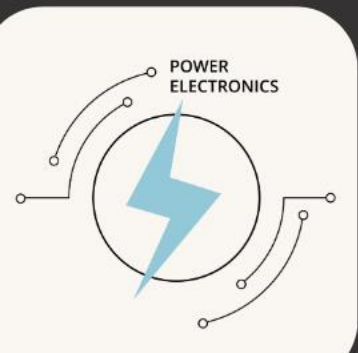


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SP TLIGHT

BATTERY SOLUTIONS





COMET Project to COMET Centre

1st funding period – April 2025 to March 2029

Battery4Life – [OPTIMIZED Safety and INCREASED Sustainability of Batteries]

Optimized **SAFETY**:

+++ Understanding of battery behavior in critical situations

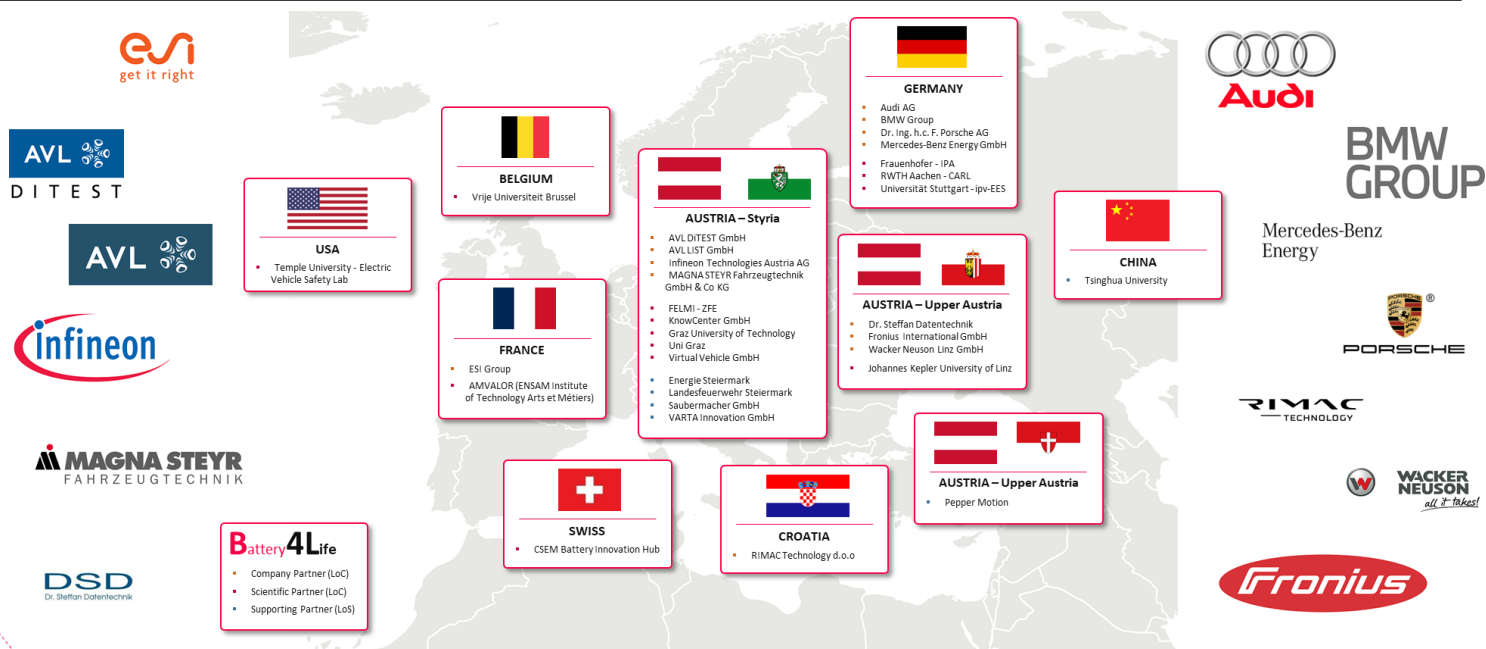
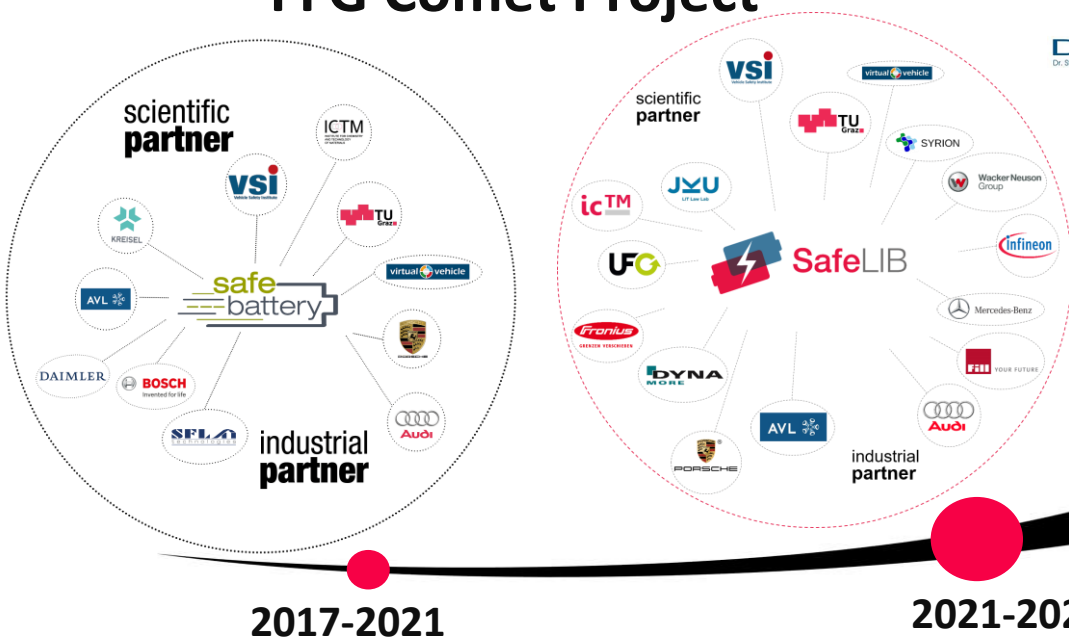
Increased **SUSTAINABILITY**:

+++ Safe battery life and operation time

Where do we start?

- Very successful COMET projects
 - SafeBattery
 - SafeLIB

FFG Comet Project



FFG Comet Centre
2025 – 2029 (2033)

Battery4Life



FFG Comet Centre: Battery4Life is accepted!

FFG Comet Centre:

— Legal entity

- Start: 1st of April 2025
- First funding period of 4 years (+4 years w/o a new funding proposal)
- ~10 Mio. € funding
- ~19 Mio. € overall budget

— Research Projects:

- Funding already available (no funding proposal)
- Research contents fit to Battery Safety and Sustainability



Neues COMET-Zentrum für anwendungsorientierte Forschung in Österreich

Im Rahmen des öster. COMET-Programms wurden ein neues und bestehende COMET-Zentren ausgewählt. Wirtschafts- und Klimaschutzministerium investieren rund 60 Mio. Euro

Wien (OTS) - „Battery4Life“ heißt das neue Exzellenzzentrum, in dem Federführung der Technischen Universität Graz gemeinsam mit Paris Wissenschaft und Wirtschaft zur Batteriesicherheit geforscht wird. D Zentrum baut auf ein erfolgreiches COMET Projekt auf und adressiert Herausforderungen der Elektromobilität. Mit rund 38,8 Millionen Euro; COMET-Zentren durch das gefordert. Weitere 20 Mill. finanziert. Die Unternehmen Entscheidung insgesamt. Partner 6,2 Millionen Euro.

Battery4Life: New COMET centre led by TU Graz

FFG Graz / TU Graz / Services / Newsletters / TU Graz News

Researchers at the Vehicle Safety Institute will team up with national and international partners to make batteries safer, extend their service life and make them more sustainable. The FFG, the provinces Styria and Upper Austria as well as companies are investing about 39 million euros in total.



Researchers from the Vehicle Safety Institute at TU Graz at a test bench of the Battery Safety Center. Photo: TU Graz

Researchers from the Vehicle Safety Institute at TU Graz are proud of the outstanding reputation of its researchers in the rapidly developing area of battery safety. TU Graz has approved the application for the new COMET TU Graz center which partners from science and industry, a research to transfer knowledge from the vehicle safety to safety, service life and sustainability of batteries. The FFG is funding the project with a total amount of 38.8 million euros and Upper Austria is contributing 19 million euros. In addition, the partners from the area are investing several tens of millions over the scheduled project term of four years.

„Battery4Life“ (TU Graz) further expanding the position as Austria's most successful university in the FFG's second round of funding for Battery4Life, says TU Graz Rector Hans Bruchler. „It demonstrates the continuing success of our research in the field of safety and sustainability of batteries. The project will be supported by the FFG's research center, our e-Mobility campus is becoming a hub for energy storage technology over the entire life cycle.“

FFG, the Austrian funding agency, is investing 38.8 million euros in the project. The project will be supported by the FFG's research center, our e-Mobility campus is becoming a hub for energy storage technology over the entire life cycle. The project will be supported by the FFG's research center, our e-Mobility campus is becoming a hub for energy storage technology over the entire life cycle.

electrive

TU Graz erhält Zuschlag für „Battery4Life“-Projekt

Die TU Graz hat eine Förderung für ein Exzellenzzentrum im Bereich Batteriesicherheit erhalten. Die Österreichische Forschungsförderungsgesellschaft FFG hat das Antrag für das neue COMET-Zentrum „Battery4Life“ bewilligt.

„COMET sichern Österreich und stärkt den Forschungs- und Arbeitsmarkt sowie die Wirtschaft“

„Die engen Zusammenhänge für die Entwicklung innovativer Technologien sind mit dem CC Synergien fördern und die I durch COMET zukunftsweisende Fortschritt und Wachstum Geschäftsführerinnen Her der sechs COMET-Zentren

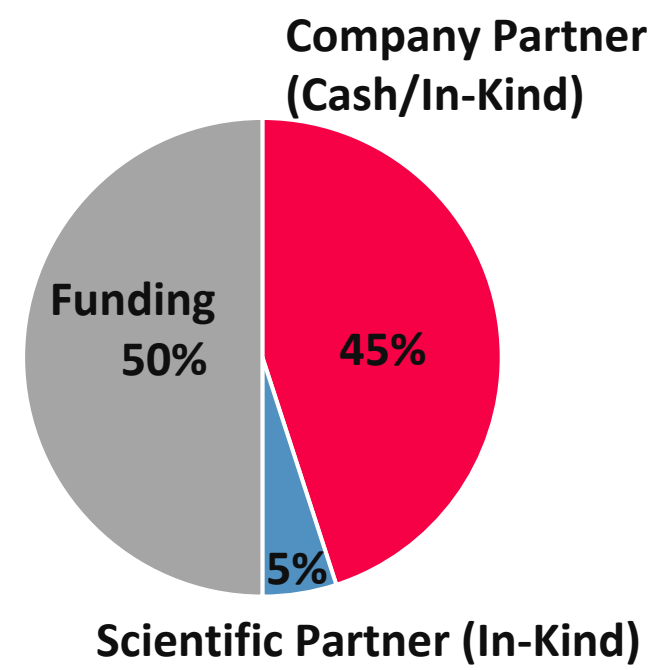


19 Millionen Euro: Hohe Investitionen in neues Kompetenzzentrum an TU Graz

COMET Kompetenzzentrum „Battery4Life“ will Batterien für die Elektromobilität sicherer, langlebiger und nachhaltiger machen. Konsortium unter Führung der TU Graz mit zahlreichen namhaften Industriepartnern.



Das österreichische COMET-Programm fördert ein neues Kompetenzzentrum in „Battery4Life“ mit ein Exzellenzzentrum unter der Federführung der Technischen Universität Graz Batterien insbesondere für die Fahrzeugmobilität sicherer, langlebiger und nachhaltiger machen. Die Österreichische Forschungsförderungsgesellschaft FFG, das Land Steiermark und Oberösterreich sowie Firmen investieren dafür in den kommenden vier Jahren knapp 39 Millionen Euro, wie die TU Graz am Dienstag informiert.

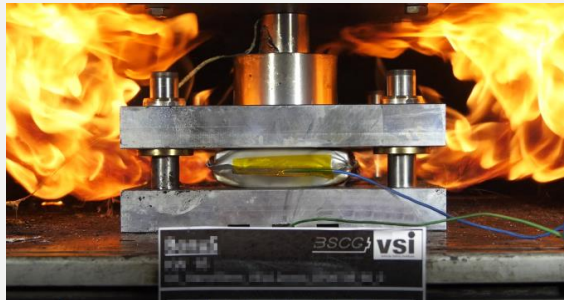


AREA: Research Overview

Battery4Life – [Increased battery safety and sustainability for electric vehicles]

RESEARCH AREAS

Area 1: Prediction and Optimization



Cross-cutting Battery Safety Research:

Sustainability, legal and economic framework

ecological, economic, legal and social aspects



Area 2: Degradation Mechanism



Area 3: Monitoring and Failure Prognosis



Unique Selling Points (USPs)



Outstanding applied and transferable approach and method portfolio



Thematical leader in battery safety research: behavior of batteries in overcritical situations, safety relevant degradation mechanisms, State of Safety



International research collaboration framework covering the whole battery value chain

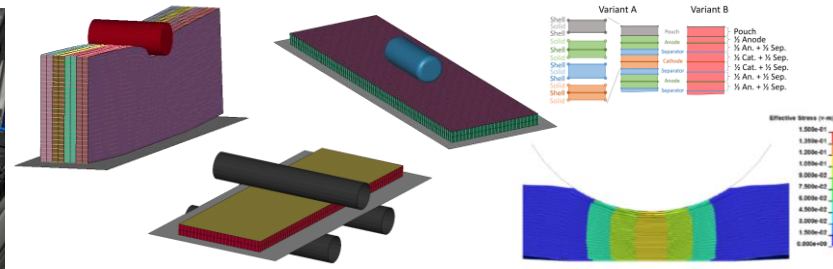
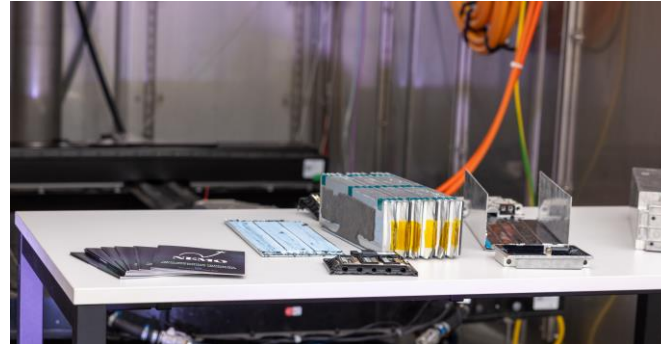
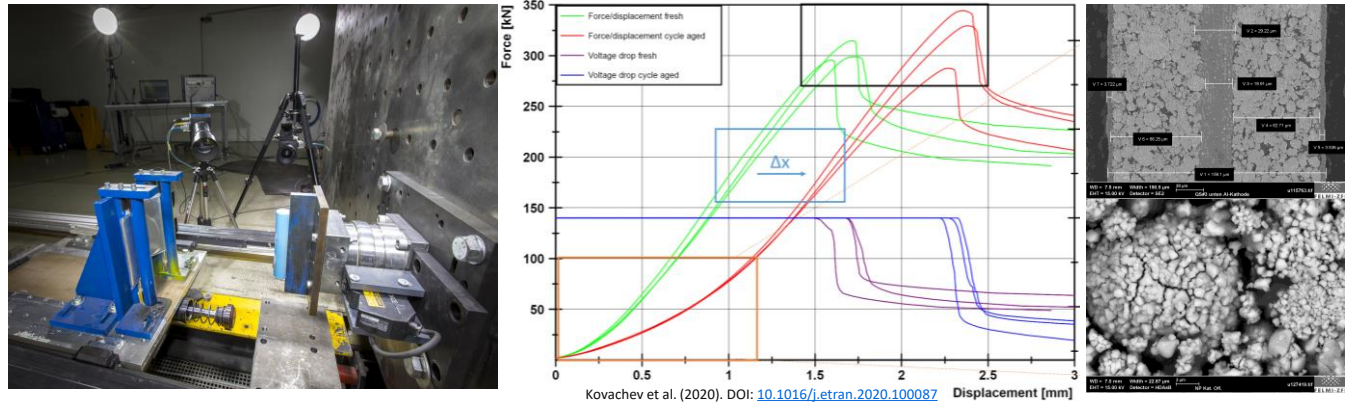


Complementary Interdisciplinary framework: technical, ecological, economic, legal and social aspects



Current/Next Steps

- Contracts, Contracts, Contracts,...
- Project shaping and partner discussions
- Administrations and Organisational tasks



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Christian Ellersdorfer

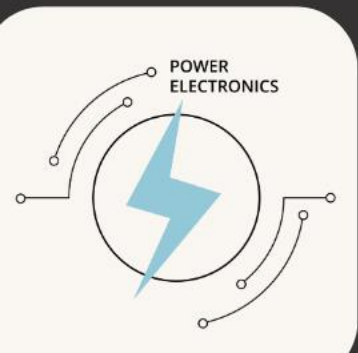
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BATTERY SOLUTIONS



Stationary energy storage: status quo and perspectives



Ecolyte

AI-driven sustainable energy storage solutions.



Welcome to Ecolyte – Innovating Sustainable Energy Storage of the Future

| *2022 in Graz, we are pioneering a revolution in energy storage through innovative, sustainable solutions

| We address the urgent need for large-scale stationary energy storage systems using sustainable, available materials

| Our vision is to become one of the leaders in the green energy transition through cutting-edge AI technology and strategic partnerships



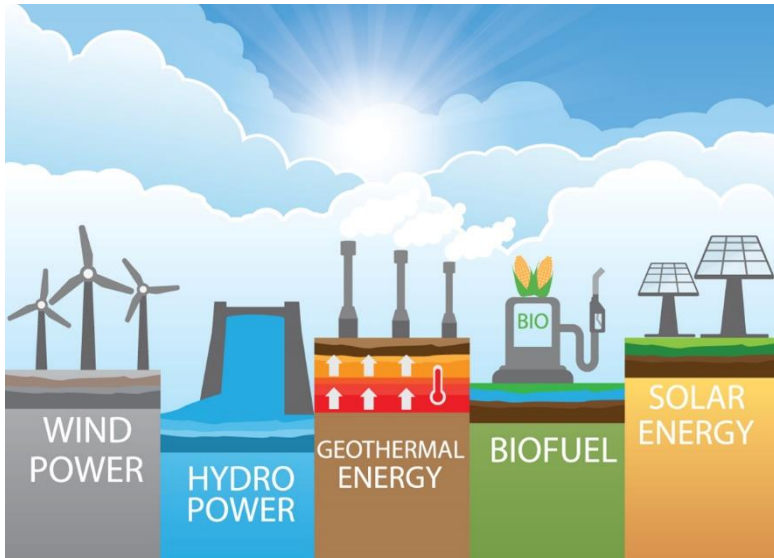
Grand Challenge:

Green energy transition and Green Deal

European
Innovation
Council



Grand Challenge – Green energy transition



Huge increase in PV and wind installation

- | Grid investments slow
- | Storage has been neglected

Example Germany:

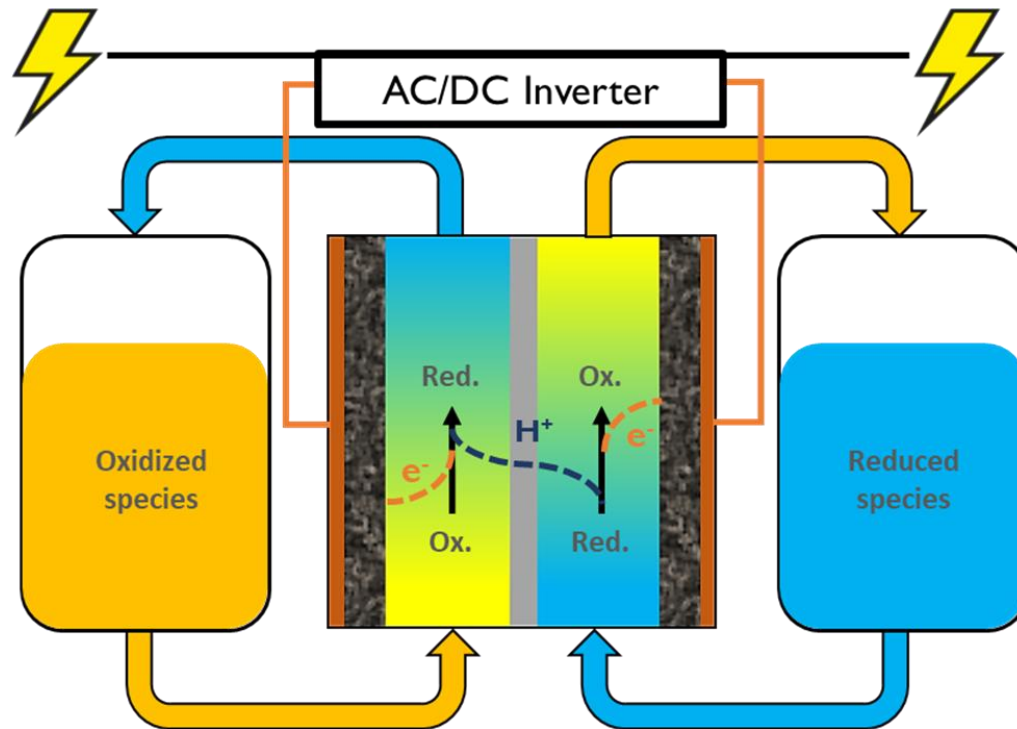
- | € 2.7b of revenues per year lost as grid cannot take wind energy
- | taking PV and wind off-grid is required at peak capacity

Large scale Li-batteries concerns:

- | Safety, raw
- | material supply
- | environment
- | child labor

Use of large scale, sustainable, safe, regionally available energy storage systems needed!

Liquid batteries



Vanillin instead of Vanadium!

Advantages:

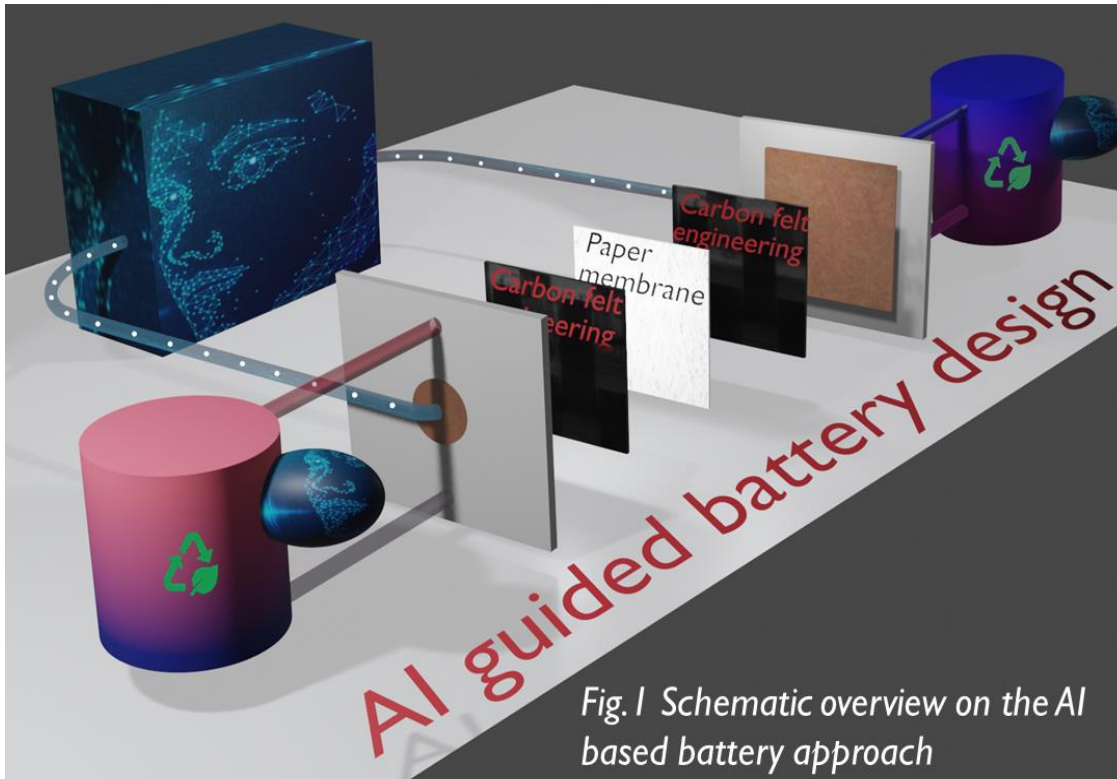
- | Independent design of power & storage capacity
- | Easy scalability to MW regime
- | No self discharge
- | No capacity fading during cycling
- | Long lifetime (20 years+)
- | Long discharge times (4-8 h)

Current technology:

Vanadium flow battery (80%)

- | not renewable
- | availability
- | transport
- | corrosive
- | toxic
- | volatile price

Technology development is AI driven



4.6m€ for artificial intelligence guided battery design
Start: 1.9.2023, 36 months
4 partners

Goal: AI for pushing borders in quinone (vanillin) based flow batteries



Funded by
the European Union

www.vanillaflow.eu

By 05/24: 520,000 molecules generated, assessment on-going

Stationary energy storage



How can we calculate how much an energy storage system can earn?

Levelized cost of storage (LCOS)

LCOS = total lifetime cost of the investment in an electricity storage technology divided by its cumulative delivered electricity in the form of electrical energy or electric power

$$LCOS \left[\frac{\$}{MWh} \right] = \frac{\text{Investment cost} + \sum_n^N \frac{\text{O\&M cost}}{(1+r)^n} + \sum_n^N \frac{\text{Charging cost}}{(1+r)^n} + \frac{\text{End-of-life cost}}{(1+r)^{N+1}}}{\sum_n^N \frac{\text{Elec}_{\text{Discharged}}}{(1+r)^n}}$$

Investment: i.e. installation costs, maintenance costs, charging costs, end-of-life costs

Assessment of stationary storage scenarios possible

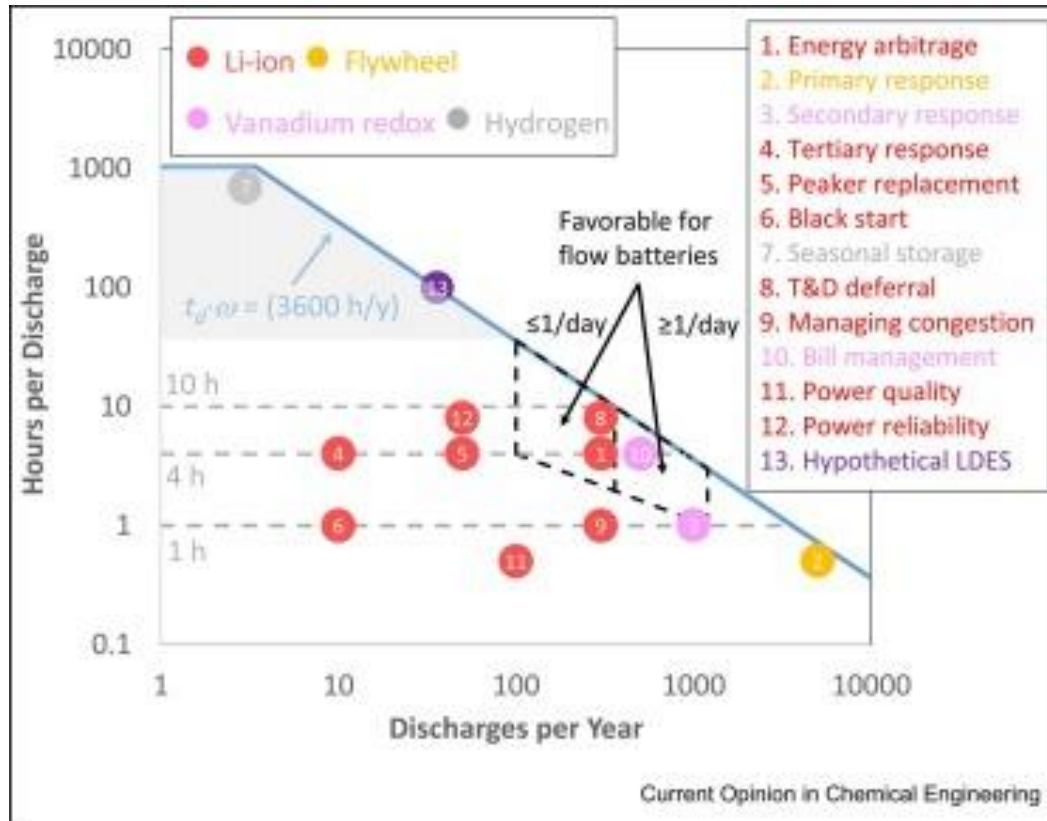
Key docs Joule, 2019, 2, 81-100 and Lazard study on LCOS v7.0, Curr. Opin. Chem. Eng. 2022, 37, 100855

Stationary energy storage?

Role	Application	Description	Pumped Hydro	Compressed Air	Flywheel	Lithium Ion	Sodium Sulfur	Lead Acid	Vanadium Redox Flow	Hydrogen	Supercapacitor
	1. Energy arbitrage	Purchase power in low-price and sell in high-price periods on wholesale or retail market	✓	✓		✓	✓	✓	✓	✓	
System Operation	2. Primary response	Correct continuous and sudden frequency and voltage changes across the network			✓	✓	✓	✓	✓	✓	✓
	3. Secondary response	Correct anticipated and unexpected imbalances between load and generation	✓	✓	✓	✓	✓	✓	✓	✓	✓
	4. Tertiary response	Replace primary and secondary response during prolonged system stress	✓	✓		✓	✓	✓	✓	✓	
	5. Peaker replacement	Ensure availability of sufficient generation capacity during peak demand periods	✓	✓		✓	✓	✓	✓	✓	
	6. Black start	Restore power plant operations after network outage without external power supply	✓	✓	✓	✓	✓	✓	✓	✓	✓
	7. Seasonal storage	Compensate long-term supply disruption or seasonal variability in supply and demand	✓	✓					✓	✓	
Network Operation	8. T&D investment deferral	Defer network infrastructure upgrades caused by peak power flow exceeding existing capacity	✓	✓		✓	✓	✓	✓	✓	
	9. Congestion management	Avoid re-dispatch and local price differences due to risk of overloading existing infrastructure	✓	✓		✓	✓	✓	✓	✓	
Consumption	10. Bill management	Optimise power purchase, minimize demand charges and maximise PV self-consumption				✓	✓	✓	✓	✓	
	11. Power quality	Protect on-site load against short-duration power loss or variations in voltage or frequency			✓	✓	✓	✓	✓	✓	✓
	12. Power reliability	Cover temporal lack of variable supply and provide power during blackouts				✓	✓	✓	✓	✓	

Application defines the technology (and LCOS)! Joule, 2019, 2, 81-100

It is a function of cycle length and number!

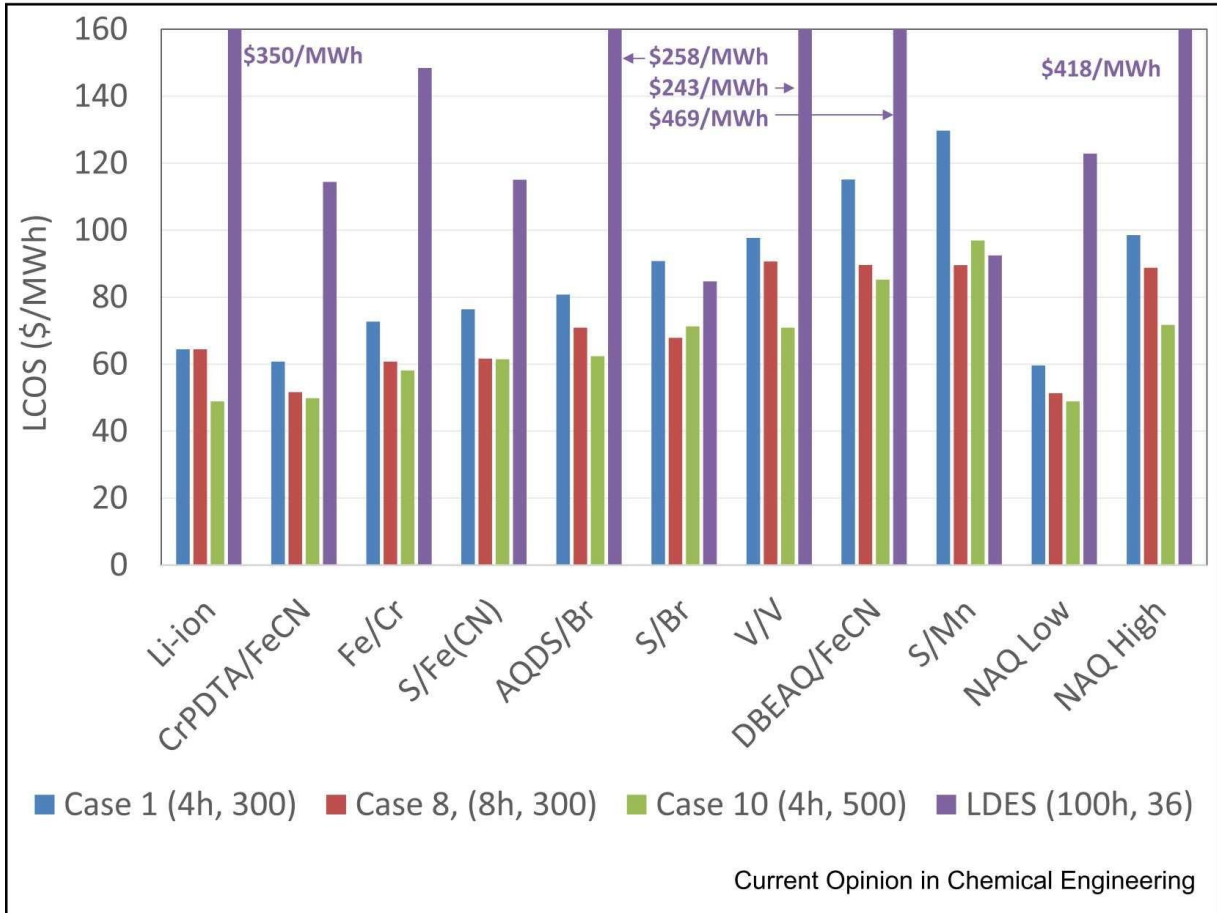


Flow battery sweetspots somewhere between 100 and 1000 discharges per year

Several application scenarios are potentially possible:

- Energy arbitrage (exploit price differences for trading energy)
- Secondary response (30s response to stabilize grid frequency)
- T&D deferral (upgrade of power rating in system)
- Bill management (buy energy cheap and use it later when expensive)

Comparison of different systems



1 – energy arbitrage

8 – T&D deferral

10 – Bill management

Meet the Ecolyte management team

Dr. Stefan Spirk



- | Expert in biobased materials (Prof.)
- | 10+ yrs in biobased energy storage
- | 10m€+ in funding 2014-2024
- | Funding and management for Ecolyte



Founder
(CEO)



Dr. Georg Rudelstorfer

- | Expert in chemical engineering
- | 5 yrs+ in reactor engineering
- | Developed process for conversion of biomass in battery materials
- | Technology developer



Founder
(Technology)

Dr. Wolfgang Zitz



- | Expert in strategy development
- | 10+ yrs experience as vice president in automotive industry
- | Introduced several cars on market (e.g. Jaguar I-Pace)
- | Planning and strategic coordination



Founder
(Strategy)



DI. Stefan Pachmajer

- | Expert in energy markets
- | 5 yrs experience as CEO of an energy company
- | Acquisition and operation of several wind mills
- | Support to make our vision real



Investor
(vkm)



Founder
(Finances)

Dieter Wurm

- | Expert in trading & selling biobased products
- | 20+ yrs of experience in business & trading
- | Introduced several products into market
- | Responsible to keep costs low

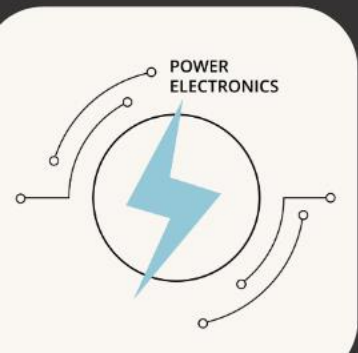
We are supported by ca. 50 people at strategic partners and the Ecolyte team!

Think big, start small, scale fast

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BATTERY SOLUTIONS



Batterierecycling als Schlüsseltechnologie: Sicherung kritischer Rohstoffe für die Zukunft

Dr. Eva Gerold

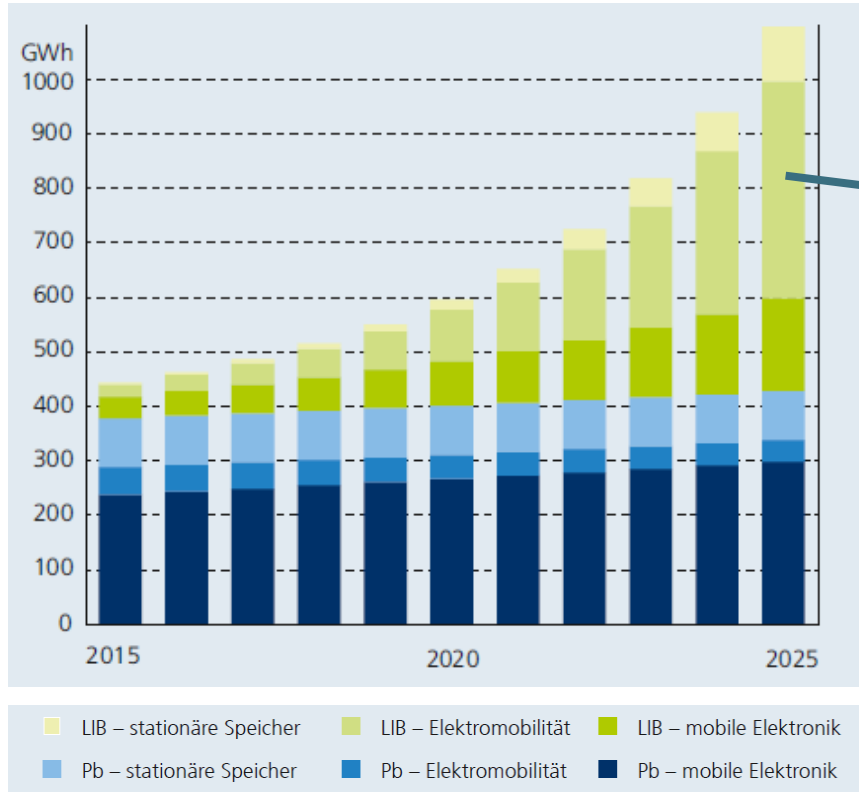
Power Electronics meets Battery Solutions,
Green Tech Valley Cluster und Silicon Alps Cluster

17. September 2024



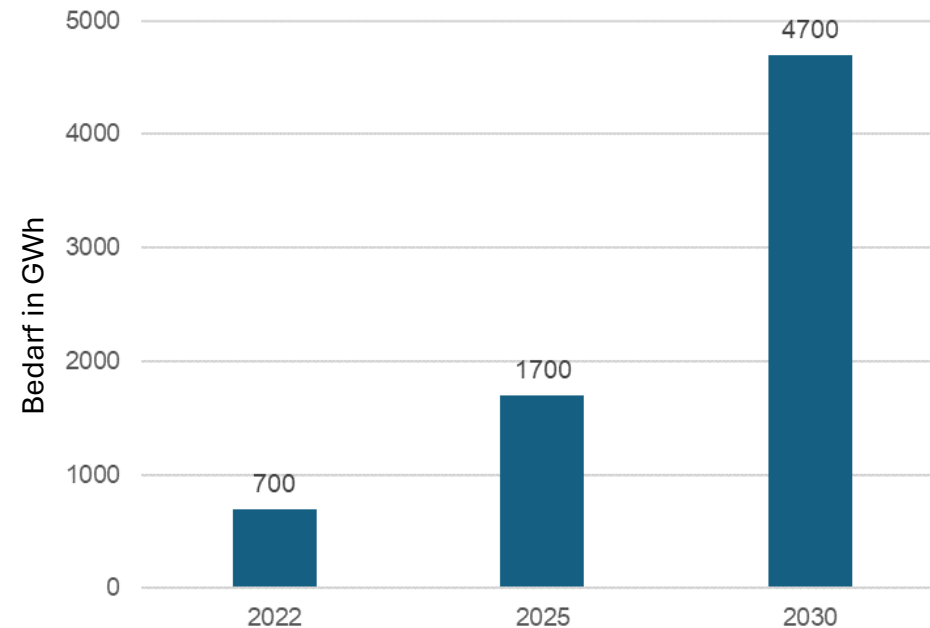
Entwicklung des Batteriemarkts

Weltweiter Batteriemarkt



Entsprechende Massen der benötigten Lithium-Ionen-Batterien:

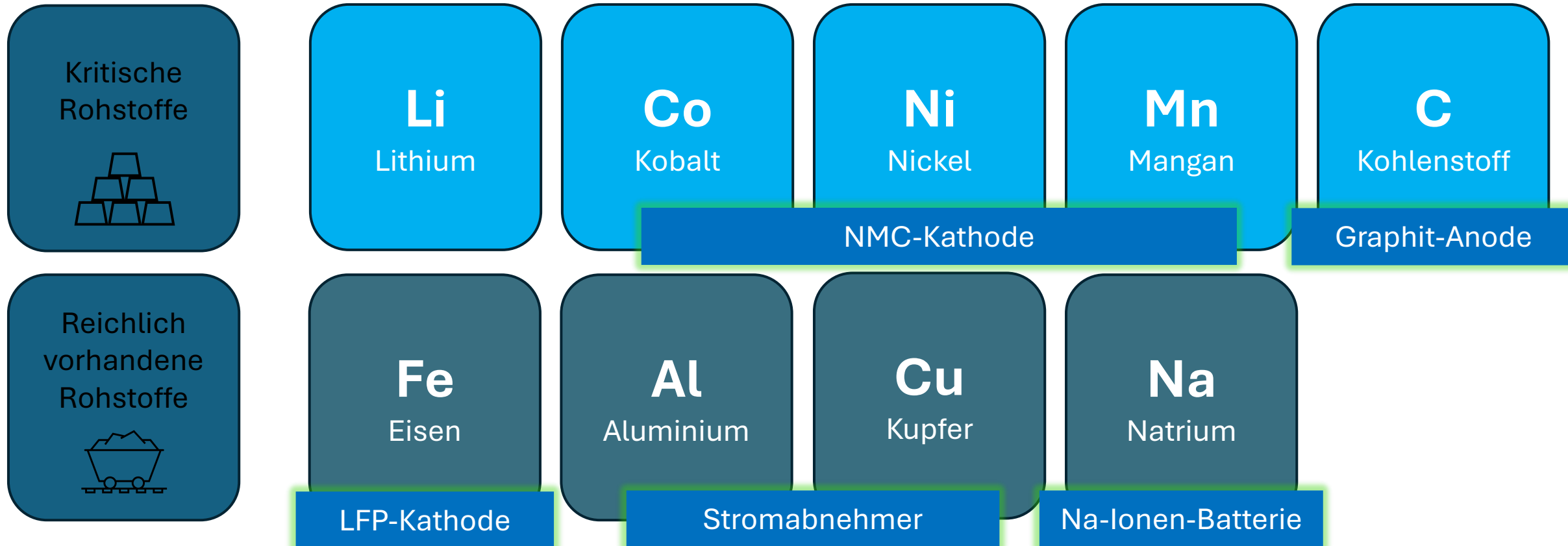
- **2022:** 5,8–7 Mio. t
- **2025:** 14–17 Mio. t
- **2030:** 39–47 Mio. t



Erwartete EV-Verkäufe:

- 13,1–20 Millionen bis 2025
- 25,8–46,8 Millionen bis 2030

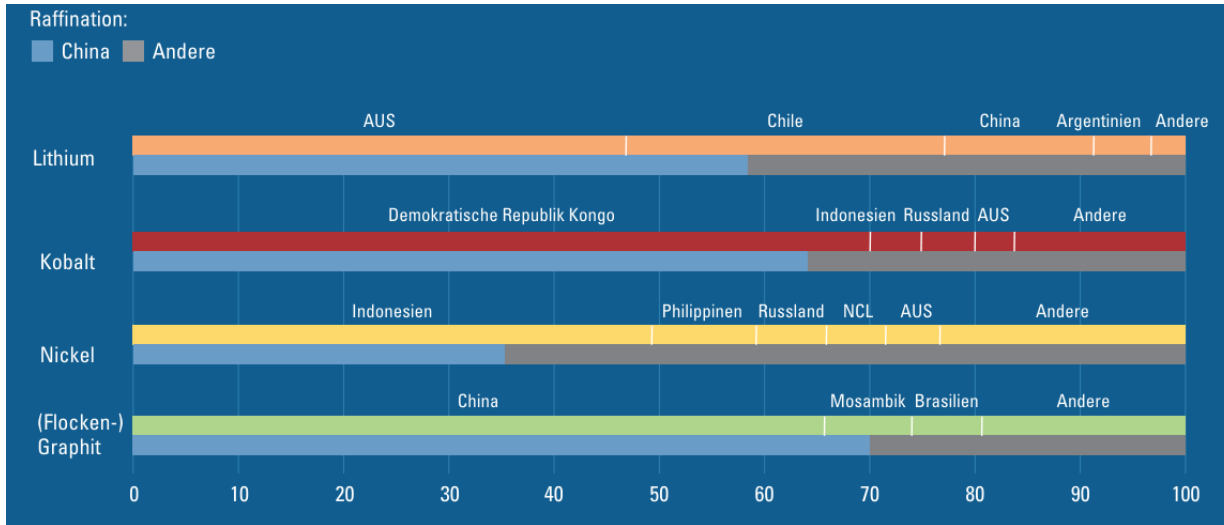
Benötigte Rohstoffe für eine Lithium-Ionen-Batterie



Rohstoffquellen für Lithium-Ionen-Batterien



Raffination von Rohstoffen für Lithium-Ionen-Batterien



Li-Förderung & Einsatzgebiete (weltweit)

	2018	2019	2020	2021	2022	2023
Förderung (Tonnen)	95.000	86.000	82.500	107.000	146.000	180.000 (est.)
Batterien	56 %	65 %	71 %	74 %	80 %	87 %
Glas & Keramik	23 %	18 %	14 %	14 %	7 %	4 %
Schmier-fette	6 %	5 %	4 %	3 %	4 %	2 %

Rohstoff-verfügbarkeit

Temporäre Rohstoff-verknappungen einzelner Materialien

Komplexe politische Situation

Effiziente Rohstoff-nutzung

„Second Life“

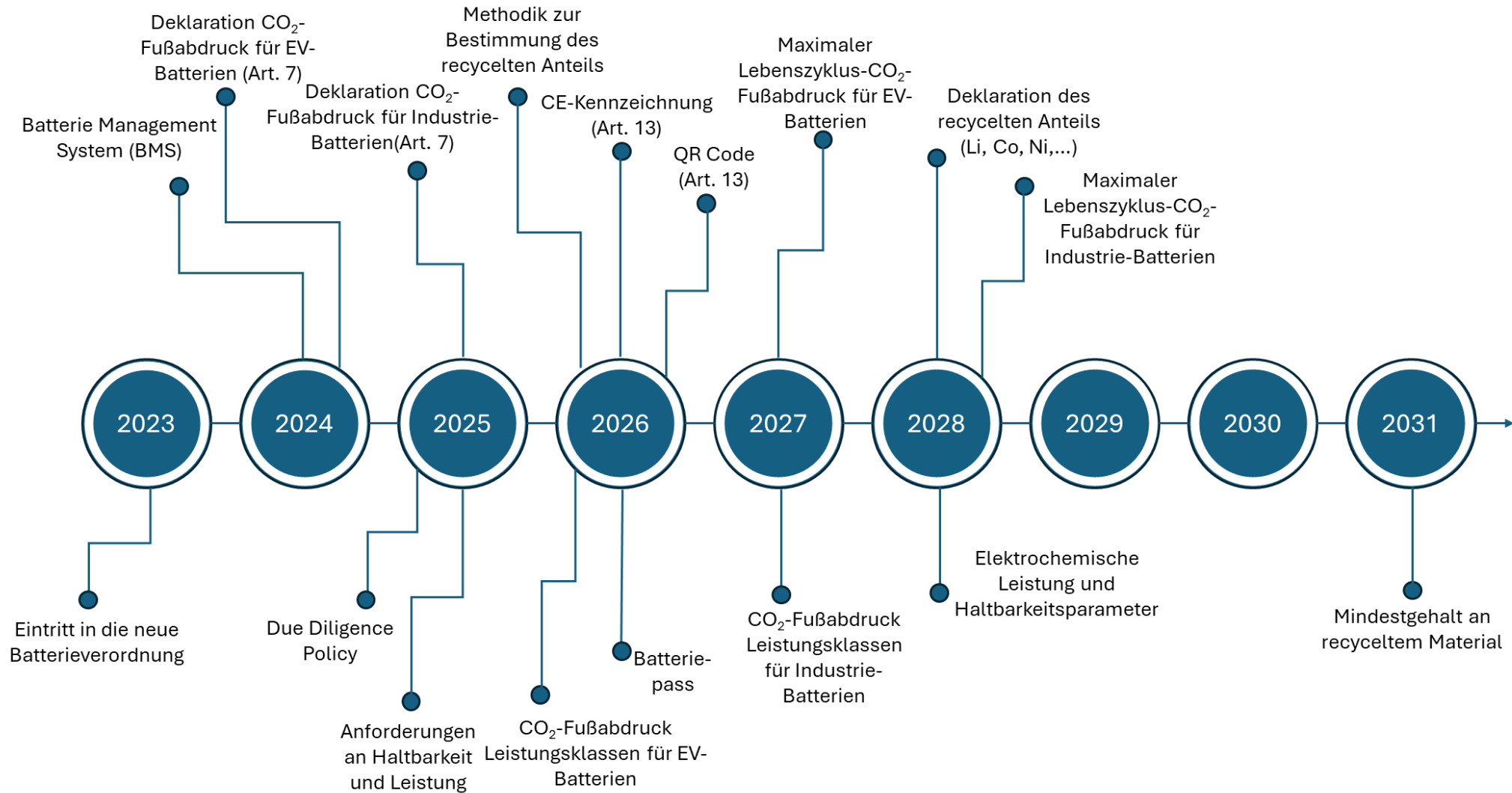
Höherer Stellenwert des Recyclings

Nachhaltiger Rohstoff-einsatz

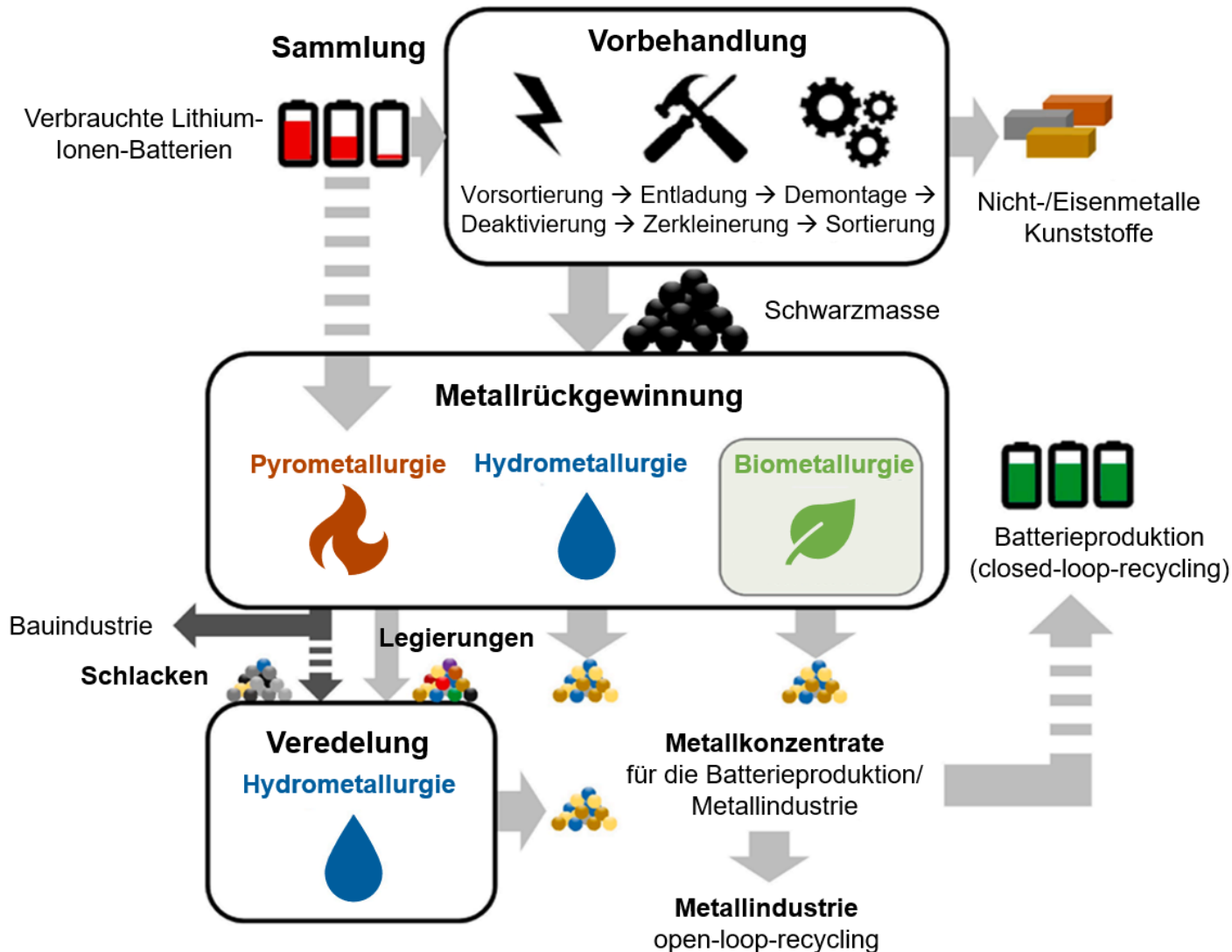
Nachhaltige und verantwortungsvolle Lieferkette

Erneuerbare Energien

Die neue Batteriedirektive



Recycling von Lithium-Ionen-Batterien



- Strategische Absicherung im Bereich der Batterierohstoffe möglich
- Erfüllung der behördlichen Vorgaben ist anspruchsvoll aber technisch realisierbar
- Implementierung nachhaltiger und effizienter Verfahren in Europa
- Globale Lieferketten, Rohstoffversorgung und Logistik/Sammlung

Vielen Dank für die Aufmerksamkeit.

Dr. Eva Gerold

Power Electronics meets Battery Solutions,
Green Tech Valley Cluster und Silicon Alps Cluster

17. September 2024



Typen von Lithium-Ionen-Batterien

Lithium-Kobalt-Oxid

Elektronische Geräte und mobile Anwendungen



Lithium-Mangan-Oxid

Kleinere (Garten)-Geräte und E-bikes



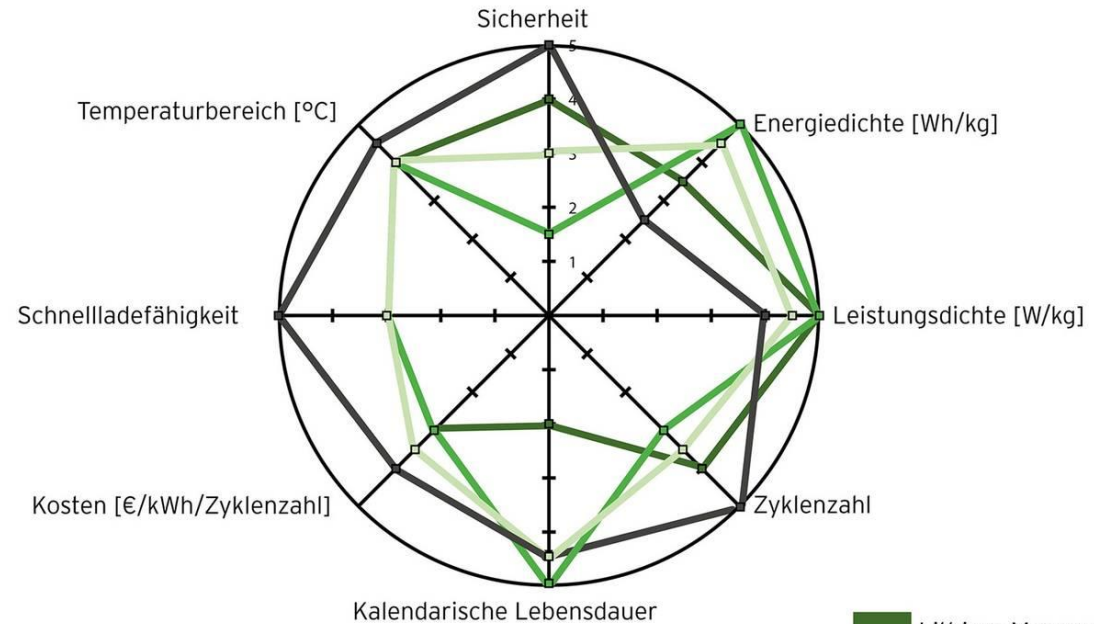
Lithium-Eisenphosphat

Energiespeicher und EVs



Lithium-Nickel-Mangan-Kobaltoxid

Automobilindustrie



- Lithium-Mangan-Oxid (LMO)
- Lithium-Nickel-Cobalt-Aluminium-Oxid (NCA)
- Lithium-Nickel-Mangan-Cobalt-Oxid (NMC)
- Lithium-Eisen-Phosphat (LFP)

SeLiReco
Selective Lithium Recovery

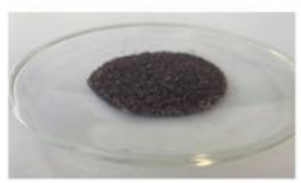
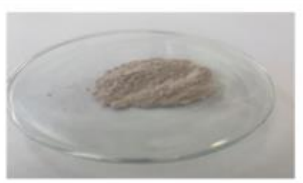
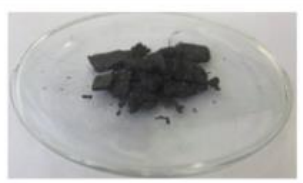
Graphit

Schwefel-
saure
Laugung

Fällung
von
Kobalt
und Nickel

Lösungs-
reinigung

Selektive
Fällung
von
Lithium



a SILICON ALPS series

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BATTERY SOLUTIONS

