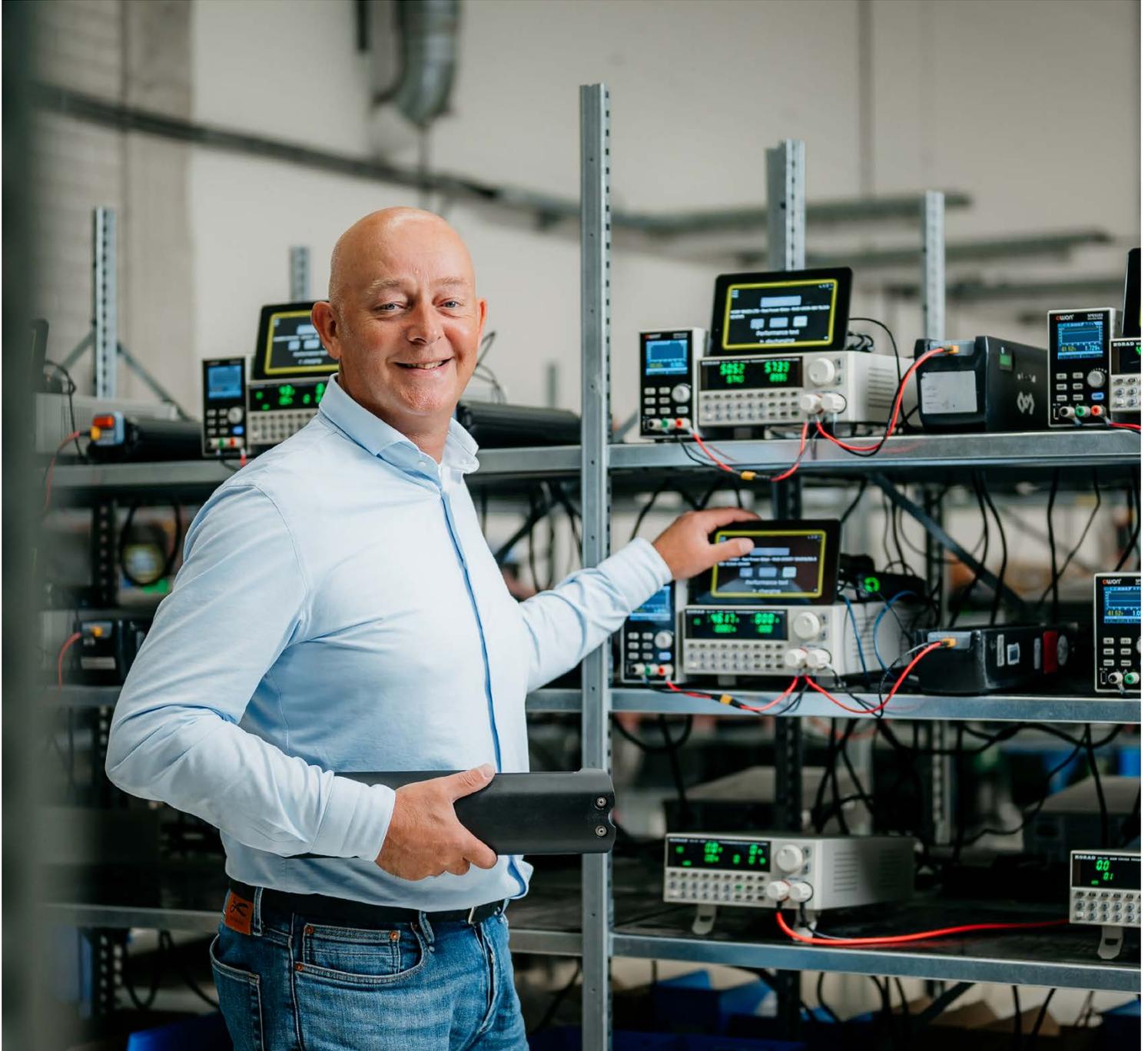


Powering partnerships for circular batteries

Collaborating for a sustainable and resilient value chain



NL

Netherlands

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Foreword

Batteries are a key technology in the transition to a sustainable, low-carbon economy that is not dependent on fossil fuels. They play a critical enabling role across mobility, energy systems, and the broader electrification of our economy. Yet their production and disposal still present environmental and economic challenges. The Netherlands is committed to turning these challenges into opportunities by building a circular battery ecosystem - where materials are reused efficiently, waste is minimized, and value chains are resilient, sustainable, and internationally competitive.

The Dutch Battery Strategy provides the foundation for this transition. Through this policy framework, the Netherlands fosters innovation, stimulates circular design, and promotes collaboration across the whole battery value chain. It is our ambition to become an important hub for circular batteries by 2030. Central to this ambition is international partnership: only by working together can we accelerate the development of sustainable solutions and unlock economic opportunities worldwide.

The Dutch battery ecosystem is dynamic, diverse, and unique in its combination of expertise, strong infrastructure, and entrepreneurial drive. Innovative companies, research institutes, and start-ups collaborate along the value chain. In the Netherlands we focus on research and development of advanced materials and battery chemistries, the design and assembly of next generation battery systems, development of second life applications, and advanced recycling technologies that recover critical materials.

Public private partnerships and innovation hubs further connect these actors, fostering knowledge exchange, enabling the scaling of breakthrough technologies and supporting the emergence of new circular business models. This integrated ecosystem positions the Netherlands as a trusted partner for international collaboration and a leading source of pioneering circular battery solutions.

I invite you to explore this guide and discover the breadth of opportunities within the Dutch circular battery ecosystem. By joining forces with the Netherlands, we can advance circular batteries at scale, create economic value, and set global standards for sustainable, resilient, and innovative battery value chains.

Dr. Afke van Rijn

Director-General for the Environment and International Affairs at the Ministry of Infrastructure and Water Management



The global energy transition is accelerating. Around the world, countries are facing the same challenge: decarbonising mobility and industry, strengthening energy systems, and reducing strategic dependencies. Battery technology plays a key role in this transition – not as an end in itself, but as an enabling technology for a sustainable, competitive and resilient economy. With this sector guide, the Netherlands positions itself explicitly as an international partner in this shared endeavour.

The Netherlands has an open, innovative and strongly internationally oriented ecosystem. Our strength does not lie in scale alone, but in high-quality knowledge, system integration, application-driven innovation and public-private cooperation. In areas such as heavy-duty mobility, battery and energy systems, materials, production processes and circularity, Dutch organisations add distinctive value at the international level. This sector guide highlights where that expertise resides and how collaboration with Dutch partners can contribute to shared ambitions.

The Battery Competence Cluster – NL (BCC-NL) was established to actively strengthen these international connections. We bring together companies, knowledge institutions and governments, and link the Dutch battery ecosystem to European and global developments. In doing so, we align with European policy frameworks, international value chains and strategic partnerships. BCC-NL serves as a gateway for organisations seeking to collaborate with the Netherlands on innovation, scale-up and market development in battery technologies.

This sector guide is intended as an invitation. To international companies, governments, investors and knowledge partners looking for reliable cooperation, joint innovation and sustainable solutions. It provides insight into the Dutch battery

sector, its focus areas and the conditions for collaboration – from research and innovation to industrialisation and circularity.

The major transitions of our time require cross-border cooperation, mutual trust and long-term commitment. The Netherlands deliberately chooses openness and partnership. We believe that progress is achieved by sharing knowledge, jointly managing risks and building future-proof value chains together.

I warmly invite you to engage with us and explore how we can create impact together – in the Netherlands, in Europe and worldwide.

Mustafa Amhaouch
Director Battery Competence Cluster – NL



This guide showcases the Dutch organisations in the circular battery sector, providing valuable insights for governments and organisations worldwide.

Circular batteries charging the future

Although batteries have been around for decades, their strategic importance has recently experienced considerable growth. Simply put, a transition to a climate-neutral society with low-carbon electricity, transportation and logistics requires a ramp-up in battery capacity and production never seen before. This unprecedented rise in the demand for batteries is fuelled in particular by the mobility sector, keen to decarbonise itself and meet the goals of the Paris Agreement. The increase of the supply of batteries, however, comes with a multitude of environmental, socio-economic and geopolitical challenges. Batteries are mined, produced, and moved across a truly global supply chain with significant negative impacts on ecosystems and local communities. Governments and businesses around the world face the need to do more with less, and to act quickly and locally to ensure a resilient supply. This creates a strong momentum for the circular economy in the sector.

Circular strategies can deliver on most, if not all, objectives in terms of resource efficiency and recovery, environmental protection, and even safety. In the EU, the Battery Regulation (2023) entered into force. This regulation is an important driver for the transition to a circular battery value chain. It recognises the fit of circularity for a resilient and thriving battery sector and includes circular battery strategies in EU legislation. With its innovative approach and technological advancements, the Netherlands has been directing considerable investments into circular batteries since 2020. A small country with the ambitious goal of becoming fully circular by 2050, the Netherlands is experiencing an increasing demand for batteries for electric vehicles, electronic devices and stationary energy storage systems. However, the availability of the raw materials needed nationally or at EU-level is limited. In order to foster the competitiveness and resilience of its economy, the Netherlands will need to diversify its supply of batteries and their components by transitioning to circular business and procurement practices and enlarging collaborations with EU and international partners.

“Batteries are the foundation of our modern society.”

Today, it is clear and widely recognised why a circular economy for batteries is necessary and beneficial. Circularity truly represents a unique opportunity to future-proof our economy, society and environment, as the no-regret scenario for Europe. Now, we must move from the why to the how and transition collaboratively as fast as possible.

This guide showcases the Dutch organisations in the circular battery sector, providing valuable insights for governments and organisations worldwide. It highlights the importance of integrated approaches and innovative technologies throughout the battery value chain that can drive the shift towards a more sustainable and futureproof battery system.

The Dutch are eager to collaborate, to share their expertise and learn from other partners. After all, international collaboration is vital on the path towards circular batteries.



Circular batteries challenges & opportunities

It is difficult today to imagine a world that is not powered by batteries. They have become a key technology in the transition to fossil free energy systems and zero-emission mobility. Yet their rapid rise also brings new sustainability challenges.



“Batteries enable the storage, timing and flexibility required to achieve climate neutrality.”

A world powered by batteries

In recent years, the strategic importance of the battery sector has grown exponentially. Batteries are not only critical for decarbonising transport but also for stabilising energy systems increasingly dependent on intermittent renewable sources such as wind and solar. They enable the storage, timing, and flexibility required to achieve climate neutrality goals such as those set by the Paris Agreement¹.

As governments divest from fossil fuels, global demand for battery energy storage systems (BESS) is expected to surge. By 2030, the capacity of operational BESS (in GWh) will be similar to the combined total energy storage capacity of all battery applications today². Beyond its storage capacity, BESS can also provide affordable and stable energy supply to remote communities without reliable electricity³.

Given that batteries also power most of our electronic and digital devices, it becomes evident how a present and future battery-powered society is unavoidable. However, the current linear mode of production, use, and disposal of batteries has significant environmental and social costs⁴. Mining and refining critical materials can damage ecosystems, while inadequate end-of-life management causes resource loss and safety risks. Transitioning towards a system in which circular design, responsible material sourcing, renewable energy-based production, and advanced recycling processes are the norm is crucial for achieving a sustainable and resilient battery value chain.

1.1 How batteries are classified

The EU Battery Regulation (2023) introduced a classification system based on its wide variety of designs and applications.

It distinguishes between

- **Electric Vehicle (EV) batteries** - used for traction in road vehicles (typically Lithium-ion batteries (LiBs) (>25 kg),
- **Light means of transport batteries** - used in two- or three-wheeled EVs (<25 kg),
- **Industrial batteries** - used in non-road vehicles, machinery and energy storage systems for industrial, agricultural and communication applications as well as electricity generation and distribution (including energy storage in private/ domestic environments),
- **Portable batteries** - used in consumer electronics and other small devices weighing >5 kg;
- **Starting, lighting and ignition (SLI) batteries** - used in vehicles or machinery.

1.2 Why focus on lithium-ion batteries specifically?

While many battery types are widely collected and recycled in the EU, Lithium-ion batteries (LiBs) remain a particular challenge. Due to the fact that LiBs are still relatively new, the amount of feedstock for recycling is still low. The bigger volumes of waste batteries expected from EVs are lacking due to longer lifespan than anticipated and an increasing market to repair the batteries rather than discarding them. Some forecasts indicate that electric vehicle batteries could have a lifespan of as much as 20 years. However, from 2030, larger volumes of waste batteries are expected to come, for which Europe and the Netherlands are preparing. Several initiatives are set up to recover the critical materials from the waste batteries

Global capacity for LiB recycling is concentrated in Asia, primarily in China and South Korea. The European Union, the United States and Australia are rapidly developing their own capacity, prompted by regulatory requirements and strategic autonomy goals. As electric vehicle production grows, so does the urgency to establish circular solutions that maximise material recovery and minimise waste.

A truly circular LiB economy will depend on

- Using **secondary raw materials and alternative materials** to meet growing demand,
- **Responsible and transparent sourcing** of critical raw materials (CRMs),
- Expanding **reuse and remanufacturing** to extend battery lifespans, and
- Developing **safe and efficient recycling** methods for end-of-life batteries.

Because of its current relevance and strategic importance, this guide focuses primarily on LiBs.



Today's batteries

1.3 Improving chemistries for enhanced performance and durability

Continuous improvements in LiB chemistry have enabled higher capacity, longer lifetimes, and lower costs. Structural instabilities in lithium cobalt oxide (LCO) have led to the use of nickel (Ni) and manganese (Mn) as battery capacity booster and structure stabiliser respectively. The development of Ni-rich compositions (such as NMC622, NMC811 and in the future ultimately LiNiO₂) aims to reduce or eliminate cobalt (Co) as a battery component due its limited geographical availability⁵.

A key challenge remains stabilising the Ni-structure and surface to obtain a sufficiently long battery lifecycle. Protective Atomic Layer Deposition (ALD) coatings present a promising solution to these issues, as shown by several Dutch startups).

1.4 Solid State Batteries: challenges and opportunities

Solid State Batteries (SSBs) is one of the most promising next-generation technologies. This technology uses the same anodes and cathodes as LiBs but replaces the liquid electrolyte with a solid one, which reduces flammability and potentially enables energy densities beyond LiBs' capacity. However, the safe use of Li-metal as an anode remains a formidable challenge^{6,7}. Developing solid electrolytes that combine high lithium-ion conductivity, mechanical stability, and strong interfacial contact with electrodes is complex. Volume changes during charge–discharge cycles can degrade performance. Moreover, some SSB

chemistries require up to twice as much lithium, a CRM, for equivalent energy storage⁸. Despite these hurdles, R&D investment is accelerating. Automotive manufacturers such as Toyota have announced pilot-scale production of solid-state batteries with projected commercial viability by 2027/2028⁹. The coming years will likely determine whether SSBs can prove their scalability.

1.5 Other batteries on the horizon

Beyond lithium, researchers are exploring alternative charge carriers such as sodium-ion (Na-ion), magnesium (Mg), potassium-ion (K-ion), and aluminium (Al-ion). In parallel, new redox flow and saltwater battery chemistries are showing promising signs for their future suitability in large-scale stationary applications.

Among these, **sodium-ion batteries (Na-ion)** are advancing most rapidly. Their chemistry is similar to lithium-ion, allowing existing manufacturing infrastructure to be repurposed¹⁰. Sodium is also far more abundant and geographically distributed, significantly reducing the dependency on CRMs¹¹. Although Na-ion batteries currently offer lower energy density, their potential cost and sustainability advantages make them attractive for grid and short-range applications. Initial commercial production of these batteries is already taking place. Recent advancements have significantly improved the batteries' energy density enabling applications in small electric vehicles, stationary storage systems and low-cost applications. Sodium-ion cells also perform better in cold temperatures and have good safety and fast-charging properties.

1.6 Batteries for stationary energy storage

Similarly to batteries for e-mobility, Batteries in Energy Storage Systems (BESS) play a vital role in achieving a cleaner, more sustainable, and resilient energy future^{12,13}.

The main technologies used for grid applications include lithium-ion, sodium-sulfur, lead-acid, and redox flow batteries. LiB are usually the preferred option, since they outperform the other technologies, offering higher power and energy density, efficiency, and low daily self discharge¹⁴.

BESS are deployed for multiple purposes

- **Renewables Integration:** storing excess energy during peak generation periods and discharging it when demand rises or production drops,
- **Grid Stabilisation and Flexibility:** rapidly regulating frequency and voltage in response to sudden power fluctuations,
- **Peak Load Management:** reducing demand surges during peak usage to avoid overloading the grid and costly infrastructure expansion,
- **Distributed Energy Systems:** enabling local power storage to reduce transmission losses and enhance grid resilience,
- **Vehicle-to-Grid (V2G):** allowing an infrastructure in which EVs act as mobile storage units that discharge back to the grid when needed.



The challenges of a linear battery supply chain

1.7 Demand for batteries is growing exponentially

Global demand for LiBs is projected to grow annually by around 33% until 2030, largely driven by the rapid electrification of the mobility sector¹⁵. The largest EV-markets today are China, Europe and the United States. In 2024, EVs represented over 20% of all cars sold worldwide¹⁶. This milestone was reached due to national financial incentives, targeted policies, and the fuel price volatility of 2022-2023.

This positive trend is also encouraged by the latest updates on battery manufacturing capacity projected to be enough to meet estimated demand by 2030¹⁷. The electrification of the mobility sector extends beyond passenger cars to bikes, scooters and mopeds, to both light- and heavy-duty vehicles. The result is a steep rise in the demand for batteries across the entire mobility sector.

1.8 Matching supply and demand for battery materials is increasingly difficult

Scaling up LiB production presents a number of challenges. The EV industry alone accounts for approximately 60% of global lithium demand, 30% of cobalt demand, and 10% of nickel demand, much of which is destined for batteries¹⁸.

Meeting this surge in demand means increasing the global output of CRMs like nickel, neodymium (Nd), cobalt and lithium by 300% within the next ten years. Yet developing a new mining site typically takes more than ten years, so the rising demand calls for a much-needed acceleration of production¹⁹.

Silicon is another concern. A small amount of silicon is mixed with graphite as a capacity booster in LiBs to increase energy density and lifespan. Despite being the second most abundant element on earth, silicon is considered a CRM due to its geographical concentration. Silica-rich quartz is mined and processed predominantly in China where its energy-intensive refining process adds to its environmental footprint^{20,21}.

Environmental risks and concerns

Demand is further amplified by consumer preferences. In leading EV markets, SUVs dominate sales. These larger cars require batteries up to three times the size of those in compact vehicles, which drives up the need for limited raw materials, with consequent environmental and social impacts²².

Beyond market dynamics, securing a stable supply of battery materials is increasingly also a matter of geopolitics. Many CRMs are concentrated in only a few regions, leaving markets such as the EU reliant on imports. The war in Ukraine, for instance, has disrupted the supply and pricing of metals such as nickel, as considerable reserves of these materials exist in both Russia and Ukraine²³.

Whether global supplies can meet future needs remains uncertain. However, CRM demand can be significantly reduced by the uptake of new battery chemistries that are more material efficient and/or reliant on more naturally abundant raw materials, together with circular strategies enabling their reuse and recovery²⁴.

1.9 Environmental and social impacts of mining and processing

The extraction and processing of battery materials frequently carry high social and environmental costs. In several producing countries, mining operations have been linked to poor working conditions, health risks and child labour²⁵.

The Democratic Republic of Congo (DRC) supplies around half of the world's cobalt and has become frequently associated with these injustices. Cobalt mining is vital to the DRC's economy but often takes place under conditions that violate basic human rights²⁶.

Similarly, the "Lithium Triangle" of Argentina, Bolivia and Chile promises some of the world's richest lithium reserves and hold significant economy potential for local communities. However, little data is available on the environmental and social impact of such large-scale extraction²⁷.

Lithium mining costs enormous amounts of water, requiring 700,000 litres of water per tonne of lithium produced²⁸. More than half of lithium is mined in areas where water supplies are already under pressure, as in the case of the Bolivian and Chilean salt flats. Risks of water and air contamination from unintentional lithium release persist, with consequent detrimental impacts on biodiversity and human health²⁹.

Overall, 40-to-60% of the GHGs emitted during EV production are attributable to batteries. This high carbon footprint is caused by the mining, refining, and shipping of battery materials, and by the energy-intensive production of anode and cathode materials³⁰.

Advancing responsible sourcing, sustainable mining and production practices and circularity can all help to lower the environmental and social impacts of batteries.

1.10 Emerging concerns: deep-sea mining

One potential future source of battery materials is the deep ocean floor, which contains large concentrations of strategic minerals³¹. However, the environmental impact of deep-sea mining is not entirely clear yet³². Disturbing seabed ecosystems could have irreversible impacts on marine biodiversity, water chemistry, and the ocean's capacity to absorb carbon. In July 2023, the International Seabed Authority held their final decision on large-scale industrial mining until 2024, following widespread international concern and growing calls for a ban on such activities.



1.11 Risks in transporting, storing and handling batteries

The rapid expansion of the battery market also increases the need for safe handling and logistics. Lithium-ion batteries can pose significant fire and explosion risks if damaged, improperly stored, or exposed to high temperatures.

A thermal runaway is a chemical reaction involving heat and gas generation in the battery, which can ignite neighbouring cells and lead to large-scale fires. Lithium exposure to oxygen can cause explosions, releasing corrosive and toxic substances that are harmful to people, property and the environment. Fires involving batteries are difficult to extinguish and can create toxic firewater, posing a danger to emergency responders, employees, and nearby communities. Common causes include impact damage during falling (by far the most important cause), manufacturing faults, errors during loading process in storage, ageing during storage and short circuits due to water.

To mitigate the safety risks during transport, international requirements already apply. LiBs fall under ADR class 9 in the ADR for road transport and are covered by the IATA-DGR regulations for air transport.

In the Netherlands, new national guidelines were published in 2024 but have not yet come into force. The PGS 37 standard is the guideline for safe handling of energy systems on site (PGS37-1) and storage of lithium-containing energy carriers (PGS37-2). The measures address temperature control, storage configuration, fire prevention, and emergency response, and apply to vendors, distributors, warehouses, and recycling facilities.



On the road to a circular battery value chain

Circularity:
a collective endeavour

“The battery recycling industry alone is expected to generate over USD 95 billion annually by 2040, underscoring the economic potential of circular systems.”

Transitioning to circular batteries requires collaboration across the entire value chain, from design, to policy, to investment, and international cooperation. All circular strategies need to be considered, from refuse and rethink, to reuse and recycling.

A circular approach can aid in balancing supply and demand for LiBs and their materials by strengthening resource efficiency, process innovation, and creating resilient business models. At the same time, it offers broader benefits such as better social and environmental conditions and increased financial profitability in both the short and long term.

Recognising these opportunities, the 2023 EU Battery Regulation has introduced requirements for:

- Due diligence in the supply chain,
- Design for repair, reuse and recycling,
- Use of secondary raw materials,
- Standardisation and circular design.

However, creating a truly circular battery value chain requires a paradigm shift, enabled by concerted

actions and joint efforts between governments, companies, researchers, and financiers, and grounded in systemic change across national and international networks.

2.1 What defines a circular battery?

There is no single definition of a “circular battery”.

In this guide, we define it as a battery that has a considerably lower social and environmental impact throughout its lifetime compared to a contemporary average battery, due to the simultaneous application of several circular practices and strategies.

Overall, a circular battery should be safe, durable, easily repairable and/or reusable, and fully recyclable at end of life (i.e. once all reuse and repair options have been exploited and no more value than that of the inner materials remains). It should be manufactured with as little material and energy inputs, through environmentally-sound processes, without hazardous or pollutant processes involved, and with fair working conditions. In addition, supply chains should be as local and as short as possible to limit transport emissions and safety risks.



2.2 Refuse, Rethink and Reduce throughout the battery lifecycle

To indicate the degree of circularity, the so-called R-ladder has been introduced: ten strategies ordered in increasing level of efficiency. At the top of the R-ladder stand Refuse, Rethink and Reduce. These question not only how batteries are produced, but rather whether we need to make them at all.

Reducing new production means prioritising efficiency and smart use. Smaller, lighter, and more efficient batteries can deliver the same functionality with fewer resources. Business models based on leasing, sharing, and modular ownership can further decrease the need for new production. Increasing the accessibility and affordability of public transport also indirectly reduces demand for large battery systems.

Equally vital is the need to rethink battery design. Though still emerging in this sector, circular design allows batteries to be easily disassembled, repaired, reused, and recycled, ideally using secondary raw materials and non-critical metals. Such design thinking reduces material dependency and price volatility for countries within the EU.

Standardisation is another key enabler. Uniform formats and interfaces simplify reuse, repair, and recycling. Yet achieving it is complex, as battery chemistries continue to diversify in response to application-specific demands and raw-material constraints.

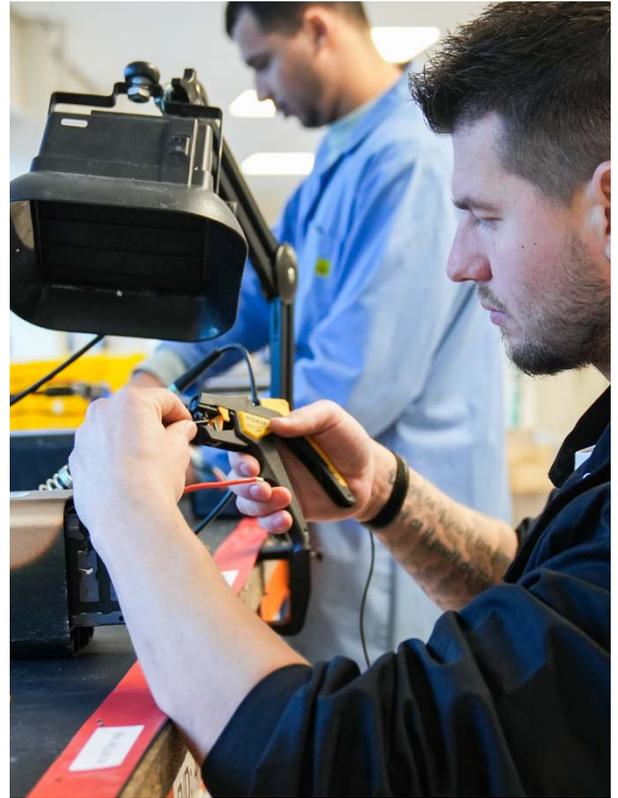
Progress therefore requires collaborative lifecycle assessment across disciplines, such as chemistry, engineering, logistics, and recycling, to align innovation with sustainability and performance goals.

2.3 Redesigning materials and processes

Circularity also extends to how materials are extracted and processed. Manufacturing processes can be redesigned to minimise pollution and enhance worker safety. Examples include replacing organic solvents with aqueous-based systems, eliminating fluorinated electrolytes and binders, and avoiding the need for energy-intensive dry rooms.

These improvements target some of the most environmentally burdensome stages of current LiB production.

In today's Li-ion batteries, a Li-salt dissolved in carbonate-based solvents provides a balance between stability, safety and high Li-ion conductivity. However, the next-generation cathodes and anodes can promote electrolyte degradation reactions. Hence, a better understanding of these degradation reactions and the use of protective electrode coatings or improved electrolyte formulations - is paramount for the realisation of next generation batteries.



In the Netherlands, the BatteryNL research consortium (part of the national NWA-NWO programme) is advancing research in both these areas, demonstrating how cross-disciplinary innovation can accelerate circular progress.

2.4 Reducing raw material consumption for batteries in electric cars

The circular battery industry should rethink LiB batteries as well as the vehicles containing them, particularly EVs. Whereas EVs eliminate tailpipe emissions, their production remains resource- and energy-intensive.

In 2024, nearly 15% of all kilometres driven by personal vehicles in the Netherlands were covered by electric cars. By early 2025, the number of electric vehicles in the country surpassed one million, meaning that one in ten personal vehicles was electric. Although this is a major milestone, this share must increase rapidly to reach carbon neutrality by 2050. However, this poses a material challenge, as an average E-car contains 10 kg of lithium and 40 kg of nickel. The global demand for precious metals is predicted to exceed supply before 2030.

This prediction highlights the urgency of using raw materials sparingly – to avoid repeating the extractive, high-impact model that characterised the fossil fuel era. Instead of replacing every fossil-fuel car with an e-car, the goal should be to rethink the role of cars altogether within a sustainable mobility system.

2.5 Rethinking mobility for circularity

Reducing battery demand starts not in factories, but in urban planning and government policies. Today, cars occupy about 50% of public space in Dutch cities³³. Meanwhile, in rural areas, car dependence is growing as public transport services shrink and local facilities disappear³⁴. For many, car ownership is not a choice but a necessity.

Integrated action at multiple levels could encourage the transition towards circular mobility. For example, reducing the number of parking spaces, promoting shared mobility and public transport, and introducing standards and financial incentives for smaller batteries.

2.6 Reusing and repairing to extend battery lifespan

Keeping materials in circulation and reducing the demand for new batteries and virgin raw materials requires strong investment in “slow-loop” strategies – including **reuse, repair, refurbishing, remanufacturing, and repurposing**. These so-called R-strategies extend product lifespans while requiring far fewer resources and less energy than manufacturing new batteries from scratch.

Each of these strategies entails varying levels of intervention

- Reuse involves deploying a battery again for the same purpose.
- Repair restores functionality by replacing or fixing faulty components.
- Refurbishment returns a battery close to its original performance.
- Remanufacturing and repurposing adapt batteries for new, less demanding uses.

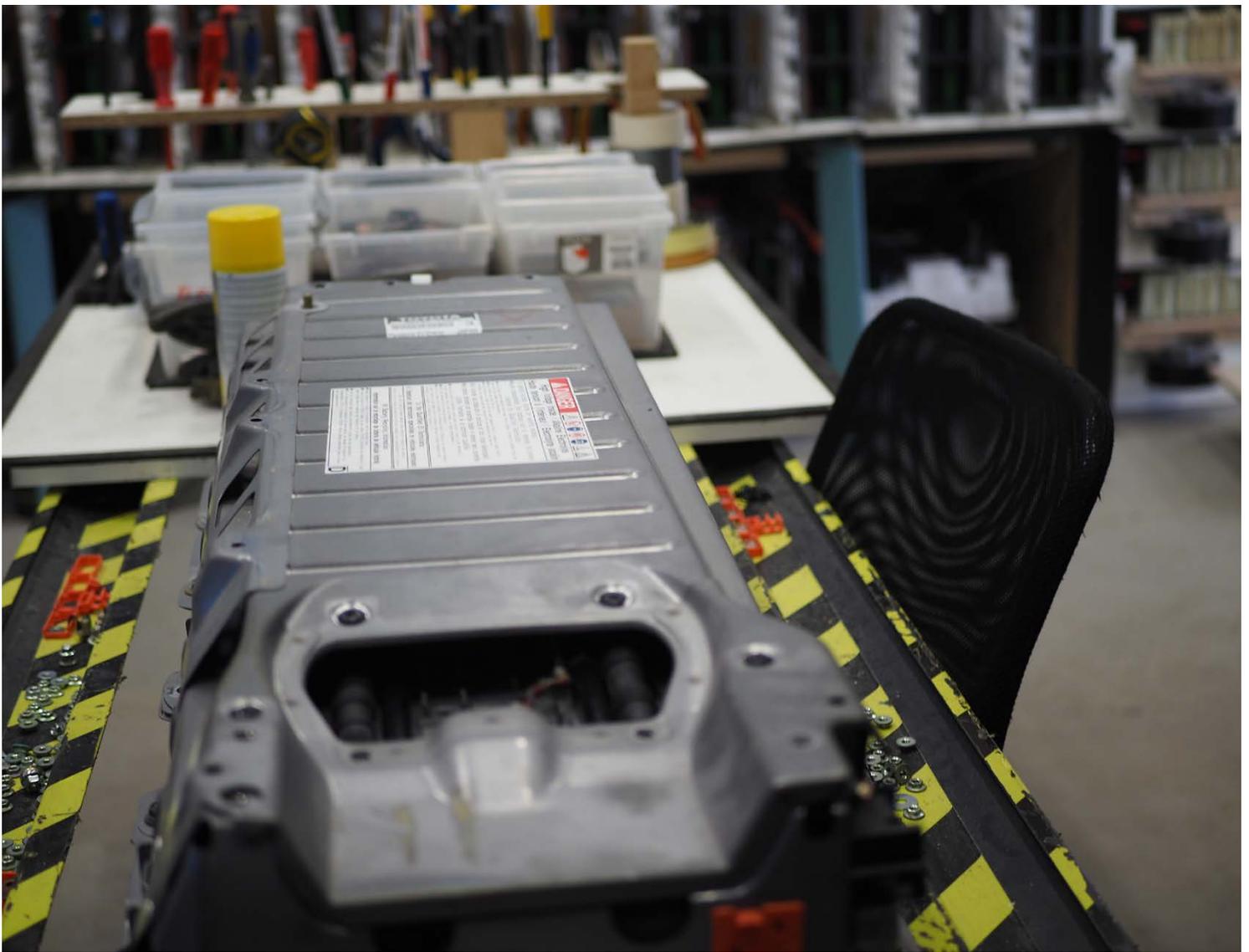
Currently 15% of end-of-life EV batteries are repurposed for other applications than mobility purposes. Examples include appliances for energy supply during events or roadworks. The number of batteries entering second-life applications is declining because they are being used longer in their initial application and repaired rather than repurposed.

To enable these circular practices at scale, data transparency and traceability are essential. Accurate labelling, open access to information about the battery pack’s composition and state of health, and clear rules on ownership and liability are prerequisites for safe reuse and repurposing.

The 2023 EU Battery Regulation reflects this by mandating the introduction of a battery passport, providing a digital record of each battery’s origin, chemistry, and performance history³⁵. It also requires that, by 2027, all portable and light-transport batteries (such as those in e-bikes and scooters) be removable and replaceable, either by the end user or a qualified professional.

The EU-funded CIRPASS project is currently laying out the groundwork for the implementation of the digital battery passport, a major step toward ensuring interoperability, traceability, and consumer trust in circular battery systems.





2.7 Recycling end-of-life batteries & recovering critical materials

Recycling requires large amounts of energy, water and/or reagents to recover raw materials and has a considerable environmental footprint.

“From a circularity standpoint, material recycling is one of the last resorts for scrap and end-of-life (EoL) battery materials.”

Despite its drawbacks, recycling remains essential to prevent waste and recover valuable materials. While it requires considerable inputs of energy and chemicals, the overall environmental footprint of recycling remains significantly lower than that of mining and refining equivalent quantities of new raw materials. Moreover, safe and efficient recycling mitigates fire risks, prevents toxic leaks, and supports the EU’s drive toward strategic autonomy in CRMs.

Recycling LiBs is technically challenging because of their complex mix of materials and cell chemistries, as well as the fire and explosion risks during processing. However, recycling of LiBs also provides promising benefits such as the reclamation of valuable secondary resources, the improved management of hazardous waste, and increased EU market resilience with reduced import dependency.

Currently, the EU is rapidly expanding its recycling capacity. The Netherlands hosts a growing ecosystem of recycling innovators. Besides that, several other initiatives are underway that focus on innovative technologies using less energy and fewer chemicals for the recovery of CRMs. These initiatives are part of the National Growth Fund Program of Battery Competence Cluster. The initiatives focus on the treatment of black mass.

Given the need to scale up efficient battery recycling, hydrometallurgical recycling routes are becoming increasingly popular. These processes indeed allow the recovery of additional materials compared to the pyrometallurgy route. This trend is already visible, with most of the facilities planned to open in the EU over the coming years following this method.

Because of the absence of a recycling industry in the Netherlands LIBs are currently brought to recycling facilities elsewhere in Europe. Such as Umicore (BE), Accurec (GER), Redux (GER), and Fortum (FIN). They use a combination of pyrometallurgical and hydrometallurgical processes to recover the CRMs.

The 2023 EU Battery Regulation established new recycling targets and prescribed minimum levels of recycled materials in new batteries. This is creating a strong momentum for battery recycling and will push investments, technological developments and infrastructure development across Europe.

2.8 Common and emerging routes for battery recycling^{36,37}

Pyrometallurgical recycling

This high-temperature route involves smelting battery cells in a furnace. The initial relatively low temperature in the furnace decomposes electrolytes and plastics, which releases additional energy for the process. Subsequently, some of the primary components in the cathode are smelted and transformed into a metal alloy consisting mainly of Co, Ni, and Cu. Further hydrometallurgical steps refine these alloys into metal salts suitable for new battery production.

While flexible across multiple battery chemistries and requiring minimal pre-treatment, this route recovers only a few key metals. Several installations in Europe with the use of Pyro in the meantime are able to retrieve Lithium. Plastics, electrolyte and graphite, however, are not recovered and are lost in the process.

Hydrometallurgical recycling

Hydrometallurgy starts with a more complex mechanical and chemical pre-treatment, often performed in inert or cryogenic conditions to avoid fire risk. Like in pyrometallurgical recycling, batteries are first shredded, and components are separated into concentrated material streams, like metals, plastics, and black mass.

The black mass is dissolved in aqueous solutions to extract metal ions, which are then separated using chemical precipitation or solvent extraction. This route achieves high recovery rates (>90%) and material purity (>98%), recovering a wide variety of elements. However, it is water- and reagent-intensive and requires multiple purification stages to handle contaminants and mixed chemistries. That is why innovations in the Netherlands are focused on less energy consumption and the use of other chemicals in the process.

Direct recycling (emerging)

An emerging alternative, direct recycling, aims to restore cathode materials directly rather than breaking them down into elemental compounds. The process modifies the composition of recovered material to recreate the desired crystal structure and morphology for immediate reuse in new cells.

Although simpler and potentially more sustainable, this method currently works best for production scrap or well-characterised battery streams, as impurities and degradation in spent batteries can compromise the performance of regenerated materials.





“This is creating a strong momentum for battery recycling and will push investments, technological developments and infrastructure development across Europe.”



The Netherlands: Paving the way towards the circular batteries of tomorrow

With a strong focus on public-private partnerships and strategic R&D investments, the Netherlands is emerging as a leading innovator in the global circular battery value chain.



A pioneer in circular economy practices and sustainability-driven innovation, the Netherlands is committed to achieving a climate-positive future, advancing the clean energy and mobility transitions through coordinated national and international actions.

3.1 A national commitment to circularity

Circularity is an important overarching policy theme for the Dutch Government.

“The Netherlands strives to have a circular economy by 2050, with an interim goal of reducing the use of primary raw materials by 50% in 2030.”

The 2022 National Raw Materials Strategy reinforces this ambition by ensuring the sufficient supply of raw materials through import diversification, material substitution and circularity.

As an EU member, the Netherlands actively supports supranational policies and legislations in this field, such as the EU Battery Regulation (2023) and the European Critical Raw Materials Act, which represent major milestones towards battery circularity.

3.2 The Dutch battery strategy

Recognising the importance of batteries for the energy transition, the Dutch government published the National Battery Strategy in 2020, in which circularity plays a key role. The strategy aims to ensure that the growing use of batteries in society is safe, responsible, and sustainable, while also capturing emerging economic opportunities.

Eleven out of fifteen Dutch ministries and several other government organisations collaborate in this integrated and coherent approach.

The governmental strategy is organised around five pillars

1. **Raw materials:** promoting responsible and secure access to raw materials through responsible mining, traceability (e.g. the Battery Passport) or by stimulating innovation in alternative battery chemistries.
2. **Circular economy:** encouraging R-strategies to extend batteries' lifespans and reduce reliance on raw materials.
3. **Safety:** developing knowledge on risks and safety and adapting these insights into regulation, training and awareness for producers, users and policy makers.
4. **Economic opportunities:** fostering innovation in safety, sustainability and performance of batteries while strengthening the Netherlands' competitive position in the global value chain.
5. **Energy system:** supporting research and policies that foster the role of batteries in enhancing the energy system in grid flexibility, energy storage, and vehicle-to-grid applications.

3.3 Investing in innovation and circular value chains

Through the National Growth Fund, the Dutch government channels large-scale investments into projects that promise long-term sustainable growth. Its flagship programme, “Material Independence & Circular Batteries” is part of the investment initiative. The eight-year innovation programme (2024-2032), developed by the Battery Competence Cluster NL, the Ministry of Economic Affairs and the Ministry of Infrastructure and Water Management, consists of around €800 million - including €296 million in government subsidies. Its main goals are to establish recycling capacity in the Netherlands and further develop circular battery technologies.

Relevant Dutch subsidy programmes

1. **BatteryNL**: Developing safer next generation batteries with higher energy density and longer lifecycles. (NWO-ORC, €9.3 mln, 2023-2031).
2. **Inland Shipping**: Developing 77 maritime battery containers (ZES-packs), 14 charging docking stations and 45 electrified inland vessels. (National Growth Fund, €50 mln subsidy and additional company investments, 2023-2021).
3. **NXTGEN Hightech**: Developing new equipment and material technologies for battery production. (National Growth Fund, €64.17 mln subsidy and additional company investments, 2023-2031).
4. **Material Independence & Circular Batteries**: Building a fully circular battery chain in the Netherlands. (National Growth Fund, around €800 mln, of which €296 mln subsidy, 2024-2032).



Public-Private Partnerships for an innovative Dutch battery ecosystem

3.4 Building the Dutch battery ecosystem: BCC-NL

To strengthen collaboration between industry, academia, and government, the Battery Competence Cluster NL (BCC-NL) was launched in 2022 as the first nationwide ecosystem for battery innovation. It unites three major sectors: battery technology, transport, and energy, to coordinate efforts in research, skills development, and circular innovation.

BCC-NL's activities focus on

1. **Ecosystem development** – Connecting Dutch and international actors to co-develop projects, share expertise, and create new business opportunities.
2. **Strategic roadmapping** – Identifying national challenges and priorities through collective planning instruments, such as the National Battery Systems Action Agenda.
3. **Collaborative innovation** – Investing in shared R&D facilities to lower barriers for companies, especially SMEs, to test and pilot new technologies.

The cluster capitalises on the Netherlands' strengths in material science, high-tech manufacturing, and heavy-duty mobility, positioning the country as a European leader in circular battery innovation. By integrating circularity into every stage – from cell and pack design to recycling and reuse – BCC-NL aims to enhance resource security, reduce import dependency, and create skilled employment within the national industry.



3.5 Fostering battery collection & recycling through EPR

The Netherlands is also advancing battery circularity through Extended Producer Responsibility (EPR), a principle embedded in the EU Batteries Regulation (2023).

The regulation sets ambitious goals for collection and recovery, including

- Portable batteries: 45% collection rate (by average weight of batteries put on the market in the previous three years) by 2024 (which was achieved), 63% by 2028, 73% by 2031,
- Light means of transport batteries: 51% collection rate by 2028, 61% by 2031,
- Lithium recovery: 65% by 2028, 70% by 2032.

Under EPR, producers and importers are financially and operationally responsible for managing their products throughout their lifecycle – from collection to recycling³⁸. This approach encourages eco-design, reuse, and safer waste management, aligning with the polluter-pays principle³⁹. Similar EPR schemes have long applied to product groups such as cars, vans, packaging, electronics and more recently textiles and single-use plastics⁴⁰.

3.6 EPR in practice in the Netherlands

Auto Recycling Nederland (ARN) for LMT & EV batteries

ARN serves as the Dutch PRO for automotive and EV and LMT batteries, including those used in cars, trucks, buses, and light transport vehicles. Through its Battery Management plan, developed with RAI Vereniging, ARN ensures legal compliance with the 2023 Battery Regulation on behalf of Dutch importers.

The organisation oversees the collection of recycling EoL-batteries by collaborating with collection and recycling companies. Predominantly, EoL batteries are collected at dealerships and garages, with a minor percentage sourced from aged or total-loss vehicles.

The Battery Management plan is a collective voluntary system, whereby importers that introduce battery-equipped vehicles to the market – such as cars, trucks, buses, motorcycles, or mopeds – and their corresponding batteries, actively participate. Funding for this plan comes from a fee levied on every battery introduced to the market.

In 2024, 15% of collected batteries found a second-life application, while 85% were recycled with over 60% recycling efficiency. As of now, the Netherlands lacks the capacity to recycle Li-Ion batteries. Therefore ARN collaborates with European recycling entities for treatment.

ARN anticipates a significant surge in EoL batteries in the coming years and is preparing accordingly. Predicting the lifespan of an EV battery is challenging, but the latest data suggests a durability of over 15-20 years. Therefore ARN has launched safety training initiatives to future-proof operations at car dismantling companies, ensuring safe handling of high-voltage batteries. A certification initiative is underway to ensure that dismantlers adhere to safety protocols for the disassembly, storage, and management of these batteries.

Stichting OPEN for electrical and electronic equipment and batteries

Stichting OPEN (Organisation for Producer Responsibility for E-waste Netherlands) is the official implementing authority for the Extended Producer Responsibility (EPR) in the Netherlands for electrical and electronic equipment as well as batteries.

The foundation represents over 11,000 producers and importers in the country and ensures the proper registration and reporting, and the safe collection and processing of discarded batteries. It works closely with European umbrella organisations such as EUCOBAT (the European association of battery compliance schemes) and CO-NEBI (the Confederation of the European Bicycle Industry) to align best practices, regulatory developments and compliance with EU regulations.



Stichting EPAC for bicycle (e-bike) batteries

Stichting EPAC (Electric Power Assisted Cycle) oversees the collection and recycling of bicycle batteries on behalf of over a hundred producers and importers. They ensure that discarded bike batteries are properly taken back, processed, and recycled instead of ending up as electronic waste.

3.7 The Battery Register

The Batteries Regulation requires Member States to establish and maintain a producer (battery-) register. A closed and consistent chain of market access from registration to the EPR, to execution, to enforcement is essential to safeguard the EPR and its implementation for batteries.

The Battery Register, established and managed in the Netherlands by Rijkswaterstaat (RWS), plays a central role in this system. Every producer must undergo a verification process and obtain a registration number. Without registration, a producer may not place batteries on the Dutch market.

A logical and effective sequence of verification is

1. Verification of market conformity by a government-designated and accredited body (for product safety, labelling, CE requirements, and so on).
2. Verification of the EPR obligations (collection, reporting, financing) based on the collective or individual approval request assessed by RWS and the Ministry of Infrastructure and Water Management.

This results in a robust system in which RWS only registers those producers that meet the market-conformity requirements in the Battery Register. These producers are subsequently required to comply with the EPR requirements for the end-of-life phase of the products they place on the market.

Stichting OPEN, in its role as Producer Responsibility Organisation (PRO), enrolls producers into the collective collection system for portable batteries and bicycle batteries that have been registered by RWS in the Battery Register on the basis of market-conformity. Producers that do not wish to join are reported by OPEN to the Human Environment and Transport Inspectorate (ILT), which is the competent supervisory authority. These producers are informed that they no longer have access to the Dutch market.



The EU Battery regulation: challenges in practice

3.8 Compliance and market challenges

The EU Battery regulation promotes reuse and high-quality recycling. In practice, several challenges remain. A major issue is that batteries are a growing waste stream, but reuse is technically complex and can be unsafe without proper testing. However, European standards for such testing are still lacking. At the same time, untested imported batteries enter the EU via online sales, avoiding compliance and safety checks. Collaboration in customs controls and EU-wide market surveillance can help mitigate these risks.

Illegal trade

Another major issue is illegal trade in EoL batteries. Some batteries still contain valuable components when their initial life span is over. These materials are bought, merged, or resold outside official channels. Online marketplaces, for instance, feature “repaired” or “combined” e-bike batteries that have never been tested. These pose serious safety concerns and reduce the formal recycling volumes necessary to make reuse or recycling economically viable. Without mandatory testing standards and enforcement, this informal market continues unchecked.

Market imbalances

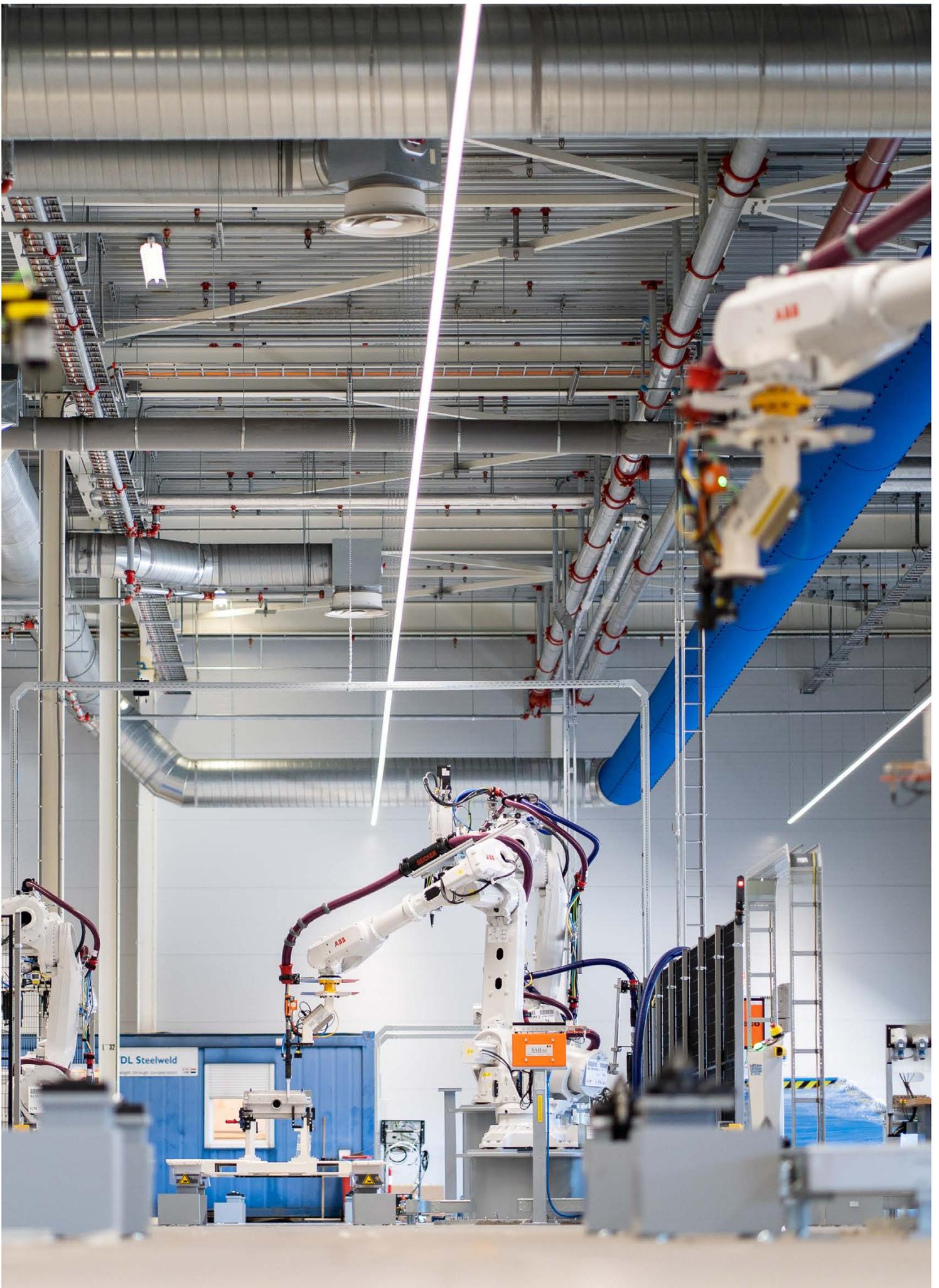
The EU’s internal market creates opportunities but also puts the sector at risk for imbalances. The system requires harmonised implementation and enforcement across the Union to prevent batteries from being bought where cheapest and discarded where EPR-schemes function, creating higher costs and environmental burdens in these countries.

The Digital Product Passport

The Digital Product Passport is one of the requirements of the new regulation and can be a powerful tool for transparency. The passport contains data on the origin, composition, carbon footprint and recyclability of each battery. This allows regulators to verify compliance without testing every single imported product. However, as this system is vulnerable to human error or manipulation, independent verification and reliable data sharing are therefore essential.

The new EU framework will create the foundation for a functioning circular battery market. By introducing testing, product information and reuse standards, the regulation combats common pitfalls in the current situation, such as scale-up difficulties due to high costs, a lack of regulation and absent enforcement. Everyone benefits from a well-regulated battery market; producers, importers, recyclers and consumers alike. Safety, environmental impact and fair competition depend on joint effort.

“Everyone benefits from a well-regulated battery market; producers, importers, recyclers and consumers alike.”



The Dutch best practices fostering a circular battery value chain

Dutch circular battery expertise

By integrating policy, innovation, and collaboration, the Netherlands is laying the groundwork for a truly circular battery economy. Through its strategic battery framework, investment in R&D, and robust EPR systems, the country is reducing dependency on CRMs, creating sustainable industry growth, and supporting Europe's transition to a resilient, climate-neutral energy system.

To highlight the breadth and depth of expertise driving this transition, the following index presents an overview of Dutch organisations active across the circular battery value chain. Each profile includes key activities, areas of innovation, and contact information, offering a clear gateway for collaboration, partnerships, and investment opportunities within the Netherlands' growing battery ecosystem.



The battery value chain

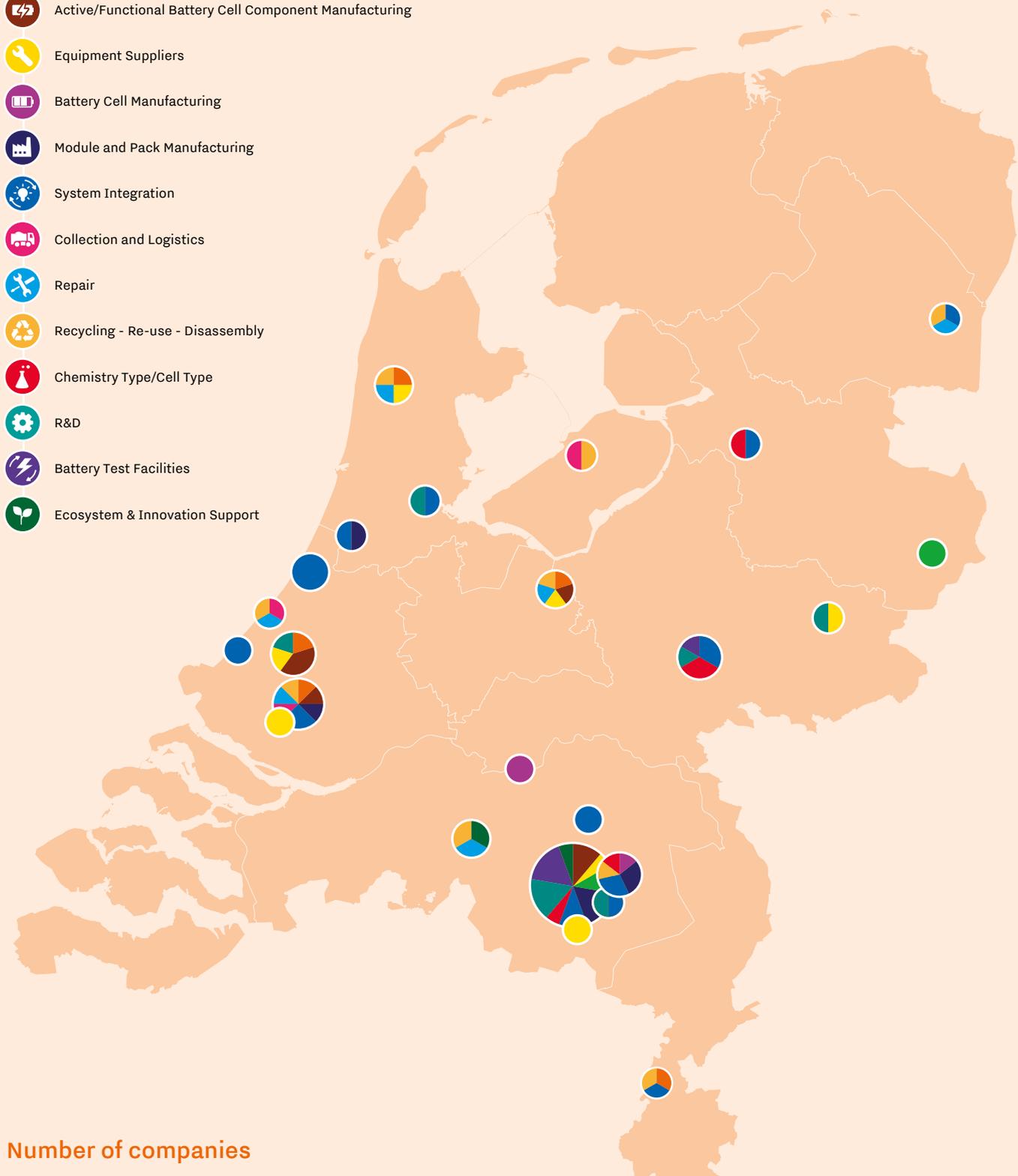


Circular battery value chain

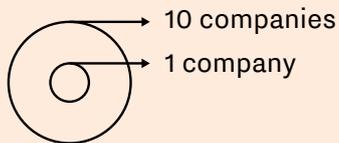
An overview of the Dutch circular ecosystem

Circular batteries categories

-  (Active) Material Suppliers/Processors
-  Passive Battery Cell Component Manufacturing
-  Active/Functional Battery Cell Component Manufacturing
-  Equipment Suppliers
-  Battery Cell Manufacturing
-  Module and Pack Manufacturing
-  System Integration
-  Collection and Logistics
-  Repair
-  Recycling - Re-use - Disassembly
-  Chemistry Type/Cell Type
-  R&D
-  Battery Test Facilities
-  Ecosystem & Innovation Support



Number of companies



Dutch circular battery ecosystem based on organisational applications

Organisation profiles

Name of organisation	(Active) Material Suppliers/Processors	Passive Battery Cell Component Manufacturing	Active/Functional Battery Cell Component Manufacturing	Equipment Suppliers	Battery Cell Manufacturing	Module and Pack Manufacturing	System Integration	Collection and Logistics	Repair	Recycling - Re-use - Disassembly	Chemistry Type/Cell Type	R&D	Battery Test Facilities	Ecosystem & Innovation Support	Page number
A&M Batteries								•	•	•					42
Aeroborn	•		•									•			42
AQUABATTERY B.V.							•				•	•	•		43
Aurora Netherlands							•					•			43
Back to Battery B.V.	•									•					44
Baattery							•								44
Battery Competence Cluster NL														•	45
BNA Battery									•	•					45
BNL Supplies B.V.								•	•	•					46
Brabant Development Agency (BOM)														•	46
Bronkhorst High-Tech B.V.				•								•			47
CarbonX	•		•									•			47
Cleantron						•	•								48
De EV Garage							•		•	•					48
DEKRA													•		49
DENS B.V.						•	•								49
Durapower					•	•	•			•					50
Eindhoven University of Technology												•	•	•	50
Elestor							•				•	•			51
E-magy	•		•												51
Euro Support B.V.	•		•	•											52
Exergy Storage B.V.							•			•					52
Festo B.V.				•											53
Flexiramics B.V.		•													53
Fortona B.V.							•			•					54

Name of organisation															Pagenumber
	(Active) Material Suppliers/Processors	Passive Battery Cell Component Manufacturing	Active/Functional Battery Cell Component Manufacturing	Equipment Suppliers	Battery Cell Manufacturing	Module and Pack Manufacturing	System Integration	Collection and Logistics	Repair	Recycling - Re-use - Disassembly	Chemistry Type/Cell Type	R&D	Battery Test Facilities	Ecosystem & Innovation Support	
Hecht Technology				●											54
Heskon B.V.									●	●					55
High Tech NL												●			55
INNER													●		56
LeydenJar	●		●												56
LionVolt			●		●										57
Maxwell and Spark B.V.						●	●								57
Nobleo Technology							●					●	●		58
Novocycle Technologies B.V.	●						●			●					58
NOWOS B.V.								●	●	●		●		●	59
Powall B.V.			●												59
Prime Power B.V. - Stroomzaken	●	●	●		●	●	●			●	●		●	●	60
Proven Concepts B.V.				●											60
Qurmit						●	●				●				61
SALD B.V.				●											61
SparkNano B.V.				●											62
Staad B.V.							●								62
TechMatter												●			63
Tulip Tech					●	●	●								63
University of Twente												●	●	●	64
Van Peperzeel B.V.								●		●					64
VDL ETS													●		65
VDL Groep B.V.					●	●	●						●		65
Vestel Mobility							●								66
Wattwise						●									66

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A&M Batteries offers businesses a comprehensive and fully compliant service package for the safe and responsible collection, storage, and recycling of lithium batteries. Our solutions are designed to meet both short-term and long-term needs, and comply with all relevant legislation and regulations.

End-of-life battery management includes the safe disposal and recycling of batteries, with transportation carried out in accordance with ADR guidelines using certified transport packaging. Batteries are processed by carefully selected recyclers who operate in line with the EU Battery Regulation, ensuring minimal environmental impact. Annual reporting is available.

In addition, A&M operates a licensed lithium battery storage facility in the Port of Rotterdam and provides expert advice on the application of PGS 37-2 guidelines. Storage containers can also be delivered on-site. Where appropriate, we explore possibilities for battery reuse or refurbishment.

Businesses can rely on expert guidance and tailored solutions for the safe and responsible handling of lithium batteries.

Organisation profiles



Aeroborn

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Aeroborn is a European deep-tech company transforming carbon waste into strategic advantage through its patented electrochemical platform technology. The company addresses Europe's critical battery supply chain vulnerability by converting battery waste and captured carbon dioxide into high-performance, circular materials.

Operating at the intersection of battery recycling and advanced materials manufacturing, Aeroborn produces four product families: graphene-silicon anodes, graphene, recycled graphite, specialty activated carbon for supercapacitors, and commodity activated carbon for filtration. The proprietary electrochemical process delivers superior performance while maintaining the lowest carbon footprint in the industry.

Based at the Port of Rotterdam, Aeroborn combines industry veterans with deep technical expertise to scale innovative solutions from laboratory to commercial production. The company's mission centres on building Europe's circular battery economy by enabling sustainable, resilient supply chains that reduce dependence on imported materials.

The platform technology generates dual revenue streams by processing waste materials while producing battery-grade outputs that meet stringent regulatory requirements. This unique positioning addresses the urgent need for European battery independence while supporting decarbonisation objectives across multiple industries. Aeroborn's approach turns environmental challenges into competitive advantages through fully recyclable, drop-in compatible materials.

Organisation profiles



 Material Suppliers/Processors

 Passive Battery Cell Component Manufacturing

 Active/Functional Battery Cell Component

 Equipment Suppliers

 Battery Cell Manufacturing

 Module and Pack Manufacturing

AQUABATTERY B.V.

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AQUABATTERY develops and deploys long-duration energy storage systems that use water and table salt to store electricity - safely, sustainably, and affordably. Based on a unique flow battery architecture, our technology decouples power and energy, enabling flexible scaling for a wide range of applications in a modular fashion - from commercial and industrial sites to renewable energy projects and utilities.

AQUABATTERY systems can be seamlessly integrated into both existing and new infrastructures, supporting the transition to a fully electrified and circular economy. Imagine AQUABATTERY everywhere, quietly storing clean electricity in residential areas, industries, and renewable energy plants across the world, ensuring power is available whenever it's needed.

Free from scarce, toxic, or flammable materials, AQUABATTERY offers one of the most sustainable and circular storage technologies available today. With four pilot installations completed, including a 5 kW/50 kWh system at Deltares in Delft, and additional installations underway, AQUABATTERY is preparing for commercial deployment across Europe and beyond.

We are building toward a fully European supply chain, strengthening energy resilience and independence. Our mission: to empower net-zero by providing safe, sustainable, and affordable energy storage for all.

Organisation profiles



Aurora Netherlands

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Innovation guides our actions. The disruptive development of vehicle-attached heating marked the beginning of AURORA in 1930. Today, energy efficient solutions for electric mobility are the focus of our development efforts. The AURORA Difference lies in how we develop and manufacture the original components for our entire systems ourselves – starting with heat exchangers and sheet metal across synthetic parts through to electronics.

Our HVAC systems and components for on-road and off-road vehicles help to maximize driving comfort while minimizing energy consumption. Our pursuit to make the best systems and components challenges us in development and production day after day. We are continuously seeking for pioneering individual series solutions. Worldwide.

AURORA sets the standards for tomorrow's mobility. AURORA is one of very few producers to offer an R290 HVAC solution for buses tried and tested by TÜV SÜD. At the same time, we are continuously developing additional R290 products, especially for use in buses and cabs.

With our technology we rely on the natural refrigerant R290 (propane) – a high-performance, sustainable and future-proof alternative to synthetic refrigerants, the use of the latter being increasingly restricted due to the EU F-Gas Regulation (EU-2024-573).

Organisation profiles



Back to Battery B.V.

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Back to Battery makes new battery materials from end-of-life lithium ion batteries, sustainable recovery of critical raw materials from “black mass, closed-loop recycling”.

We recycle Li-ion batteries that are end-of-life, because there are still many valuable materials in old, used batteries. The recovery of these materials fits perfectly in this time, because the energy transition is really getting underway and it requires a lot of batteries. The energy transition is a material transition. The growing number of discarded batteries offers a huge opportunity, it creates an “urban mine”. The discarded Li-ion batteries will be flooding the market.

We focus on the Black Mass, which is the part of the discarded batteries that remains after the batteries have been shredded. During shredding, the batteries are crushed and plastic, iron and copper are removed. The powder that remains is called Black Mass and it contains CRM (lithium, cobalt, nickel, manganese and graphite). Our innovative approach is zero-waste recycling and minimal consumption of energy and chemicals through a closed cycle of reagents. That makes us unique. We make new battery materials and our materials are just as good as “virgin” materials; there is no loss of functionality.

Organisation profiles



Baettery

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Baettery is a Dutch distributor and integrator of green energy storage technologies, delivering safe, sustainable, and affordable solutions for businesses and public organizations. We focus on sodium-ion batteries, a next-generation, non-toxic alternative to lithium-ion, while remaining open to other innovative and circular storage technologies.

With over a decade of experience in renewable energy, project development, and policy advisory, our team bridges the gap between technology, regulation, and real-world deployment. Baettery actively seeks partnerships with manufacturers and OEMs to bring sustainable battery systems to the Dutch and European markets. Our mission: make green energy storage the new standard: reliable, safe, and sustainable.



Organisation profiles



Material Suppliers/Processors

Passive Battery Cell Component Manufacturing

Active/Functional Battery Cell Component

Equipment Suppliers

Battery Cell Manufacturing

Module and Pack Manufacturing

BNA Battery

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BNA Battery, based in Alkmaar, the Netherlands, specialises in the replacement and refurbishment of hybrid car battery packs. Particularly for the brands Toyota, Lexus, Honda, Peugeot and Citroën. Founded by two engineers motivated by the high cost of dealer replacement units, the company developed proprietary diagnostic software to analyse each individual NiMH cell and identify defective units for replacement.

Our service model offers three main options: new cell battery packs (with reused housings/electronics but brand new cells), fully refurbished battery packs, and “young used” battery packs salvaged from total loss hybrid vehicles.

BNA Battery emphasises sustainability by reusing materials, extending battery life and giving up to 12 months of warranty on refurbished battery packs.

With an own workshop and mobile onsite installation service in the Netherlands and Paris and shipping across Europe, the firm has grown beyond local scope: about 80% of our packs are now sold outside the Netherlands.

Our core proposition: high quality, lower cost and more sustainable battery replacement for hybrid vehicles.

Organisation profiles



Battery Competence Cluster NL

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Battery Competence Cluster – NL (BCC-NL) is an innovation program aimed at developing a strong battery ecosystem in the Netherlands. Industry, knowledge institutions, and trade associations join forces with BCC-NL to build knowledge and competencies in battery technology. This public-private partnership unites the Dutch battery, transport, and energy industries to harness and accelerate the opportunities of the energy transition and battery technology.



Organisation profiles



 System Integration

 Collection and Logistics

 Repair

 Recycling - Re-use - Disassembly

 Chemistry Type/Cell Type

 R&D

 Battery Test Facilities

 Ecosystem & Innovation Support

BNA Battery

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BNL Supplies B.V. is a Dutch company based in The Hague, the Netherlands. Founded in 2020, we operate across three business divisions:

First, we provide lithium-ion battery after-sales services, including testing, repairing, reworking, refurbishing, dismantling, re-using, and recycling. We primarily serve B2B customers who must provide two or more years of warranty coverage to their end users. We collect damaged batteries through ADR-compliant transportation from branded companies across EU countries, and we also receive components such as BMS units and software from battery manufacturers for repair. Our after-sales services cover batteries for e-bikes, e-scooters, e-motorcycles, energy storage systems, and even electric vehicles.

Second, we operate as an energy solutions provider, distributing products such as energy storage systems and solar panels. We are the official distributor for various Chinese brands as well as the Korean brand Hyundai.

Third, in 2024 we established a software engineering team that has developed a Battery Passport software/platform in compliance with EU Regulation 2023/1542, which will be implemented across the EU in 2027. Our company is a member of the Global Battery Alliance (GBA) in Brussels and participates in the Battery Passport expert group of Catena-X which is part of the German automotive network. The logo of our Battery Passport software/platform is BNLPASS.

Organisation profiles



Brabant Development Agency (BOM)

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Entrepreneurship is the driver of innovation. From sustainable food sources to a healthy future, climate-neutral energy, and developing promising key technologies – the Brabant Development Agency (BOM) ensures that startups playing a role in these fields get off to a flying start and grow into scaleups, that the right facilities are always available to Brabant-based companies, and that companies that aspire to go global can actually do so. Every year BOM works with dozens of companies to create this impact. BOM is an executive body of the Province of Brabant and the Ministry of Economic Affairs. BOM. Catalyzing Change.

Brabant is home to innovative companies, high-tech manufacturers and renowned research institutes driving the future of battery technology. With expertise in thin-film technology, interface engineering and plasma chemistry, advanced anodes and spatial Atomic Layer Deposition technology that improve battery performance come to life. The region's manufacturing sector, specialized in high-mix, high-complexity, low-volume production, ensures rapid deployment of new battery technologies. Brabant also excels in electrifying heavy-duty mobility, with OEMs like DAF and VDL at the forefront. Brabant combines cutting-edge research with industrial expertise, making it a powerhouse for next-generation battery materials and components, advanced equipment, and integrated battery systems.

Organisation profiles



Material Suppliers/Processors

Passive Battery Cell Component Manufacturing

Active/Functional Battery Cell Component

Equipment Suppliers

Battery Cell Manufacturing

Module and Pack Manufacturing

Bronkhorst High-Tech B.V.

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Bronkhorst[®]
The low-flow specialists

Bronkhorst High-Tech is a leading manufacturer in the field of flow measurement and control technology. We offer an extensive product range of thermal, Coriolis and ultrasonic flow meters and controllers for low flow rates of gases and liquids. Our instruments - partly produced in a cleanroom - are used for a variety of applications in laboratories, test-benches, machinery and a wide variety of industries. By sharing our knowledge and closely cooperating with OEM customers, we develop customer specific low flow solutions, e.g. of multi-functional, pretested modules or skids for gas mixing, liquid dosing or vapor flow control.

With our headquarters based in Ruurlo (NL), Bronkhorst is represented by 12 wholly owned subsidiaries in Europe, in the USA and in Asia and additionally by a network of distributors in more than 30 countries worldwide.

Organisation profiles



CarbonX

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CarbonX is emerging as the leading alternative to imported graphite for Li-ion battery cell manufacturers seeking to reduce geopolitical risks in their anode material supply chains.

We are building a fully independent anode material supply chain designed to replace graphite. With our scaled production capabilities, CarbonX delivers economies of scale without compromising on performance or quality.

Our material's unique structure not only matches graphite in performance but also provides additional benefits – including faster charging and greater stability. Through our patented technology, we collaborate with production partners across all continents, enabling localized solutions for our customers. Our highly efficient process achieves up to five times lower carbon footprint compared to synthetic graphite.

CarbonX's first fully independent production facility in the EU is set to open in 2030, marking a major step toward a more secure and sustainable battery materials future. By eliminating geopolitical risks, CarbonX stands as the strategic and proven alternative to graphite.



Organisation profiles



System Integration

Collection and Logistics

Repair

Recycling - Re-use - Disassembly

Chemistry Type/Cell Type

R&D

Battery Test Facilities

Ecosystem & Innovation Support

Cleantron

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Cleantron designs and manufactures lithium-ion battery modules and systems for mobility, industrial automation and construction machinery. We develop standard and customized battery packs for low and high voltage applications, including e-bikes, light electric vehicles, AGVs, warehouse robotics, construction equipment, and agricultural equipment. All Cleantron batteries are designed and manufactured in the Netherlands in our ISO-certified automated factory, benefiting from our proprietary Battery Management System (BMS) technology and thermal solutions that ensure performance, safety, durability and smart integration.

Our mission is to make lithium-ion energy storage the technology of choice for more mobile and off-highway applications, through advanced engineering, integrating standard battery modules or solutions tailored to the needs of our customers.



Organisation profiles



De EV Garage

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www.deevgarage.nl/en

We are the leading specialist in electric cars in Emmen and beyond. We offer everything related to electric vehicles, like battery pack repairs, maintenance, diagnostics, air-conditioning service, and parts for LEVs, electric passenger cars, and light commercial vehicles.

We specialize primarily in the Nissan Leaf/e-NV200 and Citroën C-Zero, Mitsubishi i-MiEV, and Peugeot Ion models.

We also offer energy storage systems based on used car batteries, primarily based on used Leaf battery packs.



Organisation profiles



 Material Suppliers/Processors

 Passive Battery Cell Component Manufacturing

 Active/Functional Battery Cell Component

 Equipment Suppliers

 Battery Cell Manufacturing

 Module and Pack Manufacturing

DEKRA

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www.dekra.nl/en/battery-testing-and-certification/



Organisation profiles



DEKRA was founded in 1925 to ensure road safety through vehicle testing. Today, DEKRA is the world's largest independent, non-listed expert organization in the field of testing, inspection, and certification. As a global provider of comprehensive services and solutions, we help our customers improve their safety, security, and sustainability outcomes.

The history of DEKRA starts with the automobile: The Deutsche Kraftfahrzeug-Überwachungs-Verein e.V. (German Motor Vehicle Monitoring Association) was founded in 1925 in Berlin. DEKRA has been ensuring safety ever since. At first, attention was focused on technical safety – primarily in the automotive sector. Now, DEKRA has expanded its activities into many diverse aspects of daily life “on the road, at work, and at home”.

With decades of expertise in the battery industry and a proven track record of building trust, transparency, and quality assurance, DEKRA is your trusted partner in powering the future of batteries. Through our global network of advanced battery laboratories and deep knowledge in sustainability and circularity, we bring cross-sector technical excellence to help the industry develop safer, more reliable, and more sustainable battery solutions.

DENS B.V.

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DENS is a cutting-edge technology company located in the heart of the Brainport region. We design and manufacture high-performance battery systems that set new standards in safety, energy density, and reliability.

Our systems are proudly developed and produced entirely in the Netherlands, using components sourced almost exclusively from Dutch and European suppliers. This ensures exceptional quality and dependable delivery.

Thanks to our modular approach, we offer a versatile product range tailored to diverse applications—from charging vehicles and equipment to providing (temporary) energy solutions in areas affected by grid congestion. We develop our own software, apps, and APIs—enabling full customization, effortless integration with customer platforms, and rapid deployment of updates. This in-house capability ensures our energy solutions are not only powerful, but also smart, connected, and future-ready.

DENS: Engineered in Europe.
Built for performance.



Organisation profiles



System Integration

Collection and Logistics

Repair

Recycling - Re-use - Disassembly

Chemistry Type/Cell Type

R&D

Battery Test Facilities

Ecosystem & Innovation Support

Durapower

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Headquartered in Singapore, Durapower offers closed-loop, end-to-end energy storage solutions for electric mobility and renewable energy applications including on- and off-road Electric, Hybrid and Plug-in Hybrid Electric Vehicles, electric marine vessel and stationary energy storage solutions. Since 2009, Durapower has been a leading innovator of Lithium-Ion cell technology, focusing on the research and development of battery materials, battery cell manufacturing and system integration.

With a global presence spanning 25 countries and 70 cities, including European countries, China, India and Southeast Asia, Durapower strives to make scalable, sustainable batteries that support the circular economy, empowering lives and transforming the future towards a carbon neutral economy. Durapower does not manufacture, sell or distribute batteries intended for use in relation to household or consumer electronics.

Organisation profiles



Eindhoven University of Technology

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Eindhoven University of Technology (TU/e) is an internationally oriented technical university located in the Brainport region of the Netherlands. TU/e focuses on sustainable impact, innovation, and societal relevance. The university integrates cutting-edge research and education while fostering strong collaboration with industry, government, and regional partners. Its mission is to create a future-proof society by addressing global challenges such as the energy transition, digitalization, and health technology through interdisciplinary research and education.

Within the research on batteries, TU/e's Energy Institute (EIRES) and its Eindhoven Artificial Intelligence Systems Institute (EAISI) lead initiatives in energy storage, conversion, and system integration, particularly in mobility and long-duration storage. Researchers explore microscopic and macroscopic modelling, thin films and interfaces, membranes for redox flow batteries, battery management systems, integration into electric vehicles, drones, and smart grids, and the socio-technical value and impact of the battery transition. TU/e's approach combines materials science, electrochemistry, and systems engineering to accelerate the development of sustainable, efficient, and reliable battery technologies for a renewable-energy future.

Organisation profiles



 Material Suppliers/Processors

 Passive Battery Cell Component Manufacturing

 Active/Functional Battery Cell Component

 Equipment Suppliers

 Battery Cell Manufacturing

 Module and Pack Manufacturing

Elestor

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Organisation profiles



Elestor is redefining how electricity can be stored at scale. The company develops hydrogen-iron flow batteries that deliver large-scale, long-duration energy storage (8-130 hours), a crucial building block for a fully renewable energy system. Without such storage, renewable electricity cannot be reliably supplied when generation is low, leaving grids dependent on fossil backup and limiting the share of renewables.

At the core of Elestor's innovation lies a simple yet powerful concept: storing energy using hydrogen and iron, two of the world's most abundant and low-cost elements. This electrochemical process enables a storage system that is not only highly efficient and safe, but also circular by design. Both active materials can be reused indefinitely, and the system's lifetime far exceeds that of conventional batteries.

Elestor's technology offers unique design freedom: it decouples power and capacity, allowing flexible scaling from 8 to 130 hours of storage. The iron-based electrolyte keeps costs low, enabling affordable long-duration energy storage at grid scale.

With its circular materials, scalable architecture, and long-duration capability, Elestor sets a new standard in sustainable electricity storage: providing a flexible, sustainable storage solution that helps balance renewable energy, strengthen industrial resilience, and move the world closer to a zero-carbon future.

E-magy

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Organisation profiles



E-magy is a European advanced materials manufacturer revolutionising Li-ion batteries with its innovative silicon anode material. We drive the transition to electric mobility and next-generation battery-powered devices across sectors, including drones and consumer electronics. Using our proven, patented and proprietary manufacturing process, we develop third-generation silicon anodes, also known as silicon-dominant anodes (over 80% silicon by weight).

We offer scalable solutions that empower manufacturers to achieve up to 40% higher energy density and 3x faster charging while reducing silicon expansion and minimising environmental impact. This makes next-generation lithium-ion batteries a reality.

 System Integration

 Collection and Logistics

 Repair

 Recycling - Re-use - Disassembly

 Chemistry Type/Cell Type

 R&D

 Battery Test Facilities

 Ecosystem & Innovation Support

Euro Support B.V.

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Since more than 30 years, Euro Support is the leading independent partner for the scale-up and custom manufacturing of advanced inorganic materials. We offer all the capabilities needed to scale up and produce your battery cathode or anode materials from gram scale to thousands of tons. By making use of our existing production facilities, we aim to debottleneck new technologies by reducing investment costs and time-to-market for your product in the challenging first stages of commercialization.

Whether you are a green startup with a great new idea or a major worldwide manufacturer looking for a partner to handle your specialties, Euro Support is motivated and equipped to handle your every request. From procurement of raw materials to final QC and shipping, we are a one-stop shop for all of your production needs.



Organisation profiles



Exergy Storage B.V.

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Exergy Storage developed and is scaling up with partners a new sustainable battery technology for energy storage. The batteries are made of abundant and affordable raw materials such as salt (NaCl), (recycled) aluminum and iron. The new battery is characterized by high energy density and safety, being deployable both in densely populated residential areas or used in large utility-scale systems (containerized batteries). The characteristics also make the battery suitable for electrification of transport over rivers and coastal waterways, including barges and passenger transport. Exergy is designing the batteries to have a long lifespan, allowing high deep cycling numbers and to be easily recyclable for closed material loops.

Together with Dutch and German partner companies and institutes (supported by Euregio) and Dutch universities (supported by RVO), the value chain for these batteries is being build up. With Nobian, Exergy is preparing upscaling of delivery of salt and the electrolyte. In contrary to Li-ion batteries, the raw materials can be mined, produced and recycled in Europe or Netherlands, dependence on scarce materials and geopolitical issues can be avoided.



Organisation profiles



 Material Suppliers/Processors

 Passive Battery Cell Component Manufacturing

 Active/Functional Battery Cell Component

 Equipment Suppliers

 Battery Cell Manufacturing

 Module and Pack Manufacturing

Festo B.V.

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Driver and shaper of automation and technical education

Each and every day at Festo, we pursue the goal of making tomorrow's working world more productive, simpler and more sustainable. That's why we develop solutions for automation and technical education that prepare people, companies and organisations for the digital future in production, and for new technologies. As an international, family-owned company, we know how important it is to have a solid base. That's why we don't just work with representatives around the globe – we also have our own on-site companies with their own local identities. This helps to create our global network of around 20,600 experts who contribute their expertise every single day. They make us a driver and shaper within our industry sector and help to keep the world moving.

Facts

- Founded in 1925 in Esslingen, Germany
- Around 20,600 employees worldwide
- Companies in more than 60 countries

Organisation profiles



Flexiramics B.V.

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Flexiramics B.V. is a deep-tech materials company pioneering flexible ceramics. Our patented technology platform delivers a ceramic microfiber nonwoven that uniquely combines the high-temperature stability and chemical resistance of ceramics with the flexibility of nonwovens.

Flexiramics® offers thermal stability, chemical durability, dielectric purity, and controlled porosity - making it an ideal candidate for substrate reinforcement in electronics and semiconductor applications. It also serves as an effective filtration medium for separation and purification, a catalyst support or structural reinforcement to enhance system performance, and an efficient separator or thermal interface material for energy storage and heat management.

The Flexiramics® material can be customized in fiber chemistry, surface functionality, and structure, providing a scalable solution that enables innovation across multiple industries. Flexiramics® products are suitable for use in power electronics, quantum computing, RF and sensors, advanced packaging, microfiltration, energy and power systems, and many other applications.

Pure ceramics. Fully flexible.
Ready for the future.

Organisation profiles



 System Integration

 Collection and Logistics

 Repair

 Recycling - Re-use - Disassembly

 Chemistry Type/Cell Type

 R&D

 Battery Test Facilities

 Ecosystem & Innovation Support

Fortona B.V.

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Fortona B.V. is a Dutch technology company founded by Parsa Tashacori, dedicated to accelerating the energy transition through smart innovations in Salt battery, DC microgrids and energy management. Based in Zwolle and part of the Hanzestrohm group (135 fte), Fortona develops and delivers hardware and software solutions that help housing associations, contractors, and energy professionals optimize energy usage, reduce peak loads, and increase energy independence.

In addition to its core expertise, Fortona is pioneering the development of a hybrid solid-state molten salt Battery Energy Storage System (BESS) tailored for the Dutch and Belgian markets. This advanced storage technology offers a sustainable, 100% safe and scalable solution for grid flexibility and renewable integration. With a strong focus on innovation, sustainability, and social impact, Fortona collaborates nationally to build smarter, cleaner energy systems for the future.



Organisation profiles



Hecht Technology

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Hecht Technology is a recognized specialist in bulk material handling and containment solutions, with a strong presence in the battery industry. We provide innovative equipment and turnkey solutions for the safe and efficient handling of powders and bulk materials, including opening and filling of big bags and precise dosing into production lines. Our expertise in powder handling makes us a trusted partner for leading automotive and battery manufacturers in Europe and worldwide.

projects for prominent players in the battery and automotive sectors, helping them scale up production while maintaining strict compliance and minimal product loss.

By combining decades of engineering experience with hands-on know-how, we tackle complex challenges in high-containment environments, offering tailored systems that optimize throughput, reduce downtime, and enhance process safety. At Hecht Technology, we pride ourselves on being the powder experts—turning handling challenges into reliable, efficient, and sustainable solutions for the modern battery industry.

Our solutions are designed to meet the highest standards of safety, quality, and efficiency, ensuring smooth integration into clients' production processes. Hecht Technology has successfully delivered



Organisation profiles



Material Suppliers/Processors

Passive Battery Cell Component Manufacturing

Active/Functional Battery Cell Component

Equipment Suppliers

Battery Cell Manufacturing

Module and Pack Manufacturing

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Heskon has been one of Europe's leading service providers in the field of lithium batteries for several years. In addition to refurbishing used lithium batteries for consumers, the company has increasingly focused on providing consultancy and repair services for battery manufacturers, OEMs, and distributors of light electric vehicles.

The independent battery expert is based in Tilburg, the Netherlands, operating from a dedicated service center equipped for large-scale repair and remanufacturing. Heskon's technicians specialize in Li-ion batteries for light electric vehicles and industrial applications. Since 2019, over 50,000 batteries have been successfully refurbished for consumers, and several tens of thousands more have been repaired for business partners worldwide.

Heskon shares the vision of the European Union as outlined in the proposed 'Right to Repair' legislation. By focusing on repair and remanufacturing rather than selling new products, the company aims to conserve valuable raw materials. Heskon also works to reduce environmental impact throughout the battery life cycle and supports European businesses and consumers in using lithium batteries more sustainably.

Organisation profiles



High Tech NL

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High Tech NL is the driving force behind innovation and collaboration within the Dutch high-tech industry. As a national industry association, we unite companies, startups, knowledge institutes and public partners to accelerate deep-tech solutions that strengthen the competitiveness of the Netherlands and contribute to a sustainable future.

We focus on four strategic domains - semiconductors, robotics, life sciences and energy - each closely linked to major societal transitions. In the field of energy, High Tech NL plays a key role in supporting the development of new energy technologies, including battery innovation. Together with our members, we work on the full value chain: from advanced (and circular) materials and manufacturing technologies to system integration, testing, lifetime optimisation and end-of-life reuse strategies.

By facilitating ecosystem collaboration, shared roadmaps, international partnerships and industrial scaling, we help translate research and technological breakthroughs into concrete applications and business growth. Our mission is to make the Netherlands a global frontrunner in high-tech solutions that support the energy transition and strengthen Europe's strategic resilience.

Organisation profiles



 System Integration

 Collection and Logistics

 Repair

 Recycling - Re-use - Disassembly

 Chemistry Type/Cell Type

 R&D

 Battery Test Facilities

 Ecosystem & Innovation Support

INNER

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INNER bridges the quality gap in EV battery diagnostics by providing automakers with a complete picture of physical faults inside sealed battery packs. Our proprietary, non-invasive X-Ray/CT (Computed Tomography) scanner, designed for in-line comprehensive analysis of complete EV battery packs, is an end-to-end solution producing a quick and simple actionable report. All of this by making use of proprietary pattern recognition and machine learning (ML) software.

We assess the State of Integrity (SoI) of an EV battery pack down to 50 micron, which refers to physical faults such as torn wires, unfit welding, leakages, swollen cells and more in and in between the cells. This innovative technology enables rapid detection and analysis of microscopic physical faults with exceptional accuracy.

INNER

Organisation profiles



LeydenJar

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Society needs electric vehicles with longer driving ranges and shorter charging times. People need smart phones with increased functionality, without compromising on battery life. And tackling climate change relies on humanity's ability to electrify new modes of transport like electric planes. The existing lithium-ion batteries that power our life, work and play aren't currently equipped to sustain this future.

LeydenJar holds the key to these issues, for a future full of energy. Our ace is our energy density of 1350 Wh/L, 50% more than state-of-the-art smart phones or electric vehicles have today. The secret lies in LeydenJar's super thin, pure silicon battery anodes, produced using our patented process. Beyond providing record energy density in batteries, these ultra-thin anodes enable lower CO2 footprint, significant cost savings and charge to full capacity in less than 10 minutes.

Since starting out in 2016, we have raised a total of €100M in venture capital and now call 70 of the world's brightest scientist, engineers and innovators our colleagues.



Organisation profiles



Material Suppliers/Processors

Passive Battery Cell Component Manufacturing

Active/Functional Battery Cell Component

Equipment Suppliers

Battery Cell Manufacturing

Module and Pack Manufacturing

LionVolt

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LionVolt is a pioneering company in the field of battery technology, based in the Netherlands and the UK. The company is known for its 3D structured (lithium-) metal anode technology which enable next-generation battery cells. The first product is a drop-in 3D lithium-metal anode which increases the energy density of a lithium-ion battery cell by >50%, while supporting a very fast charge rate. Beyond this, LionVolt's 3D anodes will enable long-duration solid state batteries and high performance sodium-ion batteries.

LionVolt's technology is based on a patented 3D anode architecture which combines lightweight 3D structures with thin film technology. The architecture leverages a highly scalable roll-to-roll manufacturing process, translating to low costs. LionVolt is currently constructing a pilot production facility in Eindhoven to manufacture its unique 3D anodes at MWh scale which together with the company's MWh scale state-of-the-art cell manufacturing facility in the UK, allows its products to be supplied to the growing client list.



Organisation profiles



Maxwell and Spark B.V.

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Maxwell+spark engineers and manufactures lithium iron phosphate (LFP) battery systems designed for safety, circularity, and long service life. Built on a modular, serviceable architecture, its batteries are engineered for easy disassembly, repair, and reuse—enabling multiple lifecycles across industrial applications such as materials handling, refrigerated transport, and stationary power.

Headquartered in the Netherlands with operations in South Africa, the EU, and the US, maxwell+spark delivers proven, field-tested LFP technology for demanding environments. Its mission is to power a cleaner, quieter, and safer industrial world through accountable, data-driven battery innovation.

Each pack integrates advanced battery management and data connectivity to ensure consistent performance, real-time monitoring, and superior safety across thousands of deployed units. The company's circular design approach extends product lifespan, reduces waste, and ensures readiness for responsible recycling and repurposing.



Organisation profiles



Nobleo Technology

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Nobleo Embedded & Electronics specializes in delivering electronic systems that take an idea from proof of concept to a production-ready product. With a deep understanding of both hardware and embedded software, we design and develop systems that meet the functional requirements and comply with the highest standards in security, safety, quality and environmental regulations. Nobleo offers an innovative BMS platform that accelerates development while maintaining flexibility and scalability. The platform provides a robust foundation, allowing companies to integrate domainspecific functionalities tailored to their needs. Customization or adding functionalities can now be realized against lower cost and shorter lead times.

With a stable electronic platform and modular architecture, businesses can focus on their technological roadmap without the complexities of developing a BMS from scratch. Beyond standard functionalities, Nobleo's BMS is designed for compliance with stringent safety standards, including SIL (1500V) and ASIL (800V) regulations. Built on the NXP chip family, the system supports a wide range of voltages, ensures battery safety and provides a high level of configurability. Advanced SoX algorithms can increase battery pack performance and contribute to an extended lifetime. The platform is suitable for electrification of automotive- and energy storage system (BESS) applications.

Organisation profiles



Novocycle Technologies B.V.

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Novocycle Technologies is a clean-tech company advancing lithium-ion battery recycling through a chemical-free, modular, and decentralized processing method and digital on-demand traceability. Operating in the Netherlands and Türkiye, Novocycle has developed a proprietary dry-direct recycling process that enables safe disassembly and high-purity material recovery - without shredding, solvents, or acids.

production scrap and end-of-life batteries, recovering battery-grade materials with minimal processing and building strong synergies with refining partners to enable multiple closed-loop cycles. Novocycle delivers Recycling-as-a-Service (RaaS) and Technology-as-a-Service (TaaS) solutions along the value chain.

Novocycle's strategy encompasses the prior diagnosis and check of batteries for reuse before recycling and then utilizing disassembly of batteries down to electrodes for separate processing and recovery of high quality cathode and anode materials. The technology is designed to be chemistry-agnostic and compatible with a wide range of lithium ion batteries that achieves up to 96% total material recovery and greater than 99.6% purity for both cathode and anode materials. The modular, decentralized architecture of Novocycle's recycling solution reduces transport, energy, and processing costs, supporting cost-efficient scale-up across multiple sites and markets. Novocycle leads in the direct recycling of

Beyond recycling, the company conducts end-of-life and recyclability testing to support eco-design, regulatory compliance, and next-generation battery development. Novocycle also contributes to Safe and Sustainable by Design (SSbD) battery concepts for stationary storage and e-mobility, with a focus on second-life use and full recyclability.

The technology surpasses the EU Battery Regulation (EU 2023/1542) and stated thresholds for 2036 even today, supporting high recovery efficiencies, material purity, recyclability, and closed-loop value chains required for compliance and future recycled-content targets. Novocycle is pioneering a truly circular battery economy across Europe and beyond.

Organisation profiles



Material Suppliers/Processors

Passive Battery Cell Component Manufacturing

Active/Functional Battery Cell Component

Equipment Suppliers

Battery Cell Manufacturing

Module and Pack Manufacturing

NOWOS B.V.

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NOWOS is a specialist in the repair and maintenance of lithium-ion batteries, dedicated to building a circular economy and reducing material waste. As a social enterprise, its core mission is to extend the lifespan of batteries used in electric vehicles, bicycles, power tools, industrial batteries and energy storage systems.

By diagnosing, repairing, and preparing batteries for re-use, NOWOS extends their life, significantly cutting down on the need for new raw materials and lowering the total cost of ownership for its partners. In 2024 alone, the company successfully repaired over 90,000 batteries.

With facilities in the Netherlands, France, and the UK, NOWOS partners directly with manufacturers to improve battery design for better reparability and durability. The company is expanding its services to new sectors, including robotics and medical devices, positioning itself as a key European player in battery life extension and waste prevention.

NOWOS

Organisation profiles



Powall B.V.

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Powall is a pioneering force in sustainable technology, advancing energy applications through innovative nanocoatings. Founded in TU Delft and headquartered in Delft, the Netherlands, we serve clients across 12 countries, delivering coating solutions that unlock the full potential of their materials.

Specializing in lithium-ion battery materials, Powall collaborates with leading active material suppliers, battery manufacturers, and OEMs to push the boundaries of performance and efficiency. Our breakthrough gas-phase process enables continuous, scalable nanocoating of powders at mild pressures and temperatures. Powall offers nanocoating production units for each scale, be it for a pilot line or a industrial giga scale production site at lower cost compared to traditional coating technologies.

Leveraging advanced atomic layer deposition (ALD), our platform technology enhances active battery materials by extending cycle life, increasing capacity, and reducing internal resistance. Compatible with cathode materials such as NMC, LMNO, and LFP, as well as carbon and silicon anodes, Powall's coatings provide nano-precision customization tailored to each application.

As a drop-in solution, Powall's systems integrate seamlessly into existing production lines, improving performance while lowering costs and environmental impact. Beyond batteries, our reactor technology also reduces precious metal usage in green hydrogen and fuel cell applications while improving performance.

Powall - Empowering the energy transition through precision nanocoating innovation.

powall

Organisation profiles



 System Integration

 Collection and Logistics

 Repair

 Recycling - Re-use - Disassembly

 Chemistry Type/Cell Type

 R&D

 Battery Test Facilities

 Ecosystem & Innovation Support

**Prime Power –
JOEP Batterijen – Stroomzaken**

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PRIMEPOWER



Organisation profiles



Prime Power B.V. – Stroomzaken is a Dutch company active in sustainable energy systems, including battery storage (BESS), hybrid energy solutions, and generator-based power systems. Building on a technical heritage dating back to 1984, the company combines more than forty years of experience in energy supply, engineering and international collaboration.

Over the past decades, Prime Power B.V. has established strong partnerships with manufacturers and suppliers in Europe, Asia and the United Kingdom. From its headquarters in Naaldwijk, the company coordinates system-design, technical-development, project-management and the integration of residential and SME (Small and Medium-sized Enterprises), LV and HV, for home storage battery systems up to 80A three-phase, as well as 20ft-40ft-containerised BESS-solutions up to 1000A-2MW+. Activities are carried out directly or through certified partners, with engineering and coordination based in the Netherlands.

Operating under the trade names Stroomzaken and JOEP Batterijen the company works closely with long-term partners such as Power Link Energy, and several certified OEM suppliers. Prime Power B.V. is involved in ongoing developments in LiFePO₄ technology and supports European adaptation and innovation through short communication lines with its partner factories. The company acts as a technical advisor and enabling partner within the growing European battery value chain.

Proven Concepts B.V.

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**—PROVEN
CONCEPTS—**

WE MAKE IDEAS VISIBLE

Organisation profiles



Based in Valkenswaard (NL- Brainport region), employs 24 FTEs and can best be described as a ONE STOP SHOP Partner. From engineering, our own production departments (including model making, sheet metal shop (welding facilities, bending, deep drawing presses, etc.) CNC milling machines, assembly and measuring department.

We are particularly strong in the development and production of prototype and small/medium series parts in both metal and plastic.

We translate ideas into tangible solutions. That's what Proven Concepts stands for. Whether the final product is a CAD model, a metal/plastic product, a visual/ergonomic model, or the management of your small series, our service portfolio is extensive. We develop testable products, even from the most complex ideas. We can certainly add value to the battery industry.

Our team can offer you a complete development package. From the very first conceptual idea, CAD development, and the production of prototype tools to the delivery of the final product and small series, including measurement reports. We guide you from start to finish. Our relatively small organisation (short lines of communication) and one-stop-shop principle (having everything in-house) results in flexibility, short lead times, increasing quality and a reduction in TCO (total cost of ownership) for our customers.

Naturally, we have a management system in place that complies with international standards, such as ISO9001.

Material Suppliers/Processors

Passive Battery Cell Component Manufacturing

Active/Functional Battery Cell Component

Equipment Suppliers

Battery Cell Manufacturing

Module and Pack Manufacturing

Qurmit

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Organisation profiles



Qurmit is a Dutch manufacturer of innovative, safe, and sustainable energy storage systems. Our home batteries and industrial solutions are designed to make reliable energy storage accessible to everyone — from households to businesses.

Qurmit originated from TSS4U, an organization with over 20 years of worldwide experience in off-grid solar energy systems. The extensive technical knowledge and field experience have been translated into battery systems that excel in sustainability, safety, and performance.

Our batteries are based on advanced gel lead technology and are produced in the Netherlands using European components which are:

- Sustainable: up to 95% recyclable and made with more than 50% recycled materials.
- Long-lasting: up to 20 years of lifespan and around 9,000 charge cycles.

- Robust: capable of withstanding extreme temperatures from -40°C to $+55^{\circ}\text{C}$.
- Innovative: thanks to the self-developed charging protocol in the Qurmit Booster, charging sessions are optimized for maximum lifespan and efficiency.
- Scalable: from compact home systems (17–42 kWh) to large-scale business solutions such as the Qurmit XL (up to 800 kWh of storage capacity).
- At Qurmit, we combine the strength of proven technology with the ambition to make the energy transition truly circular and future-proof.

SALD B.V.

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Organisation profiles



SALD B.V. – Advancing Circular Battery Innovation through Atomic Precision
SALD B.V. is a high-tech company based in Eindhoven, the Netherlands, pioneering Spatial Atomic Layer Deposition (SALD) — a scalable thin-film coating technology that enables precise control of material interfaces at the atomic level. Unlike conventional ALD, the SALD process allows for roll-to-roll high-throughput, continuous coating of complex 3D surfaces, making it ideally suited for industrial battery manufacturing.

In battery applications, SALD coatings improve cycle life, thermal stability, and increased C-rates, while reducing material degradation. By extending cell longevity and using sustainable materials, SALD directly supports the circular battery economy and aligns with EU sustainability goals.

SALD B.V. collaborates with leading OEMs, research institutes like TNO, and material developers to integrate its technology into next-generation lithium-ion, and sodium-ion batteries. Through atomic-level engineering, SALD transforms energy storage systems into more durable, efficient, and sustainable technologies — enabling a cleaner, electrified future.

 System Integration

 Collection and Logistics

 Repair

 Recycling - Re-use - Disassembly

 Chemistry Type/Cell Type

 R&D

 Battery Test Facilities

 Ecosystem & Innovation Support

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SparkNano is the first and leading OEM in spatial ALD equipment. Our patented atmospheric spatial Atomic Layer Deposition technology delivers unmatched coating precision, control, and speed for industrial manufacturing. With our lab-to-fab product portfolio, including SparkNano LabLine™ for R&D and pilot production, and the SparkNano Omega™, the world's first high-speed Roll-to-Roll spatial ALD system, along with our expert team and partners,

we help customers bridge lab-scale innovations to high-volume production. In the battery market our equipment is used to deposit thin films to form artificial SEI or passivation layers, improving the cycle rate and longevity of Li-ion batteries, while supporting industrial-scale high-performance manufacturing. Together we advance next-gen product manufacturing to drive the energy transition.



Organisation profiles



Staad B.V.

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Staad is a leading Dutch company that develops innovative earthmoving machines and mobile energy solutions, with a strong focus on sustainability.

With a rich history and a reputation for reliability and customer focus, Staad is further strengthening their position in Europe by launching a new generation of electric earthmoving machines and mobile battery solutions. We gladly share our vision for a zero-emission future, where we work with passion, pride, and dedication to create high-quality earthmoving machines.

Our goal? Machines that not only meet the highest standards and user demands but also deliver optimal performance.



Organisation profiles



Material Suppliers/Processors

Passive Battery Cell Component Manufacturing

Active/Functional Battery Cell Component

Equipment Suppliers

Battery Cell Manufacturing

Module and Pack Manufacturing

TechMatter

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TechMatter is a Dutch materials and technology development consultancy specializing in advanced material solutions for high-tech and cleantech industries. With a multidisciplinary team of experts, we combine deep technical, industrial, and scientific expertise to accelerate the transition toward sustainable and circular manufacturing.

TechMatter's experts have been actively involved in nearly all major national cleantech initiatives in the Netherlands, supporting partners in developing next-generation materials, processes, and technologies for energy storage, circular batteries, and advanced manufacturing. Our work bridges the gap between research and industry by combining materials science, engineering innovation, and process optimization.

We provide R&D consultancy, prototype development, and strategic technical and business development support to companies and organizations seeking to strengthen innovation capacity and enhance material efficiency, recyclability, and performance. TechMatter's mission is to enable smarter, cleaner, and more circular use of materials across high-tech value chains.

Organisation profiles



Tulip Tech

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Tulip Tech is a Netherlands-based manufacturer redefining energy for UAVs and aerospace systems. We develop ultra-high-density batteries surpassing 500 Wh/kg, built for maximum endurance, safety, and reliability in demanding flight environments.

Our industrial-scale production platform is designed for rapid scaling, enabling consistent, high-volume output without compromising precision or quality. Tulip batteries power a broad range of defense and commercial drone platforms, supporting missions in logistics, agriculture, inspection, and advanced aerial mobility.

Rooted in European engineering excellence, Tulip Tech blends innovation, sustainability, and manufacturing discipline to accelerate the transition toward electric flight. We work with leading UAV manufacturers and government partners to deliver next-generation energy systems that extend flight times and redefine what's possible in aerial performance.



Organisation profiles



System Integration

Collection and Logistics

Repair

Recycling - Re-use - Disassembly

Chemistry Type/Cell Type

R&D

Battery Test Facilities

Ecosystem & Innovation Support

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UNIVERSITY OF TWENTE.

At the University of Twente's Battery Centre Twente, our R&D spans novel materials to industrial scale manufacturing—all grounded in solving practical technical challenges in safety, durability, performance, and lifecycle impacts. We strongly partner with industry to translate discoveries into sustainable solutions that meet real-world demands. This is embedded across our four Missions: 1) Next Gen. Mat'ls and Cells; 2) Advanced Manufacturing; 3) Energy Efficient Packs & Systems; 4) Smart Applications & Systems Design.

We lead (inter)national R&D and education programs via the Nationaal Groeifonds (NXTGEN High Tech, Material Independence & Circular Batteries; BatteryNL), Horizon Europe, and other large initiatives.

Our cross-border partnership with the University of Münster and the Fraunhofer Forschungsfertigung Batteriezelle (FFB) connects us to world-leading expertise in electrochemistry, materials, and manufacturing. Together with institutes such as MEET, Helmholtz Münster, Fraunhofer Innovation Platform, and through UTwente becoming a partner in the BACCARA international graduate program, we are building one of Europe's strongest clusters for battery innovation. This collaboration integrates materials science, electrochemistry, nanotechnology, and advanced manufacturing to accelerate breakthroughs and strengthen the Dutch-German region as a global hub for next-generation batteries.

Organisation profiles



Van Peperzeel B.V.

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Van Peperzeel is a collector of waste batteries in the Netherlands and Belgium. The annual collection amounts to thousands of tons of lead-acid batteries. We work for nationally operating wholesalers in the automotive sector, among others. The batteries are prepared for recycling and delivered to certified recycling companies in Europe.

In addition, Van Peperzeel is active in the purchase and sale of various non-ferrous metals. Approximately five thousand tons of non-ferrous metals and non-ferrous residues (such as old license plates, rims, car catalysts, and various industrial waste like slag and turnings) pass over the scales annually.

Finally, Van Peperzeel is the national sorting center for all household batteries in the Netherlands for Stichting Open (formerly Stichting Batterijen - the Dutch Battery Foundation). Thanks to our years of experience with sorting and our unique accumulated knowledge about (lithium) batteries, we also collect large quantities of industrial lithium batteries for recycling and second use.



Organisation profiles



 Material Suppliers/Processors

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 Active/Functional Battery Cell Component

 Equipment Suppliers

 Battery Cell Manufacturing

 Module and Pack Manufacturing

VDL ETS

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Organisation profiles



VDL ETS – Driving Europe’s Smart & Sustainable Mobility Transition

At VDL ETS, we develop and deploy cutting-edge technologies that accelerate the shift to zero-emission transport, autonomous mobility, and smart urban infrastructure.

Battery Testing

We offer full spectrum testing of cells, modules, and packs under electrical, mechanical, and environmental conditions. Our modular setups and engineering support help OEMs reduce time-to-market and improve reliability—essential for Europe’s energy transition.

Zero-Emission Transport

From hydrogen-powered trucks to battery-electric buses and agricultural machinery, our proven solutions support clean mobility across sectors. We’re already powering daily logistics for Toyota Motor Europe with our H₂ trucks—connecting Germany, the Netherlands, and Belgium.

Robotizer – Autonomy Made Scalable

Our modular platform enables fleet operators to deploy autonomous vehicles faster and more flexibly. With remote operation, OTA updates, and scalable licensing, Robotizer is built for real-world deployment.

Vehicle Motion Manager (VMM)

VMM ensures safe and seamless control transitions between autonomous driving, teleoperation, and remote control. It’s hardware-agnostic, plug & play, and designed for operators—not just engineers.

Why VDL ETS?

We combine deep engineering expertise with a cooperative, customer-first approach. Our solutions are modular, scalable, and future-proof—ready to support national and European goals in climate, mobility, and digital infrastructure.

Let’s build future—together.

VDL Groep B.V.

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Organisation profiles



VDL Groep has over 14,000 employees in 20 countries and develops and produces a wide variety of industrial products, from parts to advanced sub-modules and end products. The Group consists out of more than 100 closely cooperating operating companies, each with its own specialism. In 2024, VDL Groep achieved a combined annual turnover of €4.3 billion.

With our electric buses VDL is an experience partner in battery technology with a network of companies active within the battery value chain. VDL is acting as one-stop-shop for external customers: from design engineering and prototyping towards series production and advanced testing facilities and services on full vehicle integration as the assembly of the battery and components itself. Including the development of high-tech equipment for first-of-a-kind pilot lines or high-volume production lines. The group’s integrated approach allows for system-level design and manufacturing, crucial for scalable battery production and testing.

Vestel Mobility

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Vestel Mobility is redefining the future of mobility and energy with innovative, end-to-end solutions. Powered by the industrial strength of Vestel Group and its 30-million-unit annual production capacity, we lead Türkiye's export landscape and serve 163 countries. Since 2017, we've combined deep local engineering know-how, sustainable practices, and global collaboration to deliver high-quality, scalable technologies. As a major OEM partner for leading mobility brands, we offer tailor-made solutions in automotive electronics, EV charging systems, and energy storage.

Vestel Mobility has a broad range of EV chargers, all manufactured in-house. Both AC and DC solutions ranging from 7kW to 1.2MW. A solution for each need with tailor-made HW and SW solutions to optimize your vehicle and energy infrastructure performance.

Our Battery Storage solutions are modular in set up. Home installations with our 5kWh modules and utility installations up to 418kWh storage to optimize power consumption or provide security of power.

Display solutions are Vestel Mobility's key products as automotive supplier. With full in-house development, a strong ecosystem of suppliers and competence in competitive manufacturing in the proximity of Europe we offer a lean alternative to Far East solutions.

Vestel Mobility masters SMT manufacturing. We offer Electronic Manufacturing Services. With our competence in Domain Controllers, ECU's and Power Electronics and a flexible business model we offer competitive manufacturing solutions.

Organisation profiles



Wattvise

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Wattvise is an innovative Dutch SME located at the High Tech Campus Eindhoven, specializing in advanced energy storage systems and intelligent energy management solutions. The company develops and integrates high-quality battery packs with smart Battery Management Systems, AI-driven diagnostics, and robust energy platform with built-in cybersecurity. By combining expertise in battery technology, embedded software, and cloud and edge integration, Wattvise delivers solutions that enhance resilience, reduce energy costs, and support grid flexibility.

Its technology includes energy production and consumption forecasting, enabling batteries and connected devices to operate proactively based on expected demand and generation. Through smart sensing and data-driven control, Wattvise optimizes battery use, extends lifetime, and supports reuse within the circular economy. Wattvise's mission is to enable efficient, intelligent, and sustainable energy solutions for everyday life, strengthening the position of the Netherlands as a leader in smart energy and battery innovation.

Organisation profiles



Material Suppliers/Processors

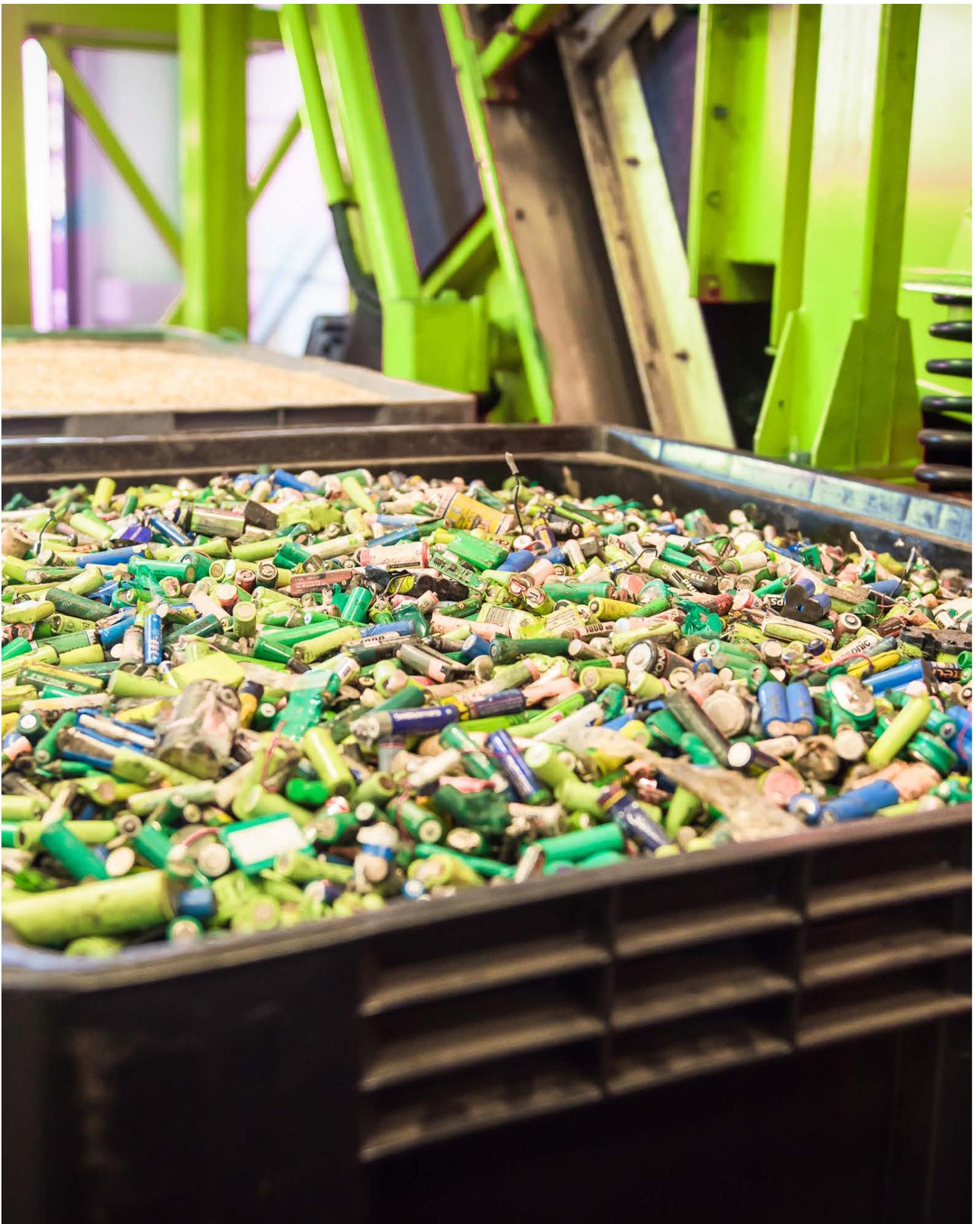
Passive Battery Cell Component Manufacturing

Active/Functional Battery Cell Component

Equipment Suppliers

Battery Cell Manufacturing

Module and Pack Manufacturing



 System Integration

 Collection and Logistics

 Repair

 Recycling - Re-use - Disassembly

 Chemistry Type/Cell Type

 R&D

 Battery Test Facilities

 Ecosystem & Innovation Support

Glossary

Battery Energy Storage Systems (BESS): Stationary energy storage systems that use batteries to serve multiple purposes, from supporting renewable energy production and enhancing self-consumption to peak shaving and providing backup power in both industrial and residential systems. Read more on their potential at page 13.

Circular Battery: A battery designed with minimal material and energy inputs with maximal lifespan, repairability and recyclability. See page 18 for other key characteristics of a circular battery.

Climate-Neutral Economy: An economy with net-zero greenhouse gas (GHG) emissions. This objective is at the heart of the European Green Deal and in line with the EU's commitment to global climate action under the Paris Agreement.

Critical Raw Materials (CRMs): Materials defined by the European Commission as essential to EU economy but with respective supply risk and uncertainty. The fifth CRM list was published in 2023 and supported the development of the list of Strategic Raw Materials (such as copper and nickel) and of the EU Critical Raw Materials Act, to ensure EU access to a secure and sustainable supply of these resources. Further details at page 13.

Electric Vehicle Battery (EV battery): As defined in the 2023 EU Battery Regulation, these are used for traction in four-wheeled road vehicles, such as lithium-ion batteries (LiBs). See full battery classification at page 11.

E-mobility & EV Sector: The electrification of mobility is paramount to meeting the 2050 climate neutrality goal. Batteries power all kinds of vehicles, from passenger cars to heavy-duty trucks and ships.

End of Life (EOL): the final stage in the lifespan of a product, such as a battery, when it can no longer be reused or repaired and must thus be recycled.

Extended Producer Responsibility (EPR): A mix of policy instruments deployed by governments to hold manufacturers accountable for the environmental costs and impacts of their products at end-of-life. Further details at page 28.

Producer Responsibility Organisation (PRO): An organisation tasked with fulfilling EPR requirements in practice, such as the collection and recycling of batteries. Dutch examples at page 28 and 29.

R-ladder & R-strategies: A hierarchical framework for circular practices from refusing and rethinking products until recovering their materials at EOL, as defined by Rood and Kishna (2019). Strategies higher on the ladder require fewer materials, which reduces their resource-related environmental footprint. Recycling is considered a 'last resort' option, when other R-strategies are no longer possible. R-strategies can be combined with innovations such as new product design, technologies and business models. Further details at page 19.

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Things To Make And Do

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