

MAGAZINE
2018/19

RE / SHAPE

THE FUTURE

 **Aurubis**
Metals for Progress

RE / SHAPE

Our goal is to improve each and every day, a goal we weren't always successful in achieving during the past fiscal year. This pushes us to continue working hard and focusing on the things that really count, the things that make a difference, in an effort to reshape our future.

Our strategic orientation to the multi-metal business is the basis for tomorrow's success. We plan to strengthen our recycling activities with additional international acquisitions. Recycling materials are real treasures that we unlock with our knowledge and our technology, allowing us to recover valuable metals while fulfilling our responsibility to society through our sustainable approach to resources.

The prefix "RE" best sums up our recycling activities – it represents metal recovery, a responsible approach to business, and being open every day to new ideas that simply make us better.

It starts with our magazine and Annual Report, which are 100% recyclable and printed in a CO₂-neutral process.





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RE / PUTATION



“
We're still on the right track with our multi-metal strategy. And we'll continue to implement this approach.
”

ROLAND HARINGS
EXECUTIVE BOARD CHAIRMAN

INTERVIEW WITH THE EXECUTIVE BOARD CHAIRMAN

“I see fantastic opportunities for Aurubis, especially in recycling”

MR. HARINGS, YOU’VE BEEN AT THE HELM OF AURUBIS FOR ABOUT HALF A YEAR NOW. HOW WERE YOUR FIRST FEW MONTHS?

They were both very exciting and very intense. I’m pleased with the warm welcome I received at Aurubis, and I’m proud to be part of this dedicated team. But I also came during a phase of far-reaching decisions for the company, so there wasn’t much time to get settled.

THAT’S TRUE. IN THE FIRST MONTH OF YOUR TERM, YOU WERE ABLE TO ANNOUNCE THE ACQUISITION OF THE METALLO GROUP.

Right, a crucial transaction for our company, and a very positive one at that. The acquisition of the Metallo Group, which is still subject to approval by the European Commission, will take us to a new level in multi-metal processing. The combination of the two complementary business models considerably strengthens our portfolio in metals of the future, such as nickel, tin, zinc, and lead. It makes us a leading solution provider in Europe when it comes to processing complex recycling raw materials. Metallo and Aurubis are also united by their efforts towards sustainable

metal production: together, we’ll recover even more environmentally friendly and recycled material. This is something that is very important to me. And something that we have to preserve in Europe.

SPEAKING OF EUROPE: POLICYMAKERS ARE STRIVING FOR CARBON NEUTRALITY BY 2050. WHAT DOES THAT MEAN FOR AURUBIS?

I’m convinced that we have to make our production processes as carbon-neutral as possible. And my goal is to achieve this as quickly as possible. As an industrial company, we’re already working intensively on being part of the solution for the energy shift. We are steadily improving our energy management, optimizing material cycles within our value chain,

and checking out new ideas and technologies. For example, we’re currently sounding out how we can reduce fossil fuels by using hydrogen in production.

However, the fact is that Aurubis will remain an energy-intensive company now and in the future. That’s the nature of metal manufacturing. As a result, we in Europe have to make sure that metal production stays profitable – otherwise, its existence is at risk. We need reliable conditions at the political level to ensure our international competitiveness.

WHAT ARE SOME CURRENT, CONCRETE EXAMPLES OF CO₂ REDUCTION?

For one, there’s our award-winning Industrial Heat project, which already reduces about



Roland Harings advocates reliable conditions that ensure that metal production in Europe remains internationally competitive.

In Harings' opinion, Aurubis has some internal homework to do to make itself fit for the future.



20,000 t of CO₂ annually and has the potential to reduce up to 140,000 t. That alone accounts for over 90% of the voluntary CO₂ reduction commitment that Hamburg companies have agreed on. Another example is our power-to-steam plant, which went online this year. It can reduce CO₂ emissions by up to 4,000 t per year by using renewable energies. But to be very clear: we achieve a large part of this reduction outside of the plant boundaries. This means that it is only offset against our CO₂ emissions to a limited extent. Nevertheless, this isn't a reason to avoid implementing such meaningful projects.

THIS IS A TOPIC THAT OBVIOUSLY MEANS A GREAT DEAL TO YOU.

Absolutely. Another issue that's also important to me personally is occupational health and safety. In this area, Aurubis hasn't gotten to where we want to be yet. We'll therefore work more consistently on this in the future, especially when it comes to substantially reducing the number of accidents and injuries. Among other things, we've developed a new communication concept for this purpose, called 10forZero. It combines new communication materials with modern training units. All of these measures together have to lead to a change in employee conduct so that we can quickly reach our long-term vision of zero accidents and injuries.

YOU HAD TO STOP A COMPLETELY DIFFERENT PROJECT IN 2019 – FUTURE COMPLEX METALLURGY, OR FCM FOR SHORT. CAN YOU SAY ANYTHING ABOUT THE REASON FOR THIS DECISION?

Of course. First of all, however, it's important for me to emphasize that halting the internal growth project FCM, with which we had wanted to process higher volumes of complex material, was fully detached from our multi-metal strategy. We're still on the right track with the strategy and we'll continue to implement it. The best example is the acquisition of the Metallo Group, which has more than ten years of experience in multi-metal recycling alone.

But back to FCM: the Executive Board and Supervisory Board made the decision in June to discontinue the project in its current form. Why? In particular, because it became clear at that point in time that the project would require much higher investments than planned. We therefore wouldn't have been able to maintain our profitability targets anymore. This decision was not easy for us, but it was the right step to take, especially since none of the key facilities had been ordered at that point yet. We are now fully documenting the project with the core team. Nothing is

lost, we're just back to square one. Following the successful integration of Metallo, we will look at the material flows in the expanded smelter network again in more detail. At that point, we will discuss what additional multi-metal projects will be implemented in the future.

YOU'VE DESCRIBED 2018/19 AS A TRANSITIONAL YEAR FOR AURUBIS. WHERE DO YOU SEE THE GREATEST CHALLENGES?

The past fiscal year has shown that we definitely have some internal homework to do to make ourselves fit for the future. The unplanned shutdowns in the plants and our cost basis are two key topics I'd like to mention here. Without a doubt, 2018/19 was a transitional year during which we had to equip ourselves for multiple large-scale maintenance shutdowns. In Hamburg alone, we invested approximately € 50 million in around 450 individual projects for this purpose in the fall. To give you an idea: in addition to 750 of our own employees, about 1,200 employees from partner companies worked during these shutdowns – around the clock! It's also clear that unplanned downtimes can't happen to the extent that they did in the past fiscal year. We have to improve in this area. Our research and development activities will therefore concentrate more

strongly on optimizing operating processes in the future.

While we're talking about challenges, we should also discuss the markets. Our business is influenced by different market developments that we have zero or very little control over. During the past year, we closely monitored topics such as the global capacity buildup on the mine and smelter side, the weakening global and European economy due in large part to trade conflicts, and the sagging global metal demand that ensued. Although we view some of these effects as temporary and look positively to the future in light of the healthy fundamental data regarding the metal markets, we still have to keep one thing in mind: to ensure our success on the market in challenging times, it's crucial that we position ourselves

more efficiently internally and continue to pursue our strategy.

HAVE YOU ALREADY OUTLINED ANY MEASURES THAT WILL SHAPE YOUR FIRST YEARS AT AURUBIS?

Yes, absolutely. Our multi-metal strategy will of course be the focus of my attention, along with the successful integration of the Metallo Group. However, this also includes finding a meaningful solution for our Segment Flat Rolled Products since the European Commission prohibited the sale in February 2019. We stand by our intention to sell Segment FRP. As soon as we're on the right track with that, we'll once again take a closer look at growth opportunities abroad. We have the financial means, with available funds exceeding € 1 billion.

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We'll once again take a closer look at growth opportunities abroad.
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ROLAND HARINGS

And I already addressed our cost basis earlier. With our top-down efficiency improvement program and the Aurubis Operating System, or AOS for short, we've achieved important project success in the last three years, uncovering inefficiencies and driving continuous development. Our internal AOS consultants will continue this throughout the company in the future in the new department Group Process Management. We want to keep making our processes leaner and push digitalization forward in the Group.

Nevertheless, we intend to go one step further in the future, placing a stronger focus on the cost side.

We'll identify corresponding measures at all of the sites and start implementing them promptly. We of course plan to report on these measures at regular intervals. However, what's even more important to me is that we see the results in the company's success.

LET'S CLOSE ON A DIFFERENT SUBJECT. WHAT IS IT ABOUT AURUBIS THAT EXCITES YOU THE MOST?

I can think of a number of things. First and foremost, the people. I've now visited most of our sites and I'm delighted by the enthusiasm the "Aurubians" have for their work, and by the fact that many colleagues come to me with new ideas. And then there are of

course our products, our metals. We're truly at the place where the future is being created. Copper is the metal of the energy shift. Renewable energies require up to twelve times more copper than conventional energy systems. And we produce this copper today from recycled material to a large extent, under the strictest environmental standards in the world. And I see fantastic opportunities for Aurubis, especially in recycling.

AND WHAT IS YOUR PERSONAL WISH FOR THE CURRENT FISCAL YEAR?

I would be happy for more positive news to dominate again. We invested extensively in our facilities in 2018/19 and learned a great deal. The company has to secure its operating performance. Together with all Aurubis employees, we on the Executive Board team want to lead the company to a successful future. We're confident that the potential is there. I, personally, will put all of my energy into implementing this as well. And we'll be successful if we all focus on our strengths.

Roland Harings reaffirms that with Aurubis' multi-metal approach and its targeted expansion of the recycling business, the company is pursuing the right strategy for a successful future.



The interview was conducted by Angela Seidler, Vice President Investor Relations & Corporate Communications.

“
***Together with all Aurubis
employees, we on the Executive Board
team want to lead the company
to a successful future.***
”



From left to right:

DR. THOMAS BÜNGER
Chief Operations Officer

RAINER VERHOEVEN
Chief Financial Officer

ROLAND HARINGS
Executive Board Chairman

RE / FOCUS

BUSINESS MODEL

Robustly positioned for sustainable success

Today, Aurubis has a broader position than ever before: we process metal concentrates, scrap metals, and metal-bearing recycling materials into metals of the highest purity and products with added value. Christophe Koenig, Senior Vice President Commercial, on mine partners, market flows, and why recycling is becoming increasingly important as a driver of value.

“To put it very simply, our business rests on three main pillars: the processing of raw materials from the mining industry, the processing of recycling materials from preprocessors and the electronics industry, and product business,” says Koenig. “The core of this unique positioning within the metal value chain is the use of different metallurgical flows, and each of these three pillars is influenced by different market cycles. This broad positioning ensures the sustainability of our results and the robustness of our business model.”

Christophe Koenig is Senior Vice President Commercial and, together with his team, coordinates the purchase of raw materials and the sale of metals for the sites.



CONCENTRATE BUSINESS: COMPLEXITY, SUSTAINABILITY, AND A FOCUS ON INDIVIDUAL SOLUTIONS

Aurubis sources metal concentrates from its global network of over 30 mining partners and a few traders. The company has decided that mining metal ores is not part of its strategy. What some would see as a disadvantage is something that Koenig views as a strength. “The independence and flexibility of this setup allow Aurubis to create an optimal input mix of standard and complex raw materials for its production facilities. We are focusing on our core expertise.”

Thanks to its integrated smelter network, Aurubis can process complex concentrates and optimize its concentrate mixes. For Koenig, the advantages for both the mines and Aurubis are clear: “We enable our mining partners to unlock the value of their

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We favor mine partners that demonstrate the same dedication to sustainability in their downstream value chain as we do.
”

CHRISTOPHE KOENIG



complex metal concentrates, and Aurubis benefits from a higher margin for the solution they provide.” This expertise makes Aurubis an in-demand partner for developing specific answers to the needs of the mining industry, for instance when it comes to concentrate quality. Furthermore, the topic of sustainability is gaining more traction. “Not only consumers are becoming more aware of environmental and social issues. Our mining partners now also increasingly value a responsible and environmentally sound business approach. We at Aurubis pride ourselves on setting benchmarks in the industry!”

Aurubis enters into long-term supply contracts with its mine partners to ensure the capacity utilization of its assets and provide planning security. This is also a way of committing to its partners: “We are committed to our long-term partnerships and we favor mine partners that demonstrate the same dedication to sustainability in their downstream value chain as we do. Sustainability is not only a topic of environmental protection and social responsibility, it also means that we value partners who have a long-term view and are not only seeking to maximize short-term margins.”

Precious cargo: at our site in Pirdop, Bulgaria, we transport copper concentrates from the storage facility to the primary smelter by conveyor belt.



Find out more about how KfW IPEX-Bank and Aurubis work together to develop solutions for mine projects. www.kfw-ipex-bank.com

RECYCLING BUSINESS: THE CIRCULAR ECONOMY DRIVES EARNINGS

The recycling business has established itself as an additional key earnings driver at Aurubis. "From high-copper scrap to industrial residues and end-of-life electronics that make their way back to us, we are one of the leading copper recyclers in the world," says Koenig.

The company currently processes about 700,000 t of recycling material per year at its sites. "Sustainability being close to our heart, we are committed to providing solutions to the growing recycling market. With our expertise and assets, we are well positioned to answer the needs of the recycling market," according to Koenig.

Aurubis also offers to purchase production residues or scrap from its customers to then, if required, deliver refined copper back to them. This is done mostly through longer-term contracts and thus dampens fluctuating availability of scrap in the short term. These "closing-the-loop" contracts provide Aurubis with additional planning security.

The recycling market is currently undergoing various developments: different national regulations, such as the import restrictions on certain copper scrap qualities in China, are causing global market streams to shift. "The recycling business is becoming more and more important as an earnings factor for Aurubis," says Koenig.

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The recycling business is becoming more and more important as an earnings factor for Aurubis.
”

CHRISTOPHE KOENIG

From old to new: we offer our customers the option to sell their production residues or copper scrap to us in return for refined copper.

PRODUCT BUSINESS: AN IMPORTANT OUTLET FOR METAL OUTPUT AND AN EAR TO THE MARKET

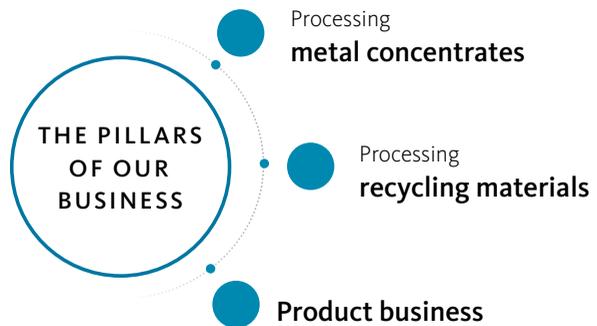
The product business combines several earnings factors: in particular, the manufacturing and marketing of various copper products and other metals, sales of sulfuric acid, and sales of by-products. According to Koenig, the product business is not only an important earnings driver. It also allows the company to stay in continuous contact with its copper consumption markets and the downstream industry.

Aurubis processes most of its refined copper output into copper products such as wire rod and shapes. “We at Aurubis are involved in an ongoing dialogue with our customers and discuss a wide range of issues such as material specifications, future trends, and aspects of sustainability,” says Koenig.

Another earnings component in the product business is sulfuric acid, which is mainly sold to the chemical and fertilizer industry as a by-product of concentrate processing. “In good years, the sulfuric acid business is an attractive earnings contributor.” Depending on the contents of the copper concentrates and recycling materials Aurubis processes, the company also increasingly recovers additional

metals and sells them on a number of metal and precious metal markets. “Aurubis specialists regularly check whether the company should develop its intermediate products further to ensure marketability and the best positioning in the value chain at attractive margins.”

Koenig summarizes: “The strength of our business model lies in the fact that the main features that drive earnings balance each other out in some cases, allowing us to handle the volatility of different market prices relatively well. And by developing our recycling business, we are working on the big societal challenges of our time.”



RE / CYCLING

RECYCLING QUALITIES

Our credo: the more complex, the better

Slags, electronic scrap, and filter dust – Andreas Nolte recognizes the intrinsic value of things that most people would consider waste material. He knows where the real treasures can be found in recycling – and how to recover them.

Up to 80 trucks make it to the Lünen site on a normal day. This is where Aurubis processes the lion's share of its recycling raw materials. Each year, the entire Aurubis Group receives a total of about 28,000 truckloads of 25 t each. Roughly 30 to 40% of the material is simple copper scrap, while the rest is made up of complex compositions. The latter is increasing steadily. While this development entails challenges in processing, it also provides opportunities on the earnings side.

Andreas Nolte oversees Integrated Management Systems, Security & Risk, and Public Recycling Affairs at the Lünen site.





Aurubis processes recycling materials that couldn't be any more different or complex.

SCRAP METAL: MADE IN EUROPE

Aurubis sources most of its recycling raw materials directly from Europe. The metal processor relies on a network of specialized companies that concentrate on collecting, sorting, and preprocessing these materials. Aurubis also obtains materials directly from its industrial customers. "Our supplier portfolio comprises companies numbering in the mid-triple-digit range," says Nolte. "They all undergo our Business Partner Screening process. We don't buy anything from anyone we don't know."

The suppliers receive the delivered material directly from consumers in some cases – from recycling centers, community waste collection points, or scrapyards. Metal that lands in the normal garbage by mistake also makes its way to Aurubis in the form of metallic residues in ashes from waste incineration. Likewise, metallic remnants and waste products that collect in production processes are also redirected to the value cycle through different recycling methods. This cyclical approach doesn't just make good business sense, it's also part of the Aurubis Sustainability Strategy.

FROM SAMPLING TO PRODUCTION

Every day, an unknown value of raw materials is delivered to Aurubis. The processing steps such raw materials have to undergo depend on their unique material properties. The company's Sampling department first determines what these properties are. Depending on the material at hand, employees from the department take representative subsamples, which they analyze to establish the metal content. Only then can they assess the actual value of the raw materials.

About 65 employees in Lünen alone are involved in accepting, weighing, examining, and, ultimately, accurately analyzing and sampling raw materials. "Our credo: the more complex, the better – because we're particularly good at that," says Nolte. Take memory cards, for example: while the first hard drives were as big as wardrobes and just as heavy, modern memory chips are the size of a fingernail. The tiny components are made of a combination of different metals – a growing challenge for sampling and, subsequently, recycling.

HIDDEN TREASURES

E-scrap contains many substances – a typical analysis of circuit boards

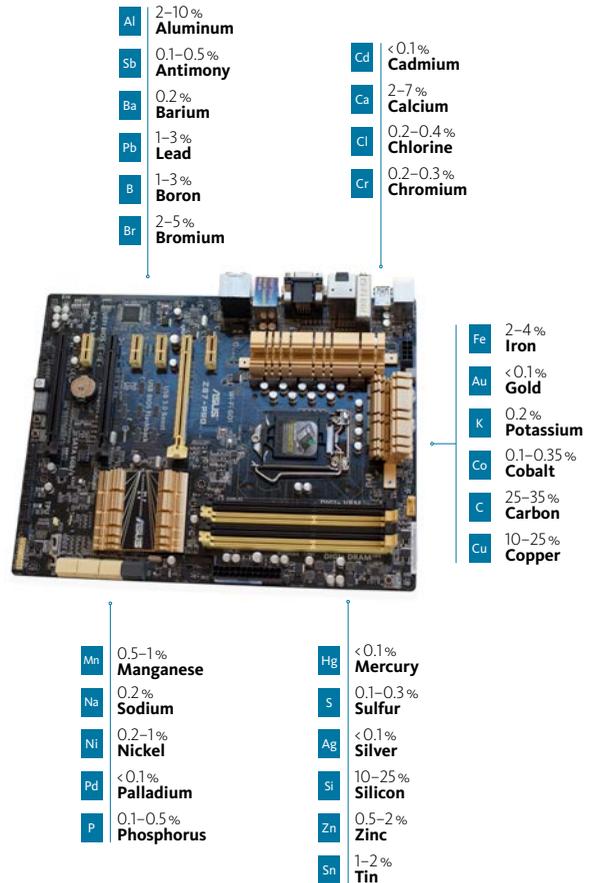
Sampling is followed up by the material preparation step. For example, electronic scrap is initially preprocessed – that is, shredded and sorted. Aurubis operates a special plant at the Lünen site for this material preparation. “This allows us to remove substances such as aluminum or some plastics – large volumes of which disrupt our recycling process – immediately at the beginning of the process,” says Nolte. “It’s important that we put together the right mixture of recycling raw materials early on in the process.”

FROM “A” AS IN ALLOYS TO “Z” AS IN ZINC SCRAP

Aurubis processes recycling materials that couldn’t be any more different or complex. These include various qualities of copper scrap, from production waste to gutters to alloyed scrap. The company processes industrial residues such as slags; lead, electroplating, and wastewater slimes; catalysts; filter dust; shredder materials; complex metal concentrates; and precious metal-bearing residues. More and more, Aurubis is also being offered complex electronic scrap such as circuit boards and old appliances from external preparation processes in the recycling industry.

SITE SPECIALIZATIONS

Every Aurubis smelter site has a different focus: while Lünen handles and processes slimes, dust, and complex electrical scrap, the Bulgarian site in Pirdop primarily uses pure copper scrap as cooling scrap. The facility in Olen inputs copper scrap as one of the three main components in the smelting process. In contrast, Hamburg



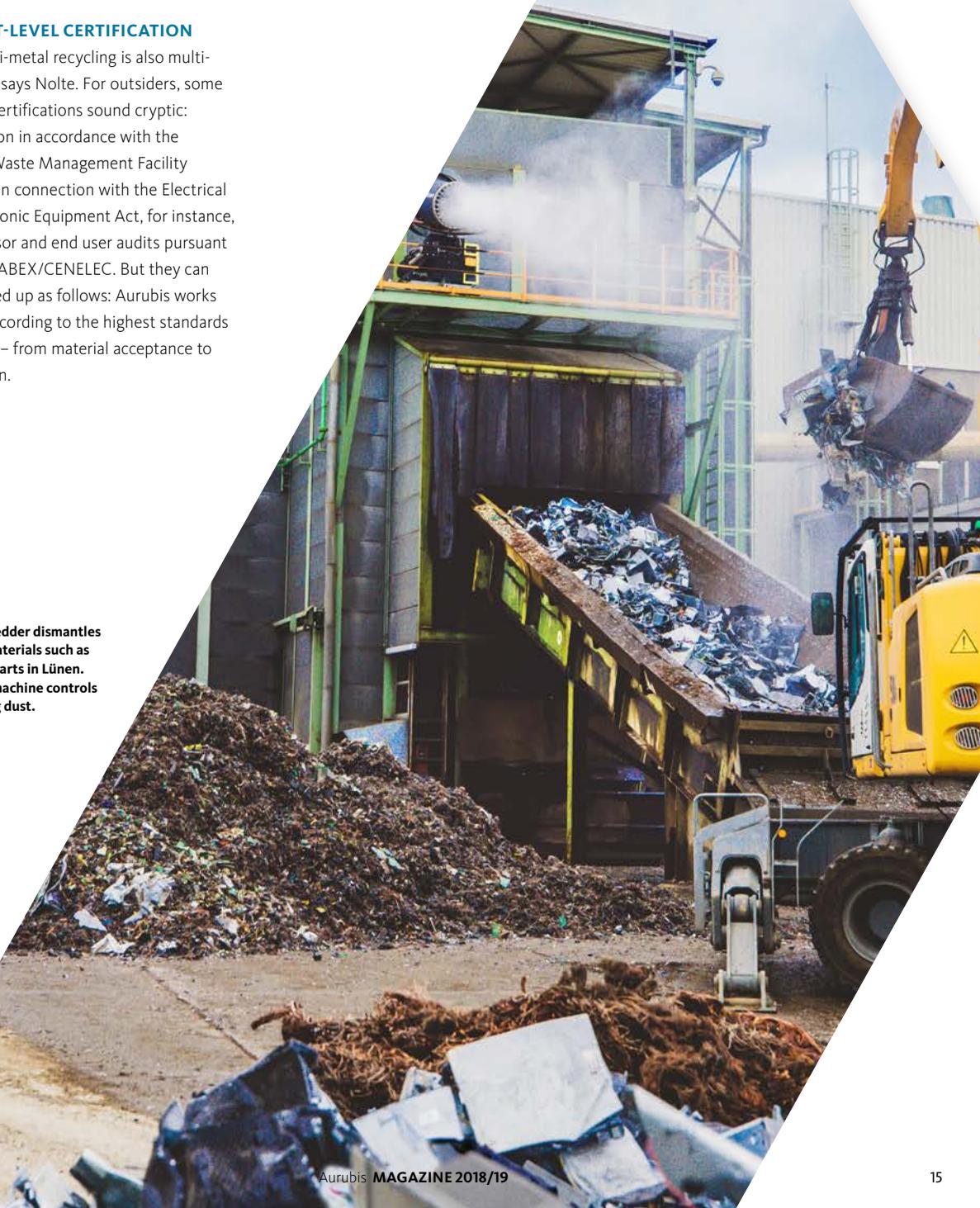
recycles both electrical scrap and pure scrap metals. Recycling is thus a topic at every site in different ways. “Thanks to this integrated smelter network, we can recover metals like gold, silver, tin, and lead from supposed waste materials. For example, a ton of cell phone scrap contains up to 300 grams of gold,” says Nolte. “In light of declining resources and growing mountains of waste, our expertise is now in higher demand than ever. And we don’t just deal with our main metal, copper, but

use its property as a collector of many other accompanying metals to recover a total of 19 metals and metal compounds.”

HIGHEST-LEVEL CERTIFICATION

“Our multi-metal recycling is also multi-certified,” says Nolte. For outsiders, some of these certifications sound cryptic: certification in accordance with the German Waste Management Facility Directive in connection with the Electrical and Electronic Equipment Act, for instance, or processor and end user audits pursuant to WEEELABEX/CENELEC. But they can be summed up as follows: Aurubis works reliably according to the highest standards in Europe – from material acceptance to production.

A huge shredder dismantles complex materials such as computer parts in Lünen. A misting machine controls the ensuing dust.



RESEARCH & DEVELOPMENT

“Lithium-ion batteries are more electrical scrap than battery”

What will be the scrap of tomorrow? Dr. Marcus Eschen, recycling expert in the Research & Development department, tackles this and other questions. An interview about challenges in recycling, lithium-ion batteries, and why he's on the lookout for the unusual.

Dr. Marcus Eschen researches future challenges and opportunities at the recycling site in Lünen.

DR. ESCHEN, WHAT DOES THE RECYCLING OF THE FUTURE LOOK LIKE?

We're dealing with more and more complexity, especially in the recycling of electrical scrap, so the number of metals is rising. But because products have to be increasingly efficient, everything's becoming smaller as well – including the metal components. We've experienced this trend for years, and it will continue. As a result, it's becoming increasingly important to recover even the metals that are only present in small concentrations. Tantalum, a base metal needed for building capacitors, is a good example. Currently, it oxidizes in the recycling process, so it ends up in the slags and we lose it. In a research project, we're currently working on ways to remove tantalum before the melting process. This could be interesting for other metals such as gallium and indium as well. So innovative solutions are more in demand than ever.

THE PROPORTION OF PLASTIC IN ELECTRICAL SCRAP IS GROWING, WHILE THE PROPORTION OF METAL IS FALLING. WHAT DOES THAT MEAN FOR AURUBIS?

For one, we have to process larger and larger raw material volumes to recover the same amount of metal. This confronts us with multiple challenges: separating the plastic from the electrical scrap will become more important than it already is. We have to work on the existing systems and improve detection rates.

At the same time, however, there's the question of: What do we do with all of the plastic? There are plastic recyclers, but not enough of them for the volumes that accumulate in Europe alone. We're therefore considering what feasible and efficient solutions could look like – in some cases, together with industrial and research partners. One possible idea is to recover oil from the plastic, which could then ideally be used by the chemical industry, for instance.





EVERYONE'S TALKING ABOUT RECYCLING LITHIUM-ION BATTERIES. IS THAT A TOPIC FOR AURUBIS AS WELL?

Of course! After all, lithium-ion batteries are actually more electrical scrap than classic battery. Lithium-ion batteries consist of different components that Aurubis can already handle today. At the same time, they would also bring more metals into our smelter network that we're not quite as involved with yet, such as nickel. However, there haven't been any reliable volumes for recycling lithium-ion batteries so far. On top of that, there are very different battery systems on the market that aren't processed the same way and that contain different materials. And they're changing all the time. As a result, we can't exactly say what's in store for us – but we're preparing for it.

ON THE TOPIC OF INDUSTRY 4.0 – WHAT'S GOING ON AT AURUBIS IN THIS REGARD?

Needless to say, we're working intensively with the possibilities that sensors and data analysis provide us today. With our current computing power, we're in a position to implement ideas that seemed a long way off five years ago. This of course only works in connection with the knowledge of our colleagues at the furnace. Collecting data isn't everything, after all. It's more about gathering data in a targeted way with a highly efficient set of sensors and then interpreting this data correctly. And interdisciplinary teamwork is key here. We have to bring a variety of skills to the table. This is the only way to improve our process understanding and optimize our process management in the medium term.

CAN YOU NAME AN EXAMPLE?

Let's take the example of the anode. To the untrained eye, all anodes might look the same. But that's not the case! Every anode has an individual fingerprint since hot copper never flows into the anode mold in exactly the same way. We look at the process for anything that's unusual because we want standardization. Imaging sensors and comparative analytics now give us the chance to understand what makes a good product. By evaluating the sensor readings of thousands of casting steps, we learn more about the different temperature profiles, for example. Only when we know what happens there specifically can we ask ourselves the question: How can we gradually optimize the casting process? These are the details that ultimately lead to noticeable positive impacts when it comes to our throughput.

We are increasingly using imaging sensors, for example to further standardize anode casting.

RECYCLING MARKETS & MARKET DRIVERS

Recycling materials as raw materials

Today, nearly 50% of European copper demand is covered by metal recycling. And tomorrow? Vice President Recycling Raw Materials Lars Radowitz provides an overview of the most important market drivers and explains why recycling is the future.



Lars Radowitz, Vice President Recycling Raw Materials, is familiar with the dynamics of the global recycling markets and has an eye on future trends.

“
There's huge potential for recycling: the global anthropogenic metal warehouse for copper amounts to about 400 million t.
 ”

LARS RADOWITZ

MORE METALS FOR A MODERN WORLD

While it used to be the G8 nations that discussed the challenges of the global economy, the G20 brings a much more varied group of players to the table. Continued industrialization is the primary goal of many emerging countries, which are encouraged by the promise of growth and prosperity. This goes hand in hand with increased migration to metropolitan areas, as well as a growing global middle class. These developments spur infrastructure expansions and demand for products using metals, particularly copper. “To make it more concrete: while the per capita consumption of copper is 6 kg in an industrialized country, it's not even 2 kg in a developing country,” states Radowitz. “There's a lot of catch-up potential.”

But the hunger for metals hasn't been satisfied in industrialized nations, either. Trends like digitalization, electric vehicles, and smart homes drive demand. Copper plays a special role in all of this. It's the metal of the energy transition. According to the German Copper Institute, renewable energy systems need up to twelve times more of the energy-efficient metal than traditional energy systems.

These trends will drive global metal demand and use. Annual growth rates of between 1.5 and 4% are expected for copper, tin, nickel, and zinc. This growth comes from electronics, industry, and the automotive sector in particular and supports higher metal prices. Ultimately, a higher level of processed metal means that larger and larger volumes are available for recycling.

THE ANTHROPOGENIC METAL WAREHOUSE IS GROWING

These volumes boost the so-called anthropogenic metal warehouse, which consists of all of the metals that humans have removed from their natural deposits and used in our surroundings in the form of infrastructure, buildings, and everyday items. For copper, the German Federal Environment Agency assumes that the global anthropogenic warehouse reaches up to 400 million t and thus encompasses about 50% of the current geological copper reserves. Or to provide another comparison: around two-thirds of the copper produced since 1900 is still in use today. Depending on how it's used, it will be available for recycling again at some point. But one thing's for sure: the volumes are growing.

RISING PRICES, MORE RECYCLING POSSIBILITIES

The attractiveness of recycling increases with the price, for both traders and smelters. Many metal prices are notably higher today than they were in the early 2000s. Copper, for example, was quoted below the US\$ 2,000 mark back then. Today, a ton of the red gold is traded on the London Metal Exchange for nearly US\$ 6,000. "Higher metal prices mean rising incentives to collect the materials and direct them to recycling," stresses Radowitz.

GLOBAL RECYCLING POTENTIAL

2030–2040
~85 million t

2020–2030
~70 million t

2010–2020
~50 million t

With higher metal prices expected over the long term, the supply of recycling materials should grow.

OUR WORLD IS BECOMING INCREASINGLY COMPLEX

The life cycles of today's products are becoming shorter and shorter. This is especially apparent in consumer electronics – how many TVs are older than ten years anymore? According to a study by the German Öko-Institut, however, more than half of all TVs that are replaced still work. The reasons are attributed to things like too few functions, energy consumption, or simply not liking the current model. Each product generation has a different composition of materials as newer, more efficient production processes and alloys come into use.

Society is becoming ever more digitalized, prompting industry to release a number of innovative products. For instance, the more widespread use of electronic steering systems in vehicles will lead to a higher

accumulation of precious metals, tin, and nickel in vehicle recycling. "Our consumer society is producing more and more recycling materials, which are becoming increasingly complex at the same time. Specifically, they contain a growing variety of elements and compounds," states Radowitz. "This presents Aurubis with both challenges and opportunities."

LOCAL PREPROCESSING

End-of-life products and residues from Western industrialized countries will have to be processed locally to a greater extent in the future. Many developing countries where end-of-life products have been manually disassembled up to now are reducing their imports. Apart from that, processing in these countries rarely fulfills the high standards of the EU. Consequently, recycling capacities in Europe have to be expanded and exports of end-of-life products have to be reduced. "Former export regions like Europe and North America need more of their own efficient, sustainable recycling solutions down the road. The political framework in this context is also extremely important," asserts Radowitz. "We at Aurubis want to be part of the solution."

Aurubis processes electrical and electronic devices. High-performance processors, connectors, and electronic resistors in particular include a high proportion of gold.

RESPONSIBILITY MOVES INTO FOCUS

Environmental protection is one of our society's central issues for the future. This is evident not just in people's increasing awareness but also in stricter legislation such as the WEEE directive, a standard for copper and precious metal processing that also regulates electrical and electronic waste. The directive positively impacts collection systems as well, which leads to rising volumes of electronic scrap. Nevertheless, the collection rate of around 45% for this type of scrap indicates that there's still a great deal of potential.

The consumer goods industry and original equipment manufacturers (OEMs) are also showing heightened interest in recycling. They're all placing a stronger emphasis on closing the loop. Moreover, they're pushing for transparent and efficient waste management systems. After all, the social and political pressure impacts every economic actor and calls for sustainable joint solutions that will positively influence the entire recycling market in the long term.

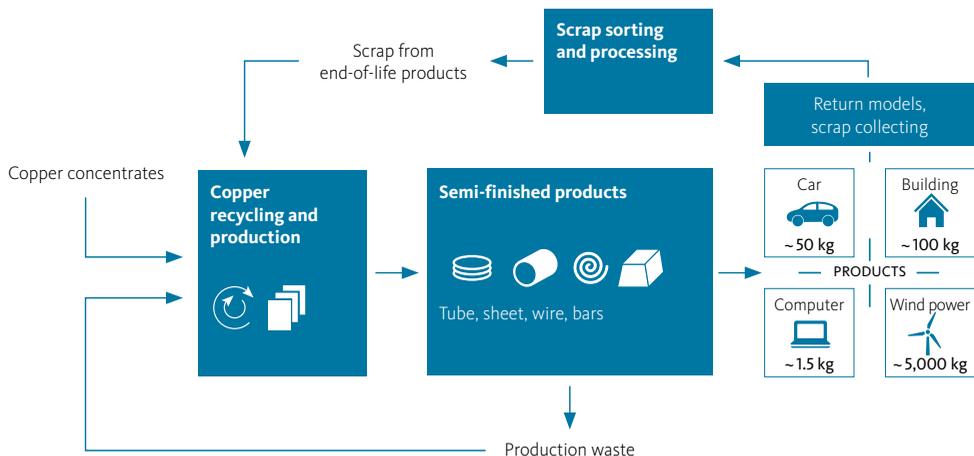
“
Former export regions like Europe and North America need more of their own efficient, sustainable recycling solutions.
 ”

LARS RADOWITZ

For Aurubis, growing quantities of increasingly complex recycling materials open up a great deal of potential for growth in recycling. “With our technical processing expertise, first-class environmental standards, and strong metal recovery rates, the market conditions in recycling reveal attractive opportunities for long-term business success,” says Radowitz.

THE COPPER VALUE CHAIN

Copper recycling includes material from end-of-life products such as cable, wire, and electronic devices, as well as from melting down production waste.



Source: based on Glöser, 2013, Deutsches Kupferinstitut

RE / THINK

DESIGN FOR RECYCLING

Inconvenient truths of the circular economy

Everyone's talking about recycling. It feels like Europe is the global leader in this area. "Unfortunately, that's not always the case," says metallurgy and recycling expert Prof. Dr. Dr. h.c. mult. Markus Reuter. He's been researching and implementing system methods and technology in this field both in academia and industry for over 35 years, sometimes drawing attention to inconvenient truths and challenges – but also pointing out opportunities for a better future.



Prof. Dr. Dr. h.c. mult. Markus Reuter has been director at the Helmholtz Institute Freiberg for Resource Technology (HIF) since 2015. He is involved in the topics of recycling, recycling-friendly product design, resource efficiency, and process metallurgy.

PROF. REUTER, EUROPE IS NOW RECYCLING MORE THAN EVER. ISN'T THAT ENOUGH?

Recycling doesn't end when dropping something into the garbage can. True recycling recovers and produces valuable, high-purity raw materials from old products for reuse in high-tech products. Consider your smartphone: it is a complex functional mix of metals, plastics, and glass. One does not require much of an imagination to picture how complex it is to physically and chemically separate these components again to ultimately retrieve the metals. It's just about as difficult as recycling your morning cup of coffee into its ingredients, so pure water, sugar, milk,

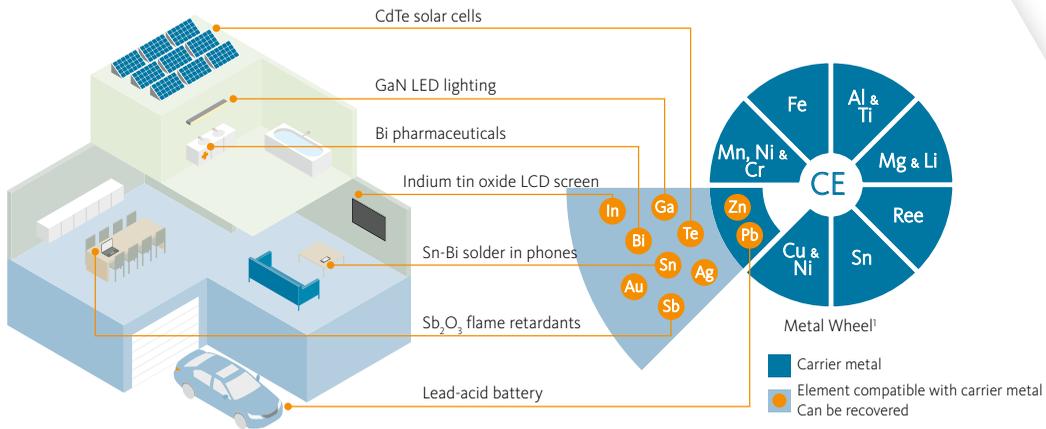
and coffee. There are no simple answers here – at some point, the amount of effort also outweighs the value of the metal content. This knowledge should prompt a consciousness shift in our utilization of our limited resources.

THAT'S WHY THE EU IS PRESSING AHEAD WITH THE CIRCULAR ECONOMY (CE), RIGHT?

The image of the closed loop of the CE is a convenient one. It conveys the impression that everything that enters the cycle also emerges in a way that can ultimately be used again without the use of energy. The inconvenient truth is that closing the loop is impossible! Therefore, an honest discussion involves speaking transparently about losses in the process: in the form of energy, metals, and dust, for example. There are technological and economic limits to closing the loop. As a result, policy conditions are necessary that promote recycling instead of hindering it.

NO LEAD, NO CIRCULAR ECONOMY

Lead – like copper – functions as a key metal collector in multi-metal recycling. Lead makes the circular economy (CE) possible in the first place by helping recover metals such as gold, silver, bismuth, and antimony.



¹ Simplified version from the SOCRATES EU MSCA-ETN project in which only the elements that dissolve in the carrier metal in metallic state and which can be recovered are shown. Full version: Verhoef et al., (2004): Process knowledge, system dynamics and metal ecology. Journal of Industrial Ecology, 8(1-2), 23-43

WHAT DO YOU MEAN BY HINDERING?

Consider the example of lead. Yes, lead is unfortunately toxic, and this is prompting the EU to consider banning its use. But it is also a fact that lead – like copper – is crucial as a metal collector in multi-metal metallurgical recycling. It is a key enabler of the CE, as it recovers metals such as gold, silver, bismuth, and antimony. Therefore, the circular economy paradigm is in danger without lead. This is often forgotten and overlooked in today's contentious and often unfortunately superficial discussions on circularity. The result of premature policy decisions and bans of metals opens up the risk of metal production migrating away from Europe. This would severely disrupt our control of metal production and recycling.

ARE THERE ANY POSITIVE EXAMPLES?

Absolutely. For instance, there are the collection systems for recycling materials in Europe, where we've already made a great deal of progress when compared internationally – this would be inconceivable without European standards and approaches. Gains can also be achieved by considering recycling during product design.

AND WHAT COULD THAT LOOK LIKE?

As stated, one can never recycle 100% of any given product; those are the laws of Mother Nature. But we can optimize a lot if we link product design with metallurgy

“
True recycling means recovering and producing valuable, high-purity raw materials from old products for reuse in high-tech products.
 ”

PROF. DR. DR. H.C. MULT.
 MARKUS REUTER

knowledge and calculate in detail in advance what can be recycled later. If a product is manufactured smartly into different modules, for example, the raw materials could be distributed in such a way that each module could be directly processed with suitable technology when metallurgically processed. This would render the recycling of many valuable metals easier, while also maximizing energy efficiency.

ARE MANUFACTURERS ALREADY DOING THIS?

Fairphone takes this into account, for instance, but they are still an exception. While there's a lot of talk, the imperative isn't there yet. This is why we're working on a recycling label to provide information about products' actual recyclability

to the consumer. We have developed simulation models that digitally twin the entire extremely large value chain, allowing products' actual recyclability to be calculated and improved. This enhances transparency for the consumers to assist them in making choices, a key step to precipitating change.

WHAT CAN THE SMELTER INDUSTRY CONTRIBUTE?

Smelters are a key enabler of the material cycle within the CE, as they are familiar with technical and economic limits. Routine communication with product manufacturers is just as important as dialogue with the public about what is feasible and what is not; existing digital twins help with this.

For Europe, we need multi-metal recovery solutions in the CE. We speak about the metallurgical infrastructure's criticality for the CE. In this context, smelters are the drivers to agilely manage the extraction of different metals simultaneously and maximize their respective recovery.

MODULAR DESIGN OF A FAIRPHONE



Thanks to its modular design, the Fairphone is recyclable to a great extent. www.fairphone.com

I'LL CLOSE WITH THE CRUCIAL QUESTION: WHO SHOULD ULTIMATELY PAY FOR THIS?

I believe there is a growing understanding in today's society that both manufacturers and consumers have to contribute to responsible resource consumption. However, this always comes at a cost. And this cost has to factor in the ability to disassemble the product at the end of its life cycle. In the Netherlands, for example, the costs for the collection and recycling of waste electrical and electronic equipment are borne by the producers and importers. This begs the question: Should the recycling fees that are incorporated in the product price become significantly larger? As metallurgists, we know what refining charges are necessary for processing such complex materials. Therefore, we could play a key role in transparently informing society about what is possible and what isn't.

Improved product design and metal recycling have to be the solution. There is a growing understanding in today's society that both manufacturers and consumers have to contribute to the responsible use of resources.

POLITICS & SOCIETY

Showing up for metal recycling

With metal recycling we tap new raw material sources, right at our doorstep. We want to give quality recycling a face and to nudge it more strongly into focus in the political discussion. Head of External Affairs Marie-Christine von Hahn on the current discussions, how Aurubis participates in them, and why we take recycling personally.

MS. VON HAHN, WHERE DOES THE TOPIC OF RECYCLING STAND IN THE PUBLIC DISCUSSION?

It's everywhere at the moment. The topic has a number of facets, extending from the European battery directive to the ecodesign directive to the European Union's higher environmental ambitions, which have been discussed under the buzzword "Green Deal." Nevertheless, there are no one-size-fits-all solutions, and the quality recycling of metals isn't enough of a political priority, unfortunately. We want to change this! We advocate political regulations that ensure that technologies in use are as recyclable as possible.

AND WHERE DO YOU SEE THE BIGGEST CHALLENGES?

Without a doubt, metal recycling is a complex process that requires some explanation, and it also requires a large amount of energy – a point that hasn't been considered in its entirety across the value chain thus far. We're therefore

in regular contact with representatives in Berlin and Brussels when it comes to issues such as CO₂ price development, renewable energy reallocation charges, and grid charges. At the end of the day, it comes down to whether there are long-term, reliable conditions for metal recycling and the downstream metal processing industry here in Europe. Another challenge is illegal scrap exports from Europe, for example to Africa.

HOW CAN THIS BE PREVENTED?

It's clear that prohibiting it isn't enough, as the appliances and devices are usually exported as "functional electrical and electronic waste." However, we advocate against the dismantling or burning of scrap and recycling materials to recover the metals under poor conditions for humans and the environment. Ultimately, it's imperative that high European standards serve as a benchmark. Based on international agreements and regulations, all kinds of recycling materials can be, and are being, traded legally around the world. However, everyone needs to abide by this system.

WHERE CAN AURUBIS MAKE THE GREATEST CONTRIBUTION TO THE POLITICAL DISCUSSION, IN YOUR OPINION?

Metal recycling means actively securing raw materials for Europe, which makes

Head of External Affairs Marie-Christine von Hahn speaking at our parliamentary evening in Berlin in October 2019.



“
Our goal is to direct the political focus to quality metal recycling.
”

MARIE-CHRISTINE VON HAHN

us less dependent on imports from other regions in global competition. At the same time, we tap raw material sources, right at our doorstep. Apart from the discussion on these kinds of strategic issues, we at Aurubis also see ourselves as the ones who carry out the practical tests for laws regarding metal recycling. After all, ideas that sound promising in theory have to be feasible in practice as well. As one of the largest copper recyclers, we stand for more than 150 years of expertise and process knowledge. We foster political and public debate with this experience. In this way, we also enable pragmatic, functional, and rapid solutions for the circular economy. In the end, everyone benefits from these solutions.

HOW DO YOU DO THIS CONCRETELY?

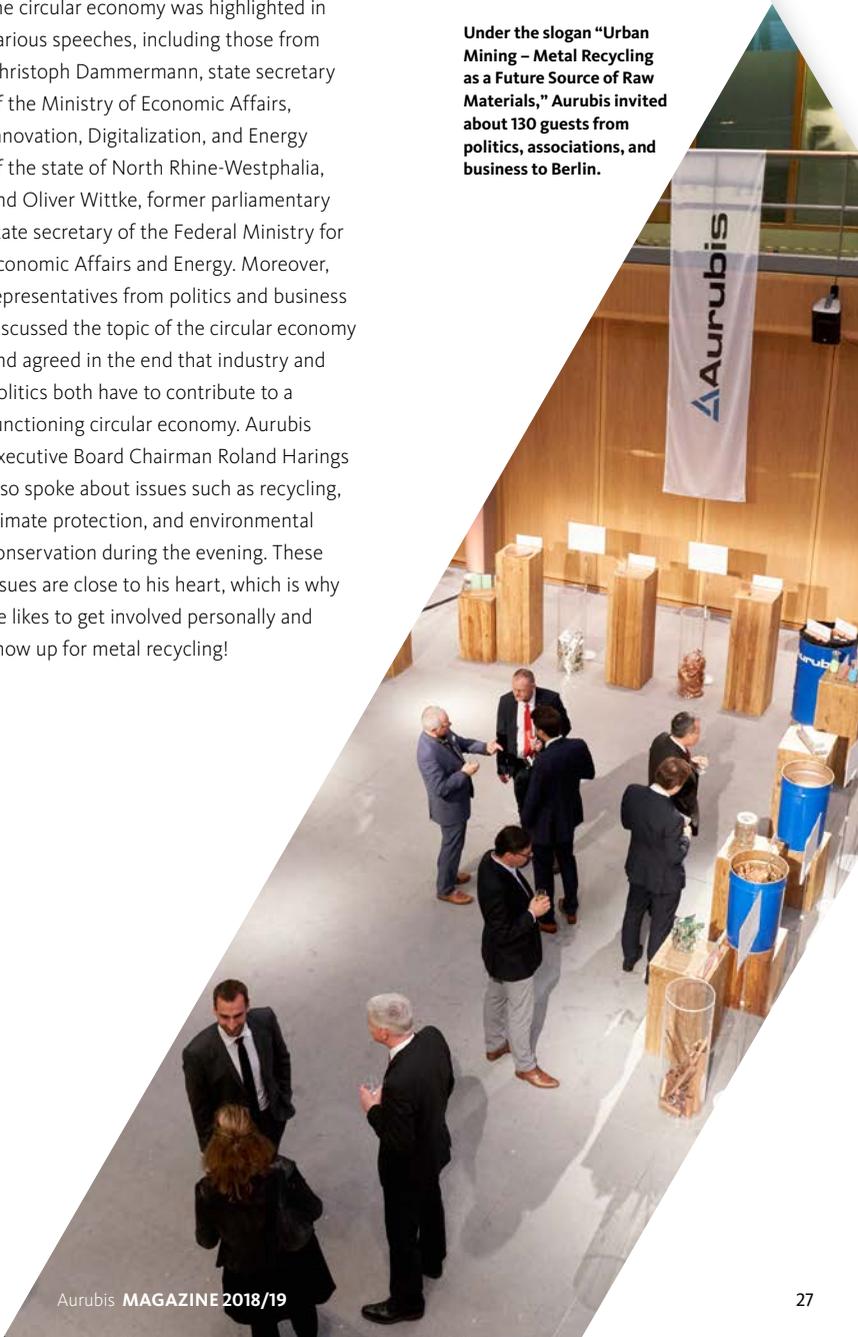
We of course actively work in different associations on topics involving metal recycling. We publish positions on relevant draft laws because we want to continue strengthening the voice of the metals industry in the public perception. A clear example of our involvement is our parliamentary evening, which we held in Berlin in October 2019. Under the slogan “Urban Mining – Metal Recycling as a Future Source of Raw Materials,” about 130 guests from politics, associations, and business accepted our invitation to the event.

AND WHAT WAS THE OBJECTIVE OF THE EVENT?

Our objective with the event in October was not only to present ourselves as a valuable recycling industry actor in the political center of Berlin but also

to provide the invited experts with a high-level platform for dialogue. The growing significance of recycling and the circular economy was highlighted in various speeches, including those from Christoph Dammermann, state secretary of the Ministry of Economic Affairs, Innovation, Digitalization, and Energy of the state of North Rhine-Westphalia, and Oliver Wittke, former parliamentary state secretary of the Federal Ministry for Economic Affairs and Energy. Moreover, representatives from politics and business discussed the topic of the circular economy and agreed in the end that industry and politics both have to contribute to a functioning circular economy. Aurubis Executive Board Chairman Roland Harings also spoke about issues such as recycling, climate protection, and environmental conservation during the evening. These issues are close to his heart, which is why he likes to get involved personally and show up for metal recycling!

Under the slogan “Urban Mining – Metal Recycling as a Future Source of Raw Materials,” Aurubis invited about 130 guests from politics, associations, and business to Berlin.



RE / SPECT

SUSTAINABILITY & PRODUCTS

Multi-metal recycling is active resource conservation

Some challenges are easier to overcome with partners in the value chain. Sustainability Manager Kirsten Kück and Vice President Product Sales & Marketing Commercial Stefan Gröner, both of Aurubis, and Purchasing Manager Daan Kuipers of the Dutch cable manufacturer TKF met for a stakeholder dialogue and discussed CO₂ emissions, closing the loop, and why copper is here to stay.

RECYCLING: MORE COPPER, LESS CO₂

The topic of copper recycling includes some interesting figures. The fact that recycling saves up to 85% of the energy and about 60% of the CO₂ emissions that arise in copper production from primary raw materials is especially exciting.¹ Worldwide, the reduction

amounts to around 100 million MWh of energy and approximately 40 million t of CO₂ emissions, according to the International Copper Association. "To put it plainly, if we're able to continue boosting recycling rates, the copper industry has the possibility to reduce energy consumption and the resulting CO₂ emissions," says Kirsten Kück. "We have developed progressive technologies in the European copper industry that enable us to process a broad range of copper scrap while adhering to increasingly strict energy and environmental standards." Aurubis alone hopes to reduce its CO₂ emissions by 100,000 t, compared to fiscal year 2012/13, by implementing projects until 2023. During the reporting year, Aurubis reached about 74% of this goal, which is part of its Sustainability Strategy.

Sustainability Manager Kirsten Kück is proud that Aurubis is one of the most environmentally friendly metal producers in the world.

UP TO **85%**

LESS ENERGY
IS REQUIRED FOR COPPER RECYCLING
COMPARED TO PRIMARY PRODUCTION.¹

COPPER: A LOYAL COMPANION OVER THE CENTURIES

Aurubis' main metal is predestined for recycling thanks to its unique qualities. Copper is here to stay. Once it's mined from the earth, it's available for an infinite amount of time, from a metallurgical perspective. Between 70 and 80% of all of the copper ever produced is still in circulation today.¹ "Copper can be reprocessed over and over without a loss of quality or a decline in performance," says Stefan Gröner. The product expert from Aurubis is convinced: "With our multi-metal recycling, we actively conserve resources and make ourselves less dependent on raw material imports from non-EU countries."

RESPONSIBILITY: A TASK FOR THE ENTIRE VALUE CHAIN

The sustainable use of resources is a challenge for the entire value chain. "We can only take on this task with a concerted effort," stresses Kück. Aurubis is developing individual logistical and technical concepts with its industry partners for this purpose. The goal: to reuse production waste or, even better, to avoid it altogether. Stefan Gröner believes that this is the responsibility of both the upstream and the downstream side: "The downstream industry has to be involved in this equation, for example when it comes to product design to enable recycling and when we're talking about industry standards."

“
*If we're able to continue
boosting recycling rates, the
copper industry has the
possibility to reduce energy
consumption and the
resulting CO₂ emissions.*
”

KIRSTEN KÜCK

Some examples of the collaboration along the value chain are closing-the-loop projects in which Aurubis takes back the production waste from its customers, making its customers copper scrap suppliers. Losses – in landfilling, waste collection, or processing – are a key reason why not all of the copper ever mined is in circulation today. "We have to find more efficient ways to retain as much material as possible in the cycle," explains Gröner. The dialogue with our partners goes even further to make sure recycling is even better in the future. "This includes working together with our customers and manufacturers of end products on a common understanding of how easily recyclable end products could look – that is, design for recycling."

Vice President Product Sales & Marketing Commercial Stefan Gröner works with product customers to find more efficient ways to keep as much material as possible in the value cycle.



¹ According to the Copper Alliance/
International Copper Association.

**“
We can rely on
Aurubis 100%.
And we consider
Aurubis an industry
leader when it
comes to
sustainability.
”**

DAAN KUIPERS, TKF

PARTNERSHIPS: COLLABORATING WITH OUR CUSTOMERS

One of our partners on the customer side is cable manufacturer TKF in Haaksbergen in the Netherlands. Focusing on innovative, high-end technologies in the telecommunications, construction, and industrial solutions sectors, the company discusses topics such as the use of renewable energies and responsible consumption with Aurubis within the scope of stakeholder dialogues. TKF and Aurubis work together to identify ways to contribute to the UN Sustainable Development Goals (SDGs), which TKF has also used as a basis for its reporting since 2017. “Environmental, social, and corporate governance criteria are fully incorporated in our strategy,” explains Purchasing Manager Daan Kuipers from TKF. “Together with our partners in the supply chain, we look for opportunities to make a joint contribution to the UN Sustainable Development Goals.” He values this dialogue and the collaboration with Aurubis a great deal.

Purchasing Manager Daan Kuipers of the Dutch cable manufacturer TKF values the dialogue and collaboration with Aurubis.



“Our stakeholders can directly or indirectly influence our activities. Being in constant dialogue with them enables us to share and test our vision, our strategy, and our expectations with them. This always gives us very valuable feedback that we use for further improvements,” says Kuipers. “We can rely on Aurubis 100% when it comes to fulfilling its obligations. And we consider Aurubis an industry leader when it comes to sustainability. Our discussions have proven that environmental topics are very important to Aurubis. We like these open discussions and the way we do business together.”

One key element of the collaboration between Aurubis and TKF is a closing-the-loop project. “We try to establish closing-the-loop systems with as many of our customers as possible,” says Gröner. “Bringing these loops full circle needs to be the norm in the industry. Ultimately, everyone benefits.”

RISING DEMAND: RED GOLD WITH A GREEN CONSCIENCE

“As an integrated copper producer, Aurubis has set the objective of producing even more copper from secondary materials, especially complex recycling raw materials,” says Gröner. “We already produce more than one out of three

cathodes from recycling materials, and the trend is rising.” Gröner can imagine copper products made completely of recycled material creating a new market for sustainably produced metals and metal products at some point down the road. “Industry still has trouble paying a surcharge on a metal that’s traded as a commodity on the exchange. However, the trend towards a sustainable, transparent value chain, which is evident in some industries and driven by consumers, can’t be overlooked.” Kuipers also believes that demand for recycled copper could increase and that the market could

TKF processes the copper it sources from Aurubis into medium- and high-voltage cables, for example. The company provides connectivity solutions and an extensive portfolio of cables, systems, and services.

ultimately honor this development. “Yes, this demand will grow for sure. Our customers’ mindset is also changing with regard to using primary materials. At TKF, we have set clear targets for the recycling of different materials, including copper.”

The interior of an onshore wind turbine, which requires about 5,000 kg of copper.

COMING FULL CIRCLE: USING COPPER TO REDUCE CO₂

The market’s influence on the responsible use of resources is also apparent in megatrends such as electromobility and renewable energies. In this context, Aurubis contributes to reducing future CO₂ emissions not only by producing metals with recycling materials, but also with its finished products. For instance, copper plays a key role when it comes to renewable energies and thus the energy shift as a whole. “According to the Deutsches Kupferinstitut, energy systems for renewable energies require up to twelve times more copper than conventional energy systems,” says Kück, “because copper typically improves energy efficiency.” As an example, a ton of copper used in rotating machinery – such as an electric engine or a wind turbine – saves up to 7,500 t of CO₂ emissions during its life cycle. That’s a pretty interesting figure, too.

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~ 700,000 t

RECYCLING MATERIALS

was our throughput in fiscal year 2018/19.



~ 25,000 t

CO₂ REDUCTION

annually thanks to the Industrial Heat and Power-to-Steam projects



~ 100,000 t

CO₂ EMISSIONS

is what we plan to reduce through projects until 2023 – compared to 2012/13. We had achieved 74 % of this goal as at September 30, 2019.



70 – 80 %

OF ALL COPPER EVER PRODUCED

is still in circulation. One car alone includes ~50 kg of copper.



~ 85 million t

COPPER IN CIRCULATION

is available for recycling between 2030 and 2040 (overall theoretical potential).

Additional environmental measures

Eco-ink: The printing ink we use in conventional offset printing is produced on the basis of renewable raw materials and is therefore free of cobalt and mineral oil.

Foil: The foil lamination on the report and the magazine is ECO foil from Achilles.

Dispersion varnish: The semi-matte dispersion varnish used for the magazine fulfills the conditions for an environmental clearance certificate.

FSC: Certified FSC Recycled Credit Material used

CO₂: CO₂-neutral production with a Gold Standard certificate. www.klima-druck.de/leistungen

The background of the entire page is a close-up photograph of a dense, tangled mass of metal wires. The wires are in various colors, including bright blue, yellow, and silver, and are set against a clear blue sky. A large, semi-transparent blue triangle is overlaid on the right side of the image, pointing towards the top right corner. The text is positioned on the left side of the image, within the white space of the triangle.

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Metals for Progress

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