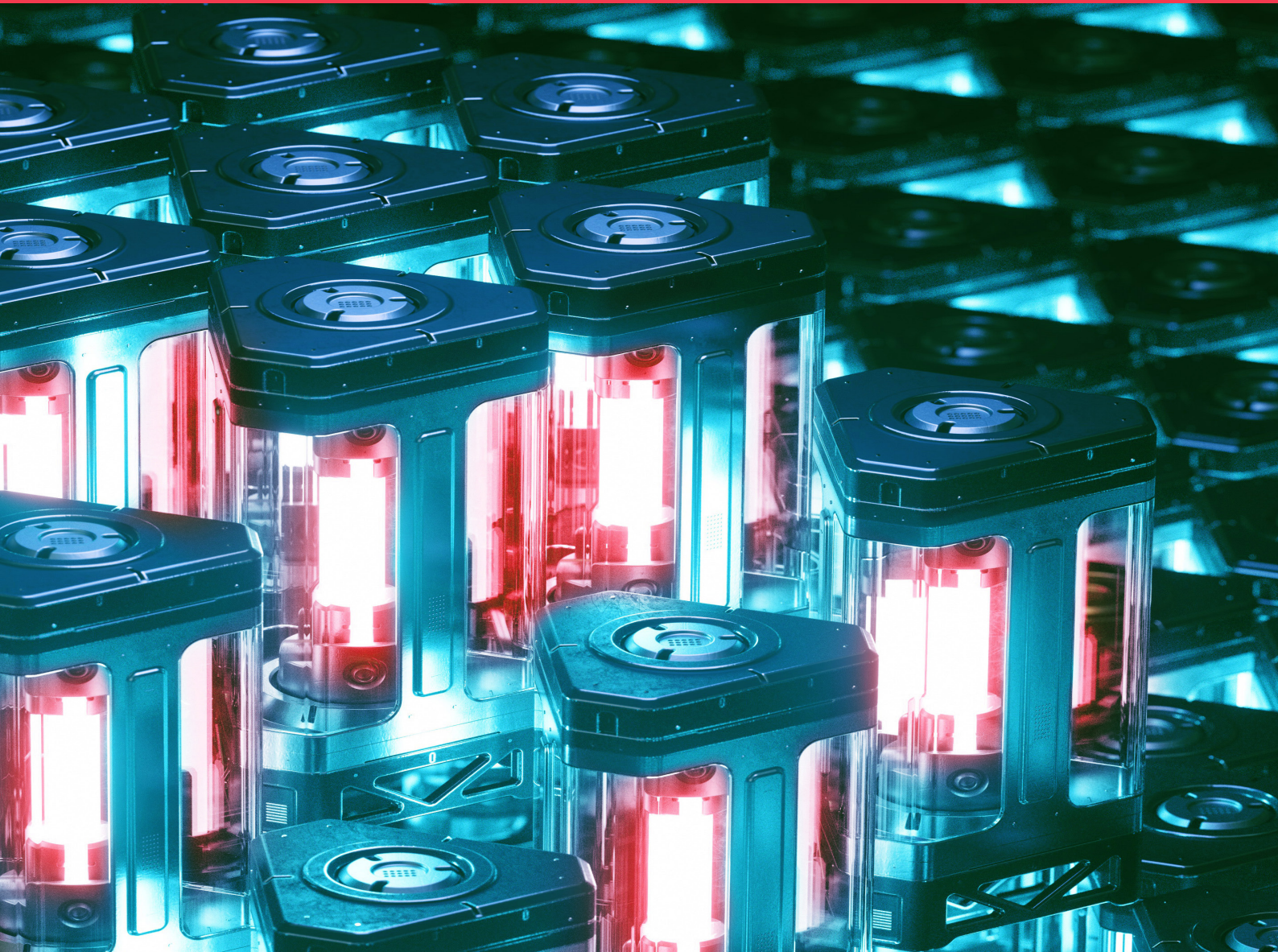




# Scale, pace and shifting sands at the forefront of the electromobility revolution

Dave OudeNijeweme, Batteries Material Innovation Lead, discusses the policies that are influencing investment in battery facilities in North America and Europe, and how they impact an automotive industry that is hungry to electrify

[WORLEY.COM](http://WORLEY.COM)



# Introduction

---

## **Climate change is driving governments around the world to act.**

The move to limit global CO<sub>2</sub> emissions requires a complete rewiring of the energy system. Making this sustainable transition happen within the timeframe required is the biggest challenge we face.

However, with challenges and uncertainties also come opportunities. And for battery material producers, the opportunities are enormous.

As the policy landscape evolves, geopolitical issues may rise, then fall, as the battery materials industry matures. It's a journey that may take another 25 years or more. Until this time, we need new solutions and partnerships to make this voyage viable.

Investment is powering the industry forward. Can the latest solutions keep pace with the relentless demand from gigafactories?

**Dave OudeNijeweme,**  
Batteries Material  
Innovation Lead,  
Worley

---



## COMMITMENT COMES IN THE BILLIONS

The energy transition is in full swing, with much of this momentum being driven by the automotive industry. According to McKinsey & Company, the batteries market is set to become a USD 410 billion business by 2030<sup>1</sup>. The automotive industry has pledged to invest over USD 515 billion into EV technologies and supporting supply chains so far.

To date, most of the 'buzz' has been around gigafactories – giant battery plants that produce hundreds of thousands of battery packs to support the automotive industry as it moves toward all-electric. There are over 300 gigafactories under construction globally. More than 200 are in China. The rest are in the West.

However, these gigafactories are hungry for materials used in batteries – far hungrier than we can supply them with today. As a result, the focus is now shifting to the materials that feed these factories, as well as looming shortages.

To realize an electrified future, new mines and processing plants are required at pace. But this isn't something individual companies, investors or governments can solve alone.

# 300

gigafactories under construction globally. More than 200 are in China

## MADE IN CHINA IN 2025? OR WILL POLICIES ENCOURAGE DIVERSIFICATION AND LOCALIZATION OF THE BATTERIES SUPPLY CHAIN?

**Chinese companies, driven by central policy making, understood the value of battery grade materials long before the rest of the world. So, it shouldn't come as a surprise that most of these materials are currently made in China.**

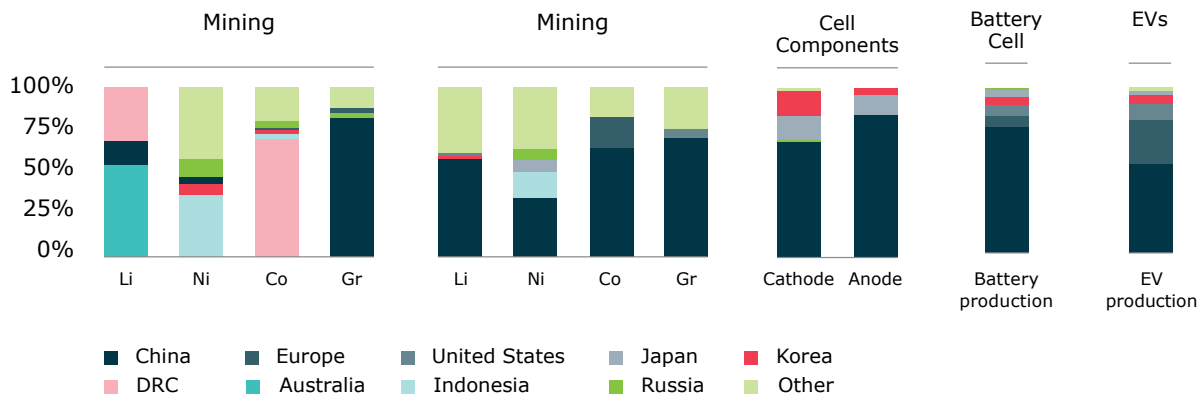
Chinese companies have successfully ensured raw material supply through long-term offtake agreements and significant strategic investments. One example is Ganfeng Lithium, which recently invested USD 3.1 billion to expand their ability to produce batteries by lifting capacity across three lithium battery plants<sup>2</sup>.

This, and many similar investments, are intended to feed the growing appetite for battery materials, initially from China but now also from Europe, the US, and other parts of the globe. The Chinese supply chain is fairly mature, and companies are investing billions of dollars to increase the capacity to hundreds of kilotons of cathode and anode materials, equivalent to 100GWh.

The batteries supply chain has historically relied on supply from all over the world, including China. This in itself is not the issue, nor is this level of investment. However, western governments, with significant end markets and industries to protect, now want a slice of the value-add pie.

Countries such as Indonesia, Australia, Canada, and Chile – with significant resources like nickel, lithium, copper and other valuable raw materials – are keen to grab more of the value add.

## CHINA DOMINATES THE ENTIRE DOWNSTREAM EV BATTERY SUPPLY CHAIN



## THE END OF GLOBALIZATION AND START OF PROTECTIONISM?

With governments keen to protect national interests, jobs, and economic growth, they are both increasing support for domestic industries and introducing new legislation.

These actions range from relatively minor R&D and capital grant incentives to the extremely influential Inflation Reduction Act in the USA or Indonesia's recent ban on raw nickel exports.

The variety of legislation, both direct and indirect, that impacts the battery value chain can be perplexing. For example, the Trade and Cooperation Agreement, also known as the Brexit deal, stipulates minimum levels of locally made (EU and UK) components before a battery qualifies as local.

Non-local batteries would mean that an EV doesn't qualify as locally made and as such, attracts a 10 percent tariff on the whole vehicle when a car made in the EU27 is exported to the UK or vice versa.

In response, car manufacturers are putting significant pressure on their cell manufacturers to ensure their batteries qualify as local. And the easiest way of doing so is ensuring locally sourced cathode active material. This promptly led to investment announcements from companies such as Posco and EcoProBM in support of SK, LG and Samsung.

How will these policies influence the localization of batteries over time?



**Cell manufacturers  
to ensure their batteries  
qualify as local.**

---

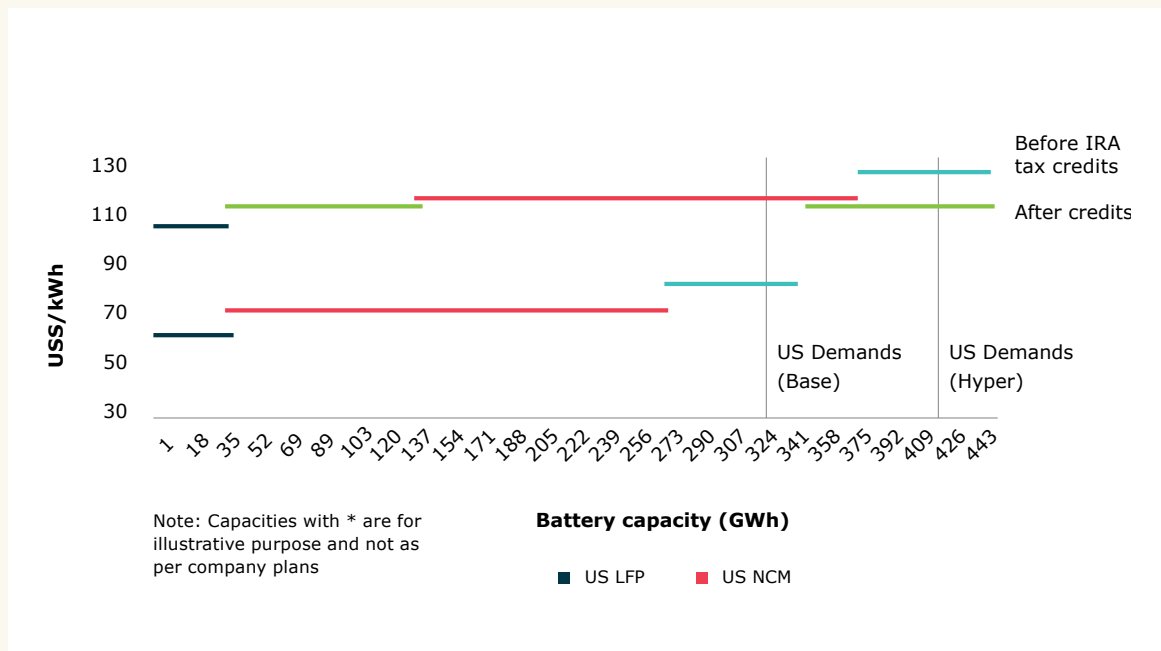
# USA AND ITS IRA LOOK TO ACCELERATE BATTERY MANUFACTURING

**Let's start with the Inflation Reduction Act (IRA). Though the final details are still being decided, the impact on EVs and batteries is likely to be huge. According to Goldman Sachs, the IRA effectively lowers the US domestic battery cost curve by US\$45/kWh.**

## What this chart means:

The IRA tax credits move high-nickel cathode materials (NCM, NCA) below the cost curve for Chinese-based materials – ultimately enabling base US battery demand to be met by cheaper, IRA compliant, material.

BATTERY PACK POST CURVE (CFR US, AS OF 2023)



A figure of US\$45/kWh nearly halves the cost of a battery pack and drops it well below the 'magic number' of US\$100/kWh, where we would expect large scale uptake due to the cost effectiveness of an EV relative to its gasoline equivalent.

However, to qualify, there are strict requirements around local content as well as car pricing brackets.

BloombergNEF estimates that around 70 percent of vehicles sold in 2022 met the requirements in full and qualified for the USD 7,500 clean car tax credit. But with local content requirements for critical material and battery component increasing year on year until 80 percent in 2027 and 100 percent in 2029 respectively, the number of vehicles that qualify might well reduce.

Company data, Goldman Sachs Global Investment Research

Source: [https://www.linkedin.com/posts/bernard-rowe-6219112b\\_inflationreductionact-ev-lithiumionbattery-activity-7009309671664607232-wokl/?utm\\_source=share&utm\\_medium=member\\_android](https://www.linkedin.com/posts/bernard-rowe-6219112b_inflationreductionact-ev-lithiumionbattery-activity-7009309671664607232-wokl/?utm_source=share&utm_medium=member_android) (accessed 11/1/23)

## NEW DETAILS ARE BEING RELEASED ON AN ONGOING BASIS.

In late 2022, the U.S. Treasury Department issued a white paper<sup>1</sup> detailing the upcoming regulation of the critical mineral and battery component requirements.

Started in March 2023, and increasing over time, automakers are required to demonstrate that 50 percent of the extraction, or processing of critical minerals (by value), occurs in a country that has a free trade agreement with the US. With flexibility in mineral processing locations, this will make it much easier to meet the requirements.

Many countries and industry players are seeking clarification into what constitutes a free trade agreement country. A recent agreement with Japan means that South Korea could soon have another significant competitor.

In addition, 50 percent of the value of components in a vehicle's battery need to come from North America.

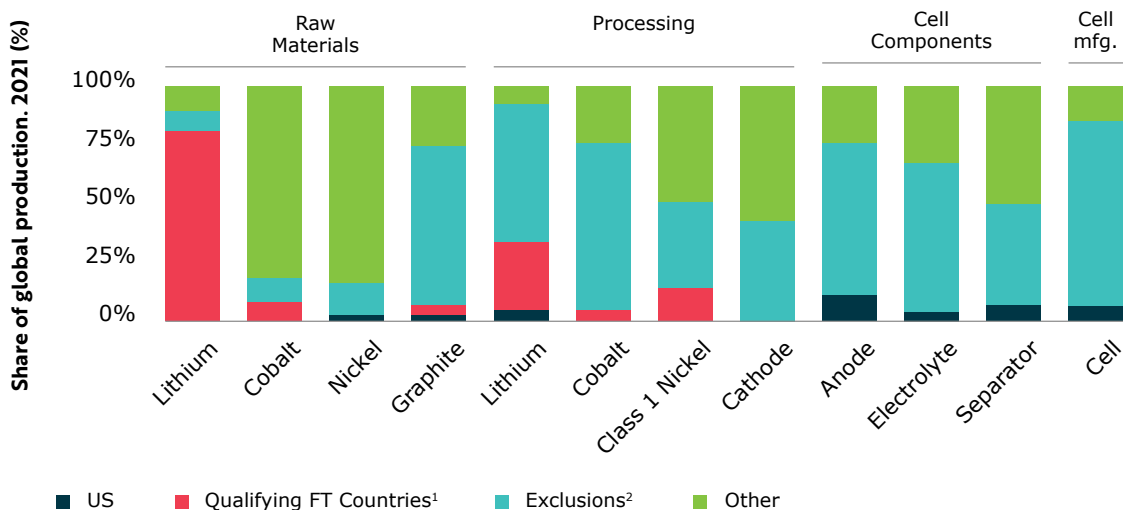
For high nickel chemistries, cathode active materials already make up around half of this value. Using these materials is the easiest way to meet this requirement.

Alternatively, most other components of a battery need to be sourced locally. Details on exactly how 'locally produced' and 'value addition' are defined are still to be confirmed.

Despite more details and uncertainty to come, it's fair to say that the IRA has made companies rethink their global investment portfolio, with a swing toward North America as shown by the Boston Consulting Group, below.

But even with strong localization policies, Chinese-made EVs or materials extracted or processed in China will still qualify for the EV credit, at least until the end of 2023. It's also likely that Chinese companies, such as CATL, will seek to invest in the Americas.

### EXHIBIT 2 – THE GLOBAL BATTERY MATERIALS FLOW THROUGH THE LENS OF THE IRA



Source: <https://www.bcg.com/en-ca/publications/2022/competitive-edge-for-ev-battery-manufacturers-canada> (accessed 11/1/23)

1. For raw materials and processing, includes all countries where US has a free trade agreement. For cell and component, includes only North America.
2. Russia, China, Cuba Source: US White House ("Building resilient Supply chains..."), USGS, Industry Experts, BCG Analysis.

# Europe is likely to respond to the IRA with the Critical Raw Materials act.

## HOW WILL THE EUROPEANS RESPOND?

Slowly and underwhelmingly seems to be the consensus. The Critical Raw Materials Act (CRMA) was published on 14 March 2023 as one of the four pillars of the wider Green Deal Industrial plan. This was promptly followed by the proposed Net-Zero Industry Act on 16 March.

The CRMA acknowledges the lack of critical resources in Europe and calls for global collaboration with likeminded nations. It set the following target supply as a percentage of local consumption:

- 10 percent local extraction
- 40 percent of processing
- 15 percent of recycling by 2030.

In addition, the proposed Net-Zero industrial act targets 40 percent local manufacturing by 2030, highlighting cathodes and anodes specifically. These acts create a patchwork of legislation, directives and aims in addition to the already existing legislation such as the Brexit deal and the battery legislation, that in many ways seems more impactful. The Brexit deal, with its built-in 'Rule of Origin' requirements, and the new battery legislation was agreed on 9 December 20225.

The Brexit deal has similar local content requirements as the IRA and means that companies will initially focus on localizing the production of cathode active materials.

The new battery legislation sets minimum quantities of recycled content for new cells that increase over time, helping the European Union become less dependent on other regions, but not before 2040. A carbon threshold could be introduced as early as 2027 and the supply chain provenance metrics, such as a battery passport, to demonstrate where the materials come from as early as 2024.

In September 2022, commissioner Thierry Breton said in his blog, "Lithium and rare earths will soon be more important than oil and gas. Our demand for rare earths alone will increase fivefold by 2030. We must avoid becoming dependent again, as we did with oil and gas."

According to HSBC, the "proposed new EU (Net-Zero Industrial) Act in our view lacks the simplicity, clarity and duration of the US Inflation Reduction Act (IRA)". And at BNEF; "EU's Critical Minerals Act Lacks Incentive and Funding." In other words, Europe seems to have taken some positive steps forward, but not enough to put it on a path towards resilience, let alone material independence.

## HAVE YOUR PASSPORT READY

Common features across European and US requirements mean that supply chain provenance is going to be key. This is likely to culminate in a battery passport. This topic is hotly discussed by the Global Battery Alliance as well as its European counterpart.

A battery passport will capture and share key battery metrics describing its contents, aid identification and help recycling. It will also contain a battery's sustainability performance. This currently consists of embedded carbon but will most likely be extended over time to full impact on a Life Cycle Analysis (LCA) basis as well as other ESG metrics.

Supply chain provenance is already key from a Rules of Origin /IRA local content perspective. It further aids traceability in case of quality and warranty issues, something that the automotive industry is used to. Minimum recycled content requirements will make supply provenance data crucial.

## OVERCOMING TODAY'S CHALLENGES TO PREPARE FOR FAST-PACED TOMORROW

In the evolving world of critical minerals, many things remain uncertain. But the overall end point is clear: most cars will be powered by electric motors and store energy in a sizeable battery. There is enough nickel, lithium, and other critical material reserves in the earth's crust to transition from internal combustion engines to battery electric.

For participants in the battery market, the success of this transition depends on having a vision, strategy, and plan. It's key to have clear advice at the front end underpinned by solid information and market insights to make the right investment decisions at the right time.

Finding the right delivery partner to help access raw materials such as lithium, nickel and copper will determine the growth rate of any battery materials company. Successful companies will also have vertical integration strategies. For example, owning a natural graphite extraction operation in Africa that's directly linked to an active anode plant in the USA.

There is also an urgent need for new technology to reduce cost and lower the environmental impact of batteries. This will therefore be the key differentiator going forward. It takes a highly skilled and experienced delivery partner wrapping solutions around the main technology to scale them successfully.

In the world of cell manufacturing, companies have realized they need to bring the value addition of cathode active materials in house and start a circular economy. Posco Chemicals is possibly the best example of a fully vertically integrated supply chain for cathode and anode materials. They have publicly announced the size and locations of their planned expansion by 2030. This includes significant lithium, nickel, natural and synthetic graphite extraction, and refining plants.

## STANDARDIZATION IS THE CONSISTENT SOLUTION

The number of pre-cursor, active material and recycling facilities – plus the investment required to feed the demand for EVs – is significant.

Designing one, and then building many identical facilities is an obvious answer to this challenge. Concepts exist that would enable the battery materials industry, and therefore the world, to transition to an electrified future more quickly. But this is not without its own set of challenges to standardize what are extremely complex and large-scale processing facilities – akin perhaps to standardizing aircraft construction. But other industries have done it, and successfully.

Benefits of a 'design one, build many' approach include lower overall capital investment levels, increased speed to market, and easier operation and maintenance. We expect new technology to lower operating costs and enable easier upgrades. And all this translates into lower investment risk.

And perhaps most importantly, increased standardization and improved planning frees up precious engineering, construction and supply chain capacity; enabling a significantly faster transition to a sustainable future.



# 2030

They have publicly announced the size and locations of their planned expansion by 2030



## CLOSING THE LOOP WITH RECYCLING

Battery recycling in North America is now included in meeting the critical material requirements. It's therefore becoming an increasingly important strategy and solution to looming shortages in raw materials.

Recycling technology with over 90 percent recovery and recycling efficiencies is already achievable for most materials and therefore, a mostly circular economy seems likely in the long run.

This would also mean that most geopolitical issues relating to raw material supply today could simply melt away post 2050. Perhaps like the age long global struggle for salt. In the end the issue just went away.

But not after empires were built and lost.

The availability of recycled materials is initially dominated by gigafactory scrap. And it will be some time before battery producers can realize the full impacts of recycling due to the lack of feedstock. But the need for materials combined with legislation should help initiate localization of recycling, precursor material and cathode active material production in Europe. Others will be quick to follow.


## GLOBAL SOLUTIONS FOR LOCAL CONDITIONS

The battery value chain – from raw materials to recycling – is truly global. But success depends on global solutions tailored to specific local conditions.

The focus is on speed to market, to service the urgent need for battery grade materials to enable the world's transition to EVs. This ambition requires new engineering and execution approaches such as design one, build many, which are based on experience gathered across many battery materials projects.

Successfully implementing and scaling new technology will be the key differentiator. And it will be invaluable to find technology partners with the skills and experience to scale these facilities from pilot through to commercial scale.

However, no company can drive the electric mobility transition alone. To realize the ambitious electrification projections across the world, businesses, industries, and governments will need to collaborate like never before. But each investment, and each new partnership, will make this sustainable transformation more viable.



**The battery value  
chain – from raw  
materials  
to recycling –  
is truly global.**

---

WORLEY.COM

