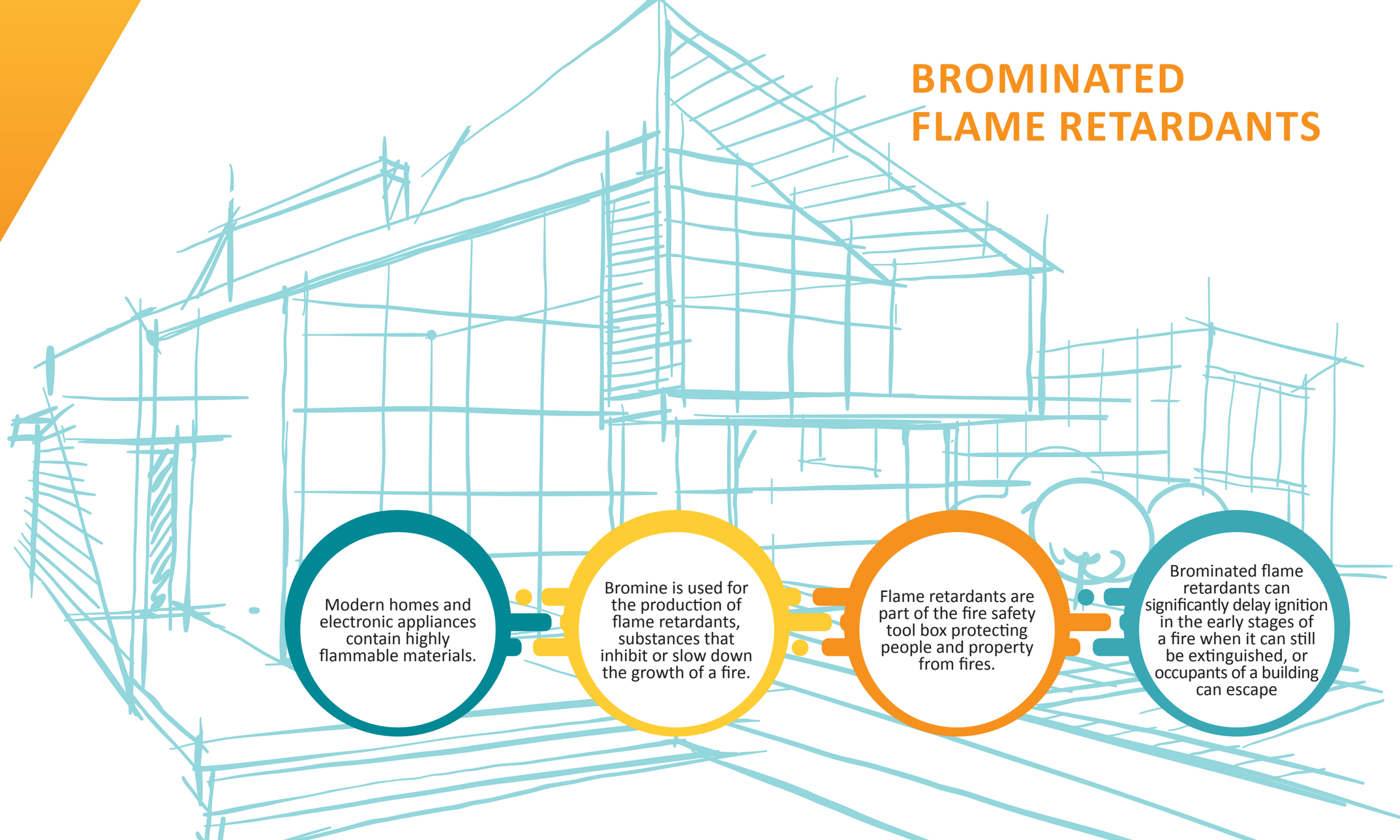
November 2020

Impact of Brominated Flame Retardants on the Recycling of WEEE plastics

BSEF
The International Bromine Council
www.bsef.org

BROMINATED FLAME RETARDANTS



Modern homes and electronic appliances contain highly flammable materials.

Bromine is used for the production of flame retardants, substances that inhibit or slow down the growth of a fire.

Flame retardants are part of the fire safety tool box protecting people and property from fires.

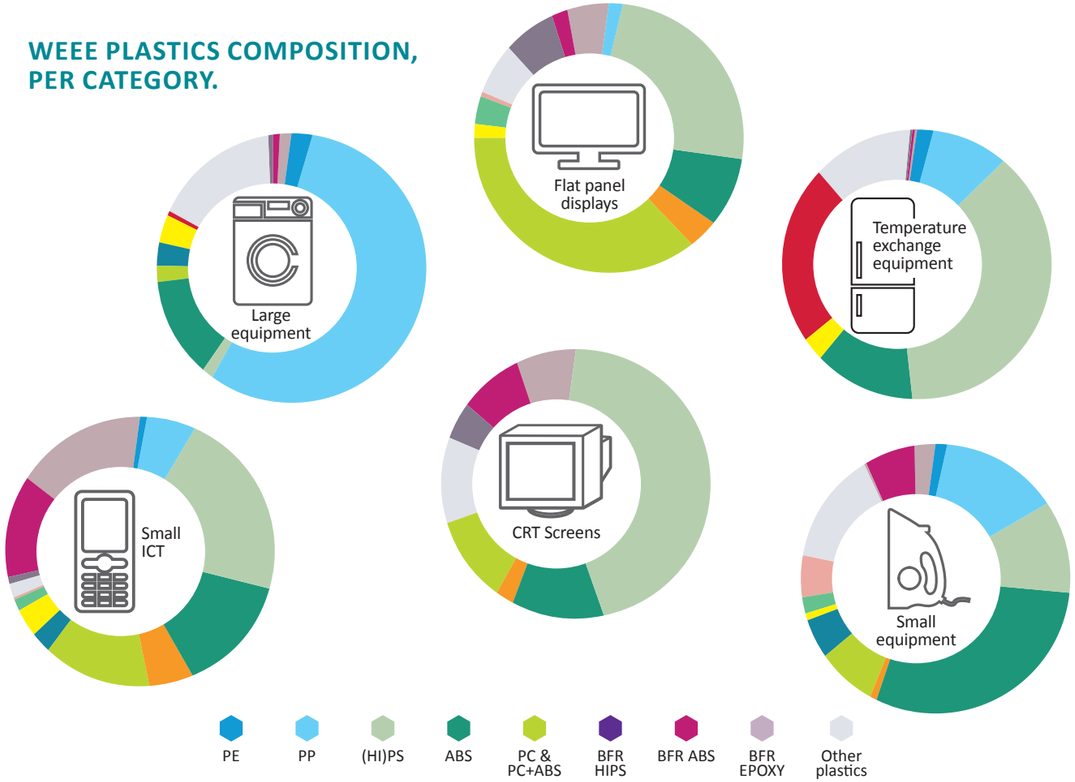
Brominated flame retardants can significantly delay ignition in the early stages of a fire when it can still be extinguished, or occupants of a building can escape

WEEE PLASTICS AND THE CIRCULAR ECONOMY

In December 2018 the European Commission launched the Circular Plastic Alliance with the aim of boosting the EU market for recycled plastic with an initial pledge of 10 million tonnes by 2025 and with more than 230 signatories to date.
This initiative is also seen as a contribution to the EU Circular Economy Action Plan launched in January 2020.

Electronic equipment is not only one of the key waste streams identified in the Circular Economy Action Plan, but also represents a relevant source of plastic waste: approximately 25% by weight of Waste Electrical and Electronic Equipment (WEEE) consists of plastics in the form of various polymers (mainly ABS, PP, PS and PC-ABS). Such plastics however contains a wide range of additives such as flame retardants, fillers, pigments and stabilisers which collectively impact the recycling of WEEE plastics.

WEEE PLASTICS COMPOSITION, PER CATEGORY.



FATE OF WEEE PLASTICS IN EUROPE

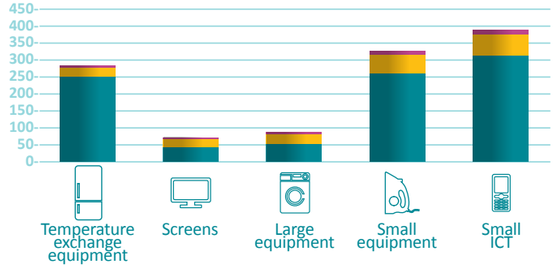
Nowadays approximately **2.6 million tons of WEEE plastics are generated annually in Europe**; Plastic **containing Brominated Flame Retardants (BFR) is representing about 9% of the total**. Restricted BFRs (e.g. Octa-BDE and Deca-BDE) only represent a small and rapidly declining fraction of all BFRs found in WEEE plastic streams reflecting the restriction on the use of these substances for more than a decade (2003 for Octa-BDE, 2008 for Deca-BDE).

Unfortunately, around **half of all WEEE plastics** generated in Europe **do not enter official WEEE collection channels**, ending up in the waste bin, processed at substandard recycling facilities, or exported.

Out of the **1.3 million tons of WEEE plastics officially collected**, **about 1 million tons is sent to specialized WEEE plastics recycling facilities** (or integrated smelters in the case of epoxy contained in printed circuit boards). The remaining **300 kt is either sent to incineration** or, rarely, landfilling after WEEE pre-processing, or lost into metal fractions as a result of sorting inefficiencies.

DESTINATION OF WEEE PLASTICS IN WEEE COLLECTED (kt)

- Sent for plastic recycling
- Sent for incineration/lost in metal fractions
- Sent for landfilling



THE WEEE PLASTICS RECYCLING PROCESS

Specialized WEEE plastic recycling facilities apply a series of sorting stages that typically include a stepwise **density separation**, which uses differences in density of WEEE plastics to create more homogeneous fractions. Low- and medium-density fractions are further separated (e.g. through electrostatic separation) to produce pure PP, PE, ABS and PS fractions that can be turned into regranulates. The **high-density** fraction contains a complex mixture of **heavy plastics and various additives**. Its high heterogeneity makes it unsuitable for recycling and it is therefore disposed of by incineration, co-processing in cement kilns or landfilling.

This **high-density fraction** contains **more than 95% of the original BFR** content (as BFRs significantly increase the density of plastics containing them) but also various additives (mineral fillers, phosphorus FRs, etc.) and heavy polymers (such as PVC, PET, PC, Nylon, etc.).

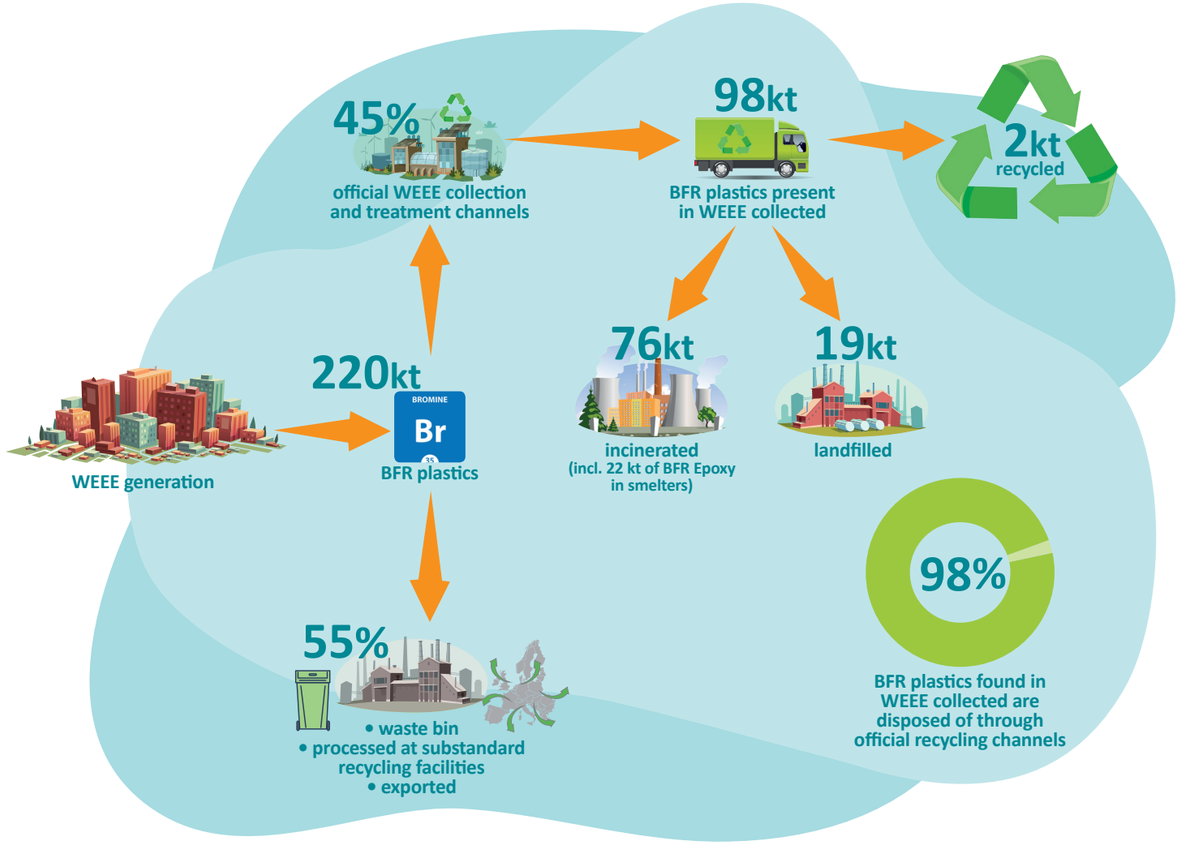
Overall, **about 55% WEEE plastics entering WEEE plastic recycling facilities are effectively recycled**, i.e. turned into regranulates that can be used in the manufacture of new plastics products. **This recycling yield would not be improved by a switch to non-brominated flame retardants**, as other FRs would also be sorted out for disposal during the conventional density-based recycling process.

Interviews and feedback from WEEE plastic recyclers confirmed that BFR plastics represent nowadays a well-controlled stream, which is easily sorted out during conventional and industrial recycling processes. They are therefore not a hindrance in of themselves to the recycling of WEEE plastics.

Concerns were however expressed by WEEE plastic recyclers on the poorly documented but potentially serious impacts of some of the other FRs on the recycling of WEEE plastics. Some of the most widely used other FRs, organophosphates, are for instance known to negatively impact the recyclability of WEEE plastics due to chemical degradation during processing.

FATE OF BFR PLASTICS

Some 220 kilotons (kt) of BFR plastics can be found in WEEE arising annually in Europe, of which only 45% enter official WEEE collection and treatment channels. The remaining 55% are found in WEEE thrown in the waste bin, processed at substandard recycling facilities, or exported. Out of the 98 kt of BFR plastics present in WEEE collected, 76 kt are incinerated (incl. 22 kt of BFR Epoxy in smelters), 19 kt landfilled and only 2 kt are recycled, representing 2% of the BFR plastics originally found in WEEE collected.
In other words, 98% of BFR plastics collected can be currently separated and disposed of through official WEEE recycling channels. However, 55% of all BFR plastics generated are not actually entering these channels, as a result of improper sorting of WEEE by consumers or substandard WEEE treatment practices.



REQUIREMENTS FOR BFR PLASTICS SEPARATION

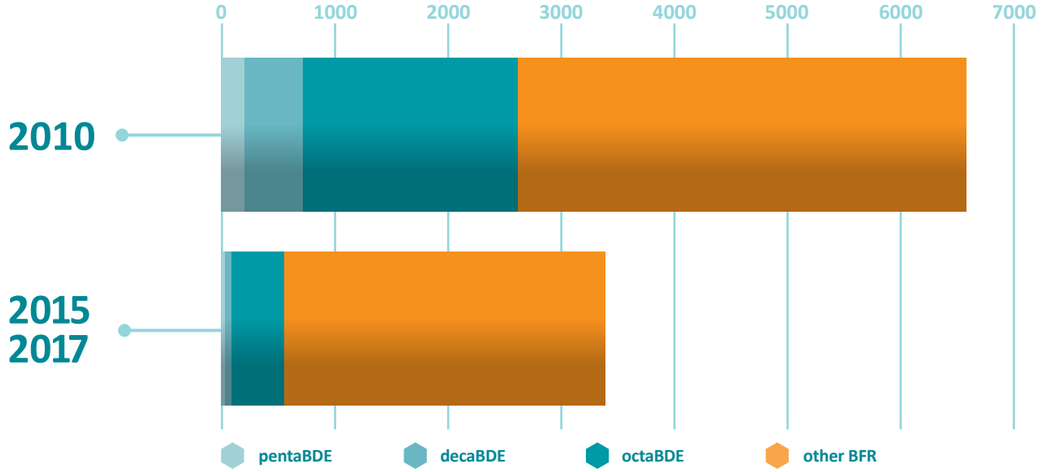
The **WEEE Directive** requires the segregation of plastics containing restricted BFRs during the treatment of WEEE, and the **CEN standard** on WEEE treatment (EN 50625) specifies the modalities of this segregation. Plastics from screens and small appliances must undergo a BFR separation method able to separate a Br-poor fraction that can be recycled, and a Br-rich fraction that shall be disposed of.

An **operational threshold of 2,000 ppm* total bromine** was introduced to enable separation of BFR-containing plastics in operational settings, since plastic sorting technologies cannot distinguish between restricted and non-restricted BFRs.

When it was defined, this 2,000 ppm* threshold corresponded to a total Br level below which exceedance of the limit values for restricted BFRs was statistically unlikely, due to the fact that restricted BFRs only represented a small share of the total Br content (about 40% in 2010). Since then, this share further decreased (to about 15% in 2017) which calls for a revision of the 2,000 ppm threshold. **Recent analytical data indeed suggests that current limit values for restricted BFRs would not be exceeded even with a threshold as high as 6,000 ppm Br**. An increase of this threshold will have the immediate effect of reducing the volume of WEEE plastics that need to be separated prior to recycling, thus **increasing WEEE plastics recycling yields**.

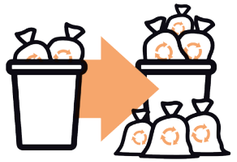
*parts per million (1% = 10'000 ppm)

Average BFR levels (ppm) in WEEE plastics



CONCLUSIONS

POLICYMAKERS:



Increase the quantities of WEEE plastics reaching specialized WEEE plastic facilities by raising WEEE collection rates, enforcing compliance with EN 50625 standards, and facilitating intra-EU cross-border shipments towards state-of-the-art WEEE plastic recycling facilities (for instance by classifying shredded WEEE fractions as non-hazardous).

Investigate the impacts of alternative FRs on the recyclability of WEEE plastics to avoid "regrettable substitution" effects that could prove detrimental to WEEE plastics recycling performance.

Improve the knowledge base necessary for evidence-based policies and decisions by regularly collecting and analysing representative data on levels of BFRs and other additives in WEEE plastic streams.

Consider a review of the relevance of normative requirements on treatment of BFR-containing WEEE plastics (WEEE Directive and related limit value of 2,000 ppm in EN 50625) considering the reduction of restricted BFR levels over time.

Harmonize and ensure stability of legislation of chemical, waste and products having a direct impact on WEEE plastic recycling, to facilitate much needed investment in innovative recycling technologies.

PRODUCERS:

Adopt and implement recycled content targets to boost demand for WEEE plastic recyclates and decouple from virgin plastic prices.

Exchange with WEEE plastics recyclers in order to understand how the choice of polymers and additives influence the recyclability of plastics, and on this basis select polymers (and additives) used in the manufacture of EEE considering the extent to which they are currently recycled.

RECYCLERS:

Develop innovative sorting and recycling methods to recover a higher share of plastics, enabling for instance the recovery of PC-ABS, PA, or PBT polymers.

Seek long-lasting partnerships with producers to optimize design for and from recycling.

BROMINE
Br
35

Bromine's symbol is Br. It is part of the halogen group of the periodic table.
Bromine is a reddish brown liquid. It is never naturally found in its elemental form but in inorganic compounds, known also as bromides, and in natural bromo-organic compounds. These are found in soils, salts, air and sea water.

BSEF

BSEF – the International Bromine Council, represents the major global bromine producers. Since 1997, the organisation has been working to foster knowledge on the uses and benefits of bromine-based solutions.
BSEF strongly believes in science and innovation. Through investments in research and development BSEF members create robust bromine-based technologies meeting the needs of society

OUR MEMBERS

BSEF champions bromine's many benefits around the world. Bromine-based solutions are essential to many of the most important advancements in science and technology.
The members of BSEF are Albermarle Corporation, ICL Industrial Products, Lanxess and Tosoh Corporation.

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