

CREATING A SAFE AND CIRCULAR LI-ION BATTERY VALUE CHAIN

**MAKE
ELECTRIC MOBILITY
EVEN MORE
SUSTAINABLE**

CONTACT US

recycling-battery.ve@veolia.com

TRANSFORMATION FOR A SUSTAINABLE FUTURE

Massive incoming volumes of lithium-ion batteries from electric vehicles (EV) and other devices, fast changing regulations and growing concerns over the decarbonization of activities, drive the need to build large-scale operations and create circular and efficient business models to deal with the entire batteries life cycle.



We all have our part to play in the circular economy. Working alongside our partners, our challenge as a recycler is to offer high-quality closed-loop solutions for EV batteries in an ecological project.

JEAN-FRANÇOIS NOGRETTE,
Senior Executive Vice President,
France & Special Waste Europe

THE GLOBAL BATTERY CHALLENGE

— STRATEGIC METALS SUPPLY UNDER PRESSURE

Highly strategic metals such as lithium, cobalt and nickel, are essential for the production of electric batteries and are therefore critical to the energy transition. But the extraction and production of these metals is concentrated in a few geographical areas, a situation potentially leading to geopolitical tensions over resources. Moreover, the extraction and refining of these metals have a significant human and environmental cost.

Recovering the metals contained in end-of-life batteries can thus allow countries to reduce their dependence on raw material imports while diminishing the carbon footprint of new batteries and the social costs related to metal extraction.

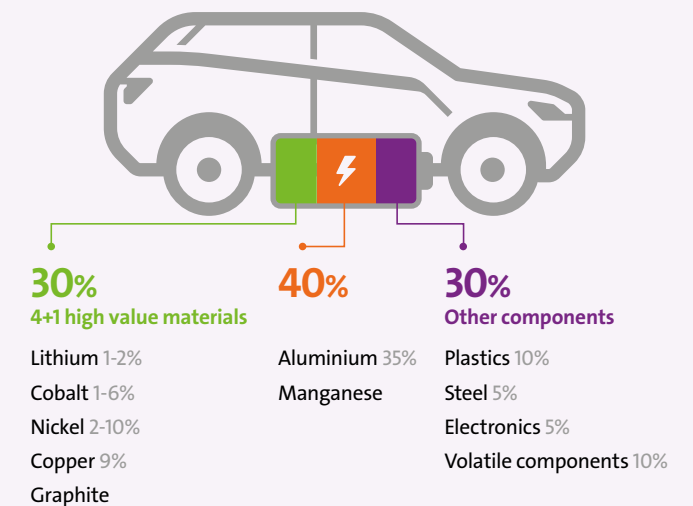
DID YOU KNOW?

Electric vehicles use around six times more minerals than conventional vehicles

[Source: IEA]

The value lying in batteries

typical composition of NMC batteries



— ELECTRIC VEHICLES: A BOOMING MARKET

After a decade of fast growth, the global fleet of electric vehicles reached the threshold of **25 million units in 2022**, and is expected to **keep rising exponentially** over the next decades as more and more countries are setting **target dates for the banning of internal combustion engine vehicles**, thus promoting the sale of hybrid and electric vehicles.

DID YOU KNOW?

In June 2022, the European Parliament voted to ban sales of new internal combustion engines in the European Union from 2035.

— STRICTER LEGISLATION FOR BATTERY RECYCLING

More and more countries are imposing ambitious rates for Li-ion battery recycling and metals recovery, requiring reliable and efficient recycling processes to comply with current or upcoming legislation in Europe, Asia and the United States.

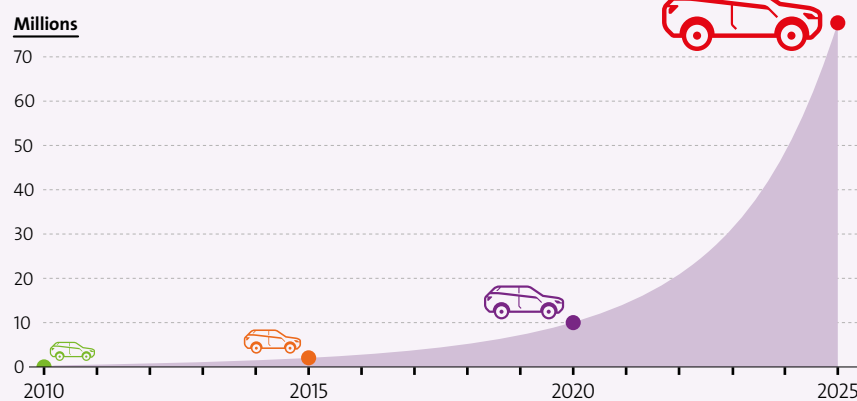
— PAVING THE WAY FOR RAPID DEVELOPMENT OF RECYCLING ACTIVITIES

Recycling activities involve two types of battery waste, scraps from current production processes and end-of-life batteries. Production waste should remain the principal feedstock for recycling in the coming years, as end-of-life batteries volumes correspond to the batteries produced 10 to 15 years ago. But the flow of end-of-life batteries available for recycling will catch up as the demand for batteries is growing exponentially.

— A WORLDWIDE MARKET

Battery recycling is becoming a key topic on several continents, as they are progressively accelerating on the electric vehicle market. Three main geographical areas should represent most of the recycling market by 2035: Asia, and particularly China, which has taken the lead for several years; Europe which is quickly catching up on the recycling market; and North America.

An exponentially EV growing fleet



[Sources: IEA, Bloomberg]

TRANSPORTATION
STORAGE
DISMANTLING
BLACK MASS EXTRACTION
HYDROMETALLURGY
LEGAL COMPLIANCE
DISCHARGING



INCREASINGLY STRINGENT LEGISLATION REGARDING BATTERY END-OF-LIFE

Regulations on the management of EV batteries at the end of their life are evolving quickly with the aim of supporting recycling operations and the incorporation of recycled materials into new batteries.

European legislation has taken the lead on the subject with a new regulation proposal for the mandatory inclusion of recycled metals in the production of new batteries:

- 2025 mandatory declaration of recycled content
- 2031 16% for cobalt, 6% for lithium and nickel
- 2036 26% for cobalt, 12% for lithium and 15% for nickel

Those contents can seem pretty low but are in fact extremely ambitious. In order to achieve this proportion of inclusion while produced volumes are rising, a strong redirection of recycling by-products to new battery production will be necessary.

Hence, the European institutions also aim at controlling the efficiency of the recycling process, and thus the recovery of material, with new mandatory targets:

- 2027 90% for cobalt, copper and nickel, 50% for lithium
- 2031 95% for cobalt, copper and nickel, 80% for lithium

Final figures for the regulations adopted by the European Parliament on June 14, 2023

MULTIPLE ISSUES TO TACKLE WHEN DEALING WITH BATTERY END-OF-LIFE



— SAFETY

Ensuring proper management of end-of-life batteries

Massive volumes and the need to comply with increasingly stringent regulations regarding battery recycling and production will soon call for industrial-scale activities. The challenge will be to build up capacities to meet growing demand for recycling while maintaining the safety of employees dealing with end-of-life batteries, which are considered as hazardous waste and require a high-level expertise as they are inherently flammable and can undergo thermal runaway reactions.



— SUSTAINABILITY

Implementing traceability in your battery-related activities

With the transition to low-carbon mobility, industrial firms increasingly need to show the implementation of a thorough and coherent strategy to address environmental challenges regarding the battery lifecycle. A key challenge will be to implement low-emission production as the manufacturing of active materials and other components is currently the most GHG emission-intensive step in the battery value chain. In a more comprehensive way, battery supply chain traceability will be required to demonstrate sustainable battery management by tracking the lifetime journey of each battery.



— SELF-SUFFICIENCY

Securing supply of strategic materials

End-of-life Li-ion batteries are a real deposit of strategic metals such as lithium, cobalt, and nickel, which are critical for the energy transition. Battery producers will need to reduce raw material supply risks by ensuring proper access to sufficient quantities of high-quality metals.

DID YOU KNOW?

In 2035, recovered cobalt, lithium and nickel could make up 30%, 16% and 21% respectively of metals required for new battery manufacturing – and this proportion is expected to keep increasing significantly over time.

[Source: Bloomberg]



— SHARING VALUE

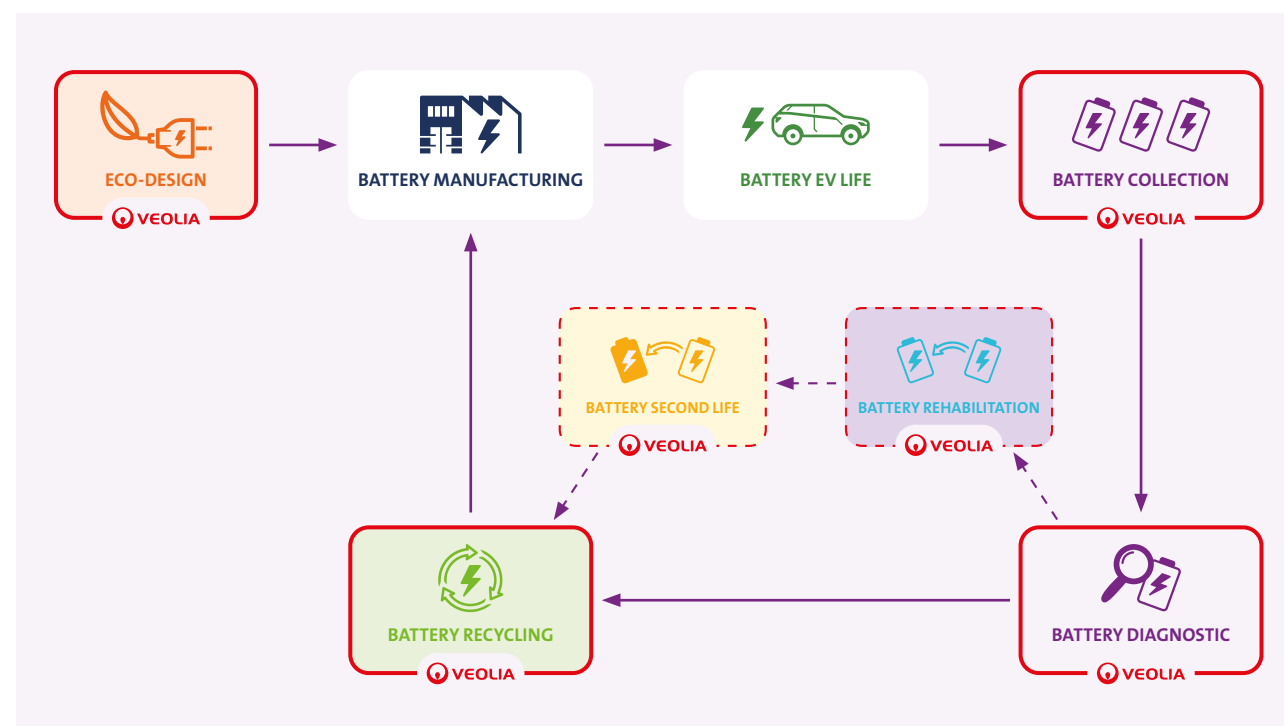
Continuously exploring new business models to optimize the value generated for our clients

Emerging activities regarding end-of-life batteries, calls for an innovative mindset and continuous rethinking on how to create value. The challenge will be to quickly set up new business models for battery recycling in order to draw value from what is currently a cost for automobile manufacturers. It will be key to build trust-based partnerships in order to scale up and standardize activities, quickly adapt the business model to market evolutions and leverage new revenue streams.

VEOLIA'S SOLUTIONS TO MANAGE END-OF-LIFE LI-ION BATTERIES

Veolia is committed to closing the loop in the battery supply chain of its partners, in compliance with incoming regulation and to develop safe and local raw materials supply.

— WORKING FOR A NEW CIRCULAR ECONOMY



→ Veolia is actively working to solve three burning issues regarding the management of end-of-life batteries.

Eco-design

Veolia is working with its ecosystem on the eco-design of EV batteries to facilitate their reuse and their recycling.

Battery second life

Veolia is developing solutions for battery second-life activities in electrical network flexibility, storage for renewables integration and EV charging stations.

Battery recycling

Veolia is able to safely recycle almost all Li-ion battery technologies thanks to its efficient internal recycling processes.

— UNCOMPROMISING CUSTOMER CENTRICITY

5
continents

685
waste
processing
facilities
operated

→ Safety and traceability

As a pioneer in the treatment of hazardous waste for over 50 years, the Group has rooted its activities in strongly held, non-negotiable values: traceability, non-dilution, effective treatment of pollution, protecting the environment, as well as the health and safety of employees and local people.

→ Global company that delivers locally

Working with us is the opportunity to tap into our worldwide networks wherever you are, while we commit ourselves to our local services quality and workforce development. Indeed, we provide our clients with a “glocal” regulation knowledge and the ability to scale up activities quickly thanks to the relevant authorisations to operate being in place. Moreover, the range of our activities and partners enables us to propose mutualized activities to further reduce transportation and processing costs.

→ A collaboration tailored to your needs

Veolia is committed to building sustainable and fruitful relationships with its partners and clients. Our partnerships, whether they are in the form of strategic alliances, joint ventures or other, are based on trust and transparency in order to deliver concrete results. Thanks to its expertise in hazardous waste management, Veolia is also able to position itself on the entire battery supply chain and can take over from the stage that suits you.

→ Innovative mindset

Ongoing R&D projects, both inhouse and with partners, ensure the continuous improvement of recycling processes and technologies. Veolia is also exploring new business partnerships and new activities such as eco-design or second-life in order to cover a large operational scope. Furthermore, the Group is dedicated to the development of innovative solutions to meet partners expectations regarding digital and data services.



OUR DEDICATED TECHNOLOGIES FOR LI-ION BATTERY RECYCLING

Veolia has been specializing in battery treatment and recycling for 30 years. The Group is now able to collect and recycle almost all Li-ion battery technologies from end-of-life batteries or production scraps thanks to its internal recycling process.

— TAILORING LOGISTICS TO YOUR NEEDS

Veolia operates 3 types of recycling facilities worldwide, an approach which allows the Group to adapt to its clients' requirements and improve the economic viability of recycling thanks to a coherent supply chain.



DISMANTLING FACILITIES

On a local scale to cover the territory thoroughly and reduce CO₂ emissions from battery transportation.



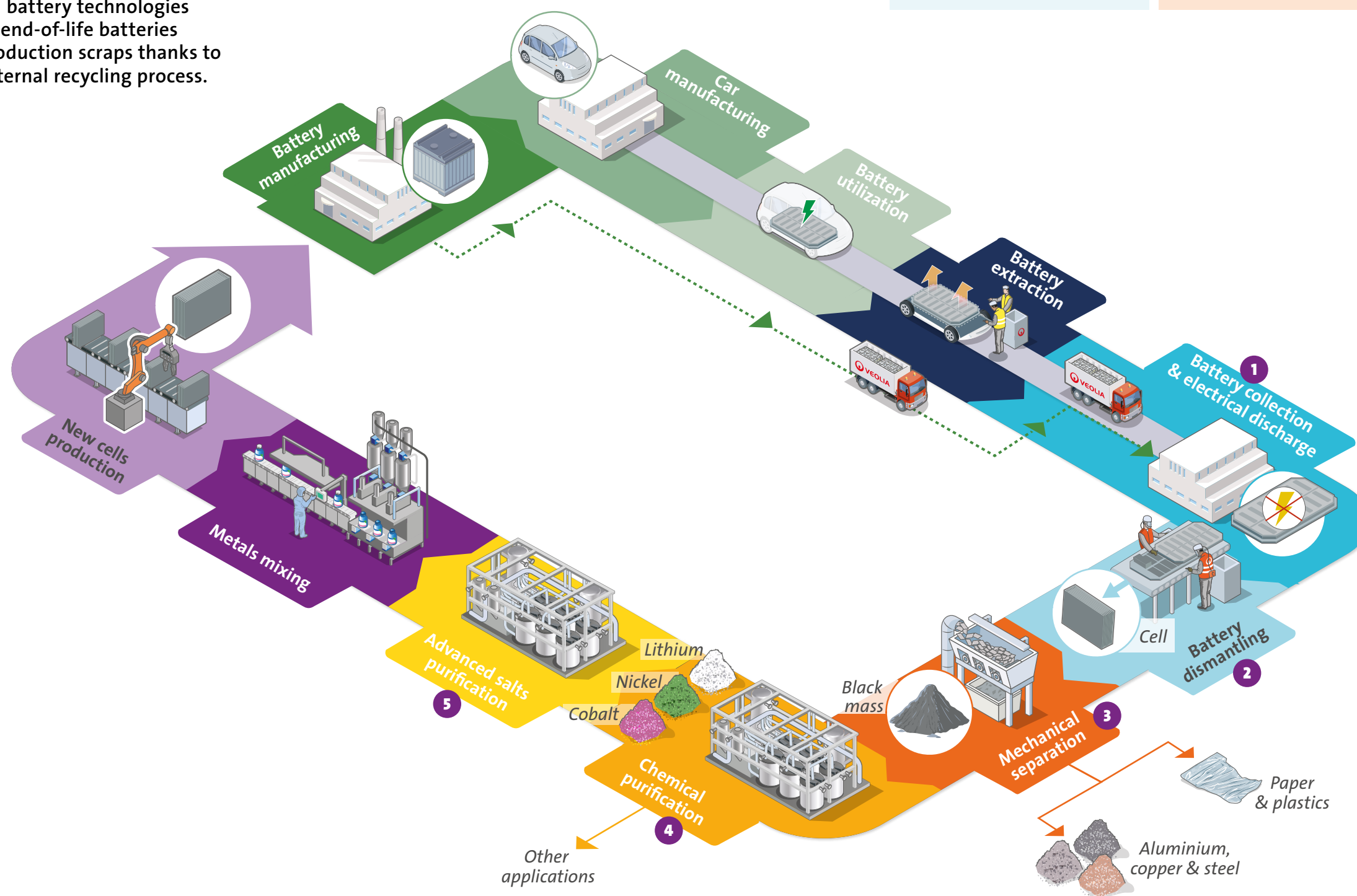
MECHANICAL FACILITIES

On a regional scale in order to mutualize the process and achieve economies of scale.



HYDROMETALLURGICAL FACILITIES

On a continental scale to establish hydrometallurgical hubs on all geographical areas and further mutualize the recycling process.



1) ELECTRICAL DISCHARGE

Batteries are systematically discharged and secured to be handled without danger through the whole process.

2) DISMANTLING

Battery packs are deconstructed to module or cell level by trained operators.

3) MECHANICAL SEPARATION

Battery cells are shredded in wet conditions to avoid any fire or explosion risk.

4) CHEMICAL PURIFICATION

Veolia has developed an inhouse hydrometallurgical process and does not apply pyrometallurgy which requires large amounts of energy and does not deliver high levels of purification.

5) ADVANCED SALTS PURIFICATION

The process is able to treat black mass with a wide range of composition and to obtain different levels of final product purity tailored to the client's needs.



TREATING AND RECYCLING YOUR BATTERIES AND STRATEGIC METALS WITH VEOLIA

Safety
of a proven
process

Highly
robust
and large
tolerance
to variability

**Industrial
scale**
on the whole
value chain

9
patents

— OUR PRODUCTS: A TAILOR-MADE SOLUTION

Its process enables Veolia to recycle a wide range of products, including strategic metals but also copper, plastics and aluminium. The Group also has ongoing R&D projects for the recycling of remaining battery components. Our metals are sold in hydroxide or carbonate form according to your needs.



Black mass



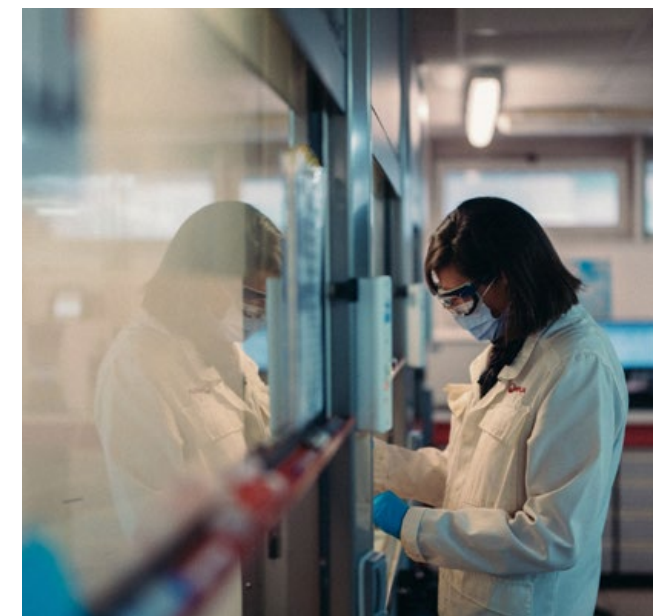
Lithium



Cobalt



Nickel



— ONGOING RECYCLING OPERATIONS

Veolia currently has **4 sites** with the capacity to process **30,000 metric tons** of batteries, corresponding to about **100,000 EV batteries**, and has the ambition to further increase its recycling capacities with around 10 other sites projects in multiple locations.

“I am committed to developing our Li-ion battery reuse and recycling facility at Minworth, which is strategically placed in the growing “battery corridor” in the Midlands.”

DAVID REYNOLDS,
EV Battery Recycling Business Manager - UK

“Euro Dieuze Industrie (France, Moselle) has been involved in battery recycling since the late 1990’s. From household batteries to EV batteries, from alkaline/saline to lithium-ion by way of nickel-cadmium batteries, EDI developed an expertise about transporting, handling and recycling batteries across Europe.”

ARNAUD SCHOUB,
Euro Dieuze Industrie Plant Manager - France

OUR OPERATIONS

Veolia is scaling up its activities in 3 geographical areas: Europe, Asia and North America.



EURO DIEUZE INDUSTRIE
(Dieuze – FRANCE)
TYPE: Pre-treatment/Mechanical separation
PROJECT STRUCTURE: 100% Veolia - SARPI
FEEDSTOCK: End of Life batteries + Scraps



REVISION – CEDILOR
(Metz – FRANCE)
TYPE: Metals refining/Hydrometallurgy
PROJECT STRUCTURE: 100% Veolia - SARPI
FEEDSTOCK: Black mass (from Veolia & external suppliers)

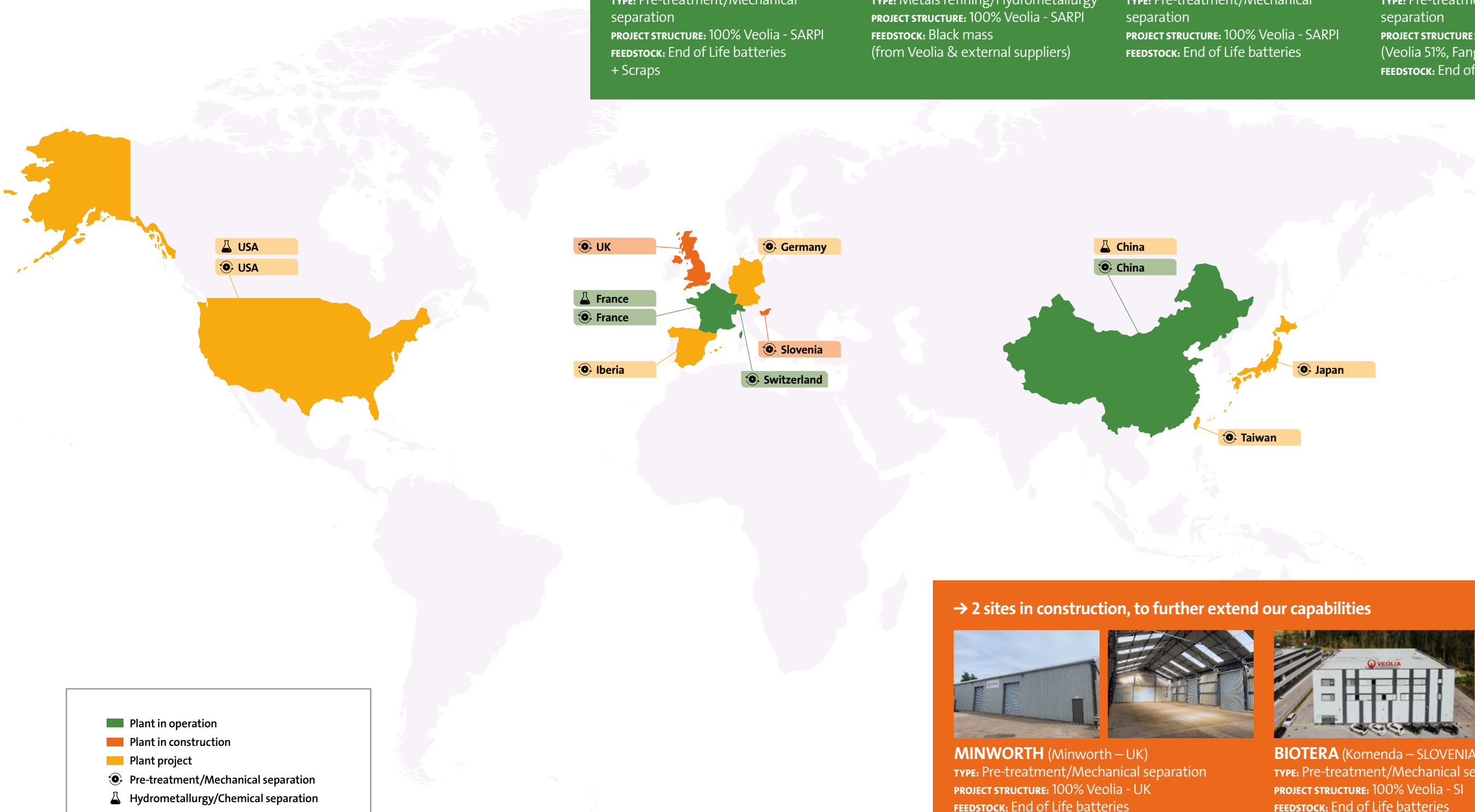


BATREC
(Wimmis – SWITZERLAND)
TYPE: Pre-treatment/Mechanical separation
PROJECT STRUCTURE: 100% Veolia - SARPI
FEEDSTOCK: End of Life batteries



NEOENERGY TECHNOLOGY
(Jiangmen – CHINA)
TYPE: Pre-treatment/Mechanical separation
PROJECT STRUCTURE: JV (Veolia 51%, Fang Yuan 16%, others 33%)
FEEDSTOCK: End of Life batteries

→ 4 sites to leverage our activities in Europe & Asia



- Plant in operation
- Plant in construction
- Plant project
- ⚙️ Pre-treatment/Mechanical separation
- 🧪 Hydrometallurgy/Chemical separation

→ 2 sites in construction, to further extend our capabilities



MINWORTH (Minworth – UK)
TYPE: Pre-treatment/Mechanical separation
PROJECT STRUCTURE: 100% Veolia - UK
FEEDSTOCK: End of Life batteries



BIOTERA (Komenda – SLOVENIA)
TYPE: Pre-treatment/Mechanical separation
PROJECT STRUCTURE: 100% Veolia - SI
FEEDSTOCK: End of Life batteries



OUR OTHER SERVICES TO SUPPORT BATTERY PRODUCTION

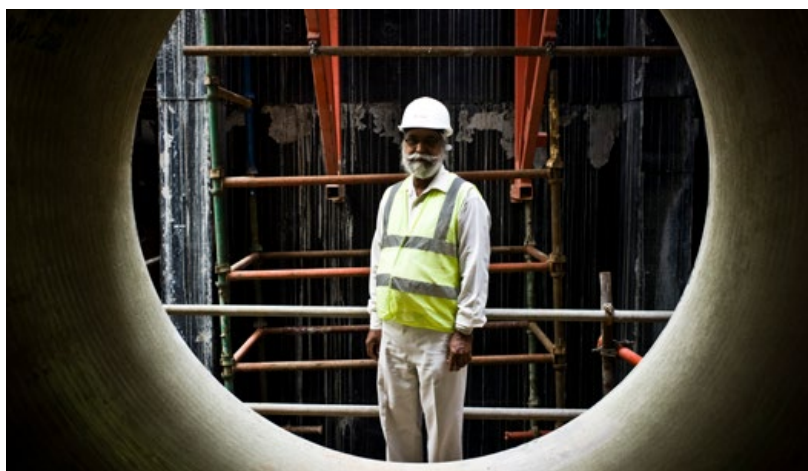


— NMP

Veolia is currently working on recycling and purification solutions for N-Methyl-2-pyrrolidone (NMP), a solvent widely used within battery manufacturing processes.

— SODIUM SULFATE

Veolia has developed innovative solutions to transform and reuse the large amounts of sodium sulfate salts (Na_2SO_4) produced at various stages of battery manufacturing. Among the main solutions proposed are on-site reuse by separating the salt into acid/base or recovery as agricultural fertilizer.



— ZERO LIQUID DISCHARGE

Veolia offers solutions to minimize the environmental footprint and water consumption of this new industry. Our wide range of offers not only limits the discharge of industrial effluents into the environment, but also allows direct reuse of most of the water available on site.



VEOLIA, GLOBAL CHAMPION OF THE ECOLOGICAL TRANSFORMATION

— LEADER IN ENVIRONMENTAL SERVICES

160 YEARS OF EXPERIENCE
in operating environmental infrastructures

€45.3
billion in revenue worldwide

218,000
employees around the world

Its experience and dimensions enable the Group to create high-impact innovation and accelerate the deployment of solutions that are ready to use now and applicable on a large scale, at the service of its clients in all geographies.

— PRACTICAL SOLUTIONS FOR ECOLOGICAL TRANSFORMATION

Ecological Transformation requires the implementation of high environmental, regulatory and societal requirements, but also a strong awareness.

We can turn the tide thanks to an ecology of solutions!

Decarbonization, saving & regenerating resources, depollution: these are the three challenges we are addressing for our stakeholders:



→ DECARBONIZATION

To achieve zero net emissions, energy self-sufficiency and respond to the climate emergency.

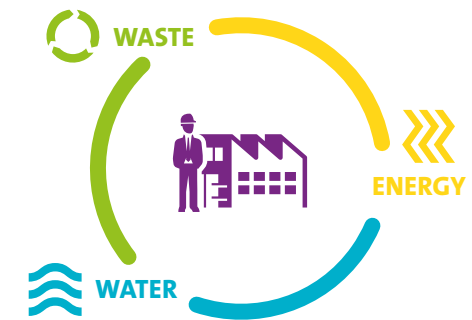
→ SAVING & REGENERATION OF RESOURCES

To reduce the strain on strategic supplies and implement more efficient and circular usage of resources.



→ DEPOLLUTION

To protect biodiversity and the health of populations and minimize the impact of human activity in the various environments (water, air, soil).



— ONE VEOLIA: A SINGLE ENTRY FOR ALL UTILITIES

Veolia can create solutions which bundle our specialised capabilities across water, waste and energy services, delivering economies of scale and a truly robust environmental competence. You focus on your core business, we create synergies to optimize your costs and increase performance.

— ACTING EVERY DAY FOR THE ECOLOGICAL TRANSFORMATION

Veolia is committed to deliver a multifaceted performance that creates value for all stakeholders. This commitment guides us in how we support our customers, seeking the most effective solutions in technical and economic terms, but that also have a positive impact for people and the regions.

The multifaceted performance of battery end-of-life activities



Resourcing the world