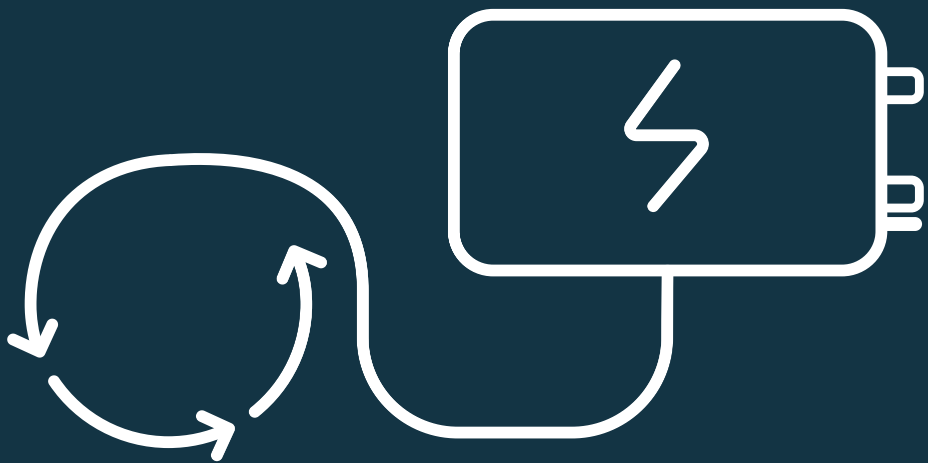
THE BUSINESS VALUE OF CIRCULARITY

How NMC outperforms LFP in recycling profitability and lifecycle ROI



White paper - 2026

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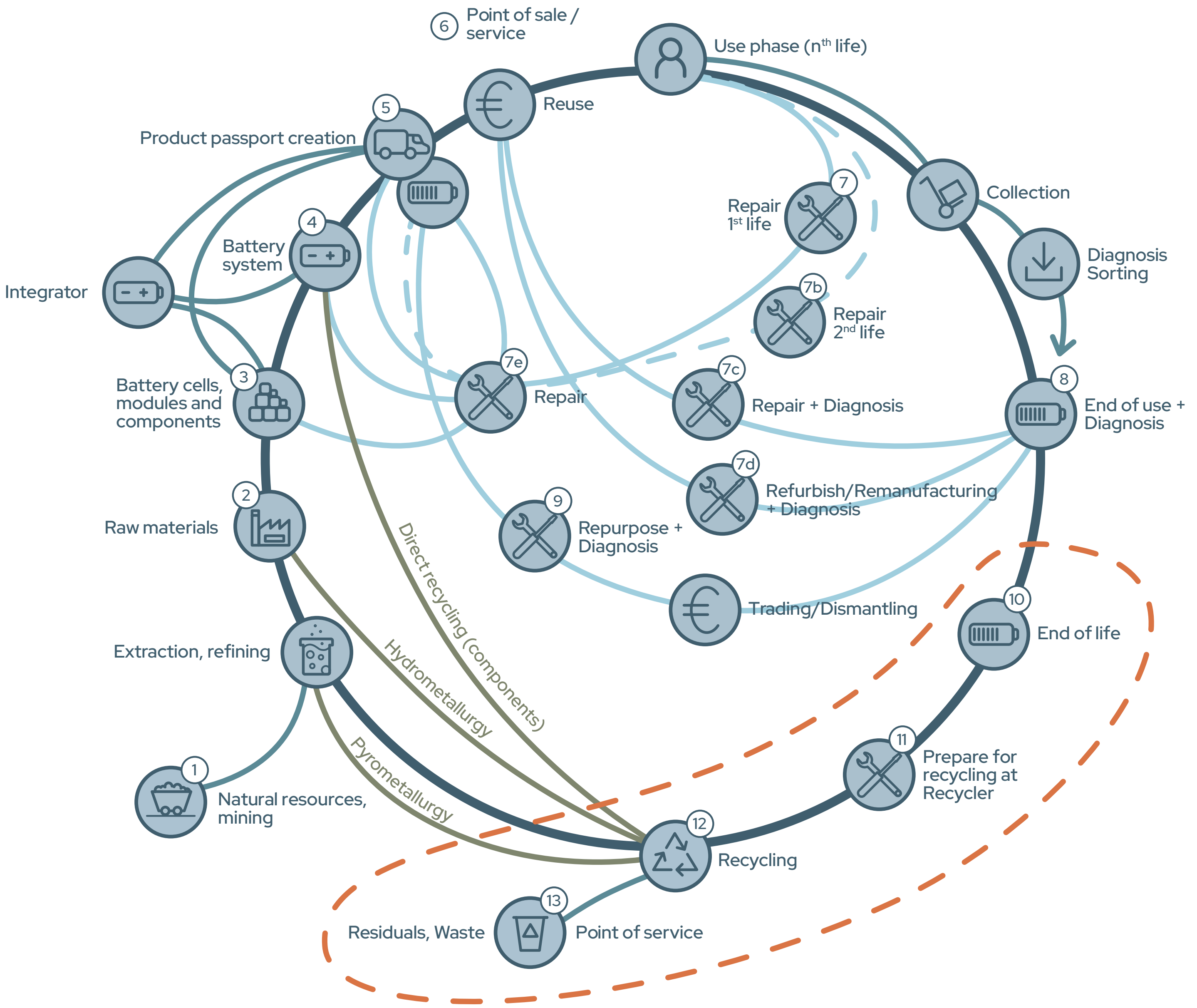
UNDERSTANDING THE FULL VALUE CHAIN

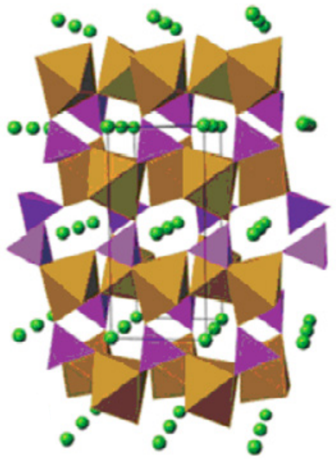
As the focus on reuse, repurpose, remanufacturing and recycling continues to grow, it is becoming clear that true circularity depends on understanding the full battery value chain. Each stage—from production to end-of-life—shapes both environmental impact and economic outcomes.



At the same time, emerging product legislation is shifting both responsibility and cost from end-users to the supply side, with the aim of creating closed-loop systems and a stronger need for upstream design choices that enable efficiency, traceability, and recoverability across the entire lifecycle.

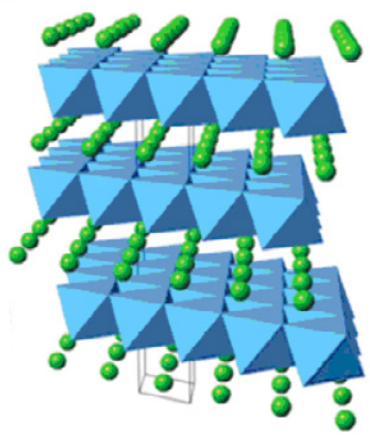
CHEMICAL STRUCTURE AND PROPERTIES

At the core of this lies the battery itself: its chemistry, structure, and material properties. These intrinsic characteristics ultimately determine performance, longevity, recyclability, and the value that can be recovered at end of life.



LFP

- High discharge power at room temperature
- Long cycle life, but with lower energy per cycle
- No oxygen release during thermal runaway, though not inherently safer overall
- Mainly available in prismatic and pouch formats
- Based on low-cost, abundant raw materials
- Unfavorable recycling economics
- Cell production largely concentrated in China



NMC

- Versatile power performance
- Medium life cycle
- High specific energy enabled by increased nickel content
- Releases oxygen during thermal runaway
- Available in all major cell formats
- Uses rare and expensive materials (Co, Ni)
- More favorable business case for recycling
- Cell production distributed across Chinese, Japanese, Korean and U.S.manufacturers

MATERIAL COST DRIVE RECOVERY VALUE

Global raw material prices for nickel, cobalt, and lithium have fluctuated in recent years, but the overall direction is upward. Factors such as supply risks, geopolitical developments, and new regulations continue to influence the market. Market outlooks indicate that prices may continue to rise by around 30% in the coming years. As raw material prices rise, the value of recovered metals is expected to follow the same trend—creating stronger incentives for recycling and for selecting chemistries with solid residual value. *[1]

AVERAGE RECOVERABLE MATERIAL VALUE OF NMC 811 VS LFP

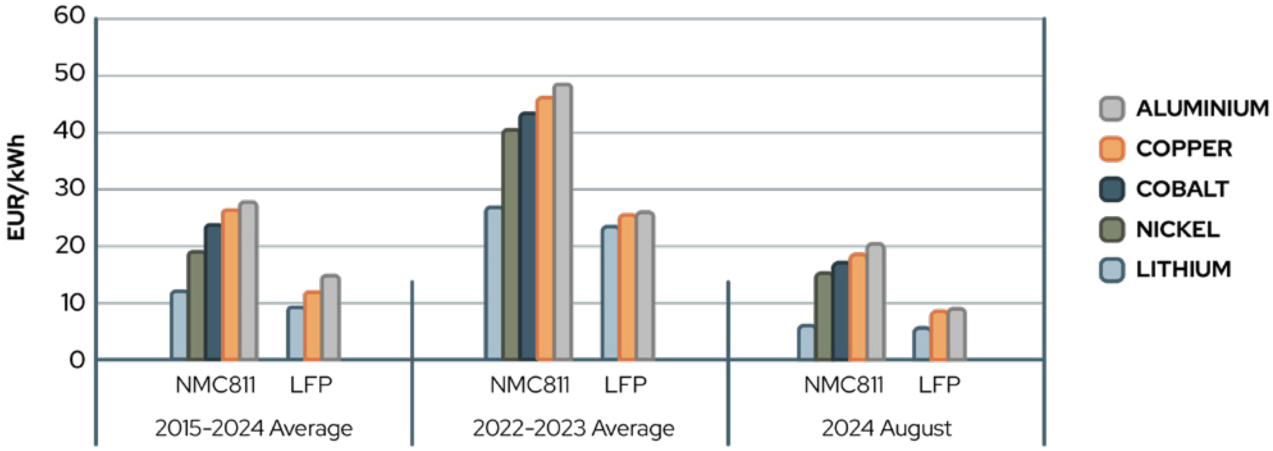


Figure 1: Across market cycles, NMC continues to provide meaningful recovery value, while LFP's contribution remains marginal.

THE BUSINESS CASE FOR CIRCULARITY

Circularity refers to the principle of maintaining materials and products in use for as long as possible through strategies such as reuse, repair, remanufacturing, and recycling, thereby minimizing waste and reducing the need for virgin resource extraction. In the case of batteries, comparing NMC and LFP requires considering several factors, including the energy required for recycling processes, the amount of recoverable valuable materials, and differences in expected lifespan. *[2]

Cost advantage in recycling
Hydrometallurgical recycling of cobalt-rich chemistries like NMC delivers 80-120% greater cost savings compared to LFP.

Circularity ROI
Material recovery rates have the greatest impact on circularity, while product lifetime extension contributes the least.

Value in circularity
NMC batteries deliver 6–25% higher circularity compared to LFP batteries, even with a one-third extension of LFP lifespan.

THE VALUE GAP IN END-OF-LIFE

Variations in battery chemistry generate different end-of-life outcomes. NMC batteries contain higher-value metals such as nickel and cobalt, but their cobalt content adds complexity to the recovery process. In contrast, LFP batteries are simpler to recycle yet yield lower-value materials such as lithium and manganese. Even though NMC requires a more complex recycling method, the overall processing cost remains similar. When these factors are combined into a theoretical end-of-life residual value, the difference between the chemistries is clearly demonstrated. *[3]

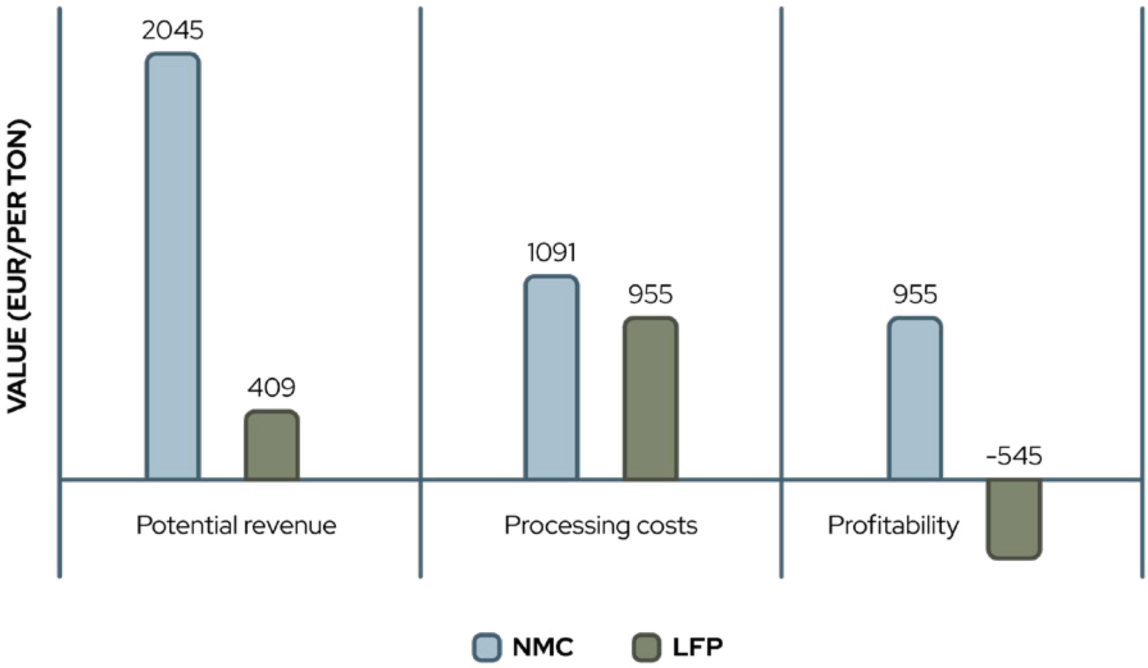


Figure 2: Comparison of revenue potential, processing costs, and resulting profitability, illustrating the end-of-life value gap between NMC and LFP.

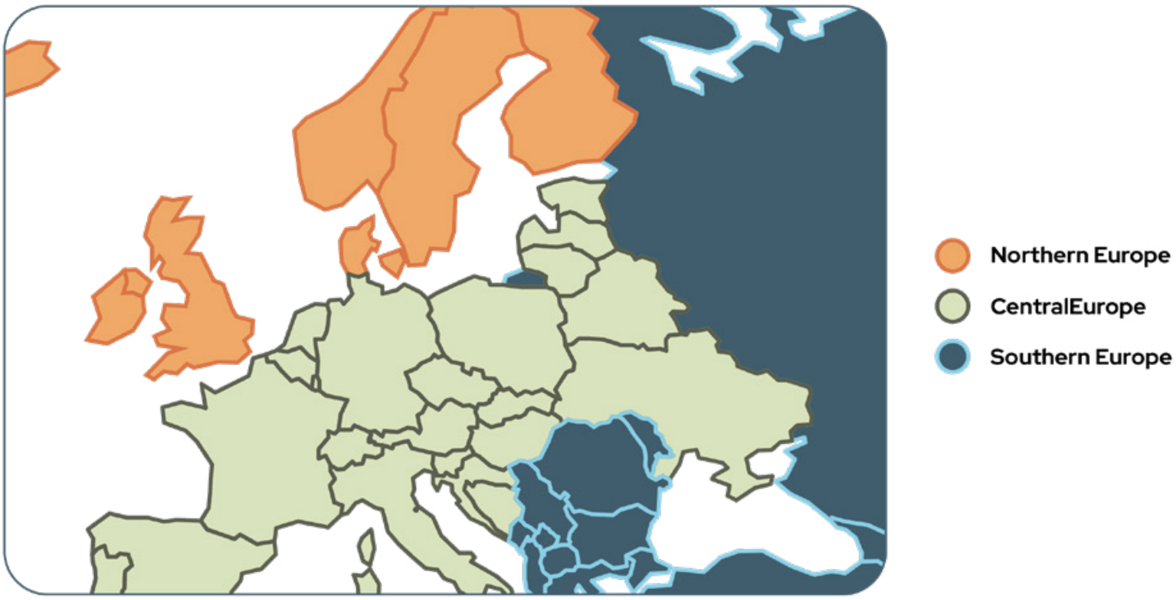
NMC theoretical profitability delta vs LFP

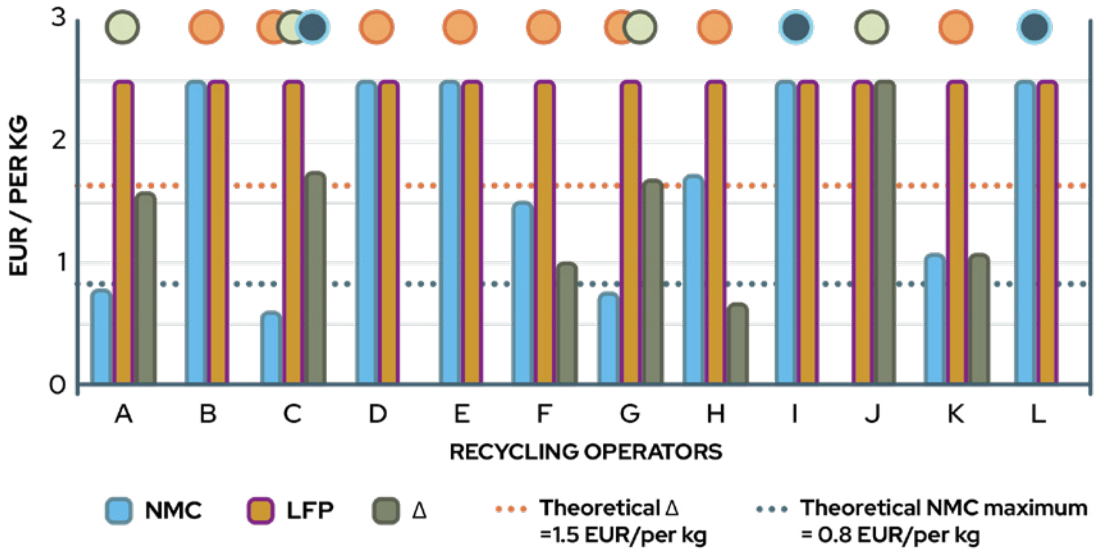
Δ = 1500 EUR/per ton

Δ = 1.5 EUR/per kg

MARKET BENCHMARKING OF DISPOSAL COSTS

The figures represent an indicative market snapshot based on data from recyclers, producer responsibility organizations (PROs) and customer sources. To enable comparison– and to align with theoretical values– all inputs were normalized to 25 SEK/kg for LFP. The values therefore illustrate relative differences rather than actual EUR-per-kg levels. The variation across operators underlines the importance of selecting a partner with both market insight and technical competence.





HOW CELL CHEMISTRY AFFECTS THE AFFAIR

NMC carries higher residual value due to its richer composition of high-value materials and the cost structure of current recycling processes.

Rising material prices amplify the value of recovered materials, which means residual value follows the upward trend in the raw materials market.

Circularity unfolds over long time horizons. With most batteries in the field still being NMC, these chemistries will dominate the recycling market and value flows for the coming decades.

Producer Responsibility Organizations for batteries are new and fragmented, with disposal costs varying widely – making partner selection a critical cost factor.

SOURCES

[1]Subchapter “Material cost drives recovery value”: Volta Foundation, Annual Battery Report (2025), https://volta.foundation/battery-report-2025/, page 446

[2]Subchapter “Business case of circularity”: Picatoste, A., Schulz-Mönninghoff, M., Niero, M., Justel, D., & Mendoza, J. M. F. (2024). Comparing the circularity and life cycle environmental performance of batteries for electric vehicles. Resources, Conservation and Recycling, 210, Article 107833. https://doi.org/10.1016/j.resconrec.2024.107833

[3]Subchapter “The value gap in end-of-life”: Safarzadeh, H.; Di Maria, F. Progress, Challenges and Opportunities in Recycling Electric Vehicle Batteries: A Systematic Review Article. Batteries 2025, 11, 230. https://doi.org/10.3390/batteries11060230

All values are set according to the conversion rates of the Swedish crown, US dollars and the Euro in May of 2026.

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