Electric and electronic scrap represents a growing share of plastic waste, but most of it is currently not recycled because of inappropriate collection schemes and difficulties in dealing with the harmful chemical substances they may contain.

In this event report, EURACTIV looks at ways of increasing the recycling of e-waste.
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Round half of plastic waste from electronic and electrical equipment (WEEE) is not properly collected or sorted in the EU, meaning it is not recycled at the end of the day, according to a new report.

This plastic ends up in general rubbish, goes to ill-suited recycling facilities or is exported outside the EU where they are often burnt without measures to control toxic emissions, says the report by SOFIES, a leading sustainability consulting firm.

Banning the export of WEEE plastics to third countries would greatly help reduce the presence of toxic chemicals in everyday products like food packaging, experts say.

Brominated flame retardants, a family of substances used to prevent computer plastics from catching fire, have been found in children's toys and food packaging, according to some environmental NGOs.

Although the levels are not of concern from a human health point of view, their potential presence in everyday products “is fairly well known,” said Dr Kevin Bradley, secretary-general of the International Bromine Council, a trade association.
“Experts and the Commission are aware of this, but don’t often talk about it,” he told EURACTIV.

“If we want to avoid situations where plastics containing legacy BFRs find their way back into products as has been occasionally evidenced by some NGOs, we need to ensure that WEEE and WEEE plastics are retained in the EU for proper treatment in accordance with the WEEE Directive or treated under appropriate equivalent conditions in third countries,” Bradley said.

**BROMINATED FLAME RETARDANTS**

The report, published on 18 November, looked into the impact of brominated flame retardants on the recycling of WEEE plastics. Approximately 2.6 million tons of WEEE plastics are generated annually in Europe, with plastics containing brominated flame retardants representing about 9% of this.

WEEE plastics contain a wide range of additives such as flame retardants, fillers, pigments and stabilisers which collectively impact the recycling of WEEE plastics. However, the presence of flame retardants doesn’t hinder recycling, with 55% of WEEE plastics entering facilities effectively recycled, the report found.

This is also why flame retardants are sometimes able to re-enter the plastic manufacturing chain and find their way back into new products such as children’s toys.

Brominated flame retardants are used to prevent fires in electronics. The most toxic were restricted in the 2000s and are now known as ‘legacy additives’. Others are still allowed, but have to be recycled with special processes.

However, only 2% are recycled. The remaining 98% are either incinerated or sent to cement kilns.

Recycling these plastics is made harder by competition from cheap virgin materials and producers cautious of restricted legacy additives and heavy metals that may be present in WEEE plastics.

Issues like low collection rates, poor intra-European movement and rapidly changing legislation make recycling WEEE plastics even harder.

As a result, “there are few investors willing to invest because of the instability and uncertainty relating to chemical waste and regulations, which are not harmonised and with many ongoing discussions, which just create this climate of uncertainty,” said Arthur Haarman, a consultant at SOFIES.

**RAISING THE THRESHOLD**

The European Commission has acknowledged those issues but has so far not been able to articulate an effective policy response.

“We are aware of the problems,” said Maria Banti, policy officer for WEEE at the European Commission’s environment department. “Practically speaking, some intra-EU movement will take place in any case, but we need to revise the rules in order to make it as simple as possible.”

The SOFIES report showed the presence of restricted brominated flame retardants have decreased significantly and Haarman called for the EU to reflect this by raising the threshold for bromine content to enable easier recycling.

Almost a decade ago, the CEN standard laid out the threshold between bromine poor plastics, which can be recycled, and bromine rich plastics, which have to be separated. With levels of restricted brominated flame retardants dropping, the industry wants this threshold raised.

“Today this safe level could be set at 6,000 ppm level. Basically, we think that the treatment requirements and the threshold should be reviewed in view of the trends in levels of restricted BFRs,” said Haarman, who was speaking at an event organised by the International Bromine Council.

The European Environmental Bureau, a green pressure group, said raising the threshold was “absolutely ludicrous” and goes against the Commission’s circular economy ambitions.

“Instead of preventing substances of concern from being blended into consumers products, industry lobbyists are pushing for more of the same,” said Stephane Arditi, director for circular economy at the EEB.

“This goes against growing calls for a phase out from civil society and even fire fighters who argue that flame retardants can do more harm than good. We should instead

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focus on safer and more effective alternatives such as smoke detectors and sprinklers, which unlike flame retardants, would give people enough time to escape a fire while avoiding potentially toxic dioxins,” he added.

To tackle the amount of WEEE plastics exported from the EU, experts say collection needs to be improved.

“Making sure that we collect all the WEEE and treat in line with the standards is the most effective way of reducing the substances of concern and restricted flame retardants,” said Chris Slijkhuis, General Manager of MGG Polymers and board member of the European Electronics Recyclers Association.

“If we really want to improve WEEE plastic recycling in Europe, we should really work on increasing collection rates to increase the quantities, also enforcing compliance with CEN standards and facilitating intra-European, cross-border shipments to state of the art WEEE plastics recycling facilities to ensure that the material is going where it should go,” Haarman said.

**PROMOTING A CIRCULAR ECONOMY**

WEEE is a growing waste stream with 11 million tonnes produced in Europe in 2020. Plastics make up 25% of this.

The Circular Plastics Alliance, an industry coalition, aims to reach 10 million tonnes of plastics recycled by 2025 and improving WEEE recycling will contribute towards that.

The recycling of WEEE feedstock uses less than 10% of the energy than virgin production and produces virgin-like quality, according to Slijkhuis.

“"We have a fantastic carbon footprint. We have super energy savings. So let’s make sure that we strike the right balance, an intelligent balance between the non-toxic world and the circular economy,” he said.

The Commission projects an increase in electronics production. Less than 42% are currently recycled in the EU and the Commission is looking to launch repair and take back schemes under its circular economy initiative.

“We need to support take back schemes to incentives consumers to return these unwanted devices and to bring them to specific WEEE collection points or repair facilities in order to give them a second life as a product or bring them to the recyclers for further treatment,” said Banti.
Around half of e-waste plastics are not recycled in Europe but rather shipped abroad where they often end up being dumped or burnt. Simpler laws on recycling in Europe would help keep those materials at home and recycle them, argues Chris Slijkhuis.

Chris Slijkhuis is General Manager of MGG Polymers and board member of the European Electronics Recyclers Association.

A recent report has shown that around half of WEEE plastics, are not entering proper recycling channels. So where are they going?

Until only a few years ago, most of these plastics disappeared from Europe. The majority went to China. At some stage, China realised that they were also importing environmental problems. On 1 January 2018, China banned the import of these plastics from Europe or from anywhere.

Many of these Chinese recyclers – and there were many of them – went to other places in the Far East. They went to Vietnam, and then Vietnam closed their doors, and they went to Malaysia, India, England and Serbia. In the past, I would think that something like one million tonnes of plastics went abroad. This is largely reduced by the China ban, but there are still exports.

What is the issue with WEEE plastics going to those countries?

Half of the material coming from electronics waste is not recyclable. The problem with these non-recyclable plastics is they can also have restricted additives, which the legislators do not
want anymore.

Now either, these recyclers use the plastics with the additives, which is not good, or they separate them. The good ones do that.

The majority of these Chinese recyclers, now also in Malaysia and in Vietnam, are tropical places, so they don’t have incinerators for recovering the heat and the energy from the plastics. What often happens is that, at best, they will be landfilled, but in smaller locations, you can imagine what has happened.

**How can the industry and the European Commission work together to prevent WEEE plastics leaving Europe?**

It’s going to be much more difficult. The Basel Convention two years ago took a decision, which I call the Norwegian proposal, which said in order to reduce marine litter, you have to make it more difficult for plastics to be transported anywhere.

They made a ruling that only pure plastics that have been recycled can cross borders, without any prior consent, without any controls. Every mixed plastic needs to be notified.

**The report also says that only 2% of WEEE plastics containing brominated flame retardant is currently recycled – how can that be improved? Can WEEE plastics ever become circular?**

WEEE plastics are circular already for a good proportion. If you take the whole cake of these plastics, shown in the report, only between 7-10% contain brominated flame retardants. That means that 90-93% is a material that does not have flame retardants.

The problems with the flame retardants is that a proportion are restricted substances. They cannot re-enter the circular economy. But we as a recycler cannot make the distinction between flame retardant Y and flame retardant Z. Y is prohibited and Z is permitted.

**So there will always be a certain amount of waste in this system?**

There’s always going to be a certain amount of waste. Many of these plastics are what I call ‘exotic plastics’. There are four types of plastics that are mainly used, but there is a whole lot of exotics, which are present in far too small percentages to be recycled.

**How do you prevent the issues with some brominated flame retardants returning in children’s toys or food packaging?**

This is one of the things that you often find in NGO reports. Toys are mainly produced in China. There is hardly any toy production in Europe and we, as European recyclers, at least in the company I am managing, have a very clear policy: recycled plastics cannot be used in toys and cannot be used for food contact.

There is also product legislation in Europe that prevents this. So, if there are flame retardants in plastics found in toys, you may safely assume that this material doesn’t come from Europe.

**Turning to the threshold, which the report recommends is raised from 2000 to 6000 ppm. The European Environment Bureau has called that “ludicrous” saying brominated flame retardants should be phased out completely – what is your response to that?**

Let’s face it, some electronic equipment creates heat. Plastic is a solidified oil. That can burn. For product safety, there is some legal requirement to add flame retardants.

The amount of restricted brominated flame retardants is continuously reducing, as they were restricted long ago. So when the EEB and NGOs say “all of brominated flame retardants are bad”, this is a mistake. We need to have flame retardants. There are a number of brominated flame retardants that can absolutely be used without any problem – they’re not restricted, they have no issues.

In 2014, when we did this first standard with 2000 ppm of bromine, we were absolutely certain that you we would not hit the threshold levels set by law for the restricted flame retardants. As the level of restricted flame retardants goes down in the waste, you can imagine that you’re still safe if you increase the bromine levels.

The mistake that EEB and some non-toxic NGOs are making is that they simply call all brominated flame retardants “hazardous stuff”, which is not correct. Let’s face it, bromine is a normal element in nature, you will find huge quantities in the sea for instance, and we need tiny amounts of it even in our food.

We fear that alternatives to brominated flame retardants might turn out to become regrettable substitutions, as any separations techniques still fail and as these might
result in degradation of the recycled materials eventually.

You previously raised the issue of lawmakers constantly changing regulations and making it hard to invest in recycling – how can there be one policy which is safe, but easier for recyclers?

It would be easy if we just had one chemicals legislation. I hoped when REACH was introduced in 2007 that we would indeed have one piece of legislation that regulates all substances.

We have a number of legislations all ruling the same substance. The same substance is discussed in REACH, but it’s also discussed in RoHS and in the POP regulation. At the same time, it’s discussed in the Basel Convention and in the Stockholm Convention on a global level.

What happened in 2017 is that, suddenly, the European Union had to implement the decision of the Stockholm Convention that deca-PBDE was a persistent organic pollutant, and the European Union had to set a threshold level for it. The Parliament – they take decisions on emotions, and not necessarily on facts – took the decision that it’s bad, we need to reduce it, let’s make it 10 ppm.

That 10 ppm means we cannot recycle anymore, because we cannot check this, there is no measurement system for it. You can send it to an external laboratory to do a very expensive analysis on it. But we as a recycler in our day-to-day operations, we cannot send every sample to an external laboratory, do an analysis of €1000 and then come back with the results.

We need to have something simpler. And this simpler method is what we call the XRF measurement system. This XRF measures only an element, in this case only bromine. This bromine measurement system is only validated for 1000 ppm. You can have lower readings, but the measurement is not validated, so it’s not necessarily what the reading says.

The European Commission wants a circular economy for plastics. How can recyclers do that?

Let’s take persistent organic pollutants regulation in Europe. The POP regulation was implemented and published in June 2019. What I find surreal is that even one year after this there was a big discussion in the Basel Convention. The Basel Convention came to the conclusion, ‘We have to discuss this again and, at the next Conference of Parties, we want to see if further reductions of these levels can be done.’

Well, this is an obligation for the European Union, so the European Union came back and set a new consultant at work to see what further reductions can be made. We are confronted, again, with the new discussion around the threshold levels of the same set of substances.

Of course, this makes people who want to invest in this industry very unhappy and uncertain. They don’t want to invest in an industry where even within the permitting time of the factory, you can come into a situation that you made the investment and now the investment can be stopped because we cannot do it anymore.

You mentioned the Norwegian proposals earlier, coming into force in 2021 – what is the impact of those on WEEE recycling?

On January 1 2021, the delegated act will be implemented, in which only clean plastics that will not create any further waste can be moved without any problem. Everything else needs to have a notification. There is a third category that is not only mixed, but also mixed and contaminated plastics, which are then called hazardous waste, which needs to have a notification as well.

The problem with a classification as hazardous material is that most recyclers of WEEE plastics in Europe, do not have a permit to take in hazardous waste. The delegated act, as it is now, doesn’t really make a statement on whether plastics with brominated flame retardants are considered hazardous material.

What we, as an industry asked for, is WEEE plastics, always containing some brominated flame retardants, requiring a notification anyway, can be transported as mixed plastics.
How is Bromine a Circular Economy enabler? [BSEF]

Brominated flame retardants (BFRs) are used in plastics materials in electrical and electronic products to aid fire safety by reducing their propensity for ignition. This not only means a contribution to saving lives, but also products and property, thus preventing waste of resources.

The International Bromine Council (BSEF) is the voice of the bromine technology industry globally.

In the EU, the WEEE Directive (EU 2012/19/EC) requires that plastics from electrical and electronic products are subject to recycling to recover different valuable technical plastics for use again in new plastic parts and components.

The Directive further requires the segregation and separate treatment of BFR-containing plastics in order to ensure that restricted substances (four specific BFR substances restricted under RoHS) are removed from the material stream and destroyed. The WEEE CEN Standards provide the basis for recyclers to achieve this and ensure that plastics being used again do not contain legacy BFRs.

Plastics with BFRs have excellent stability during recycling which allows recycled plastics to meet the same levels of fire safety as virgin material and maintains the value originally provided by flame retardants in the
material. Despite this, recycling of BFR containing plastics, is perceived as problematic with some stakeholders saying they impact the yield from plastics recycling.

**DO BFRS HINDERING RECYCLING OF PLASTICS?**

To respond to these concerns and to understand the factual situation in the EU, BSEF commissioned the consultancy SOFIES to undertake a study on BFR-containing Plastics and WEEE recycling in 2020.

The results of this study reveal that BFR additives or BFR-containing plastics are not hindering plastics recycling nor are they the substantive factor when it comes to plastics yield from end of life WEEE plastics recycling. Key findings include:

- 6 million tons of WEEE plastics are generated annually, mainly comprised of PP (20% of total), ABS (19%), (Hi)PS (18%) and PC/PC-ABS (7%). Brominated plastics represent about 9% of the total, mainly BFR ABS (4%), BFR Epoxy (3%) and BFR HIPS (1%). The remaining 27% includes other engineering polymers used in electrical and electronic equipment.

- WEEE plastics contain significant loads of additives, whether fillers, flame retardants, plasticizers or others, and as such all plastics with these elements (45% of the total) must be sorted out prior to recycling and are sent for incineration or to cement kilns.

- on average, 55% of WEEE plastics entering WEEE plastic recycling facilities will actually be turned into regranulates. This yield is mainly influenced by the composition of WEE plastics, particularly the share of target polymers (PP, PE, ABS, PS and eventually PC-ABS) as well as the densimetric profile.

- the levels of legacy BFRs as a share of total BFRs in WEEE plastics have decreased significantly over the last ten years, demonstrating the positive effect and efforts undertaken by the industry to phase out these legacy BFR PBDE levels can be expected to further decrease in the coming years.

- 98% of BFR plastics collected can be separated and disposed of through official WEEE recycling channels demonstrating the effectiveness of the WEEE CEN standards in aiding the treatment of WEEE plastics.

An important challenge to address based on the SOFIES findings, is how to extract more value from the 45% of plastics that are currently incinerated or sent to cement kilns. New, innovative chemical and dissolution recycling technologies (e.g. pyrolysis) are emerging which can address this issue and ensure more recovery of plastic resins and their reuse in new plastics products. The report and its recommendations have been shared with EU policy makers as contribution to the debate on improving plastics recycling generally.

**INNOVATING TO SUPPORT THE CIRCULAR ECONOMY**

As part of its [global Circular Economy Action Plan](#), BSEF and its member companies are engaged in several projects to improve end of life recycling of materials containing brominated flame retardants (BFRs). For instance, BSEF along with the North American Flame Retardant Alliance (NAFRA) and its member companies are supporting an exciting new approach to sorting and separating legacy BFRs from non-restricted BFRs using novel blockchain technology.

The [pilot project](#) involves a chemical-based hidden “barcode” system, alongside a unique “reader” to identify these codes. These codes will enable a blockchain record to be developed to store and protect ownership data.

The bromine industry and its value chain are also innovating the way it helps manage plastics with legacy chemicals. One example of this is the EU LIFE co-funded Polystyrene Loop Project[3]. The project involves using CreaSolv® technology for the recycling of post-consumer construction polystyrene foam waste, the destruction of HBCD (a POP under the Stockholm Convention), while recovering the bromine. This technology can also be applied to WEEE plastics containing BFRs and other additives.

**CONCLUDING REMARKS**

The bromine industry is committed to working closely with policy makers, regulatory authorities, its value chains and other stakeholders to encourage further sustainable end of life solutions across the different applications of bromine. Some solutions are easily or more readily available and achievable. Others will take time and require both innovation as well as pragmatism in terms of what is realistically feasible.
1. Article 8.5 of the WEEE Directive 2012/19/EU requires the establishment of standards for the collection, treatment and re-use of waste electrical and electronic equipment. These standards are published by CEN as a series - 50625. S.R.CL/TS 50625-3-1:2015 addresses inter alia treatment of bromine containing plastics.
