GREEN TECH VALLEY

In Cooperation with

a SILICON ALPS series

SP TLIGHT

BATTERY SOLUTIONS

POWER ELECTRONICS

COMET Project to COMET Centre

1st funding period – April 2025 to March 2029

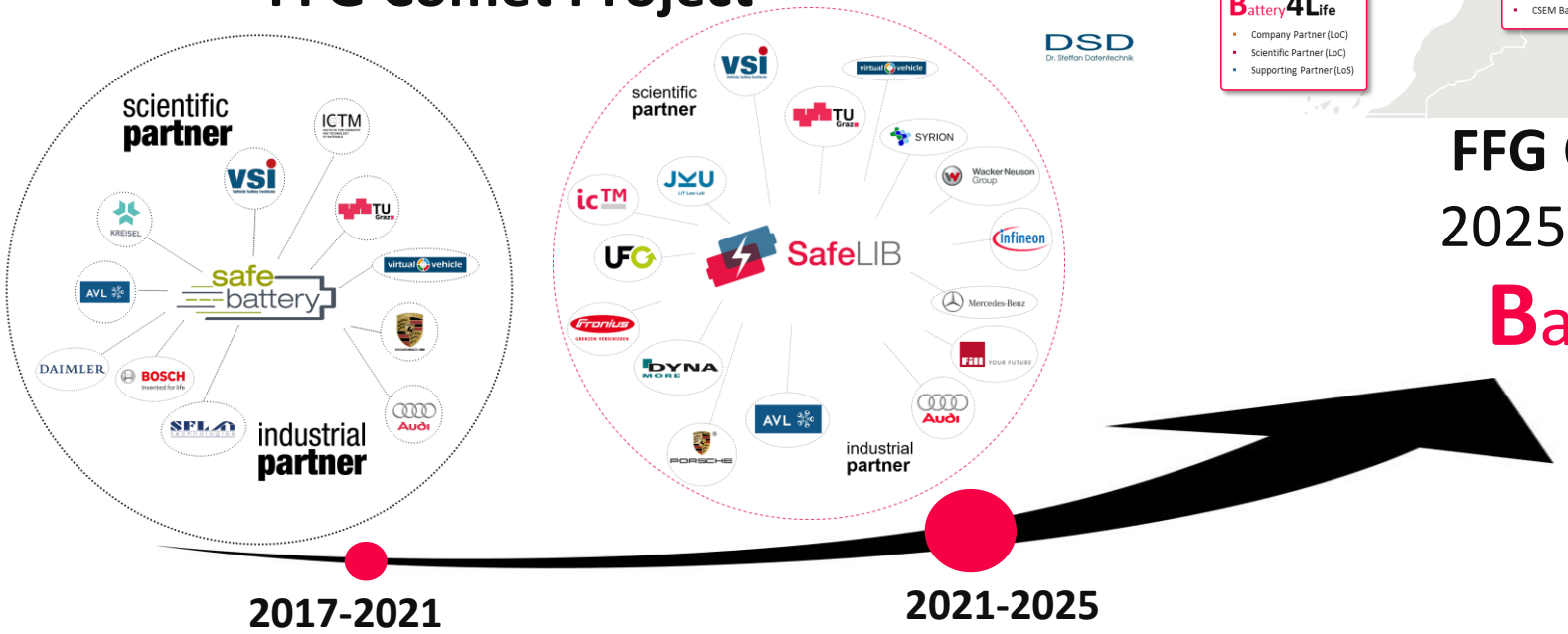
Battery4Life – [OPTIMIZED **Safety** and INCREASED **Sustainability** of Batteries]

Optimized SAFETY: +++ Understanding of battery behavior in critical situations
Increased SUSTAINABILITY: +++ Safe battery life and operation time

Where do we start?

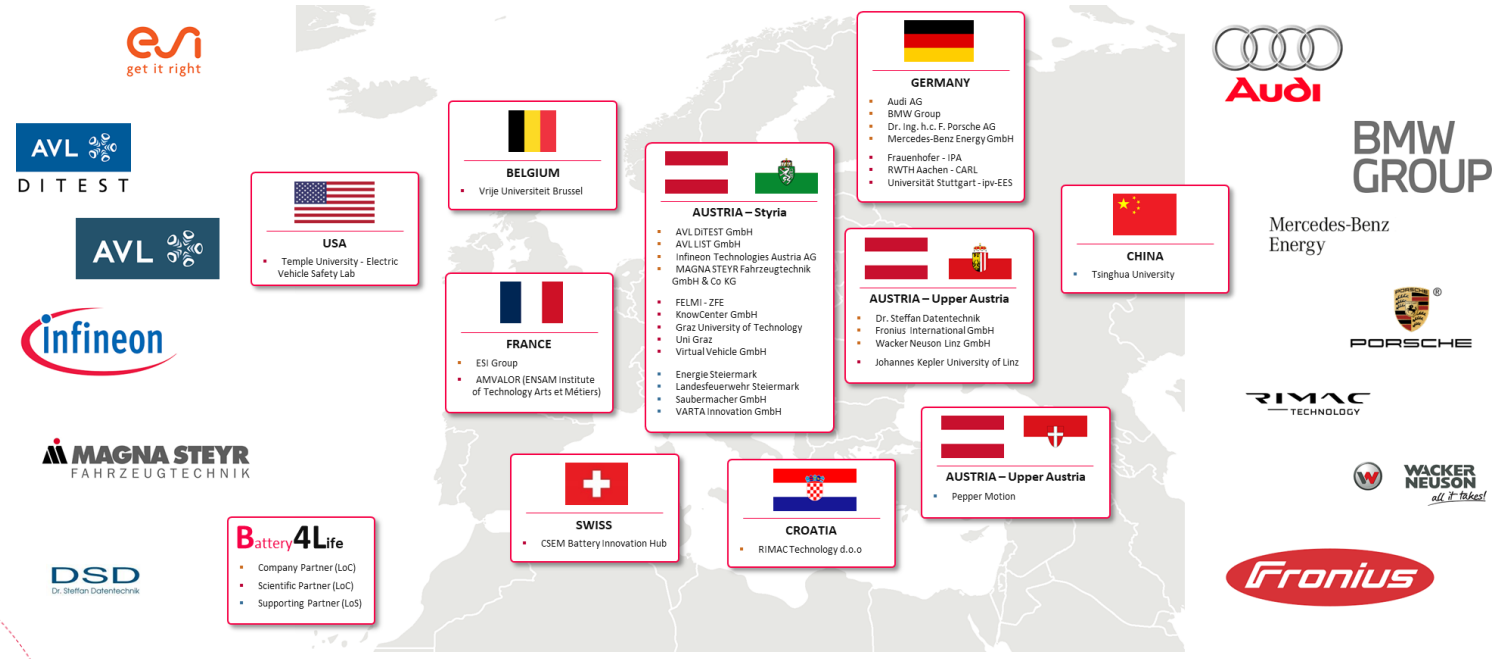
- Very successful COMET projects
  - SafeBattery
  - SafeLIB

FFG Comet Project



2017-2021

2021-2025

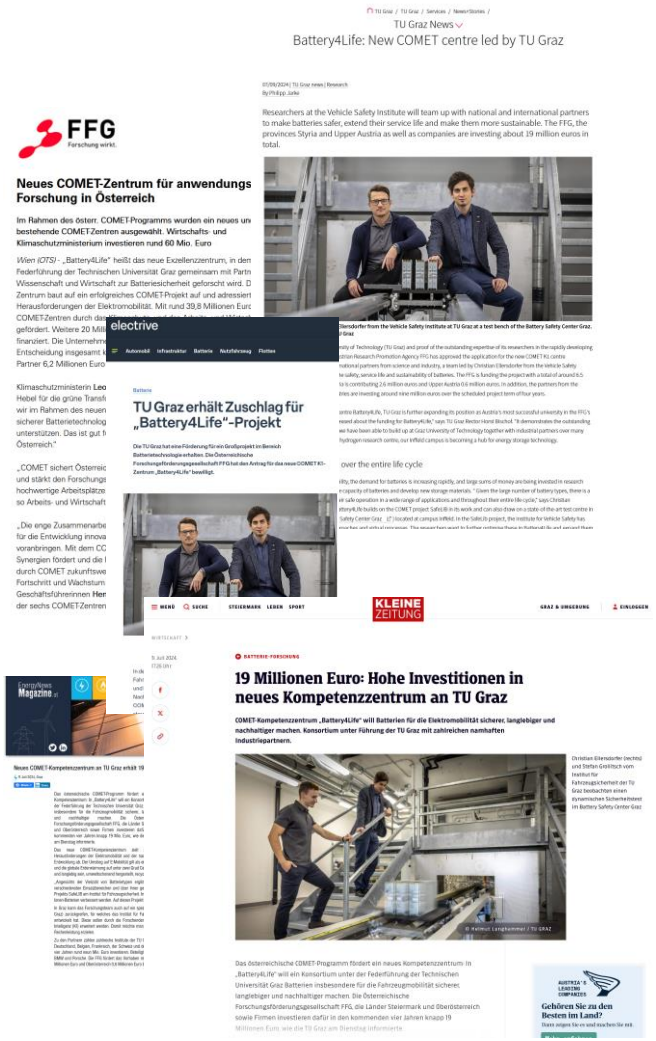


FFG Comet Centre

2025 – 2029 (2033)

Battery4Life

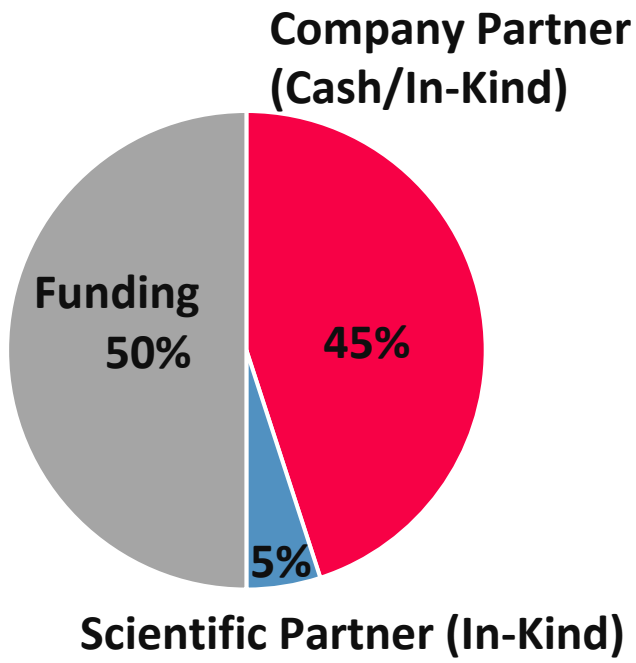
FFG Comet Centre: Battery4Life is accepted!



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

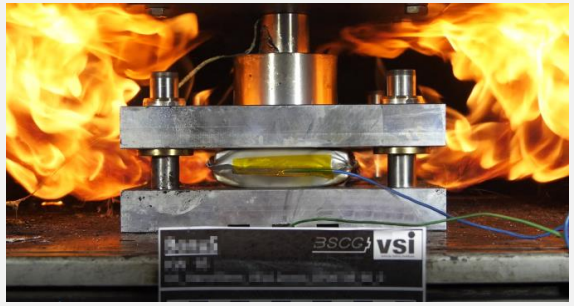


AREA: Research Overview

RESEARCH AREAS

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

Area 1:
Prediction and Optimization



Area 2:
Degradation Mechanism

Area 3:
Monitoring and Failure Prognosis

Cross-cutting Battery Safety Research:

Sustainability, legal and economic framework

ecological, economic, legal and social aspects

Source: adobe stock

Unique Selling Points (USPs)

Outstanding applied and transferable approach and method portfolio

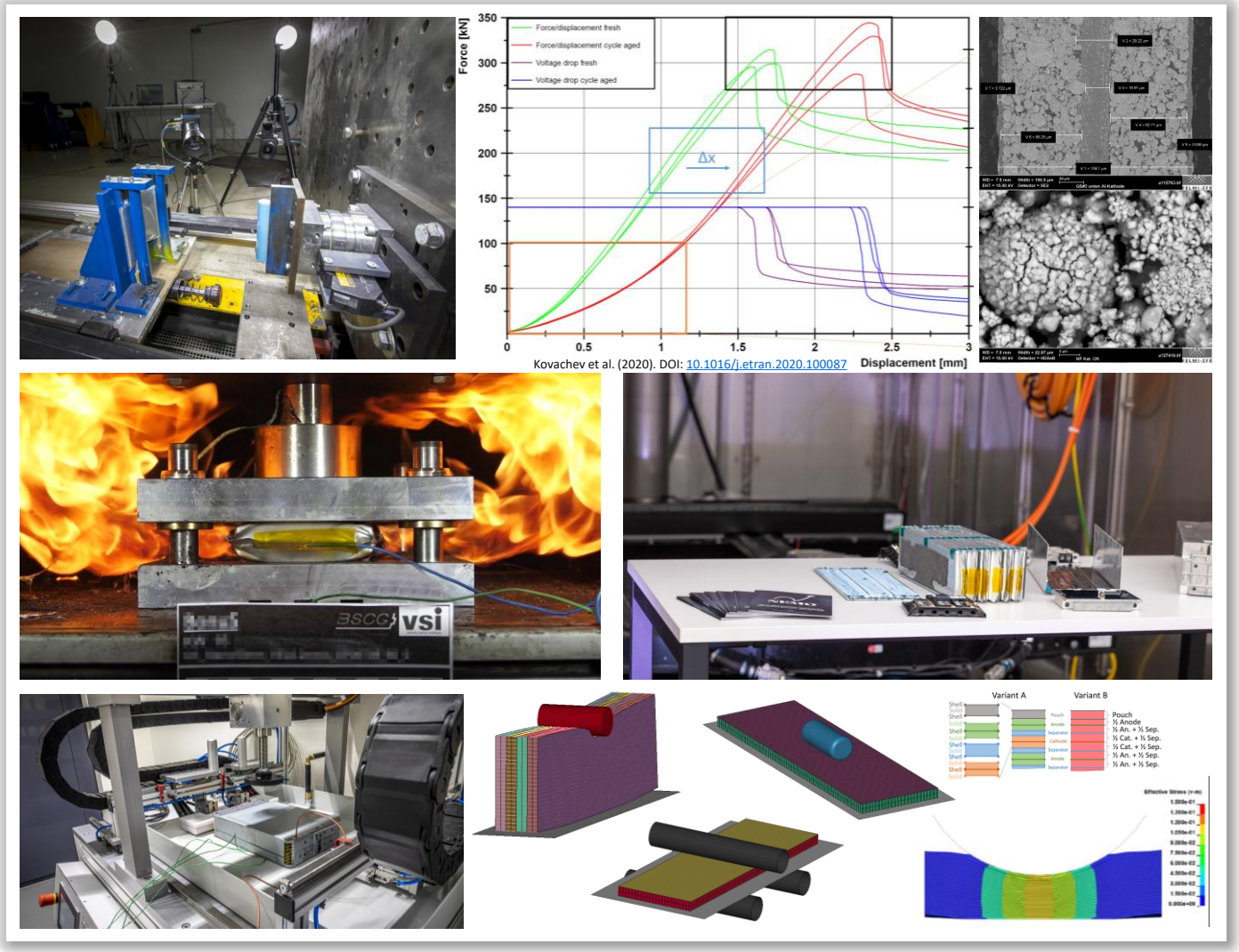
Thematical leader in battery safety research: behavior of batteries in overcritical situations, safety relevant degradation mechanisms, State of Safety

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



Kovachev et al. (2020). DOI: 10.1016/j.etran.2020.100087

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BATTERY SOLUTIONS

POWER ELECTRONICS

Stationary energy storage: status quo and perspectives

Prof. Dr. Stefan Spirk

www.ecolyte.at

Ecolyte

AI-driven sustainable energy storage solutions.

Prof. Dr. Stefan Spirk

www.ecolyte.at

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

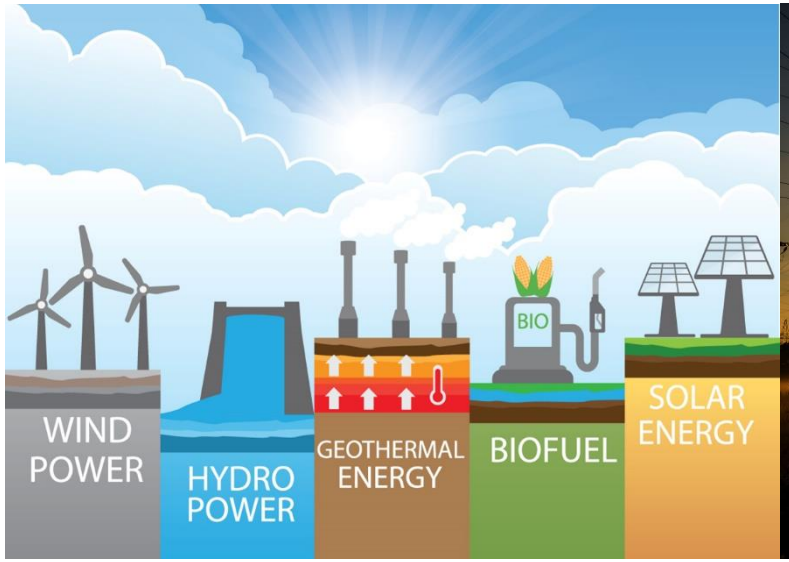
Grand Challenge:

Green energy transition and Green Deal

European Innovation Council

VANILLA FLOW

Grand Challenge – Green energy transition



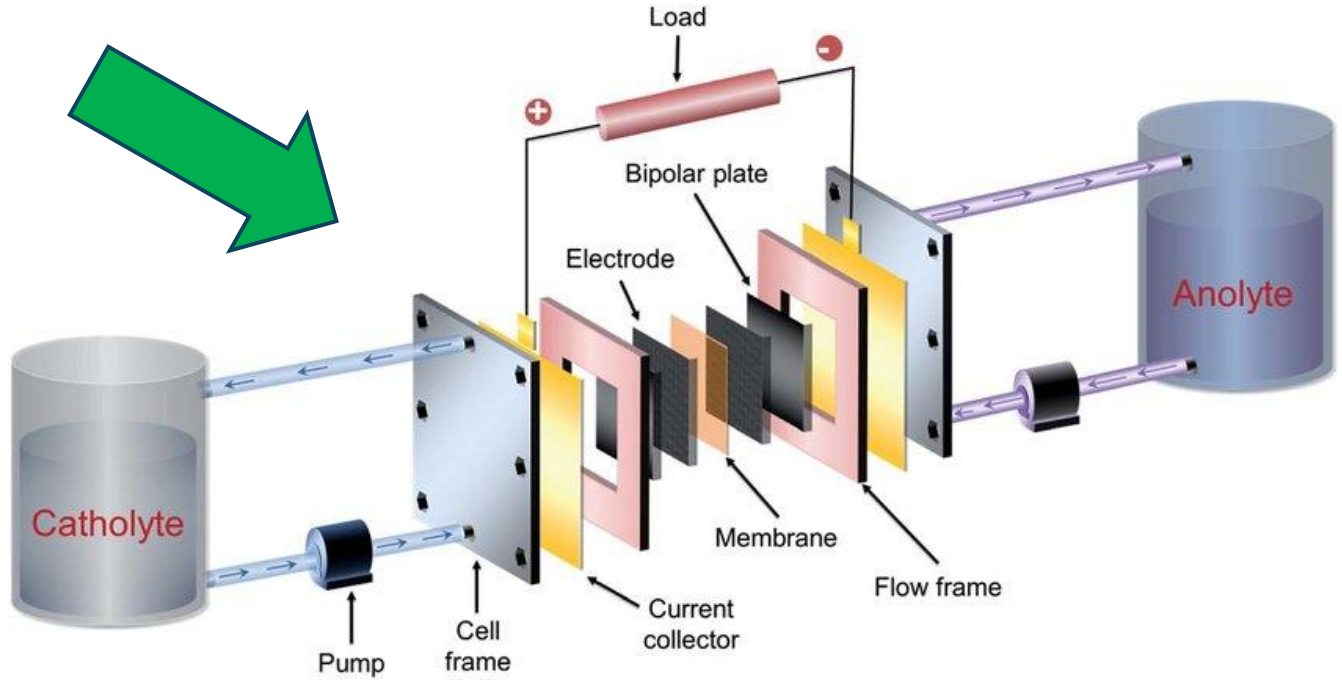
Huge increase in PV and wind installation
- Grid investments slow
- Storage has been neglected

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

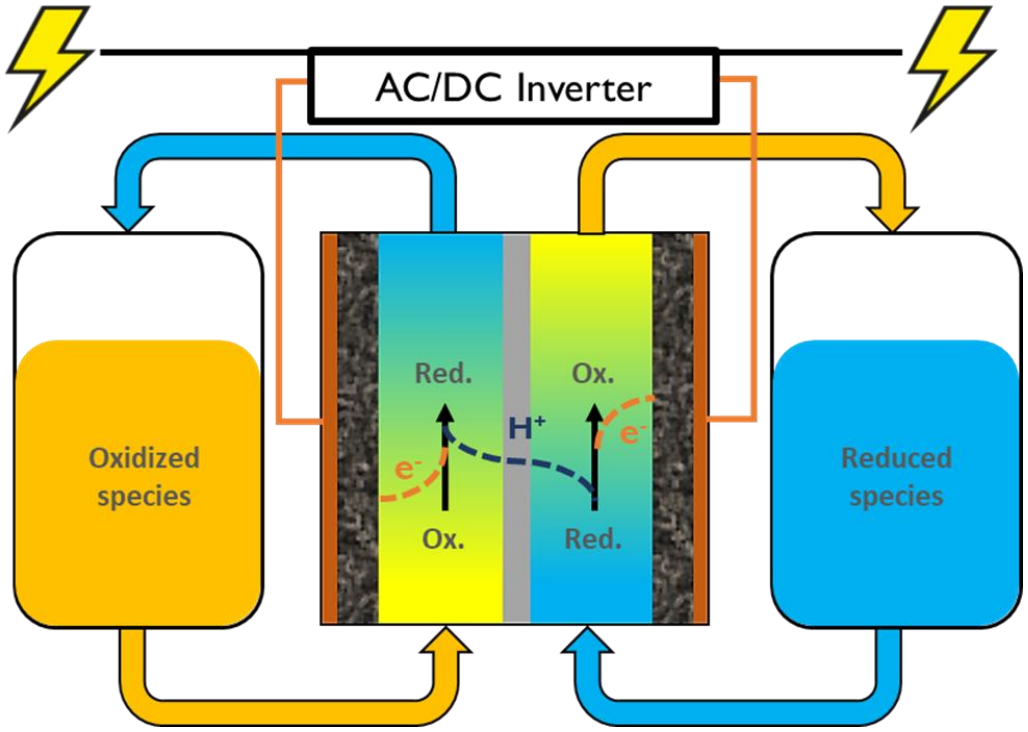
Use of large scale, sustainable, safe, regionally available energy storage systems needed!

Our vision – renewable liquid batteries in stationary energy storage



J. Mater. Chem. A, 2015,**3**, 16913-16933

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

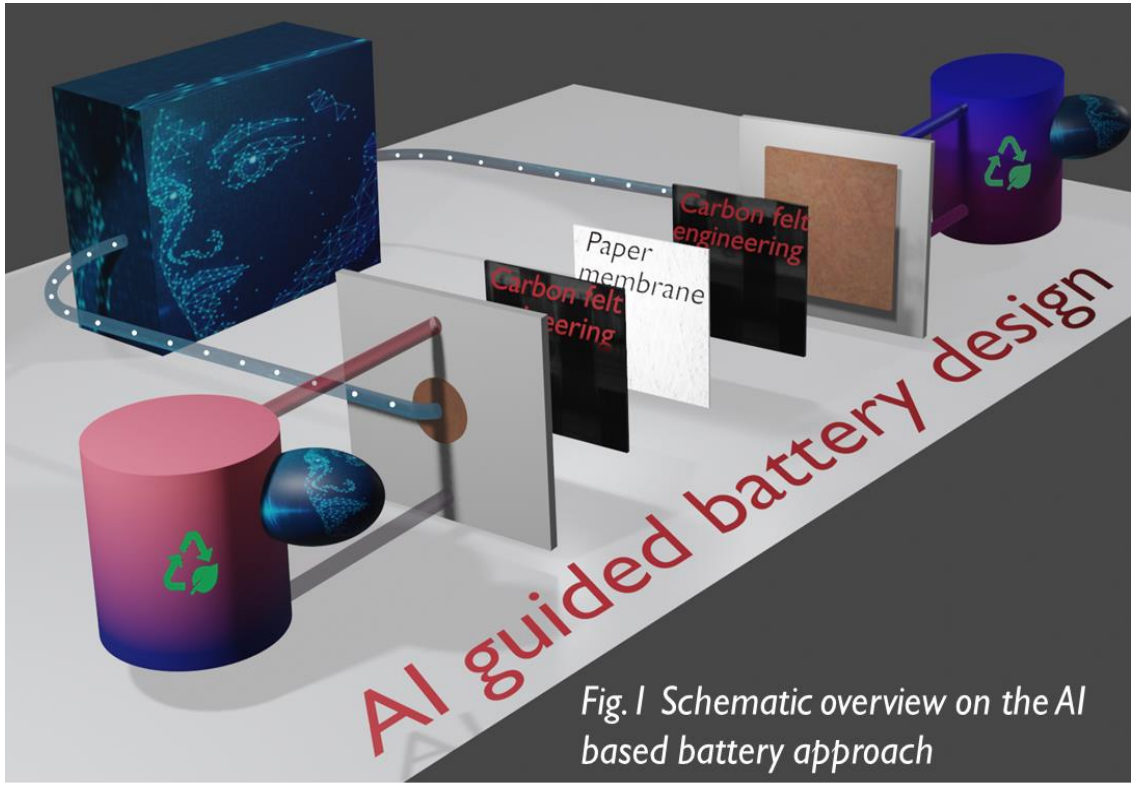


Fig. I Schematic overview on the AI based battery approach

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

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

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

Assessment of stationary storage scenarios possible

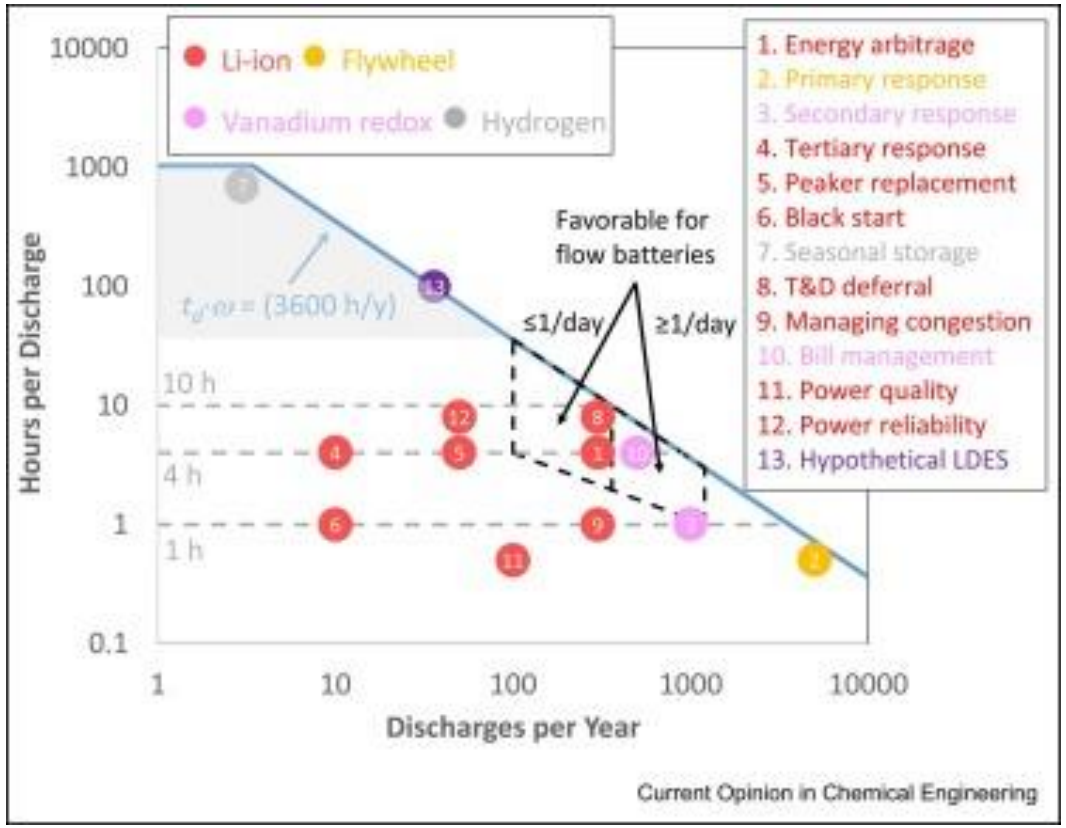
Key docs Joule, 2019, 2, 81-100 and Lazard study on LCOS v7.0, Curr. Opin. Chem. Eng. 2022, 37, 100855

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!



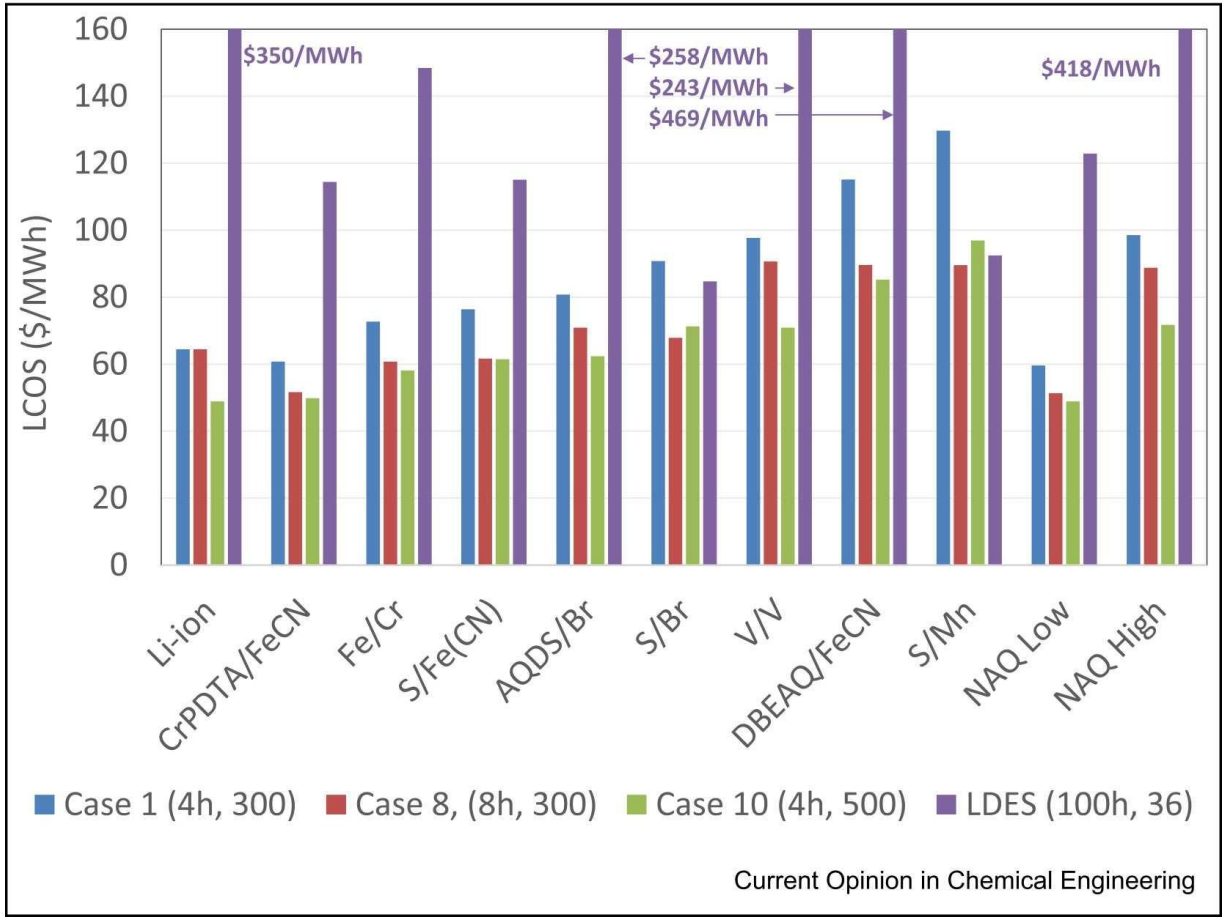
Curr. Opin. Chem. Eng. 2022, 37, 100855

Flow battery sweetspots somewhere between 100 and 1000 discharges per year

Several appliation scenarios are potentially possible:

- Energy arbitrage (exploit price differences for trading energy)
- Secondary response (30s response to stablize 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

Curr. Opin. Chem. Eng. 2022, 37, 100855

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)

Ecolyte

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

POWER ELECTRONICS

Batterierecycling als Schlüsseltechnologie: Sicherung kritischer Rohstoffe für die Zukunft

Dr. Eva Gerold

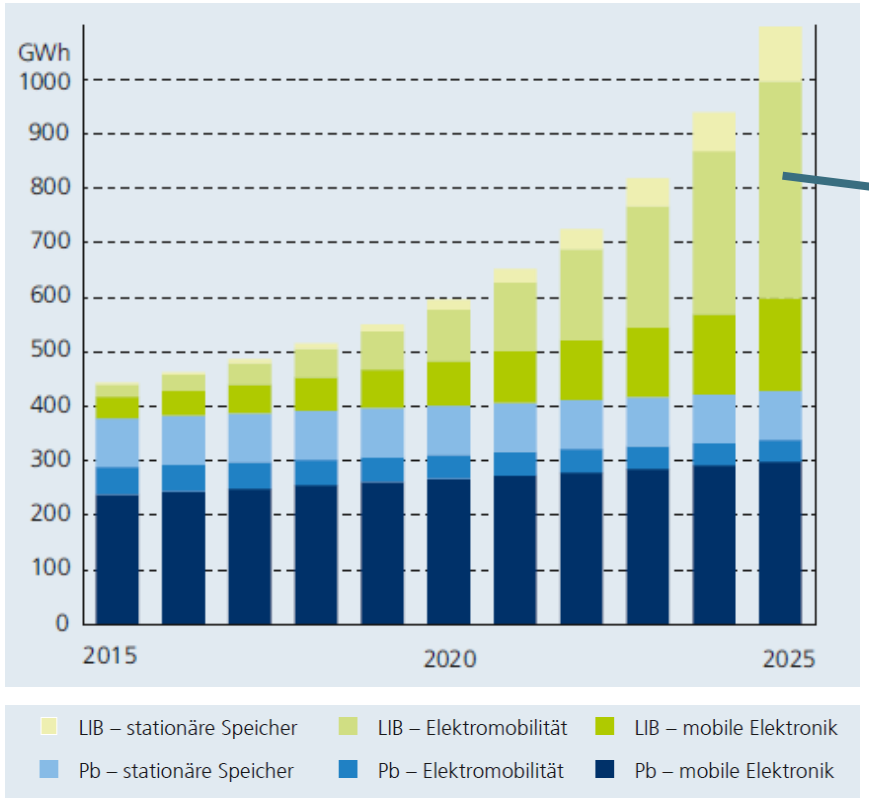
Power Electronics meets Battery Solutions,

Green Tech Valley Cluster und Silicon Alps Cluster

17. September 2024

Entwicklung des Batteriemarkts

Weltweiter Batteriemarkt

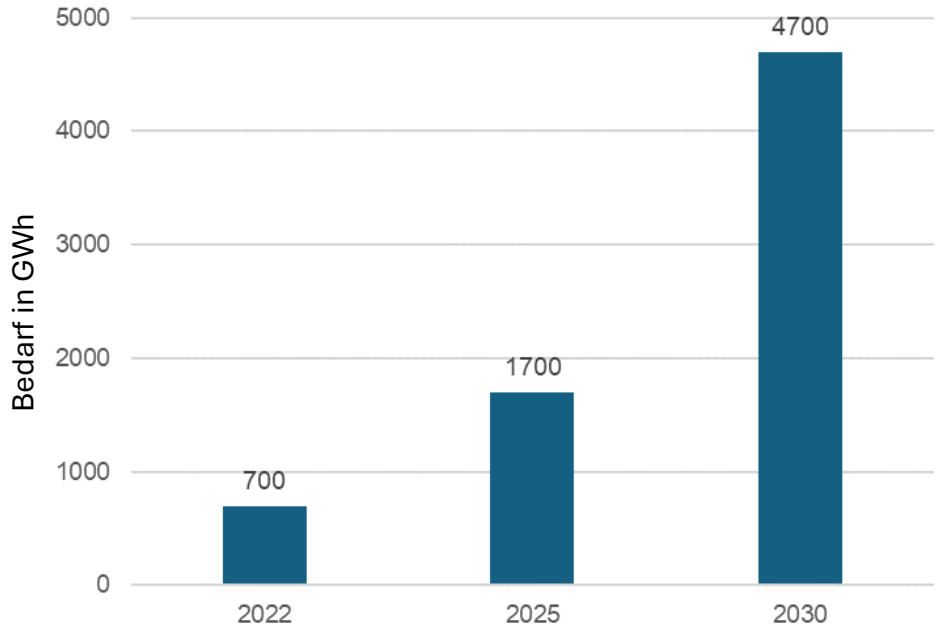


Erwartete EV-Verkäufe:

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

Entsprechende Massen der benötigten Lithium-Ionen-Batterien:

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



Benötigte Rohstoffe für eine Lithium-Ionen-Batterie

Kritische Rohstoffe

Li Lithium

Co Kobalt

Ni Nickel

Mn Mangan

C Kohlenstoff

NMC-Kathode

Graphit-Anode

Reichlich vorhandene Rohstoffe

Fe Eisen

Al Aluminium

Cu Kupfer

Na Natrium

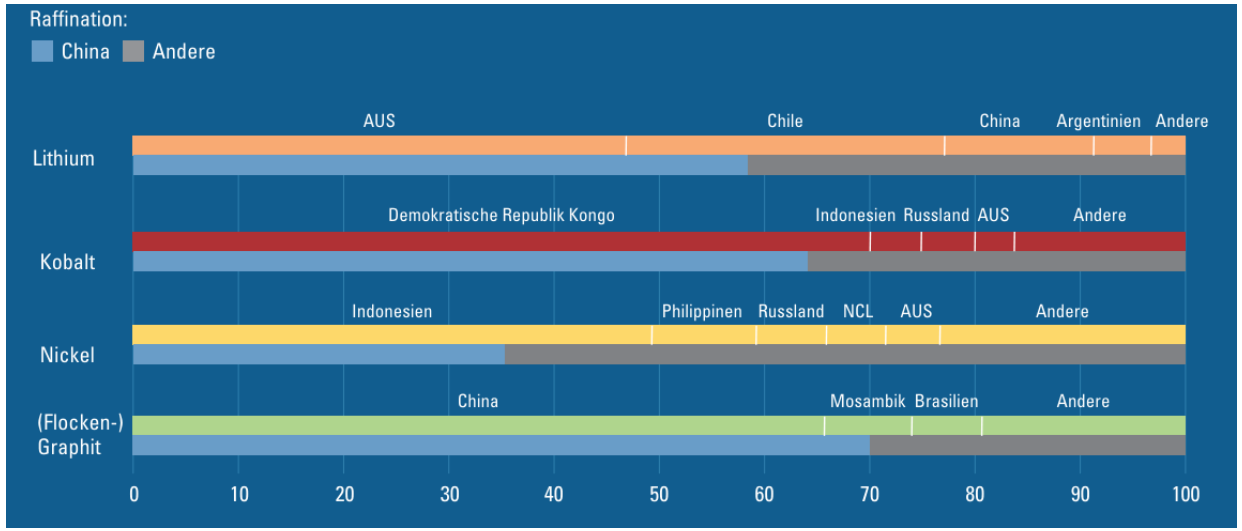
LFP-Kathode

Stromabnehmer

Na-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“

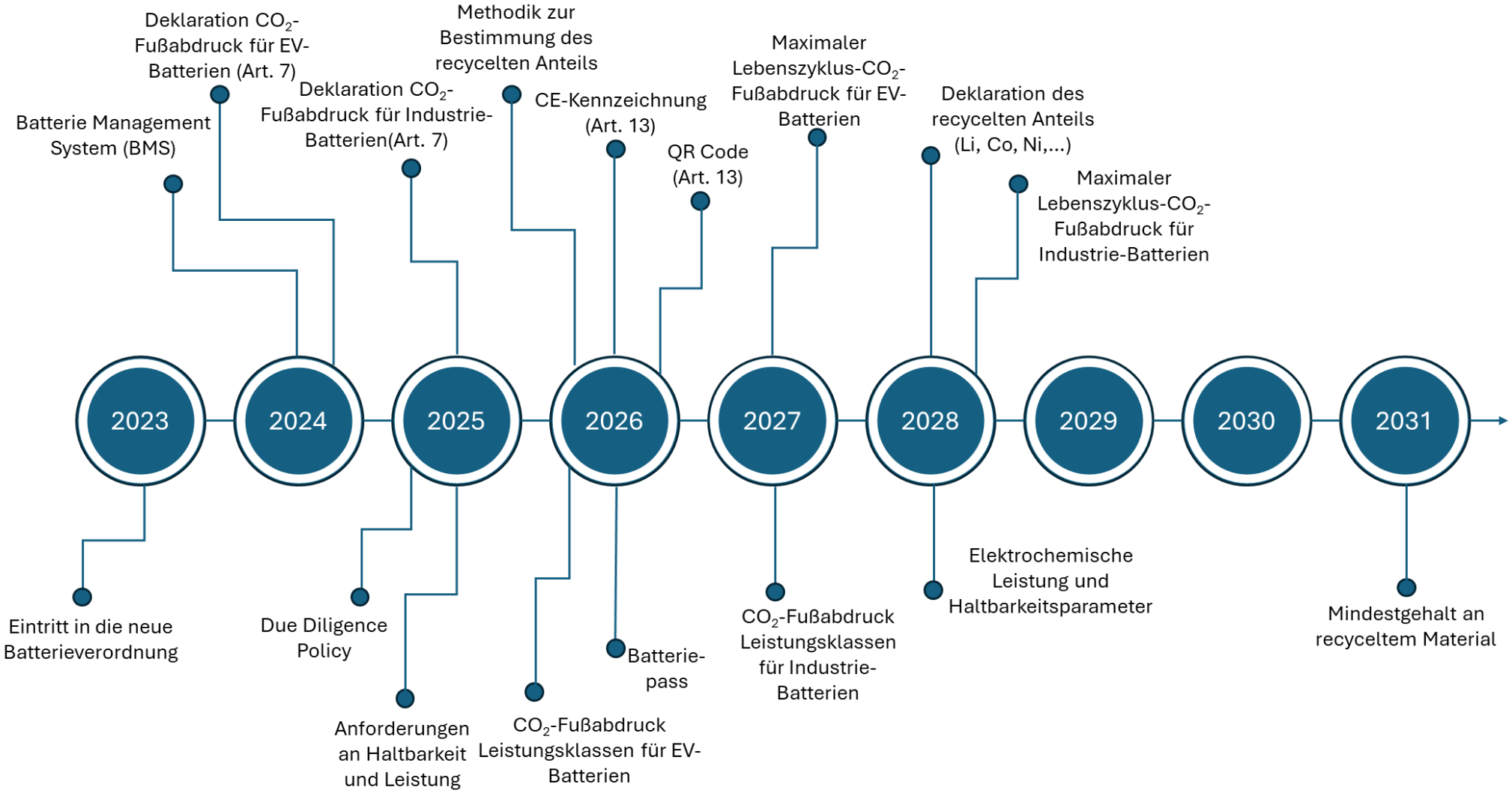
Höherer Stellenwert des Recyclings

Nachhaltiger Rohstoff-einsatz

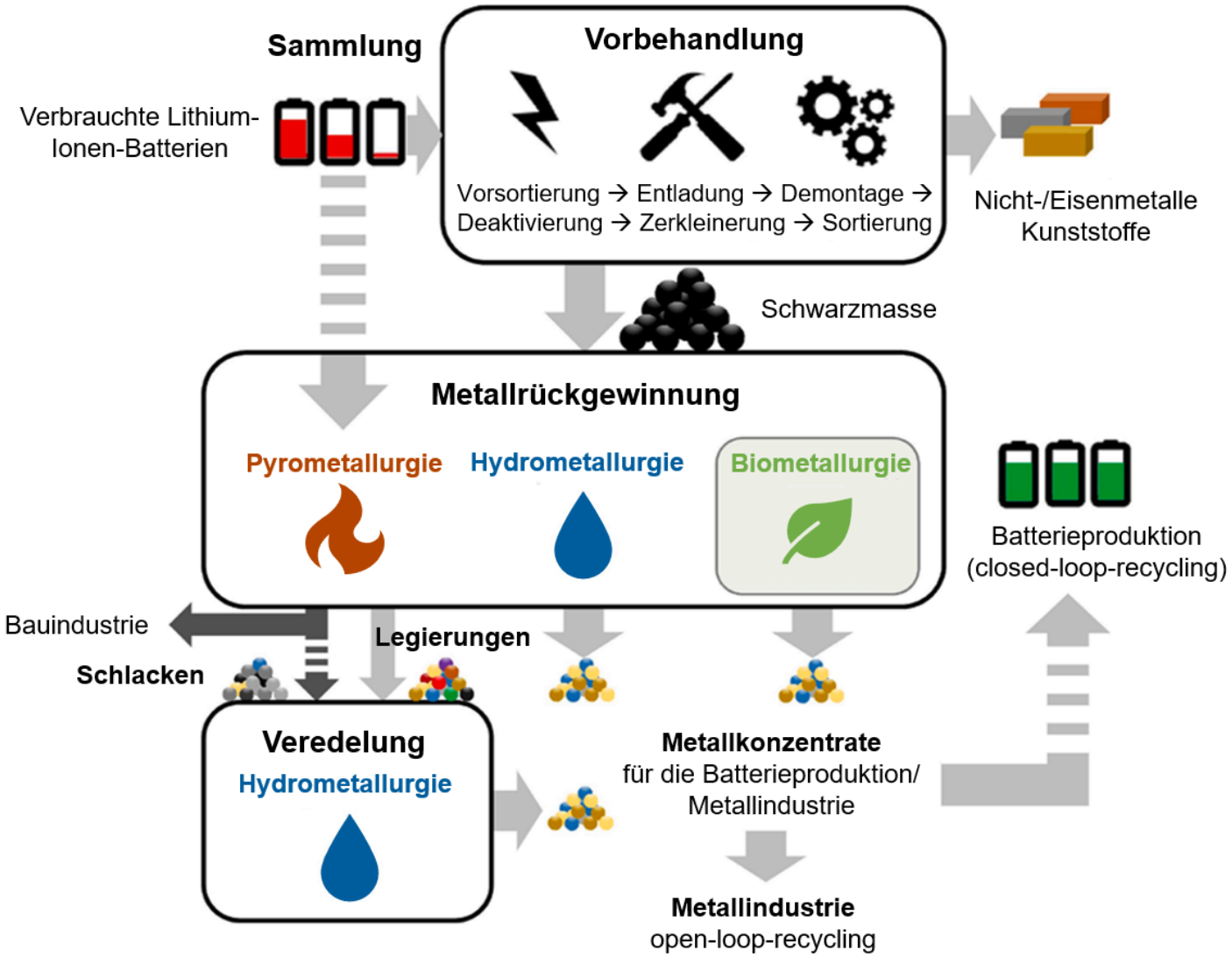
Nachhaltige und verantwortungsvolle Lieferkette

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

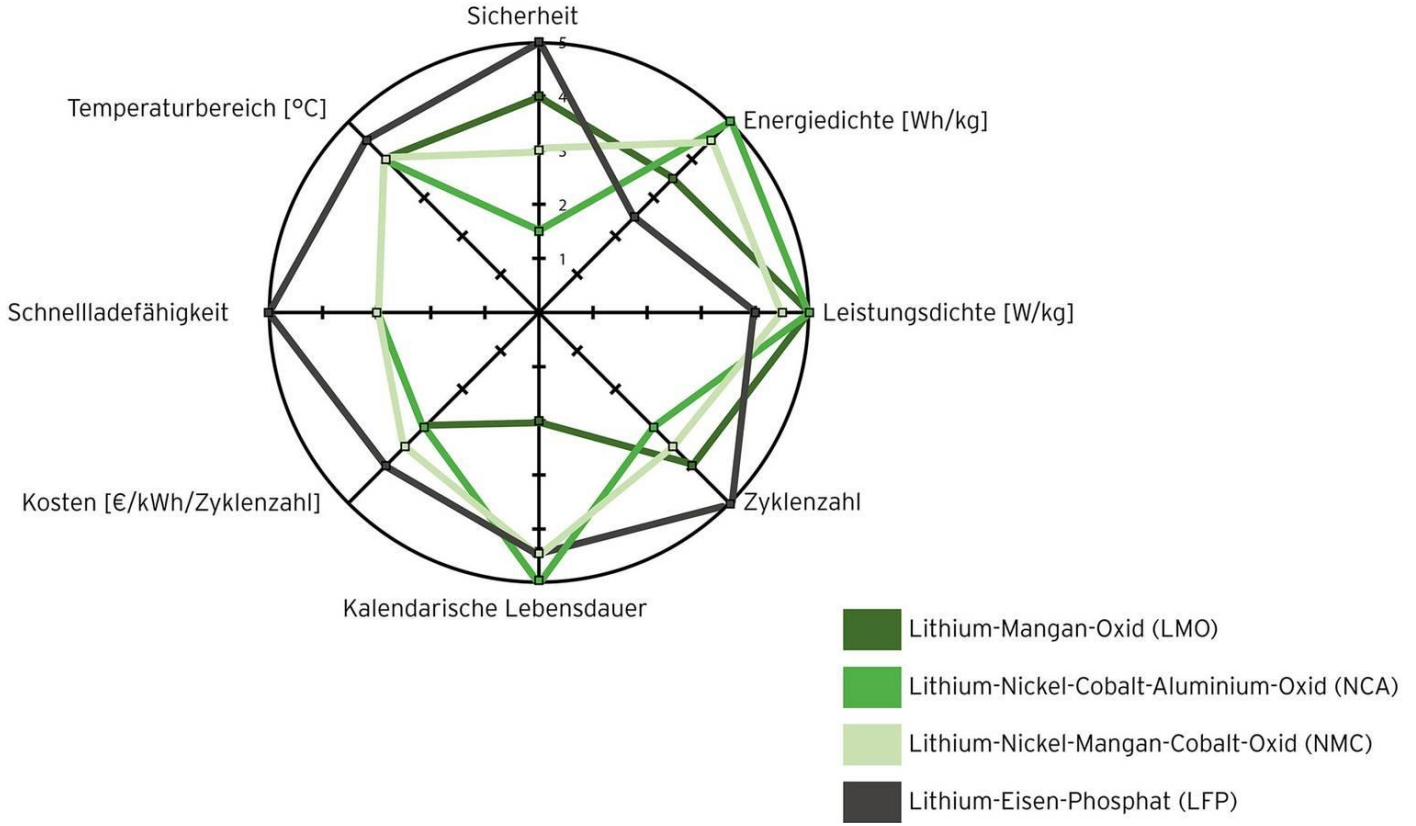
Typen von Lithium-Ionen-Batterien

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




SeLiReco
Selective Lithium Recovery
Graphit
Schwefel-saure Laugung
Fällung von Kobalt und Nickel
Lösungs-reinigung
Selektive Fällung von Lithium

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