



Sustainable Supply Chain Connectivity in Europe

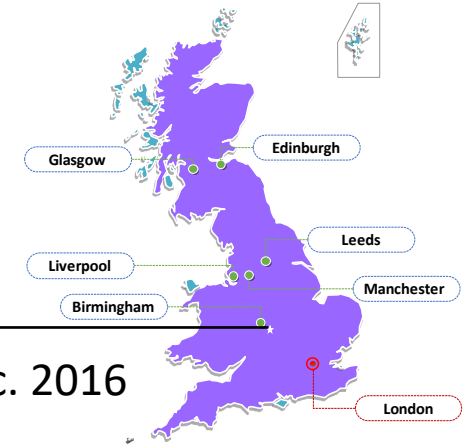
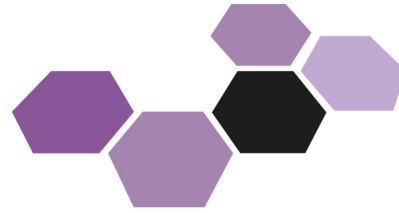
Dr Michelle Lynch

Battery Tech Sweden

28th September 2023



Enabled Future



The Team



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Key Clients



Enabled Future Limited Business Proposition

Optimising Technology Portfolios



Consulting – Training – Multiclient Reporting
Thought Leadership – Industry Tracking



New Membership Programme As Of November 2022

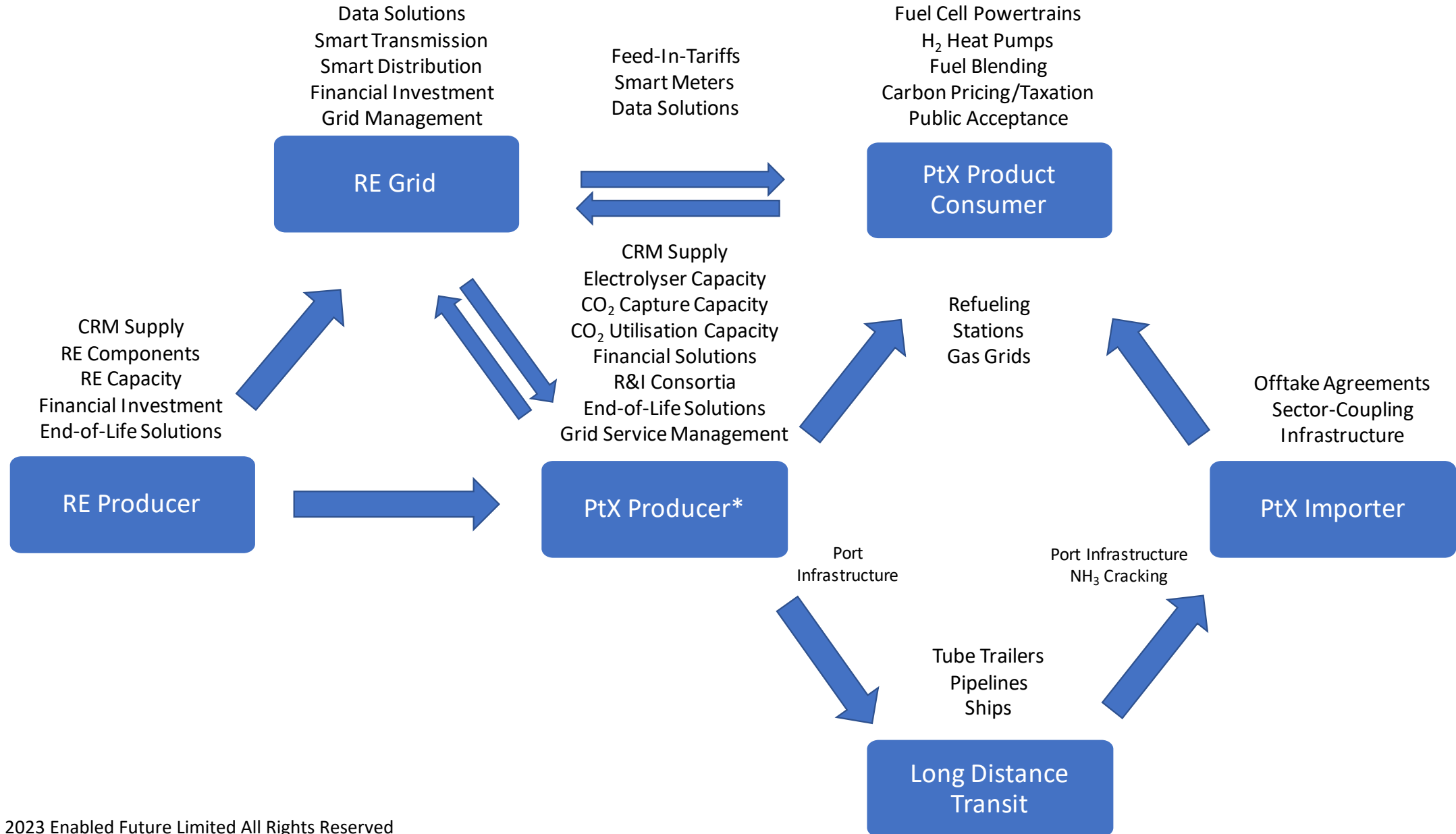
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- Supply Chain Connectivity
- Achieving Sustainable Chemicals and Materials
- Sustainable Supply Chain Gaps in Europe
- Take Home Messages

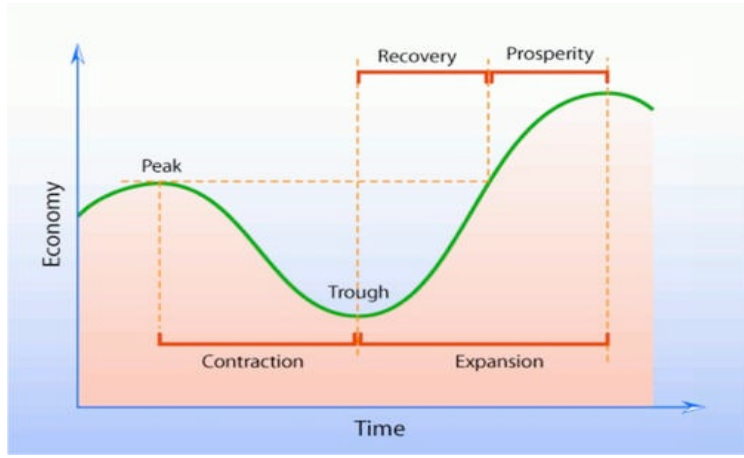
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Energy Transition Supply Chain Complexity

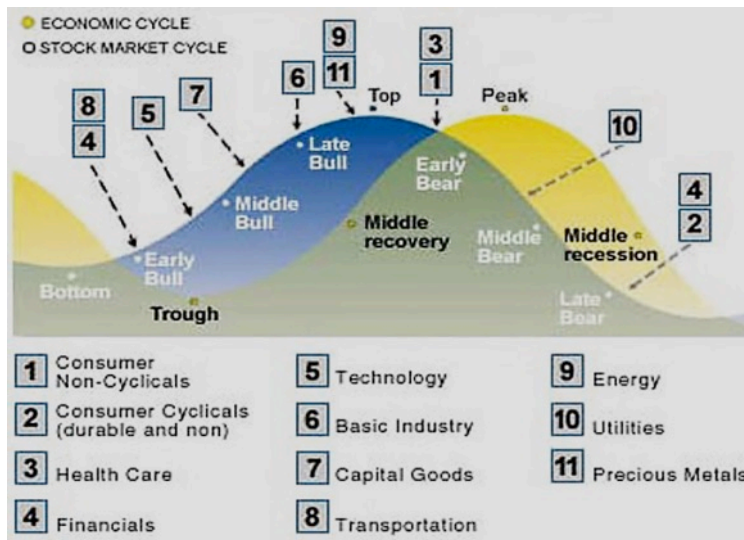


Economic Boom and Bust Cycles



Recovery and Prosperity:

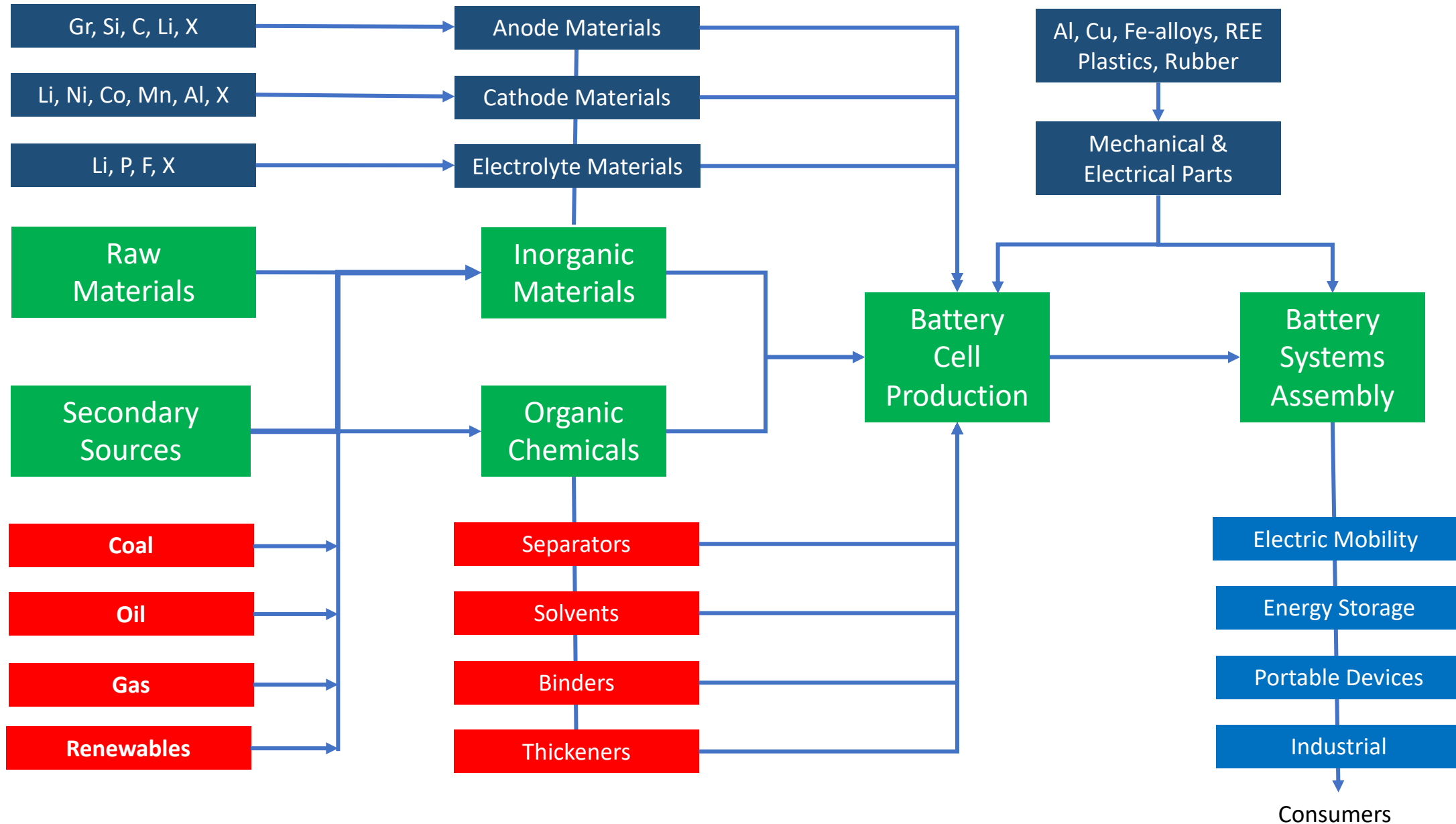
- Increase in productivity
- Consumer confidence
- Increasing demand
- Higher prices



Contraction and Stagnation:

- Over exuberance
- Over investment
- Over supply
- Prices Collapse

Lithium Ion Battery Supply Chain



Key Traits of Successful Supply Chains



Upstream/Downstream
Knowledge & Relationships

Growth Mindset in
Procurement

Shared Mission & Vision

(Planned) Synchronicity

Optimised Integration
Levels

Versatility and Readiness
for Change

Market & Technology
Awareness

Efficient/Effective IT, Data
Approaches & Digitisation

Investment in Education
and Skill Building

Investment in R&I,
Intangibles/Patenting

Investment in Sustainable
Products & Services

Investment in Capacity

Foreign Direct Investment

Technology Licensing &
Specialisms

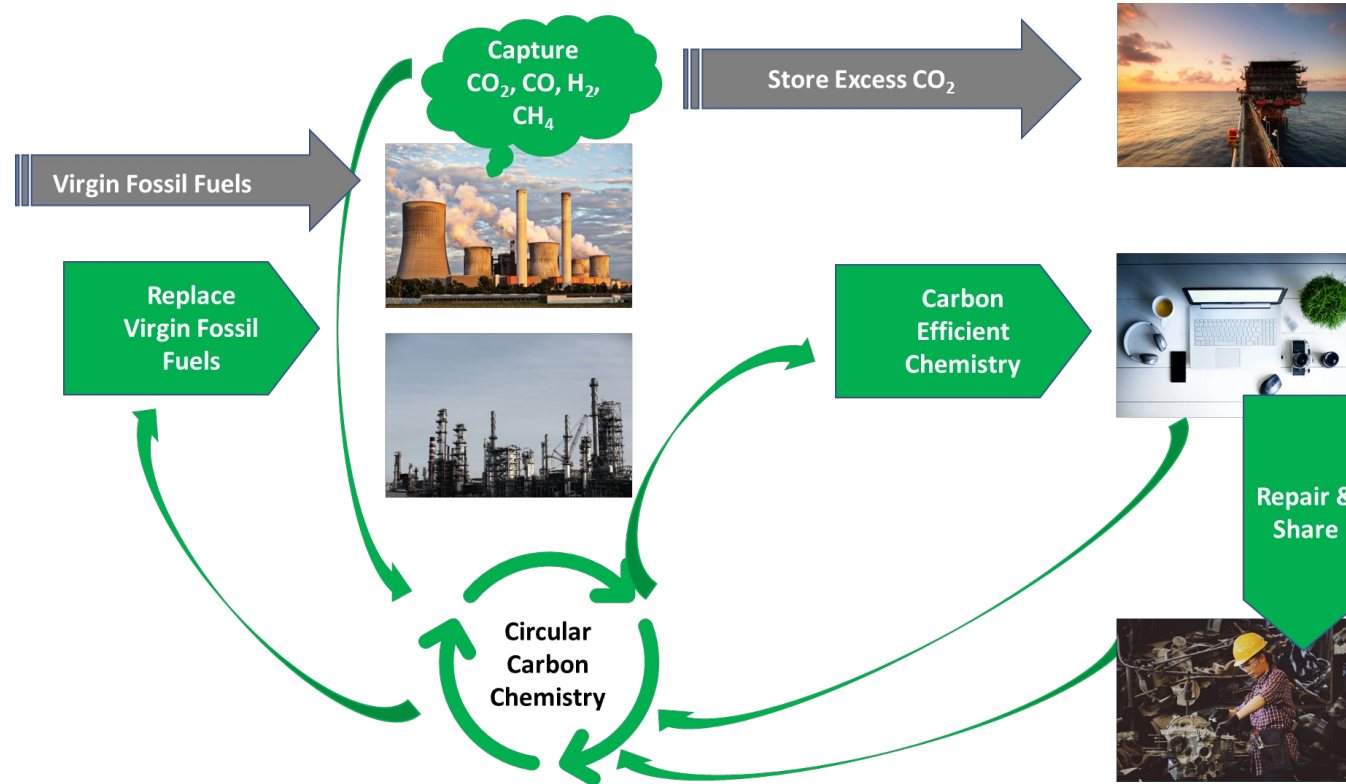
Global Cooperation on
Trading Mechanisms

Rational Policymaking for
Supply Chains

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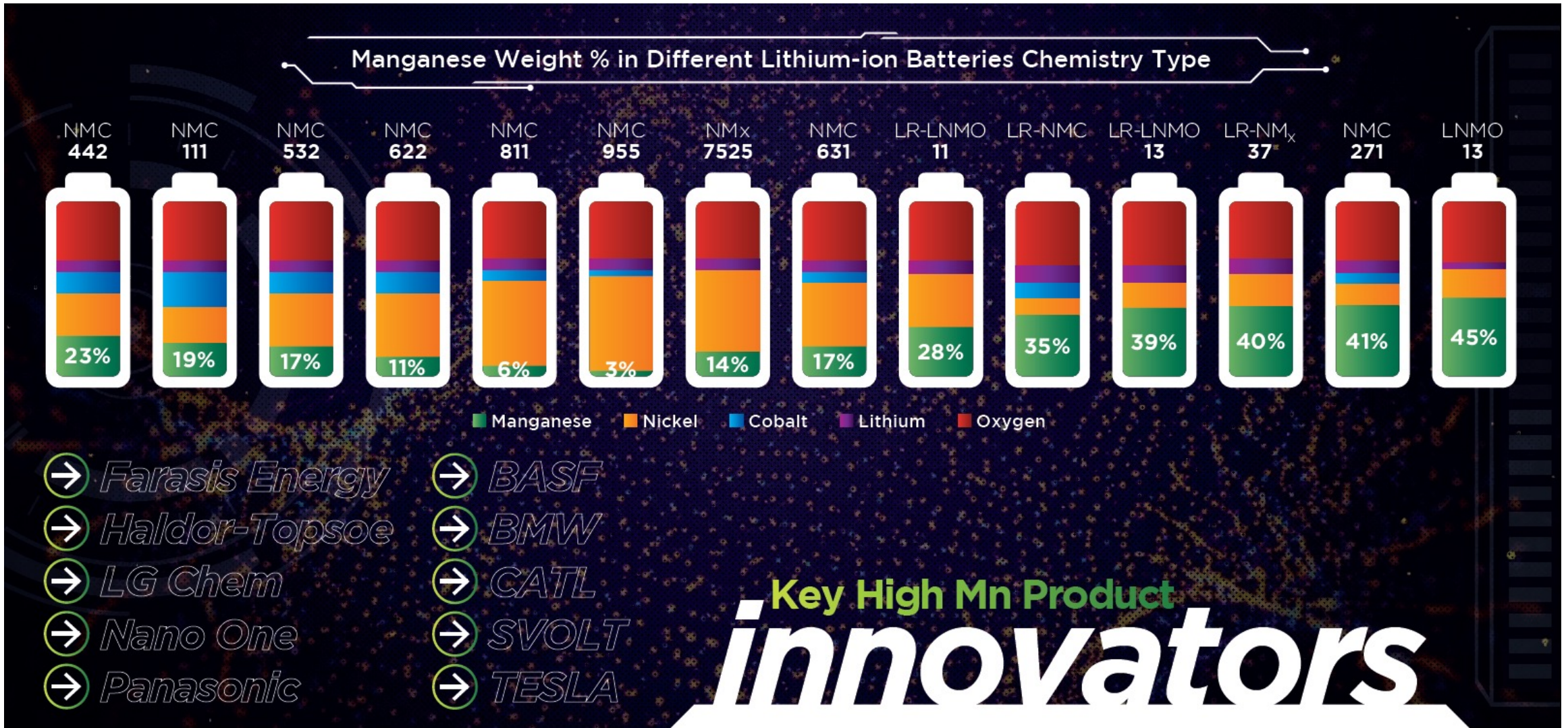
- Supply Chain Connectivity
- **Achieving Sustainable Chemicals and Materials**
- Sustainable Supply Chain Gaps in Europe
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NetZero Does not Enable the Circular Economy

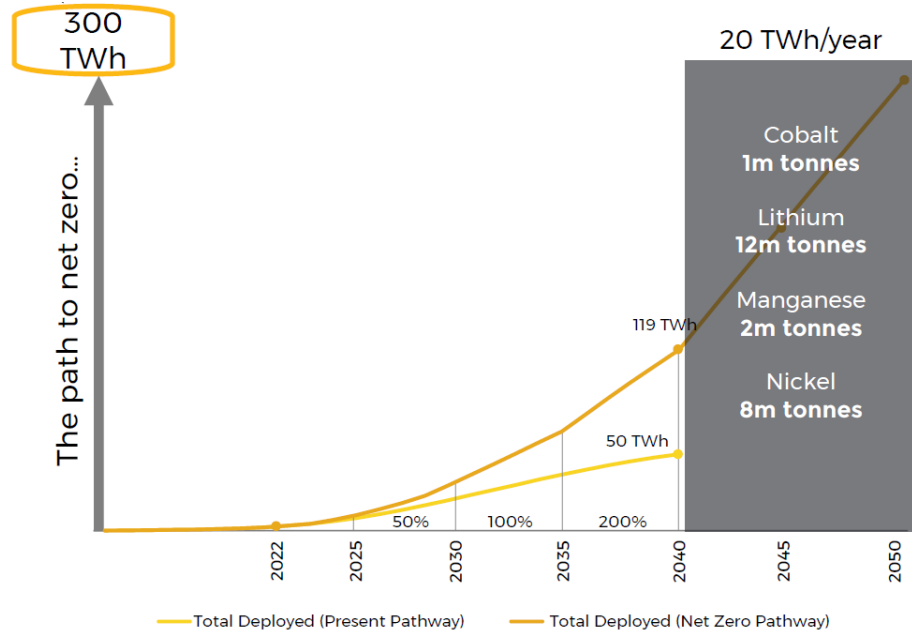


- ❖ Non-Circular Net Zero is essentially a linear economy with a massive penalty for burying CO₂
- ❖ Business as usual already has implemented many efficiency improvements using catalysis, chemical and heat engineering; replacing fossil fuels with waste CO₂ and green hydrogen drops into the same downstream
- ❖ The Circular Economy reduces virgin material dependence and waste disposal
- ❖ Sustainability 4.0 – “The repair and share economy” is a way by which we can limit the damage we do to the planet while maintaining a reasonable quality of life. It’s a quietly growing movement.

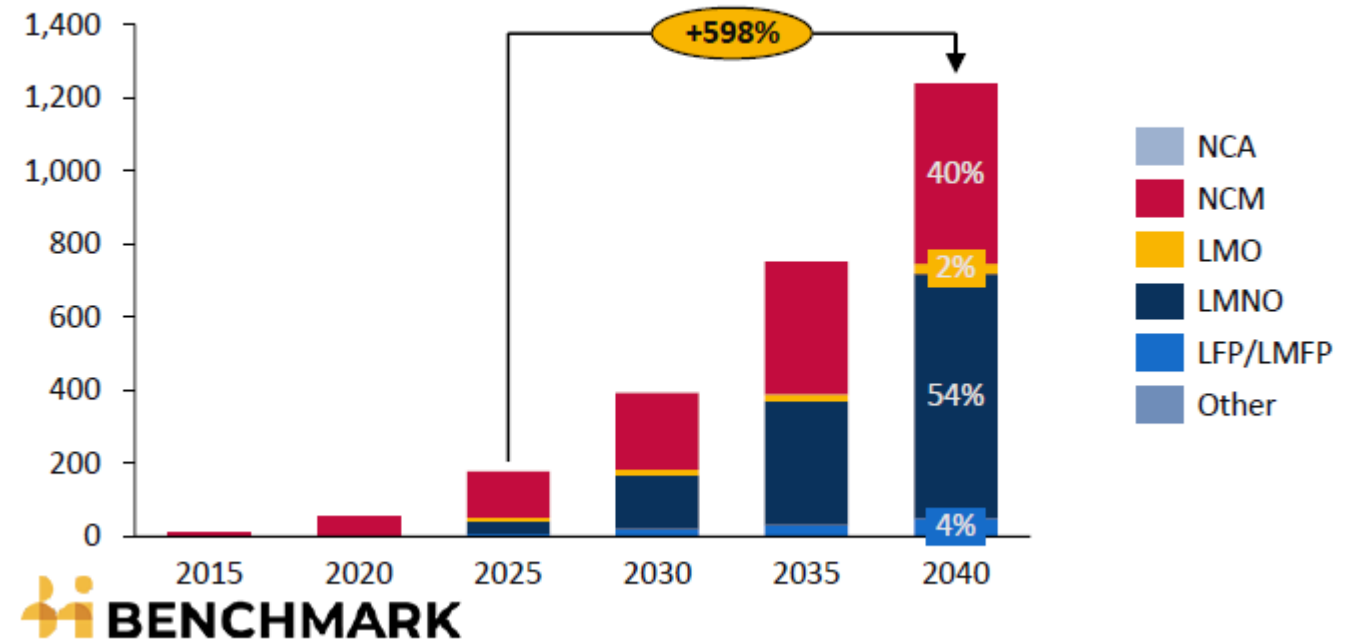
Metal Content by Battery Chemistry



Key Critical Raw Material Needs Include Manganese

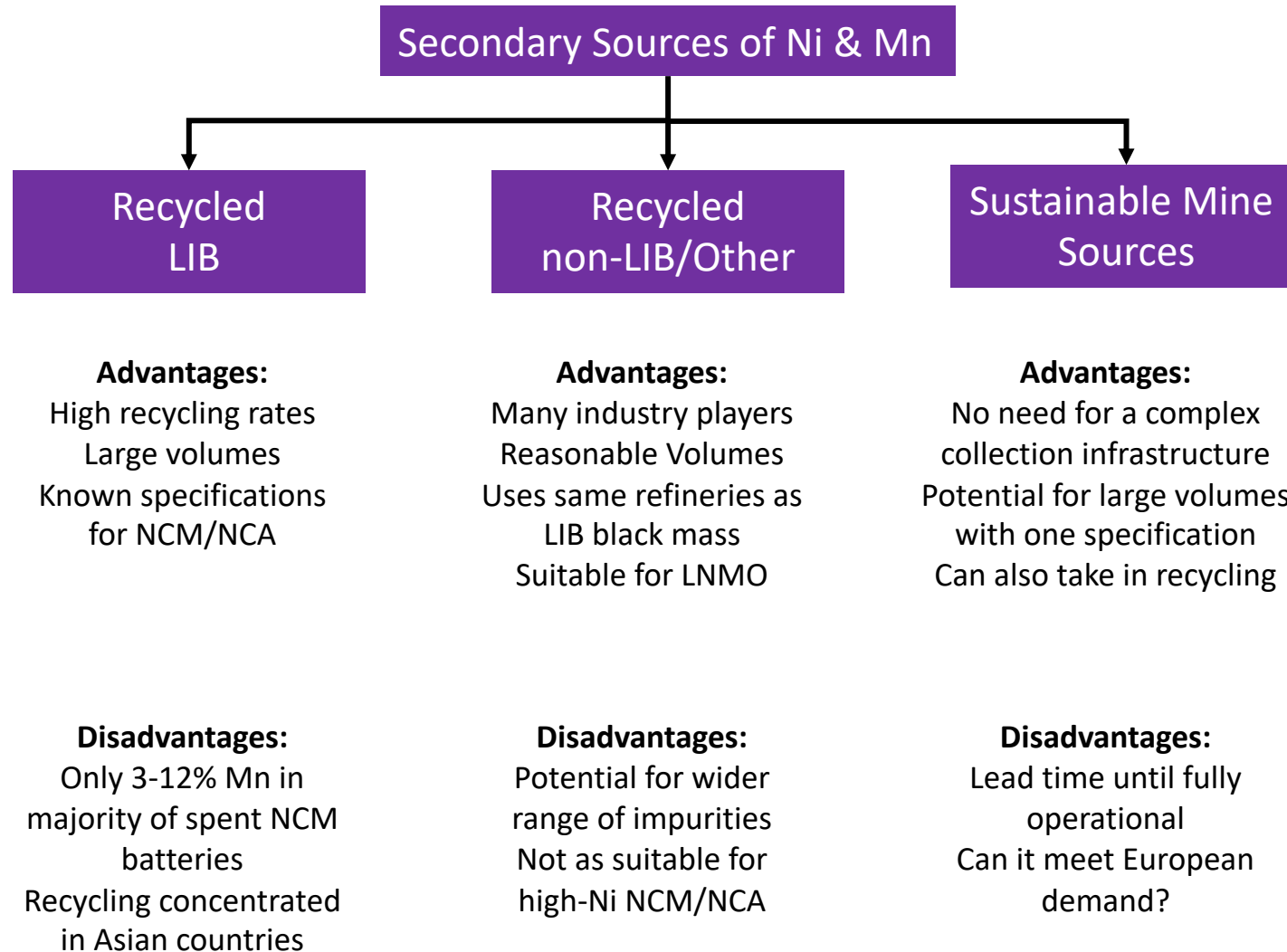


Manganese demand from cathodes, '000 tonnes Mn contained, 2015-2040



Source: Benchmark Minerals, January 2023

Meeting Demand for Ni and Mn from Secondary Sources



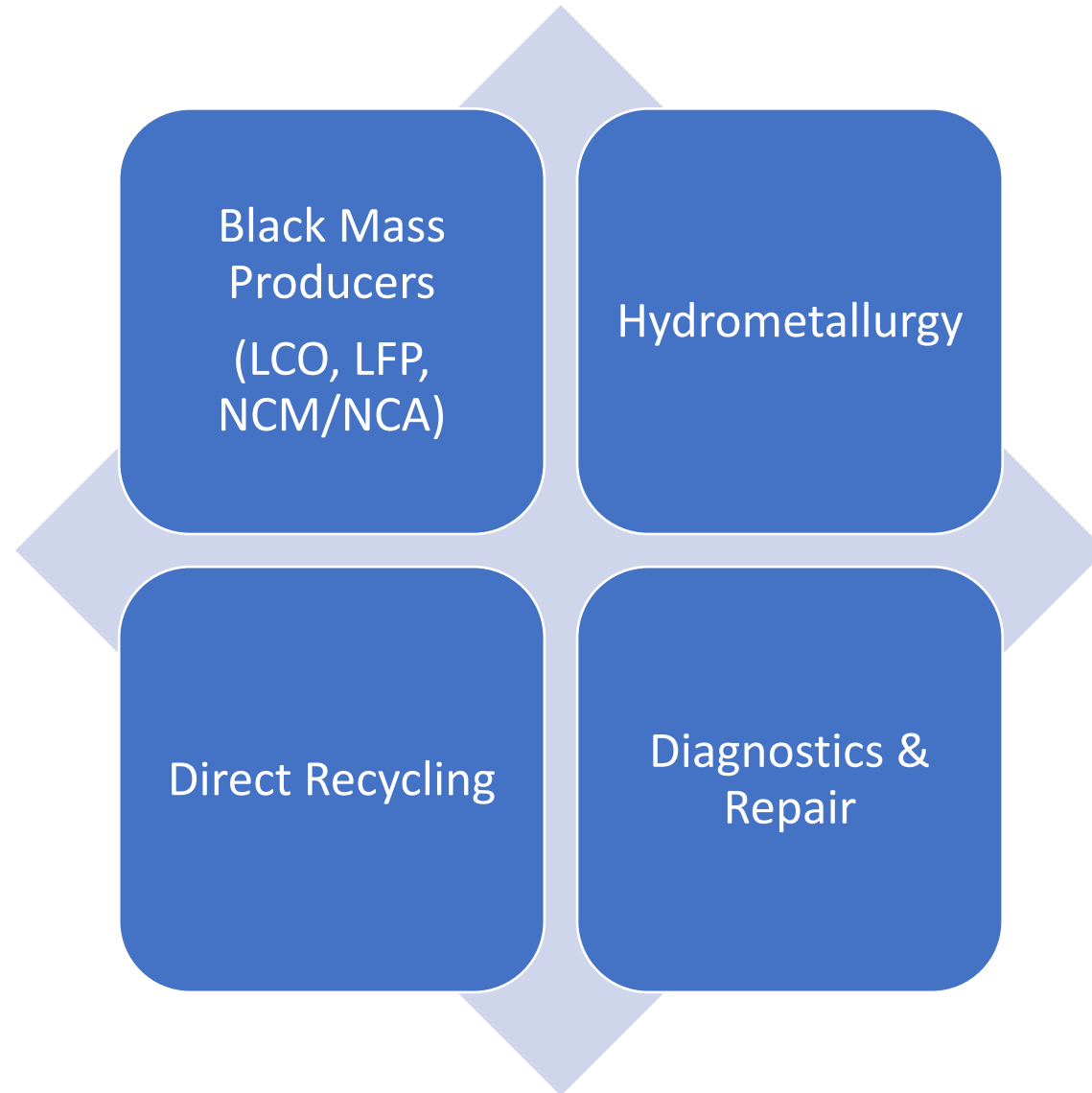
Manganese Recycling Challenges

- ❖ Mn is the last priority for a hydromet after Ni, Co and Li.
- ❖ It costs as much to recycle Mn as it does Ni and Co combined.
- ❖ Mn doesn't get recycled back to the grade needed for most batteries (NCM, NCA).
- ❖ Usually end up getting Mn(OH)_x when the carbonates would be preferable.
- ❖ Need to rationalize different Mn-rich precipitates and process centrally.
- ❖ Pyro units have a Mn-containing slag which is in the form of oxides and silicates, goes into construction materials currently. With some upgrading, could be viable for LNMO/LMFP.
- ❖ As long the feeds don't have too much Fe or fluorine, they can be viable for upgrading – companies can also choose to do an extra upgrade themselves then send for refining – needs discussion between the companies and the refiners.
- ❖ Blending of Mn salts from different recycled materials with purer feeds of Mn e.g., from the mine tailings can be a useful strategy – but need to demonstrate it.
- ❖ Cathode-to-cathode is one useful strategy but difficult for LNMO where there is no EoL scrap.
- ❖ There is competition from other industries – e.g., steel alloys and taking the feed into batteries could cause a structural deficit there.
- ❖ We still need much higher-grade recycled Mn for NCM. Not clear where all of it will come from.

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Diversity of Capabilities Key to Meeting Supply Chain Needs



LIB recycling projects as of May 2023

Sweden

northvolt **STENA**
 Installed, Halmstad
 2030, Skellefteå 125,000 t/a
 Installed, Kristiansand
 10,000 t/a
 (2033: 100,000 t/a)

2025, Europe
 X t/a

REDWOOD MATERIALS **202X, Europe**
 X t/a

BlueWhale MATERIALS **202X, Europe**
 X t/a

Finland

ACCUREC
 Installed, Nivala
 4,000 t/a

fortum
 Installed, Ikaalinen
 3,000 t/a + X
 2023, Harjavalta
 X t/a

Norway

hydrovolt
 Installed, Fredrikstad
 12,000 t/a

Li-Cycle MORROW **ecOSTOR**
 2023, X
 10,000 t/a

GLENCORE NIKKELVERK
 Installed, Kristiansand
 7,000 t/a

$\Sigma = \text{Installed } 152,200 \text{ t/a} + X$ *Based on official announcements

Netherlands

TES **SK eoplast**
 Installed, Rotterdam
 14,000 t/a

Great Britain

ALTIUM METALS
 2025, Teesside
 10,000 t/a

ecobat
 Installed, Darlaston
 500 t/a
 (2023: 10,000 t/a
 2024: 20,000 t/a)

GIGAMINE
 202X, X
 X t/a

VEOLIA
 2024, Minworth
 5,000 t/a

Belgium

ABEE
 2023, X
 1,000 t/a

Aurubis
 2025/26, Olen
 X t/a

umicore
 Installed, Hoboken
 7,000 t/a

France

SNAM
 202X, Saint Quentin
 10,000 t/a

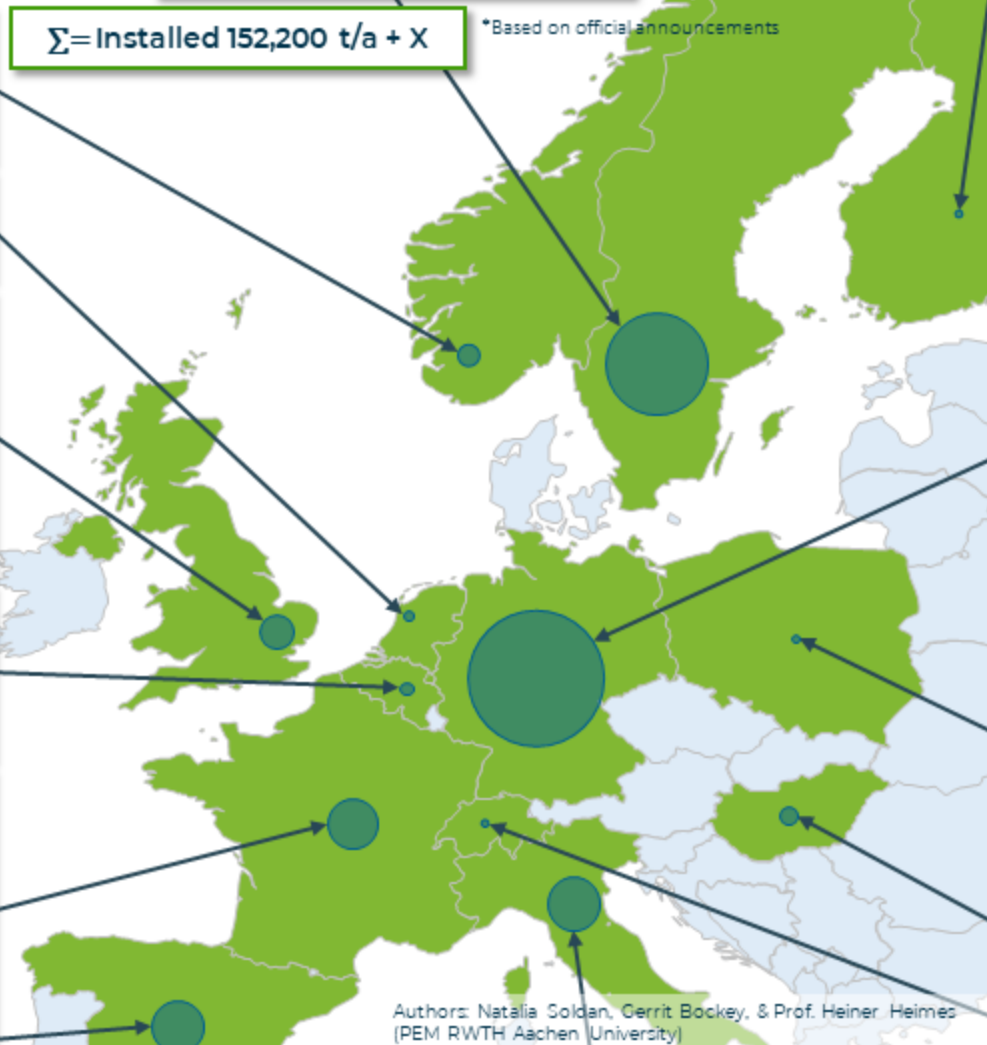
TES **SK eoplast**
 Installed, Grenoble
 2,200 t/a

GROUPE RENAULT **VEOLIA**
 2023, Amneville
 4,000 t/a

Li-Cycle
 2024, Harnes
 10,000 t/a
 (202X: 25,000 t/a)

suez **BRAMET** **VEOLIA EDI**
 2024, X
 X t/a

ecobat
 2024, Bazoches-les-Gallerandes
 20,000 t/a



Germany

ACCUREC
 Installed, Krefeld
 3,250 t/a

Aurubis
 202X, Hamburg
 X t/a

BASF
 2024, Schwarzheide
 15,000 t/a

Duesenfeld
 Installed, Wendeburg
 2,900 t/a

ecobat
 Installed, Hettstedt
 3,000 t/a (2023: 20,000 t/a)

ERLOS
 Installed, Zwickau
 950 t/a

Mercedes-Benz
 2023, Kuppenheim
 2,500 t/a

Hilti
 Installed, Aue
 4,000 t/a

Li-Cycle
 2023, Sülzetal
 30,000 t/a

fortum
 Installed, Kirchart
 3,000 t/a

northvolt
 2025, Heide
 X t/a

Primobius
 Installed, Hilchenbach
 18,250 t/a

REDUX
 Installed, Bremerhaven
 10,000 t/a

ROTH International
 202X, Wernberg-Köblitz
 9,000 t/a

STENA
 Installed, Wangerland
 350 t/a (2023: 2,500 t/a)

VW
 Installed, Salzgitter
 1,500 t/a

WALCH
 Installed, Baudenbach
 1,000 t/a

LUEG **deppe**
 2024, Meppen
 20,000 t/a
 (202X: 60,000 t/a)

Poland

ATTER
 2023, X
 X t/a

ROYAL BEES
 Installed, Legnica
 3,600 t/a

SungEel HiTech POSCO
 Installed, Bukowice
 7,000 t/a

Spain

endesa
 Installed, Cubillos del Sil
 8,000 t/a

et **InnoEnergy** **IR RECYPLAS**
 202X, X
 15,000 t/a

Installed, Erandio
 X t/a

CNLI
 2025, X
 45,000 t/a

TES **galp** **VW**
 202X, X
 X t/a

202X, X
 X t/a

Italy

ITALVOLT
 2024, Scarmagno
 X t/a

Li-Cycle **GLENCORE**
 2027, Portovesme
 70,000 t/a

Switzerland

BATREC
 Installed, Wimmis
 500 t/a

KYBURZ
 Installed, Freienstein
 200 t/a

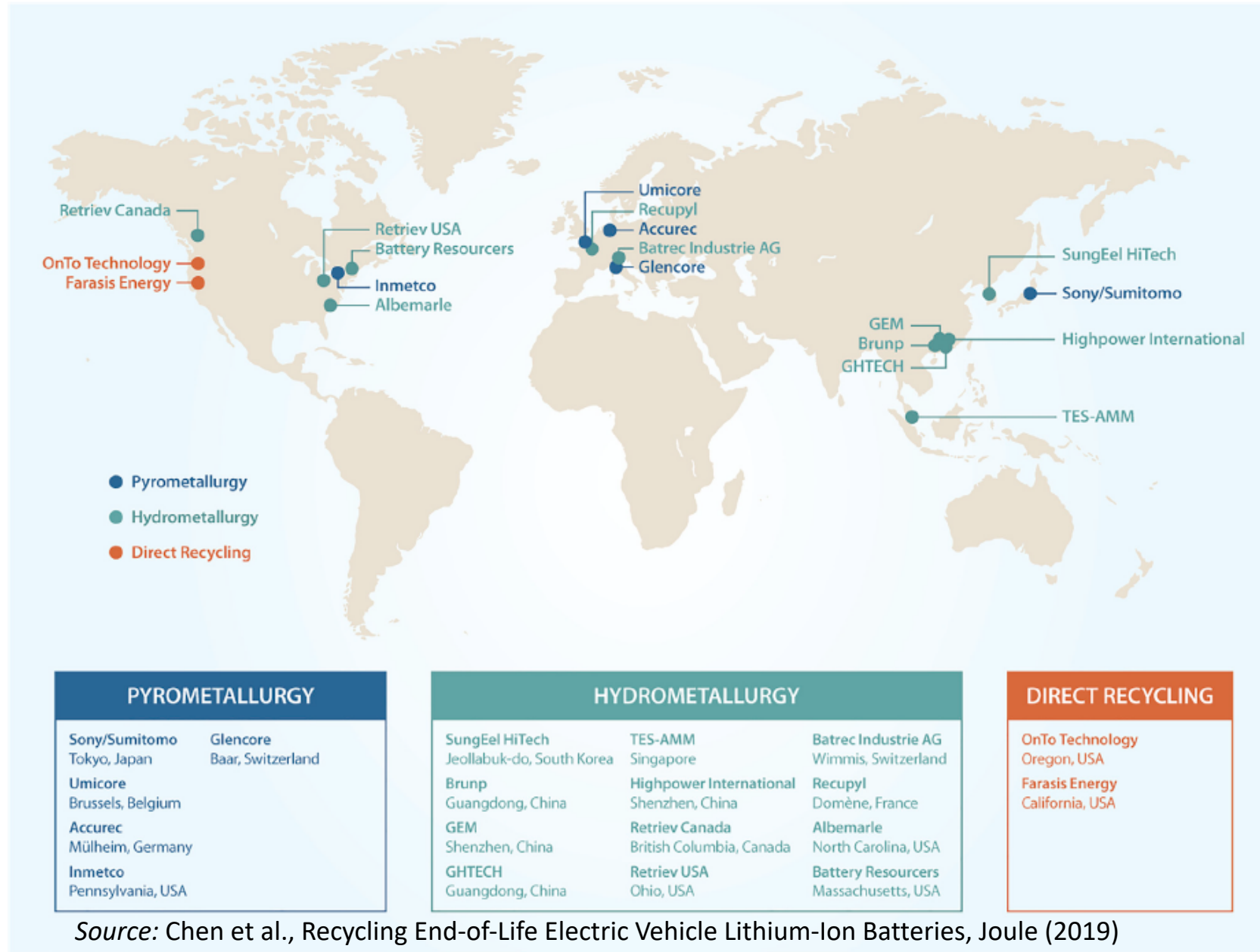
librec
 2023, X
 8,000 t/a

Hungary

SungEel HiTech
 Installed, Bányterenyé
 25,000 t/a

Authors: Natalia Soldan, Gerrit Bockey, & Prof. Heiner Heimes (PEM RWTH Aachen University)

Map of Downstream Battery Processing



Key Announced Recycling Projects With Hydrometallurgy



2023

Fortum, Harjavalta, Finland, 5 kt of batteries

2023

Tozero, Munich, Germany (Pilot)

2025

BASF, Schwarzeide, Germany

2025 (Black Mass), 2027 (Hydromet)

Eramet/Suez, Dunkirk, France, 50 kt of battery modules

2025/26

EcoNiLi Battery, Southern Spain

45 kt of batteries, 25 kt hydromet

2026/27

Li-Cycle/Glencore Portovesme, Italy (the “Portovesme Hub”).

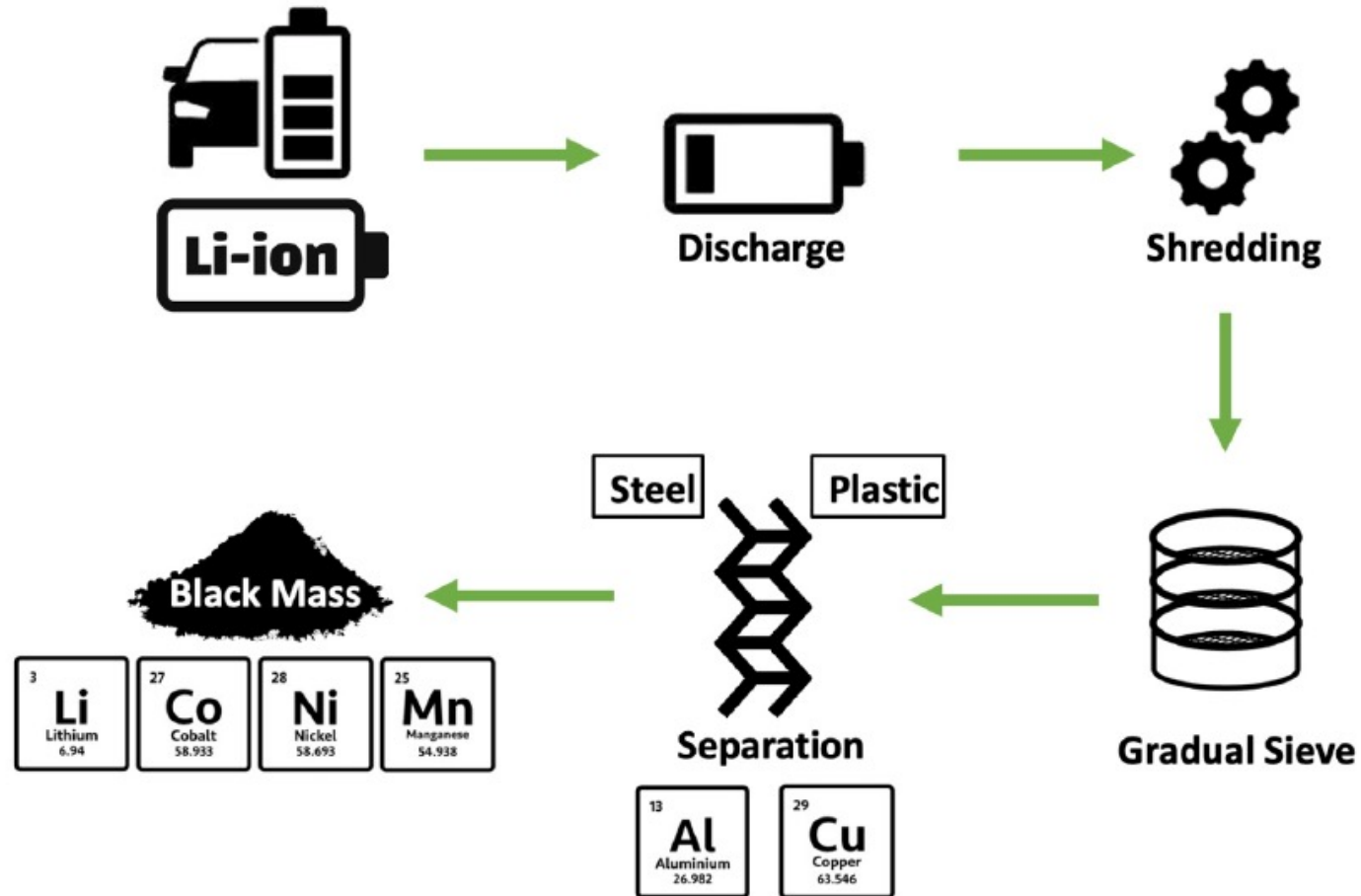
50,000-70,000 tonnes black mass (36GWh) batteries

**TOTAL SCRAP BATTERY WEIGHT
FORECAST FOR 2030 AVAILABLE
FOR RECYCLING IN EUROPE
~500 KT (33% EOL, 67%%
PRODUCTION SCRAP) (@10%
PRODUCTION SCRAP RATE) (CES
DATA, 2022)**

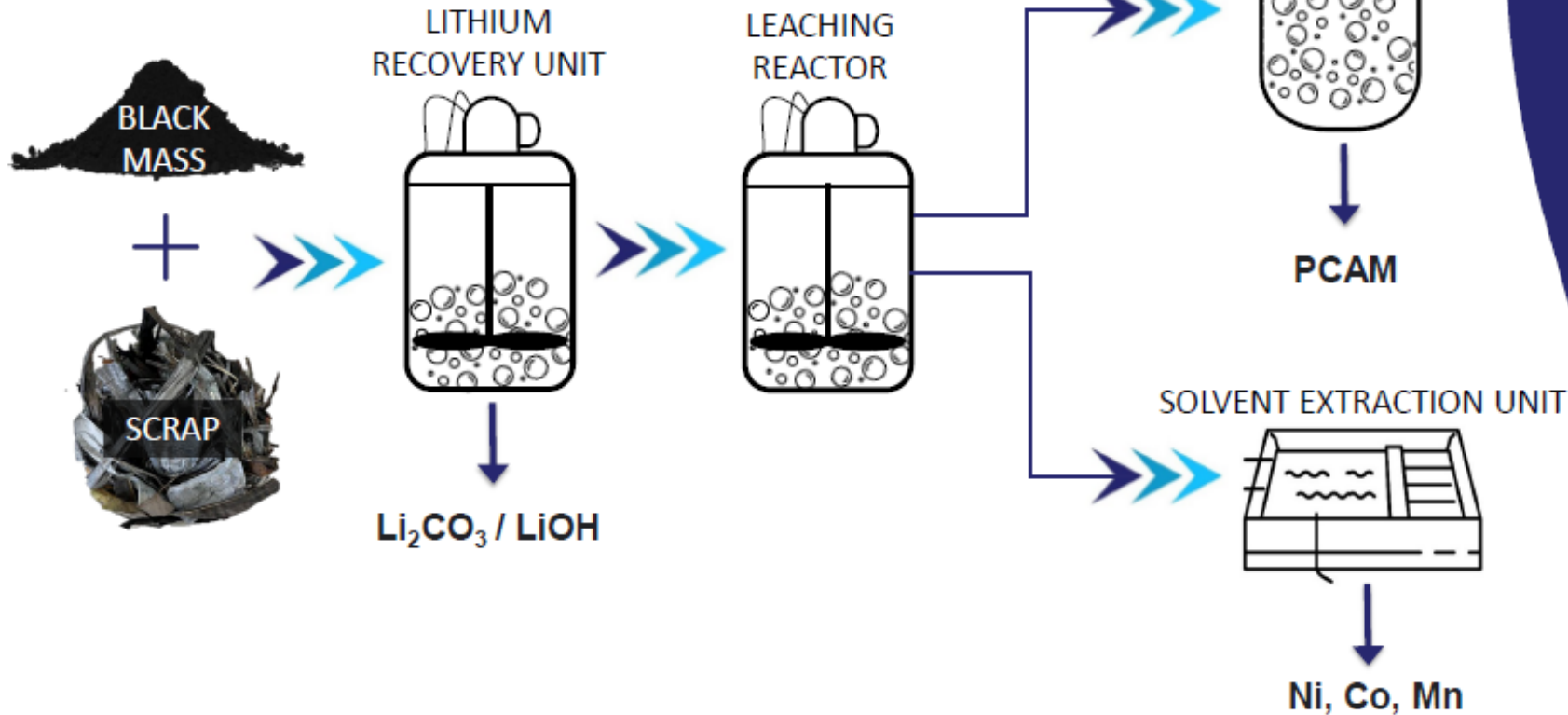
**CONSERVATIVELY NEED AROUND
250 KT HYDROMET CAPACITY BY
2030 AND 500 KT BY 2040**

Proses Makina Flex Batt® Process

 **BATTE-RE's Flex Batt™ Process**
Turning Different Batteries into a Variety of Products



Proses Makina Flex Batt® Process



Benefits of Flex Batt Process:

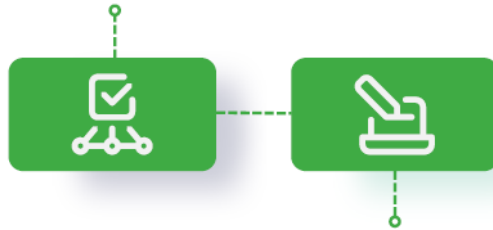
- Processing of diverse battery types within a single facility
- Capability of producing different products
- Production of PCAM through a direct pathway
- High-Efficiency 99% Recovery of Li, Ni, Co, Mn
- Production of PCAM with less chemicals
- Low energy consumption
- Production of high-purity goods
- Low investment cost

ECONILI BELIEVE IN GREEN FUTURE WHERE FINANCIAL RETURNS AND PROTECTING THE WORLD

CAN BE IN HARMONY

OUR VISION

- Pioneering the worldwide provision of recycled essential battery materials to foster a sustainable energy



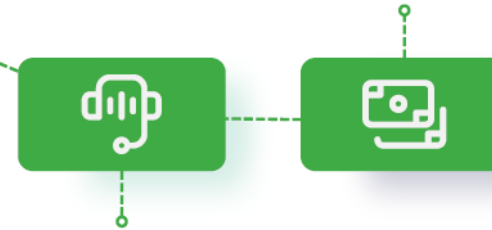
We believe that, with developed and efficient recycling solutions and experience of EcoNiLi Battery, battery recycling can be affordable and sustainable.



Ensuring Spoke & Hub Integrated Network between Asia & Europe

OUR MISSION

- Recycle critical materials to create a sustainable closed-loop battery supply chain



The strength of our supply chain allows us to create central hubs, first in Asia and then in Europe, to ensure the most sustainable and economical end-of-life solutions for waste LIB.



1. ECONILI BATTERY EUROPE S.L.

EcoNiLi, an OEM specializing in Li-ion battery recycling based in Spain, operates from a sprawling 64,000 square meters factory located in Alicante. The facility is dedicated to handling a substantial battery treatment volume of 45,000 tons annually, complemented by a robust hydrometallurgical process capacity of 25,000 tons per year.

2. ECONILI MALAYSIA

In a parallel venture, EcoNiLi is initiating a strategic relocation of its operations to a modernized factory occupying 7,000 square meters on a 3-acre expanse in Perak. This advanced facility is poised to accommodate a production capacity of nearly 10,000 MT per year. Within this new establishment, the focus remains on efficient battery treatment, with a monthly processing capability of 15,000 tons. This endeavor is further enhanced by the concurrent hydrometallurgical process capacity, enabling the treatment of 12,000 tons of material each month.



Take Home Messages

- ❖ Creating a sustainable supply chain within Europe for batteries requires a high degree of cooperation and transparency amongst the supply chain to avoid or at least limit the boom-bust cycles seen in other industries.
- ❖ Much of the effort needed isn't necessarily technical – it's logistical and requires cooperation between different stakeholders.
- ❖ A much more granular view is required on the capabilities of the existing and new entrants and if they are covering the future supply chain rationally.
- ❖ Cathode formulations are increasingly Ni and Mn centric, and more recycled metal is required in line with sustainability/ESG goals.
- ❖ More large sophisticated recycling and hydrometallurgical capacity is needed to meet future demand and investment is needed along with input from investors, technology specialists and licensors.
- ❖ Newcomers and companies from adjacent industries with broad skill sets at TRL9 are keen to expand capacity in Europe and investment will enable a faster ramp up of sustainable capacity.



Enabled
Future



Enabled Future Limited Membership Prospectus

Enabled Future Limited (EFL) is a consultancy which works to **Optimise Technology Portfolios** with stakeholders involved in the sustainable production, use and recycling of chemicals, catalysts, plastics and polymers, energy carriers and valuable metals.

Discover the range of services including Included in the new EFL Company Membership Programme to be launched in November 2022.

Don't miss out on the limited time offer of 3-month's free membership which is available until 1st November 2022!

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Thank you for listening!

Catch us at:

EV Battery Recycling & Reuse, 2023, 23-24th, Oct 2023,
Frankfurt, Germany

www.ev-battery-recycling.com

GDMMC Asia Intl Battery Recycling Summit (AIBR)
Conference, 4-7 Dec, 2023, Singapore

Barecycle