CHEMISTRY IN TRANSITION - THE CHALLENGE OF CHEMISTRY FOR THE ELECTROMOBILITY OF THE FUTURE


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High market growth

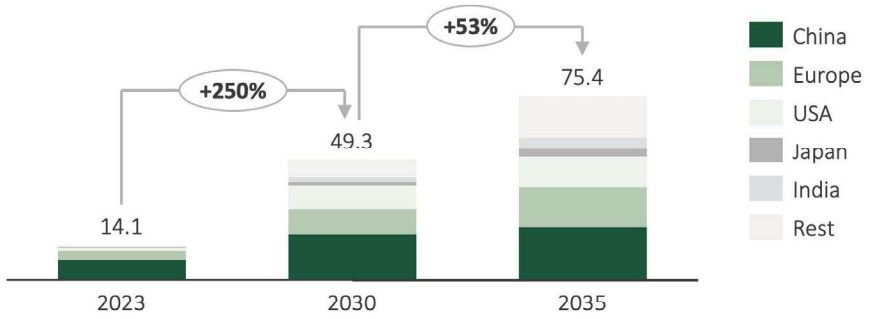
The market for electric vehicles (EVs) has experienced remarkable growth in recent years. This growth is driven by various factors, including increasing environmental awareness, government incentives and technological advancements and infrastructure development.

One important factor is the growing awareness of climate change and the need to reduce CO2 emissions. Many consumers are consciously opting for EVs in order to reduce their ecological footprint. Governments in Europe and around the world are encouraging this trend through subsidies, tax breaks and strict emissions regulations.

In addition, the increasing availability of charging infrastructure plays a decisive role. More and more charging stations are being installed in cities and along motorways, which makes owning an electric vehicle more practical.

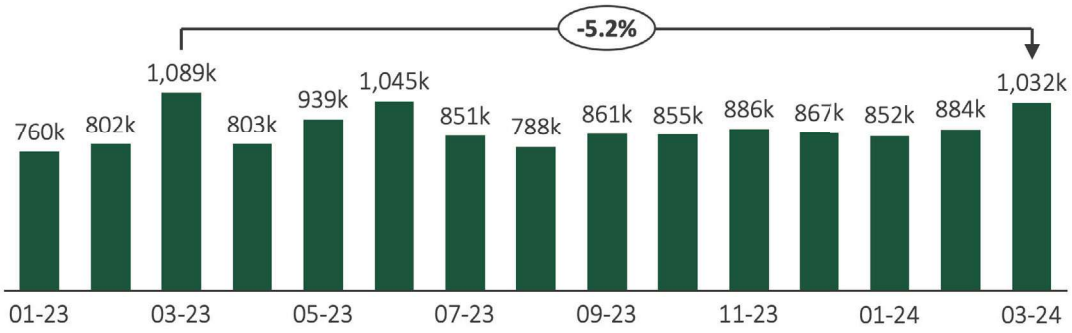
A key aspect of growth is the continuous improvement of battery technology, which is currently mainly based on lithium-ion batteries (LiB). The development of more powerful and cost-effective LiBs has significantly increased the range of electric vehicles and shortened charging times. As a result, more and more consumers are willing to switch to EVs.

FIGURE 1: FORECASTED SALES VOLUME OF ELECTRIC VEHICLES BY REGION (IN MILLIONS; SOURCE: IEA - SUSTAINABLE DEVELOPMENT SCENARIO, 2024)



However, the past year has revealed certain limitations to this growth trajectory. The total cost of EV ownership – including purchase price, operational costs, maintenance, and insurance – remains prohibitively high for many consumers. Additionally, key performance metrics, particularly range capabilities, have not progressed as rapidly as anticipated.

FIGURE 2: NEW REGISTRATIONS OF ELECTRIC VEHICLES IN EUROPE (SOURCE: ACEA, 2024)



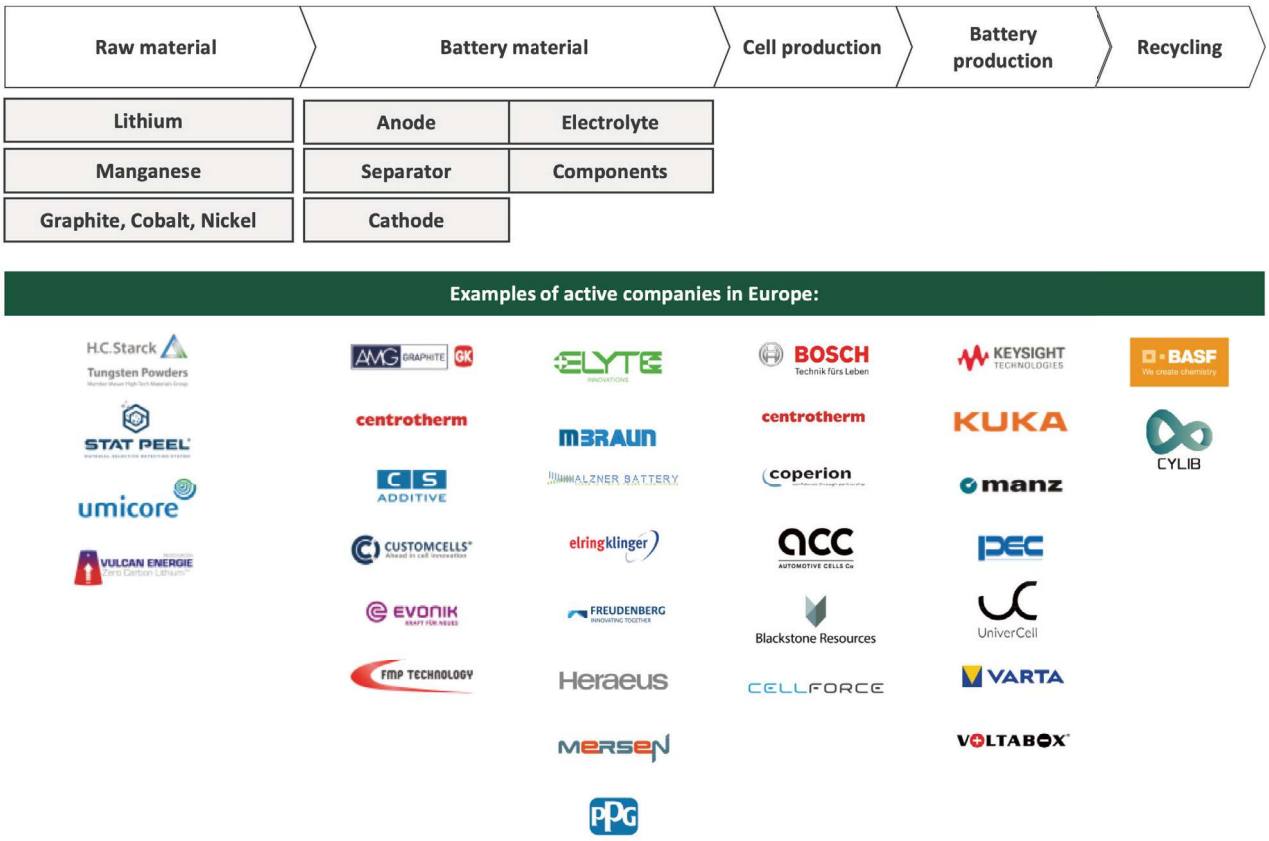
The significantly slower growth is currently leading to temporary overcapacity for EVs and suppliers, as shown by Northvolt's reduced growth plans, for example. With the ongoing development of technology and infrastructure and the support of politicians and society, EV are still expected to dominate the market for passenger cars in the coming decades.

European value chains for batteries are being established

Europe is witnessing the rapid development of a sophisticated battery materials value chain, spurred by growing demand from both the EV sector and stationary energy storage applications. Companies across the continent are making strategic investments in capabilities and processing capacity throughout the value chain.

The value chain comprises five key stages:

FIGURE 3: SIMPLIFIED OVERVIEW OF THE LITHIUM-ION BATTERY VALUE CHAIN (SOURCE: KOMPETENZNETZWERK LITHIUM-IONEN-BATTERIEN, 2024)



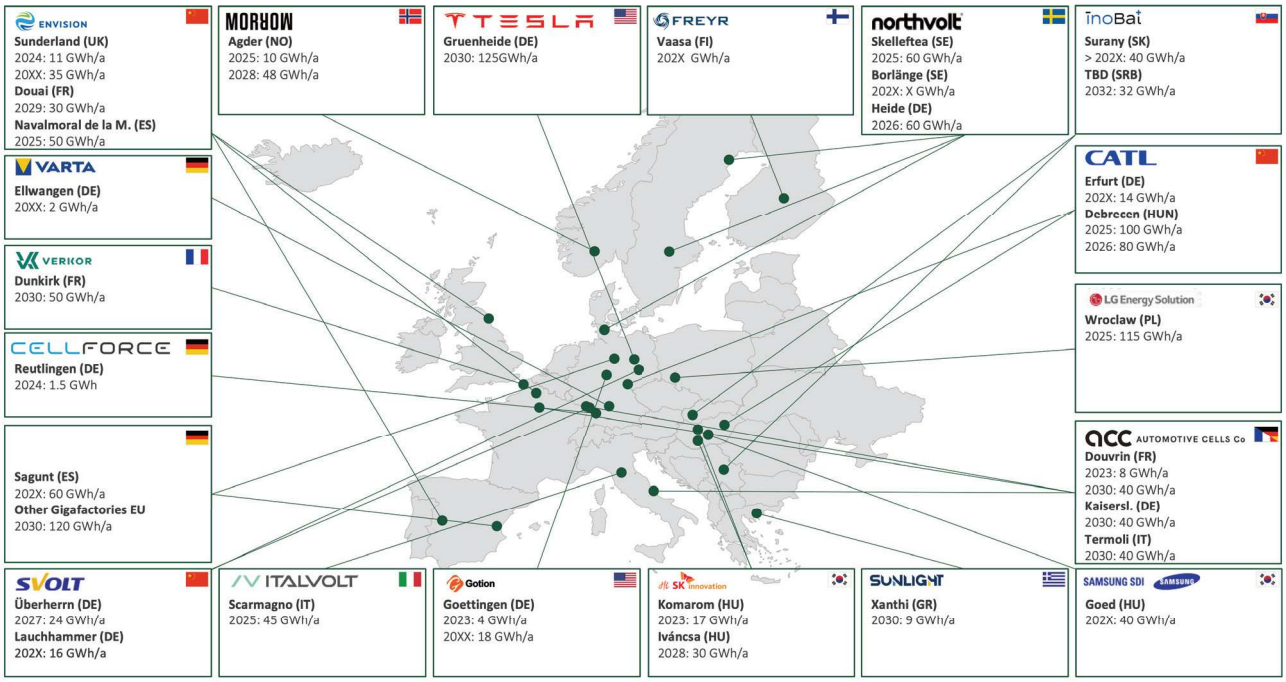
Raw materials: The value chain begins with the procurement of raw materials, especially for the active elements of electrochemistry, such as lithium, cobalt, nickel and graphite. Europe has begun to develop strategies to reduce its dependence on imports and strengthen the domestic supply of raw materials.

Battery materials: The production of active materials for lithium-ion batteries is a complex process involving several chemical and physical steps. These materials are crucial for the performance, capacity and service life of the batteries. In addition to active materials, there is a rapidly increasing demand for many other elements that are critical to a functioning LIB battery such as electrolytes, membranes or components.

Cell production: Battery cell manufacturing is a multi-stage, highly complex and technologically demanding process that requires precision to produce high-quality, high-performance batteries. Continuous innovation is required to increase performance, safety and sustainability.

Battery production: The production of batteries from the cells themselves is a central part of the value chain. Europe is investing in the construction of gigafactories to increase the production of lithium-ion batteries. Companies such as Northvolt and Tesla have already built or are planning to build large factories in Europe to meet demand.

FIGURE 4: OVERVIEW OF EUROPEAN GIGAFACTORIES
(STATUS: 2024; SOURCE: COMPANY PRESS RELEASES, NEWSPAPER ARTICLES AND OTHER RESEARCH)



Recycling: The recycling of batteries is an increasingly important aspect of the value chain. The recovery of active materials in particular from used batteries is crucial to promoting sustainability and reducing dependence on primary raw materials.

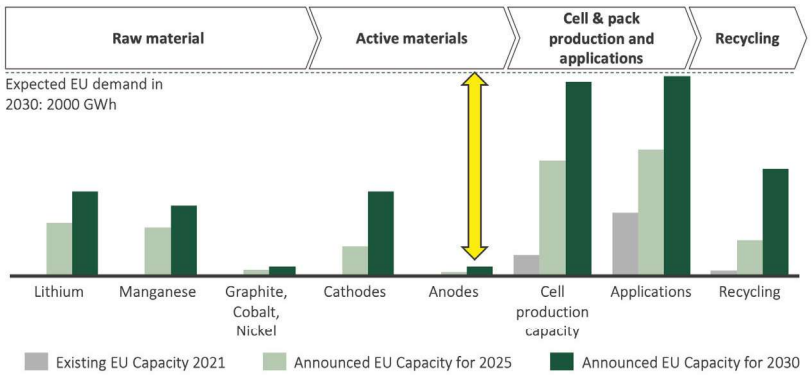
European policy plays an important role in the development of the value chain for battery materials. The EU has launched various strategies and support programmes to strengthen the competitiveness of the European industry and promote sustainability.

Significant supply gap for battery materials in Europe - risk and opportunity

With the growing production of EVs, the demand for LIBs is increasing rapidly and with it the corresponding raw materials, battery materials and components, which puts the existing supply chains under very strong growth pressure.

The significant capacity bottlenecks for battery materials, shown here using the example of active materials, are a strategically important issue, particularly in the context of the growing demand for electric vehicles and renewable energies.

FIGURE 5: FORECASTED CAPACITIES AND DEMAND FOR ACTIVE MATERIALS IN THE EU (ILLUSTRATION BASED ON THE BASELINE SCENARIO FOR THE BATTERY CHEMICALS MARKET AND THE EUROPEAN BATTERY ALLIANCE)



Europe is heavily dependent on imports of critical raw materials such as lithium, cobalt and nickel, which are mainly mined in countries such as Australia, Chile and the Democratic Republic of the Congo. This dependence can lead to supply risks. In addition to strict European regulations governing the mining and processing of raw materials, there are often acceptance problems among the local population, which can lead to delays and risks for new projects in Europe, as current examples in Portugal and Serbia show.

In addition to the procurement of raw materials, the development of new technologies and investment in new capacities for the chemical production of high-purity battery materials for cathodes and anodes, among other things, are essential for completing the value chain.

These investments are capital-intensive and must be made against the backdrop of technology, market and regulatory risks as well as strong competition from China. Currently, many of the critical battery materials are produced in China, regardless of whether the raw materials come from China or have to be imported. For example, more than 90% of the global demand for graphite for anodes comes from China and around 65% of lithium.

Electrification is creating new markets for chemical products with growth rates of well over 10% p.a. and therefore offers a significant growth opportunity for the chemical industry, which has the infrastructure and expertise.

Nevertheless, the majority of the necessary active materials such as lithium hydroxide (LiOH) or specialty graphite are currently imported to Europe. There are many reasons for this, but the core problem is that considerable investments have to be made with significant market, technology and project risks. These risks can easily be illustrated by the sale of Johnson Matthey's loss-making battery materials business.

In addition to the strategic and economic risks of this import dependency, such an outsourced value chain leads to slower innovation cycles in the battery technology clusters if the technical standards for key elements are set elsewhere. The next decade will show to what extent some of the major markets for EVs and LIBs can successfully establish local production of LIBs and battery materials.

Motivation for M&A transactions - market entry and consolidation

In the attractive growth market for battery materials, there have been over 100 M&A transactions in all stages of the value chain in the last 15 years. However, the total value of M&A transactions remains below investments in organic growth, as acquisition opportunities are relatively limited in this emerging industry.

FIGURE 6: SELECTED TRANSACTIONS IN THE BATTERY MATERIALS SECTOR - ANNOUNCED + CLOSED (SOURCE: CAPITAL IQ)

Year	Buyer	Target
2012	ALCONIX Corporation	Univertical Corporation
2012	BASF SE	Merck Electrolyte Business
2014	China Baoan Group Co., Ltd.	BTR New Energy Materials Inc.
2015	Johnson Matthey Plc	Clariant AG, Battery Materials Business
2015	Albemarle Corporation	Rockwood Holdings, Inc
2015	RWC Partners Limited; RWC European Focus Master Inc	AMG Advanced Metallurgical Group N.V.
2016	PMHC II, Inc.	Erachem Comilog S.A.
2017	Imerys Graphite & Carbon Switzerland SA	Nippon Power Graphite Co., Ltd.
2017	Graphitecorp Limited (nka:NOVONIX Limited)	Novonix Battery Technology Solutions Inc.
2017	Resonac Holdings Corporation	Assets Concerning SiC for Power Devices
2017	Shenzhen Capchem Technology Co., Ltd.	BASF Battery Material (Suzhou) Co., Ltd.
2018	Arcadium Lithium plc	Livent Corporation (FMC)
2018	Syrah Resources Limited	Battery Anode Material Site in Vidalia, Louisiana
2019	Umicore SA	Cobalt refining and cathode precursor activities of Freeport Cobalt
2020	Tokai Carbon Co., Ltd.; COBEX HoldCo GmbH	Carbone Savoie SAS
2022	Norsk Hydro ASA; Altor Equity Partners AB	Vianode AS
2022	Nano One Materials Corp.	Johnson Matthey Battery Materials Ltd
2023	Albemarle Corporation	Patriot Battery Metals Inc.
2024	Arcadium Lithium plc	Allkem Pty Ltd

In the phase up to 2021, a key motivation for transactions was the acquisition of technology for battery materials and production capacities for market entry. Examples include the purchase of Merck's electrolytes by BASF in 2018 and Clariant AG's battery materials by Johnson Matthey in 2015.

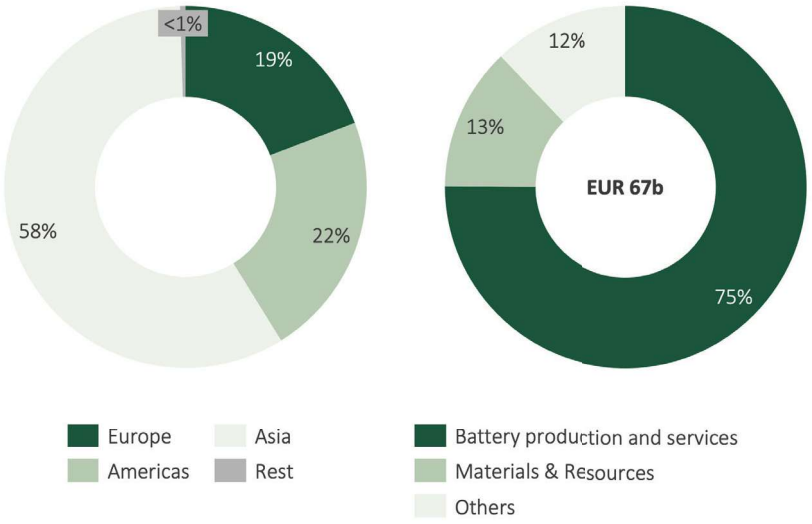
Since 2021, however, we have seen increased market consolidation through M&A transactions, as the more difficult economic conditions due to higher competitive pressure and technology risks can be better tolerated in larger units, leading to the exit of smaller competitors. Notable examples include Johnson Matthey's sale of its battery materials business in 2022 and the 2024 merger of Arcadium Lithium with Allkem Pty.

Growth capital Investments in the battery value chain

Growth capital investors have invested a total of around EUR 67 billion in the battery value chain worldwide over the last 15 years in around 3,000 transactions. In regional terms, Asia accounts for around 60% of these investments, while 19% have been invested in Europe and around 22% in America.

Battery production and services account for a significant share of 75%, while critical materials and raw materials only account for around 13% of investments.

FIGURE 7: GLOBAL VC AND GROWTH FUND INVESTMENTS IN LIB (SOURCE: PITCHBOOK)



Conclusion

Although it is accepted that building the overall value chain for lithium-ion batteries makes sense for strategic, economic and innovation IP development reasons, the build-up is clearly too slow.

The need for significant investment combined with technology and market uncertainty makes market entry and expansion a complex decision and, paradoxically, the need to deliver significant volumes at competitive prices in the short term is an additional negative factor.

Ultimately, this strategically vital value chain—holding significant potential for innovation and value creation within the European chemical industry—risks remaining unrealized, which could leave the continent dependent on imports in the long term.