

**RECYCLING OF
VEHICLE BATTERIES
WE CLOSE THE CIRCLE**

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One of the biggest challenges to emerge from the electrification of society is how to take care of used lithium-ion batteries in a safe, circular way”

Stena Recycling sets the standard in recycling of vehicle batteries

The electrification of the vehicle fleet has accelerated in recent years. In the first half of 2021, sales of plug-in cars doubled compared to the same period in 2020, and this strong trend has continued in 2022.

According to a report by Circular Energy Storage Research & Consulting, the number of lithium-ion batteries used in vehicles is expected to increase almost tenfold over the next decade. A growing number of countries are also setting end dates for the sale of vehicles powered by internal combustion engines, linked to the EU's decision to end all sales of these vehicles by 2035. The consequence of this will be that the manufacture and demand for lithium-ion batteries will increase significantly. The supply of valuable

battery metals such as cobalt, lithium and nickel is limited and is expected to become scarce in the near future due to the sharp increase in demand. At the same time, the number of end-of-life electric vehicles will increase in the coming years. Recycling solutions must therefore exist to manage all these resources in a sustainable way and also to reuse selected batteries and extend their useful lives to the maximum. Stena Recycling is committed to becoming a leading player in Europe in the recycling and reuse of lithium-ion batteries, enabling the automotive industry's transition to circular solutions.

Stena Recycling increases battery recycling capacity in Europe

Stena Recycling is currently investing a quarter of a billion SEK in what will be one of Europe's most advanced battery recycling facilities. The facility will be located close to the Stena Nordic Recycling Center in Halmstad, Sweden. In early autumn 2022, construction began on the facility, which is expected to initially handle 10,000 tonnes of battery material per year, equivalent to around 30,000 electric car batteries. As the market grows, there is scope to scale up further to 20,000 tonnes. The facility and processes are flexible, which means that Stena Recycling can accept batteries from most products, as well as production scrap from battery manufacturers. The battery recycling plant will be one of the first of its kind on an industrial scale and aims to be operational by spring 2023. Stena Recycling's many years of

experience in the recycling industry has enabled the development of a method and process that will eventually recycle more than 95 percent of the material in a lithium-ion battery. Through advanced technology, the company is breaking new ground and setting the standard in lithium-ion battery recycling. In parallel and in line with the market, Stena Recycling is investing in facilities in Sweden and the rest of Europe. The company has currently established battery centers for collection, recycling and pre-treatment of batteries in Sweden, Norway, Denmark, Finland, Germany, Poland and Italy. Proximity to customers allows for more efficient transportation and safer handling by dismantling, discharging and short-circuiting the batteries at these battery centers. Discharged modules and cells will then be transported to the Halmstad plant for recycling. Stena Recycling also cooperates with other players in Europe to offer its services in countries where the company is not yet established.



The facility can handle around

30,000

vehicle batteries per year

EU increases requirements for battery recycling – Stena Recycling’s solution meets targets

In the coming years, the new EU battery regulation will enter into force in different phases. It replaces the old battery legislation from 2006 and provides a comprehensive tightening of legislation to stimulate entirely new circular partnerships between battery manufacturers, the industry and recyclers. Among other things, the regulation increases the requirements for recycling and reducing the climate impact of battery production and will ensure that batteries released on the European market are sustainable and safe. The legislation is new in that it regulates the entire life cycle from sustainable extraction of raw materials to waste management.

The regulation sets out requirements affecting the manufacture, design, traceability, collection, re-use and recycling of batteries throughout their life cycle. The proposed regulation also introduces a “Battery Passport”, which will be unique for many lithium-ion batteries placed on the European market. With this passport, operators and authorities will be able to track and add information about the battery throughout its life.

Stena Recycling welcomes the new battery regulation and shares the EU’s ambition to forge new circular partnerships between manufacturers and recyclers in Europe. Thanks to Stena Recycling’s unique recycling process, which aims to recycle 95 percent of a lithium-ion battery, the company’s solution can meet the very strict new long-term requirements from the EU.

The goal is to recycle

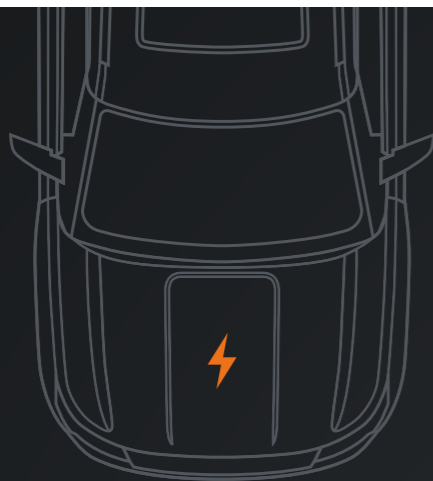
95

percent of lithium-ion batteries

Societal challenge

With increasing sales of electric cars and rising demand for raw materials for battery manufacture, it is of growing importance that batteries can be recycled to a greater degree. As part of the proposed battery regulation, battery manufacturers are required to use recycled materials in their production of new batteries as early as 2030 and that recyclers meet both general recycling levels for the whole battery as well as specific recycling rates for key metals such as lithium, cobalt, copper and nickel.

Stena Recycling wants to be an enabler for the battery and automotive industries, as it offers a circular solution for end-of-life batteries and battery manufacturers' production waste through its strong engagement in battery recycling. The possibility of reusing certain batteries is another important part of Stena Recycling's work. The aim is to recover more resources that can be re-used, instead of mining new battery minerals.



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PRODUCTION OF NEW ELECTRIC CARS

The aim is for new electric car batteries to be made from a certain percentage of recycled material. The more that is recycled, the closer one gets to a circular solution.

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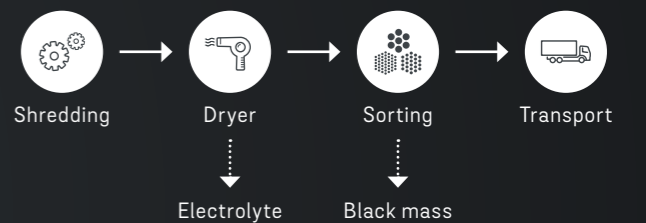
NEW BATTERY PRODUCTION

Using recycled materials in production is one of the most effective ways of reducing environmental impact, conserving resources and significantly increasing the degree of recycling.

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RECYCLING PROCESS

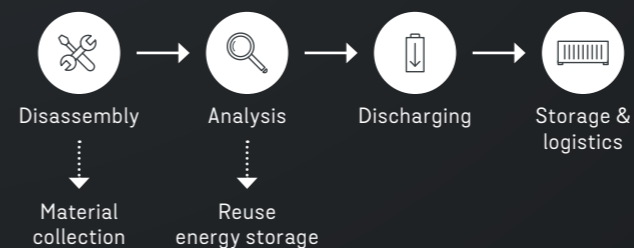
The battery material is shredded in shredders. Even if the batteries are completely discharged when they arrive in Halmstad, the shredding process takes place in an oxygen-free environment to avoid the risk of fire. The solvent is separated in a drying process. Once the battery material is finely shredded, a mechanical sorting process takes place which sorts out the different types of material, such as plastic, aluminium, iron and copper. They are then delivered for recycling. The valuable battery minerals – lithium, cobalt, nickel and graphite – are separated and collected into a black powder known as black mass. It is then delivered to industrial partners who, in turn, process the material through hydrometallurgical processes so the metals can then be used in the production of new batteries. In the future, the Halmstad plant aims to recycle 95 percent of a lithium-ion battery.



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CONTROL, ENERGY RECOVERY AND SAFE HANDLING

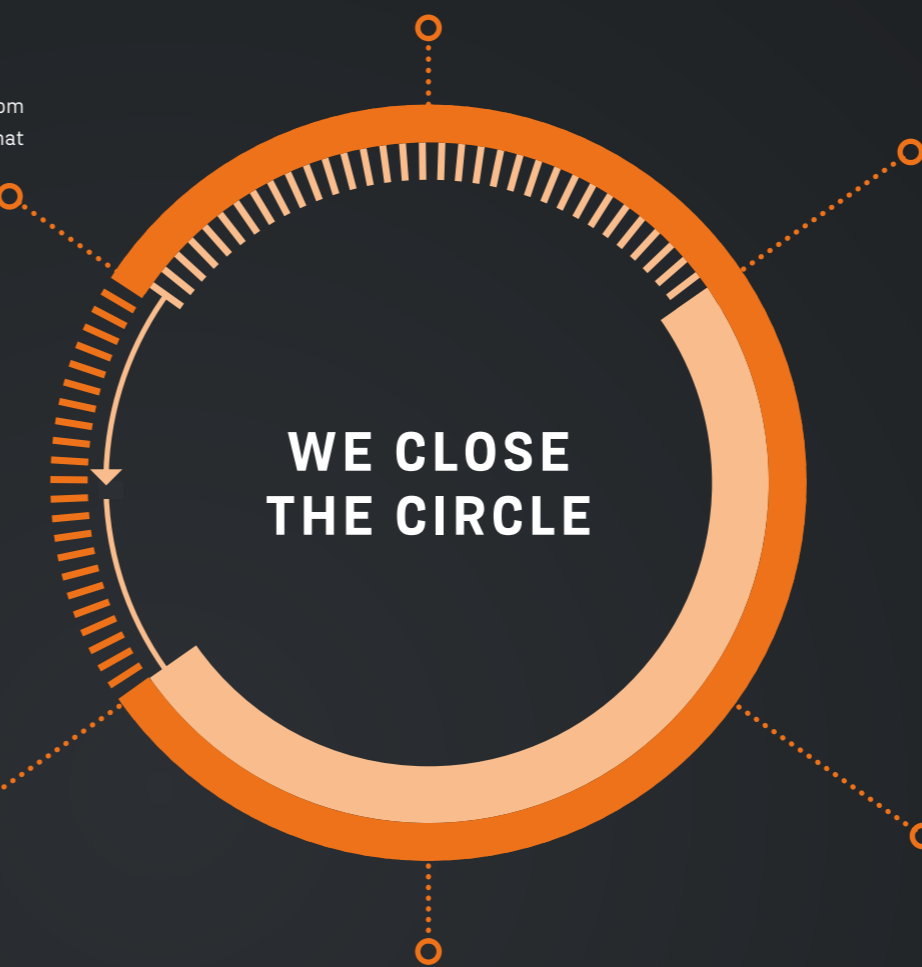
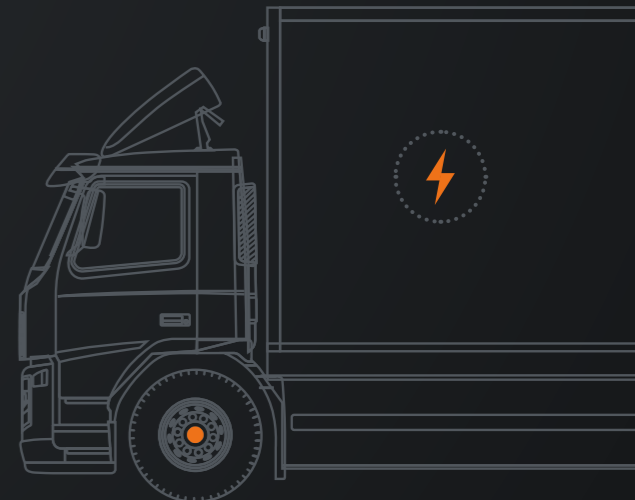
At the battery centre, the collected batteries are carefully checked to determine their condition. It is also determined whether all or part of the battery can be reused or whether it should go directly to recycling. End-of-life batteries for recycling are safely discharged, and the residual energy left in the batteries is captured and used in the company's recycling processes. In this way, Stena Recycling expects to cover about 20 percent of the energy requirements for battery recycling in Halmstad. The remaining energy consumption comes from origin-labeled renewable electricity. The effect of the chosen technology means that Stena Recycling can use the energy stored in the batteries.



#3

TRANSPORT OPTIMISATION AND SECURE LOGISTICS MANAGEMENT

Stena Recycling's entire business is based on extensive logistics of materials to the company's facilities which, after processing, is transported out by road and rail. The company thus has extensive experience in transporting dangerous goods in a safe and responsible manner, where every part of the chain is based on traceability.



Higher recycling rate, lower carbon footprint

Stena Recycling has chosen a new technology with significantly higher recycling rates and a lower climate impact than older plants.

Stena Recycling's method, which is based on a technology that uses a low treatment temperature, makes it possible to harness the energy stored in the batteries. This amounts to an estimated 1,200 kWh of energy per tonne of batteries.

The aim is to make the battery recycling process as efficient as possible, turning end-of-life resources into new raw materials. At the same time, close cooperation between all actors in the chain – battery manufactu-

rers, vehicle manufacturers and recyclers – is needed to achieve the highest possible recycling rate. Starting in the production phase of the batteries, they need to be designed in such a way that maximises the possibilities for recycling all parts of the battery. Moreover, when recycled raw materials replace virgin ones in the manufacture of new products, less energy is needed, leading to lower emissions.

In addition to an efficient process, all the electricity used for battery recycling will also be renewable in Stena Recycling's recycling plant in Halmstad.

Battery recycling needs to be promoted

End-of-life batteries can be handled in different ways: they can be reused, extending the life of the product, or they can be sent directly for recycling. Many of today's electric vehicle batteries are considered end-of-life in their first application when the original capacity has dropped to around 70-80 percent.

This means the batteries still have a good residual capacity and can therefore be reused for another purpose, for example in so-called stationary energy storage. At Stena Recycling's battery centers, battery performance is assessed. If the battery is in good condition, its product life can be continued and it can be reused. If the battery life is deemed to be exhausted, the battery is recycled.

Continued investment in research and development is necessary

The need for new solutions for battery recycling and circular product development has never been greater. Swedish research therefore needs to be stimulated and strengthened in order to remain competitive and contribute to the introduction of new sustainable solutions to the market. Stena Recycling believes in increased collaboration between government, industry and academia to achieve this.

The new EU battery regulation is driving development in the battery recycling sector and forcing all market players to further develop their process solutions. In this respect, industrial cooperation between actors

across national borders will be very important if we as an industry are to meet the requirements and expectations of the legislator.

Stena Recycling already contributes to and participates in several research projects together with the leading universities in Sweden and at EU level, which aim to promote the development of recycling and circularity linked to the electrification of society. But the research is not only about increasing the recycling rate of battery waste, it is also about identifying and preventing health risks in the process, and ensuring a good health and working environment for the staff at the facilities.



How we can create a more circular battery supply chain

Batteries are central and crucial pieces of the puzzle in the electrification of industry, transport and the automotive sector to meet climate challenges. Stena Recycling's engagement is a step toward meeting the growing need for recycled battery raw materials but more needs to be done, and all stakeholders, from battery manufacturers and vehicle manufacturers to recycling operators, have a shared responsibility.

RIGHT DESIGN FROM THE START

We need to work together to create a circular battery chain in society. Batteries are found in thousands of different products manufactured around the world, and Stena Recycling handles end-of-life batteries every day with designs that make recycling difficult. For example, the battery may be so built into the product that it is difficult to separate. The new European battery legislation will push for the industry to agree on standards

and principles for manufacturing practices that promote circularity. It is simply a matter of getting it right from the start.

Around 80 percent of a product's environmental impact is determined at the design stage. To facilitate the recycling of the battery in a product, it must be accessible and easy to remove. It needs to be designed in such a way that the recycler can take it apart and deal with each material separately. This is a prerequisite for achieving a high level of recycling. Much of the new European battery regulation is about promoting this, which Stena Recycling welcomes.

In addition to improving the recycling potential, better collaboration in the industry would also lead to a more cost-effective process and make batteries and electrical products both better and cheaper. Therefore, in addition to the climate, consumers will also benefit from this.

BATTERY LABELLING NEEDS IMPROVEMENT

Today it is very difficult to find and retrieve information about the batteries available on the market. This creates challenges for recycling and recovery operators. In practice, this means that it can be very difficult to recycle a battery due to a complete lack of information on, for example, chemical composition, dismantling instructions and battery capacity. As a consequence, recycling processes are very time-consuming, the maximum recycling potential cannot be obtained from the battery and the batteries cannot be reused.

The battery passport proposed in the new EU regulation aims, among other things, to remedy this and improve the exchange of information between market participants, which Stena Recycling is looking forward to. Openness and transparency are a prerequisite for full battery circularity. The battery passport is proposed to enter into force on 1 January 2026. Stena Recycling is ready for cooperation, for example when it comes to information on existing batteries.

An important part of the recycling process is the discharge of batteries. In order to carry out a deep discharge of batteries, which makes the recycling process as safe and time-efficient as possible, recycling operators should be given access to parts of the battery management system (BMS) or in other ways access to one point of discharge.

ENSURE EFFECTIVE INSPECTION AND COMPLIANCE

Stena Recycling welcomes the new European battery legislation. But the public sector must also ensure that the regulatory authorities have the resources and capacity needed to ensure that operators and society live up to the higher ambitions and requirements. Much of the challenge lies in giving authorities more resources and tools to better track and prevent a large proportion of electric cars and other large electric vehicles from disappearing into an unregulated part of the market outside the EU. This is a major problem when the ambition is to keep battery materials within the EU.

Stena Recycling invests large sums to meet new EU requirements on circularity and recycling. To balance such efforts, society must ensure that as large a share as possible of the recycling market is kept within the Union.





It starts here.