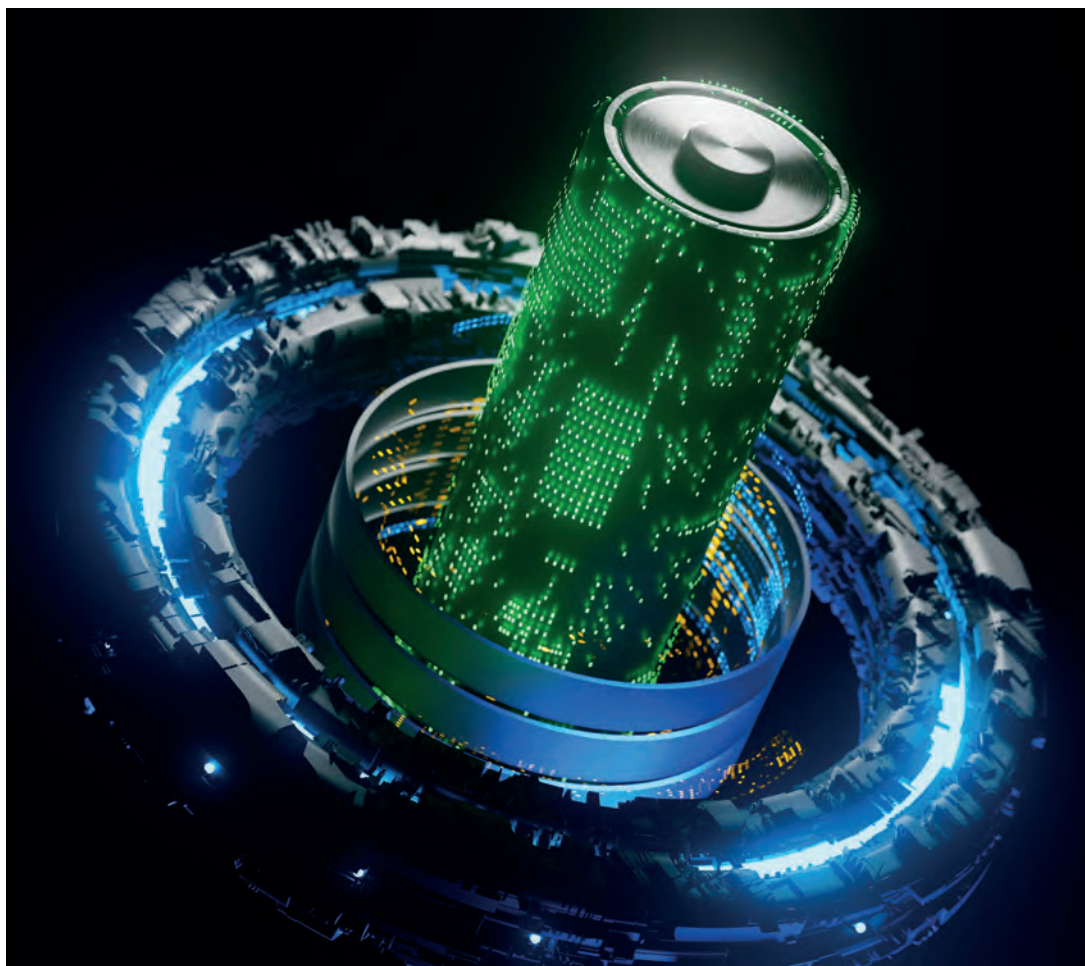


# Recyclers scramble to boost battery metals market share

The global battery recycling market was valued at EUR 10.4 billion in 2021 and is projected to reach EUR 19.2 billion by 2030. 'The potential growth of battery driven products is incredible,' says Laurent Cohen of Solvay. 'However, the input recyclers provide today is but a drop in the ocean in the demand for battery metals.'



E-mobility has radically changed the battery recycling landscape.

The stakes are 'higher than ever', Laurent Cohen told delegates at the recent International Congress for Battery Recycling (ICBR) in Salzburg. Solvay's global director, strategic development and alliances cites data from Cirba Solutions stating that 95% of metal demand will be driven by battery-operated products, notably in e-mobility.

Demand for globally mined lithium is projected to increase threefold by 2030, to roughly 2 360 000 tonnes a year. Projected supply will be only at 1 285 000 tonnes resulting in a significant shortfall by the end of the decade. The forecast is not that different for nickel and cobalt, demand for which (2 975 000 tonnes for nickel and 157 000 tonnes for cobalt) is expected to double by 2030. The shortfall for these metals will be over 25% and 30%, respectively. Battery manufacture is thought to represent between 20% and 50% of total demand.

## LIBERTY

In the current scenario, scrap is projected to deliver 210 000 tonnes of lithium and nickel per year and 20 000 tonnes of cobalt. 'But there is still time to take action,' Cohen tells delegates in Salzburg, confident that recyclers could have a large market share by 2040.

Eager to see this become reality 'sooner rather than later', Solvay has teamed up with carmaker Renault and waste manager Veolia for an R&D project known as 'Liberty'.

'Instead of starting from scratch, we've pooled our expertise and are using the latest technology,' Cohen reports. This is based on Veolia's proven black mass dry metallurgical process. It includes sorting and leaching steps to remove copper, manganese and iron to yield a crystallised output of lithium, nickel and cobalt with 99.9% purity.

Cohen says this delivers 'very attractive prices' on the LME, with a recovered value estimated at US\$ 9 459 per tonne of spent battery metals. 'Mind you, these numbers are based on minimum efficiency, so they could be much higher.'

#### **MORE CAPACITY, MORE SYNERGY**

Shabnam Gholamifard, business development director at Veolia, says her company 'has a new vision' for EV battery recycling. Its hydrometallurgical process is being fine-tuned by its hazardous waste business unit SARPI, which is active in nine European countries treating a total of six million tonnes of material per year.

'By 2020, our metallurgical expertise was quite robust. We saw good results in black mass recovery and started building a battery recycling site in late 2021 as part of the R&D project 'ReVision', a spin-off of the Liberty initiative,' Gholamifard adds that construction of the new hydrometallurgical hub in Cedilior, France, is 'coming along nicely'.

The site is due to open in 2029, with a planned capacity of 7 000 tonnes per year. It increases the capacity of an existing plant at the same location, currently capable of treating 130 tonnes per year, as well as two other battery recycling plants in Metz and Dieuze.

Veolia also has two sites in the UK and Slovenia, one with 4 000 tonne annual capacity and the other 7 000 tonnes. The aim is to boost them to 10 000 tonnes in the medium term.

Gholamifard points out the UK site has the capacity to process 20% of the UK's 350 000 tonnes end-of-life electric vehicle batteries by 2024.

'It's all about creating more synergy,'

#### **BALANCE SPENT BATTERIES AND PRODUCTION SCRAP**

'E-mobility has become part of our daily life; this is why we launched the company in 2021,' says Denis Werner of Swiss start-up Librec. He observes that there are already giga-factories in Europe, with more to come in the next few decades.

'Production volumes could see available battery scrap reach 6.5 million tonnes by 2040, of which roughly 500 000 tonnes represents manufacturing scrap sourced from battery producers,' Werner informs delegates. 'It's an enormous amount of waste. We must capitalise on this potential.'

Librec is currently in talks with two European manufacturers to help them expand their in-house recycling capacity by 2025. 'We plan to build a demonstration plant in Switzerland to encourage more producers to join the game,' Werner adds.

The new facility is co-funded by the Swiss government and will be located at a demolished paper mill near Bern. It will have an initial capacity of 8 000 tonnes per year. 'We expect to receive the building permission in December and hope to begin operations in early 2024,' the entrepreneur adds.

Meanwhile, Librec is constructing two battery processing plants for a recycler to in either Poland, Germany, Italy or Spain. These sites are expected to become operational by 2026. 'The situation is not always black and white,' Werner underlines. 'Scrap availability will change, as will demand, commodity prices and regulations. Battery recycling is a dynamic industry so our approach must mirror that.'

He concludes: 'Relying only on battery scrap is not going to work – even if we activate the entire urban mine. On the one hand, it's important to have an independent position as a recycler. On the other hand, we would be wise to combine business models and work closely together with producers to ensure a stronger position overall.'

she explains. 'We expect our growing network will create more recycling capacity in Germany and Eastern Europe.

Our main focus is to increase the volume and quality of the black mass output in order to comply with ambitious regulations.' Veolia also intends to capture more battery materials.

'Our long-term vision is to increase the recovery of nickel hydroxide, lithium carbonate and cobalt hydroxide by approximately 3 000, 2 000 and 1 000 tonnes per year by 2030, respectively.'

#### **HEFTY PROFITS**

Cohen quotes Tesla ceo Elon Musk recently saying that 'lithium margins are now practically computer margins'. He explains there is simply not enough material that is battery grade. 'That creates a money-printing industry. If you're a refiner, just buy the industrial grade and refine the lithium to battery grade and you can enjoy very hefty profits based on the difference in price. That's what we may also see happen to cobalt.'

'They say that necessity is the mother of invention, right? Then you may also say that circularity is the mother of optimisation.'

Initiatives like Liberty are intended to help cope with metal market volatility while mitigating feedstock dependency and proving the added value of recycling in a closed loop.

'Collaboration can take our sector to the next level,' Cohen believes.

'Compared to a solo operation, recycling partners enjoy more flexibility and opportunities, allowing them to optimise profits and scale up.'

#### **ASIA: THE #1 BATTERY POWERHOUSE**

Most batteries produced in 2021 came from China, Korea and Japan and were made by brands including CATL, LG Chem, Panasonic, BYD Auto, SK Group and Samsung. 'China has already announced major new planned manufacturing battery capacity, estimated to reach 1.2 TWh in 2023 and 3TWh in 2025,' says Xue Wang, co-founder of Botree Cycling based in Beijing.



Lithium demand is booming. While scrap is available, there is simply not enough material that is battery grade.

‘Our country’s battery recycling is also projected to grow in the near future,’ she adds quickly. In 2022, total processing capacity in China stood at 700 000 tonnes, realised by 16 operators. ‘These parties have indicated they want to seriously scale up their operations.’

Xue notes that producers are showing more interest in recycling, because using secondary cathode and anode materials will ‘dramatically’ reduce their carbon footprint by at least 30%. She adds that the Chinese government aims to establish regional recycling hubs, not just to ensure a closed-loop system but also to reduce long-distance transport. Doing so would curb carbon emissions and yield a ‘robust’ domestic resource efficiency strategy.

‘At Botree Cycling, we applaud announced investment plans,’ she says with enthusiasm. ‘We believe that, by as early as 2035, battery recyclers will be just as important, if not more important, than the mining industry.’

#### **‘ATTRACTIVE MATERIAL’**

Botree Cycling has developed several innovative technologies over the last three years. ‘For example, our ultra-short hydrometallurgical process for NMC batteries allows for simultaneous extraction of nickel, cobalt and manganese with a recovery rate of 98.5%,’ Xue states. Added benefits include cutting production costs by up to 20% while reducing the carbon footprint by 8% compared to hydro processing.

‘This approach especially targets high-content nickel power batteries, which enables nickel, cobalt and manganese to be extracted selectively while impurities like calcium and magnesium are left behind,’ she explains.

Botree Cycling is also pioneering a process for LFP batteries that yields a 95% recycling rate for lithium, and a 90+% recycling rate for iron and phosphorus. The resulting battery-grade LiCo has a 47% lower carbon footprint compared to that produced from lithium aluminium silicate minerals.

The entrepreneur adds that regenerated LFP exhibits a high discharge capacity of over 150 mAh/g. ‘It provides a very attractive material for battery recyclers as it has a positive value. The cost of recycling one tonne of LFP is about US\$ 4 000-5 000, with the product selling at almost double that. This yields a profit of roughly US\$ 3 000.’

‘But we are looking far beyond the borders of China and our network in Asia,’ she stresses. ‘We are currently engineering a recycling plant in Europe to treat various types of modern-day batteries.’

Botree Cycling is also actively pursuing direct recycling of production scrap. ‘Since we’re dealing with clean material straight from the source, separating the stream into aluminium and copper foils, battery cathode and anode powder is easy. It’s a perfect closed loop.’

#### **WHICH TARGETS WILL MAKE THE CUT?**

EuRIC president Emmanuel Katrakis took a look at the legislative landscape during the battery event. He pointed out that EU member states must collect at least 75% of e-mobility batteries by the end of 2025, growing to 85% by the end of 2030.

‘Granted, the updated Battery Directive has not yet come into force and is still being discussed with industry parties but I think it is likely these targets will make the cut,’ he said ‘I do hope we will

also get a digital product passport. We’ve often talked about this smart tool and its potential to accurately map the flow of the battery waste stream, including materials used and players involved. Will it finally become reality?’

At any rate, Katrakis expects both recyclers and producers will have to ‘roll up their sleeves’ with the latter probably taking responsibility for take-back at end-of-life stage. ‘They would also be wise to create only e-mobility products with a modular design so batteries may be easily inspected and removed. I know eco-design is an overused concept but it’s a fact that 80% of the product’s environmental impacts are determined at the design stage. Upcoming battery regulation will have much stricter design targets, I’m sure.’

Katrakis ended his review on a critical note. ‘So much is possible, but not if thermal events [fires] keep happening. Even if they are incidental, battery fires cause a lot of damage, delays and they hurt the reputation of our sector as a whole. More effort is needed to ensure safety is a top priority rather than a side mission.’

#### **‘AGE OF AMBITION’**

‘A lot is being asked of us as recyclers these days,’ remarks Bart Verrecht of Belgian precious metals processor Umicore. He addressed an ‘age of ambition’ theme at the Salzburg assembly. ‘I realise the targets outlined by the EU and trade associations can seem like a lot to live up to. Basically, you need to ensure an effective volume and mass reduction of footprint on a massive scale, at least one million tonnes per year.’

Umicore currently recycles around 7 000 tonnes of lithium-ion batteries at its site in Hoboken each year – the equivalent of 350 000 electric car batteries. This includes production scrap from battery and car manufacturers. Umicore manages end-to-end recycling, with a recycling rate of 95% for nickel, cobalt and copper, and over 70% for battery-grade lithium.

‘The route from urban mine to wheel is not always easy,’ Verrecht laments. He says Umicore is ‘eager to contrib-



ute' and is planning build a 150 000 tonnes per year battery recycling plant in Europe by 2026. 'More details about this state-of-the-art battery hub will follow in the coming months.'

### THE 'SWEET SPOT'


The company is looking to advanced technology to optimise its operations. 'We have applied for 20 patents, 15 of which have already been granted,' Verrecht points out. The recycler believes combining high temperature with wet chemical processing steps is essential to meet long-term circular requirements. Pre-treatment further enhances the results of this pyro-hydro approach. Umicore believes it's all about finding the 'sweet spot' between curbing costs, ensuring high purity output and boosting overall efficiency. 'Our new method makes efficient use of the chemical energy present in the

battery,' Verrecht says. 'This means our furnace shaft no longer requires large amounts of coke. The carbon in graphite and electrolyte also acts as a reductant, meaning the interesting metals are separated into the alloys and the other ones go into the slag. 'Best yet, there will be a lot of excess energy. You can use this to power your facility and to generate heat. That's especially useful at a time like this with high energy prices.'

### LET'S TALK ABOUT GRAPHITE

Stakeholders argue that recycling graphite is crucial to improve sustainability in the sector. 'But it's not yet feasible at industrial scale, at least, not yet,' Verrecht observes. 'I have heard the EU is drafting proposals on this. We'll have to wait and see what this means exactly.' He stresses this is about black mass carbon, not the pure carbon used in

battery manufacture. 'Obviously, the quality deteriorates during a battery's lifecycle so I'm curious to see how we can begin to bring carbon back into the battery. Do we have to resort to other uses, in other words down-cycling? Will there be targets to avoid that?'

Then there are trends that may impact recyclability such as the presence of silicon in anodes as well as lithium-metal anodes. It may also impact future demand for graphite. 'Ultimately, even if it's technically possible to recycle all battery materials, we must consider if it's a sustainable reality,' Verrecht concludes. 'What are the costs involved of producing the materials in question and how much does recycling cost? We have to be transparent about those figures so we come up with solutions that actually benefit our world, not just on paper.' 

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