AUTOMOTIVE CELLS Co

"We move it-

Herausforderungen und Potentiale des Recyclings von Traktionsbatterien"

Batteriecycling aus Sicht eines Zellherstellers

Kaiserslautern, 11-11-2022

Gefördert durch:
Bundesministerium für Wirtschaft und Klimaschutz
aufgrund eines Beschlusses des Deutschen Bundestages
RheinlandPfalz
MINISTERIUM FÜR WIRTSCHAFT, VERKEHR, LANDWIRTSCHAFT UND WEINBAU

ACC- Automotive Cell Co.

C1 - Open

ACC: Member of the IPCEI Partners- Backbone of the new European battery value chain

IPCEI on Batteries Partners

RAW MATERIALS AND ADVANCED MATERIALS	CELLS/ MODULES	BATTERY SYSTEMS	REPURPOSING, RECYCLING AND REFINING
BASF	ACC	BMW	BASF
ENERIS	BMW	ENDURANCE	ELEMENTAL STRATEGIC METALS
KELIBER	ENDURANCE	ENEL X S.R.L.	ENDURANCE
NANOCYL	ENERIS	ENERIS	ENERIS
SOLVAY	FAAM	FLASH BATTERY SRL	FAAM
TERRAFAME	SEEL SWEDISH ELECTRIC TRANSPORT LABORATORY	SEEL SWEDISH ELECTRIC TRANSPORT LABORATORY	FORTUM RECYCLING & WASTE
UMICORE AG & CO. KG	VARTA		SEEL SWEDISH ELECTRIC TRANSPORT LABORATORY
			UMICORE AG & CO. KG

IPCEI European Battery Innovation (EuBatIn) Partners

RAW AND ADVANCED MATERIALS	BATTERY CELLS	BATTERY SYSTEMS	RECYCLING AND SUSTAINABILITY
ACI SYSTEMS	ALUMINA SYSTEMS	ACI SYSTEMS	BOREALIS
ALKEEMIA SPA	BMW	ALUMINA SYSTEMS	ENEL X
ARKEMA	CELLFORCE GROUP	AVL	ENGITEC
BOREALIS	ELRINGKLINGER	BMW	FORTUM
FERROGLOBE	FCA	ENDURANCE	HYDROMETAL
GREEN ENERGY STORAGE	GREEN ENERGY STORAGE	ENEL X	ITALMATCH CHEMICALS
HYDROMETAL	INOBAT ENERGY	ENERGO-AQUA	KELIBER
ITALMATCH CHEMICALS	MANZ	FCA	LIOFIT
KELIBER	MIDAC	FPT INDUSTRIAL	LITTLE ELECTRIC CAR
SGL CARBON	NORTHVOLT	INOBAT ENERGY	MIDAC
SOLVAY	SGL CARBON	MANZ	SGL CARBON
TOKAI COBEX	SKELETON TECHNOLOGIES	MIBA	VALMET AUTOMOTIVE
VARTA MICRO INNOVATION	SUNLIGHT GROUP ENERGY STORAGE SYSTEMS	MIBA BATTERY SYSTEMS	ZTS
	VARTA MICRO INNOVATION	MIDAC	
		RIMAC AUTOMOBILI	
		ROSENDAHL NEXTROM	
		SKELETON TECHNOLOGIES	
		SUNLIGHT GROUP ENERGY STORAGE SYSTEMS	
		VALMET AUTOMOTIVE	

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IPCEI BATTERIES

KLiB Kompetenznetzwerk Lithium Ionen Batterien

RECHARGE

upcell European Battery Manufacturing Alliance

IPCEI Batteries: Technology Fields (ipcei-batteries.eu)

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Automotive Cell Co.

OUR AMBITIONS ARE:

+

To be a high-tech and innovative center of excellence.

+

To be competitive, producing automotive batteries more affordable than ever.

+

To be cleaner & greener, acting in a sustainable, ethical and environmentally friendly way.

+

To grow as fast as the mobility transition, creating many job opportunities.

ACC…
European footprint

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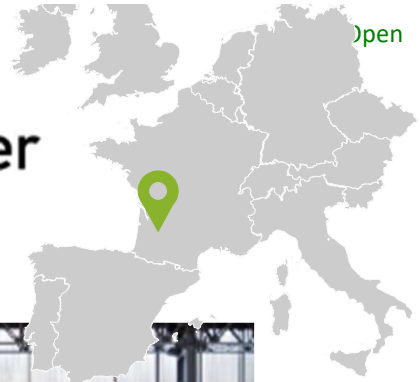
R&D Center Bordeaux (France)

acc AUTOMOTIVE CELLS Co | Expertise Center



- An 11 000m2 building
- 2 300m^2 of laboratories
- 1 300m^2 of test area
- 1 100m^2 of prototype line
- 1 000m^2 of logistics area
- 2 300m^2 of offices

acc AUTOMOTIVE CELLS Co

Nersac pilot plant (France)

acc AUTOMOTIVE CELLS Co | Nersac Industrial Excellence Center

- **24 000m2** of buildings
- **6 000m2** of dry room
- Inauguration March 2022
- Validation and optimisation of processes; production of small series

Billy-Berclau / Douvrin (Hauts-de-France)

- A **34ha** site, near Stellantis factory (ex PSA)
- **1,700 m2** prototype workshop
- **13.4 GWh** production capacity at the start in 2023
- **3** production blocks by 2030 i.e. 40 **GWh** ramp up by 2030

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C1 - Open

Kaiserslautern

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© Christian Fernandez Gamio

Kaiserslautern
Gigafactory and Engineering Center

- A 41 ha (48 soccer fields) site near Stellantis-Opel factory
- ~15 GWh production capacity from end 2025
- 3 production blocks by 2030 > 40 GWh
- Engineering Center for higher TRL and factory related research

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On the way to accelerate mobility for all

Started in 2020, ACC has become one of the fastest growing companies in the automotive sector

0 to 700+
TALENTED EMPLOYEES

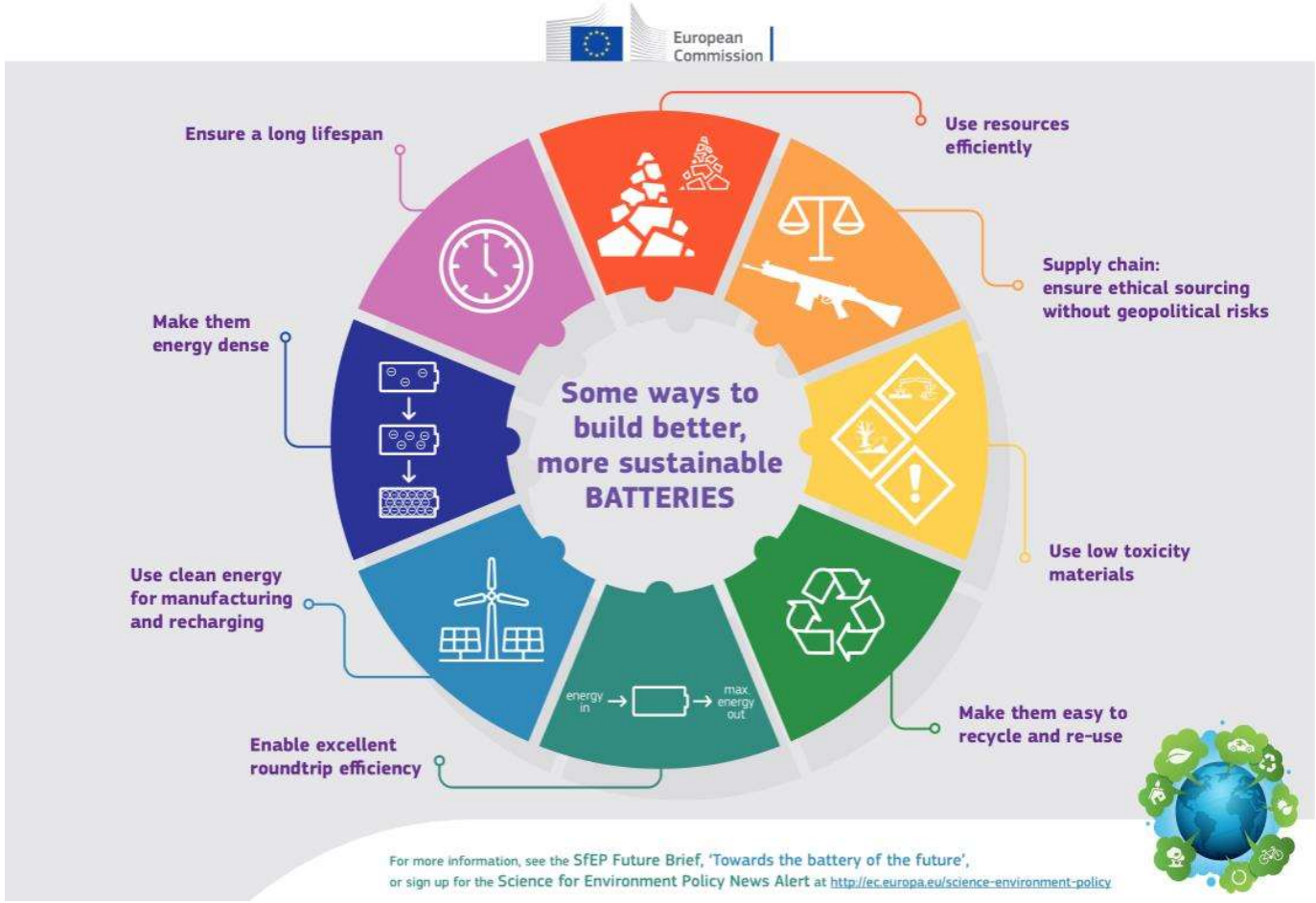
3.2b EUR
FUNDING RAISED

>320 GWh
AWARDED CAPACITY 2024-2030

120 GWh
YEARLY PRODUCTION CAPACITY IN 2030

Accelerating towards sustainability and recycling

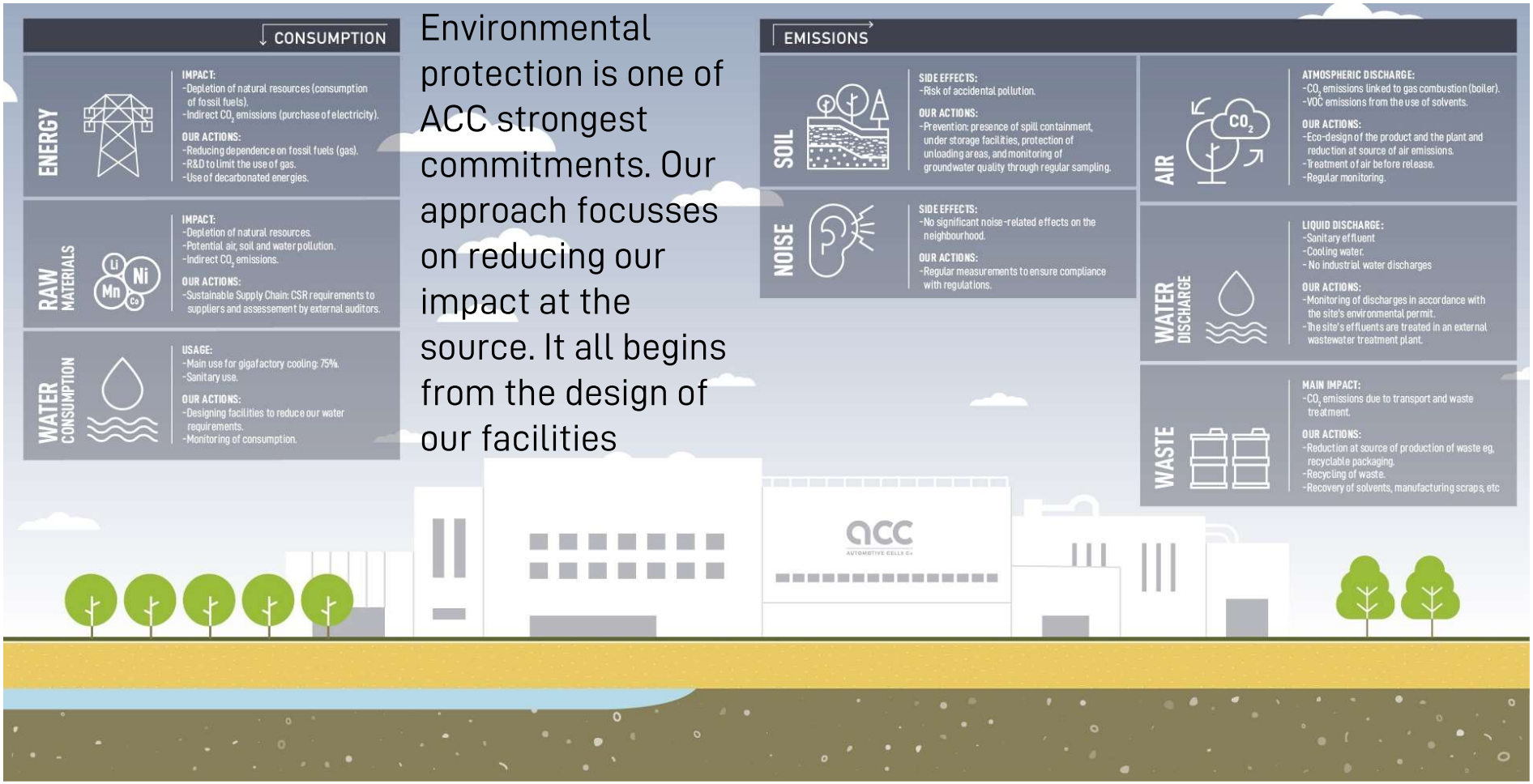
Sustainability is a must



Sustainability- Brownfield approach

Our environmental responsibility

Environmental protection is one of ACC strongest commitments. Our approach focusses on reducing our impact at the source. It all begins from the design of our facilities



ACC produces battery cells and battery modules

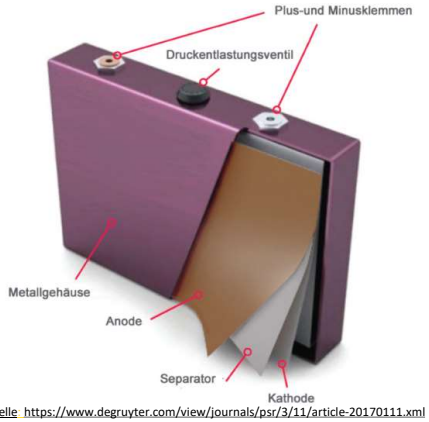
Battery module

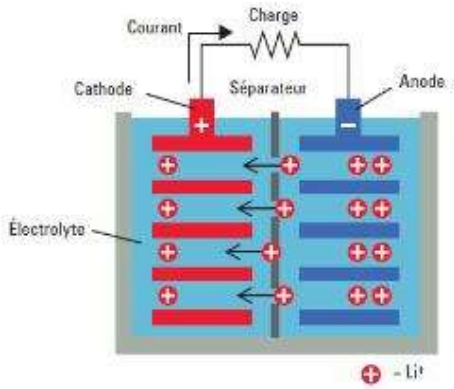
A large number of cells are installed in one module.

The customer assembles several modules for the final car battery

Battery cell

The most important components of a cell ar
electrodes through which the electric currer
well as the separator and the electrolyte





Quelle https://www.degruyter.com/view/journals/psr/3/11/article-20170111.xml

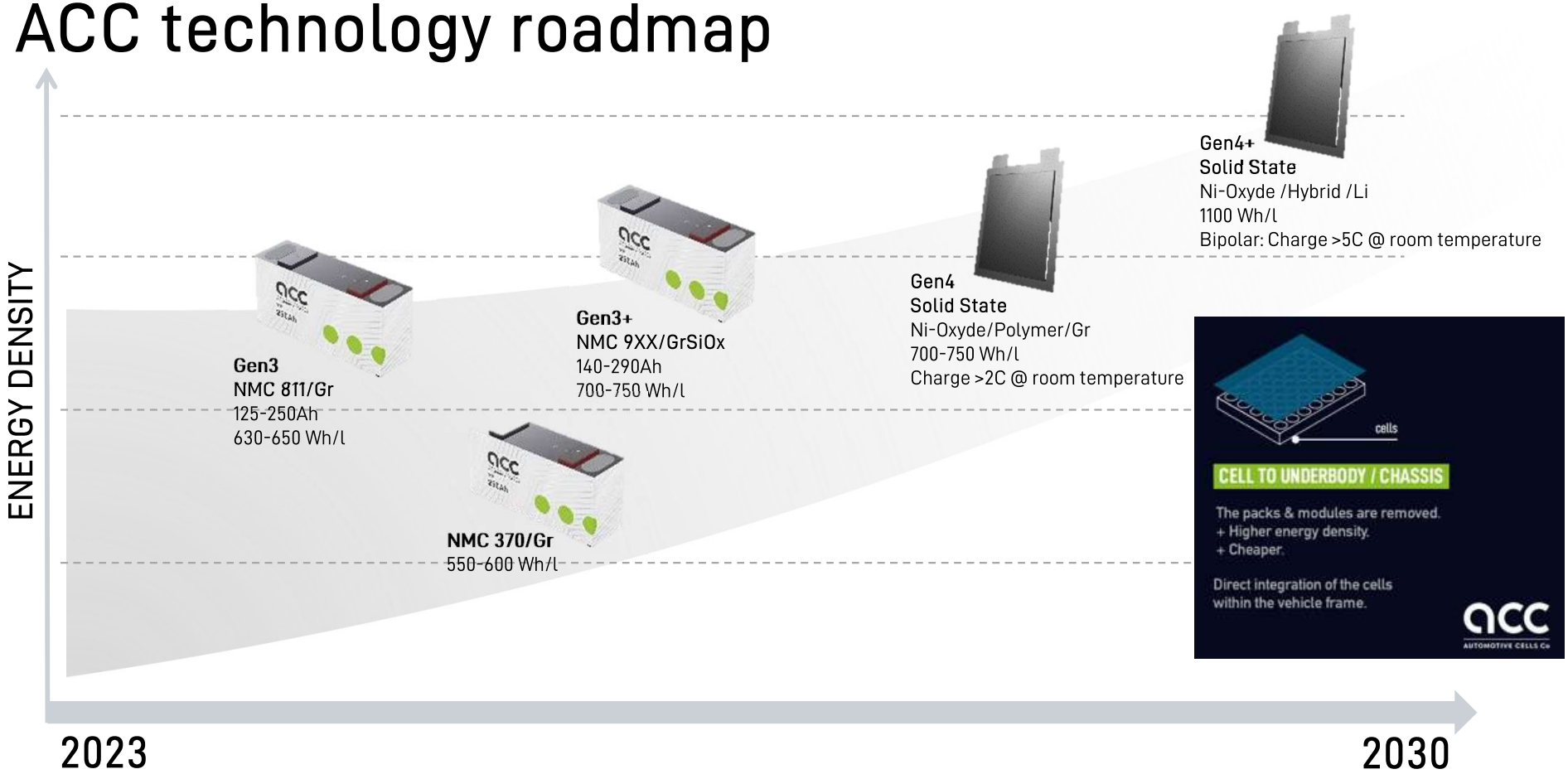
Exemplary commercial Li-ion battery cell composition

Battery component	Materials	Mass-%
Housing	Steel or Al	20-25
Cathode (positive electrode)	LCO, NMC, NCA, LFP or LMO	25-35
Anode (negative electrode)	Graphite	14-19
Electrolyte	$LiPF_6$ dissolved in PC, EC, DMC or DEC	10-15
Cathode current collector foil	Aluminum	5-7
Anode current collector foil	Copper	5-9
Separator	PP, PE	1-4
Others (additives)	Carbon black, silicon, etc.	Balance

DEC	Di Ethyl Carbonate
DMC	Di Methyl Carbonate
EC	Ethylene Carbonate
EMC	Ethyl Methyl Carbonate
LCO	Lithium Cobalt Oxide $LiCoO_2$
LFP	Lithium Iron Phosphate, $LiFePO_4$
LMO	Lithium Manganese Oxide, $LiMn_2O_4$
NCA	Lithium Nickel Cobalt Aluminum oxide, $LiNi_xCo_yAl_zO_2$
NMC	Lithium Nickel Manganese Cobalt Oxide,$LiNi_xMn_yCo_zO_2$
PC	Propylene Carbonate

Source: www.accurec.de:- Comparative study of Li-ion battery recycling processes R. Sojka, et al. 2020

ACC technology roadmap



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EU Critical raw material (CRM) reflects economic importance and supply risk

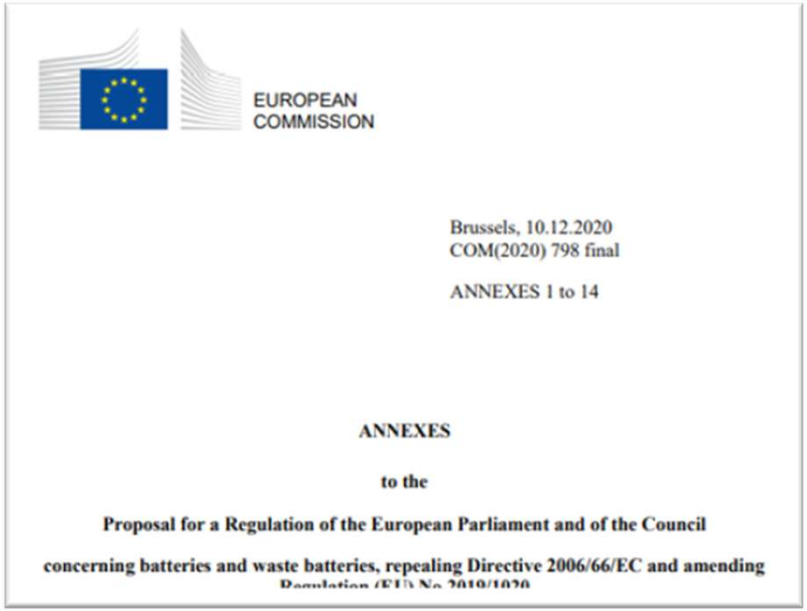
2020 critical raw materials (new as compared to 2017 in bold)		
Antimony	Hafnium	Phosphorus
Baryte	Heavy Rare Earth Elements	Scandium
Beryllium	Light Rare Earth Elements	Silicon metal
Bismuth	Indium	Tantalum
Borate	Magnesium	Tungsten
Cobalt	**Natural graphite**	Vanadium
Coking coal	Natural rubber	Bauxite
Fluorspar	Niobium	**Lithium**
Gallium	Platinum Group Metals	Titanium
Germanium	Phosphate rock	Strontium

Source: Critical raw materials (europa.eu)

Several CRM materials are needed for EV Batteries

EU proposed recycling quota requirements

EU Battery Regulation:



EUROPEAN COMMISSION

Brussels, 10.12.2020
COM(2020) 798 final

ANNEXES 1 to 14

ANNEXES

to the

Proposal for a Regulation of the European Parliament and of the Council

concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending

	2026	2030
Battery Recycling Efficiency (%)	>65 % (2025)	>70 %
Material Recovery Rate		
Nickel (%)	90 %	95 %
Cobalt (%)	90 %	95 %
Lithium (%)	35 %	70 %
Copper (%)	90 %	95 %

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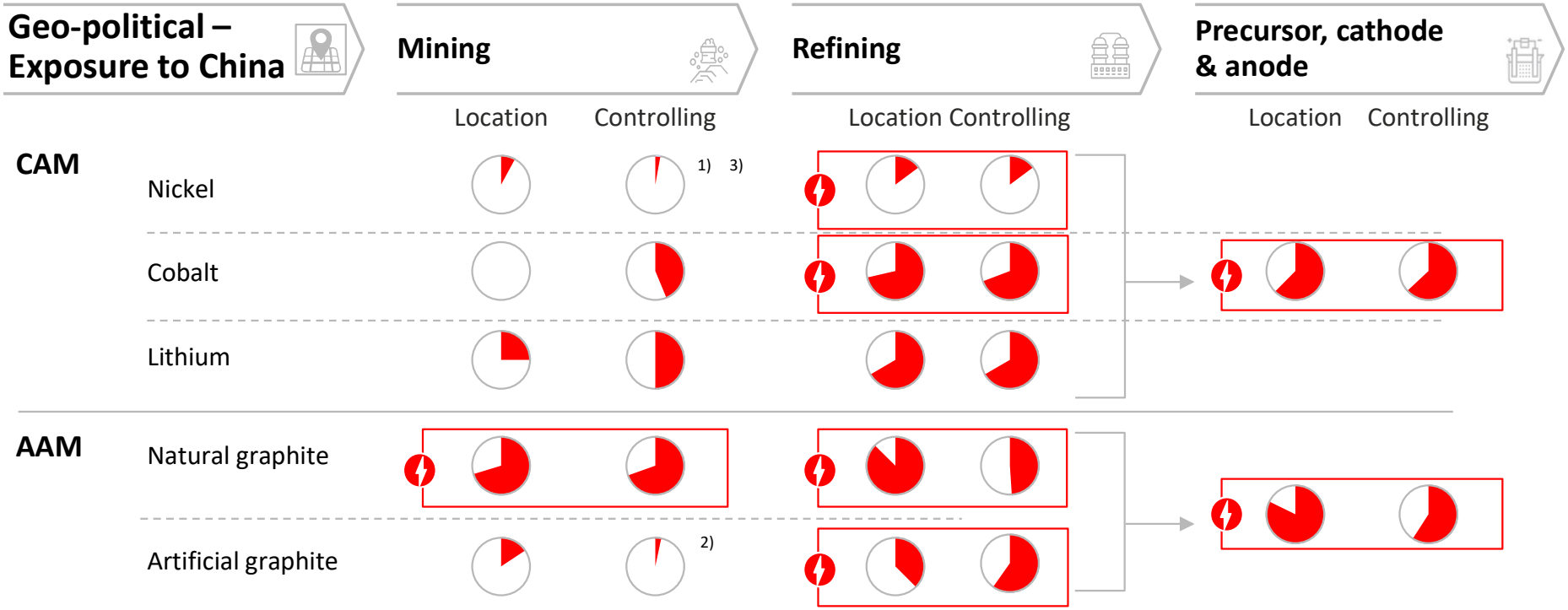
European technology sovereignty not secured- China controls most of the midstream value chain



0% exposure to China | 100% exposure to China | Very high dependence on China | 1) Considering class 1 Nickel; 2) Petroleum coke only; 3) 40% of production not considered

Source: Fastmarkets, BMI, B3, ACC, Roland Berger, Verkor

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ACC requirements for raw materials suppliers

- Compliance to ACC Sustainable Supply Chain Charter
- Highest technical performance with lowest tolerances
- Reliable raw material supply preferably out of Europe
- Production and material transportation with lowest CO_2 footprint
- Development progress in cell chemistry and materials
- Increasing recycled content
- Ready and able to scale-up production
- Economically competitive

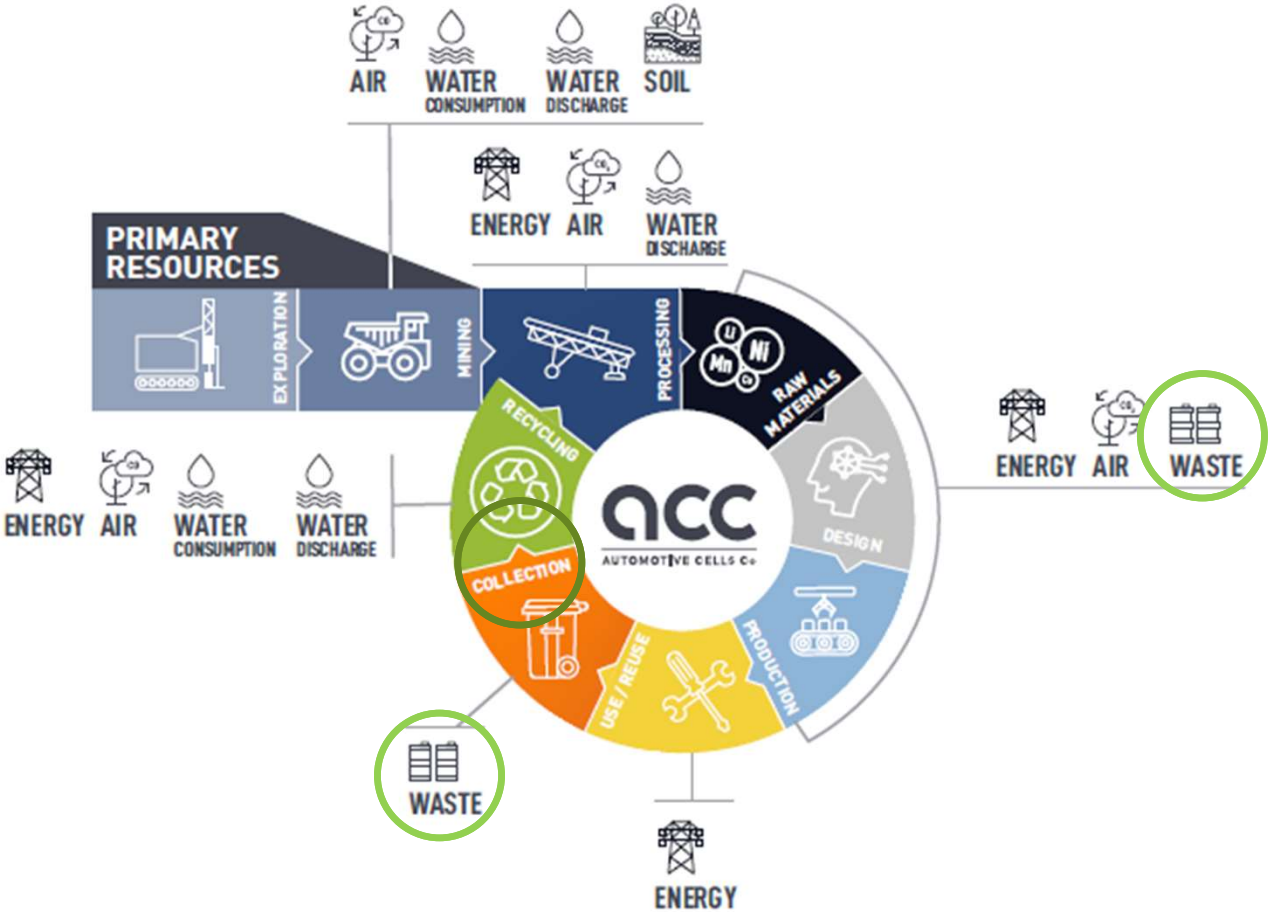
ACC Sustainable Supply Chain Charter

ACC Corporate Social Responsibility Requirements and Guidelines for Suppliers

The following Sustainable Supply Chain Charter applies to any Supplier doing business with Automotive Cells Company SE or its subsidiaries ("ACC") and are part of any contract with ACC that obligates a Supplier to comply with ACC sustainability requirements or policies, including the Codes of Conduct.

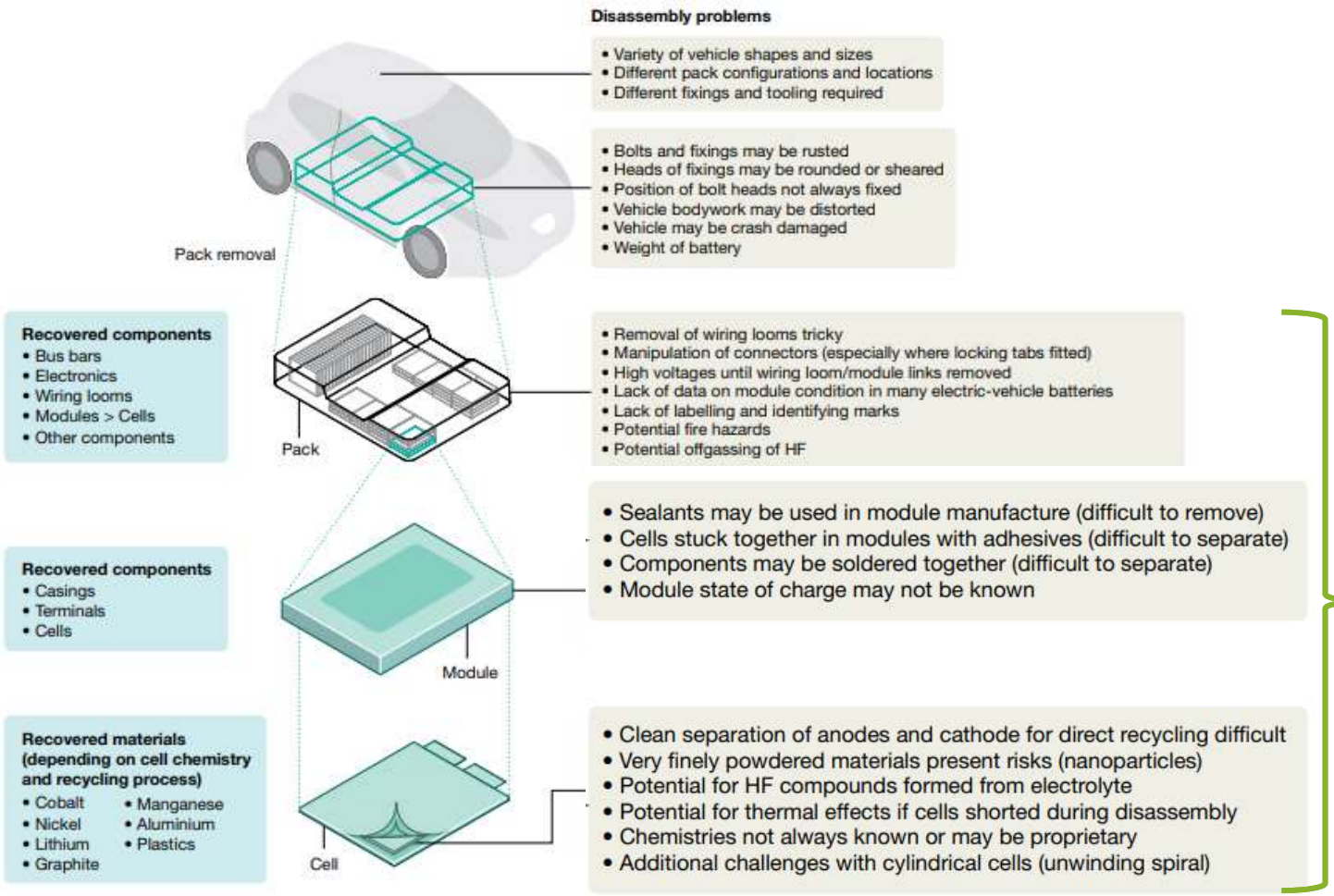
VERSION 1 – SEPTEMBER 2021

Sustainable business conduct



https://www.acc-emotion.com/stories/umicore-introduces-new-generation-li-ion-battery-recycling-technologies-and-announces-award

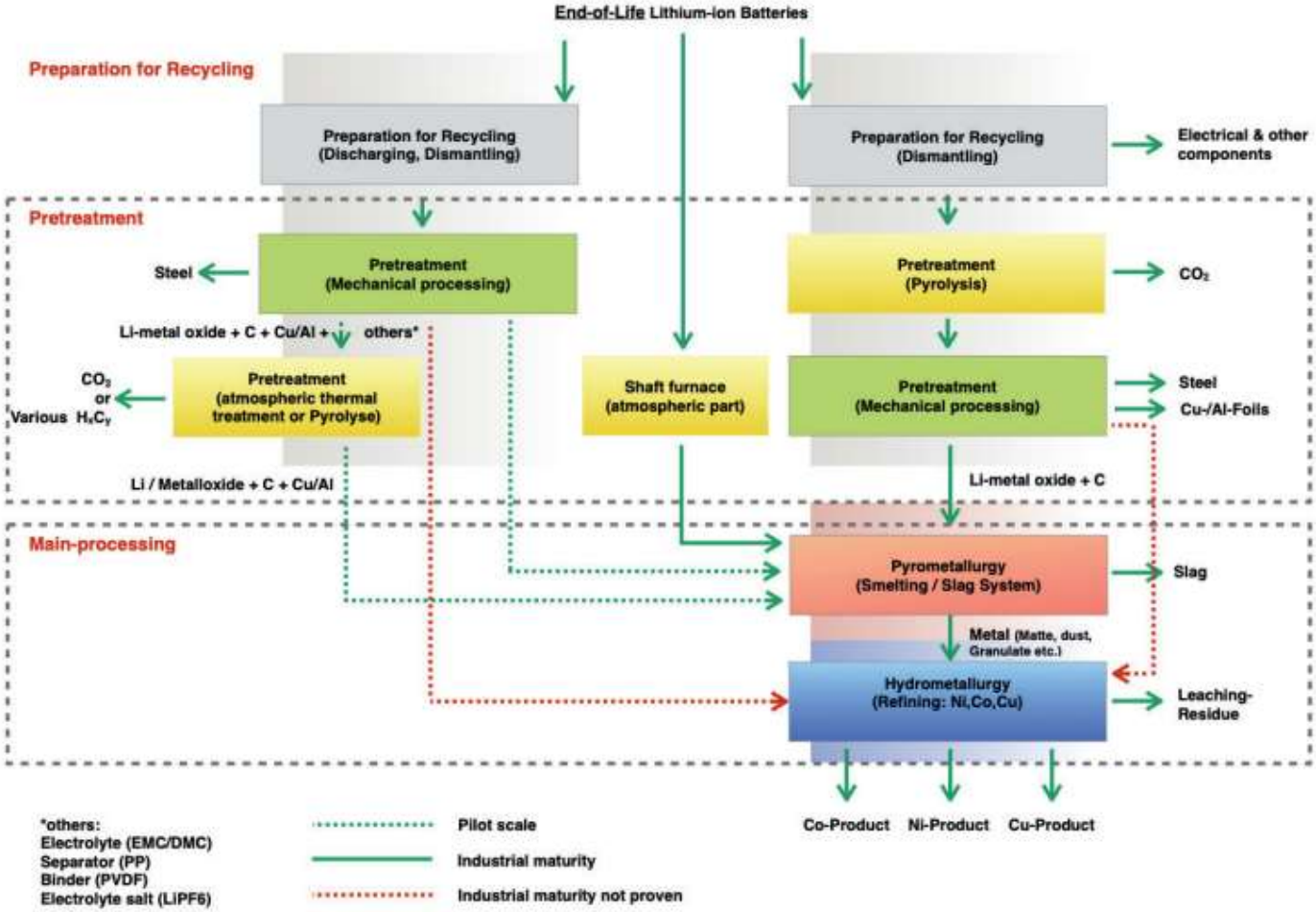
Preparation for efficient recycling processes



More **Dismantling Friendly Design** and **Automation Concepts** are needed to reduce material contamination

Source: G. Harper, Nature, Vol 575, 7.11. 2019, 75

Schematized Li-ion batteries recycling routes



Source: www.accurec.de:- Comparative study of Li-ion battery recycling processes R. Sojka, et al.

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Quantifying global development of production scrap

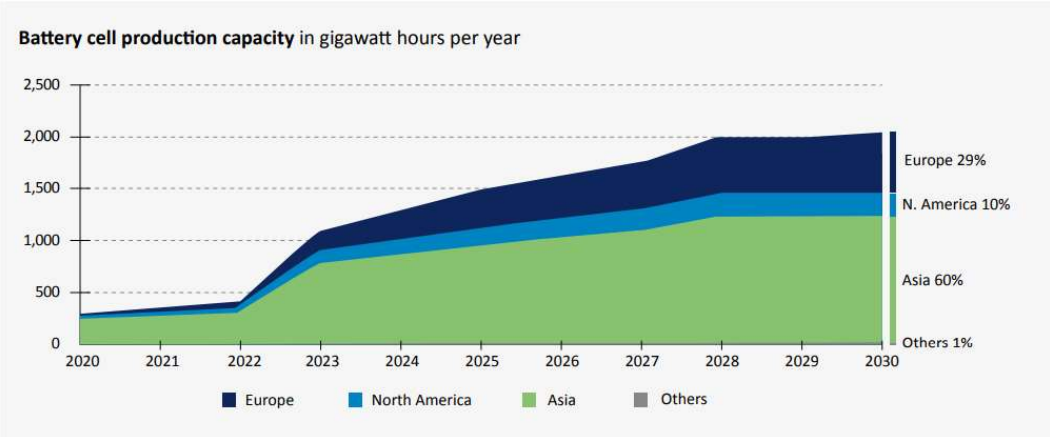
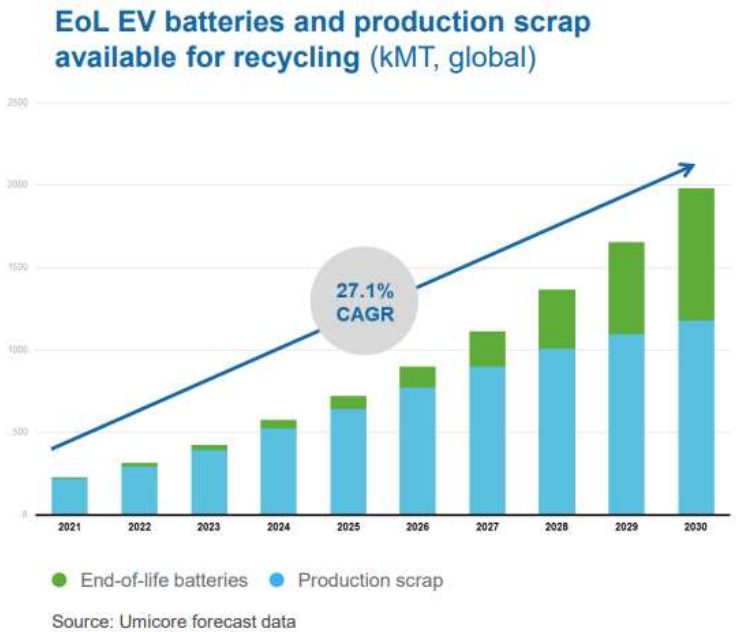


Figure 5: Development over time of the annual production capacity of battery cells in Europe. Source: Analysis of the scientific monitoring of battery cell production based on publicly available information sources.

Source: VDI/VDE IT, TÜV Rheinland, TU Berling 2021



- Market information suggest that per GWh production capacity about 500 – 1000 t of production scrap a year may be generated

Global activities for battery recycling

Table 6: Current worldwide LIB recycling companies and their recycling technologies

Scale	Inside EU		Info. reliability*
Industrial scale (>1000 t/a)	Umicore (BE)	**Pyro + Hydro**	(Green: Detailed info. confirmed by various sources)
	Accurec (DE)	**Thermal + Mech + Pyro + Hydro**	
	Nickelhütte Aue (DE)	**Thermal + Pyro + Hydro**	
Pilot scale (<1000 t/a)	SNAM (FR)	**Thermal + Pyro + Hydro**	
	EDI (FR)	**Mech** (aqueous shred + unknown)	(Red: limited info. available, only official source from the company)
	TES-AMM (formerly "Recupyl") (FR)	**Mech** (inert gas)	
	AkkuSer (FI)	**Mech** + unknown	(Orange: Further info. available, but still limited)
	Duesenfeld (DE)	**Mech** + Hydro	
	Promesa (DE)	**Mech** (aqueous shred) + unknown	
	Redux (DE)	**Thermal + Mech** + unknown	
Lab scale	Erlos (DE)	Mech + reconditioning (direct recycling)	

	Outside EU		
Industrial scale (>1000 t/a)	SungEel (KR)	**Mech +** (thermal +) **Hydro**	(Green: Detailed info. confirmed by various sources)
	Kyoei Seiko (JP)	**Pyro**	
	Dowa (JP)	**Thermal + Pyro + Hydro**	
	Brunp (CN)	**Thermal + Mech + Hydro**	
	GEM (CN)	**Mech + Hydro**	(Red: limited info. available, only official source from the company)
	Huayou Cobalt (CN)	**Mech + Hydro**	
	Ganzhou Highpower (CN)	**Mech + Pyro + Hydro**	
Pilot scale (<1000 t/a)	Retriev (US)	**Mech** (aqueous) + Hydro	(Orange: Further info. available, but still limited)
	Kobar (KR)	**Mech+ Hydro**	
	JX Nippon (JP)	**Thermal + Mech + Hydro**	
	Telerecycle (CN)	**Mech + Hydro**	
	Guanghua (CN)	Mech **+ Hydro**	

Source: www.accurec.de:- Comparative study of Li-ion battery recycling processes R. Sojka, et al. 2020

- Worldwide recycling activities with varying scales, TRL levels, and technologies exist

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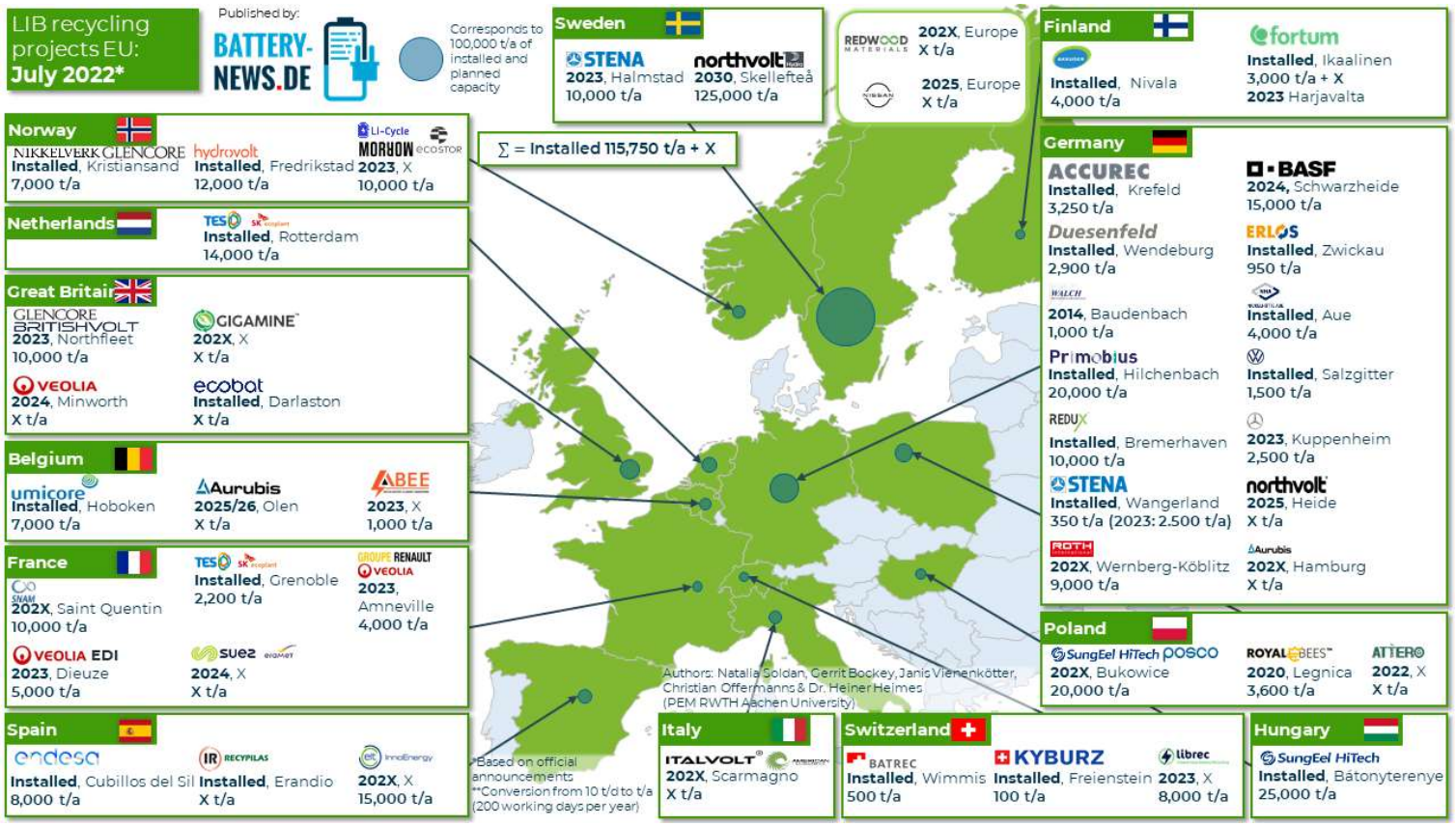
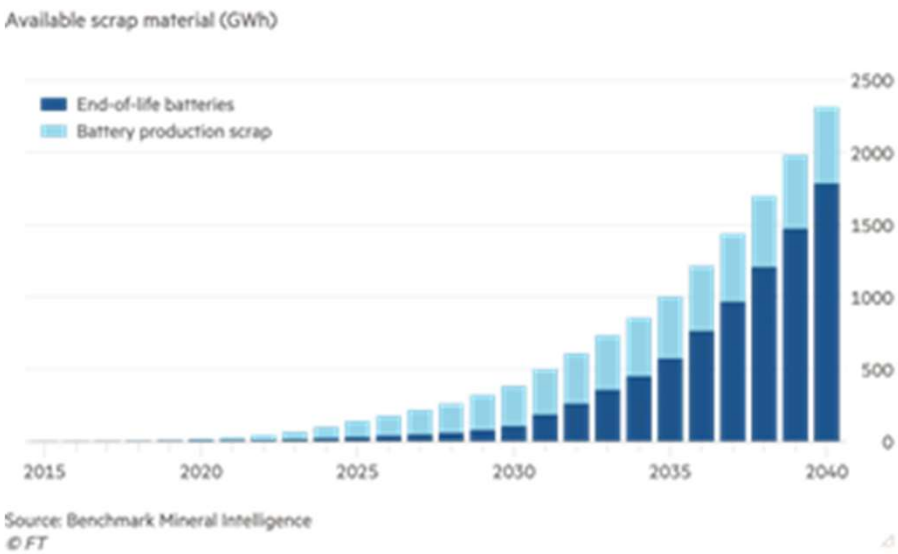
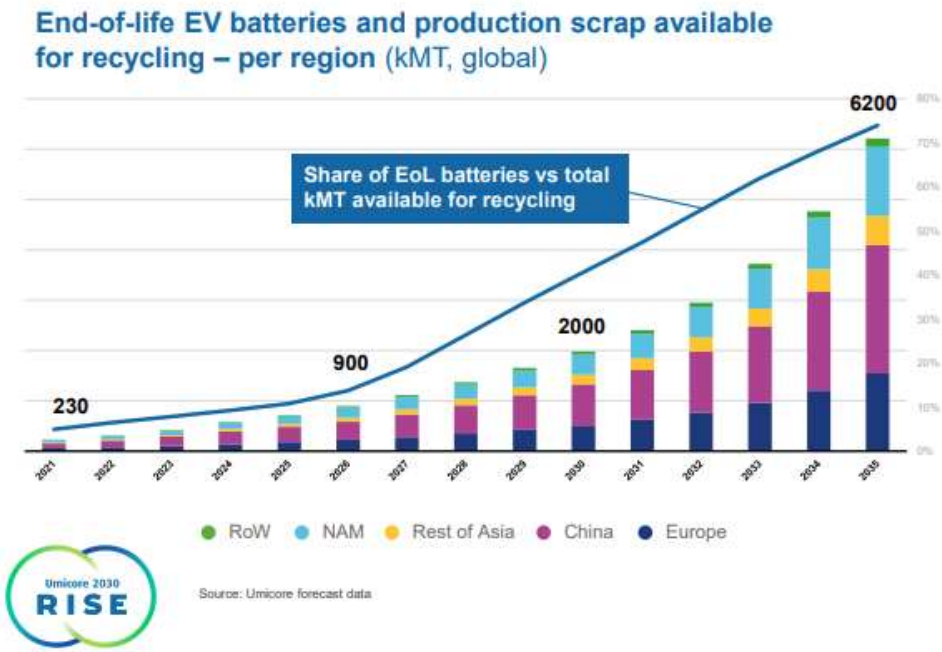
European activities for battery recycling



PEM und LKQ Europe stellen Studie zur Batterie-Kreislaufwirtschaft vor - RWTH AACHEN UNIVERSITY PEM - Deutsch (rwth-aachen.de)

Global recycling opportunities rise exponentially

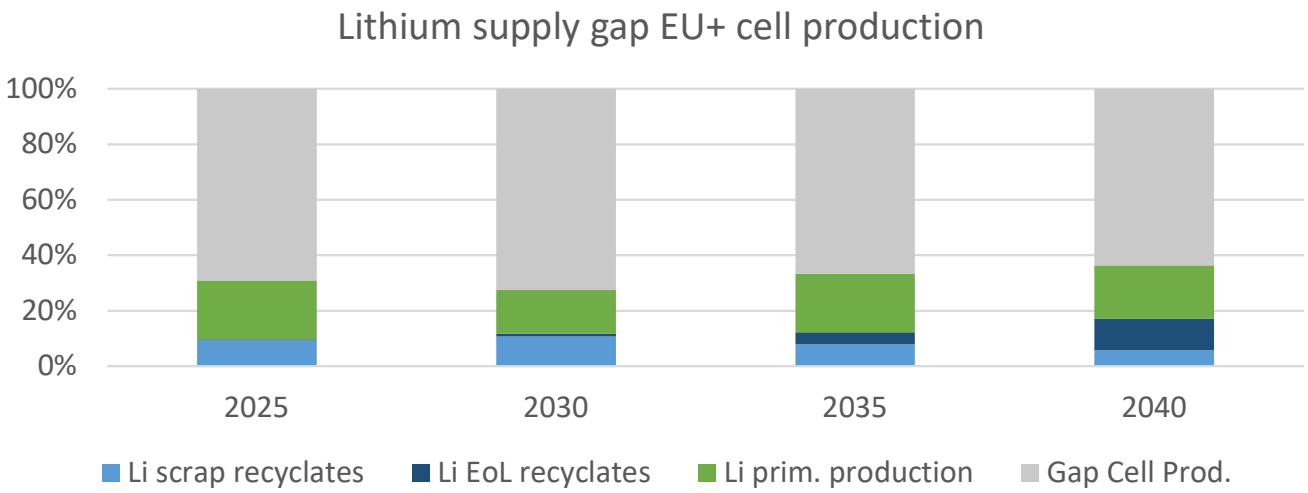




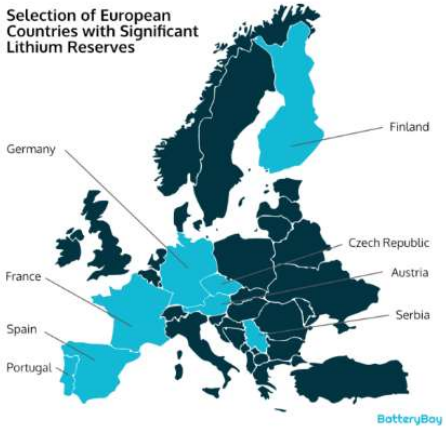
- Break even point of scrap versus EOL batteries to be reached in about 10 years
- Requirement of globally functional collection system

Recycled Li and EU Li production: ~40% of EU demand by 2040

- Scrap from cell production can be a major source for recycling Li, but it does not change the balance, as it leads to increased demand at the same time.
- Self-sufficiency cannot be achieved in the next 20 a.



Source: FHG ISI, BMBF Statusseminar, Köln, Oct22



Source: How European Lithium Could Make Batteries More Sustainable - BatteryBay

➢ High demand for recycled Lithium even beyond 2040

Conclusions

- ACC
  - On the way to become a **leading European cell manufacturer**
  - ACC builds 40 GWh **Gigafactory** plus Application Engineering Center **in Kaiserslautern**. Operational **by 2025**
    Full capacity planned for 2030 with ~2100 new jobs on site
  - **Sustainability** is one of ACC's strongest commitments

- Recycling
  - **Recycling is a necessity** for sustainability, legal and supply chain stability reasons
  - Unavoidable battery scrap and future end-of-use batteries will create a **new recycling industry**
  - Recycling is global battery challenge **lead by battery industry in Asia**. Many activities started in Europe
  - **ACC supports recycling** activities in cooperation with our customers and partners within the circular value chain

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AUTOMOTIVE CELLS Co

Christoph Weber
R&D Manager Germany
Christoph.weber@acc-emotion.com

Thank you!

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