• Export of used batteries outside the EU will only be permitted if the recipient's battery management procedure meets EU's requirements</li> <li>• Collection rate target 63% by end 2027 and 73% by end 2030 (lower for LMTs)</li> <li>• 65% (70% from 2030) of battery weight must be recycled</li> <li>• Minimum recycled content for EV, SLI and industrial batteries: 6% for Ni and Li, 16% for Co from 2031; 26% for Co, 12% for Li and 15% for Ni from 2036</li> <li>• Carbon footprint declaration</li> <li>• Register of producers and Extended Producer Responsibility</li> </ul>
EU Proposal to Designate Black Mass as Waste	TBD	To develop dedicated waste codes for lithium-ion batteries and intermediate streams, e.g., black mass
US, materials from recycled origins qualify for the EV tax credit under the Inflation Reduction Act		
China has implemented policies to encourage closed-loop relationships between manufacturers and recyclers, a whitelist of recyclers and companies that repurpose batteries to ensure compliance with environmental requirements and minimum recovery rates. 2018: Provisional measures on the recycling and repurposing of EV power storage batteries. And 2020: New Solid State Law.		

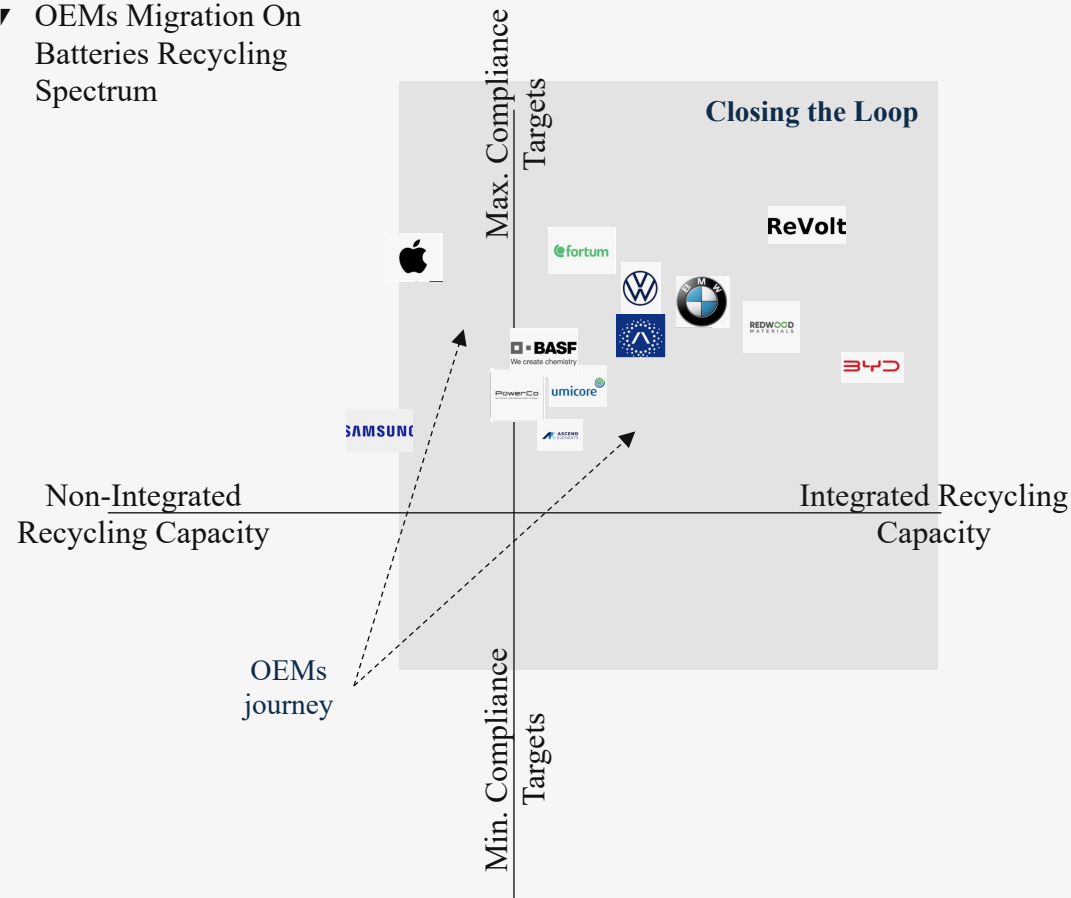
- ? Overlap with REACH regulation
- ? Complexity and practical application. Stifling effect
- ? Recycled content in cathodes vs. rest of the battery?
- ? European Parliament elections in June 2024
- ? Traceability
- ? End-of-Life definition
- ? Second life treatment
- ? Black mass export limitation
- ? EU's self-sufficiency in hydrometallurgical processing
- ? Black mass standardization
- ? Competition with Indonesian MHP



# OEMs Are Securing Part Of Their Battery Materials Recycling Needs Through Partnerships

## Ascertain Demand By Taking The Supply Chain View

### ▸ OEMs Migration On Batteries Recycling Spectrum



### Assess Business And Counterparty Risks For Each Supply Chain – A Check List

- Supply chain who's who, integrated vs. non-integrated capacity and qualification process
- Financial discipline and technology risk at battery manufacturing level
- Liquidity risk with OEM procurement processes
- Likely Opex competitiveness; ESG contamination risks
- Beyond regulatory compliance, OEMs have own recycled content targets at car level, and at battery level (cathode only?)
- Varied recycling technologies, unproven at scale. Education is key
- Different integration styles with OEM to further ascertain demand
  - Joint Venture with / without profit sharing, or
  - Capacity reservation, and/or
  - Technology sharing



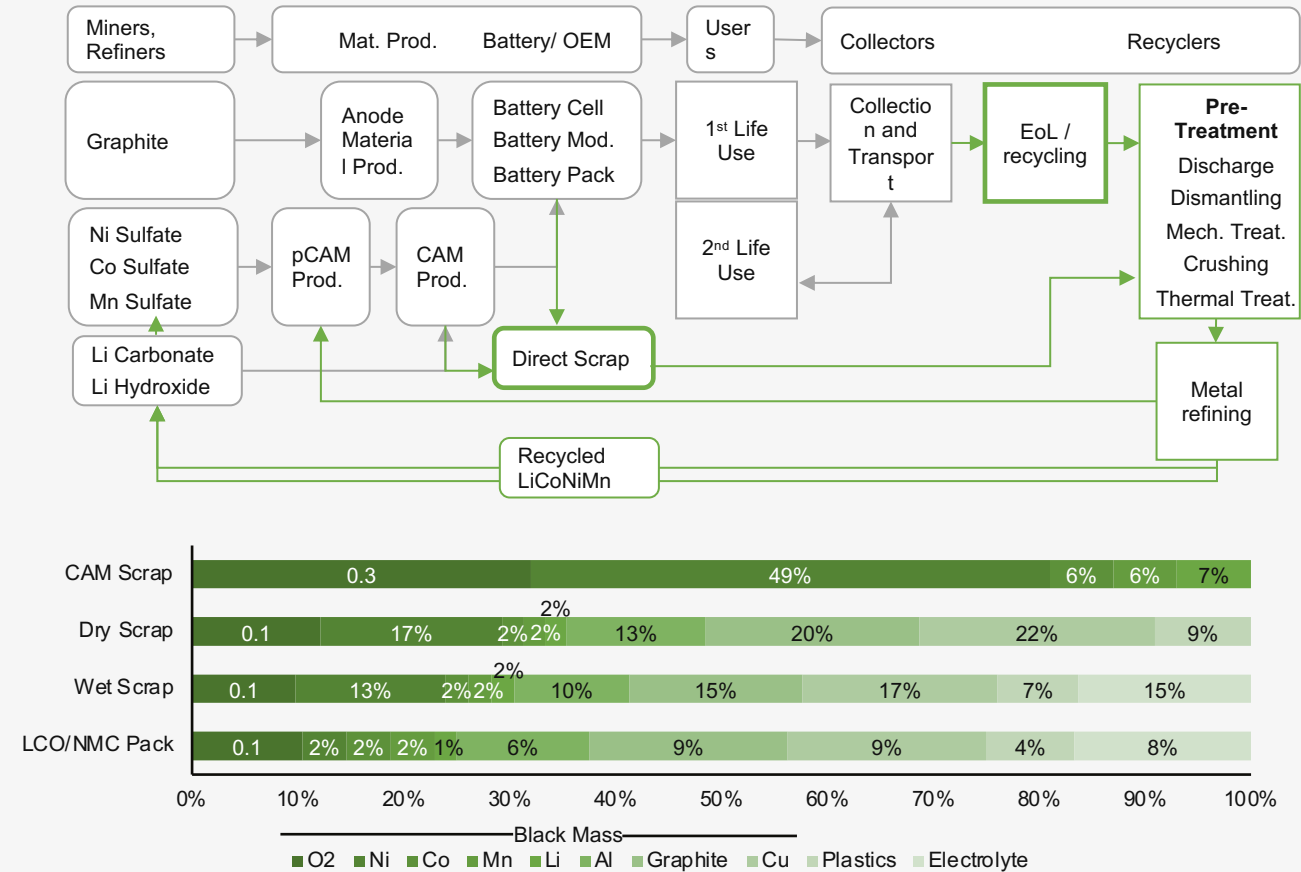


# **Build Collaboration and Strategic Partnerships Across the EV Supply Chain**

# Collaboration Is Key In EV Li-Ion Batteries Supply Chains

## Black Mass Composition and Type of Feed Determine Value and Processability

- Recycled output product positioning
  - Black mass vs. hydromet. vs. pCAM
  - Industrial grade vs. battery grade salts
  - Size of production units / breakeven capacity
  - Batch vs. continuous production
  - Some users welcome compounds standardization
- Invent new partnership models
  - From risks/profit sharing mechanisms to technology and capacity swaps. New governance models
  - Collaborate with differing levels of the value chain up and downstream vs. integration at one node
  - Calibrate product while in R&D
- Localise recycled solutions and follow the (uncommitted) scrap



Source: Industry analysis, BCG, Sterling Acumen



# Collaboration Is Key In EV Li-Ion Batteries Supply Chains

## Diversify Your Revenue Generation Model, Protect Your Margins

- Find simple technological integration models upstream
  - Upstream scrap beneficiation with mechanical equipment capex at
    - Battery, cathode makers sites
    - Scrap collectors and vehicles dismantlers sites
  - Co-design for ease of dismantling / feedback loop with OEMs
  - Choice of positioning recycling-as-a-service at OEM's production sites
- Diversify in end-of-life batteries use cases
  - Second life
  - Repurposing, EVs are likely to be sold in export markets
- Partner with mining companies as a way to raise profile and green credentials
- Partner with reverse logistics service providers. New business models underway with logistics and warehousing service providers offering shredding solutions

### Disassembly of EV batteries using advanced robotics-AI

With an unwavering commitment to sustainability and driving the wheels of the circular economy, NSRC excels in the meticulous disassembly of Electric Vehicle Batteries, taking them apart from the pack level down to the cell level. This intricate process allows us to extract valuable materials with utmost efficiency. Our innovative approach ensures that every component is carefully handled maximizing the

Dr. Rastegarpanah, a highly professional with over five years of experience in the robotic disassembly of EVs, leads a team of skilled roboticists. Their efforts revolve around the development of adaptive AI-based control and task planners that collaboratively carry out the disassembly process. For this series of AI models capable of estimating the state of he

universe  
energy

## We are the battery dismantler that makes 2nd life batteries with robots.

In 'Sustainable Robotics'

- > National Sustainable Robotics Centre
- > About Us - National Sustainable Robotics Centre
- > Disassembly of EV

Universe Energy | Mission | Batteries | Technology

Our mission is to make the next billion batteries out of use reverse the need for mining.

The problem is that batteries are challenging to reuse today supply is constrained by non-standard testing, dangerous by hand, and expensive shipping.

We streamline the supply of 2nd life batteries by scanning still are using a visual brain scan of the battery and disassemble robots for 50% of the cost.

Once we have 1000s of batteries flowing through our disassembly we'll turn batteries into cheap grid storage packs. It prevents new battery manufacturing, mining raw materials, and recycling.

Our vision is to become the largest manufacturer of clear energy without touching new materials. It will power a truly clean energy

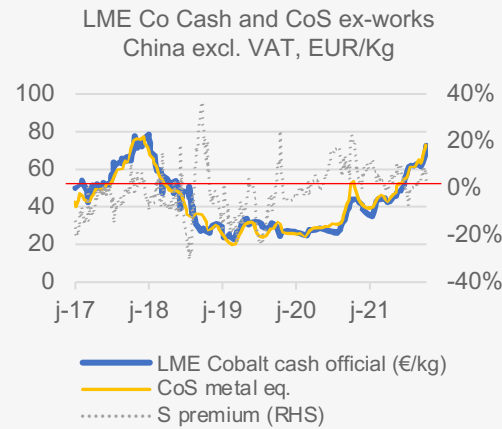


# **Risks Allocation Across the Supply Chain Must Follow the Premium**

# Risks Are Becoming More Complex And Correlated Within The EV Battery Supply Chain

## Risks Should Follow The Premium

### Price Risk



- Stocks management and price volatility
- Shorten processing time or integrate upstream
- Back-to-back contracts
- Existing indices: LME (FM settled), CME futures market (FM settled), Wuxi China. No options. No reliable hedge
- The premium materialises market tightness for BG or intermediates, it must pass through to customer

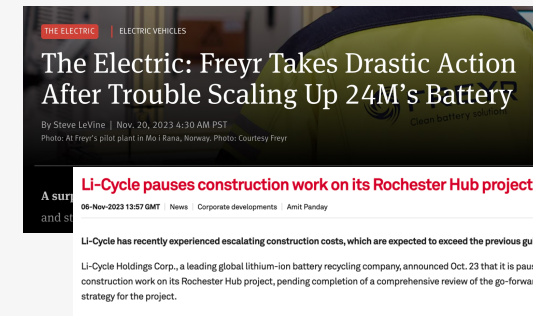
### ESG Risk

Risk	Likelihood of presence in supply chain					Total
	Cobalt	Graphite	Lithium	Nickel	Manganese	
Level of reporting / investigation	Good	Poor	Poor	Poor	Poor	
Human rights abuses associated with artisanal mining	3	0	0	1	2	6
Child labour in artisanal mines	3	0	0	1	1	5
Provenance from conflict-affected / high-risk countries, political insecurity (excl. China)	3	2	2	2	1	10
Environmental damage around industrial mines	2	3	3	3	2	13
Poor community relations and disrespect for human rights around industrial mines	3	1	3	1	2	10
Poor occupational health and safety (OHS) in industrial mines	2	3	1	1	3	10
<b>Total</b>	<b>16</b>	<b>9</b>	<b>9</b>	<b>9</b>	<b>11</b>	

Source: RCS, 1 is rare, 3 is certain

- Traceability reset with battery scrap materials?
- ESG risk attached to OEMs pre-booked materials? Contagion risk
- Due diligence regulations. Cost of compliance
- Supply chains specific targets
- Monetise investment in data visibility. Penalties and rewards
- CO2 footprint, hydrometallurgical process circularity

### Technology Risk



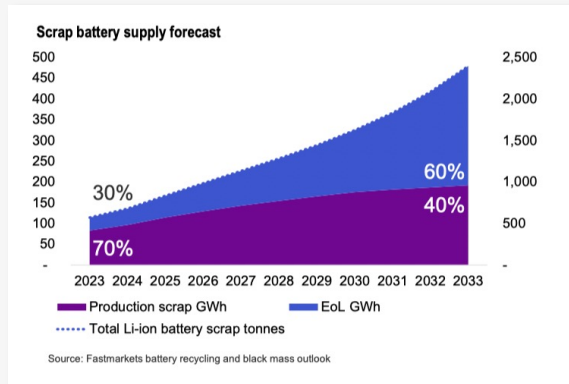
- Scaling with a centralized plant: what is your breakeven capacity?
- Most prone for single strong (OEM/ battery manufacturer) partner integration model
- Partner with an organization that has experience scaling industrially
- Explore modular deployment across geographies
- Resilient and adjustable manufacturing-as-a-service
- Follow the scrap



# Mind the Gaps In the Li-Ion Batteries Supply Chains

## Insufficient Coverage Ratios Likely At The Beginning Of the Value Chain In The Short Term

### Lack of Battery Scrap



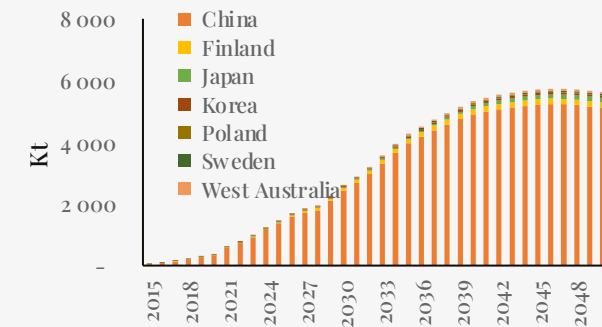
- Majority of scrap is cathode: no valorisation for graphite, slurry, or other battery parts
- Shredders running at reduced capacity, hits profits as high-volume business
- 70% of supply currently from production scrap
- In 2031 End of Life becomes largest source of scrap accounting for 66% of supply in 2033

### Black Mass To Metal Salts



- Uncertain data in Europe and in the US
- **What about battery scraps other than cathode and anode?**

### pCAM Production



\*Source: Roskill, Wood Mackenzie, Sterling Acumen, as of 2020

- Global supply sufficient and utilization rate low as of 2021
- 20% Europe's self-sufficiency in 2021\*
- Uncertain evolution given environmental license hurdle
- Caustic soda dependency and sodium sulfate disposal
- Innovation in process and feedstock
- Usually integrated upstream raw materials



# Wrap-up

# Takeaways

- **Uncover your positioning in the li-ion battery supply chain:** do you have to go to battery grade materials? Can your output product be standardized? What is your breakeven capacity?
- In an industry still in the making with high counterparty risk, **locking demand through partnership** with a corner stone client is a winning model (if client is blue chip) but not the only one. **Take the supply chain view**
- **Explore modularity and manufacturing-as-a-service solutions** vs. centralized capex heavy solutions. **Collaboration across the supply chain is key: reinvent upstream partnerships, diversify revenue generation**
- **Proactively identify and manage your risks**, and gaps in the value chain
  - **Price risk** by dampening volatility through longer integrated materials processing (go upstream) and back-to-back contracts structure. Hedge residual risk
  - **ESG risk** through appropriate data collection and disclosure for sound (end-user's) procurement practices, monetise it through blended finance (cheaper funding) support, carbon certificates trading
  - **Technology risk** by educating respondents on product / process design performance, and by partnering with organisations that have track-record in successfully scaling industrial businesses (different skill set)





# STERLING ACUMEN

Myriam El Kara

CEO

[Myriam.elkara@sterlingacumen.com](mailto:Myriam.elkara@sterlingacumen.com)

[www.sterlingacumen.com](http://www.sterlingacumen.com)