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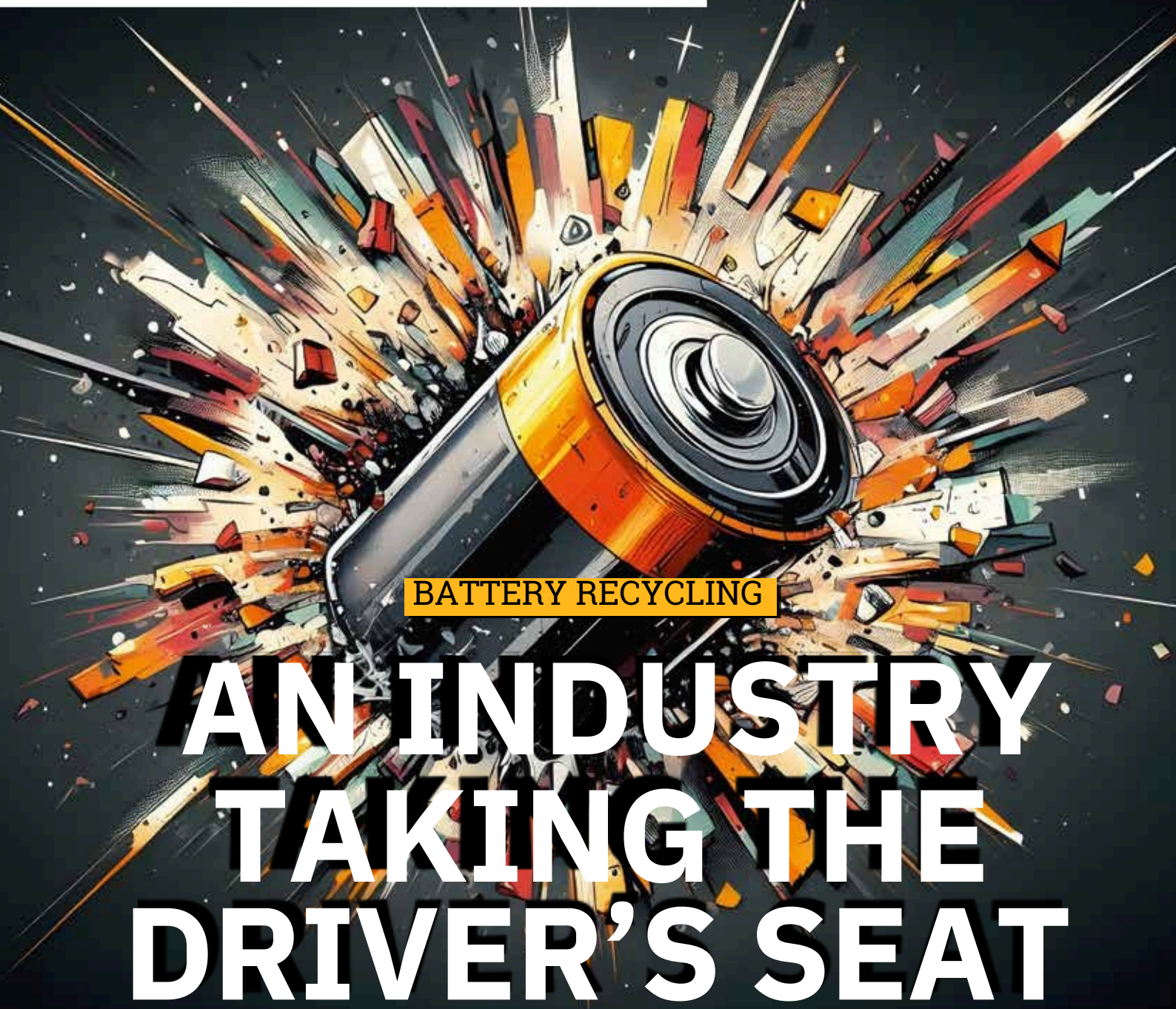
Special Edition

WASTEWATER



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Chief Editor Rudolf Loidl
rudolf.loidl@wmw.news

International Advertising Manager
Elisabetta dal Bello M. A.
dalbello@wmw.news
Fang Wei Goh (Singapore)
fangwei.goh@wmras.org.sg **Publisher**
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Editorial Correspondence/Press Releases
rudolf.loidl@wmw.news

w w w.wmw.news

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AN INDUSTRY UNDER POWER

Themoreelectriccars thereare on Europe'sroads,the greaterthe number of discarded batteriesthatneed to be recycled. How the industry is preparing for this challenge and the revision of the EU Battery Directive.

CONTRIBUTORS

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Incineration reloaded

Around a quarter of the waste produced in Europe is thermally utilised. With carbon capture and carbon storage, the industry wants to take a new approach and create CO2-negative waste incineration plants. But can the project succeed?

COP 28: HALFWAY POINT TO THE 2030 GOALS

adopted at the UN Climate – COP21, in 2015 setting the overarching goal to limiting global warming to 1.5°C, thus requiring effective actions to tackle GHG emissions by 45% by 2030. At the same point the UN Member States adopted the 2030 Agenda, aiming to achieving the 17 Sustainable Development Goals (SDGs) by the end of the current decade.

We are at the halfway point for both global milestones (Paris Agreement and 2030 Agenda): seven years have passed since its adoption and there are seven years to go before the window for impactful change closes. However, several recent reports show that humanity is lacking behind the deadlines and off track to achieve the goals set for 2030.

Therefore, COP28 subsists as a unique opportunity to accelerate actions and commit for immediate and consistent solutions, to change the current trend and secure a sustainable future for all, creating a forward-looking pathway to beat the effects of the triple planetary crisis.

At this halfway point, it's important to reflect on the journey since the adoption of the Paris Agreement and examine the way forward, with a clear and comprehensive assessment of the commitments presented so far and what is still missing to effectively cut GHG emissions towards a net zero future. And the instrument to audit the progress of the Paris Agreement is set to take place during this next Conference of the Parties. The first "global stocktake", to be concluded at COP28, will engage member states and stakeholders to analyse the progress since the adoption of the agreement, considering the climate ambitions expressed by the NDCs, in order to bridge the gaps and define the efforts to be considered for the next round to be delivered by 2025.

"AS THE WORLD'S LEADING NETWORK FOR PROFESSIONAL AND SUSTAINABLE WASTE MANAGEMENT AND THE TRANSITION TO CIRCULAR, ISWA IS PROUDLY HOSTING THE FIRST-EVER 'WASTE & RESOURCES PAVILION' AT COP28."

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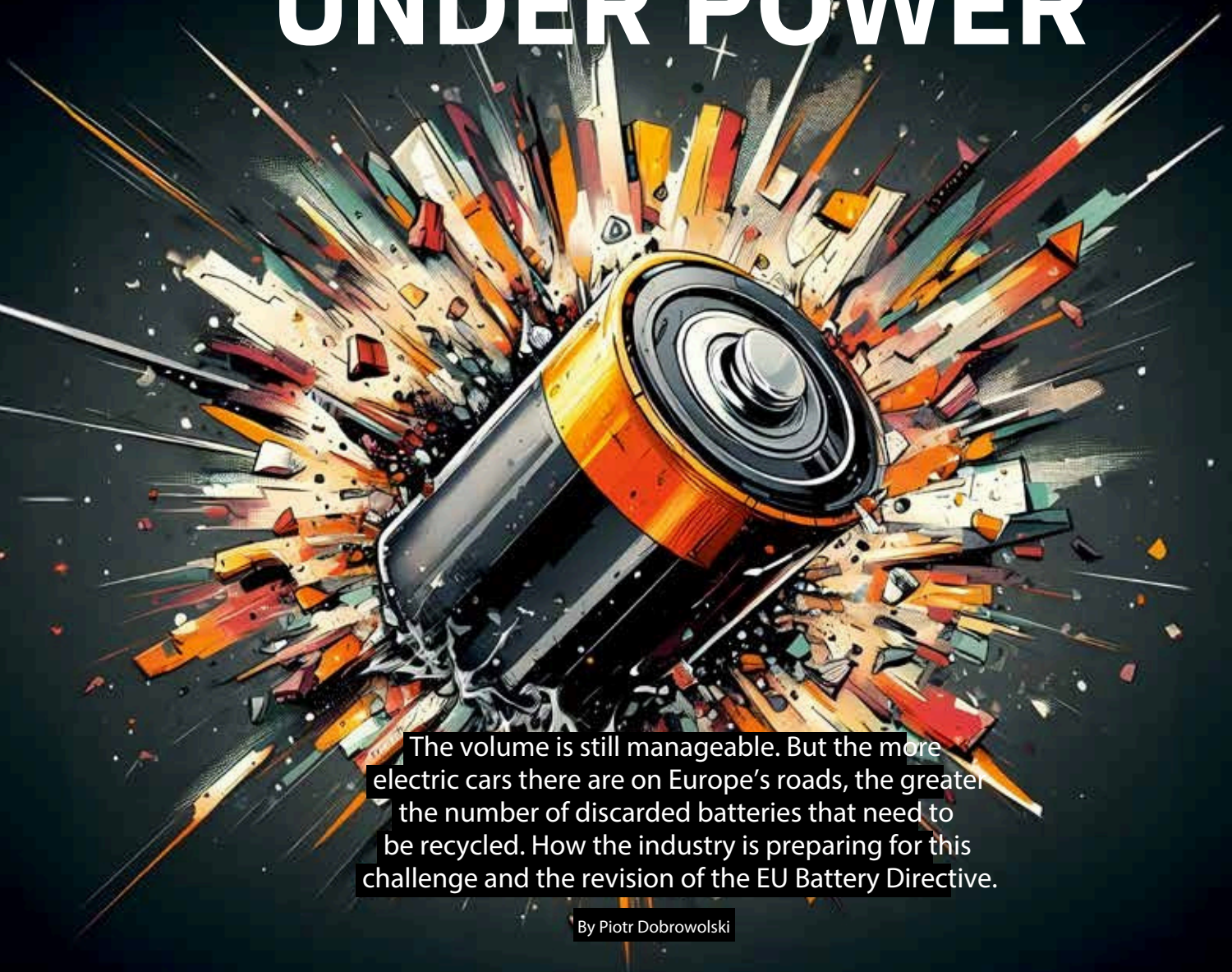
Carlos RV Silva Filho
ISWA President

In this sense, sound waste and resources management occupy a singu- lar position, as a net reducer of GHG emissions and key contributor to tackle the planetary crisis of pollution, biodiversity loos and, obviously, climate change. And ISWA is going to COP28 with the ambition to amplify the voice of the waste and resource management sector, calling upon decision-makers to recognize the positive potential brought by this sector for a low carbon future. As the world's leading network promoting professional and sustainable waste and resource management and the transition to a circular economy, ISWA is proudly hosting the first-ever "Waste & Resources Pavilion" at COP28, and together with key partners will deliver an extensive and meaningful program during the Conference in Dubai.

The schedule has been prepared to inform delegates, global stakeholders, investors and researchers about key messages, opportunities, case studies, technologies, and innovative solutions available to support the development of climate action plans directed to reach the 1.5°C goal.

This Conference of the Parties in 2023, marking the halfway point to the 2030 goals, is the pivotal moment to catalyze a collective effort for increased capital allocation to support bold and transformative actions directed to revert the adverse impacts of climate change and pollution, towards a cleaner, healthier, and sustainable planet.

BATTERY RECYCLING: AN INDUSTRY UNDER POWER



The volume is still manageable. But the more electric cars there are on Europe's roads, the greater the number of discarded batteries that need to be recycled. How the industry is preparing for this challenge and the revision of the EU Battery Directive.

By Piotr Dobrowolski

cording to estimates by the on Europe's roads by 2030 - mainly cars and two-wheelers, but also an increasing number of lorries. The major goal of the European Green Deal to reduce transport-related greenhouse gas emissions by 90 per cent by 2050 is therefore a good deal closer. But there is also a downside to this ambitious plan: if the millions of e-vehicles announced are actually to become a reality, battery production will have to increase by a factor of almost twenty over the next few years. It is

obvious that the waste industry and legislators are already thinking about how this will affect the future European circular economy, material flows and their recycling.

With its updated EU Battery Directive, the European Parliament has provided a number of guidelines. Firstly, the directive creates a new classification by introducing a separate category of batteries, namely batteries used to power light road vehicles such as e-bikes and e-scooters. The EU Parliament argued that the increasing importance of these batteries for e-mobility makes this step necessary, as in future, batteries for light vehicles as well as those used to power heavy vehicles such as cars, ships or aeroplanes will have to show their carbon footprint and contain a minimum proportion of recycled material. These requirements should also apply to industrial batteries with a capacity of more than 2 kWh.

AMBITIOUS QUOTAS.

While the requirement to use certain quantities of recycled material in certain types of batteries already creates a strong pressure to recycle, the European Parliament's idea is to increase this pressure by imposing stricter collection targets. The new directive therefore also provides for the collection target for portable batteries to be increased from the current 45 per cent to 63 per cent in 2027 and 73 per cent in 2030. For batteries from light transport vehicles, 51 per cent is to be achieved by 2028 and 61 per cent by 2031. At the same time, minimum quantities were also set for the recycling of lithium, cobalt, copper, lead and nickel from batteries.

However, battery recycling is increas- ingly becoming an indispensable necessity, even beyond legal regulations. In the area of battery construction alone, eighteen times as much lithium will be needed by 2030 as today, and sixty times as much by 2050. The demand for cobalt will increase fivefold by 2030 and fifteenfold by 2050. The industry is generally open to the

regulatory requirements that it will have to fulfil in the future in order to obtain at least some of the required raw materials through recycling. Emeric Malefant, Head of the Electric Vehicle Batteries Recycling Programme at Veolia, says: “We support the new regulations. However, there are still some unanswered questions, in particular how the introduction of these regulations can be organised in such a way that it promotes the recycling of batteries in the best possible way.” Julian Proells, Director Business Management Battery Recycling at BASF, is also fundamentally in favour of the updated Battery Directive. “It ensures that all players within Europe operate under the same conditions.”

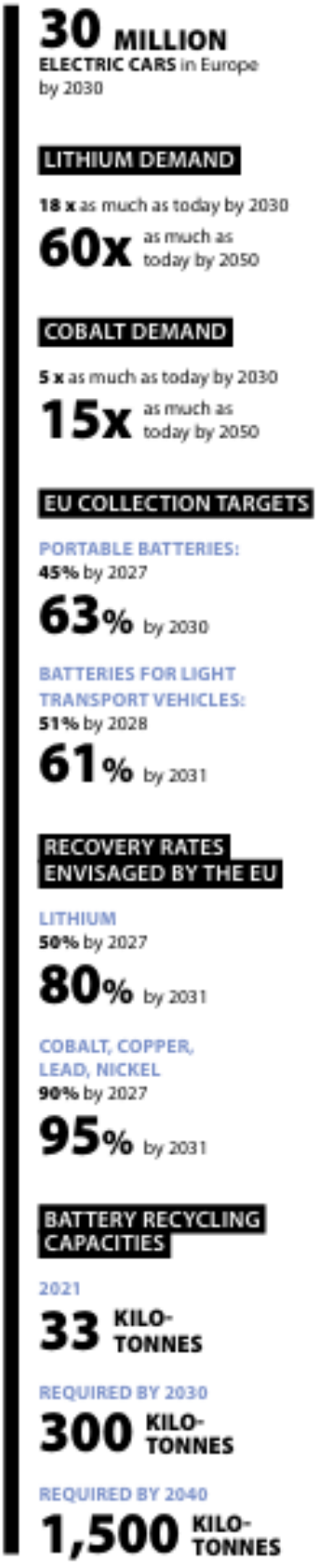
MARKET IN A DISCOVERY PHASE.

At the same time, it is clear that the market is currently in a discovery phase. On the one hand, there are currently no large quantities of vehicle batteries that could be recycled - most batteries from electric cars, bikes and scooters will only reach the end of their life cycle. On the other hand, there is also currently a lack of capacity to recycle larger quantities. Most of the recycling plants in Europe are only pilot projects; scaling them up to a commercially viable level will be the next step.

A study by the German Fraunhofer Institute for Systems and Innovation Research has put the existing capacity for battery recycling in Europe at 33 kilotonnes per year in 2021. At the same time, the study suggests that the volume of lithium-ion batteries and battery components to be recycled across Europe will increase to up to 300 kilotonnes per year by 2030. By 2040, the figure will be 1,500 kilotonnes per year. Battery recyclers are still far from sufficiently equipped to handle such quantities, even on the logistics side. This is confirmed by Robert Sommer, Senior Segment Manager at Dolav, an international logistics equipment provider: “Everyone knows that large quantities are coming, but it is still a matter of preparing for the future, of investing in it.”

UNRESOLVED TECHNOLOGY ISSUES.

There are also a number of technical issues that still need to be resolved at every stage of the recycling process. On the one hand, it is clear that automation will be unavoidable in the dismantling



"USED BATTERIES CAN WORK WELL AS STORAGE MEDIA FOR ELECTRICITY FROM WIND TURBINES AND PHOTOVOLTAICS FOR ANOTHER TEN TO FIFTEEN YEARS BEFORE THEY HAVE TO BE SCRAPPED OR RECYCLED."

Maximilian Fichtner
University of Ulm

"WE SUPPORT THE NEW REGULATIONS. HOWEVER, SOME QUESTIONS REMAIN UNANSWERED, IN PARTICULAR HOW THE INTRODUCTION OF THESE REGULATIONS CAN BE DESIGNED TO BEST PROMOTE THE RECYCLING OF BATTERIES."

Emeric Malefant
Veolia

of batteries as soon as volumes increase. On the other hand, many of the batteries currently installed in vehicles are not particularly suitable for disassembly by a robot, for example because they have flexible parts that are difficult for a robot arm to grip. Regardless of this, automated disassembly also raises many safety issues: from the leakage of hazardous substances to the risk of fire. The best way to design disassembly robots in such a way that they can process as many types of batteries from as many manufacturers as possible is also still an open technical question.

Zied Shakrun, Business Development Future Markets and Innovation at Siemens, is nevertheless convinced that automation will find its way into battery recycling, despite all the uncertainties that still exist: "Digitalisation and automation are the tasks that lie ahead. The potential we see here is huge."

FOCUS ON BLACK MASS.

Many of the developments currently being researched in the field of battery recycling relate to the steps following the dismantling and shredding of used batteries. Shredding is usually followed by treatment of the shredded material, in which steel, aluminium and copper components are separated, leaving behind a mixture of electrode materials, binders, additives and residual electrolyte components - the so-called black mass. It is particularly valuable in terms of reuse, as it contains cobalt and lithium, among other things. However, extracting the two from the black mass so that they can be reused is anything but trivial. With current recovery technologies, recovery rates of forty to fifty per cent are achieved for lithium, for example, and up to eighty per cent should be possible in the medium term.

But even if ninety per cent were to be achieved: After just a few cycles, more than half of the original lithium would have been lost. After a few more cycles, only traces would remain. "This illustrates very well the problem that arises with all recyclable materials that are not one hundred per cent recyclable. Even with high recovery rates, the material loss is very quickly so high that you can hardly speak of a cycle," says Stefan Freunberger, who conducts research at ISTA, the Institute of Science and Technology Austria.

BATTERIES MADE FROM ORGANIC MATERIAL.

At present, however, recyclates can only cover a very small proportion of the demand for raw materials for battery production anyway, as high demand is offset by only small quantities of batteries that are recycled. However, according to estimates by the Fraunhofer Institute for Systems and Innovation Research, it will still only be possible to cover forty per cent of the demand for cobalt with recyclates in 2040, but only around fifteen per cent for lithium, nickel and copper.

Research has therefore been endeavouring for some time to design batteries that can do without problematic and scarce raw materials and that use organic material. In addition to better availability, such batteries also have an advantage when it comes to recycling. Even if not every organic material is equally degradable, organic materials are generally easier to recycle.

The researchers led by Stefan Freunberger have found a solution in which organic material can be used to produce a battery that achieves similar energy densities to lithium-ion batteries based on iron phosphate. Lithium-ion batteries are used in many areas, including e-mobility, where the even more energy-dense nickel-manganese-cobalt cells are also used in the high-end segment.

SUBSEQUENT UTILISATION OF ELECTRICCAR BATTERIES.

The potential for utilising batteries based on organic materials is huge. They are already being used in stationary applications where space is not a limiting factor. With a solution that achieves the energy density of lithium-ion cells, their use in e-mobility is also conceivable in the medium term.

Aside from new technological solutions, one way of dealing with the high demand for batteries could also be various reuse concepts and using batteries for as long as possible. The German

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Veolia's battery recycling activities: The process is based on the know-how developed over many years around the recycling of metal-bearing waste by chemical means.

Cadmium batteries and has deployed processes for valorizing Li-ion batteries from D3E and new electric vehicle battery technologies. Through its CEDILOR site in Amnéville (Moselle), has units dedicated to the extraction of metals contained in other types of waste (sludge metallurgical products, catalysts, chemical effluents), in particular for nickel and zinc.

How does Veolia refine the precious components?

The process developed is based on the know-how developed over many years around the recycling of metal-bearing waste by chemical means: catalysts from chemistry and petrochemicals, portable batteries, effluents from surface treatments, etc. The objective is to selectively extract nickel, cobalt and lithium in the form of mono-metallic salts that can be reused in the production of new batteries. The co-products thus obtained have characteristics compatible with their reuse in refining processes to replace natural resources. Depending on their degree of purity, they can be reinjected throughout the battery manufacturing line, either at technical grades upstream of the metal sulfate production processes, or refined, to manufacture precursors.

About Veolia Veolia Group aims to become the benchmark company for ecologi- cal transformation. Present on five continents with nearly 213,000 employees, the Group designs and deploys useful, practical solutions for the management of water, waste and energy that are contributing to a radical turnaround of the current situation. Through its three complementary activities, Veolia helps to develop access to resources, to preserve available resources and to renew them. In 2022, the Veolia group provided 111 million inhabitants with drinking water and 97 million with sanitation, produced 44 terawatt hours of energy and recovered 61 million tonnes of waste.

What is the planned scope of the venture (geographicalandvalue growth)?

The new hydrometallurgical recycling unit is located on the Cedilor site in Amnéville. After a gradual increase in power, the unit should be able to recycle at full capacity of around 7,000 tonnes of black mass, or the equivalent of 60,000 batteries. The start of the installation is planned for the end of 2023.

Why is your investment in this area soimportant?

Recycling electric vehicle batteries is crucial to reducing environmental impacts, preserving natural resources, fostering a circular economy and supporting the transition to more sustainable mobility. According to a Eurostat study carried out in 2020, transport represents 23.2% of sources of greenhouse gas (GHG) emissions in Europe, equivalent to the energy production sector (23.3%). . In comparison, waste management emits 3.3% of GHGs. Among the different modes of transport, road transport predominates over all others, in terms of the volume of travel and the energy used. To reduce the impact of transport on the environment and achieve the objective of carbon neutrality in 2050, European governments have committed to the development of electric mobility. As such, end-of-sale targets for new passenger cars and light commercial vehicles using fossil fuels have been set in different countries. They are accompanied by ambitious objectives for the production of electric vehicles.

What are the capacity targets?

In France, for example, a production target of 2 million electric vehicles per year by 2030 has been set. It is therefore a question of producing in electric models the equivalent of all the vehicles sold annually in France, all types combined. To ensure the production of these electric vehicles, the development of Gigafactories (battery manufacturing plants) will need to reach an annual capacity of approx- imately 140 to 160 GWh of electrical power, or 2 million batteries.

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INCINERATION RELOADED

Around a quarter of the waste produced in Europe is thermally utilised. The incineration plants used for this contribute to energy generation, but are also CO2 emitters. With carbon capture and carbon storage, the industry wants to take a new approach and create CO2-negative waste incineration plants. But can the project succeed?

By Piotr Dobrowolski

The matterisdifficult. Anyone trying togetan overview of the carbonfootprintof waste incineration inevitably ends up ina jungleof figures,statistics, graphs and comparisons fromwhich it is difficult to distil a consistentpicture.

In Norway, for example, around five per cent of energy requirements are covered by heat from waste incineration. At the same time, waste incineration accounts for around thirty per cent of CO2 emissions in the energy sector. However, this is not because

but also contributes only one per cent to energy generation. This is due to the fact that fossil fuels are still heavily utilised in Italy and, against this background, the share of waste incineration in CO2 emissions is modest.

And to complicate things further: If Italy and Norway were to utilise less waste in waste incineration plants, this would not necessarily have a positive effect on the CO2 balance. At least not if the waste were to be stored in landfills instead, where it would release the greenhouse gas methane.

For this reason, the EU clearly favours thermal recovery over landfill where recycling is not possible. This is also why China is currently investing heavily in incineration. (For background information, see box on page 22).

"THERE WILL ALWAYS BE A NEED TO STORE CARBON UNDERGROUND SAFELY AND FOR A LONG TIME."

Uni[redacted]

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INVESTING TOO MUCH?

China is focussing on waste incineration. And on recycling. But those responsible may have made a few planning mistakes.

It's actually good news. China's collection and recycling systems for household waste are growing at an impressive rate. In Shanghai, for example, only 21 per cent of collected household waste was recycled in 2018, compared to 54 per cent in 2021. At the same time, China has built countless new waste incineration plants so that waste that cannot be sorted and recycled is sent for thermal utilisation instead of being deposited in landfill sites as was previously the case.

However, there is a catch to this success story. There are many indications that China has expanded its waste incineration capacities more than necessary, despite repeated protests from neighbours. As of November 2023, the country has 927 such plants, compared to just 130 twelve years ago.

In view of the large number of plants and increasing recycling volumes, operators in some regions are now running out of material, i.e. waste that is to be thermally utilised. There were 8,499 operational interruptions in Chinese waste incineration plants in May of this year alone. Not all of these are due to a lack of material, but the assumption that the stoppages are mainly to do with this is also supported by figures.

For example, across all provinces in China, there is a de facto balance between the quantities of waste to be thermally utilised and the utilisation capacities. However, a closer look reveals that, on the one hand, there is massive overcapacity in many provinces, for example in Hebei at 177 per cent or in Hainan at 169 per cent, while elsewhere there is still massive pent-up demand, for example in Inner Mongolia, where capacity is just 41 per cent of demand, or in Xinjiang, where it is 45 per cent.

phase. Norway is a pioneer in this respect, promoting CCS projects in various sectors, including waste management, via the public Longship programme. The best known of these is the Klemetsrud waste incineration plant in Oslo. If the project proves to be viable, Klemetsrud could become the world's first waste incineration plant with a negative carbon footprint. It would bind more CO2 than it emits. The concept would also be scalable to around 500 plants of a similar size throughout Europe.

COST ISSUE DAMPENS OPTIMISM

The fundamental technical feasibility of the project is beyond dispute: In a pilot project, it has been possible to process the CO2 capture in such a way that it is stable and transportable. The transport itself is initially to take place by rail to the port of Oslo and then by tanker to the storage sites in the North Sea. However, the high costs led to a significant slowdown in work on the project in April of this year. An updated estimate, the operators wrote in a press release in the spring, showed that a sharp rise in prices, geopolitical instability and a fall in the exchange rate of the Norwegian krone made it necessary to lead the project into what is described as a cost-cutting consolidation phase.

At the same time, however, the operators emphasise that the project should not be put on ice forever: "Our clear goal is still to establish CO2 capture at the Klemetsrud waste incineration plant, but we need to adjust the path to the goal," says Knut Inderhaug, Managing Director of the operating company Hafslund Oslo Celsio.