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October 2024

Sustainable reading
from the Oeko-Institut

Urban Mining

Aims, strategies, potential

Tapping into the stock Interview with Jürgen Odszuck

Knowing what's inside

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My own personal anthropogenic stock can be found in a drawer in my office – or at least, the parts of it that I really must sort out. Here, over the past few years, I've accumulated a selection of mobiles and smartphones that are waiting in vain for someone, some day, to call. There are far better uses for them, for each one contains raw materials – nickel, copper and iron, for example.

But my desk drawer here in Freiburg is only a miniscule part of the entire anthropogenic stock – the pool of materials produced by human activity – in this country. According to a survey by the German Environment Agency (UBA), more than 50 billion tonnes of materials were already bound up in this anthropogenic stock in 2010. We lock away raw materials in buildings and cars, in solar panels and electrical appliances. And sadly, when we no longer need them, we often fail to ensure that an equally high-quality and prompt solution is found for their reuse. There are many reasons for this: primary raw materials are often too cheap, industrial recycling has yet to be set up for some substances – and often, we don't have a clear idea of what's actually inside.

This is where urban mining comes in. It sees our habitat as a stock of raw materials and looks at how they can be recovered more efficiently when a building, vehicle or electrical appliance is no longer needed. This not only benefits the environment and the climate, but also counteracts Germany's and Europe's heavy reliance on imports of many raw materials – because whatever we can "mine" here at home won't have to be sourced by us on the global markets. But in urban mining, focusing on the past and what's already there is not enough. We must also answer the question of how we can one day recover the raw materials – approximately 600 million tonnes – that we newly install, bolt down or fill in every year and how we can make this task easier in future. Product passports may be helpful here: they record in detail which resources a product contains, whether it's a building or a TV.

By the way, my own anthropogenic stock will be dismantled before this issue is published – that's a promise! Perhaps you'll also find something in your own home that needs to be sent for recycling at last?

Yours,
Christof Timpe

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"We're very happy with 90 per cent"

Take a derelict housing estate, use it to build a new one and, in the process, throw nothing away – can it be done? That's what the City of Heidelberg is currently attempting to do. In Patrick Henry Village – a former housing estate for US Army families on the edge of town – every brick, toilet bowl, water tap and light switch is logged so that as much as possible can be built into the new design or passed on for reuse elsewhere. We talked to Heidelberg's First Mayor Jürgen Odszuck about this pilot project. He is well-acquainted with the building trade: before studying architecture, he worked on building sites and, among other things, later served as Deputy Director of the Building Inspectorate in Erlangen.

Mr Odszuck, from your experience in the building sector, when did the option of reusing building materials start to play a role?
It was the established practice for centuries, but it was forgotten about in recent decades: everything had to be as quick, easy and cheap as possible. But with the multiple challenges that we face, such as the climate crisis and resource scarcity, it's clear that this can't continue. And the building sector can make a major contribution: after all, it produces around 40 per cent of CO_2 emissions worldwide.

Heidelberg is currently pursuing a very proactive approach to urban mining in the building sector. How did that come about?
The city is developing the Bahnstadt district on the site of a former railway freight yard, where it is consistently applying sustainability criteria with a climate-neutral heat supply. Combined with the passive house standard for all buildings, this will reduce CO_2 emissions by 85 per cent compared to the national average. However, we also see that it will take quite some time to offset the emissions from construction. We do need to address the issue of what we use to build new houses.

You have now launched a pilot project. What does it involve?
Our aim is to reuse most of the material from the demolished buildings in the new construction project. We started by setting up a digital cadastre. We now know with a fair degree of accuracy what kind of raw materials are contained in each building. In fact, we have very accurate data for a 15-hectare site. Material estimates were verified by drilling in ceilings and walls, which was also necessary due to the possible presence of harmful substances. We are now finding answers to the question of what we can reuse in the newbuilds and what we can find other uses for. We are also preparing invitations to tender for the new construction project.

Are there any plans to introduce a cadastre for the city as a whole in future?
We have considered it, because the cadastre was easier to set up than we thought. Even with basic data – the year of construction, type of use and class of building – it is possible to produce estimates of the material that a structure contains, generally with a margin of error of less than 10 per cent. In my view, however, it is only worthwhile setting up a cadastre for sites where relevant changes are pending in the next 10 years.

How much material will you be able to recycle in Patrick Henry Village?
In total, we're talking about some 466,000 tonnes of material, including around 235,000 tonnes of concrete alone. If 90 per cent is recycled or reused, we'll be very happy. In some cases, it's simply not worth it – if the plaster is contaminated with asbestos, for example. It would cost too much money and energy to remove it.

And what are acceptable costs overall, compared to a newbuild using primary raw materials?
We'll be happy whether we're in the red or in the black. The point is that this is a far more environmentally compatible and climate-friendly way of building, and we are also trying out new methods and processes. And we shouldn't forget the macroeconomic costs associated with environmental and climate impacts.

Are new frameworks needed to facilitate this kind of pilot project?
Certainly. For example, reuse often fails when it comes to proving the quality of the building materials obtained from recycling. But for many of the materials reclaimed from buildings that are decades old, certificates no longer exist. And the people who are keen to use these materials are justifiably concerned about problems with guarantees. New approaches are needed here in order to mitigate the risks for the persons concerned.

Thank you for talking to eco@work.
The interviewer was Christiane Weihe.

Talking to eco@work:
Jürgen Odszuck,
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Quotas and incentives

Urban mining in Germany

The building in which we're sitting forms part of it. So does the street outside the door – and the car that's just driving past. We are surrounded by what's known as the anthropogenic material stock. It consists of buildings and infrastructures but also everyday goods that contain raw or processed materials. Electrical and electronic equipment and furniture also form a pool of raw materials – albeit on a much smaller scale. Monitoring and recovering raw materials via urban mining eases the pressure on natural resources, the environment and the climate – and ultimately, therefore, on us humans as well. So how can urban mining be taken forward and improved? The Oeko-Institut is researching this question in many of its projects.

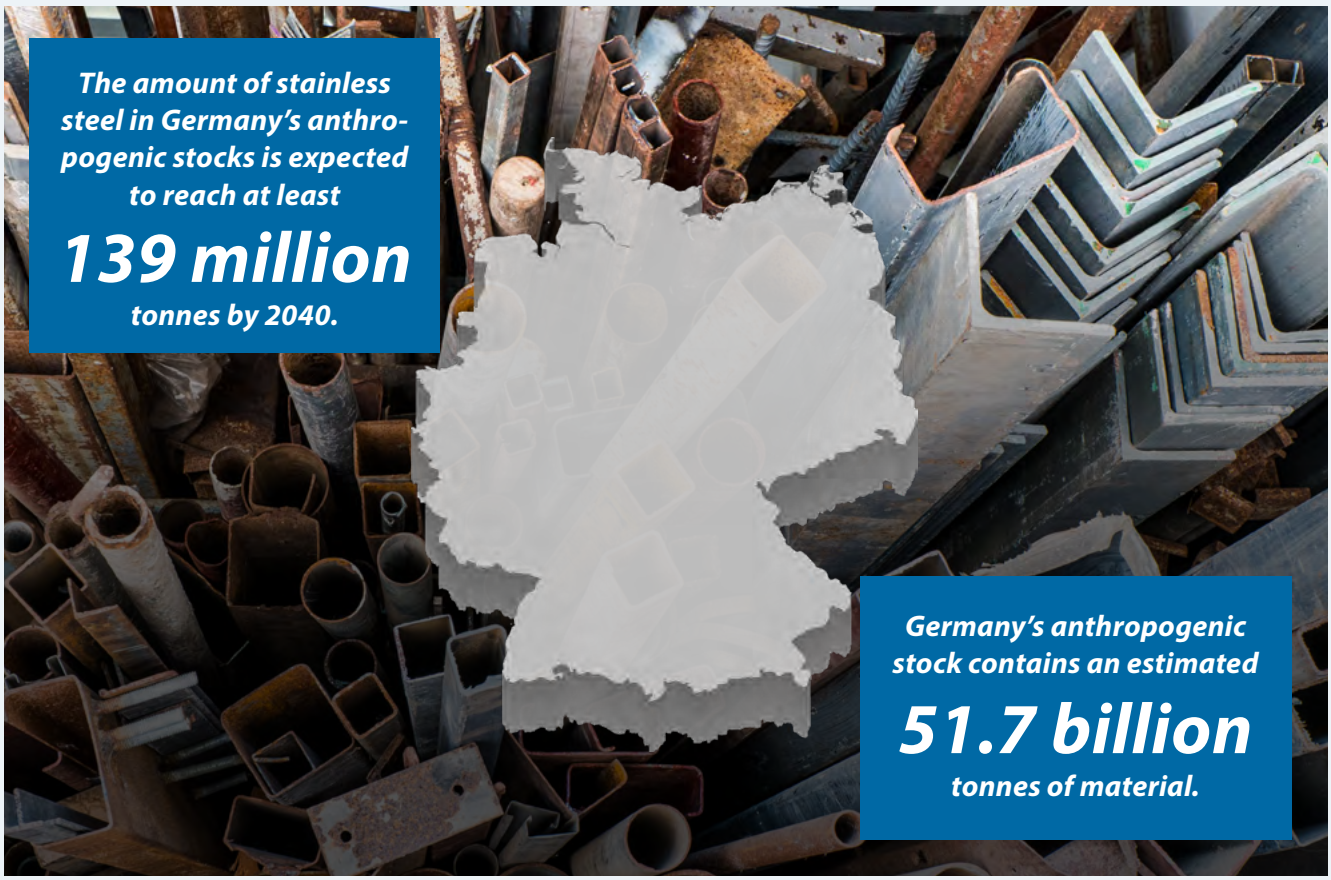
For some years now, researchers working on the KartAL – Mapping of the Anthropogenic Stock project on behalf of the German Environment Agency (UBA) have been investigating the anthropogenic material stock and ways to make better use of it. Within the KartAL V project framework, the Oeko-Institut is currently involved in preparing an urban mining strategy with key content and objectives for Germany. "This kind of strategy is needed for multiple reasons," Dr Johannes Klinge, a Senior Researcher in the Resources and Transport Division, explains. "It is about easing the pressure on the environment and preserving natural resources, as well as reducing our import dependency and avoiding resource shortages. It is also important to safeguard a supply of the raw materials that are urgently needed as we move towards climate neutrality. Rare earths, which are components of many electric motors and wind turbines, are one example."

The researchers are dealing with a highly complex topic, for it involves a vast range and diversity of substances, materials and products. And when it comes to their lifetimes, too, anthropogenic stocks vary considerably. "It is essential to set priorities in order to create momentum for urban mining in the most relevant sectors. In a first step, we therefore defined the key sectors – in other words, those areas where there is potential to achieve particularly significant reductions in environmental impact or resource dependency." These include wind energy and photovoltaic systems, electric motors and lithium-ion batteries, as well as mineral building materials in the construction industry, for example. "In addition, we focus on fossil and nuclear power plants and plastics from pipes and sanitation systems, among other things."

NOT ENOUGH INCENTIVES

During the further course of the project, the researchers are defining targets for urban mining here in Germany, as well as possible instruments. There is a dire need for these, as at present, a substantial share of the raw materials is not recovered when a building is demolished or a car is scrapped. "For example, most of the plastics from vehicles are currently incinerated. In some cases, the copper is melted down along with the steel, which not only means that the copper goes to waste: it also reduces the quality of the secondary steel so that at best, it is only fit for use in construction." But why? There's a simple answer: at present, high-quality recycling of these materials is not worthwhile in financial terms. The dismantling and separation that it entails, as well as the purification of the various materials, involve additional effort. Yet it is important to set up recycling systems, especially for the critical raw materials that are needed for the shift in propulsion technology in the transport sector. "Previously, there were no incentives to do so, and no relevant legal provisions. What was also lacking, at the same time, was a stable market for the recycled material; that's because it always has to compete with the strongly fluctuating prices of primary materials. Why should companies make a commitment here if they are unable to sell the recycled material at break-even prices further down the line?" Pollutants are another issue that can hinder urban mining – at landfill sites, for example, where different materials are all mixed together. "We can't establish a closed loop if we pursue a zero pollutant strategy. A zero per cent pollutant scenario does not exist anywhere in reality, so sensible limit values must be found. Here, it's about carefully assessing and weighing up the risks to health and the environmental benefits of recycling," says Johannes Klinge.

So where do we start? "The first thought is often to introduce a resource tax, thereby pushing up the price of primary raw materials consumption and making recyclates more competitive," says Johannes Klinge. "But from a legal per-



spective, that's difficult to implement in this country." What's more, the existing rules at EU level do not deal with individual materials but focus on specific products. For example, there is a Batteries Regulation, which sets targets for recycling efficiency, among other things; a Directive on End-of-Life Vehicles, which defines quotas for recycling; and, at the national level, a Substitute Building Materials Ordinance, which regulates the management of recycled material. "So in order to establish an appropriate legal framework, it is essential to proceed sector by sector, ideally at EU level."

A precise and nuanced definition of recycling is especially important in this context. "For example, for a long time, many countries classed it as recycling if waste was used for backfilling in the mining industry," Johannes Klinge explains. "And if the vehicles sector achieves a 95 per cent recycling rate but that only relates to total weight, it doesn't achieve very much overall. That's because many valuable materials that have substantial environmental impacts and are associated with high import dependency don't weigh much – rare earths are one example."

SETTING PERCENTAGES

How can the use of raw materials from the automotive sector be improved? The Resource-Efficient Motor Vehicles (AutoRess) project, conducted in partnership with the Institute for Energy and Environmental Research (ifeu), Mehlhart Consulting and Team Ewen on behalf of the German Environment Agency (UBA), shows how. Vehicles contain countless resources: iron and steel, aluminium and copper, glass, plastics and textiles, as well as critical raw materials like platinum and cobalt. "In 2020 alone, the European automotive industry used 22.4 million tonnes of primary raw materials and six million tonnes of recyclates," Dr Johannes Klinge explains. A key lever in ensuring that raw materials do not go to waste, according to the researchers, is to increase the percentage shares of recyclates used in production – backed by binding rules. In their view, the EU Batteries Regulation, adopted last year, is a major step forward here. "It stipulates clear recovery quotas for the key metals – lithium, copper, cobalt and nickel." From 2031, requirements for the percentage share of recycled content will be introduced on a stepwise basis, including for lithium-ion batteries. "For cobalt, for example, the figure is 16 per cent from 2031, rising to 26 per cent from 2036." In the resource expert's view, the recycling of lithium-ion batteries will become increasingly worthwhile in future. "If electromobility continues to make inroads into the market, the stock of end-of-life batteries will also increase. According to projections, battery manufacturing will account for 25 per cent of global demand for nickel alone by 2030. Recycling of batteries that are used in Europe will continue to be carried out in Europe, as at present. Currently, however, large-scale recycling facilities are mainly located in China, due to the quantities of manufacturing scrap generated there."

With other metals used in vehicle manufacturing, such as iron, copper and aluminium, no statutory provisions on the use of secondary raw materials are currently in place. "They could be useful here as well," says Dr Johannes Klinge. "Other approaches are also expedient, such as those put forward in the Euro-

pean Commission's proposal for a new End-of-Life Vehicles Regulation: it will require manufacturers to provide detailed, user-friendly information on dismantling and recycling and also to make financial contributions towards improved management of end-of-life vehicles."

QUOTAS SUPPORT DECOUPLING

In principle, a requirement for manufacturers to incorporate a specific percentage share of recycled material into new products – a recycle input quota, in other words – is a valuable tool, according to the Oeko-Institut's expert. The researchers explain why, with reference to plastics, in a project entitled "Examination of concrete measures to increase the demand for recycled plastics and plastic products containing recycled materials", conducted in partnership with the Institute for Ecological Economy Research (IÖW) on behalf of the German Environment Agency (UBA). "If these quotas are introduced for specific plastic products, this safeguards demand for recycled material and also decouples the question of how much recyclate is used from the prices of primary plastics. These prices are still so low that recycling is often not economically viable at present." Recyclate input quotas can also create incentives for recycling companies to build capacity. "Due to the strongly fluctuating prices of primary plastics, there is often a lack of certainty for investment in the recyclates that compete with them. This certainty can be created by introducing a fixed recyclate input quota."

MORE INFORMED IN FUTURE

Urban mining is about making use of the existing anthropogenic stocks – but it is also about investing them more wisely in future. They are, after all, currently growing by around eight hundred million tonnes of materials annually. "For example, a first step is to produce building cadastres, which is what's happening in Heidelberg right now, so that in future, we know exactly which dormant resources exist and where," says Dr Johannes Klinge. "This is a sensible approach across all sectors. It may also be worthwhile to set up cassette landfills, for example, so that further down the line, we know exactly what is located where – and also to prevent raw materials from becoming contaminated with pollutants." Knowing where something is located is only part of the solution, however. Reusing it is a different matter – and far more difficult. "Urban mining is beset with challenges. But if it is done properly, it has the potential to be economically viable in many sectors in future, alongside its social and environmental benefits."

Christiane Weihe

Dr Johannes Klinge (formerly Betz) is a chemist in the Resources and Transport Division, where issues relating to resource consumption and recycling management are his main area of research. His work focuses on mining, raw material refining and lithium-ion battery and plastics recycling.
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Lead in the blood

Battery recycling in Nigeria

The lead smelting furnaces operated illegally. The soil was heavily contaminated with lead. Fires often broke out at the site. Local residents filed complaints about bodily harm and severe environmental pollution. That was in the mid-1980s – at a battery factory with the innocuous and hence highly misleading name "Sonnenschein", meaning "sunshine", in the heart of Berlin. Anyone who handles lead-acid batteries bears a heavy responsibility – and failure to fulfil it can cause serious health and environmental problems, as became apparent more than 40 years ago in Berlin's Mariendorf district and is evident in Nigeria's recycling industry today.

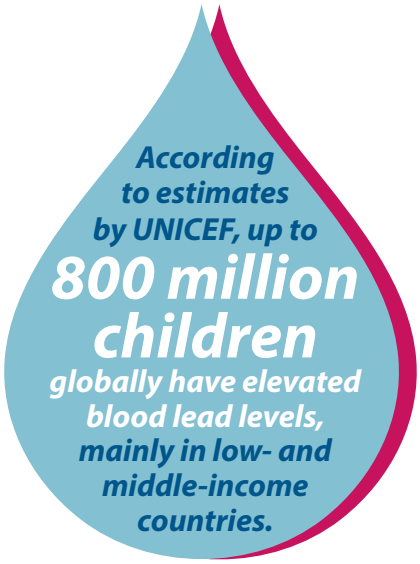
Lead-acid batteries are used in cars, off-grid solar applications and back-up power systems. "Safe, high-quality recycling of these batteries is already possible these days and can effectively recover up to 97 per cent of the raw materials," says Frederick Adjei from the Oeko-Institut. "Unfortunately, in Nigeria, recycling of these batteries often takes place in dangerous and unsafe conditions, exposing workers and neighbouring communities to toxic lead dust, while liquid effluent is discharged unfiltered. This can have serious impacts on health, including irreversible nerve damage and developmental delays in children." So why are elevated lead levels in soil and a poisoned population considered acceptable? "For the operators, it's mainly about profit maximisation. There is also a lack of robust standards and enforcement by the competent authorities."

Nigeria is the largest economy on the African continent. It has one of the largest lead-acid battery recycling industries, as well as the highest volume of used batteries. At least 10 facilities recycle lead-acid batteries on an industrial scale. "A substantial proportion of the secondary raw materials recovered in this way is exported – including to Europe. That's not something we can simply ignore," says Frederick Adjei, a researcher in the Oeko-Institut's Sustainable Products and Material Flows Division. "Unlike the situation in many other segments of the waste management industry, it is possible to make money here." However, competitive pressure means that very few operators act responsibly, with many aiming for profit maximisation – and this often seems to be at odds with protection of health and the environment. "In Nigeria, the circular economy plays an increasingly significant role, with substantial investment in some cases. But when systematic pollution and cases of poisoning came to light a few years ago, the authorities reacted: they set a target for battery recycling to be improved in line with international standards."

SHARED RESPONSIBILITY

So how can responsible recycling of batteries and metals be established in Nigeria and, indeed, in other countries in sub-Saharan Africa? This question is explored by the Partnership for Responsible Battery and Metal Recycling (ProBaMet) project, which is funded by GIZ's Initiative for Global Solidarity (IGS) until May 2025. "ProBaMet is a practical project which pursues a cooperative approach. We are working with numerous partners from Nigerian civil society and industry, the Nigerian Federal Ministry for Environment and the National Environmental Standards and Regulations Enforcement Agency," says Frederick Adjei. "It looks at how minimum standards can be established and enforced in recycling, thus protecting human communities and reducing environmental impacts. But it is also about establishing sustainable business models and creating high-value jobs in industry." This recognises that there is substantial demand for secondary raw materials, increasingly linked to whether compliance with minimum standards can be achieved. High-quality processes can thus deliver economic benefits. The project simultaneously involves the Nigerian solar industry: with the growth of a decentralised photovoltaics-based electricity supply, this industry needs sustainable solutions for end-of-life batteries.

The project team assists businesses and public authorities to introduce health, environmental and safety standards. It shares knowledge on environmental performance and workplace safety, delivers training with plant managers at the local level, and assists public authorities to adopt, monitor and enforce binding standards. "Knowledge transfer is a key element of the project: together with our partners, we build an understanding of the overall context, as well as sharing very practical everyday know-how." In April 2024, the researchers visited Nigeria and ran workshops with various stakeholders. "One of the aims was to provide information about current German and EU legislation, with a focus on supply chains." In addition, they visited six recycling plants in and around Ogun in south-west Nigeria. At five of these plants, major technical and operational weaknesses were identified that inevitably cause the release of lead dust into the workplace and the environment. "At these plants, there were no protective measures in place for the storage of the often already damaged batteries. What's more, dismantling was performed using very basic methods, directly exposing workers to lead and acid," Frederick Adjei explains. "There was also a lack of effective dust control systems on the factory floor." There was only one plant where the experts encountered much better conditions, including automated battery breaking and better handling overall. "But even here, there is still room for improvement – as regards protective clothing, for example."



At one of the plants, blood tests performed on workers revealed that they had greatly elevated lead levels. "The other plants don't do any blood testing at all, which violates the fundamental principles of good practice in this branch of industry." Alongside the enforcement of more robust standards in general, special safeguards and support must be provided for frontrunners in particular; otherwise, their chances of surviving the price competition in this sector are minimal, says Frederick Adjei. And in his view, company liability is also required, along with the possibility to sue for damages. "Companies will only take consistent action on protective measures once this becomes less expensive than paying for any damage that has been caused." However, the responsibility lies not only with the recycling companies, but also with manufacturers. "Anyone who earns money from a product should also ensure – in line with the principle of extended producer responsibility – that it is properly recycled."

A JUSTICE ISSUE

The waste industry in countries of the Global South – as elsewhere – is a source of raw materials, a sector that plays a key role for urban mining. But it is, simultaneously, much more than that. "The people who produce the least amount of waste here are the ones who suffer most as a result of poor management – as regards their health and their quality of life overall. Waste is therefore a justice issue as well." A functioning waste management industry is never just a source of raw materials, however; it is also a key service for society. "It's essential to think holistically about this sector. The revenue from sales of raw materials will not be sufficient, on its own, to get a grip on the waste problems in developing countries and emerging economies. Additional sources of funding are needed to provide targeted compensation for the costs of maintaining a clean environment. Product manufacturers and importers have a key role to play here, but in most African countries, they are rarely held accountable at present."

Christiane Weihe

Frederick Adjei graduated in Materials Engineering, Purchasing, Procurement/Acquisitions and Contracts Management, and Business Administration. After completing his studies, he was employed by GIZ Ghana and Bochum University of Applied Sciences, among others. In 2023, he joined the Oeko-Institut, where his areas of research include social and environmental standards in global supply chains, and global material cycles.
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