Graphite in batteries

As the world increasingly switches from fossil fuel power to emission-free electrification, batteries are becoming a vital storage tool to facilitate this energy transition. Batteries are the fastest growing storage technology and will play a **key role to meet the EU goal of cutting greenhouse gas emissions by 55% by 2030**.

The use of graphite in batteries has increased since the 1970s. **Natural and synthetic graphite are used as components in major battery technologies** incl. nickel-metal hydride and lead-acid. The use as anode material in lithium-ion batteries has become the predominant application which accelerated the demand for graphite material in the past and will do so in the future.

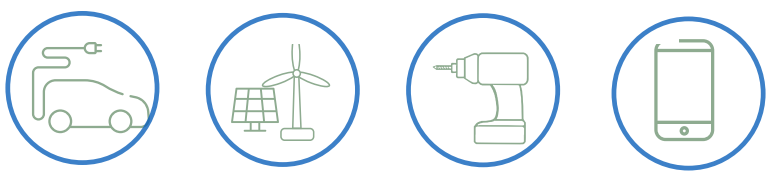
Graphite anode materials provide excellent application properties (namely the combination of high specific energy densities, good fast charging properties, and long cycle life and safety) better than any other technology and proven scalability to mass production which allows to satisfy the rapidly increasing demand driven by electromobility and renewable energy storage.

Given the utmost importance of graphite as anode material in lithium-ion battery, the following will strongly focus this major segment.

Battery markets

Batteries store chemical energy for later conversion to electrical energy. Lithium-ion batteries can be discharged and recharged several thousands of times. They power plenty of modern-life devices.

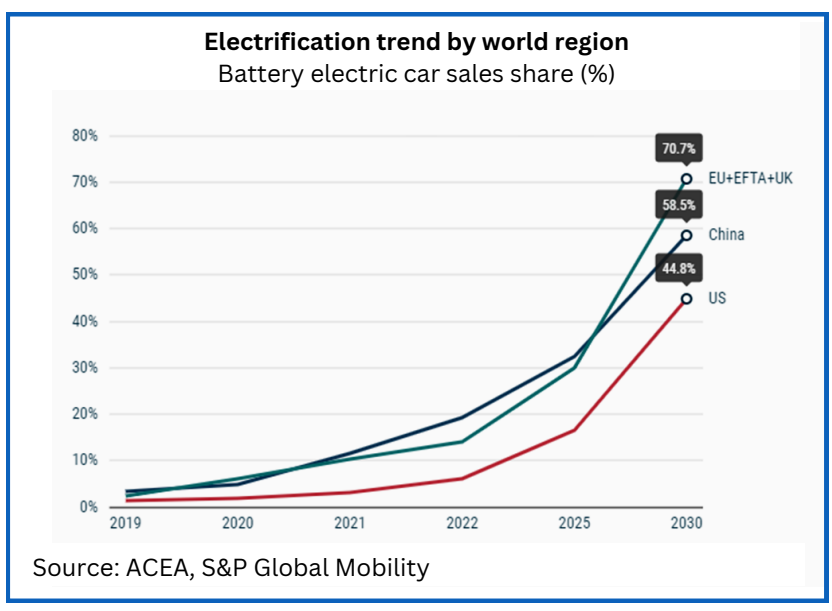
Some of the applications →



The market for batteries is going to increase significantly in the following areas:

Green Mobility

Rechargeable batteries provide opportunities for transport with lower emissions and increased environmental performances.
EU has approved a **ban on the sale of new petrol and diesel cars from 2035**, aiming to speed up the switch to electric vehicles and combat climate change and aims at having **at least 30 million zero-emission vehicles on its roads by 2030**.



Source: ACEA, S&P Global Mobility

Stationary Energy Storage Systems

Rechargeable batteries are a flexible storage solution in renewables-based energy production.
They ensure:

- electricity supply in low production periods and help optimize the electric system by balancing the electricity distribution.
- affordable and sustainable solution for off-grid energy generation in remote areas.

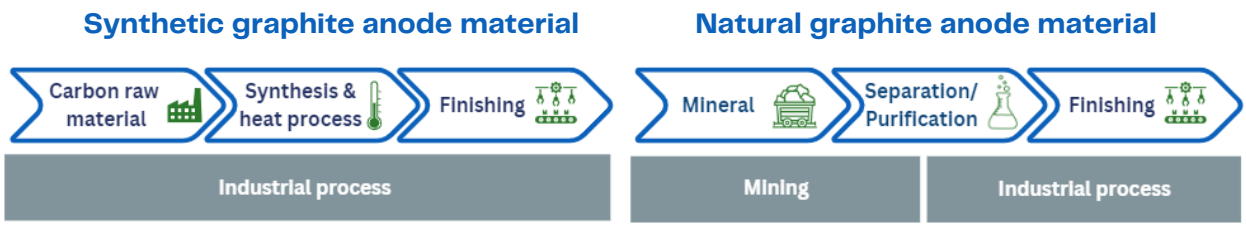
Communication

Modern society relies on cordless electric energy sources such as rechargeable batteries to satisfy our needs for barrierless, mobile communication.

Graphite's role in batteries

Anode material in lithium-ion batteries

Approx. 95% of anode material used in lithium-ion batteries (LiBs) is based on graphite, either synthetic graphite manufactured from carbon containing precursors or natural graphite obtained by mining and refining.
Natural and synthetic graphite are used as anode material in lithium-ion battery cells in combination in varying ratios according to the required performance, cost and the battery model.



Safety — Graphite is widely regarded as a thoroughly tested and proven safe anode material.

Charging speed — Battery charging speed is determined by the anode material, graphite allows quick and effective charging speeds.

Energy density — Graphite provides high capacity to allow high driving range in EVs. Continued development of silicon-graphite composites for future generations will increase overall battery capacity.

Lifetime — Graphite enables a long cycle life as evidenced by EVs reaching more than 500.000 km with the original battery.

Availability — Natural graphite deposits of battery grade exist in Europe. Synthetic graphite production capacities are already on stream in Europe and can be further expanded in line with market demand.

Sustainability — Production using renewable energies and performed under EU ESG standards enables high sustainability.

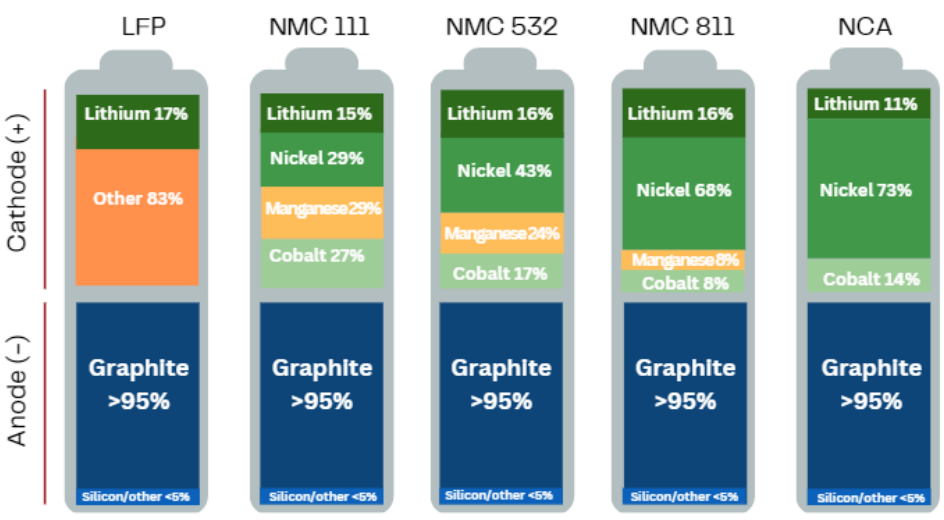
Recyclability — Graphite provides the potential to be recycled from used batteries and can be repurposed for further use.

Graphite – Key to a green future

DID YOU KNOW?

- Graphite is **the anode material of choice in a modern state-of-the-art lithium-ion battery**
- Graphite is **the single largest component in volume in a lithium-ion battery** which contains multiple times more graphite than lithium and more than e.g. nickel and cobalt
- Graphite represents approx. **95% of the anode market**
- **Best cost/performance ratio** compared to non-graphite based alternatives
- The average EV battery contains typically **50 to 100kg of graphite**
- **Sustainable and secure EU supply** in needed dimension can be realized from EU sources and EU production

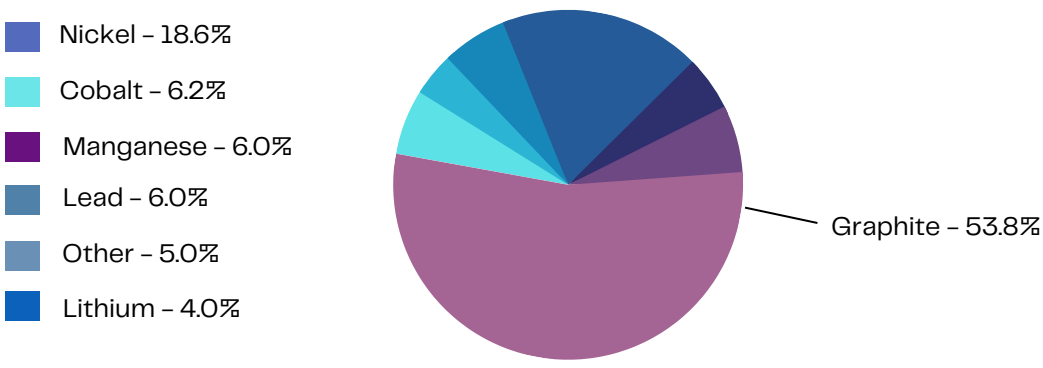
Graphite is fundamental to every battery



Various widely-used lithium-ion batteries – from lithium iron phosphate (LFP) to nickel cobalt manganese (NMC) cathodes (positive) – use graphite anodes (negative).

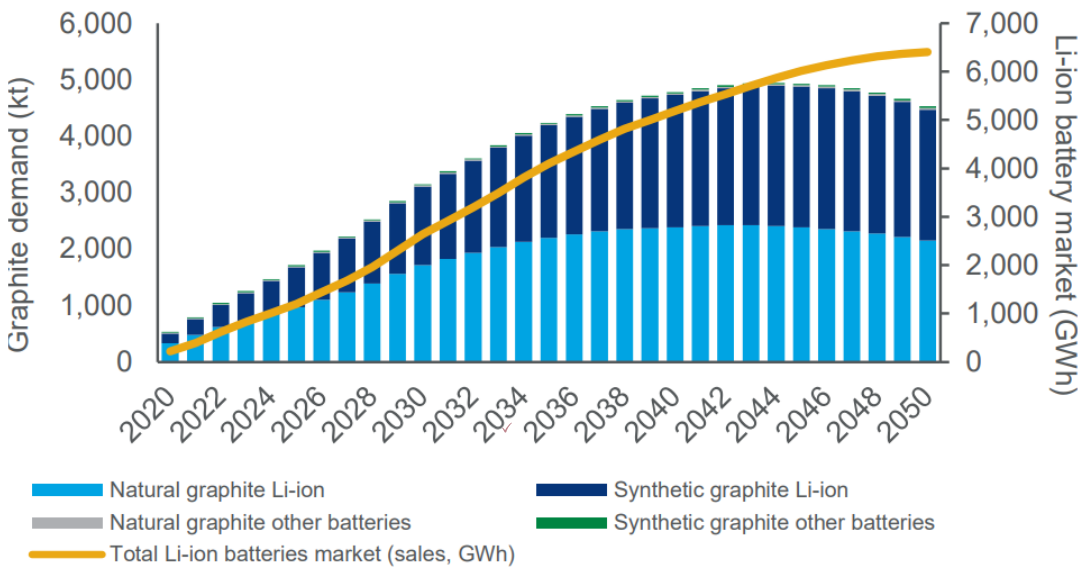
Source: Pallinghurst – Traxys battery analysys. %s represent the proportions of cathode and anode in each battery respectively/ NCA batteries contain 2% aluminium (not shown)

Graphite forecast to dominate battery mineral demand to 2050



Source: World Bank Group, May 2020

Graphite demand in batteries by type



Source: Wood MacKenzie

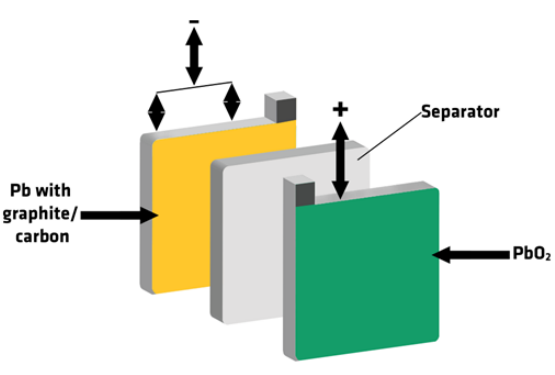
Graphite products as material for various types of batteries

Also for other battery types, graphite plays an important role to maximize their performance. However, the graphite content in these battery types and the applied volumes are dimensionally lower compared to lithium-ion batteries.

Key advantages that graphite brings to all batteries:

- high electrical conductivity
- high chemical stability
- insertion chemistry, intercalation
- high cycling stability
- high chemical purity
- high lubricity
- high thermal conductivity

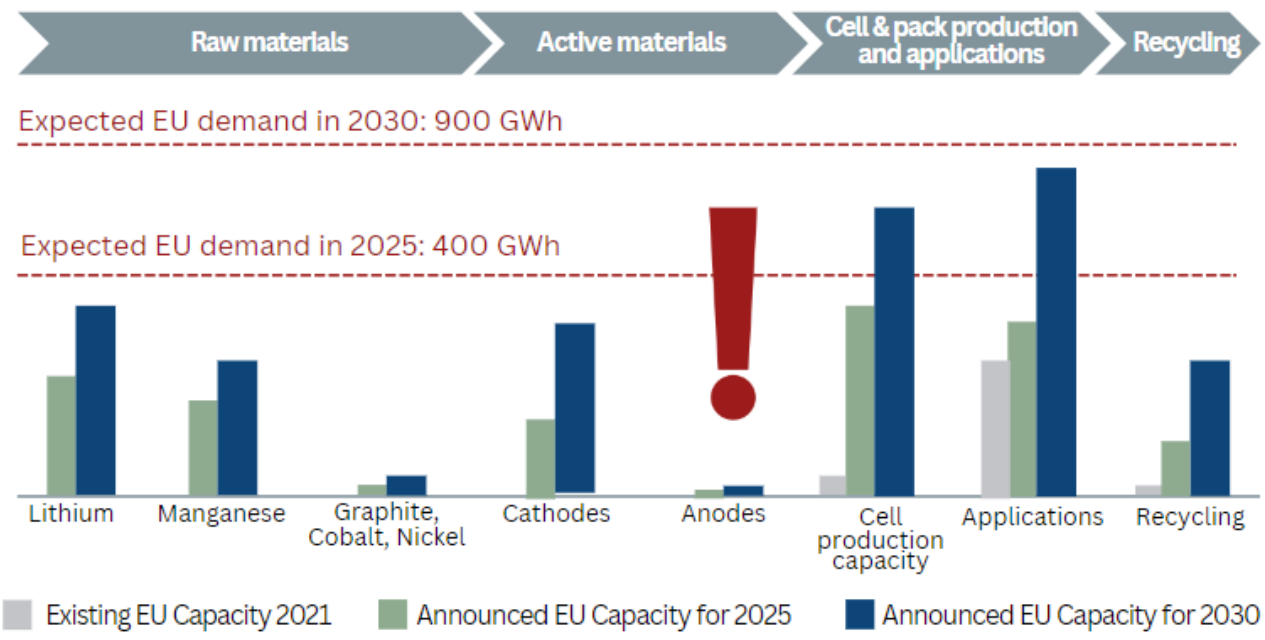
Carbon Enhanced Lead-Acid Battery



Source: Superior Graphite

Increasing graphite's availability for LiB in the EU through domestic supply

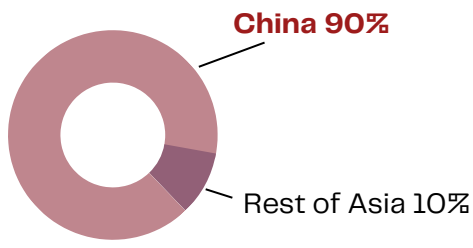
Predicted share of EU supply vs expected demand



source: Illustration based on European Battery Alliance, Innovation Norway and Eyde Cluster: The Nordic Battery Scene

- Current availability of anode material from **EU production is marginal**
- **High dependency on imports** from dominating Chinese suppliers leads to vulnerable situation in EU
- **Significant capacity** can be built from EU sources to satisfy the projected EU demand

Graphite anode material production region →



Natural graphite battery-grade project plans in Europe

Grafintec Oy, Finland
GreenRoc, Greenland
Talga Resources, Sweden
MRC Skaland, Norway
Leading Edge Materials, Sweden

Synthetic graphite battery-grade production in Europe

Existing production:

SGL Carbon, Poland
Vianode, Norway
Tokai Cobex Savoie, France
Superior Graphite, Sweden
Imerys Graphite and Carbon, Switzerland

Projects plans:

Sangraf, Italy

Policymakers in Europe must **create a level playing field for EU-based battery grade graphite production** to protect the industry and the respective jobs against unfair competition, in order to incentivize and de-risk the massive investments in the industry that are needed to cover the upcoming demand and reduce dependency on Chinese supply.
Required measures are:

- **competitive energy costs** (e.g., USA and China);
- **funding programs for investments** at the same level as other economic zones (e.g., US IRA, US BIL);
- **incentives for sourcing from European graphite production** (e.g., US IRA);
- **corrective barriers** for imports from countries which do not meet EU standards in terms of ESG and fair market practices (e.g., CBAM, punitive duties & taxes).

Recycling of anode materials from lithium-ion batteries

Recycling battery components is extremely important, both from a material and an environmental standpoint. Not only do we use and reuse the battery itself by charging and discharging it, at the end of its life it can be taken apart and the components recycled to provide materials for other applications or to be made into new batteries.

Decreasing environmental footprint

Graphite can be recycled by high temperature processing without damaging the graphite structure, which makes it feasible to recycle LIB graphite anodes.
It would still require a lower purification temperature than for graphitization of virgin material, making recycled graphite a product with relatively low environmental footprint.

Lowering dependency on raw materials

Recycling of synthetic graphite would make batteries less dependent on high quality coke (used as raw material for synthetic graphite), which has been prone to volatile prices, and on imports from Asia, strengthening the internal market.

Increasing circularity

Production scrap will provide in the short- to medium-term the main supply of graphite concentrate for recycling. End-of-life batteries will eventually take over as the main source.

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